National Marine Sanctuaries ™

Gerry E. Studds
Stellwagen Bank

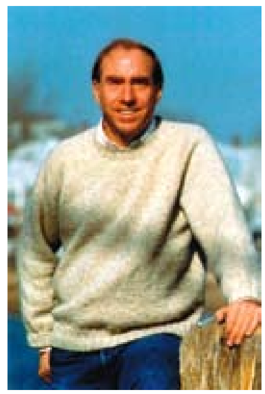
Draft Management Plan

and Environmental Assessment

April 2008

STELLWAGEN BANK
NATIONAL MARINE SANCTUARY

In Memoriam



Gerry E. Studds
1937–2006

Gerry Eastman Studds, former Congressman from the Massachusetts 10th District (1973–1996) and tenacious advocate for the ocean. Congressman Studds authored the National Marine Sanctuaries Reauthorization and Improvement Act of 1992, which officially designated the Stellwagen Bank National Marine Sanctuary. His legacy lives on in the sanctuary's research, education and conservation efforts, as well as in the vast array of marine legislation that he eloquently supported. In honor of his dedication to marine issues, Congress renamed the sanctuary the Gerry E. Studds Stellwagen Bank National Marine Sanctuary during the 1996 reauthorization of the Sanctuaries Act.

Stellwagen Bank National Marine Sanctuary

Draft Management Plan and Environmental Assessment

April 2008

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About This Document

This document is the revised draft management plan and environmental assessment for the Stellwagen Bank National Marine Sanctuary. The public is encouraged to provide comment on this document. When final, this plan will chart the course for the sanctuary over the next five years.

Comments or questions on this management plan should be directed to:

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Executive Summary

Overview

The Stellwagen Bank National Marine Sanctuary (SBNMS or sanctuary) stretches between Cape Ann and Cape Cod at the mouth of Massachusetts Bay in the southwestern corner of the Gulf of Maine. Virtually the size of the state of Rhode Island and located wholly within federal waters, sanctuary boundaries include the submerged lands of Stellwagen Bank, all of Tillies Bank and Basin, and the southern portions of Jeffrey's Ledge. The sanctuary protects 842-square miles (638 square nautical miles) of open-ocean, overlaying a diverse seafloor topography and array of benthic and pelagic habitats that support biological communities broadly representative of the Gulf of Maine.

The sanctuary mission is to conserve, protect and enhance the biological diversity, ecological integrity and cultural legacy of the sanctuary while facilitating uses that are compatible with the primary goal of resource protection. When Congress designated the sanctuary in 1992, it did so to recognize the nationally significant conservation and aesthetic qualities of the site. Congress directed that the sanctuary be managed to maintain the habitats and ecological services of the natural assemblage of living resources of the area, as well as its maritime heritage resources. The Stellwagen Bank sanctuary is the only federal entity mandated to conserve biological diversity and protect maritime heritage resources in the offshore waters of the Gulf of Maine.

The management plan review process is, in essence, an exploration and rediscovery of the sanctuary. It is a journey across earlier decades of scientific monitoring and analysis, leading to the directed research and evaluation of the moment. It draws upon a foundation of over 670 source documents, most of which are peer-reviewed scientific papers published in reputable professional journals. It is a quest for facts and findings, culminating in the up-to-date synthesis and characterization of the resources and human uses of the sanctuary today. It is a public collaboration of immense proportion, involving comments from over 20,000 concerned citizens, more than 300 individuals participating in scoping meetings, and over 200 people serving on issue-driven working groups. The entire process was coordinated with, and reviewed by, the 45 members and alternates on the Stellwagen Bank Sanctuary Advisory Council holding appointments during 2002-2006 and offering representation from Connecticut to Maine.

The Stellwagen Bank sanctuary was designated for a multitude of reasons, not the least of which was its long history of human use and its high natural productivity and resource diversity. The historic exploitation of the whales and fish on Stellwagen Bank and vicinity helped forge a cultural tradition that is difficult to perpetuate today as a result of overfishing, habitat destruction and rapid transformation of the region's economy. The modern appreciation for these resources requires that they be protected for their intrinsic value, multiple ecosystem services, and recreational and ecotourism importance, while facilitating uses (including fish and seafood production) that are environmentally sustainable and compatible with the widely recognized need and Congressional mandate for resource protection.

The environmental condition of the sanctuary is subject to major alterations that are largely due to the effects of human activities. The basic diversity of marine life and the patterns and processes that control the distribution and abundance of marine organisms in the sanctuary is still not well understood. Yet, conserving this biodiversity is central to the implementation of ecosystem-based sanctuary management, an evolving approach that stresses the management of the entire sanctuary ecosystem including all biological communities, habitats and species populations, together with all compatible uses. Comprehending the great importance of marine biodiversity, and the need to maintain ecological complexity in the sanctuary, this draft management plan is based on the concept of managing marine resources for biodiversity conservation.

Key Findings

There are well over 575 known species in the sanctuary and the list is largely incomplete. Living landscapes (anemone forests, sponge gardens, hydroid meadows, worm tube beds) carpet the seafloor and the associated marine communities support benthic and pelagic species that are dependent upon them. The number of invertebrate species that constitute these landscape features remains to be adequately counted. Water column and seafloor habitats sustain over 80 species of fish and provide important feeding and nursery grounds for 22 marine mammal species, including the endangered humpback, fin and sei whales and the critically endangered North Atlantic right whale. The area supports foraging activity by 34 species of seabirds, dominated by gulls, storm petrels, gannets, auks (alcids), sea ducks and shearwaters. Four species of endangered or threatened sea turtles are known to frequent the area. Numerous shipwrecks occur throughout the sanctuary, encapsulating the rich maritime history of the place.

The sanctuary is a hotspot for prey abundance, which is what ultimately attracts the whales, sustains the fish, seabirds and other wildlife, and supports the economic viability of most current uses in the sanctuary. Key prey species include sand lance (small semi-pelagic fish), herring and planktonic copepods. Sand lance numbers in the sanctuary are the highest and most concentrated anywhere in the southern Gulf of Maine and the sanctuary is in an area of high relative abundance of herring. Accordingly, the sanctuary is one of the most intensively used whale habitats in the northeast continental region of the U.S. The World Wildlife Fund and *USA TODAY* named Stellwagen Bank and vicinity one of the top ten premiere places in the world to watch whales. The readers of *Offshore* magazine voted Stellwagen Bank the best place to watch wildlife and the number three favorite recreational fishing spot in the northeastern U.S.

However, fishing—especially commercial fishing—impacts and pressures every resource state in the sanctuary. On an annual basis, virtually every square kilometer of the sanctuary is physically disturbed by fishing. Fishing has removed almost all of the big old growth individuals among biologically important fish populations and reshaped biological communities and habitats in the process. Commercial fishing lands 17.0 million pounds to 18.4 million pounds of fish and crustaceans from the sanctuary each year on average (1996-2005), yet discards approximately 23% of the total catch as bycatch (based on 2002/2003 estimates). The part of the catch from the sanctuary that actually is landed amounts to 1.9%–2.8% of the total New England landings value for all northeast fisheries. Fishing removes 3,200 metric tons of herring from the sanctuary each year on average, an amount sufficient to potentially deplete the forage base for whales and other sanctuary wildlife. The area in and around the sanctuary has the highest use of fixed gear vessels anywhere along the eastern seaboard of the U.S., and the sanctuary area has the highest number (41%) of reported whale entanglements in the Gulf of Maine. Fishing gear fouls eleven of eighteen known historic shipwreck sites in the sanctuary, which also display evidence of damage by gear impacts.

The sanctuary receives more commercial shipping traffic than any other location within U.S. jurisdiction in the Gulf of Maine and approximately ten percent of the vessel/whale collisions recorded world-wide is reported from the sanctuary area. The annual mean and maximum operating speeds of whale watch boats in the sanctuary doubled between 1980–1987 and 1998–2004, as did their annual rate of whale strikes. The overall level of non-compliance with NOAA whale watch guidelines, based on the distance traveled by the whale watch boats, was 78%. The sanctuary seems prone to biological invasion by exotic species. This is based on factors associated with community maturity and niche opportunities created by a history of lowered species diversity and extensive chronic habitat disturbance by fishing, together with the sanctuary's location amid extensive commercial shipping traffic that can serve as primary vectors for the introduction of exotics from hull bottoms and ballast water. Harmful algal blooms and degraded water quality continue to be concerns with expanding coastal development and increasing urbanization in the region, coupled with unrelenting population growth and commensurate waste management needs. Creeping industrialization along the western boundary of the sanctuary in the form of deepwater LNG ports may lead to chronic underwater noise affecting sanctuary resources in virtual perpetuity. Over half of all resource condition categories (10 of 17) evaluated for the sanctuary had fair through poor ratings. The general trend for habitat and living resources appears to be static and in need of improvement.

Management Plan

This document provides the basis to consider how things should be done differently to improve the resource conditions of the sanctuary, since that is what the findings indicate is needed. The Sanctuary Advisory Council provides a vision for the future that contrasts the current conditions in the sanctuary:

> *"The Stellwagen Bank National Marine Sanctuary is teeming with a great diversity and abundance of marine life, supported by diverse, healthy habitats in clean ocean waters. The ecological integrity of the sanctuary is protected and fully restored for current and future generations. Human uses are diverse and compatible with maintaining natural and cultural resources."*

The management plan represents the first step toward achieving this vision.

This draft management plan serves as a non-regulatory policy framework for addressing the issues facing the Stellwagen Bank sanctuary over the next five years. It lays the foundation for restoring and protecting the sanctuary's ecosystem. It details the human pressures that threaten the qualities and resources of the sanctuary. It recommends actions that should be taken now, and some that should be considered in the near future, for restoring and protecting this special place.

At this time, NOAA is not proposing any regulations or changes to the Stellwagen Bank sanctuary designation document. However, several regulatory initiatives that derive from the strategies presented in the draft management plan ultimately could be considered for action prior to the next management plan review nominally scheduled for 2013. These include: management of whale watching, maritime heritage resources management, preventing local depletion of key forage species, and instituting requirements for habitat zoning and compatibility analysis. These initiatives may necessitate that the designation document be amended.

This document provides strategic guidance for management actions and focuses those actions on four priority programmatic areas: capacity building, ecosystem protection, marine mammal protection and maritime heritage management. NOAA is focusing on these priority areas because they will significantly contribute to achieving the vision and mission of the sanctuary. The eleven action plans in this document address issues relative to these four areas and are based extensively on the advice of working groups established by the Sanctuary Advisory Council.

The public is invited and encouraged to comment on this draft management plan. Comments may be submitted in writing to Dr. Craig MacDonald, Sanctuary Superintendent, Stellwagen Bank National Marine Sanctuary, 175 Edward Foster Rd., Scituate, MA 02066 or by facsimile to (781) 545-8036. For information on the open comment period, or to obtain a copy of the draft management plan, please call (781) 545-8026 or send an email to sbplan@noaa.gov. Copies of this document may be downloaded from the internet at http://stellwagen.noaa.gov/management.

Organization of this Document

The draft management plan is organized into ten principal sections.

Section I provides background information on the national marine sanctuaries and the management plan review process.

Section II is an overview of the institutional setting within which the sanctuary operates.

Section III presents the sanctuary setting. This section is divided into three sub-sections: biodiversity conservation; physical setting, including geography, geology, and oceanography; and primary producers and decomposers.

Section IV describes the resource states of the sanctuary and provides context and foundation for the action plans in Section VII. This section is divided into eight sub-sections: seafloor and water column habitats, benthic invertebrates, fishes, seabirds, sea turtles, marine mammals, and maritime heritage resources.

Section V discusses the kinds and status of human use and the economic value where available.

Section VI is a summation of the effects of human uses on sanctuary resources including a discussion of cumulative impacts.

Section VII contains the action plans, which detail the management actions the sanctuary will take to address priority issues and meet the purposes and policies of the National Marine Sanctuaries Act.

Section VIII provides an environmental assessment of the two alternatives considered: no action and revising the management plan.

Section IX lists the sources and literature cited in this document.

Section X includes a number of appendices, which provide supporting information on various aspects of this draft management plan.

The sanctuary management objectives, included in this draft management plan, are organized by priority programmatic area and their respective action plan in the list that follows.

Capacity Building

Administrative Capacity and Infrastructure Action Plan

ADMIN.1 Improve Site Staffing and Support Capabilities for SBNMS Programs

ADMIN.2 Maintain and Enhance the Infrastructure of the Site

ADMIN.3 Develop a SBNMS Volunteer Organization to Support Sanctuary Programs and Enhance Site Visibility

Interagency Cooperation Action Plan

IC.1 Facilitate Cooperation and Coordination Between Agencies

IC.2 Establish Mechanisms for Improving Information Sharing

Public Outreach and Education Action Plan

POE.1 Improve Outreach and Education Capacity to Increase Sanctuary Visibility, Awareness, and Stewardship

POE.2 Improve Capacity for Formal and Informal Education Programs that Support Management Goals

Compatibility Determination Action Plan

CD.1 Develop a Framework for Sanctuary Compatibility Determination

Ecosystem Protection

Ecosystem-Based Sanctuary Management Action Plan

EBSM.1 Establish a Science Review Protocol

EBSM.2 Establish an Information Management System

EBSM.3 Understand Ecosystem Structure and Function

EBSM.4 Protect Ecological Integrity

EBSM.5 Evaluate the Need and Feasibility of Modifying the Sanctuary Boundary

Ecosystem Alteration Action Plan

EA.1 Reduce Impacts of Laying Cables and Pipelines

EA.2 Reduce Alteration of Benthic Habitat by Mobile Fishing

EA.3 Reduce Impacts of Biomass Removal by Fishing Activity

Water Quality Action Plan

WQ.1 Assess Water Quality and Circulation

WQ.2 Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary

Marine Mammal Protection

Marine Mammal Behavioral Disturbance Action Plan

MMBD.1 Reduce Marine Mammal Behavioral Disturbance by Vessels

MMBD.2 Reduce Marine Mammal Behavioral Disturbance by Noise

MMBD.3 Reduce Marine Mammal Behavioral Disturbance by Aircraft

Marine Mammal Vessel Strike Action Plan

MMVS.1 Reduce the Risk of Vessel Strike Between Large Commercial Ships and Whales

MMVS.2 Reduce the Risk of Vessel Strike Through Speed Restrictions

MMVS.3 Support and Develop Research Programs to Reduce the Risk of Vessel Strikes

Marine Mammal Entanglement Action Plan

MME.1 Aid Disentanglement Efforts

MME.2 Reduce Marine Mammal Interaction with the Trap/Pot Fishery

MME.3 Reduce Marine Mammal Interaction with the Gillnet Fishery

Maritime Heritage Management

Maritime Heritage Management Action Plan

MH.1 Establish a Maritime Heritage Program

MH.2 Inventory, Assess and Characterize Historical Resources

MH.3 Protect and Manage Historical Resources

MH.4 Develop and Implement a MH Outreach and Education Program

MH.5 Assess Shipwrecks and Other Submerged Objects for Potential Hazards

ACKNOWLEDGEMENTS

This draft management plan was written and compiled by:

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From 2002-2006, the Sanctuary Advisory Council was instrumental in the development of this draft management plan. NOAA acknowledges and thanks the Advisory Council representatives for their individual and collective contributions to this process. The following members of the Advisory Council are acknowledged for chairing the working groups that led to development of the action plans in this document: Regina Asmutis-Silvia, Susan Farady, Alan (Jerry) Hill, Porter Hoagland, Ph.D., Judith Pederson, Ph.D., Mason Weinrich, Richard Wheeler, John Williamson and Sally Yozell. NOAA also acknowledges and thanks the many members of these working groups. The early foundation for this management plan review was laid during 1998-1999 by Brad Barr, former Sanctuary Superintendent, and the previous Advisory Council (1996-2000), and is recognized.

The National Marine Sanctuary Program staff gratefully acknowledge the enormous assistance provided by the NOAA Fisheries Service Northeast Regional Office and Northeast Fisheries Science Center for access to the numerous and extensive databases that underlay many of the analyses in this management plan, for the many agency scientists and managers who devoted considerable time serving on the working groups as members and technical advisors, and for collaboration with sanctuary staff on several key research projects conducted to inform sanctuary management. Related assistance was provided by local and State agency partners, which also is acknowledged. The Sanctuary Program's collaboration with NOAA's National Centers for Coastal Ocean Science yielded substantial information to characterize the sanctuary's ecological setting, and is acknowledged.

Photography and Art Credits

Section I. Captain Henry S. Stellwagen—Courtesy of the Stellwagen Family

Section II. Smooth sunstar on seafloor—Credit: USGS

Section III. Northern red anemone and American lobster—Credit: USGS

Section IV. Squid and starfish on mud habitat—Credit: USGS

Section V. Sand lance over gravel, shells and coarse sand—Credit: USGS

Section VI. Frilled anemones on a boulder—Credit: USGS

Section VII. Burrowing anemone with pink shrimp—Credit: USGS

Section VIII. Northern sea stars in a muddy basin—Credit: USGS

Section IX. Shell pile in the trough between sand waves—Credit: USGS

Section X. Gravel with encrusting coralline algae and sponges—Credit: USGS

Page 26 "Inside the anemone forest" painting—Credit: Joline Putnam, RI School of Design[1]

Page 36. "Exploring the deep boulder reef" painting—Credit: Mary Jane Brush, UConn[2]

Page 43. Diatoms (*Chaetoceros affins*, *Coscinodiscus* sp., *Chaetoceros debilis*)—Credit: Paul Hargraves, Univ. RI

Page 48. Feeding humpbacks and seabirds—Credit: Ari Friedlander, Duke Univ/SBNMS (NOAA Permit 981-1707)

Page 49. American lobster, cunner and benthic invertebrates—Credit: Matthew Lawrence, SBNMS

Page 57. Hydromedusae—Credit: Norman Despres

Page 68. Field of sand dollars—Credit: USGS

Page 74. Northern puffer—Credit: Norman Despres

Page 82. Greater shearwater—Credit: Glen Tepke

Page 90. Leatherback turtle—Credit: Glen Tepke

Page 92. Humpback whale calf fluke—Credit: Kate Sardi, WCNE/SBNMS (NOAA Permit 981-1707)

Page 120. "Evening Shipping on Boston Bay, 1898" painting—Credit: William G. Muller

Page 132. Various human uses during a summer day on the SBNMS—Credit: Regina Asmutis-Silvia

Page 132. Commercial Fishing section—Credit: SBNMS/NOAA

Page 144. Recreational Fishing section—Credit: SBNMS/NOAA

Page 154. Whale Watching section—Credit: Regina Asmutis-Silvia

Page 155. Other Recreation and Tourism section—Credit: Deborah Marx, SBNMS

Page 156. Maritime Transportation section—Credit: SBNMS

Page 166. Cunner and invertebrates—Credit: Tane Casserley

Page 184. Whale tagging research boat—Credit: WCNE/SBNMS; Humpback and NOAA Ship Nancy Foster—Credit: WCNE/SBNMS (NOAA Permit 981-1707); Sanctuary exhibit at Gloucester Maritime Heritage Center—Credit: Anne Smrcina, SBNMS; SBNMS facilities—Credit: Anne Smrcina, SBNMS

Page 207. Haddock—Credit: NURC-UConn; Greater Shearwater—Credit: WCNE/SBNMS; Atlantic herring—Credit: Jon Witman, Brown Univ.; Sea Scallop—Credit: USGS

Page 227. Breaching humpback whale—Credit: Ari Friedlander, Duke Univ/SBNMS (NOAA Permit 981-1707); Recreational boat and humpback whales—Credit: Kate Sardi, Duke Univ./SBNMS (NOAA Permit 981-1707); Dead right whale with propeller marks—Credit: PCCS; Entangled humpback whale—Credit: PCCS (NOAA Permit 932-1489)

Page 246. *Portland's* steam release pipe—Credit: NURC-UConn, The Science Channel and SBNMS; *Portland's* bitts with encrusting invertebrates—Credit: NURC-UConn, The Science Channel and SBNMS; Teacups in *Portland's* galley—Credit: NURC-UConn/SBNMS; Pipes and mug on *Portland's* deck—Credit: NURC-UConn, The Science Channel and SBNMS.

LAST PAGE. Whales and birds feeding at sunset in the Stellwagen Bank National Marine Sanctuary—Credit: Cara Pekarcik, WCNE/SBNMS (NOAA Permit 981-1707)

[1,2]Both paintings are scientifically accurate portrayals of characteristic seafloor landscapes based on the artists' examination of over a hundred hours of underwater video made by remotely operated vehicles (ROVs) in the sanctuary.

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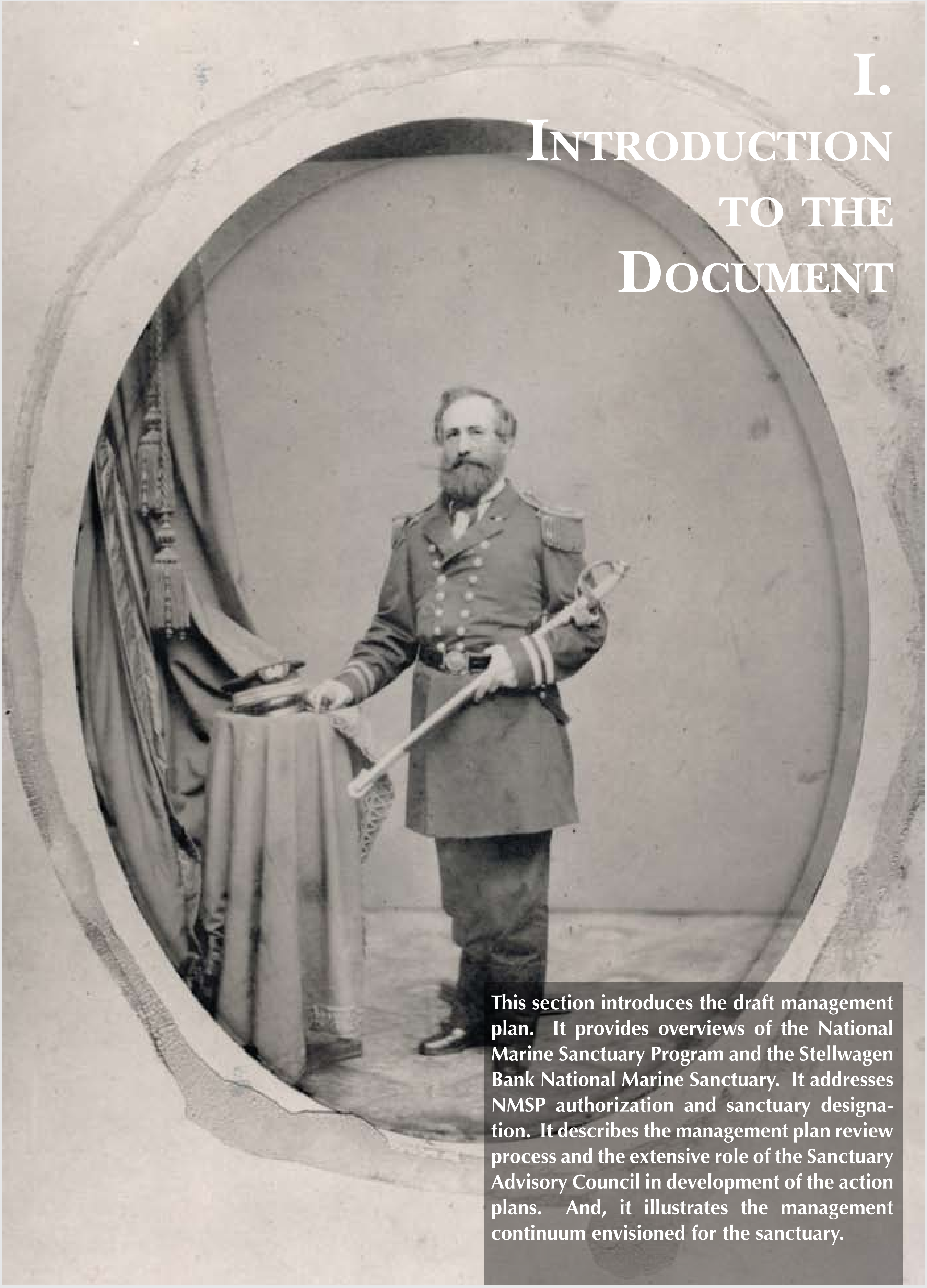
I. Introduction to the Document



This section introduces the draft management plan. It provides overviews of the National Marine Sanctuary Program and the Stellwagen Bank National Marine Sanctuary. It addresses NMSP authorization and sanctuary designation. It describes the management plan review process and the extensive role of the Sanctuary Advisory Council in development of the action plans. And, it illustrates the management continuum envisioned for the sanctuary.

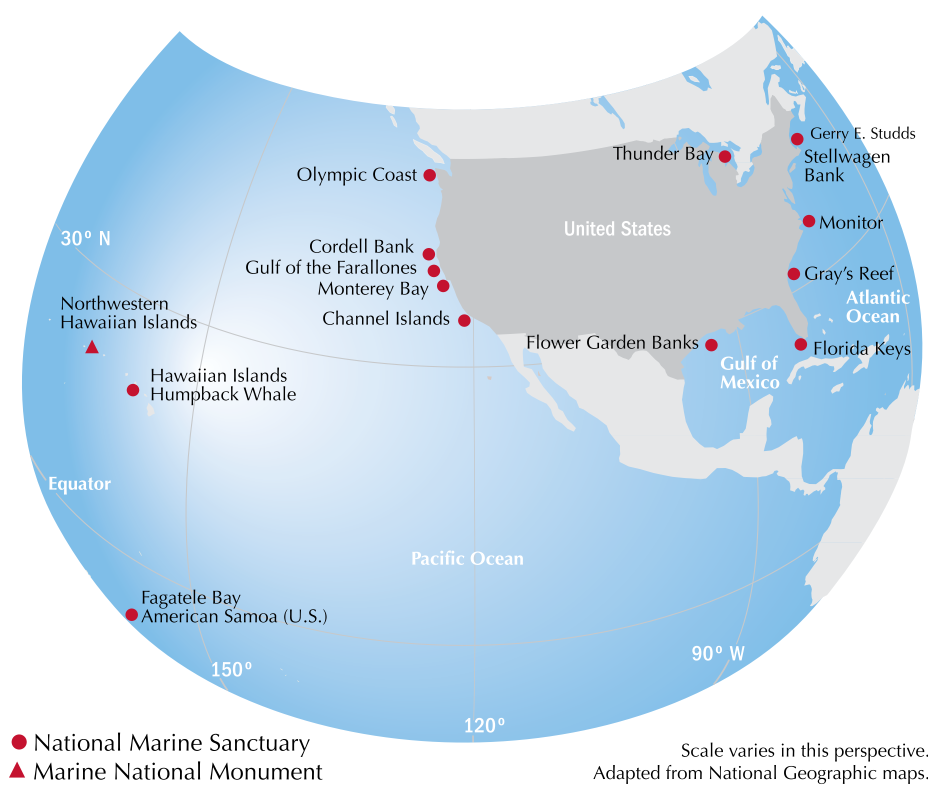
Overview of the National Marine Sanctuary Program

The NMSP serves as the trustee for a system of 14 marine protected areas[1], encompassing more than 290,000 square miles of marine and Great Lakes waters from Washington State to the Florida Keys, and from New England to American Samoa (Figure 1). The NMSP is an office within the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) (see Sidebar). The sanctuary system includes: 13 national marine sanctuaries and the Papahanāumokuākea Marine National Monument. The NMSP works cooperatively with the public to protect the living marine and non-living resources of sanctuaries while allowing recreational and commercial activities that are compatible with the primary goal of resource protection. The NMSP raises public awareness of sanctuary resources and management issues through programs of scientific research, monitoring, exploration, education and outreach.

The national marine sanctuaries are an essential part of this country's collective environmental riches. Within their protected waters, giant whales feed, breed and nurse their young, coral colonies flourish, and shipwrecks tell stories of our maritime history. Sanctuary habitats include beautiful rocky reefs, lush kelp forests, whale migration corridors and destinations, spectacular deep-sea canyons, and underwater archaeological sites. Our nation's marine sanctuaries provide a safe habitat for species close to extinction or protect historically significant shipwrecks. They range in size from one-quarter square mile in American Samoa's Fagatele Bay to the more than 140,000 square miles in the Papahanāumokuākea Marine National Monument in the Northwestern Hawaiian Islands—the largest marine protected area in the world. Each sanctuary is a unique place needing special protection. Serving as natural classrooms, cherished recreational spots and places for valuable commercial activities, marine sanctuaries represent many things to many people.

The NMSP provides oversight and coordination of the sanctuary system by setting priorities for addressing resource management issues and directing program and policy development. The NMSP is responsible for ensuring that the management plan prepared for each sanctuary is consistent with the National Marine Sanctuaries Act. The NMSP provides a general budget for expenditures for program development, operating costs and staffing. On an annual basis, the NMSP reviews and adjusts funding priorities and requirements to reflect resource management needs of the respective sanctuaries. The NMSP also monitors the effectiveness of the management plan, makes recommendations to promulgate regulatory changes where necessary, and monitors intra- and inter-agency agreements.

Figure 1. The system of National Marine Sanctuaries.



The National Marine Sanctuaries Act

The National Marine Sanctuaries Act (NMSA) (16 U.S.C. 1431 et. seq.) is the organic legislation governing the NMSP (Appendix A). The NMSA authorizes the Secretary of Commerce to designate as national marine sanctuaries, areas of the marine environment or Great Lakes with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational or aesthetic qualities. Sanctuaries are special areas set aside in perpetuity for long-term protection and conservation and are part of our nation's legacy to future generations; essentially the marine equivalent to our national parks. The NMSP is the Federal program within NOAA charged with managing national marine sanctuaries. The primary objective of the NMSA is to protect sanctuary resources. The NMSA also directs the NMSP to facilitate all public and private uses of those resources, to the extent that they are compatible with the primary objective of resource protection.

1 Ex. Ord. No. 13158, May 26, 2000, 65 F.R. 34909 Sec. 2. (a) defines a "marine protected area" as, "…any area of the marine environment that has been reserved by Federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein."

The purposes and policies of the NMSA are

(1) To identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System;

(2) To provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner that complements existing regulatory authorities;

(3) To maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations and ecological processes;

(4) To enhance public awareness, understanding, appreciation, and wise and sustainable use of the marine environment, and the natural, historical, cultural and archeological resources of the National Marine Sanctuary System;

(5) To support, promote and coordinate scientific research on, and long-term monitoring of, the resources of these marine areas;

(6) To facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of the resources of these marine areas not prohibited pursuant to other authorities;

(7) To develop and implement coordinated plans for the protection and management of these areas with appropriate Federal agencies, state and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas;

(8) To create models of, and incentives for, ways to conserve and manage these areas, including the application of innovative management techniques; and

(9) To cooperate with global programs encouraging conservation of marine resources.

Comprehensive Management of National Marine Sanctuaries

The NMSA states that the NMSP shall "maintain for future generations the habitat and ecological services of the natural assemblage of living resources that inhabit [sanctuaries]" (16 U.S.C. 1431 et seq., §301(a)(4)(A),(C). The NMSA further recognizes that "while the need to control the effects of particular activities has led to enactment of resource-specific legislation, these laws cannot in all cases provide a coordinated and comprehensive approach to the conservation and management of the marine environment" (16 U.S.C. 1431 et seq., §301(a) (3)). Accordingly, the NMSP subscribes to a broad and comprehensive management approach to meet the NMSA's primary objective of resource protection.

This comprehensive management approach differs from that of various other national and local agencies and laws directed at resource-specific management. Comprehensive

National Oceanic and Atmospheric Administration (NOAA)

NOAA Mission: To understand and predict changes in Earth's environment and conserve and mange coastal and marine resources to meet our Nation's economic, social, and environmental needs (NOAA, 2005).

The NMSP is part of the National Oceanic and Atmospheric Administration (NOAA), which conducts research and gathers data about the global oceans, atmosphere, space and sun, and applies this knowledge to science and service that touch the lives of all Americans (www.noaa.gov). In doing so, NOAA warns of dangerous weather, charts the nation's seas and skies, guides the use and protection of ocean and coastal resources, and conducts research to improve the collective understanding and stewardship of the environment that sustains the nation.

A Commerce Department agency, NOAA provides these services through five major organizations: the National Weather Service; the National Ocean Service; the National Marine Fisheries Service; the National Environmental Satellite, Data and Information Service; the Office of Oceanic and Atmospheric Research; as well as numerous special program units. In addition, NOAA research and operational activities are supported by the nation's seventh uniformed service, the NOAA Corps, a commissioned officer corps of men and women who operate NOAA ships and aircraft, and serve in scientific and administrative posts.

National Ocean Service (NOS)

The NMSP is part of the National Ocean Service (NOS). The NOS (http://www.nos.noaa.gov) develops the national foundation for coastal and ocean science, management, response, restoration and navigation. The NOS maintains a leadership role in coastal and ocean stewardship by bridging the gap between science, management, and public policy in the areas of healthy coasts, navigation, coastal and ocean science, and coastal hazards. Ten program offices are located within the NOS:

- National Marine Sanctuary Program
- Center for Operational Oceanographic Products and Services (CO-OPS)
- National Centers for Coastal Ocean Science (NCCOS)
- Coastal Services Center (CSC)
- Office of Coast Survey (OCS)
- Office of Ocean and Coastal Resource Management (OCRM)
- Office of Response and Restoration (OR&R)
- National Geodetic Survey (NGS)
- International Program Office (IPO)
- Management and Budget Office (MBO)

sanctuary management serves as a framework for addressing long-term protection of a wide range of living and non-living marine resources, while allowing multiple uses of the sanctuary to the extent that they are compatible with the primary goal of resource protection. The resources managed by the NMSP span diverse geographic, administrative, political and economic boundaries. Strong partnerships among resource management agencies, the scientific community, stakeholders and the public at-large are needed to realize the coordination and program integration that the NMSA calls for in order to comprehensively manage national marine sanctuaries.

Overview of the Stellwagen Bank National Marine Sanctuary

Designation

Designation of Stellwagen Bank as the nation's twelfth (and New England's first and only) national marine sanctuary was the culmination of over a decade of effort (see Appendix B). In the late 1980s, an elevated public awareness of regional development activities prompted calls for greater protection of New England's marine resources. Stellwagen Bank was first nominated for consideration as a national marine sanctuary in 1982 by the Center for Coastal Studies in Provincetown, Massachusetts and the Defenders of Wildlife in Washington, D.C. The following year NOAA added Stellwagen Bank to its "Site Evaluation List" from which NOAA chose ocean areas as active candidates for designation as national marine sanctuaries.

NOAA elevated the Stellwagen Bank proposal to Active Candidate status on April 19, 1989 (54 FR 15787). This was done in response to a requirement in the 1988 amendments to the NMSA that a prospectus on the Stellwagen Bank proposal be submitted to Congress by September 30, 1990 (P.L. 100-627, s. 205(b)(1)). NOAA commenced gathering public comment and prepared the Draft Environmental Impact Statement/Management Plan and the Prospectus for Congress. These were published on February 8, 1991, initiating a 60-day public comment period and a 45-day Congressional review period. During the comment period, a series of public hearings were held, 860 written comments were submitted, and petitions signed by more than 20,000 persons supporting designation of the Stellwagen Bank National Marine Sanctuary were received by NOAA.

On October 7, 1992, Congress passed legislation reauthorizing and amending Title III of the Marine Protection, Research and Sanctuaries Act (MPRSA) [now titled the National Marine Sanctuaries Act]. This legislation was signed into law on November 4, 1992. Section 2202 of that law designates the Stellwagen Bank National Marine Sanctuary. Among related initiatives, it establishes the sanctuary boundary; prohibits the exploration for and mining of sand and gravel and other minerals in the sanctuary; and requires consultation with the Secretary of Commerce by Federal agencies proposing agency actions in the vicinity of the sanctuary that may affect sanctuary resources. The sanctuary consists of an area entirely within federal waters, measuring approximately 842 square miles (638 square nautical miles) and lying off the coast of Massachusetts.

Resource Characteristics

The Stellwagen Bank sanctuary was designated for a multitude of reasons, including its high natural productivity and species diversity, as well as its long history of human use. There are well over 575 known species in the sanctuary and the list is largely incomplete. Living landscapes (anemone forests, sponge gardens, hydroid meadows, worm tube beds) carpet the seafloor and the associated marine communities support benthic and pelagic species that are dependent upon them. Water column and seafloor habitats sustain over 80 species of fish and provide important feeding and nursery grounds for 22 marine mammal species including the endangered humpback and fin whales and the critically endangered North Atlantic right whale. The area supports foraging activity by 34 species of seabirds dominated by gulls, storm petrels, gannets, auks (alcids), sea ducks and shearwaters. Fish and invertebrate populations include both demersal and pelagic species, such as cod, flounders, bluefin tuna, herring, lobster and scallops. Leatherback and Kemp's ridley sea turtles (endangered species) on occasion visit the area for feeding.

Sitting astride historic fishing grounds and shipping routes, the Stellwagen Bank sanctuary has been a locus for a variety of human maritime activities for centuries. As Gloucester is America's oldest seaport, Stellwagen Bank (formerly Middle Bank) is among the most historic fishing grounds in the Gulf of Maine, harkening back to colonial times. The major shipping corridors established in the past are still prominent today where they cross the sanctuary. Shipwrecks on the sanctuary's seafloor represent the development of commercial fishing and maritime transportation during the nearly 400 years that maritime commerce passed through the area. To date 18 historic shipwreck sites have been located in the sanctuary and four of the shipwrecks have been identified by name; three shipwreck sites are listed on the National Register of Historic Places. These shipwrecks are tangible connections to the past that allow the sanctuary to study and better understand the area's history.

Sanctuary Management Plan Review

The sanctuary management plan review (MPR) process is based on three fundamental steps: 1) public scoping, which includes a formal comment period and public meetings to identify a broad range of issues and concerns related to management of the sanctuary; 2) analysis and prioritization of the issues raised during scoping, followed by the development of action plans; and 3) preparation of the draft and final management plans and relevant NEPA documentation, such as an Environmental Impact Statement or Environmental Assessment. Public review of the draft management plan provides guidance for staff to revise the document and prepare the final management plan. Once approved by NOAA, the final management plan will outline the sanctuary's priorities for the next five years.

Management plans are sanctuary-specific documents that perform many functions, including describing regulations and boundaries; outlining staffing and budget needs; setting priorities and performance measures for resource protection, research and education programs; and, guiding development of future budgets and management activities. Periodic management plan review, required by law for all National Marine Sanctuaries, is conducted to ensure that each site properly conserves and protects its nationally significant living and cultural resources. The Stellwagen Bank sanctuary's existing management plan was published in July 1993. Five years later, NOAA initiated its five-year management plan review.

From December 1998 to January 1999, the sanctuary initiated formal review of its management plan by holding public scoping meetings in Barnstable, Boston and Gloucester (MA) to ask the public for comments on the status of site management. The MPR was delayed several years due to a change in sanctuary management. The MPR resumed with an open public comment period during July 2–October 18, 2002. An additional round of nine public scoping meetings, coincident with this comment period, was held during September and October at the following locations: Mystic, CT; New Bedford, MA; Provincetown, MA; Falmouth, MA; Plymouth, MA; Boston, MA; Gloucester, MA; Portsmouth, NH; and Portland, ME. The *State of the Sanctuary Report*, published in June 2002, set the stage for these meetings and public comment period.

During the scoping process, the public identified a range of important considerations for sanctuary management. Eight key topics comprised of 27 issues were synthesized by sanctuary staff from the input of over 300 participants who attended the scoping meetings and the approximately 20,000 written comments received during both public comment periods. These key topics and their respective issues are listed in Appendix C. Upon conclusion of public scoping, the Sanctuary Advisory Council engaged in a lengthy and intensive effort during 2002–2005 to prioritize these issues and, through working groups, develop action plans with recommendations to address them.

Sanctuary Advisory Council

Citizens of New England are politically and socially engaged on issues affecting their communities and the surrounding environment, including the ocean. The Stellwagen Bank sanctuary came about largely due to the dedication and determination of thousands of local citizens and elected officials who strongly advocated for sanctuary designation. To this day, public participation permeates nearly every aspect of the sanctuary's management and operation, with people serving on the Sanctuary Advisory Council and its working groups, becoming involved in the sanctuary's community outreach and educational activities, as well as offering informal advice on a variety of sanctuary issues and related opportunities.

Much of the time, this public interest is channeled through the Advisory Council, which serves as the primary connection to the stakeholders of the sanctuary, including concerned citizens. The Advisory Council is formed of members from the public to provide advice to the sanctuary superintended on the management and protection of the sanctuary. Section 315 of the National Marine Sanctuaries Act authorizes the Secretary of Commerce to establish Sanctuary Advisory Councils. This authority has been delegated to the Director of the NMSP.

The current Stellwagen Bank Sanctuary Advisory Council was formally constituted and approved on October 3, 2001; the first meeting was convened on November 5, 2001. The Advisory Council is comprised of a total 21 members, of which 15 voting public members represent various stakeholder interests and 6 non-voting *ex-officio* members (or their designee) represent state and federal agencies. There are also 15 alternates for the public seats, who assume the seat and vote in the absence of the respective public member. [Note: the Advisory Council charter was amended on December 10, 2007 to increase the number of public members to 17.] The Stellwagen Bank Sanctuary Advisory Council has public representation from four states (Connecticut, Massachusetts, New Hampshire and Maine) and eight Congressional districts; the Advisory Council is among the largest in the national system and is distinguished by its multi-state representation. Advisory Council membership is listed in Appendix D.

Advisory Council members are selected through an open recruitment process to represent the views of their particular constituency. Applications are reviewed by the Advisory Council executive committee working with the sanctuary superintendent, who makes final recommendations. Appointment is by the Director of the NMSP. Members are volunteers serving two- or three-year terms. The Stellwagen Bank Sanctuary Advisory Council has participated in every step of the MPR process, including the public scoping meetings.

Between 2002 and 2005 the Advisory Council held frequent meetings to accomplish the following:

- prioritize issues
- formulate action plan topics
- agree on working group tasking and make-up
- convene working groups to develop and recommend action plans
- review, revise and adopt working group action plans
- forward amended action plans to the sanctuary superintendent
- prioritize action plan strategies
- formulate a sanctuary vision statement

Appendix E lists the Advisory Council meetings related to MPR.

Role of Working Groups

The preparation of action plans required a prodigious effort, involving the simultaneous convening of 11 working

Working Groups

- Administrative Capacity and Infrastructure Development and Maintenance
- Interagency Cooperation
- Public Outreach and Education
- Compatibility Determination
- Ecosystem-Based Sanctuary Management
- Ecosystem Alteration
- Water Quality
- Marine Mammal Behavioral Disturbance
- Marine Mammal Vessel Strike
- Marine Mammal Entanglement
- Maritime Archaeology
- Site Characterization

groups of the Advisory Council (see Sidebar). This effort was possible because of the able leadership and dedication of the Advisory Council members and alternates, who served as chairs for these groups. Other working group members represented stakeholder interests, including industry and environmental organizations, and government agencies having relevant jurisdiction and technical capacities, academia and general educational institutions, and members of the concerned public. In some cases, technical advisors informed working groups on specific issues. Sanctuary staff represented the sanctuary on each working group and offered support services, such as making meeting arrangements and preparing minutes. After the other 11 working groups had completed their tasks, an additional working group on compatibility determination was convened. This sequencing was necessary because the sanctuary did not have the capacity to simultaneously staff this working group, in addition to the others.

Working group topics generated considerable discussion among the Advisory Council, particularly with regard to fishing. Some members felt that fishing warranted its own action plan. Others felt that the working groups should be organized around issues and concerns, irrespective of the type of activity that may be involved. As an outcome, the effects of fishing were largely subsumed within the broader context of ecosystem alteration and other related concerns, such as marine mammal entanglement and damage to maritime heritage resources. The Advisory Council chose to evaluate the suite of impacts first, and then consider their cause in relation to human activity.

Working group members were selected through an open, competitive recruitment process approved by the Advisory Council. Recruitment was conducted by the Advisory Council executive committee working with the sanctuary superintendent. The working groups followed a set of ground rules that were approved by the Advisory Council. Working groups elected to operate by consensus rather than voting and allowed for alternates among their membership. Combined membership on the working groups totaled more than 200 people and is listed in Appendix F.

Principal Outcomes

The Advisory Council reviewed and, where deemed necessary, modified the working group action plans at their October 10, 2004 meeting. The amended action plans were adopted by vote of the Advisory Council, and then forwarded as advice for consideration by the sanctuary superintendent. At a follow-up meeting in November 5, 2004, the Advisory Council prioritized the strategies and activities within each action plan. At their July 11, 2005 meeting, the Advisory Council developed a vision statement for the sanctuary that has been adopted by NOAA and included in this document. It reads as follows:

> *"The Stellwagen Bank National Marine Sanctuary is teeming with a great diversity and abundance of marine life supported by diverse, healthy habitats in clean ocean waters. The ecological integrity of the sanctuary is protected and fully restored for current and future generations. Human uses are diverse and compatible with maintaining natural and cultural resources."*

The intent and overall goals of the action plans, as submitted by the Advisory Council, have been maintained and serve as the foundation for the draft management plan. NOAA has significantly reorganized and condensed these versions in order to eliminate duplication among them and to make them more strategic in their expression. The action plans are presented in Section VII of this document.

The Draft Management Plan

This draft management plan serves as a non-regulatory policy framework for addressing the issues facing the Stellwagen Bank sanctuary over the next five years. The document provides strategic guidance for management actions and focuses those actions on four priority programmatic areas: capacity building, ecosystem protection, marine mammal protection and maritime heritage management. NOAA is focusing on these priority areas because they will significantly contribute to achieving the vision and mission of the sanctuary.

At this time, NOAA is not proposing any regulations or changes to the designation document and an environmental assessment (Section VII) accompanies this management plan, rather than an environmental impact statement pursuant to the requirements of the National Environmental Policy Act (42 U.S.C sec. 4321-4370 et seq.) and Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508). However a suite of regulatory initiatives that derives from the strategies presented in the draft management plan ultimately could be considered. Figure 2 illustrates the management continuum envisioned and examples of potential management actions.

The remainder of this document is organized into nine sections.

Section II. Institutional Setting provides an overview of the administration of the sanctuary and how the sanctuary interacts with other federal and state agencies to accomplish its mission.

Section III. Sanctuary Setting introduces the concept of managing sanctuary resources for biodiversity conservation. It describes the physical characteristics of the sanctuary and the primary producers and decomposers that are essential to the sanctuary's ecosystems function.

Section IV. Resource States offers an in-depth analysis of the status of the natural and cultural resources of the sanctuary, drawing on extensive new information never before compiled in one synthesis. For each resource state, the analysis begins with a discussion of status, followed by a description of pressures, and concludes with a summary of the current protections in place.

Section V. Status of Human Uses characterizes the primary uses occurring within or near the sanctuary.

Section VI. Summation reviews points raised in previous sections, forms conclusions and considers outcomes of cumulative actions and effects.

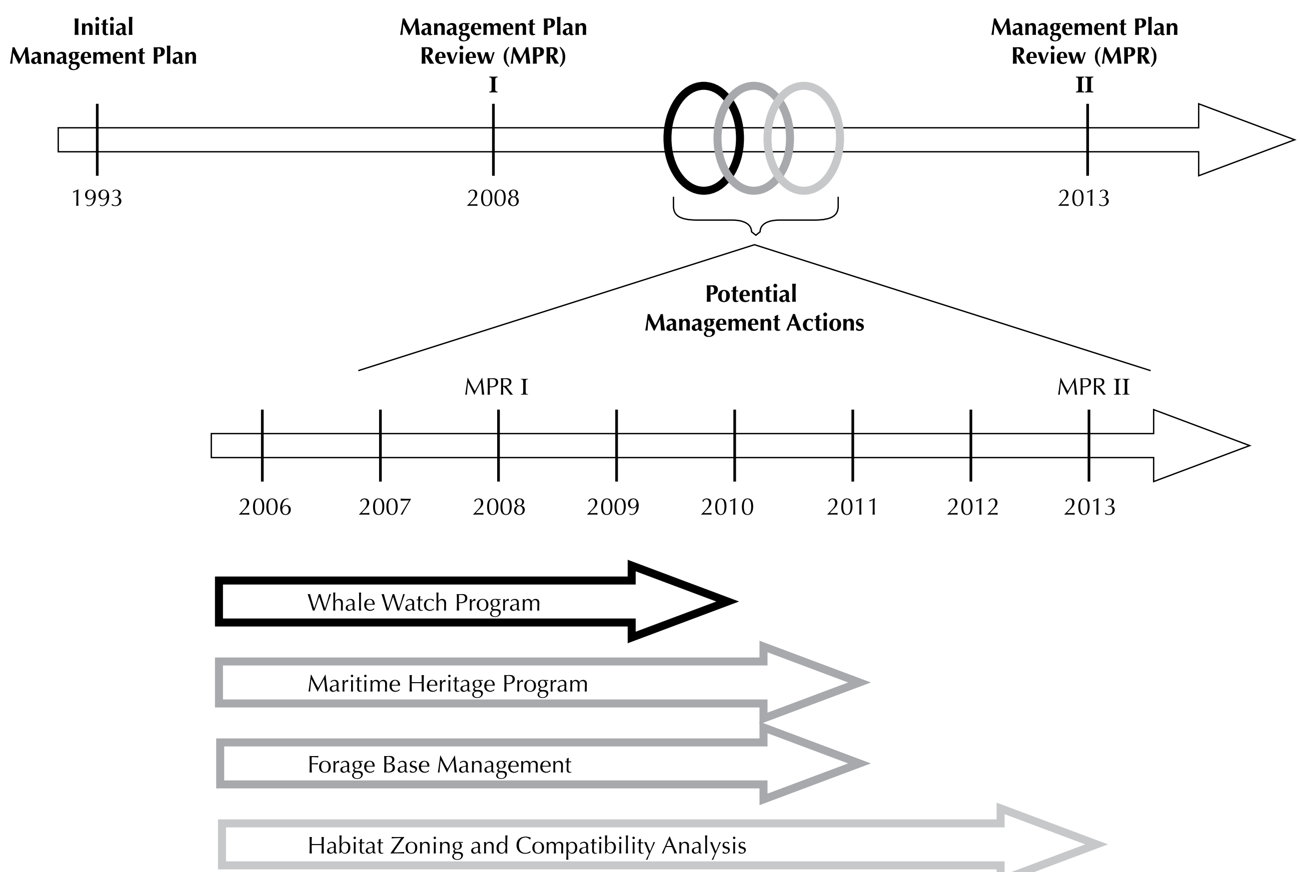
Section VII. Actions Plans presents the suite of recommended strategies and activities that should be implemented to adequately address the many issues that need to be resolved, in order to manage, protect and restore the resources of the sanctuary.

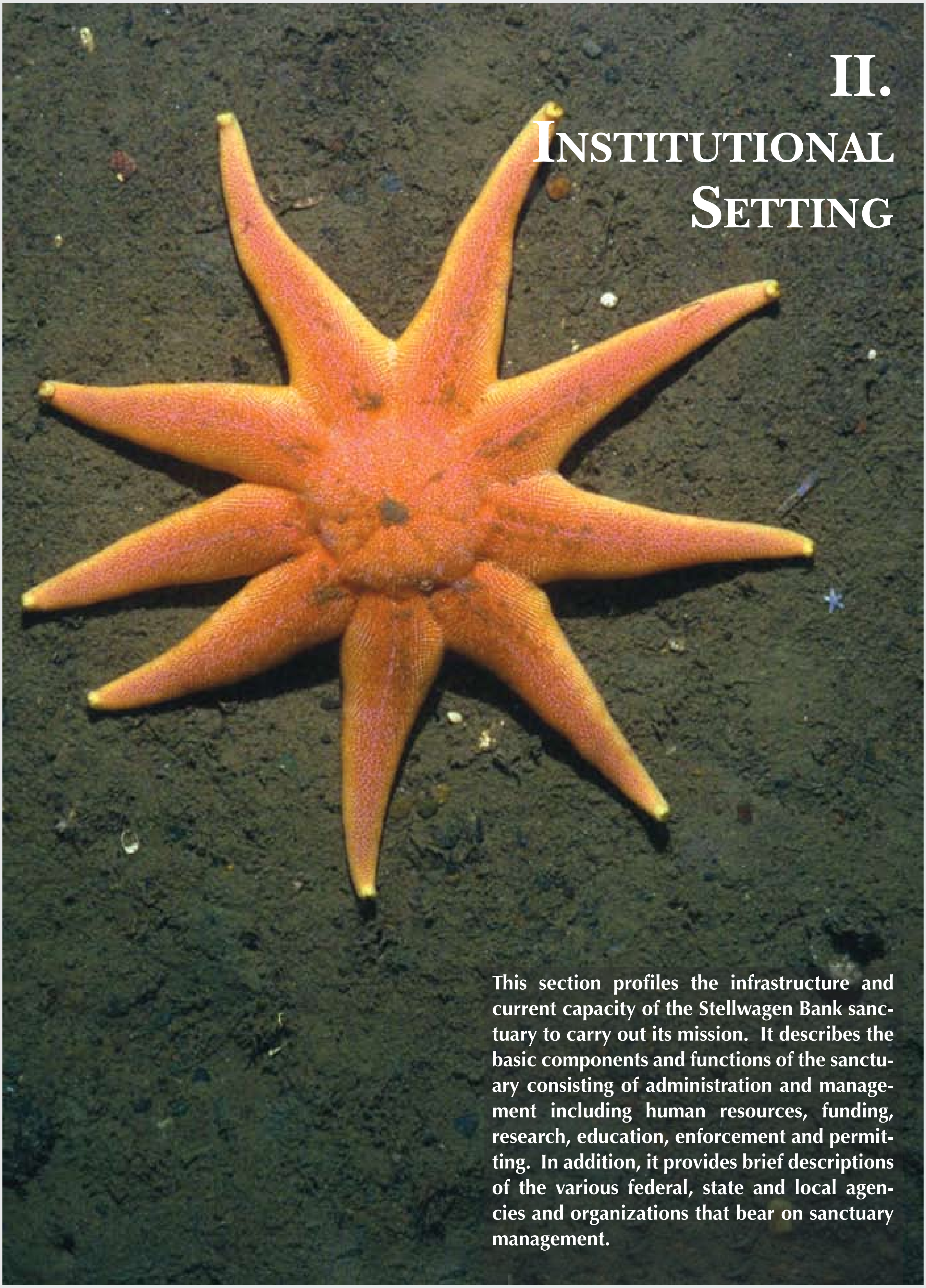
Section VIII. Environmental Assessment complies with NEPA and CEQ regulations and provides a description of the proposed management action and alternatives.

Section IX. Sources Cited lists the more than 670 technical references that offer substantive documentation supporting or elaborating on statements made in the text.

Section X. Appendices include background documentation that lends support, context and fuller understanding to the draft management plan.

Figure 2. Illustration of the Proposed Management Continuum for the Stellwagen Bank Sanctuary.





II. Institutional Setting

This section profiles the infrastructure and current capacity of the Stellwagen Bank sanctuary to carry out its mission. It describes the basic components and functions of the sanctuary consisting of administration and management including human resources, funding, research, education, enforcement and permitting. In addition, it provides brief descriptions of the various federal, state and local agencies and organizations that bear on sanctuary management.

Human Resources

Sanctuary Superintendent

The sanctuary superintendent oversees site-specific management functions, including revision and implementation of the management plan. The superintendent designates responsibility for implementing specific programs or projects, establishes the administrative framework to ensure all resource management activities are coordinated, and maintains and manages an appropriate infrastructure to adequately support site operations. The superintendent reports to the Regional Superintendent for the Northeast and Great Lakes Region of the National Marine Sanctuary Program (NMSP). General responsibilities of the sanctuary superintendent include:

- Submitting an annual operating plan that recommends priorities to the NMSP for annual allocation of funds for site operations and resource protection;
- Formulating and directing research, education, marine resource management and maritime heritage resource management programs;
- Determining staffing needs and requirements;
- Coordinating with the NMSP in the evaluation, processing and issuing of permits and the conduct of inter-agency consultations;
- Coordinating on-site efforts of all parties involved in sanctuary activities including state, federal, regional and local agencies;
- Working closely with constituents and the community; and
- Evaluating progress made toward achieving sanctuary goals and objectives.

Sanctuary Staff

Basic staffing supports program activities in ten functional areas:

- Management Planning
- Technology Integration and Management
- Site Operations
- Resource Protection
- Research and Monitoring
- Education and Outreach
- Maritime Heritage Resources
- Sanctuary Advisory Council Coordination
- External Affairs
- Office Administration

Sanctuary staff has knowledge and expertise in policy, marine resource management, education and outreach, scientific research and monitoring, maritime heritage resources, geographic information systems (GIS), information technology, program development and office administration. The existing organizational structure is shown in Figure 3. There are currently seven full-time staff, four of whom are federal employees and three are contract employees. Five other contract employees are part-time status. There also is one post-doctoral fellow working with the sanctuary.

Infrastructure

Site Facilities

The site facilities of the Stellwagen Bank sanctuary are located in the Town of Scituate, Massachusetts, approximately one hour drive south of Boston. These core facilities are situated in a residential area known as First Cliff, a peninsula that separates Massachusetts Bay and Scituate Harbor. The sanctuary offices reside at this one site; there are no plans in the next 5 years to develop a satellite office.

However, the sanctuary maintains visitor exhibits in Gloucester and Provincetown in partnership with private organizations. It has semi-permanent displays in cooperation with the New England Aquarium, Cape Cod Museum of Natural History, Cape Cod National Seashore, Scituate Maritime and Irish Mossing Museum, and the Woods Hole Aquarium. It also has multiple traveling exhibits consisting of interactive

Figure 3. Current organizational chart for the Stellwagen Bank sanctuary.

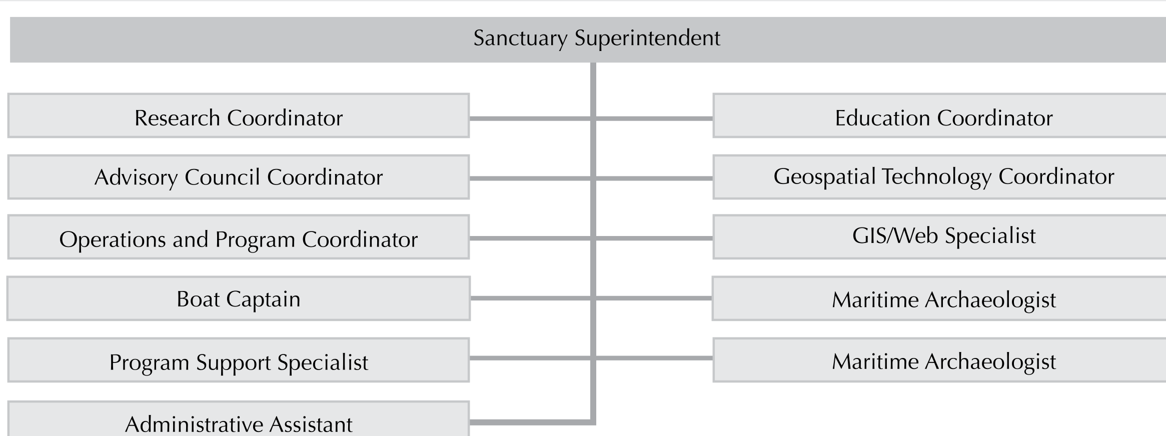


Figure 4. Oblique aerial photograph showing the Stellwagen Bank sanctuary buildings (red roofs), pier and docks on Scituate Harbor in 2003 during facilities renovation.

(Source: Microsoft Corporation/Pictometry International Corp., 2006)

kiosks that rotate through town public libraries and community educational organizations in the region.

The site facilities consist of an administrative office, meeting annex, boathouse, attached pier and two floating docks (Figure 4). Administrative offices and conference room occupy a 6,800-sq-ft., three-story building in the former Scituate USCG Station. An adjacent 2,200-sq-ft., two-story annex houses a meeting facility and office space for visiting faculty, post-doctoral fellows and graduate interns. Both buildings are climate-controlled using geothermal technology. Major renovation of the Administrative Building and the Annex was completed in 2004.

A 3,565-sq-ft., two-story boathouse is built on pilings over the water and includes a 300-ft. pier, with two floating docks attached. The docks have the capacity to berth one 50-ft. vessel and three smaller boats simultaneously. Additionally, the sanctuary has three moorings adjacent to the pier. Renovations are planned for both the boathouse and pier to better utilize the existing capacity and to accommodate the new 50-ft. research vessel. The entire complex of structures was transferred by Congress in 1999 to NOAA from the USCG, which had occupied the site since 1937.

Vessels

The sanctuary currently operates two vessels in support of research and monitoring, education and emergency response.

The R/V *Auk* is the sanctuary's new aluminum hydrofoil-assisted research catamaran (Figure 5). The R/V *Auk* is a multi-purpose research vessel designed primarily to support the sanctuary's science and education missions. Its length overall is 50 ft., its beam is 19 ft. and its draft is less than 5.5 ft. It has twin 484 hp diesel engines that drive propellers. Its cruising speed in the sanctuary is 20 kts, but has a top speed of 28 kts. It has a fuel capacity of 600 gallons and a range of 400 nm. It carries a crew of two and a science party of 12 for day trips. While principally intended as a day boat, it can conduct 2-3 day missions with berthing for six (two crew and four scientists). Its stable twin-hull configuration and sea keeping ability provide year-round access to all parts of the sanctuary.

The vessel incorporates special design features to facilitate research. The vessel holds both wet and dry labs. It can deploy, tow, and retrieve scientific equipment with its 750 lb capacity oceanographic winch. A 2,000-lb hydraulic A-frame and articulated knuckle crane aid in the deployment or retrieval of equipment. Bow thrusters aid in positioning the vessel. A dive ladder supports diving operations and the spacious flying bridge facilitates wildlife observations. An 11-ft. rigid hull inflatable can be deployed as necessary. The R/V *Auk* also offers secondary capabilities as an emergency response asset and for on-the-water enforcement patrols, if required. The R/V *Auk* was recognized as one of the "Great Boats of 2006" by *Marine News* magazine (December 2006).

The R/V *Gannet* is the sanctuary's 28-ft. 'quick response' vessel. It is has twin 225 hp outboards, cuddy cabin and observation tower. The *Gannet* serves as a research and dive platform that supports single day or half-day trips.

Figure 5. The Stellwagen Bank sanctuary's 50-foot research vessel R/V *Auk*.

Sanctuary Advisory Council

Public involvement in sanctuary management is vitally important. Section 315 of the NMSA authorizes the Secretary of Commerce to establish Sanctuary Advisory Councils. This authority has been delegated to the Director of the NMSP, who approves Council charters and appoints Council members. All sites in the NMSP have Sanctuary Advisory Councils.

The charter for the Stellwagen Bank Sanctuary Advisory Council (Advisory Council) was revised and adopted in 2001. The Advisory Council is composed of a total of 21 members, of which 15 seats are public voting and six seats are *ex-officio* non-voting (three federal and three state agencies). There are also 15 alternates for the public seats, who assume the seat and vote in the absence of the respective public member. [Note: The charter was amended on December 10, 2007 to increase the number of public voting seats to 17.] The sanctuary superintendent participates in Advisory Council meetings in a non-voting *ex-officio* capacity. The Advisory Council has public representation from four states (Connecticut, Massachusetts, New Hampshire and Maine) and eight Congressional districts. The Stellwagen Bank sanctuary Advisory Council is among the largest in the national system and is distinguished by its representation from multiple states.

The public member seats represent varied constituent interests. Two seats represent research interests, two represent conservation interests, two represent education/outreach interests, and one seat each represents marine transportation, recreational fishing, whale watching, fixed gear commercial fishing, mobile gear commercial fishing and business/industry, while three at-large seats represent the general public. [The two seats added by charter amendment on December 10, 2007 are for diving and maritime heritage.] With its broad expertise and diverse representation, the Advisory Council offers advice to the sanctuary superintendent on resource management issues that helps ensure that a wide range of viewpoints are provided upon which to base management decisions.

In order to better understand and address specific management issues and broaden public involvement, the Advisory Council extends its capacities by forming a variety of working groups. Working groups invite additional community members and experts to participate in the development of sound management advice for the sanctuary. Working groups are temporary and chaired by an Advisory Council member. Working groups are instruments of and make their recommendations to the Advisory Council. The Advisory Council evaluates the working group recommendations and in turn makes their recommendations to the sanctuary superintendent. For a list of current and former Advisory Council members see Appendix D.

Relationship with Other Agencies and Authorities

The Stellwagen Bank sanctuary works with the numerous other agencies listed below. The laws authorizing many of these agencies and authorities are provided in Appendix G.

NOAA Offices

Several NOAA offices work closely with the sanctuary, including:

NOAA Fisheries Service (National Marine Fisheries Service or NMFS)

NOAA Fisheries Service administers NOAA programs that assess, manage and promote the domestic and international conservation of living marine resources within the U.S. Exclusive Economic Zone (3–200 miles offshore). NOAA Fisheries Service Northeast Regional Office (NERO) (Gloucester, MA) and associated Northeast Fisheries Science Center (NEFSC) (Woods Hole, MA) serve the northeastern U.S. Fishery management plans (FMPs) are developed to manage Northeast fisheries by the New England and Mid-Atlantic Fishery Management Councils. These plans are reviewed by NOAA Fisheries Service and, if they comply with the Magnuson Fishery Conservation and Management Act (MFCMA) and other applicable laws, are approved and implemented. Many of these plans are developed cooperatively with the states through Interstate FMPs developed by the Atlantic States Marine Fisheries Commission (ASMFC). NOAA Fisheries Service promulgates and enforces the regulations for each FMP. NOAA Fisheries Service Habitat Conservation Division (HCD) plays an important role in proposed actions that may affect essential fish habitat (EFH) including coordination of comments to permitting agencies and sanctuary zoning.

NOAA Fisheries Service also shares responsibility with the U.S. Fish and Wildlife Service (USFWS) for the implementation of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), both of which prevent the taking of any endangered, threatened or otherwise depleted species. As part of the MMPA mandate, the NOAA Fisheries Service Office of Protected Resources (OPR) works in collaboration with the protected resources divisions of the NOAA Fisheries Service regional offices and science centers to develop and implement a variety of programs for the protection, conservation, and recovery of marine mammals.

NOAA Fisheries Service OPR is also responsible for implementing the ESA, generally managing endangered and threatened marine species, including anadromous salmonids. NOAA Fisheries Service and USFWS share joint responsibility for managing sea turtles. In the Atlantic Ocean, NOAA Fisheries Service manages four species of sea turtles, the Atlantic salmon, including their critical habitat, five large whale species and several species of pinnipeds. In coordination with the regional offices and science centers, OPR develops policies and regulations to implement the provisions of the ESA with the goal of protecting and recovering endangered and threatened marine and anadromous species and their habitat.

NOAA Fisheries Service offers resources to the sanctuary such as collaborative assistance on environmental policy processes and enforcement through HCD and NOAA's Office of Law Enforcement (OLE). NERO and the sanctuary collaborate on policy issues where there is an overlap in jurisdiction such as: marine mammal protection, habitat conservation and marine protected areas. This collaboration extends to permitting of prohibited activities in the sanctuary and review of proposed projects that may impact sanctuary resources such as the recent LNG deepwater ports. NOAA Fisheries Service and sanctuary staff periodically serves on each other's agency issue-specific working groups. NERO is a non-voting *ex-officio* member (Regional Administrator or designated representative) of the Sanctuary Advisory Council.

Similarly, the NEFSC and the sanctuary collaborate on science and technical issues where there is an overlap in jurisdiction. Specifically, collaboration occurs on whale research, acoustic monitoring, ecosystem-based management and ecosystem monitoring.

Office of Marine and Aviation Operations (OMAO)

The Office of Marine and Aviation Operations (OMAO) operates NOAA's large ships and aircraft by providing highly skilled NOAA Corps officers. The sanctuary periodically uses the NOAA ships *Delaware* and *Nancy Foster* and occasionally NOAA aircraft for research in the sanctuary. NOAA Corps officers sometimes assist with diving operations in the sanctuary.

Office of Coastal Resource Management (OCRM)

National Ocean Service's (NOS) Office of Coastal Resource Management (OCRM), is responsible for implementing the Coastal Zone Management Act of 1972 (CZMA), which Congress passed to address the growing concerns about the health of the nation's coastal resources. The office works with state and territorial governments to implement their coastal management programs and find local solutions to problems occurring throughout the entire nation. Thirty-four states and territories have active coastal management programs. The Massachusetts Coastal Zone Management (MCZM) program implements the CZMA for the Commonwealth.

Office of Response and Restoration (OR&R)

NOS's Office of Response and Restoration (OR&R) works to prevent and mitigate harm to coastal resources and is the primary NOAA office responding to oil spills and hazardous material releases. It provides scientific support to the U.S. Coast Guard for spills and technical assistance to other agencies for hazardous material releases. The Scientific Support Coordinator for the Northeast, based in Boston, serves as the sanctuary's representative in the case of a hazardous material spill. OR&R also works with federal and state trustees to restore damaged coastal resources.

Damage Assessment Center (DAC)

NOS's Damage Assessment Center (DAC) makes natural resource damage assessments for releases of oil and hazardous substances. DAC scientists and economists provide the technical foundation for these assessments and work with other trustees and responsible parties to restore resources injured by releases of oil and hazardous substances, as well as other injury to resources of national marine sanctuaries and estuarine research reserves. DAC collects data, conducts studies, and performs analyses needed to determine whether coastal resources have sustained injury from releases of oil or hazardous materials, how to restore injured resources, and to ascertain the damages that must be recovered to accomplish restoration. DAC provides technical support to NOAA's Office of General Counsel and the Department of Justice for litigation and for settlement of natural resource damage claims.

National Centers for Coastal Ocean Science (NCCOS)

NOS's National Centers for Coastal Ocean Science (NCCOS) conducts and supports research, monitoring, assessment, and provides technical assistance for managing coastal ecosystems and society's use of them. NCCOS recently completed the extensive ecological characterization of the sanctuary region (http://www.nccos.noaa.gov/sbnmns) (NOAA 2006).

Marine Protected Area (MPA) Center

NOS's Marine Protected Area (MPA) Center works to implement Executive Order 13158, which directs federal agencies to conserve the nation's valuable marine resources through a variety of tasks related to marine protected areas. This implementation requires considerable cooperation, collaboration and information sharing among many government and non-governmental institutions. Working with the Department of the Interior (DOI) and other partners, the MPA Center: develops the framework for a national network of MPAs; coordinates the development of information, tools, and strategies; and guides agencies in their efforts to enhance and expand the protection of existing MPAs, and to establish or recommend new ones; coordinates the MPA web site; partners with federal and non-federal organizations to conduct research, analysis and exploration; helps construct and maintain an inventory of existing U.S. marine managed areas and the MPA List; and supports selection of the MPA Advisory Committee and its operation.

National Undersea Research Program (NURP)

Office of Oceanic and Atmospheric Research (OAR) National Undersea Research Program (NURP) and its regional centers work to support marine science conducted *in situ* underwater. NURP is a grant program that provides advanced technologies and funding support for scientists to address issues of national and regional importance through a comprehensive proposal solicitation and review process. NURP maintains a network of six regional National Undersea Research Centers (NURCs), funded by annual grants from NOAA, that implement the majority of its research mission.

The NURC North Atlantic and Great Lakes at the University of Connecticut (NURC-UCONN) is one of the six regional centers and is affiliated with the University of Connecticut. The sanctuary partners with this center frequently to characterize sanctuary resources.

National Sea Grant College Program

OAR's National Sea Grant College Program encourages the wise stewardship of marine resources through research, education, outreach and technology transfer. Sea Grant is a grant program working in partnership between the nation's universities and NOAA. It began in 1966, when the U.S. Congress passed the National Sea Grant College Program Act. Sea Grant specializes in synthesizing the latest developments in marine research and making it accessible to the public. The sanctuary works closely with MIT Sea Grant and UNH Sea Grant to increase public awareness of sanctuary issues and ocean literacy.

Other Federal Agencies

The sanctuary seeks to provide comprehensive and coordinated sanctuary management in ways that complement existing regulatory authorities and shares resources when appropriate. The following federal agencies have jurisdiction or conduct research within or adjacent to the Stellwagen Bank sanctuary.

National Park Service (NPS)

The Department of the Interior (DOI) National Park Service (NPS) operates the Cape Cod National Seashore (CCNS) and the Salem Maritime National Historic District. The NPS conserves scenery and wildlife, historic structures and provides for the enjoyment of those resources in a manner that will leave them unimpaired for the enjoyment of future generations—goals that are consistent with the sanctuary's mission. The CCNS seashore's proprietary jurisdiction extends out to one nautical mile offshore, including northward from the tip of Cape Cod which does not overlap with the sanctuary jurisdiction that begins three nautical miles offshore. The sanctuary and CCNS cooperate in areas of mutual interest, such as increasing awareness of environmental stewardship among the public and interpreting maritime heritage resources.

Minerals Management Service (MMS)

DOI's Minerals Management Service (MMS) manages the nation's oil and natural gas resources in the outer continental shelf (OCS) pursuant to the Outer Continental Shelf Lands Act (OCSLA), as well as leases pertaining to these resources. OCS lands technically include the sanctuary, but there is a moratorium on hydrocarbon exploration in the sanctuary.

U.S. Fish and Wildlife Service (USFWS)

DOI's U.S. Fish and Wildlife Service (USFWS) works to conserve, protect and enhance seabirds, wildlife, and plants and their habitats. In the sanctuary, the USFWS is responsible for protecting migratory seabirds pursuant to the ESA and Migratory Bird Treaty Act (MBTA).

U.S. Geological Survey (USGS)

DOI's U.S. Geological Survey (USGS) provides scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy and mineral resources; and enhance and protect our quality of life. The USGS has no regulatory or management mandate. Scientists within the USGS work within four disciplines: biology, geography, geology and water. Scientists at the USGS Woods Hole Coastal Geology Center conduct extensive research on habitat mapping and classification, sediment transport and contaminant transport modeling. In 1994–1995, the USGS successfully mapped the entire sanctuary area in high resolution using multi-beam echo-sounder technology in conjunction with the Canadian Hydrographic Service.

U.S. Army Corps of Engineers (USACE)

The Department of Defense (DOD) U.S. Army Corps of Engineers (USACE) has authority to issue permits, based on EPA guidelines, for the disposal of dredged materials at EPA-approved and designated ocean disposal sites (i.e., the Massachusetts Bay Disposal Site). Under Section 404 of the Clean Water Act, the USACE is responsible for issuing permits for any marine construction, excavation, or fill activities in navigable waters of the U.S. In 2000, the USACE issued a permit for the burying of a fiber optic cable across the northern portion of the sanctuary.

U.S. Navy

DOD's U.S. Navy seldom conducts operations in the sanctuary, due to the shallow depths which are unsuitable for submarine operations, and the crowded waters which make warfare training exercises inadvisable. Naval ships transit the sanctuary approximately seven times a year primarily to access the Port of Boston and in so doing follow internal protocols of posting a lookout for whales and avoiding discharges in the sanctuary (Tom Fetherston, U.S. Navy, personal communication, 2004). Operations in deep waters (greater than 200 m) beyond the sanctuary have the potential to acoustically disturb sanctuary resources. The Navy's Undersea Warfare Center in Newport, Rhode Island has provided research support to the sanctuary by deploying a bottom-imaging autonomous underwater vehicle to characterize one of the sanctuary's historic shipwrecks.

U.S. Coast Guard (USCG or Coast Guard)

The Department of Homeland Security's U.S. Coast Guard (USCG) has broad responsibility for enforcing all federal laws and regulations throughout the sanctuary and assists NOAA in the enforcement of sanctuary regulations. The USCG provides on-scene coordination with Regional Response Center facilities under the National Contingency Plan for removal of oil and hazardous substances in the event of a spill threatening sanctuary resource or qualities. In addition to enforcing fishing and vessel discharge regulations, the USCG is responsible for regulating vessel traffic, maintaining aids to navigation, increasing boater safety, and coordinating search and rescue operations. On any given week, the USCG typically has one 270 ft cutter transiting the

Western Gulf of Maine Closure Area (WGoMCA) looking for fishery violations. The USCG is a non-voting *ex-officio* member (Admiral 1st District or designated representative) of the Sanctuary Advisory Council.

Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) helps protect sanctuary water quality by regulating sewage outfalls via National Pollutant Discharge Elimination System Permits and ocean dumping under Title I of the Marine Protection, Research, & Sanctuaries Act. Title I requires a federal permit for the transportation and disposal of any materials beyond state jurisdiction (3 nm) and out to the 200 mile EEZ. EPA is responsible for designation of ocean disposal sites, certifying the dredged material is suitable for disposal in designated ocean dumpsites, and oversees ACOE permits for disposal of dredged material.

Regional Authorities

Three regional fishery management authorities are responsible for managing species occurring in the sanctuary. The New England Fishery Management Council (NEFMC) and the Mid-Atlantic Fisheries Management Council (MAFMC) are authorized by the MFCMA; the Atlantic States Marine Fisheries Commission (ASMFC) is authorized by the Atlantic Fisheries Act of 1942 and the Atlantic Coastal Fishery Cooperative and Management Act (ACFCMA).

Species or species complexes in federal waters are managed under fishery management plans (FMPs) prepared by the NEFMC and MAFMC. For those species that cross jurisdictional boundaries, one of these authorities will take the lead on the management plan development and coordinate implementation with the other as affected. The ASMFC prepares coastal fishery management plans (CMPs) for any fishery resource that moves among, or is broadly distributed across, waters under the jurisdiction of one or more States or waters under jurisdiction of one or more States and the U.S. Exclusive Economic Zone, which explains why some species are double listed below. The respective authority(s) for managing fisheries for the following species, which at least sometimes occur in the sanctuary, is as follows:

NEFMC:

- Northeast multispecies (cod, haddock, pollock, halibut, yellowtail flounder, winter flounder, windowpane flounder, witch flounder, American plaice, white hake, ocean pout, redfish)
- Monkfish
- Atlantic herring
- Scallops
- Skates (thorny and smooth)
- Red crab
- Atlantic salmon
- Whiting complex (silver hake, red hake, and offshore hake)

MAFMC:

- Spiny dogfish
- Bluefish
- Summer flounder
- Ocean quahog
- Atlantic mackerel
- Surf clam
- Black sea bass
- Tilefish
- Squid
- Butterfish
- Scup

ASMFC:

- American lobster
- Menhaden
- Striped bass
- American eel
- Atlantic menhaden
- Scup
- Winter flounder
- Northern shrimp
- Tautog
- Atlantic sturgeon
- Bluefish
- Atlantic herring
- Summer flounder
- Black sea bass
- Spiny dogfish and coastal sharks
- River herring (alewife and blueback herring)

The regulation of fishery resources in national marine sanctuaries is a collaborative process whereby the sanctuary superintendent works with fishery managers and the councils to ensure that sanctuary resources are appropriately managed (Appendix H). Stellwagen Bank sanctuary works primarily with the NEFMC on fishery management and habitat protection issues. Sanctuary staff sits on the advisory board to the Habitat and MPA committee. The NEFMC is a non-voting *ex-officio* member (Executive Director or designated representative) of the Sanctuary Advisory Council.

Gulf of Maine Council on the Marine Environment (GoM Council)

The Gulf of Maine Council is a U.S.-Canadian partnership of government and non-government organizations working to maintain and enhance environmental quality in the GoM to allow for sustainable resource use by existing and future generations. The sanctuary and the GoM Council share many common goals and objectives albeit at different scales. To date, interaction between the two organizations has been intermittent. Much of what is being learned about the smaller scale of the sanctuary is applicable and transferable to the larger scale gulf. Many of the projects of the GoM Council are of related interest to the sanctuary.

State Agencies

The sanctuary lies entirely outside of state waters. However, the sanctuary boundaries to the north and south are coterminus with those of the Commonwealth of Massachusetts.

Massachusetts Executive Office of Environmental Affairs (EOEA)

The Executive Office of Environmental Affairs (EOEA) is responsible for implementing the Commonwealth's environmental protection policies including those related to coastal zone and ocean protection. EOEA recently developed an ocean management policy. EOEA oversees the MCZM Office, the Ocean Sanctuaries Program and the Board of Underwater Archaeological Resources. The sanctuary coordinates with EOEA primarily on proposal reviews for projects that may mutually impact on both state and sanctuary (federal) waters.

Coastal Zone Management Office (MCZM)

The Massachusetts Coastal Zone Management (MCZM) implements the Coastal Zone Management Act (CZMA) on behalf of the Commonwealth. The sanctuary works with MCZM on issues such as pollution prevention, invasive species, ballast water discharge, MPA policy and habitat protection. The MCZM south shore extension agent is co-located at the sanctuary headquarters in Scituate. MCZM is a non-voting *ex-officio* member (Director or designated representative) of the Sanctuary Advisory Council.

Massachusetts Division of Marine Fisheries (DMF)

The Massachusetts Division of Marine Fisheries (DMF) is responsible for managing the Commonwealth's fishery resources and developing and implementing fishery policies including aquaculture. The sanctuary works with DMF on issues such as project proposal review, MPA policy, contingency planning and fish research. DMF is a nonvoting *ex-officio* member (director or designated representative) of the Sanctuary Advisory Council.

Massachusetts Division of Fish and Wildlife and Environmental Law Enforcement (DFWELE)

The Division of Fish and Wildlife and Environmental Law Enforcement (DFWELE) is responsible for enforcement of the Commonwealth's environmental protection laws. DFWELE oversees the Massachusetts Environmental Police (MEP). The MEP provides uniformed patrol officers to enforce laws on both land and water. One of MEP's South Coastal offices is co-located at the sanctuary headquarters in Scituate. By formal agreement, MEP officers are cross-deputized to work with NOAA OLE in sanctuary enforcement. MEP is a nonvoting *ex-officio* member (Director or designated representative) of the Sanctuary Advisory Council.

Massachusetts Board of Underwater Archaeological Resources (BUAR)

The Board of Underwater Archaeological Resources (BUAR) is responsible for managing the Commonwealth's underwater archaeological resources. The sanctuary works with BUAR on outreach efforts associated with maritime heritage resources and on the development of maritime heritage resource management policies in the sanctuary.

State Ocean Sanctuaries Program

The Ocean Sanctuaries Program protects five state-designated ocean sanctuaries (two of which abut the sanctuary) from exploitation, development or activity which would seriously alter or otherwise endanger the ecology and appearance of the ocean, the seabed, or the subsoil of the seabed, or the Commonwealth waters adjacent to the Cape Cod National Seashore. Activities specifically prohibited in ocean sanctuaries include the building of any structure on the seabed or under the subsoil; the construction or operation of offshore electrical generating stations; the removal of sand and gravel; oil and gas exploration and exploitation; and the dumping or discharge of commercial or industrial waste.

Local Government Agencies

Town of Scituate

The town and the sanctuary are developing a relationship around common interests such as marine operations, increased ocean literacy, heritage resource management and environmental stewardship. Specifically, the town and sanctuary are working on the following projects:

- Marine operations — the sanctuary is considering leasing slip space at the town's new Marine Park for winter berthing of the R/V *Auk* and the sanctuary provides the Fire Department slip space at its pier;
- Ocean literacy — the sanctuary has placed a temporary interactive exhibit at the town library and provides presentations upon request to town and school groups;
- Heritage resources — the sanctuary worked with the town's historic commission to create an exhibit at the town's Maritime and Irish Mossing Museum and the sanctuary has facilitated the town's application for designation as a "Preserve America City" which would qualify the town for potential grant funds to develop and interpret its heritage resources; and
- Environmental stewardship — the sanctuary provides the town use of its meeting annex for marine-related committee meetings including the Waterways Commission and the Marine Park Authority Committee.

City of Gloucester

The mayor's office facilitated development of the sanctuary's exhibit in partnership with the Gloucester Maritime Heritage Center. The sanctuary worked with the mayor's office to help facilitate the town's successful application for designation as a "Preserve America City."

City of Provincetown

The sanctuary is working with the city to secure a space for a permanent sanctuary visitor exhibit. A seasonal exhibit has been available since 2001.

Tools for Formalizing Relationships

The sanctuary superintendent has numerous options to formalize interactions with these and other federal, state and local agencies or private interests including:

- Memoranda of Understanding and Memoranda of Agreement formalize in writing, relationships between the sanctuary and other entities for a specific purpose or project;
- Interagency Agreements are used to share expertise, equipment and/or personnel;
- Grants/Cooperative Agreements are financial assistance tools used to provide or receive certain funding for projects and/or products benefiting the public;

- Contracts are used to procure goods and services to meet sanctuary goals and objectives;
- Consultation is formal communication between agencies, which can be invoked when one agency's activity may affect the resources of another.

Sanctuary Funding

Appropriations

Funding for the NMSP is derived primarily from federal appropriations and divided into two principal categories: funds for base budget and funds for capital facilities. The NMSP distributes its base budget funds to individual sanctuaries for site-specific core operations (labor costs for existing staff and other administrative expenses) and programmatic costs (the additional costs the sanctuary incurs carrying out management strategies such as marine mammal protection). Capital facility funds supplement the site's base budget to cover costs of such things as exhibits and building renovations. Each action plan in the Management Plan section of this document includes a table identifying costs for the individual strategies over the next five years (from the date of publication of this document). The tables provide a rough estimate of the programmatic costs needed to implement each of the strategies.

Additional Sources of Support

In addition to federal appropriations, the sanctuary relies on partnerships, appropriate outside funding sources, such as grants and in-kind services, to assist in the implementation of the management plan. These other sources include:

The National Marine Sanctuary Foundation (NMSF)

The National Marine Sanctuary Foundation (NMSF) provides collaborative opportunities for the national marine sanctuaries through public and private sector partnerships. The NMSF helps to develop external funding opportunities for NMSP outreach and education programs and other resource protection efforts.

Federal, Regional, State and Local Agencies

Federal, regional, state and local agencies participate in on-going resource protection, management, monitoring, enforcement and permit programs to help carry out sanctuary goals and objectives. As intra- and interagency relationships become formalized and common goals and objectives are identified, the sanctuary pursues opportunities to share staff, expertise and financial resources, as appropriate.

Nonprofit Organizations and Foundations

Nonprofit organizations and foundations have joined the sanctuary in numerous cooperative projects. For example, in conjunction with the sanctuary, the International Wildlife

Table 1. Summary of current research and monitoring projects in the Stellwagen Bank sanctuary.

Project	Type		Funding		
	Research	Monitoring	Intramural	Extramural	Collaboration
Marine Mammal Protection					
Whale tagging for understanding behavior	■		■	■	NMFS, WHOI, UNH, UHI, Duke, WCNE
Passive acoustic characterization		■	■	■	Cornell U., NMFS
Commercial shipping		■	■	■	NMFS
Marine mammal distribution		■	■		WCNE, PCCS
Whalewatch guidelines	■		■	■	NMFS
Ecosystem Protection					
Seafloor habitat recovery monitoring		■	■		NURC-UConn, U. Maine, Brown U.
Use assessment		■	■		
Water quality		■	■		Battelle, MWRA
Ocean observing		■		■	GoMOOS
Commercial fisheries effort		■	■		NMFS, NEFMC
Sand lance ecology	■		■	■	MFP, Boston U.
Fish tagging	■		■	■	Boston U.
Trends in fish size	■		■		
Historical ecology	■		■		UNH
Maritime Heritage Management					
National Register listed site monitoring		■	■	■	NURC-UConn
Maritime heritage inventory	■		■	■	NURC-UConn
Historic wrecks characterization	■		■	■	NURC

Coalition originated and the Whale and Dolphin Conservation Society spearheads the "See-A-Spout" program to increase boater awareness of how to enjoy and protect marine mammals in the sanctuary and beyond.

Research and Monitoring

The sanctuary conducts a robust science program focused on providing information to support key management needs. Science is comprised of both research and monitoring activities. The science coordinator works with the superintendent to develop the program and is responsible for both conducting and facilitating science activities in the sanctuary. A status summary of the current research and monitoring projects supporting sanctuary management is presented in Table 1. By necessity, the sanctuary relies on partnerships with other organizations that have the specialized knowledge and/or technical capability to conduct the science essential to answer management questions.

The year-around capabilities of the R/V *Auk* enhances the sanctuary's capacity to understand seasonal dynamics in ecosystem structure and function. The sanctuary provides office space for visiting scientists, fellows and interns working on sanctuary research needs. Renovation of the boathouse and development of the marine operations center will expand support for science conducted in the sanctuary. The following is a brief description of recent science findings in the sanctuary that have management implications.

Marine mammal protection:

- Whale tagging has begun to reveal the underwater behavior of humpback and right whales. Humpbacks feed in the water column and scour sand habitats to forage on prey species such as sand lance. The latter behavior makes them highly vulnerable to entanglement in fishing gear on the seafloor.
- Right whales have been documented spending extensive time feeding on zooplankton patches less than 20 m below the sea surface where prey is concentrated along the thermocline. This is within a depth range that increases the chances of collision with deep draft oceangoing vessels that are not always able to detect whales in time to divert from their path.
- Right whales vocalize extensively during the winter and early spring. This makes their detection and monitoring possible by remote hydrophones on the seafloor and has implications for the extent of anthropogenic noise in the sanctuary that masks communication of this endangered species.

Ecosystem protection:

- The Western Gulf of Maine Closure Area (WGoMCA) overlaps 22% of the sanctuary and is referred to as the "sliver." The sliver serves as a relatively unimpacted reference area for studying seafloor habitat recovery in the absence of bottom tending fishing gear relative to natural disturbance. Preliminary results demonstrate that cessation of fishing gear impacts can help restore ecosystem structure.
- Cod tagging on gravel and boulder reef habitats reveals that approximately 35% of the tagged cod are long-term residents of specific small areas and an additional 13% are repeat visitors to the same area they were tagged. This implies that local subpopulations of cod and possibly other demersal species may respond to relatively small scale area management measures, such as marine reserves.
- Biodiversity in mud habitats is equivalent to or greater than biodiversity in other habitats such as gravel and boulder reefs, implying that measures to restore or protect biodiversity need to include representation of all habitat types in the sanctuary.

Maritime heritage:

- The sanctuary contains many shipwreck sites of historic value and importance.
- Shipwrecks have been heavily impacted by fishing gear.
- Shipwrecks in deep water have good structural preservation.
- Shipwrecks become important habitat for sessile organisms and refugia for fish.

Education and Outreach

The goals of the education and outreach program are to bring information about the sanctuary's research and resource protection programs before the public, to encourage stewardship of sanctuary resources, and to advance ocean literacy among students, teachers and the general public, which is a NOAA priority. The education coordinator works with the sanctuary superintendent to develop the education and outreach program and is responsible for conducting and facilitating activities that implement it.

The education and outreach program for the sanctuary consists of multiple elements including print publications and audio-visual productions, general public outreach, user group outreach, formal education, informal education, media relations and exhibits. A summary of representative education and outreach products and programs developed by the sanctuary or through collaboration with its partners is listed in Table 2. Many of the sanctuary's education and outreach projects have developed as cooperative ventures with partners including non-governmental organizations, educational institutions, museums and aquariums. In recent years, a variety of projects have been initiated that meet site needs and incorporate NMSP priorities, including several education mini-grant projects.

Intramural

Intramural products and programs are specific to the sanctuary and are funded primarily through NOAA. These efforts are directed at delivering information about ongoing sanctuary research and resource conservation programs to the general public and specific user groups. Funding for these programs has come from the site budget, national education mini-grants, capital facilities funds for exhibits, and national program priority allocations. The following is a brief description of recent education products and programs developed by the sanctuary that have management implications, particularly in describing work in three principal resource sectors—marine mammal protection, ecosystem protection and maritime heritage management.

Media Relations. The sanctuary has produced press releases, media advisories and backgrounders, including notices about upcoming sanctuary advisory council meetings, special events, workshops and research results. When applicable, press conferences have been held to announce significant findings, as was done with the confirmation of the wreck of the steamship *Portland*. Editorial board visits by sanctuary staff have also been made to major news outlets. When appropriate, sanctuary staff members have been interviewed by reporters from print and broadcast media to provide technical expertise and program content to the stories. Recent articles have highlighted sanctuary whale tagging research and shifting of the Boston Traffic Separation Scheme to protect whales from ship strikes. Media relations is a key means of disseminating sanctuary news to the wider public.

Publications and Audio-Visual Materials. The sanctuary has produced various printed and A-V materials, including an annual summer newspaper called "Stellwagen Soundings" since 1995 and periodic newsletters called "Stellwagen Banknotes" since 2002, along with a variety of other flyers, brochures, posters and videos. The summer newspaper, print run of approximately 40,000, contains updates on sanctuary research, discussions of management issues, and provides information on stewardship programs. It is distributed in bulk to whale watch operations, museums, and tourism centers and serves as the major outreach tool for the sanctuary to the interested public.

Web Site. The sanctuary redesigned the entire Web site in 2006 to better meet management needs. It serves as the primary year-round distribution point for sanctuary information. The Web site now includes sections about the resources of the sanctuary, visitor uses, research and education programs, enforcement, staffing and facilities. The site incorporates design and navigation standards developed for the NMSP's Web page.

Exhibits. The sanctuary has developed seasonal visitor exhibits in Provincetown and Gloucester, gateway communities to the sanctuary. The sanctuary has also developed several traveling exhibits, including interactive computer kiosks that tour local public libraries, a trade show pop-up, window shade banners and photograph collections, which have been displayed at various venues, including the Independence and Cape Cod Malls, Nantucket Whaling Museum, Salem National Historic Site Visitor Center, New England Aquarium and South Shore Natural Science Center; a newly redesigned version of the show was completed in 2007. These exhibits provide a means of explaining key sanctuary management issues and research to the public, using attractive visual media, including videography, photography and computer graphics. The sanctuary exhibit at the New England Aquarium is a collaborative effort that received funding from various governmental and non-governmental sources.

Extramural

Various organizations and commercial operations, such as whale watch companies, provide education and outreach about the sanctuary to the public without funding from the sanctuary. The organizations often consult with sanctuary staff in the development of their outreach programs, and may use data or imagery from the sanctuary in the products or programs they produce. Table 2 includes listings of extramural projects that have been entirely undertaken by outside organizations or have some component of external funding/expertise and sanctuary participation.

Of foremost importance in this category are public outreach products (advertising flyers and brochures from whale watch companies, books and articles) and formal and informal education programs, including multi-day programs or dock-side half-day programs on regional tall ships. These vessels include the Provincetown Center for Coastal Studies' *Spirit of Massachusetts*, Sea Education Association's *Corwith Cramer*, and the Commonwealth of Massachusetts' Schooner *Ernestina*. Marine policy and marine science programs at area colleges and high schools may include information about the sanctuary when covering the Gulf of Maine ecosystem.

Collaborative

The sanctuary collaborates with many institutions in the development and delivery of public outreach products, such as printed information, video programs; formal and informal education programs; and exhibits. In many cases, the sanctuary shares the cost of the project with its partners, or may offer in-kind support in the form of staff time or facility use. These collaborative efforts are a key element in disseminating information about sanctuary resources, issues and management activities to a wider public. Table 2 lists important collaborative education and outreach efforts; the following productions and programs are of particular note.

Media Productions

The high cost of producing audio-visual programs has led to several collaborative projects. The sanctuary provided technical expertise and staff assistance in the production of The Science Channel's one-hour special on "The Wreck of the *Portland*," on the History Channel's "Deep Sea Detectives: *Portland*" and *Chronicle Magazine*'s episodes focusing on shipwrecks. Game Warden/Wildlife Journal produced an episode on the sanctuary research and enforcement, and Divers Down covered fish and invertebrate biodiversity.

The sanctuary aided master storyteller Jay O'Callahan in the development of his oral presentation/tape/CD on "The Spirit of the Great Auk," which focused on human use of the marine environment and extinction of a marine species.

This audiotape/CD serves as a companion piece to the NOVA special (The Haunted Cry of a Long Gone Bird). The "Whaling to Watching: Right Whales" video was developed jointly with the Gray's Reef National Marine Sanctuary and the Georgia Department of Natural Resources, and serves as a companion piece to a book and poster by the same name.

In 2005 and 2006, the sanctuary worked with the National Undersea Research Center at the University of Connecticut to deliver two live broadcasts from sanctuary historic shipwreck sites in collaboration with the Provincetown Memorial Museum and the Gloucester Maritime Heritage Center. These programs, in addition to showings at on-shore auditoriums, were streamed live on the World Wide Web.

Formal and Informal Education

The sanctuary has worked collaboratively with various organizations to develop education products and programs for formal and informal education audiences (K-12, college/graduate students, teachers, and user groups). Of particular note was a 13-week course offered at the Cape Cod Museum of Natural History in the spring of 2005 that focused on sanctuary resources and issues, and was targeted to high school educators, whale watch naturalists and the interested public. The sanctuary has worked with the Boston Globe to develop two education supplements: "Water" in 1998 and "Saltwater Sanctuary" in 2002. A special issue of the Massachusetts Marine Educators quarterly journal focused on the sanctuary in 1997 and again in 2007.

Less formal, more user-oriented education programs have also been developed, including the Fish and Invertebrate Identification Programs for divers, and the See-A-Spout boater education program with the Whale and Dolphin Conservation Society to promote safer boating around whales. The annual Whale Naming Workshop serves to identify new humpback whales in the sanctuary, a service to researchers and naturalists, and is conducted in collaboration with several local non-governmental organizations.

Enforcement and Permitting

Enforcement

Sanctuary resource protection depends in part upon enforcement of sanctuary regulations and other applicable state and federal statutes and regulations. The sanctuary's approach to enforcement focuses on two specific components: 1) the use of interpretive enforcement as a means to inform the public and encourage voluntary compliance, and 2) the legal enforcement of regulations. Currently the sanctuary enforcement program consists of *ad hoc* patrols conducted by the USCG or the OLE and Massachusetts Environmental Police (MEP). Routine patrols are not conducted because of budget limitations to fund dedicated enforcement officers. When a violation is documented in the sanctuary, NOAA OLE and General Counsel prosecute the case.

Sanctuary regulations are enforced by the NOAA OLE and the USCG, through cooperative agreements which allow OLE to cross-deputize enforcement officers from state agencies. Accordingly, enforcement officers from MEP are authorized to enforce sanctuary regulations. The sanctuary currently has individual enforcement agreements with USCG and the MEP. The sanctuary continues to develop and update cooperative agreements among enforcement agencies (see Strategy ADMIN 2.5) for purposes of ensuring effective enforcement of sanctuary and other pertinent federal regulations.

Permitting

Permits are required in all sanctuaries for conducting activities otherwise prohibited by sanctuary regulations (current sanctuary regulations, Appendix I). Under current regulations, the sanctuary superintendent may issue, in some cases with NMSP Director's approval, a permit to conduct an activity in the sanctuary otherwise prohibited by sanctuary regulations provided the activity: 1) is research related to the resources of the sanctuary, or 2) furthers the educational value of the sanctuary, or 3) furthers the management purposes of the sanctuary (15 CFR Subpart N).

The permit application process requires the submittal of a project summary, including the exact location of activities, description of methods, rationale for use of the sanctuary environment, explanation of environmental consequences, and plan for reporting results to the sanctuary. In considering whether to grant a permit the sanctuary superintendent (or NMSP Director where appropriate) evaluates: the professional and financial responsibility of the applicant; the appropriateness of the methods envisioned to the purpose(s) of the activity; the extent to which the conduct of any permitted activity may diminish or enhance the value of the sanctuary as a source of recreation, or as a source of educational or scientific information; the end value of the activity; and such other matters as may be deemed appropriate (15 CFR. Subpart N).

Table 2. Summary of representative education and outreach products and programs developed by the Stellwagen Bank sanctuary or through collaboration with its partners.

Products and Programs	Intramural	Extramural	Collaboration
Publications			
Book — Stellwagen Bank: A guide to the whales, sea birds, and marine life of the Stellwagen Bank National Marine Sanctuary. 1995.		■	Provincetown Center for Coastal Studies (PCCS)
Stellwagen Soundings — annual newspaper (bulk distribution, approx. 40,000) 4-color, 8-page, tabloid, 1995–present.	■		Bulk distribution though whale watch companies, aquariums, museums, tourism offices, NGO's
Stellwagen Banknotes — periodic newsletter (approx. 5,000 per issue) B&W, 8-page, 8.5x11 (3xyr), 2002–present.	■		
State of the Sanctuary Report – 2002.	■		
Whale Watch Guidelines — brochure — 2001, 2006.	■	■	NOAA Fisheries Service
Whale Safety Sticker — 2001.		■	International Fund for Animal Welfare (IFAW)
See A Spout boater education brochure, sticker, transparencies and CD — 2003, 2005, 2007.	■	■	International Wildlife Coalition (IWC) — 2003, 2005; Whale and Dolphin Conservation Society (WDCS) — 2007
Advertising flyers and brochures from whale watch companies incorporating sanctuary information.		■	Various companies and whale research groups
Technical fact sheets on sanctuary geology and oceanography.		■	US Geological Survey (USGS)
Assorted flyers and fact sheets, including sanctuary rack card, Provincetown exhibit rack card — 1994–present.	■		
Exhibits			
Provincetown MacMillan Wharf Kiosk — 1995–present.	■		PCCS
Provincetown Exhibit (formerly at Bradford Street, now in Aquarium Wharf) — 2001–present.	■		
Gloucester Maritime Heritage Center — temporary exhibit 2004–2005; permanent exhibit 2006–present.	■	■	Gloucester Maritime Heritage Center (GMHC), NMSF
Museum of Natural History; South Shore Natural Science Center; Nantucket Whaling Museum — 1997–2000.			
Revised/Updated Photo Exhibit (whale research) — South Shore Natural Science Center, other locations in future — 2007.	■		Various whale researchers/ photographers
Traveling Touchscreen Kiosks and Windowshade Exhibit for libraries, nature centers and other educational venues and public meeting places — 2006–present.	■		
NE Aquarium — interpretive signs; Immersive Theater show — Storm Over Stellwagen; Stellwagen Bank Sanctuary exhibit (two tanks and associated signage) in Gulf of Maine cold water gallery — 1997–present.	■	■	NE Aquarium (NEAq), NMSF
Scituate Maritime and Irish Mossing Museum (Shipwreck exhibit) — 2003–present.	■		Scituate Maritime Museum
Woods Hole NOAA Fisheries Service Aquarium — signs, photos, and tanks with sanctuary species; distribution of sanctuary literature — 2000–present.	■		NOAA Fisheries Service
Sanctuary wall panels at Provincelands Visitor Center of the Cape Cod National Seashore.	■		Cape Cod National Seashore
Portable 8'x10' Pop-Up Exhibit and Portable Windowshade Panels — 1996–present.	■		
National Aquarium in Washington DC (tank with photos) — 2003–present.	■	■	NMSF
Public Outreach Programs & Events — General Public			
Sanctuary Speakers Program — staff talks to various groups, including Rotary Clubs, Power Squadrons, historical societies, etc.	■		
Stellwagen Bank National Marine Sanctuary Celebration and Great Annual Fish Count in Gloucester — 2002–present.	■		GMHC

Table 2. Summary of representative education and outreach products and programs developed by the Stellwagen Bank sanctuary or through collaboration with its partners.

Products and Programs	Intramural	Extramural	Collaboration
Sanctuary Open House — 2006.	■		
Participation in various fairs and celebrations, including Marshfield Fair, Duxbury Bay Day, Earth Day (Boston), Gloucester Seafood Festival.	■		
Whale Day at various sites, including Independence Mall, Cape Cod Mall, Boston Children's Museum, South Shore Natural Science Center.	■	■	NOAA Fisheries Service, WDCS
Stellwagen Bank Sanctuary 10th Anniversary Lecture Series — 2002.	■	■	NEAq
Stellwagen Bank lectures as part of Cape Cod Biodiversity Course with Cape Cod Museum of Natural History — 2002, 2003.	■	■	Cape Cod Museum of Natural History (CCMNH)
Steamship *Portland* Symposium with Portland Harbor Museum — 2003.	■	■	Portland Harbor Museum
Sustainable Seas Expedition (SSE) and Sanctuary Weekend on Central Wharf — 1999.	■	■	National Geographic Society (NGS), NEAq
Sanctuary Video and Lecture Series in Scituate — 2006–2007.	■		
User Group Meetings and Conferences			
Coastal Zone 99 conference.	■		
Boston Sea Rovers (divers) Annual Conferences — 2000–present.	■		
Massachusetts Marine Educators Annual Conferences — 1994–present.	■		
National Marine Educators Conference — 2001.	■		
Massachusetts Environmental Education Society Annual Meetings — 1998, 1999.	■		
Fish Expo, Workboat Atlantic — 2000, 2002, 2004, 2006.	■		
Massachusetts Lobstermen's Association Annual Meetings — 2002–present.	■		
Oceans 2006 Conference.	■		
Cape Cod Natural History Conference — 2005–present.	■		
Media Outreach			
Press releases and community calendar notices as needed (fax and e-mail distribution) 1994–present.	■		
Interviews with local print, radio, TV and cable stations as needed — 1994–present.	■		
PSA on right whales and the sanctuary 1996.	■	■	Boston University
Articles in tourism publications, including Kids on the Cape — free articles in publications (250,000 circulation) 2002-present; Official Cape Cod Guidebook (Cape Cod Chamber of Commerce) 4-page article — 2004, 2005, 2006, 2007.	■		
Articles in trade publications, including Sea History, Oceanography, etc.	■		
Audio-Visual Productions			
"The Wreck of the *Portland*" one-hour HD TV program.		■	The Science Channel
"Deep Sea Detectives: *Portland*" one hour TV program.		■	History Channel
"Massachusetts Shipwrecks"(2006) and "Wreck of the Portland" (2001) half-hour TV program.		■	Chronicle Magazine (WCVB-TV5)
"Stellwagen Bank" one-hour TV program.		■	Game Warden/Wildlife Journal
"Bounty of the Banks" (1998) half-hour video.	■		

Table 2. Summary of representative education and outreach products and programs developed by the Stellwagen Bank sanctuary or through collaboration with its partners.

Products and Programs	Intramural	Extramural	Collaboration
"Northern Right Whales: From Whaling to Watching" (1997) half-hour video.	■	■	Gray's Reef NMS, Georgia Dept. of Natural Resources
"The Spirit of the Great Auk" audiotape by master storyteller Jay O'Callahan (2002).	■	■	
GreenCape radio shows with WOMB in Provincetown (5-15 minute programs) — 1998.	■		Creative Resources Group (studio time donation)
Live Video Programs of missions to the *Portland* and *Palmer/Crary* shipwrecks — 2005, 2006. DVDs of footage from programs (2007).	■	■	NURC-UConn
Education Programs K-12 and college/graduate — Guest Lectures, workshops, programs, products			
Graduate Credit course on Stellwagen Bank National Marine Sanctuary natural and cultural resources (credit from Framingham State College) — 2005.	■	■	CCMNH
Right Whale Course, 12 professional development points for educators — 2007.	■	■	WDCS
Northern Right Whale: From Whaling to Watching – educator book and poster — 1997.	■	■	Gray's Reef NMS
ROV Teacher Workshops — 2004, 2006; annual support for regional ROV Competition.	■	■	Marine Advanced Technology Education Center (MATE), New England Chapter Marine Technology Society (NE-MTS)
"Lefty the Right Whale" traveling inflatable whale program for elementary schools — 1997–present.	■		
Staff talks and workshops at various schools, High School science symposia workshops — 1994–present.	■		Mass Marine Educators (MME); Mass Maritime Academy
Annual Marine Art Contest (K-12) — 1994–present.	■	■	MME, NEAq
Newspaper in Education Supplement (topics: water — 1998; sanctuary — 2003).	■	■	Boston Globe
Exploring Data with GIS to Experience Sanctuaries (EDGES) curriculum — 2004; Discovering Sanctuaries GIS teacher workshop — 2005.	■	■	Channel Islands, Gray's Reef and Florida Keys NMSs; National Geographic Society (NGS)
MimiFests for students (1500 students per year) — 1995–1999; teacher workshop 1995.	■	■	Barn School Trust and Brockton and Plymouth School Systems
Sustainable Seas Expedition — web pages, logs, activity in teacher resource book — 1999.	■	■	NGS
Salt Water Studies Teacher Workshop — 2004, 2005.	■	■	Waquoit Bay National Estuarine Research Reserve (WBNERR)
Cape Cod Biodiversity college course (3-week marine component) — 1998–2001.	■	■	CCMNH
Stellwagen Bank Science and Education Symposium — 1997.	■	■	MME
Student Ocean Forum — 2002, 2003, 2004.	■	■	Coastal America; NEAq
Heroes of the Planet — distance learning lecture series (subjects Sylvia Earle, Dick Wheeler, U.S. Coast Guard).	■	■	Cape Cod Community College and Cape and Islands high schools
Aquanaut Program with, cruise support and on-shore education 1994–present.	■	■	NURC–UConn
Tall Ship education programs.		■	PCCS, Sea Education Association (SEA), Commonwealth of Mass., and others
User Education Programs			
Whale Watch passenger education by on-board naturalists.		■	Most whale watch companies traveling into the sanctuary; some are affiliated with whale research groups

Table 2. Summary of representative education and outreach products and programs developed by the Stellwagen Bank sanctuary or through collaboration with its partners.

Products and Programs	Intramural	Extramural	Collaboration
Fish and Invertebrate Identification courses for divers — 2002–present.	■	■	Reef Environmental Education Foundation (REEF); Professional Association of Diving Instructors (PADI); MIT Sea Grant
See a Spout boating safety around whales — 2001–present.	■	■	International Wildlife Coalition (IWC) and WDCS
Whale Naming Workshop, production of new whales CD-ROM — 2001–present.	■	■	Whale Center of New England (WCNE), PCCS and other cetacean research groups
On-the-water Boater Education — 2001–2003.	■		Massachusetts Environmental Police (MEP)
Stellwagen Bank Flotilla of the USCG Auxiliary/Operation Cetacean Shield and other joint Stellwagen Bank National Marine Sanctuary and USCG programs — 1996–present.	■	■	USCG Auxiliary
Whale Watch Naturalist Lectures — 2002, 2006.	■	■	NEAq, WDCS

III. Sanctuary Setting

This section presents the concept of managing marine resources for biodiversity conservation in the sanctuary. It describes the physical setting of the sanctuary including its geography, geology and oceanography, as well as its connectivity to other parts of the Gulf of Maine. It profiles the primary producers and decomposers essential to the sanctuary's ecosystem function.

Biodiversity Conservation

The environmental condition of the sanctuary is subject to major alterations that are largely due to the effects of human activities. Threats to resource states (e.g., water quality, ecological integrity, habitat complexity) fall into two general categories: those that involve exploitation of resources above a certain level or threshold and those that destroy or degrade marine habitats and the associated biological communities. Exploitation includes both directed harvest and incidental taking of marine life. Threats to habitat include activities leading to physical alteration, various sources of pollution, coastal development and introduction of alien species. Many of these threats are interrelated and have cumulative impacts.

The ability to accurately evaluate the scale and consequences of changes in the sanctuary's resource states (and the subsequent impacts on human society) is challenged by inadequate knowledge of historic baselines for comparison with conditions today. The basic diversity of marine life and the patterns and processes that control the distribution and abundance of marine organisms in the sanctuary is still not well understood. At the same time, exciting new technologies and conceptual advances permit us to implement novel research approaches that seek to reveal fuller understanding of the sanctuary's ecological structure and the diversity and function of its biological communities.

NOAA can and should play a powerful role in protecting this special marine area, increasing public awareness and support for marine conservation, and providing sites for research and monitoring. By changing public attitudes, improving scientific understanding and developing effective models for management, the sanctuary can extend its benefit well beyond the limit of its geographic boundaries. Comprehending the great importance of marine biodiversity, and thereby gaining insights to interpret, explain and maintain ecological complexity, is the basis for marine resource management in the Stellwagen Bank sanctuary.

Emphasis on Community Ecology

Sanctuary management is predicated on the application of science to help formulate understanding of key issues and problems and to infuse the related public dialogue with substantive fact and thought. While many scientific disciplines (e.g., geology, oceanography) are invoked in the process, ultimately, ecology is paramount. While there have arisen a variety of approaches to the study of ecology (e.g., physiological, evolutionary), three basic and classical approaches remain fundamental to the science and are prevalent in the articulation of public policy. These approaches are population ecology, community ecology and ecosystem ecology (Ricklefs and Miller, 2000; Ricklefs, 2001).

Population ecology emphasizes the uniquely biological properties that are embodied in the dynamics of populations. A population consists of many organisms of the same species living together in the same place. Populations differ from organisms in that they are potentially immortal, their numbers being maintained over time by the births and deaths of new individuals that replace those that die. Populations also have properties such as geographic boundaries, densities and variations in size and age composition. Population ecology is essentially the study of the vital rates (births, deaths, recruitment) and biological processes that maintain numbers of animals in a species population. Population ecology is directly relevant to the management of fisheries, forestry and agriculture where rates of removal by harvest need to be balanced against natural means and rates of replenishment.

Community ecology is concerned with understanding the diversity and relative abundances of different species living together in the same place. An ecological community is the sum of many populations of different species living in the same or similar habitats. The community approach focuses on interactions among multiple populations, which promote and limit the coexistence of species. The focus of community studies is principally on how biotic interactions such as predation and competition in relation to habitat influence the numbers and distributions of organisms. These interactions include feeding relationships, which are responsible for the movement of energy and materials through the ecosystem, providing a link between community and ecosystem approaches. Community ecology has particular relevance to the understanding of the nature of biological diversity and to the management of national marine sanctuaries.

Ecosystem ecology describes the dynamics of energy transformations and material transfers among large assemblages of organisms and the physical environment occupied by those organisms. Ecosystems are large and complex systems, sometimes including many thousands of different kinds of organisms living in a great variety of habitats. In the course of their lives, organisms transform energy and process materials. To accomplish this, organisms must acquire energy and nutrients from their surroundings and rid themselves of unwanted waste products. In doing so, they modify the conditions of the environment and the resources available for other organisms, and they contribute to energy fluxes and the cycling of elements. Ecosystem function results from the activities of organisms as well as from physical and chemical transformations in the seafloor, water column and atmosphere. Ecosystem understanding and approaches to both fishery and sanctuary management are recognized as essential by NOAA.

For purposes of implementing ecosystem-based resource management, the term "ecosystem" needs to be defined. A marine "ecosystem" is a human construct that artificially delineates a related portion of the ocean (Francis *et al*., 2007) over what can be a variable spatial scale (e.g., Stellwagen Bank sanctuary, Gulf of Maine). In the context of this DMP a marine ecosystem is defined by NOAA (2005:3): "An ecosystem is a geographically specified system of organisms, the environment, and the processes that control its dynamics. Humans are an integral part of an ecosystem. An ecosystem approach to management is management that is adaptive, specified geographically, takes into account ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives."

During the public comment phase of sanctuary management plan revision, questions were raised about the respective roles of the National Marine Sanctuary Program and NOAA Fisheries Service. Both parts of NOAA strive to meet a common goal of preserving or restoring the ecological integrity of unique habitats while recognizing that human uses of those habitats must be managed in an environmentally sustainable manner. Both NMSP and NOAA Fisheries Service work towards that goal using the various statutory and regulatory tools at their disposal. Under the Magnuson-Stevens Fishery Conservation and Management Act (MFCMA), NOAA Fisheries Service strives to provide for sustainable fisheries using principles of population ecology while at the same time conserving the habitat of both target and non-target marine species. While many of the existing fishery management plans focus on single species or multi-species complexes, NOAA Fisheries Service is mandated to consider the broader impact of fishing on the ecosystem and has begun converting many of these plans into ecosystem plans. The NMSP is principally tasked with managing biological communities (together with maritime heritage resources) using the principles of community ecology within explicitly designated areas (under the National Marine Sanctuaries Act (NMSA)). Both take an ecosystem approach to managing fisheries and sanctuaries respectively and when applied in a complementary fashion, both statues can advance the goal of conserving and restoring the ecological integrity of important marine areas.

Conserving biodiversity is central to the implementation of ecosystem-based sanctuary management, an evolving approach that stresses management of the entire sanctuary ecosystem including all biological communities, habitats and species populations, together with all uses. Biodiversity encompasses all levels of organizational complexity in the sanctuary, from genetic diversity to species diversity to community diversity. Maintaining the ecological integrity of the sanctuary and, hence, its sustained production of resources and services requires attention to how the component species interact and how we value those species and interactions.

Managing for Biodiversity Conservation

In federal waters, marine biodiversity conservation is achieved primarily by the interplay of four national statutes: the MFCMA, MMPA, ESA, and the NMSA. These statutes encompass two main objectives: (1) enable long-term sustainable harvest and/or human use and (2) protect and/or restore species, habitats, biological communities, and/or ecosystems.

The MFCMA was primarily designed to ensure the sustainable harvest of fish and shellfish and has evolved to include the capability to protect the habitat of target and non-target species. Similarly, the MMPA was designed to protect marine mammal species many of which were severely depleted. While offering broad protection to these species to ensure their recovery, the MMPA also regulates sustainable harvest or take in specialized cases. By ensuring that marine mammals are protected as "significant functioning elements of the ecosystem" the MMPA maintains the capability to protect individual animals, species, populations, and the habitats that sustain them. The ESA's mandate overlaps that of the MMPA for marine mammal species facing extinction. The ESA's mandate to protect listed species also includes a mandate to protect distinct animal population units and habitats deemed critical to their survival.

Enacted around the same time, Title III of the Marine Protection, Research and Sanctuaries Act (now NMSA) was the first legislation to focus on comprehensive and area-specific protection of the marine environment. The NMSA allows uses compatible with the primary purpose of resource protection. The NMSA affords managers the opportunity to consider management measures (e.g., zoned use within designated areas) for the purpose of maintaining "natural biological communities." By including the broad mandate "to protect, and where appropriate, restore and enhance natural habitats, populations, and ecological processes" the NMSA highlights its purpose to provide holistic protection of biodiversity in these special areas. Thus, within designated sanctuaries, NOAA encourages integrated implementation of these four statutes for the purpose of biodiversity conservation.

Of the 3,317 species of marine life documented in the GoM region to date (COML, 2006), there are 41 species of fish that are managed by the regional fishery management councils and the ASMFC, eight species of tuna and shark that are managed separately as highly migratory species, and 12 species of marine mammals and sea turtles managed under the ESA. Additionally, there are 39 species of seabirds managed under the Migratory Bird Treaty Act. Many other species occur in the GoM which are not subject to direct management plans, including species that are rare but not endangered, and this group is sizeable (see Sidebar). While many of these species could potentially be the subject of direct management, they often gain significant derivative benefits from the directed management actions mentioned above and other actions taken by Federal, State and local partners in the region.

Rarity

Ecological rarity is defined in a variety of different ways over a range of spatial scales, and the forms that analyses take are highly varied (Kunin and Gaston, 1997). Although definitions of rarity differ in regard to the metrics involved, the concept of rarity is universally accepted and implicitly linked to the practice of managing for biodiversity conservation. Notably, rare species most often are not targeted for economic gain but are impacted as a consequence of activities directed at the exploitation of more abundant species (e.g., Auster 2005; Watling and Auster 2005).

Most species in the GoM might be considered rare based on the relative abundance of their numbers that occur in samples. For example, over a 30-year period (1975-2005), 90% of the numerical abundance of the fish community came from 7-10 species out of a total of 77 species sampled during NOAA Fisheries Service research trawls (Auster *et al.*, 2006). The remaining 67-70 species made up only 10% of the numerical abundance and, therefore, would be considered to have some degree of rarity in the community.

Analysis of such sample data leads to questions about the distribution and abundance of rare species within the sanctuary. For example, are species rare due to human-caused disturbance or are they naturally rare in their associated communities? Answers to this question lead to discussions of the necessity of management and the need for listing under provisions of the ESA. Another question that arises is focused on whether rare species are distributed sparsely and evenly through particular habitats or are they rare in most places and have dense concentrations at limited locations? Answers to this question may indicate the need to manage impacts in centers of species abundance and to insure that potential source populations continue their ecological function.

In addition, seven important fish species—Atlantic wolfish, cusk, Atlantic halibut, Atlantic salmon, Atlantic sturgeon, thorny skate and barndoor skate are all on the Species of Concern List for the Endangered Species Act (NOAA 2006). While this designation does not grant any protected status, it indicates that these species warrant attention to insure their populations do not decline further. All of these species currently frequent the sanctuary or once did (salmon and sturgeon). Halibut, salmon, sturgeon and skates are included under various fishery management plans (FMPs). Two of these species (wolfish and cusk), while being considered for inclusion under the Multispecies FMP, have no directed fishery management plan despite continued exploitation of their populations; they are among the top ten species caught by the recreational fishery in the Stellwagen Bank sanctuary (see Table 20 in Recreational Fishing section of this document).

The NMSA is unique in that it allows management actions focused on the protection and conservation of the full spectrum of biological diversity at a unique and significant site (e.g., the Stellwagen Bank sanctuary) and can serve as an important complement to other tools available under the MFCMA and the ESA or MMPA. Congress found that national marine sanctuaries are areas of the marine environment which have special conservation and esthetic qualities (among others). Congress mandated that sanctuaries be designated upon a determination that existing authorities are insufficient or need to be supplemented to protect the resources of that area. Congress directed that national marine sanctuaries be managed to maintain the habitats, and ecological services, of the natural assemblage of living resources that inhabit these areas. Among the purposes and policies of the NMSA is provision of authority for comprehensive conservation and management to maintain the natural biological communities and to protect, restore and enhance natural habitats, populations and ecological processes.

In specifying the management of "natural biological communities," "natural assemblages of living resources" and "natural habitats" rather than focusing on species populations per se, Congress essentially mandated that national marine sanctuaries be managed to protect and conserve biodiversity. In managing for biodiversity conservation, the authorities and protection measures afforded by all relevant statutes should be brought to bear on solving the problems described in this Draft Management Plan (DMP). Given the unique roles that sanctuaries can play in overall resource conservation and management, it is reasonable to anticipate that the DMP would advocate for a higher level of conservation of living marine resources in the Stellwagen Bank sanctuary than may apply broadly throughout the whole Gulf of Maine. And it is reasonable to expect that human uses such as fishing would be done in a manner that was environmentally sustainable (see Sidebar).

Biodiversity Explained

The ocean is the cradle of biological diversity as life began in the sea. A liter of ocean water contains over a 100 million micro-organisms (Sogin *et al*., 2006). In fact, micro-organisms represent over 50% of the biomass in the sea. Some micro-organisms produce their own food using sunlight while others are predators, hunting for microbial prey in a fluid and turbid environment. The ocean also contains larger multi-cellular plants, including encrusting species that produce calcareous "skeletons" as well as large fast growing kelps that can produce dense forests rivaling those in tropical jungles. Unlike the land and freshwater realms of our planet, the ocean contains representatives of every major type of animal group (phyla) on earth, from sponges to mammals. Although animals are but a single branch of the tree of life, they are the group with which we are most familiar.

Biological diversity is, simply stated, the variety of life on earth; it is the variability in all living things at all levels of examination (United Nations, 1992). It is inclusive of the millions of plants, animals and microbes; the genes they contain; and the ecosystems they build into the living environment. The definition of "biological diversity" or "biodiversity" deserves some discussion as it can mean different things to different people. The most common meaning refers simply to "species diversity," which is all of the species in a defined area or on earth as a whole, including bacteria, protists, and fungi as well as the multi-cellular organisms (plants, animals).

The genetic variation within species, both among geographically separate populations and among individuals within single populations is termed "genetic diversity." While species diversity by definition includes all of the species, or particular groups of species in an area, genetic diversity refers to the variation within single species. The level of genetic diversity within a population is an indication of the ability of the population to respond to and persist in the face of environmental change.

At the highest levels of complexity, "community diversity" and "ecosystem diversity" refer to the different biological communities and their associations with the physical environment (i.e., the ecosystem) that occur within an area, geographic region or the earth as a whole. The diversity of communities and ecosystems within a region is an indication of the range of evolutionary forces that have influenced species distributions. The range of organisms supported at particular sites provides a benchmark to understand both natural and human-induced change

Species diversity, quantified simply as the number of species in a particular area, is one of the most straightforward means

Concept of Environmentally Sustainable Fishing

The concept of environmentally sustainable fishing is compatible with the goal of managing sanctuary resources for biodiversity conservation. An environmentally sustainable fishery protects the fish and the environment in which they live while allowing responsible use of the species that come from that environment. It is a fishery in which target species populations and associated habitats and biological communities remain functionally intact while ensuring a future for the industry and all those who depend on the fishery for their livelihoods. It is a fishery based on the principle of optimization that incorporates within its goals the maintenance of biodiversity, biological community structure and ecological integrity together with the realization of economically and socially viable fishery production and yield.

An environmentally sustainable fishery is prosecuted in a manner that does not lead to over-fishing or depletion of the exploited resources to a level that imperils their ability to be a long-term functional component of the ecological community and the industry that relies on them. For those populations that are depleted to that level, the fishery is conducted in a manner that demonstrably leads to their recovery to sustainable levels. Environmentally sustainable fishing allows for the maintenance of the structure, productivity, function and biodiversity of the ecosystem, including habitat and associated dependent and ecologically related biological communities. The fishery is conducted in a way that does not lead to trophic (food web) cascades or ecosystem state changes. The fishery does not threaten biological diversity at the genetic, species or population levels and avoids or minimizes mortality of, or injuries to endangered, threatened or protected species. The fishery minimizes bycatch (unintentional capture of non-target species) and reduces the wasteful practice of discarding that bycatch.

The practice of environmentally sustainable fishing is consistent with the 1995 FAO Code of Conduct for Responsible Fisheries (United Nations). Environmentally sustainable fishing is conducted in ways that are consistent with the MFCMA national standards and that are most likely to be compatible with the sanctuary's primary goal of resource protection. Its practice derives from implementation of the principals of ecosystem-based resource management, and its fishery products can gain promotional and market advantage through voluntary certification programs (e.g., Marine Stewardship Council (MSC)). Managing the sanctuary for biodiversity conservation does not imply that fishing should be eliminated and may require the sanctuary to work with its partners, including the Fishery Councils and NOAA Fisheries Service, to modify fishing within the sanctuary in order to conserve biodiversity.

of characterizing biodiversity and is the metric used in this document. Using this measure, there are over 575 species in the Stellwagen Bank sanctuary. Appendix J provides a preliminary list of species, ordered by phylum, currently known to occur within the sanctuary boundaries. The list is incomplete as it does not include many pelagic planktonic species that are difficult to capture and identify. NOAA intends to augment this list as more is learned about the diversity of species in the sanctuary.

Biogeographic Context

Gulf of Maine (GofM) Large Marine Ecosystem (LME)

The GoM LME forms a distinctive sub-region of the North American continental shelf in the northwest Atlantic Ocean, based not only on topography and circulation but on the communities of organisms that inhabit the area (Sherman *et al*., 1996). The GoM LME is located at the southerly end of the Acadian biogeographic province, which also includes the Bay of Fundy and the Scotian Shelf. The Stellwagen Bank sanctuary is the only national marine sanctuary in the Acadian biogeographic province.

Georges Bank is included in the Acadian biogeographic province by some scientists but in the Virginian biogeographic province to the south by others. The affinity to one or the other biogeographic province is based on differences in the distributions of major groups of organism, patterns of endemism or oceanographic features (Cook and Auster, 2007). Many scientists view Georges Bank, as well as the southern New England Shelf and mid-Atlantic Bight, as a broad transition zone with no unique biogeographic characteristics.

The Stellwagen Bank sanctuary is located in the southwest part of the GoM LME and has depths that range from 20 to greater than 200 m. The shallower parts of the sanctuary support species that are primarily coastal in origin while the deeper waters support species more characteristic of northern and deeper marine communities. Seafloor topography in the western GoM blocks the flow of Maine deep water from the north and east, thereby excluding species that reside in conditions characteristic of Maine deep water environments from sanctuary waters.

The diversity of organisms that occur in the Stellwagen Bank sanctuary is a subset of the species that occur within the larger GoM LME. While not all species found in the GoM LME occur within its boundaries, the sanctuary contains a representative sample of many of the species in the region. Because of the wide range of depths (that cross major water column boundaries) and the high diversity of habitat types (e.g., mud, sand, gravel, boulder), the sanctuary exhibits a wide range of communities and species in a relatively small area (Auster *et al*., 2001; Auster, 2002; Cook and Auster, 2006).

The GoM LME is relatively species poor when compared to other shelf ecosystems in the world ocean. For example, while the GoM has 652 species of fish (GoM Register of Marine Species at http://www.usm.maine.edu/gulfofmaine-census/Docs/About/GoMRMSClassification/index.htm; downloaded 8 August 2006), the tropical seas off northern Australia and Indonesia contain over 2,000 species of fish (Allen and Steene, 1999)—a diversity hotspot with the greatest number of fish species on earth.

Biodiversity Coldspot

Biodiversity "hotspots" are regions of the world with unusually high concentrations of endemic species (species that are found nowhere else on Earth) and that, by the original definition (Myers, 1988), also suffer severe habitat destruction. Today the term is more loosely applied to areas having the perceived biological quality of high species richness. The term is used in practice to identify areas of the world that should be managed to protect biodiversity (Myers *et al*., 2000).

By this definition, hotspots occur almost exclusively at lower latitudes in tropical and subtropical climes. Temperate places in the world that may be relatively species poor can also have high biological value, when those values are defined differently. Such places are considered to be biodiversity "coldspots" (Kareiva and Marvier, 2003). Coldspots take on particular and unique importance when they can be linked in additive fashion to become part of a regional network that fully characterizes and effectively maintains functioning ecosystems.

The Stellwagen Bank sanctuary is an important biodiversity coldspot. The sanctuary area is one of thirty priority sites for networked marine ecosystem conservation in New England and Maritime Canada that were identified through an extensive science-based approach (Crawford and Smith, 2006). That study is the foundation for a systematic effort to conserve and network high-quality and enduring examples representative of the full range of communities, habitats, environmental gradients and ecological processes in the GoM and northeast continental shelf. The sanctuary was a particularly important contributor for meeting a range of network goals, including demersal fish goals (89%), marine mammal goals (73%) and benthic habitat and seascape goals (80%).

So while the GoM region is not a global hotspot of biological diversity (*sensu* Myers, 1988), it does contain species endemic to the region, species which are the products of evolutionary forces that act selectively within the region. Hence the GoM LME contains a unique fauna based on a number of species occurring nowhere else, some having a distinct genetic composition if they are a subset of a wider ranging species, and others occurring within unique communities or habitats and having a unique ecological role when compared to other regions.

Fundamental Concepts of Biodiversity

Historical Baselines

To the extent possible, an understanding of the historic abundance and diversity of organisms in the Stellwagen Bank sanctuary area is essential to effectively manage for biodiversity conservation. Long-term population trends of economically important fish species, as well as marked changes in the ecosystem through time, can be used to make empirical estimates of key metrics. While historical baselines may be insufficient by themselves to set realistic targets for restoration efforts, they add useful perspective for consideration of what the goals and policies should be (e.g. Roberts, 2007; Bolster, 2008).

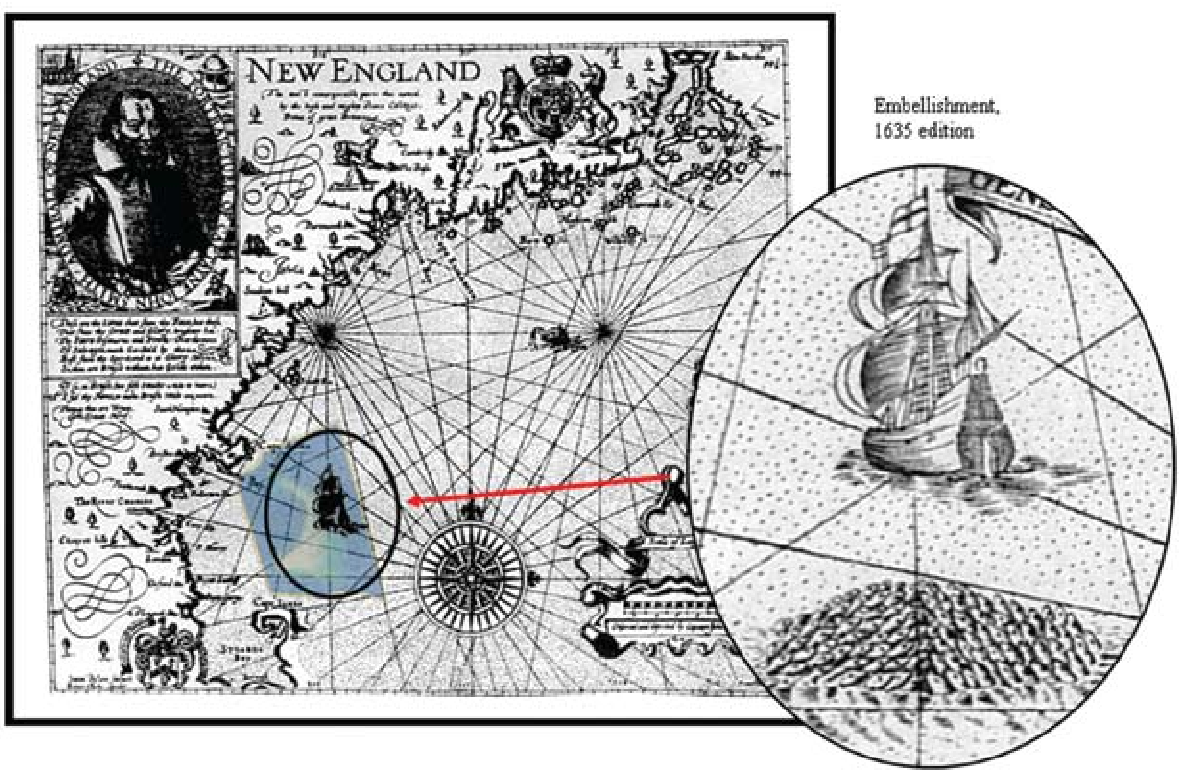
The phenomenon of "shifting baselines" as described by Pauly (1995) and Jackson *et al*. (2001), whereby standards of resource condition degrade through time, directs us towards the importance of historical perspectives as tools for determining long-term trends and setting baselines for comparison. Historical baselines can help avoid underestimations of ecosystem capacity or biased policy decisions resulting from lack of historical context. For example, Rosenberg *et al*. (2005) used fishing logs from the mid-19th century to model Atlantic cod biomass on the Scotian Shelf of Canada in 1852.

Using daily catch records, fleet activity and communication with other vessels, Rosenberg *et al*. (2005) inferred fishing capacity of the Beverly (Massachusetts) fishing fleet, and related the change in catch per unit fishing effort between 1852 and 1859 to a population dynamics model. This analysis allowed for estimation of original biomass prior to 1852 of 1.26 million metric tons of Atlantic cod. The 2002 biomass estimate, determined by Canada's Department of Fisheries and Oceans was approximately 3,000 metric tons, a decline of 99.7% from the population biomass of 1852. Growth of cod populations due to recent conservation efforts does not bring numbers of fish close to historical biomass.

Determination of historical baselines of ecosystem condition are required to make appropriate conservation decisions. Without a historical baseline, there is the risk that managers and the public mistakenly assume that recent condition of the resource in question is an appropriate reference point on which to base target restoration measures when, in fact, this reference point represents a significantly degraded condition. Absent historical context to gauge ecological potential, restoring the sanctuary's resources may result in serious underestimation of the system's capacity to respond.

The GoM cod project focuses on the collection and analysis of historical data of fish populations in the GoM including the sanctuary area (Rosenberg *et al*., 2005). The first phase of this project was aimed at the collection and review of historical sources providing biological indicators and population trends for fishes in the sanctuary. Data indicate that the sanctuary area was identified as a site of high biological productivity from the earliest times (Figure 6). The

FIGURE 6. EXPLORER JOHN SMITH'S *MAP OF NEW ENGLAND*, 1616, WITH STELLWAGEN BANK AND THE SANCTUARY AREA (SHADED BLUE) SUPERIMPOSED.



The ship was positioned over Stellwagen Bank (and within the boundaries of what today is the Stellwagen Bank sanctuary) and was an early convention to identify good fishing grounds. In the 1635 revised edition, the map was embellished with a pyramid of "cod heads" under the ship to depict the area as being especially good fishing. Courtesy: Karen Alexander, GoM cod project, University of New Hampshire.

second phase will incorporate the data into a Geographical Information System (GIS) database, as well as analyze the data in order to determine historical trends in fish diversity and population abundance. The Sidebar on researching historical trends offers background for work ongoing in the sanctuary.

Trophic Interactions

Food Webs

Other than primary producers and chemosynthetic organisms that make their own food from inorganic sources, all other organisms must consume others to sustain life processes, grow and reproduce. The range of interactions of species feeding on one another is referred to as a food or trophic web. The food web is a conceptual model of how the ecosystem functions.

Species are grouped according to trophic level (TL) as primary producers (like phytoplankton and algae), primary consumers (those that feed on primary producers), secondary consumers (those that feed on organisms that feed on primary producers), and up through higher TL predators (like sharks and tunas and humans) as well as the tremendous diversity of microbial organisms that either prey on other microscopic prey or decompose organic material in microbial food webs. While this is a highly simplistic view of the major types of trophic interactions that occur within natural communities, the true nature of such interactions are highly complex when many species are involved.

For the GoM region, which includes the Stellwagen Bank sanctuary, Link (2002) developed a food web model that was composed of 81 “trophic compartments” from detritivores and phytoplankton through to human predators (Figure 7). Some nodes of this food web are actual species (like Atlantic cod and silver hake) while other nodes are designated as trophic groups (like copepods and sponges). The food web is most detailed for fishes and their interactions with primary prey and reveals a highly complex and interconnected set of relationships.

This food web, based on relationships between predators and prey from across the northeast continental shelf (northwest Atlantic ocean), is in sharp contrast to food webs developed in more discrete and complex habitats such as coastal kelp forests and coral reefs. It is in such distinct habitat types that trophic

Researching Historical Trends

Context. European settlement marked the beginning of documented exploitation of marine resources in Massachusetts Bay. Explorations of the New England region reported the abundance of fish as far back as 1602, when Bartholomew Gosnold visited the sanctuary area. The abundant marine resources provided surrounding settlements with close, protected fishing grounds to make a living. From Plymouth to Gloucester, regional fishing camps grew into towns dependant on the local fisheries. As early as 1670, concerns arose over the coastal fisheries resources. Licensing fees and limits on the taking of particular fish species, such as mackerel, came about in the Plymouth colony. However, open ocean resources were viewed as “inexhaustible,” a view held until relatively recent times.

The early 19th century brought about rising concerns over declines in fish species and populations. In 1839, David Humpheys Storer reported concerns of fisherman over changes in “composition, size, and distribution of the region’s fish populations.” Louis Agassiz established the Museum of Comparative Zoology at Harvard University, collecting samples and investigating the biology of fishes of the GoM. Human activity, such as damming rivers, and pollution had significant effects on fish populations, particularly anadramous species such as alewife, shad and salmon, as did directed fishing pressures.

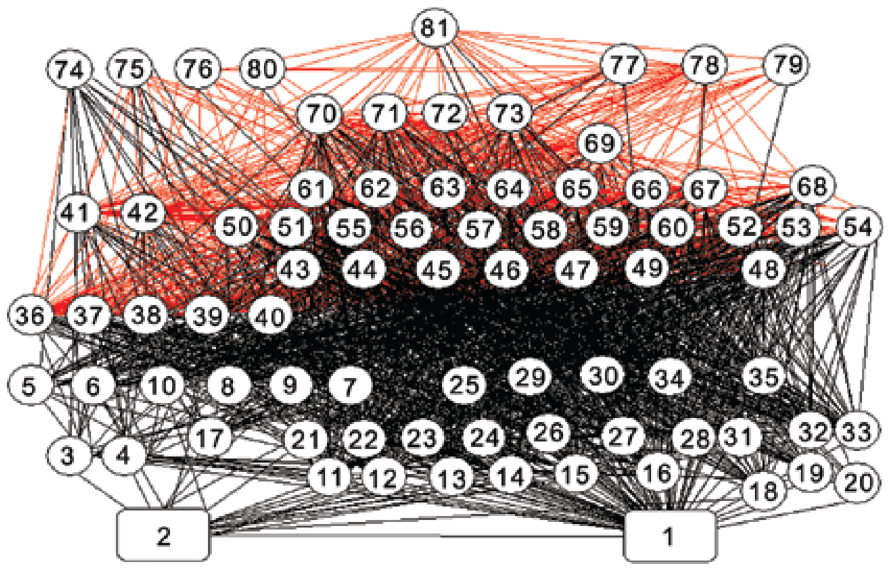
The federal government established the U.S. Fish Commission in 1871 to investigate the declines of fisheries of the area and research the biology and oceanography of the regional marine ecosystem. This Commission was replaced by the U.S. Fish and Wildlife Service in 1940. The federal government did not impose fishing restrictions on the banks or any offshore areas of New England until the mid 20th century. In 1970, the National Marine Fisheries Service became a part of the NOAA.

Sources of Information. Baselines based on historical data and trends are essential to decision-making agencies needing to compare present resource conditions to those of the past. Sources of these historical data range from personal journals of sailors aboard fishing vessels, to documents annually reported to the federal government. Maps, journals or log books, letters and interviews taken directly from fishermen throughout the history of this area provide specific quantitative fish counts, areas of high catch and trends of catch throughout years of fishing, as well as observations and insight into the lives of fishermen and their thoughts on changing environmental conditions.

Private business records from many fishermen provide some on the most detailed information with names, bait used, catch and other personal information. Newspapers from local fishing towns, as well as census data from the Commonwealth of Massachusetts, provide detailed information on vessels owned and run in the region, giving insight into fleet size and investments or products of the fisheries in the area.

Scientifically collected data from government research vessels through the U.S. Fish Commission, local government or local scientific societies such as the Boston Society of Natural History, are available in serial sets published as early as 1834. Federal statistics collected from fishermen on a monthly basis (in the later half on the 19th century) provide data on types of fish caught, landings, numbers of crew members and fishing methods. Legislative documents from as early as the 17th century and right up through the 20th century provide information on regulations focused on local fishing activities. These various forms of historical documentation provide many pieces to a puzzle that must be carefully pieced together, producing baseline context for conservation decision making.

Figure 7. Species and trophic interactions of the northwest Atlantic food web.



This tangled "bird's nest" represents interactions at the approximate trophic level (TL) of each species, with increasing TL towards the top of the web. The left side of the web generally typifies pelagic organisms, and the right to middle represents more benthic/demersal oriented organisms. Species interactions in the top half of the web are dominated by predation on fish.

1 = detritus, 2 = phytoplankton, 3 = *Calanus* sp., 4 = other copepods, 5 = ctenophores (comb jellies), 6 = chaetognatha (arrow worms), 7 = jellyfish, 8 = euphasiids, 9 = *Crangon* sp., 10 = mysids, 11 = pandalids (shrimp), 12 = other decapods, 13 = gammarids (amphipods), 14 = hyperiids, 15 caprellids, 16 = isopods, 17 = pteropods, 18 = cumaceans, 19 = mantis shrimps, 20 = tunicates (sea squirts), 21 = porifera (sponges) , 22 = cancer crabs, 23= other crabs, 24 = lobster, 25 = hydroids, 26 = corals and anemones, 27 = polychaetes, 28 = other worms, 29 = starfish, 30 = brittlestars, 31 = sea cucumbers, 32 = scallops, 33 = clams and mussels, 34 = snails, 35 = urchins, 36 = sand lance, 37 = Atlantic herring, 38 = alewife, 39 = Atlantic mackerel, 40 = butterfish, 41 = loligo (squid), 42 = illex, 43 = pollock, 44 = silver hake, 45 = spotted hake, 46 =white hake, 47 = red hake, 48 = Atlantic cod, 49 = haddock, 50 = sea raven, 51 = longhorn sculpin, 52 = little skate, 53 = winter skate, 54 = thorny skate, 55 = ocean pout, 56 = cusk, 57 = wolfish, 58 = cunner, 59 = sea robins, 60 = redfish, 61 = yellowtail flounder, 62 = windowpane flounder, 63 = summer flounder, 64 = witch flounder, 65 = four-spot flounder, 66 = winter flounder, 67 = American plaice, 68 = American halibut, 69 = smooth dogfish, 70 = spiny dogfish, 71 = goosefish, 72 = weakfish, 73 = bluefish, 74 = baleen whales, 75 = toothed whales and porpoises, 76 = seals, 77 = migratory scombrids (tunas), 78 = migratory sharks, 79 = migratory billfish, 80 = birds, 81 = humans (adapted from Link, 2002).

cascades have been shown to regularly occur when these communities are disturbed by human activities.

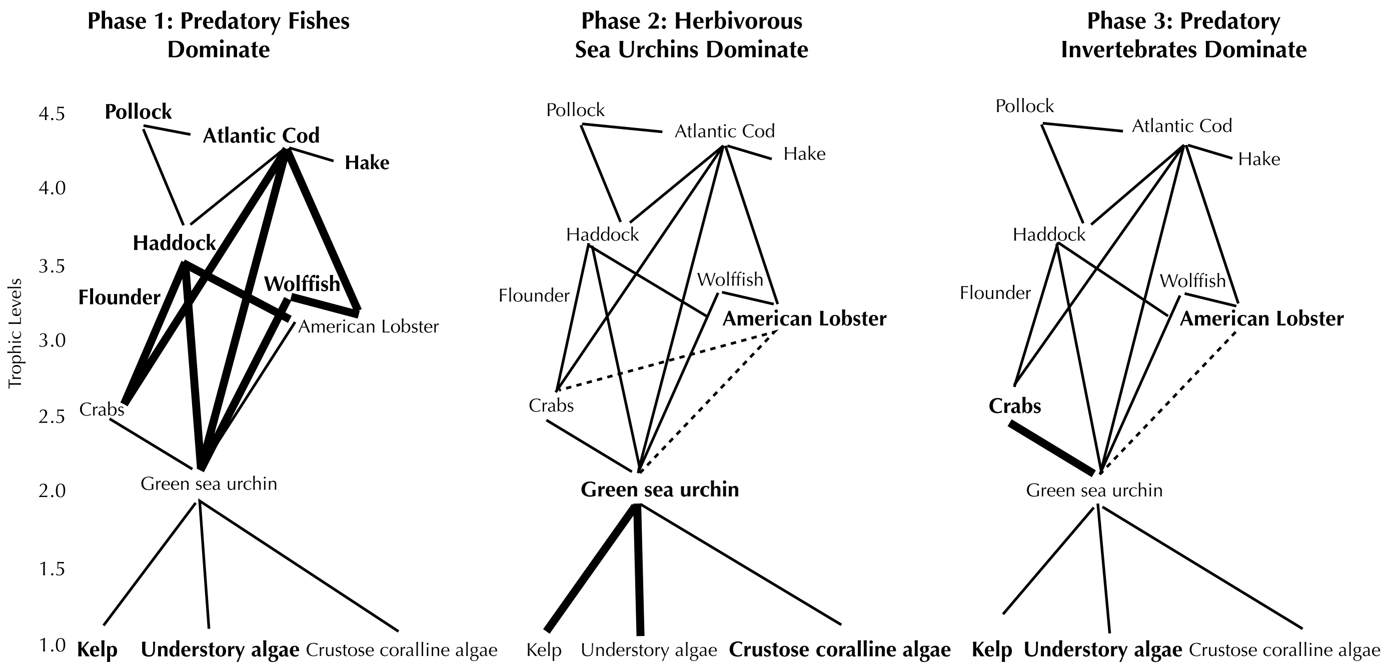
Trophic Cascades

Trophic cascades occur when change in the abundance of a particular species affects the abundance of species at two or more lower TLs. For coastal kelp forests in the GoM, Steneck *et al*., (2004) defined trophic relationships that were significantly more limited and well defined than those for the northeast continental shelf (Figure 8). The effects of human exploitation over the last century produced trophic cascades in the kelp forests by reducing predators such as cod and other gadids (phase 1). This reduced predation pressure, primarily on green sea urchins, resulting in urchin dominated communities that decimated kelp forests and shifted the dominant primary producers to species of corralline algae (phase 2). Overexploitation of urchins in the late 1980s and early 1990s resulted in the recovery of kelp forests and increased abundances of crabs and lobsters (phase 3). Similarly, over-exploitation of piscivores and herbivores has caused trophic cascades on coral reefs shifting the system from one dominated by corals to one dominated by algae (Jackson *et al*., 2001).

One of the underlying assumptions of the trophic relationships discussed above is that interactions of species within particular habitat patches (e.g., kelp forests, coral reefs) is tightly linked to those habitats, and that interactions with species outside of those habitats is weak (i.e., not "leaky"). While made an explicit assumption of many trophic web models, this is not necessarily the case in less complex and more spatially extensive habitats such as those of the offshore GoM, including the Stellwagen Bank sanctuary. For example, approximately half of the fish species in communities on deep boulder reefs in the sanctuary are either seasonal residents or transients (Auster and Lindholm, 2006), suggesting that such habitats are quite "leaky" and that predator-prey interactions extend beyond their boundaries.

Given the high levels of exploitation of fish species on the northeast continental shelf, the concern is that regional or shelf-wide trophic cascades could occur, resulting in long-term changes in the shelf ecosystem including that of the sanctuary. Such cascades have already occurred in more discrete habitats in the nearshore environment of the GoM (Jackson *et al*., 2001; Steneck, 2004). However, an analysis of patterns in the abundance of fish species within particular trophic guilds (groups of species that feed on the same kinds of prey, e.g., piscivores, benthivores, crab eaters, echinoderm eaters, planktivores, shrimp-fish eaters) on the northeast continental shelf revealed that most trophic guilds remained remarkably stable over the four-decade time series studied, despite large changes in the abundance of

FIGURE 8. TROPHIC CASCADES IN KELP FORESTS ALONG THE COAST OF MAINE.



All species determined to have been abundant at one time were plotted with their assigned TL. Abundant species are shown in bold face; rare or low-abundance species are shown in smaller regular type. Most trophic linkages (TL-*lines connecting species*) have been demonstrated with ecological studies. Apex fish predators (all above TL 3.2) feed on invertebrates (TL less than 3). Predatory invertebrates (TL 2.5-3.0) feed on the herbivorous sea urchin (TL 2), which feeds on algae (all TL 1). Interaction strengths correspond to the width of trophic linkage lines. Some species are weak interactors in this system, for example flounder have no identifiable trophic linkage with other species in this system. Note: Lobster's trophic linkages are weak despite their abundance in recent years because they feed primarily on lobster bait in the trap fishery (Steneck, unpublished) (adapted from Steneck *et al*., 2004).

individual species (such as Atlantic cod) within the guilds (Auster and Link, in preparation).

These data suggest that there is a form of compensation in the way fish communities within the GoM and the sanctuary respond to exploitation and that in habitats and landscapes where significant connectivity occurs, a level of protection against trophic cascades exists. This is not to say that trophic cascades could not occur in the sanctuary. For example, data suggest a trophic cascade has occurred in the nearshore kelp communities of the GoM and on the Scotian Shelf to the north, attributed to extreme reductions in the abundance of top predators (Steneck *et al*., 2004; Frank *et al*., 2005). However in the offshore GoM, researchers have shown that compensation in the abundances of species within trophic guilds, including piscivores, may buffer the potential for trophic cascades (Auster and Link, in preparation).

Structuring Biological Communities

While trophic cascades *per se* among fish communities may not have occurred on the northeast continental shelf, despite the extreme effects of overexploitation on individual species, competitive interactions due to changes in the populations of exploited species have impacted the composition of GoM fish communities. For example, the decline in cod and flounders due to fishing likely resulted in a competitive release allowing extreme increases in skates and spiny dogfish on Georges Bank (Fogarty and Murawski, 1998). Consider also the documented decrease in mean TL in the northeast continental shelf fishery landings for the hundred-year period, 1901-2003 (Figure 9).

The abundance and distribution of preferred prey species has played a significant, perhaps critical, role in structuring the distribution of baleen whale populations in the GoM (Payne *et al*., 1990). The distribution of humpback whales has been shown to be significantly correlated with the number of sand lance obtained from standardized trawl tows (Payne, et. al., 1986). Humpback whale sightings from 1978-1986 showed a shift in distribution from the upper GoM-lower Bay of Fundy region to the southwestern GoM concurrently with an increase in sand lance in this area during the same period. This shift in distribution coincided with a dramatic increase in the concentrations of sand lance throughout the shelf waters of the eastern United States. The sand lance populations apparently expanded in response to the collapse of the Atlantic herring stocks in the mid-1970s due to over-fishing from foreign, distant water factory fleets (Meyer *et al*., 1979; Sherman *et al*., 1981).

Significant changes in the biomass of sand lance and the abundance of copepods have co-occurred with a shift in the occurrence and abundance of four species of baleen whales (northern right, humpback, sei and fin) in the southern GoM (Payne *et al*., 1990). Peak years in the abundance of the copepod *Calanus finmarchicus* were the lowest years in abundance for sand lance. Right whales and sei whales were common in the region only during 1986, when *C. finmarchicus* reached a regional maximum and sand lance were at a regional minimum. These distributional shifts in cetaceans have been characterized as an ecological response to human-induced changes in the abundance of herring and mackerel due to over-harvesting and a compensatory response by sand lance (Payne *et al*., 1990).

Since the elimination of foreign fisheries on the northeast continental slope in the late 1970s, Atlantic herring populations were able to re-colonize much of the area's spawning habitat during the period from 1988-1993 (US DOC, NOAA, 1993a). During 1992-1993, the abundance of sand lance was well below the average for previous years. This change in the abundance of species which feed at the same TL is referred to as a "biomass flip". This shift in the abundance and distribution of cetacean prey could possibly trigger a similar shift in the distribution of humpbacks and other cetaceans that feed on these small pelagic species. Many species of marine mammals and predatory fish follow the movements and abundance of their prey, which in turn may be linked to physical oceanographic conditions including circulation patterns, water temperature and salinity as well as local depletion of prey species due to targeted fishing activity.

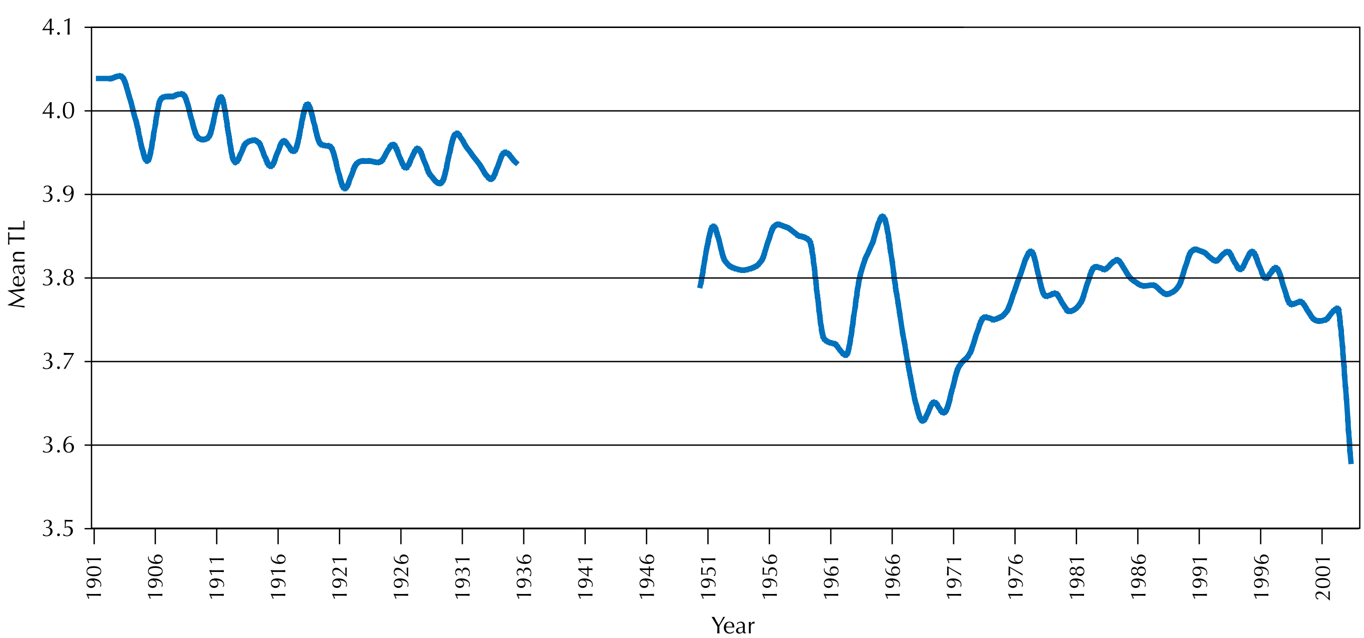
Climate change may have the most unpredictable effects on community structure and trophic interactions. Many species are at the southern or northern limits of their distributions in the sanctuary area. Small increases in water temperature may result in significant increases in more warm temperate species and the loss of cold water taxa. Long-term trends in warming have already resulted in shifts in the distribution of fishes in the GoM (Garrison, 2001).

Habitats

A variety of habitats occur within the sanctuary. The underwater landscape is a patchwork of habitat features that are composed of both geologic and biologic components. Habitat is defined as the location occupied by an organism, population or community. It is the physical part of the community structure in which an organism finds its home, and includes the sum total of all the environmental conditions present in the specific place occupied by an organism. Habitats can be found on the seafloor or in the water column. Seafloor habitats are formed by the physical substrata in an area or by the combination of physical substrate and inhabiting organisms (biogenic habitats), such as anemones attached to a boulder.

Habitat features provide shelter from predators and the flow of tidal and storm generated currents, serve as sites that enhance capture of prey such as drifting zooplankton, and serve as foci for spawning activities including egg laying and brooding young. All organisms have particular habitat

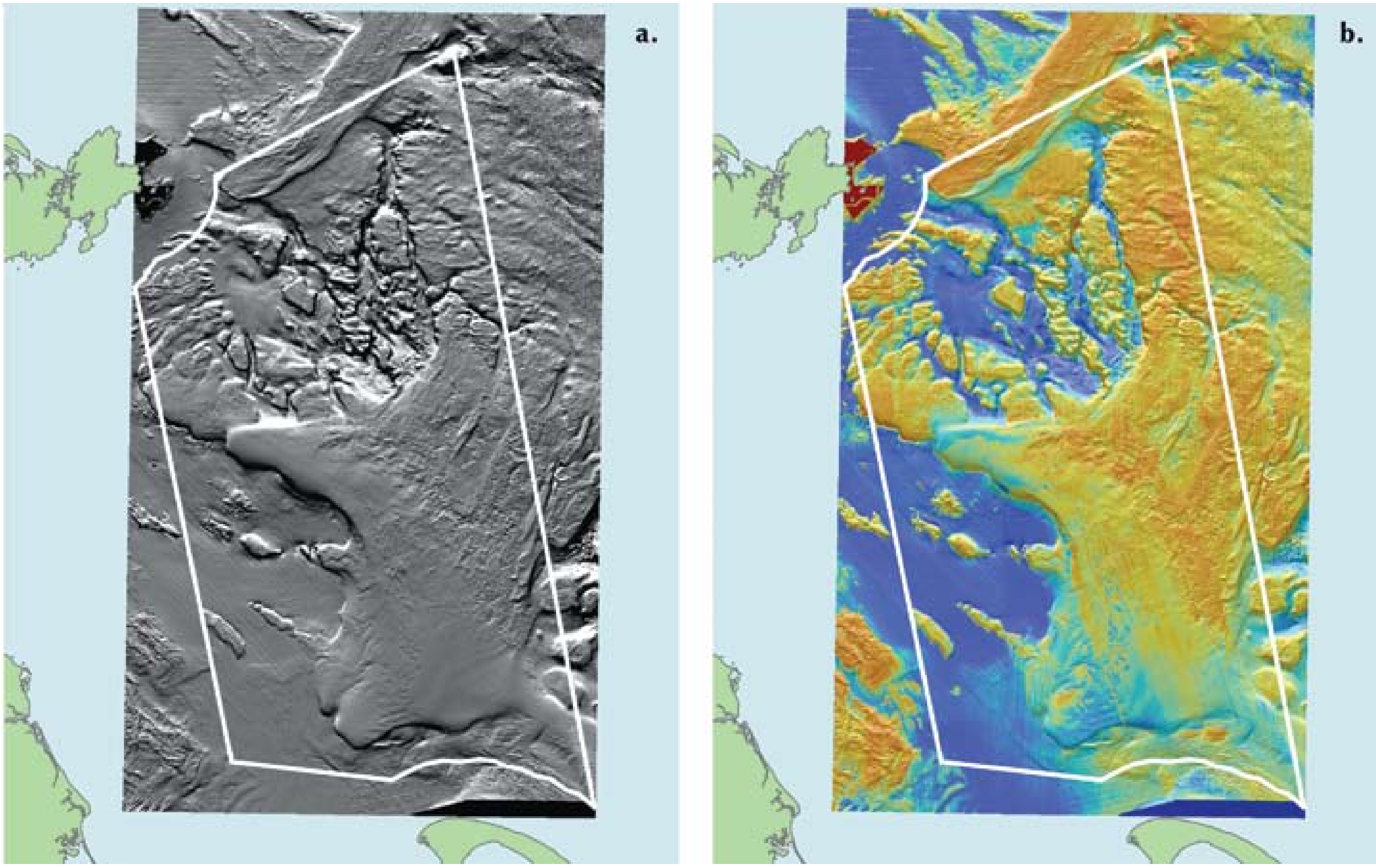
Figure 9. Historic reduction in mean TLs in fishery landings in the GoM from statistical bulletin landings data (1901–1935) and LME Northeast U.S. continental shelf landings (1950–2003).



Fishing pressure over the past century has reduced the mean TL of landings in the GoM region, a long-term trend that continues through the present. This figure serves as an example of a historical baseline of ecosystem condition. Trophic level indicates position in the food chain determined by the number of energy-transfer steps to that level. By convention, plants have a TL = 1, herbivores TL = 2, and so on up to a TL = 5 such as for killer whales. Courtesy: Stephan Claussen, GoM cod project, University of New Hampshire.

Figure 10. Multi-beam sonar image of the Stellwagen Bank sanctuary area showing (a) sun-illuminated seafloor topography and (b) backscatter intensity of sediments.

Source: USGS.



requirements and the important attributes of "habitat" vary between species and between the various life history stages within species.

Regional topography and surficial seabed features of the sanctuary have been mapped in great detail based on multi-beam echo sounder imagery and on extensive ground-truthing with video and photographic imagery and geological and biological sampling. Habitat characterization produces descriptors of habitats based on geological, biological, chemical and oceanographic observations. Habitat classification produces a set of habitat types based on a suite of standard descriptors of topographical, geological, biological, natural, and anthropogenic features and processes. Habitat mapping is the spatial representation of described and classified habitat units (Valentine *et al*., 2005). The development of a new seabed classification scheme has made it possible to map habitats based on substrate texture, seabed dynamics, the complexity of physical and biological structures on the seabed, and fauna (Valentine *et al*., 2005).

The simplest classification of habitats in the Stellwagen Bank sanctuary that can be discerned is based on the multi-beam echo sounder imagery which reveals backscatter intensity—a measure of the hardness of the substrate (Figure 10). Based on this imagery, the sanctuary contains three basic physical habitat types: gravel, sand and mud with the following coverage: 34%, 28% and 38%, respectively. Bedrock outcrop and piled boulder reefs are other important physical habitats. Bedrock outcrop is found only on Sanctuary Hill in the northeastern-most corner of the sanctuary; piled boulder reefs are extensively associated with sand and gravel areas of the sanctuary (Valentine *et al*., 2001). Imagery from ground-truthing and physical sampling reveals that each of the three basic habitat types can be further subdivided into more descriptive categories such as mobile rippled coarse-grained sand, for example (Valentine *et al*., 2005).

Physical Setting

The physical setting of the sanctuary is the structural foundation for its biological processes. The first set of sanctuary regulations that were established when the sanctuary was designated was intended to prevent Stellwagen Bank from being mined for its sand and gravel resources. Minerals extraction has enormous potential to adversely impact the ecosystem functions of the sanctuary by physically altering the surface profile of Stellwagen Bank and its attendant oceanography. Exploring for, developing or producing industrial materials such as oil and gas within the sanctuary are strictly prohibited. Other regulations prevent the drilling into, dredging or otherwise altering the seabed of the sanctuary or constructing, placing or abandoning any structure, material or other matter on the seabed of the sanctuary, except as exempted as an incidental result of traditional fishing operations, for example.

An understanding of the physical setting—the linkages between its geography, geology and oceanography—enables understanding of how regional, large-scale processes of the GoM ecosystem connect with and directly impact the local biodiversity patterns and processes at the scale of the sanctuary. For example, the habitats of marine mammals are affected by the physical and chemical properties of the water through which they swim and communicate, the topography and substrate type of the ocean bottom and water column characteristics where they feed, the physical state of the ocean surface where they breath, and the numerous factors influencing the distribution of food organisms (including temperature, salinity, currents and winds) that determine their distribution and local abundance.

Geography

The Stellwagen Bank sanctuary stretches between Cape Cod and Cape Ann at the mouth of Massachusetts Bay and is virtually the size of the state of Rhode Island (Figure 11). It covers 842 square-miles (2,182 km2) of marine waters and is located entirely within federal jurisdiction. At its greatest distance from the coast, the sanctuary is located approximately 25 nautical miles east of Boston, Massachusetts, and 3 nautical miles off Cape Ann and Cape Cod. On a regional scale, the sanctuary is a part of the GoM LME.

The sanctuary is a topographically diverse area that encompasses the submerged Stellwagen Bank and Basin, Tilles Bank and Basin and a portion of Jeffreys Ledge in the southern GoM. The GoM is a large gulf of the Atlantic Ocean on the northeastern coast of North America, roughly between Cape Cod in Massachusetts to the south and Cape Sable Island on the southern tip of Nova Scotia to the northeast (Figure 12). It includes the entire coastlines of the States of New Hampshire and Maine, as well as Massachusetts from the north side of Cape Cod, and the southern and western coastlines of the Canadian provinces of New Brunswick and Nova Scotia, respectively. Massachusetts Bay and the Bay of Fundy are included within the GoM LME.

There are three major basins contained within the GoM: Wilkinson Basin to the west, Jordan Basin in the northeast, and Georges Basin in the south, which are isolated from each other beneath the 650 ft. (200 m) isobath. Georges Basin, just north of Georges Bank, is the deepest of the three at just over 1,200 ft. (370 m) and generates a pocket at the end of the Northeast Channel, a deep fissure between Georges Bank and Browns Bank, the southwestern edge of the Nova Scotian Shelf. The Northeast Channel is the major channel between the GoM and the rest of the Northwest Atlantic. A secondary, shallower connection to the rest of the Atlantic is the Great South Channel, located between Georges Bank and the Nantucket Shoals. The sanctuary's geographic location relative to the arctic and temperate regions of the Northwest Atlantic makes it an obvious focus for biodiversity research.

Geology

Stellwagen Bank is the most prominent geological feature in the sanctuary and is one of only two shallow (less than 20 m depth) sandy banks in the Gulf of Maine (GoM)—the other one being Georges Bank. Stellwagen Bank is a glacially-deposited feature, curved in a southeast-to-northwest direction for almost 32.2 km; it measures 18.75 miles in length and roughly 6.25 miles across at its widest point, at the southern-most portion of the bank (Figure 11). The seabed of the sanctuary is a complex of geomorphic features and substrate types that formed by 1) glacial ice movement, 2) erosion and deposition of sediments during ice melting and sea level rise, and 3) reworking by modern currents (Valentine *et al*., 2005).

Like Cape Cod and the islands of Martha's Vineyard and Nantucket, Stellwagen Bank and other submerged banks and ledges off the northeastern United States coast were created by the advance and retreat of glaciers. Stellwagen Bank owes much of its existence to the Laurentide Ice Sheet that advanced out of Canada and into southern New England approximately 21,000 years ago (Oldale, 1993,1994). As the ice sheet advanced, it was shaped into huge lobes. One ice lobe was formed by what is now Cape Cod Bay; the other by the present-day Great South Channel, located to the southeast of Cape Cod. The advance of ice over the continental land mass ground the land into fragments and carried them along with the movement of the ice.

With general climatic warming between 18,000 and 15,000 years ago, the glaciers began to melt and retreat from their coverage. The ice lobes became more pronounced, and retreated at differing rates, depending on the depths of topographical depressions within which they moved. During this process enormous amounts of pulverized continental land were released from the melting ice. These land fragments, or "outwash" from the two ice lobes formed much of the present-day Cape Cod peninsula. Retreat of the ice lobe formed by the Great South Channel was sufficiently slow that much of the land fragments it carried melted out and was deposited on the sea floor. These materials formed the submerged elevation now known as Stellwagen Bank

Through the continual evolution and refinement of technologies for mapping the seafloor, the characterization of the sanctuary landscape is also continuously evolving (Valentine *et al*., 2001). Multi-beam imagery provides a level of resolution of landscape features that has been unattainable with lower resolution bathymetric and seafloor geological surveys. Multi-beam imagery provides a highly detailed picture of the seafloor landscape, providing detailed bathymetry. Most multi-beam systems also provide a measure of acoustic backscatter. Using backscatter data, the relative hardness of a substrate can be determined by the strength of the acoustic signal reflectance.

The USGS completed an initial series of 18 seafloor topographic maps (scale 1:25,000) in 1997 that covers the entire sanctuary. The data were collected using a hull-mounted multi-beam system. This map series was followed by sun-illuminated versions of the multi-beam maps in 2001. Additional backscatter and sediment characterization maps are in preparation that will also cover the sanctuary.

The entirety of the sanctuary as well as a surrounding buffer area has been mapped using multi-beam sonar (approximately 1,100 nm2 in total) at a vertical resolution of approximately 25 cm and a horizontal resolution of approximately 10 m. Figure 10 shows the sun-illuminated seafloor topography and acoustic backscatter sediment maps of the sanctuary. Substrate type is color coded and superimposed over the bathymetry. The sanctuary multi-beam map, in conjunction with extensive ground truthing (e.g., video, still photos, sediment samples), provides the most complete characterization of the seafloor in the GoM. For more information on seafloor maps of the Stellwagen Bank sanctuary go to http://woodshole.er.usgs.gov/project-pages/stellwagen/stellwagenbank.html.

This section served as an introduction to the gross geological features and processes of the sanctuary area. Descriptions of additional geological aspects of the sanctuary are provided in subsequent discussions of landscapes and physical and biogenic habitats.

Oceanography

Ocean circulation through and around the Stellwagen Bank sanctuary drives the dynamic biology of the area, and that circulation is greatly influenced by the sanctuary's location within the greater GoM. While Stellwagen Bank is an important feature driving local water circulation, the sanctuary's water properties and dispersal mechanisms are largely determined by large-scale oceanographic patterns. To gain perspective, it is necessary to understand these large-scale patterns and how they influence the smaller-scale unit of the sanctuary. Many processes (tides, currents, sea surface temperature, internal waves, thermal fronts, etc.) comprise the oceanographic character of the region and their interactions drive large and small-scale biological dynamics.

An in-depth description of the sanctuary area's physical oceanography is provided in "An ecological characterization of the Stellwagen Bank National Marine Sanctuary region" (NOAA, 2006). Drawing from that document, a general description of the key oceanographic features that shape the sanctuary environment follows and includes discussion of general patterns of circulation at different geographic scales and the role of internal waves. A key attribute of the sanctuary's physical oceanography is its regional connectivity with other parts of the GoM. This connectivity is important in understanding the sanctuary's ecological role in supplying and receiving larval recruits across the region, as well as the paths taken by pollutants and contaminants in relation to the sanctuary.

General Patterns of Circulation

Gulf of Maine Circulation

A combination of physical and oceanographic characteristics in the GoM results in cycles of biological productivity that support exceptionally large and diverse populations of fish, that in turn attract and support seasonal populations of cetaceans and seabirds. Bounded by underwater offshore banks, the prevailing counterclockwise circulation results from ocean currents, freshwater inflow, and the configuration of shoreline and underwater topography which together create a nearly self-contained oceanographic system (Figure 12).

The interior GoM has cyclonic circulation regions situated over three deep basins—Georges, Jordan and Wilkinson. The gyres are influenced by the deep inflow of saline waters through the Northeast Channel and forced by topography (Hannah *et al*., 1996; Lynch, 1999). The dominant temporal variability in the gyres or between gyres is on the order of months (Xue *et al*., 2000). The current patterns in the GoM are greatly affected by the physical characteristics of the gulf and its coastline.

In general, cold water enters the gulf over the Scotian Shelf, Browns Bank and through the Northeast Channel. Water flows around Nova Scotia and into the Bay of Fundy. The coast then deflects currents southwestward forming the GoM gyre, which rotates counterclockwise, moving surface waters about 7 nm per day. Tidal fluctuations and shallow water over Georges Bank form a secondary, clockwise-spinning gyre. Water leaves the Gulf through the Great South Channel and over the eastern portion of Georges Bank. It takes about three months for surface water to completely circle the GoM. Deep waters also circulate, but much more slowly, taking about a year to complete the circuit (Xue *et al*., 1999).

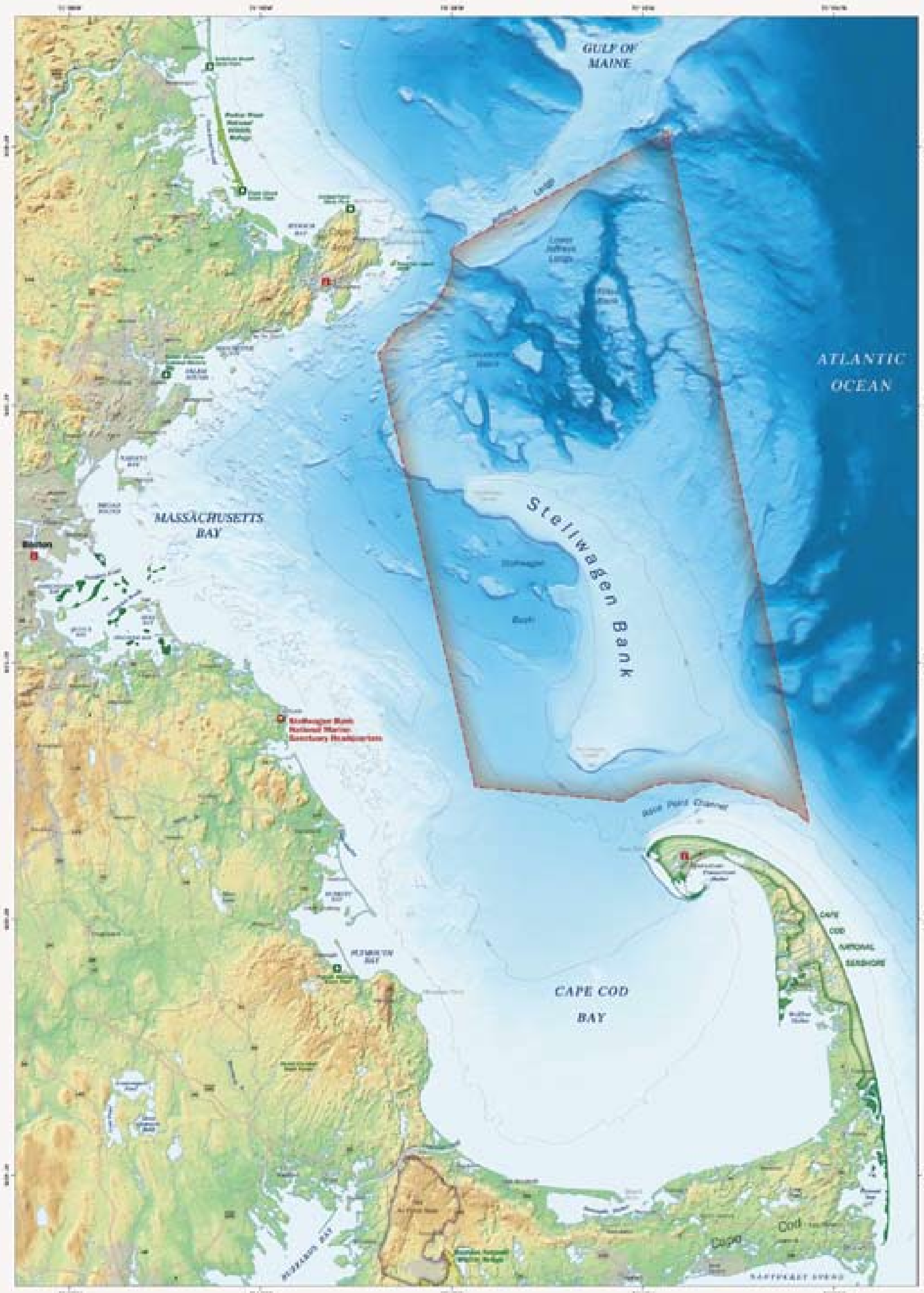


FIGURE 11. THE STELLWAGEN BANK SANCTUARY IN RELATION TO ADJACENT LAND AND ASSOCIATED GEOGRAPHIC PLACES.

The image shows the glacially-deposited Stellwagen Bank within the boundaries of the national marine sanctuary. Source: NOAA/NOS.

Current speed and direction can vary spatially and temporally throughout the GoM. Over 20 buoys are stationed throughout the Gulf that collect hourly oceanographic and meteorological data as part of the Gulf of Maine Ocean Observing System (GoMOOS). For more information, visit URL http://gomoos.org/buoy/buoy_data.shtml. Hourly current speeds were obtained from the GoMOOS Buoy A during 2002-2006 to examine monthly and inter-annual patterns. During this time period, mean current speed was highest (and most variable) during April and May and lowest speeds were observed during the summer and fall.

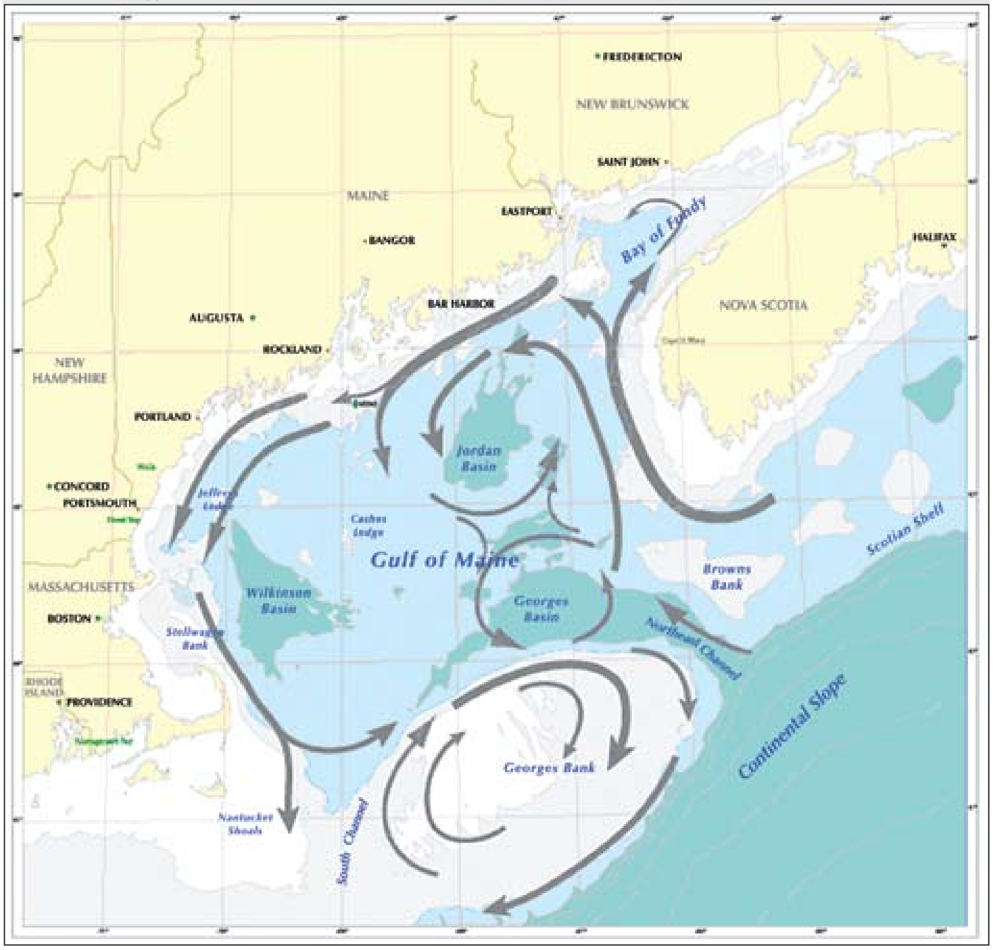
Massachusetts Bay Circulation

Circulation in Massachusetts Bay (Figure 13) is controlled by the large-scale circulation in the GoM, localized wind forcing, and freshwater inflow (Signell *et al*., 2000). The Maine Coastal Current (MCC) flows south at 5–15 cm/s along the Maine and New Hampshire shoreline. A weak branch (2–5 cm/s) occurs near Cape Ann. Usually the MCC flows south along the eastern edge of Stellwagen Bank and east of Cape Cod (Normandeau Associates, 1975; Vermersch *et al*., 1979; Blumberg *et al*., 1993; Bumpus, 1973; Lynch *et al*., 1997). However, as explained below, the MCC can strongly influence the circulation pattern in Massachusetts Bay and Cape Cod Bay depending on the season (Figure 13).

The circulation pattern can be altered by seasonal wind and runoff events (Signell *et al*., 2000). The main current joins smaller coastal currents and flows southward, often penetrating deep into Cape Cod Bay (Jiang and Zhou, 2004). Seasonal variation in stratification occurs in Massachusetts Bay, with well-mixed conditions during winter and strong stratification during summer (Geyer *et al*., 1992). The stratification greatly reduces vertical exchange between surface and bottom waters and isolates the bottom water from the direct influence of wind stress and river runoff (Signell *et al*., 2000).

Figure 12. Generalized diagram of the counter-clockwise circulation patterns in the GoM.

Source: Pettigrew *et al*. (2005).



The seasonal variations of stratification, wind stress, and river discharge change the nature of transport and dispersion processes in Massachusetts Bay. During winter, strong northerly winds enhance the counter-clockwise circulation along the shoreline and northward flow in the deeper portions of the Bay (Butman, 1975; Brickley, 1994). In the spring, shallow (5–15 m) fresh water plumes enter the Bay, commonly generating strong currents (20–30 cm/s) with 10–30 km spatial scales (Butman, 1976; Lee, 1992). Summer conditions stratify the water column and frequent southwesterly winds can result in localized upwelling along the western and northern coast. During the fall, mean circulation reverses and flows northward as the result of strong cooling (Geyer *et al*., 1992).

Significance to the Sanctuary

These broad-scale circulation patterns significantly affect water column mixing and transport mechanisms in the sanctuary. Mixing on the continental shelf is an important process for redistributing nutrients, sediments, freshwater, pollutants, plankton and fish larvae (Carter *et al*., 2005). Stellwagen Bank serves as a boundary between the GoM to the east and Massachusetts Bay to the west and is an important determinant of the water properties within Massachusetts Bay. The sanctuary is located along the major path of the Maine coastal current, while also receiving surface and subsurface flows from Massachusetts Bay (Figures 12 and 13).

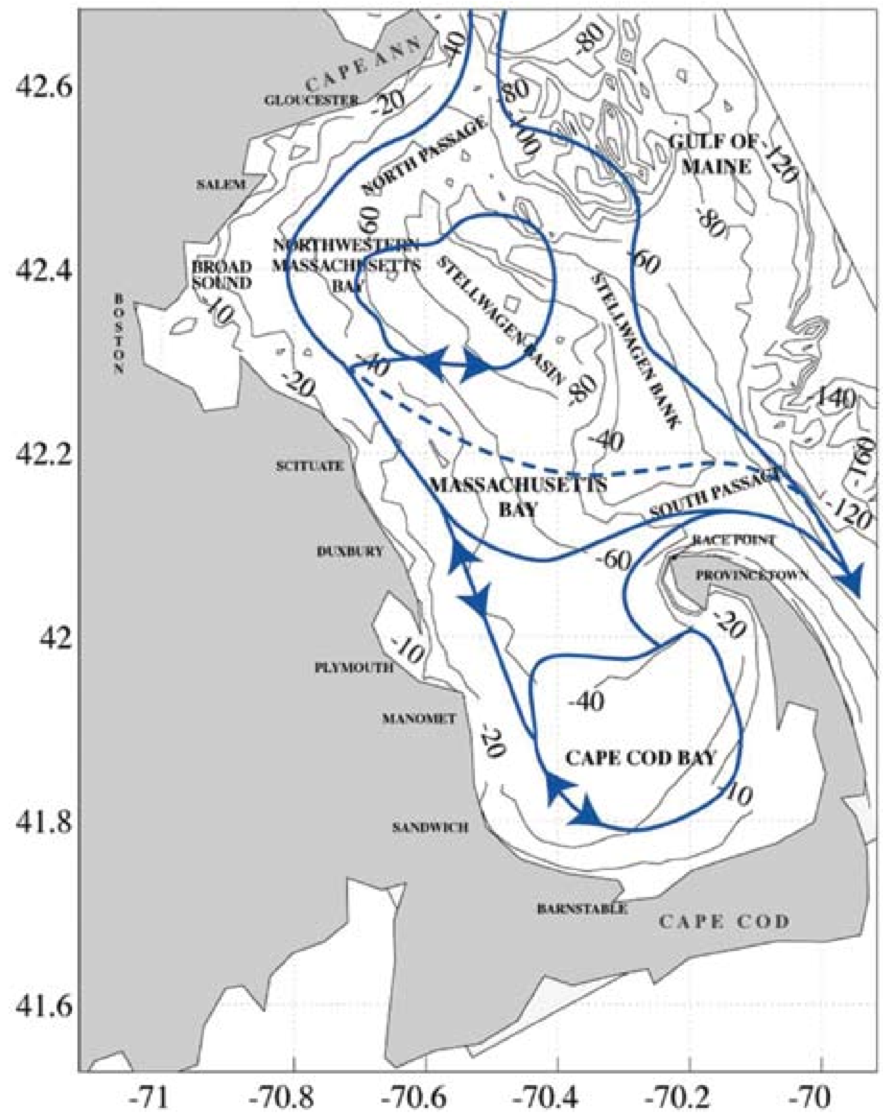
The physical oceanographic processes at work in Massachusetts Bay are critical to the generation of biological productivity and maintenance of biological diversity in the sanctuary. These ecological qualities are in turn important to sustaining local fishing and recreation industries and for resource conservation efforts. Understanding circulation patterns helps to identify biological sources to and exports from the sanctuary in the form of larval recruits or zooplankton concentrations and provides insight into the transport and deposition of sediments and "red tide" spores as well as potentially harmful contaminants from local sewage discharges.

Internal Waves

Internal waves are particularly important for internal mixing and localized transport within the sanctuary area (Figure 14). Stellwagen Bank (most notably) and Cashes Ledge are biologically productive as a result of internal wave dynamics (Sherman *et al*., 1996). Internal waves are literally waves under the ocean's surface that occur at the interface between two water layers of differing densities (Brown *et al*.,

Figure 13. Generalized diagram of the various water circulation patterns in the upper layers that exist within the Stellwagen Bank sanctuary during stratified conditions.

Solid lines represent most common patterns; dashed lines represent less common patterns. Source: Lermusiaux (2003).



1989). They occur when seasonally stratified water is forced over abrupt topographic features, such as banks or ledges, by diurnal tides. Internal waves disappear as they approach shallow water (typically 25 to 40 m in depth) because of decreasing depth (Jackson and Apel, 2004). Internal waves usually occur in Massachusetts Bay between May and October when the water column is stratified.

Internal waves contribute to the energetics of the upper ocean in many ways; in particular, they enhance mixing and nutrient availability (Jackson and Apel, 2004). Plankton distribution exhibits strong vertical displacements and mixing associated with the passage of internal wave packets (Haury *et al.*, 1979). The ability of internal waves to mix stratified water layers during the summer provides a mechanism for benthic-pelagic trophic coupling by moving phytoplankton downward to benthic communities (Witman *et al.*, 1993). This mechanism may also serve as vertical transport for passively dispersed larvae of benthic invertebrates and fish (Witman *et al.*, 1993; Meekan *et al.*, 2006).

Strong convergence of internal waves at the bottom causes sediment re-suspension (Boczar-Karaiewicz *et al.*, 1991), including recently settled invertebrate larvae and toxic algae cysts (Scotti and Pineda, 2004). The existence of trapped cores (pockets of water) between internal wave crests also suggests internal waves are a prime candidate for concentrating and transporting larvae which nourish benthic communities (Scotti and Pineda, 2004). Internal waves, and potentially other related transport mechanisms, have a significant influence on ecological processes in the sanctuary (Scotti and Pineda, 2004).

Internal waves can have additional benthic impact by re-suspending sediments. Recent evidence (Butman *et al.*, in preparation) has shown that benthic currents associated with internal waves caused sediment re-suspension within Stellwagen Basin at depths between 50-85 m. Net transport direction was offshore and currents were of considerable speed to carry sediments 5-20 km. Thus, sediments in shallower portions of Massachusetts Bay are frequently re-suspended and carried offshore and are typically deposited in the deeper Stellwagen Basin. Due to weaker current flows, sediments re-suspended in Stellwagen Basin do not typically leave the basin, but are re-deposited (Butman *et al.*, in preparation).

Synthetic Aperture Radar (SAR) can detect internal waves by emitting pulses of microwave energy, producing a two-dimensional radar backscatter map of the roughness of the ocean surface (Apel and Jackson, 2004). In SAR imagery, internal waves appear as packets or groups of waves characterized by alternating bright and dark bands and decreasing wavelengths from front to back of each packet, indicating direction of propagation. While wave packet size is variable, imagery from Massachusetts Bay and surrounding waters has shown high density (number of packets/km2) internal waves within the Stellwagen Bank sanctuary area (Figure 14).

Connectivity

The GoM connects the New England states (Massachusetts, New Hampshire, and Maine) and the Canadian provinces

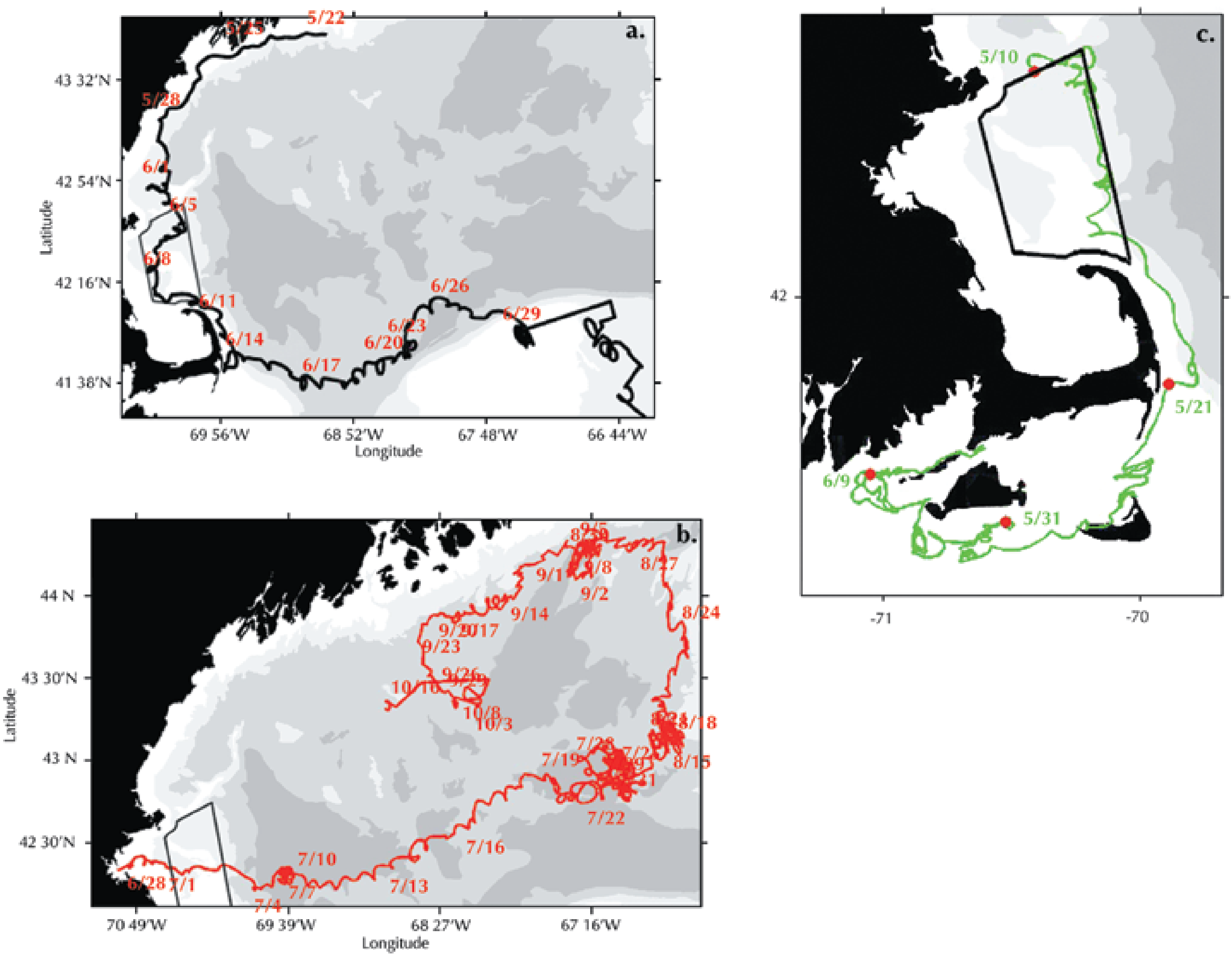
(New Brunswick and Nova Scotia) with 93,239 km2 of ocean along 19,424 km of shoreline. Stellwagen Bank sanctuary is integrally connected with the rest of the GoM through water circulation. The sanctuary both receives water and associated particles (larvae, plankton, etc.) via the Maine Coastal Current and disperses water and particles to areas to the south (Great South Channel) and east (Georges Bank). A recent example of this connectivity occurred when one of the sanctuary's acoustic recording units deployed on the bottom broke free and drifted to Georges Bank where it was retrieved by the USGS. Additionally, this connectivity has been shown through the use of telemetered drifter buoys.

NOAA Fisheries Service NEFSC has deployed telemetered drifter buoys for several years throughout the GoM to serve as proxies for the transport of American lobster larvae which remain in the water column as plankton for approximately one month. Many of the buoys deployed in or near the Stellwagen Bank sanctuary have revealed how complex the surface currents are in Massachusetts Bay and how strong the connection is between the sanctuary and areas to the east and south, such as Georges Bank and outer Cape Cod and the Islands (Figure 15). These drifter tracks correspond well with the generalized circulation depicted in Figure 12. The implication of this connectivity is that the sanctuary serves as both a source (for export) and a sink (for import) for larvae of most fish and invertebrate species throughout the southwestern and central GoM.

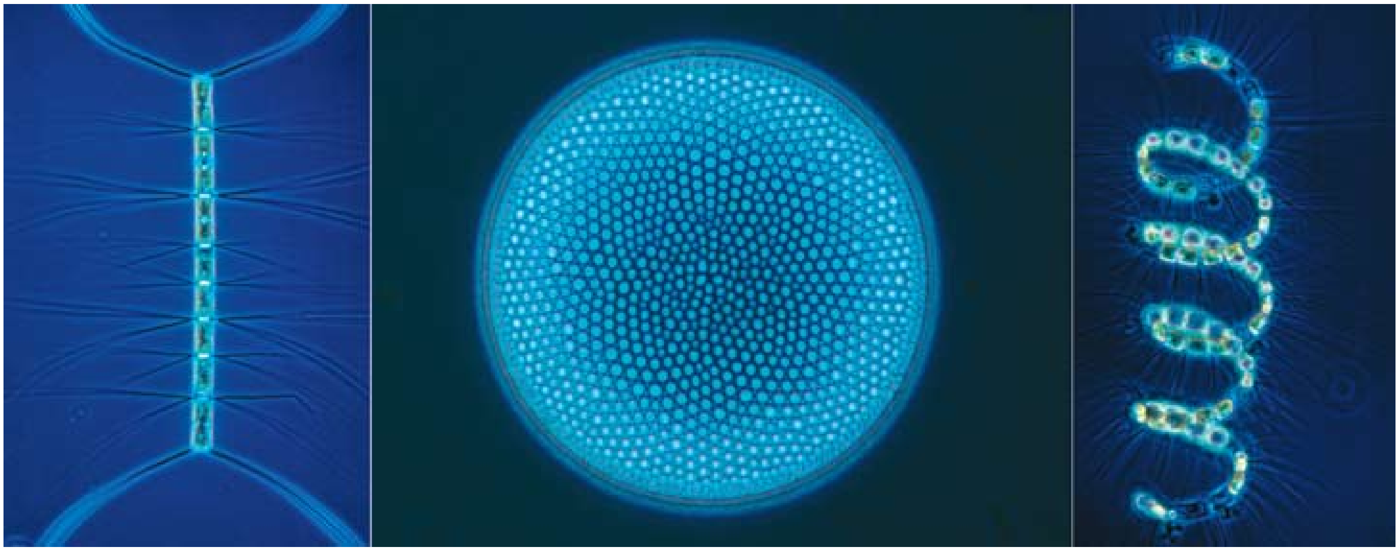
Figure 14. Synthetic Aperture Radar (SAR) image of internal wave events in Massachusetts Bay on August 7, 2003.

Three internal wave packets are obvious as curvilinear features in the sanctuary area north of Cape Cod. Image courtesy of European Space Agency, processed by Jose da Silva, Univ. of Lisbon. Envisat ASAR, 7 August 2003 2:30 GMT; image precision mode.

Figure 15. Selected tracks of telemetered drifter buoys depicting generalized current flow in the vicinity of the Stellwagen Bank sanctuary.



(a) Track of drifter buoy 65208 deployed on May 2004 off of Isle au Haut, Maine, revealing connectivity between the south-west margin of the GoM, the sanctuary and Georges Bank; (b) Track of drifter buoy 65207 deployed on June 27, 2006, off of Boston Harbor revealing connectivity between the sanctuary and the interior GoM; and (c) Track of drifter buoy 55202 deployed on June 13, 2005, off of Cape Ann, Massachusetts, revealing connectivity between the sanctuary and the islands south of Cape Cod. Courtesy: James Manning, NOAA Fisheries Service/NEFSC.



Primary Producers and Decomposers

Marine bacteria, protists (e.g., algae, phytoplankton, protozoans) and fungi are crucially important at many levels of ecosystem function. By most accounts vascular plants and seaweeds do not occur in the sanctuary, but microscopic organisms are astronomically numerous and make up the bulk of the primary producers and decomposers, fixing carbon and recycling nutrients through a variety of biochemical processes. These microscopic organisms are actively engaged in all processes of biologically induced energy transfer through all ecosystem pathways involving all TLs, biological communities and habitats. While the species diversity of this group of organisms is poorly documented, their great importance as a functioning element of the sanctuary ecosystem merits their acknowledgement in this document.

Investigations of biodiversity are complicated by the paucity of knowledge of certain taxonomic groups, particularly those in the following three categories (prokaryotes, protists and fungi). What one taxonomist considers a species may be only a subspecies to another. The greater scientific body relies on the expertise of taxonomists in their fields of specialization as to what level of phenotypic and genetic variation is sufficient to warrant species status. In addition, many taxonomic groups such as the marine bacteria and fungi have received little attention in relation to their species diversity. Instead, one must consider their generic or functional diversity. With such disparities, the study of biodiversity in these groups is just beginning; an annotated technical summary follows. Scientific nomenclature not explained in the text is described in the glossary of this document.

These organisms are mostly found in or on the sediments and plankton of the sanctuary. Plankton consists of microscopic drifting organisms that inhabit the water column. The plankton is primarily divided into broad functional (trophic level) groups consisting of bacterioplankton, phytoplankton and zooplankton. Bacterioplankton are bacteria and archaea which play the role of decomposers and recyclers. Phytoplankton are largely pro- or eukaryotic algae that live in the upper water column where there is sufficient light to support photosynthesis; they serve as the primary producers. However, the TL of some phytoplankton is not straightforward, and some species, e.g., certain dinoflagellates are mixotrophic (producers or consumers) depending on environmental conditions. Zooplankton are small protozoans or metazoans (e.g., crustaceans and other animals) that feed on other plankton and serve as the primary consumers in the ecosystem.

Zooplankton are not addressed separately in this document because of the extensive treatment that would require, but their ecosystem role as primary consumers of phytoplankton and prey for organisms at higher TLs is enormously important. Certain species, such as the Calanoid copepod *Calanus finmarchius* is prey both for fish (e.g., sand lance) and whales (e.g., North Atlantic right whale) in the sanctuary.

Viruses, another group of microscopic organisms, also are not given any treatment here because virus diversity has not been addressed in the Northwestern Atlantic (Fuhrman, 1999). Viruses are known primarily as pathogens and little is known of their ecology. The topic is of pragmatic importance due to the likelihood for transport or accidental introduction of exotic pathogens and the complicated density dependant functions of disease. The role of virus particles as pathogens and gene vectors in nature makes the lack or near absence of data on their distribution in the GoM an acute problem, but only a general concern for sanctuary management at this time because there are no overt problems.

Prokaryotes

Prokaryotes (bacteria and archaea, the latter group not distinguished in this review) are the biochemical specialists of the ecosystem. Each bacterium consists of a simple, single cell, lacking a nucleus and chromosomes to organize its DNA. Nonetheless, bacteria accomplish many unique biochemical transformations due to the enormous range of their metabolic capabilities. Only a very small amount (perhaps less than 1%) of all microbial diversity has been studied (Colwell *et al*., 1995). Thus, it would be impossible to include a list of prokaryote species found in the sanctuary. The official list of the described bacteria is contained in the *International Journal of Systematic Bacteriology*. In marine communities, some taxonomic categories are studied considerably more than others.

Margulis and Schwartz (1998) provide a description of the major prokaryotic lineages and functional groups and describe their intimate relationships with higher organisms. The prokaryotes are involved in virtually every metabolic pathway and every link in the marine food web (e.g., Cavanaugh, 1994; Dubilier *et al*., 1999; Hinrichs *et al*., 1999). Bacteria drive and regulate a seemingly infinite number of marine processes (e.g., Schlitz and Cohen, 1984; Schropp *et al*., 1987; Hines *et al*., 1991) and y*et al*most nothing is known of their distribution or diversity. Bacteria in the North Atlantic, as everywhere, are the key operators of biological processes in marine sediments (Chepurnova *et al*., 1987; Christensen and Rowe, 1984; Lyons *et al*., 1980; Vetriani *et al*., 1999) and constitute a significant portion of the primary producers within the euphotic zone (Ducklow, 1999). The evolution and species diversity of certain of these groups has been considered (Kawasaki *et al*., 1993), while others have been ignored or await description. Rath *et al*. (1998) discuss the biological diversity of marine snow communities.

In marine ecosystems, like most others, prokaryotes play a significant role as pathogens (Colquhoun *et al*., 1998; Cook and Lynch, 1999; Greger and Goodrich, 1999; Lewis *et al*., 1992; Linn and Krieg, 1978; Schropp *et al*., 1987; Tall *et al*., 1999). The ecology, physiology and evolution of bacteria are discussed in every issue of the *Journal of Fish Diseases*, yet a synthesis and overview of prokaryote ecology in the marine environment is lacking and probably premature because of all that is still unknown.

Bacterial communities are governed by distinct temporal cycles (Balch, 1981; Glover *et al*., 1985b; Keller *et al*., 1982, 1999), inherent behavioral variances (Dalton *et al*., 1996) and site-specific environmental variables (Cuhel *et al*., 1983; Ducklow *et al*., 1992; Ducklow *et al*., 1993; Nold and Zwart, 1998). Spatial variances in bacterial community structure are apparent across landscapes (Mullins *et al*., 1995; Murray *et al*., 1999; Zubkov *et al*., 1998) and across ocean strata (Gutvejb *et al*., 1987; Townsend and Cammen, 1985). Some researchers have investigated the ecology of specific prokaryotes (Balch *et al*., 1992; Fredrickson *et al*., 1999; McHatton, 1999; Rieley *et al*., 1999), but such studies are rare when weighed against the overall diversity and functional importance of the group.

Several studies have considered the genetic diversity of marine prokaryotes (Field *et al*., 1997; Fuhrman and Ouverney, 1998; Giovannoni *et al*., 1996; Zumarraga *et al*., 1999), but these results are difficult to interpret in light of the species definition dilemma. The picoplankton or ultraplankton (0.2-2 micrometers in size) are given separate status by some. Glover *et al*., (1985a) and Murphy and Haugen (1985) suggest that cyanobacteria (formerly referred to as blue-green algae) are the most important segment of the bacterioplankton in unproductive sites, since cyanobacteria are known for their resourcefulness in acquiring nitrogen under oligotrophic conditions. Murphy and Haugen (1985) cover the vertical distribution and abundance of the cyanobacteria. Glover *et al*. (1985a, 1985b) include them in discussion of the picoplankton, as do Murphy and Haugen (1985). Genetic work suggests this group is globally intermixed (Mullins *et al*., 1995).

Davis *et al*., (1978) showed that marine waters contain approximately equal amounts of heterotrophic and autotrophic picoplankton. A heterotroph is an organism that requires organic substances to get its carbon for growth and development; it is known as a consumer in the food chain. An autotroph is an organism capable of synthesizing its own food from inorganic substances, using light or chemical energy; it is known as a producer in the food chain. These general studies are only first insights into the functional diversity of marine prokaryotes. No studies have related this topic directly to the sanctuary.

Wichels *et al*. (1998) discuss bacteriophage (a virus that infects bacteria) diversity in the North Sea. One would expect similar levels of diversity in the sanctuary, but the constituent species from that region may be quite different.

Protists

Protists are an extremely diverse group of mostly single-celled eukaryotes—organisms having nuclear membranes and other cell organelles—ranging from slime molds and protozoans to phytoplankton and red, brown and green algae. The protists are a paraphyletic grade, rather than a natural group, and do not have much in common besides a relatively simple organization (unicellular, or multicellular without highly specialized tissues). Protists were traditionally subdivided into several groups based on similarities to higher kingdoms: the animal-like protozoa, the plant-like algae, and the fungus-like slime molds. While these groups have been replaced by phylogenetic classifications, they are still useful as an informal way to characterize this assemblage of organisms.

Several authors have described the macrophytes (large aquatic plants) and phytoplankton assemblages of the northeast region. Villalard-Bohnsack (1995) presents an illustrated key to the seaweeds. South and Tittley (1986) developed a checklist of the benthic algae for the whole North Atlantic. Bigelow (1924) gives an overall description of the offshore plankton from the GoM. A comprehensive discussion is given by Taylor (1957) for the northwestern Atlantic and addresses geographic distribution of algal species within that region. Marshall and Cohn (1982b, 1983) discuss general patterns of distribution and diversity of the algae. A more recent discussion of the topic is given in Silva (1992). Vadas and Steneck (1988) outline the geographical zonation of benthic algal species, and Townsend and Cammen (1985) showed zonation along vertical strata of the open ocean.

Mathieson (1989) includes some discussion of the distribution and diversity of the Rhodophta (red algae); their taxonomy is unresolved. Taylor (1957) includes most species one would encounter in the region. Mathieson (1989) includes discussion of the distribution and diversity of the Phaeophyta (brown algae) as well. South and Tittley (1986) include some discussion of the distribution of benthic Phaeophytes. There is currently no text dedicated to this group, and there is no research relating the specific diversity or distribution of the Phaeophyta relative to the sanctuary. Mathieson (1989) discusses the distribution and diversity of the Chlorophyta (green algae). Taylor (1957) covers the green algae in his descriptions, and this dated work is still one of the most complete. There are no published descriptions or records for these macrophytes from the Stellwagen Bank sanctuary.

Cahoon *et al*. (1993) discussed the productivity of benthic micro-algae on Stellwagen Bank, one of the few studies to address the *habitus* of this ocean feature. Protist productivity is at least partially governed by physical oceanographic processes, and several authors consider this relationship in the region of the sanctuary (Townsend *et al*., 1987; Franks, 1990; Townsend, 1991; Kerkhof *et al*., 1999). A more detailed examination is provided by Matta and Marshall (1983). Ducklow *et al*. (1992, 1993) discuss the growth of the protists during a plankton bloom, an important food web phenomenon.

In addition to physical-spatial variances, seasonal environmental variances play a significant role in growth, productivity (Durbin *et al*., 1995b; Keller *et al*., 1982) and patterns of diversity (Marshall and Cohn, 1982) of the protists. Mathieson (1989) discusses seasonal variance and its relation to reproduction of the protists in the GoM. Glover *et al*. (1985b) cover diurnal variations in the photosynthetic rates. Environmental and biological variances at all time scales may affect protist diversity.

Diatoms are a major group of eukaryotic algae and one of the most common types of phytoplankton. Most diatoms are unicellular, although some form chains or simple colonies; a characteristic feature of diatom cells is that they are encased within a cell wall made of silica. The general distribution of diatoms is covered in Marshall (1984). Over 1,000 species have been described. Several authors address the diatoms in their general discussion of marine algae (Bigelow, 1924; Marshall and Cohn, 1982; Sears and Cooper, 1978; Taylor, 1957). Round *et al*. (1990) describe the diatom genera and their biology, and include the marine groups.

Dinoflagellates are a large group of flagellate algae; most are marine plankton. About half of all dinoflagellates are photosynthetic, and these make up the largest group of eukaryotic algae aside from the diatoms. The dinoflagellates are most famous for their toxic blooms, i.e., "red tides" (Franks and Anderson, 1992). The blooms are so deadly they have even killed large whales (Geraci *et al*., 1989). Tomas (1995) is the most recent comprehensive text for the diatoms and dinoflagellates. Tomas (1997) covers the marine phytoplankton on the whole, including species level descriptions of the most common representatives of the major groups.

Other than the general summaries of the microbial communities discussed above, there are virtually no works that address the Cryptophyta (unicellular flagellate phytoplankton similar to dinoflagellates) as they relate to Stellwagen Bank or the GoM. Genetic variance in the coccolithosphores is discussed by Edvardsen and Medlin (1998), and the major groups have been described (Throndsen *et al*., 1993). Coccolithopores are species of planktonic single-celled algae that produce and encase themselves in coccoliths, which are individual plates of calcium carbonate. The coccoliths, which are dispersed after death or continuously shed by some species, settle to the sea floor and become part of the sediments. Coccoliths are the main constituent of chalk deposits such as the white cliffs of Dover.

Foraminifera are amoeboid protozoans with reticulating pseudopods (fine strands of cytoplasm) that branch and merge to form a dynamic net; they typically produce a mineral shell or "test." They can be planktonic or benthic. A number of forms retain unicellular algae and conduct photosynthesis. These organisms play a critical role in both primary production and transport of minerals, energy and nutrients to benthic communities. Corliss and Emerson (1990) addressed the distribution of benthic foraminifera. Settling foraminifera (components of marine snow) have been associated with diverse bacterial assemblages (Rath *et al*., 1998) and their diversity is of considerable interest to paleontologists. The foraminifera Families and Genera have been carefully delineated for marine communities (Hemleben *et al*., 1989; Sen Gupta, 1999), though new groups are regularly being discovered and described.

Stoecker *et al*. (1989) discuss the distribution of heterotrophic protists on Georges Bank and briefly address the Choanoflagellida, Rhizopoda, Actinopoda, Microspora, Ciliophora and Sporozoa (groups of motile unicellular or colonial protozoans). This is perhaps the only peer-reviewed study of its kind and there is no definitive text in print on the heterotrophic protists elsewhere in the GoM or the northwestern Atlantic. The Sporozoans are parasites of organisms which are found within the sanctuary (Sherburne and Bean, 1979; Lom *et al*., 1980; Bachere and Grizel, 1982). The Ciliophora are of special interest both as food for many marine larvae and as symbionts with higher taxa (i.e., Dupuy *et al*., 1999).

Fungi

Cavaliere (1977) provides one of the first descriptions of marine fungi (Kohlmeyer and Volkmann-Kohlmeyer, 1991); Ho *et al*. (1991) provide some of the more recent taxonomical revisions. Some taxa have been found in association with Foraminifera and marine snow (Kohlmeyer, 1985). Several taxa are known to be parasitic (Studies, 1980). There are no recent descriptions of marine fungi from the GoM or Stellwagen Bank. In general, marine fungi have been greatly ignored by scientists relative to most groups.

IV. Resource States

This section documents the status, pressures and current protections for sanctuary resources. These resources include seafloor and water column habitats, benthic invertebrates, fishes, seabirds, sea turtles, marine mammals and maritime heritage resources. This section provides context and validation for the sanctuary action plans.

Context

The nutrient-rich waters of the Stellwagen Bank sanctuary sustain an abundant biodiversity largely representative of the GoM LME and totaling well over 575 species of marine life including over 80 species of fish, 34 species of seabirds and 22 species of marine mammals, for example. As a comparatively shallow continental shelf area, offering great variety among its geological features and topographic relief, the sanctuary is a biodiversity haven when compared to the open ocean of the North Atlantic. In addition to the array of different kinds of species, the sanctuary exhibits diverse habitats, biological communities and species assemblages and displays a complex tapestry of interwoven environmental processes, all of which are extensively impacted by multiple human uses.

Biodiversity in the sanctuary is heavily mediated through habitat type and condition. In this document, habitats are divided into two principal categories: seafloor (benthic) and water column (pelagic) habitats. These habitats are composed of multiple types, such as gravel beds and piled boulder reefs. Habitat quality and structural complexity are important factors in supporting biodiversity. For example, the condition of benthic habitat affects the life history processes of recruitment, survivorship and growth of the organisms that occupy the seafloor. The condition of habitats also influences the community processes of competition, predation and symbiosis. Within water column habitats, water quality can affect biodiversity by prohibiting or enabling survival of rare or cosmopolitan species.

Understanding the processes that control the abundance, distribution and interaction of species (i.e., the functional composition of communities) is a central challenge facing management of the sanctuary. The level of difficulty in meeting this challenge is heightened by recognition that the sanctuary's resource states are greatly compromised. Water quality is threatened by multiple sources of pollution, including point, non-point and atmospheric sources and marine debris. Population declines and biomass removals, degraded seafloor habitats and invasive species compromise the ecological integrity of the sanctuary. Coastal planning and fishery management policies have limited, but not prevented, harmful impacts—both incremental and cumulative—on sanctuary resources.

This section is organized within a Pressure-State-Response framework that mirrors the approach used in the Stellwagen Bank National Marine Sanctuary *Condition Report* (NMSP, 2006). "Pressures" are human activities (such as fishing or pollutant discharge), which alter the marine environment leading to changes in the "state or condition" of sanctuary resources (e.g., water quality, ecological integrity, habitat complexity). Sanctuary management then "responds" (e.g., Action Plans section) to changes in pressures or states with policies, programs, and/or regulations intended to prevent, eliminate or mitigate pressures and/or environmental damage in order to protect and conserve sanctuary resources.

Sanctuary resources described in this section are: seafloor habitat, water column habitat, benthic invertebrates, fishes, seabirds, sea turtles, marine mammals and maritime heritage resources. Each resource subsection begins with a summary of its **status** based on the best available information followed by the known human **pressures** that impact the status. A summary of the **current protection** measures that are in place affecting the resource in question is presented next.

Seafloor as Habitat

Status

The species composition of seafloor communities in general is highly correlated with the grain size of benthic sediments, and seafloor substrata represent an important component of habitat for many organisms in the sanctuary. Recent studies on the continental shelf of the northeastern United States, including portions of SBNMS, indicate that substrate and water mass characteristics are highly correlated with the composition of benthic communities (e.g., Auster *et al*., 2001; Skinder, 2002) and may therefore serve as proxies for the distribution of biological diversity, where detailed information on the distributions and abundances of species is lacking (Cook and Auster, 2006).

Infaunal invertebrates, those that burrow *into* the seafloor, show strong associations with grain size in sand and unconsolidated mud sediments in the sanctuary (Grannis and Watling, 2004). Epifaunal species, those that live *on* the seafloor, are linked to variation in larger grain sizes at the scale of the GoM (Skinder, 2002). Within each habitat type, there are many microhabitats formed by the combination of habitats and inhabiting organisms. For example, cerianthid anemones that burrow in mud provide structure and shelter on the seafloor and serve as important habitat for redfish and hake (Figure 16).

Biological communities are formed by the interaction of populations with habitats in a particular area. The interaction of fish with their habitat is of particular concern and has been well-studied in the Stellwagen Bank sanctuary. For purposes of discussion in this document, the ecological role of seafloor habitats is largely restricted to our understanding of links to the distribution and abundance of fishes. Higher plants are virtually absent from and play no substantive role in structuring seafloor habitats in the sanctuary; instead benthic invertebrates make up the biogenic structure of the seafloor. In the absence of vascular plants, benthic microalgal production on Stellwagen Bank is important and can be high (Cahoon *et al*., 1993).

Figure 16. Example of a microhabitat formed within a mud habitat by burrowing anemones.

In this example, Cerianthid anemones provide refuge to juvenile Acadian redfish. Image courtesy: Ivar Babb and Peter Auster, NURC-UConn.

Habitat Mediated Interactions

There is an important biogenic component to habitat complexity. For instance, many fish species in the sanctuary associate with particular microhabitats formed by other living organisms (Auster, 1998). Attached and emergent invertebrates such as erect sponges and burrowing anemones provide important habitat structure, while certain megafaunal organisms such as skates produce pits and burrows, which also provide structure by adding to the complexity of sediment surfaces. Reductions in seafloor habitat complexity increase the mortality of early demersal phase juvenile fish, such as Atlantic cod and winter flounder that utilize the structure provided by emergent fauna and physical substrata for protection from predation (Tupper and Boutilier, 1995; Lindholm *et al*., 1999; Scharf *et al*., 2006). Modeling studies have demonstrated that such habitat-mediated mortality of juvenile fish can have significant population-level effects (Lindholm *et al*., 1998, 2001).

The distribution and abundance of demersal fishes at large spatial scales is correlated with temperature and depth, but medium to small-scale variation is attributed to considerable extent to habitat attributes (i.e., sediment type, structural complexity, prey type and abundance) on the seafloor (Langton *et al*., 1995). The distribution of a variety of demersal fishes in the GoM LME is correlated with various structural habitat features such as boulder reefs, distribution of sand wave features, density of amphipod tubes, and presence and density of sponges, anemones and other epifauna (Auster *et al*., 1997, 1998, 2003a, 2003b; Auster 2005; Auster and Lindholm 2006). The communities of fishes in the sanctuary are directly correlated with particular habitats defined by a combination of both geologic and biologic attributes (Auster *et al*., 1998).

The patchiness and spatial arrangement of habitats mediate many of the behavioral interactions of fishes. Fish exhibit, as many mobile organisms do, a range of behavioral interactions that have negative, neutral, or positive consequences in terms of growth and survivorship. For example, predation has a positive consequence for the predator and a negative one for the prey. Other interactions include competition and mutualism. Competition for shelter sites can be intense when the abundance of individuals is high and shelter space is limited, such as rock crevices for night-time shelter required by cunner. Mutualistic relationships within and between fish species are often short term in scope and mediated in part by habitat features. For example, the foraging activities of one species can aid in prey capture of other species. Flounders are sometimes followed by piscivores such as silver hake which gain access to disturbed prey such as shrimp and small fish when flounders sift through sediments in search of infaunal prey (e.g., Auster *et al*., 1991, 2003a). Such relationships, while lasting only tens of seconds, are repeatedly linked to particular habitats and species groups and constitute important feeding strategies.

Habitat complexity mediates access to prey and the behavioral trade-offs in minimizing risk of predation. For example, Acadian redfish are zooplanktivores and feed in the water column above boulder reefs. Height of fishes above the reef dictates the rate of water flow that delivers prey and distance to shelter is a measure of hunger level and the risk of predation individuals would take. In general, smaller fish venture less from shelter than larger individuals. Further, boulder reef structure also mediates the species composition and abundance on different parts of reefs. For example, while Acadian redfish are dominant on the central parts of reefs with deep crevices formed by piled boulders, cunner increase in abundance on the margins of reefs, possibly due to the availability of smaller shelter sites that are better suited to this species than open deep crevices. Cusk generally occur in deep crevices on the central parts of reefs while ocean pout and Atlantic wolffish occur in burrows along reef margins (Auster and Lindholm, 2006).

As the density of a species within a habitat increases there is increased competition for resources such as shelter and prey. At some stage emigration from the habitat patch and a search for new habitats is a choice made by individuals who have access only to marginal shelter sites (e.g., with increased risk of predation) or access only to areas of reduced prey abundance (e.g., with reduced growth). Acadian redfish exhibit distribution patterns that are consistent with increased migration from boulder reefs, due to competition for shelter or prey, as animals grow in size (Auster *et al*., 2003b). While young-of-the-year redfish were found only in boulder reefs due to habitat selection or extreme predation in other habitats, some older juvenile redfish move to habitats composed of dense burrowing anemones. Such habitats provide some shelter away from boulder reefs as well as access to zooplankton prey.

Habitat Mediated Movement

Mediation of fish movement by different habitat types and features is not well understood for species in the GoM. This information is needed to understand how key predators like Atlantic cod influence the structure and composition of biological communities in the sanctuary. The degree of localized movement by individuals and their tenure of residency differentiated by habitat type and season are important aspects to be understood, as are the associated factors of size and sex. The successful conservation and management of cod and other commercially important species in the GoM is highly dependent on this information as well. Site residency and fidelity among Atlantic cod stocks is now widely documented (Robichaud and Rose, 2004; Wright *et al*., 2006; Neat *et al*., 2006; Lindholm *et al*., 2007).

A study was begun in 2001 in the sanctuary that used acoustic telemetry technology to quantify cod movement over different habitat features of the sanctuary landscape. Cod were caught and tagged with coded-acoustic transmitters (each of which emits a unique identification code) then released within the overlap of the sanctuary and the Western Gulf of Maine Closed Area (WGoMCA). Movements of tagged cod were recorded by an array of four acoustic receivers deployed on the seafloor. Data were collected at the scale of minutes for several months at a time. Preliminary tracking occurred in the gravel habitat of northeastern Stellwagen Bank in 2001 (Lindholm and Auster, 2003). From May 2002 through October 2002 and from September 2004 through March 2005, cod movement was investigated at additional four piled boulder reef sites (Lindholm *et al*., 2007). The same piled boulder reefs were used in both periods in order to quantify any influence of seasonality on cod movement behavior.

Three broad categories of movement behavior were identified at each of the four piled boulder reefs, across years and across seasons: 35% of adult cod (38-94 cm total length) showed very high site fidelity to individual boulder reefs (greater than 80% of 1-hour time bins); 51% of cod left after a couple of days and were never recorded again; the remaining 13% fell somewhere in between those two extremes. Several animals were recorded at more than one reef. A few animals exhibited behavior that may be evidence of homing. The behavior did not differ significantly with fish length, among individual reefs, and between summer and winter.

These results are strong evidence that some subset of the cod population in the sanctuary is "resident" on boulder reefs. The results of this study are consistent with the results of a review of 100 years of cod tagging studies in the North Atlantic. The review revealed that 32% of the tagged cod in the northwest Atlantic exhibited the sedentary behavior (Robichaud and Rose, 2004). The high site fidelity of many cod to individual piled boulder reefs suggests that habitat-specific management measures, such as marine reserves, may offer significant protection to cod within the sanctuary. Neat *et al*. (2006) conclude that marine protected areas could be an effective management measure in sustaining small resident populations of Atlantic cod.

Habitat and Sound Production

Sound production by fishes can serve a variety of purposes including species identity, individual identity, mate location, readiness to spawn, individual size and level of aggressiveness (Lobel, 2002). Over 150 species of fish in the northwestern Atlantic and at least 51 from the New England region are known to produce sounds (Fish and Mowbray, 1970; Rountree *et al*., 2002). Species across a spectrum of diversity, like Atlantic cod, haddock, silver hake, longhorn sculpin, cusk, fawn cusk-eel, American eel and cunner all produce sounds, although the behavioral context for producing sounds for these and other species is not always clear. However, there are clear relationships between particular sounds and spawning events in species like Atlantic cod, haddock, cusk, and fawn cusk-eel. Assuming much of sound production is behavior-specific, correlations between habitat selection and use in terms of spawning or territorial defense among demersal fishes is inferred.

Seafloor Habitat Recovery

Context

In May 1998, NOAA Fisheries Service established the WGoMCA at the recommendation of the NEFMC for the purpose of recovering groundfish stocks, specifically Atlantic cod and haddock. Gear capable of catching groundfish was prohibited from this closed area, specifically bottom-tending trawl gear, bottom-tending gillnets, and clam and scallop dredges. Allowable gear included lobster pots, hagfish pots, pelagic longline, pelagic hook and line fishing, recreational hook and line, pelagic gillnets, tuna purse seining and midwater trawls. The closure area overlaps 22 % (453 km^2) of the sanctuary along the eastern boundary; the area of overlap has been dubbed the "sliver" (Figure 17).

In May 2004, NOAA Fisheries Service, at the recommendation of the NEFMC, designated the majority of the WGoMCA as a "Level 3" habitat closed area for the purpose of protecting EFH. A Level 3 habitat closed area is closed indefinitely on a year-round basis to all bottom-tending mobile gear. In addition to prohibiting bottom-tending mobile gear, the closure prohibits bottom-tending gillnets, clam and scallop dredges, and shrimp trawls. Allowable gears in this closure are: lobster pots, hagfish pots, pelagic longline, pelagic hook and line fishing, recreational hook and line, pelagic gillnets, tuna purse seining and midwater trawls except for shrimp. For a complete listing of prohibited and allowed gear visit URL http://www.nero.noaa.gov/nero/fishermen/multispecies/gom/CAYearRound.htm#wgomca.

De Facto Reference Area

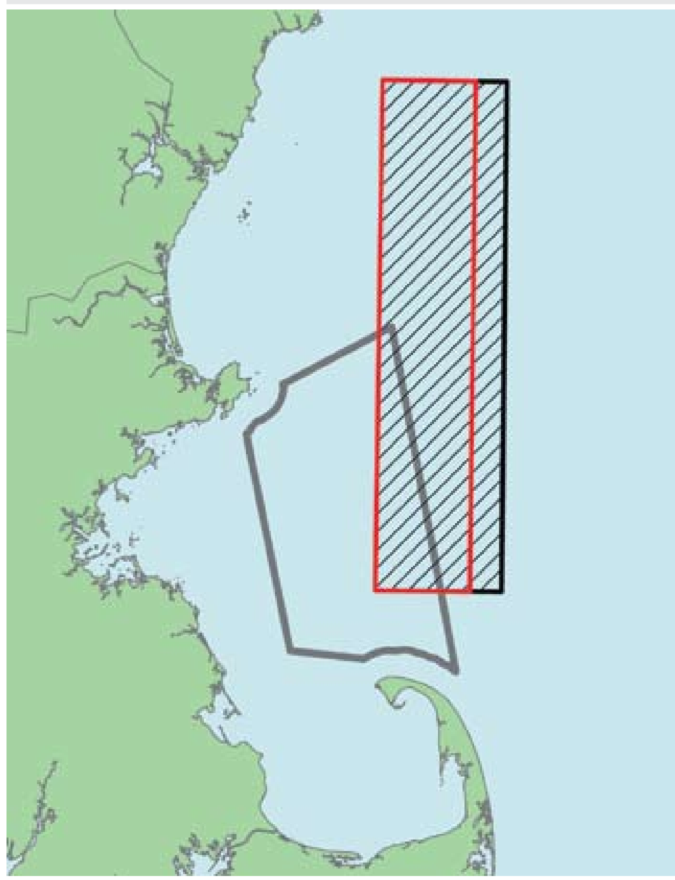
There is no formally designated undisturbed reference or control area in the Stellwagen Bank sanctuary. Because of the compelling need for a control site, the sliver has become a *de facto* reference area which the sanctuary and other researchers are using to discern the effects of human versus natural disturbance on seafloor habitats and their associated biological communities. However, the sliver is far from a true control area owing to three shortcomings: (1) several extractive activities are still allowed (i.e., fishing gears listed above) that alter the area's ecological integrity, (2) additional resources for enforcement are needed to assure deterrence of unlawful incursions, and (3) deep mud habitat is seriously underrepresented (75.5% gravel, 23.5% sand and 1.0% mud) in the sliver making it difficult to draw definitive conclusions about the effects of fishing in this habitat type.

These shortcomings need to be addressed. As a first step, the sanctuary formally proposed on July 2, 2003 to the NEFMC through its Amendment 13 process that the sliver be designated a 'habitat research area' under the MFCMA. There are several properties of the sliver that make it a suitable choice for a habitat research area, including scientific, practical and political rationales:

- The sliver includes the major seafloor habitat types found in the GoM — bedrock outcrop, boulder, gravel, mud and sand. This habitat mix enhances the exportability and extrapolation of research results to diverse areas outside the habitat research area.
- The habitats in the sliver are distributed on both sides of the closure boundaries, both within the sanctuary (to the west) and outside of the sanctuary proper (to the east), making comparative habitat studies possible across the boundaries.
- The proximity of the sliver to the ports of Boston, Gloucester, Scituate, Plymouth and Provincetown make it accessible to researchers for day-trips using small and relatively inexpensive vessels, which makes research in the sliver more cost-effective than at alternative offshore northeast continental shelf locations.
- The sliver has already been closed to commercial bottom fishing for nine years. From a scientific perspective, this greatly enhances study of the ecological processes and expedites the timeline on which research results can be attained.

Figure 17. Map depicting the WGoMCA (cross-hatched) and its overlap with the Stellwagen Bank sanctuary.

Majority of the WGoMCA is a Level 3 habitat closed area (red outline) for the purpose of protecting EFH.



- The sanctuary has the resources to help support enforcement of the habitat research area in ways that would complement regulation under NOAA Fisheries Service purview.

In its current capacity as a *de facto* reference area, the sliver is supporting several on-going long-term studies by sanctuary staff and sanctuary-supported scientists. Projects include: (1) quantification of fish movement rates relative to seafloor habitat type (1998 to the present), (2) recovery of seafloor habitats and associated taxa following the cessation of trawling, dredging and bottom gillnet fishing (1998 to the present), and (3) species-area relationships of multiple taxa (1999 to the present).

This combined research represents a public investment totaling more than $1.9 million over the last five years. A comparable level of investment will be made over the next several years. The results of these ongoing projects in the sliver, and other projects currently in various stages of planning and proposal preparation, will contribute to advancing ecosystem understanding in the sanctuary and by extension the GoM. The NEFMC is in the process of revising its omnibus amendment to better protect EFH and has not yet acted on the sanctuary proposal.

Pressures

Disturbance in General

Disturbance is defined as any discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability or the physical environment (Pickett and White, 1985). Disturbance can be caused by many natural processes such as currents, predation and iceberg scour (Hall, 1994). Human caused disturbance can result from activities such as harbor dredging, cable laying and fishing with fixed and mobile gear. Disturbance can be gauged by both intensity (as a measure of the force of disturbance) and severity (as a measure of impact on the biotic community). General concepts associated with the types and ecological implications of spatially mediated disturbance are described in the accompanying Sidebar.

Table 3 summarizes the effects of the range of agents which produce disturbance in marine communities. The various forms of disturbance range from small to large in spatial scale as well as acute to chronic in periodicity. From an ecological perspective, fishing is the most widespread form of direct disturbance in marine systems below depths (approximately 85 m) which are affected by storms (Watling and Norse, 1998; Auster and Langton, 1999; National Research Council, 2002).

Activities that have the greatest potential impact on the seafloor habitats of the sanctuary are the laying of underwater cables and pipelines, the use of mobile fishing gears, removal of forage species and bycatch due to fishing, and ocean dumping. The chief distinction between these activities is whether they produce chronic (repeated) or acute (intermittent) disturbance. Chronic disturbance has

Types of Spatially Mediated Habitat Disturbance

The spatial extent of disturbed and undisturbed biological communities is a concern in designing and interpreting research studies (Pickett and White, 1985; Thrush *et al.*, 1994) and in managing the sanctuary. Single, widely spaced disturbances may have little overall effect on habitat integrity and benthic communities, and may show reduced recovery times as a result of immigration of mobile species (e.g., polychaetes, gastropods). In the ecological literature, this is a "Type 1" disturbance, where a small patch is disturbed but surrounded by a large unimpacted area.

In contrast, a "Type 2" disturbance is one where a small patch is unimpacted but surrounded by a large disturbed area. Recruitment into such patches requires large scale transport of larvae from outside source patches, or significant reproductive output (and high planktonic survival and larval retention) from the small undisturbed patches. Making predictions about the outcome of either type of disturbance, even where spatial extent is known, is difficult since transport of colonizers by either immigration or recruitment depends on oceanographic conditions, larval period, movement rates of juveniles and adults, time of year and distance from source.

Type 1 disturbances have habitat recovery rates that are generally faster because they are subject to immigration dominated recovery versus the dependence on larval recruitment for the recovery of Type 2 disturbances. The associated population responses of obligate and facultative habitat users to such disturbances are also variable. Obligate users are restricted by narrow requirements and have no habitat options; facultative users have options because of less restrictive requirements. Obligate habitat users have a much greater response to habitat disturbance than facultative users.

Comparatively, it would be difficult to detect responses from populations of facultative habitat users to Type 1 disturbance because of the large adjacent areas of undisturbed habitat. Type 2 disturbances would produce large responses in obligate habitat users because a large percentage of required habitats would be affected. Facultative habitat users would have a measurable response only at population levels where habitat mediated processes became important.

This discourse on the types of spatially mediated habitat disturbance and the respective responses of obligate and facultative habitat users is relevant to how the sanctuary will eventually have to approach management of fishing activities and other impacts to biogenic habitats (structure and associated populations). The majority of sanctuary area is subjected to chronic disturbance by fishing and the sliver is the only relatively unimpacted patch (see sections on spatial distribution and density of commercial and recreational fishing under Human Uses in this DMP).

TABLE 3. COMPARISON OF INTENSITY AND SEVERITY OF VARIOUS SOURCES OF PHYSICAL DISTURBANCE TO THE SEAFLOOR (BASED ON HALL (1994) AND WATLING AND NORSE (1998)).

Intensity is a measure of the force of physical disturbance and severity is a measure of the impact on the benthic community (adapted from Auster and Langton (1999)).

Source	Intensity	Severity
ABIOTIC		
Waves	Low during long temporal periods but high during storm events (to 85 m depth)	Low over long temporal periods since taxa adapted to these events but high locally depending on storm behavior
Currents	Low since bed shear normally lower than critical velocities for large volume and rapid sediment movement	Low since benthic stages rarely lost due to currents
BIOTIC		
Bioturbation	Low since sediment movement rates are small	Low since infauna have time to repair tubes and burrows
Predation	Low on a regional scale but high locally due to patchy foraging	Low on a regional scale but high locally due to small spatial scales of high mortality
HUMAN		
Dredging	Low on a regional scale but high locally due to large volumes of sediment removal	Low on a regional scale but high locally due to high mortality of animals
Land Alteration (Causing silt-laden runoff)	Low since sediment-laden runoff per se does not exert a strong physical force	Low on a regional scale but high locally where siltation over coarser sediments causes shifts in associated communities
Fishing	High due to region wide fishing effort	High due to region wide disturbance of most types of habitat

lasting effects because the ecosystem does not recover fully before the next disturbance. Fishing impacts have the greatest effect on seafloor habitats of any human activity in the Stellwagen Bank sanctuary for this reason.

The laying of an underwater cable has occurred only once in the sanctuary (in 2001) and is an acute impact. The results of this impact are discussed below. Ocean dumping of vessel-generated wastes occurs more frequently in the sanctuary; however, at current discharge levels and dilution rates that activity does not have the lasting effects on physical structure and ecological integrity as does fishing. Much of the following discussion of pressures applies primarily to or involves fishing activities because of the pervasiveness of those activities in the sanctuary and the abundant information available in the scientific literature on the habitat disturbance effects of fishing.

Disturbance of Seafloor Habitats in the Sanctuary

Preliminary results of the Seafloor Habitat Recovery and Monitoring Project (SHRMP) (see Sidebar) are listed below. This project evaluates the relative effects of disturbance due to laying the fiber-optic cable, fishing and natural disturbance over a decadal time frame. Samples have been collected from 1998-2006. While analyses of the various approaches are at different stages, the preliminary results to date demonstrate notable patterns and trends:

1. There are significant differences in epifaunal community structure between boulder and gravel habitats despite the fact that both are composed of hard substrate (Tamsett, in preparation).

2. Within boulder and gravel habitat types there are differences in community structure between sites inside and outside the sliver indicative of impacts from fishing activities (Tamsett, in preparation).

3. Within mud habitat types there are differences in community structure between sites inside and outside the sliver indicative of impacts from fishing activities (Grannis, 2001).

4. Contrasts in the composition of sand habitat communities inside and outside of the sliver are not clearly different, suggesting that fishing effects superimposed on background patterns of natural disturbance have similar effects on sand communities (Grannis, 2001).

5. Community structure is changing across time both inside and outside the sliver in all habitats, suggesting a dynamic environment where both natural and human caused disturbances (from fishing) mediate the composition and pattern shift of seafloor communities (Grannis, 2001; Tamsett, in preparation).

6. Analysis of samples from inside and outside the sliver along the route of the fiber-optic cable does not demonstrate an effect of the acute impact of the cable being laid but does suggest a chronic effect from fishing (Grannis, 2001).

7. The trench produced during the cable burial operation in 2001 is still visible in 2006 along significant parts of the path through the sanctuary based on sidescan sonar records, demonstrating that the passage of five years has been insufficient time for sediment transport processes to fill in the feature (Auster and Lindholm, unpublished).

Seafloor Habitat Recovery and Monitoring Project (SHRMP)

The long-term Seafloor Habitat Recovery Monitoring Project (SHRMP) was initiated in 1998, when the WGoMCA went into effect, and is ongoing ideally through 2010. The project uses the sliver as a relatively unimpacted reference site to quantify the recovery of seafloor habitats and associated biological communities previously subject to fishing activities and to understand the dynamics of these habitats and communities over time. The study design includes representative sites inside and outside the sliver in mud, sand, gravel and boulder habitat types. The study compares and contrasts the effects of natural and fishing-related disturbance on seafloor habitats and community structure.

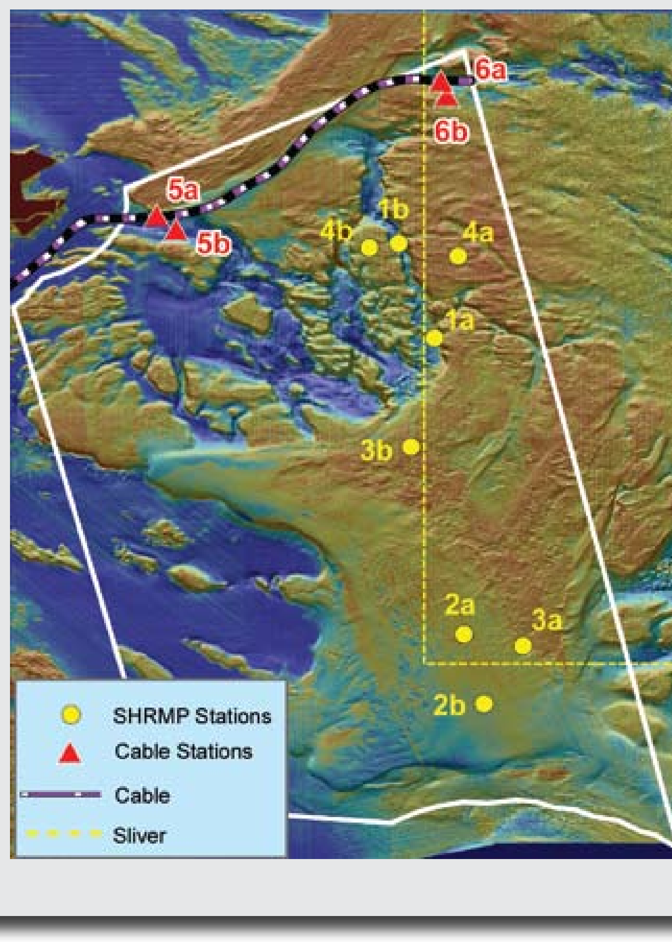
In 2001, NOAA permitted installation of a fiber-optic cable across the sanctuary, including the northern portion of the sliver. At that time the objectives and hypotheses of SHRMP were modified to include the effects of the cable laying (a one-time, acute anthropogenic disturbance). The revised monitoring program began in summer 2001 and, pursuant to terms of the permit, will continue through 2010.

Sampling. Eight sites are sampled along the fiber optic cable route, located directly over the cable trench and in adjacent areas, both inside and outside of the sliver (Figure 18). A total of eight other sites are sampled, half inside and half outside the sliver, to monitor fishing impacts (Figure 18). Four of these sites (inside) serve as control sites; the other four (outside) sites serve as impact sites for fishing disturbance.

Primary sampling of the fiber optic cable route, the fished sites and the respective control sites is done using underwater imaging systems (still and video) from various underwater vehicles, as well as grab samples for fine-grained sediments. Additional sampling is conducted using side-scan sonar to understand the large scale dynamics of the seafloor landscapes. Current meters are deployed on the seafloor to characterize the level of oceanographic forcing of sediment transport processes and the related variation in landscape features (e.g., natural disturbance by storm driven currents).

Figure 18. Location of long-term sampling sites for the Seafloor Habitat Recovery Monitoring Project.

Triangles indicate fiber optic cable monitoring sites; circles indicate SHRMP sites: 1a = mud closed, 1b = mud open; 2a = sand closed, 2b = sand open; 3a = gravel closed, 3b = gravel open; 4a = boulder closed, 4b = boulder open. Cable sites: 5a = on cable open, 5b = off cable open; 6a = on cable closed, 6b = off cable closed.



Project Objectives. The general objective of SHRMP is to compare the distributions of microhabitats and associated fauna in impacted and unimpacted areas with regard to the laying of the fiber optic cable and fishing. This objective can be stated as two null hypotheses (that an observed difference is due to chance alone and not due to a systematic cause):

HO(1): There are no differences in the relative abundance of each microhabitat type in impacted and unimpacted sites, and:

HO(2): There are no differences in faunal abundance, density and microhabitat associations between impacted and unimpacted sites.

The specific objectives of the project are to quantify the relative impacts of the laying of the fiber optic cable and fishing with respect to:

- fish communities
- microhabitat structure
- soft-sediment infaunal communities
- hard-bottom epifaunal communities

There are also trends in the composition of particular species and groups (Tamsett, in preparation):

(a) The abundance of ascidians (primarily the tunicate *Mogula* sp.) has increased significantly inside the sliver over time while the brachiopod *Terebratulina septentrionalis* has increased outside. The exact mechanism is not clear from these observations but various types of direct and indirect interactions, where either differential rates of survivorship or competitive interactions mediated by fishing disturbance result in such patterns, are hypothesized.

(b) Across the entire area there has been a decline in brittle stars, obviously resulting from some type of area-wide effect, such as the possible heightening of predation due to increasing demersal fish populations.

(c) Finally, there is a general pattern in species groups that provide shelter resources for fishes, such as sponges and erect bryozoans, to be more abundant inside the sliver than outside (McNaught, unpublished). This type of response is a common pattern based on multiple reviews of fishing effects studies.

Habitat Disturbance Due to Fishing

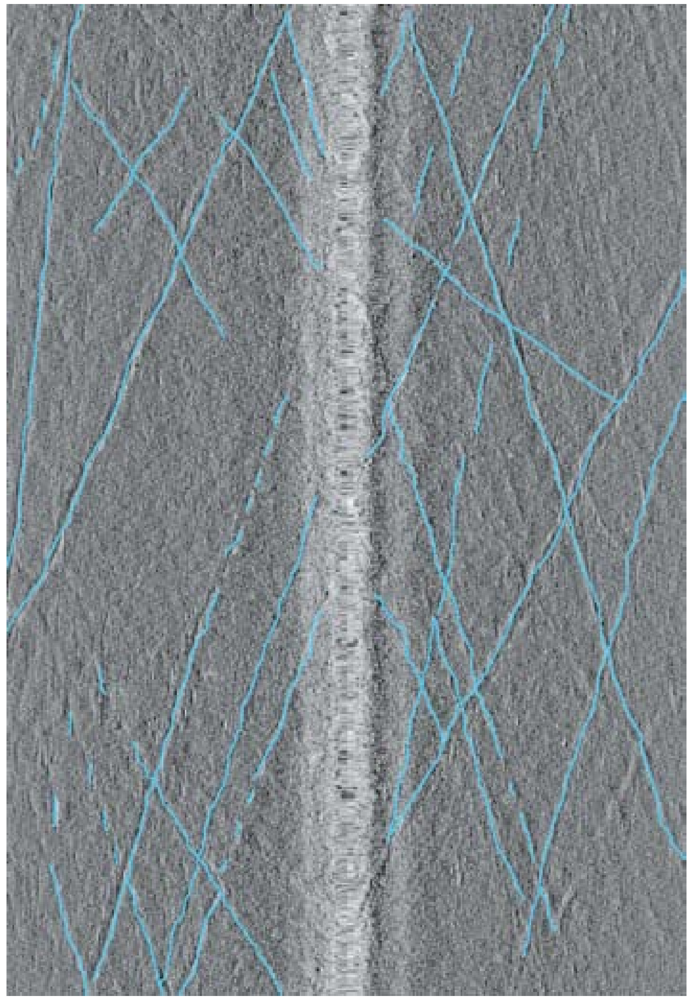
The pervasiveness of disturbance by bottom trawling and dredging and the effects of that disturbance are extensively demonstrated by the recent literature, for example: Auster *et al*., 1996; Auster and Langton, 1999; Ball *et al*., 1999; Caddy, 1973; Churchill, 1989; Collie *et al*., 1997; Collie, 1998; Collie *et al*., 2000; Dayton *et al*., 1995; Duplisea *et al*., 2002; Engel and Kvitek, 1998; Freese *et al*., 1999; Friedlander *et al*., 1999; Hall, 1999; Hansson *et al*., 2000; Jennings and Kaiser, 1998; Jennings *et al*., 2001, 2002; Kaiser *et al*., 1996; Kaiser, 1998; Kaiser and de Groot, 2000; Kaiser *et al*., 2002; Lindegarth *et al*., 2000; Mayer *et al*., 1991; McConnaughey *et al*., 2000; Messiah *et al*., 1991; Palanques *et al*., 2001; Pilskahn *et al*., 1998; Riemann and Hoffmann, 1991; Rijnsdorp *et al*., 1998; Roberts *et al*., 2000; Sanchez *et al*., 2000; Simpson, 2003; Simpson and Watling, 2006; Smith *et al*., 2000; Sparks-McConkey and Watling, 2001; Thrush *et al*., 1998, 2001; Tuck *et al*., 1998; Watling *et al*., 2001; Watling and Norse, 1998; and Widdicombe *et al*., 2004. The majority of these studies were conducted in the North Atlantic, and all bear on the kinds of seafloor habitat disturbance due to fishing that pertain to the Stellwagen Bank sanctuary. Many of these studies were reviewed by the NEFMC in its Amendment 13 description of fishing effects on the environment (NEFMC, 2003). An example of the intensity of bottom trawling on a seafloor habitat in the sanctuary is presented in Figure 19.

Effects of Disturbance

The disturbance of the seabed by bottom mobile fishing gear (otter trawls and dredges) is sometimes viewed as synonymous with forest clearcutting (Watling and Norse, 1998). Structures in marine benthic communities are generally much smaller than those in forests but structural complexity is no less important to their biodiversity. Use of mobile fishing gear crushes, buries and exposes marine animals and structures on and in the substratum, sharply reducing structural diversity. It also alters bio-geochemical cycles. These fishing activities have a number of effects that can alter the value of habitats for fishes and change the composition of epifaunal and infaunal invertebrate communities as well.

Figure 19. Side-scan sonar image of bottom otter trawl tracks over the mud habitat of Gloucester Basin in the Stellwagen Bank sanctuary.

The area depicted (100 m swath width) is extensively furrowed by trawl doors during successive tows by fishing vessels. A trawl door is attached to each side of the mouth of the net to keep it open. Recent trawl tracks are colorized to provide contrast; earlier tracks are evident in the background. The image was made by side-scan sonar towed behind a research vessel in 2005; the center stripe indicates the path of the instrument. Source: NOAA/SBNMS.



A large number of research studies (e.g., Auster and Langton, 1999) has shown that bottom contact fishing gear has the following general effects on the physical structure of seafloor habitats: (1) smoothing of bedforms like sand waves and ripples; (2) removal of habitat-forming epifaunal species like sponges, bryozoans and corals; and (3) removal of "ecosystem engineers" that produce various structures based on their activities, such as crabs and fishes that produce burrows and depressions. Studies have also shown generalized effects on community composition and ecosystem processes. Increased disturbance from fishing can shift stable seafloor communities from those that are dominated by slow-growing and long-lived species to those dominated by organisms that are fast-growing and short-lived (i.e., opportunistic or weedy). While communities are often a mosaic of both types, the large scale impacts of fishing can homogenize communities to those dominated by the "weedy" species that gain competitive advantage from periodic disturbance.

Fishing activities alter the biological structure of marine habitats as well and influence the diversity, biomass and productivity of the associated biota (Auster *et al*., 1996). These effects vary according to gear used, habitats fished and the magnitude of natural disturbance, but tend to increase with depth and the stability and complexity of the substrate. The effects are most severe where natural disturbance is least prevalent, where storm-wave damage is negligible and biological processes, including growth and recruitment, tend to be slow. Benthic habitats and the effects of fishing are extensively reviewed in Barnes and Thomas, eds. (2005).

Meta-Analysis of Fishing Effects

Empirical studies of fishing effects realistically can not be done everywhere under conditions that separate the effects of gear type, habitat and community composition. However, it is possible to use a wide range of empirical studies to conduct a meta-analysis that extracts such information from existing studies. Collie *et al*. (2000) showed that inter-tidal dredging and scallop dredging had a greater impact on seafloor communities than did trawling. Further, communities in stable gravel, mud and biogenic habitats (e.g., sponges, corals) were more affected by fishing than communities in unconsolidated sediments like coarse grain sand. Rates of recovery after impacts were fastest in less stable and complex habitats like sand (e.g., six months to one year), while biogenic habitats had the longest recovery, on the order of years to decades.

A recent and comprehensive summary of gear effects on benthic marine habitats was prepared by the National Research Council, which verifies and amplifies earlier research findings. This report, entitled "Effects of Trawling and Dredging on Seafloor Habitat" (NRC, 2002) reiterated four general conclusions regarding the types of habitat modifications caused by trawls and dredges:

- Trawling and dredging reduce habitat complexity.
- Repeated trawling and dredging result in discernable changes in benthic communities.
- Bottom trawling reduces the productivity of benthic habitats.
- Fauna that live in low natural disturbance regimes are generally more vulnerable to fishing gear disturbance.

The NRC report also summarized the indirect effects of mobile gear fishing on marine ecosystems. It did not consider the effects of all gear types, only the two (trawls and dredges) that are considered to most affect benthic habitats.

A related 2003 study of the collateral impacts of fishing methods ranked various types of fishing gear based on severity of impacts to habitats and degree of bycatch (Morgan and Chuenpagdee, 2003). The highest impact gears were: bottom-tending trawls, bottom-tending gillnets, dredges

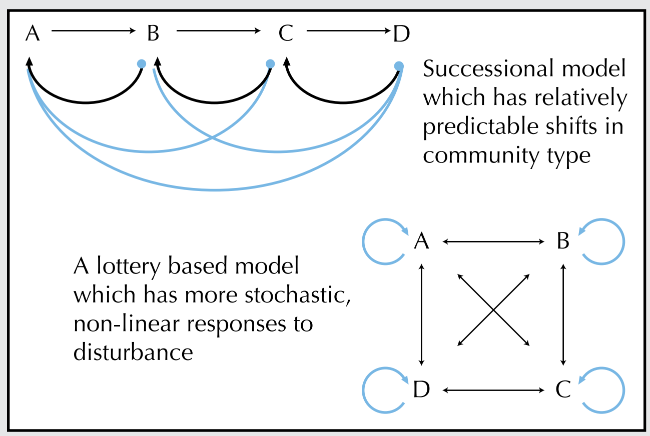
Models of Pattern Shifts in Community State Due to Disturbance

The first pattern is the successional model where communities change from type A to B to C and so forth (Figure 20). There are empirical examples of this type of succession in soft bottom benthic communities. Succession is based on one community of organisms producing a set of local environmental conditions (e.g., enriching the sediments with organic material) which make the environment unsuitable for continued survival and recruitment but are favorable for another community of organisms. Disturbance can move the succession back in single or multiple steps, depending on the type of conditions that prevail after the disturbance. The successional stages are predictable based on the conditions which result from the organisms themselves or from conditions after a perturbation.

The second pattern is the lottery model which is less predictable and disturbance mediated (Figure 20). There are multiple outcomes for community recovery after the end of the disturbance. Empirical studies of such relationships are generally found in hard substrate communities. Shifts in community type are produced by competition and disturbance (e.g., predation, grazing, storms, fishing gear) that can result in shifts toward community types which are often unpredictable because they are based on the pool of recruits available in the water column at the time that niche space becomes available.

Figure 20. Two conceptual models of pattern shifts in community state due to disturbance.

(from Auster and Langton, 1999).



(e.g., scallop and clam) and pelagic gillnets. Medium impact gears were: pots and traps, pelagic longlines and bottom-tending longlines. Low impact gears were: midwater trawls, purse seines, and hook and line.

Successional Shifts in Community State

Disturbance has been widely demonstrated as a mechanism which shifts communities (Dayton, 1971; Pickett and White 1985; Witman, 1985; 1987). Auster and Langton (1999) provide an in-depth synthesis of disturbance ecology related to seafloor communities and fish habitat. General models produced from such work are useful for understanding fishing as an agent of disturbance from an ecological perspective and are discussed below.

Assumptions regarding the role of fishing on the dynamics of marine communities generally assert that the cessation or reduction of fishing will allow populations and communities to recover. That is, recover to a climax community state as is the case in long-lived terrestrial plant communities (e.g., the succession of old farm fields to mature forest). That does not always happen in marine ecosystems.

Succession of communities implies a predictable progression in species composition and abundance. Such knowledge of successional patterns would allow managers to predict future community states and directly manage patterns of biological diversity. While direct successional linkages have been found in some communities, others are less predictable. Two generalized models (from Auster and Langton, 1999) that depict patterns in shifts in community state due to disturbance are illustrated and discussed in the Sidebar.

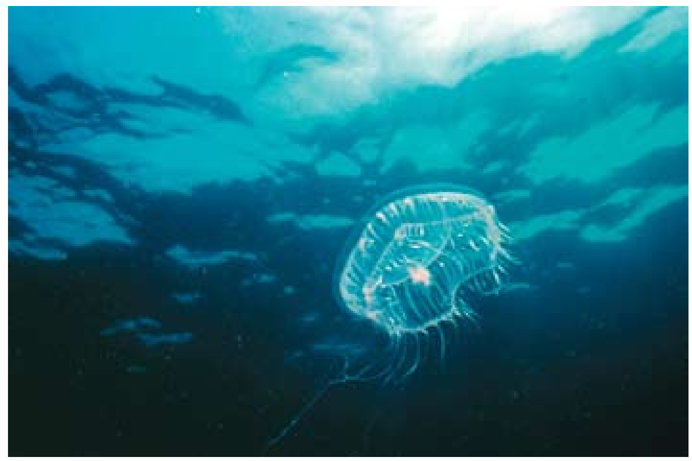
These two models of shifts in community state due to disturbance illustrate the complexities underlying management of biological communities in the sanctuary. Changes of community structure due to disturbance may or may not be predictable based on numerous factors including type of habitat and organism. The models portend that the character and structure of present-day communities in the sanctuary very likely have changed and in ways that may not be strictly reversible.

Current Protection

Sanctuary regulations (15 C.F.R § Subpart N) prohibit drilling into, dredging or otherwise altering the seabed of the sanctuary; or constructing, placing or abandoning any structure or material or other matter on the seabed of the sanctuary, except as an incidental result of (1) anchoring vessels; (2) traditional fishing operations; or (3) installation of navigation aids. The exemption for traditional fishing activities reduces the effectiveness of these regulations in managing habitat disturbance, and thereby protecting ecological integrity and managing for biodiversity conservation.

The most effective regulations to date for protecting seafloor habitat and communities in the sanctuary are those promulgated by NOAA Fisheries Service under the MFCMA to restore groundfish stocks in the GoM and protect EFH. Over the past two decades NOAA Fisheries Service, in collaboration with the NEFMC, has promulgated fishing regulations that have significantly reduced fishing effort, and, therefore, habitat impacts to some degree in the northeast region which includes the sanctuary. Examples of these regulations are: reducing fishing days at sea, creating groundfish and habitat closed areas (e.g., WGoMCA), increasing net mesh size to allow escapement of juvenile fish, reducing trawl net roller gear sizes to prevent trawlers from accessing high relief habitat, and creating seasonal closures to protect migrating or spawning species.

While these regulations help to reduce fishing mortality and rebuild fish stocks, with the exception of the WGoMCA and roller gear size reduction, their overall effect on protecting or recovering seafloor habitats and the biological communities of the sanctuary is less clear.



Water Column as Habitat

Status

The water column in the Stellwagen Bank sanctuary represents important habitat for numerous planktonic and nektonic organisms as well as many fishes, turtles, seabirds and marine mammals. In addition to the three major water masses occurring throughout the GoM, each of which provides habitat for a variety of organisms, the interaction of moving water masses with the sanctuary's complex seafloor topography creates local zones of upwelling and mixing that serve as habitat as well. Additionally, features such as thermal fronts and the thermocline (sharp temperature gradients between water packets of differing characteristics) and shear zones (separating countervailing currents), for example, segment and highly structure the open ocean, creating ecotones that serve as unique midwater habitats. An ecotone is a transition area between two adjacent ecological communities.

In general, major surface currents flow counterclockwise in the vicinity of the sanctuary. Local productivity is seasonal with the overturning and mixing of ocean waters from deeper strata during the spring and fall producing a complex and rich system of overlapping midwater and benthic habitats. The heightened seasonal productivity supports a large variety of marine mammal and fish species in the water column. Many of these predators rely on both water column and benthic habitats for foraging. While there is concern for impacts to seafloor habitats due to fishing, there is also concern for impacts to water column habitats due to pollution and contamination including biological agents like harmful algal blooms (HABs) and invasive species. Refer to the Sidebar for a description of potential sources of pollution and contamination. Refer to Bothner and Butman (2007) for a summary of processes influencing the transport and fate of contaminated sediments in Massachusetts Bay.

Potential Sources of Pollution and Contamination

Much of the pollution reaching the sanctuary comes from non-point sources or from distant point sources. Several waste water treatment facilities discharge directly into Massachusetts Bay, the largest being the Massachusetts Water Resources Authority (MWRA) Boston Harbor outfall located 9.5 miles from Boston and 12 miles west of the sanctuary border. Air pollution from power plants and industrial facilities, some as far away as the midwest, and urban smog release a variety of chemicals over Massachusetts Bay, some of which are accumulated by organisms.

In addition, the sanctuary is heavily traveled by commercial and recreational vessels and cruise ships that discharge wastes during their voyages. Shipping activities may result in a variety of chemical releases from discharges, spills and/or collisions, and the possibility of importation of invasive species. Other sources of contamination include clean material disposal at the Massachusetts Bay Disposal Site (historical dumping operations there have included hazardous military and industrial wastes and dredge spoils) and disturbances during the laying of underwater pipes and cables (only one of which crosses the sanctuary). Of particular concern are the cumulative impacts of multiple activities that could contaminate the habitats and resources of the sanctuary and increased environmental loading of nutrients and pollutants above scientifically established background levels.

Nutrient enrichment is one factor in the development of harmful algal blooms (HAB). HABs are high densities of toxic phytoplankton (*Alexandrium* sp.) that can kill marine life and impair human health. Saxitoxin from these organisms was implicated in the death of 14 humpback whales in 1987. The most recent HAB event occurred in 2005 and covered a broad area encompassing all of Massachusetts Bay (including the sanctuary) and Cape Cod Bay. While no injury or mortality of sanctuary resources was observed, the highest concentration of *Alexandrium* cysts was recorded in the sediment of the sanctuary.

Regular monitoring of key water quality indicators and associated seafloor variables is conducted in and around the sanctuary to detect and evaluate trends that could favor HABs or otherwise threaten environmental functions in the sanctuary. The Stellwagen Bank sanctuary relies on collaboration with the MWRA for routine water quality monitoring and on the occasional assessments of the NOAA National Status and Trends (NS&T) Bioeffects (BE) Program and the National Benthic Surveillance (NBS) Program to understand and characterize the threats to and status of water column and related seafloor habitats in the sanctuary. The NBS Program is a collaborative effort between NS&T and NOAA Fisheries Service. The threat of introduction of water-borne invasive species may be under-appreciated and deserving fuller understanding as provided below.

Monitoring

In 2001, the Stellwagen Bank sanctuary increased the area coverage of water quality monitoring within its boundaries to better determine whether the MWRA sewage outfall, which began operating in September 2000, was causing increased eutrophication and contaminant loading. To leverage resources and obtain compatible information that could be integrated into the existing data base for ongoing monitoring work, the sanctuary added four new stations to MWRA's existing five stations within the sanctuary area (Libby *et al*., 2006).

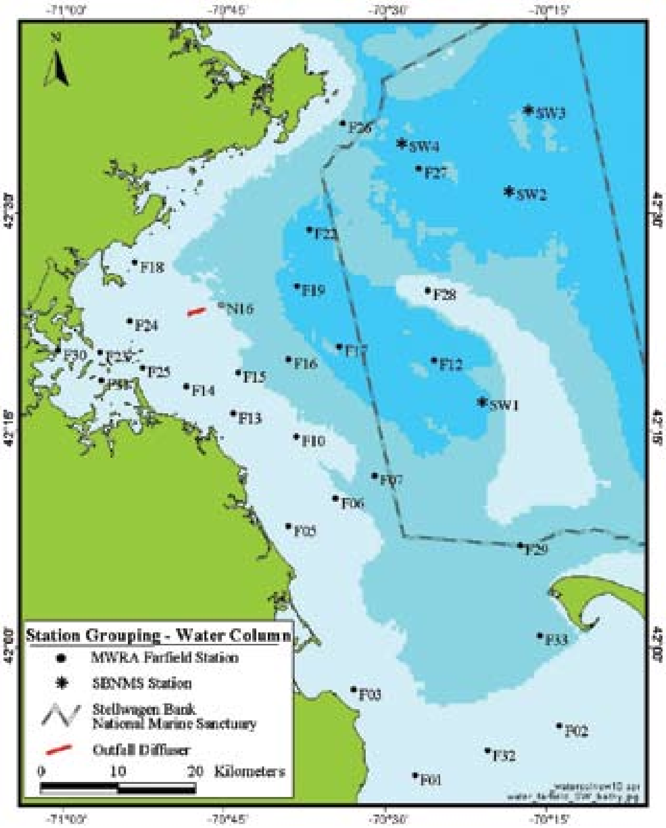
The MWRA's discharge permit recognizes concerns about possible effects of the outfall on the sanctuary and requires an annual assessment of those possible effects. The MWRA classifies stations as near field and far field for the purpose of assessing potential impacts from the sewage outfall; those in the sanctuary are included among the far field stations. Since 2001, independent contractors have sampled the four additional stations in August and October, which are two of the six MWRA survey periods each year. Sampling includes measurements of water column physical variables (salinity, temperature, density structure), nutrients, chlorophyll and dissolved oxygen, as well as the numbers and species of phytoplankton and zooplankton.

The four sanctuary stations are strategically placed to detect nutrient inputs to the sanctuary from the GoM and Merrimack River to the north, as well as from the MWRA outfall to the west (Figure 21). The data allow inferences about fine scale circulation patterns and water column productivity in the sanctuary. The data are also entered into a three-dimensional computer model that has been developed to understand how the system might respond to increased and decreased levels of nutrients, dilution of outfall and dispersion (Jiang, 2006).

Results to date show no evidence of increased eutrophication or unacceptable contaminant loads in the sanctuary relative to the outfall startup (Werme and Hunt, 2006, 2007; NOAA 2006). Overall, water quality within the sanctuary was excellent during 2005 and there was no indication of any effect of the MWRA outfall (Libby *et al*., 2006). While ammonium concentrations rose in the near field sampling

Figure 21. Location of water column stations, including the additional Stellwagen Bank sanctuary stations sampled in August and October 2001-2005.

F32 and F33 sampled in February, March and April; other stations sampled in February, March, April, June, August and October. Source: MWRA, 2006.



stations following start of the outfall diversion, there has been no parallel annual increase in the area of Stellwagen Bank or Cape Cod Bay (Figure 22 top). Nitrate concentrations (Figure 22 bottom) continue to show an upward trend in offshore Massachusetts Bay and in the near field, a regional phenomenon that predates the outfall diversion and is not well understood.

Other measurements of nitrogen and dissolved phosphate also show these long-term trends. Concentrations of total dissolved nitrogen (Figure 23 top) and dissolved inorganic nitrogen (Figure 23 middle) have consistently been higher in samples from the sanctuary than those measured at other stations. In contrast, concentrations of total nitrogen have been similar in all regions (Figure 23 bottom).

The mean annual chlorophyll levels have not changed in response to the outfall discharge (Figure 24). Annual chlorophyll levels were similar in the nearfield, Cape Cod Bay and Stellwagen Bank. Concentrations of dissolved oxygen and percent saturation have not declined in the Stellwagen Basin or in the near field (not shown). Rather than showing a decline, levels in 2005 were slightly high compared to the baseline years (1992–2000).

No changes in concentrations of sewage tracers or sewage-related contaminants were observed in the sediment samples from stations within the sanctuary and there were no changes in community parameters in 2005 (Maciolek *et al.*, 2006). The deep-water stations continued to support a distinct infaunal community with recognizable differences from communities in the nearfield and Cape Cod Bay. Benthic community parameters at individual stations showed no pattern of change following start-up of the outfall in 2000 (Figure 25). Overall the numbers of individual organisms and species per sample have increased, as has the index of species diversity (log series alpha), paralleling results from throughout Massachusetts Bay. No consistent pattern has been found that relates to outfall operation.

Assessment

In 2004, field samples were taken to assess the status and trends of chemical contamination in sediments and resident biota and to assess the biological condition of the various habitat types found in the Stellwagen Bank sanctuary area (Figure 26). Sampling efforts employed a combination of the NOAA NS&T BE Program and the NBS Program protocols. The BE Program assesses sediment contamination, toxicity and benthic community condition. The NBS

Figure 22. Annual mean ammonium (top) and nitrate (bottom) concentrations in the Stellwagen Bank sanctuary, the nearfield and Cape Cod Bay relative to the outfall startup.

Source: MWRA, 2006.

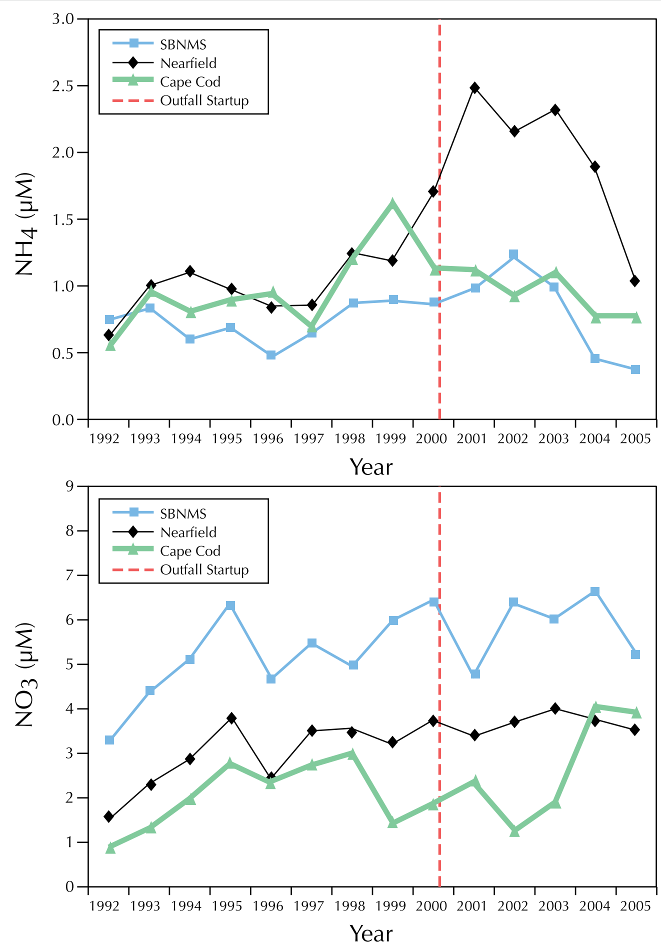


Figure 23. Top: annual mean total dissolved nitrogen (TDN); Middle: dissolved inorganic nitrogen (DIN); Bottom: total nitrogen (TN) in the Stellwagen Bank sanctuary, the nearfield and Cape Cod Bay relative to the outfall startup.

Source: MWRA, 2006.

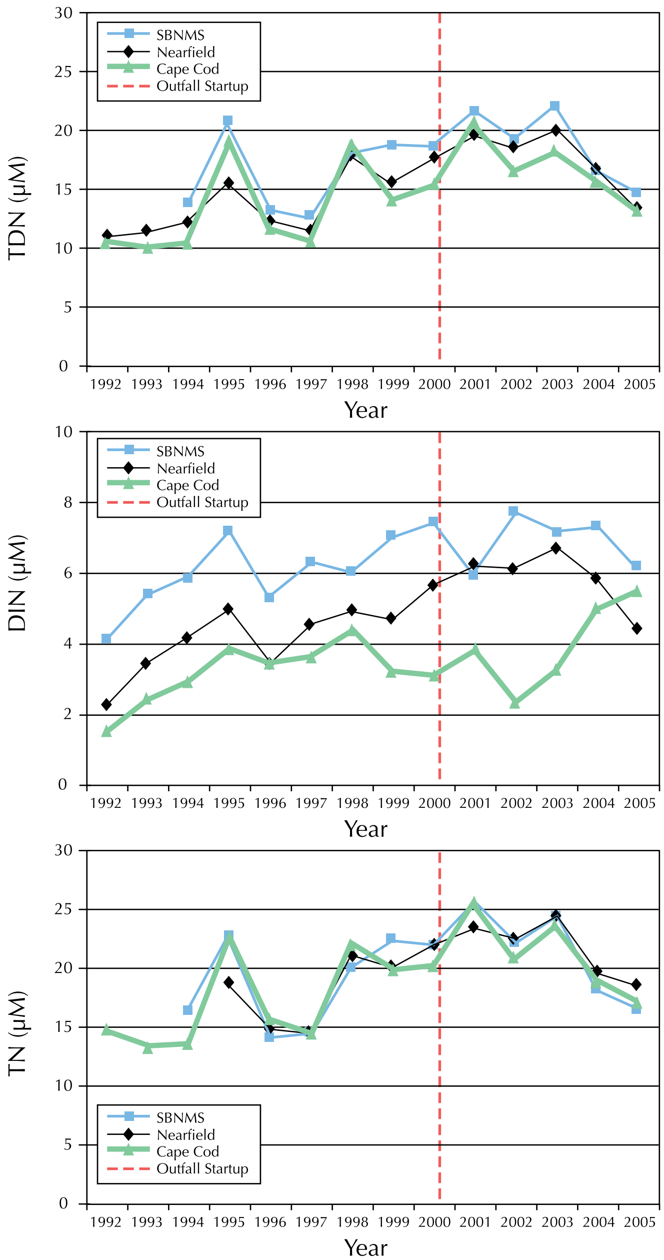
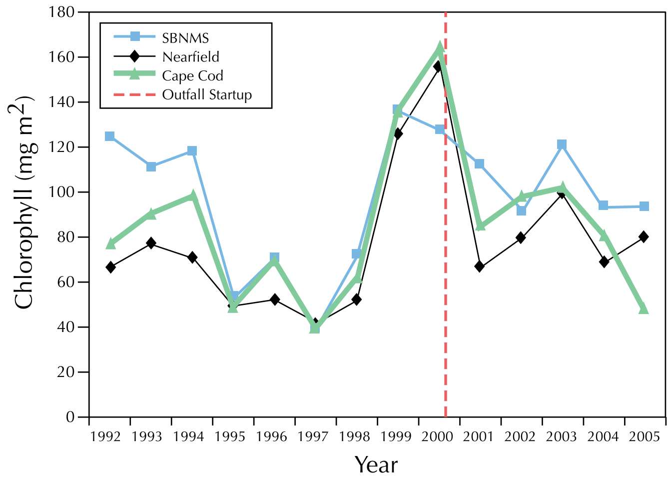


Figure 24. Annual mean chlorophyll in the Stellwagen Bank sanctuary and other regions relative to the outfall startup.

Source: MWRA, 2006.



Program also addresses sediment contamination, in addition to contaminant body burdens and histological indicators in resident fish. Data from 2004 were contrasted with historical (1983–1994) NOAA data, and the data from the MWRA to assess the spatial and temporal trends in chemical contamination in and around the sanctuary. The work reported here was done by NCCOS in cooperation with the sanctuary and unless indicated otherwise, the following account is excerpted from Hartwell *et al.* (2006).

In an analysis of the spatial distribution of select contaminants in sediments, the lowest concentrations were consistently found in the Stellwagen Bank sites (Figure 27). Contaminant data from the 2004 sampling effort are consistent with historical data. The NS&T NBS long-term sediment monitoring data (1984–1991) showed similar spatial distribution patterns. The larger pattern indicates a gradient of contaminant concentration from inshore to offshore. This suggests an export of contaminants from Boston Harbor eastward toward Stellwagen Bank and southward toward Cape Cod Bay via suspended sediments and/or the water column.

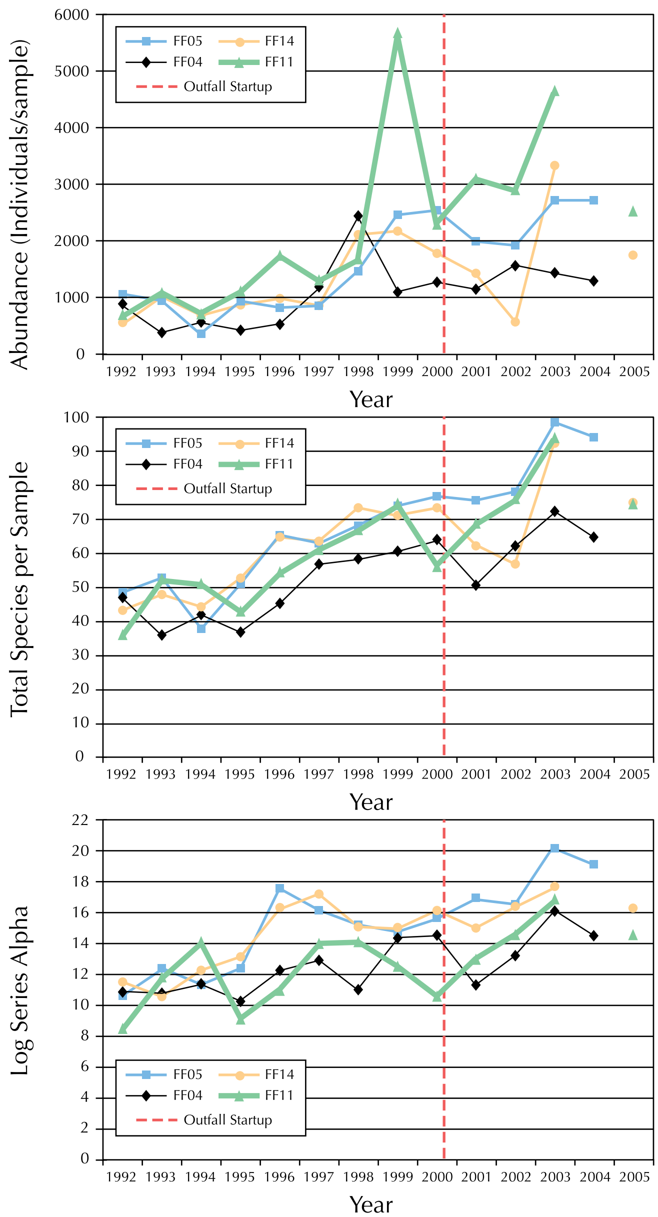
The NBS data show similar patterns of spatial distributions based on contaminant concentrations in winter flounder liver. Overall, tissue contaminant concentrations were higher in organisms collected in and around Boston Harbor than those from remote sites, with intermediate concentrations in the mid-Bay area between the Harbor and Stellwagen Bank. These observations also suggest that export from Boston Harbor is a source of contamination for Massachusetts Bay and possibly for the sanctuary.

The Hartwell *et al*. (2006) study evaluates and summarizes contaminant conditions in the sanctuary area over a period of about twenty years. The current (2004) status of chemical contaminants in the shallow portions of Stellwagen Bank is significantly lower than those of the other regions of Massachusetts Bay including Cape Cod Bay. Boston Harbor is the most polluted zone of the Massachusetts Bay/Cape Cod Bay system. Sediments in the deep areas in Stellwagen basin are accumulating contaminants from a variety of sources.

The temporal assessment revealed no statistically significant trends for trace metals and Polycyclic Aromatic Hydrocarbons (PAHs), while banned but persistent organic contaminants (DDTs and chlordanes [both pesticides]) show very slow decreasing trends over the monitoring years. The persistence of some organic compounds at relative high concentrations in Boston Harbor implies that the Harbor may be a continuing source of contaminants to other areas of Massachusetts Bay including the sanctuary. However,

Figure 25. Benthic community parameters at stations (FF05, FF04) in or (FF14, FF11) near Stellwagen Bank sanctuary (1992-2005) relative to the outfall startup.

Source: MWRA, 2006.



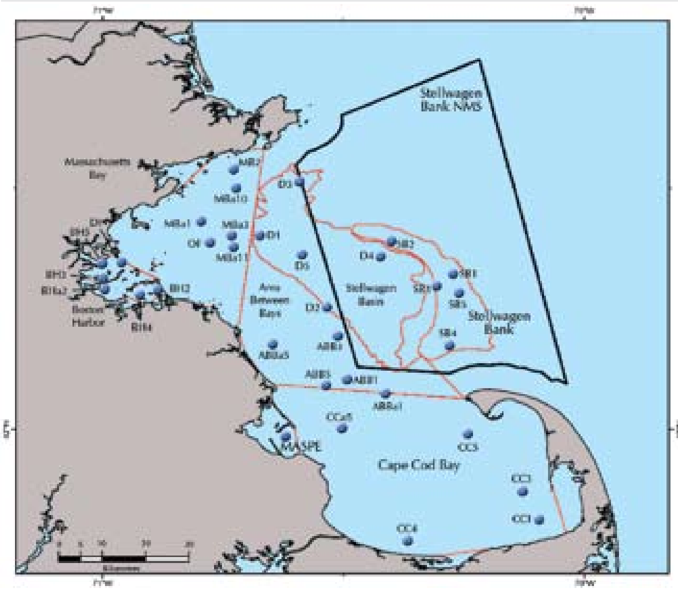
data in the current study indicates that pollution impacts in the sanctuary appear minimal and are largely consistent with the finding from MWRA monitoring.

Invasive Species

Invasive species, also commonly referred to as non-indigenous, alien, exotic, introduced, nuisance or bio-invader species, are organisms that have moved into an area outside of their natural geographic range. Their environmental effect can be similar to that of the relatively rare species in a biological community that, when triggered by environmental signals, suddenly expands in population and geographic distribution with negative consequences (e.g., HABs).

Figure 26. Location of the NOAA NS&T BE sampling sites (2004) within Massachusetts Bay including the Stellwagen Bank sanctuary.

Sampling was done within six zones indicated by the red lines: Boston Harbor, Massachusetts Bay, Area Between Bays, Cape Cod Bay, Stellwagen Basin and Stellwagen Bank. Source: Hartwell *et al.*, 2006.



Invasive species are recognized as a serious emerging threat to biological diversity (Drake and Mooney, 1989). Impacts of invasive species threaten 36% of marine species, yet only 8% of the conservation studies published on marine systems have dealt with this topic (Lawler *et al.*, 2006). Community ecology theory can be used to understand biological invasions by applying new concepts to alien species and the communities that they invade (Shea and Chesson, 2002) (see Sidebar).

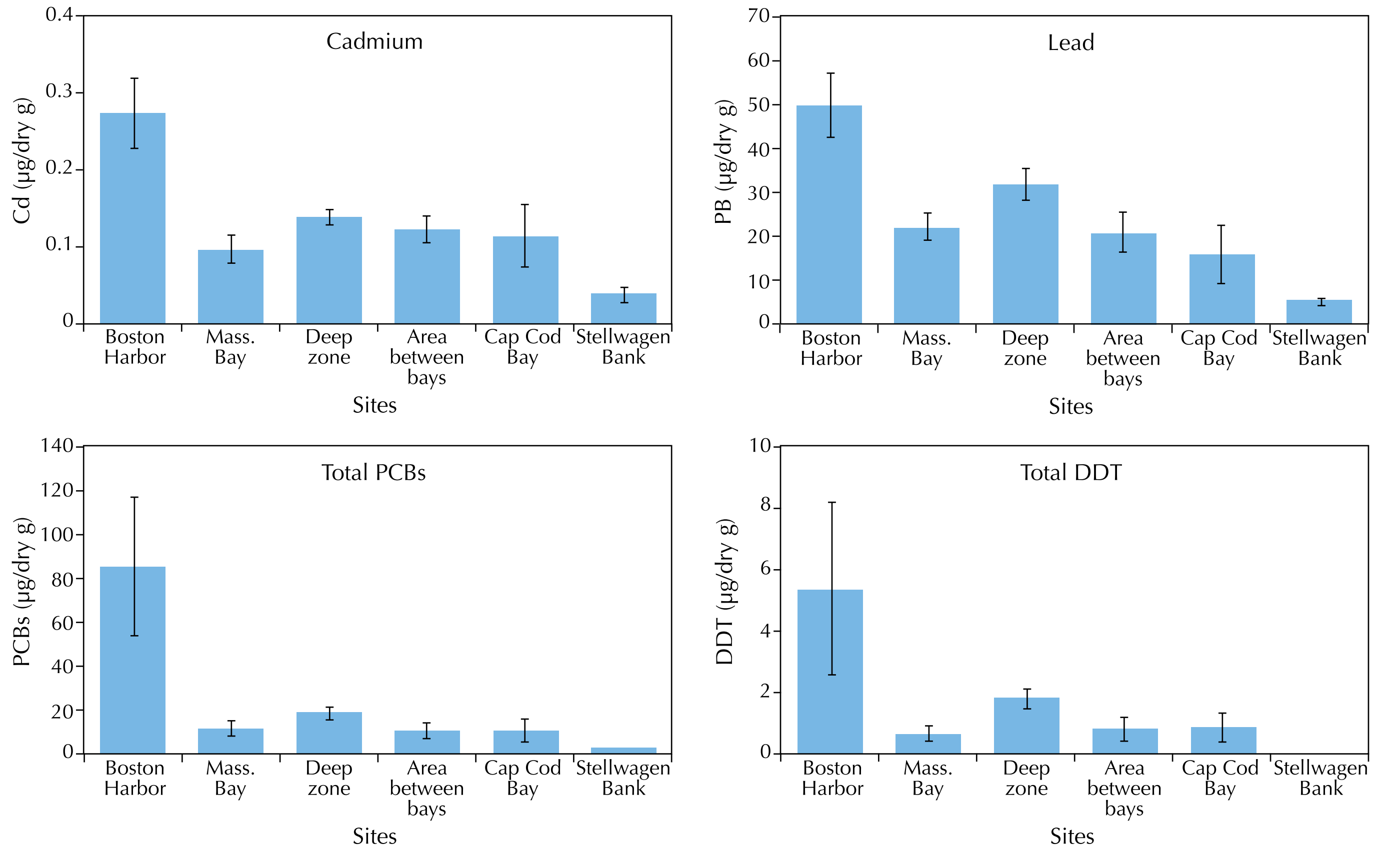
Specific Occurrences

First observed in 2003, the sea squirt (tunicate) *Didemnum* sp. has invaded gravel habitats on Georges Bank fishing grounds and the infestation is persistent and increasing in density (USGS, 2006). Within the 88 sq mi study area, the colonies doubled at 75 percent of the sites observed in 2005 and 2006. Preliminary evaluation of the sample data indicates that 50-75 % of the gravel is covered at some study sites. Sea-squirt mats smother the gravel habitat and render it unusable by the native community; no other species are known to prey on or over-grow the mats. The tunicate can be spread by mobile bottom fishing gears that break-up the colonies and aid in their dispersion. For more information visit URL http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/. This species was noted as occurring in the Stellwagen Bank sanctuary as early as 2003.

Biological agents such as phytoplankton spores or cysts which develop HABs can behave similarly to invasive species. Nutrient enrichment is one factor in the development of HABs, but so too are the niche opportunities created by the disturbance of their associated biological

Figure 27. Concentration of contaminants, select metals (Cd [cadmium] and Pb [lead]) and organic compounds (total PCBs [Polychlorinated Biphenyls] and DDT [pesticide]), in sediments within Massachusetts Bay including the Stellwagen Bank sanctuary.

Source: Hartwell *et al.*, 2006.



communities. These communities occupy water column and seafloor habitats and support the HAB organism in its various life stages. Planktonic and benthic predators as well as competitors for seafloor habitat settlement space serve as natural controls that limit population. The only HAB event recorded in the sanctuary occurred in 2005 and was due to the toxic phytoplankton *Alexandrium* sp. As noted above, the highest concentration of *Alexandrium* cysts in Massachusetts Bay and Cape Cod Bay was recorded in the sediment of the sanctuary.

Means of Introduction

While niche opportunities for invasive species may be created by human activities that disturb biological communities and their habitats, the primary means by which many of these invasive species are introduced in the marine environment is via ballast water from ships. Scientists estimate that as many as 3,000 alien species per day are transported by ships around the world; however, not all transported species survive the trip or exposure to their new environment (MITSG, 2004). Other methods of introduction include:

- Organisms attaching to the hulls of vessels
- Algae used as packing material for fisheries products
- Fouling or accumulation of organisms in fishing nets that are then re-deployed in other areas
- Mariculture of introduced marine species (e.g., fish, shellfish and seaweed)
- Natural processes such as ocean currents

The introduction of invasive species is considered to be one of the most harmful types of disturbances that can occur within any ecological system (Deitz, undated). Once established, these species have the potential to change the structure, pattern and function of a biological community. Some of the ecological impacts associated with the introduction of invasive species in the marine environment include:

- Occupying habitat space and competing for food of native species
- Altering the gene pools of native organisms through cross breeding
- Shifting predator/ prey relationships
- Spreading disease and/or parasites

These impacts can take time to present themselves. Oftentimes invasive species, although present, remain in low abundance until some aspect of their environment changes allowing their competitive release against native species. These changes could be the result of a change in temperature that allows for an increase in growth rate or reproduction, or a change in the abundance of a native competitor or

Community Ecology Theory Relating to Biological Invasions

Two concepts are relevant to understanding the introduction of invasive species in the GoM and the Stellwagen Bank sanctuary: community maturity and niche opportunity.

Community Maturity. Community maturity is defined as the opportunity an ecosystem has had to accumulate species, and for adaptation within the ecosystem to have taken place. It depends on the time that the ecosystem has had the current climate, including its short-term fluctuations and recurring disturbance events. Maturity depends also on the size of the species pool that has historically served as a source of species to the ecosystem.

Biological communities that have had less evolutionary time to assemble, and less time for their constituent species to adapt to the local conditions, are likely to have fewer species with broader niches. Species in these communities might also have lower competitive abilities than those in communities (such as coral reefs) that have had a longer time to evolve under their present environmental regime.

The former communities, which characterize those in the GoM, tend to be less invasion resistant. The North Atlantic is relatively young, the assembly of its biota from the North Pacific is recent, i.e., 3.5 Mya (Vermeij, 1991), its nearshore environments have been frequently glaciated causing localized extinctions at approximately 20,000 year cycles (Adey and Steneck, 2001) and its species pool is comparatively low throughout the region. On the basis of community maturity, both the GoM and the sanctuary as a subset would seem inherently susceptible to biological invasion.

Niche Opportunity. Niche opportunity is a concept which defines conditions that promote invasions in terms of resources, natural enemies, the physical environment, interactions between these factors, and the manner in which they vary in time and space. Niche opportunities vary naturally between biological communities but can be greatly increased by disruption of communities, i.e., disturbance. Recent niche theory predicts that low niche opportunities (high invasion resistance) result from high species diversity (Stachowicz *et al.*, 1999; Shea and Chesson, 2006).

The sanctuary would also seem prone to biological invasion because of the niche opportunities afforded (together with the sanctuary's location amid extensive commercial shipping traffic that can serve as primary vectors for the introduction of exotics from hull bottoms and ballast water). The majority of the sanctuary area is chronically disturbed by fishing, especially seafloor habitats regularly swept by bottom otter trawling. The results of the SHRMP research (described in the section on seafloor habitats) indicate the greater relative ecological importance of physical disturbance by fishing versus natural events such as storms.

The extensive exploitation of fish populations in the sanctuary has caused significant declines in species abundance and in a range of diversity metrics that take both species richness and abundance into account (Auster, 2000), although recovery to earlier higher levels of fish species diversity has recently been documented (Auster *et al.*, 2006). Such extensive chronic disturbance and the history of lowered species diversity are factors that create niche opportunities for biological invasion.

predator that enables the invasive to become better established (Deitz, undated).

General Status

A growing number of non-native marine organisms are appearing in the waters of the GoM (Table 4). Of these only the tunicate *Didemnum lahillei* is documented from the Stellwagen Bank sanctuary. Researchers attribute this increase in number of invasive species to two regional trends: 1) warming coastal waters becoming more hospitable to non-native species; and 2) lower biodiversity resulting from the urbanization of shore lands and the increase in human activity and pollution stressing critical marine habitats (Deitz, undated). According to the Massachusetts Institute of Technology Sea Grant (MITSG) Rapid Assessment Survey (RAS) conducted in August of 2000 and 2003, a total of 34 introduced organisms, several of which were identified for the first time in this region, and 37 organisms whose native geographic distribution is unknown were discovered throughout New England coastal waters (MITSG, 2003). For more information visit URL http://www.usm.maine.edu/gulfofmaine-census/Docs/About/Organisms/Invasive.htm.

Pressures

Although studies show that water quality in and around the Stellwagen Bank sanctuary is currently at acceptable levels by most standards, the continuing pressures of point- and non-point sources of pollution are cause for continued concern and constant vigilance. Given the sanctuary's proximity to the populous coastal zone in Massachusetts, New Hampshire and southern Maine, as well as being "downwind" from the industrial activity of the mid-west and northeastern part of the U.S., the sanctuary is exposed to pollutants from a variety of anthropogenic sources. These sources include direct discharge of waste to coastal waters (generally referred to as point sources) and indirect contamination (generally referred to as non-point sources).

Point source discharges potentially impacting the sanctuary include discharges from publicly owned treatment works (POTWs), industrial discharges permitted under the National Pollutant Discharge Elimination System, effluents from combined sewer overflows (CSOs) and disposal of dredge materials at the MBDS. Nonpoint sources of contamination entering the sanctuary, such as pesticides, manufacturing chemicals, fertilizer and automobile runoff are primarily derived from the rivers of the

Table 4. Inventory of known invasive species to the Gulf of Maine region.

Of these only the ascidian (tunicate) *Didemnum lahillei* is documented from the Stellwagen Bank sanctuary. Common name is included in parentheses if known. Source: Dietz (2005).

Scientific Name and Type of Organism
Chlorophyta (green algae)
Codium fragile (deadman's fingers, green fleece)
Rhodophyta (red algae)
Bonnemaisonia hamifera
Grateloupia turuturu
Lomentaria clavellosa
Lomentaria orcadensis
Neosiphonia harveyi
Porifera (sponges)
Halichondria bowerbankia (bread-crumb sponge)
Cnidaria (hydroids, anemones, jellyfishes)
Cordylophora caspia (colonial hydroid)
Diadumene lineate (striped anemone)
Sagartia elegans (purple anemone)
Polychaeta (segmented worms)
Janua pagenstecheri (formerly *Spirorbis pagenstecheri*) (bristleworm)
Gastropoda (snails)
Littorina littorea (common periwinkle)
Bivalvia (clams, oysters, mussels)
Ostrea edulis (European oyster)
Arthropoda (crabs, shrimps)
Praunus flexuosus (mysid shrimp)
Ianiropsis sp. (isopod)
Caprella mutica (skeleton shrimp)
Microdeutopus gryllotalpa (amphipod)
Carcinus maenas (European green crab)
Hemigrapsus sanguineus (Asian shore crab)
Anisolabis maritime (maritime earwig)
Bryozoa (moss animals)
Barentsia benedeni
Bugula neritina
Membranipora membranacea (lacy crust bryozoan)
Ascidiacea (tunicates, sea squirts)
Ascidiella aspersa
Botrylloides violaceus
Botryllus schlosseri (golden star tunicate)
Didemnum lahillei
Diplosoma listerianum
Molgula manhattensis (sea grapes)
Styela canopus (formerly *Styela partita)*
Styela clava (club tunicate)
Protozoa (single-celled organisms)
Haplosporidium nelsoni (Eastern oyster parasite)
Perkinsus marinus (Eastern oyster parasite)
Bonamia ostreae (European oyster parasite)

GoM, especially the Merrimack River, discharges from vessel traffic and atmospheric inputs.

While it appears that inputs from point source discharges have been decreasing over the past decade, it has been difficult to adequately estimate the magnitude of the non-point source inputs. A major component missing in the present MWRA and the Stellwagen Bank sanctuary water monitoring projects is "event-driven" sampling geared to wastewater system failures and storm-water overflows. While 98% of the effluent in 2002 underwent secondary treatment, for example, there was still part of the waste-stream that was released untreated or only partially treated due to storm events and temporary inability of the facility to handle the overflow.

The most significant types of point and non-point source discharge and disposal activities occurring in the sanctuary vicinity are discussed in greater detail below.

SOURCES

Municipal Waste Discharges

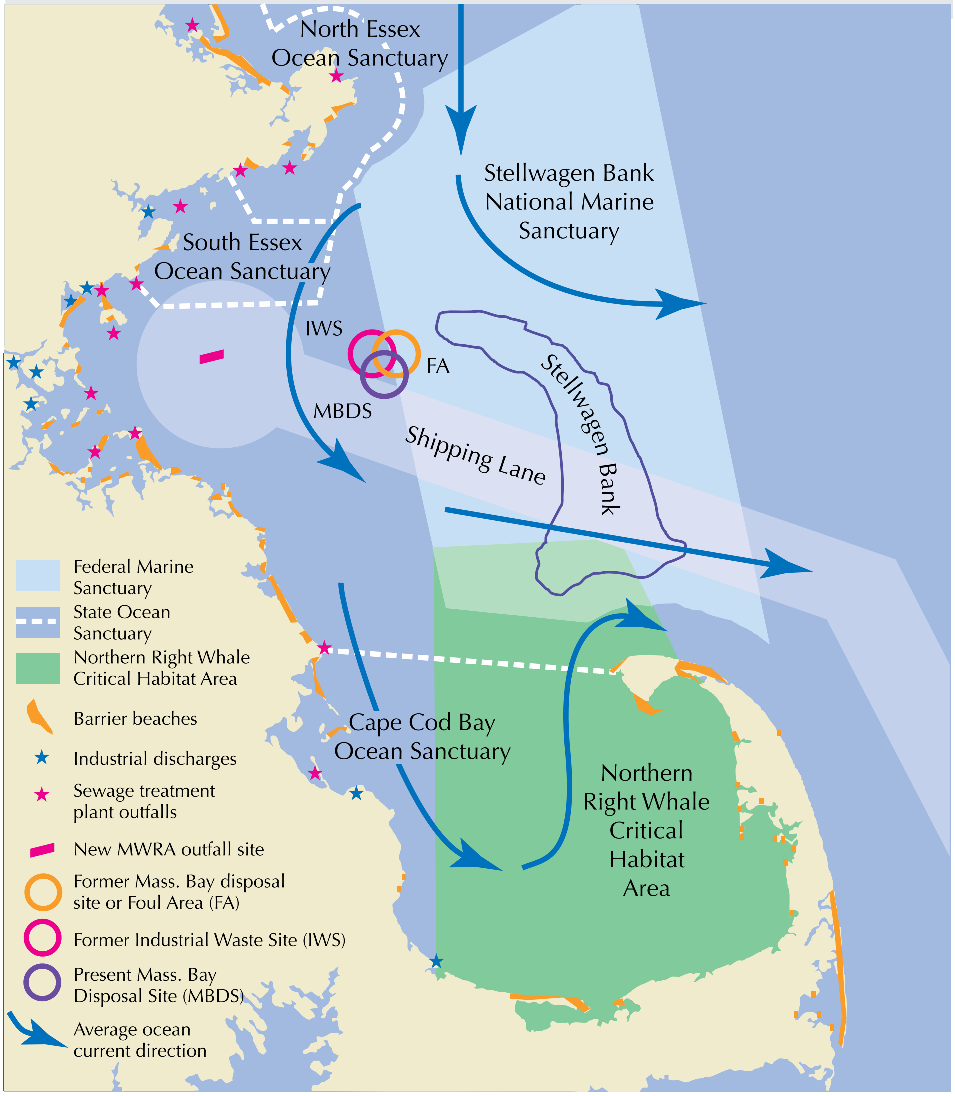
Massachusetts Bay and Cape Cod Bay historically have received inputs of waste in the form of effluent or sludge from a number of pipes extending from municipal wastewater treatment plants along the coast of Massachusetts (Figure 28). In the past, the total combined flow of this material was reported to be 566 million gallons per day (MGD), with approximately 500 MGD of that total being discharged by the MWRA treatment works at Deer and Nut Islands, the plants that served the greater Boston Area.

These discharges into Boston Harbor combined with CSOs were considered to be the greatest point sources of contaminants (metals, PAHs, PCBs, nutrients) to the Massachusetts Bay area (Menzie-Cura, 1991). However, over the years improved treatment and pre-treatment methods and technologies have helped to dramatically lessen the quantity of pollutants discharged into the Massachusetts Bay/Cape Cod Bay system (MWRA, 2002).

In a major effort to improve the quality of waste water entering into Massachusetts Bay, the MWRA constructed a new wastewater treatment facility on Deer Island. The facility, completed in 2000, provides a more effective, secondary treatment of the wastewater and eliminates the discharge of sludge into coastal waters. This new plant also moved the discharge point, known as the ocean outfall, from the entrance of Boston Harbor to the waters between 12.7 km and 15.1 km (7.9 mi. and 9.4 mi.) east-northeast of Deer Island inside Massachusetts Bay.

Figure 28. Location of sewer outfalls, the MWRA outfall, industrial discharge sites and dumping/disposal sites within Massachusetts Bay.

Also indicated are the locations of state ocean sanctuaries, the Cape Cod Bay Right Whale Critical Habitat Area and the Stellwagen Bank sanctuary as well as the pattern of general ocean circulation for the area. Source: MWRA (2004).



The MWRA is the discharge site of most significance to the sanctuary, with the new location being sited approximately 23.12 km (12.5 nm) from the sanctuary western boundary. The facility discharges 350 million gallons of secondary treated sewage per day. While the new MWRA outfall tunnel remains a leading source of contaminants in Massachusetts Bay, the repeated environmental monitoring and assessments conducted by the MWRA and NOAA discussed above conclude that scientifically determined baselines for key indicator variables are not being exceeded in the sanctuary and adjacent areas.

Currently, under the Massachusetts Ocean Sanctuaries Act (MOSA) any new discharge of wastewater into areas designated as ocean sanctuaries by POTWs and CSOs is prohibited along the coast of Massachusetts except for the area between Marshfield and Lynn. However, according to the MOSA, existing wastewater treatment plants may increase their discharge volumes if a case of "public necessity and convenience" can be made (Massachusetts Department of Conservation and Recreation, M.G.L. c. 132A, 12A-16F, 18, and 302 CMR 5.00).

Massachusetts Bay Disposal Site

Between the 1940s and the 1970s, numerous offshore areas throughout Massachusetts Bay were used for the disposal of a variety of industrial waste products including canisters, construction debris, derelict vessels and radioactive waste. These activities were largely unregulated and unrecorded. Today, this type of disposal activity is not allowed within Massachusetts Bay. Currently there are only two dredge disposal sites active within Massachusetts Bay and Cape Cod Bay: the MBDS designated in 1993, and the Cape Cod Bay Disposal site designated in 1990. Each of these active sites is monitored by the U.S. Army Corps if Engineers under their Disposal Area Monitoring System (DAMOS).

The MBDS is the disposal site of most significance to the Stellwagen Bank sanctuary. The MBDS is located directly adjacent to the western boundary of the sanctuary and encompasses an area two nautical miles in diameter, centered at 42° 25.1'N X 70° 35.0'W (Figure 28). This site incorporates the areas of two historic disposal sites, the Industrial Waste Site (IWS), an area that was once authorized for the disposal of toxic, hazardous and radioactive materials and the Interim MBDS (also known as the Foul Area Disposal Site [FADS]) designated only for the disposal of dredged materials. Given the proximity of the dumpsite to the sanctuary, there is lingering concern that these dumped materials have impacted sanctuary habitats and that previously-dumped toxic materials might be leaking. Currently, the MBDS is the most active disposal site in DAMOS, receiving dredge materials from many ports, including Scituate, Hingham, Boston, Salem and Gloucester.

Since 1982, approximately 8.4 million cubic yards of dredged material have been disposed at the current MBDS or the original MBDS location, established in 1977 and located one nautical mile eastward and one-half nautical mile northward of the current MBDS location (USACE, 2004). Annual disposal volumes for the period 1982-2003 are indicated in Figure 29. While sediments derived from dumping, as well as contaminants from the IWS (e.g., toxic chemicals, low level radioactive waste), have the potential to contaminate the sanctuary (Wiley *et al*. 1992), both the EPA and NOAA concluded in 1993 that MBDS would not threaten resources within the sanctuary. Recent assessments (Hartwell *et al*., 2006) support that early assessment.

In areas approved for ocean disposal of dredged material, such as the MBDS, those that utilize the site must conform to the EPA's ocean dumping criteria regulations. The site can only be used for disposal following an individual disposal determination that concludes that ocean disposal is an "environmentally appropriate alternative" as compared with other disposal alternatives. If there are no economically feasible alternatives to a particular dumping proposal, EPA is directed to grant a project-specific waiver unless "certain unacceptable environmental harms would result." Currently disposal of contaminated materials, as defined by state regulations, is not permitted at the MBDS (USACE, 2003).

Vessel Discharges

The location of many ports and harbors in Massachusetts Bay and Cape Cod Bay, particularly the Port of Boston, means that large numbers of vessels regularly travel through the sanctuary. On average, over the period 2000-2005, there were 2,257 transits per year to/from the Port of Boston by large deep drafts ships, the majority of which crossed the sanctuary. There are approximately 100 cruise ship departures or ports of call from Boston annually and this number is expected to increase; Boston is now considered one of the fastest growing high-end cruise markets in the country. See the Maritime Transportation section of this document for details.

Approximately 800 commercial fishing vessels use Massachusetts Bay as a fishing area or as a transit zone to open ocean fishing areas. On average, 327 commercial fishing vessels and 105 party and charter boats fished the sanctuary on an annual basis during 1996–2005. The popularity of recreational fishing and whale watching in the sanctuary accounts for many of the boats frequenting the area, especially during the months of April through October. On average, party and charter fishing boats made 1,967 trips per year to the sanctuary during 1996–2005. (See the Commercial and Recreational Fishing sections of this document for details.)

Discharges from vessels have the potential to be a significant source of pollution to the sanctuary. Appendix A provides information on the types of vessel discharges, their production and current status of regulation. Cruise ships serve as the example for type and production, but the regulations apply generally or as specified. Time taken for representative types of discarded objects to dissolve in seawater is provided in Table 5.

Hazardous Material Spills

Accidental discharges and vessel casualties do occur within the sanctuary. According to the USCG, a total of four fishing vessels sank within the boundaries of the sanctuary over the last three years (2003–2005). These vessel casualties resulted in only minor discharges of oil into the marine environment and had no significant impact on the sanctuary. Other than these incidents, there have been no spills or accidental discharges in or around the sanctuary area over the last decade that would have placed sanctuary resources at risk (S. Lehmann, NOAA/NOS, personal communication, 2005).

Transport Pathways

Contaminant levels are a concern due to: (1) the discharge from the MWRA outfall, (2) the historic and current discharge of municipal sewage from the Boston metropolitan area

Figure 29. Annual disposal volumes at the Massachusetts Bay Disposal Site for the period 1982–2003.

Source: USACE (2004).

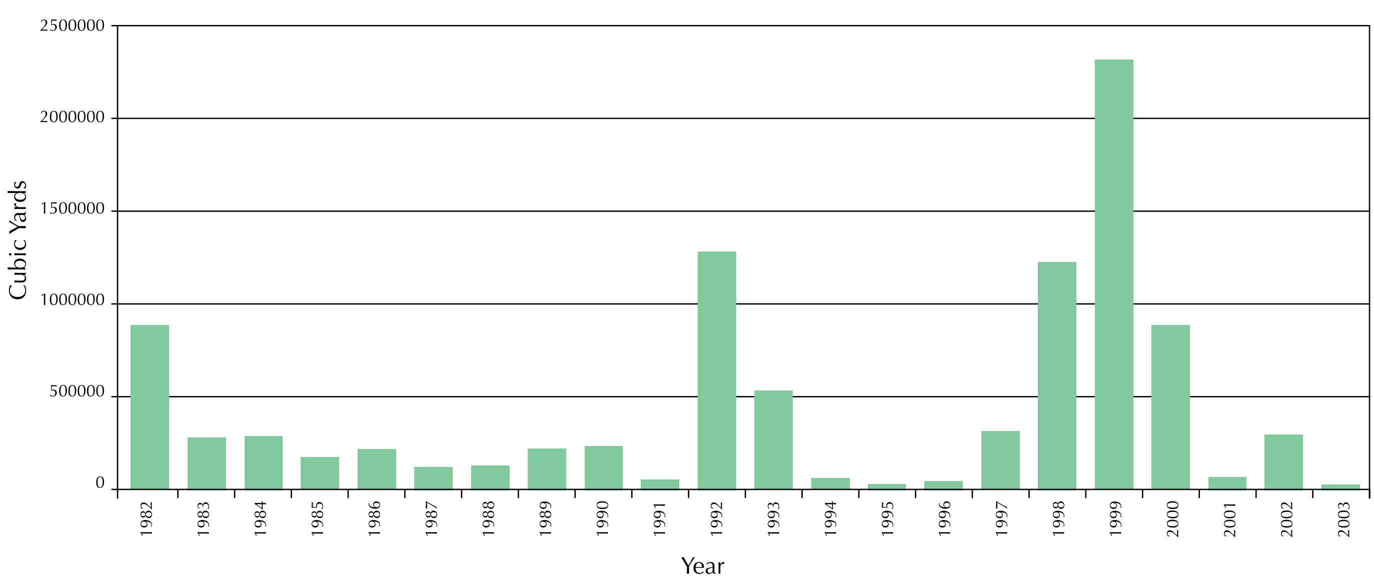


Table 5. Time taken for objects to dissolve at sea.

(Source:
IMO http://www.imo.org/Environment/mainframe.asp?topic_id=297)

Paper bus ticket	2–4 weeks
Cotton cloth	1–5 months
Rope	3–14 months
Woolen cloth	1 year
Painted wood	13 years
Tin can	100 years
Aluminum can	200–500 years
Plastic bottle	450 years

and other cities and towns along Massachusetts Bay, (3) the historic dumping of toxic material at the Massachusetts Bay Disposal Site, and (4) the air deposition of toxic materials transported from the west. Knowledge of transport pathways and residence times of contaminants in the Massachusetts Bay/Cape Cod system helps in the evaluation of the threats they pose to sanctuary resources.

Boston Harbor, Stellwagen Basin and Cape Cod Bay are long-term sinks for fine-grained sediments and associated contaminants from all sources in the region. Bottom deposits on the inner shelf of the western shore of Massachusetts Bay are gravel, coarse sands and bedrock. Fine sediments do not accumulate here because storm currents resuspend and displace them. During much of the year, a weak counterclockwise circulation persists in Massachusetts and Cape Cod Bays, driven by the southeastward coastal current from the GoM. Currents flow southwesterly into the Massachusetts Bay south of Cape Ann, southward along the western shore, and easterly out of the Bay north of Race Point at the tip of Cape Cod. This flow pattern may reverse in the fall, especially near the western shore. The flow-through flushing time for the surface waters in most of Massachusetts Bay ranges from 20 to 45 days (USGS, 1998).

Northeasters (storms) generate large waves that enter Massachusetts Bay from the east. The currents associated with these waves resuspend the bottom sediments in exposed areas along the western shore of Massachusetts Bay. The wind-driven currents flow southeastward parallel to the coast (with an offshore component near the bottom) and carry the suspended sediments toward Cape Cod Bay and offshore into Stellwagen Basin. Sediments settle to the sea floor along these transport pathways. Currents caused by surface waves are the principal cause of sediment resuspension. Cape Cod Bay is sheltered from large waves by the arm of Cape Cod, and waves are rarely large enough to resuspend sediments at the seabed in the deep areas of Stellwagen Basin. Thus once sediments reach Stellwagen Basin or Cape Cod Bay, carried either by the mean current flow or transported by storm waves, it is unlikely that they will be re-suspended and transported away again.

As indicated previously, sampling for this assessment was coordinated by NS&T in collaboration with the NOAA Northeast Fisheries Science Center. Data from 2004 were contrasted with historical data, and data from the MWRA to assess the spatial and temporal trends in chemical contamination in the region as a whole. Both the NOAA and MWRA sampling regimes included sampling sites within the following four zones: Boston Harbor, Massachusetts Bay, Area Between Bays and Stellwagen Bank (Figure 26). The lowest contaminant concentrations were consistently found in the Stellwagen Bank sites (Bothner *et al*., 1993, 1994; Bothner and Butman 2005; NOAA, 2006).

Current Protection

Sanctuary regulations (15 C.F.R § Subpart N) specifically prohibit:

1. Discharging or depositing, from within the boundary of the sanctuary, any material or other matter except:

- fish, fish wastes, chumming materials or bait used in or resulting from traditional fishing operations in the sanctuary;
- biodegradable effluent incidental to vessel use and generated by marine sanitation devices approved in accordance with the Federal Water Pollution Control Act [Clean Water Act (CWA)];
- water generated by routine vessel operations (e.g., cooling water, deck wash down and gray water as defined by the Federal Water Pollution Control Act), excluding oily wastes from bilge pumping; or
- engine exhaust.

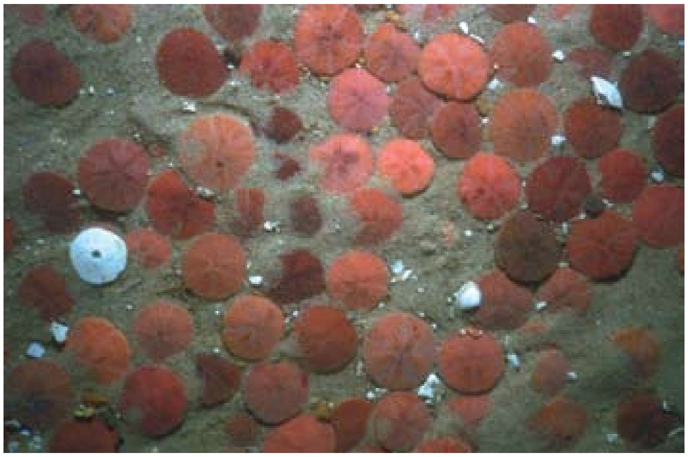
2. Discharging or depositing, from beyond the boundary of the sanctuary, any material or other matter except those listed above, that subsequently enters the sanctuary and injures a sanctuary resource or quality;

3. Lightering in the sanctuary (transferring cargo, usually oil, between vessels).

Oil spills or spills of hazardous substances in U.S. waters come under regulations that are known as Natural Resource Damage Assessments (NRDA). It is possible to apply NRDA regulations to any vessel discharge that contains oil and petroleum, and/or toxic substances if the discharge causes injury and damage to marine resources and living organisms. It is also possible to apply the CWA to discharges of petroleum and hazardous substances as well as excessive nutrients, and sewage containing pathogens and bacteria that could impair water quality. Lastly, the disposal of plastic trash, and other overboard trash by vessels is regulated by the Marine Plastic Pollution Research and Control Act of 1987 in the U.S. as well as MARPOL 73/78 Annex V.

Vessel discharges and potential contaminants that could be problematic are: black water (vessel sewage), grey water (soils, cleaning solvents, metals, pesticides, medical waste), bilge water (fuel, oils, cleaning agents, paint, rags), ballast water (foreign marine organisms), hazardous materials (chemicals from cleaning and photo processing, paints, solvents, inks) and solid waste disposal.

There are no direct federal regulations for control of nutrients such as nitrogen and phosphorous (NRC, 2000), for biologically active agents (hormones, endocrine disrupters), or for pathogens, including viruses, parasites and bacteria (NRC, 1994). Concern over biologically active agents is increasing because of their potential to alter the health of organisms, the growing industrial proliferation and public use, and the high density of biotechnology companies in the Boston metropolitan area that may inadvertently discharge these agents.



Benthic Invertebrates

Status

The sanctuary's benthic invertebrates include species from nearly all GoM invertebrate phyla. These animals live in (infauna) or on (epifauna) the seafloor during most of their lives, although most species have pelagic larvae. Characterized as "sessile" (sedentary or attached) or "motile" (free moving), benthic invertebrates range in size from little known microscopic forms (hydroid medusae) to the more common larger macroscopic organisms (e.g., scallops). Invertebrate communities vary with substrate; while cerianthid anemones may be the most visible in deep-mud basins, sand dollars might dominate shallow sand areas.

The Stellwagen Bank sanctuary supports a wide variety of seafloor substrates including mud, sand, gravel, piled boulder reefs and bedrock habitats. The seafloor provides a base for attachment by a variety of sessile invertebrates including bryozoans (moss animals), ascidians or tunicates (sea squirts), sponges, anemones, barnacles and hard-tube worms that form dense encrustations. Larger sessile invertebrates, such as sea whips (gorgonians) and sponges, provide refuges for many smaller cryptic (camouflaged) invertebrates. Other dominant benthic invertebrates include brittle stars, starfish, bivalves, shrimps, crabs and lobsters.

Structure-forming epifaunal invertebrates (such as sponges and anemones) provide critical habitat for juvenile fish of many species (such as Atlantic cod and Acadian redfish), while the greater invertebrate community provides an important source of food for these and many other fish species in the sanctuary. In the GoM, invertebrates, including sponges, jellyfish, worms, mollusks, echinoderms such as starfish, sea urchins and sand dollars, and crustaceans, outnumber vertebrates such as fishes, birds, and mammals, almost two-to-one (1,669 known invertebrate species versus 914 vertebrates).

GoM and Northeast Region

The diversity of invertebrate animals in the GoM is only generally described in the scientific literature; their many types are sorely under-represented in species counts. Many of the following citations are the principal works representative of the major taxonomic groups in the Northeast region. Although this section is intended to be primarily about the macrobenthic invertebrates of the sanctuary (and principally those that are structure-forming), the following annotated overview strives to recognize the greater cross-section of invertebrate diversity. Scientific nomenclature not explained in the text is described in the glossary of this document.

The aggregate macrobenthic invertebrate fauna of the continental shelf ecosystems of the Northeastern United States consists of 44 major taxonomic groups (phyla, classes, orders) (Theroux and Wigley, 1998). A striking fact is that only five of those groups (belonging to four phyla) account for over 80% of both total biomass and number of individuals of the macrobenthos. The five dominant groups are Bivalvia, Annelida, Amphipoda, Echinoidea and Holothuridea. The macrobenthos of the New England region (a subset of the northeastern continental shelf area) is dominated by members of only four phyla: Annelida (e.g., segmented worms), Mollusca (e.g., shellfish and squid), Arthropoda (e.g., crabs and shrimp) and Echinodermata (e.g., starfish and sea cucumbers).

Hartman (1964) describes the region's Porifera (sponges); Larson (1976) discusses Cnidarian taxonomy of the northeastern United States. Caims (1991) provides a checklist of the cnidaria and ctenophores from North America. The region's species of Hydrozoa (hydroids, jelly fishes) are described in Fraser (1944). Bush (1981) discusses the Turbellaria (flat worms) in the Northwestern Atlantic. Smith (1964) covers the taxonomy of nemerteans (flat worms) and nematodes (round worms) in the region. Bryozoans (moss animals) are critical sources of benthic structure and their taxonomy in the northeastern United States has been recently revised (Ryland and Hayward, 1991). Although the literature may suggest that the Bryozoa are well studied overall, remarkably little is known about the distribution of species within the GoM.

Molluscs are ever-present. Cephalopods such as squid are nektonic predators with a complex life history (Mauerer and Bowman, 1985). Gastropods (snails) and Bivalves (clams, mussels) are part of the epifaunal and infaunal benthic community (Maney and Ebersole, 1990). Nudibranchs (sea slugs) have been well described and many have a unique life history (Bleakney, 1996). Hunter and Brown (1964) describe the taxonomy of local molluscs. Work by Cook and Brinkurst (1973) covers the taxonomy of the Annelida (segmented worms) of the northeastern United States.

Coffin (1979) and Ho (1977, 1978) wrote the classic descriptions of the Copepoda in the region; a more recent analysis was done by Dudley and Illg (1991a, b). Tremblay and Anderson (1984) provide an annotated list of local species. Durbin *et al*. (1995a,b) discuss the relationship between environmental variables and the copepod community (notably *Calanus finmarchicus*). Kahn and Wishner (1995) describe the spatial and temporal patterns of this and other copepod species on baleen whale feeding grounds. Lynch *et al*. (1998) present a model of the population growth of *Calanus finmarchicus*; Meise-Munns *et al*. (1990) discuss longer-term population trends and the inter-annual variability in availability. Copepods may play an important link in the ecology of toxic dinoflagellates (Teegarden and Cembella, 1996); the species diversity of the two groups may be closely related.

Bowman and Abele (1982) review the Crustacea and their species diversity as a whole. Productivity and growth of the Decapoda (crustaceans e.g., lobster, crabs) is extensively researched because of that taxonomic group's commercial importance. Steneck *et al*. (1991), Wahle (1995) and Rangeley and Lawton (1999) discuss the geographical distribution of the American lobster. Fell (1982) covers the general taxonomy of the Echinodermata; Pawson (1997) covers the holothurians. Ecinoderms are greatly affected by physical disturbance to the benthos of the GoM, according to Collie *et al*. (1997) and Thrush *et al*. (1998). Smith (1964) covers the ascidian (tunicate) taxonomy.

A first-order assessment (presence/absence) of the kinds and species of invertebrates in the sanctuary was conducted based on the analysis of a 19-year database (1953-1972) collected during NOAA Fisheries Service research cruises beginning over 50 years ago as described in Theroux and Wigley (1998). The analysis was done in 2003 by John Crawford of the University of Pennsylvania who served as visiting scientist with the Stellwagen Bank sanctuary during that year. The analysis included over 4,000 data records for the sanctuary obtained using standardized sampling methods involving four gear types: (1) Campbell grab, (2) 1.0 meter dredge, (3) scallop dredge, and (4) otter trawl. The analysis produced a taxonomic list documenting invertebrate species in the sanctuary, which has been incorporated into the sanctuary's species list (Appendix J).

Importance of Structure-Forming Invertebrates

A great diversity of structure-forming invertebrate species lives on or in the seafloor of the Stellwagen Bank sanctuary. Many of these invertebrates create and are the source of important biogenic habitats (e.g., anenome forests, sponge gardens, hydroid meadows, worm tube beds, burrows and other substrate modifications) which promote and sustain biodiversity and make a pivotal contribution to ecosystem function. Structure-forming macrobenthic invertebrates, such as sponges, bryozoans, tunicates and anemones, play a particularly important role in the ecology of small, juvenile fishes, offering shelter from currents and serving as nurseries and refugia from predation, for example.

As explained in the section on seafloor habitats, biogenic structures underpin and shape the biological communities associated with them; they form the "living landscapes" that carpet the sanctuary seafloor. Their three-dimensional structure and sessile behavior make these particular invertebrates highly susceptible to damage from mobile fishing gear, e.g., trawls and dredges. Below are some examples of the invertebrate species that form the living landscapes of the sanctuary. The accompanying discussion does not include the hundred or so other species of benthic invertebrates, such as echinoderms (e.g., starfish, brittle stars, sand dollars, sea cucumbers) and crustaceans (e.g., lobsters, crabs, shrimp, isopods) that serve different ecological roles (e.g., predators, scavengers) within the benthic communities of the sanctuary. Many of these structure-forming and other benthic invertebrate species are colorfully pictured in Martinez (2003).

Sponges

Sponges are common throughout the Stellwagen Bank sanctuary and serve as important habitat and refugia for a variety of organisms (Figure 30). The boring sponge *Cliona celata* is known within the sanctuary (Ward, 1995) and grows on mollusk shells at depth to 40 m (Gosner, 1971). They attach to both living and abandoned shells, contributing to the breakdown of shells on the sea floor. *Cliona* may grow to a diameter of 20 cm and can be free-standing (Ruppert and Fox, 1988). Gosner reports that the gamma form may be a massive free-standing structure (Gosner, 1971). *Iophon nigricans* is an erect sponge that has been collected in the sanctuary (McNaught, in preparation) and lives at depths of 29–740 m (Gosner, 1971).

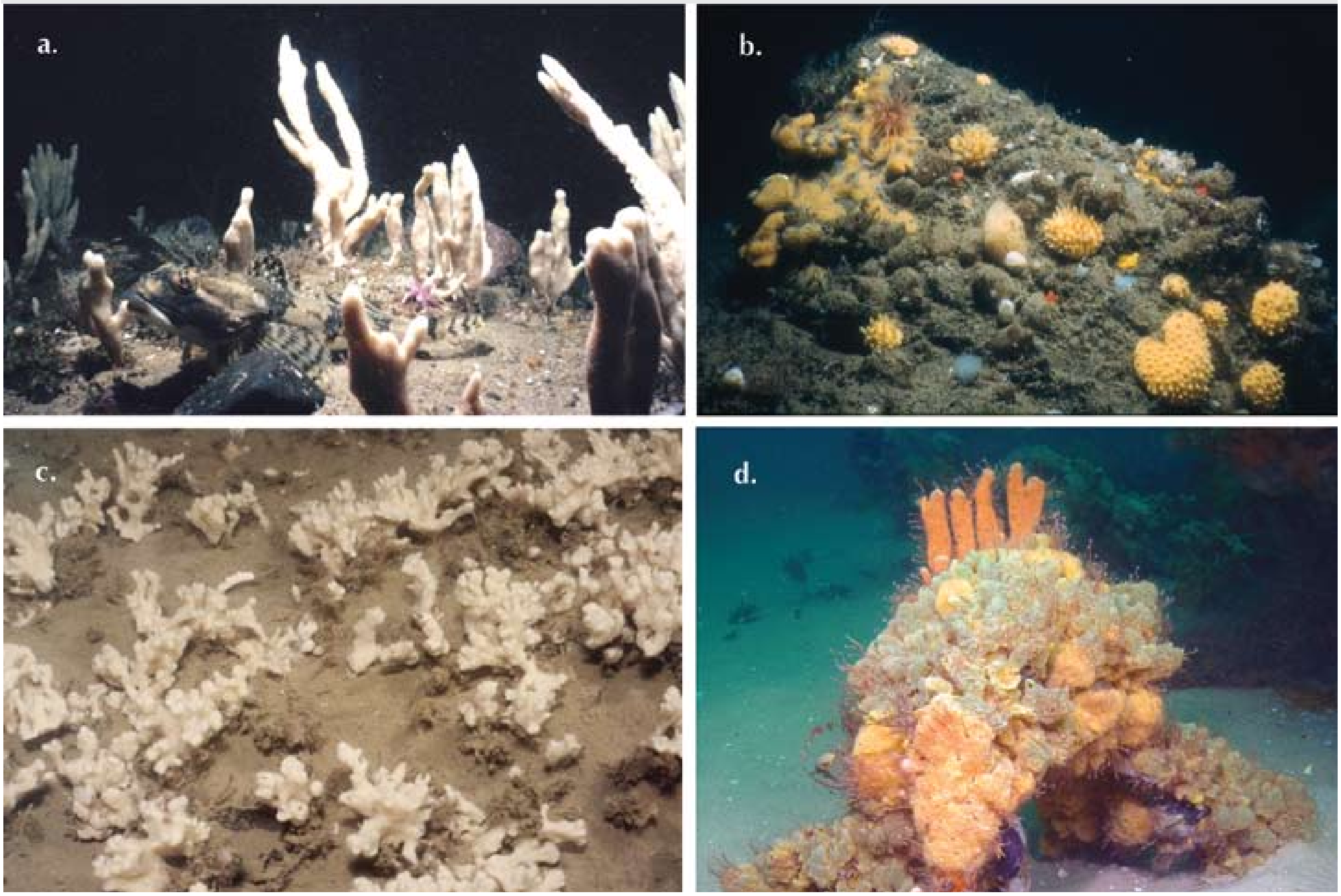
Cnidarians

Cnidarians are a large and varied phylum including jellies, hydroids, corals and anemones. These soft-bodied invertebrates serve as refugia for other organisms and are highly vulnerable to damage from fishing gear. Many cnidarians such as the hydroids have a polyp (attached) and medusa (free floating) stage (Figure 31). Each "flower" of the pink-hearted hydroids (*Tubularia corcea*) is an animal or polyp approximately 3 cm long with the blossom about 1 cm across. These hydroids are found in the sanctuary (Ward, 1995) and serve as habitat for other organisms. Another species, the stalked hydroid (*Corymorpha pendula*) is known to extensively carpet the seafloor in some areas of the sanctuary. The branching soft coral (*Gersemia rubiformis*) is known to occur within the sanctuary and grows to 15 cm or more in height (Ward, 1995), occurring at depths of 37–91 m (Gosner, 1971). Gorgonians may take 30 years to reach full size (Ruppert and Barnes, 1994).

Sea pens and pansies (*Pennatulacea*) are found anchored to soft bottoms (sand or mud) and are fleshy structures which generally have a stalk or pedestal anchored to the substrate and secondary polyps at the upper end of the stalk (Barnes, 1974). Sea pens are common in Georges Basin, the Stellwagen Bank area and Jeffreys Ledge with densities as high as $8/m^{-2}$ having been measured (Langton *et al*., 1990). They

Figure 30. Representative species of sponges in the Stellwagen Bank sanctuary.

(a) common palmate sponge (*Isodictya palmata*) sheltering a sculpin; (b) boring sponge *(Cliona celata)* on left side of image, *Halichondria panicea* with knobs on right side of image; (c) *Iophon nigricans*; and (d) miscellaneous sponge species interspersed with hydroids (feathery organisms pictured here). Credits: (a-c) NURC-UConn; and (d) Tane Casserley, NOAA Maritime Heritage Program.



are found on mud and silt bottoms, at depths of 174–351 m. They have been collected as by-catch by fishermen (Langton *et al*., 1990) and are sometimes damaged by traps (Eno *et al*., 2001). The Pennatulacea encountered by Theroux and Wigley (1998) were feather-shaped and stood 10–25 cm high.

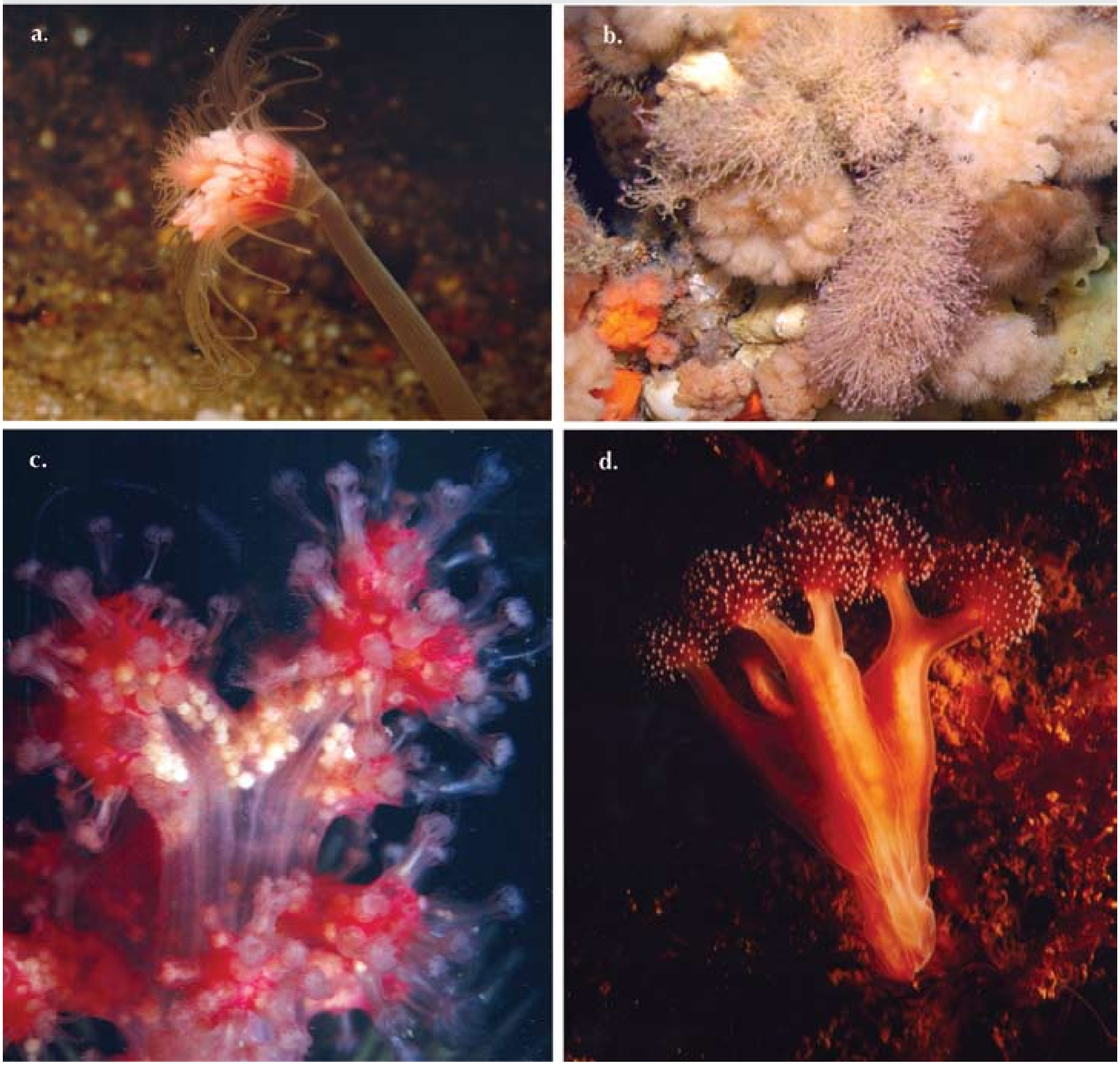
Anemones are a common, abundant class of cnidarian that serve many important functions in the sanctuary such as: refugia, a food source, and, in turn, a predator on zooplankton and even fish (Figure 32). They are found throughout the sanctuary on all bottom types, but are most common on sandy substrata and are most abundant at depths of 100 m or more (Theroux and Wigley, 1998). The colorful and abundant northern red anemone *Urticina felina* is found to 73 m depth and is 5 cm high by 12 cm wide. The burrowing anemones, *Ceriantheopsis americanus* and *Cerianthus borealis*, may have tubes extending over 45 cm into the water column and 4 cm in diameter. *Cerianthus borealis* is most common in deep muddy basins (130 m to > 400 m) with burrowed tube lengths of 45 cm. Behavioral-ecological studies have revealed a close association between *Cerianthus* sp. and Acadian redfish within the Stellwagen Bank sanctuary (Auster *et al*. 2003).

Annelid Worms

Worms are an important food source for many bottom-dwelling fishes. They can be important detritivores (decomposers), predators or filter feeders. Some worm species build complex three-dimensional structures. The serpulid worm (*Filograna implexa*) is an important member of the seafloor community on pebble/cobble substrate in Georges Bank, where its abundance is known to be reduced by dredging (Collie *et al*., 1997). This species occurs in the sanctuary (McNaught, in preparation) and is found at depths from 33–55 m (Gosner, 1971). It can grow to a tube length of 5 cm with groups of tubes joining to form large above-surface structures (Ruppert and Fox, 1988). *Myxicola infundibulum* is a soft-bodied burrowing worm approximately 3x20 cm in size (Gosner, 1971). McNaught *et al*. (in prep) found them in the northern parts of the sanctuary around the submerged fiber-optic cable in the sliver (closed area). Depths range from the shallow littoral zone to 55 m (Gosner, 1971). Trumpet worms (*Pectinari goudi*) are known in the sanctuary (Ward, 1995). Their delicate tubes are made from sand grains and most of the tube is buried.

Figure 31. Representative species of cnidarians in the Stellwagen Bank sanctuary.

(a) stalked hydroid (*Corymorpha pendula*); (b) pink-hearted hydroid *(Tubularia corcea)*; (c) soft coral *(Gersemia rubriformis)*; and (d) stalked jelly *(Haliclystus auricula)*. Credits: (a) NURC-UConn; (b) Tane Casserley, NOAA Maritime Heritage Program; (c) Bob Michelson; and (d) Jeff Hannigan.



Bryozoans

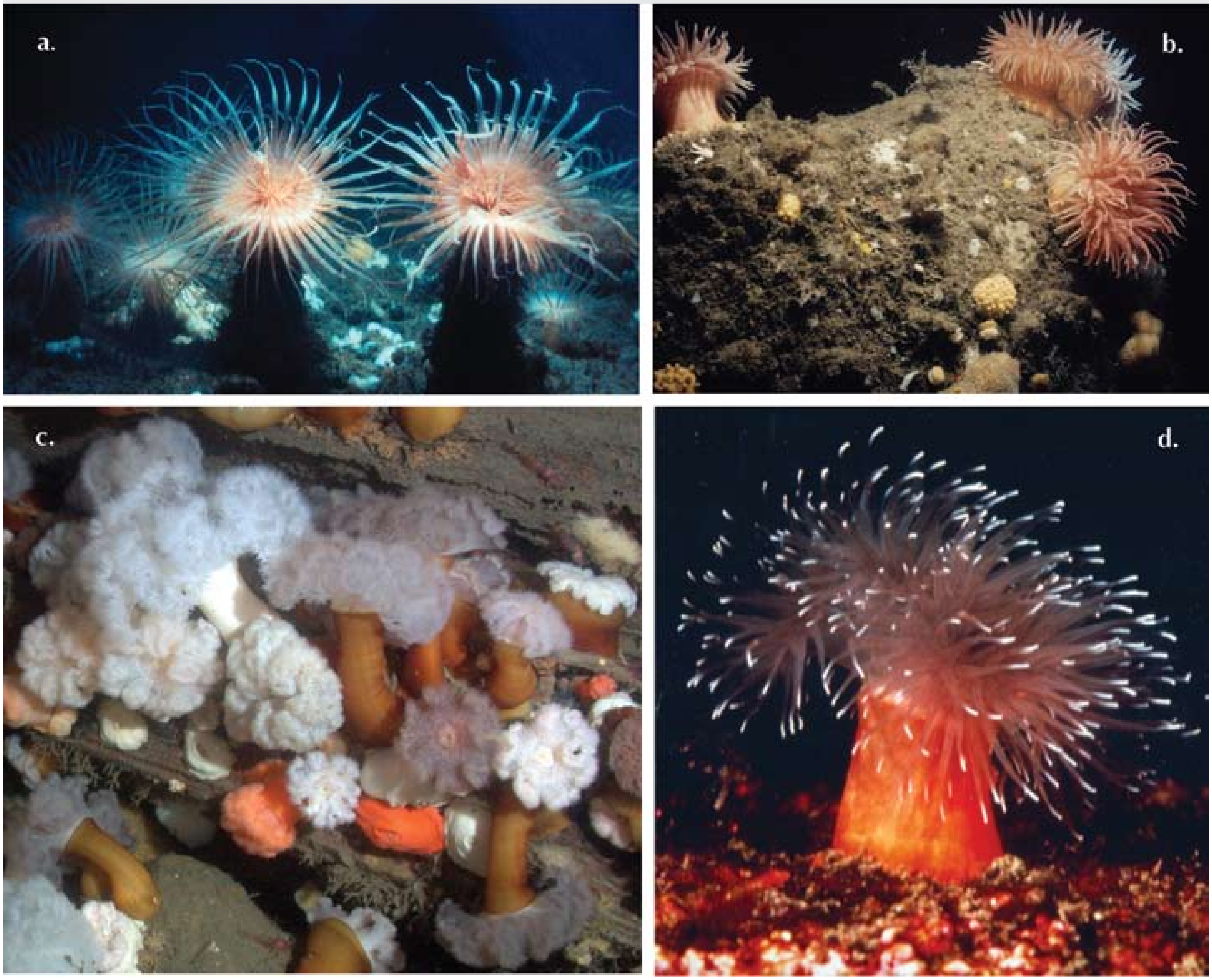
Bryozoans are sessile colonial animals, commonly referred to as "moss animals." They are most common on shell and gravel substrata and are most abundant in shallow water (less than 100 m) in Massachusetts Bay (Theroux and Wigley, 1998). Colonies of spiral tufted bryozoans (*Bugulia turrita*) are found within the sanctuary (Ward, 1995) and are known from very shallow depths to more than 27 m. Colonies of *Bugula* spp. tend to be small, less than 2.5 cm in height (Gosner, 1971), and are soft, bushy and plant-like in form (Ruppert and Fox, 1988; Ruppert and Barnes, 1994). Two species of erect bryozoans were reported from the sanctuary in the SHRMP study, *Caberea ellisii* and *Idmidronea atlantica*. These species were more abundant within the cable closed area (sliver), which is protected from the effects of fishing that occur outside the closed area.

Molluscs

Molluscs such as clams, mussels and scallops are an important component of the sanctuary ecosystem serving as habitat and a food source for many species, while filtering plankton and organic particles from the water column. The

Figure 32. Representative species of anemones in the Stellwagen Bank sanctuary.

(a) mud anemone *(Cerianthus borealis)*; (b) northern red anemones *(Urticina felina)* shown on boulder [These animals catch, kill and digest prey as large as fish. They sting prey with nematocysts on their tentacles and draw the stunned prey into the mouth in the center of the tentacles.]; (c) shipwrecks can serve as substrate for frilled anemones *(Metridium senile)*; and (d) unidentified frilled anemone species. Credits: (a-c) NURC-UConn; and (d) Norman Depres.



shells of dead ocean quohog (*Arctica islandica*) are known to provide habitat for juvenile hake (Auster *et al*. 1991) and other fish as well as invertebrate species (Figure 33). Found at depths from 11–165 m, shells may be 10 cm in length (Gosner, 1971). Ocean quohogs can live to be more than 100 years old and have been aged in excess of 200 years (NMFS, 2000).

Tunicates

The tunicates (sea squirts) fall within the phylum Chordata, meaning they are primitive relatives of vertebrates (Figure 34). *Ciana intestinalis* and *Mogula* spp. are reported from the littoral zone to depths of about 500 m (Gosner, 1971) and are found throughout the sanctuary. *Ciana intestinalis* forms colonies to a height of 12 cm; *Mogula* spp are smaller, with the largest species forming colonies to only 7 cm, and most less than 3 cm (Gosner, 1971) (Ruppert and Fox, 1988).

Pressures

Pressures are the same as those for seafloor habitats, principally fishing practices that disturb seafloor communities and the laying of cables or pipelines.

Current Protection

Sanctuary regulations (15 C.F.R § Subpart N) prohibit drilling into, dredging or otherwise altering the seabed of the sanctuary; or constructing, placing or abandoning any structure or material or other matter on the seabed of the sanctuary, except as an incidental result of (1) anchoring vessels; (2) traditional fishing operations; or (3) installation of navigation aids. The exemption for traditional fishing activities

Figure 33. Empty ocean quohog shells (*Arctica islandica*) serve as habitat for a variety of fish such as the blenny shown here.

(Credit: NURC-UCconn).

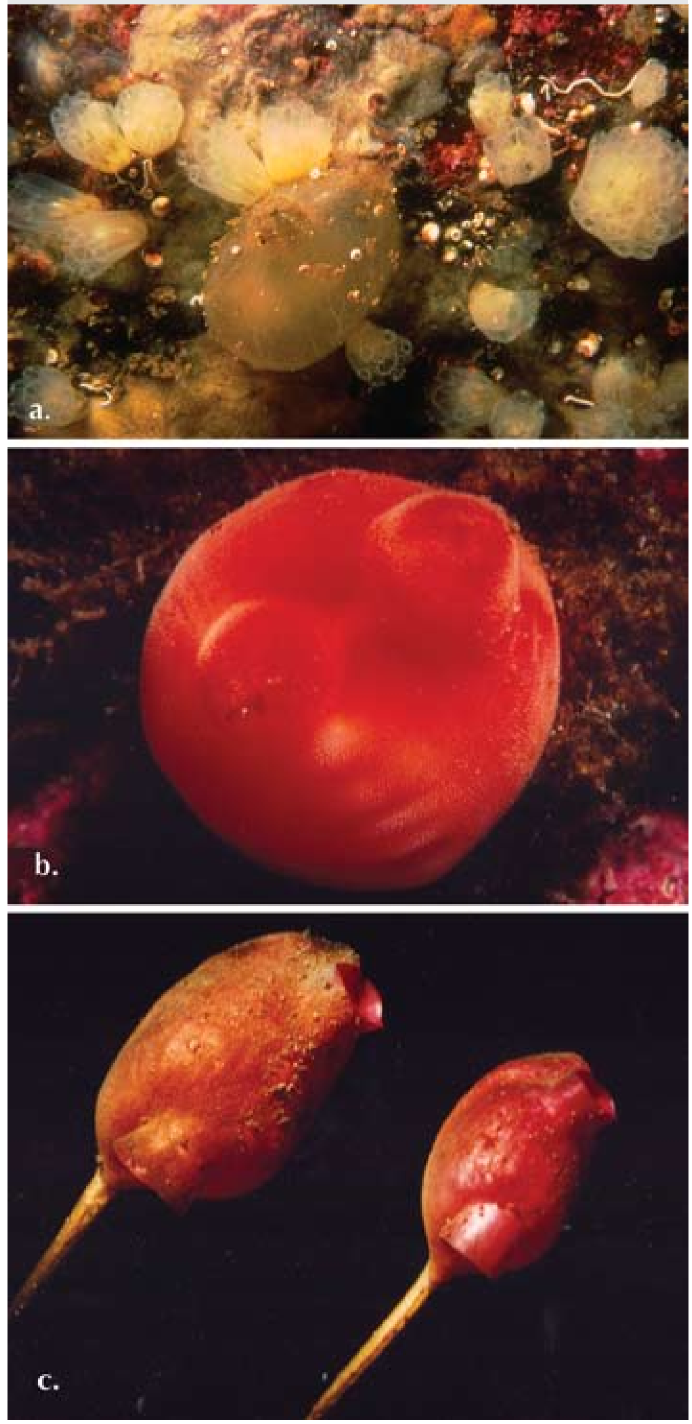
reduces the effectiveness of these regulations in protecting ecological integrity including habitat and biodiversity.

Several indices of biodiversity are based on numbers of individuals of a species as well as the number of species. These measures of diversity are sensitive to the effects of traditional fishing. A reduction in biodiversity in the sanctuary does not require that species are entirely removed (i.e., local extinction). "Local extinction" is a common scientific term in community ecology and conservation biology. It is defined as the eradication of any geographically discrete population of individuals while others of the same species or subspecies survive elsewhere.

The most effective regulations for protecting benthic invertebrates are those promulgated by NOAA Fisheries Service under the MSA in order to restore groundfish stocks in the GoM and protect EFH. Specifically, over the past two decades NOAA Fisheries Service in collaboration with the NEFMC has promulgated fishing regulations that have significantly reduced fishing effort, and therefore disturbance to invertebrates, in the entire northeast, including the sanctuary. Some examples of these regulations are: reducing fishing days at sea, creating groundfish and habitat closed areas (e.g., WGoMCA), reducing trawl net roller gear sizes to prevent bottom trawlers from accessing high relief habitat, and creating seasonal closures to protect migrating or spawning species. The protections provided by the WGoMCA and the results to date are previously described.

Figure 34. Representative species of tunicates in the Stellwagen Bank sanctuary.

(a) sea grape (*Molgula* spp.); (b) sea peach (*Halocynthia pyriformis*); and (c) stalked tunicate (*Boltenia ovifera*). Credits: (a) Jeff Hannigan; (b) Bob Michelson; and (c) Kevin McCarthy.



Fishes

Status

Fish are a vital component of the sanctuary's biological diversity and also one of its strongest links to the human population. The groundfish community in the sanctuary, made up of fishes such as cod, haddock, whiting (silver hake) and various flatfish, has been sought for food from the earliest European settlements to the present. The fish species found in the sanctuary are generally representative of fish assemblages in the GoM region. Of the known 652 GoM species, over 80 species of fish exist in the sanctuary. These known species are listed by common and scientific name in Appendix J.

The diverse seafloor topography and nutrient-rich waters in the sanctuary result in increased primary productivity and large zooplankton populations, which support abundant populations of small schooling species such as sand lance, herring and mackerel. Many groundfish and larger pelagic fish prey upon these schooling species, which also form part of the varied diet of marine mammals and seabirds. Fish found in the sanctuary range in size from small snake blennies to basking sharks. Some fish, such as giant bluefin tuna, are annual migrants to the area, while others, such as the Acadian redfish, are likely year-round residents.

Fishes are among the species most identified with use of and co-dependence on both seafloor and water column habitats because of their obvious mobility. Their distribution and abundance in the sanctuary was used to illustrate the ecological role of seafloor habitats and was described extensively in that section. As juveniles and adults, many species become closely associated with benthic habitats and communities (e.g., Atlantic cod, haddock), but virtually all species spend part of their life in the water column as eggs or larvae (as also do many benthic invertebrate species). Many species of fish live on the seafloor and feed in the water column (e.g., Acadian redfish, sand lance) and many other species live entirely in the water column (Atlantic herring, bluefin tuna). Out of the wide array of ecological niches filled by fishes, and the related sets of selective forces that shape their speciation, diverse species have evolved.

Species Diversity

One of the most geographically comprehensive data sets of species composition and abundance across the GoM LME is for demersal fishes (e.g., cod, haddock). NOAA Fisheries Service has collected a unique time series of data that stretches across decades (1963-present). This time series has been the basis for two comprehensive analyses of fish species diversity in the GoM inclusive of the sanctuary that address both temporal trends and spatial patterns.

Trends

The first analysis of these trawl data using a 25-year time series (1970–1994) found that the sanctuary had 41 of 48

Figure 35. Seasonal mean fish species diversity (species richness) across the GoM for the period 1975–2005.

(Figure excerpted from Auster *et al*, 2006.)

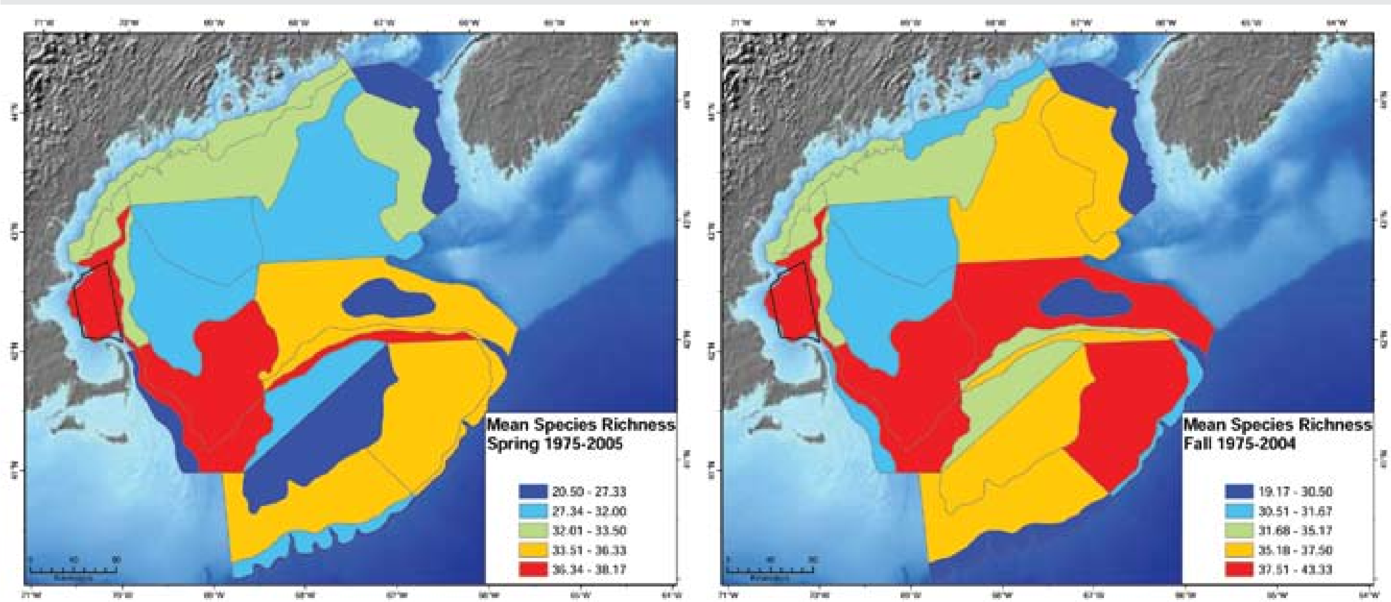
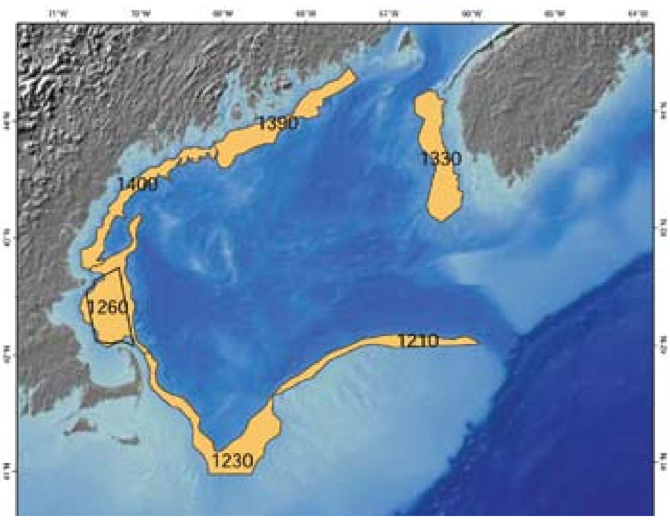


Figure 36. Geographic strata of similar bathymetric profile used to compare diversity indices with the Stellwagen Bank sanctuary.

(Figure excerpted from Auster *et al*., 2006.)



resident fish species, 7 of 17 annual migrants, and 6 of 12 shallow coastal species suggesting that the sanctuary supported a significant number of the species represented in the GoM LME (Auster, 2002). While the effects of heavy exploitation of fish populations in the GoM did not result in local extinctions over this period, there were significant declines in a range of diversity metrics in the sanctuary that take both species richness and abundance into account.

Notably, both Shannon and Simpson indices showed a steep decline over time (1970–1994) at the sanctuary scale while remaining stable at the regional GoM scale (Auster, 2002). The author concludes that these declines in diversity suggest that patterns in species richness and evenness are conservative properties of fish assemblages at the scale of the GoM but not at the scale of the sanctuary and that managing fishing at the regional scale does not necessarily maintain trends in diversity in the sanctuary. These declines in diversity were attributed to extensive fisheries exploitation of dominant species and bycatch mortality of species of lower abundance and of little economic value.

The second analysis of the NOAA Fisheries Service trawl data using a 30-year time series (1975–2005) showed that the Stellwagen Bank sanctuary is in an area of high fish species diversity in the GoM (Auster *et al.,* 2006) (Figure 35). Values for mean species richness at the regional scale were variable across the GoM and between spring and fall in most of the sample strata, but were consistently high in the sanctuary. Overall, slightly lower richness values were evident in spring than in fall. This difference is attributed to colder temperatures in spring and a reduced number of southern migrants that draw from a more diverse species pool than do migrants from the north during this season. This seasonal difference is also evident in trends among several diversity indices for fish species within the sanctuary (presented below).

In order to contrast the uniqueness of the Stellwagen Bank sanctuary with other similar regions in the GoM, six different diversity indices within the sanctuary were compared across other geographic strata that have similar bathymetric ranges (Figure 36). In general, comparison of fish diversity indices for the six strata yielded variable results (Figure 37a and b) (Auster et al., 2006). Diversity patterns were quite similar for some indices, while there was little correlation among others. However, fish diversity indices within the sanctuary were overall higher than or equal to indices within most of the other strata. Figures 35, 36 and 37a and b are based on NOAA Fisheries Service sampling strata for the GoM.

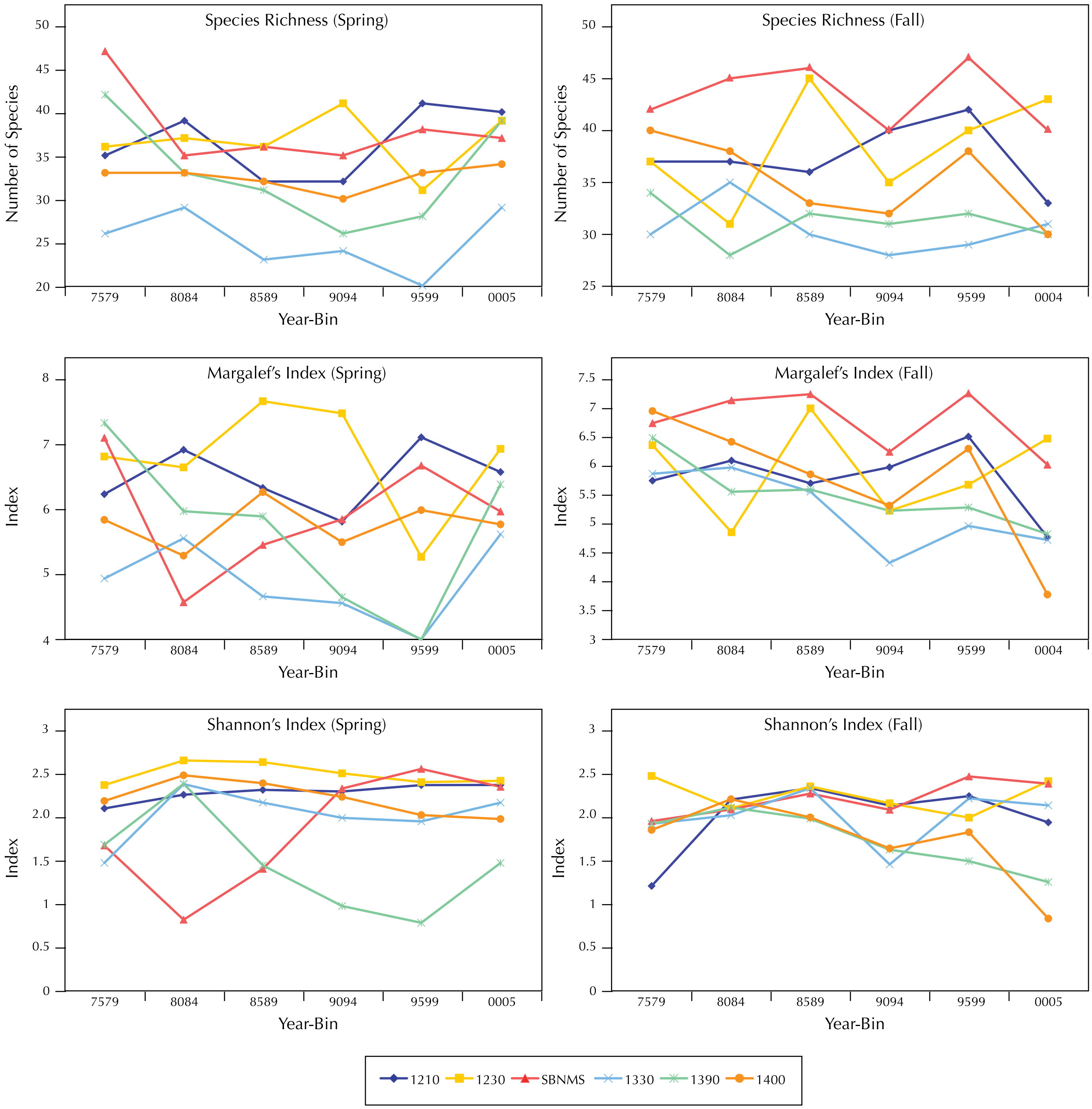
Trends among the fish diversity indices within the sanctuary were relatively stable or slightly increasing or decreasing over the 30-year time period examined, demonstrating no consistent pattern (Figure 37a and b). This more recent analysis (Auster *et al.,* 2006) shows a reversal in the Shannon and Simpson indices, which were in decline in the previous study and attributed to extensive fisheries exploitation (Auster 2002). The proximate cause of this change is unclear, since most fishery management actions occurred beginning around the mid 1990s.

The lower diversity index values for the Margalef's, Shannon, Simpson, and taxonomic diversity indices in the spring during the 1975–1989 time period all occurred because sand lance dominated trawl sample abundance within the sanctuary and this species alone comprised more than 50% of the total abundance. The high abundance of sand lance captured within the sanctuary during spring 1980-1984 severely depressed the diversity index value of these indices. High fish larval abundance within the sanctuary during the winter and spring months during 1977–1988 was also driven by sand lance (Auster et al., 2006), where their long hatching period (Nov-May) and persistent larval stage maintains a dominant presence in the sanctuary area (Reay, 1970).

The diversity indices presented in the foregoing analyses are described as follows. Species richness is the simplest index and represents the total number of species from each sample. Margalef's index incorporates both species richness and the number of individuals in a sample; it is a measure of the number of species per individual. The Shannon index is a measure of both species richness and the number of individuals of each species in a sample; it is most sensitive to changes in the number of rare species in a sample. The Simpson index is an estimate of the probability that any two individuals drawn from a sample are members of the same species; it is most sensitive to changes in number and abundance of dominant species in a sample. The other two indices are based on the relatedness of species through links of a classification tree (i.e. number of links between species in a sample based on connections at generic, family, class levels, etc.). Taxonomic diversity is based on the average number of links between two individuals chosen at random from the sample. Taxonomic distinctiveness is based on average distances of random pairs of individuals that are not the same species. Magurran (2004) and Clarke and Warwick (2001) provide overviews of the range of diver-

Figure 37a. Comparison of fish species diversity (species richness, Margalef's and Shannon indices) between the Stellwagen Bank sanctuary and other similar strata within the GoM.

(Figure excerpted from Auster *et al.*, 2006.)



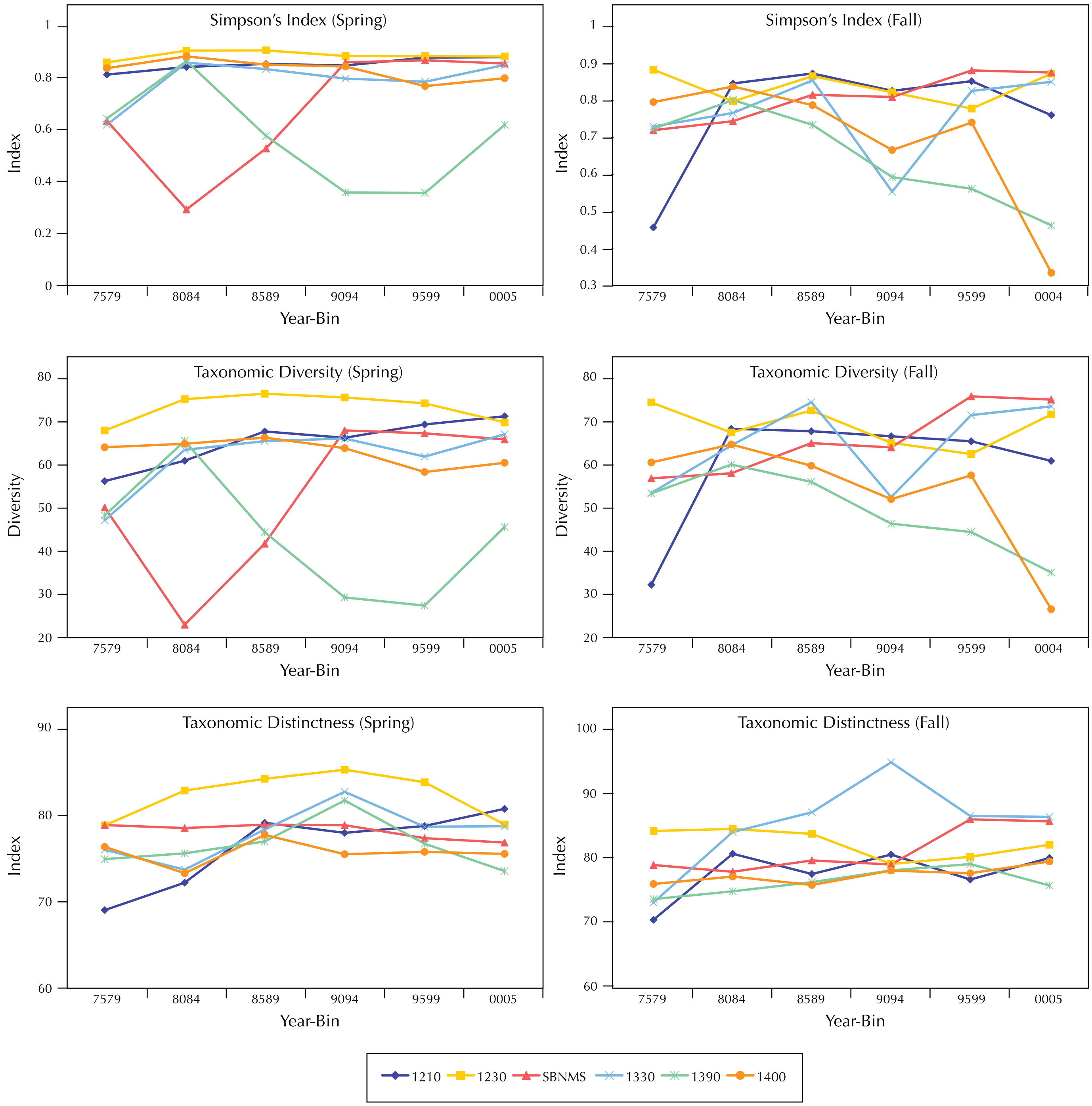
sity indices available, their calculation and issues regarding interpretation.

Patterns

In general, the greater an area that is sampled the greater number of species that are found. An analysis of the rate at which fish species increase with increasing area sampled in the sanctuary showed that more complex habitats do not necessarily harbor greater species diversity overall. Different habitats (i.e., gravel, boulder reef, mud) were found to contain some similar and some unique species and that particular habitats, like boulder reefs, were not significantly more species diverse than others; however the highest slope for both species-area and species-individual curves was for mud habitat (Auster *et al.*, 2006). These data were collected using an ROV and counts of fish and classification of habitats were accomplished using video observations of fish communities on the seafloor, much like divers counting fish on coral reefs, and allowed sampling within particular habitats.

Figure 37b. Comparison of fish species diversity (Simpson, taxonomic diversity and taxonomic distinctness indices) between the Stellwagen Bank sanctuary and other similar strata within the GoM.

(Figure excerpted from Auster *et al.*, 2006.)



The patterns of species diversity identified for both the large and small scale studies cited above suggest that habitats within regions and the regions within the larger GoM LME contain part of the overall pool of species. That is, the number of species coexisting in local communities, such as in the sanctuary, must be a result of processes that function at both local and regional spatial scales. Any sites within the GoM should be expected to have some, but not all of the species represented within the LME and that a network of sites across the GoM would be needed to contain representative examples of diversity for the entire biogeographic province.

These findings support the role that can be attributed to the sanctuary as an important biodiversity "coldspot" (*sensu* Kareiva and Marvier, 2003) and as a priority area for networked marine ecosystem management in the GoM (Crawford and Smith, 2006). A study of marine invertebrate communities that occur on shallow rock walls from around the world has found similar patterns for epifaunal species (Witman *et al.*, 2004), suggesting this is a common attri-

Figure 38. Annual per capita egg production (in millions of eggs) for cod (*Gadus morhua*) as a function of age (and by implication size).

Fecundity estimated from Bireta and Warwood (1982); mean lengths at age estimated from O'Brien (1999). (Figure excerpted from Palakovich and Kaufman, in preparation).

bute of species distributions in marine ecosystems. (See the Biogeographic Context section of this document for background discussion.)

Truncation of Size and Age Structure

The fact that large fish produce many more offspring than small fish is well established in the scientific literature (Figure 38). This is largely because eggs are produced in proportion to a fish's volume, which is proportional to the cube of its length, but also because larger fish devote a greater proportion of energy stores to egg production. It is now also evident that old fish produce healthier eggs and larvae than do young fish (Berkeley *et al*., 2004a; Marteinsdottir and Steinarsson, 1998; Wright and Gibb, 2005). The eggs of older fish are invariably of higher quality than the eggs of younger fish due to the greater amount of oil stored in the yolk sac at parturition (i.e., hatching). This produces larvae that grow faster and which are more resistant to starvation than larvae from younger females. A doubling of the growth rate of larval Atlantic cod for example, due to sufficient energy stores in the yolk sac, can produce a 5- to 10-fold increase in survival rate (Meekan and Fortier, 1996).

Many species of marine fish are long-lived, with the maximum age of species in a diverse range of families often exceeding 100 years (Cailliet *et al*., 2001). The association of longevity with variability in recruitment is also widespread among many fish species (Longhurst, 2002). The adaptive value of a long life span is that reproductive output is allocated across many years, a bet-hedging strategy that ensures some reproductive success despite potentially long periods of environmental conditions unfavorable for larval survival (e.g., Secor, 2000a). A growing body of evidence indicates that a broad age distribution can also reduce recruitment variability (Lambert 1990; Marteinsdottir and Thorarinsson 1998; Secor, 2000b).

Berkeley *et al*. (2004) offer two mechanisms by which reproductive optimization due to broad age distribution can occur: (1) there may be age-related differences in the time and location of spawning, effectively spreading larval production over temporally and spatially variable environmental conditions (Hutchings and Myers, 1993; Lambert, 1987), and (2) older fish may produce more fit eggs and larvae, which can survive under conditions inadequate for survival of progeny from younger fish (Hislop, 1988; Marteinsdottir and Steinarsson, 1998). Whereas older fish are likely to produce larvae of better condition, in larger numbers and in more frequent batches than younger fish, thereby ensuring population viability, fishing obliterates this benefit by selectively removing larger, older individuals.

These findings are important considerations for sanctuary management because it is becoming abundantly apparent that high numbers of larger, older fish are what ultimately sustain fish populations (Lambert, 1990; Leaman and Beamish, 1984; Marteinsdottir and Thorarinsson, 1998; Trippel *et al*., 1997). And larger fish, especially among keystone species such as Atlantic cod, are important agents in the structuring of biological communities through size mediated differences in food habits and rates of predation, as well as in competitive outcomes between species of the same or similar feeding guilds. Large fish are also the target of commercial and recreational fishing activities, which in light of current knowledge may be contrary to optimizing conservation benefit (Berkeley *et al.,* 2004b; Birkeland and Dayton, 2005), depending on the management objective, e.g., maintenance of biological communities.

Big Old Fat Females

Research on a variety of fish species clearly indicates the great importance of experienced spawners (BOFFs or "big old fat females") to the future of a fish population. Empirical studies indicate that Atlantic cod exhibit a BOFF effect. In a paper recently submitted for peer review (Palakovich and Kaufman), researchers examined the strength and significance of this effect to stock rebuilding using a dynamic model and the Stellwagen Bank sanctuary as the target area. Results of this modeling study indicated that first, second and third-time spawners were cod ages 1 to 9 years old and experienced (BOFF) spawners were ages 10 and 11. BOFF spawners contributed about ten times more offspring that survived their first year than did younger, less experienced spawners. Third-time spawners contributed the greatest proportion of recruits but still had much lower per capita reproductive output than BOFF year classes. The reproductive value of first and second-time spawners was negligible due to both low output and low larval survival.

Current fisheries management practice in New England, based upon the paradigm of optimum sustainable yield (OSY), favors a population dominated by young breeders. Palakovich and Kaufman (in review) conclude that failure to protect large, experienced female cod produces a yield that may be optimal in a conventional sense but may not be sustainable under historic high levels of exploitation. In addition, the truncation of the cod size distribution favored by current management eliminates large "old growth" cod as a functional component of the ecosystem, altering the food web and possibly also other aspects of community structure. Palakovich and Kaufman (in review) conclude that if fishery management objectives are for cod populations to rebuild and for cod to once again become a major functional part of the ecosystem, then the BOFF effect should be incorporated into management models for fishing in the Stellwagen Bank area; most likely they should apply to the GoM as a whole for the sanctuary to appreciate major benefits.

Changes in Fish Maximum Length

Retrospective time series of mean body length of Atlantic cod from kelp forests in the coastal GoM declined from 1.0 m 3550 yrs B.P. (before present) to 0.3 m at present time, indicating a 3-fold decrease in trend due to fishing (Jackson et al., 2001). This analysis was conducted on data derived from archaeological and historic sources. This trend has extended offshore to Georges Bank (Sherman, 1991) and, as explained below, to the Stellwagen Bank sanctuary for cod and other species as well. In the 1960s and 70s, the maximum length of cod in the sanctuary approximated what the mean length had been historically in the GoM.

Figure 39. Decrease in maximum length of white hake sampled in the Stellwagen Bank sanctuary by NOAA Fisheries Service standardized trawl surveys over the period 1963–2000.

(Figure excerpted from Crawford and Cooke, in preparation.)

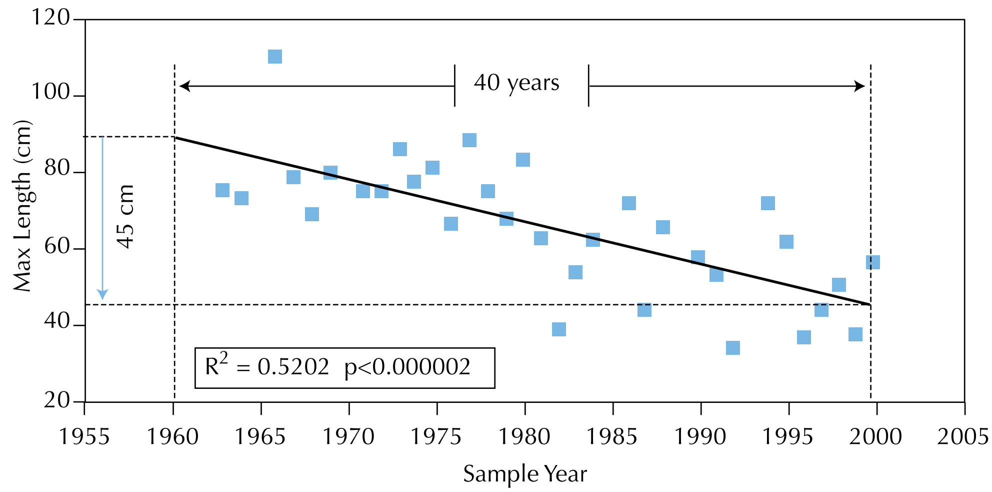
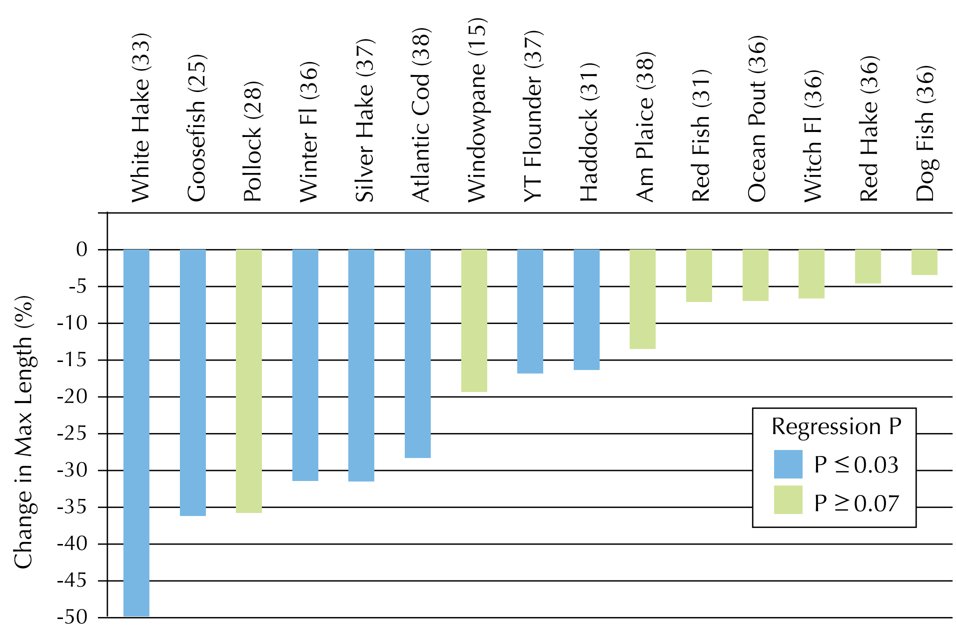


Figure 40. Reduction in maximum length of 15 species of ecologically and commercially important fish over a 38-year period (1963–2000) within the Stellwagen Bank sanctuary.

All species showed decreases in maximum length; those signified by the blue bars were statistically significant. The number in parenthesis following fish name was the number of trawl samples analyzed for the respective fish species identified (Crawford and Cook, in preparation).



A study was conducted in 2003 that analyzed the 38 years of NOAA Fisheries Service research trawl data that was available at the time (1963-2000) to assess changes in fish maximum length within the sanctuary over this period (Crawford and Cook, in preparation). The length of the largest individuals sampled each year (for example Figure 39), and by separate analysis the length of the 90 percentile point, were regressed over time for each of the 15 species studied with comparable findings. Based on the regressions of the length of the largest individuals sampled, all of the species examined showed decreasing trends in maximum length over the 38-year period (Figure 40). For seven of these species (white hake, goosefish, winter flounder, silver hake, cod, yellowtail flounder, haddock), the decrease was significant. Estimated maximum length decreases for the seven species ranged from 15% to 49% for this period. The maximum length of white hake was reduced by nearly half (49%) and Atlantic cod was reduced by 27% over this period, for example. The average decrease for all 15 species combined was 20%. While the study did not address the cause of the decrease in maximum length, the simplest explanation is the consequence of nearly four decades of heavy exploitation.

A subsequent analysis of the maximum length of fish caught in the sanctuary for a more recent time period (1990-2005) offers some cause for optimism for a subset of the species originally examined by Crawford and Cooke (i.e., Atlantic cod, haddock, white hake, American plaice, winter flounder, witch flounder, and yellowtail flounder). Since the onset of fishery management actions in the 1990s, the maximum length of some species, particularly cod and haddock, appears to be increasing (Figure 41). Other species (particularly the flatfishes) show signs of a reversing trend in maximum size but are still of concern. The data analyzed are from the NOAA Fisheries Service research trawl surveys conducted within the sanctuary and serve to update the results of the analysis by Crawford and Cooke presented above.

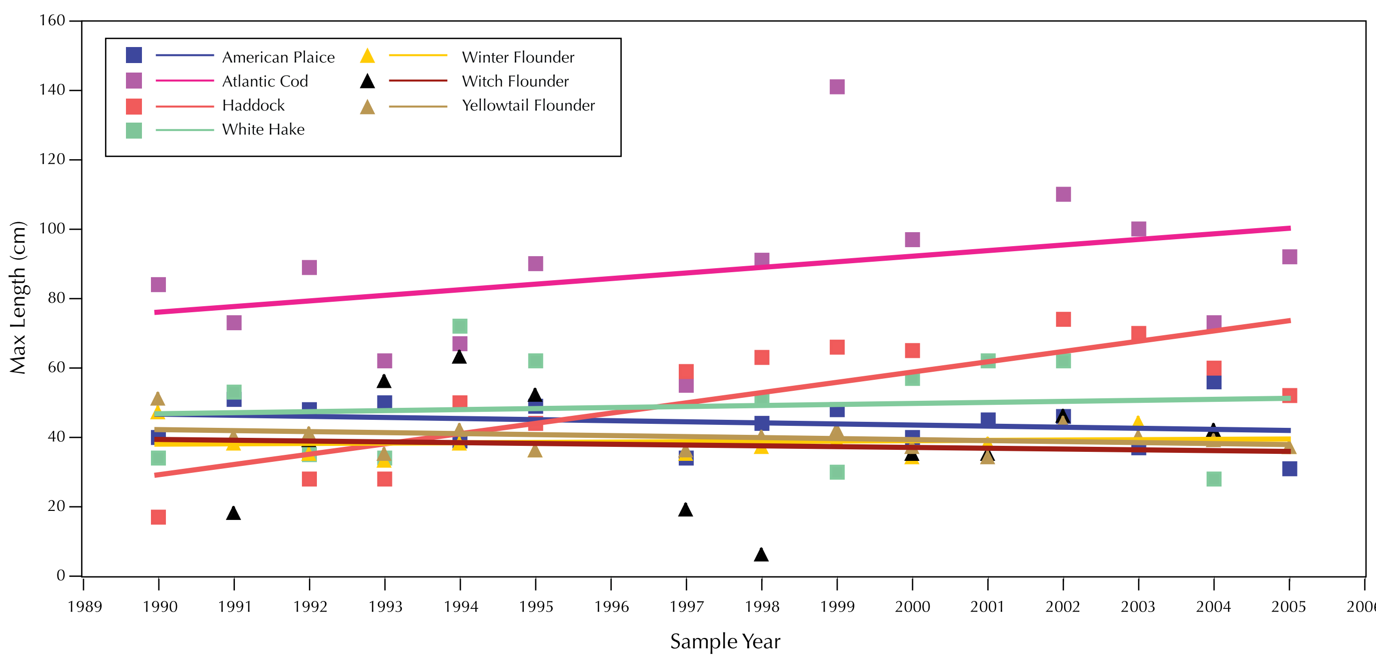
The finding of the great extent to which the size and (by implication) age structure of key commercial and ecologically important fish species has been truncated in the sanctuary compounds the likely population consequences of the BOFF effect, if it extends to these species as well. Related work with haddock suggests that it does (Wright and Gibb, 2005). The removal (i.e., absence) of large size classes among these key predatory species should also have a profound effect on the composition of their associated biological communities within the sanctuary due to ontogenetic diet shifts associated with predator morphology and/or habitat. Size-based diets are a common pattern in the Northeast shelf fish community and diet shifts have important implications for trophic dynamics and both sanctuary and fisheries management (Garrison and Link, 2000). In the case of piscivores (such as cod), the range of available prey generally increases with predator size related to increases in predator gape width (size of mouth), swimming speed and visual acuity (reviewed in Juanes, 1994).

The truncation of old-growth age structure due to fishing can also have a profound effect on the genetic make-up and expression of traits within exploited fish populations. Selective fishing pressure on the larger (older) individuals of fishes over recent decades has caused the rapid evolution of decreased body size and fecundity of northern cod (Olsen et al., 2004). An evolutionary change more troublesome than the reduction in body size and fecundity is the reduction of genetic diversity within fish species due to the harvesting of old-growth age structure. Marine fish populations are vulnerable to the loss of genetic variability, potentially leading to reduced adaptability and population persistence when the older members of the fish population are removed (Hauser et al., 2002).

Management Implications

One of the principal objectives of the sanctuary is to protect and restore the ecological integrity of the sanctuary. In order to do this, the recent evidence discussed above suggests that old-growth age structure and large body-size classes be maintained in the population. As previously explained (Habitat Mediated Movement section this document), 35% of Atlantic cod tagged in the sanctuary demonstrated a high degree of site fidelity and a meta-analysis of 100 years of cod tagging studies across the North Atlantic showed a high rate (32%) of sedentary behavior for the species. These findings suggest that management directed at the sanctuary area alone (as opposed to the entire GoM) may be effective in meeting the sanctuary's objectives.

FIGURE 41. CHANGE IN MAXIMUM LENGTH OF A SUBSET OF FISH SPECIES SAMPLED IN THE STELLWAGEN BANK SANCTUARY DURING 1990–2005.



Old-growth age structure in long-lived fish (such as cod) can be maintained by three approaches (Berkeley *et al.,* 2004b): (1) lowering catch rates substantially, which can be economically infeasible; (2) implementing slot limits (release of both small and large individuals), which may be impractical due to capture mortality (e.g., via swimbladder expansion); and (3) implementing marine protected areas (MPAs) to ensure that at least part of the stock can reach old age and large size. The obvious conclusion is the need to minimize what has conventionally been seen as an expected and harmless side-effect of fishing to maximize density-dependent surplus production: age and size truncation (the loss of older age classes and large size classes) (Francis *et al,* 2007).

As indicated below under regulatory provisions, NOAA Fisheries Service has instituted regulations that are working to lower catch rates in the GoM region and established the WGoMCA in 1998 (although only overlapping 22% of the sanctuary area), hence implementing two of the three approaches identified that could help restore and maintain old-growth size and age structure of fishes in the GoM. The data series used to examine old-growth size structure in the sanctuary will continue to be extended to include the most recent data years available for all 15 species and analyzed to evaluate whether and to what degree these management actions are effective at restoring the old-growth size (and hence age) structure of these ecologically important fish species within the sanctuary.

Pressures

Commercial fishing with mobile gear, such as trawls and scallop dredges, together with fixed gear, such as bottom-tending gill nets and lobster pots, occurs extensively throughout the sanctuary. Commercial fishermen take species from four principal categories: groundfish, pelagics, other finfish and invertebrates. On average, 327 commercial fishing vessels per year fished in the sanctuary during 1996-2005 (see Commercial Fishing section of this document for details). Stressors resulting from commercial fishing include alteration of habitat and biological communities, removal of biomass, disturbance of feeding whales, entanglement of marine mammals, discharges of pollutants and destruction of historic resources. Other stressors, i.e., water quality, HABs, invasive species, are addressed in previous sections of this document.

The sanctuary is also a popular destination for recreational fishing boats. Recreational fishing by party, charter and private boats in the sanctuary targets primarily groundfish but also pelagic species such as tuna, shark and bluefish. On average, 69 party and charter boats per year fished in the sanctuary during 1996-2005 (see Recreational Fishing section of this document). Party boat and charter boat recreational fishing occurs over much of the sanctuary; however, the precise amount of private recreational use of the sanctuary has not been quantified. The recreational fishing fleet is estimated to take 25% of the Atlantic cod in the GoM (NEFMC, 2003). Stressors resulting from recreational fishing activities include targeted removal of large fish, fishing at times and places associated with spawning aggregations, discard mortality, disturbance of feeding whales, vessel strikes to whales, discharge of pollutants and destruction of historic resources.

Current Protection

Regulatory Provisions

Fishery resources in the Northeast, including in the sanctuary, are regulated by NOAA Fisheries Service with input from the NEFMC, the Mid-Atlantic Fishery Management Council (MAFMC) and the Atlantic States Marine Fisheries Commission (ASFMC). Some restrictions on fishing that affect the sanctuary have been put in place, including limited access programs and effort controls, rolling closures for groundfishing, catch and minimum size limits for individual species, and a large, permanent year-round habitat closure in the WGoMCA. See Sidebar for related considerations.

The latest approved Fishery Management Plan (FMP) developed by the NEFMC and the MAFMC is currently implemented by Amendment 13 to the Northeast Multispecies FMP (2004) (50 CFR Part 648). Other plans exist for the following species: Atlantic salmon; Atlantic sea scallop; American lobster (50 CFR Part 697); northeast multispecies and monkfish; mackerel, squid and butterfish; surfclam and ocean quahog; summer flounder; scup; black sea bass; Atlantic bluefish; Atlantic herring; spiny dogfish; Atlantic deep-sea red crab; tilefish; and the skate complex.

The Northeast Multispecies FMP establishes the following:

- Reduction in the number of Days at Sea
- Minimum size regulations for several major commercial and recreational species including but not limited to: monkfish, Atlantic cod, haddock, pollock, witch flounder, yellowtail flounder, American plaice and winter flounder
- Closures of spawning areas over Georges Bank, southern New England and the GoM
- New habitat closed areas over Georges Bank, southern New England and the GoM
- Increase in the mesh size of mobile trawl gear and gillnets
- Fish excluder devices and modified gear (raised footrope) for small mesh exempted fisheries
- Limits to hook size and number for hook gear
- Marking requirements for gillnet gear

In addition, federal lobster regulations (50 CFR Part 697) limit trap sizes and the number of traps allowed.

Under Amendment 13, the NEFMC and the MAFMC have also developed an updated FMP for Atlantic herring in coordination with the ASMFC; they also have developed a fishery management plan for the Arctic surf (or Stimpson) clam, for which commercial exploitation has been initiated in the Stellwagen Bank area (Amendment 13, 50 CFR part 648).

The northern shrimp FMP was developed by the ASFMC. The ASFMC is additionally responsible for striped bass and bluefish fisheries; the plan for the latter species is developed in cooperation with the MAFMC. The MAFMC is also charged with sole responsibility for management plans on summer flounder, butterfish, short and long-finned squid, surf clam, ocean quahog and mackerel.

Fishing for commercial bluefin tuna is regulated under the International Commission for the Conservation of Atlantic Tuna (ICCAT), as implemented via the Atlantic Tunas Convention Act of 1975. Quotas for bluefin tuna are determined by ICCAT. NOAA Fisheries Service allocates this quota by categories assigned to the four gear types employed in the fishery: hand-line, rod and reel, harpoon and purse seine net. The species is also caught incidentally by pelagic longline vessels.

Fishing for Atlantic striped bass in the sanctuary is prohibited by the general provisions set forth in 50 CFR 697.7(b). This section states that it is unlawful for any person to do any of the following: (1) fish for striped bass in the US EEZ [Exclusive Economic Zone], (2) harvest any striped bass from the EEZ, (3) possess any striped bass in or from the EEZ (noted exceptions in areas of New York and Rhode Island), and (4) retain any striped bass taken in or from the EEZ. Boundaries of the Stellwagen Bank sanctuary fall entirely within the EEZ, hence this regulation applies to the sanctuary.

Related Considerations

Fishing is not currently subject to regulation by the Stellwagen Bank sanctuary pursuant to the sanctuary Designation Document (Appendix B). In 1993 when the sanctuary was established, NOAA/NOS concluded that adequate legal mechanisms existed under the MFCMA to provide appropriate management of fisheries and that no supplementary fishing regulations under the NMSA were necessary (USDOC, 1993).

In the 15 years since sanctuary designation conditions have changed. As of the 4th quarter of 2007, twenty one stocks require rebuilding within the New England fisheries, the highest number among the nation's fishery management councils; eighteen stocks are overfished and overfishing is occurring in eight stocks (http://www.nmfs.noaa.gov/sfa/domes_fish/StatusoFisheries/2007/FourthQuarter/TablesA_B.pdf). Associated context is provided in Rosenberg *et al.*, (2006). Moreover, the condition of resource states in the sanctuary is now more fully characterized and is much better understood than in 1993, when the first management plan for the sanctuary was published by NOAA.

Importantly, for those stocks currently experiencing overfishing, the MFCMA calls for all overfishing to be eliminated by 2010. In terms of an ecosystem approach to management, NOAA must also consider the significant collateral effects of fishing on sanctuary resources that must be accounted for under the comprehensive resource protection objectives of the NMSA. These include biodiversity loss at the genetic, species and community levels; food web changes and shifts in community composition that occur through depletion of forage species and top level predators; the truncation of population size and age structures; and, degradation and loss of the sanctuary's biogenic habitats and living landscapes.

The congressionally mandated periodic review of sanctuary management plans allows national marine sanctuaries to adjust to better protect sanctuary resources. NOAA has determined that renewed consideration should be given to reduction of ecological impacts from fishing activities and mobile fishing gear in the sanctuary as described in the Ecosystem Alteration Action Plan in this document, for example. An explanation of the regulatory coordination tools available through the NMSA on fishery management issues in national marine sanctuaries is provided in Appendix H.

Seabirds

Status

Seabirds are defined as birds that spend a large proportion of their lives at sea, feeding either entirely or predominantly on marine organisms, and coming ashore for relatively short periods for resting or breeding (Schreiber and Burger, 2001). Most seabirds are assigned to one of three orders: the Procellariiformes (e.g., shearwaters, fulmars, petrels and albatrosses), the Pelecaniformes (e.g., gannets, pelicans, boobies and cormorants) or the Charadriiformes (e.g., gulls, terns, auks). Seabirds are usually numerically abundant, long lived (15-70 years) and feed at a variety of TLs (i.e., predators and scavengers). As such, seabirds can be very responsive to changes in their environment.

The broad-ranging movements and longevity of seabirds mean that they track environmental changes at spatial and temporal scales that are otherwise difficult to monitor

(Diamond and Devlin, 2003; Huettmann and Diamond, 2006). For example, seabird species are useful bioindicators by providing valuable information to define pelagic habitat types (Springer *et al*., 1996) and assess ecosystem health (Furness and Greenwood, 1993). Changes in seabird distribution and abundance, as well as breeding success, growth rates, survival and diet composition, have been closely linked to regional climate variability (e.g., North Atlantic oscillations and El Niño/La Niña events) and global climate change (Aebischer *et al*., 1990; Brown, 1991; Monaghan, 1992; Montevecchi and Myers, 1997; Schreiber and Schreiber, 1989;) and changes in prey abundance (Cairns, 1987; Diamond and Devlin, 2003; Hamer *et al*., 1991; Garthe *et al*., 1996). Seabirds also have the potential to function as indicators of pollutants, particularly since they rapidly bio-accumulate chemicals that are lipid-soluble such as organo-chlorines (e.g., DDT, PCBs) and organo-metals (e.g., methyl mercury) (Chapdelaine *et al*., 1987; Furness and Camphuysen, 1997).

The GoM is locally and internationally recognized as an important area for seabirds, with seabird densities that are considerably higher than adjacent oceanic waters (Powers *et al.,* 1980; Powers, 1983; Powers and Brown, 1987; Platt *et al.,* 1995). The shallow banks and shelves, including Brown's Bank, Georges Bank, Stellwagen Bank, Cashes Ledge, Cape Cod and the Grand Manan region, have long been known to support large numbers of seabirds (Powers, 1983; Powers and Brown, 1987; Huettmann and Diamond, 2006). In its capacity as the U.S. partner of BirdLife International, the Massachusetts Audubon Society (Mass Audubon) has designated Stellwagen Bank an Important Bird Area (IBA). An IBA is a site that provides essential habitat to one or more species of breeding, wintering or migrating birds, and which supports high-priority species, large concentrations of birds, exceptional bird habitat, and/or has substantial research or educational value.

Species Frequenting the GoM

Many of the seabirds observed in the GoM are seasonal migrants that have traveled vast distances from remote islands in the south Atlantic where they nest (Brown, 1973). For example, Wilson's storm-petrel migrates to the GoM during summer from breeding sites in sub-Antarctic islands. Sooty shearwaters and greater shearwaters are also summer migrants to the GoM from breeding sites on several remote south Atlantic islands (Tristan da Cunha and Gough Island) and sub-Antarctic islands (Huettmann, 2000). Other birds, including some arctic terns and red phalaropes connect the GoM with southern and western Africa (Brown, 1979).

Black-legged kittiwakes and great cormorants are winter migrants, typically migrating from more northerly regions along with some auks, especially razorbills. Other seabirds migrate shorter distances (e.g., from Canada) to specific sites within the GoM that are considered to be important moulting grounds for immature birds (Huettmann and Diamond, 2000; Huettmann *et al*., in press). Non-resident seabirds visiting the GoM typically exhibit a spring and fall arrival and departure pattern (Powers and Brown, 1987). Atlantic puffins from Maine and Canada are frequently observed feeding in the sanctuary during winter months. The majority of shearwater species in the region are migrants and breed outside the study area (Brown, 1988, 1990).

Seabirds that have established breeding colonies in the GoM region include Atlantic puffin, black guillemot, common murre, Leach's storm-petrel, razorbill, common eider and several species of cormorant, gull and tern. In fact, the islands of Maine provide the only breeding sites in the United States for Atlantic puffin and razorbill (one of the rarest breeding auks in North America) and provide some of the southernmost breeding sites for Leach's storm-petrel and common eider. These breeding sites prompted the U.S. Fish and Wildlife Service (GoM coastal program) to recognize approximately 300 "nationally significant" seabird nesting islands in the GoM.

Relationships with the Environment

Many seabirds have distinct utilization patterns associated with specific ocean currents and water masses, and the boundaries between those features, as well as finer-scale oceanographic and bathymetric features that affect prey dispersion and availability (Balance *et al*., 2001; Daunt *et al*., 2003; Schneider, 1990b, 1997). In most regions, oceanographic (e.g., sea surface temperature and chlorophyll concentrations) and bathymetric variables show a strong across-shelf spatial gradient that is associated with patterns of seabird distribution and prey abundance.

Seabird preference for shallow continental shelf waters versus deeper oceanic waters, proximity to shore, or to some distinct bathymetric feature (e.g., continental shelf edge) have been found to explain broad-scale patterns in abundance for a wide range of seabird species (Schneider, 1997; Wynne-Edwards, 1935; Yen *et al*., 2004a,b). For example, Yen *et al*. (2004a,b) found that seabirds target regions of complex and steep topographies where oceanographic conditions lead to elevated productivity (fronts and upwelling zones) and increased prey retention.

The razorbills, murres and puffins (Alcidae), terns and some gulls (Laridae), fulmars, shearwaters and storm-petrels (Procellariiformes), gannets (Sulidae) and cormorants (Phalacrocoraciidae) are key components of the offshore ecosystem, where they form an important group of predators of small fish, squid and planktonic crustaceans. The primary prey items for most of these seabird species are small fish including Atlantic herring, sand lance, hake and mackerel, although they will also feed on cephalopods, crustaceans, annelids and some plant material (Powers *et al*., 1980; Hall *et al*., 2000; Diamond and Devlin, 2003).

Stomach content analysis of 156 individuals of nine seabird species (five species of Procellariiformes and four gulls, Laridae) collected at sea from the northeastern continental shelf showed that all species fed on fish, with sand lance being an important prey item for most marine birds throughout the year (Powers *et al*., 1980). Squid were also a major prey item for many species, particularly greater shearwaters, while euphausiids (pelagic crustaceans) were an important component of the diet of Wilson's storm-petrel.

Seabird Utilization of the Sanctuary

An estimated 60 species of seabird were recorded within the GoM, based on sightings from the Manomet Bird Observatory (MBO) surveys (1980-1988). More than half of these, 32 species, were identified for the Stellwagen Bank sanctuary (34 species were identified in a separate standardized survey of the sanctuary as presented below). The seabird species utilizing the sanctuary are listed by common and scientific name in Appendix J. Species rank based on frequency of occurrence was very similar between the sanctuary and the broader GoM, with the exception of gulls which, respectively, were more frequently and shearwaters, less frequently sighted within the sanctuary. In addition, there were five separate sightings of the federally endangered roseate tern in the GoM, one of which was recorded within the sanctuary. Since the surveys, MBO was renamed the Manomet Center for Conservation Sciences.

Predictive Modeling

The NOAA National Center for Coastal and Ocean Science (NCCOS) integrated the MBO seabird survey database covering the U.S. portion of the GoM with the PIROP (Integre des Recherches sur les Oiseaux Pelagiques) seabird survey database covering the Canadian portion of the GoM for predictive modeling purposes (Pittman and Huettmann, 2006). The combined database provides large sample sizes and exceptional spatial and temporal resolution for the GoM region and the northeastern U.S. continental shelf. This database was used to model and predict temporal patterns of seabird distribution and total abundance across a very broad spatial scale.

Monthly total abundance data for eight focal seabird species, corrected for effort, were compared to examine temporal patterns of abundance (Pittman and Huettmann, 2006). For this analysis, the GoM region was divided into 5 x 5 minute cells. Although the model presented a simplified estimate of monthly changes in seabird abundance, the temporal patterns of presence and absence for the GoM were clearly shown. This was true at the scale of the sanctuary area when seasonal summer-winter comparisons were made.

The sanctuary area supported all eight focal species in either one or both seasons. The sanctuary supported a higher number of species during winter months than summer months. In winter months, the maximum mean number of focal species (per cell) using the sanctuary was eight. Highest seabird diversity was recorded over the northern tip of Stellwagen Bank and southern Tillies Basin. In summer months, the maximum mean number of focal species (per cell) using the sanctuary was four, with highest mean number of species occurring over the central Stellwagen Bank area and Tillies Basin. Non-breeding summer migrants (greater shearwater and Wilson's storm-petrel) were particularly prevalent within sanctuary waters.

Table 6. Sightings totaling 5,825 seabirds of 34 species in nine families recorded in the Stellwagen Bank sanctuary during July 1994–August 1995.

Family	Common Name	Count
Laridae	Great Black-Backed Gull	1,516
	Herring Gull	1,431
	Black Legged-Kittiwake	276
	Common Tern	48
	Ring-Billed Gull	11
	Pomarine Jaeger	5
	Least Tern	4
	Laughing Gull	3
	Parasitic Jaeger	2
	Unidentified Gull	1
	Unidentified Jaeger	1
	Total	**3,298**
Hydrobatidae	Wilson's Storm-Petrel	1,100
	Leach's Storm-Petrel	4
	Total	**1,104**
Sulidae	Northern Gannet	510
	Total	**510**
Alcidae	Razorbill	219
	Unidentified Large Alcid	30
	Dovekie	14
	Atlantic Puffin	5
	Common Murre	5
	Black Guillemot	4
	Thick-Billed Murre	1
	Total	**278**
Anatidae	Common Eider	206
	White-Winged Scoter	37
	Black Scoter	12
	Surf Scoter	6
	Oldsquaw	2
	Total	**263**
Procellariidae	Greater Shearwater	176
	Sooty Shearwater	64
	Cory's Shearwater	6
	Manx Shearwater	5
	Northern Fulmar	5
	Total	**256**
Phalacrocacidae	Double-Crested Cormorant	54
	Great Cormorant	27
	Total	**81**
Gaviidae	Common Loon	21
	Red Throated Loon	1
	Total	**22**
Scolopacidae	Unidentified Phalarope	12
	Red-Necked Phalarope	1
	Total	**13**
	Total	**5,825**

Patterns of prevalence indicated that auks used the sanctuary more in winter than summer. Highest auk prevalence was recorded in winter at the southern end of the Stellwagen Bank and northern tip of Cape Cod. Highest prevalence for auks in winter over the southern tip of Stellwagen Basin was also predicted in the model. Similar seasonal use patterns were found for razorbill, with absence in summer and intermediate level prevalence in the southern part of the sanctuary in winter. Greater shearwaters were more prevalent than auks in both winter and summer seasons, with sightings recorded from most cells within the sanctuary area. Tillies Basin supported highest prevalence of greater shearwaters, particularly in the summer months.

Northern gannets were widespread throughout the sanctuary in winter with highest prevalence in the south and central portions of the sanctuary. Northern gannets were also recorded in summer, although they were both less widespread and less prevalent than in winter. Wilson's storm-petrels were also distributed throughout the sanctuary in summer with highest prevalence over shallow waters on central Stellwagen Bank and over deeper waters of Tillies Basin. Wilson's storm-petrels were not recorded within the sanctuary during winter months.

Standardized Survey

During July 1994–August 1995, a 14-month long study was undertaken by the sanctuary to quantify and map patterns of human and wildlife use of the sanctuary, including seabirds (D. Wiley and S. Highley, unpublished data). Each month data were collected along 10 standardized shipboard survey tracklines (strip transects of 400 m width) that crossed the sanctuary at 5 km (2.5 nm) intervals providing complete coverage of the southern two-thirds of the sanctuary that were surveyed. The 1994–1995 survey was repeated in 2001–2002 with area coverage at this later date including the entire sanctuary but excluded seabirds. (Refer to Wiley *et al.*, 2003 for details of the methodologies used.)

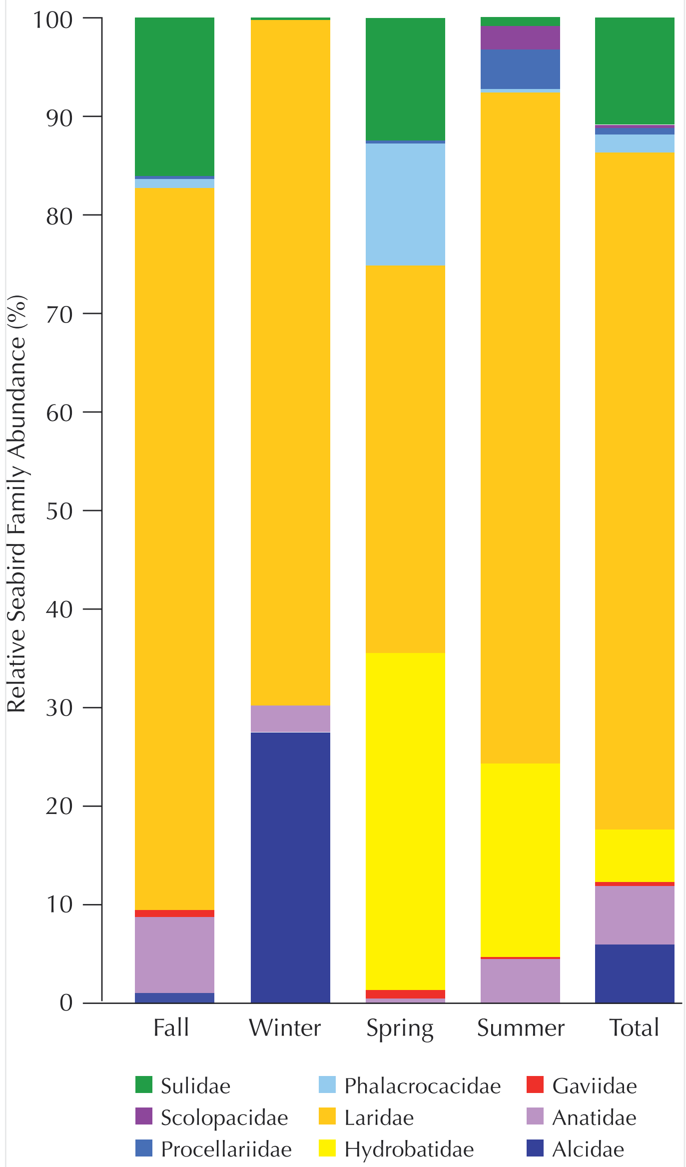
The distribution of data grouped by seabird family was analyzed to portray the grid density and spatial intensity of seabird use of the sanctuary. Data were binned into 5 x 5 minute grid cells for analysis, as done for the GoM region model discussed above. The analysis of the standardized survey data was done by NCCOS on behalf of the sanctuary during preparation for their larger scale GoM modeling. These results do not appear in their published work (Pittman and Huettmann, 2006).

Sightings totaling 5,825 seabirds of 34 species in nine families were recorded within the sanctuary during July 1994–August 1995 (Table 6). Their relative seasonal abundance grouped by family is summarized in Figure 42 for the calendar year July 1994–June 1995. This figure should be referred to in the subsequent descriptions of seasonality. The spatial distribution and density over all seasons for selected families is presented in a series of grid plots of the sanctuary that accompany the following family accounts (Figure 43).

The family Laridae (gulls, terns and jaegers) was numerically dominant over the year, being less abundant in the spring.

Figure 42. Relative seasonal abundance of seabirds within the Stellwagen Bank sanctuary for the calendar year July 1994–June 1995.

Data are individual sightings of species from the standardized survey grouped by family.



Highest numbers were seen in vicinity of the northern and southern portions of Stellwagen Bank. Great black-backed gulls and herring gulls were most frequently seen.

The family Hydrobatidae (storm-petrels) was present only during spring (especially) and summer. Storm-petrels were sighted widely over Stellwagen Bank and area in spring, with highest numbers in both the northern and southern portions; but sightings in summer were entirely in the southern portion of the bank, especially the southwest corner and adjacent area.

The family Sulidae (gannets and boobies) was most numerous during fall (especially) and spring, although present in

Figure 43. Part 1. Spatial distribution and density of seabirds in the Stellwagen Bank sanctuary.

Data are individual sightings of species from the standardized survey for the period July 1994 – August 1995 grouped by family and aggregated over all seasons. Families included in the figure are: Laridae (gulls, terns and jaegers), Sulidae (gannets and boobies), Hydrobatidae (storm-petrels), Alcidae (auks, murres and puffins), Anatidae (ducks, geese and swans), and Procellaridae (shearwaters and fulmars). Data were analyzed by *ArcView's ArcMap* program.

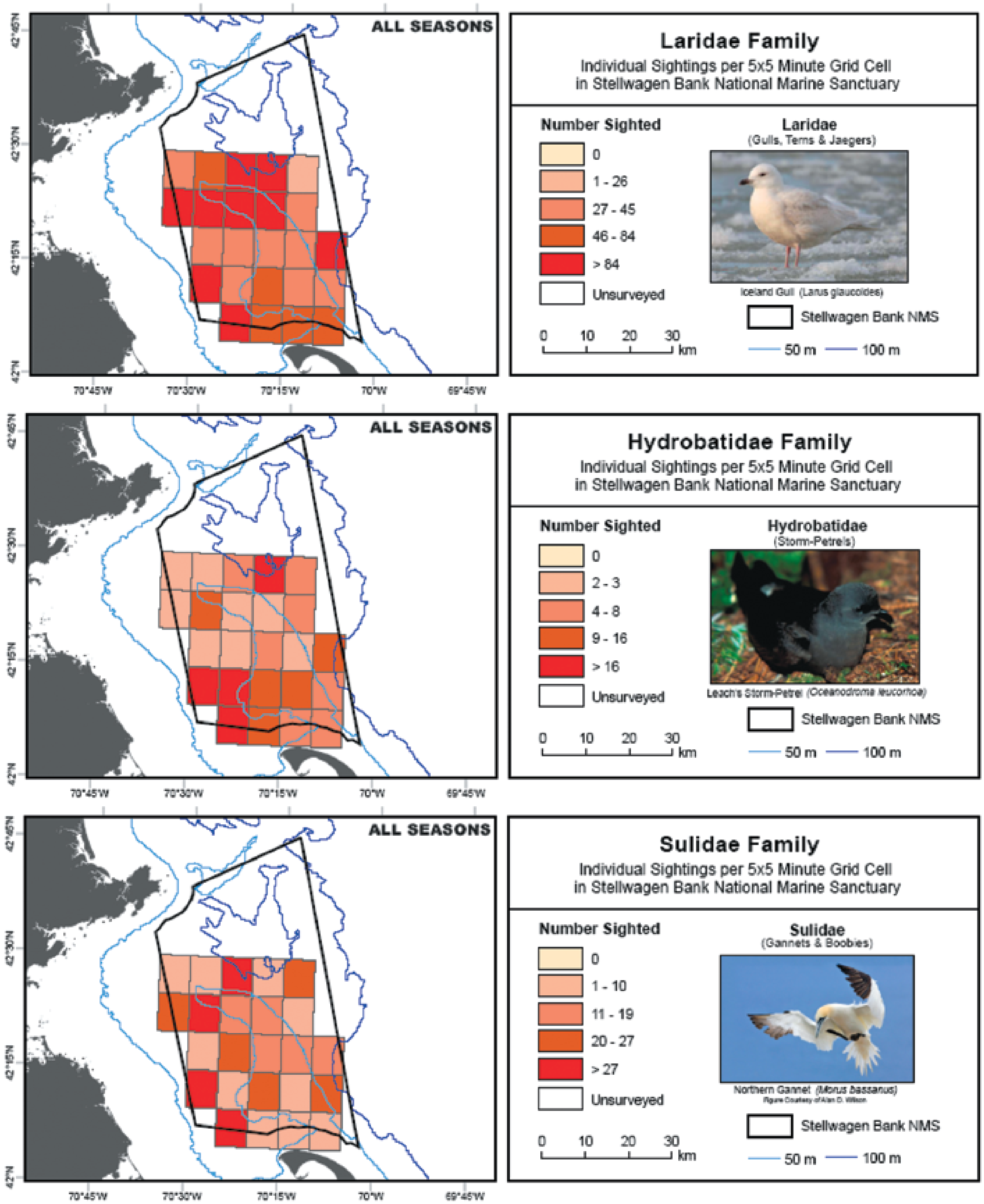
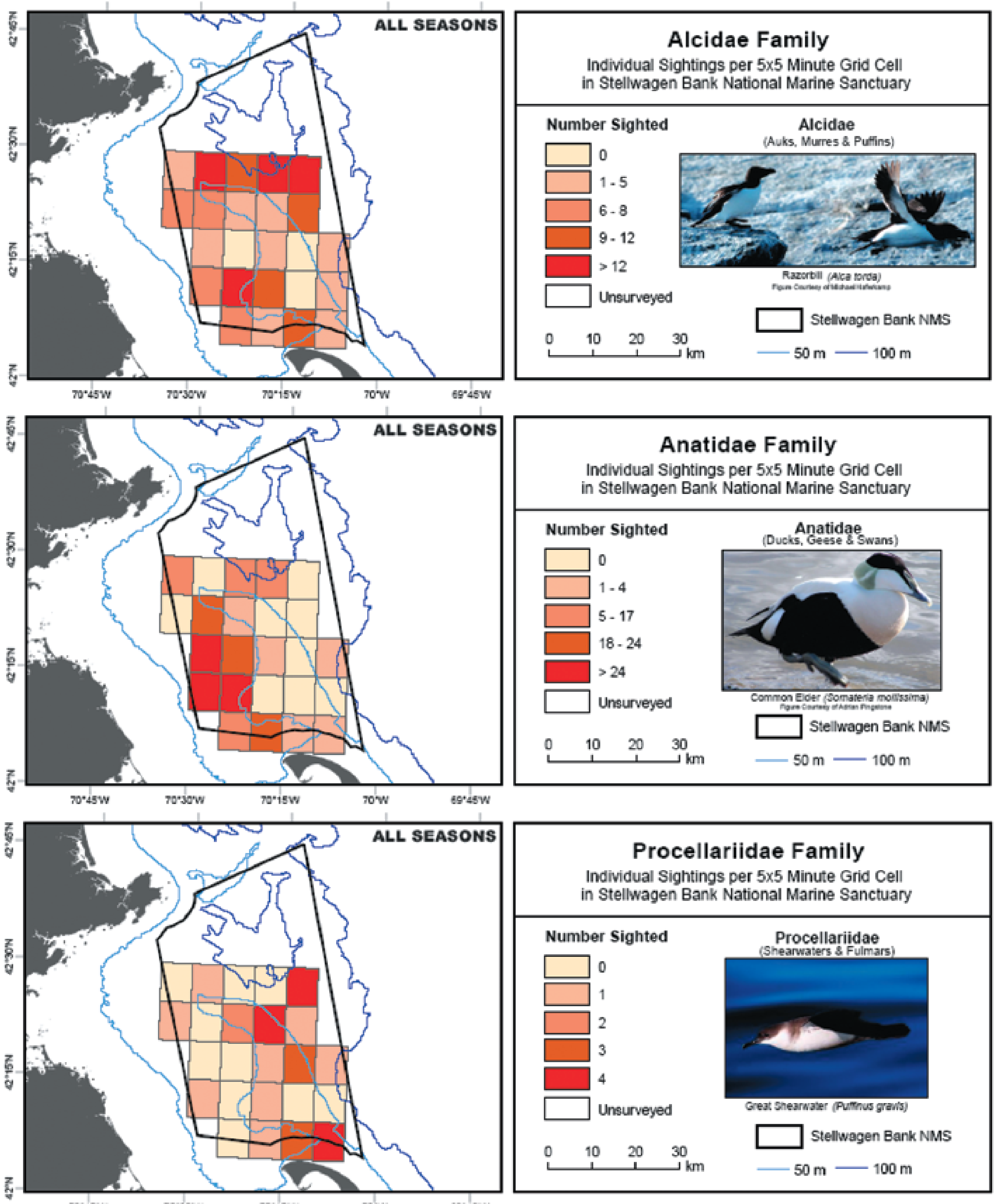


FIGURE 43. PART 2. SPATIAL DISTRIBUTION AND DENSITY OF SEABIRDS IN THE STELLWAGEN BANK SANCTUARY.

Data are individual sightings of species from the standardized survey for the period July 1994–August 1995 grouped by family and aggregated over all seasons. Families included in the figure are: Laridae (gulls, terns and jaegers), Sulidae (gannets and boobies), Hydrobatidae (storm-petrels), Alcidae (auks, murres and puffins), Anatidae (ducks, geese and swans), and Procellaridae (shearwaters and fulmars). Data were analyzed by *ArcView's ArcMap* program.



lower numbers over other seasons. Highest numbers were seen widely over and around Stellwagen Bank and Basin.

The family Alcidae (auks, murres and puffins) was present only during fall and especially winter. Numbers were seen widely over Stellwagen Bank and area in both seasons, but areas of greater concentration occurred in both the northern (especially) and southern portions of the bank in winter.

The family Anatidae (ducks, geese and swans) was principally sighted during summer, fall (especially) and winter. Highest numbers were seen over Stellwagen Basin and the western margin of the bank.

Sightings of species in the remaining four families were relatively rare during this particular 12-month period. The Procellariidae (shearwaters and fulmars) were sighted in spring, summer (notably) and fall; they were not sighted in the winter. This family is customarily well-represented in the sanctuary, which is the case when the entire 14-month sampling period is considered (Table 6) rather than just the 12 months chosen for the seasonal analysis. This variability in sightings is discussed below.

The family Phalacrocacidae (cormorants and shags) was sighted mostly during fall and especially spring; they were not sighted in the winter. The Gaviidae (loons and divers) were sighted in spring, summer and especially fall; they were not seen in winter. The Scolopacidae (sandpipers and phalaropes) were sighted only in summer.

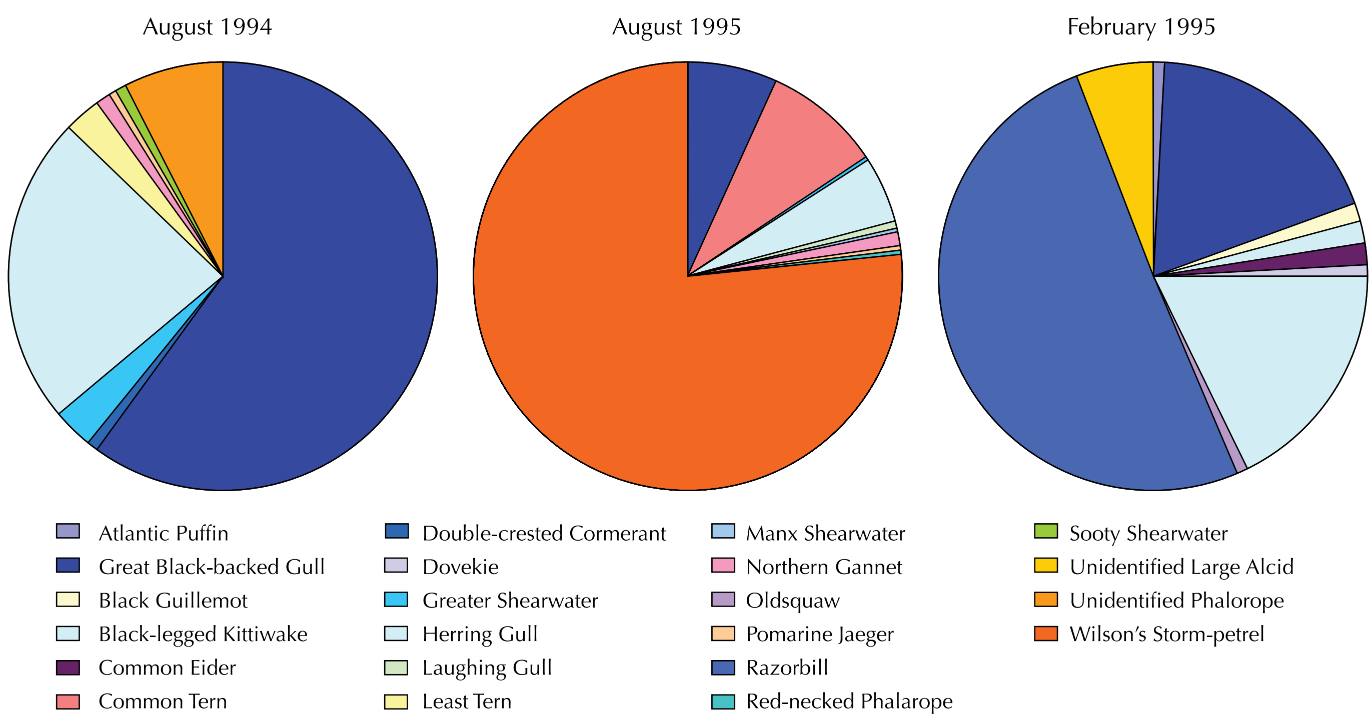
Sources of Variability

Variability in seabird sightings occurs seasonally and inter-annually within the Stellwagen Bank sanctuary. Comparison of the predictive modeling results over 1980-1988 (9-year period) at the scale of the GoM with the standardized survey sightings over 1994–1995 (1-year period) at the scale of the sanctuary demonstrates general agreement in seasonal presence or absence by species for some major groups. For example both analyses indicate that razorbills (auks) use the sanctuary more in winter and storm-petrels in summer.

However, the predictive modeling indicates that northern gannets are widespread in the sanctuary in winter, especially, and summer, whereas the standardized survey sightings made over a shorter time frame indicate that the family Sullidae (gannets and boobies) was most prevalent in fall especially and spring. Anecdotal observations from the sanctuary tend to support the fall-spring pattern as well. As noted above, seabirds are far ranging and environmentally facile; oceanographic climate and late or early seasonal turnover of sanctuary waters and associated productivity changes have the potential to influence seabird abundance patterns within relatively short time frames at the geographic scale of the sanctuary.

Standardized survey sightings in the sanctuary demonstrate that the relative abundance of seabird species can vary as much within the same month (August) between subsequent years (1994 and 1995) as between different months (August and February) in the same year (1995) (Figure 41). Great black-backed gulls accounted for the majority (60.1%) of the seabirds recorded in August 1994, while Wilson's storm-petrels made up the majority (76.7%) of the seabird sightings in August 1995. Likewise, while Wilson' storm-petrels made up 76.7% of the sightings in August (summer) 1995,

Figure 44. Demonstrated high seasonal and inter-annual variability in the relative abundance of seabird species frequenting the Stellwagen Bank sanctuary based on standardized survey sightings data for the period July 1994–August 1995.



The Great Auk

For 17th century European sailors to New England, the great auk (Figure 45) was a common and welcomed sight, indicating proximity to land. But by the middle of the 19th century the species had disappeared completely and forever (Eckert, 1963). While this once plentiful sea bird cannot return to life, the sad story of its extinction lives on as a stark reminder that humans do and have had a significant and sometimes permanent impact on the marine ecosystem of the Stellwagen Bank sanctuary.

The only flightless species of North Atlantic bird, the great auk was a noble animal of great speed and strength in the water. The largest of the alcids, the great auk was bigger than a goose in size and penguin-like in appearance. They were in fact the first birds to be called "penguins" (scientific name: *Pinguinus impennis)*, but their name was changed to great auk after scientists determined that they were not related to the birds of similar appearance in southern latitudes. One of their closest living relatives today is the razorbill which winters in large numbers in the sanctuary.

The great auk was a powerful and graceful swimmer, capable of diving to great depths in search of food. It made an annual migration in vast rafts of individuals swimming along the surface of the sea from summer breeding locations on or near Labrador, Newfoundland and points north and east, to winter feeding grounds on Stellwagen Bank, Georges Bank, and along the New England and Mid-Atlantic states. The birds spent most of their lives in the water—visiting land only to lay one egg per pair each year in massive breeding colonies.

Figure 45. Illustration of the great auk.

Adapted from painting by John J. Audubon titled "*Pinguinus impennis*—Great Auk."

But these terrestrial sojourns proved fatal for the great auk. Heavy bodies, small wings and flightlessness, the very qualities that adapted the great auks so well to their aquatic environment, coupled with the birds' tendency to group together in large numbers, made the animals easy prey for human visitors to the nesting colonies. First hunted for use as fish bait and food (fresh meat and eggs and salted meat for long voyages), the great auk later became economically popular for its oil and its feathers for fashion and for mattresses. The final chapter of its existence was closed by collectors searching for specimens for public and private museums, but the species was doomed by the time of the inauguration of President George Washington.

For generations, sailors and fishermen decimated the flocks, thinking that there would always be more. Even in the waning hours of the great auk's existence, scientists claimed there had to be additional stocks in the more northerly areas. We know now that they were very wrong. The naming of the sanctuary's research vessel in honor of this icon to local extinction is a constant reminder that the public must be ever-vigilant in protecting the resources of the Stellwagen Bank sanctuary.

razorbills made up 50.7% of the seabirds recorded in February (winter) that same year.

The combined use of predictive modeling and standardized surveys allows for the start of a comprehensive assessment and understanding of the seabird communities in the sanctuary. Results to-date indicate that while it is certain that a characteristic set of seabird species routinely use the sanctuary, and while there are demonstrated spatial patterns of seasonal use among the major groups, relative abundance among these species varies greatly and seasonal and interannual variability is high.

Pressures

Historically, the main threats to seabirds have been coastal development, predation by humans and other animals, removal of prey through fisheries activity and pollution of the marine environment. Drury (1973, 1974) describes the extensive harvesting of seabirds for food and feather in New England that resulted in extirpation of many seabird species even from remote outer islands by the turn of the 20th century. Great auks (*Pinguinus impennis*) were once frequently sighted in the GoM where some populations over-wintered, but were hunted to extinction by 1844. Great auk bones have been found in Massachusetts (Martha's Vineyard, East Wareham, Marblehead, Eagle Hill and Plum Island) and at least ten islands along the Maine coast (Burness and Montevecchi, 1992). Refer to the Sidebar for more information about the great auk.

Interactions between fisheries and seabirds have been well documented in many regions worldwide, with both increases and declines of seabird populations linked to patterns of fishing activity (Tasker *et al.*, 2000; Tasker and Furness, 2003; Votier *et al.*, 2004). Intense fishing activity can impact seabird populations through reduction of prey abundance and perturbation of prey population and community structure (Pauly *et al.*, 1998; Tasker *et al.*, 2000). Food web changes related to heavy fishing over many years have been found to adversely affect seabirds in the GoM (Lotze and Milewski, 2004). In addition, mortality related to entanglement with fishing gear has been reported.

Based on NOAA Fisheries Service fishery observer data for 1994–2003, entanglement currently is not considered a major source of seabird mortality in the GoM or the sanctuary (Soczek, 2006). While occurring at a low rate, this study found that 88.6% of the overall observed seabird bycatch in the New England area was in the gillnet fishery, and shearwaters, particularly the greater shearwater, comprised 78.6% of all identified seabirds. This species is not currently classified as globally endangered or threatened (BirdLife International, 2004), but the potential for declines in the population have prompted its inclusion in the "Moderately Abundant Species with Declines or High Threats" category of the American Bird Conservancy's Green List (American Bird Conservancy, 2004) and in the "High Concern" category in the North American Waterbird Conservation Plan (Kushlan *et al*., 2002).

Possibly the greatest threat for many seabirds (particularly terns and auks) in the GoM is from other seabirds, primarily gulls (Drury, 1965). Increases in fishery discards (offal and bycatch) and the spread of open landfills during the mid-1900s led to increased herring gull and great black-backed gull populations. This in turn led to greater pressure on other seabirds, particularly terns, through competition for prime nesting sites and increased predation by gulls on their eggs and chicks (Anderson and Devlin, 1999; Drury, 1965; Platt *et al*., 1995).

Industrial contaminants are also a potential threat to seabird populations (Burger and Gochfeld, 2002). Elevated PCBs have been found in roseate tern chicks at Bird Island (Massachusetts) (Nisbet, 1981) and a wide range of metals has been found in common terns at breeding colonies in Massachusetts (Bureger *et al*, 1994). The impact of pollutants on seabirds, including sub-lethal effects, has not been adequately assessed for the GoM.

Analyses of changes in seabird populations in the Bay of Fundy (northern GoM) since European colonization have shown that approximately 50% of marine and coastal bird species have been severely affected by human activity with several species extirpated and major colonies abandoned (Lotze and Milewski, 2004). With the exception of the great auk, re-colonization of abandoned breeding colonies has taken place for most species, albeit relatively slowly with estimated recolonization time considered to take as long as 45 years for the common murre and 133 years for the northern gannet (Lotze and Milewski, 2002).

Current Protection

Sanctuary regulations (15 C.F.R § Subpart N) prohibit the taking of any seabird in or above the sanctuary, except as permitted by the Migratory Bird Treaty Act, as amended, (MBTA), 16 U.S.C. 703 et seq. or possessing within the sanctuary (regardless of where taken, moved or removed from), except as necessary for valid law enforcement purposes, any seabird taken in violation of the MBTA.

In addition where applicable, the MBTA, which implements conventions with Great Britain, Mexico, Russia and Japan, makes it unlawful except as permitted by regulations "to pursue, hunt, take, capture, kill… any migratory bird, any part, nest or egg" or any product of any such bird protected by the Convention (16 U.S.C 703).

Sea Turtles

Status

General Knowledge

Sea turtles are long-lived species that mature late in life and move great distances during their lifetimes, migrating hundreds or even thousands of kilometers between foraging and nesting grounds. They spend their lives at sea but return to land to reproduce.

Sea turtles are generally solitary creatures that remain submerged for much of the time they are at sea, which makes them extremely difficult to study. They rarely interact with one another outside of courtship and mating. Adult females nest in multiyear cycles, usually 2–4 years. They come ashore several times to lay hundreds of eggs during a nesting season in tropical waters. After about 50 to 60 days of incubation, the hatchlings emerge and head for the open ocean to begin life as pelagic drifters. This period is often referred to as the "lost years." In most cases, it is not known where the hatchlings go or how long this period lasts. While maturing over the course of several decades, sea turtles move in and out of a variety of ocean and coastal habitats. This open ocean existence often frustrates efforts to study and conserve them. Juvenile survival to adulthood is low.

Sea turtles serve important functions in the ecosystems in which they are found. For example, seagrass beds where green turtles graze regularly are more productive, nutrients are cycled more rapidly and the grass blades have higher protein content, thus benefiting other species. Some populations of sea turtles, whose feeding areas may be hundreds or even thousands of kilometers from their nesting beaches, serve an important role in nutrient cycling by transporting massive quantities of nutrients from the nutrient-rich feeding grounds (in colder waters of the North Atlantic) to typically more nutrient-poor coastal and inshore habitats in the vicinity of the nesting beaches (in tropical waters).

Table 7. Conservation status of sea turtles found in the Stellwagen Bank sanctuary and GoM region.

Common Name	Scientific Name	ESA Status
Kemp's Ridley	*Lepidochelys kempi*	Endangered
Leatherback	*Dermochelys coriacea*	Endangered
Loggerhead	*Caretta caretta*	Threatened
Green	*Chelonia mydas*	Endangered

Occurrence in the Sanctuary

Seven species of sea turtles occur worldwide, four of which have been recorded in GoM: Kemp's ridley, leatherback, loggerhead and green. Only the leatherback and Kemp's ridley are seen with any regularity in the GoM. Leatherbacks and loggerheads have been the species most commonly reported in the sanctuary. Two families of sea turtles are represented in the sanctuary: the Dermochelyidae is represented solely by the unique *Dermochelys coriacea* (leatherback), which lacks the hard shell that characterizes the other sea turtles that make-up the family Cheloniidae. Three of the species recorded in the GoM are listed as endangered, and the fourth as threatened, under the ESA (Table 7).

Leatherback turtles have been sighted in the vicinity of the sanctuary in the spring and summer, and strandings have occurred in Cape Cod Bay spring, summer and fall. The predicted seasonality of leatherbacks is in the summer only. Loggerhead turtles have been sighted around the sanctuary in summer and strandings in Cape Cod Bay have occurred year-round. The predicted seasonality of loggerheads around the sanctuary is in the summer only. There have been no sightings of Kemp's ridley turtles around the sanctuary, though they have stranded in Cape Cod Bay winter, spring and fall. This species is not predicted to occur around the sanctuary throughout the year (Department of Navy, 2005; Shoop and Kenney, 1991). For additional information regarding sea turtle species accounts, visit URL http://www.iucn-mtsg.org/species/

Pressures

Sea turtles are transient visitors to the Stellwagen Bank sanctuary and there is very little documentation of human impacts to turtles in the vicinity of the sanctuary. In general, major threats to sea turtles in the U.S. include, but are not limited to: destruction and alteration of foraging habitats, incidental capture in commercial and recreational fisheries, entanglement in marine debris and vessel strikes. The NOAA Fisheries Service Observer Program documents fishing impacts to protected species and is the primary source for such information. NOAA Fisheries Service has not recorded any sea turtles taken in gillnets or otter trawls fished within the sanctuary since 1994 (NOAA Fisheries Service, unpublished data).

Sea turtles die from eating or becoming entangled in non-degradable debris each year, including packing bands, balloons, pellets and plastic bags thrown overboard from boats or dumped near beaches and swept out to sea. Leatherbacks especially, cannot distinguish between floating jellyfish—a main component of their diet—and floating plastic bags.

Turtles are affected to an unknown, but potentially significant degree, by entanglement in persistent marine debris, including discarded or lost fishing gear including steel and monofilament line, synthetic and natural rope, and discarded plastic netting materials. Monofilament line is the principal source of entanglement for sea turtles in U.S. waters.

To effectively address all threats to marine turtles, NOAA Fisheries Service and the USFWS have developed recovery plans to direct research and management efforts for each sea turtle species. More information on threats to marine turtles is available at: http://www.nmfs.noaa.gov/pr/species/turtles/.

Current Protection

Sanctuary regulations (15 C.F.R § Subpart N) prohibit the taking of any marine reptile in the sanctuary, except as permitted by the ESA, as amended, 16 U.S.C. 1531 et seq., or possessing within the sanctuary (regardless of where taken, moved or removed from), except as necessary for valid law enforcement purposes, any marine reptile taken in violation of the ESA.

Sea turtles are given legal protection in the U.S. and its waters under the ESA, which lists the leatherback, Kemp's ridley and green turtle as endangered; the loggerhead is listed as threatened. This designation makes it illegal to harm, harass or kill any sea turtles, hatchlings or their eggs. It is also illegal to import, sell, or transport turtles or their products. NOAA Fisheries Service has jurisdiction over sea turtles in the water; USFWS has jurisdiction over sea turtles when they are on land.

Presently, all sea turtle species are listed in the International Union for the Conservation of Nature (IUCN) and Natural Resources Red List as endangered or vulnerable; included in Appendix I of the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora; and, all species are listed in Appendices I and II of the Convention on the Conservation of Migratory (CMS) Species of Wild Animals.

Marine Mammals

Marine mammals are a functional part of the biodiversity of the Stellwagen Bank sanctuary in a number of important ways, including their interdependence on seafloor and water column habitats and their predator-prey relationship to key forage species. They are a highly visible component of the species mix, which merits special consideration because of their charismatic attraction and universally protected or endangered status. They also are highly attuned to the acoustic environment and might be especially prone to harassment and behavioral disturbance due to human activity.

The major issues associated with marine mammals in the sanctuary are distinctly different from the issues otherwise associated with biodiversity conservation, such as biomass removal, changes in food webs and community composition, and disturbance or degradation of seafloor habitats and landscapes. Instead, marine mammal issues include entanglement in commercial fishing gear, vessel strikes from shipping, ocean noise, localized prey depletion, and marine pollution and contamination. However, the interactions with fishing and shipping are the key mortality factors for marine mammals (NOAA, 2007).

Of special note, the data set for humpback whales in the Stellwagen Bank sanctuary is the longest and most detailed study of baleen whales in the world. Matrilineal studies show evidence of four generations (1975–2006) of humpback use of, as well as inter-generational site fidelity to, the sanctuary as a feeding and nursery area. The newly-established sister sanctuary relationship between the Stellwagen Bank sanctuary and the Sanctuario de Mamiferos Marinos de la Republica Dominicana (Dominican Republic humpback whale sanctuary) is the first conservation management action worldwide to protect a migratory marine mammal species on both ends of its range (between sanctuary feeding/nursery grounds and the largest mating/calving grounds for humpback whales in the North Atlantic) by functionally linking two important nationally acclaimed marine protected areas.

Status

Cetaceans and Pinnipeds

The marine mammal fauna of the Stellwagen Bank sanctuary is diverse and has significant ecological, aesthetic and economic value. At least 22 species of marine mammals are known to occur in the waters over and around the sanctuary—six species of baleen whales (Mysticeti), eleven species of toothed whales (Odontoceti), and five species of phocid seals (Pinnipedia) (Table 8). For many of these species, the biological productivity of sanctuary waters provides primary habitat for feeding and other critical activities such as nursing. In fact, the sanctuary is one of the most intensively used cetacean habitats in the northeast continental shelf region of the United States (Kenney and Win, 1986).

Both cetaceans and pinnipeds are subject to a variety of human-related pressures, ranging from the visible impacts of human activities (e.g., vessel strikes, entanglements in fishing gear) to ubiquitous threats such as pollution, boat traffic, and noise. In some instances, the impacts may be difficult to assess but may be particularly significant, especially for marine mammals that live in coastal areas or an environment that brings them into close contact with human activities.

Cetaceans

Cetaceans are divided between two suborders: the Mysticetes (baleen whales) and the Odontocetes (toothed whales). Representatives of both suborders are found in the sanctuary and throughout the GoM. Two morphological features distinguish cetaceans: mysticetes have baleen and two blowholes, and odontocetes have teeth and a single blowhole.

Baleen Whales

Baleen whales in the sanctuary range in maximum length from 6.4 m (26 ft.) for the minke whale to 30 m (100 ft.) for the blue whale. They have evolved baleen, instead of teeth, to feed upon zooplankton and small schooling fish. The plates of baleen form an efficient filtration system that separate prey from vast volumes of water taken into the mouth. Baleen whales typically forage throughout the water column, preying on species (such as sand lance, herring and copepods in the sanctuary) that are found from the surface to several hundred feet down. Humpback whales also are known to feed along the ocean bottom, scouring sand and gravel seafloor habitats that shelter sand lance; other species might also engage in similar behavior.

Within the sanctuary, the mysticetes are represented by six species arranged into two families, the Balaenopteridae (rorqual whales) and the Balaenidae (right whales) (Table 8). The Baleanopteridae are characterized by their sleek body form, generally, and the “rorqual” pleats on the underside of the mouth. This family includes the blue, fin, sei, minke and humpback whale, with the latter being alone in its own genus. The rorquals are ‘gulpers,’ feeding in discrete events, taking prey a mouthful at a time.

Group	Common Name	Scientific Name	MMPA Status	ESA Status
Baleen Whales (Mysticetes n=6)	Blue whale	*Balaenoptera musculus*	Protected under the MMPA	Endangered
	Fin or Finback whale	*Balaeneptera physalus*		Endangered
	Humpback whale	*Megaptera novaeangliue*		Endangered
	Sei whale	*Balaenoptera borealis*		Endangered
	Minke whale	*Balaenoptera acutorostrata*		
	North Atlantic right whale	*Eubalaena glacialis*		Endangered
Toothed Whales (Odontocetes n=11)	Sperm whale	*Physeter macrocephalus*	Protected under the MMPA	Endangered
	Long-finned Pilot whale	*Globicephala melaena*		
	Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*		
	White-Beaked Dolphin	*Lagenorhynchus albirostris*		
	Harbor Porpoise	*Phocoena sp.*		
	Bottlenose Dolphin	*Tursiops truncatus*		
	Common Dolphin	*Delphinus delphis*		
	Striped Dolphin	*Stenella coeruleoalba*		
	Grampus (Risso's) Dolphin	*Grampus griseus*		
	Killer whale or Orca	*Orcinus orca*		
	Beluga	*Delphinus leucas*		
Seals (Pinnipeds n=5)	Harbor Seal	*Phoca vitulina*	Protected under the MMPA	
	Gray Seal	*Halichoerus grypes*		
	Harp Seal	*Pagophilus groenlandica*		
	Hooded Seal	*Cystophora cristata*		
	Ringed Seal	*Pusa hispida*		

Table 8. Conservation status of 22 species of marine mammals sighted in the Stellwagen Bank sanctuary.

The Balaenidae includes the North Atlantic right whale, characterized by its robust body with no dorsal fin, no ventral pleats and very long, narrow baleen. The right whales are "skimmers," grazing through patches of zoolplankton with their mouths open and continuously filtering prey as they swim. This skimming can be done at the sea surface, along the density gradient of mid-depth thermoclines or over the seafloor.

Besides the unique filtering system for feeding, most baleen whales share a number of broad characteristics in common. Most have wide geographic ranges and extensive migrations. They lack any known capability for sonar or echolocation. They often have a mating system in which both males and females are promiscuous. Often, they exhibit a relatively short period (less than one year) of maternal care with no strong kinship bonds aside from a mother and her new calf. They have large bodies requiring massive quantities of small prey. Despite these commonalties, the baleen whales of the sanctuary exhibit many differences. For more information, see species descriptions in Appendix L.

Toothed Whales

Toothed whales observed in the sanctuary are represented by four families: Delphinidae (dolphins), Phocoenidae (porpoises), the Physeteridae (sperm whales) and Monodontidae (beluga whale). Of the eleven odontocete species that have been sighted in the sanctuary, common visitors include the white-sided dolphin, long-finned pilot whale and harbor porpoise (Table 8). From giants like the sperm whale to the diminutive harbor porpoise, sightings of odontocete species vary from year to year and may demonstrate cyclical or extralimital occurrences in the vicinity of the sanctuary.

As a rule, the odontocete diet consists of larger prey than that taken by the baleen whales. Unlike baleen whales, which often engulf large prey patches and ingest thousands or even millions of organisms at once, toothed whales usually feed by taking one item (such as a single fish) at a time. They often swallow their prey whole, and their teeth function to grip rather than to chew.

Unlike the baleen whales, the odontocetes usually do not make long annual migrations. Their seasonal responses tend to be onshore-offshore movements. Toothed whales are highly social animals, moving around in groups called pods. Different species and different populations within a species may vary in how these pods are organized. Some pods may be stable relationships between individuals over long periods of time; other pods may represent seasonal associations surrounding feeding or reproduction. For more information, see species descriptions in Appendix L.

Pinnipeds

True seals, or phocids, comprise one of three major families of pinnipeds (i.e., seals, sea lions and walrus). The term "pinniped" means "wing- or fin-footed" and refers to the family's modified front and hind appendages, which have a fin-like appearance. Members of the family Phocidae, called true or earless seals because they lack external ear flaps, are represented by five species in the sanctuary (Table 8). Of the five seal species found with any frequency in the Stellwagen Bank sanctuary, two (harp, hooded) are found only sporadically. The ringed seal is rare while gray and harbor seals can be found year-round, albeit generally in single sightings. Each species uses the sanctuary and nearby coast in different ways, but they do share many characteristics. Like toothed whales, pinnipeds have a broad diet including a wide variety of fishes, squid and other prey. For more information, see species descriptions in Appendix L.

Cetacean Habitat

The southern GoM, particularly the area of the Great South Channel, Stellwagen Bank and Jeffreys Ledge, supports the highest densities of baleen whales on the northeast U.S. continental shelf (Kenny and Winn, 1986). Additionally, critical habitat designation was established for the North Atlantic right whale in 1994 inclusive of the southwestern portion of the Stellwagen Bank sanctuary and Cape Cod Bay. The GoM (which includes sanctuary waters) is recognized as one of five geographically distinct feeding grounds for aggregations of endangered humpback whales in the western North Atlantic (Katona and Beard, 1990).

Cetaceans are capable of traveling large distances relatively rapidly, but also show distinctive site fidelity to specific feeding grounds and calving areas. Humpback, fin and right whales exhibit strong maternal fidelity to specific feeding grounds in the southern GoM (Clapham and Seipt, 1991). Weinrich found that individual humpback whales which visit Stellwagen Bank and Jeffreys Ledge as calves are more likely to return in subsequent years (Weinrich, 1998).

Hotspot for Prey Abundance

Sand lance are common in the GoM and prefer shallow areas of sandy bottom or fine gravel (such as Stellwagen Bank) for burrowing and spawning (Robards *et al.*, 1999). Herring use the seafloor for spawning (Stevenson and Scott, 2005). Sand lance and herring represent a vital link in the area's ecology, serving as a major food source for a variety of piscivorous species including invertebrates, many other fishes, numerous seabirds and a dozen species of marine mammals (Robards *et al.*, 1999; Stevenson and Scott, 2005). Within the Stellwagen Bank sanctuary, sand lance is a noted food source for humpback whales (Hain *et al.*, 1995; Overholtz and Nicolas, 1979; Baraff *et al* 1991; Weinrich *et al.*, 1997; Weinrich *et al.*, 2000).

Sand lance occur within the Stellwagen Bank sanctuary at higher levels of abundance than in any other area of the southern GoM (Figure 46). The figure also depicts the higher herring abundance that occurs in waters from just north of Cape Ann south to Cape Cod Bay, including the sanctuary, relative to other parts of the southern GoM. Sand lance distribution shows close association with sand and gravelly sand habitats, while herring distribution does not (Figure 46).

The distribution and abundance of North Atlantic right whales are closely linked to the life history and spatial distribution of its main prey, the calanoid copepod *Calanus finmarchiscus*. *Calanus* early life stages coincide with the spring phytoplankton blooms on which they feed, particularly in Massachusetts and Cape Cod Bays, in waters overlapping or adjacent to the Stellwagen Bank sanctuary. This species of copepod also is prey for the sand lance, which in turn is important as prey for piscivorous baleen whales, as noted above.

Comparison of the spatial patterns of North Atlantic right whale abundance and *Calanus* abundance (all life stages combined) for both the spring and summer season shows a clear geographic shift in whale abundance that broadly tracks *Calanus* abundance hotspots (Figure 47). In spring (lower panel), these hotspots were located along the northern slope of Georges Bank, the Great South Channel, Cape Cod Bay and the western portion of the Stellwagen Bank sanctuary. In summer (upper panel), *Calanus* hotspots shifted offshore towards the central, southern GoM.

The margins of Stellwagen Bank are sites of high horizontal and vertical movement of both water and plankton due largely to the bank's exposure to GoM water circulation (Flagg, 1987). The interaction between physical oceanography and bathymetry creates environmental conditions that result in the aggregations of large numbers of planktivorous fishes, such as sand lance and Atlantic herring, which are key prey for humpback, fin and minke whales, as well as dolphins and porpoises. These same environmental conditions support an abundance of *Calanus* which are the primary prey of right whales. These environmental variables interact to establish the sanctuary as a hotspot for prey abundance.

Predictors of Cetacean Relative Abundance

Predictive modeling to explain patterns of cetacean relative abundance, based on sightings-per-unit-effort (SPUE) and on environmental data including bathymetry, substratum type, potential prey and oceanography, was used to explain spatial patterns of cetacean densities in the southern GoM for the period 1997–2005 (Pittman *et al.*, 2006). Analysis of the SPUE data was based on 34,589 cetacean observations. Model results were reported for spring and summer, which were least variable because the modeling techniques performed best for seasons with the highest cetacean abundance.

Prey availability or habitat indicators of prey availability were important predictors of distribution and density for important cetacean species which frequent the sanctuary. Sand lance abundance was a contributing factor in every case. Significant predictors of abundance for humpback, fin and minke whales in all cases included proximity to the 100 m isobath, sand and gravely sand, and mean (average) sand lance abundance. The 100 m isobath is the general lower depth limit of sand lance distribution and sand and gravely sand is preferred habitat for sand lance (Meyer *et al.*, 1979). Zooplankton abundance (all species combined) and abundance of the calanoid copepod *Calanus finmarchiscus,* were among the most significant predictors for the North

Figure 46. Spatial distribution and density of key prey species for piscivorous cetaceans in the Stellwagen Bank sanctuary and the southern GoM.

Sand lance abundance is indicated in the top panel; herring abundance is indicated in the bottom panel. The spatial extent of sand and gravelly sand habitats is denoted in both panels. Data are from the NMFS Northeast Fisheries Science Center research trawl surveys for the period 1975-2000. Figure excerpted from Pittman *et al.*, 2006.

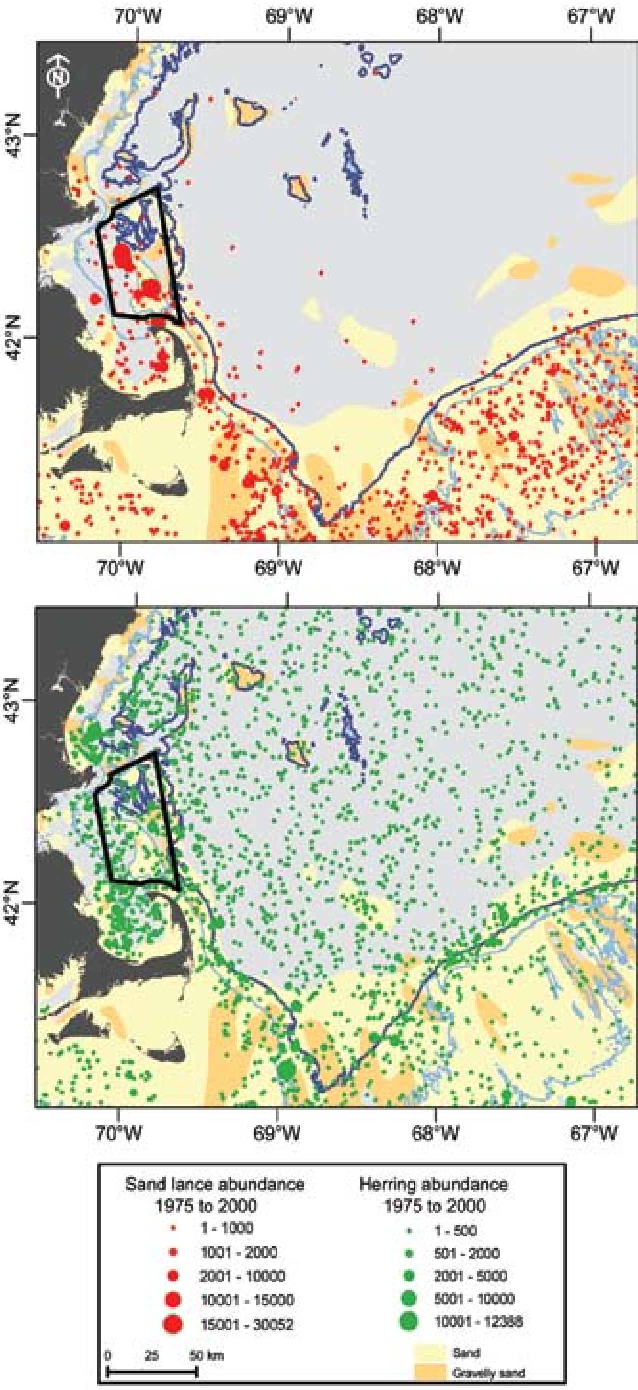
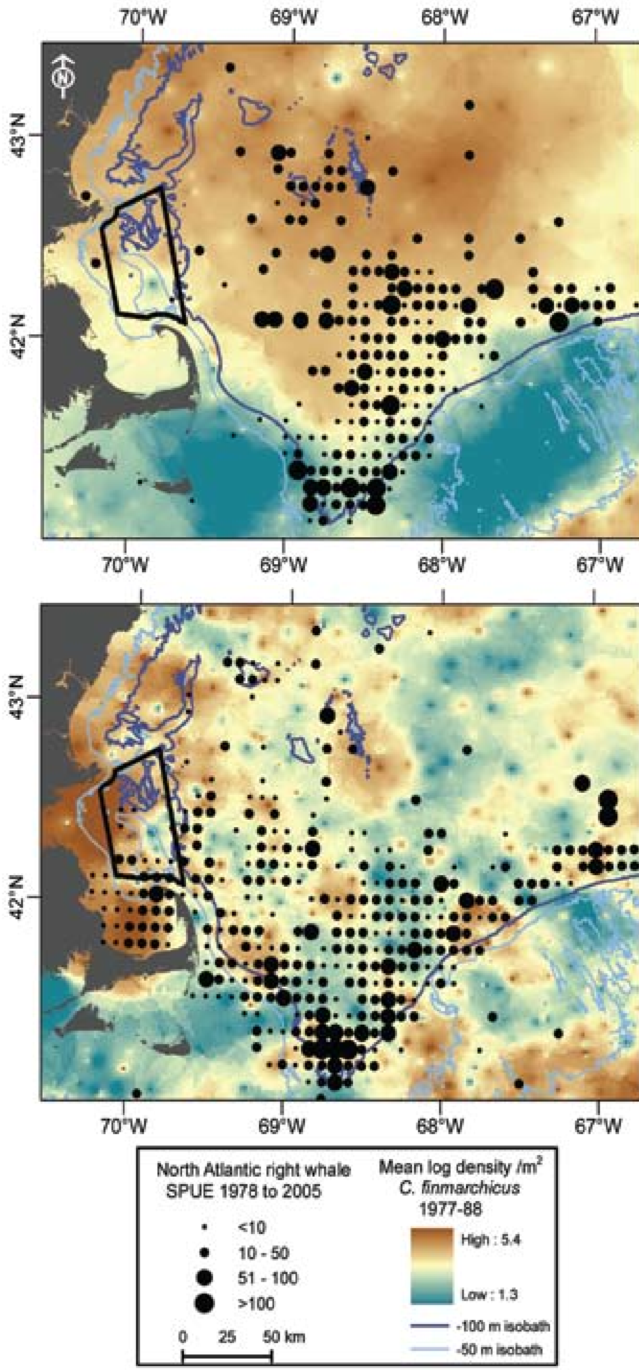


Figure 47. Overlay of spatial distribution of North Atlantic right whale relative abundance (sightings-per-unit effort: SPUE) on spatial distribution of *Calanus* copepods for the Stellwagen Bank sanctuary and the southern GoM.

Circles represent right whale SPUE; color shading represents density of copepods. Lower panel indicates spring season conditions; upper panel indicates summer season conditions. North Atlantic right whale SPUE data are for 1978-2005; copepod data are for 1977-1988. Figure excerpted from Pittman *et al.*, 2006.



Atlantic right whale abundance. Other significant predictors of right whale abundance included sand and gravely sand, and mean sand lance abundance. The combined abundance of sand lance, hake, mackerel and herring were among the significant predictors for Atlantic white-sided dolphin abundance.

Results of the predictive modeling also found that the 100 m isobath was a hotspot for herring, suggesting that humpback and fin whales may switch prey depending on local availability. Prey switching by these species has been noted between seasons (Macleod *et al*., 2004) and inter-annually (Payne *et al*., 1986; Weinrich *et al*., 1997). In winter, there was a shift in the SPUE for humpback and fin whales from Stellwagen Bank to deeper waters over Tillies Basin and Jeffreys Ledge, both areas in or overlapping with the sanctuary and associated with abundant herring (Pittman *et al*., 2006). This winter shift may result from decreased availability of sand lance prior to their spawning and decreased accessibility because sand lance spend more time buried in the sand during winter. A geographically similar but longer term shift from Stellwagen Bank to Jeffreys Ledge, and switch from sand lance to herring prey, was reported for humpback whales between 1988 and 1994 (Weinrich *et al*., 1997).

Cetacean Occurrence

Southern Gulf of Maine

Using the SPUE database for 1997-2005, Pittman *et al*. (2006) calculated the occurrence and relative abundance of cetaceans within the southern GoM. Among baleen whales, the Stellwagen Bank sanctuary was used most heavily by humpback and fin whales and to a lesser degree by minke whales, all of which are piscivorous and feed on sand lance and herring in the sanctuary (Figure 48a). North Atlantic right whales and sei whales, both of which feed primarily on plankton, also used the sanctuary although occurrence was higher for right whales (Figure 48b). The occurrence of toothed whales in the sanctuary was highest among Atlantic white-sided dolphins, but included pilot whales as well (Figure 48b).

A comparison of the spatial distribution patterns for all baleen whales and all dolphins and porpoises in the southern GoM showed that both groups have very similar spatial patterns of high- and low-use areas (Figures 49 and 50). The baleen whales, whether piscivorous or planktivorous, were more concentrated than the dolphins and porpoise. They utilized a corridor that extended broadly along the steeply sloping edges in the southern GoM, indicated broadly by the 100 m isobath. The Stellwagen Bank sanctuary supported a high abundance of cetaceans throughout the year. The waters on and around the sanctuary also support high cetacean richness (number of species) (Pittman *et al*., 2006).

Stellwagen Bank Sanctuary

Direct knowledge of the relative occurrence and spatial/temporal distribution of cetaceans in the Stellwagen Bank sanctuary was derived from two sources: non-standardized data collected aboard whale watching vessels and standardized surveys conducted by the sanctuary. Whale watch sightings data were provided by the Provincetown Center for Coastal Studies and the Whale Center of New England. Whale watching trips targeted high use areas where companies expected to see the largest number of whales, particularly humpbacks. The database is robust in that it consists of multiple daily trips occurring from April through October, has been continuous over 25 years (1979–2004), and consists of over 255,000 sightings of animals. However, effort is not equally distributed throughout the sanctuary.

Standardized surveys of the entire sanctuary for a 12-month period were conducted from July 2001–June 2002 (Wiley *et al*., 2003). This survey provided equal effort in all parts of the sanctuary, but was of a limited time span (one year) and sample size (528 sightings of 2,124 animals). Use of both databases provides a richer understanding of the relative occurrence and spatial/temporal distribution of cetaceans in the sanctuary. Relative use of the sanctuary by species and seasonal trends were based only on the 12-month standardized survey data.

Among baleen whales, the Stellwagen Bank sanctuary was used most heavily by humpback whales, followed by minke, fin and right whales (Figure 51). Among humpback whales, Robbins (2007) determined that the sanctuary is preferentially used by juveniles (nursing) and reproductively mature/active (pregnant and lactating) females. The occurrence of toothed whales in the sanctuary was highest for white-sided dolphins, followed by harbor porpoise and pilot whales (Figure 52). In general, the sanctuary was dominated by baleen whales during the summer period and toothed whales during the winter (Figure 53).

A comparison of both databases revealed similar patterns of spatial distribution and density (Figure 54). Baleen whales in particular tended to cluster on the northwest and southwest portions of Stellwagen Bank with a secondary cluster on the southeast section of the Bank. A three-dimensional visualization of the spatial distribution of these whales over 25 years further illustrates this finding (Figure 55). A common feature of each of these areas of high use is a substrate dominated by sand and gravelly sand, seafloor habitat types which support concentrations of sand lance. Standardized survey data revealed an additional high use area on the southern portion of Jeffreys Ledge (Figure 54).

Humpback Whale Foraging Behavior

The Stellwagen Bank sanctuary is leading a multi-institutional tagging project investigating the underwater foraging behavior of humpback whales to understand how they use habitat and interact with fishing gear and shipping. Tagged whales carry a computerized package developed at the Woods Hole Oceanographic Institution (WHOI) that continuously records pitch, role, heading and depth (Johnson and Tyack, 2003). Tag-derived data are mapped in four dimensions using GeoZui4D software, allowing scientists to create virtual whales that move like the tagged animals. GeoZui4D is a software application developed at the University of New Hampshire (UNH) for interacting with time-varying geospa-

Figure 48a. Spatial distribution and relative abundance of key cetacean species in the Stellwagen Bank sanctuary and the southern GoM based on interpolation of SPUE for the period 1970–2005.

Data are aggregated for all seasons. Species depicted include the humpback whale, fin whale, minke whale, North Atlantic right whale, sei whale, Atlantic white-sided dolphin and pilot whale. Figure adapted from Pittman *et al*., 2006.

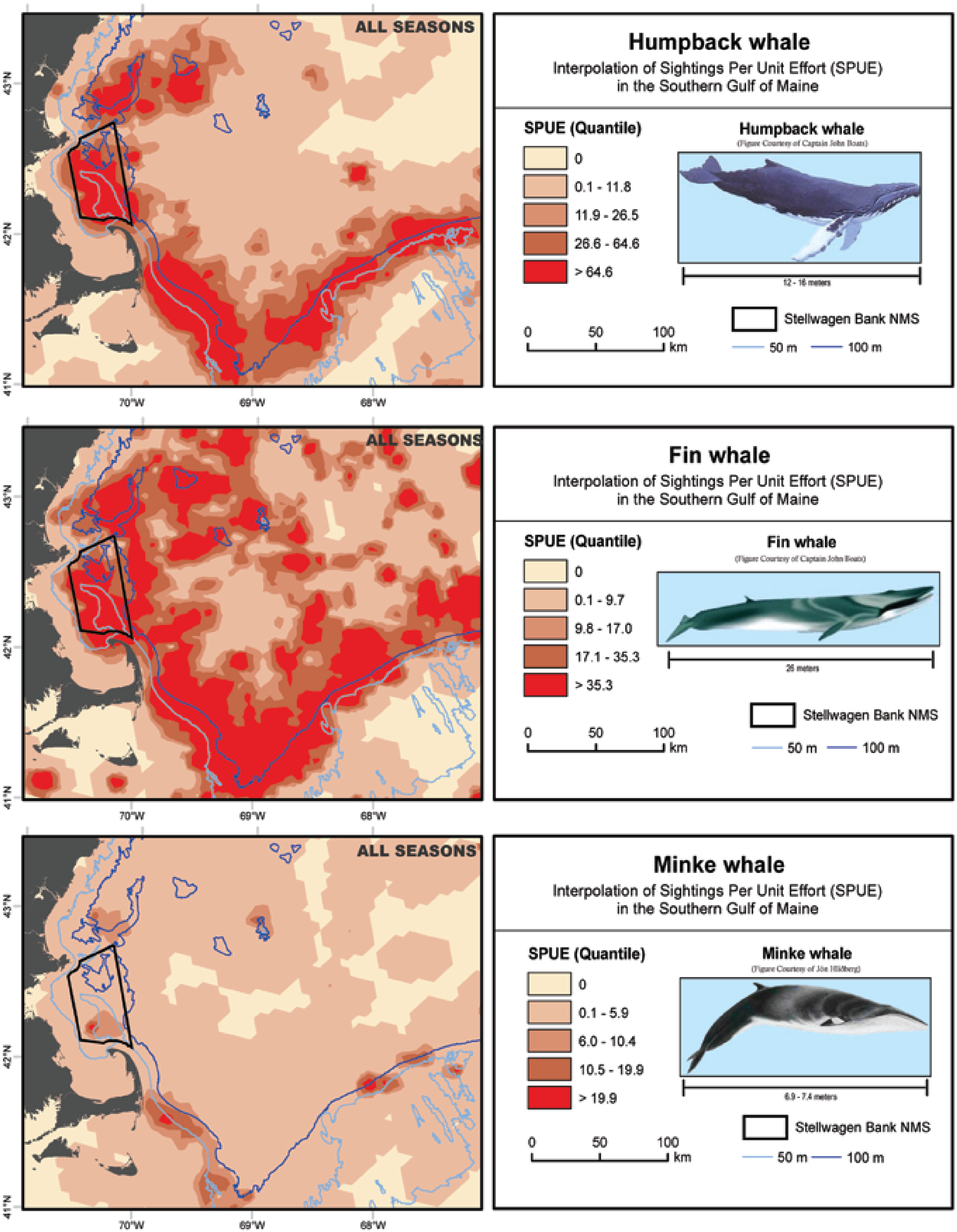


Figure 48b. Spatial distribution and relative abundance of key cetacean species in the Stellwagen Bank sanctuary and the southern GoM based on interpolation of SPUE for the period 1970–2005.

Data are aggregated for all seasons. Species depicted include the humpback whale, fin whale, minke whale, North Atlantic right whale, sei whale, Atlantic white-sided dolphin and pilot whale. Figure adapted from Pittman *et al.*, 2006.

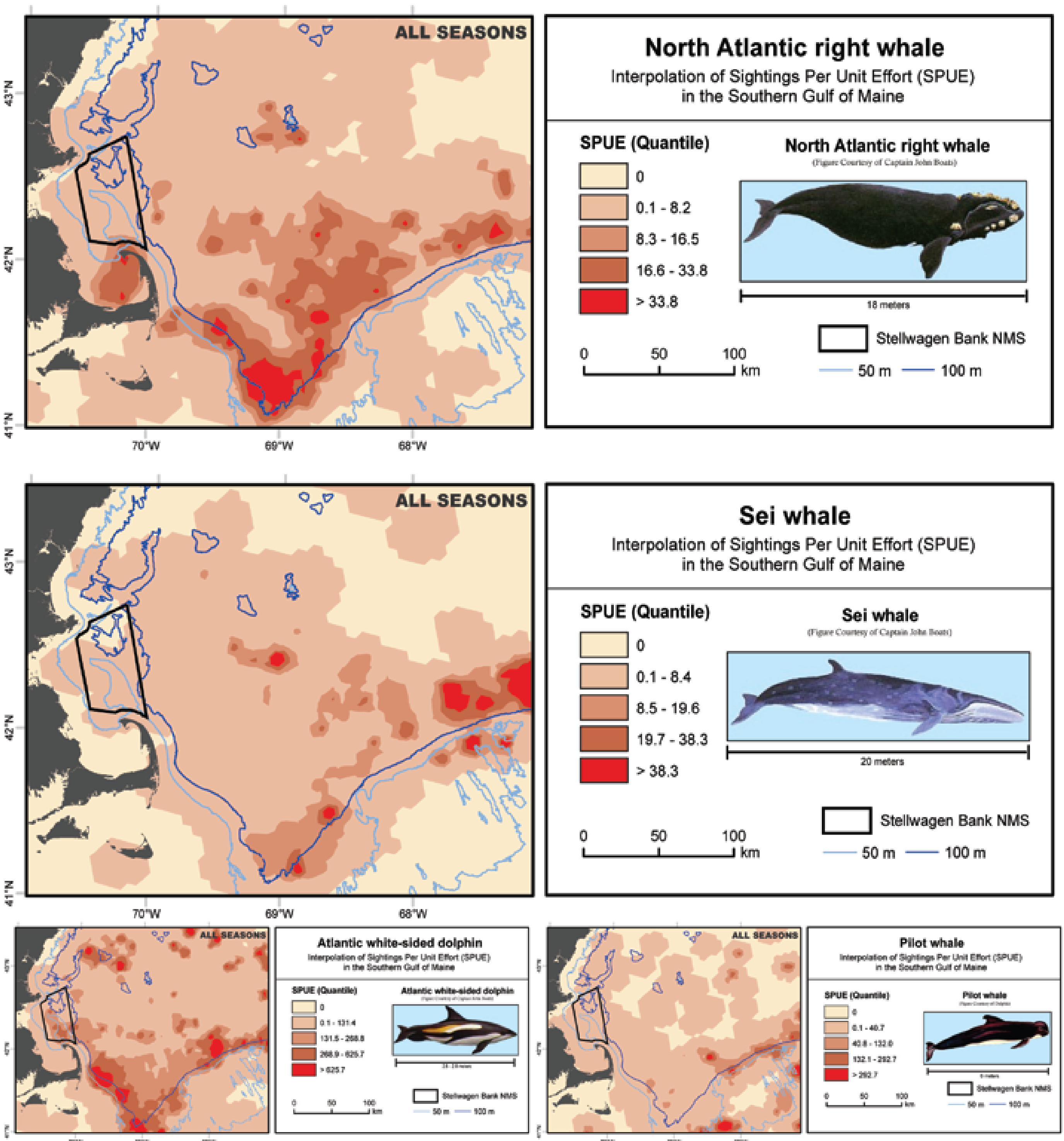


Figure 49. Seasonal patterns of interpolated SPUE data for all baleen whale species in spring, summer, fall and winter and all seasons combined for the Stellwagen Bank sanctuary and the southern GoM (1970–2005).

Figure excerpted from Pittman *et al.*, 2006.

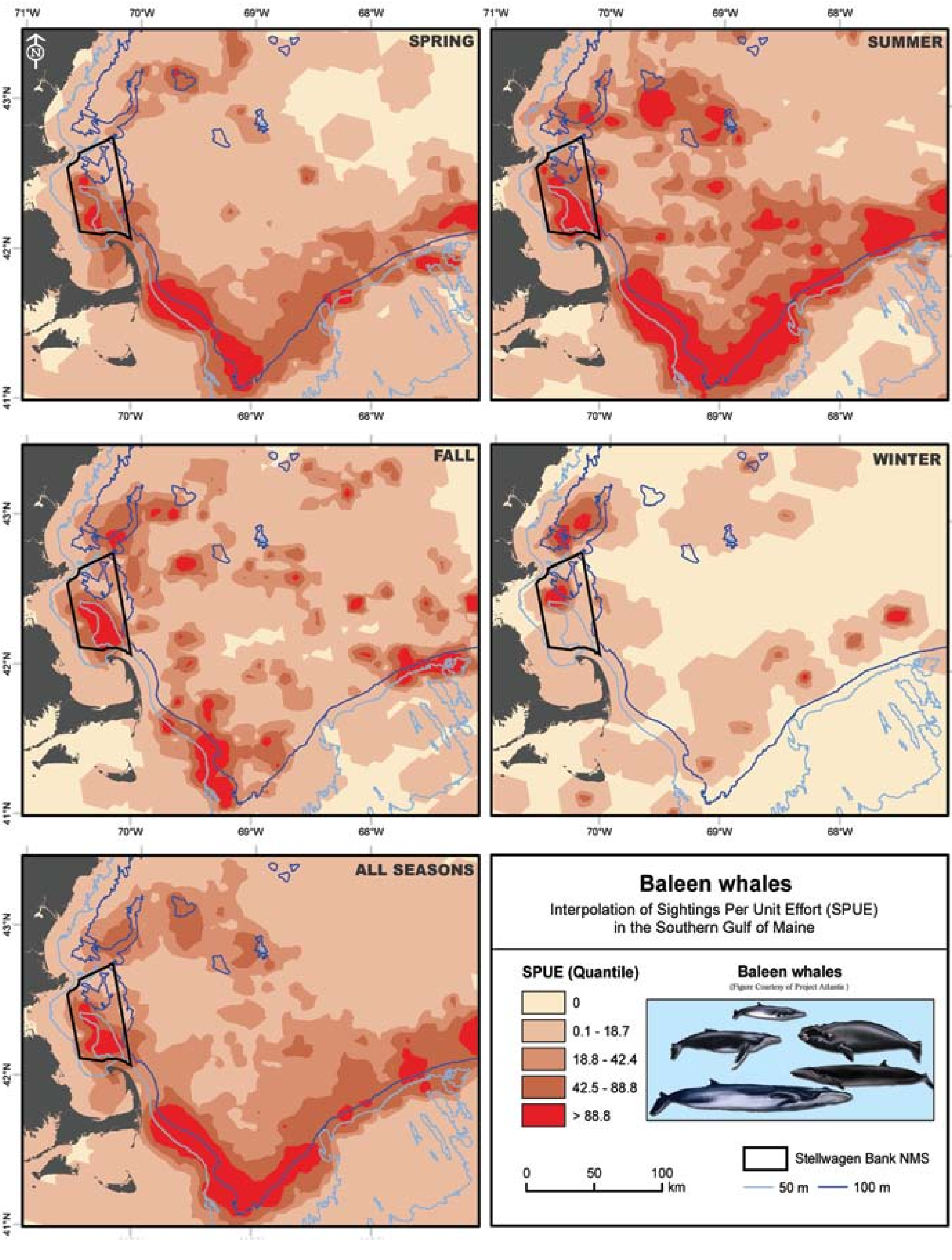


Figure 50. Seasonal patterns of interpolated SPUE data for all dolphins and porpoises in spring, summer, fall, winter and all seasons combined for the Stellwagen Bank sanctuary and the southern GoM (1970–2005).

Figure excerpted from Pittman *et al.*, 2006.

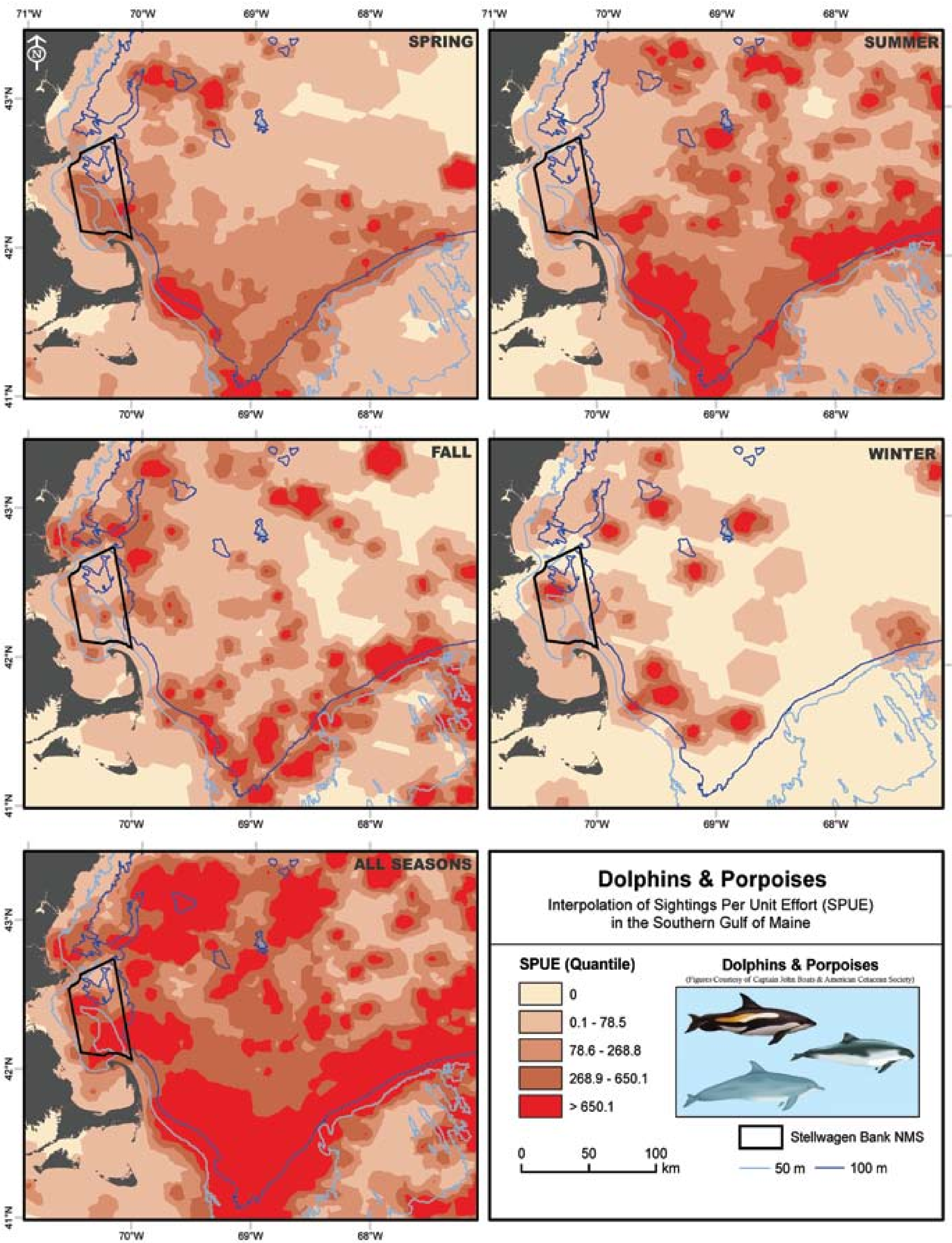


Figure 51. Relative occurrence of fin, humpback, minke and right whales in the Stellwagen Bank sanctuary.

Data are based on standardized surveys from July 2001–June 2002 (303 sightings of 361 animals). Adapted from Wiley *et al.*, (2003).

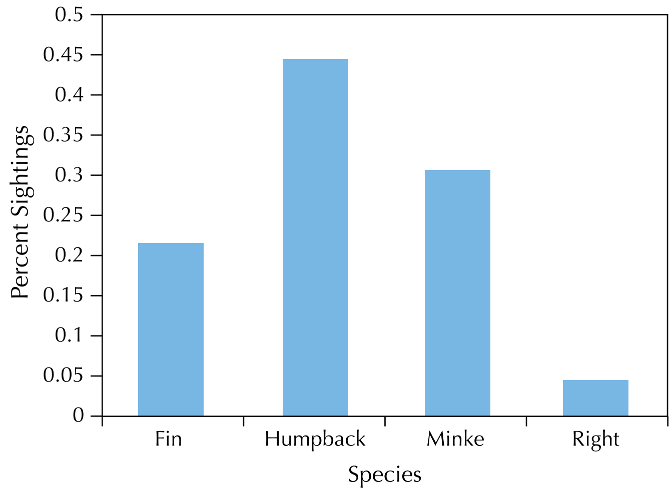


Figure 52. Relative occurrence of harbor porpoise, white-sided dolphins and pilot whales in the Stellwagen Bank sanctuary.

Data are based on standardized surveys from July 2001–June 2002 (162 sightings of 1,708 animals). Adapted from Wiley *et al.*, (2003).

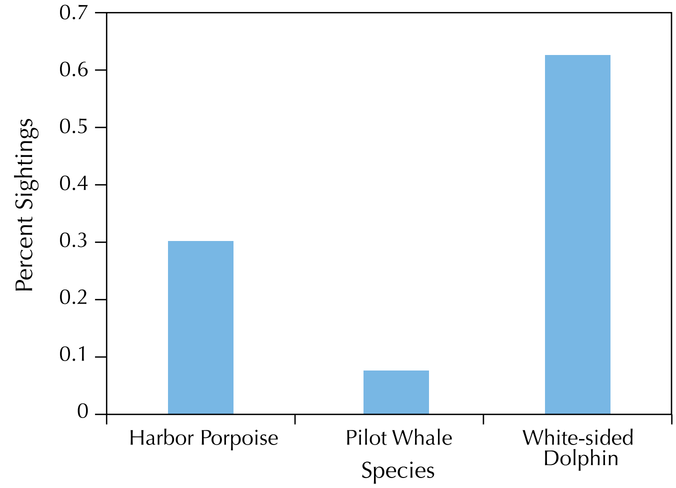


Figure 53. Frequency of Cetacean Sightings within Stellwagen Bank sanctuary by month. Data are from standardized surveys from July 2001–June 2002.

Adapted from Wiley *et al.*, (2003).

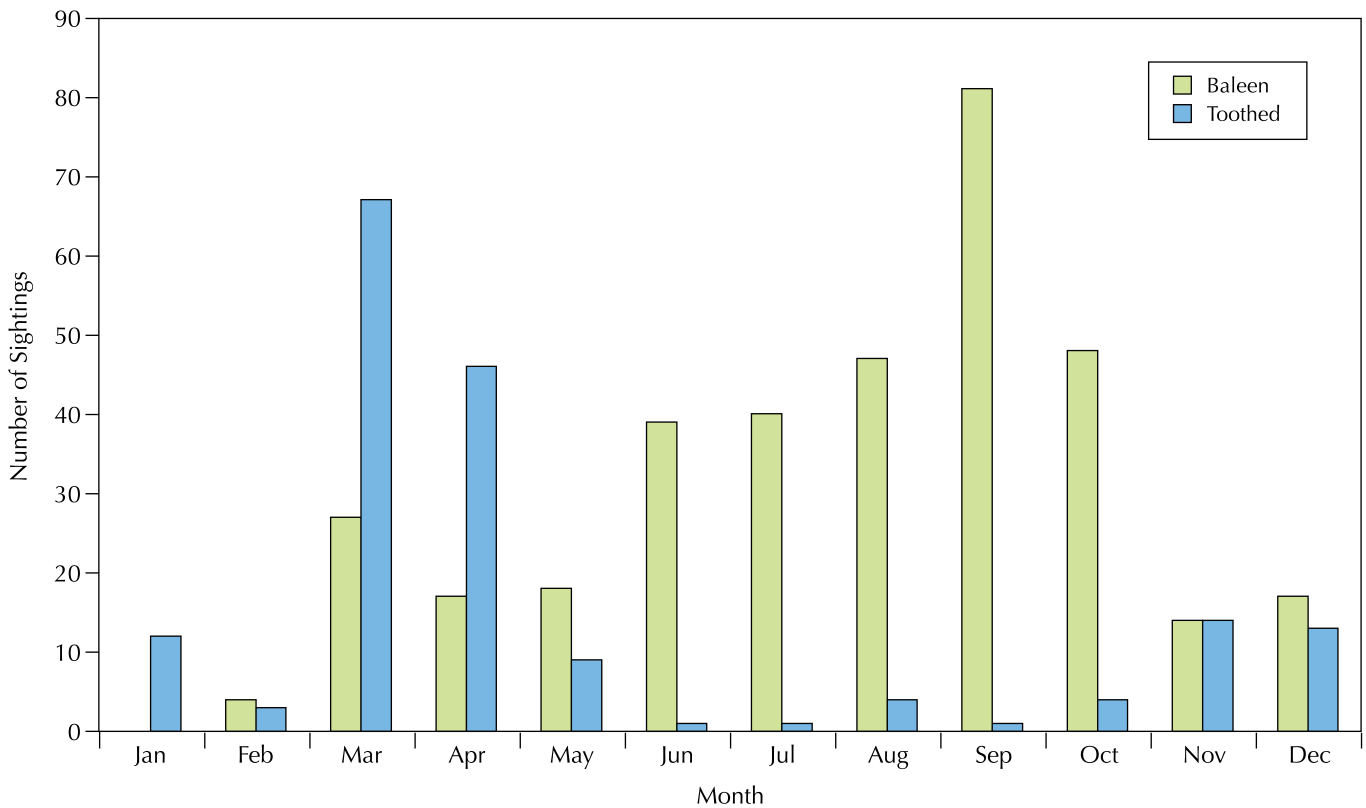
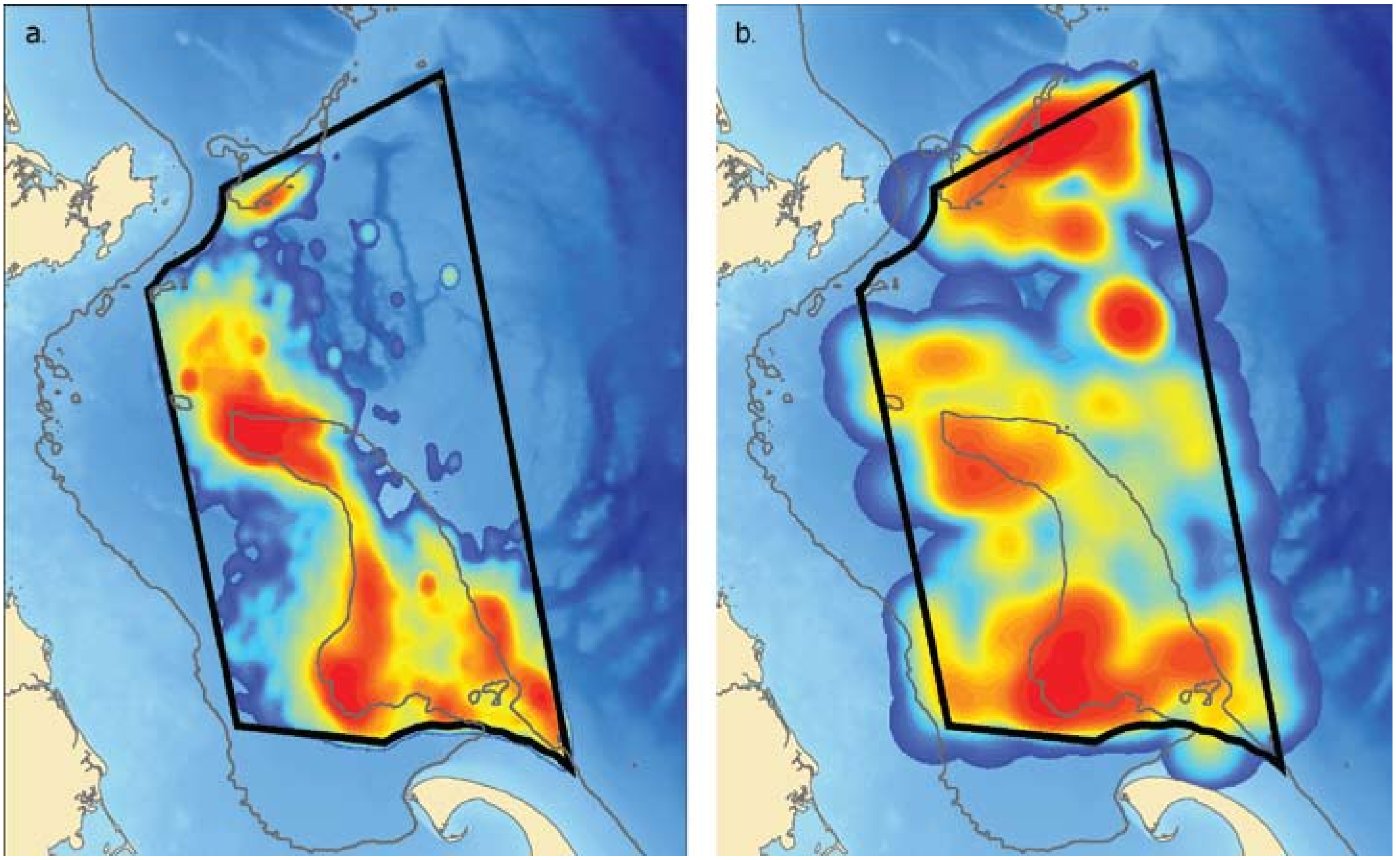


Figure 54. Comparison of the spatial distribution of baleen whales within the Stellwagen Bank sanctuary from whale watch and standardized survey data.

Whale watch data (a.) are non-standardized observations made during April through October from 1979-2004 (n = ~255,000). Survey data (b.) are based on standardized surveys from July 2001–June 2002 and include animals not identified to species (352 sightings of 413 animals). Survey data are adapted from Wiley *et al*., 2003. Whale watch data were collected by the Provincetown Center for Coastal Studies and the Whale Center of New England. The two illustrations are Kriged density plots of information from both data sets using a 5,000 m search radius analyzed by ESRI ARCGIS.



tial data (Ware *et al.,* 2006), such as that provided by the whale tags. Tag data were also viewed in TrackPlot (Ware *et al.,* 2006; Wiley *et al.,* 2005) to provide a static 3-D representation of spatial patterns in whale movement.

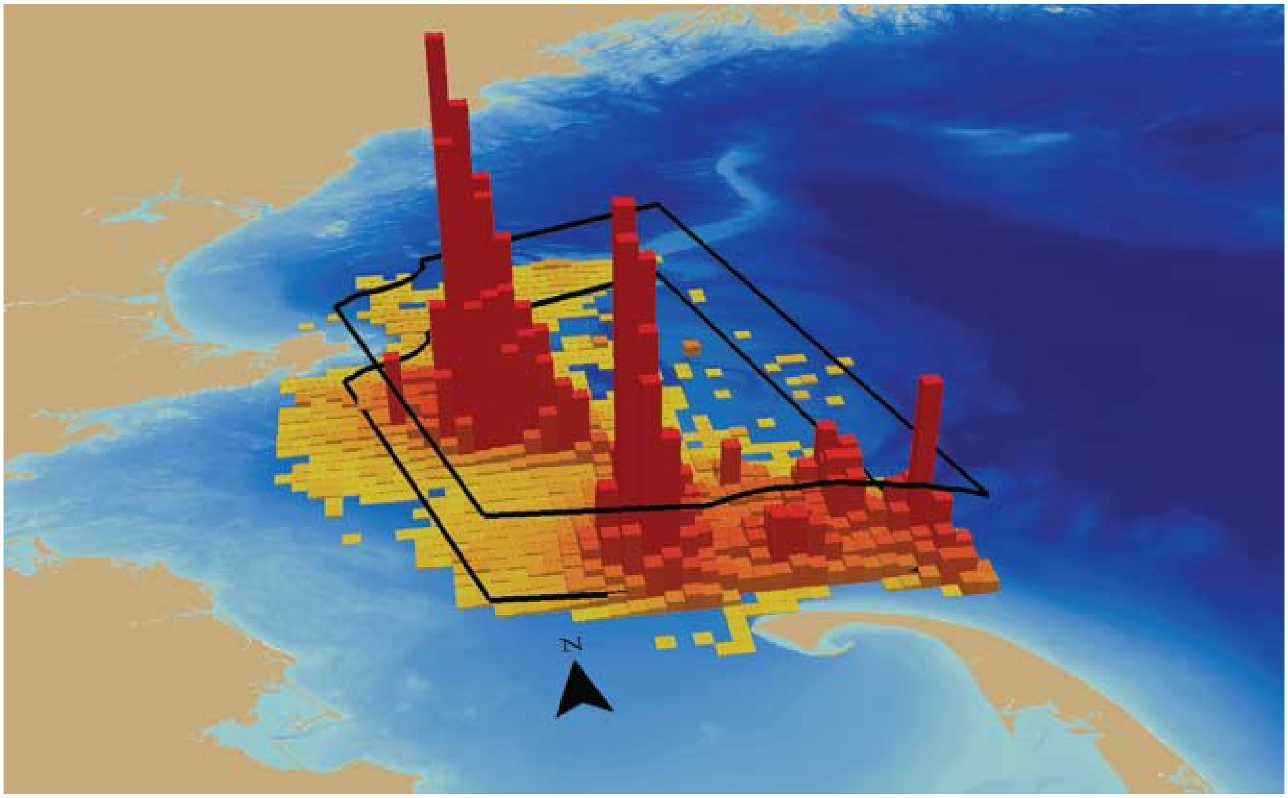
Figure 56 illustrates behavior that is typical of the high interrelated use of both seafloor and water column habitats by humpback whales feeding in the sanctuary based on the tagging results of 15 individuals in July of 2006. Sand lance prey fields were simultaneously mapped acoustically in areas adjacent and parallel to the whale tracks, confirming their presence in large numbers (Figure 57). Acoustics offer a minimally invasive technique for collecting continuous along-track data on biomass at fine horizontal and vertical spatial scales throughout the water column (Simmonds and MacLennan, 2005). The whale tracks were mapped over the sanctuary's seafloor multi-beam sonar image, which indicated that the whales were feeding over sand and sandy gravel which is sand lance habitat. More extensive treatment of this research is provided in Friedlaender *et al.* and Hazen *et al.* (both in review).

The depth versus time series recorded for the subject whale shows how and when it uses the water column, demonstrating pronounced shifts in lengthy bouts of repeated dives (Figure 56). During hours of daylight, dusk and early evening (1400 hr to 2100 hr) the whale spent its time in an alternating series of frequent short duration dives to the seafloor followed by extensive time spent in the upper water column and at the surface. During the ensuing hours of darkness and pre-dawn (2120 hr to 0440 hr) the whale spent its time in long duration dives to the seafloor. Bouts of predominantly near-surface activity resumed with the return of daylight. These findings of diurnal foraging patterns are generally supportive of those of Goodyear (1989), who also conducted tagging studies of feeding humpback whales on Stellwagen Bank during times of high sand lance abundance. Sand lance make daytime migrations into the water column where they form schools and feed, returning to the seafloor at night (Casey and Myers, 1998), a behavior that corresponds to the whale's diel (24-hr period) use of these habitats.

Two types of foraging behavior were characteristic of how the whales differentially used water column and seafloor habitats. During the "daylight" sequence, whales engaged in repeated bubble-net feeding in which individual or

FIGURE 55. A THREE-DIMENSIONAL VISUALIZATION OF THE SPATIAL DISTRIBUTION OF BALEEN WHALES WITHIN THE STELLWAGEN BANK SANCTUARY (1979–2004).

Data are non-standardized observations from whale watching vessels operating from April through October (n = ~255,000) and collected by the Provincetown Center for Coastal Studies and the Whale Center of New England.



multiple animals exhale, encircle and corral sand lance in the water column. By diving below the level of schooling sand lance, the whales presumably can better detect their prey contrasted and profiled against the sky. During the "darkness" sequence, whales engaged in repeated bouts of bottom feeding where they turn on their side to scour the sandy bottom while feeding on sand lance burrowed in the seafloor. Each of these characteristic behaviors is illustrated in Figure 56.

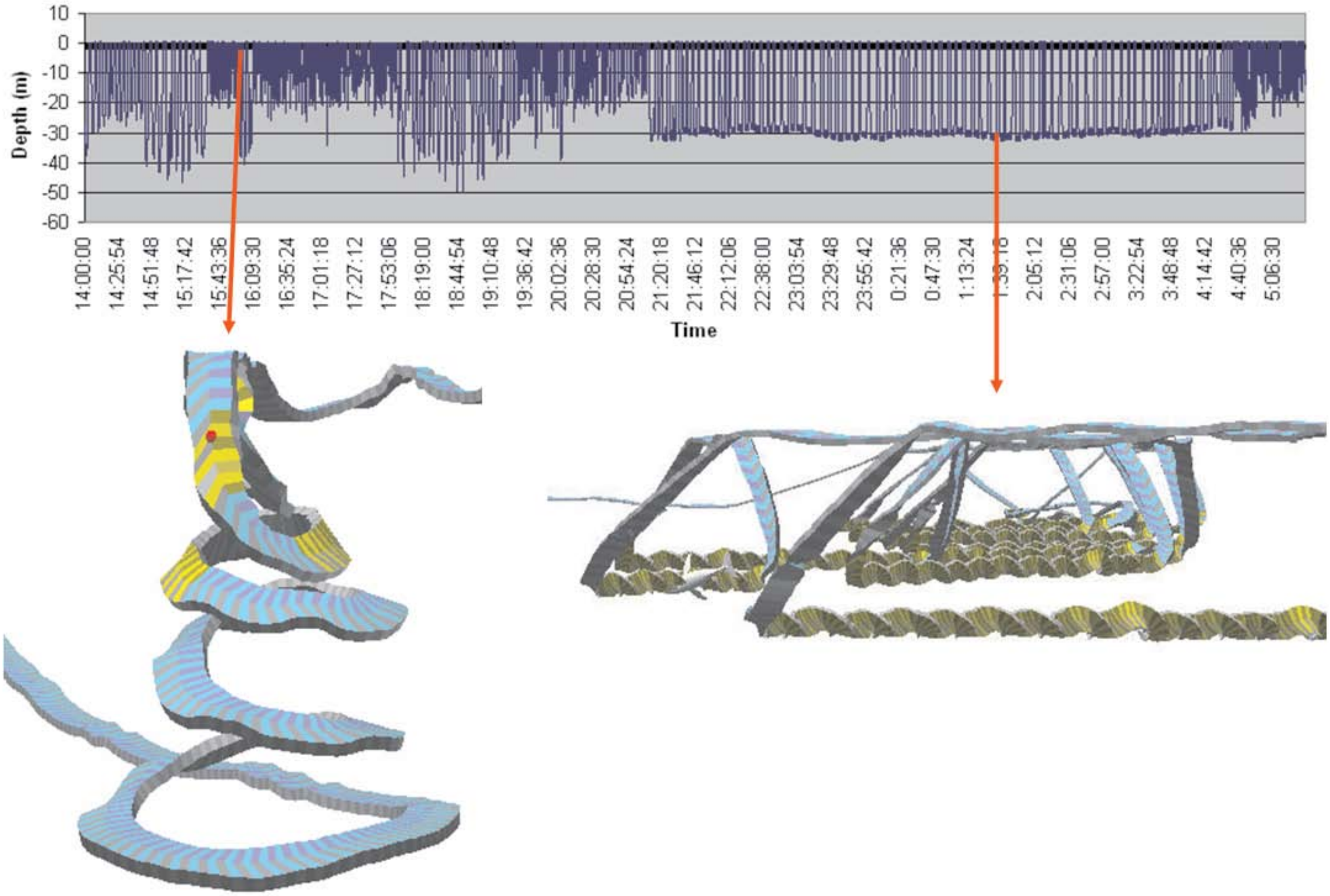
Results from Friedlaender *et al*. (in review) suggest that surface feeding activities in humpback whales are based primarily on visual prey detection and secondarily on the presence of prey over a certain threshold level in the water column. Hazen *et al*. (in review), in fact, show that humpback whales on Stellwagen Bank maximize their foraging efficiency when surface feeding by preferentially targeting dense, vertically oriented patches of sand lance. Hazen *et al*. found that whale surface feeding was significantly affected by prey school shape. Surface feeding occurred more often around prey schools with a large area, taller height, and shorter length. Longer schools were often associated with a thin layer (less than 2.5m tall) in the water column, potentially more difficult or less cost-effective to consume. Sand lance schools reached up to 4km in length and vertical thickness up to 30m. Examples of such schools are shown mapped in Figure 57. This visualization of actual data depicts the linear transect through a series of prey patches in the sanctuary and provides a 2-dimensional portrayal of 3-dimensional prey aggregations (i.e. length, width, vertical thickness). Because the spatial characteristics of prey fields is an important determinant of the optimality of humpback whale foraging, maintenance of prey patch integrity needs to be considered in sanctuary management.

CONSERVATION STATUS

All marine mammal species are protected under the MMPA; five baleen whale species frequenting the Stellwagen Bank sanctuary are listed as endangered under the ESA (i.e., blue, fin, humpback, sei and North Atlantic right whale) (Table 8). The North Atlantic right whale population continues to be depleted (NOAA, 2006); the best estimate of the size of the population is 300 to 350 animals. Earlier models indicated that this population was likely declining rather than remaining static or increasing (Caswell *et al.,* 1999). More recent models that estimate survival rate from re-sightings data collected during 1980-2004 indicate that the median population growth rate is about 1% (Pace *et al.,* 2007). However, the models also revealed that this population has almost no capacity to absorb additional mortality. Because the primary causes of premature mortality among right whales are anthropogenic, mainly ship strikes and fishing gear entanglements, recovery of the right whale population is contingent upon reducing the effects of these activities on the species (Pace *et al.,* 2007).

Figure 56. A time/depth plot of the diving behavior of a tagged humpback whale in the Stellwagen Bank sanctuary over a 15-hour period in July of 2006.

The animal used complex spiral bubble maneuvers in the water column to corral fish (presumed sand lance) during daylight and exhibited bottom side-roll behavior at night. Ribbon tracks used to visualize behavior were created using TrackPlot (Ware *et al*., 2006). Data are from Wiley *et al*. (unpublished).



Pressures

Habitat loss, habitat degradation and competition for prey are recognized as key threats to cetaceans worldwide (Reeves *et al*., 2003). Known or potential threats to the survival of marine mammals are due to the increasing pressures of human activity in and around the sanctuary and the marine mammals' dependence on resources that are also used intensively by humans. Marine mammals are vulnerable to disturbances caused by ship noise, industrial activity and other acoustic inputs to the marine environment, collisions with powered vessels and entanglements with fishing gear. Other types of human activities (e.g., water pollution) occur that may influence living resource quality (e.g., reduced availability of prey). High levels of chemical contaminants in the tissues of cetaceans may be affecting the animals' immune and reproductive systems (Reeves, 2003).

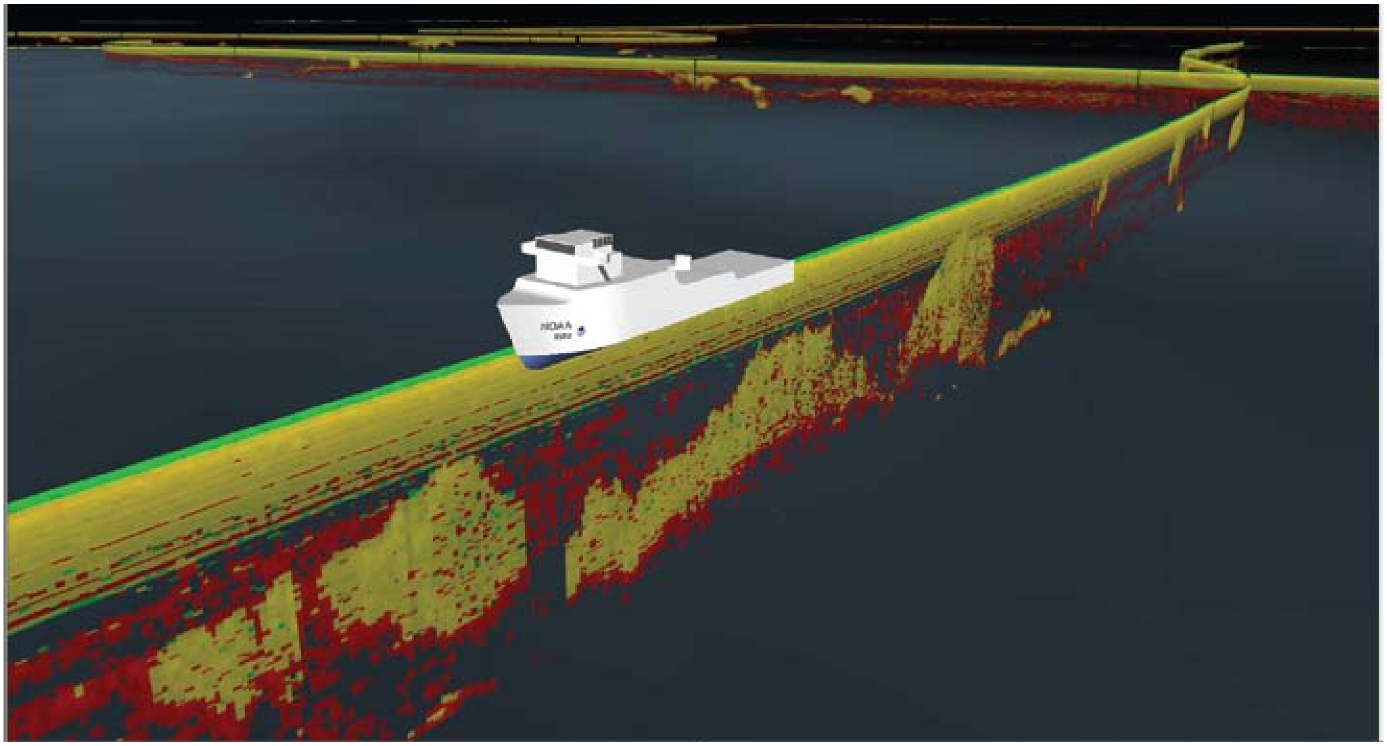
There are undoubtedly more threats than are presently recognized, and even the most basic information on cetacean mortality caused by human activity is limited due to funding restraints, under-reporting and the lack of directed scientific effort. Moreover, the total impact of the various threats cannot be predicted by simply summing their effects as though they were independent. For example, the immunosuppressive effects of environmental contaminants (Lahvis *et al*., 1995) with range shifts of pathogens caused by global warming and ship ballast transport (Harvell *et al*., 1999) could increase the susceptibility of cetaceans to emergent diseases. While research is underway to better identify emerging threats, cautionary measures should be taken to moderate or eliminate the relevant and acknowledged anthropogenic input factors (Reeves, 2003).

Behavioral Disturbance

There are numerous ways in which marine mammals are disturbed or potentially disturbed by human activities within or around the Stellwagen Bank sanctuary. These include activities associated with vessels, aircraft flying over the sanctuary, fishing activities and underwater noise from the high number of vessels passing through and nearby the sanctuary.

Figure 57. Visualization showing the NOAA Ship *Nancy Foster* acoustically mapping sand lance prey fields in the Stellwagen Bank sanctuary.

The horizontal band is the zone of cavitation caused by the ship's propellers and is an artifact. Prey fields are evident below this zone: yellow = higher density; red = lower density. Visualization portrays actual data. Image: UNH/SBNMS.



Whale Watching

Twelve commercial whale-watch companies operate regularly scheduled trips on as many as 22 vessels that make multiple trips daily to the sanctuary, from April through October, out of six Massachusetts ports. A sampling of tracks from whale watch vessels representing all companies and all ports were recorded in 2003 during whale watch trips to the sanctuary and adjoining areas (Figure 58). With the exception of vessels departing from Newburyport, the northernmost port depicted, virtually all whale watching trips were made to the sanctuary and almost all of these were made to northern and southern Stellwagen Bank, where whales historically are most abundant (Figures 54 and 55). More than one million people visit the sanctuary yearly aboard these platforms (Hoyt, 2001).

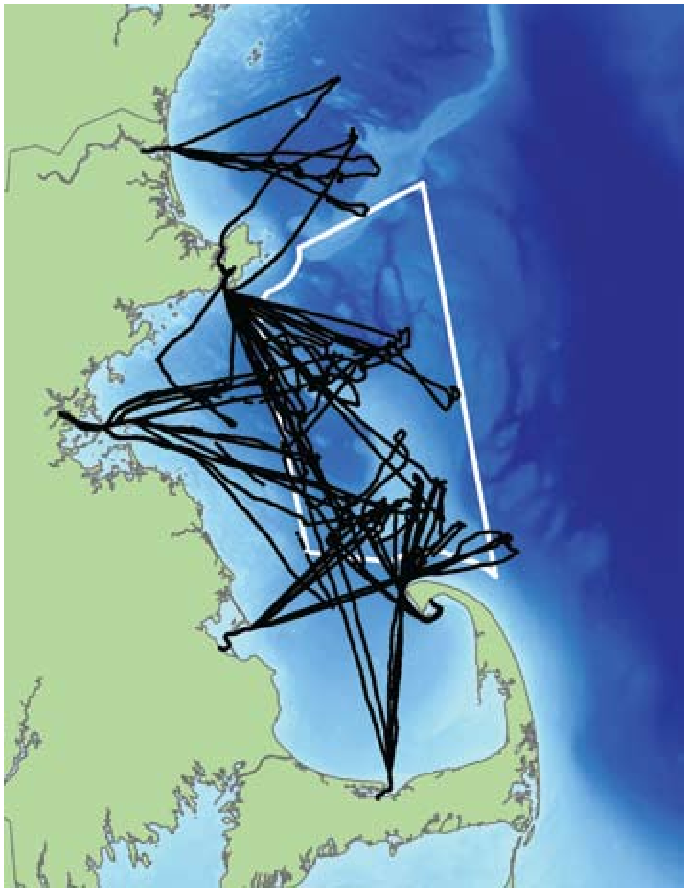
There is growing awareness, however, that cetacean tourism can have a downside (Corkeron, 2004). Intensive, persistent and unregulated vessel traffic that focuses on animals while they are resting, feeding nursing their young or socializing can disrupt those activities, and possibly cause short and long-term problems for targeted populations. Impact studies worldwide have shown changes in ventilation rate (Baker, 1988), avoidance behavior (Donovan, 1986) and changes in habitat use (Corkeron, 1995). The concerns are further compounded by the increase in popularity of whale watching, not just on commercial vessels, but also privately-owned recreational vessels. In both cases, instances occur where numerous boats surround a single whale or group of whales, disturbing the animals and at the same time detracting from the quality of the tourist experience.

Working with the whale watching industry and non-profit conservation organizations, NOAA established voluntary whale watch guidelines in the Northeast region in 1999 following a sharp increase in whale watch vessel speeds and collisions with three whales, at least one of which was fatal (Weinrich, 2005). These guidelines (operational procedures) were first developed in 1984 by an *ad hoc* committee of whale watch naturalists, captains and scientists (Beach and Weinrich, 1989). The intent of the guidelines is to avoid harassment and possible injury or death to large whales by both commercial and recreational vessels. While the guidelines are voluntary and difficult to enforce, NOAA Office of Law Enforcement enforces the intent of the guidelines through the take and harassment provisions of the ESA and MMPA.

One important aspect of the whale watch guidelines is a series of recommended vessel speeds within various distances from the whales: less than or equal to 13 knots at a 1–2 nm distance to whales (zone 3); less than or equal to 10 knots at a 1–0.5 nm distance to whales (zone 2); and less than or equal to 7 knots within 0.5 nm distance to whales (zone 1). Details of the approach guidelines can be found at the following web address: http://www.nero.noaa.gov/shipstrike/info/guidetxt.htm or Appendix M). The industry considers these guidelines to be more stringent than approach guidelines/regulations in other regions, where

Figure 58. GPS tracks of 36 commercial whale watching trips from six major whale watching ports in Massachusetts that were monitored by onboard observers during the summer and fall of 2003.

Vessels were from the 12 major companies that operate regular schedules and each company was monitored approximately three times.



distance restrictions exist but no speed restrictions have been established. The industry has used these guidelines to argue against the need for additional restrictions such as speed regulations in the sanctuary. A recent study conducted in the sanctuary indicates that compliance with the speed portion of the guidelines by the commercial whale watch fleet was extremely low and that speed exceedances were excessively high (Wiley *et al*., in press).

Observations in this study were made on 46 commercial whale watching trips in 2003 and 2004 that occurred in and around the sanctuary; all of the principal whale watching companies were represented. Results indicate that whale watching vessels often ignored speed zone guidelines and the degree of non-compliance increased as distance from the whale(s) increased (Table 9). The overall level of non-compliance based on distance traveled by the whale watch vessels (data from all speed zones combined) was 78%. The maximum vessel speed recorded in zone 1 (where the level of non-compliance was lowest and boats were closest to whales) differed little from the maximum vessel speed recorded for the entire whale watch trip (Figure 55). The high degree of non-compliance and the magnitude by which the recommended speeds in each zone were exceeded indicate that the guidelines cannot be relied upon as a voluntary measure to reduce the risk of behavioral disturbance or vessel strike to whales in the sanctuary and that regulation should be considered. Such regulation would be aligned with NOAA's Ship Strike Reduction Program. The MMBD AP proposes several strategies that address this issue (AP: MMBD 1.1).

Ocean Noise

There is growing evidence that noise in the ocean has increased dramatically over the past 50 years (Andrew *et al*., 2002; MacDonald *et al*., 2006). As the primary source of low frequency ocean noise is commercial shipping (Wenz, 1962), noise is expected to increase most dramatically in areas experiencing increased commercial shipping such as access-ways for growing ports. Although pre-industrial ambient noise estimates are not available for the Stellwagen Bank sanctuary, growth in the Port of Boston continues to be accompanied by increases in large vessel traffic transiting the sanctuary.

Increasing ocean noise is of concern given growing evidence that some underwater sound sources can negatively impact sensitive marine species (NRC, 2003). For example, some marine mammal populations have been documented to respond to sources by altering their breathing rates, spending more time underwater before coming up for air, changing the depths or speeds of their dives, shielding their young, changing their song note durations and/or swimming away from the affected area (Richardson *et al*., 1995; NRC, 2005). In addition, high intensity underwater sounds can cause temporary or permanent hearing loss in marine mammals, which in a few cases has been associated with animals

Table 9. The level of non-compliance with the speed portion of the NOAA whale watching guidelines based on the monitoring of 46 commercial whale watching trips operating in and around the Stellwagen Bank sanctuary during 2003–2004.

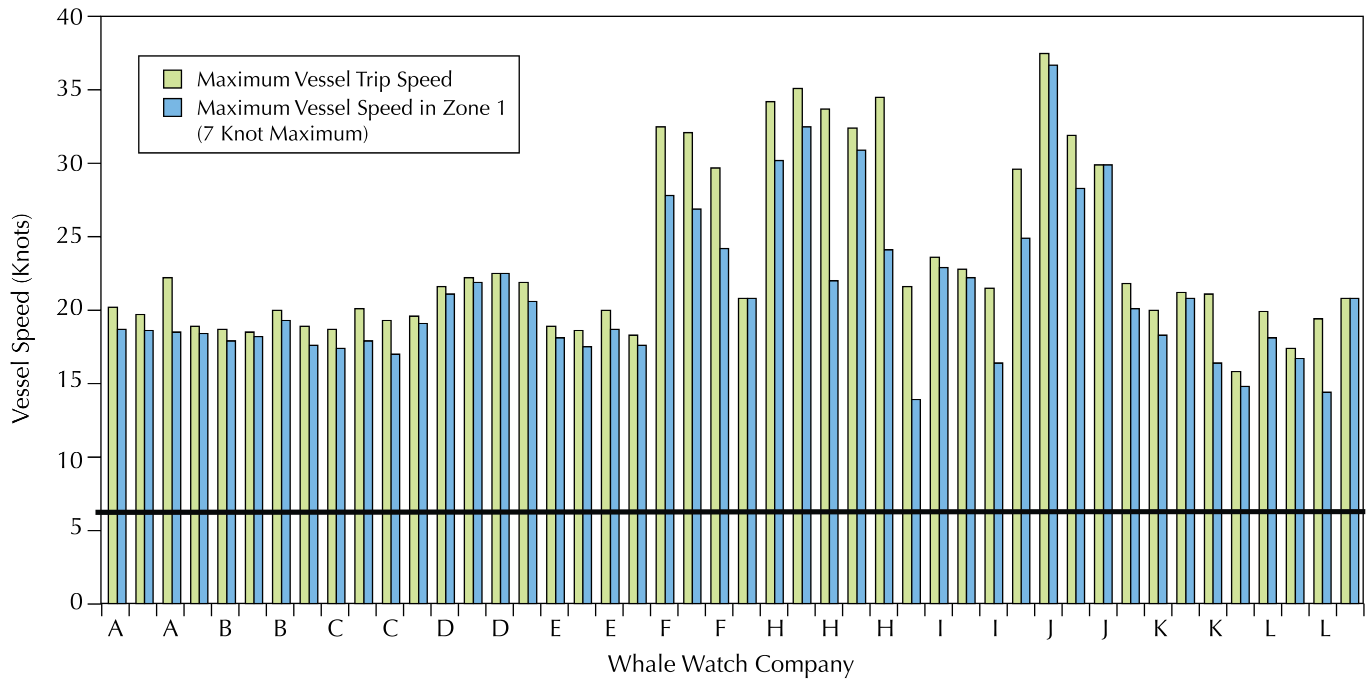
GPS receivers onboard each vessel provided information on the vessel's track and speed. Non-compliance was registered when a vessel's speed exceeded that specified by the guidelines. For each speed zone, a vessel's non-compliant level was calculated by comparing the distance the vessel traveled out of compliance to the total distance traveled in that zone. The industry's non-compliant level was calculated by summing the total non-compliant distances for all vessels traveling in a zone and comparing that to the total distance traveled by all vessels in that zone.

Zone Number	Suggested Speed (Knots)	Industry Non-compliant Level (%)	Non-Compliant Range for All Trips (%)
1	≤ 7	62	33–84
2	≤ 10	93	67–100
3	≤ 13	92	61–100
Overall		**78**	**33–100**

(≤) less than or equal to

Figure 59. Comparison of a vessel's maximum recorded trip speed and its maximum recorded zone 1 speed for 46 commercial whale watching trips representing 12 companies operating in and around the Stellwagen Sanctuary in 2003 and 2004.

In general, all vessels attained speeds well above the 7 knots (horizontal black line in figure) specified by the guidelines for zone 1 and reached near maximum trip speeds in zone 1. This indicates that operators were not following speed guidelines meant to safeguard whales. Speed data were derived from GPS devices and collected by unannounced and inconspicuous observers. Speed zones around whales were identified by those observers using military grade binoculars with a digital compass and laser rangefinder to position whales. ESRI ARCGIS was used to create speed zones around the whales for purposes of calculation.



becoming disoriented and stranding (NRC, 2005). Finally, but perhaps most importantly for the sanctuary, increasing ocean noise may "mask" signals produced by acoustically-active marine animals to communicate with conspecifics (NRC, 2003). Such masking would decrease the distance over which signals could be received by conspecifics, thus limiting their utility as reproductive, feeding and/or navigation behaviors. Although there has been much less research on the impacts of noise on non-mammalian marine animals, many fish and marine invertebrates also utilize sound to communicate.

Given the importance of sanctuary waters to several vocally-active and endangered marine mammals (e.g., humpback, fin, sei and North Atlantic right whales), conducting research and developing a policy framework to minimize human-induced underwater noise is a cautionary guiding principle in the DMP (AP: MMBD.2))

Tuna Fishing

Tuna fishing consists of a variety of gear types and methods including harpoon, hook and line (trolling or anchored chumming) and purse seine. The target species is principally bluefin tuna, which is often attracted to the same forage base (sand lance and Atlantic herring) as piscivorous marine mammals such as endangered humpback and fin whales, minke whales and dolphins and porpoise. To help find tuna, fishermen often search directly for the prey and sometimes use surface feeding whales and birds as indicators of tuna availability and location. Indirectly, commercial whale watch boats are used as proxies in the search for feeding whales. As a result, there is a high co-occurrence of baleen whales where tuna fishing occurs in the sanctuary (Figure 60), and the potential for interaction and disturbance is correspondingly high (Figure 61). The frequency of hooked whales trailing tuna fishing tackle in 2007 prompted calls from so many whale watch patrons, that it clogged the whale disentanglement hotline jeopardizing its effectiveness (S. Landry, PCCS, pers. comm., 2007).

Other Activities

Additional activities that impact whale behaviors include watercraft approaching whales too closely, vessels disrupting critical feeding behaviors (such as transiting through bubble clouds or bubble nets) and potential disturbance by aircraft, specifically fixed-wing aircraft, helicopters and airships. (APs: MMBD 1.2, 1.3 and MMBD.3)

Vessel Strikes

Research indicates that approximately 10% of the vessel/whale collisions recorded world-wide were reported from the Stellwagen Bank sanctuary area (including Cape Cod Bay and Boston Harbor) and that the sanctuary area is a "hot spot" for vessel strikes along the eastern U.S. seaboard (calculated from Jenson and Silber, 2003) (Figure 62). Data indicate that about 39% of the reported strikes result in

Figure 60. Co-occurrence of baleen whales and tuna fishing in the Stellwagen Bank sanctuary during July 2001–June 2002.

Whale distribution is represented as a Kriged density plot of sightings data from the standardized survey using a 5,000 m search radius and analyzed by ESRI ARCGIS. Dots indicate locations where bluefin tuna were caught based on Fishing Vessel Trips Reports (VTR) for the same period. Source: NOAA Fisheries Service VTR data selected for the sanctuary area. The VTR database is discussed in the Human Uses section under Commercial Fishing – data types and sources.

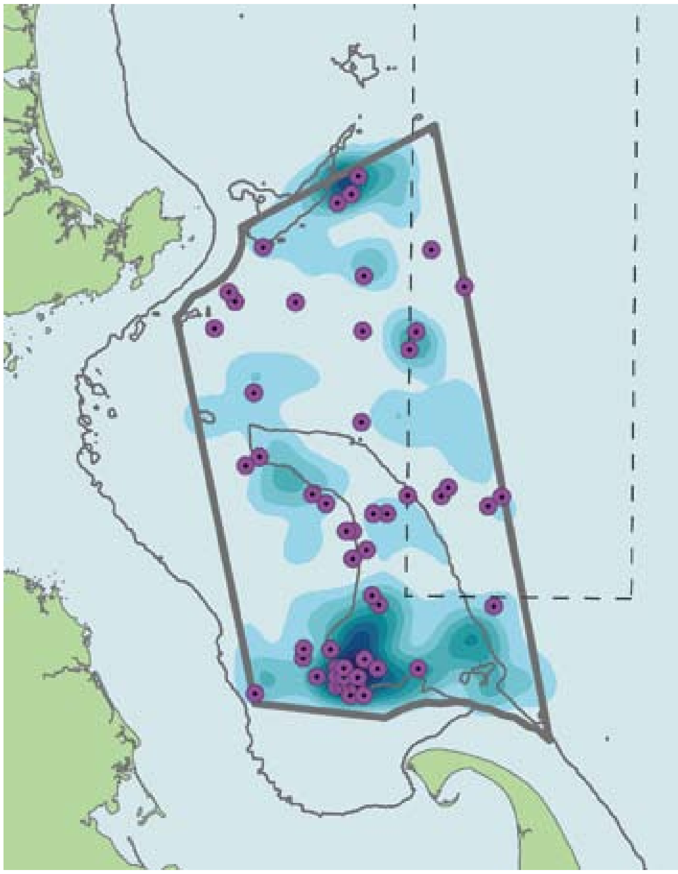


Figure 61. Photograph of a hooked humpback whale in the Stellwagen Bank sanctuary trailing tuna fishing tackle.

Credit: Provincetown Center for Coastal Studies.

mortality or serious injury (Anon, 2004). Species struck include four endangered species (humpback, fin, sei and North Atlantic right) and one protected species (minke). Vessel types involved in the strikes of these whales include large commercial ships, commercial whale watch vessels and private recreational-type boats. Historical records demonstrate that the most numerous, per capita, ocean-going strikes recorded among large-whale species accrue to the North Atlantic right whale (Vanderlaan and Taggart, 2006).

Vessel Speed

Jenson and Silber (2003) documented 27 reported vessel/whale collisions that occurred in the greater Stellwagen Bank area over a 22-year period (1980-2002) with a general increase in strikes occurring between 1984 and 2001. The annual mean cruising speed of commercial whale watch vessels in the Stellwagen Bank sanctuary over the related 25-year period (1980-2004) increased from 11 kts

Figure 62. Approximate location of ship strikes to baleen whales along the eastern seaboard of the U.S. including the Stellwagen Bank sanctuary from 1979–2002.

Note high occurrence in and around the sanctuary where indicated by arrow. Positions inferred from Jensen and Silber (2003).

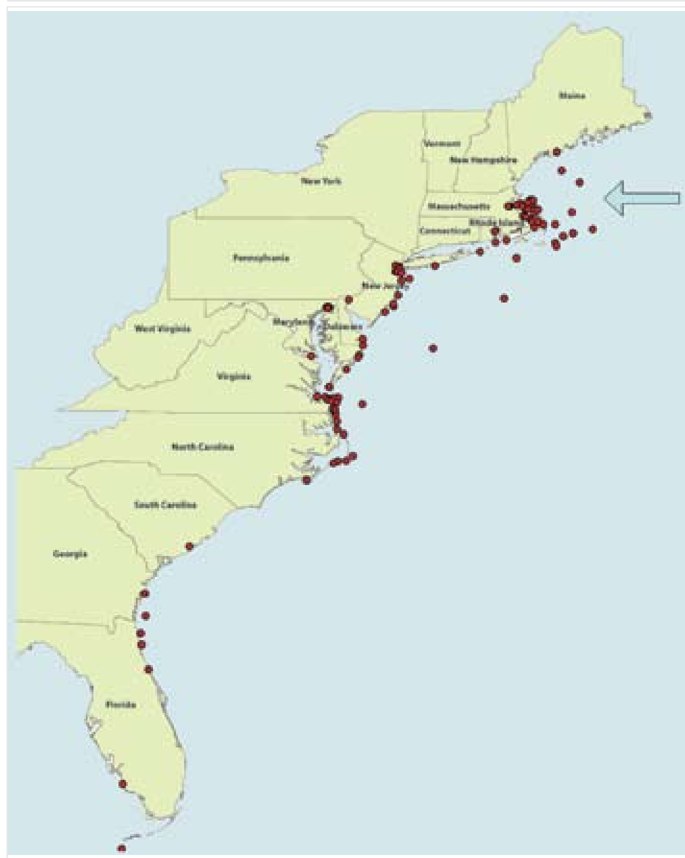


Figure 63. Historical trends (1980–2004) in the cruising speed (annual minimum, maximum and mean) of commercial whale watch vessels operating within and around the Stellwagen Bank sanctuary.

Reported strikes of whales due to collision with the whale watch boats are also indicated in the year that they occurred. Data for 1980-2002 were gathered by naturalists on whale watch cruises and provided by the Whale Center of New England; data for 2003-2004 were gathered by data loggers integrated with GPS receivers during the sanctuary study of industry compliance with NOAA whale watch guidelines (Wiley *et al.*, in press).

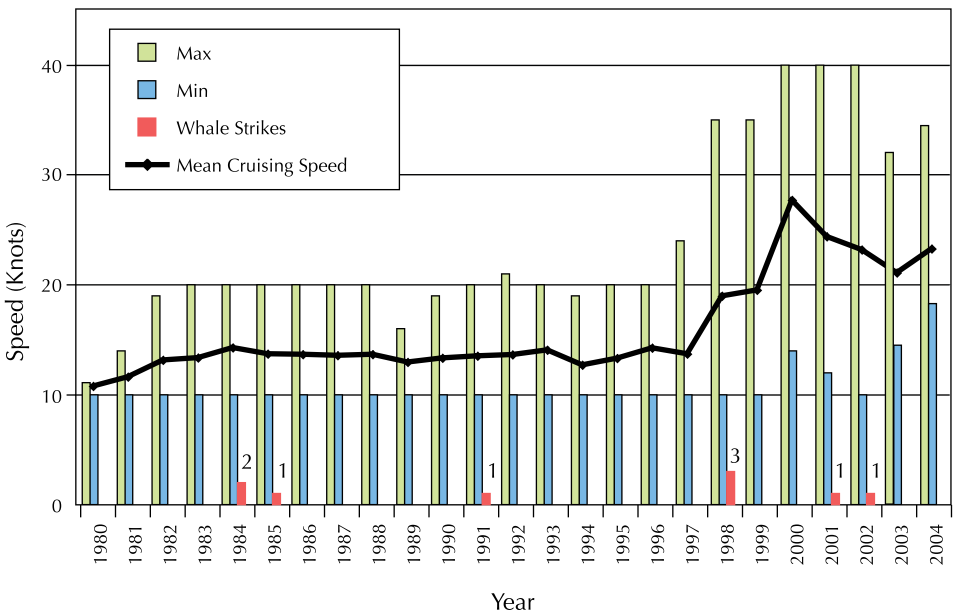
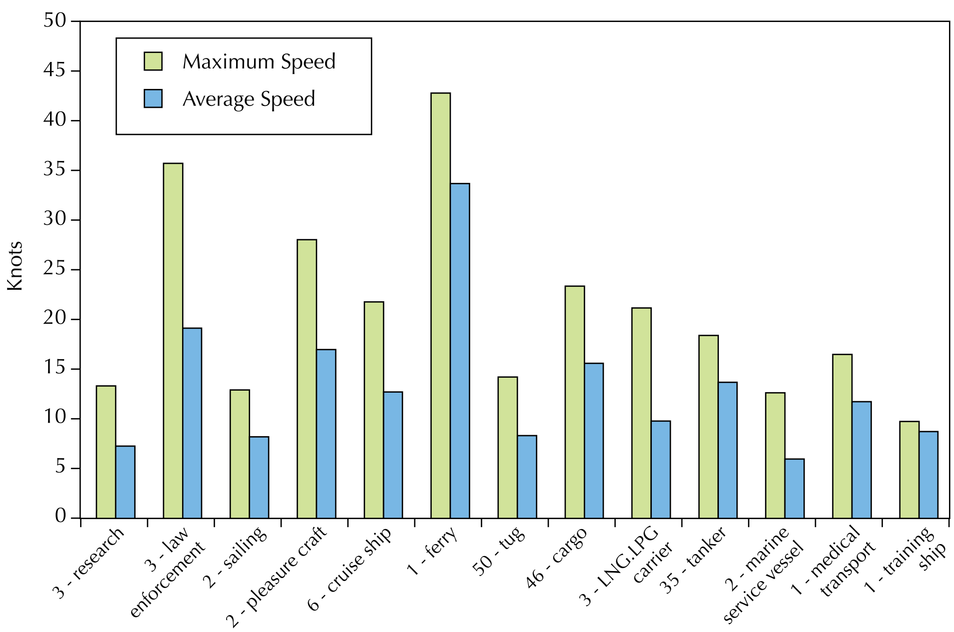


Figure 64. Maximum and average speed in knots for all (156) tracked commercial vessels transiting the Stellwagen Bank sanctuary during the months of April and May 2006 using the USCG's AIS.

The number of vessels of each type tracked within this time frame is indicated along the bottom axis.



to 28 kts, with maximum speeds doubling from 20 kts to 40 kts; the higher speeds began in 1998 (Figure 63). The annual rate of strikes by these whale watch vessels during 1998-2004 (5/7 = 0.714) was 3.2 times greater than during 1980-1997 (4/18 = 0.222). [Note: There were no reported strikes in 2005 or 2006, which lowers the rate during 1998-2006 (5/9 = 0.556). However, that rate is still 2.5 times greater than during 1980-1997 when vessel speeds were lower.]

Vanderlaan and Taggart (2007) calculate that the greatest rate of change in the probability of a lethal injury to a large whale (any species) due to vessel strike occurs between vessel speeds of 8.6 kts and 15 kts; the probability drops below 50% at 11.8 kts and approaches 100% above 15 kts. The increased vessel speed by commercial whale watch vessels operating in the sanctuary places whales at greater risk of being struck and raises the probability of lethal injury. Increase in size and speed of vessels generally has resulted in a corresponding increase in the number of vessel strikes (e.g., Laist *et al.,* 2001; Taggart and Vanderlaan, 2003; Pace and Silber, 2005).

To further characterize speed of commercial vessels transiting the sanctuary, records from the USCG Automatic Identification System (AIS) were analyzed for the months of April and May 2006. The AIS data were collected as part of a collaborative effort between the Stellwagen Bank sanctuary and the USCG (see below). One hundred and fifty-six AIS-tracked vessels transited the sanctuary during these two months. Tug and tows, cargo ships and tankers made up 86% of the total traffic volume (Figure 64). Cargo ships were recorded to be transporting a wide variety of container types, while the majority of tanker traffic specialized in mineral resource and chemical transport. The highest average speeds recorded (all greater than 15 kts) were reported for a single large passenger ferry, motorized pleasure craft and law enforcement vessels; these and cruise ships, cargo and LNG carriers all showed maximum speeds greater than 20 kts.

Vessel Traffic

Collisions with large commercial ships constitute the majority of human-caused North Atlantic right whale mortalities (see Sidebar). NOAA Fisheries Service and the USCG established the Mandatory Ship Reporting System (MSRS) in July 1999 to reduce this threat (Figure 65). Under this system, all commercial ships, 300 gross tons or greater, are required to report to a shore-based station when entering into critical habitat areas (i.e., Great South Channel). Analysis of relative ship traffic density (kilometers of ship track per square kilometer) representing MSRS data from the first three years (1999-2002) of the northeast Mandatory Ship Reporting System indicates that five major high-use corridors of vessel traffic pass directly through the sanctuary (Ward-Geiger *et al*., 2005).

The Stellwagen Bank sanctuary is working in partnership with the USCG to adapt the AIS, originally developed for tracking vessels in real time to reduce the risk of vessel collisions, as a means to analyze vessel traffic patterns across the sanctuary. The AIS is a national shipboard broadcast system operating in the VHF maritime band. Compliance is mandatory for all vessels 300 gross tons or more, vessels carrying 150 or more passengers, and some other types of commercial shipping such as tug and tow (http://www.navcen.uscg.gov/enav/ais/default.htm). Together with the USCG, the sanctuary has established a network of receivers on Cape Ann, Scituate and Cape Cod that provides complete coverage of the sanctuary and adjoining area.

The AIS data portrayed in Figure 66 indicate that the sanctuary, because of its proximity to the Port of Boston, receives more commercial shipping traffic than any other location within U.S. jurisdiction in the GoM. These data are for the months of April and May 2006. While the overall traffic pattern displayed is similar to that indicated by the MSRS data, the AIS data have the advantage of being automatic and thus free of voluntary reporting bias, of representing all vessel tracks and not just one-way traffic upon entering critical habitat areas, and of documenting the entire vessel path actually traveled, not just the straight line distance inferred from initial point of reporting and arrival at destination. Vessel reports include information about vessel type and behavior, such as speed and course, and cargo carried.

The main Boston shipping channel transects historic whale high-use areas across southern Stellwagen Bank. All cetacean species that frequent the sanctuary and surrounding waters exhibit space-

ON THE BRINK OF EXTINCTION—the North Atlantic Right Whale

The North Atlantic Ocean has been home to the North Atlantic right whale (*Eubalena glacialis*) for eons. The Basques began hunting North Atlantic right whales in Europe in 1150, taxed by royal decree, and continued for nearly 600 years. By the 1500s, the Basques had exterminated the right whale population on the eastern side of the North Atlantic Ocean. In the latter part of the 16th century, Basque whalers expanded their hunting grounds westward to North America, particularly to the waters off southern Labrador.

Eventually, New England shore-based whalers dominated the local industry, seeking oil and baleen for energy and commercial products. Their catches of right whales peaked in the early 1700s, but Yankee whalers continued to pursue this species whenever opportunity afforded. The last animals to be taken intentionally were a mother and calf off Madiera in 1967, although the species had been afforded protection from hunting since an international agreement signed in 1935. This species had been the "right" whale to take because of its proximity to coasts and its high oil content making the whale positively buoyant so that it floated when killed.

Despite seven decades of protection from whaling, the North Atlantic right whale population has not rebounded. Today only a remnant of the population survives, no more than 350 whales clustered in calving and feeding grounds along the eastern seaboard of North America. Only occasional right whale sightings in the Gulf of St. Lawrence or in the waters between Iceland, Greenland and Norway give echoes of their once substantially greater range.

A critical factor in the right whale's population decline is human-induced mortality. Right whales are frequently struck and killed by ships or become fatally entangled in fishing gear, because their migratory routes overlap with major fishing areas and heavily trafficked shipping lanes along the east coasts of the United States and Canada. They are also more frequently killed and entangled because they spend most of their time at the surface, feed at the surface and travel slowly compared to other whales. In addition, the whales are not reproducing consistently or fast enough to increase their numbers—perhaps because of disease, pollutants, poor food supplies or genetic insufficiencies. Right whales reach reproductive maturity at a late age relative to other whales (>9 yrs), produce one calf every 3-6 yrs (a lower frequency than other whales) and only 50% of the calves survive the first year.

An area consisting of Cape Cod Bay and the southernmost portion of the sanctuary was designated a right whale critical habitat in 1994 because of its significance as a feeding area for right whales, which are resident primarily from January through early May. More than half the total population has been sighted in the area since studies began of right whales in the 1980s. Results of ongoing acoustic monitoring of the Stellwagen Bank sanctuary indicate that this species frequents the sanctuary to a greater extent than previously understood.

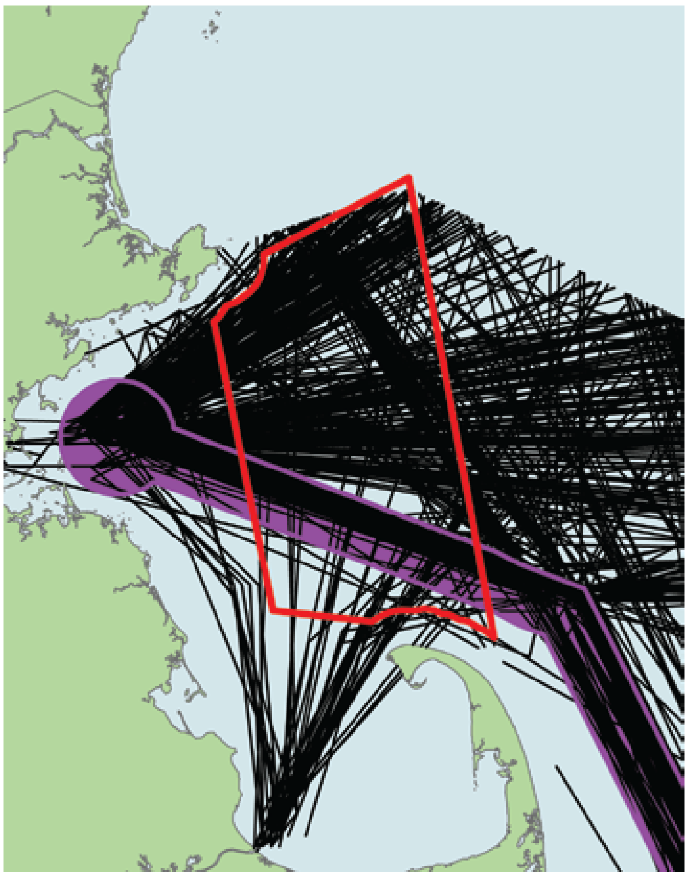


Figure 65. Mandatory ship reporting system (MSRS) data from 1999–2002 showing tracks of large commercial vessels traversing the Stellwagen Bank sanctuary.

Tracks depict only incoming traffic and represent only the straight line projected path of ships as they enter the MSRS zone, hence the straight lines. Only half of the actual traffic is illustrated, because vessels leaving the port are not required to report upon their departure. Tracks going north-south are ships or tugs in tow that are transiting through the Cape Cod Canal. The Boston Transportation Separation Scheme (TSS) (outlined in purple) is a voluntary shipping lane established by the International Maritime Organization (IMO) (data courtesy of NOAA Fisheries Service).

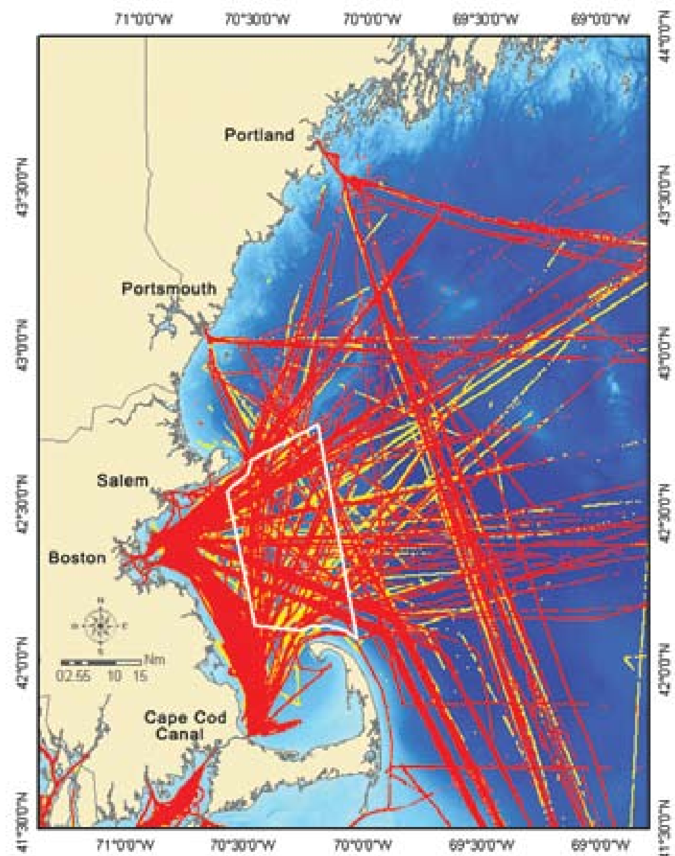


Figure 66. Ship tracks in the Stellwagen Bank sanctuary and western GoM for the months of April and May 2006 derived from the USCG AIS.

The data consist of more than 36 million position records generated along vessel paths at several second intervals from a total of 916 ships. Yellow represents the April tracks overlain by the May tracks in red.

use patterns with areas intensively utilized by boat traffic for fishing, commercial shipping, military shipping and recreational activity. The MMVS AP proposes several strategies to address these issues including re-routing shipping lanes (AP: MMVS.1) and instituting voluntary speed restrictions for vessels other than large commercial ships to mitigate vessel strikes to marine mammals (AP: MMVS.2).

Entanglement

The Stellwagen Bank sanctuary and adjoining area is a hot spot for fishing gear entanglements with whales and has the highest number of reported incidents in the GoM (Figure 67). The area in and around the sanctuary has the highest use (combination of spatial extent and density) of fixed gear vessels (gillnet, lobster and other trap/pot fisheries) anywhere along the eastern seaboard of the United States (Figure 68). Relative to other areas, entanglement reports in the sanctuary area are more frequent, which could reflect an increased rate of entanglement, increased observer effort, or both.

Analysis of scars on humpbacks and right whales in the GoM region indicate that between 50% and 70% of the animals have been entangled at least once in their lives and between 10% and 30% are entangled each year (Robbins and Mattila, 2004). Chronically entangled whales lose blubber reserves making them more likely to sink when they die, thus it is believed that gear-induced mortality is underestimated more than ship kills. A study of the morbidity and mortality of chronically entangled North Atlantic right whales indicates that gear entanglement is a major animal welfare issue as well as being an obvious conservation concern (Moore *et al*., 2000).

Co-occurrence between various marine mammal species and types of fishing gears capable of entangling them are of priority concern in the sanctuary. Such co-occurrence varies on a spatial and temporal basis and Wiley *et al*. (2003) calculated a Relative Interaction Potential (RIP) index to identify hotspots of potential whale entanglement in the sanctuary (Figure 69). This risk analysis predicts that the highest possibility of entanglement within the sanctuary should occur around the southwest and northwest corners of Stellwagen Bank.

The risk of whale entanglement in the sanctuary increases in areas where whales and fixed fishing gear co-occur, as indicated by the shading with the darkest area representing the top quartile of risk (Figure 69). For the study period of July 2001–June 2002, all three sightings (100%) of entangled whales occurred within or in the immediate vicinity of top-quartile cells. For the period 2000–2002, 85% (11 of 13) of entangled whales were found within or in the immediate vicinity of top-quartile cells. Although the locations where entangled whales were sighted are not necessarily the sites of entanglement, the high frequency of entanglements in areas of the sanctuary predicted to be high risk is a compelling correlation.

Tagging data indicate that humpback whales can be extremely active at or within a few meters of the seafloor for many hours (Figure 70) and that bottom feeding is an important strategy (Wiley *et al*., 2005). Therefore, fishing gear anywhere in the water column presents an entanglement risk to the animals. In 95% of flat-bottomed dives in the four humpback whales tracked in this study, the animals exhibited a characteristic "side-roll" behavior along the seafloor (Figure 70). Side rolls involved the animal rolling laterally more than 40 degrees from dorsal and holding that position for a consistent duration, usually more than 10 seconds and less than a minute. The consistency of the behavior is evident from the bimodal distribution of body orientation measurements.

Side-roll behavior is presumed mouth-open feeding during which whales turn on their side to scour the sandy bottom and engulf sand lance burrowed in or located along the seafloor. This behavior indicates that the likelihood of entanglement by open mouth and protruding appendages (flippers and tail) would be elevated during bottom feeding bouts in areas with co-occurrence of fixed fishing gear strung across the ocean bottom. In a study of 30 cases of entangled humpback whales (Johnson *et al*., 2005), the most common

Figure 67. Sighting locations of whales reported entangled in fishing gear in the Stellwagen Bank sanctuary and GoM between 1985 and 2006.

Note: entangled whales can tow gear for long distances and the location of reported sightings might or might not be the original site of entanglement. Source: Provincetown Center for Coastal Studies.

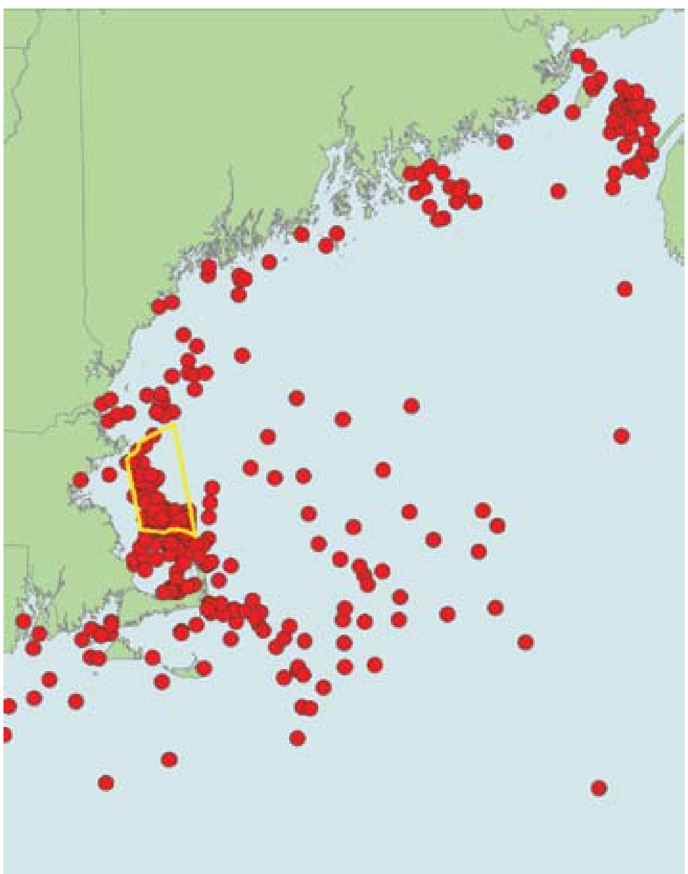


Figure 68. Distribution and density of number of active fixed gear fishing vessels (gillnet, lobster, and other trap/pot fisheries) from Virginia to Maine during 2004.

While not pictured here, few fixed gear fisheries occur in the Virginia to Florida area. Graphic based on VTRs and federal lobster permit data analyzed by 10 x 10 minute grid cell. Analysis does not include state-only permitted vessels. Source: Industrial Economics, Inc./NOAA Fisheries Service, NERO.

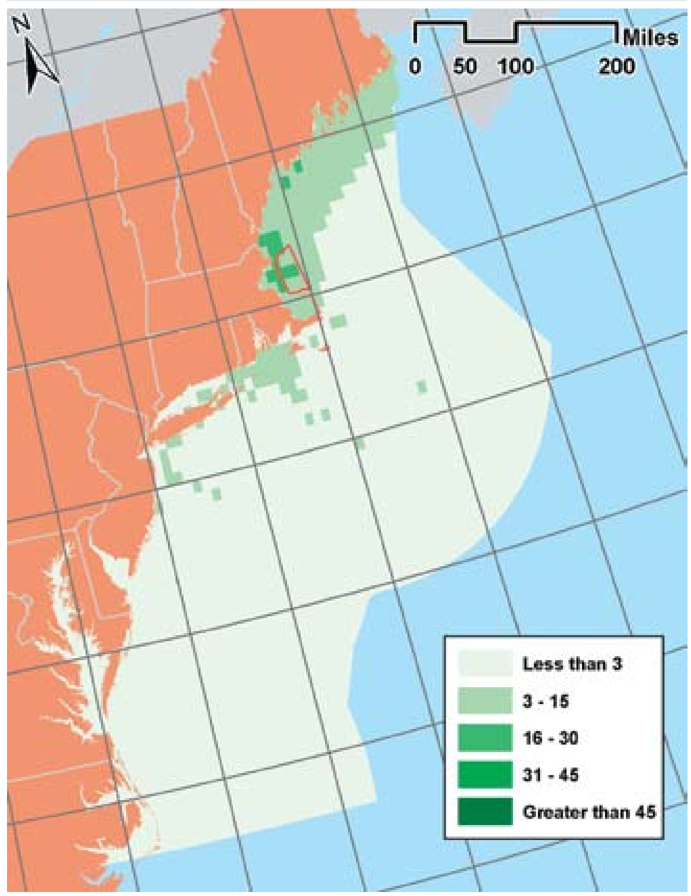
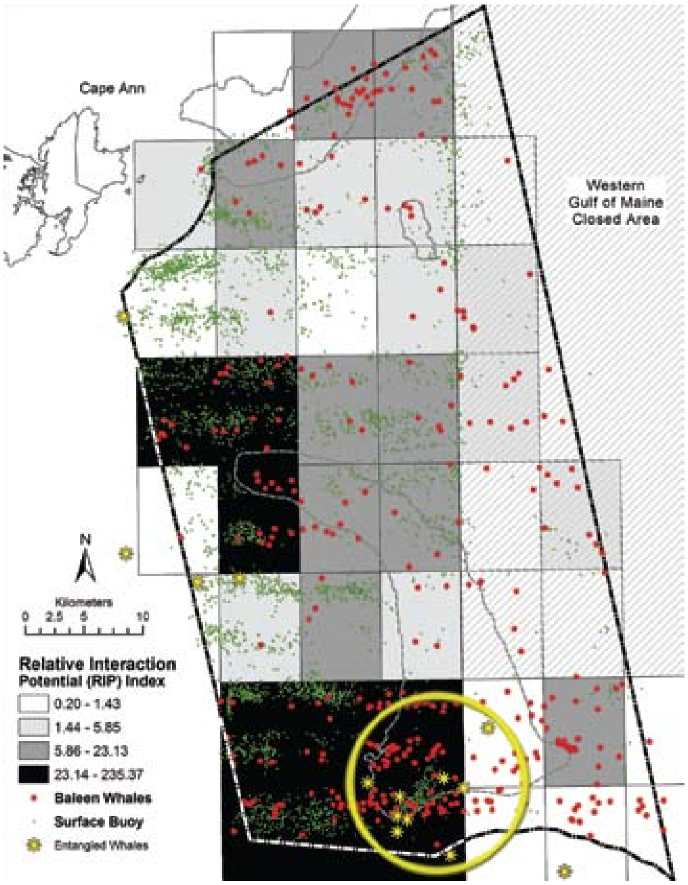


FIGURE 69. RELATIVE INTERACTION POTENTIAL (RIP) INDEX SHOWING THE POTENTIAL FOR INTERACTION BETWEEN BALEEN WHALES AND FIXED FISHING GEAR IN THE STELLWAGEN BANK SANCTUARY, BY 5-MINUTE SQUARE AREA.

The index was calculated by multiplying the total number of fixed gear surface buoys within a 5-minute square by the total number of whales sighted in that square. Data were collected from July 2001 through June 2002 for calculation of the index. Yellow symbols depict where entangled baleen whales were sighted during 2000-2002. (Source: adapted from Wiley *et al*., 2003)



point of gear attachment was the tail (53%) and the mouth (43%) which seems to affirm this inference.

The immediate effects of entanglement include mortality by drowning as well as serious and minor injuries such as lacerations. Long-term effects can include deteriorating health and susceptibility to disease, crippling deformation and impaired body function, and decreased competitive and reproductive ability. Marine mammal species reported in the sanctuary that are most susceptible to entanglement include baleen whales, harbor porpoises, white-sided dolphins and harbor seals.

Most cetacean bycatch in the sanctuary (and the GoM) is associated with the sink gillnet fishery, although entanglements have also been documented in lobster pots, purse seine and bottom trawl gear (Smith *et al*., 1993; Johnson *et al*, 2005). Derelict fishing gear (i.e., "ghost nets") is also suspected to cause entanglement. The incidental catch of harbor porpoise and Atlantic white-sided dolphin has been documented for gillnet fisheries in the GoM (Gilbert and Wynne, 1987; Waring *et al*., 1990; Smith *et al*., 1993). Reducing incidental mortality in fisheries through time/area closures, gear modification, and disentanglement rescue and release efforts are management solutions to address entanglement problems.

REDUCED FORAGE BASE

Atlantic herring accounted for the greatest volume by species landed from the Stellwagen Bank sanctuary during 1996–2005 (refer to subsection on commercial fishing in the Status of Human Uses section of this document for data source and details). Sand lance are not commercially fished within the sanctuary (refer to subsection EA.3 Action Plans in this document for expanded discussion of sand lance as prey). For the years 1996–2005, a total of 70.1 million pounds (31,799 mt) or an average 7.0 million pounds (3,180 mt) of herring per year were removed from the sanctuary by commercial fishing (Table 10). Herring removal in this amount by fishing reduces the forage base available to marine mammals, fish and seabirds in the sanctuary, could cause local prey depletion, and thereby could be a factor determining the local abundance of whales, dolphins and other wildlife in the sanctuary. What is meant by the term "local depletion" is explained in the accompanying Sidebar.

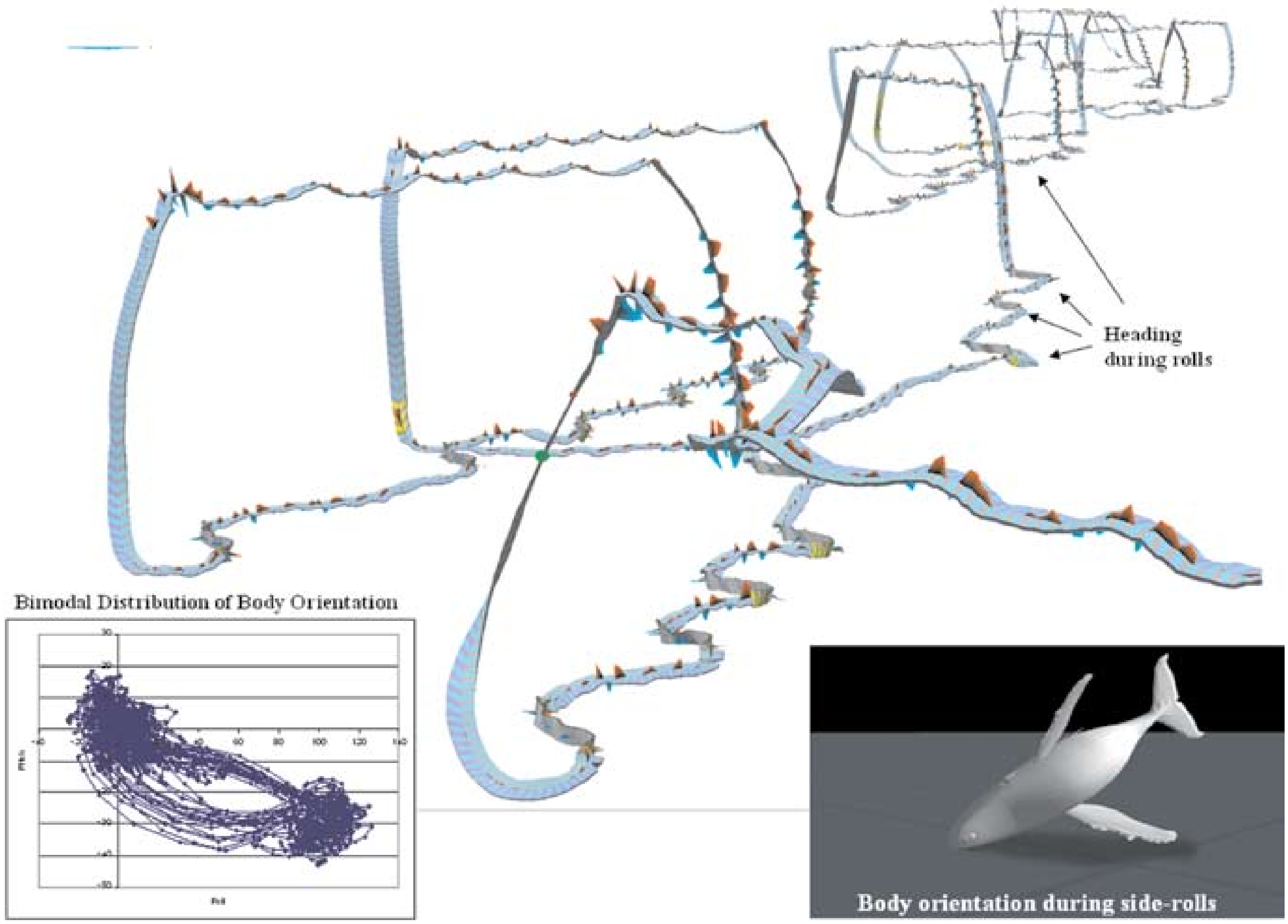
The spatial distribution of commercial herring fishing in the sanctuary, based on pounds caught and landed by all gear types during 1996–2005, is presented in Figure 71. Landings were greatest from around Jeffreys Ledge and parts of Stellwagen Bank. A variety of gear types, consisting of mid-water pair trawl, mid-water otter trawl and purse seine, was used in the early years (1996–2001), but thereafter commercial herring fishing in the sanctuary was dominated by pair-trawling (Figure 72).

According to recent stock assessments, herring are currently not overfished and no overfishing is occurring (http://www.nefmc.org/herring/index.html). Fishery management plans (FMPs) require that annual harvest levels are specified consistent with scientific advice. However, scientific models used in these stock assessments have suggested that total herring biomass may be overestimated and fishing mortality underestimated. In addition, abundance surveys in the inshore GoM are indicating a declining trend, thereby adding to the scientific uncertainty associated with these population analyses. The inclusion of biological interactions and their impacts in stock assessments and multispecies models is an important step in predicting sustainable yields and developing realistic estimates of biological reference points for key prey species (ICES, 1989; Overholtz *et al*., 1991; Hollowed *et al*., 2000). This has not been done in the herring FMP. Lacking these considerations, an over-optimistic picture of sustainable yield may result, and important trophic links may be severed if a prey resource is overfished (Overrholtz and Link, 2007).

The fishery for herring harvests the same size groups that predators (whales, dolphins) consume and is in effect in

Figure 70. Three-dimensional ribbon track of a tagged humpback whale showing extensive interdependent use of seafloor and water column during foraging along the bottom.

Twists in the ribbon correspond to side rolls by the animal. Also shown is the bimodal distribution of body orientation (0,0: normal dorsal superior swimming position; 100,30: body rolled ~100° and pitched down ~30°) and a visualization of the body roll and pitch used during suspected bottom feeding. Ribbon tracks were developed by Colin Ware (University of New Hampshire). (Adapted from Wiley *et al*., 2005).



competition with them (Overholtz *et al*., 2000); fishermen fishing for pelagic prey species (such as herring) adopt the same foraging strategy as natural predators (Bertrand *et al.*, 2007). Modeling simulation of the relationship between minke whale abundance and herring fisheries catch in the North Atlantic ecosystem shows interactions that are mainly linear and inverse (Schweder *et al*., 2000). Of consequence in discussing the issue of fishery induced prey depletion, is the fact that baleen whales (humpback, fin and minke) require a minimum threshold level of prey density to successfully forage (Piatt and Methven, 1992) and that humpback whales depend on the spatial characteristics and density of the prey school to maximize their feeding efficiency when surface feeding (Friedlaender *et al*., in review).

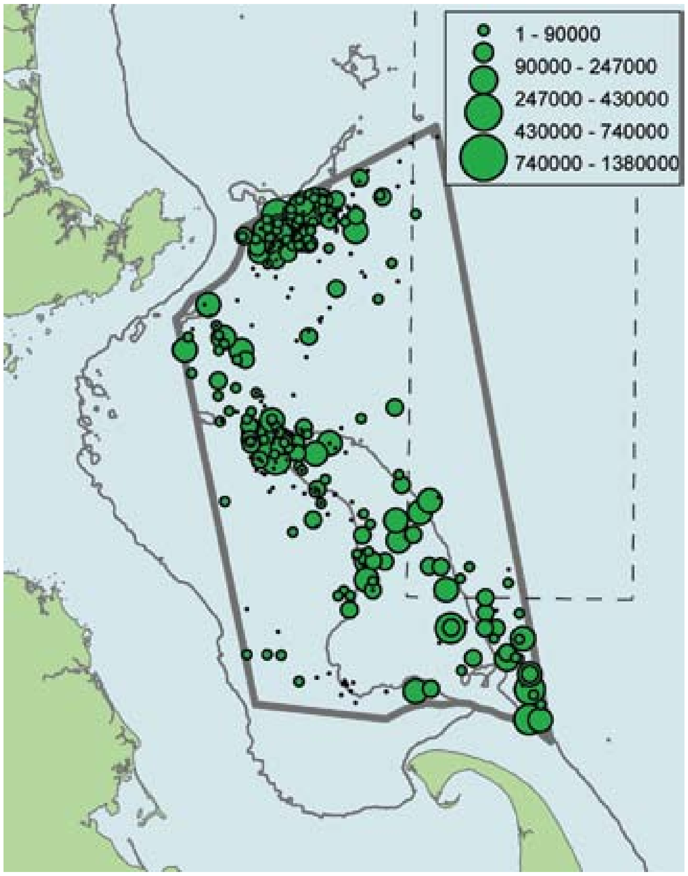
Prey patchiness tends to increase with mean prey density, so depletion of prey stocks by fishing may rapidly reduce numbers of suitable prey aggregations. Marine mammals are typically aggregated prey patch foragers. Thus local changes in prey abundance may be more important than changes across the entire stock range, i.e., GoM. Management to

LOCAL DEPLETION

The scientific meaning of the term “local depletion” derives from the fact that the assumption of unit stocks (regionally interbreeding populations that are reproductively closed) is being rethought in the scientific literature based on new findings. In modern parlance, a stock is actually a “metapopulation” comprising local populations linked by larval dispersal, rather than the older and often false assumption of a larger, spatially discrete and reproductively isolated population. Recent genetic and otolith microchemical studies indicate that marine stocks have complex spatial structures at much smaller scales than previously assumed. The important implication of these findings is that a decline in fish abundance in one area may not be replenished quickly or inevitably from another area. This creates the possibility for localized overfishing and local depletion (Francis *et al*, 2007).

Figure 71. Spatial distribution of commercial herring fishing in the Stellwagen Bank sanctuary during 1996–2005.

Area of circle is proportional to pounds of herring caught and landed from that location. Source: NOAA Fisheries Service VTR data selected for the sanctuary area.



avoid depletion of the prey fields composed of herring and sand lance by fisheries in local areas of critically important foraging habitat for marine mammals, such as the sanctuary, may be needed. Also the sanctuary is a hotspot for prey abundance (see Figure 46 and associated text). An important characteristic of pelagic forage fish hot spots is their persistence, allowing predators to predict their locations and concentrate search efforts to enable optimal foraging (Gende and Sigler, 2006). Fishing down prey aggregations in SBNMS diminishes the reliability and functional utility of this important attribute of the sanctuary.

While reductions in prey abundance might not always be sufficient to directly cause a predator species population to decline *per se*, they can cause shifts in predator species distribution which affects local predator abundance. Local changes in humpback whale abundance and distribution in the western North Atlantic have been correlated with variation in prey availability (Payne *et al*., 1986; Weinrich *et al*., 1997). A negative relationship was shown between the relative abundance of herring and sand lance in the GoM and humpback whale movement from the GoM to eastern Canada when prey densities dropped (Stevick *et al*., 2006). This study also found that humpback whales exhibited high levels of site fidelity to specific feeding grounds and that the duration of stay at, and tendency to return to, each feeding ground was related to relative prey density. Since activities that remove biomass (i.e. reduce prey density) simultaneously disrupt prey patch configuration, extraction can have a cumulative negative impact on predators. These impacts would be greatest during periods of natural prey decline, during which additional removal by fishing would hasten the decrease of prey and cause whales and other predators to leave the sanctuary earlier than would have occurred under conditions of non-extraction.

The ease and impacts of such departures by endangered whales from the sanctuary to other parts of the GoM might not be trivial. Recent investigation (Robbins 2007) has determined that despite inter-annual variation, the sanctuary is a site of persistent humpback whale aggregation, thus animals are reticent to leave the area even when faced with reduced prey. Robbins (2007) also determined that the sanctuary is preferentially used by juveniles and reproductively mature/active females. These classes typically play important roles in large mammal population dynamics because of their sensitivity to environment and/or population density (juveniles) and importance to population growth (adult females). Thus, the preferential and persistent use of the sanctuary by the most important segments of this endangered whale population indicate that management actions specific to the sanctuary could benefit the population as a whole (Robbins 2007). Assuring an adequate prey base is a key component of such management, as the growth requirement of juveniles and the increased nutritional cost of lactation would require high rates of prey consumption.

While less data exist for other species, similar conditions might exist. For example, Agler *et al.* (1993) found that fin

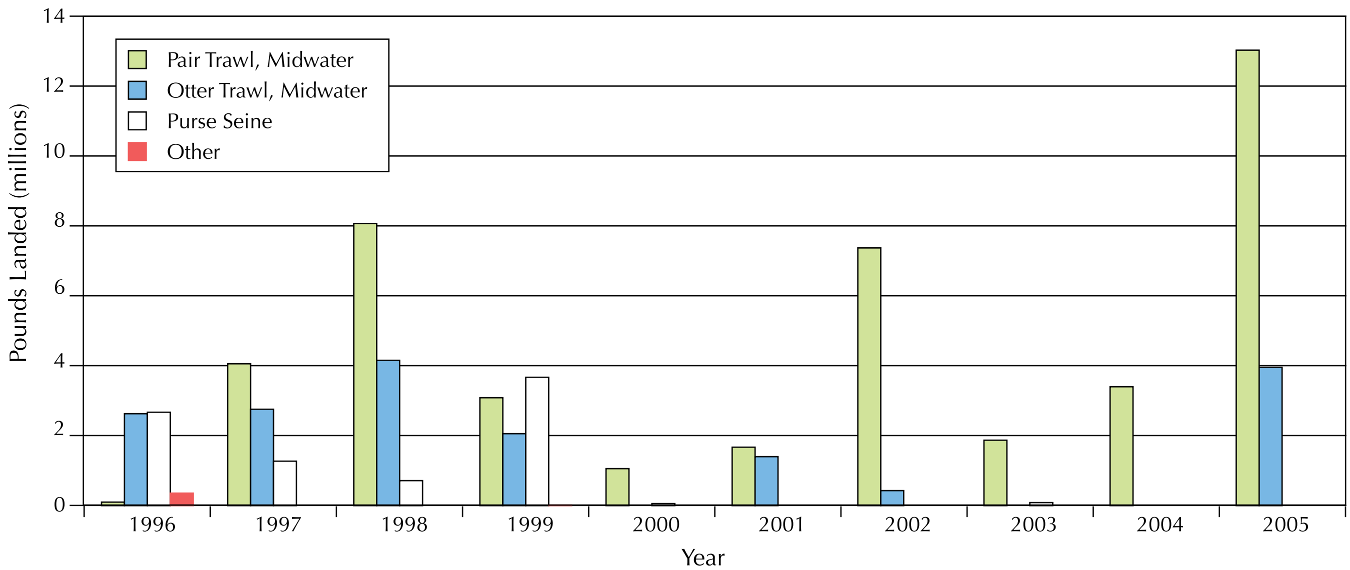
Table 10. Herring landings (millions of pounds) from the Stellwagen Bank sanctuary by gear type (1996–2005).

Gear Type	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total
Pair Trawl, Midwater	95	4,060	8,083	3,098	1,060	1,676	7,383	1,881	3,407	13,057	**43,800**	**62.5**
Otter Trawl, Midwater	2,627	2,761	4,162	2,064	0	1,406	430	0	0	3,971	**17,421**	**24.9**
Purse Seine	2,680	1,274	710	3,682	60	0	0	80	0	0	**8,486**	**12.1**
Other *	358	3	4	8	0	0	0	2	4	0	**378**	**0.5**
Total	**5,760**	**8,098**	**12,958**	**8,852**	**1,120**	**3,082**	**7,813**	**1,963**	**3,411**	**17,028**	**70,085**	**100.0**

* Other includes: otter trawl, bottom, fish; gill net, sink; hand line/rod & reel; otter trawl, shrimp; and mixed gear.

Figure 72. Herring landings in pounds by fishing gear type and year from the Stellwagen Bank sanctuary during 1996–2005.

Source: NOAA Fisheries Service VTR data selected for the sanctuary area.



whales in the southern GoM had higher reproductive rates than those in the northern areas. These results are similar to those reported for humpbacks (Robbins 2007) and might result from a similar preference for adult females to use the sanctuary. Thus, increased prey availability at the scale of the sanctuary could have a population level impact on that endangered species as well.

It is unclear whether herring fishery management adequately accounts for the energetic requirements of species that rely on herring such as large whales (i.e., humpback, fin, minke), pinnipeds, seabirds, and piscivorous fish (i.e., bluefin tuna, cod, bluefish, striped bass), but such knowledge is consequential to ecosystem-based management of the sanctuary. One recent study suggests that stock assessment models for herring in the GoM seriously underestimate the amount of herring needed to sustain not only the fishery but also the biota that relies on healthy herring populations (Read and Brownstein, 2003). The following illustration implies no defined need for whales and dolphins to remain within the sanctuary, nor is there any such expectation. However, there is the expectation that whales will be able to feed optimally and realize net benefit without competition from fishing while in the sanctuary.

The herring landings from the sanctuary reported above can be converted to an equivalent number of marine mammals that could be supported in the sanctuary, if the herring were not extracted by fishing. This illustration uses a measure of consumption of herring by whale and dolphin species for representative terms of residency in the GoM based on Read and Brownstein (2003). The average landings of 3,180 mt of herring per year from the sanctuary are equivalent to the annual forage required to support approximately: 219 fin whales or 253 humpback whales or 499 minke whales or 2,978 Atlantic white-sided dolphins, for example. The results derived from these calculations are exclusive to each of the four species of marine mammals considered and only allow general inference. In actuality, a mix of marine mammal species and multiple piscivorous sea birds and fishes would consume the herring if they were not caught (Overholtz and Link, 2006).

Herring and sand lance are keystone prey species that constitute a major segment of the forage base of the sanctuary. The species affected by the removal of herring by fishing include those (e.g., whales, cod, blue fin tuna) central to supporting tourism and recreation in the sanctuary, which are activities that generate direct sales far greater in value than the ex-vessel landings of the herring *per se*. For example, annual direct sales value for commercial whale watching in the sanctuary was approximately $24 million in 2000 (Hoyt, 2001); ex-vessel value for herring landings from the sanctuary that year was $64 thousand (fishing Vessel Trip Report [VTR] data, NOAA Fisheries Service); ex-vessel value for herring landings from the sanctuary for the decade (1996–2005) was $5.4 million (Table 15, Commercial Fishing section of this document). The total volume of herring removed annually by commercial fishing in the sanctuary (and accompanying disruption of prey fields) may be sufficient to reduce the amount of prey available to attract and sustain a broad array of sanctuary fish and wildlife and to diminish the economic and social activities ultimately dependent on them.

Pollution and Chemical Contaminants

The environment of the Stellwagen Bank sanctuary provides feeding and nursery areas for humpback, fin, sei, minke and North Atlantic right whales, the latter being the most critically-endangered of all large cetacean species. Cetaceans are key predators of small fish and zooplankton and they exhibit low fecundity relative to many other marine animals.

These biological characteristics, coupled with their sensitive dependence on specific prey types, mean that cetaceans also function as important bioindicators of the health and productivity of marine ecosystems (Reijnders *et al*., 1999; Greene *et al*., 2003).

Pollution in the form of dredge spoils, ocean dumping and disposal, and noise, as well as chemical contaminants may affect the health and survival of baleen whales (Perry *et al*., 1999; Reeves *et al*., 2000; Rolland *et al*., 2005). Sand lance is a key species within the sanctuary and serves as the primary prey of humpback whales and other baleen whales in the sanctuary. The populations of key species, such as sand lance, are highly variable, and fluctuate widely from year to year, with concomitant effects on consumers, such as whales. Although contaminant concentrations have not been determined for prey species (e.g., sand lance) to date, predator-prey relationships are important pathways to consider when evaluating possible adverse effects of contaminants on the health of marine mammals.

In addition to point-source pollution that may affect food webs (e.g., chemicals from discharge sites and dumping), the atmospheric transport of contaminants represents a global danger (Reeves, 2003). Exceptionally high levels of chemical contaminants in the tissues of cetaceans may be affecting the animals' immune and reproductive systems (Reeves, 2003). For example, Weisbrod *et al*., (2001) found elevated levels of organochlorine in pilot whales and Atlantic white-sided dolphins from the southern GoM, with the later considered to have bioaccumulated hazardous concentrations of polycholorinated biphenals (PCBs) and chlorinated pesticides. In addition, a wider range of PCBs and pesticides have been detected in baleen whale species, including the endangered right whale, although concentrations were not considered hazardous (Weisbrod *et al*., 2000).

Cetacean exposure to marine biotoxins associated with harmful algal blooms (HABs) has been documented in the GoM (Doucette *et al*., 2006). The dinoflagellate genus *Alexandrium*, which produces paralytic shellfish poisoning (PSP), blooms at the time of right whale abundance. The trophic transfer of marine toxins has been hypothesized to be a contributing factor to the poor recovery of the North Atlantic right whale, although neither chronic nor sublethal effects are known for cetaceans (Durbin *et al*., 2002). Similarly in 1987, 14 humpback whales washed ashore dead and decomposed along Cape Cod Bay and Nantucket Sound. The cause of this unprecedented stranding of large baleen whales was attributed to a naturally occurring neurotoxin called saxotoxin or STX (Geraci *et al*., 1989). Additionally, marine debris pollution (e.g., from ingestion of plastic bags) and its impact on marine animal populations is a global problem, which is extremely difficult to evaluate (Laist *et al*., 1999).

Current Protection

The protection of marine mammals in the sanctuary is provided through the following laws, regulations, and guidelines:

- National Marine Sanctuaries Act (NMSA) of 1972 (16 U.S.C. § 1432 et seq.)
- SBNMS Regulations (15 CFR § Subpart N)
- Marine Mammal Protection Act (MMPA) of 1972
- Endangered Species Act (ESA) of 1973
- NOAA Voluntary Whale Watch Guidelines

Sanctuary regulations prohibit the taking or possessing (regardless of where taken, moved or removed from), except as necessary for valid law enforcement purposes, of any marine reptile, marine mammal or seabird in or above the sanctuary, except as permitted by the Marine Mammal Protection Act, as amended, (MMPA), 16 U.S.C. 1361 et seq., the Endangered Species Act, as amended, (ESA), 16 U.S.C. 1531 et seq., and the Migratory Bird Treaty Act, as amended, (MBTA), 16 U.S.C. 703 et seq. All marine mammals while in or transiting the sanctuary are sanctuary resources. Five species of baleen whales are endangered (Table 8).

The MMPA and ESA prohibit the "taking" of a marine mammal (i.e., "harass, hunt, capture or kill") without authorization. The relevant definition of the term "harassment" means any "negligent or intentional act which results in the disturbing or molesting of marine mammals" causing by disruption of "behavioral patterns, including, but not limited to migration, breathing, nursing, breeding, feeding, sheltering" {16 U.S.C. 1362(13)}. All marine mammals are federally "protected" by the MMPA and most large whales are further listed as "threatened or endangered" under the ESA.

Behavioral Disturbance

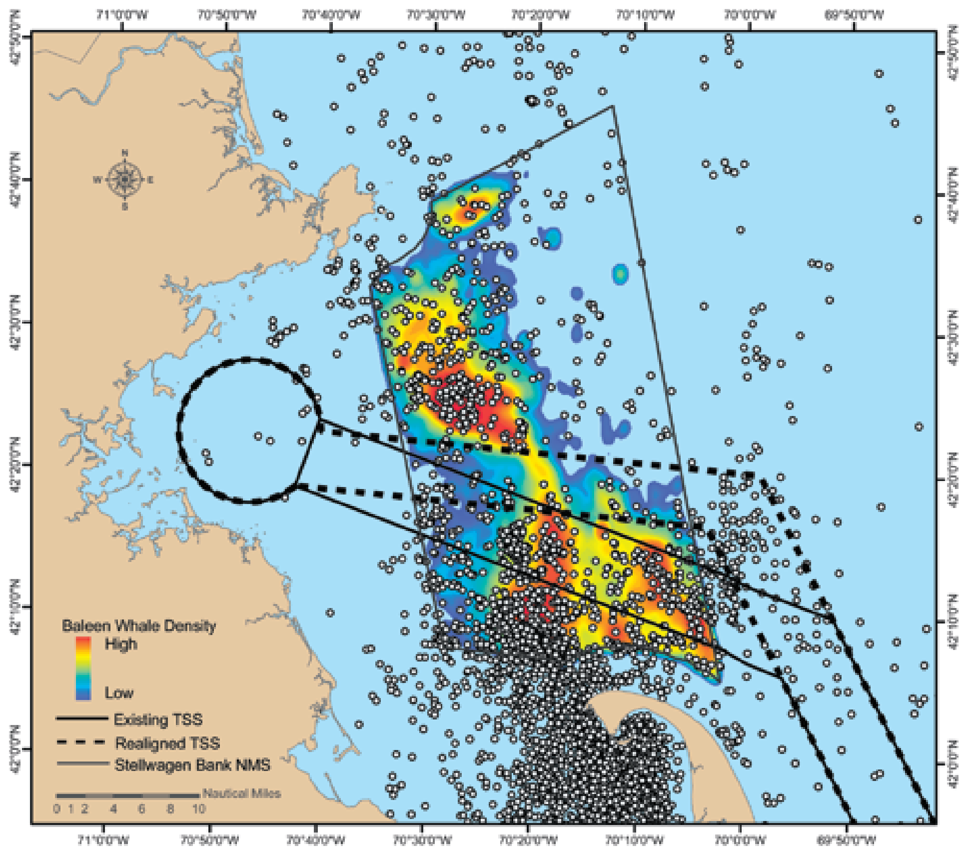
NOAA regional whale watch *guidelines* are intended to prevent harassment and possible injury or death to large whales by both commercial and recreational vessels (Appendix M). The North Atlantic right whale is protected by separate State and Federal *regulations* that prohibit approach within 500 yards (457 m) of this species (50 CRF 222.32). Any vessel finding itself within the 500-yard buffer zone created by a surfacing right whale must depart immediately at a safe slow speed. The only vessels allowed to remain within 500 yards of a right whale are vessels with appropriate research permits, commercial fishing vessels in the act of hauling back or towing gear, or any vessel given prior approval by NOAA Fisheries Service to investigate a potential entanglement. Except for the North Atlantic right whale, no federal rule regulates how vessels behave around whales in the northeast region.

The Stellwagen Bank sanctuary has no overflight restrictions governing airplane activity. To date, guidelines or legislation regarding sound (acoustic) energy and the need to manage it appropriately do not exist. NOAA Fisheries Service published a notice of intent on 11 January, 2005, in the Federal Register (70 FR 1871) to prepare an EIS to analyze the potential impacts of applying new criteria in guidelines to determine what constitutes a "take" of a marine mammal under the MMPA and ESA as a result of exposure to anthropogenic noise in the marine environment.

Vessel Strike

Figure 73. Realignment of the shipping lanes (TSS) into the Port of Boston by the International Maritime Organization to reduce the risk of ship strikes to baleen whales in the Stellwagen Bank sanctuary.

Analysis based on non-standard whale sightings (n=~255,000) from commercial whale watching vessels from 1979-2004 overlain with right whales sightings (circles) from the Right Whale Consortium database (n=5,675). Kriged density plots of whale watch derived sightings were produced using a 5,000 m search radius analyzed using ESRI ARCGIS; whale watch data were collected by the Provincetown Center for Coastal Studies and the Whale Center of New England.



NOAA issues ship speed advisories using NOAA-based communications to help reduce ship strikes to North Atlantic right whales. The NOAA National Weather Service issues right whale advisories and speed advisories on NOAA weather radio when aggregations are sighted. Advisories are voluntary and apply to areas where right whales sightings have been confirmed; they indicate that neither navigational nor human safety is to be jeopardized as a result of reduced speeds or other maneuvers to reduce the risk of striking a whale. Speed advisories have also been integrated into many NOAA publications. Ships reporting into the Mandatory Ship Reporting System receive an automated message indicating precautionary measures to be taken to avoid hitting whales, including speed advisories (Ward-Geiger *et al*., 2005).

Current efforts to reduce occurrence of North Atlantic right whale deaths and serious injury from ship strikes have not been sufficient to recover the species. NOAA is proposing regulatory measures, as part of the NOAA Ship Strike Reduction Program, designed to significantly reduce the likelihood and severity of collisions with right whales while also minimizing adverse impacts on ship operations. NOAA rulemaking proposed vessel speed restrictions of 10, 12 or 14 knots or less in areas and during time periods where right whales are predicted to be most prevalent; sightings outside these times and areas could also trigger management actions under some alternatives (FR 7-26-06). These regulations, pursuant to rulemaking authority under MMPA section 112(a) (16 U.S.C. 1382(a)) and ESA 11(f) (16 U.S.C. 1540(f)), are also consistent with the purpose of the ESA "to provide a program for the conservation of [...] endangered species" and "the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species [...] and shall utilize their authorities in furtherance of the purposes of [the ESA]."

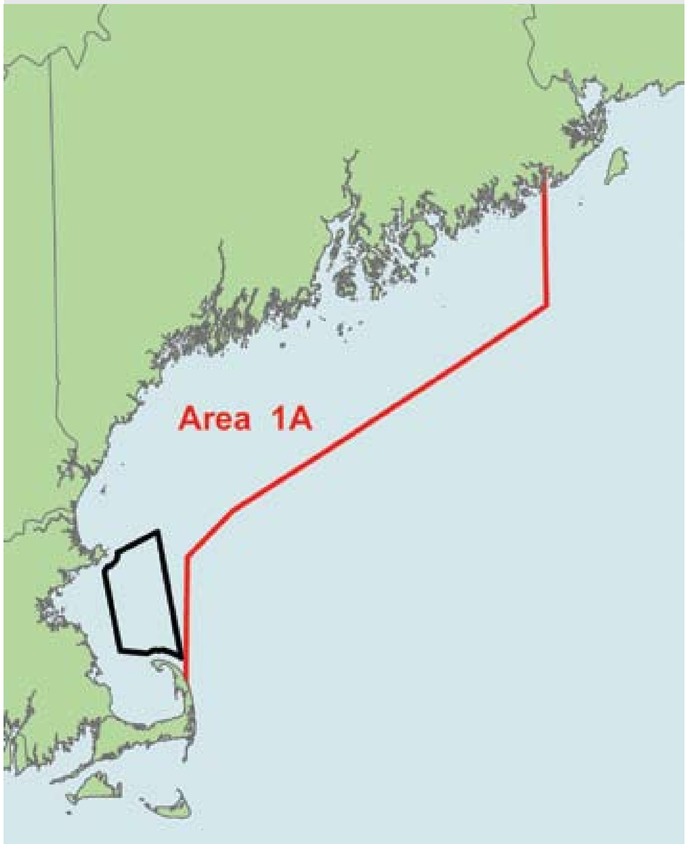
On December 12, 2006, the International Maritime Organization approved a proposal submitted by the USCG on behalf of NOAA to narrow and move the Boston area Traffic Separation System (TSS) (i.e., the shipping lanes that cross the sanctuary to and from the Port of Boston) 12 degrees to the north (Figure 73). The proposal was developed by the Stellwagen Bank sanctuary in collaboration with NOAA Fisheries Service, NOAA General Counsel (International) and the USCG. The lane shift greatly reduces the risk of vessels striking whales—by up to 81% for all whales (humpback, fin, minke, northern right) and by up to 58% for the critically endangered right whale—while minimally impacting shipping interests. The conservation benefit is realized by moving the TSS away from areas of historical high use by whales over prime feeding habitat. This action is strategy AP:MMVS.1 recommended in this document.

Entanglement

Besides MMPA and ESA mandates, a number of existing regulations and plans designed to reduce the risk of marine mammal entanglement in the Northeast apply to, but are not specific to, the sanctuary. Regulations that are most applicable to marine mammal entanglement within the sanctuary are those pertaining to trap/pot fisheries and gillnet fisheries. Examples are:

- Federal lobster trap limits
- Lobster trap gear identification

Figure 74. Location of the Stellwagen Bank sanctuary relative to Area 1A in the herring fishery management plan.



- Lobster trap maximum size
- Trap/pot gear restrictions
- Lobster trap gear configuration
- Special restrictions on critical habitat areas
- Reconfiguration of anchored gillnet gear
- Multispecies sink gillnet regulations (aimed at rebuilding overfished groundfish stocks)
- Seasonal and rolling closure areas
- Gear stowage requirements

The Atlantic Large Whale Take Reduction Plan (NOAA, 2007) addresses broad-based gear modifications and special management areas to reduce serious injury and mortality of right, humpback and minke whales due to incidental interactions with commercial fisheries.

Reduced Forage Base

Amendment 1 to the Atlantic Herring Fishery Management Plan was developed by the NEFMC and submitted to NOAA Fisheries Service on May 3, 2006. Notice of the final rule implementing Amendment 1 was published on March 12, 2007 (72 FR 11252). Of significance to the Stellwagen Bank sanctuary is how the commercial herring fishery impacts the forage base of the sanctuary, particularly in regard to Area 1A which entirely overlaps the sanctuary (Figure 74).

Relative to the 2005/2006 total allowable catches (TACs) of herring, the 2007 fishery specifications reduced the Area 1A TAC by 10,000 mt (17%), modified the seasonal split of the Area 1A TAC, and increased the Area 3 TAC by 5,000 mt. Domestic annual harvest for the fishery was set at 145,000 mt, domestic annual processing was set at 141,000 mt, and there was no specification for either total allowable level of foreign fishing or total joint venture processing. The 2007 fishery specifications provided the opportunity for total U.S. fishery landings to increase about 35% above recent (1995–2005) levels.

However, when implementing multi-year specifications for 2007–2009, NOAA Fisheries Service determined that the 2008 and 2009 specifications should include an additional reduction in the Area 1A TAC with a corresponding increase in the Area 3 TAC. As a result, the Area 1A TAC was reduced another 5,000 mt to 45,000 mt, and the Area 3 TAC was increased another 5,000 mt to 60,000 mt. All other specifications remain the same for 2008 and 2009. In addition, the research set-aside program became effective in 2008, and 3% of each management area TAC has been set-aside to support herring-related research. The information in this and the previous paragraph is from the NEFMC "Herring Fishery Specifications for the 2007–2009 Fishing Years."

From the perspective of the sanctuary, the key component of the actions taken is the 10,000 mt (17%) reduction in 2007 and additional 5,000 mt reduction specified for 2008 and 2009 in Area 1A TAC. This reduction is three to five times the total average annual landings (3,180 mt) of herring caught in the sanctuary over 1996–2005 and is more than the highest single year landings in the sanctuary to date (7,726 mt) made in 2005.

While the numeric level of reduction seems appropriately scaled to address the concern of diminished prey base in the sanctuary, that concern would only be fully addressed if the TAC were harvested entirely outside of the sanctuary (for reasons explained in the previous subsection on Reduced Forage Base and subsequently under Action Plan Objective EA.3). Thresholds for prey density as well as the shape and spatial integrity of prey fields are determinants of the optimality of humpback whale foraging in the sanctuary; both of these conditions are degraded by herring fishing. And the calculations underlying the determination of the TAC do not include empirical estimates of herring consumption by whales or other key predators in the sanctuary.

Maritime Heritage Resources

National Marine Sanctuary Program (NMSP) regulations define "historical resource" as any resource possessing historical, cultural, archaeological, or paleontological significance, including sites, contextual information, structures, districts and objects significantly associated with or representative of earlier people, culture, maritime heritage, and human activities and events. Historical resources include "submerged cultural resources" and also include "historical properties," as defined in the National Historic Preservation Act.

The term "historical resource" as used in the NMSP regulations also encompasses prehistoric archaeological sites; therefore, the NMSP's Maritime Heritage Program prefers the term "maritime heritage resource." "Maritime heritage resource" is defined as any shipwreck or other site or object that is of archaeological, historical, or cultural significance found in, on or under the submerged lands, including sunken State craft.

Maritime heritage resources in the Stellwagen Bank sanctuary require management as mandated by the NMSA and sanctuary regulations. In addition, there is a limited relationship of maritime heritage resources to biodiversity conservation consisting of the role that shipwreck structures serve as substrate for epibenthic organisms and shelter for fishes and invertebrates that warrants consideration.

Status

Uncounted prehistoric and historic archaeological sites lie within the Stellwagen Bank sanctuary. The sanctuary's position at the mouth of Massachusetts Bay places it astride the historic shipping routes and fishing grounds for such historic ports as Gloucester, Salem, Boston, Plymouth and Provincetown. These ports have been centers of maritime activity in New England for nearly 400 years. As a result of man's long association with the sea, the sanctuary contains a broad cross-section of this nation's maritime heritage. The only archaeological resources identified to date in the sanctuary are shipwrecks

The Stellwagen Bank sanctuary has been actively pursuing maritime heritage research since 2000. The sanctuary has relied heavily on a partnership with NOAA's Undersea Research Center—University of Connecticut (NURC-UConn) to access appropriate tools, including side scan sonar, remotely operated vehicles (ROVs) and skilled pilots, to investigate maritime heritage resources. The sanctuary has also benefited greatly from the generosity of independent researchers, such as John Fish and Arnold Carr of the American Underwater Search and Survey, who have provided locations or information about sanctuary maritime heritage resources.

The sanctuary's research has been focused along two paths: locating maritime heritage resources and characterizing those resources. Prior to 2000, the sanctuary was unaware of the precise location of any such sites within its boundaries. Since 2000, the sanctuary has conducted nine research cruises that utilized side scan sonar to survey the seafloor and identify potential maritime heritage resources. These surveys have mapped 85 square kilometers (32.8 square miles) of the sanctuary's seafloor, or approximately four percent of the sanctuary's total area.

As potential maritime heritage resources were located, the sanctuary began to characterize the resource utilizing the appropriate technology. Maritime heritage resources shallower than 130 feet were investigated by researchers utilizing SCUBA (Self-Contained Underwater Breathing Apparatus). Divers recorded diagnostic features with still and video photography, measurements and scaled drawings. Sites monitored repeatedly were examined for changes in each vessel's structure and artifact assemblages. Maritime heritage resources beyond recreational diving limits were investigated with an ROV carrying lights and digital still and video cameras. The ROV's cameras recorded diagnostic features, and its scaling lasers provided dimensions of these features. The large size of several of the sanctuary's shipwrecks, notably the *Portland* and *Frank A. Palmer/Louise B. Crary,* and the time-consuming delays to avoid entangling fishing gear on these sites, have caused site characterization to be ongoing.

Beginning in 2003, the sanctuary instituted a monitoring program for the steamship *Portland* and *Frank A. Palmer/Louise B. Crary*. Each year since, the sanctuary researchers have returned to the sites with an ROV to monitor artifacts and structures for change. At both shipwreck sites, researchers have noted changes to artifact assemblages and deterioration of wooden structure. The sanctuary also periodically revisits other maritime heritage resources to document site changes. The Stellwagen Bank sanctuary has adopted a policy of *in situ* preservation as its preferred preservation method for maritime heritage resources. This policy is recognized by the international community through the United Nations Education, Scientific, and Cultural Organization (UNESCO) Convention on the Protection of Underwater Cultural Heritage's objectives and general principles.

Maritime heritage resources begin to deteriorate shortly after submersion in a saltwater environment. The physical and chemical oceanographic aspects of the ocean, such as waves, currents, salinity, and pH erode and corrode cultural material, while biological and biochemical activities of organisms, such as wood boring mollusks and bacteria, contribute to the natural deterioration of archaeological sites. The specific environment in which an archaeological site is located greatly influences how rapidly the site will deteriorate. The sanctuary's low energy deep muddy basins preserve an archaeological site much longer than the much more dynamic top of Stellwagen Bank. Additionally, the composition of submerged artifacts greatly affects how long the item will remain in the archeological record. In general, organic material, such as wood and fabric, does not last as long as iron, brass or ceramics.

Archaeological sites reach equilibrium with the environment after a period of deterioration. Corrosion products enclose ironwork, insulating it from rapid oxidation. Likewise, anoxic sediment covers hull remains greatly reducing biological and biochemical consumption. Archaeological sites can last for thousands of years, as evidenced by classical Greek shipwrecks found in the Mediterranean Sea. Even though these ancient shipwrecks have deteriorated significantly since their deposition, the sites maintain archaeological integrity and can be invaluable gateways to learn about past human activities. Disturbance by human impact can upset this natural equilibrium and accelerate disintegration.

Prehistoric Resources

Ancient geologic and glacial processes once exposed the sanctuary's seafloor to the sun, allowing it to support flora and fauna that may have been utilized by the Paleo-Indian peoples (Barber, 1979). Around 12,000 years ago, groups of migratory humans, known as Paleo-Indians, inhabited southern New England. The retreat of the Laurentide ice sheet 21,000 to 16,000 years ago allowed these people access to Stellwagen Bank, which rose above the surrounding ocean as a result of lower sea levels and the rebound of the Earth's crust after the retreat of the heavy ice sheets (Funk, 1978; Barber, 1979).

Although no archaeological evidence of Paleo-Indian inhabitation has been found on Stellwagen Bank, sea level models suggest that the bank remained accessible to the Paleo-Indians for approximately 1,000 years. During this time, people likely utilized the bank to hunt for land mammals, as a base for fishing and hunting marine mammals, and for gathering shellfish and vegetation (Barber, 1979). The possibility of finding Paleo-Indian cultural remains on Stellwagen Bank is supported by the recovery of mastodon skeletal remains by local fishermen (Carr, 1990). Further geologic study, site modeling, and sampling will be necessary to determine the potential for locating prehistoric cultural remains in the sanctuary.

Native Americans developed complex societies in New England during the approximately 12,000 years of human habitation prior to the arrival of Europeans. At the time of European contact Penobscot, Abenaki, Pequot, Massachusett, Narragansett, Wampanoag and Confederated River tribes inhabited the region surrounding Massachusetts Bay. These coastal tribes utilized the marine environment as their ancestors had, but it is unlikely that they ventured into the sanctuary's waters considering the wealth of resources close to shore.

Rising sea levels covered the bank within several millennia of its exposure, displacing any Native Americans living within the area to the edges of Massachusetts Bay, but not diminishing their usage of marine resources. The arrival of Europeans in the New World dramatically amplified the quantity of maritime traffic on Massachusetts Bay.

Historic Resources

As a result of four centuries of historic vessel traffic through the sanctuary, several hundred historic vessel losses are recorded in the sanctuary's vicinity. Primary causes of vessel loss (shipwrecks) in the sanctuary fall into four broad classes: (1) acts of war—naval engagements, piracy, law enforcement; (2) natural forces—storms (gales/hurricanes); (3) human error—seamanship, fire, collision; and (4) abandonment—for the reasons stated above, plus vessel condition and economic reasons (Fish, 1989). The sanctuary's minimum depth of 20 m (65 ft.) means that no vessel was lost in the sanctuary as a result of grounding or stranding. Vessels reported lost to either of these two causes are not considered to lie within the sanctuary.

The ambiguity of location given for most maritime disasters, and particularly for sanctuary shipwrecks, generally precludes establishing statements about impacts to specific resources. Ambiguity exists over the reported locations of shipwrecks, particularly the types of vessel losses at sea. A presumed nearest landfall is assigned when the shipwreck does not occur at a recognized landmark, i.e., on shore, on rocks, near a buoy marker or lightship. References such as off-Provincetown, off-Cape Ann, off-Massachusetts Coast, or off-New England, or "left port never to be heard of again," are frequently the only description of shipwreck locations that may be in the sanctuary. Additionally, for most colonial writers, places of loss were far less important to record than the persons and property that were lost.

Government data collection has been primarily aimed at identifying and locating man-made and natural objects that are hazards to navigation. These locations within the sanctuary are approximated and not verified, because they do not pose a hazard to navigation. Further, reliable location information is often in private hands (sport divers, researchers, fishermen), for whom personal interests generally preclude making the information public.

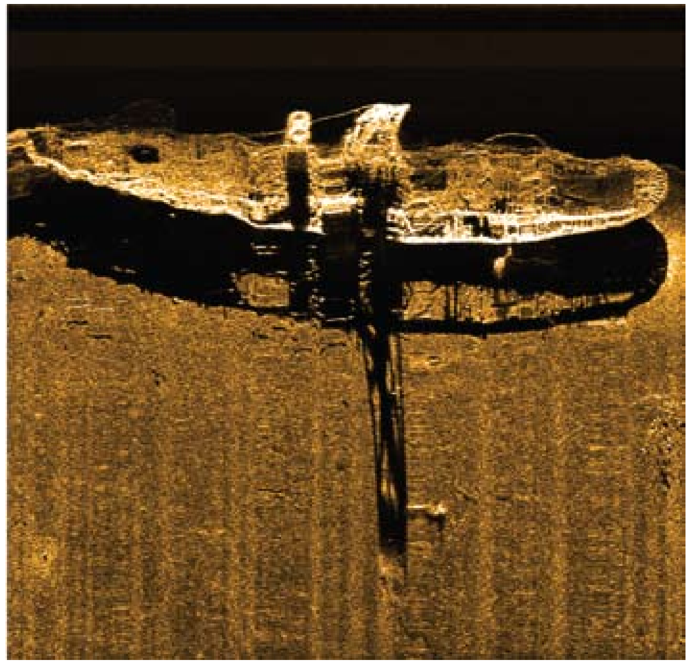
Most available published sources of shipwreck information concentrate on "romance of the sea" and/or major calamities and disasters; their audience is typically popular and not scholarly. Many of these works are laundry lists of shipwrecks, often published without sources. Further, many works reflect a certain selective presentation of facts, such as including only larger vessels or those carrying "valuable" cargo. Thus, precise statements of historic vessel losses in the sanctuary are not possible.

Figure 75. Historic photograph of the steamship *Portland* from 1891. The *Portland* sank with all hands during the Portland Gale in November 1898.

Courtesy: LARC.

Figure 76. The steamship *Portland*'s location in the sanctuary was confirmed by NOAA scientists in 2002.

Depicted here is a side scan sonar image of the *Portland* showing it sitting upright on its keel with boiler uptakes and walking beam engine projecting above the main deck. Courtesy: Klein Sonar Associates, Inc.



Vessels

Since the sanctuary began investigating its maritime heritage resources in 2000, archaeologists have located 18 historic shipwreck sites and identified four of these shipwrecks by name. Historical records indicate that several hundred more vessels sank within the sanctuary or its vicinity. Past research expeditions have used remote sensing technology, such as side scan sonar and ROVs, to locate and identify shipwreck sites. Archaeologists have also used SCUBA to investigate shallower shipwreck sites, such as the 5-masted coal schooner *Paul Palmer* that caught fire and sank off Provincetown in 1913.

In 2002, a team of NOAA scientists confirmed that a shipwreck in the sanctuary was the side paddle wheel steamship *Portland*. The wooden hulled steamship, built in 1889 by the New England Shipbuilding Company of Bath, Maine, for the Portland Steam Packet Company, ran between Portland, Maine, and Boston, Massachusetts, from 1890 to 1898 (Figure 75). At 85.6 m (281 ft.) long, the steamship was one of the largest and best-appointed vessels afloat in New England during the 1890s. The steamship sank with all hands on November 27, 1898 during a fierce storm, thereafter known as the "Portland Gale." Historians believe that nearly 200 people lost their lives.

Remains of the Portland include its upright and intact wooden hull, which has survived from the main deck level down to the keel (Figure 76). Machinery assemblages such as the boilers, paddle flanges and shaft, steam engine, walking beam and wooden A-frame are articulated and in their original positions. Smaller cultural artifacts such as plates and cups lie scattered inside and outside the hull (Figure 77). The *Portland's* hull is draped with fishing nets and provides substrate for sponges and anemones. In 2005, the *Portland* was listed on the National Register of Historic Places.

Another visually spectacular shipwreck site is the wrecks of the 83.5-m (274 ft.) long 4-masted schooner *Frank A. Palmer* (Figure 78) and 81.4-m (267 ft.) long 5-masted schooner *Louise B. Crary* (Figure 79), which sit upright on the seafloor connected at their bows after colliding (Figure 80). Both vessels were built at the turn of the century in Bath, Maine, for the coal trade between the Chesapeake Bay and New England. While enroute to Boston, Massachusetts, from Hampton Roads, Virginia, with coal cargos, the *Frank A. Palmer* and *Louise B. Crary* collided on December 17, 1902. Eleven of the twenty-one sailors onboard the schooners perished during the accident or while awaiting rescue in a lifeboat. Both schooners are intact from keel to main deck and have portions of their masts still standing. Surveys have encountered cultural artifacts within the remains of the Frank A. Palmer captain's cabin (Figure 81). In 2006, the *Frank A. Palmer* and *Louise B. Crary* were listed on the National Register of Historic Places.

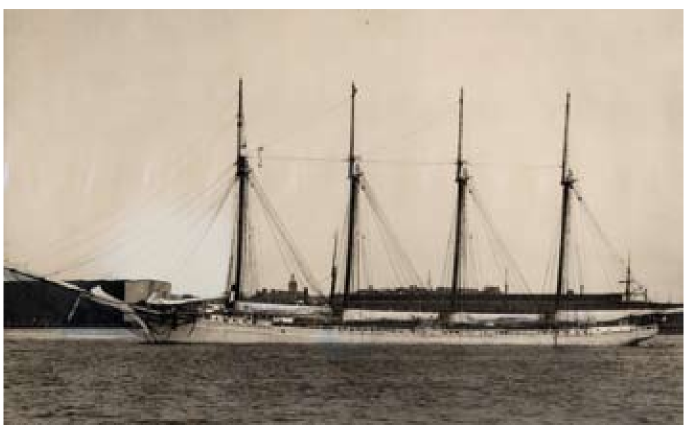
In addition to the *Frank A. Palmer* and *Louise B. Crary*, archaeologists have located and investigated several other collier sites with varying degrees of preservation. Similar in size to the *Frank A. Palmer*, the shipwreck of the 5-masted schooner *Paul Palmer* exemplifies the differences in site preservation as a result of the wrecking event and the environment in which the shipwreck lies (Figure 82). While

Figure 77. Fragile teacups and dishware in the galley survived the *Portland*'s plummet to seafloor in 1898.

The shipwreck is listed on the National Register of Historical Places and is the best preserved of any New England "night boat" found to date. Source: NOAA/SBNMS, NURC-UConn, and the Science Channel.

Figure 78. Historical photograph of the 4-masted coal schooner *Frank A Palmer*.

The Maine built *Frank A. Palmer* was the longest 4-masted schooner ever built. Courtesy: Maine Maritime Museum.



sailing south from Maine to the Chesapeake in ballast, the schooner's forecastle caught fire off Highland Light in 1913. Flames quickly engulfed the schooner, thwarting efforts to extinguish the flames with the schooner's pumps. The vessel's crew escaped the fire by boarding a tug that approached the schooner to help fight the blaze. Burned to the waterline, the schooner sank on top of Stellwagen Bank. In 2007, the *Paul Palmer* was listed on the National Register of Historic Places.

Today, the *Paul Palmer's* remains consist of its wooden hull, intact to the turn of the bilge, keelsons, a pile of anchor chain and the schooner's windlass (Figure 83). Ship fittings, such as bitts, a davit, anchors and rigging components, lie throughout the site. While the fire likely destroyed much of the vessel's hull, the dynamic environment on top of Stellwagen Bank caused the schooner's structure to degrade faster than the more static environment in which the *Frank A. Palmer* rests. The schooner's degradation has also been hastened by impacts from commercial fishing. Evidence of these impacts is graphically demonstrated by a trawl net that has become wrapped around the shipwreck's windlass. The sanctuary has documented recent impacts in the form of broken timbers and displaced anchors.

Other collier sites represent much smaller vessels more typical of the sailing vessels that plied the East Coast during the nineteenth and early twentieth centuries. The archaeological preservation of these smaller collier shipwrecks varies

Figure 79. Historical photograph of the 5-masted coal schooner *Louise B Crary*.

In 1902, the *Louise B. Crary*'s mate miscalculated his tack causing his vessel to strike the *Frank A. Palmer*'s bow. Courtesy: Maine Maritime Museum.

Figure 80. In 2002, NOAA scientists confirmed the location of the schooners *Frank A. Palmer* and *Louise B. Crary* in the Stellwagen Bank sanctuary.

Depicted is a side-scan sonar image of the two intact vessels, connected at their bows, in the same orientation in which they sank. Source: NOAA/SBNMS and NURC-UConn.

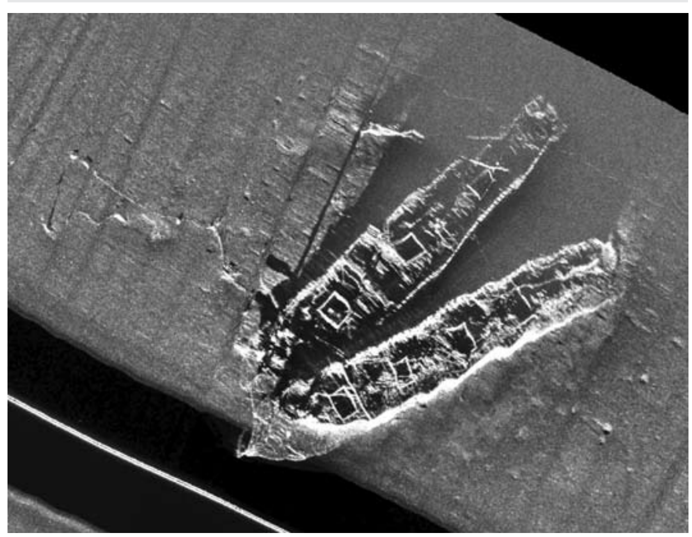


Figure 81. The *Frank A. Palmer*'s stern cabin contains the remains of the captain's sink and toilet.

The *Frank A. Palmer* and *Louise B. Crary* are listed on the National Register of Historic Places and are the best preserved examples of New England coal schooners in the archaeological record located thus far. Source: NOAA/SBNMS and NURC-UConn.

widely. One 32 m (100 ft.) long vessel is nearly intact up to its deck level. Features of the site include copper-alloy sheathed hull planking, wooden hanging knees, and a variety of ship fittings and artifacts (Figure 84). In contrast, the hull remains of another collier are only represented by eroded frames protruding centimeters from a pile of coal 35 m (114.8 ft.) long. Very few ship fittings and no smaller artifacts were found on this site (Figure 85). Both vessels were likely two-masted schooners that carried a variety of cargos, but happened to be loaded with coal when they sank. While both vessels lie in water of similar depth, the more intact vessel lies in an area that is less frequently fished by bottom trawl gear.

Figure 82. Historical postcard of the 5-masted coal schooner *Paul Palmer* offloading coal in New Hampshire.

The *Paul Palmer* caught fire and sank off Cape Cod in 1913 while en-route to Virginia. Courtesy: LARC.

The granite industry is another coastal trade represented by a sanctuary shipwreck. In the remains of this sailing vessel, the cargo of granite slabs vary in size, ranging from blocks measuring 2 m long by .5 m wide, to others stretching over 3 m long. Approximately 40 slabs were contained within the vessel's hold (Figure 86). The most common slab shape measures 3 m long by 2 m wide with a manhole bored into its center. Blocks of this variety were used to cover sewer basins that captured the drainage from street gutters. The uniform shape of the manholes suggests that they were bored using a large diameter drill, a technology first used in the second half of the 19th century.

After colliers, the second most common variety of shipwreck located thus far in the sanctuary is 20th century commercial fishing vessels. Of these, wooden-hulled eastern-rig draggers represent the majority. Constructed from the 1920s through the 1970s, these side trawlers exemplify the transition from hook and line fishing to engine-powered trawling (Figure 87). Several of the eastern-rig dragger shipwrecks in the sanctuary are remarkably intact, with extant pilot houses and masts. Others are much more fragmentary as a result of damage incurred from the impact of nets and trawl doors of successive generations of fishing vessels.

Aircraft

At least one aircraft crash site is believed to be located within the sanctuary. Divers reported finding a P-38 Lightning on the western edge of Stellwagen Bank. Fishermen also report recovering military aircraft parts from a site north of Stellwagen Bank (B. Lee, pers. comm., 2004).

Pressures

Sanctuary shipwreck sites below the zone of storm wave disturbance (~85 m) generally reside in a depositional envi-

Figure 83. The *Paul Palmer* rests on top of Stellwagen Bank with its wooden frames and hull planking protruding up from the sand.

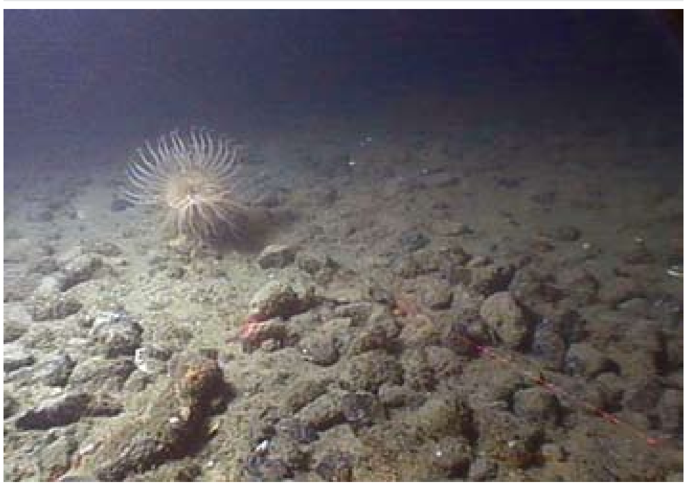
Substantial information can be learned about the role coal schooners played in the growth of New England by examining *Paul Palmer*'s archaeological remains. Source: NOAA/SBNMS.

Figure 84. Artifacts, such as the brass hand bell and ceramic dishes seen here, are well preserved on this wooden hulled shipwreck with a coal cargo.

The sanctuary is studying this vessel to discover its identity and learn about life onboard a merchant sailing vessel in the New England coasting trade. Source: NOAA/SBNMS and NURC-UConn.

Figure 85. The coal cargo depicted in this photograph covers the remains of a shipwreck.

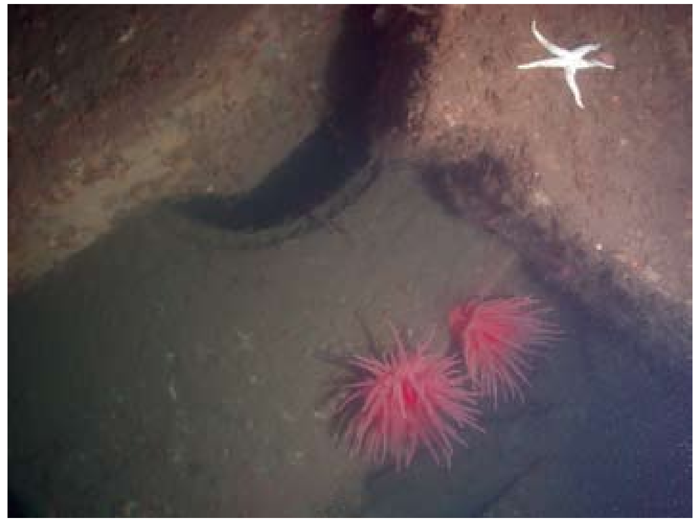
Bottom trawling has destroyed the vessel's structure above the sediment and removed all the durable artifacts, such as anchors and iron fittings. Source: NOAA/SBNMS and NURC-UConn.



ronment of little natural disturbance. Consequently, the chief impacts to archaeological sites in this realm result from fishing activities. The sanctuary's maritime heritage resources have been adversely impacted by fishing activities and are highly susceptible to future damage due largely to two factors: structural materials and fishing impacts. Every maritime heritage resource located to date is a shipwreck with a wooden hull, and much of the sanctuary's seafloor is regularly accessed by a variety of fishing gears. While the sanctuary's cold deep water helps preserve the shipwreck's organic structure, wooden hulls slowly degrade over time

Figure 86. This shipwreck's granite block cargo was destined for use in the construction of sidewalks and sewer systems.

Granite transportation supported a large fleet of sailing vessels during the 19th and early 20th centuries. Source: NOAA/SBNMS and NURC-UConn.



becoming very fragile. The ongoing characterization of the sanctuary's maritime heritage resources continues to reveal the results of past damaging interactions between historic shipwrecks and fishing gear. Other potential anthropogenic pressures on maritime heritage resources include SCUBA diving and remote sensing.

Fishing

Interactions between fishing gear (mobile and fixed gear as well as hook and line) and many of the sanctuary's maritime heritage resources have resulted in the degradation of the shipwrecks' archaeological integrity, reduction of their historical/archaeological significance, and diminishment of their aesthetic qualities. Currently, reference material mainly focuses on the impacts of fishing on marine habitats and the environment (Dorsey and Pederson, 1998; Smith *et al.*, 2003; Tudela, 2004). Marine archaeological literature has not yet adequately addressed fishing impacts to maritime heritage resources.

Many recreational and commercial fishermen intentionally target shipwrecks due to the higher density of fish typically found around structures that rise above the surrounding seafloor. By targeting these non-renewable resources, irreparable damage is done. A single impact from fishing gear can cause extensive damage, compromising the information contained within the archaeological site.

While some fishing gear impacts a site momentarily and then continues along without getting hung up, other gear may become tangled on the shipwreck, and then ultimately abandoned. The lost gear provides direct evidence of the interaction between fishing and maritime heritage resources. Eleven of the eighteen archaeological sites located within the sanctuary exhibit entangled fishing gear. The discard-

Figure 87. Many Eastern rig draggers similar to the one pictured here sank within the Stellwagen Bank sanctuary and are being documented by sanctuary archaeologists.

This style of fishing trawler, common to the waters of Massachusetts Bay in the 20th Century, is a transitional design bridging the gap between earlier wooden sailing schooners and modern-day steel trawlers. Source: NOAA/SBNMS.

ed gear presents a serious safety and operations hazard to SCUBA divers and remote sensing equipment, such as side scan sonars, ROVs and Autonomous Underwater Vehicles (AUVs). The nets, lines and cables from lost gear close off completely or limit the site's accessibility to archaeologists, recreational SCUBA divers and the interested public. Discarded nets and line also present an entanglement hazard to marine life.

Mobile Gear Impacts

Mobile fishing gear (otter trawls, beam trawls, shellfish dredges) has had the greatest impact on maritime heritage resources. Mobile fishing gear components have been found on eleven historic shipwrecks. These towed nets or dredges, often weighing hundreds of pounds, roll or are dragged across the seafloor. When the net encounters a wooden shipwreck rising above the seafloor, it interacts with the shipwreck in one of three ways:

1) The gear breaks apart the shipwreck's structure;

2) The gear rolls over the shipwreck, damaging fragile structure; or

3) The gear catches on the shipwreck, stopping the vessel. If the gear can be pulled free it usually results in partial destruction of the shipwreck. Oftentimes, pieces of the net are left behind. Less frequently, the gear is so entangled with the shipwreck's structure that entire nets and even trawl doors are lost.

Considerable damage to the shipwreck's structure results in all three situations. In addition, trawl nets often remove artifacts from the site. Fishermen frequently snag and recover anchors, windlasses, pumps and other assorted ship fittings. The removal of this material is particularly harmful to the site's archaeological integrity. In many cases, fishermen using mobile gear seek to avoid shipwrecks; however, some fishermen choose to tow their nets as close as possible to the shipwreck to catch fish inhabiting the shipwreck. This behavior has the potential to damage or destroy artifacts surrounding the shipwreck, damage the shipwreck through contact with the trawl doors, and potentially damage or entangle the main shipwreck structure.

Two examples of negative mobile fishing gear impacts are found on the steamship *Portland* and the schooner *Paul Palmer*. The Portland has a complete otter trawl net, including rollers and a trawl door, wrapped around its bow and starboard side. The wire tow rope has cut deeply into the steamship's stempost, while one of the trawl doors lies on the main deck (Figure 88). The net is tangled with and extends nearly the length of the starboard side forward of the boiler uptakes. More wire rope is draped across the top of the boiler uptakes. The trawl net has damaged portions of the wreck and greatly hampers the sanctuary's ability to archaeologically investigate the shipwreck. The net and its wire tow rope present a severe entanglement risk for the ROV vehicle used to study the site.

The schooner *Paul Palmer* also had a trawl net wrapped around its bow. The net and rollers were entangled with the site's windlass and chain pile, and likely altered the orientation of the windlass when it was snagged (Figure 89). The net posed an entanglement hazard for SCUBA divers and marine life. NOAA divers removed the net in September 2006.

Fixed Gear Impacts

Fixed fishing gear (gillnets and lobster trawls) has also negatively impacted sanctuary maritime heritage resources. Fixed fishing gear components have been found on six historic shipwrecks. The initial placement of the gear may damage a resource if the gillnet anchor or lobster pot falls directly on a maritime heritage resource or its associated artifacts; however, the greatest damage results when fishermen attempt to recover their gear. If the gear has not already become entangled in the shipwreck's structure, pulling the gear to the surface can ensnare it. Once gear is firmly entangled, a fisherman will likely use the full power of his or her net or pot hauler and boat to free the gear. The high tension exerted on the lines easily snaps fragile wooden structure.

Entangled fixed gear continues to degrade the shipwreck by blocking access to the resource. SCUBA divers cannot safely approach the gillnet, for example, and researchers are unable to document the resource and share the information with the public. The *Frank A. Palmer* and *Louise B. Crary* have been negatively impacted by gillnets that are entangled on the shipwrecks. The *Louise B. Crary's* bow is enshrouded with a gillnet that covers the forecastle and forward deck house (Figure 90). The net prevents the archaeological examination of this area. A gill n*et al*so stretches between the two schooners preventing the archaeological examination of the collision point.

Hook and Line Impacts

Hook and line gear has been found on four historic shipwrecks. Hook and line bottom fishermen often target wrecks to catch the fish inhabiting the shipwrecks' structure. Boats often anchor to maintain position, risking anchor damage to the shipwreck and any surrounding debris fields. Heavy lead jigs, weighing up to two pounds are repeatedly raised and lowered to attract fish (Figure 91). When a jig comes into contact with a maritime heritage resource, it has the potential to break fragile artifacts made from glass or ceramics. Frequently, fishermen snag their tackle on the shipwreck's structure. Attempts to free the line may damage the resource. If the jig is firmly stuck, the fisherman will break or cut the line, which may then fall across the shipwreck. Lost fishing line limits access to a shipwreck

Figure 88. Wire rope associated with a trawl net cuts into the steamship *Portland*'s bow.

The negative impacts of commercial fishing activities are well documented on the wreck of the Portland. Source: NOAA/SBNMS and NURC-UConn.

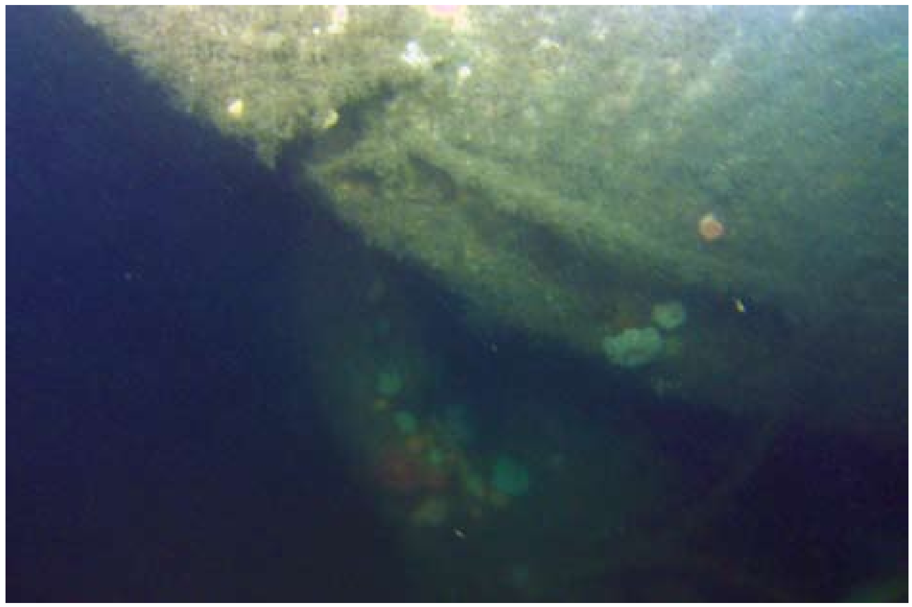


Figure 89. This large trawl net was once wrapped around the schooner *Paul Palmer*'s windlass, where it was a hazard to SCUBA divers and marine life.

In 2006, NOAA divers removed the net to facilitate the documentation of the schooner's windlass. Courtesy: Tane Casserley, NOAA Maritime Heritage Program.

Figure 90. Gillnets cover the schooner *Louise B. Crary*'s bow.

The fishing gear entangled in this shipwreck prevents archaeologists from documenting most of the wreck's bow area and main deck space. Source: NOAA/SBNMS, NURC-UConn and the Science Channel.

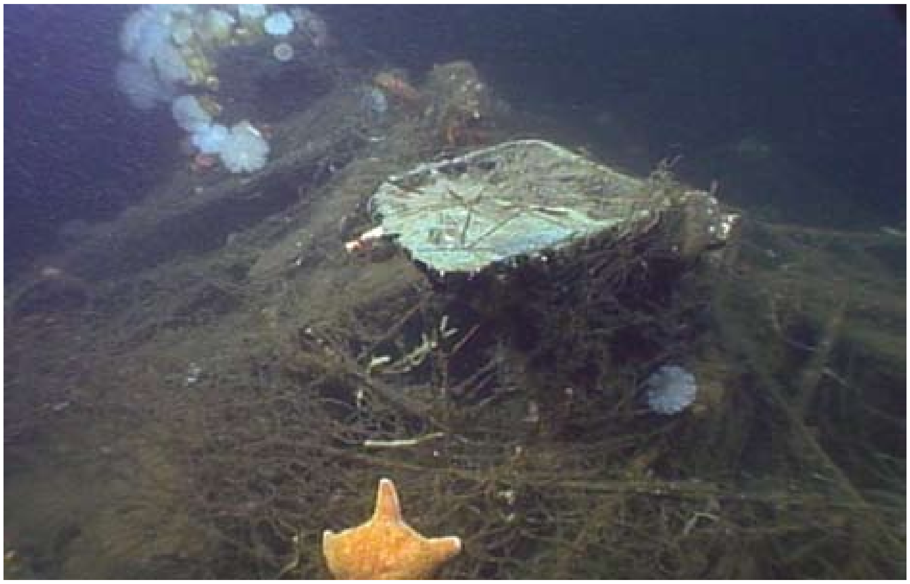


Figure 91. Jigs are evidence of hook and line fishing activity on the schooner *Paul Palmer*.

Lost fishing gear poses a hazard to divers and degrades the archaeological integrity of the shipwreck. Source: NOAA/SBNMS.

in much the same way a trawl net or a gillnet limits access to a shipwreck. Additionally, single strands of fishing line are difficult to see underwater, making entanglement of an ROV or a SCUBA diver a possibility.

An example of the impact of lost fishing line on a shipwreck is found on the *Frank A. Palmer*. A 2004 archaeological investigation of the site encountered no lost fishing lines crossing the aft deckhouse space. Returning to the same area in 2005, researchers found several fishing lines crossing the area (Figure 92). The lines prevented the researchers from maneuvering their ROV into the area to investigate the artifacts contained within the cabin. Additionally, an unseen fishing line entangled and fouled a ROV thruster, preventing its operation and forcing termination of the dive.

Diving

While SCUBA diving will not necessarily damage a shipwreck, certain diving practices and activities have the potential to impact the sanctuary's historical integrity (Edney, 2006). In comparison to the rocky shorelines and near shore waters of Massachusetts, the sanctuary has been visited by considerably fewer SCUBA divers. However, many divers have communicated their interest in visiting the sanctuary's shipwrecks. When SCUBA diving is conducted in the sanctuary, the dive location is usually near or on a maritime heritage resource.

The techniques and practices, both above and underwater, associated with SCUBA diving on a shipwreck may negatively impact the site and its historic resources if not done with care and resource preservation in mind. To access sites, boats carrying divers may drag their anchor across the seafloor and through the debris field of the archaeological site. The anchor may catch on the structure of the maritime heritage resource. Anchors or down weights dropped from a boat can plummet directly onto a fragile wooden hull and/or the associated artifacts, causing damage. Repetitive anchoring on, or securing a down line to, a maritime heritage resource can increase its rate of structural deterioration and reduce the site's archeological and historical significance.

Once underwater, divers' actions can be low-impact, such as observing the shipwrecks and their marine life or photographing, videotaping the site. But high-impact actions, such as souvenir collecting, remove artifacts and reduce the archaeological significance of the sites. Divers who remove tightly secured artifacts often damage or destroy larger areas of the sites. While prohibited by sanctuary regulations, artifact collecting still occurs in National Marine Sanctuaries (*Craft, Ferguson, Jernigan, King, Parrott, Stocks, and Wilson v. NOAA,* 6 O.R.W. 150 United States Department of Commerce, 1990; *Craft, Ferguson, Jernigan, King, Parrott, Stocks, and Wilson* *v NPS, NOAA, and National Marine Fisheries,* 34 F.d 918. United States Court of Appeals, 1994).

Artifacts lose their provenance once removed from a site and are no longer able to provide as much information about their history. Additionally, artifacts recovered from the marine environment deteriorate if not properly conserved and thus lose their ability to educate the general public. Artifact collecting also deprives future SCUBA divers of the excitement of exploring an "untouched" shipwreck.

Remote Sensing

Remote sensing allows individuals to use technology to explore the underwater environment without personally entering the water. Technologies vary from side scan sonar to ROVs and AUVs. Most remote sensing technologies are not designed to physically interact with maritime heritage resources and can do damage if unintentional contact is made.

Towed sensors, such as side scan sonars, drop cameras and magnetometers, can cause damage by striking or becoming entangled in a maritime heritage resource. Damage to the resource is then exacerbated when a remote sensing operator attempts to free an entangled piece of expensive marine technology. Remotely operated vehicles are designed to operate in proximity to maritime heritage resources and are capable of interacting with the resources using manipulator arms. Remotely operated vehicle operators can remove or disturb archaeological resources in a manner similar to divers.

Entanglement risks for ROVs are especially great in the Stellwagen Bank sanctuary due to derelict fishing gear that entangles many of the shipwreck structures. Freeing an ensnared ROV will likely damage a maritime heritage resource. Submersibles, manned underwater vehicles, pose the same hazards to maritime heritage resources as ROVs.

Current Protection

The sanctuary's mandate to protect and manage maritime heritage resources arises from various federal regulations and laws. The sanctuary boundary encompasses an 842-square mile area of seafloor outside of the territorial sea of Massachusetts Bay and does not overlap with the jurisdiction of the Commonwealth of Massachusetts.

The protection of maritime heritage resources is provided through the following laws and regulations:

- Antiquities Act of 1906
- Historic Sites Act of 1935
- Archaeological and Historic Preservation Act of 1960
- National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. § 470 et seq.)
- Department of Transportation Act of 1966 (section 4(f))
- Presidential Order 11593 of 1971
- National Environmental Policy Act (NEPA) (Section 101(b)(4))
- National Marine Sanctuaries Act (NMSA) of 1972 (16 U.S.C. § 1432 et seq.)
- Stellwagen Bank National Marine Sanctuary Regulations of 1992 (15 C.F.R § Subpart N)

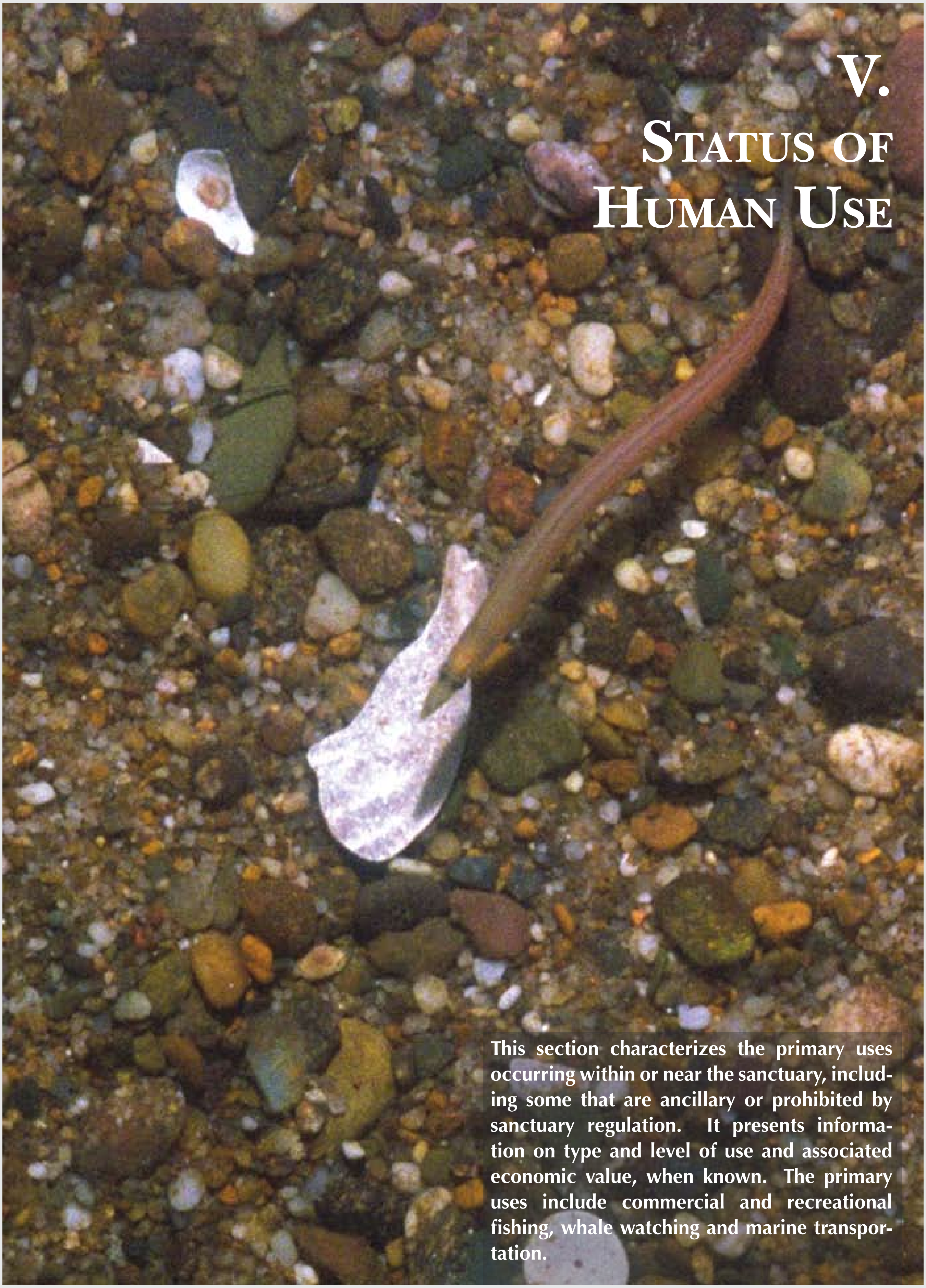
The NMSA mandates that the National Marine Sanctuary Program manage maritime heritage resources in a fashion that protects the resources while facilitating compatible public and private use of the resources. National Marine Sanctuary Program regulations incorporate all laws and regulations of the Federal Archaeology Program, such as the National Historic Preservation Act. These regulations require that a heritage resource inventory and management program be developed for each site, that federal activities that may affect historic and cultural resources be undertaken in such a way as to prevent harm to historic resources, and that the Sanctuary Program nominate potentially eligible sites to the National Register of Historic Places.

The Sanctuary Program must also ensure mitigation of any federally-funded activity that might threaten historical and cultural resources under its control to facilitate the protection of these resources. The Sanctuary Program is required by Section 106 of the National Historic Preservation Act of 1966 to allow the Advisory Council on Historic Preservation an opportunity to comment on all sanctuary actions affecting historic resources in the sanctuary.

Figure 92. Braided and monofilament fishing line is caught around the *Frank A. Palmer*'s steering wheel.

Fishing line stretched across the schooner's stern prevents the complete documentation of this area, which would provide important information about the vessel's crew. Source: NOAA/SBNMS and NURC-UConn.

Current sanctuary regulations prohibit moving, removing or injuring, or attempting to move, remove or injure a sanctuary historical resource except as an incidental result of traditional fishing operations. These regulations also prohibit drilling into, dredging or otherwise altering the seabed of the sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the sanctuary, except as an incidental result of an anchoring vessel, traditional fishing operations; or the installation of navigational aids. Lastly, sanctuary regulations prohibit possessing within the sanctuary (regardless of where taken, moved or removed from), except as necessary for valid law enforcement purposes, any historic resource.



V.
Status of Human Use

This section characterizes the primary uses occurring within or near the sanctuary, including some that are ancillary or prohibited by sanctuary regulation. It presents information on type and level of use and associated economic value, when known. The primary uses include commercial and recreational fishing, whale watching and marine transportation.

Context

The Stellwagen Bank sanctuary attracts extensive commercial, recreational, scientific and educational activities and is heavily utilized throughout all seasons. The many ports, large and small, that rim Massachusetts Bay offer direct access. Located in the backyard of an estimated 4.8 million people living in the greater Boston metropolitan area, the sanctuary is exposed to the environmental stresses of human population and development, including waste disposal and discharge and creeping industrialization along its western boundary. This section characterizes or describes the primary uses occurring within or near the sanctuary, including some that are ancillary or prohibited by sanctuary regulation.

A characterization or *status* of current uses—who, what, where, when and how the resource is affected—is pivotal to understand and evaluate the *pressures* which are applied to sanctuary resources. Some of the questions the sanctuary must address are: what do we know about the pattern and scale of these uses, how are they altering habitat structure and the organization of marine communities, and are the impacts chronic or acute? Ultimately, can we and how do we improve our ability to make human uses compatible with resource protection? Answering these questions requires a substantially improved understanding of the spatial distribution and intensity of major uses in the sanctuary.

The Sanctuary Program is mandated by Congress to facilitate uses that are compatible with the primary goal of resource protection. The term "compatible" is articulated as the standard for acceptable use in the National Marine Sanctuaries Act, but the Act does not define or provide the criteria to apply that standard. The resource protection goals articulated in the Act include comprehensive conservation and management to maintain the natural biological communities and to protect, restore and enhance natural habitats, populations and ecological processes. The previous section on Resource States presents cases where uses impact and pressure sanctuary resources.

When available, information on the types and levels of human use of the Stellwagen Bank sanctuary and the associated economic value is presented in this section. In those cases, discussion of economic value is limited to direct sales value of the products or services provided. The total economic impact of these uses has not been determined as part of this management plan review process. While other uses occur and are briefly described, the primary uses addressed include commercial and recreational fishing, whale watching and marine transportation.

Commercial Fishing

History in the GoM

Commercial fishing was once the most economically important activity directly dependent on the natural resources of the GoM including Stellwagen Bank. The discovery of vast codfish grounds in the northwest Atlantic in the late 1400s by explorer John Cabot was a significant driving force behind the colonization of the New England seaboard. It was cod fishing that brought the first settlers to Gloucester, Marblehead, Salem, Weymouth and Scituate, Massachusetts (McFarland, 1911). In the decade between 1765 and 1775, the business of cod fishing actively involved 20 towns, 605 vessels, 1,475 fishermen and 9,600 others in curing, packaging and shipping (McFarland, 1911).

As the consumption of seafood increased and markets expanded, so too did the pressure to extend fishing efforts to offshore locations. The technology of fishing gear advanced rapidly with the mechanization of equipment during the 19th century. Primitive nets evolved into purse seines, otter trawls, gill nets and trap and pound nets. The major advance in the fishing industry during this time was the development and use of diesel-propelled fishing vessels, which replaced steam-driven and sail craft. Fishing gear itself became mechanized, greatly enhancing success. Ice replaced salt as the principal means of preservation and offered consumers a fresh product.

Navigation capabilities and the power and productivity of fishing improved with the introduction of electronic equipment, such as ship-to-shore telephones, LORAN and Global Positioning System (GPS) plotters, direction finders, depth indicators, the enhanced efficiency of record keeping "fish finders", radar and automatic steering devices. The introduction of synthetics, now used in most fishing gear and equipment, increased durability and cost effectiveness and further improved fishing methods.

The collective effect of these early innovations was an increase in fresh fish landings from shorter trips. As the demand for fish grew, Boston became the primary fishing port because of its position as the New England marketing and transportation center. Gloucester businesses, suffering from this change of venue and competition from less expensive imports from Norway, Canada and Iceland, prevailed by improving fish processing techniques (notably "quick-freeze") and shipping. These industry advancements enabled the introduction of formally underutilized species to both fresh and frozen fish markets in the eastern and midwestern parts of the country.

Large foreign trawlers began fishing on Georges Bank in 1961, primarily on non-traditional fish species, such as hake, herring and squid. By 1973, approximately 300 vessels from 16 countries were also targeting more traditional domestic species, notably haddock. New England fisheries began to feel the pressure from these foreign vessels. Because there was no effective management of fisheries outside the existing U.S. 12-mile contiguous zone, the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976 was passed to extend U.S. management jurisdiction out to 200 nautical miles. This action reduced the level of foreign fishing in the GoM, and for a while revitalized both New England and U.S. fisheries (MacIssac and Hotz, 1982).

Just as Gloucester is considered America's oldest seaport, Stellwagen Bank (formerly Middle Bank) is listed among the most historic fishing grounds in the GoM, harkening back to early colonial times. Today, the sanctuary area remains one of several areas of concentrated commercial fishing effort in the GoM, in addition to Jeffreys Ledge, Cashes Ledge, Tillies Bank, Brown Bank and the more expansive Georges Bank. Due to this effort, many of the principal GoM groundfish stocks are overfished and rebuilding is proving difficult (http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0513/). Several species among these stocks have been added to the Species of Concern List for the Endangered Species Act (http://www.nmfs.noaa.gov/pr/species/concern/). The Northwest Atlantic, most of which is outside of the U.S. Exclusive Economic Zone (EEZ) and therefore not subject to U.S. jurisdiction, has become one of the most overfished regions of the world (Essington *et al*., 2006).

Current Trends and Status in the Sanctuary

Data Types and Sources

Commercial fishing in the Stellwagen Bank sanctuary is characterized through the use of two primary types of data from different sources: standardized surveys and mandatory Fishing Vessel Trip Reports (VTR). These data types and sources are described and compared below. The data were gathered and/or analyzed to document and typify the spatial distribution, landings value (ex-vessel, dockside sales paid to fishermen) and volume, and species composition representative of commercial fisheries in the sanctuary. Ex-vessel or landings value is the price paid to the fishermen upon direct sale of the fish landed.

Standardized Surveys

During July 2001–June 2002, a year-long study was undertaken to quantify and map patterns of human and marine mammal use of the sanctuary (Wiley *et al*., 2003). Each month, sightings data were collected along 15 standardized shipboard survey tracklines that crossed the sanctuary at 5 km (2.5 nm) intervals providing 100 percent coverage. The density and distribution of the data were analyzed with *ArcView's Spatial Analyst* program to develop a "user geography" of the sanctuary based on spatial patterns and intensity of use. The 2001–2002 survey was the repeat of a nearly identical year-long study undertaken in the sanctuary by Wiley during May 1994–August 1995, which allows comparison over the two time periods. The 1994–1995 survey covered only the southern two-thirds of the sanctuary prior to creation of the Western GoM Closure Area in 1998. Refer to Wiley *et al*. (2003) for details on the methodologies used.

The standardized survey data, together with the Vessel Trip Report data for the July 2001–June 2002 period, were used for the analyses of spatial distribution and density of fishing in the sanctuary. This base period was chosen based on analysis of the comparability of these data sources as explained below.

Fishing Vessel Trip Reports (VTR)

Since April 1994, fishing vessel trip reporting has been phased in for all NOAA Fisheries Service northeast permitted species as mandated by their corresponding Fishery Management Plans (FMP). In their Vessel Trip Reports (VTR), fishermen are required to report the location of catches using latitude and longitude or LORAN lines. The data series for the sanctuary analyses begins with the year 1996, as there was only partial coverage in 1994 and fleet adjustments to the requirements during 1995. The only NOAA Fisheries Service northeast permitted species that do not have VTR reporting requirements inherent in the FMP are Lobster and Surf Clam/Ocean Quahog (SC/OQ).

The SC/OQ FMP requires vessel owners or operators to maintain an accurate daily fishing log for each trip on forms provided by the NOAA Fisheries Service Regional Administrator. The logbook data indicate that these species were not fished in the sanctuary during 1996-2005. Many lobster vessels have federal permits that require them to report all catches to the VTR system. The Highly Migratory Species Division of NOAA Fisheries Service manages albacore, bluefin tuna, dorado, sharks, swordfish and tropical tuna. These species do not have VTR reporting requirements in their FMPs, but catches of these species under other federal permits also result in some reporting to the VTR system. As noted below, adjustments are made that consider under-representation of lobster and bluefin tuna landings in the VTR data for the sanctuary.

The VTR database was integrated with vessel number and home port-of-registry information to better describe fleet characteristics. This integration provided information about the state from which each vessel hailed as well as the respective port(s) which received each vessel's landings. The integrated VTR database was also used to determine the ex-vessel value and volume of landings from the sanctuary as well as the related attributes involving species and gear.

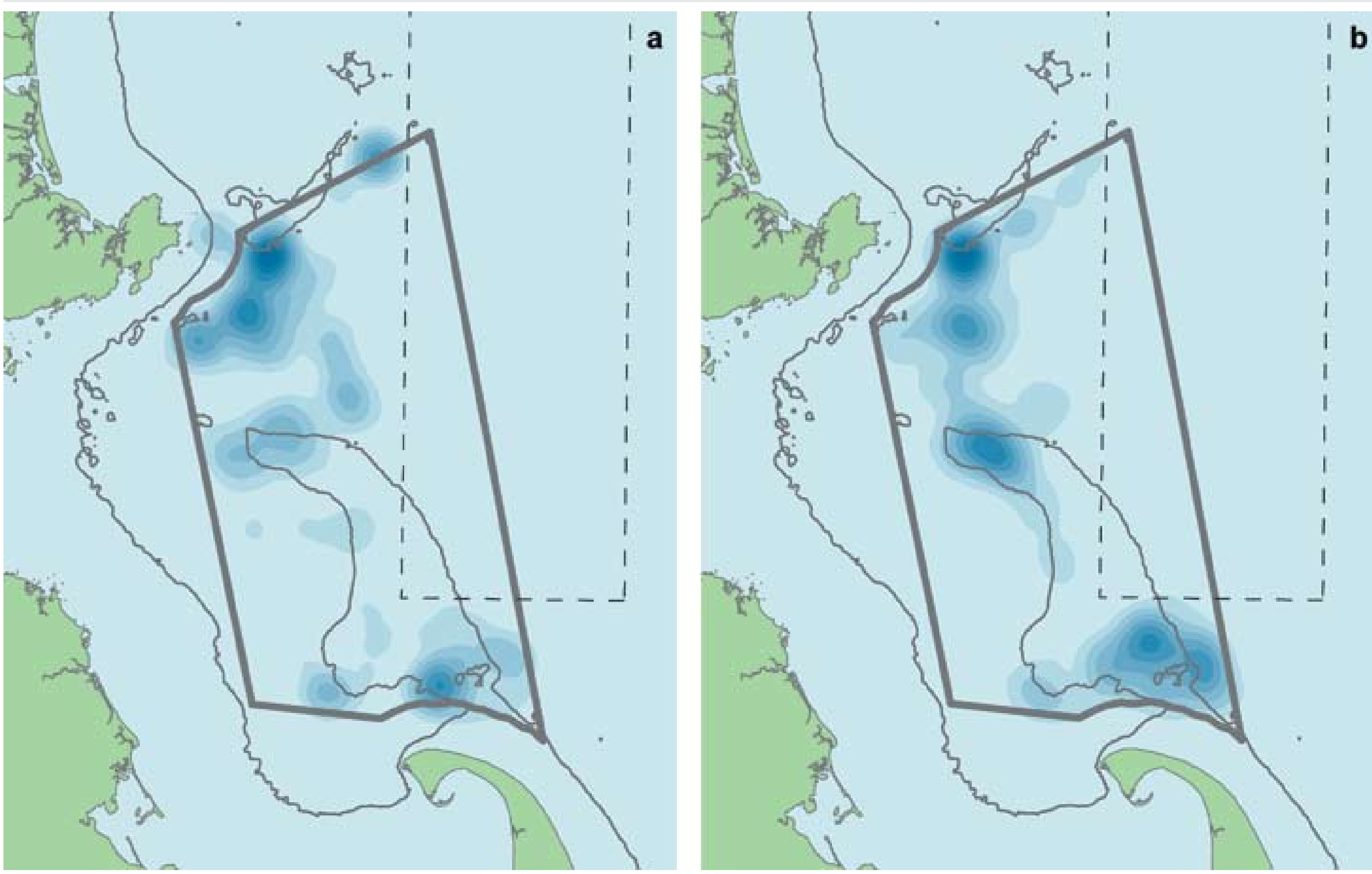
Comparability of Data Sources

The distribution of the 2001-2002 standardized survey and 2001-2002 VTR data for the same period exhibit consistent spatial patterns when comparable categories of fishing activity are mapped and analyzed using identical methodologies. For example, Figure 93 compares the distribution and density of two categories of mobile gear fishing in the sanctuary, trawling and scallop dredging, using data from the standardized surveys and the VTR information. Similarly, Figure 94 presents comparisons of the distribution and density of fixed gear fishing in the sanctuary, e.g., lobster traps, sink gillnets and longlines, using data from the two sources.

Qualitatively, there is a high degree of correlation between the results from the two data set analyses. Given this corroboration, the 2001-2002 timeframe is the period chosen to typify the spatial distribution and density of fishing in the

Figure 93. Spatial density patterns based on fishing trips for two types of bottom mobile gear (otter trawls and dredges combined) in the Stellwagen Bank sanctuary are compared using standardized survey data (a) and Vessel Trip Report (VTR) data (b) over the same time period (July 2001–June 2002).

The patterns are Kriged density plots of information from both data sets using a 5,000 m search radius and analyzed by ESRI ARCGIS. VTR gear codes: DRC, DRS, OTF, OTM, PTM.



sanctuary. By this standard, the VTR data are considered a reliable estimator of commercial fishing activity at the spatial scale of the sanctuary. A related but independent analysis of commercial fishing in the sanctuary area also concluded that the VTR data, once aggregated and processed via GIS, was a good predictor of broad categories of fishing activities and the locales at sea where the activities occurred (Martin and Hall-Arbor, 2006).

Conversion to 2005 Constant Dollars

To normalize dollar value for comparison of fishery landings over the decade 1996–2005, ex-vessel revenues (direct sales) were converted to 2005 constant dollars using the Boston Consumer Price Index (CPI-U). Inflation exerts an effect on the value of a dollar and, in most cases, a dollar today can't buy the same amount of goods or services it did in the past. To account for such price changes, it is appropriate to analyze financial data that have been "deflated" to produce a more consistent time series. Accordingly, financial data can be adjusted for inflation using the CPI prepared by the US Bureau of Labor Statistics. The CPI-U tracks changes in the prices paid by urban consumers based on a

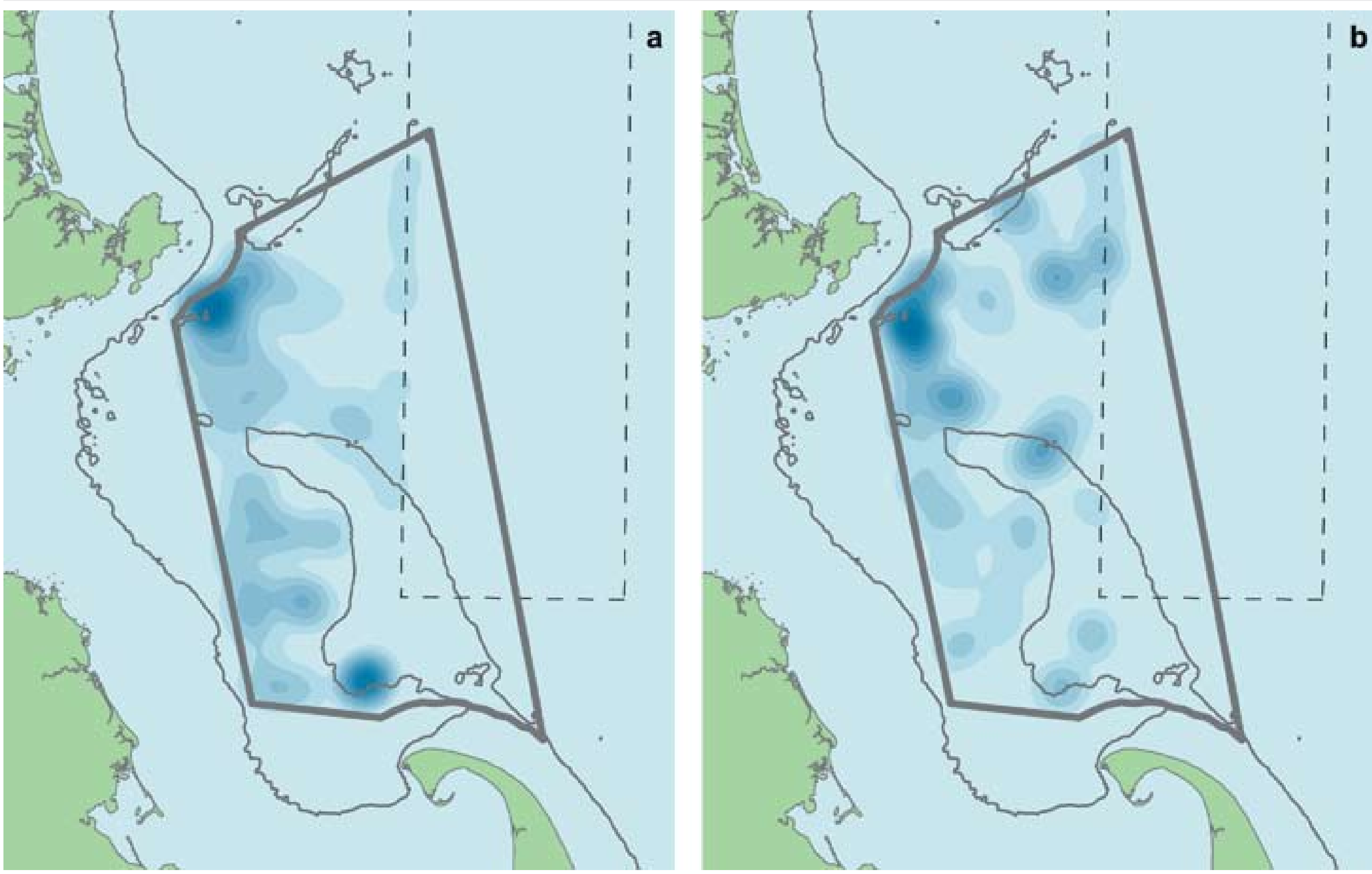
Table 11. Principal gear types fished in the Stellwagen Bank sanctuary during 1996–2005.

The respective Vessel Trip Report (VTR) gear codes are included in parentheses.

Trawls	Hook and Line
Otter Trawl, Bottom, Fish (OTF)	Longline/Tub Trawl, Bottom (LLB)
Otter Trawl, Midwater (OTM)	Longline, Pelagic (LLP)
Otter Trawl, Bottom, Scallop (OTC)	Hand Line/Rod & Reel (HND)
Otter Trawl, Shrimp (OTS)	**Pots and Traps**
Pair Trawl, Midwater (PTM)	Pot, Crab (PTC)
Purse Seine (PUR)	Pot, Fish (Sea Bass, etc.) (PTF)
Gillnets	Pot, Barrels (Hag) (PTH)
Gillnet, Sink (GNS)	Pot, Lobster (PTL)
Dredges	**Other**
Dredge, Ocean Quahog/Surf Clam (DRC)	Harpoon (HRP)
Dredge, Scallop (DRS)	
( ) = Vessel Trip Report Gear Codes	

Figure 94. Spatial density patterns based on fishing trips using fixed gear (e.g., lobster traps, sink gillnets and longlines) in the Stellwagen Bank sanctuary are compared using standardized survey data (a) and Vessel Trip Report (VTR) data (b) over the same time period (July 2001–June 2002).

Survey data calculations were based on sightings of surface buoys. The patterns are Kriged density plots of information from both data sets using a 5,000m search radius and analyzed by ESRI ARCGIS. VTR gear codes: GNS, LLB, PTC, PTH, PTL.



U.S. city average for a representative lot of goods and services through an annual survey of retailers, landlords and consumers.

Description of Fishing Gear

As will be shown, the majority of fish and invertebrates caught in the sanctuary are captured by two types of fixed (stationary) fishing gear, lobster traps and sink gillnets, and by two types of mobile fishing gear, otter trawls and scallop dredges. The Sidebar presents detailed descriptions and information on these principal gear types as excerpted from Wiley *et al.,* 2003. The most important gear types used in the sanctuary during 1996-2005 based on volume of landings (greater than 1,000 lbs/yr) and their respective VTR gear codes are listed in Table 11. A more detailed description of these fishing gears is provided in Mooney-Seus and Dianto (2000).

Spatial Distribution and Density

Fishing using fixed (stationary) gear was the dominant human use of the sanctuary in 2001–2002 and occurred throughout the sanctuary as determined by the standardized surveys (Figure 95). Density surfaces for the survey data ranged from a high of 1.73–1.92 surface buoys/km²/month around the southwest corner of Stellwagen Bank and the northwest section of the sanctuary off Cape Ann, to lows of 0.0–0.19 surface buoys/km²/month, primarily in the southeastern section of the sanctuary. The dense areas coincided with the presence of trap fishing vessels, indicating concentrations of fishing gear targeting lobsters or, in some cases, crabs. This conclusion is corroborated by the distribution of the catch of lobster in the sanctuary revealed by spatial analysis of the VTR landings data for1994–2002 (not shown).

In general, the density of fixed fishing gear was greatest in the western portions of the sanctuary and diminished to the east. While the level of fixed fishing activity decreased to the east, substantial levels of use still occurred there. These levels were highest (approximately 0.2–0.6 surface buoys/km²/month) in an area

DESCRIPTION OF PRINCIPAL GEAR TYPES

Fixed Gear

Trap Fishery. Trap fisheries employ a passive methodology where traps sit on the seabed and use bait (usually dead fish) to attract lobsters, and to a lesser extent crabs, to the traps. Traps are wire or wooden cages that typically measure 91 cm by 53 cm by 34 cm (36 in by 21 in by 13.5 in), although some can be larger. Traps are often fished in "trawls" consisting of a number of traps leading off a common "ground line." In the area around the sanctuary, trawls typically consist of approximately 25 traps spaced 30-55 m (100-180 ft) apart (W. Hoffman, Massachusetts Division of Marine Fisheries, Boston, MA, Pers. Comm.). Therefore, a single trawl can be over 1,219 m (4,000 ft) in length. Ground lines along the length of the trawl characteristically consist of buoyant polypropylene line that can float more than 5 m (16 ft) above the bottom (McKiernan *et al.*, 2002). On each end of a trawl, a "buoy line" runs from the gear to a buoy visible at the surface (i.e., the surface buoy). As described above, two surface buoys might indicate the presence of over 1,219 m (4000 ft) of lobster gear.

Gillnet Fishery. Gillnets are comprised of thin, transparent, monofilament webbing stretched between a buoyant "float line" running along the top of the net and a heavy "lead line" running along the bottom. Tension between the buoyant float line and the heavy lead line causes the webbing to rise from the seabed to a height of 2.5 to 3.6 m (8 to 12 ft). If flatfish (e.g., flounder) are targeted, the float line and lead line are tied together, limiting the height to ~ 1 m (3 ft). A single net is ~ 91 m (300 ft) long and nets are joined together into "strings". In the GoM, net strings range between 458 m (1500 ft) and 2,292 m (7,500 ft) in length (Read, 1994). Each end of a string is marked on the surface with a buoy (usually a "high flyer") that is attached to the gear by a line also used for hauling. Strings of gillnets are often set in a zigzag or even circular pattern, with small weights along the lead line acting as pivot points. As with the trap fishery, it is important to note that an observation of two surface buoys can indicate the presence of hundreds or thousands of meters of netting on the seafloor below them.

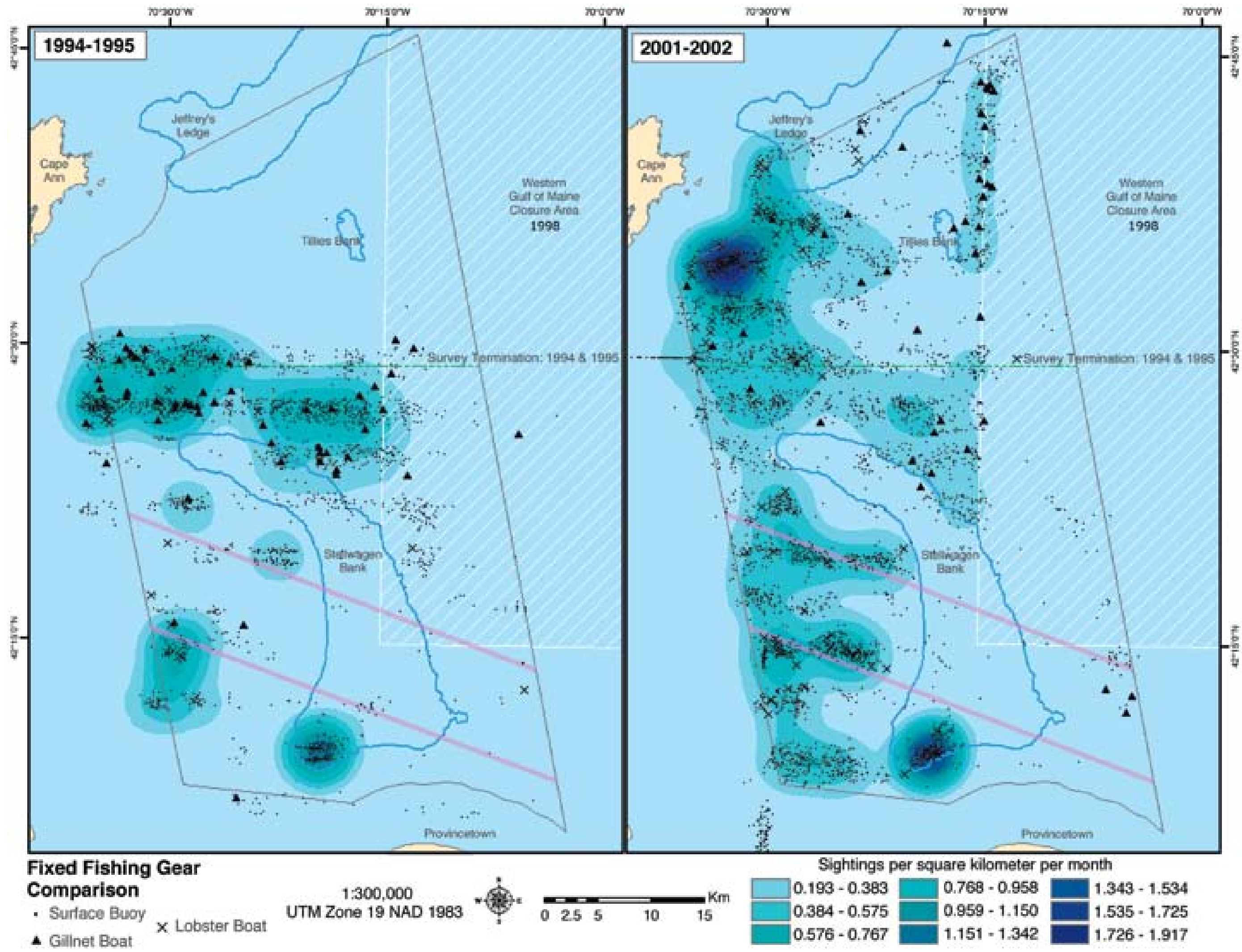
Mobile Gear

Otter Trawl Fishery. Bottom otter trawlers or "draggers" target primarily groundfish by towing a large conical n*et al*ong the seabed (Von Brandt, 1984). The net opening is maintained by the action of a buoyant "headrope" (on the top), a weighted "footrope" (on the bottom), and the spreading effect of heavy trawl "doors" (up to 450 kg or approximately 1,000 lbs) on either side of the net's mouth. The resistance of the doors moving through the water maintains a net opening width of 15 to 25 m (50–80 ft) (Carrothers, 1981). Fish are captured by the forward motion of the n*et al*ong the bottom, which causes fish to enter the net's mouth and collect in the anterior "cod end". Fish capture is facilitated by the movement of the footrope along the bottom that disturbs bottom dwelling fish and forces them up into the path of net. The footrope can be modified with rollers or other devices that provide fishermen with access to rocky or uneven bottom (Carr and Milliken, 1998). Midwater otter trawls and pair trawls are similarly configured but fish above the bottom in the water column for species such as Atlantic herring.

Scallop Dredge Fishery. A scallop dredge consists of an approximately 5 m (15 ft) wide rigid metal box trailing a bag of metal rings. The weight of the dredge (up to 700 kg or 1500 lbs) and the angle of the forward cutting bar force the dredge to dig a few centimeters (1–2 in) into the seabed. The forward motion of the cutting bar dislodges scallops from the bottom causing them to pass over the bar and collect in the trailing chain bag. Scallop vessels usually tow two dredges simultaneously at speeds under approximately 5 knots (Rago and McSherry, 2001). Scallop dredges are considered "dry" dredges in that they do not use water jets or suction in the capture process.

Figure 95. Comparison of the density and distribution of surface buoys within the Stellwagen Bank sanctuary over two survey periods: from May 1994 through August 1995 and from July 2001 through June 2002.

Each point represents the sighting of one or more surface buoys. Surface buoys are indicators of fixed fishing gear (trap or gillnet) "sets" that can extend thousands of meters along the seafloor. Two surface buoys equal one set. Trap and gillnet sets cannot be unambiguously differentiated by surface buoys. Sightings of actively fishing lobster (trap) and gill net vessels are provided as an aid to determining the type of gear in an area. The 1994–1995 survey covered only the southern two thirds of the sanctuary prior to establishment of the Western GoM Closure in 1998. The spatial patterns are Kriged density plots using a 5,000 m search radius and analyzed by ESRI ARCGIS. (Source: 1994–1995 sanctuary data; 2001-2002 from Wiley *et al.*, 2003).



northeast of Stellwagen Bank and along a line delineating the Western GoM Closed Area (WGoMCA), an area closed to groundfishing. These areas coincided with the presence of gillnet fishing vessels, indicating that this fishery occurred primarily in the eastern and northern portions of the sanctuary. Subsequent analyses utilizing VTR data indicate that some of that fixed gear was bottom longline as well as gillnet. With the exception of the southwest corner, there was a tendency for fixed gear not to be associated with the shoal water of Stellwagen Bank itself.

There were two major concentrations of mobile fishing vessels in 2001–2002 as determined by the standardized surveys (Figure 96). The densest aggregation (0.048–0.052 vessels/km²/month) occurred in the southeast section of the sanctuary. The primary vessels associated with that area were scallop dredges, although substantial numbers of stern and eastern trawlers also worked the area. A second aggregation occurred over a broad area covering the sanctuary's northwest quarter and consisted primarily of stern and eastern trawlers. Monthly densities in this region ranged up to 0.036 vessels/km²/month. With the exception of the heavily used portion in the southeast corner, mobile vessels made less use of the sanctuary's eastern section and the shallower area on top of Stellwagen Bank proper.

Comparison of results from the two survey periods between 1994–1995 and 2001–2001 indicates that the area fished by fixed gear in the sanctuary greatly expanded during the interim (Figure 95). Eastward expansion in the lobster fishery since the early-mid 1990s is due to declining recruitment occurring in shoaling waters and/or competition

Figure 96. Comparison of the density and distribution of mobile fishing vessels (stern dragger, eastern dragger and scallop dredge) within the Stellwagen Bank sanctuary over two survey periods: from May 1994 through August 1995 and from July 2001 through June 2002.

Each point represents the sighting of an active fishing vessel. The 1994–1995 survey covered only the southern two thirds of the sanctuary prior to establishment of the Western Gulf of Maine Closure Area in 1998. The spatial patterns are Kriged density plots using a 5,000 m search radius and analyzed by ESRI ARCGIS. (Source: 1994–1995 sanctuary data; 2001-2002 from Wiley *et al*., 2003).

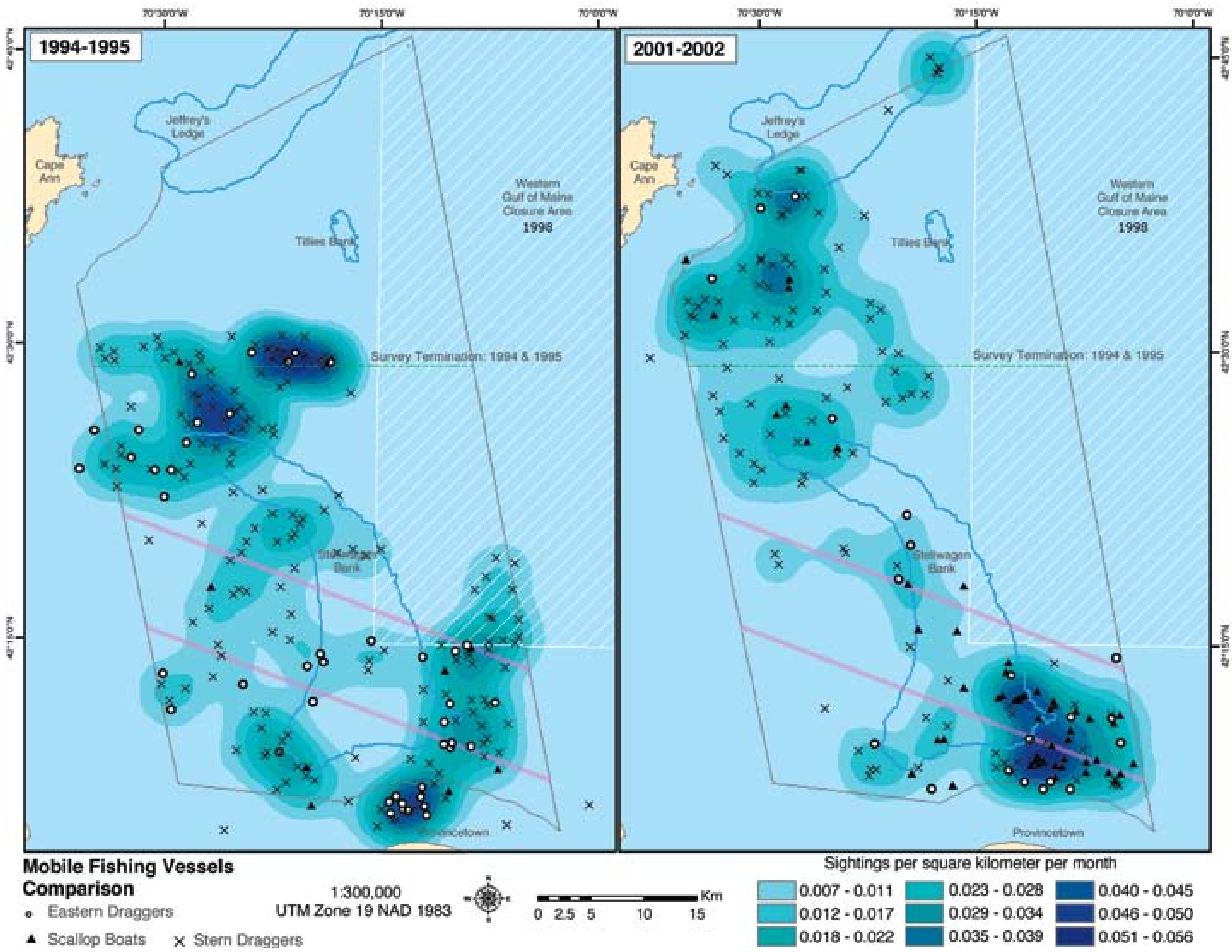
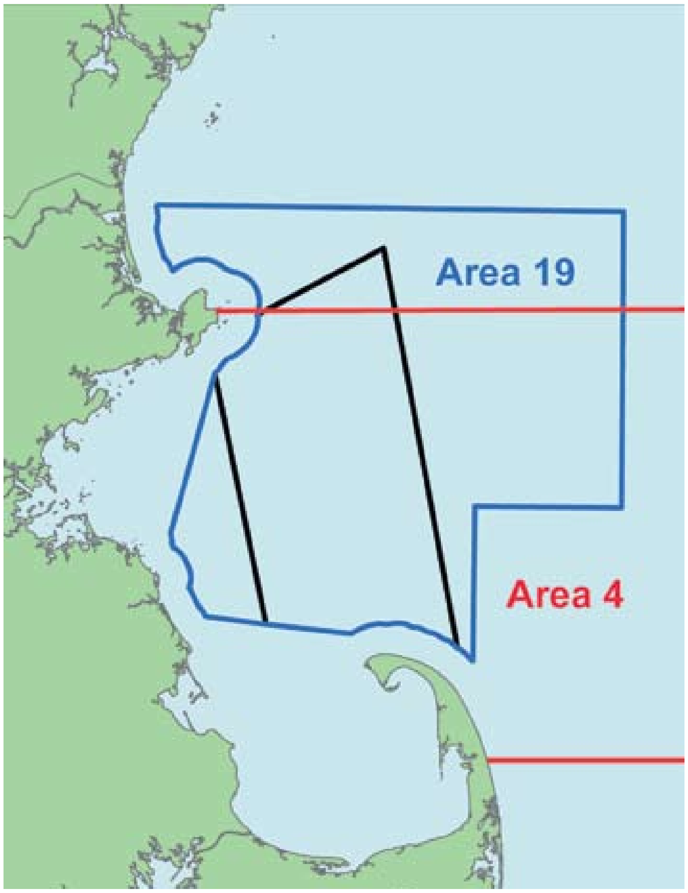


Table 12. Commercial vessels fishing within the Stellwagen Bank sanctuary by state of homeport.

State of Home-port	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total
Massachusetts	318	315	276	276	328	293	267	228	249	231	**2,781**	**85.0**
New Hampshire	16	13	16	20	29	32	13	13	26	26	**204**	**6.2**
Maine	24	19	19	13	21	17	17	15	14	27	**186**	**5.7**
Rhode Island	4	7	9	10	6	7		6	3	5	**57**	**1.7**
New York	2	4	5	4	1	4	3		2		**25**	**0.8**
New Jersey	3	2	5	5	1		1		1		**18**	**0.6**
Total	**367**	**360**	**330**	**328**	**386**	**353**	**301**	**262**	**295**	**289**	**3,271**	**100.0**

Figure 97. Size and location of the Stellwagen Bank sanctuary relative to State of Massachusetts Offshore Area 19 for reporting lobster landings and NOAA Fishing Area 4 for reporting bluefin tuna landings.

NOAA Fishing Area 4 extends directly eastward to the furthest extent of the 200-mile U.S. Exclusive Economic Zone (EEZ).



among fishermen for territory (Estrella and Glenn, 2004). Over the same timeframe, the area covered by draggers in the sanctuary contracted, while scallop dredge fishing increased, the latter most notably on the southeast corner of Stellwagen Bank (Figure 96). The timeframe during which the two surveys occurred corresponds to when regulatory changes imposed by NOAA Fisheries Service resulted in fishing effort being redirected from groundfish species, as well as when many boats converted to lobstering. Unless indicated otherwise, the following assessments are based on the VTR data.

Fleet Characteristics

Commercial fishing in the sanctuary is conducted by vessels primarily from home ports in several New England states, but especially from the Commonwealth of Massachusetts. Between 1996 and 2005, an average of 327 (range 262-386) boats fished in the sanctuary each year (Table 12). These boats came from home ports in six states, but four states accounted for 98.6% of the total number of vessels. These four states and their percentages were: Massachusetts (85.0%), New Hampshire (6.2%), Maine (5.7%) and Rhode Island (1.7%). The two other states were New York and New Jersey.

The total number of vessels fishing the sanctuary and those from home ports in Massachusetts decreased over this decade. The number of boats from Maine, New Hampshire and Rhode Island fishing the sanctuary varied year-to-year but remained at more or less the same level.

Landings Value and Volume

As acknowledged above, the VTR data under-represent the total landings of lobster and bluefin tuna from catches in the sanctuary. Fishery landings differ from catch (see Sidebar). Additional data on lobster landings from Massachusetts Offshore Area 19 and data on bluefin tuna landings from NOAA Fishing Area 4, both areas being greater in size and subsuming the sanctuary (Figure 97), were adjusted by subtracting values already reported in the VTR data. The difference was added to the VTR base amount to identify a likely maximum for total commercial fishery landings from the sanctuary (Tables 13 and 14). Landings value is reported in 2005 dollars.

Landings from party boats and charter boats are reported in the VTR system as quantity of fish, not landed value or pounds as required for all other gear types, and are not represented in this summary of total commercial fish landings. Sales generated by those boats derive from charter and head fees, not from ex-vessel landings. Party boat fishing and charter boat fishing are treated separately under the subsequent section on recreational fishing.

State and County

Based on the VTR data, total commercial fishery landings value from the sanctuary during 1996-2005 ranged from a low of $12.5 million in 2003 to a high of $19.6 million in 2000 (Table 13). The average annual total landings value

Distinguishing between Catch and Landings

"Landings" is defined as the part of the fish catch that is unloaded and put ashore for sale. The distinction between catch and landings is important because considerable quantities of fish and fishable invertebrates caught are discarded at sea as bycatch. The overall discard to landings ratio (0.49) in northeast fisheries in 2002-2003 was among the highest nationwide (Harrington et al, 2005); essentially a third of everything caught was discarded (32.7 % of total nominal catch). The discard to landings ratio in the fishery for northeast groundfish in 2002-2003 was 1.79 indicating that nearly two-thirds of the catch (64.2%) was discarded (i.e., only one fish was landed for every three fish caught). While the by-catch of protected species such as marine mammals, turtles and sea birds is a major conservation issue, those species were not included in these calculations. More recent discard rates for this northeast fishery show that discarding from bottom trawls and gill nets is substantially reduced (NOAA Fisheries Service, personal communication, 2008).

Table. 13. Landings value (2005$) by commercial fishing in the Stellwagen Bank sanctuary by state and county landed (1996-2005). Table is based on VTR data with adjustments made for Area 19 and Area 4 landings.

	Vessel Trip Report Data											
State and County Landed	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**% Total**
Maine	**63,354**	**251,482**	**125,521**	**130,811**	**157,974**	**361,936**	**196,933**	**26,266**	**92,036**	**145,166**	**1,551,481**	**0.99**
Washington	0	265	0	0	0	0	0	2,024	0	0	**2,289**	**0.00**
Hancock	850	0	0	0	3,092	316,199	96,532	0	0	0	**416,672**	**0.27**
Knox	0	105,926	80,087	53,621	22,092	0	0	0	0	0	**261,727**	**0.17**
Lincoln	0	0	3,883	426	10,585	0	1,246	0	0	0	**16,141**	**0.01**
Saqadahoc	4,255	0	0	0	0	0	0	0	0	0	**4,255**	**0.00**
Cumberland	50,086	122,728	25,154	73,242	113,393	27,125	97,091	21,681	86,178	86,864	**703,542**	**0.45**
York	8,163	22,563	16,397	3,522	8,811	18,612	2,065	2,561	5,857	58,302	**146,854**	**0.09**
New Hampshire	**72,967**	**28,490**	**39,964**	**121,861**	**332,430**	**261,227**	**133,748**	**148,721**	**260,850**	**370,201**	**1,770,459**	**1.13**
Rockingham	72,967	28,490	39,964	121,861	332,430	261,227	133,748	148,721	260,850	370,201	**1,770,459**	**1.13**
Massachusetts	**16,720,219**	**18,737,542**	**16,620,546**	**14,783,746**	**19,062,685**	**14,094,167**	**13,723,907**	**12,292,621**	**12,222,166**	**14,273,689**	**152,531,287**	**97.61**
Essex	8,732,583	10,526,240	11,225,017	10,225,216	11,927,139	9,289,915	9,312,114	2,9,004,148	9,212,145	10,849,245	**100,303,763**	**64.19**
Suffolk	594,643	513,646	221,546	143,678	570,989	145,608	102,481	45,342	166,966	150,424	**2,655,323**	**1.70**
Norfolk	1,744	27,135	6,666	0	42,366	29,532	15,925	3,335	29,342	7,049	**163,096**	**0.10**
Plymouth	2,975,603	2,600,429	2,954,051	2,575,654	4,172,305	1,358,764	961,650	1,264,538	1,468,468	1,247,526	**21,578,988**	**13.81**
Barnstable	1,326,212	1,270,883	1,457,121	1,366,509	1,565,946	2,295,199	1,921,863	1,438,251	1,081,316	1,601,205	**15,324,505**	**9.81**
Nantucket	0	0	0	0	21,702	0	0	0	0	0	**21,702**	**0.01**
Dukes	0	0	0	0	24,231	8,314	12,880	24,852	0	4,002	**74,279**	**0.05**
Bristol	3,089,434	3,793,567	752,481	472,689	736,452	966,835	1,396,993	512,154	263,929	413,426	**12,397,959**	**7.93**
Other MA	0	5,641	3,664	0	1,555	0	0	0	0	813	**11,672**	**0.01**
Rhode Island	**20,538**	**34,679**	**63,547**	**22,740**	**3,967**	**43,991**	**16,927**	**36,989**	**0**	**3,681**	**247,060**	**0.16**
All RI Counties	20,538	34,679	63,547	22,740	3,967	43,991	16,927	36,989	0	3,681	**247,060**	**0.16**
All Other Counties	**3,032**	**0**	**134,818**	**23,010**	**0**	**0**	**7,101**	**0**	**0**	**1,998**	**169,958**	**0.11**
VTR Total	**16,877,079**	**19,052,193**	**16,984,397**	**15,082,168**	**19,557,056**	**14,761,321**	**14,078,617**	**12,504,597**	**12,575,052**	**14,794,735**	**156,267,213**	**100.00**
Additional Data Sources (modified by subtracting values already reported in Vessel Trip Report Data)												
Offshore Area 19 Lobster	4,709,061	10,269,317	8,348,659	8,012,993	4,410,118	4,022,054	3,766,661	4,253,402	3,525,367	3,707,774	**55,025,407**	
Federal Area 4 Bluefin Tuna	983,926	3,940,467	3,200,957	4,338,574	1,626,347	2,419,523	1,536,272	1,010,777	1,071,393	1,554,766	**21,683,002**	
Adjusted Total	**5,692,988**	**14,209,783**	**11,549,615**	**12,351,567**	**6,036,465**	**6,441,577**	**5,302,933**	**5,264,179**	**4,596,761**	**5,262,541**	**76,708,409**	
Overall Total	**22,570,066**	**33,261,976**	**28,534,012**	**27,433,735**	**25,593,520**	**21,202,898**	**19,381,550**	**17,768,776**	**17,171,812**	**20,057,276**	**232,975,622**	

Table 14. Landings in pounds by commercial fishing in the Stellwagen Bank sanctuary by state and county landed (1996-2005). Table is based on VTR data with adjustments made for Area 19 and Area 4 landings.

	Vessel Trip Report Data											
State and County Landed	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**% Total**
Maine	**207,333**	**548,017**	**313,771**	**1,444,946**	**170,826**	**84,955**	**421,258**	**11,938**	**64,086**	**359,683**	**3,626,813**	**2.13**
Washington	0	64	0	0	0	0	0	1,035	0	0	**1,099**	**0.00**
Hancock	1,050	0	0	0	2,260	51,030	15,000	0	0	0	**69,340**	**0.04**
Knox	0	91,544	287,559	571,866	64,634	0	0	0	0	0	**1,015,603**	**0.60**
Lincoln	0	0	2,176	99	7,210	0	330	0	0	0	**9,815**	**0.01**
Saqadahoc	366	0	0	0	0	0	0	0	0	0	**366**	**0.00**
Cumberland	204,868	447,527	13,596	872,565	88,066	20,900	405,401	10,361	62,852	337,121	**2,463,257**	**1.45**
York	1,049	8,882	10,440	416	8,656	13,025	527	542	1,234	22,562	**67,333**	**0.04**
New Hampshire	**45,906**	**23,268**	**22,079**	**70,171**	**243,684**	**194,457**	**372,061**	**451,498**	**179,217**	**1,210,240**	**2,812,581**	**1.65**
Rockingham	45,906	23,268	22,079	70,171	243,684	194,457	372,061	451,498	179,217	1,210,240	**2,812,581**	**1.65**
Massachusetts	**14,997,849**	**21,985,280**	**25,640,158**	**18,791,535**	**11,957,970**	**11,736,627**	**14,742,787**	**9,218,717**	**10,597,011**	**22,609,500**	**162,277,434**	**95.28**
Essex	11,049,365	15,218,614	21,760,724	13,462,473	7,753,228	8,600,173	12,363,538	7,140,379	8,720,955	18,280,362	**124,349,811**	**73.01**
Suffolk	316,935	343,001	216,517	49,261	349,513	82,994	58,173	34,484	121,833	98,018	**1,670,729**	**0.98**
Norfolk	608	6,056	1,488	0	7,476	5,890	3,756	640	6,100	1,837	**33,851**	**0.02**
Plymouth	2,284,997	4,399,816	2,191,020	3,503,532	1,613,768	516,236	354,410	752,931	814,452	638,676	**17,069,838**	**10.02**
Barnstable	409,072	869,152	1,155,689	1,464,239	1,569,644	1,684,638	1,231,896	738,968	539,347	506,481	**10,169,126**	**5.97**
Nantucket	0	0	0	0	17,544	0	0	0	0	0	**17,544**	**0.01**
Dukes	0	0	0	0	21,015	7,950	10,345	18,950	0	2,525	**60,785**	**0.04**
Bristol	936,872	1,147,382	312,955	312,030	624,747	838,746	720,669	532,365	394,324	3,081,132	**8,901,222**	**5.23**
Other MA	0	1,259	1,765	0	1,035	0	0	0	0	469	**4,528**	**0.00**
Rhode Island	**225,000**	**190,000**	**190,102**	**13,096**	**2,968**	**141,285**	**35,977**	**25,050**	**0**	**3,141**	**826,619**	**0.49**
All RI Counties	225,000	190,000	190,102	13,096	2,968	141,285	35,977	25,050	0	3,141	**826,619**	**0.49**
All Other Counties	**662**	**0**	**742,488**	**18,871**	**0**	**0**	**4,736**	**0**	**0**	**1,402**	**768,159**	**0.45**
VTR Total	**15,476,088**	**22,746,565**	**26,908,598**	**20,338,619**	**12,375,448**	**12,157,324**	**15,576,819**	**9,707,203**	**10,840,314**	**24,183,966**	**170,310,944**	**100.00**
Additional Data Sources (modified by subtracting values already reported in Vessel Trip Report Data)												
Offshore Area 19 Lobster	1,177,862	837,101	1,628,137	1,549,096	742,601	769,263	789,107	825,361	699,694	674,620	**9,692,842**	
Federal Area 4 Bluefin Tuna	479,789	490,241	680,616	684,169	227,611	388,720	253,976	195,582	54,998	440,063	**3,895,765**	
Adjusted Total	**1,657,651**	**1,327,342**	**2,308,753**	**2,233,265**	**970,212**	**1,157,983**	**1,043,083**	**1,020,943**	**754,692**	**1,114,683**	**13,588,607**	
Overall Total	**17,133,739**	**24,073,907**	**29,217,351**	**22,571,884**	**13,345,660**	**13,315,307**	**16,619,902**	**10,728,146**	**11,595,006**	**25,298,649**	**183,899,551**	

Figure 98. Trends in value (2005$) of annual commercial fishery landings from the Stellwagen Bank sanctuary for the period 1996–2005.

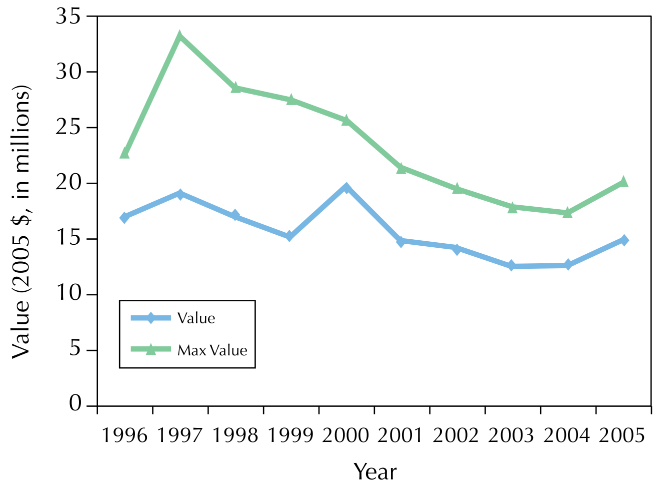
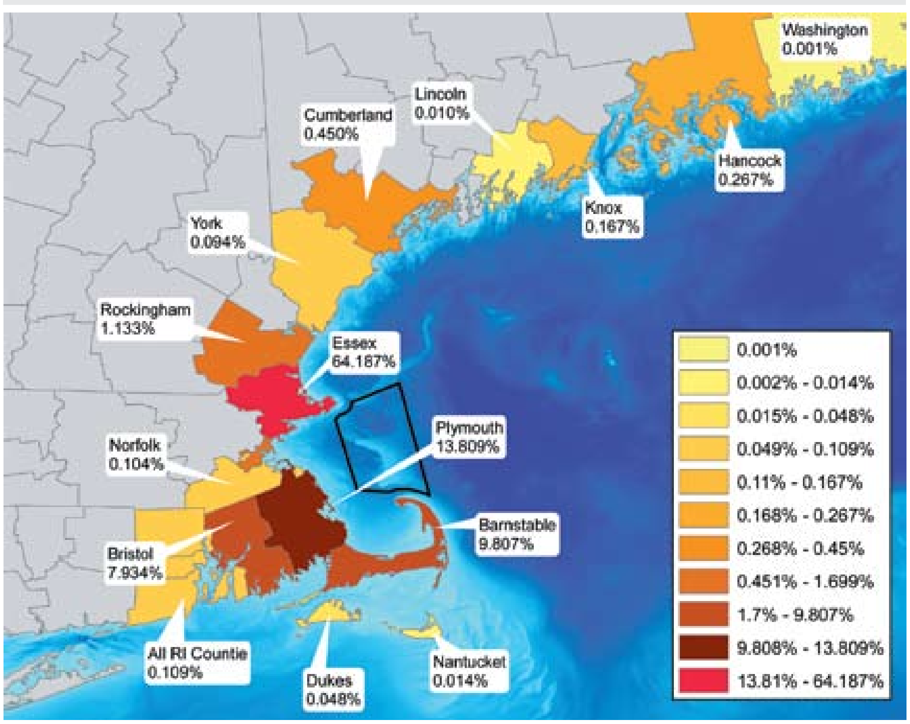


Figure 99. Trends in annual commercial fishery landings in pounds from the Stellwagen Bank sanctuary for the period 1996–2005.

from the sanctuary was $15.6 million over this period. The upper possible average annual value for this period after adjustment for lobster and bluefin tuna was $23.3 million; annual adjusted upper values ranged between $17.2 million in 2004 to $33.3 million in 1997. Comparable landings information in pounds is presented in Table 14 but, except where noted, the remainder of this discussion is based on dollar value (2005$).

Massachusetts ports received the bulk of the landings (97.8%) and determined the overall temporal pattern in value, which trended down over the decade (Table 12 and Figure 98). [Landings in pounds show a steeper decline with an uptick in 2005 due to record catches of Atlantic herring, a low value product, in the sanctuary that year (Table 13 and Figure 99).] Landings in Maine ranged from $0.03 million in 2003 to $ 0.36 million in 2001. Landings in New Hampshire ranged from $0.03 million in 1997 to $0.37 million in 2005. Landings in both Maine and New Hampshire, while low overall, varied by an order of magnitude over this period. Landings in Rhode Island were the lowest and most variable. New Hampshire was the only state to see higher landings in 2005 than in 1996, trending opposite to these other states.

Figure 100. Distribution of commercial fishery landings from the Stellwagen Bank sanctuary by county landed based on total landings value for the period 1996–2005.



The percent of total landings from the sanctuary by county landed for the period 1996–2005 is presented in Figure 100. Essex County in Massachusetts received 64.2% of the landings, followed by Plymouth County (13.8%), Barnstable County (9.8%) and Bristol County (7.9%), all also in Massachusetts. Landings in all other counties amounted to 2% of the total or less. Landings information is presented in aggregate by county, rather than by port, to ensure that data confidentiality is maintained.

Species and Gear

The top ten species landed from the sanctuary during 1996-2005 based on ex-vessel dollar value and volume (pounds) are indicated in Table 15. Lobster and cod contributed the greatest value; four species (lobster, cod, yellowtail flounder and sea scallops) accounted for more than half (60.0%) of the total ex-vessel value. Atlantic herring contributed the greatest volume (41.0%) and together with cod accounted for half (51.4%) of the total pounds landed.

Table 15. Top ten species landed and top ten commercial fishing gear types used in the Stellwagen Bank sanctuary (1996–2005) based on landed value (2005$) and volume (lbs.).

	a. Species	Total lbs 1996–2005	% Total 1996–2005
1	Herring, Atlantic	70,084,751	40.99
2	Cod	17,781,281	10.40
3	Dogfish, Spiny	17,429,616	10.19
4	Flounder, Yellowtail	12,187,130	7.13
5	Lobster, American	7,781,831	4.55
6	Monkfish (Round/tails/livers)	5,799,527	3.39
7	Hake, Silver/Whiting	4,385,477	2.57
8	Flounder, Witch/Gray Sole	4,374,122	2.56
9	Flounder/ Winter/Blackback	3,952,821	2.31
10	Pollock	3,806,895	2.23

	b. Species	Total value 1996–2005 (2005 $)	% Total 1996–2005
1	Lobster, American	37,643,120.87	23.93
2	Cod	27,428,431.67	17.44
3	Flounder, Yellowtail	16,021,158.90	10.19
4	Scallop, Sea	13,239,975.18	8.42
5	Monkfish (Round/tails/livers)	11,189,345.56	7.11
6	Flounder, Witch / Gray Sole	8,269,795.59	5.26
7	Flounder, Winter / Blackback	5,552,683.01	3.53
8	Herring, Atlantic	5,374,683.03	3.42
9	Flounder, American Plaice /Dab	4,808,256.36	3.06
10	Tuna, Bluefin	4,448,954.58	2.83

	c. Gear Types	Total lbs 1996–2005	% Total 1996–2005
1	Pair Trawl, Midwater	45,305,120	26.52
2	Otter Trawl, Bottom, Fish	43,002,828	25.17
3	Gill Net, Sink	36,598,845	21.42
4	Otter Trawl, Midwater	18,352,059	10.74
5	Purse Seine	8,521,839	4.99
6	Pot, Lobster	7,523,142	4.40
7	Longline, Bottom	5,352,766	3.13
8	Dredge, Scallop, Sea	2,448,887	1.43
9	Pot, Hag	1,426,663	0.84
10	Hand Line/Rod & Reel	913,209	0.53

	d. Gear Types	Total value 1996–2005 (2005 $)	% Total 1996–2005
1	Otter Trawl, Bottom, Fish	55,674,129.20	35.40
2	Pot, Lobster	35,358,454.48	22.48
3	Gill Net, Sink	35,176,080.73	22.37
4	Dredge, Scallop, Sea	13,251,335.64	8.43
5	Pair Trawl, Midwater	4,242,985.73	2.70
6	Longline, Bottom	4,160,609.74	2.65
7	Hand Line/Rod & Reel	3,093,587.95	1.97
8	Harpoon	2,041,146.18	1.30
9	Otter Trawl, Midwater	1,539,612.43	0.98
10	Purse Seine	1,077,952.71	0.69

Overall, the top ten species accounted for 85.2% of total landings value and 86.3% of total volume landed from the sanctuary.

The top ten gear types fished in the sanctuary based on ex-vessel value and volume for the same period are also provided in Table 15. The bottom otter trawl-fish accounted for the highest dollar value of landings from the sanctuary (35.4%) and the midwater pair trawl accounted for the greatest landed volume (26.5%). Four gear types (bottom otter trawl-fish, lobster pot, sink gill net and sea scallop dredge) accounted for the greatest ex-vessel value (88.7% of total) and four gear types (midwater pair trawl, bottom otter trawl-fish, sink gill net and midwater otter trawl) accounted for the greatest volume of pounds landed (83.9%). Overall, the top ten gear types accounted for 99.0% of total landings value and 99.1% of total volume landed from the sanctuary.

Table 16. Comparison of ex-vessel value (2005$) of commercial fishery landings from the Stellwagen Bank sanctuary (1996–2005) by New England state landed relative to total value of fishery landings in those states from all sources.

Adjusted total is likely maximum value for commercial fishing in the sanctuary.

State Landed	Total *	Sanctuary	% Sanctuary
Massachusetts	3,274,371,313	138,257,598	4.22
Maine	3,226,531,641	1,406,314	0.04
New Hampshire	178,314,569	1,400,258	0.79
Rhode Island	949,036,882	243,379	0.03
VTR total	**7,628,254,405**	**141,307,549**	**1.85**
Adjusted Total		**212,753,418**	**2.79**

* Source: Northeast Fisheries Science Center, NOAA Fisheries Service

Two species caught in the sanctuary, American lobster and Atlantic herring, are notable because of the inverse relationship exhibited between their landed value and volume and their relationship to one another in the conduct of fishing. Lobster accounted for 23.9% of the landed value, but landings were only 4.6% of volume. By contrast, herring accounted for 3.4% of the landed value, but landings were 41.0% of volume. Lobster is high value/ low volume (poundage), while herring is low value/high volume. Lobster is caught entirely for human consumption, while a large share of the herring catch is for use as bait in the pot fishery for lobster.

Northeast Landings Value

The ex-vessel value of commercial fishery landings from the sanctuary based on the VTR data is compared to the total value of commercial landings by state for Rhode Island, Massachusetts, New Hampshire and Maine (all of coastal New England except Connecticut) for the period 1996-2004 (Table 16). The New England landings data are not available for 2005; these data are for all species caught in the northeast area fisheries and were provided by the NOAA Fisheries Service Northeast Fisheries Science Center. Landings value was adjusted and continues to be reported in 2005 dollars. Essentially all (99.9%) of the commercial fishery landings from the sanctuary over that period were landed in the ports of these four states.

The total value of commercial fishery landings from the sanctuary was 4.2% of the total landings value for Massachusetts, 0.8% for New Hampshire and 0.04% or less for Maine and Rhode Island based on the VTR data alone. The total value of landings from the sanctuary was 1.9% of the total landings value for all fisheries in New England. When the upper possible values based on adjusted lobster and bluefin tuna landings are added to the VTR data and factored into this analysis, the total value of landings from the sanctuary was still no more than 2.8% of the New England total over the decade. This analysis omits Connecticut, which realized next to no landings from the sanctuary and which, if included, would reduce this percentage.

Total Catch by Commercial Fishing

As noted above, commercial fishing landed 17.0 million pounds (7,725 mt) to 18.4 million pounds (8,342 mt) of fish and crustaceans from the sanctuary on average per year during 1996–2005 (Table 14). The lower estimate is the VTR landings; the upper estimate is the VTR landings plus adjustments for lobster and bluefin tuna.

These landings are minimal estimates of total catch from the sanctuary because they do not include the landings by charter and party boats and by private recreational fishing, nor do they include the bycatch and regulatory discards associated with all the fisheries involved. This total also does not include biomass estimates for seafloor biogenic habitat and associated biological community losses due to fishing. These losses could be considerable given the broad spatial extent over which the sanctuary is routinely fished.

A first order approximation of the level of commercial fishery discards in SBNMS in 2002/2003 is 4.0 million pounds (1.8 mt) on average per year. The total VTR landings for SBNMS in 2002/2003 were 13.3 million pounds (6.0 mt) on average per year. This approximation suggests that commercial fishery discards amounted to about 23% of total average annual catch (17.3 million pounds or 7.8 mt) in SBNMS in 2002/2003. [Note: The level of commercial fishery discards in the SBNMS in 2002/2003 was approximated as follows: The regional total discard to landings ratio for northeast commercial fisheries in 2002/2003 was 0.49 (Harrington *et al.,* 2005). Fishery ratios ranged between a high of 1.790 for northeast groundfish to a low of 0.040 for Atlantic herring. The VTR landings data (fisheries for lobster and bluefin tuna were not included in the calculation of the ratios) for SBNMS were partially stratified by fishery type. Since herring accounted for an average of 41% of the landings from the sanctuary during 1996–2005 (Table 14), the 0.040 ratio for the herring fishery was applied to the average of the 2002/2003 herring landings; the regional total ratio of 0.49 was applied to the remainder of the fishery landings averaged over 2002/2003.]

Recreational Fishing

Although a few party boats initiated a recreational ground fishery in the Stellwagen Bank area in the late 1940s, commercial vessels supporting recreational fishing have only regularly worked the area since the mid 1970s (NOAA, 1993). Previous to that time, the recreational fishery was largely based in nearshore waters within 4.8 km or 6.4 km (3 mi. or 4 mi.) off the coast. The seaward movement of recreational fishing in the mid 1970s is attributed to the decline in nearshore groundfish stocks, which necessitated vessels moving farther offshore to catch these species. Three decades later in 2006, readers of *Offshore* magazine voted Stellwagen Bank the number three favorite recreational fishing spot in the northeast (*Offshore*, July 2006).

Recreational fishing in the sanctuary is divided into two categories: party/charter boat and private. In the party/charter boat category, commercial operators take customers fishing for a fee. In the private category, individuals own or rent boats that they use to go fishing. Party boats are usually 15.2 m (50 ft.) or longer and carry 20 to 80 passengers. Charter boats generally measure 7.6 m to 9.1 m (25 to 30 ft.) and carry an average of six paying passengers (hence the expression “six-pack” charters). Private boats often measure 6.1 m (20 ft.) or longer and carry one to several anglers.

Data Types and Sources

Fishing Vessel Trip Report (VTR) data for the period 1996-2005 (described above) were used to characterize party and charter boat fishing in the sanctuary, and consisted of the reported quantity (i.e., number) of fish landed by species. A comparable data base for private recreational fishing specific to the sanctuary does not exist. The sample size for private recreational fishing boats in the standardized survey database (described above) for the sanctuary is too limited for reliable analysis at the scale of the sanctuary. Shipboard survey tracklines were run primarily during weekdays and likely under-sampled boating activities occurring during weekends and holidays, when this sector would be expected to be most active. Alternatively, results from the NOAA Marine Recreational Fisheries Statistics Survey Query were used to draw general inferences about private recreational fishing in the sanctuary (Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division [http://www.st.nmfs.noaa.gov/st1/recreational/queries/index.html]).

NOAA Survey Query data are the estimated pounds caught by species, based on a standardized random telephone survey of the general public. Data from the survey query used in this analysis are for offshore Massachusetts (i.e., Federal Exclusive Economic Zone three to 200 miles off the coast), which is an area inclusive of, but many times the size of, the Stellwagen Bank sanctuary. The data are also problematic because they include catches from two distinct biogeographic provinces, i.e., the database is inclusive of species from the GoM to the north of Cape Cod and from the mid-Atlantic shelf to the south. While there is sharing of seasonal transitional species between these segments of offshore Massachusetts, the two provinces are associated with differing species assemblages and ranges, a fact apparent in the species mix listed in the query results.

Party and Charter

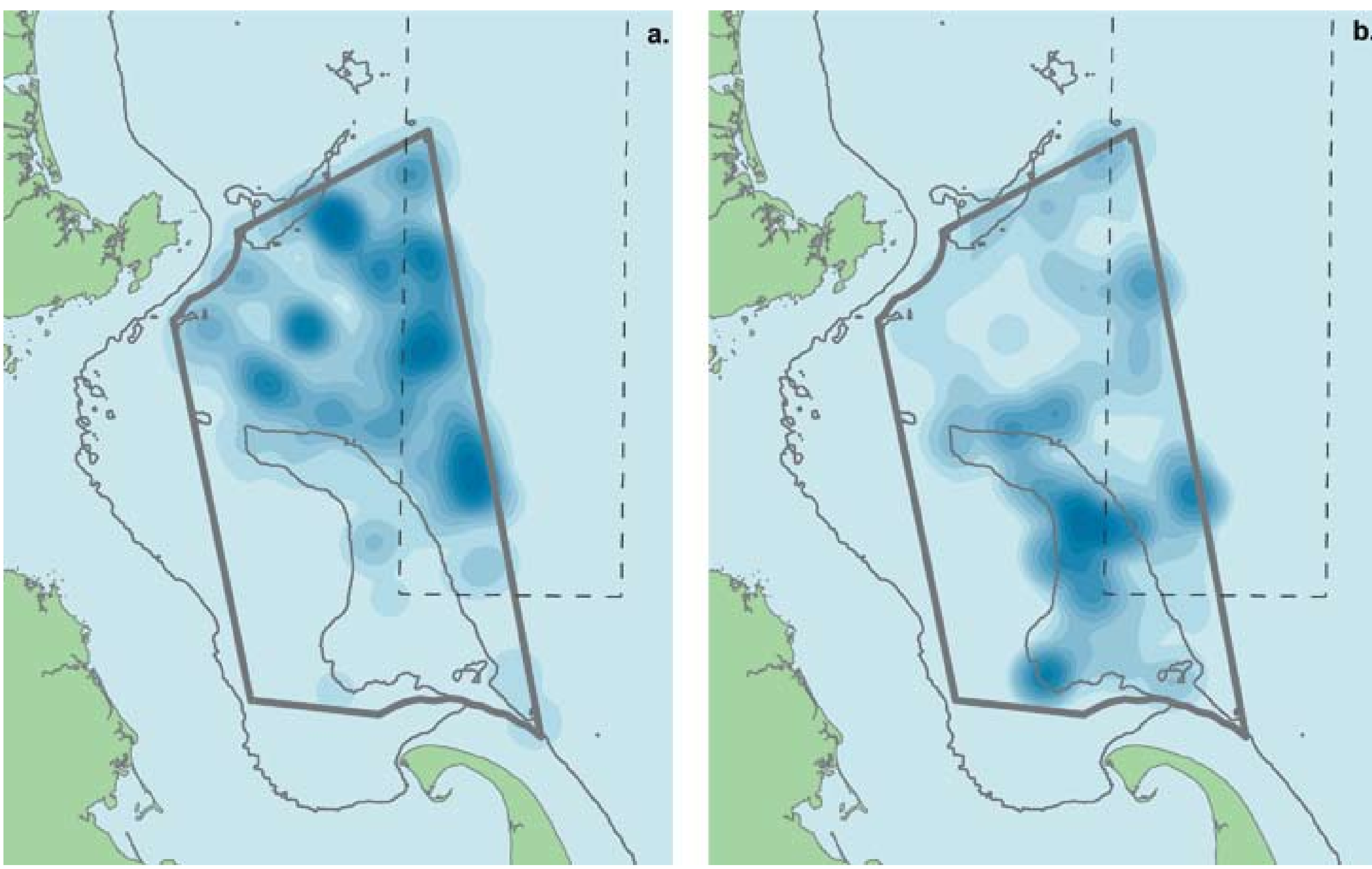
Spatial Distribution and Density

Party and charter boats show distinctly different spatial patterns of use within the sanctuary (Figure 101). This figure is based on the VTR data for the period July 2001–June 2002, which is the base period for analyses of spatial distribution and density established in this document for treatment of fishing. The Western Gulf of Maine Closure Area (WGoMCA) also is indicated in this Figure; 22 percent of this closed area overlaps the eastern side of the sanctuary and is known as the "sliver."

As previously explained, the WGoMCA (and sliver) was established by NOAA Fisheries Service in 1998 at the recommendation of the NEFMC for the purpose of recovering groundfish stocks, specifically cod and haddock. Bottom-tending trawl gear and gill nets were specifically excluded from this closed area, but recreational hook and line remained among the allowable gear for catching

Figure 101. Spatial density patterns based on fishing trips for party boat (a) and charter boat (b) fishing in the Stellwagen Bank sanctuary during July 2001–June 2002.

The patterns are Kriged density plots using a 5,000 m search radius and analyzed by ESRI ARCGIS. VTR gear code: Party/Charter (Trip ID: 2, 3).



groundfish there. Party and charter boats have come to view the sliver as a refuge from competing forms of commercial groundfishing.

Trip density for party boats was highest across all but the southern-most part of the sliver and over most of the northern half of the sanctuary; trip density was lowest over Stellwagen Bank and in the southwest quadrant of the sanctuary. Trip density for charter boats was highest over almost all of Stellwagen Bank and portions of the sliver; trip density was lowest in the western and north-central portions of the sanctuary. High trip densities for both party and charter boats occurred in the sliver, but the concentrated coverage indicated there for party boats is compelling.

Fleet Characteristics

Fishing by party boat and charter boat in the sanctuary is conducted by vessels with home ports of registry from across the entire eastern seaboard from Florida to Maine (Table 17). Three states (Massachusetts, New Hampshire and Maine) accounted for essentially 94% of the total number in each category; Massachusetts accounted for the great majority of the party (76.6%) and charter boats (78.7%) fishing in the sanctuary. Other states represented in the total include Vermont, Rhode Island, Connecticut, New York, Virginia, West Virginia, Missouri, North Carolina and Florida.

Between 1996 and 2005, an average of 25 party (range 17-43) and 44 charter (range 27-75) boats fished in the sanctuary each year. The number of party boats each year remained relatively steady over 1996-2003, increasing sharply over 2004-2005 (Table 17a). The number of charter boats each year trended upwards over 1996-2003, also increasing sharply over 2004-2005 (Table 17b). These trends are illustrated in Figure 102.

The annual number of trips for party boats over this period ranged from 133 to 517 with an annual mean of 292; the range for charter boat trips was 352 to 937 and the mean was 598. The annual number of party boat anglers ranged from 3,416 to 21,150 (mean 10,610); the range for charter boat anglers was 3,377 to 6,142 (mean 4,808). On average over this period, party boats made half the number of trips as charter boats but took twice the number of anglers. These data are summarized in Table 18. Counts based on these measures all increased over this period.

Pricing and Sales Value

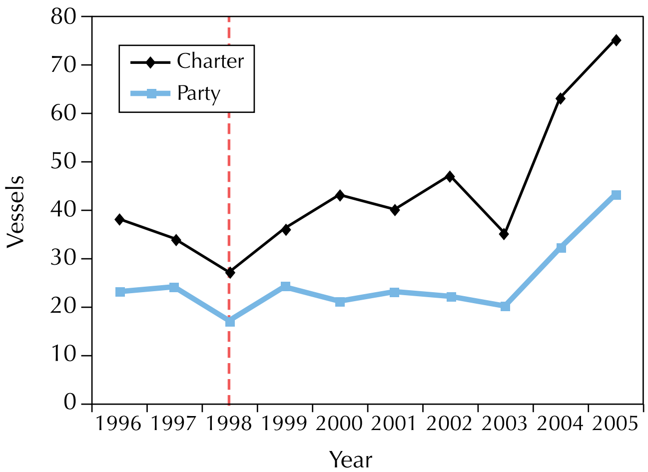
General approximation of the direct sales value of party boat and charter boat fishing in the sanctuary suggests a

Table 17. Number of (a) party boats and (b) charter boats by state of home port that landed fish from the Stellwagen Bank sanctuary during 1996–2005.

State of Home-port	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total
a. Party Boats												
Massachusetts	32	31	25	31	27	28	22	25	32	39	**292**	**76.6**
New Hampshire	5	4	1	3	5	5	6	5	8	7	**49**	**12.9**
Maine		4	2	2	2	4			2	3	**19**	**5.0**
Rhode Island	1	2		1				1		2	**7**	**1.8**
New York			1	1			1		1		**4**	**1.0**
Connecticut		1				1				1	**3**	**0.8**
Florida		1	1		1						**3**	**0.8**
North Carolina						1			1		**2**	**0.5**
Virginia			1	1							**2**	**0.5**
Total	**38**	**43**	**31**	**39**	**35**	**39**	**29**	**31**	**44**	**52**	**381**	**100**
a. Charter Boats												
Massachusetts	41	49	36	44	54	46	52	43	81	94	**540**	**78.7**
New Hampshire	6	4	4	6	8	12	11	14	13	14	**92**	**13.4**
Maine	1	1	1	2	2	2	1		3	2	**15**	**2.2**
Florida	1	1	2	2	2	1	1	1	1	1	**13**	**1.9**
New York	2	2	1		1		1			2	**9**	**1.3**
Connecticut					1	2	1	1	1		**6**	**0.9**
Vermont		1	1	1	1						**4**	**0.6**
West Virginia				1	1				1	1	**4**	**0.6**
Rhode Island				1						1	**2**	**0.3**
Missouri	1										**1**	**0.1**
Total	**52**	**58**	**45**	**57**	**70**	**63**	**67**	**59**	**100**	**115**	**686**	**100**

Figure 102. Trend in number of party and charter boats fishing in the Stellwagen Bank sanctuary during 1996–2005.

Establishment of the Western Gulf of Maine Closure Area (WGOMCA) in 1998 is indicated by the vertical line.



combined total of about $2.5 million in 2005. This calculation is based on a representative "head" fee of $50 per party boat passenger and a representative charter cost of $1,200 per trip, using the VTR data for number of passengers and trips in 2005 (Table 18). This approximate value is rounded upwards to account for tips to crew members, which is customary and which can be 10%-20% of the purchase price. Representative pricing was provided by several companies offering party boat fishing in the sanctuary and by the Stellwagen Bank Charter Boat Captains Association.

Landings Characteristics

As remarked earlier, "landings" is defined as the part of the fish catch that is unloaded and put ashore. The distinction between catch and landings is important because quantities of fish are discarded at sea as bycatch. The discard to landings ratio in northeast recreational fisheries is not known, but discarding does occur. Recreational discards can be sublegal size fish or undesired species caught, for example.

Discard mortality also is not well known for the northeast recreational fisheries. However, species like cusk are particularly susceptible to discard mortality because of the barotrauma experienced in being brought to the surface from depth. Landings are invariably minimum indications of the total numbers of fish caught and the total mortality experienced in recreational as well as commercial fisheries.

State and County

The total number of 353,459 fish landed by party boats from the sanctuary during 1996–2005 (Table 19a) was less than the total 503,735 fish landed by charter boats over that period (Table 19b). Massachusetts ports received 81.1% and New Hampshire ports received 16.8%, together totaling 97.9% of the party boat landings from the sanctuary. Massachusetts ports received 98.4% of the landings from charter boats. Massachusetts and New Hampshire ports are predominant in the party boat fishery in the sanctuary, while Massachusetts ports dominate charter boat fishing there.

The percent of party and charter boat landings from the sanctuary by county is presented in Figure 103. Essex County in Massachusetts received 68.5% of the party boat landings followed by Rockingham County in New Hampshire (16.8%) and Plymouth County in Massachusetts (11.3%), together totaling 96.6% of the party boat landings during 1996–2005. By contrast, Plymouth County received 68.4% of the charter boat landings followed by Essex County (29.7%), together totaling 98.1% of the charter boat landings over the same period. These results are consistent with the spatial patterns of use presented earlier in this section in which party boats demonstrated intensive use of the northern portions of the sanctuary, while charter boats predominantly used the southern portions, especially Stellwagen Bank proper (Figure 101).

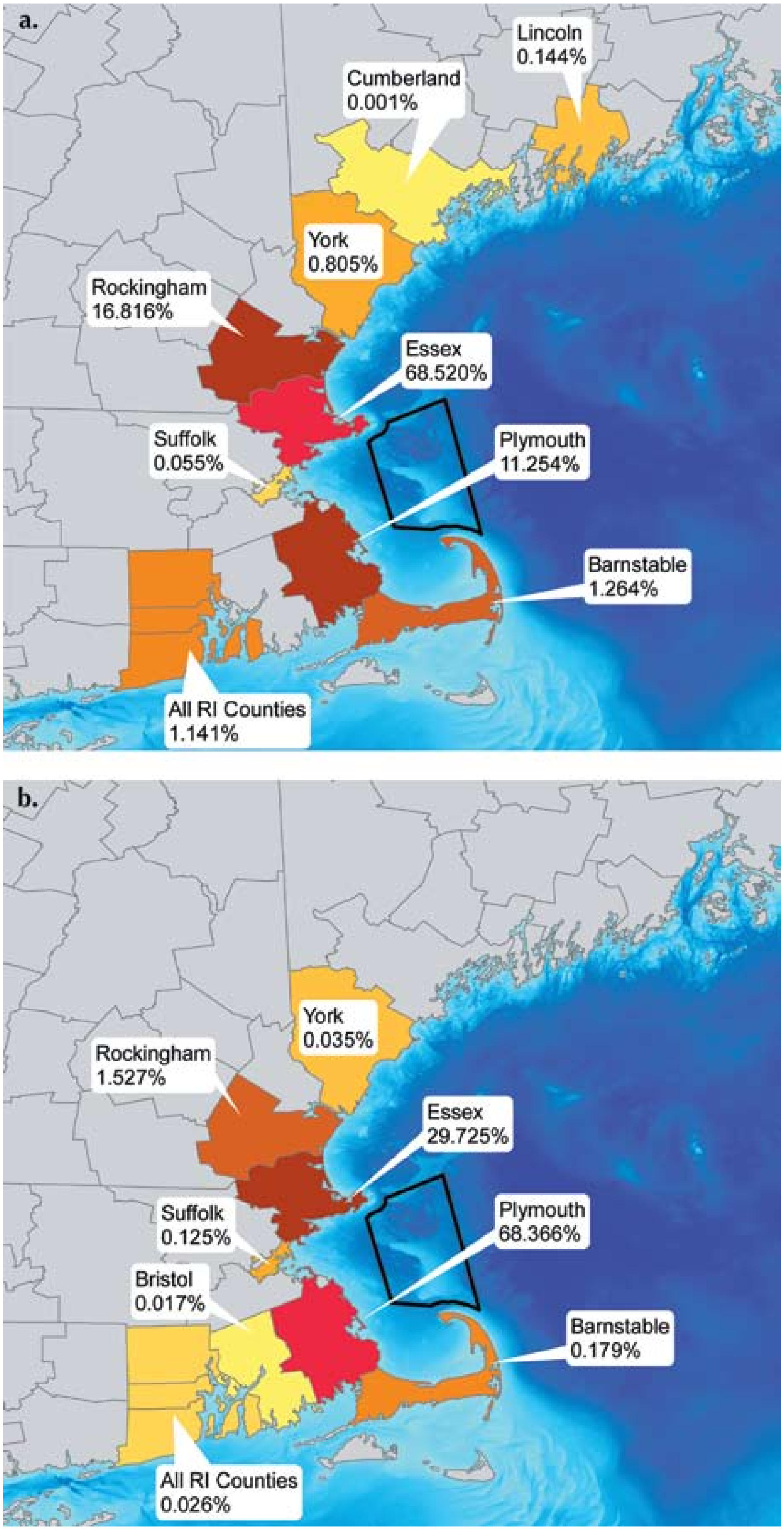
Table 18. Number of vessels, trips and anglers fishing in the Stellwagen Bank sanctuary by (a) party boats and (b) charter boats during 1996–2005.

a. Party Boats				b. Charter Boats			
Year	Vessel	Trip	Angler	Year	Vessel	Trip	Angler
1996	38	772	26,501	1996	51	622	7,521
1997	43	799	27,060	1997	57	679	6,683
1998	31	676	23,654	1998	44	619	5,339
1999	39	814	27,891	1999	57	692	6,261
2000	35	740	26,335	2000	69	1,082	8,489
2001	39	912	34,885	2001	63	1,109	9,471
2002	29	912	32,703	2002	67	1,255	9,273
2003	31	798	29,373	2003	59	987	8,285
2004	45	1,510	55,815	2004	100	1,586	12,410
2005	53	1,268	46,849	2005	115	1,841	13,012
Total	**383**	**9,201**	**331,066**	**Total**	**682**	**10,472**	**86,744**

Table 19. Quantity of fish landed by (a) party boats and (b) charter boats fishing in the Stellwagen Bank sanctuary by state and county landed (1996–2005).

State and County Landed	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total
a. Party Boats												
Maine	**0**	**664**	**618**	**264**	**1,298**	**0**	**0**	**0**	**315**	**197**	**3,356**	**0.95**
Lincoln	0	0	509	0	0	0	0	0	0	0	**509**	**0.14**
Cumberland	0	0	0	0	0	0	0	0	0	2	**2**	**0.00**
York	0	664	109	264	1,298	0	0	0	315	195	**2,845**	**0.80**
New Hampshire	**1,031**	**796**	**102**	**2,103**	**3,774**	**5,271**	**10,367**	**7,394**	**16,338**	**12,263**	**59,439**	**16.82**
Rockingham	1,031	796	102	2,103	3,774	5,271	10,367	7,394	16,338	12,263	**59,439**	**16.82**
Massachusetts	**26,417**	**16,738**	**14,119**	**22,589**	**20,266**	**34,207**	**26,251**	**28,241**	**48,736**	**49,067**	**286,631**	**81.09**
Essex	20,207	15,067	12,799	20,234	16,426	31,703	23,841	26,123	39,959	35,831	**242,190**	**68.52**
Suffolk	0	0	0	0	0	0	0	93	0	102	**195**	**0.06**
Plymouth	6,187	1,659	1,320	2,355	3,840	2,504	2,210	2,025	8,002	9,675	**39,777**	**11.25**
Barnstable	23	12	0	0	0	0	200	0	775	3,459	**4,469**	**1.26**
Rhode Island	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2,065**	**1,968**	**4,033**	**1.14**
All RI Counties	0	0	0	0	0	0	0	0	2,065	1,968	**4,033**	**1.14**
All Other Counties	**0**	**0**	**0**	**506**	**0**	**97**	**865**	**0**	**410**	**0**	**1,878**	**0.53**
Total	**27,448**	**18,198**	**14,839**	**24,956**	**25,338**	**39,478**	**36,618**	**35,635**	**67,454**	**63,495**	**353,459**	**100.00**
b. Charter Boats												
Maine	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**99**	**72**	**177**	**0.04**
York	0	0	0	6	0	0	0	0	99	72	**177**	**0.04**
New Hampshire	**2,189**	**318**	**384**	**1,939**	**86**	**189**	**552**	**1,408**	**386**	**242**	**7,693**	**1.53**
Rockingham	2,189	318	384	1,939	86	189	552	1,408	386	242	**7,693**	**1.53**
Massachusetts	**24,755**	**22,648**	**26,052**	**50,732**	**73,119**	**104,736**	**65,807**	**29,463**	**42,205**	**56,219**	**495,736**	**98.41**
Essex	7,452	11,462	14,880	15,551	15,776	22,733	13,264	14,719	16,436	17,460	**149,733**	**29.72**
Suffolk	0	0	0	0	0	0	0	0	111	520	**631**	**0.13**
Norfolk	0	0	0	0	0	0	0	0	0	1	**1**	**0.00**
Plymouth	17,303	11,113	11,162	35,181	57,343	82,003	52,098	14,728	25,583	37,870	**344,384**	**68.37**
Barnstable	0	73	0	0	0	0	445	16	50	318	**902**	**0.18**
Bristol	0	0	10	0	0	0	0	0	25	50	**85**	**0.02**
Rhode Island	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**129**	**129**	**0.03**
All RI Counties	0	0	0	0	0	0	0	0	0	129	**129**	**0.03**
All Other Counties	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**92**	**92**	**0.02**
Total	**26,944**	**22,966**	**26,436**	**52,677**	**73,205**	**104,925**	**66,359**	**30,871**	**42,690**	**56,662**	**503,735**	**100.00**

Figure 103. Distribution of (a) party boat and (b) charter boat landings (number of fish) from the Stellwagen Bank sanctuary by county landed for the period 1996–2005.



WGoMCA

Establishment of the WGoMCA in 1998 did not have an immediate effect on the number of party boats fishing in the sanctuary (Figure 102), but counts of party boat trips and anglers increased steeply two years after the closure was instituted (Figure 104). By contrast, the effect on charter boats was more immediate (Figures 102 and 105). The number of charter boats and, especially, the number of trips increased greatly between 1999 and 2005. Party boats are much larger vessels than charter boats and represent more substantial capital investment. In a fluctuating business environment fraught with regulatory risk such as involves fishing, the greater lag in rate of increase in the number of party boats relative to charter boats is to be expected for this reason.

The greater reliance of party boats on fishing in the sliver portion of the sanctuary relative to charter boats was noted in the previous section on spatial distribution and density (Figure 101). In the 2001-2002 base period used to analyze the spatial densities of party and charter boat fishing in the sanctuary, 43% of party boat trips and 42% of party boat anglers fished within the sliver compared to 29% of charter boat trips and 34% of charter boat anglers. Figure 106 compares the annual quantity of fish landed from the sanctuary by party and charter boats over 1996–2005. The steep rise in quantity of fish landed following establishment of the sliver in 1998 is evident for charter boats but not party boats.

The steep drop in charter boat landings in 2002 and 2003 (Figure 106) appears to be the result of an interim final rule, issued pursuant to northeast multi-species recreational and party/charter vessel restrictions, that imposed possession limits on cod and haddock taken in the WGoMCA during August 1, 2002 to August 22, 2003, with Amendment 13 taking effect at the later date (NOAA Small Entity Compliance Guide, 2002). Landings by party boats, which use the sliver more often than charter boats, remained essentially level over these two years. The overall effect of these possession limits by 2005 was to bring near parity to the quantity of fish landed by party boats and charter boats fishing in the sanctuary.

FIGURE 104. TRENDS IN NUMBER OF ANGLERS AND TRIPS BY PARTY BOATS FISHING IN THE STELLWAGEN BANK SANCTUARY DURING 1996–2005.

Establishment of the WGoMCA in 1998 is indicated.

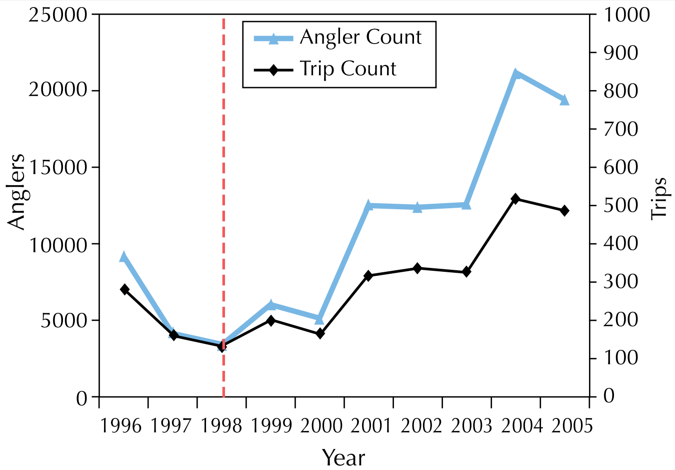


FIGURE 106. TRENDS IN PARTY BOAT AND CHARTER BOAT LANDINGS (QUANTITY) FROM THE STELLWAGEN BANK SANCTUARY DURING 1996–2005.

Establishment of the WGOMCA in 1998 is indicated.

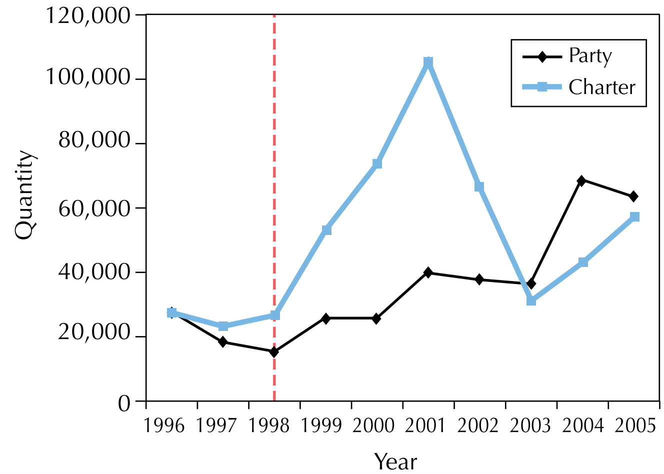
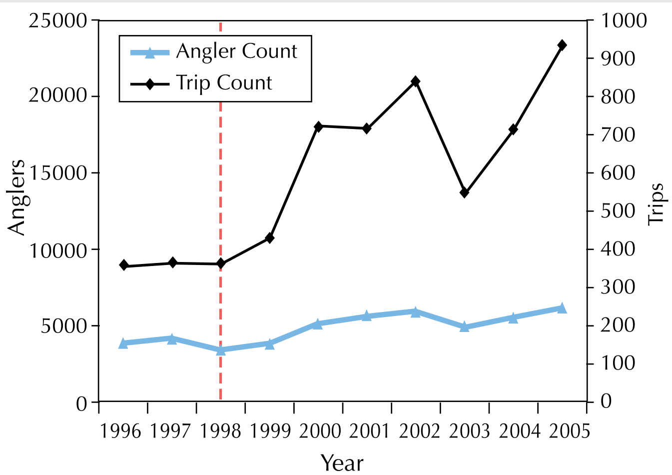


FIGURE 105. TRENDS IN NUMBER OF ANGLERS AND TRIPS BY CHARTER BOATS FISHING IN THE STELLWAGEN BANK SANCTUARY DURING 1996–2005.

Establishment of the WGoMCA in 1998 is indicated.



The apparent contradiction inherent in the fact that party boats use the sliver more intensely than charter boats, yet their landings were less affected by the interim final rule may be explained by differences in the species composition of party and charter boat landings. As indicated in the following section, cod, in particular, and haddock constituted a greater share of charter boat landings as compared to party boat landings.

Species

The top ten species caught by party and charter boat fishing in the sanctuary during 1996–2005 based on number of fish landed are indicated in Table 20. The top four species in each vessel category in descending order were Atlantic cod, haddock, pollock and cusk, together totaling 90.5% of the party boat landings and 96.9% of the charter boat landings. Cod and haddock made up 80.9% of the party boat landings and 89.4% of the charter boat landings. Importantly, cod alone made up 54.1% of the party boat landings but 77.0% of the charter boat landings.

TABLE 20. TOP TEN SPECIES CAUGHT BY (a) PARTY BOAT AND (b) CHARTER BOAT FISHING IN THE STELLWAGEN BANK SANCTUARY DURING 1996–2005 BASED ON NUMBER OF FISH LANDED.

	a. Party Boat Species	Total qty 1996–2005	% Total 1996–2005		b. Charter Boat Species	Total qty 1996–2005	% Total 1996–2005
1	Cod	192,659	54.14	1	Cod	387,215	77.03
2	Haddock	95,150	26.74	2	Haddock	62,022	12.34
3	Pollock	21,652	6.08	3	Pollock	29,234	5.82
4	Cusk	12,634	3.55	4	Cusk	8,507	1.69
5	Dogfish, Spiny	8,263	2.32	5	Tuna, Bluefin	4,665	0.93
6	Mackerel, Atlantic	8,252	2.32	6	Wolffish / Ocean Catfish	3,977	0.79
7	Wolffish / Ocean Catfish	5,307	1.49	7	Mackerel, Atlantic	3,284	0.65
8	Redfish / Ocean Perch	2,653	0.75	8	Redfish / Ocean Perch	847	0.17
9	Bluefish	1,809	0.51	9	Dogfish, Spiny	588	0.12
10	Ocean Pout	1,260	0.35	10	Striped Bass	451	0.09

As explained above, the WGOMCA was established to help rebuild groundfish stocks, specifically cod and haddock. The highest spatial densities of party and especially charter boats were in the closed area where it overlapped the sanctuary (sliver). Party and charter boats appear to target areas in the sanctuary that produce high landings of these two species. The spatial differences in their fishing patterns may reflect alternate strategies: party boats generalize to catch a mix of cod and haddock and charter boats specialize to catch primarily cod.

As explained previously, cusk and Atlantic wolfish are on the Species of Concern List for the Endangered Species Act. These two species, albeit at relatively low numbers, were among the top ten species landed by party and charter boats fishing in the sanctuary (Table 20). These species have no directed management plan under the MFCMA despite continued exploitation of their populations. Atlantic halibut also are on the Species of Concern List and were reported within the VTR system as being caught on party and charter boats in the sanctuary during 1996-2005.

Private

There are no comparable data available to assess private recreational fishing at the scale of the sanctuary. NOAA Survey Query data, as explained above, are used to draw general inferences. Landings data in pounds caught by species in the federal offshore waters of Massachusetts (three to 200 miles off the coast) are presented in Table 21.

The survey query data in these tables were adjusted by removing transitional species more associated with the offshore waters to the south of Cape Cod. These species were rarely listed among the party and charter boat landings in the sanctuary based on the VTR reports. Further adjustment was made for striped bass which is illegal to catch or possess in federal waters of the Exclusive Economic Zone (which includes the sanctuary). These data sets allow comparison (1) between survey query private/rental (Table 21a) and combined party/charter (Table 21b) landings and general comparison (2) between survey query party/charter and the VTR party boat and charter boat landings.

General Characteristics

After adjustment to remove the species less likely to be caught in the sanctuary, the survey query private/rental landings (Table 21a) and party/charter landings (Table 21b) indicate that Atlantic cod are caught in the greatest number. When cod, other cods/hakes and pollock are combined, the subtotal amounts to 72.7% of the total landings for private/rental and 89.8% for party/charter.

The survey query party/charter subtotal (89.8%) compares favorably to 90.5% for the VTR party boat subtotal that groups cod, haddock, pollock and cusk together (above). The survey query party/charter landings (Table 21b) demonstrate further similarity to the VTR party boat landings by including Atlantic mackerel, bluefish and spiny dogfish among the species more commonly caught.

The adjusted survey query private/rental landings are considered to be a reasonable representation of that category of recreational fishing in the sanctuary. The general pattern that emerges to characterize all categories of recreational fishing in the sanctuary is one of scaled difference: from a high degree of specialization for cod by charter boat fishing, through mixed species concentration preferably for cod and haddock by party boat fishing, to more generalized fishing and species switching by private recreational boats.

The survey query data provide some indication of effort trends in recreational fishing in the federal waters off Massachusetts, although the wide coverage area limits the applicability to the sanctuary. In general, the number of angler trips and the number of anglers engaged in recreational fishing in offshore waters of Massachusetts increased over the 1996–2005 timeframe. The number of people fishing in the offshore waters of Massachusetts more than doubled, reflecting similar rate increases in party boat and charter boat fishing in the sanctuary as indicated under the "Fleet Characteristics" subsection of this document.

Striped Bass

Striped bass cannot be fished for, caught, possessed or retained within the federal waters of the U.S. Exclusive Economic Zone [50 CFR 697.7(b)] except in certain waters off Rhode Island and New York. However, the original NOAA Survey Query data indicate sizeable landings of striped bass by private/rental fishing boats (20.5% of the total) and by commercial party/charter boats (9.4% of the total) in the federal Exclusive Economic Zone off Massachusetts. Table 21, which summarizes these data, indicates that private/rental landings of striped bass totaled 6.25 million pounds and that party/charter landings of striped bass totaled 1.65 million pounds over the 1996–2005 period.

This situation requires immediate remedy. There either is a low level of understanding about the federal regulation, in which case there is need of considerable directed education to inform the public of this prohibition, or there is a high rate of violation, in which case there is need for increased enforcement. Or the question in the survey query needs to be rewritten and better specified, so that people responding do not place themselves in jeopardy by ostensibly admitting guilt to violation of federal law and to assure survey data quality.

Table 21. Landings (pounds) by species in the federal offshore waters of Massachusetts by (a) private/rental boats and (b) party/charter boats during 1996–2005 based on the NOAA Survey Query data. Adjustments were made as detailed in the text.

a. Private Rental												
Species Landed	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**% Total**
Atlantic Cod	**653,602**	**122,940**	**738,601**	**346,096**	**884,419**	**2,682,180**	**1,983,851**	**3,426,837**	**2,619,733**	**1,881,481**	**15,339,740**	**63.79**
Atlantic Mackerel	499,155	425,671	103,685	473,200	220,409	334,711	453,310	266,404	304,484	98,166	**3,179,195**	**13.22**
Bluefish	377,469	209,331	218,813	74,732	0	243,710	274,808	224,294	255,998	601,144	**2,480,299**	**10.31**
Other Cods/hakes	**1,812**	**0**	**54,663**	**17,035**	**45,267**	**178,848**	**207,369**	**32,727**	**255,476**	**697,776**	**1,490,973**	**6.20**
Pollock	**74,862**	**0**	**4,881**	**26,493**	**467**	**318,044**	**139,767**	**9,991**	**0**	**196,758**	**771,263**	**3.21**
Summer Flounder	8,728	8,036	63,195	18,799	63,224	46,749	88,166	68,396	37,405	43,206	**445,904**	**1.85**
Other Tunas/ mackerels	0	0	0	0	0	0	0	0	0	171,595	**171,595**	**0.71**
Winter Flounder	5,613	6,149	11,795	381	15,296	8,364	4,795	893	1,263	0	**54,549**	**0.23**
Other Fishes	14,700	4,092	3,858	0	0	11,285	14,806	0	5,463	0	**54,204**	**0.23**
Dogfish Sharks	0	0	7,086	0	5,029	0	0	0	29,473	0	**41,588**	**0.17**
Little Tunny/ Atlantic Bonito	0	3,768	0	0	0	0	0	6,228	0	0	**9,996**	**0.04**
Sculpins	3,516	1,151	0	0	0	0	0	0	0	0	**4,667**	**0.02**
Red Hake	0	0	0	0	0	2,046	0	0	0	0	**2,046**	**0.01**
Herrings	1,958	0	0	0	0	0	0	0	0	0	**1,958**	**0.01**
Cunner	0	818	0	0	0	0	68	0	0	0	**886**	**0.00**
Totals	**1,641,415**	**781,956**	**1,206,577**	**956,736**	**1,234,111**	**3,825,937**	**3,166,940**	**4,035,770**	**3,509,295**	**3,690,126**	**24,048,863**	**100.00**
Other Species Fished But Less Likely Caught In Sanctuary												
Black Sea Bass	9,795	4,334	789	3,364	227,250	4,493	23,896	2,511	19,114	36,131	**331,677**	
Tautog	89,934	25,789	8,300	0	0	0	0	31,083	0	0	**155,106**	
Scup	25,617	14,852	35,931	2,452	1,096	10,620	22,075	0	25,236	0	**137,879**	
White Perch	0	0	11,402	0	0	0	0	0	0	0	**11,402**	
Totals	**125,346**	**44,975**	**56,422**	**5,816**	**228,346**	**15,113**	**45,971**	**33,594**	**44,350**	**36,131**	**636,064**	
Illegal												
Striped Bass	**297974**	**562,684**	**466,626**	**309,815**	**444,445**	**704,478**	**554,411**	**1,090,730**	**1,089,930**	**729,050**	**6,250,143**	

Table 21. Landings (pounds) by species in the federal offshore waters of Massachusetts by (a) private/rental boats and (b) party/charter boats during 1996-2005 based on the NOAA Survey Query data. Adjustments were made as detailed in the text.

b. Party/Charter												
Species Landed	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**% Total**
Atlantic Cod	**954,991**	**1,450,252**	**1,532,702**	**1,384,341**	**2,336,530**	**1,035,699**	**750,840**	**986,922**	**411,491**	**1,087,790**	**11,931,558**	**75.38**
Other Cods/hakes	**1,812**	**0**	**54,663**	**17,035**	**45,267**	**178,848**	**207,369**	**32,727**	**255,476**	**697,776**	**1,490,973**	**6.20**
Bluefish	34,372	306,627	105,298	17,524	125,794	44,493	117,302	29,352	241,860	160,151	**1,182,773**	**7.47**
Pollock	**12,059**	**40,102**	**26,766**	**42,516**	**18,530**	**275,326**	**25,245**	**29,952**	**131,011**	**209,759**	**811,266**	**5.12**
Atlantic Mackerel	10,183	34,815	12,762	19,786	2,767	46,678	0	31,455	10,020	0	**168,466**	**1.06**
Other Fishes	15,132	20,620	15,406	6,310	16,903	10,159	8,430	16,460	10,234	21,333	**140,987**	**0.89**
Cunner	0	747	0	1,052	0	0	0	30,102	159	542	**32,602**	**0.21**
Summer Flounder	12,482	82	0	0	11,918	1,473	459	201	0	0	**26,615**	**0.17**
Dogfish Sharks	0	0	679	0	0	0	0	324	2,275	18,808	**22,086**	**0.14**
Other Tunas/ mackerels	0	4,176	0	0	0	0	0	0	2,119	9,969	**16,264**	**0.10**
Winter Flounder	0	0	439	0	0	1,486	1,660	229	573	1,709	**6,096**	**0.04**
Eels	0	875	0	0	0	553	0	0	0	0	**1,428**	**0.01**
Skates/rays	0	0	0	0	0	0	0	0	0	719	**719**	**0.00**
Little Tunny/atlan-tic Bonito	0	0	406	0	0	0	0	0	0	0	**406**	**0.00**
Sculpins	0	0	0	0	0	0	0	0	0	298	**298**	**0.00**
Herrings	0	0	0	0	79	0	0	0	0	115	**194**	**0.00**
Other Flounders	0	0	0	0	0	0	0	0	0	165	**165**	**0.00**
Red Hake	53	0	0	0	0	0	0	0	0	0	**53**	**0.00**
Totals	**1,046,792**	**1,870,470**	**1,721,733**	**1,507,259**	**2,785,772**	**1,549,796**	**987,642**	**1,201,170**	**946,185**	**2,212,771**	**15,829,590**	**100.00**
Other Species Fished But Less Likely Caught In Sanctuary												
Scup	32,350	51,429	125,360	11,799	260,895	25,714	184,545	72,240	11,433	1,407	**777,172**	
Black Sea Bass	558	1,217	201	201	12,912	1,616	11,777	64,401	728	0	**93,611**	
Spanish Mackerel	55,653	0	0	0	0	0	0	0	0	0	**55,653**	
Tautog	0	893	573	739	0	0	0	7,116	443	844	**10,608**	
White Perch	0	439	0	0	0	0	0	0	0	0	**439**	
Dolphins	0	0	408	0	0	0	0	0	0	0	**408**	
Totals	**88,561**	**53,978**	**126,542**	**12,739**	**273,807**	**27,330**	**196,322**	**143,757**	**12,604**	**2,251**	**937,891**	
Illegal												
Striped Bass	**597**	**212,523**	**187,534**	**42,456**	**190,250**	**66,050**	**145,559**	**116,215**	**173,224**	**515,325**	**1,649,733**	

Whale Watching

Commercial Whale Watching

The Stellwagen Bank sanctuary is one of the top-ten premiere whale-watching locations in the world, one of only three such areas in U.S. waters, as listed by the World Wildlife Fund in 2002 (ENS, 2006 and *USA TODAY*, 2007); it was voted best in the Northeast for wildlife watching by the readers of *Offshore* magazine in 2006 (*Offshore*, 2006). Threatened and endangered species of whales are the attraction for more than a million visitors who go whale watching in the sanctuary each year (Hoyt, 2001). While the educational opportunity provided on whale watching trips can have a positive effect on efforts to protect whales, growth of the industry, use of larger and faster boats and variable operational standards raise concerns for the welfare of the whales.

Commercial whale watching on Stellwagen Bank began in 1975 from Provincetown, Massachusetts, inaugurating commercial whale watching on the U.S. East Coast (see Sidebar). Today, whale watching in the sanctuary is among New England's most notable recreational industries. It is estimated that more than 1.2 million passengers participated in whale watching tours in New England in 2000, generating annual total direct sales of more than $30 million to the region and $24 million to Massachusetts alone. Massachusetts accounted for nearly 80% of the New England totals for both passengers and revenues (Hoyt, 2001) and virtually all of Massachusetts whale watching occurs in the Stellwagen Bank sanctuary.

For sanctuary bound New England whale watchers, the activity represented more than a third of the value of their entire vacation (Hoyt, 2001). In an earlier study, more than two-thirds of the surveyed whale watchers had planned to go whale watching as part of their vacation (Hoagland and Meeks, 2000). In a 1988 survey of Massachusetts whale watchers, 45% stated that their primary purpose was whale watching, with 65% traveling more than 250 miles (400 km). Only 18% of respondents in that survey were from Massachusetts; 64% were from elsewhere along the U.S. east coast (Lewis, 1988; Hoyt, 2001). The majority of whale watching in New England originates from Massachusetts ports with those boats regularly visiting the Stellwagen Bank sanctuary (Hoyt, 2001).

Commercial advertising that whale watching will be done in the "Stellwagen Bank National Marine Sanctuary," rather than at "Stellwagen Bank," can be an important distinction affecting market appeal and purchasing behavior. A survey of attitudes toward whale watching in the sanctuary conducted by Boston University's Communication Research Center (1996–97) found that 38.5% of potential customers would prefer to go whale watching if they knew the activity would occur within the sanctuary; an additional 47.8% would be equally interested. The survey also found that when going whale watching at Stellwagen Bank, 77% of customers would prefer a naturalist specifically trained about the sanctuary. When respondents were given a hypothetical situation of having two boat choices, with the only difference between the boats being that the naturalist on one boat had additional training about the sanctuary, 84% chose that boat. The survey had a margin of error of +/- 4.5%. Sanctuary branding and naturalist certification demonstrate strong marketing cache.

The concept of "eco-tourism" has a significant impact on the whale watching industry. As the industry matures and diversifies, whale watching is increasingly incorporated into broader tourism packages that are offered to the public. Typically, hotels, educational organizations, whale watch operations and travel agencies make joint arrangements (Carter, 1994) to offer whale watching packages that include transportation, an overnight hotel stay, shoreside recreation and classroom lectures (Evans, 1994). In addition to carrying tourists and students, almost all whale watching trips to the sanctuary feature a naturalist on board to interpret marine life for the public, and some also collect and record sightings data.

Naturalists and researchers, who educate passengers about the whales' natural history and interpret the behavior of whales encountered on the trips, staff most of the whale watch boats. Scientists have used whale watch boats as accessible and economical research platforms to collect data on whales in the area. In the sanctuary, whale watch boats are particularly valuable in monitoring life histories of individuals. These whale watch data have played a significant role in the definition of the structure of the North Atlantic humpback whale population including distribution, stock identity, reproductive parameters, abundance, population composition, migratory destinations, behavior and human-related impacts (Robbins, 2000).

Humpback whales are the primary attraction for whale watch trips because of their long seasonal residence in the sanctuary, their highly visible behavior at the sea surface, and because of their known genealogy based on individual identification markings on their tail flukes. In addition to humpbacks, fin whales, minke whales and white-sided dolphins are commonly seen. North Atlantic right whales are less frequently encountered, owing both to their critically endangered population status (i.e., fewer right whales

The Whale Watching Cruise

Commercial whale watch cruises are conducted in the sanctuary from April through October, when the greatest concentrations of whales are present. In 2006, at least 13 dedicated whale watching businesses with between 18–23 boats operated from six Massachusetts ports—four out of Gloucester; three out of Boston; two out of Provincetown and Plymouth respectively; and, one each out of Barnstable and Newburyport. Some operators use their boats for other purposes such as fishing, sightseeing or commuter transportation (Wright, 1994). Additionally, other chartered vessels may engage in whale watching.

Commercial whale watch boats range in size from approximately 15 m (50 ft. with 35-40 passenger capacity) to over 42 m (140 ft. with 400 passenger capacity). Some boats are propelled by screw propellers and other by jet drives. The whale watch operations can be categorized into two groups: those that deploy boats that regularly operate at speeds from 16-20 knots, and those that deploy high speed boats that regularly operate at speeds from 25-38 knots (Wiley *et al.*, in press).

Vessels may make one to three trips per day to the sanctuary. A 4-6 hour trip averages $30-40. The tour schedule of most commercial whale watch boats begins in April, with one trip scheduled daily through June with two trips scheduled on weekends. School groups are the main market during this time. The season peaks during July and August; operators generally offer two to three trips per boat daily, catering to a generalized tourist market. Schedules are reduced after Labor Day. Seasonal demand and variable weather conditions determine trip frequency. Some companies have more than one vessel and also operate charter fishing trips or other types of sightseeing tours.

overall to frequent the sanctuary), to the shorter period of residence within the sanctuary (generally late winter or early spring to approximately July) and regulations restricting vessel approach.

Until the 2006 season when numbers rebounded to a historic high, the total number of whale sightings in the sanctuary had been declining over the past decade. Scientists suggest that reduced local availability of sand lance, the main food source of humpback and fin whales which attracts the whales to the sanctuary, may have been the primary cause of this earlier decline in sightings (Payne *et al.*, 1990; Weinrich *et al.*, 1997; Kenney *et al.*, 2001). Prey field mapping by sanctuary scientists tagging humpback whales during the 2006 season revealed large quantities of sand lance in the sanctuary and in the immediate vicinity of feeding humpbacks.

Recreational Whale Watching

Recreational boaters are most numerous and often aggregate in the sanctuary during the major portion of the whale watch season from May to September. While participation in whale watching by this sector is presumed high, there are no quantitative assessments to indicate levels of participation. These smaller private craft, dubbed the "mosquito fleet" by commercial whale watch operators, follow commercial whale watch boats and/or seek out whales independently.

NOAA whale watch guidelines have been in place since 1985 for the GoM Region. These guidelines represent the best practices for the industry as endorsed by the federal government. There are occasional, albeit largely undocumented, reports of whale harassment and collisions between non-commercial vessels and whales. Evidence of smaller boat vessel collisions (i.e., less than 15.2 m or 50 ft.) are supported by photographs of cuts and scars on the backs, flukes and fins of cetaceans (CCS, 1991). A more detailed description of the guidelines is found in Appendix M.

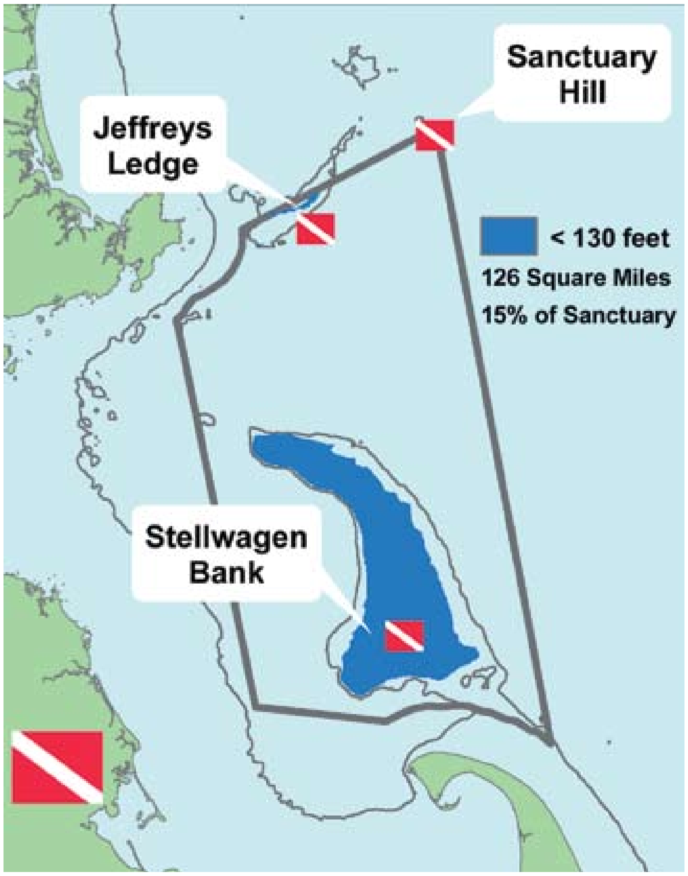
In an attempt to educate private boaters whale watching in the sanctuary, the Whale and Dolphin Conservation Society, in collaboration with the sanctuary, developed a public education program entitled "See a Spout, Watch Out! Responsible Whale Watching." Additionally, the International Fund for Animal Welfare worked with the Commonwealth of Massachusetts, the Provincetown Center for Coastal Studies and NOAA Fisheries Service to distribute educational material on this subject to registered boaters throughout Massachusetts. Development of such cooperative outreach programs can inform boaters when whales are in the vicinity and to act responsibly around these animals. However, these programs have been largely land-based and an on-the-water program is needed to increase outreach to vessels in the vicinity of whales.

Other Recreation and Tourism

In addition to fishing and whale watching mentioned above, other popular recreational and tourism activities include diving, bird watching and boating, some of which take place in and around the waters of the sanctuary. There are 65 small boat harbors and over 80 boating and yacht club

FIGURE 107. SANCTUARY MAP SHOWING THAT ALMOST 15% OR 126 SQUARE MILES OF THE STELLWAGEN BANK SANCTUARY IS WITHIN THE RECREATIONAL DIVE LIMIT OF 130 FEET.

Most of this area, depicted here in blue, lies on top of Stellwagen Bank but additional areas include parts of southern Jeffreys Ledge and Sanctuary Hill.



sites along the Massachusetts coast giving access to the sanctuary.

DIVING

While the most frequently visited New England dive spots are relatively close to shore, the sanctuary offers SCUBA divers a chance to explore different offshore environments at the mouth of Massachusetts Bay; however, strong currents and exposed waters create challenging dive conditions. Almost 15% of the sanctuary's total seafloor area (126 square miles) is less than 130 feet deep and within depth limits for recreational diving. The shallower areas are found on top of Stellwagen Bank as well as on parts of southern Jeffreys Ledge and Sanctuary Hill (Figure 107). Despite the potential dive sites, very little diving occurs in the sanctuary.

BIRDWATCHING

The sanctuary provides a rewarding birding opportunity for both novices and experienced birders. Approximately 34 seabird species occur within the sanctuary's boundaries; however, their abundance and distribution change constantly from season to season and from year to year. A more detailed list of species found within the sanctuary and the GoM area can be found in Appendix J. Each year since 1998, the Massachusetts Audubon Society (MAS) and the sanctuary conduct the Stellwagen Bank Sanctuary Christmas Bird Count. The count covers a 15-mile circle that includes the southern end of Stellwagen Bank and the northern tip of Cape Cod.

BOATING

Personal boating in the sanctuary often occurs as an ancillary activity to recreational fishing, whale watching, bird watching and diving which have been previously discussed. The considerable distance offshore and open ocean conditions constrain sanctuary access to day trips by larger more expensive boats. Sailboats frequent the sanctuary in coastwise transit from port to port, but rarely as the primary destination. Recreational boaters typically transit the sanctuary going to and from Boston, coming from the Cape Cod Canal or Cape Cod Bay, and from Provincetown or Cape Ann.

MARITIME TRANSPORTATION

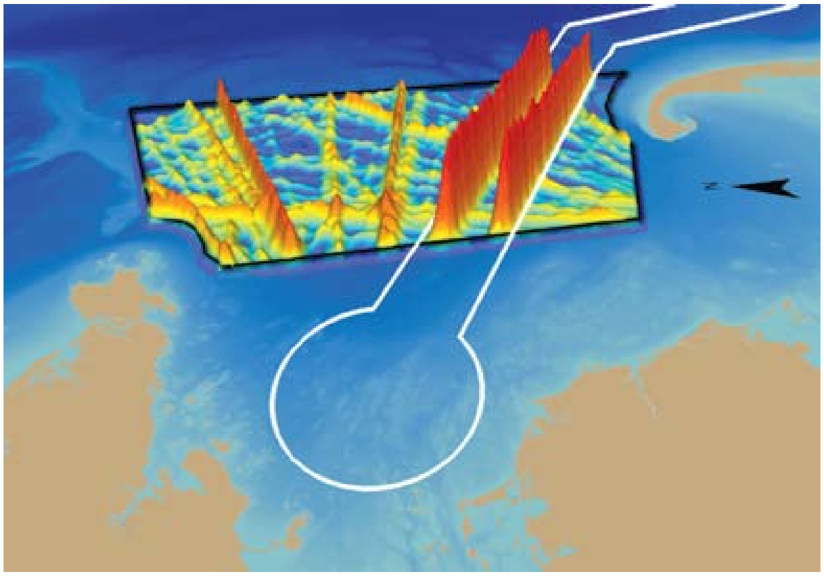
Massachusetts Bay is a body of water in which commercial maritime activities abound and which is home to many harbors that ring the coast from Cape Cod to Cape Ann. The historic Ports of Boston, Gloucester, Salem Sound and Plymouth are active industrial ports, but the former two account for the majority of the commercial shipping traffic. As an indication of volume, there were 4,561 vessel trips made to and from these ports and an additional 2,149 vessels traveled through the Cape Cod Canal in 2003 (USCG, 2006). The majority of these vessels cross the sanctuary en route to and from these ports or in transit to ports to the north and south along the eastern seaboard. Approximately 800 commercial fishing vessels use Massachusetts Bay as a fishing area or as a transit zone to open ocean fishing areas (USCG, 2006).

TRAFFIC AND ROUTING

Vessels crossing the sanctuary come from multiple sources, but two in particular. The first is vessels arriving at and departing from the Port of Boston. There is a vessel Traffic Separation Scheme (TSS) established by the International

Figure 108. Three-dimensional representation of large commercial vessel traffic (156 ships) crossing the Stellwagen Bank sanctuary based on USCG AIS data for April–May 2006.

The former vessel Traffic Separation Scheme (TSS) is indicated where it crosses the sanctuary and Massachusetts Bay.



Maritime Organization (IMO), that is recommended for this approach to Boston Harbor (Figure 73). The TSS originates in the Great South Channel, heads in a northerly direction until just off the easterly side of Provincetown (Buoy "BD"), where it proceeds in a northwesterly direction, crossing the sanctuary and ending in a precautionary area off the entrance to Boston Harbor. Most of the vessels entering and exiting Boston Harbor are large container ships, tankers, liquefied natural gas (LNG) carriers, cruise ships, salt and scrap ships, military vessels and some research vessels; they tend to cross the sanctuary along a west-east axis. High speed ferries reaching speed as great as 40 knots transit portions of the sanctuary in service along the Provincetown/ Boston route.

The second source of vessel traffic across the sanctuary is coming from or going to the Cape Cod Canal. The majority of vessels utilizing the Canal include tug and tow boats, fishing vessels, recreational boats, military vessels, passenger and cargo ships and some tankers. Most of these vessels tend to cross the sanctuary along a north-south axis.

Large commercial ships arriving at and departing from the Port of Boston generally use the voluntary TSS. This scheme was established to prevent collisions by maintaining separation between inbound and outbound vessels. With the exception of the TSS, vessels operating in the vicinity of the Port of Boston are unencumbered with regard to track. Vessel masters may use whatever course and speed they wish, consistent with the International Convention for the Prevention of Collisions at Sea (COLREG), weather conditions, sea state, visibility and other marine operations taking place along their intended track. Ships arriving from the southeast and east will typically make directly for the precautionary area and the TSS.

Non-TSS traffic, approaching from the east and northeast, typically follows historic tracks from Europe and Canada that are not marked on published navigational charts or maintained by the USCG. Figure 108 provides a three-dimensional representation of large commercial vessel traffic crossing the sanctuary based on USCG Automatic Identification System (AIS) data for April–May 2006. The tracks for vessels crossing the sanctuary going to or from the Port of Boston by way of the TSS predominate.

Port Activity

Port of Boston

Because the sanctuary's location straddles the mouth of Massachusetts Bay, it is the "gateway" to maritime commerce in Massachusetts, principally the Port of Boston. The Port of Boston is the largest seaport in New England and is among the oldest and busiest ports in the country. The seaport currently handles more than $8 billion worth of goods annually and is the largest handler of container cargo in New England (25 container shipping lines), shipping and receiving 1.2 millions tons each year. The terminals in the Port of Boston are equipped to handle 1.3 million tons of general cargo, 1.5 million tons of non-fuels bulk cargo and 12.8 millions tons of bulk fuel cargos each year (MassPort, 2006a). The Port of Boston is also a major maritime energy trans-shipment and storage location for the New England region, including many shipments of refined petroleum products via tanker and barge as well as LNG to the terminal in Everett, MA, that meet 90% of Massachusetts' petroleum consumption needs.

The majority of vessel activity occurring in and around the sanctuary throughout the year is dominated by the transport of petroleum products, cargo and LNG. Large, deep draft commercial ships in this service include: tanker ships, container ships, dry bulk carriers, roll on-roll off (RO-RO) ships and gas carriers (including LNG carriers). These deep draft ships made an average of 2,257 transits per year to and from the Port of Boston over the period 2000–2005 (Table 22). There was no pronounced seasonality character-

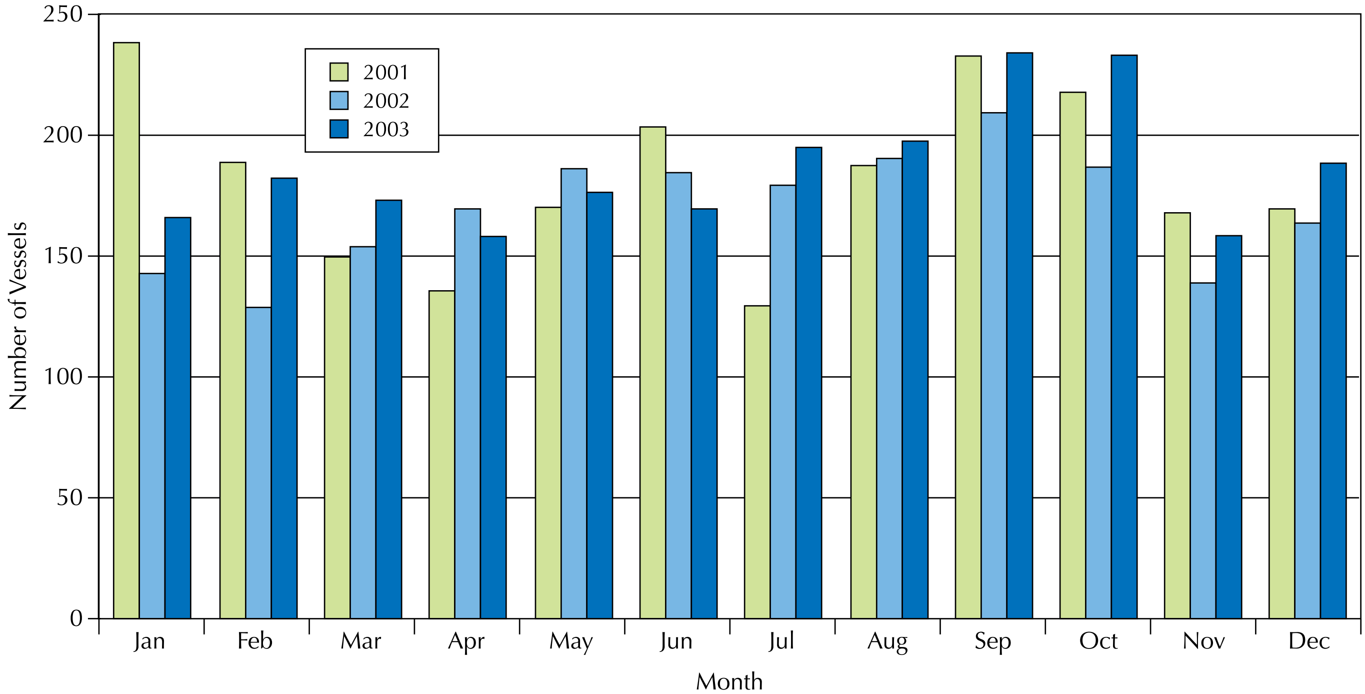
Table 22. Annual shipping transits of commercial deep draft vessels to/from the Port of Boston (2000–2005).

Source: Boston Harbor Pilots Association

Year	Transits
2000	2,188
2001	2,028
2002	2,230
2003	2,260
2004	2,299
2005	2,541
Average	**2,257**

Figure 109. Number of commercial deep draft vessel transits to/from the Port of Boston by month for the years 2001–2003.

Source: Boston Harbor Pilots Association.



istic of this traffic for the three years sampled (2001-2003) (Figure 109). Commercial deep draft and other maritime traffic entering and leaving the Port of Boston and transiting Massachusetts Bay is characterized in Table 23.

To accommodate the worldwide trend toward larger vessels, the Massachusetts Port Authority (MassPort) began the Boston Harbor Navigation Improvement Project (BHNIP) to deepen key portions of the harbor in 1998. The project was completed in 2000 and, as a result, Boston's channels are now deeper than those of many east coast ports. To date, despite the deepening of portions of Boston Harbor, vessel traffic has remained relatively stable, and there has been no significant increase in the size of vessels utilizing the harbor. While it is expected that vessel activity will continue to be dominated by the movement of petroleum products, MassPort anticipates an increase in the number of large LNG tankers utilizing the Port of Boston.

Ten major cruise lines currently service Boston as either a port of call or a cruise departure and return location. In recent years, cruise ship activity to Cruiseport Boston, particularly between the months of April through October, increased steadily as a result of the growing popularity of northern-bound cruise vacations, particularly to maritime Canada. There currently are approximately 100 cruise ship departures from or ports of call at Boston annually and this number is expected to increase. With the presence of a state-of-the-art cruise ship terminal, the Black Falcon Cruise Terminal on the Reserved Channel, the port could support considerable expansion in this type of maritime activity.

Cruise ship activity is being heavily promoted and the annual number of passengers has increased dramatically, tripling between 1996 (69,075 passengers) and 2005 (233,000 passengers) (MassPort, 2005, 2006a). The Request for Expressions of Interest (RFEI) to construct a new cruise ship terminal (MassPort, 2006b), projects that the Port could increase the total number of cruise passengers to over 400,000 each year. This would approximately double the 2005 number. Boston is now considered one of the fastest growing high-end cruise markets in the country.

Port of Gloucester

Since the first American fishing settlement was established in Gloucester in 1623, fishermen and traders made it one of the country's most famous deepwater harbors. During the first half of the 19th century, Gloucester supported an active fishing industry and a prosperous trade network. Later in the century, Gloucester turned its attention almost entirely to fishing and became known as the center for fisheries under sail. Today, the port sustains its fisheries role while seeking diversification.

The Port of Gloucester is 15 miles north of Boston. It is an import and export point for Canadian and European ports of call. Its direct connection to the Massachusetts interstate road system makes the Port of Gloucester the most accessible over-the-road port in Massachusetts and an effective inter-modal transport center between Canada and the U.S. It is poised to support regular cruise ship service to Canadian maritime destinations. Gloucester is also the largest commercial fishing port on Massachusetts Bay and was

Table 23. Characteristics of commercial deep draft vessels and other maritime traffic entering/leaving the Port of Boston. Number of transits indicated is for 2005.

Source: USCG, 2006.

Type of Ship	Hull	Displacement (tonnes)	Speed (knots)	Complement	Transits/Year
Passenger Cruise Ship	Steel	56,000	Cruising: 20–25 Top: 32.5	Passengers: 920–2,758 Crew: 545–1,253	295
Whale Watching Boats	Steel/Aluminum	<1,000	Cruising: 11 Top: 40	Passengers: 150 Crew: 2–3	3,328
Container Ship	Steel	64,000	20/25	25	455
Bulk Cargo	Steel	32,000	15	25	244
Tankers	Steel	64,000	15	25	1,160
RO-RO Ship[1]	Steel	37,500	15-25	25–30	41
LNG Carrier[2]	Steel	108,000	20	25–30	126
Dredging Vessels (Tugs)	Steel	3,700	5	3	365
Petroleum Barge (Tugs)	Steel	3,700	5	3	1,420
LNG DWP OSV[3]	Steel	<1,000	13	8	240
Fishing Trawlers (ocean-going)	Steel	2,600	12	4	11,885
Lobster Boats	Fiberglass/Wood	<1,000	15	2	39,000

[1]Roll on-Roll off [2]Liquified Natural Gas [3]Deep water port operations support vessel

ranked 13th among the top 100 U.S. commercial fisheries ports in 2003 based on landings.

The outer and inner harbors support approximately 225 deep-water commercial fishing vessels up to 300 ft. (91 m) in length. Depending on the season, harbor use is approximately 40% commercial and 60% recreational. The number of lobster boats in the harbor varies widely, from 250-300 for Gloucester and 400-800 regionally for Cape Ann (which includes the neighboring towns of Beverly and Essex).

Other Harbors

In addition to the Ports of Boston and Gloucester, mentioned above, there are several other harbors in Massachusetts whose activities use sanctuary resources. These harbors principally include Provincetown, Plymouth, Scituate, Green, Cohasset, Lynn, Marblehead and Salem.

During the 19th century, Provincetown Harbor was considered a major port, being home to approximately 175 whaling vessels and an equal number of Grand Banks fishing schooners. Today, only a small commercial fishing fleet exists; Provincetown and its harbor have become largely dependent upon tourism. Whale watch boats, fishing party boats and recreational boats prevail.

Plymouth Harbor experienced a similar history and transformation. For centuries, Plymouth harbor served host to numerous cargo and fishing vessels and was home to a prolific shipbuilding enterprise, which made the harbor famous world-wide. Following the Civil War, shipbuilding ceased and shipping in and out of the harbor declined as more modern vessels became too large to enter. Today, Plymouth Harbor is a departure point predominantly for pleasure boaters, whale-watching vessels and recreational fishing parties, although still receiving some commercial traffic. Plymouth Harbor is part of a complex that includes the small boat harbors in the neighboring towns of Kingston and Duxbury, once also historic centers for shipbuilding during the age of sailing schooners, but now primarily recreational in character.

Scituate Harbor is considered to be one of the better deep-water harbors on the Massachusetts south shore and supports a fleet of approximately 55 commercial fishing vessels, recreational charter fishing boats and numerous pleasure boats. While supporting an active commercial fleet, Scituate is primarily a recreational and seasonal-use harbor with approximately 700 moorings (harbor and rivers) and 650 slips (combined in nine private and two public marinas) in the summer season.

Green Harbor in the neighboring town of Marshfield is often associated with Scituate as a commercial fishing harbor. It is a principal harbor for the landing of bluefin tuna in Massachusetts Bay (along with Gloucester and Provincetown). It supports a small commercial fleet of groundfish and lobster vessels as well as charter boats and shelters a primarily recreational mix of small boats.

Cohasset Harbor is a small harbor used primarily by residential and summer season boaters. In addition to its large private recreational fleet, the harbor supports a small commercial lobster fleet of approximately 25 boats.

Lynn Harbor accommodates approximately 300 recreational vessels, 60 small commercial vessels, 10 commercial passenger ferries and approximately 50 commercial fishing vessels. About 40% of vessel traffic is commercial; the remaining 60% being recreational.

Marblehead Harbor is primarily a recreational summer-use harbor with 2,200 mooring permits issued each year. The harbor shelters approximately 30 commercial fishing boats.

Salem Harbor is primarily used for recreational purposes with limited commercial traffic delivering coal and petroleum products. There are 1,400 registered moorings in the harbor; there are 10,000 recreational boats berthed within Salem Sound. The harbor supports a fleet of approximately 100 commercial fishing vessels.

Due to the volume, frequency and types of vessels transiting the sanctuary area from numerous ports and harbors, the potential for vessel-vessel collisions, accidental oils spills and vessel discharges as well as vessel collisions with marine mammals are issues of concern. For more information regarding discharges and marine mammal vessel strikes refer to the sections of this document on Discharge and Disposal Activities and Marine Mammal Vessel Strikes.

Prohibited Uses

Minerals Mining

The Secretary of the Interior has the statutory authority and responsibility to plan for and to conduct the offering of leases of outer continental shelf (OCS) acreage, as directed in the Outer Continental Shelf Lands Act, as amended (OCSLA) (43 U.S.C. § 1331 et seq.). Within the U.S. Department of the Interior (US DOI), the Minerals Management Service (MMS) has primary responsibility for management of OCS minerals operations. Minerals operations include offshore oil and gas development and sand and gravel mining. However, exploring for, developing or producing industrial materials within the Stellwagen Bank sanctuary is prohibited (15 C.F.R § Subpart N, Sec. 922.142). "Industrial material" means mineral, as defined in Sec. 922.3, which includes oil and gas as well as sand and gravel.

Offshore Oil and Gas

Currently, all new oil development is prohibited within the thirteen designated US National Marine Sanctuaries, which are managed by the US Department of Commerce's NOAA (representing 0.1% of the total area under oil/gas leasing moratoria and 0.04% of total OCS area) (Chandler and Gillelan, 2005). On June 26, 1990, a Presidential Order was signed preventing any further OCS leasing and development activity within the Georges Bank area of the North Atlantic Planning Area, which includes the sanctuary until after the year 2000. This period of time was again extended on June 12, 1998, when President Clinton issued an Executive Order that prevented such activities until June 30, 2012 (Presidential Executive Memorandum 1111, 1998). No exploratory wells have been drilled anywhere on the Atlantic OCS region since 1984.

The Energy Policy Act of 2005 directs the Secretary of the Interior to inventory and analyze oil and natural gas resources beneath all of the waters of the OCS using "any available technology, except drilling, but including 3-D seismic technology to obtain accurate resource estimates" (Energy Policy Act of 2005). Not only does the Energy Policy Act's inventory include areas currently under drilling moratoria, it requires the MMS to identify resources and explain how legislative, regulatory, and administrative programs or processes restrict or impede the development of identified resources and the extent that they affect domestic supply. It has yet to be determined how oil and gas exploration as so stipulated under the Energy Policy Act of 2005 can be conducted in National Marine Sanctuaries (NMSs), since it directly conflicts with US protected area legislation such as the National Marine Sanctuaries Act of 1992.

Sand and Gravel

Within the past decade, the Boston metropolitan area has experienced significant and rapid economic growth, which has in turn encouraged substantial industrial, commercial and residential development. Pressures on both the housing industry and transportation systems to meet the demands of this growth have resulted in increased consumption of and demand for sand and gravel resources, for use as aggregate in construction activities. However, extraction of sand and gravel has considerable potential to adversely impact the biological integrity of the sanctuary (e.g., fish, invertebrates and marine mammals) as well as physically alter the surface profile of Stellwagen Bank and its attendant oceanography. As a result, in 1992, at the time of the sanctuary's designation, commercial sand and gravel mining were made prohibited activities within the borders of the sanctuary. In addition, under Stellwagen Bank sanctuary regulations 15 C.F.R § Subpart N, drilling into, dredging or otherwise altering the seabed of the sanctuary is strictly prohibited.

Submerged Cables and Pipelines

The laying of submerged cables and pipelines is a prohibited activity under Stellwagen Bank sanctuary regulations 15 C.F.R., Subpart N, Sec. 922.142. Drilling into, dredging or otherwise altering the seabed of the sanctuary, or constructing, placing or abandoning any structure, material or other matter on the seabed of the sanctuary is prohibited. However, prohibited activities can be permitted on a case-by-case basis.

Cables

In August of 2000, the Hibernia high-capacity fiber optic cable was laid across 12.1 miles (19.5 km) of seafloor in the northern part of the sanctuary under terms and provisions of a NMSP authorization/special use permit issued to the company, 360 Networks Inc. Cable ownership and permit monitoring responsibility was transferred to the company, CVC Inc. in 2002. The underwater cable provides a direct link between North America and the Republic of Ireland. The cable is designed for a life expectancy of 25 years and is buried at an average depth of approximately 1.5 m (4.9 ft.) into the seafloor. The cable was laid using a sea plow controlled from a cable ship on the surface. While an advisory to mariners has been posted to alert vessels to the cable's position, recent monitoring suggests, that while most of the cable remains buried, it may be at risk of exposure and damage where it is routed through muddy basins subjected to fish trawling or dredging.

Although the proper laying of submarine cables is thought to be reasonably benign environmentally, the presence of a cable in an active fishing area could cause problems with damage to both the cable and fishing gear. Some have speculated that cables on the sea bottom could create obstacles to the movement of bottom-dwelling organisms (Darnell, 1976). The trench and fill required for burying cables and pipelines could disturb sensitive fish spawning areas; the activity of the installation equipment could disturb marine mammals and seabirds; and excavation activity could disturb or destroy marine archaeological sites.

The impact of laying fiber optic cables to seafloor habitats and associated taxa along the cable route is not yet fully known, although the issue is being assessed in the sanctuary. In 2001, following the laying of the cable, additional sampling stations were added to the on-going Seafloor Habitat Recovery Monitoring Project (SHRMP). This 10-year program was initiated in 1998 following creation of the Western Gulf of Maine Closure Area (WGoMCA) to study the recovery rates of seafloor habitat (physical and biogenic) and associated taxa (such as fishes) in the sanctuary following the cessation of fishing. The project now compares the effects of fishing to the effects of the laying of fiber optic cable, as well as to the effects of background environmental variation. Biannual sampling is conducted using remotely operated vehicles (ROVs), video drift cameras, side scan sonar and S4 current meters. The project is expected to continue through 2010.

Pipelines

No pipelines currently exist within the sanctuary's boundaries. However, located to the west of the sanctuary and running through state waters from Beverly, Massachusetts, to Weymouth, Massachusetts, is a pipeline called the "HubLine." This 48.3-km (30-mi), 76.2-cm (30-in diameter), natural gas pipeline will connect the 901.2-km (560-mi) Maritimes & Northeast pipeline with the 1,609.3-km (1,000-mi) Algonquin pipeline (Duke Energy, 2005a). Applications to the Federal Energy Regulatory Commission (FERC) on October 10, 2000, were filed by Algonquin Gas Transmission, L.L.C. to begin construction of the pipeline (Duke Energy, 2005b).

Currently, the offshore portions of this pipeline have been completed. Most portions of this pipeline were buried at a minimum depth of 1 m (3.3 ft); however, several sections required horizontal directional drilling, conventional dredging, jetting, plowing and blasting. This operation is certain to have had an impact on the local benthic environment (Estrella, 2004). Impact assessment, mitigation and restoration are being carried out by the NOAA Fisheries Service, EPA, the Massachusetts Department of Environmental Protection (DEP) and the Massachusetts Division of Marine Fisheries (DMF). The most significant problem with pipelines, and with electrical transmission cables which use circulating oil for cooling, is the possibility of leaks causing contamination of the surrounding waters.

Deepwater Liquefied Natural Gas (LNG) Ports

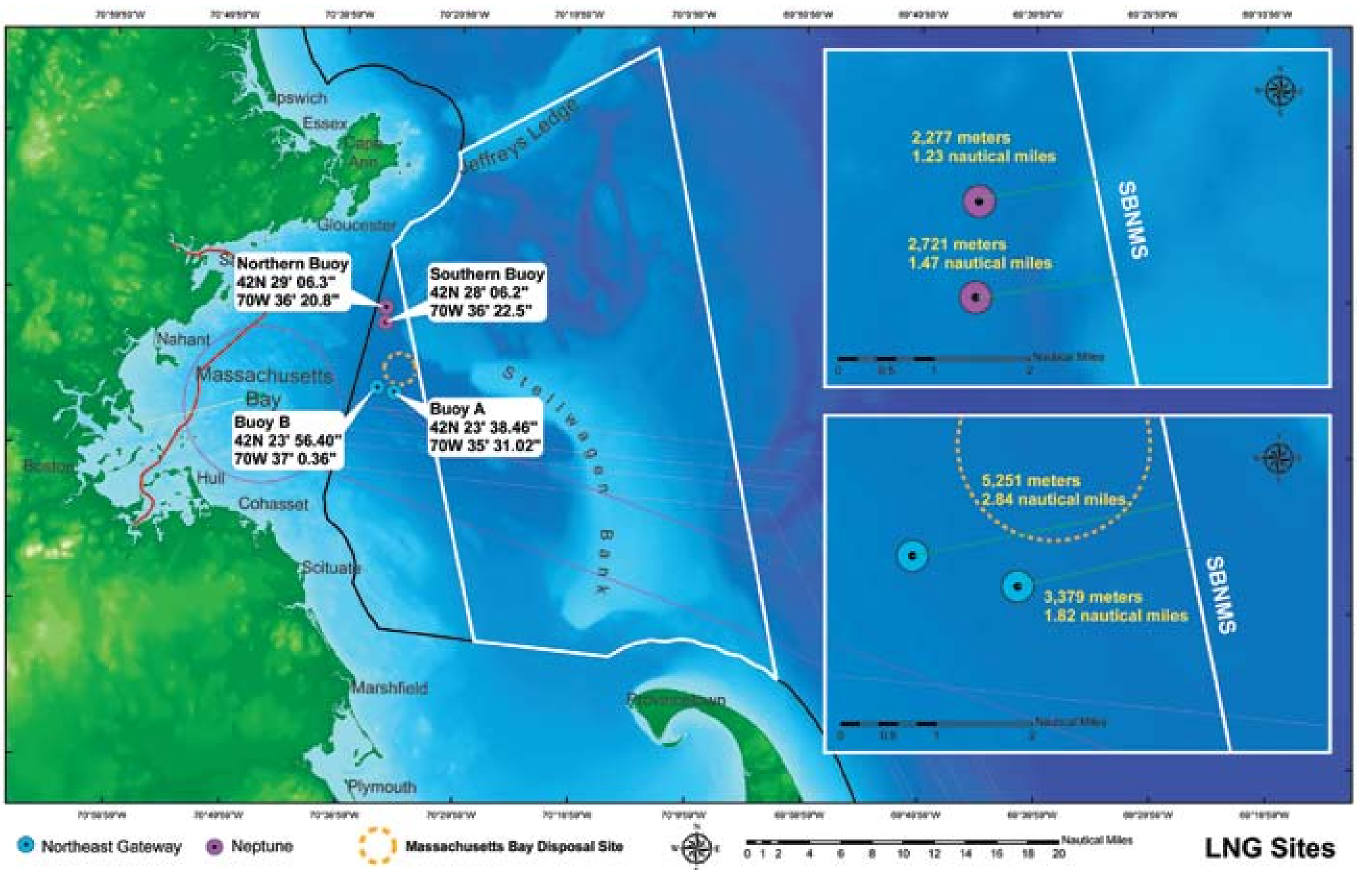
Construction of a deepwater LNG port is a prohibited activity within the sanctuary by virtue of the prohibition against alteration of the seafloor and discharge of materials. A deepwater LNG port is a system of pipelines, mooring buoys, anchors, risers and related equipment and is regulated under the Deepwater Port Act (DWPA) and administered by the USCG and the Maritime Administration (MARAD).

In late 2004, the Stellwagen Bank sanctuary was notified that two companies, Northeast Gateway Energy Bridge, LLC (Gateway) and Neptune, LLC (Neptune), would be applying for deepwater port licenses to install LNG import terminals and associated pipelines very near the sanctuary. While located outside of the sanctuary the proposed projects were found likely to affect sanctuary resources. Both applicants have proposed operating for 30–40 years within habitat utilized by four endangered whale species (North Atlantic right, humpback, fin and sei) for feeding, nursing and migration. The proposed port sites are near multiple state ocean sanctuaries with the closest port site being 1.2 nm from the sanctuary's western border and the farthest being 2.8 nm (Figure 110). Although the ports are located just outside of the boundary of the sanctuary NOAA determined that they constitute a significant threat to sanctuary resources, and mitigation measures have been adopted to reduce the risk of impact.

With the release by the USCG and MARAD of the Draft Environmental Impact Statements (DEISs) for the Gateway and Neptune projects on May 19 and June 2, 2006, respectively, formal consultation with the USCG and MARAD was initiated by the NMSP under Section 304(d) of the National Marine Sanctuaries Act (NMSA). These were the most significant consultations under Section 304(d) to date and included separate consultation under ESA and MMPA by the NOAA Fisheries Service. Under the NMSA, the NMSP has 45 days from initiation to develop and recommend reasonable and prudent alternatives for implementation by the USCG to prevent injury to sanctuary resources. The NMSA defines sanctuary resources as "any living or non-living resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archaeological, scientific, or aesthetic value of the sanctuary."

NOAA's submission in response to Gateway's DEIS, dated July 3, 2006, included both the NMSP's comments as required under the National Environmental Policy Act and the program's recommendations under the NMSA. The report is available through the USCG's docket system (http://dms.dot.gov/search/document.cfm?documentid=403755&docketid=22219). NOAA's submission in response to Neptune's DEIS, dated July 17, 2006, is also available through this system (http://dms.dot.gov/search/document.cfm?documentid=405640&docketid=22611).

Figure 110. Location of two separate Liquefied Natural Gas (LNG) deepwater ports, Northeast Gateway and Neptune, proposed adjacent to the western boundary (inserts) of the Stellwagen Bank sanctuary. Each port would have at least two offshore installations indicated by the buoy locations.



Based on information provided by the USCG and MARAD, the NMSP found that the projects, considered individually and together, were likely to have significant, constant, and long-term adverse effects upon marine resources of the sanctuary due to the following: the increased risk of ship strikes to the sanctuary's endangered whale populations, including the North Atlantic right whale; increased acoustic exposure to marine mammal and fish species; increased risk of whale entanglement and loss of benthic habitat in the sanctuary due to displaced fishing effort; possible re-suspension of toxic materials during construction; diminished visual aesthetics; and entrainment of planktonic and fishery resources by LNG carriers at port and during transit.

The NMSP made twelve 304(d) recommendations for Neptune and thirteen recommendations for Gateway suggesting conditions to be included if the project licenses were approved in order to minimize the impacts of port construction and operation on sanctuary resources. Three recommendations in particular were critical to mitigating the impacts on marine mammals. They called for implementation of acoustic technologies to detect and/or monitor the presence of whales relative to LNG vessel transits and LNG port construction and operation. The NOAA Fisheries Service commented on habitat impacts and fishery resources during the LNG approval process.

Both federal and state agencies evaluated the mitigation options to address issues raised under the National and Massachusetts Environmental Policy Acts, and the USCG and MARAD evaluated mitigation options through the finalization of the NEPA process and resulting license and associated conditions A formal response from the USCG to the NMSP regarding the 304(d) recommendations was released in mid October 2006 and Final Environmental Impact Statements (FEISs) for Gateway and Neptune were released in late October/early November 2006. Public hearings for the FEISs were held in Massachusetts the first week of November 2006. NOAA Fisheries Service issued biological opinions for the two projects following consultations under the Endangered Species Act in early 2007, and USCG/MARAD issued records of decision conditionally approving both ports soon after. The Neptune port was licensed in January 2007, and the Northeast Gateway was licensed in May 2007.

Wind Power Generation

Securing a windmill to the seafloor or anchoring a floating windmill is a prohibited activity in the sanctuary under the current regulations (15 C.F.R § Subpart N). Consideration for generating power using windmills secured to the land or seafloor is becoming more prevalent in New England. The combination of steady, year-round winds and a nearby power-hungry populace makes the Massachusetts coast a seemingly attractive site for this type of activity. Currently, a major proposal to build an offshore wind farm consisting of 130 windmills, each 247 ft. high, in Nantucket Sound is under consideration by government agencies. There is another proposal to place a similar wind farm in Buzzards Bay, Massachusetts. The sanctuary is not aware of any interest in placing windmills on top of Stellwagen Bank at this time.

Mariculture

Mariculture (or the aquaculture of marine products) is a prohibited activity within the sanctuary by virtue of the prohibition against alteration of the seafloor and discharge of materials. While the practice of mariculture is gaining recognition and popularity throughout the northeast region, few proposals have yet been made to conduct aquaculture activities in federal waters off the Massachusetts coast. Such activities would require a Section 10 permit (Rivers and Harbors Act) from the U.S. Army Corps of Engineers (USACE) and, depending on the nature and location of the project, a federal consistency review by the Massachusetts Coastal Zone Management (MCZM) Office to determine consistency with the policies of the MCZM Program.

Artificial Reefs

The placement of artificial reefs (ARs) in the Stellwagen Bank sanctuary is a prohibited activity by virtue of the prohibition against alteration of the seafloor and discharge or deposit of materials into the sanctuary. There has never been a proposal to place an artificial reef in the sanctuary, which is located offshore within the U.S. Exclusive Economic Zone (EEZ). There is currently little interest in establishing facilities within the EEZ by the commercial sector, largely because of the lack of formal regulatory structure (Stickney *et al.*, 2006). However, ARs have been established in other sanctuaries and this situation has precipitated development of a national policy on ARs for the sanctuary program.

This national policy addresses how the NMSP considers proposals to establish artificial reefs in sanctuaries. The policy is meant to build upon, not replace, the National Artificial Reef Plan developed in accordance with the National Fishing Enhancement Act. Nothing in the NMSP AR policy is meant to conflict with that plan or that act, and the policy only applies to activities within designated NMSs.

Artificial reef development is generally prohibited in NMSs and may only be undertaken in these marine protected areas for educational, research and resource management purposes. Because the impacts of ARs are not entirely understood, the NMSP will proceed cautiously in considering permits for AR development in NMSs. The NMSP will use information obtained from monitoring ARs currently in NMSs and elsewhere to determine the extent and type of future AR development allowable in NMSs.

This policy recognizes that there may be situations where ARs help a sanctuary achieve its mission. The relative merit of ARs in NMSs is the subject of continued debate within the national program.

Concerns over ARs include:

- Destruction of benthic species and habitats upon emplacement;
- Collateral damage if the ARs were to break apart;
- Attraction of biomass from surrounding natural habitats;
- Toxic contamination from PCBs, asbestos, hydrocarbons or other toxic materials left in the ARs; and
- Attraction of fishing activities, which target large, vulnerable breeding adults and spawning aggregations.

Potential benefits of ARs are:

- Provision of habitat for selected fish and invertebrate species;
- Concentration of uses (recreational fishing and diving) and their diversion from other more sensitive areas;
- Enhancement of user opportunities that increase awareness of a sanctuary.

VI. SUMMATION

This section reviews points raised in the previous sections of this document and forms conclusions. It considers the outcomes of cumulative actions and effects. It summarizes the status and condition of sanctuary resources.

Context

The Stellwagen Bank sanctuary has a long cultural tradition based around fishing and whaling. Humans have depended on the sanctuary's diverse and abundant marine resources for sustenance and economic prosperity for hundreds of years. Both Native populations and Europeans chose to inhabit the shores of Massachusetts Bay because of the easily accessible and plentiful marine natural resources, such as cod and various species of whales that could be extracted. The historic exploitation of these resources forged a cultural tradition that is difficult to perpetuate today as a result of overfishing, coastal and ocean habitat destruction and rapid transformation of the region's economy. The modern appreciation for the sanctuary's resources requires that they be protected for their intrinsic value, multiple ecosystem services, and recreational and ecotourism importance, while facilitating consumptive uses (including fish and seafood production) that are environmentally sustainable and compatible with the widely recognized need and legislative mandate for resource protection.

The sanctuary was designated for a multitude of reasons, not the least of which was its long history of human use, its high natural productivity and relative high species diversity. There are well over 575 known species in the sanctuary, including over 80 species of fish, and the list is largely incomplete. Living landscapes (anemone forests, sponge gardens, hydroid meadows, worm tube beds) carpet the seafloor and the associated marine communities support benthic and pelagic species that are dependent upon them. Water column and seafloor habitats provide feeding and nursery grounds for 22 marine mammal species, including the endangered humpback and fin whales and the critically endangered North Atlantic right whale. The area supports foraging activity by 34 species of seabirds, dominated by gulls, storm petrels, gannets, auks (alcids), sea ducks and shearwaters. Fish and invertebrate populations include both demersal and pelagic species, such as cod, flounders, bluefin tuna, herring, lobster and scallops. Leatherback and Kemp's ridley sea turtles (endangered species) on occasion visit the area for feeding.

Historic Importance

Sitting astride historic fishing grounds and shipping routes, the sanctuary has been a locus for a variety of human maritime activities for over four centuries. Beginning in the earliest days of the European exploration and settlement of North America, fishermen were drawn to the immensely productive fishing grounds off the New England coast. These initial forays paved the way for the European colonization of New England and the establishment of the English colony at Plymouth, Massachusetts. Fishery resources harvested from Stellwagen Bank played an important role as a trade commodity that ensured the success of the early English settlements established around Massachusetts Bay. Utilizing their local fisheries, New Englanders developed a trading network that spanned the Atlantic world and formed the basis for the region's early maritime-based economy.

New England developed its cultural identity through shipping and its interaction with other cultures. This cultural exchange was made possible by the international trading voyages that originated and returned to communities on the doorstep of the sanctuary. Vessels from Boston, Salem and other Massachusetts ports transited through the sanctuary on the way to the Far East, Europe and the Caribbean as part of a major marine transportation network. In addition to the commodities exchanged with Europe, tens of thousands of Europeans immigrated to the U.S. on vessels that passed through the sanctuary's waters on the way to Boston.

The major shipping corridors established in the past are still prominent today where they cross the sanctuary. Shipwrecks on the sanctuary's seafloor give evidence of the 400 year history of maritime transportation and commerce that passed through the area. To date, 18 historic shipwreck sites have been located in the sanctuary and four of the shipwrecks have been identified by name; three shipwreck sites are listed on the National Register of Historic Places. These shipwrecks are tangible connections to the past that allow the Sanctuary Program to study and better understand history as they encapsulate significant stages of shipbuilding.

The sanctuary's most notable shipwreck is the wooden hulled paddle wheel steamship *Portland*. Built in 1889 in Bath, Maine, for the run between Portland, Maine, and Boston, the steamship was one of the largest and most palatial vessels afloat until its loss with almost two hundred lives in 1898 during the "Portland Gale," the "perfect storm" of that century. The *Portland* was listed on the National Register of Historic Places in 2005 because of its historical and archaeological significance to New England and, more specifically, Maine and Massachusetts. The wreck is the most intact and best preserved New England "night boat" yet located. New England "night boats" were steamships that connected metropolitan areas separated by a distance of between 125 and 200 miles on mainly overnight voyages.

The shipwreck site of the coal schooners *Louise B. Crary* and *Frank A. Palmer* is another extraordinary sanctuary historical resource. The two Maine-built nearly 300 foot-long schooners collided in 1902 with full loads of coal from Virginia. Today, the vessels lie upright, intact to their main decks with their bows joined at the point of impact. In 2006 the shipwrecks were listed on the National Register of Historic Places because they exemplified the critical transportation network that supplied New England's energy needs. These shipwrecks are the best example of the great New England coal schooners located to date.

Venturing back to prehistory, Stellwagen Bank mostly owes its existence to the last great ice sheet (known as the Laurentide Ice Sheet) and to changes in sea level that accompanied and followed deglaciation. About 12,000 years ago, Stellwagen Bank stood well above sea level and may even have been connected to Lower Cape Cod or, at the least, separated from the Cape by a shallow strait. Stellwagen Bank, then, closely resembled present-day Lower Cape Cod. Lakes, swamps and marshes probably dotted the landscape. Along the shore, there would have been beaches, sea cliffs, spits and lagoons. The climate was colder back then than it is now, and spruce and poplar forests and park lands of tundra shrubs and grasses may have covered the bank top.

Mastodon and mammoth teeth have been dredged up from the seafloor near Stellwagen Bank, evidence of the animal life of the time. Early Paleo-Indians arrived in New England about 11,000 years ago, and they may have witnessed the beginning of the final chapter in the history of Stellwagen Bank as emergent land. By then, local sea level was rising as crustal rebound slowed and as the melting glaciers continued to return water to the ocean basins. About 10,000 years ago, Stellwagen Bank slipped beneath the sea.

Status Today

Today, whales swim where ancient elephants may have once trod. These marine mammals now make the waters of the Stellwagen Bank sanctuary one of the most intensively used whale habitats in the northeast continental region of the U.S. The humpback whales of the sanctuary represent the longest continuously studied group of baleen whales in the world. Matrilineal studies show evidence of four generations (1976-2006) of humpback use as well as intergenerational site fidelity to specific sanctuary feeding and nursery areas. Additionally, critical habitat designation was established for the North Atlantic right whale in 1994 inclusive of the southwestern part of the sanctuary.

The newly-established sister sanctuary relationship between the Stellwagen Bank sanctuary and the Dominican Republic humpback whale sanctuary is the first conservation management action worldwide to protect a migratory marine mammal species on both ends of its range (between sanctuary feeding/nursery grounds and the largest mating/calving grounds for humpback whales in the North Atlantic) by functionally linking two important national marine protected areas. The formal agreement was signed by both parties in December 2006.

The Stellwagen Bank sanctuary is a hotspot for prey abundance, which is what ultimately attracts the whales, sustains the fish and other wildlife, and supports the economic viability of most current uses in the sanctuary. Sand lance numbers in the sanctuary are the highest and most concentrated anywhere in the southern GoM. Atlantic herring also abound in the Massachusetts Bay/Cape Cod Bay system in relatively higher abundance than most elsewhere in the southern GoM. The margins of Stellwagen Bank are sites of high horizontal and vertical movement of both water and plankton due to the bank's exposure to GoM water circulation. The interaction between physical oceanography and bathymetry creates environmental conditions that result in high primary productivity and the aggregation of biomass at multiple trophic levels.

A distinctive feature of the sanctuary's physical oceanography is the seasonal generation of internal waves over Stellwagen Bank. The sanctuary is considered to be the best place in the GoM to study this phenomenon because of ease of access and proximity to research infrastructure. Internal waves are particularly important for water column mixing and localized transport within the sanctuary area; they are generated by the tides in response to the sanctuary's complex seafloor topography. The entirety of the sanctuary seafloor has been mapped using multi-beam sonar at a vertical resolution of approximately 25 cm and a horizontal resolution of approximately 10 m. In conjunction with extensive ground-truthing (e.g., video, still photos, sediment samples), the sanctuary multi-beam map provides the most complete characterization of the seafloor in the GoM.

The Stellwagen Bank sanctuary lies within the Gulf of Maine Large Marine Ecosystem (GoMLME), one of the most productive marine areas in the world. Because of the highly varied topography, wide range of depths that cross water column boundaries, and high diversity of habitat types in a relatively small area, Stellwagen Bank sanctuary encompasses the wide range of landscapes, habitats, communities and the species representative of the GoM region. Via its position amidst the Maine Coastal Current and GoM counterclockwise gyre, the sanctuary is integrally connected with the rest of the GoM through water circulation and serves as both a source (for export) and a sink (for import) for larvae of various and numerous organisms.

For centuries, Stellwagen Bank has proved to be a rich and productive fishing ground, particularly for groundfish species like cod, haddock and flounder. Historically, fishermen have also been able to catch Atlantic halibut, swordfish and large schools of mackerel and herring. During the second half of the 20th century, the area gained fame as a whale watching destination. In 2007, *USA TODAY* (and previously in 2002, the World Wildlife Fund) named Stellwagen Bank one of the top ten premiere places in the world to watch whales. In 2006, the readers of *Offshore* magazine voted Stellwagen Bank the best place to watch wildlife and the number three favorite recreational fishing spot in the northeastern U.S. And, as the U.S. partner of BirdLife International, Mass Audubon has designated Stellwagen Bank an Important Bird Area. But, challenges abound.

Current Challenges

On an annual basis, virtually every square kilometer of the sanctuary is physically disturbed by fishing, to greater or lesser degree, depending on the gear used (Figure 111). This assessment includes the portion of the sanctuary overlapped by the Western GoM fishery closure area, because regulations pertaining to that closure do not restrict all types of fishing. The disturbances caused by fishing are chronic as well as extensive; they are repetitive and recurring rather than single impact events.

Fishing impacts and puts pressure on every resource state in the sanctuary, whether it is biogenic seafloor habitats, marine mammals or shipwrecks. Fishing has removed almost all of the big old growth individuals among biologically important fish populations, reshaped biological communities and habitats in the process, and until recently, reduced fish species diversity and richness in the sanctuary. Commercial fishing lands 17.0 million pounds to 18.4 million pounds of fish and crustaceans from the sanctuary each year on average (1996-2005), yet discards approximately 23% of the total catch as bycatch (based on 2002/2003 estimates). The part of the catch from the sanctuary that actually is landed amounts to between 1.85%–2.79% of the total New England landings value for all northeast fisheries. [This analysis omits Connecticut, which realized next to no landings from the sanctuary and which, if included, would reduce this percentage.]

Atlantic herring accounts for the greatest volume by species landed from the sanctuary, averaging several thousand metric tons annually with the highest single year landings to date of 7,726 metric tons in 2005. Herring removal in this amount by fishing reduces the forage base available to marine mammals in the sanctuary and could be a factor in causing local prey depletion and in determining the local abundance of whales and dolphins in the sanctuary. Herring and sand lance are key prey species that constitute a major segment of the forage base underlying all ecological functions and economic and recreational activities that define the sanctuary.

The sanctuary is a hot spot for whale entanglement with fishing gear, accounting for 41% of all reported cases of entanglement in the northeast region. Analysis of scars on humpback and right whales in the GoM region indicate that between 50% and 70% of animals in some populations have been entangled at least once in their lives and between 10% and 30% of the population become entangled each year. Mortality subsequent to entanglement among humpback and right whales is on the order of 11%, although this rate is likely an underestimate because of the difficulty in quantification and follow-up in case studies.

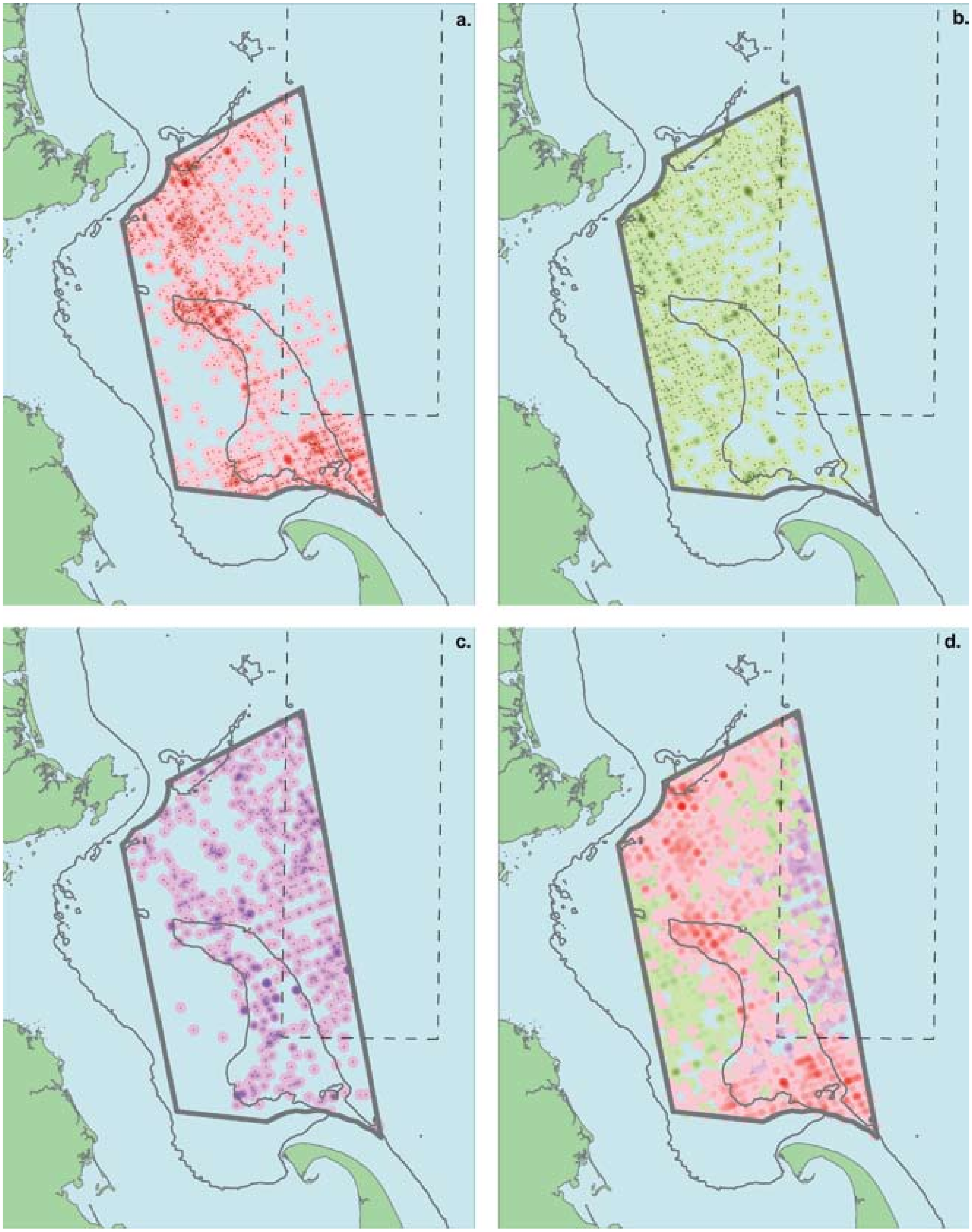
Fishing gear fouls eleven of the eighteen known historic shipwreck sites in the sanctuary, which also display evidence of damage by gear impacts. While mobile fishing gears represent the biggest threat to the sanctuary's maritime heritage resources, virtually all common gear types are involved. Shipwrecks are a non-renewable sanctuary resource as they cannot recover from damage.

Because of its proximity to the Port of Boston, the sanctuary receives more commercial shipping traffic than any other location within US jurisdiction in the GoM. Concomitantly, the sanctuary is a hot spot for vessel/whale strikes along the eastern seaboard of the U.S. Approximately 10% of the vessel/whale collisions recorded world-wide were reported from the sanctuary area including Cape Cod Bay and Boston Harbor. Species struck included fin, humpback, sei, minke and North Atlantic right whale, four of which are listed as endangered under the Endangered Species Act and all of which are protected under the Marine Mammal Protection Act. During a two-year study in the sanctuary, commercial whale watch boats, ostensibly operating under provisions of the NOAA whale watching guidelines, exhibited a non-compliance level of 78% while engaged in that activity.

The sanctuary also seems prone to biological invasion by exotic species, based on factors associated with community maturity and the niche opportunities for introduction of exotics created by a history of lowered species diversity and extensive chronic habitat disturbance by fishing. These conditions co-occur with the sanctuary's location amid extensive commercial shipping traffic that can serve as primary vectors for the introduction of exotics from hull bottoms and ballast water. Harmful algal blooms and degraded water quality continue to be concerns with continuing coastal development and increasing urbanization in the region, coupled with unrelenting population growth and commensurate waste management needs. And, creeping industrialization along the western boundary of the sanctuary in the form of deepwater LNG ports may lead

Figure 111. Spatial density patterns based on trips for all fishing recorded in the Stellwagen Bank sanctuary during July 2001–June 2002 based on Vessel Trip Report (VTR) data.

(a): Mobile fishing gear, e.g., bottom and mid-water trawls, scallop dredges, etc. (b): Fixed fishing gear, e.g., lobster traps, sink gillnets, etc. (c): Recreational fishing, e.g., party and charter boats. (d): All gear types and recreational fishing combined. The patterns are Kriged density plots of the VTR data using a 1,000 m search radius and analyzed by ESRI ARCGIS. VTR gear codes: (a) DRC, DRS, OTF, OTM, OTS, PTM; (b) GNS, LLB, PTC, PTH, PTL; (c) Party/Charter (Trip ID: 2, 3). The 1,000 m search radius is consistent with the length of fixed gear sets, falls within the length of mobile gear tows in the sanctuary, and the area of influence of recreational fishing.



to chronic underwater noise affecting sanctuary resources in virtual perpetuity.

Compatible Uses

While it is important to appreciate the sanctuary's history and today's challenges, it is also important to recognize that the sanctuary is mandated by Congress to facilitate only those uses compatible with the sanctuary's primary objective of resource protection. Therein lies both the opportunity and the challenge; the opportunity to correct practices harmful to sanctuary resources, and the challenge to accomplish that goal in ways that create positive outcomes for users and that can be supported by the general public. It is this public at large for which sanctuary resources are held in common trust.

The term "compatible" is articulated as the standard for acceptable use pursuant to the National Marine Sanctuaries Act. But the Act does not define nor does it provide the criteria to apply that standard. This term needs to be defined and made operational, the means to which is proposed in the Compatibility Determination Action Plan that follows in the next section. The underlying concept is to identify and allow uses that restore and maintain ecological integrity, protect maritime heritage resources and foster an ethic of environmental sustainability in the sanctuary. Current practices, some steeped in history, others of more recent origin, may have to be modified or even dissuaded. Innovation, experimentation and incentives can affect successful transition over time.

While the term "compatible" may be difficult to define bureaucratically, the concept may be easier to understand metaphorically. Essentially, human activities should not "bankrupt" the Stellwagen Bank sanctuary. The sanctuary's living and cultural resources can be considered forms of capital, managed as though they were holdings in a diversified investment portfolio, all capable of bearing interest. The goal is to realize successful investment (i.e., management) outcomes over the long term by minimizing or at least spreading risk.

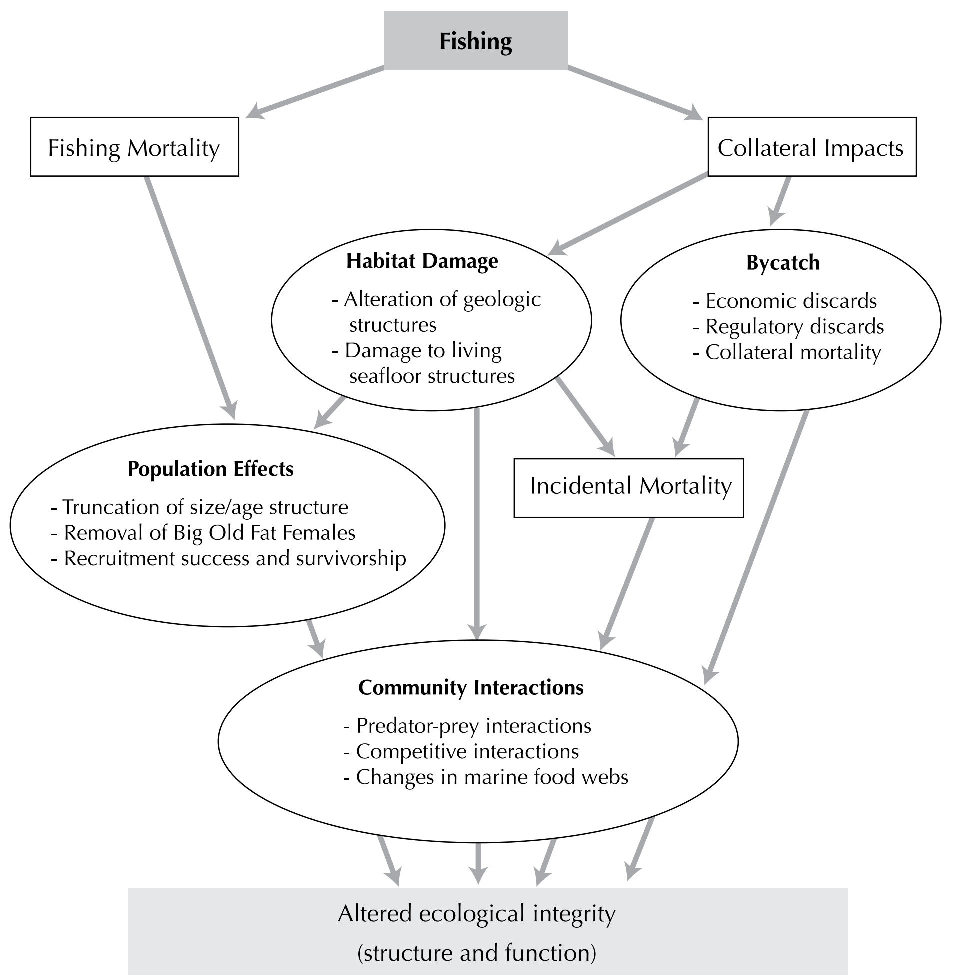
For example, seafloor biogenic and water column habitats can be considered the saving accounts, the most conservative investments because they must endure perpetually to offer reliability. Fish species of commercial and recreational interest can be considered the high yield stocks that potentially pay big dividends but incur the greatest risk because they are associated with conditions of high variability and uncertainty. If successfully applied, the compatible use standard should offer a reasonable return on investment for the users of the sanctuary without harming the principal held by the public at large.

Cumulative Impacts

Effects of Fishing

The principal effects of fishing on sanctuary resources act through multiple pathways to cumulatively impact biological community interactions (Figure 112). Resulting changes in the composition of biological communities ultimately affect the ecological integrity and biological diversity of the Stellwagen Bank sanctuary. All of these effects are documented as occurring in the sanctuary and are variously

Figure 112. Cumulative impacts caused by fishing in the Stellwagen Bank sanctuary, mediated through directed mortality and collateral impacts affecting community interactions, leading to altered ecological integrity.



Adapted from Morgan and Chuenpagdee, 2003 discussed in the section Resource States as well as summarized in Figure 112.

Fishing effects fall within two categories: effects due to (1) the direct mortality of the fish caught and landed for sale, and (2) the collateral impacts caused by the fishing activities themselves. Fishing mortality impacts community interactions indirectly through population level effects on targeted species of economic or recreational importance. These population effects include the truncation of old growth age structure and removal of the most reproductively significant fraction of the population. These altered populations then directly affect the structure and function of their associated biological communities through multiple ecological processes, including predation and competition that, in turn, affect food webs and trophic dynamics.

The collateral impacts of fishing are more numerous and exert their effects in more complex ways. Fishing activities can damage seafloor habitats by altering and simplifying their physical structure and by impairing and rendering biogenic (living) habitats dysfunctional. Habitat damage reduces shelter availability and can exert population effects through recruitment success and survivorship. The removal of biomass as fishery bycatch has unintended community level consequences mediated through collateral and incidental mortality of discards. Discards can be economic in kind (i.e., non-saleable species) or regulatory (e.g., fish below minimum size, numbers caught exceeding allowable level of take). Bycatch mortality can be direct, as the result of capture, or incidental, due to injury or habitat displacement. Both habitat damage and bycatch mortality directly impact the structure and function of biological communities in the sanctuary.

Figure 112 indicates that the sanctuary cannot effectively conserve its biodiversity by managing just for population level effects of fishing on commercially important species, and that the ultimate goal of sanctuary management must be the protection and restoration of its biological communities. The figure also indicates that the key to protecting and restoring biological communities within the sanctuary must be modification of fishing activities to make them environmentally sustainable such that habitats are not damaged and excessive biomass as bycatch is not removed. If the sanctuary is to be effectively managed for biodiversity conservation, fishing in the sanctuary cannot continue to be prosecuted solely in terms of the more conventional sense of sustainable production. Rather, the calculation of optimum yield within the sanctuary should explicitly include the protection of biological diversity pursuant to the objectives of the National Marine Sanctuaries Act.

Effects on Marine Mammals

Three principal sources pressure marine mammals in the sanctuary: (1) fishing, (2) shipping and boating, and (3) human population, industry and harmful algal blooms (HAB) (Figure 113). All three sources contribute varying levels of pollutants and chemical contaminants which can have negative effects on marine mammals.

The principal effects due to fishing include the reduced forage base available for marine mammals due to local depletion of herring, entanglement in fixed fishing gear, and behavioral disturbance associated with tuna fishing activities in the vicinity of whales feeding and underwater noise. The principal effects due to shipping and boating include vessel strikes of whales and behavioral disturbance associated with whale watching and underwater noise.

These effects can cause the mortality, injury and/or harassment of marine mammals possibly leading to their reduced local abundance in the sanctuary. Reduced local abundance of marine mammals in the sanctuary can in turn diminish the public's recreational enjoyment of the place, depress its ecotourism value, and alter the role of marine mammals as a functional element of the sanctuary ecosystem.

Effects on Maritime Heritage Resources

Fishing, diving and remote sensing all have the potential to diminish the archaeological integrity of maritime heritage resources in the sanctuary by altering shipwreck characteristics and site context (Figure 114). Fishing impacts have been documented on eleven of the eighteen known historic shipwreck sites in the sanctuary. While diving and remote sensing currently are occurring infrequently in the sanctuary, their potential impacts on historic shipwrecks (indicated by dashed lines in the figure) are considered in the summary of cumulative impacts presented here.

The principal effects due to fishing include structural damage associated with gear impacts and removal of artifacts through gear entanglement and "capture" in bottom trawls and gillnets. Hook and line fishing also causes these impacts through boat anchoring and the use of heavy sinkers and jigs. Access to the sites by remote sensing technology and divers may be negatively affected by lost nets and lines that entangle the wrecks and impede close approach.

While diving on a shipwreck does not necessarily have negative impact, divers can cause structural damage through boat anchoring/grappling/tying onto a shipwreck. Divers have also been known to remove artifacts. Likewise, although remote sensing does not necessarily damage a maritime heritage resource, accidental damage is possible through entanglement, and certain remote technologies, such as ROVs, can remove artifacts from an archaeological site.

Condition Summary

A "snap-shot" of the inferred state or health of key sanctuary resources is provided in the Stellwagen Bank sanctuary *Condition Report* (NOAA, 2007). The report is linked to resource conditions more fully described in the Resource States section of this document. The *Condition Report* summary table, excerpted and updated here (see following note), was originally intended to provide a preliminary overview of the status and trends of sanctuary resources as well as the basis for making judgments concerning status (Table 24). The summary table results are generally consistent with and representative of findings presented in this document, although not fully comprehensive of all issues. For more details, refer to the full *Condition Report* (http://stellwagen.noaa.gov).

[Note: Long-term changes in fish species diversity (1975-2005) measured across six indices (Figure 37) do not appear to be changing in any consistent way (question 9); indices are at levels comparable to the 1970s and the rating is upgraded to fair-poor. Sand lance has been deleted as a key species in jeopardy (question 12), adjusting for increases in sand lance availability in consecutive years 2006 and 2007. Maximum length of cod increased over 1990-2005 (Figure 41), reversing a long-term downward trend (1963-2000) (Figure 40), indicating that conditions may be improving (question 12).]

The summary table indicates the need for management actions that address the degraded conditions of key habitats and living resources in the Stellwagen Bank sanctuary. Over half of all categories (10 of 17) had fair through poor ratings, with eight of ten relating to habitat or living marine resources. The general trend for habitat and living resources appears to be static and in need of improvement, an indication that pressures on living resources are high, requiring targeted management efforts. The status of seafloor communities and habitats in the sanctuary remains problematic. Monitoring programs for water quality and a number of other concerns (e.g., environmental contaminants, invasive species) need to be more sufficiently addressed as well. The physical integrity of historic shipwrecks requires protection from human use, particularly from fishing gear impacts.

The summary table rates resource status on a scale from good to poor; the timelines used for comparison vary from topic to topic. However, the trends are generally based on observed changes in status over the past five years (2001-2006), unless otherwise specified. Evaluations of status, trends and final ratings were made by sanctuary staff, based on interpretation of quantitative and, when necessary, non-quantitative assessments and observations of scientists, managers and sanctuary users with pertinent knowledge. The *Condition Report* was peer-reviewed and complies with the White House Office of Management and Budget's peer review standards as outlined in the *Final Information Quality Bulletin for Peer Review*.

Moving Forward

The broad range and technical specificity of the information compiled in this document was derived from the very hard work of nearly 200 people participating on ten working groups representing all stakeholder interests in the sanctuary. These individuals were committed to developing a better understanding of the condition of sanctuary resources through the management plan revision process. Many of these individuals were staff specialists of fishery management agencies, especially NOAA Fisheries Service NERO

Figure 113. Effects on marine mammals caused by the cumulative impacts of human activities in the Stellwagen Bank sanctuary that could alter their role as a functional element of the sanctuary ecosystem.

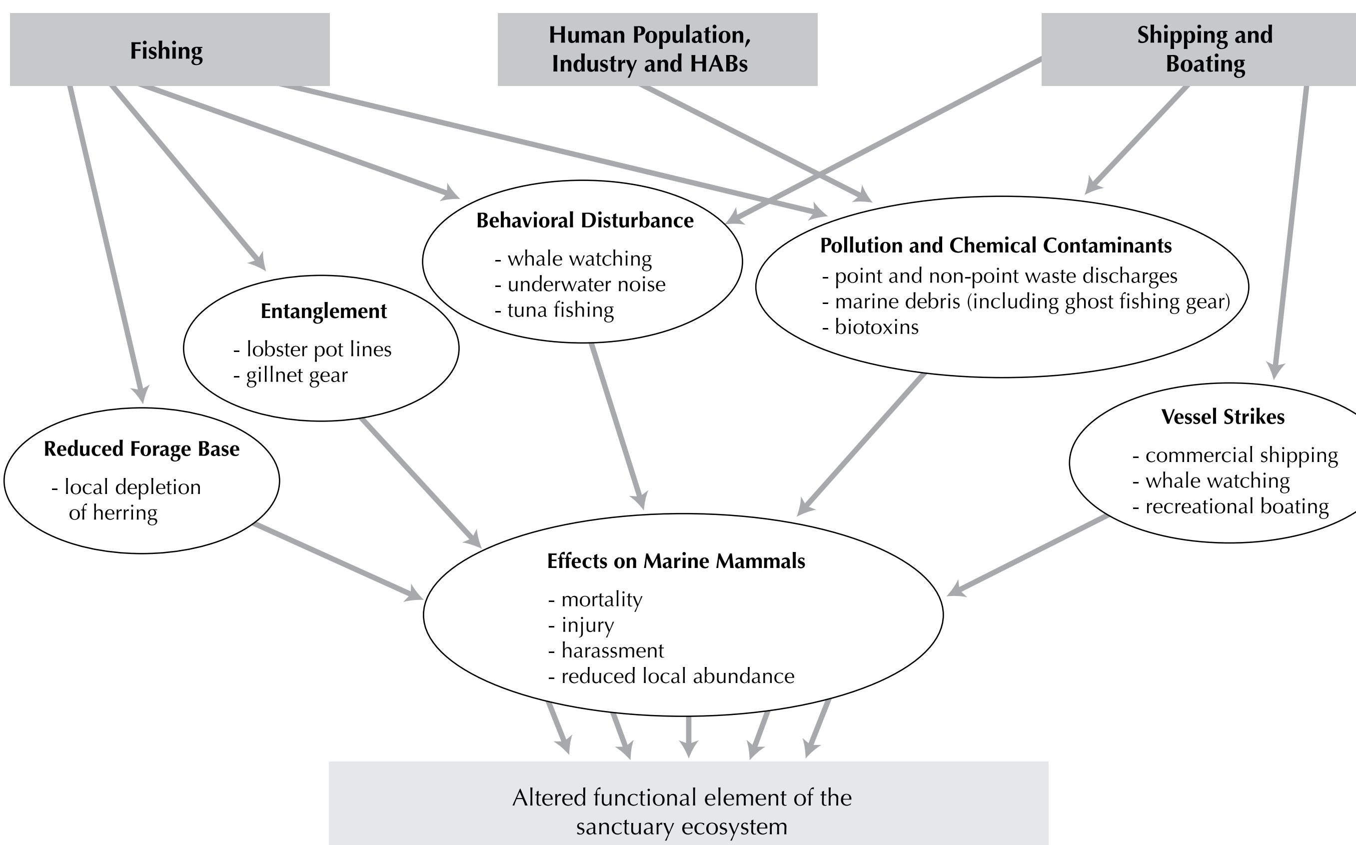
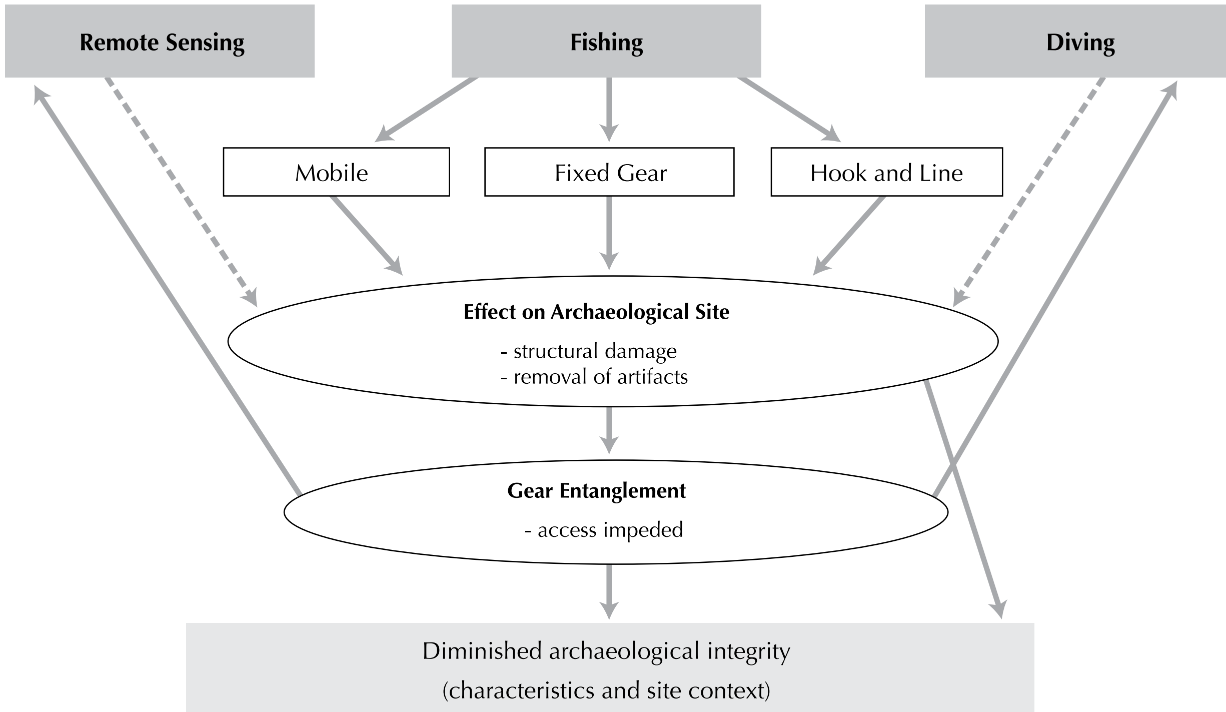


FIGURE 114. EFFECTS ON MARITIME HERITAGE RESOURCES IN THE STELLWAGEN BANK SANCTUARY CAUSED BY CUMULATIVE IMPACTS AND LEADING TO DIMINISHED ARCHAEOLOGICAL INTEGRITY.



and NEFSC, who freely made their expertise and extensive databases available to the sanctuary for use in many of the analyses and research projects referenced. Many of the members of these working groups were fishermen, who committed themselves to this planning process and engaged positively in the dialogue by bringing their practical experience to bear on the issues; so too, members of the whale watching and maritime industries, environmental organizations, academic institutions and the public at large gave valuable input.

This document provides background information necessary for managing the sanctuary for biodiversity conservation and clarifies the scale and scope of fishing and other activities in the sanctuary. The information provides a detailed picture of the present condition of sanctuary resources and the activities exerting pressures on them. There is now the basis to consider how things should be done differently to improve sanctuary management, since that is what the findings indicate is needed.

The action plans that follow in the next section are preceded by a statement and discussion of the vision for the sanctuary that was developed by the Sanctuary Advisory Council as part of the management plan revision process. This vision draws contrast to the current conditions in the sanctuary.

"The Stellwagen Bank National Marine Sanctuary is teeming with a great diversity and abundance of marine life, supported by diverse, healthy habitats in clean ocean waters. The ecological integrity of the sanctuary is protected and fully restored for current and future generations. Human uses are diverse and compatible with maintaining natural and cultural/resources."

The first step to realizing this vision is compiling a current accounting of the status of the sanctuary's resource states, which this first part of the document has done. The next step is to convert this knowledge into actions that can reasonably be taken on the basis of what is now known. These actions and their respective strategies and activities are proposed in the action plans that follow. The action plans are based extensively on the advice of the Sanctuary Advisory Council working groups and these recommendations should be put into practice.

Table 24. Revised summary of findings from the Stellwagen Bank sanctuary *Condition Report* (2006) that was prepared preliminary to this document.

Refer to Appendix A in the *Condition Report* for an explanation of the questions posed in this table.

While providing a useful overview pertinent to most key sanctuary resources, the table is not inclusive of all resource conditions and associated pressures such as local depletion of prey species for endangered whales, increased underwater noise from industrial sources, etc. that are covered in this document.

#	Questions/Resources	Rating	Basis for Judgment	Description of Findings
Water				
1	Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?	—	Numerous contaminants at low levels.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
2	What is the eutrophic condition of sanctuary waters and how is it changing?	—	Specific aspects of on-going monitoring, as explained in text, with references.	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
3	Do sanctuary waters pose risks to human health?	—	Specific aspects of on-going monitoring, as explained in text, with references.	Conditions do not appear to have the potential to negatively affect human health.
4	What are the levels of human activities that may influence water quality and how are they changing?	—	Vessel discharges. MWRA outfall.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.
Habitat				
5	What is the abundance and distribution of major habitat types and how are they changing?	—	Alteration of microhabitat due to bottom dragging & dredging.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable, but not severe declines in living resources or water quality.
6	What is the condition of biologically-structured habitats and how is it changing?	—	Fishing gear impacts.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some, but not all living resources or water quality.
7	What are the contaminant concentrations in sanctuary habitats and how are they changing?	—	Limited monitoring results.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
8	What are the levels of human activities that may influence habitat quality and how are they changing?	▼	Fishing gear impacts, shipping.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Living Resources				
9	What is the status of biodiversity and how is it changing?	—	Long-term changes in fish diversity.	Selected biodiversity loss has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity.
10	What is the status of environmentally sustainable fishing and how is it changing?	—	Published and unpublished literature on regional and local groundfish populations.	Extraction has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity.
11	What is the status of non-indigenous species and how is it changing?	▼	Recent invasives discovered.	Non-indigenous species exist, precluding full community development and function, but are unlikely to cause substantial or persistent degradation of ecosystem integrity.
12	What is the status of key species and how is it changing?	▲	Cod (keystone species).	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity; or, selected key species are at substantially reduced levels, and prospects for recovery are uncertain.
13	What is the condition or health of key species and how is it changing?	—	Whale strikes & entanglements.	The diminished condition of selected key resources may cause a measurable, but not severe reduction in ecological function, but recovery is possible.

Table 24. Continued.				
#	Questions/Resources	Rating	Basis for Judgment	Description of Findings
14	What are the levels of human activities that may influence living resource quality and how are they changing?	—	Stable levels of activity.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Maritime Archaeological Resources				
15	What is the integrity of known maritime archaeological resources and how is it changing?	▼	Fishing gear impacts.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific, or educational value, and may affect the eligibility of some sites for listing in the National Register of Historic Places.
16	Do known maritime archaeological resources pose an environmental hazard and is this threat changing?	—	Lack of hazardous cargo.	Known maritime archaeological resources pose few or no environmental threats.
17	What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?	▼	Fishing gear impacts.	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Status:	Good, Good/Fair, Fair, Fair/Poor, Poor, Undetermined	
Trends:	▲	Conditions appear to be improving toward one of the higher categories.
	—	Conditions do not appear to be changing.
	▼	Conditions appear to be declining toward one of the lower categories.
	?	Undetermined trend.
	N/A	Question not applicable.

VII. Action Plans

This section presents the sanctuary action plans. It explains what action plans are, what they are intended to do, and how they will be implemented. It presents funding scenarios and timelines, along with performance measures to gauge program effectiveness. It consists of eleven action plans that address priority needs identified in four programmatic areas: capacity building, ecosystem protection, marine mammal protection and maritime heritage management.

Introduction to Action Plans

What are Action Plans?

Action plans are detailed plans for addressing an issue or problem in the Stellwagen Bank National Marine Sanctuary (SBNMS or sanctuary) over the next five years. They are issue-driven not program- or theme-driven. You will not find a marine mammal action plan but you will find, for example, a plan to minimize behavioral disturbance of marine mammals and a plan to reduce entanglement of marine mammals.

Action plans are a collection of strategies sharing common management objectives. The plans provide an organized structure and process for implementing these strategies over the next five years, including a description of the requisite activities and requirements for implementation.

What is their origin?

Action plans arose from grassroots concerns about the sanctuary ecosystem solicited by NOAA during two separate public scoping comment periods in 1998–99 and 2002. In the latter period, NOAA received over 20,000 comments addressing issues such as water quality degradation, no-take areas, enforcement issues and whale entanglements in the sanctuary.

After reviewing the comments, the sanctuary advisory council, a 21-member citizen advisory committee established pursuant to the NMSA, grouped the comments by underlying issues and then prioritized the issues. The advisory council formed eleven working groups to develop draft recommended action plans to address these issues. The working groups were comprised of approximately 12–24 members representing users, citizens, academicians and agency representatives with relevant knowledge of the respective issues. (See Appendix F, Part 2 for a list of working groups and their membership.)

The working groups met over a period of approximately nine months (October 2003–July 2004) and formulated draft action plans for review and consideration by the advisory council. At their October and November 2004 meetings, the advisory council amended and voted to accept all draft action plans, as amended, and prioritized the strategies and activities. This advice was forwarded to the sanctuary superintendent who, with staff, developed final proposed action plans based on the advisory council's recommendations, taking into consideration budgetary and statutory constraints. The final proposed action plans are presented in this document for public review and comment.

How are they prioritized?

The sanctuary has a limited budget and cannot simultaneously address all of the issues it faces. Consequently, it was necessary to prioritize the strategies within each action plan. To accomplish this task, the staff took the following into consideration: (a) advisory council recommendations, (b) statutory requirements, (c) budget constraints, (d) feasibility and (e) prerequisites for implementation. The strategies were ranked as either High, Medium or Low priority based on staff assessments of these criteria.

Only strategies are prioritized, as activities are a subset of them. The implementation of strategies begins when the final management plan is released, unless activities are currently ongoing. Strategies are prioritized as follows:

- High (H): Strategies that are imperative and either underway or address the sanctuary's immediate needs. Work should be carried out within the first two years.
- Medium (M): Strategies that are important and need to be:
  - Initiated within three years and completed within five years; or
  - Accomplished as the opportunity arises or in conjunction with other work; or
  - Carried out if additional resources are provided (e.g., external research opportunities/funding).
- Low (L): Strategies that should be initiated within five years if additional human and financial resources are available (e.g., a post-doctoral student has extramural funding to address a particular issue).

The status of implementation of strategies and activities is noted in the action plans as either ongoing or planned with the corresponding year for initiation.

How are they evaluated?

Background. Implementation of each action plan will be evaluated through one or more performance measures. See Table 3 at the end of each action plan. These measures will demonstrate progress towards the desired outcomes stated for each action plan. With the performance measures in this draft management plan, the sanctuary is establishing a baseline of information that will be used by the sanctuary and the National Marine Sanctuary Program (NMSP) to evaluate effectiveness over time.

As part of the effort to improve overall resource management, ongoing and routine performance evaluation has become a national priority for the NMSP, and by extension, for the sanctuary. Both site-specific and national programmatic efforts are underway to better gauge the sanctuary's ability to meet its stated objectives and to address the issues identified in this management plan. Beyond these principal purposes, performance evaluation has other benefits, including:

- Highlighting successful (or not so successful) efforts to manage sanctuary resources;

- Keeping the public, Congress, and other interested parties apprised of program effectiveness;
- Helping program administration identify resource gaps;
- Improving accountability;
- Fostering the development of clear, concise and, when appropriate, measurable outcomes; and
- Providing a means to comprehensively evaluate sanctuary management in both the short and long term.

To help ensure these benefits are realized, the NMSP is developing tools for measuring and understanding the effectiveness of existing and new management programs, strategies and activities. Currently, these tools are primarily site-specific and are being worked into the regular cycle of management at each of the thirteen sanctuaries through the management plan review process. Evaluation tools are also being applied at the national level to better understand the effectiveness of the entire NMSP. These tools combine results from site-specific evaluations with results from cross-site programs, strategies and activities.

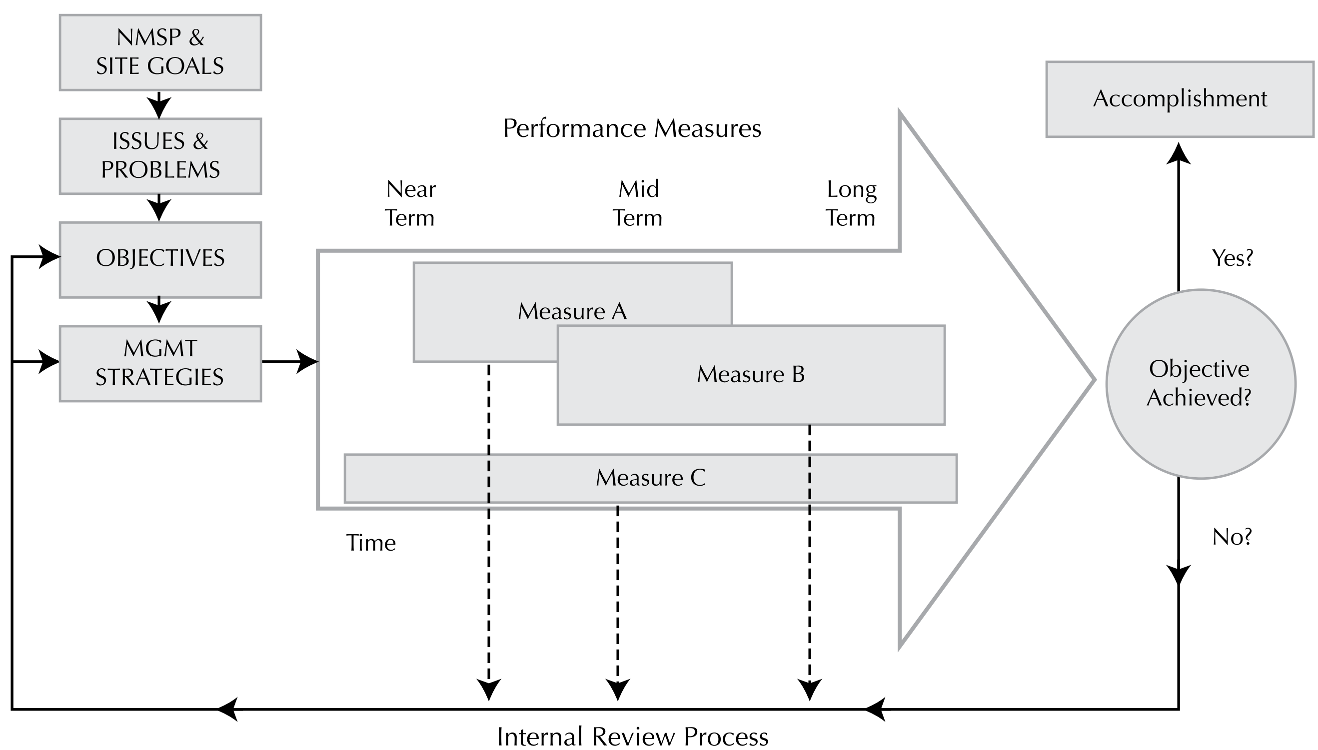
As this process matures, NMSP staff will continue to integrate new and improved methods for evaluating management effectiveness (at both the site-specific and national programmatic levels). Development and application of improved methods and approaches to evaluating and managing program effectiveness is a continuing and adaptive process in the NMSP. Figure 115 depicts the basic idea behind this process, which will be implemented in all sanctuaries undergoing management plan review.

Process. Issues and problems are identified during the scoping process relative to NMSP and site goals. Staff then works to develop objectives relative to proposed management strategies, as identified in each of the action plans. Performance measures are then drafted, which identify the means by which the sanctuary will evaluate its progress towards achievement of the objectives. As represented by the large arrow in Figure 115, measures are developed to provide information on results over time, from the near term (within one year or so) to the long term (over the span of ten years or more). As these measures are monitored over time, data are collected on progress towards the achievement of outcomes and the production of outputs (or products).

Objectives achieved and outputs produced are reported as accomplishments; inabilities to achieve objectives or produce outputs are also reported, but as areas falling short of targets. In these areas, staff will work to identify the issues preventing management from reaching targets (represented in Figure 115 by the arrow running along the bottom of the graphic). This internal review is one of the primary benefits of performance evaluation, as it provides an opportunity for staff to think carefully about why particular strategies are not meeting stated targets and how they can be altered to do so.

In the draft SBNMS management plan, each action plan contains a series of performance measures. Because it takes time and effort to track the information necessary to report on each performance measure, the sanctuary staff limited the number of performance measures. These measures are meant to be representative, not comprehensive, of all the

Figure 115. NMSP performance evaluation logic model.



activities planned by the sanctuary in the management plan. The sanctuary Superintendent is responsible for tracking all the performance measures and reporting the results of the performance evaluation. The task of gathering specific information for various measures is delegated to sanctuary staff.

All performance measures for this draft management plan are found in a series of eleven tables (one for each action plan). Each table identifies: (1) the action plan's desired outcome, (2) the performance measure(s) to track the achievement of the desired outcome, (3) the specific means of evaluation for the performance measure, and (4) a link to NMSP performance measures.

In some cases, identifying the baseline may be the first order of action so that subsequent reporting is based on concrete information. Periodic reporting on the effectiveness of sanctuary management, as evaluated by the performance measures described in each action plan, will be conducted. There will be opportunities for public comment on the sanctuary's perception of its performance, as well as ideas on how to improve the effectiveness of management, when evaluation is on the agenda at sanctuary advisory council meetings.

How are they organized?

Action plans consist of issue statements, goals, objectives, strategies and activities. The issue statement summarizes why the action plan is necessary. The goal provides the purpose for the plan. Objectives establish requirements for achieving the goal. Strategies and activities are discrete, specific management actions designed to meet the requirements of the objectives. A table at the beginning of each action plan lists the objectives with their associated strategies and respective priority (Table 1). Two tables at the end of each action plan detail estimated costs for implementing the strategies (Table 2) and provide performance measures related to achieving the desired outcomes (Table 3).

What are the costs?

Sanctuary staff developed budgets for each action plan by evaluating the resources necessary for their complete implementation. Staff estimated the programmatic cost required to address each strategy, including the number of field-operation days required (boat, air, dive), as well as materials, supplies and travel time needed. Some strategies will be contracted to other parties, in which case the total cost of the contract was included in the budget estimate. A summary of the cost estimated for each action plan is included in Table 25. Budgets were developed assuming work would begin in the first year, while allowing for resource limitations and the time necessary for program and partner development to fully occur. Figure 116 shows the management plan costs over five years.

Table 25. Estimated Annual Costs for Action Plan Implementation.

Action Plan	Estimated Annual Cost (in thousands)*				
	YR 1	YR 2	YR 3	YR 4	YR 5
Capacity Building					
Administrative Capacity and Infrastructure	638.0	1932.4	4811.9	2224.6	2417.3
Interagency Cooperation	0.6	0.6	0.6	0.6	0.6
Public Outreach and Education	54	127	330	330	330
Compatibility Determination	0	0	0	0	0
Subtotal—Capacity Building	692.6	2060.0	5142.5	2555.2	2747.9
Ecosystem Protection					
Ecosystem-Based Sanctuary Management	533.5	803.5	873.5	813.5	804.5
Ecosystem Alteration	30.0	12.0	27.0	13.0	13.0
Water Quality	15.0	55.0	50.0	35.0	10.0
Subtotal—Ecosystem Protection	578.5	870.5	950.5	861.5	827.5
Marine Mammal Protection					
Behavioral Disturbance	180.0	556.0	556.0	480.0	305.0
Vessel Strike	75.0	221.0	226.0	211.0	136.0
Entanglement	175.0	185.0	185.0	185.0	186.0
Subtotal—Marine Mammal Protection	430.0	962.0	967.0	876.0	626.0
Maritime Heritage Management					
Maritime Heritage	152.0	183.0	190.0	144.0	149.0
Subtotal—Maritime Heritage	152.0	183.0	190.0	144.0	149.0
Total Estimated Annual Cost of All Action Plans	**1853.1**	**4075.5**	**7250.0**	**4436.7**	**4350.4**
* Cost estimates reflect only programmatic costs and do not include federal labor costs.					

How are they implemented?

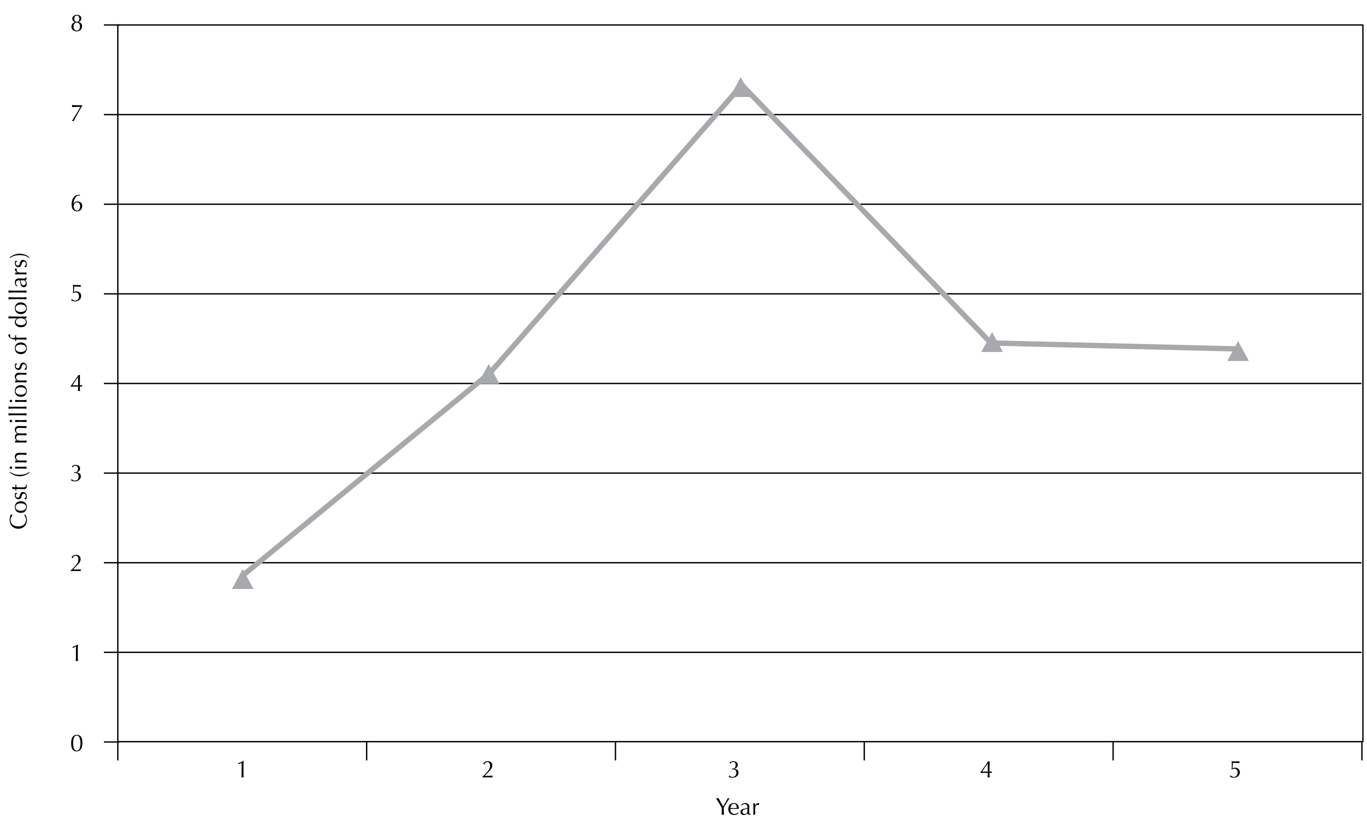
Appendix O provides an outline of how the various strategies in the management plan will be implemented. The implementation of the strategies depends on various factors including:

- priority of strategy implementation based on resources available;
- coordination level necessary with partners for implementation; and
- funding source(s) for strategy implementation.

Certain strategies and activities have been partially or wholly implemented prior to or during the management plan review process. Other strategies are new aspects of the updated management plan or may be initiated pending funding. Full implementation of the management plan exceeds current resources available to the sanctuary therefore requiring some prioritization of the action plan or strategies. As more resources become available, a greater level of implementation will be possible.

Appendix O outlines how much implementation could occur with the existing amount of resources and how increases in resources would affect the amount of implementation possible for each strategy or action plan. Implementation of most of the strategies in this management plan will require some input or coordination from partners, particularly other government agencies, research institutions, and NGO's. The table outlines the level of involvement expected from partners to achieve full implementation of each strategy. Many action plans and strategies are completely dependent on involvement from other agencies or dependent on research conducted by a research institution. Funding for implementation of many of the strategies will require a mix of internal NMSP funds as well as funding from external sources such as grants, the National Marine Sanctuary Foundation, or in-kind work from partner agencies.

Figure 116. Five-year management plan costs.



Explanation of Vision and Mission

Vision:

The Stellwagen Bank National Marine Sanctuary is teeming with a great diversity and abundance of marine life supported by diverse, healthy habitats in clean ocean waters. The ecological integrity of the sanctuary is protected and fully restored for current and future generations. Human uses are diverse and compatible with maintaining natural and cultural resources.

Mission:

To conserve, protect and enhance the biological diversity, ecological integrity and cultural legacy of the sanctuary while facilitating compatible use.

The sanctuary vision is a statement of desired outcome. It derives from public opinion and sentiment; it is realized by achieving the mission. The sanctuary mission is a statement of intrinsic purpose. It derives from the language and intent of the National Marine Sanctuaries Act and the specific guidance articulated by the sanctuary's original management plan, designation document and regulations. The mission is achieved by meeting the objectives and successfully implementing the strategies and activities in the action plans.

'Unpacking' the Vision

On July 11, 2005 the Stellwagen Bank National Marine Sanctuary Advisory Council formulated the vision statement given above. While there was consensus among the members on this vision, there was also considerable discussion as to the meaning and intent of various phrases and words in the vision. The following explanation 'unpacks' the vision so the public can better understand what the vision is for the sanctuary. In unpacking the vision, various phrases are highlighted followed by a synopsis of the discussion that occurred among advisory council members on their understanding and intent of the words and phrases.

"Stellwagen Bank National Marine Sanctuary"—Stellwagen Bank National Marine Sanctuary is an ecosystem. It is not just fish or lobsters or whales or sand lance; it is all of these and more. Physical habitat and associated physical-chemical factors such as temperature, salinity, and nutrients interact with biological organisms to create and sustain the ecosystem. The sanctuary is not an isolated ecosystem; it is part of the greater Gulf of Maine ecosystem and Atlantic Ocean. Because the sanctuary is not an isolated ecosystem, marine animals move into and out of the sanctuary throughout the year. Humans are connected to, not apart from, the sanctuary ecosystem so recreational, historical, cultural and archeological resources, such as shipwrecks, are also part of the sanctuary. The sanctuary is a special place.

"Teeming with a great diversity and abundance of marine life"—A long-time fisherman on Stellwagen Bank said he could remember when you didn't need GPS or a latitude and longitude to know when you were on Stellwagen Bank. "You could see the flocks of seabirds for miles. On cloudless days, it looked like it was raining as the sand eels broke the surface of the water. Nets were full; whales and other marine life were all around you." The vision for the sanctuary is that it will be teeming with marine life—not only great abundance of individuals, but also great diversity of species. In addition, individuals within a species will be distributed over the range of sizes possible for that species: young to old, immature to mature, small to large reflecting a healthy population of organisms.

"supported by diverse, healthy habitats in clean ocean waters"—The ecosystem definition indicates that biological organisms are not divorced from their habitats. The rich diversity of marine life is dependent on, and supported by, diverse habitats (sand, gravel, boulders, mud, outcrops, etc.) that contribute to healthy biological populations. Significant progress has been made to clean up ocean waters through the passage of international marine laws and regulations, the U.S. Clean Water Act, Clean Air Act Amendments, and other legislation, policies, and regulations. The sanctuary supports continued efforts to clean up ocean waters. Even though there currently are pollutants, invasive species, and other contaminants entering the marine environment, the vision is to have ocean waters that are clean, with the capacity to assimilate those contaminants and pollutants that continue to be emitted, released or discharged into the marine environment.

"ecological integrity"—The term 'ecological integrity' is part of the 1972 Clean Water Act and part of the National Marine Sanctuaries Act, yet it is neither well defined nor completely understood. Ecological integrity refers to the marine ecosystem and the structure (e.g., species diversity) and functions (e.g., ecological processes) needed to sustain not only the ecosystem, but also desired human uses over time. The Ecosystem-Based Sanctuary Management working group recognized that ecological integrity is an important, but poorly defined, attribute of the sanctuary. It recommended, as part of its action plan, that a separate working group be formed to: (1) define ecological integrity; (2) identify indicators that could be measured and monitored to determine how to protect ecological integrity; and (3) determine to what extent the ecological integrity of the sanctuary is degraded and needs to be restored. This working group has been formed and is developing a definition of ecological integrity that will help guide the management of the sanctuary.

"protected and fully restored for current and future generations."—As indicated above, both the Clean Water Act and the National Marine Sanctuaries Act require the ecological integrity of the nation's waters be protected. A sanctuary such as SBNMS, by definition, offers protection to those residing there, whether as permanent residents or as transients. Some animals, such as the right whale for example, find sanctuary while in this ecosystem. Management actions focus on protecting ecological integrity and facilitating public and private uses of the resources compatible with protecting ecological integrity.

There is also a general agreement that the ecological condition of Stellwagen Bank has changed from what it was historically and that the ecological integrity of the sanctuary should be restored. The extent to which the sanctuary can be restored is dependent on the state that can be sustained within the greater Gulf of Maine and Atlantic Ocean, given the changes (some irreversible) that have occurred to ecosystems throughout the globe. The restoration, protection, and stewardship of the sanctuary are not just for current generations, but also for future generations. Our posterity should be able to also enjoy the beauty, complexity and resources of the sanctuary.

"Human uses are diverse"—Given its location, the sanctuary is an 'urban' marine sanctuary. The desired uses of the sanctuary range from research and education as a living laboratory to its aesthetic appeal for whale watching to recreational and commercial fishing through exploring undersea shipwrecks. These uses and others are recognized by the sanctuary and those uses compatible with the objectives of the National Marine Sanctuaries Act are considered in developing policy and management practices for the sanctuary.

"and compatible with maintaining natural and cultural resources."—In addition to the natural resources, there are also a variety of cultural, historical, and archeological resources such as shipwrecks that are also maintained and sustained as part of the sanctuary.

The desired future state described and explained above is the vision for the sanctuary. The eleven action plans that follow are directed to achieving the sanctuary mission and moving this desired future state of the sanctuary from dream to reality, for current and future generations. The action plans are grouped into four thematic categories based on subject matter and/or functional relatedness: capacity building, ecosystem-based sanctuary management, marine mammal protection, and maritime heritage management.

Capacity Building

1. **Administrative Capacity and Infrastructure**
2. **Interagency Cooperation**
3. **Public Outreach and Education**
4. **Compatibility Determination**

Capacity Building refers to the development of increased organizational capabilities achieved through infrastructure improvements, leveraged partnerships and improved inter-jurisdictional cooperation, as well as expanded volunteerism and supplemental external funding support. It includes the refinement of institutional mechanisms to guide decision-making and adoption of new protocols to better implement policies and procedures.

Four action plans underscore public scoping concerns regarding capacity building for the sanctuary. The Administrative Capacity and Infrastructure (ADMIN) Action Plan frames the organizational structure and programmatic support needed to effectively address marine resources management and enforcement, research and monitoring, and education and outreach regarding the sanctuary. The Interagency Cooperation (IC) Action Plan clarifies the roles, responsibilities and relationships among agencies having overlapping regional jurisdiction with the sanctuary in order to strengthen resource protection and improve interagency communication. The Public Outreach and Education (POE) Action Plan is predicated on developing outreach and education programs that serve to implement management policy, raise public awareness and understanding of sanctuary resources and encourage responsible stewardship. The Compatibility Determination (CD) Action Plan provides a structured approach and protocol for determining whether or not a use is compatible with the sanctuary's primary objective of resource protection.

Administrative Capacity and Infrastructure Action Plan

Issue Statement

The Administrative Capacity and Infrastructure (ADMIN) Action Plan (AP) provides recommendations to strengthen the sanctuary's base-level staffing, facilities infrastructure and program support to effectively meet the basic needs of sanctuary management. Emphasis is placed on the human and physical infrastructure and financial resource requirements of the site.

Overall administrative direction, program policy and budgetary control of the thirteen national marine sanctuaries and the monument reside with the Director of the NMSP. The NMSP provides general oversight and coordination for sanctuary management, sets overarching priorities, and directs general policy and program development. Related responsibilities, while more limited in scope, devolve to the sanctuary superintendents for resource management and day-to-day operations of the respective sites. These responsibilities are expressed in the form of goals, objectives, strategies and activities listed in the site management plans.

Individual sites vary in size, mix of uses and complexity of issues. These differences are reflected in staffing levels, budget allocations and facilities development. As sites update and revise management plans, they identify and evaluate needs for more effective management. Additional resources are required to meet the expanded public demands and expectations raised by the process and to respond to the changing legal mandates and policy (NOAA, 2004).

Recommendations from across the SBNMS Draft Management Plan reflect new or renewed emphasis in the areas of outreach, education, research, financial resource development, marine operations and law enforcement. Increases in program visibility, scientific capability and enforcement patrol frequency are essential. A basic administrative and infrastructural insufficiency underlies the site's ability to achieve full success in these areas.

Goal

The goal of the ADMIN AP is to ensure that the administrative, operational and financial capacities of the sanctuary are adequate to effectively implement the vision, mission, goals and objectives of the sanctuary.

Objectives

The ADMIN AP has four objectives and associated strategies to build the additional capacity necessary for the sanctuary to meet basic requirements for staffing, infrastructure support and program implementation (Table 26).

- ADMIN.1—Strengthen Site Staffing and Program Support Capabilities
- ADMIN.2—Maintain and Further Develop Site Infrastructure
- ADMIN.3—Develop a SBNMS Volunteer Program That Leverages Program Implementation and Increases Site Visibility

The estimated costs for implementation of the ADMIN AP are indicated in Table 27. The performance measures are listed in Table 28.

Table 26. Objectives, associated strategies, and priorities for ADMIN action plan.

Objective	Strategy	Priority
ADMIN.1 Strengthen Site Staffing and Program Support Capabilities	(1.1) Integrate staff capabilities with program needs.	High
	(1.2) Hire additional staff and streamline organizational structure.	High
	(1.3) Enhance operation of the sanctuary advisory council.	High
ADMIN.2 Maintain and Further Develop Site Infrastructure	(2.1) Maintain and acquire vessels as necessary.	High
	(2.2) Work with NMSP headquarters to develop and implement a SBNMS long-range facilities plan that prioritizes partnering opportunities with the town of Scituate, MA.	High
	(2.3) Maintain a database for sanctuary permitting.	High
	(2.4) Maintain and enhance a SBNMS diving program.	High
	(2.5) Develop an effective enforcement program.	High
ADMIN.3 Develop a SBNMS Volunteer Program that Leverages Sanctuary Programs and Increases Site Visibility	(3.1) Develop SBNMS volunteer program.	High
	(3.2) Maintain and expand SBNMS volunteer diver corps activities.	High
	(3.3) Develop and support international exchange of volunteers between SBNMS and other MPAs.	Low

ADMIN.1 Objective—Strengthen Site Staffing and Program Support Capabilities

Background. The capability of SBNMS to implement the activities presented within the Draft Management Plan necessitates an increase in staffing over the next five years, either through the addition of permanent positions or through the effective use of contract services. Existing part-time positions should become full-time. A review and if necessary re-description of existing positions is recommended to optimally apply knowledge, skills and abilities of existing staff. Organizational structure should be modified to accommodate added channels of communication and streamline command and control functionality. Staff positions and responsibilities as currently organized (Figure 117) include:

- Sanctuary Superintendent: Responsible for overall administration of SBNMS programs and activities;
- Operations and Program Coordinator: Responsible for marine operations, facilities renovation and maintenance, management plan review, emergency and contingency planning, permitting, and dive unit supervision;
- Education Coordinator: Responsible for education, public awareness and exhibit programs, and communications;
- Research Coordinator: Responsible for research and monitoring programs;
- Advisory Council Coordinator: Responsible for sanctuary advisory council meeting planning, needs assessment and coordination (0.75 time);
- Program Support Specialist: Responsible for budgetary control, general procurement, and office management;
- Administrative Assistant: Responsible for general office support and assistance (0.5 time);
- Geospatial Technology Coordinator: Responsible for Geographic Information Systems (GIS) management, information technology management, Automatic Information System (AIS) management, and technical planning support;
- GIS/WEB Specialist: Responsible for GIS analysis, web site product development and updating, information technology, and audio-visual support;

Figure 117. Current organizational chart for the Stellwagen Bank sanctuary.

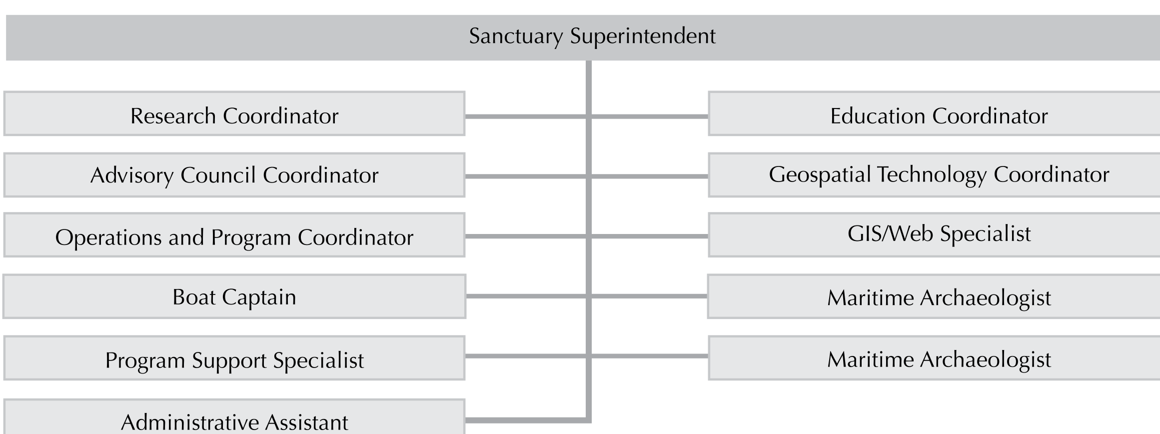
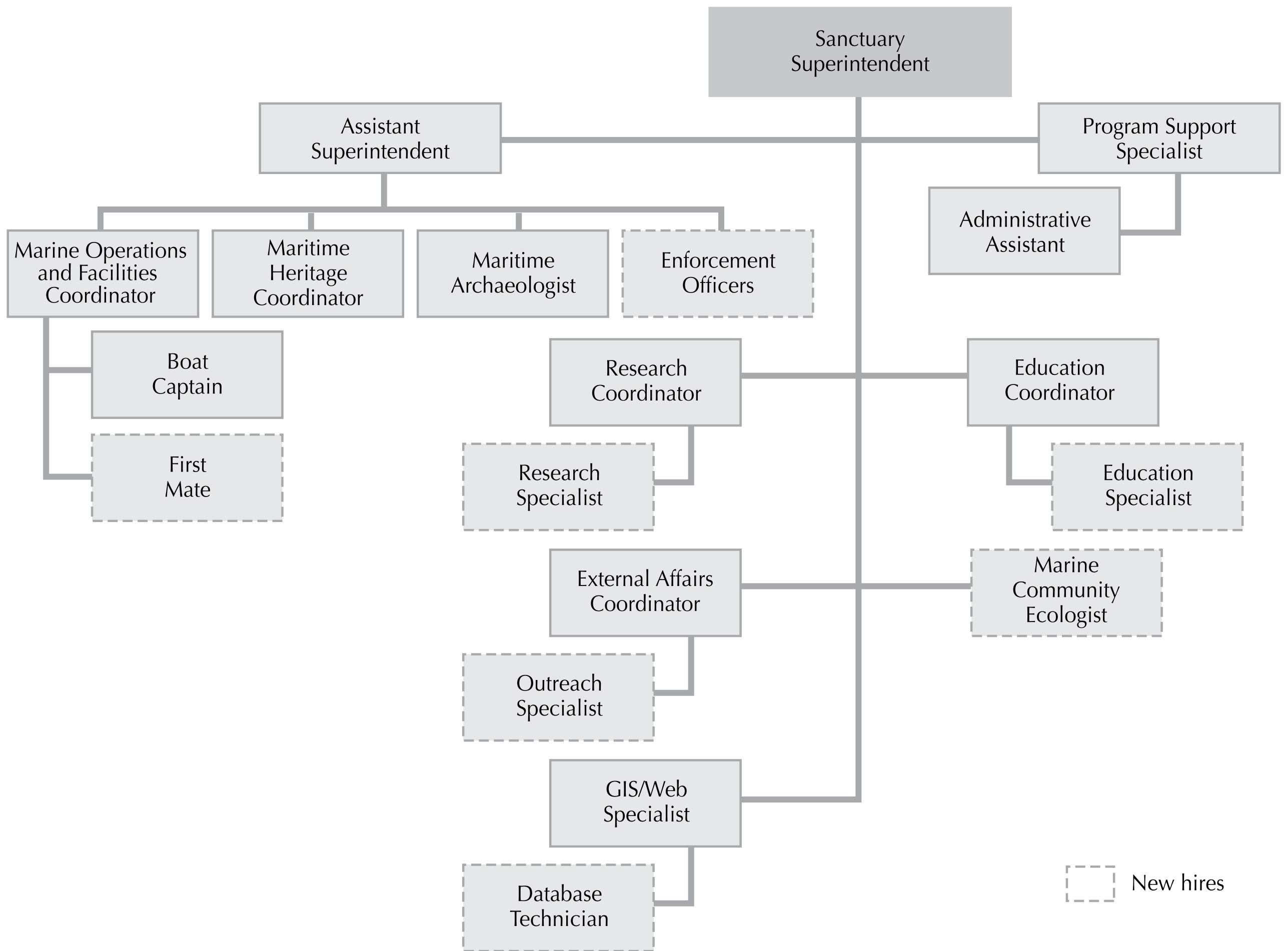


Figure 118. Organizational Chart—proposed.



- Maritime Archaeologists (2): Responsible for assessing, inventorying and documenting historic sanctuary resources (each 0.75 time); and
- Boat Captain: Responsible for maintenance and operation of sanctuary research vessels (RVs) (currently 0.5 time).

Strategies (3) To Strengthen Site Staffing and Program Support Capabilities

(1.1) Integrate staff capabilities with changing program needs. Current staffing (Figure 117) is responsible for existing project execution and day-to-day operations. Knowledge, skills and abilities of employees will be reviewed and evaluated to determine how staff may be tasked more effectively and what additional training may be necessary to improve operational effectiveness.

Priority: High
Status: Ongoing

(1.2) Hire additional staff and streamline organizational structure. Site staffing is inadequate to support new or expanded programs. At a minimum, the positions identified below are required to ensure that the sanctuary meets its priority obligations as identified in the Draft Management Plan. Staffing structure would be reorganized to accommodate these positions, streamline communication and narrow the span of supervisory control (Figure 118).

Priority: High
Status: Planned, 2008
Activities:

1.2.1 Hire a Marine Community Ecologist. This position is required to effectively implement the objectives, strategies and activities included in the three ecosystem protection action plans: ecosystem-based sanctuary management, ecosystem alteration and water quality. SBNMS currently is unable to provide this specialized expertise to sufficient extent.
Status: Planned, 2008

1.2.2 Hire a Research Specialist. This position is required to effectively implement the objectives, strategies and activities included in the three marine mammal protection action plans: marine mammal behavioral disturbance, marine mammal vessel strike and marine mammal entanglement. Specialized technical expertise is needed to complement and expand existing core competencies.
Status: Planned, 2009

1.2.3 Hire an Outreach Specialist. This position is required to build capacity and effectively implement multiple action plan outreach objectives. Outreach and education functions of the sanctuary need to be separated to achieve strategic focus and apply specialized expertise. This position would raise public awareness and understanding of SBNMS, a stated high priority need.
Status: Planned, 2009

1.2.4 Hire an Education Specialist. This position is required to build capacity, effectively implement multiple action plan education objectives. This position would develop sanctuary programming to support formal and informal public education. As noted, education and outreach functions need to be separated to improve effectiveness and expand capabilities.
Status: Planned, 2008

1.2.5 Hire two Enforcement Officers. Two positions are required to provide regular dedicated enforcement patrols of SBNMS. Currently, Massachusetts's marine enforcement officers are contracted under a Joint Enforcement Agreement by NOAA Office of Law Enforcement (OLE) to work on an elective overtime basis in the sanctuary. The arrangement has proven inadequate in terms of patrol coverage and frequency.
Status: Planned, 2009

1.2.6 Hire a First Mate. The revised NOAA small boat policy requires that a U.S. Coast Guard (USCG) licensed captain and qualified first mate operate the SBNMS research vessel, RV *AUK*. The first mate position is mandatory by this policy.
Status: Planned, 2008

1.2.7 Hire a Database Technician. This position is required to help manage and provide client services for the data information system called for in several action plans, notably ecosystem-based sanctuary management.
Status: Planned, 2010

[Note**:** In addition to these new positions, organizational capabilities can be improved by re-describing several existing positions and assigning commensurate responsibilities without increasing their position count. These positions are indicated in the revised organizational chart and include: Assistant Superintendent to assist in supervising day-to-day activities and program planning; Marine Operations and Facilities Coordinator to plan and oversee all vessel and facilities operations and support the site's technology infrastructure; and, External Affairs Coordinator to plan and coordinate all matters dealing with the advisory council, volunteer activities, sister sanctuary relationships and to liaison with 'Friends' organizations. The responsibilities of the prior Geospatial Technology Coordinator position will be subsumed under the Marine Operations and Facilities Coordinator and the GIS/Web Specialist positions as appropriate.]

(1.3) Enhance operation of the sanctuary advisory council. The advisory council serves as a conduit for community input and as a source of advice to the sanctuary superintendent. Adequate support of the advisory council ensures continued public input to management decision-making, while expanding public awareness of the sanctuary and the related marine resource management issues. Public involvement is vitally important to protect and manage sanctuary resources successfully. Additional funding is needed for workshops, working groups and related activities to ensure that the advisory council is provided the means to continue to provide relevant and timely advice on difficult and often controversial issues.
Priority: High
Status: Ongoing

ADMIN.2 Objective—Maintain and Further Develop Site Infrastructure

Background. The management and administration of sanctuary programs relies on adequate and fully functioning facilities, vessels, and vehicles for support.

Facilities. The sanctuary's facilities are located on First Cliff in Scituate, Massachusetts approximately one hour south of Boston. They are comprised of an administrative office, meeting annex, boathouse, and pier. The administrative offices and conference room occupy a 6,800-sq-ft, three-story building in the former Scituate USCG Station. An adjacent 2,200-sq-ft, two-story annex houses a meeting facility and office space for visiting scientists, post-doctoral students and graduate interns. Both buildings are climate-controlled using geothermal technology. Major renovation of the Administrative Building and the Annex was completed in 2004.

A 3,565-sq-ft two-story boathouse is built on pilings over the water and includes a 300-ft pier, with two floating docks attached. The docks have the capacity to berth one 50-ft vessel and three smaller boats simultaneously. Additionally, the sanctuary has two moorings adjacent to the pier. Renovations are planned for both the boathouse and pier to better utilize the existing capacity and to accommodate the new 50-ft research vessel.

Vessels and Vehicles. SBNMS currently operates two vessels: the RV *Gannet* (28-ft power boat) and a new 50-ft research catamaran, the RV *Auk*, which was recently constructed and put into service in summer 2006. These vessels serve as the principal means for accessing the sanctuary and support research, monitoring and education activities. The sanctuary also operates four vehicles for passenger use and equipment transport. [Note: The RV *Sentinel* (41-ft utility boat) was surplused in 2006 due to the extensive major repairs needed. Plans are for it to be replaced by a vessel suited for enforcement activities.].

Strategies (5) To Maintain and Further Develop Site Infrastructure

(2.1) Maintain and acquire vessels as necessary. Maintenance of existing vessels is required to ensure they are in safe, operating condition. New vessels will have to be acquired over time to enhance sanctuary management capacity or replace aging vessels.

Priority: High
Status: Ongoing

(2.2) Work with NMSP headquarters to develop and implement a SBNMS long-range facilities plan that prioritizes partnering opportunities with the town of Scituate. In 2001 the NMSP released a draft long-range facilities report that prioritized renovation of the SBNMS administrative building and adjacent garage during 2003-2004. The next phase in renovation of the SBNMS facility is the marine operations center (MOC). The MOC will be comprised of the following components: boathouse, pier and docks, fuel shed, boat moorings, and association with the Scituate Marine Park. The MOC will be designed to accommodate:

- Vessel maintenance and repair
- Year-round vessel docking/mooring
- Dive locker
- Restroom facilities
- Wet and dry lab for visiting scientists
- Equipment storage for Massachusetts Environmental Police
- Office and meeting space
- Parking space
- Boat trailer storage

Development of two of the components will necessitate partnering with the town of Scituate. Winter docking of the Research Vessel *Auk* may require leasing slip space at the town's marina. The NOAA pier is too exposed to storm waves to accommodate the vessel during the winter months. Acquiring parking space to accommodate vehicles and boat trailers may require cooperation with the town in purchasing or leasing a vacant lot adjacent to the boathouse. Associated requirements and possible solutions will be described in the long-term facilities plan. [Note: Strategy POE 1.3 refers to a related but separate facilities planning process.]

Priority: High
Status: Planned, 2008

(2.3) Maintain a database for sanctuary permitting. The sanctuary issues permits for research, education and special-use activities in accordance with the NMSA. Maintenance of the NMSP's online permitting database (Online Sanctuary Permitting, Reporting, and Evaluation System: OSPREY) will facilitate the efficient and timely issuance of permits on an as-needed basis.

Priority: High
Status: Ongoing

(2.4) Meet the equipment needs of an expanded SBNMS diving program. The sanctuary operates an active diving program to inventory and document shipwrecks, conduct scientific research, characterize SBNMS resources, and conduct emergency rescues as necessary. The equipment needs of the diving program will grow in support of expanded field programs, deployment of the new research vessel and renovation of the boathouse as a marine operations center (see Strategy ADMIN 4.2).

Priority: High
Status: Ongoing

(2.5) Develop an effective enforcement program. Enforcement of sanctuary laws and regulations is critically needed. The mission of sanctuary enforcement is to ensure compliance with the NMSA (*16 USC §1431 et seq.*) and the regulations of the sanctuary (*15 CFR §922*). The sanctuary's enforcement goal is to prevent harm to its living marine and maritime historical resources. The preferred approach emphasizes community-oriented policing and problem solving. Enforcement of sanctuary regulations should be supported as an ongoing activity through the Joint Enforcement Agreement (JEA) between NOAA's Office of Law Enforcement (OLE) and the sanctuary. The sanctuary needs to update its enforcement plan, utilizing a database of use and user patterns to assess enforcement needs, and help target enforcement actions.

Priority: High
Status: Ongoing
Activities:

2.5.1 Hire two full-time patrol officers dedicated to patrolling the sanctuary year-round. Patrol officers could be either NOAA OLE or Massachusetts Environmental Police (MEP) employees under hire to the sanctuary (see Strategy ADMN 1.2).
Status: Planned, 2009

2.5.2 Revise the cooperative enforcement plan between the SBNMS and NOAA OLE. The current plan allows for the cross-deputization of state MEP officers to patrol sanctuary waters, and enforce sanctuary and other relevant federal laws and regulations. The existing cooperative enforcement plan needs to be updated to ensure that enforcement needs are being met and coordination of all available enforcement assets is occurring. SBNMS enforcement needs include:

- Routine patrols of the sanctuary waters;
- Detection, investigation and prosecution of violations;
- Twenty-four hour response capability (sea or air);
- Deputization training and updates;
- Inter/intra-agency coordination of enforcement assets;
- Administrative, legal and technical support; and
- Enforcement outreach and interpretive efforts to affected commercial and recreational users.

Status: Planned, 2008

2.5.3 Acquire and maintain a dedicated, year-round enforcement boat to conduct routine sanctuary patrols. There is high demand by the public for increased sanctuary patrols and interpretive enforcement activities.
Status: Planned, 2009

2.5.4 **Expand patrol-related outreach and interpretive enforcement efforts.** There are many reasons for high-visibility presence of an enforcement vessel within SBNMS including permit oversight, compliance monitoring with whale watch guidelines particularly during high use periods, and whale disentanglement and stand-by. As importantly, it is necessary to conduct interpretive enforcement and education. During patrols, officers can provide sanctuary information directly to users, and materials can be distributed selectively as appropriate. Related communications can be increased with constituents and user groups at marinas and community events.
Status: Ongoing

ADMIN.3 Objective—Develop a SBNMS Volunteer Program That Leverages Program Implementation and Increases Site Visibility

Background. The sanctuary lacks a structured volunteer program to plan, implement and properly oversee volunteer activities. Currently, SBNMS volunteers are few in number, although interest in volunteering is high; they support limited activities and functions on an as-needed basis. However, there are many opportunities where volunteers could contribute meaningfully, if provided guidance. Such opportunities include, but are not limited to, general education and outreach in schools and communities, staff support, research and scientific monitoring.

Strategies (3) To Develop a SBNMS Volunteer Program that Leverages Sanctuary Programs and Increases Site Visibility

(3.1) Develop a SBNMS volunteer program. Many functions of the SBNMS can be enhanced through establishment of a volunteer program that provides essential support for sanctuary projects, and builds community support and commitment to the goals and strategies of the sanctuary. The program would focus on team-building, organized communication, project oversight and general support, including partnerships with other organizations.
Priority: High
Status: Planned, 2008
Activities:

3.1.1 **Develop a volunteer operations plan.** The sanctuary should identify and prioritize its volunteer program objectives. Programmatic areas may include education and outreach, science and monitoring, historic maritime resources and boater/diver corps. As part of this effort, developing criteria for a sanctuary docent program is essential. The docent program will provide a corps of knowledgeable volunteers, who will represent the sanctuary, as appropriate, at public events and other outreach functions.
Status: Planned, 2008

3.1.2 **Develop a student internship program.** The sanctuary could benefit from short-term specialized assistance, which leverages staff resources and provides education and training for high school and college level students pursuing careers in marine science.
Status: Planned, 2008

3.1.3 **Develop a post-doctoral support program.** The sanctuary needs highly specialized technical and scientific capability applied to short-term specific

Table 27. Estimated costs for ADMIN action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Integrate staff capabilities with changing program needs.	0	0	0	0	0	0.0
(1.2) Hire additional staff and streamline organizational structure.	197.0	507.7	798.5	958.3	1054.1	3515.6
(1.3) Enhance operation of the sanctuary advisory council.	10.0	10.0	15.0	15.0	15.0	65.0
(2.1) Maintain and acquire vessels as necessary.	150.0	150.0	1000.0	200.0	200.0	1700.0
(2.2) Work with NMSP to develop and implement a long-range facilities plan that prioritizes opportunities with the town of Scituate.	80.0	750.0	2130.0	0.0	0.0	2960.0
(2.3) Maintain a database for sanctuary permitting.	0.0	0.0	0.0	0.0	0.0	0.0
(2.4) Meet the equipment needs of an expanded SBNMS diving program.	1.0	3.0	3.0	4.0	4.0	15.0
(2.5) Develop an effective enforcement program.	0.0	0.0	60.0	80.0	80.0	220.0
(3.1) Develop SBNMS volunteer program.	2.0	2.0	3.0	4.0	5.0	16.0
(3.2) Maintain and expand the volunteer dive corps activities.	0.0	0.0	1.0	2.0	2.0	5.0
(3.3) Develop and support international exchange of volunteers between SBNMS and other MPAs.	1.0	2.0	3.0	3.0	3.0	12.0
Total Estimated Annual Cost	**638.0**	**1932.4**	**4811.9**	**2224.6**	**2417.3**	**12024.2**
*Cost estimates exclude federal labor costs.						

Table 28. Performance measures for ADMIN action plan.			
Desired Outcome(s) For This Action Plan			
Organizational and financial capacity is strengthened to implement the vision, mission, goals and objectives of the SBNMS.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2011, SBNMS will have sufficient capacity and adequate staffing to implement all priority strategies in the management plan.	SBNMS will annually report staffing levels and priority outcomes to the advisory council and NMSP.	Number of staff (combined federal and contract positions): 11	Build infrastructure
By 2011, enforcement patrols will be conducted in the sanctuary twice weekly from April to November.	SBNMS will track the number of hours logged in the sanctuary by enforcement officers.	Number of Patrol-hours conducted in the sanctuary: 0	Living marine resources, habitat, water quality
By 2011, creation of a Volunteer Program will increase the number of volunteer-hours contributed to sanctuary programs by 25%.	SBNMS will track the number of volunteers and respective hours.	Number of Hours contributed by Volunteer Program: 0	Volunteer
By 2011, the SAC will have formed and completed four working groups as specified in six action plans.	SBNMS will track the number of working group meetings held and action plans produced.	Number of meetings completed by Zoning WG: 2	Raise awareness

needs of programmatic areas. The sanctuary should partner with research and academic institutions to share costs for post-doctoral fellowship positions.
Status: Planned, 2008

(3.2) Maintain and expand SBNMS volunteer diver corps activities. Emphasis on recruitment and training of new diver corps volunteers will provide much-needed support for sanctuary historic maritime resource projects, research and monitoring activities and education and outreach programs. In particular, the diver corps could assist with historic shipwreck inventory and photo-documentation of biological communities. These activities have the potential to advance general understanding and greatly raise sanctuary visibility (see Strategy ADMIN 2.4).
Priority: High
Status: Ongoing

(3.3) Develop and support international exchange of volunteers between SBNMS and other MPAs. SBNMS in New England and Silver Bank Humpback Whale Sanctuary in the Dominican Republic (DR) share the same population of humpback whales. The humpback whales reproduce and calf in the DR and feed and nurse their young in SBNMS. A 'sister-sanctuary' volunteer exchange program between SBNMS and Silver Bank Humpback Whale Sanctuary will support education and research exchanges between the two countries. The programmatic exchange would promote visibility of cross-boundary sanctuary resources and could lead to increased support for joint education and outreach projects.
Priority: Low
Status: Planned, 2008.

Interagency Cooperation Action Plan

Issue Statement

The Interagency Cooperation (IC) Action Plan (AP) makes recommendations to clarify agency responsibilities that overlap those of SBNMS and to improve interagency coordination and effectiveness. The AP provides the framework to clarify the roles, responsibilities and relationships between agencies associated with SBNMS in order to strengthen resource protection within the sanctuary and improve interagency communication.

Goal

The goal of the IC AP is to foster and facilitate cooperation and coordination of planning and management actions in support of partnering state and federal agency missions, when consistent with the NMSA and bearing on sanctuary resources. SBNMS will communicate its purpose and findings to these agencies and seek opportunities to share information, resources and expertise with them.

Objectives

The IC AP has two objectives and associated strategies to foster interagency cooperation (Table 29).

- IC.1—Facilitate Cooperation and Coordination Between Agencies
- IC.2—Establish Mechanisms for Improved Information Sharing Between Agencies

The estimated costs for implementation of the IC AP are indicated in Table 30. The performance measures are listed in Table 31.

Table 29. Objectives, associated strategies, and priorities for IC action plan.

Objective	Strategy	Priority
IC.1 Facilitate Cooperation and Coordination Between Agencies	(1.1) Re-establish discussions regarding a Memorandum of Understanding (MOU) among SBNMS, NOAA Fisheries Service NERO and the NEFMC to facilitate cooperation and coordination.	High
	(1.2) Coordinate proposed activities with NOAA Fisheries Service NERO.	High
	(1.3) Facilitate cooperative research and outreach between SBNMS and NOAA Fisheries Service NEFSC.	High
	(1.4) Evaluate the Memorandum of Agreement (MOA) between the U.S. Army Corps of Engineers (USACE) and NOAA Fisheries Service for commenting on proposed activities occurring at the Massachusetts Bay Disposal Site (MBDS).	High
IC.2 Establish Mechanisms for Improved Information Sharing Between Agencies	(2.1) Provide information via the web on the responsibilities and activities of multiple agencies with roles pertinent to the SBNMS.	Medium
	(2.2) Provide regular updates to the USCG Area Contingency Plans.	Medium
	(2.3) Establish a mechanism for informal consultation with the EPA, NEFMC, MWRA, MADEP and MACZM Office on Water Quality Issues.	Medium
	(2.4) Update and continue to implement the sanctuary Cooperative Enforcement Program	High
	(2.5) Support continued meetings of the advisory council's Interagency Cooperation Working Group.	Low
	(2.6) Participate in the GoM Council and other regional initiatives.	Medium
	(2.7) Participate on relevant advisory panels of the NEFMC.	High
	(2.8) Depict sanctuary boundaries.	High

IC.1 Objective—Facilitate Cooperation and Coordination between Agencies

Background. SBNMS needs to foster and facilitate inter- and intra-agency coordination in order to better protect sanctuary resources as mandated by the NMSA. Numerous agencies operate pursuant to federal statues (e.g., Marine Mammal Protection Act, Endangered Species Act, etc.) that have jurisdiction that spatially overlaps sanctuary boundaries. These Acts often complement the intent and purpose of the National Marine Sanctuaries Act.

The following are examples of agency activities pertinent to sanctuary management. NOAA National Marine Fisheries Service (Fisheries) is responsible for managing sustainable fisheries. The U.S. Environmental Protection Agency (EPA) is responsible for managing water resource quality. The Army Corps of Engineers is responsible for managing dredging and dumping activities. The Minerals Management Service is responsible for managing offshore wind, wave and solar energy projects except in sanctuaries. The United States Coast Guard (USCG) is responsible for enforcing federal fisheries regulations, among others, and ensuring safety at sea. These responsibilities are stated in their simplest terms but indicate why coordination with the sanctuary is essential.

While SBNMS has been coordinating with these agencies since sanctuary designation, more formal mechanisms for coordination need to be developed in many cases, and more frequent communication is appropriate. In all cases, it is expected that agencies that have overlapping management authority with SBNMS will cooperate and collaborate to protect sanctuary resources while achieving their respective missions.

Strategies (4) To Establish Cooperation and Coordination between Agencies

(1.1) Initiate discussions regarding a Memorandum of Understanding (MOU) between SBNMS and NOAA Fisheries Service to facilitate cooperation and coordination. The MOU would: (1) clarify agency roles and responsibilities for protecting biodiversity and biological communities, threatened and endangered species, and habitats within the SBNMS; (2) facilitate the exchange of information, advice and technical assistance between SBNMS and NOAA Fisheries Service Northeast Regional Office (NERO); (3) coordinate agency efforts concerning research, ecosystem protection and public outreach when pertinent to the management and protection of sanctuary resources; and (4) clarify responsibilities under Sections 304(a)(5) and 304(d) of the NMSA.

<u>Priority</u>: High
<u>Status</u>: Planned, 2009
<u>Activities</u>:

1.1.1 Meet with NOAA Fisheries Service NERO staff to scope details of an MOU that facilitates cooperation and coordination with SBNMS.
<u>Status</u>: Planned, 2008

1.1.2 Work with NOAA Fisheries Service NERO to execute final MOU.
<u>Status</u>: Planned, 2009

(1.2) Coordinate proposed activities with NOAA Fisheries Service NERO. This effort will clarify the roles and responsibilities of the two agencies regarding consultation, permitting and outreach. The principal purpose is to improve communication by clarifying under what circumstances consultation between the two agencies is warranted.

Priority: High
Status: Planned, 2009
Activities:

1.2.1 Meet with NOAA Fisheries Service NERO staff to scope the details of a protocol.
Status: Planned, 2008

1.2.2 Draft and finalize the protocol with NOAA Fisheries Service NERO.
Status: Planned, 2009

(1.3) Facilitate cooperative research and outreach between SBNMS and NOAA Fisheries Service Northeast Fisheries Science Center (NEFSC). The purpose of this protocol is to facilitate cooperative research and outreach and leverage funding and technical expertise by both agencies.

Priority: High
Status: Planned, 2009
Activities:

1.3.1 Meet with NOAA Fisheries Service NEFSC staff to scope the details of a protocol.
Status: Planned, 2008

1.3.2 Draft and finalize the protocol with NOAA Fisheries Service NEFSC.
Status: Planned, 2009

(1.4) Evaluate the Memorandum of Agreement (MOA) between the U.S. Army Corps of Engineers (USACE) and NOAA Fisheries Service for Commenting on proposed activities occurring at the Massachusetts Bay Disposal Site (MBDS). The U.S. Army Corps of Engineers (USACE) 1992 interagency MOA includes the requirement to coordinate disposal projects proposed for MBDS with NOAA Fisheries. This MOA was executed prior to the 1992 amendments of the NMSA requiring consultation by a federal agency conducting activities that may affect sanctuary resources. The effectiveness of the MOA in ensuring that SBNMS resources are not injured needs to be evaluated and, because of the concerns stated below, there needs to be a mechanism for the sanctuary to be notified about dumping activities at the MBDS. Due to the number of projects using the MBDS, thresholds for coordination between NERO and SBNMS should be considered.

The MBDS is located directly alongside the western boundary of the SBNMS. The disposal site receives approximately one to two hundred thousand cubic yards of clean dredge material per year and is the USACE's most active dumpsite in New England. The sanctuary has two concerns over this activity: (1) the risk of disposed dredged material entering and injuring sanctuary resources, and (2) the disturbance of historic radioactive and toxic waste in the inactive foul area that could enter and injure sanctuary resources. Under the existing MOA, the USACE is required to notify the NOAA Fisheries Service NERO of when dredged material is going to be deposited at the disposal site but not the SBNMS. However, the consultation provision of the NMSA still applies even if this MOA is not updated and consultation by USACE with SBNMS is required.

Priority: High
Status: Planned, 2009
Activities:

1.4.1 Ensure that SBNMS is placed on the USACE public notice electronic mailing list and develop an internal protocol for following up on these notices.
Status: Planned, 2008

1.4.2 Develop a NOAA intra-agency protocol for consultation by NOAA Fisheries Service with SBNMS for dredged material disposal activities at the MBDS that may affect sanctuary resources.
Status: Planned, 2009

1.4.3 Work with the USACE to consider requiring Automated Identification System transponders on all dredge barges to facilitate tracking of their routes to ensure they do not inadvertently dump materials in the SBNMS.
Status: Planned, 2008

IC.2 Objective—Establish Mechanisms for Improved Information Sharing between Agencies

Background. One of the policies of the NMSA is to foster comprehensive and coordinated conservation and management of sanctuaries and activities affecting them, in a manner which complements existing regulatory authorities. To further this policy, it would be useful for SBNMS to serve as a clearinghouse for agency information and be a catalyst for information sharing.

Strategies (8) To Establish Mechanisms for Improved Information Sharing between Agencies

(2.1) Provide information via the web on the responsibilities and activities of multiple agencies that have roles pertinent to the SBNMS. This strategy will assist the public and agency personnel in determining what agencies have shared jurisdiction in the sanctuary, over what resources and where to go for detailed information.

Priority: Medium
Status: Ongoing
Activities:

2.1.1 Establish a SBNMS webpage that serves as a clearinghouse for pertinent fishing regulations in the sanctuary by providing web links to appropriate regulatory agencies. The purpose of this web page is to facilitate regulatory compliance by the public by directing them to the appropriate regulatory agency for details.
Status: Ongoing

2.1.2 Establish a SBNMS webpage that serves as a clearinghouse for agency contact information to inform the public about the roles of the various agencies that have authority overlapping the

sanctuary and provide web links to these agencies.
Status: Ongoing

2.1.3 Establish a SBNMS webpage that informs the public of the latest results of research and other activities conducted within the sanctuary by other agencies and provide web links to these agencies.
Status: Ongoing

(2.2) Provide regular updates to the USCG Area Contingency Plans. The sanctuary worked with the USCG First District during 2003 to develop an annex to the applicable Area Contingency Plan (ACP) that covers the SBNMS vicinity. ACPs are USCG incident response plans, which provide guidance for the protection of people, natural resources, and property from the impacts of oil spills or hazardous substance releases. The ACP presents a strategy for coordination of federal, state and local agencies with industry, response contractors, and the local community for unified responses to discharges or substantial threats of discharge of oil or release of hazardous substances. The annex to the ACP is specific to the SBNMS and details sensitive resources as well as any recommended mitigation measures (see Strategy WQ 2.4).
Priority: Medium
Status: Ongoing
Activities:

2.2.1 Update the sanctuary's annex to the Plymouth to Salisbury, MA Area Contingency Plan and the Rhode Island/Southeastern Massachusetts Area Contingency Plan.
Status: Planned, 2008

(2.3) Establish a mechanism for informal consultation with the EPA, NEFMC, Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Environmental Protection (MADEP) and Massachusetts Office of Coastal Zone Management (MACZM) on water quality issues. The purpose of this protocol is to facilitate communication on water quality issues related to the watersheds and coastal and ocean waters that may affect sanctuary resources.
Priority: Medium
Status: Planned, 2009
Activities:

2.3.1 Develop an informal mechanism that facilitates communication among the SBNMS, EPA, NEFMC, MWRA, MADEP, and MACZM on water quality issues that may affect the sanctuary.
Status: Planned, 2009

Table 30. Estimated costs for IC action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Re-establish discussions regarding a possible MOU between the NOAA/SBNMS, NOAA Fisheries Service NERO and the NEFMC to facilitate cooperation and coordination.	0.0	0.0	0.0	0.0	0.0	0.0
(1.2) Coordinate proposed activities with the NOAA Fisheries Service NERO.	0.0	0.0	0.0	0.0	0.0	0.0
(1.3) Facilitate cooperative research and outreach between NOAA/SBNMS and the NOAA Fisheries Service, NEFSC.	0.0	0.0	0.0	0.0	0.0	0.0
(1.4) Evaluate the MOA between the USACE and NOAA Fisheries Service for commenting on proposed activities occurring at the MBDS.	0.0	0.0	0.0	0.0	0.0	0.0
(2.1) Provide information via the web on the responsibilities and activities of multiple agencies that have roles pertinent to the SBNMS.	0.0	0.0	0.0	0.0	0.0	0.0
(2.2) Provide regular updates to the USCG Area Contingency Plans.	0.0	0.0	0.0	0.0	0.0	0.0
(2.3) Establish a mechanism for informal consultation with the EPA, NEFMC, MWRA, MADEP and MACZM Office on water quality issues.	0.0	0.0	0.0	0.0	0.0	0.0
(2.4) Update and continue to implement the sanctuary cooperative enforcement program.	0.0	0.0	0.0	0.0	0.0	0.0
(2.5) Support continued meetings of the sanctuary advisory council's Interagency Cooperation Working Group.	0.0	0.0	0.0	0.0	0.0	0.0
(2.6) Participate in the GoM Council and other regional initiatives.	0.3	0.3	0.3	0.3	0.3	1.5
(2.7) Participate on relevant advisory panels of the NEFMC.	0.3	0.3	0.3	0.3	0.3	1.5
(2.8) Depiction of sanctuary boundary.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**3.0**
*Cost estimates exclude federal labor costs.						

Table 31. Performance measures for IC action plan.			
Desired Outcome(s) For This Action Plan			
Sanctuary protection is increased through coordination with agencies that have jurisdiction overlapping the sanctuary.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2009, the sanctuary will have formalized an effective working relationship with NOAA Fisheries Service NERO and the NEFMC.	SBNMS will execute a signed MOU with the affected parties.	Number of signed MOUs: 0	Partnerships
By 2009, a process for formal consultation by the USACE with the sanctuary pursuant to section 304(d) of the NMSA will be in effect.	SBNMS will document a formal consultation process.	Number of consultations completed: 1	Partnerships
By 2011, the sanctuary will hold three issue-driven, problem-solving forums with other affected agencies, the findings of which will be entered into a record.	SBNMS will record the minutes of each forum and disseminate information pertinent to initiate next step to the respective agencies. The findings of each meeting will be entered into a record to document the occurrence and outcome.	Number of forums organized since publication of management plan: 0	Partnerships

(2.4) Update and continue to implement the Sanctuary Cooperative Enforcement Program. The primary agencies involved in the current sanctuary cooperative enforcement program are the SBNMS and the NOAA OLE (Appendix O). The USCG and the Massachusetts Environmental Police (MEP) have been part of the sanctuary enforcement program to varying degree depending on their resources and priorities.

Priority: High
Status: Ongoing
Activities:

2.4.1 Update and fully implement the cooperative enforcement agreement between SBNMS and NOAA OLE working with the USCG and MEP to ensure adequate enforcement presence and prosecution regarding the sanctuary. Whereas the existing agreement is considered functional in its protocols and purpose, effective implementation will require that SBNMS have regular dedicated on-the-water enforcement capabilities not currently available (see Activity ADMIN 2.6.1).
Status: Planned, 2010

(2.5) Support continued meetings of the sanctuary advisory council's Interagency Cooperation Working Group (WG). The WG has proven effective as a forum to initiate dialogue on matters of mutual interest among agencies that have regional federal or neighboring state jurisdiction associated with the sanctuary. The WG would be reconvened on an as-needed basis to address specific issues or to share relevant information.

Priority: Low
Status: Planned, 2008

(2.6) Participate in the Gulf of Maine (GoM) Council and other regional initiatives. The GoM Council on the Marine Environment is a U.S.-Canadian partnership of government and non-government organizations. The organization works to maintain and enhance environmental quality in the GoM to allow for sustainable resource use by existing and future generations. NOAA Fisheries Service currently represents SBNMS interests on the GoM Council.

Priority: Medium
Status: Ongoing
Activities:

2.6.1 Participate in GoM Council meetings and continue to host the Gulf of Maine Marine Protected Areas (GoMMPAS) list serve.
Status: Ongoing

2.6.2 Participate in GoM Council and other regional initiatives regarding the establishment of a marine protected area (MPA) network within the GoM.
Status: Ongoing

(2.7) Participate on relevant advisory panels of the NEFMC. The NEFMC operates numerous advisory panels that advise on managing fisheries, many of which occur within SBNMS. The advisory panels are a critical mechanism by which the sanctuary can provide input and express concerns over fishing activities in the sanctuary.

Priority: High
Status: Ongoing

(2.8) Depict sanctuary boundaries in fishery management plans and related documents. On December 4, 2003 the Sanctuary Advisory Council passed a motion requesting that the NEFMC include the sanctuary boundaries on all future charts, maps and relevant fisheries documents in the Gulf of Maine. Depiction of the sanctuary boundaries will establish a more informed context for Council decision-making while enabling sanctuary managers to better understand the potential implications of Council actions. This strategy supports that motion.

Priority: High
Status: Planned, 2008

Public Outreach and Education Action Plan

Issue Statement

The Public Outreach and Education (POE) Action Plan (AP) makes recommendations to resolve issues including low name recognition of SBNMS, need for better information dissemination through leveraged partnerships and public education through programming support. The POE AP is predicated on developing outreach and education tools that serve to help achieve sanctuary management goals and objectives.

Goal

The goal of the POE AP is to increase public awareness and understanding of the sanctuary, and encourage responsible stewardship of its resources.

Objectives

The POE AP has two objectives and associated strategies to enhance public awareness, understanding and appropriate use of the sanctuary through development and implementation of outreach and educational programs (Table 32).

- POE.1—Build Capacity for Outreach Programs that Increase Sanctuary Visibility, Awareness and Stewardship
- POE.2—Build Capacity for Formal and Informal Education Programs That Support Sanctuary Management Goals

The estimated costs for implementation of the POE AP are indicated in Table 33. The performance measures are listed in Table 34.

Table 32. Objectives, associated strategies, and priorities for POE action plan.

Objective	Strategy	Priority
POE.1 Build Capacity for Outreach Programs that Increase Sanctuary Visibility, Awareness and Stewardship	(1.1) Produce public outreach products and programs that best address sanctuary visibility needs.	High
	(1.2) Develop and implement outreach programs with stakeholder groups to increase sanctuary visibility and promote sanctuary stewardship.	High
	(1.3) Work with the NMSP headquarters to develop and implement a SBNMS long-range facilities plan that prioritizes partnering opportunities with interpretive centers and articulates federal funding needs.	High
	(1.4) Establish a Media Outreach Program.	High
POE.2 Build Capacity for Formal and Informal Education Programs That Support Sanctuary Management Goals	(2.1) Develop an action plan for establishing education partnerships and identify the types of programs and objectives that would best be achieved.	High
	(2.2) Support K-12 Educational Programming.	Medium
	(2.3) Support Undergraduate and Graduate Education Programming.	Medium
	(2.4) Support Adult Education Programming.	High

POE.1 Objective—Build Capacity for Outreach Programs that Increase Sanctuary Visibility, Awareness and Stewardship

Background. The purpose of this objective is to build greater awareness of SBNMS among the general public to: (1) generate name recognition; (2) create a sense of ownership and stewardship that leads to personal involvement in the protection of sanctuary resources; and (3) develop an infrastructure that includes affiliate organizations and volunteers to build partnerships and leverage capacity for sanctuary outreach activities. A million or more visitors travel to the SBNMS each year on whale watch and recreational fishing boats without realizing that they are in a federal marine protected area. Neighboring communities are mostly unacquainted with the sanctuary, as it is offshore and out-of-sight. And despite a historic relationship to the marine environment, many residents of coastal New England are unaware of the sanctuary and the diverse living marine and maritime heritage resources it shelters.

Strategies (4) To Build Capacity for Outreach Programs to Increase Sanctuary Visibility, Awareness and Stewardship

(1.1) Produce public outreach products and programs that best address sanctuary visibility needs. Develop appropriate pubic outreach/visibility products and programs that create name recognition and brand identity for the sanctuary to better inform the public of its existence, location, resource characteristics and programs. Table 2 lists some of the outreach and education products produced to date.

Priority: High
Status: Ongoing
Activities:

1.1.1 Ask the advisory council to form an outreach working group of the advisory council, consisting of representatives from interest groups, as well as experts in public relations, advertising and marketing to advise the advisory council, which in turn will advise the sanctuary superintendent on the development of outreach campaigns for SBNMS.
Status: Planned, 2008

1.1.2 Assess the level of public awareness of the sanctuary and determine the communication tools and venues that are likely to be most effective in reaching the various constituencies and geographic areas.
Status: Planned, 2008
[Note: With information gained from Activities 1.1.1 and 1.1.2 above, refine and undertake Activities 1.1.3 through 1.1.5 following.]

1.1.3 Produce periodic newsletters and other printed or electronic publications to provide information to the general public, elected officials, and user groups.
Status: Ongoing

1.1.4 Develop a website that provides a central location for all information about the sanctuary and links to affiliated organizations. The web site will provide 'one-stop shopping' for information needs from any stakeholder group or member of the general public.
Status: Ongoing

1.1.5 Develop traveling exhibits and speakers' bureau to provide outreach programs to various audiences.
Status: Ongoing

1.1.6 Work with NMSP headquarters to provide street signage at appropriate places indicating the location of the SBNMS headquarters office in Scituate, Massachusetts.
Status: Planned, 2008

(1.2) Develop and implement outreach programs with stakeholder groups to increase sanctuary visibility and promote sanctuary stewardship. This strategy will open lines of communication between stakeholder groups and the sanctuary, and involve these groups in the design and implementation of collaborative outreach projects. Communication objectives will include responsible stewardship, conservation of biological diversity, water quality protection, maritime heritage preservation and marine mammal protection. Products and programs will be developed with partners as appropriate and address the informational needs of the general public and stakeholder constituencies. Messages will be determined in consultation with sanctuary staff, stakeholder group representatives and other partners. Examples of user groups and actions include the following:

- Whale Watch Industry—boat signage, naturalist training, passenger handouts;
- Commercial Fishing—trade show workshops and exhibits, guest speakers at meetings, articles in industry association publications;
- Party/Charter Fishing Boats—passenger handouts, boat and dock signage, speakers at meetings, articles in trade magazines, information in saltwater fishing guides;
- Recreational Fishing—articles in fishing magazines, speakers at meetings, handouts at fishing supply/bait shops;
- Recreational Boaters—boat show exhibits, signage at marinas and fuel docks, speakers at boat clubs;
- Recreation and Technical Divers—programs at dive clubs, handouts at dive shops, magazine interviews, presentations at conferences;
- Cruise Industry—exhibits at cruise ship terminals, signage on boats, handouts and in-room videos for passengers, speakers programs for passengers; and
- Researchers—on-line permit application, on-line databases, science forums, and web index to sanctuary research.

Priority: High
Status: Ongoing
Activities:

1.2.1 Assess existing sanctuary outreach programs and those of stakeholder groups and develop/prioritize new or revised outreach programs, utilizing partnerships where appropriate.
Status: Planned, 2008

(1.3) Work with NMSP headquarters to develop and implement a SBNMS long-range facilities plan that prioritizes partnering opportunities with interpretive centers and articulates federal funding needs. Interpretive facilities—visitor centers, exhibits and kiosks at museums and aquariums and signage at selected locations—raise sanctuary visibility by reaching large sectors of the general public. These venues provide centralized distribution points for sanctuary outreach materials while offering a suitable and cost-effective means for the communication of sanctuary messages. [Note: Strategy ADMIN 2.2 refers to a related but separate facilities planning process.]

Priority: High
Status: Ongoing
Activities:

1.3.1 Identify and prioritize new areas and locations for installation of sanctuary exhibitry within the greater Boston metropolitan area.
Status: Planned, 2008

1.3.2 Develop or upgrade sanctuary visitor centers/exhibits in gateway cities, including but not limited to Gloucester, Boston, Plymouth and Provincetown.
Status: Planned, 2008

1.3.3 Develop exhibits and signage at New England regional and national public outreach centers, including aquariums, zoos, science museums, maritime heritage facilities and art institutions.
Status: Planned, 2009

(1.4) Establish a Media Outreach Program. Print and electronic media can be an effective and efficient means to reach vast numbers of the general public as well as targeted stakeholder groups. SBNMS will provide information to the media on sanctuary resources and resource protection activities through the use of press releases, media advisories, web sites, still images, video footage, editorial board visits, media tours and other products and programs.

Priority: High
Status: Ongoing
Activities:

1.4.1 Develop an updated media list of regional and national print, radio, and television outlets, including phone, fax and e-mail addresses to identify media contacts with interests in sanctuary-related stories.
Status: Ongoing

1.4.2 Develop a long-term sanctuary media plan including short-term event-driven media plans when appropriate. The plans will include messages and talking points. The extent of each plan will be determined on a case-by-case basis and in consultation with NOAA and NMSP headquarters.
Status: Planned, 2008

1.4.3 Prepare advisories, press releases and articles on a timely basis for distribution to the media; produce and distribute still and video images when appropriate; organize press conferences when appropriate; work with partners when applicable.
Status: Ongoing

1.4.4 Develop a web-based photo and map gallery for media use (may also be accessed by educators and other members of the general public).
Status: Ongoing

1.4.5 Organize media visits to the sanctuary, including research cruises and site visits, and staff visits to media outlets, including editorial boards, local radio talk shows, and community cable television, through a scheduled sanctuary speakers' bureau.
Status: Ongoing

1.4.6 Assess potential themes and slogans that are likely to be most successful in attracting media and reader attention. Incorporate these findings into media planning and written/audio-visual materials.
Status: Ongoing

POE.2 Objective—Build Capacity for Formal and Informal Education Programs That Support Sanctuary Management Goals

Background. The purpose of this objective is to develop and maintain leveraged partnerships that build capacity for formal and informal education programs while supporting SBNMS management goals. Educational programming for ocean science can benefit from sanctuary products and activities that highlight SBNMS as a laboratory for learning. Leveraged partnerships require that all parties find value in the results, which necessitates care in product/program design and implementation. The supplemental funding, joint staffing and/or resources generated by partnerships contribute to the success of the initiative, the ability to reach the intended audience, and project viability over time.

Strategies (4) To Improve Capacity for Formal and Informal Education Programs That Support Sanctuary Management Goals

(2.1) Develop an action plan for establishing education partnerships and identify the types of programs and objectives that would best be achieved. This effort will guide the process for forming partnerships having the highest likelihood of success for the development and delivery of effective educational programming.
Priority: High
Status: Planned, 2009
Activities:

2.1.1 Ask the advisory council to form an education working group of the advisory council comprised of teachers in grades K-12, university faculty, grade school and college administrators, informal educators, homeschoolers and other interested parties to advise the advisory council, which will in turn advise the sanctuary superintendent, in addressing education needs and trends.
Status: Planned, 2009

2.1.2 Assess the needs and availability of potential partners for sanctuary programs, especially in areas where limited sanctuary funding and staffing are inadequate to achieve project goals. This effort will broaden the scope of outside interest in and support for sanctuary programs and identify how sanctuary efforts can best support shared organizational goals.
Status: Planned, 2009

2.1.3 Develop criteria for the selection and types of contributions required of SBNMS partners for education, including other NOAA offices, other government agencies, public and private institutions and non-governmental organizations. This effort will bring strategic focus to the development of rationales for effective collaborations with partners in the educational community.
Status: Planned, 2009

(2.2) Support K–12 Educational Programming. The sanctuary's proximity to major population centers, educational institutions and research facilities makes it accessible as a living laboratory for marine science and maritime studies. SBNMS will address the needs of educators for sanctuary-related materials and programs by working with regional organizations and specialists to address how content connects with K–12 learning standards in various disciplines at state and national levels.
Priority: Medium
Status: Planned, 2008
Activities:

2.2.1 Assess needs of K-12 educators and develop products and programs deemed appropriate to further SBNMS goals for heightened understanding of sanctuary resources, stewardship, science and management issues. The assessment will link materials to state and national standards as required and wherever possible.
Status: Planned, 2010

2.2.2 Provide creative programs for student participation that encourage discovery learning about sanctuary resources, stewardship and programs, including but not limited to poster/art contests, poetry contests, photo contests, debates, junior naturalist program, and student-at-sea research.
Status: Planned, 2010

2.2.3 Post education products and programs on the sanctuary website and provide additional background materials for student and general public review.
Status: Planned, 2010

(2.3) Support Undergraduate and Graduate Education Programming. By providing access to sanctuary information and creating work study opportunities for students, SBNMS furthers NOAA's education goals, which include integrating NOAA science into high-quality educational materials and promoting participation in NOAA-related sciences and careers, particularly by members of underrepresented groups. Sanctuary programming can enhance formal and informal environmental science education. Concomitantly, the sanctuary can gain new insights and benefits from these additional participatory efforts.
Priority: Medium
Status: Planned, 2010
Activities:

2.3.1 Work with academic institutions and foundations to support appropriate undergraduate, graduate and post-doctoral research in the sanctuary.
Status: Planned, 2010

Table 33. Estimated costs for POE action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Produce public outreach products and programs that best address sanctuary visibility needs.	48.0	52.0	55.0	55.0	55.0	265.0
(1.2) Develop and implement outreach programs with stakeholder groups to increase sanctuary visibility and promote sanctuary stewardship.	6.0	20.0	20.0	20.0	20.0	86.0
(1.3) Work with NMSP headquarters to develop and implement a long-range facilities plan that prioritizes partnering opportunities with interpretive centers and articulates federal funding needs.	0.0	0.0	200.0	200.0	200.0	600.0
(1.4) Establish a Media Outreach Program.	0.0	10.0	10.0	10.0	10.0	40.0
(2.1) Develop an action plan for establishing education partnerships and identify the types of programs and objectives that would best be achieved.	0.0	0.0	0.0	0.0	0.0	0.0
(2.2) Support K-12 Educational Programming.	0.0	15.0	15.0	15.0	15.0	60.0
(2.3) Support Undergraduate and Graduate Education Programming.	0.0	15.0	15.0	15.0	15.0	60.0
(2.4) Support Adult Education Programming.	0.0	15.0	15.0	15.0	15.0	60.0
Total Estimated Annual Cost	**54.0**	**127.0**	**330.0**	**330.0**	**330.0**	**1171.0**
*Cost estimates exclude federal labor costs.						

2.3.2 **Work with educator organizations and foundations to create summer internships at SBNMS for education, outreach, marine management, maritime heritage, GIS and other sanctuary-related disciplines.**
Status: Planned, 2008

2.3.3 **Develop sanctuary components for a pre-service teacher education course, which incorporates information about sanctuary marine resources and resource management issues.**
Status: Planned, 2009

2.3.4 **Provide speakers and/or background information on the sanctuary to supplement school programming** (e.g., in marine resource management, marine science, marine professions, maritime archaeology, etc.).
Status: Ongoing

(2.4) Support Adult Education Programming. There is a large segment of the adult population interested in continuing education programs, both locally (often through on-site lectures and courses) and nationally (via the web). This educated audience is a potential source of sanctuary volunteers and donors. The development of adult education content based on sanctuary science and activities can contribute to leveraged partnerships with regional educational institutions, museums, aquariums and other organizations that offer such types of programming.

Priority: High
Status: Planned, 2009
Activities:

2.4.1 **Develop and implement a series of special lectures on sanctuary issues and resources, including, but not limited to: sea birds, whales, boating etiquette, fishing, fish identification, marine management.**
Status: Ongoing

2.4.2 **Develop education materials linked to sanctuary research cruises for distribution via the sanctuary web site and other outreach avenues including telepresence.**
Status: Planned, 2008

2.4.3 **Investigate the potential for web-based and/or remote-learning courses on the sanctuary, its resources and marine management issues.** Develop courses that can reach large segments of the general population.
Status: Planned, 2008

2.4.4 **Assess the potential for associations with adult education programs such as Elder Hostel and Earthwatch and coordinate partnerships where deemed appropriate.**
Status: Planned, 2009

2.4.5 **Develop a full semester college course on sanctuary resources and management that provides content suitable for continuing education credit.** Make classes available via digital videodisk (DVD) and video home systems (VHS) tapes for distance learning purposes.
Status: Ongoing

Table 34. Performance measures for POE action plan.

Desired Outcome(s) For This Action Plan			
Public interest and understanding of sanctuary issues and opportunities are mobilized to encourage responsible stewardship.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, personnel will be in place to effectively implement outreach activities and educational programming.	An outreach specialist and an education specialist will be hired.	Program personnel dedicated to outreach and education: 1	Raise Awareness
By 2009, an action plan to guide sanctuary programs in formal and informal education will be developed.	SBNMS will have begun to implement the action plan.	Number of action plans developed: 0	Raise Awareness
By 2010, sanctuary visitor centers and traveling exhibits will reach two million people.	SBNMS will track the number of exhibition locations and visitor exposure.	Number of people reached by exhibits: 1 million	Raise Awareness
By 2010, sanctuary outreach efforts will reach six million people.	SBNMS will track the viewership of sanctuary publications and media outreach venues.	Number of people reached by outreach efforts: 1 million	Raise Awareness
By 2010, visitation to the sanctuary website will reach four million people.	SBNMS will track the number of unique visitors to the sanctuary website.	Number of people reached by website: 1 million	Raise Awareness
By 2010, the sanctuary will implement formal and informal educational programming reaching one million people.	SBNMS will track the number of people accessing information from sanctuary educational programming.	Number of people reached: 2500	Raise Awareness

Compatibility Determination Action Plan

Issue Statement

The Compatibility Determination (CD) Action Plan (AP) recommends a process by which to determine what constitutes a compatible use of sanctuary resources. The NMSA directs the NMSP to facilitate uses that are compatible with the primary mandate of resource protection, but is silent on how compatibility should be determined. This AP describes a framework for developing a sanctuary compatibility analysis. The AP only recommends process; it does not determine the appropriateness of any specific sanctuary use, current or potential, nor does it recommend any actions that could affect the outcome of other action plans in this publication. Background information on compatible use determination is available at http://stellwagen.noaa.gov/management/mpr/workinggroups.html.

Goal

The goal of the CD AP is to develop a framework to assess and evaluate whether existing or proposed human uses are compatible with the sanctuary's primary objective of resource protection.

Objectives

The CD AP has one objective and associated strategies to address the issues regarding compatible use (Table 35).

- CD.1—Develop a Framework for Sanctuary Compatibility Determination.

The estimated costs for implementation of the CD AP are indicated in Table 36. The performance measures are listed in Table 37.

Table 35. Objectives, associated strategies, and priorities for CD action plan.		
Objective	**Strategy**	**Priority**
CD.1 Develop a Framework for Sanctuary Compatibility Determination	(1.1) Demonstrate the application of S-CAP.	High
	(1.2) Refine S-CAP by incorporating results of ongoing sanctuary monitoring.	Medium

CD.1 Objective—Develop a Framework for Sanctuary Compatibility Determination

Background. SBNMS is considering using a Sanctuary Compatibility Analysis Process (S-CAP) to clarify and resolve compatibility issues. S-CAP uses a hierarchical approach, which flows from broad statements of SBNMS 'vision' and 'mission' to more specific management 'goals' and 'objectives' to determine whether uses are compatible with sanctuary resource protection. Figure 119 provides a hypothetical application of S-CAP to sanctuary management.

S-CAP is a means to screen whether a use is compatible, or how it could be made compatible, and thus consistent with the site's vision, mission, goals and objectives. It is a potential decision-making tool for application in sanctuary management, including performance planning (such as in management plan reviews), and for addressing questionable situations regarding specific uses. S-CAP has the following objectives:

- Define the role of stakeholders and managers;
- Define the decision-making process, such that decisions are rational and transparent; and
- Address current uses, new uses, the scale of use, and the cumulative impacts of multiple uses.

[Note: Issues regarding conflicting uses that have no impact or risk of impact to sanctuary resources are not intended to be resolved by S-CAP or any other compatibility approach, as such issues present conflicts between uses, not between a use and resource protection].

Strategies (2) To Develop a Framework for Sanctuary Compatibility Determination

(1.1) Demonstrate the application of S-CAP. S-CAP will be used to answer specific questions regarding whether a use(s) is/are compatible with the sanctuary's primary objective of resource protection. The SBNMS vision, mission, goals and management objectives will provide guidance for S-CAP deliberations.

<u>Priority</u>: High
<u>Status</u>: Planned, 2011
<u>Activities</u>:

1.1.1 The NMSP will evaluate the application of S-CAP and determine its usefulness as a decision-making tool. The process is an objective approach, which seeks to incorporate the best available scientific information, allows for stakeholder involvement and should be easy to understand and apply. It can incorporate measurable standards and indicators as thresholds for decision-making, if advisable. Ultimately, a pilot study or monitoring program, preferably utilizing collaborative research, may be necessary to properly evaluate and refine the application of this tool in certain cases.

[Note**:** S-CAP should first consider whether a use is already prohibited or subject to regulation. A use in the sanctuary permitted or regulated by another agency pursuant to a different authority may still be found to be incompatible with the SBNMS vision, mission, goals and objectives. It is important at this point that the S-CAP clearly guide how to decide if and how a use can be made compatible by imposing mitigations and what those mitigations would be.]
Status: Planned, 2008

(1.2) Refine S-CAP by incorporating results of ongoing sanctuary monitoring. Regularly update monitoring information. Make the updated information available for S-CAP evaluation to ensure that the process remains applicable under changing environmental conditions and evolving uses of sanctuary resources.

<u>Priority</u>: Medium
<u>Status</u>: Planned, 2012

Figure 119. Hypothetical application of S-CAP process.

Issue: Does ‘x’ activity in the SBNMS harm marine mammals? Is it a use compatible with the sanctuary’s purpose?

Vision: Ecological integrity is protected.

Mission: Resource protection

Goal: Protect assemblages of marine mammals

Objective: Strengthen the protection of marine mammals by assessing and minimizing behavioral disturbance, including vessel strikes to and entanglement of marine mammals, and by fostering cooperation with cross-jurisdictional partners whose activities could impact marine mammals.

Standard: Marine mammal behavior is not altered and marine mammals are not struck or entangled by ‘x’ activity.

Indicators that standard is being achieved:

- No marine mammals are struck or entangled by ‘x’ activity.
- No change in marine mammal distribution due to ‘x’ activity.
- Surface-to-dive time ratio for marine mammals is within normal range and unaffected by ‘x’ activity.
- Marine mammal communication is unimpeded by ‘x’ activity.

Table 36. Estimated costs for CD action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Demonstrate the application of S-CAP.	0.0	0.0	0.0	0.0	0.0	0.0
(1.2) Refine S-CAP by incorporating results of ongoing sanctuary monitoring.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
*Cost estimates exclude federal labor costs.						

Table 37. Performance measures for CD action plan.

Desired Outcome(s) For This Action Plan

Framework is established to assess and evaluate whether human uses are compatible with the sanctuary’s primary objective of resource protection.

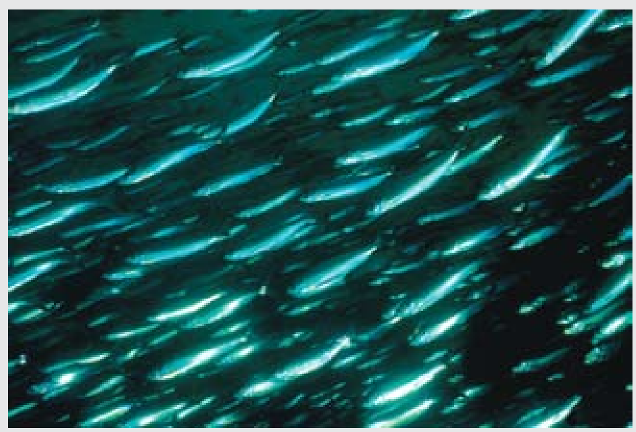
Performance Measures	Means of Evaluation	Baseline	NMSP Measure
By 2011, demonstrate the application of the Sanctuary Compatibility Analysis Process (S-CAP).	SBNMS advisory council will form a working group, which will file a report on the utility of the process as a decision-making tool.	Application of S-CAP: 0	Living marine resources, habitat, and water quality.

Ecosystem Protection

1. Ecosystem-Based Sanctuary Management
2. Ecosystem Alteration
3. Water Quality

The National Marine Sanctuaries Act provides that the primary objective of sanctuary management is resource protection. Ecosystem protection in SBNMS requires the preservation/enhancement of biological and habitat diversity *and* care for the associated physical environment. The sanctuary's challenge is to restore and maintain the ecological integrity of the site in the face of human-induced impacts and environmental uncertainty while facilitating compatible use.

Three action plans underscore public scoping concerns regarding ecosystem protection. The Ecosystem-Based Sanctuary Management (EBM) Action Plan establishes a framework and supporting infrastructure to integrate knowledge of ecological relationships with societal values to minimize human impacts to sanctuary resources. The Ecosystem Alteration (EA) Action Plan addresses the means to work with various agencies and user groups to reduce the alteration of benthic habitats by various uses and mitigate the ecological impacts of biomass removal by fishing. The Water Quality (WQ) Action Plan assesses and conserves water quality in the sanctuary by developing monitoring and contingency plans to examine and reduce pollution discharges, waste streams and catastrophic events that may adversely impact sanctuary resources.



Ecosystem-Based Sanctuary Management Action Plan

Issue Statement

The Ecosystem-Based Sanctuary Management (EBSM) Action Plan (AP) makes recommendations for comprehensive ecosystem protection, preservation/enhancement of biological diversity, zoning including no-take zones, ecosystem-based management practices and consideration of boundary modification.

Ecosystem-based management arose in the late 20th century to address the scientific uncertainty inherent in natural systems and the failures of single-species management approaches to adequately address that scientific uncertainty. In simplest terms, an ecosystem is a set of inter-related biological communities and their associated physical environment. It includes all marine organisms together with the abiotic properties of the water column and seafloor and is connected to the human users. Over the past decade, marine ecosystem-based management has been variously practiced (Arkema *et al.,* 2006); Leslie *et al.,* (2008) discuss the broader aspects of implementation.

Since SBNMS is not a singularly discrete ecosystem unto itself, but rather part of the much larger GoM ecosystem, the application of EBSM to the SBNMS will be approached in two ways. First, EBSM will involve intensive collaboration with agencies charged with managing components of the ecosystem on a regional scale that overlaps with and goes beyond sanctuary boundaries. Second, EBSM will involve intensive research and monitoring within sanctuary boundaries, where an obvious sub-set of the larger GoM ecosystem is being managed.

There are no comprehensive ecosystem-based management plans in place for the southern GoM at this time. For example, SBNMS regulates the mining of sand and gravel, disturbance of the seafloor (with the exception of fishing activity), and dumping of waste material within its boundaries. Fisheries management in the Federal waters of the region is directed at species of concern, while considering the effects on other ecosystem components and issues. Even though the NOAA Fisheries Service Atlantic Large Whale Take Reduction Team has grouped a number of large cetaceans under its auspices, the Marine Mammal Protection Act is enforced on a species-by-species basis.

Goal

The goal of the EBSM AP is to protect the ecological integrity of SBNMS including that the sanctuary contributes to the healthy functioning of the larger GoM ecosystem. Effective implementation should: consider ecological processes that operate both inside and outside sanctuary boundaries; recognize the importance of genetic, species and habitat diversity; and accommodate human uses within the sanctuary to the extent compatible with the primary goal of resource protection. EBSM will integrate knowledge of ecological interrelationships with societal values to minimize human impacts to sanctuary resources.

Objectives

The EBSM AP has five objectives and associated strategies to implement EBSM and establish the infrastructure and framework for its continued development (Table 38).

- EBSM.1—Establish a Science Review Framework
- EBSM.2—Establish an Information Management System
- EBSM.3—Understand Ecosystem Structure and Function
- EBSM.4—Protect Ecological Integrity
- EBSM.5—Evaluate the Need and Feasibility for Modifying the Sanctuary Boundary

The estimated costs for implementation of the EBSM AP are indicated in Table 39. The performance measures are listed in Table 40.

Table 38. Objectives, associated strategies, and priorities for EBM action plan.

Objective	Strategy	Priority
EBSM.1 Establish a Science Review Framework	(1.1) Work with the advisory council to establish a science advisory working group.	High
	(1.2) Convene a sanctuary science symposium.	High
	(1.3) Form a science consortium.	Low
EBSM.2 Establish an Information Management System	(2.1) Design and implement an information management system.	High
	(2.2) Design and implement a web portal for public access to databases.	Low
EBSM.3 Understand Ecosystem Structure and Function	(3.1) Define and operationalize the term ecological integrity.	High
	(3.2) Develop programs to monitor and evaluate ecological integrity within the sanctuary.	High
	(3.3) Establish research programs directed at informing EBSM.	High
	(3.4) Develop models that afford a predictive capability to better understand sanctuary dynamics and to guide EBSM.	Medium
EBSM.4 Protect Ecological Integrity	(4.1) Continue to convene the zoning working group of the advisory council to: (1) evaluate the adequacy of existing zoning schemes in SBNMS, (2) address the scientific requirements to meet the goals of EBSM, and if needed (3) develop a modified zoning scheme including consideration of fully protected reserves.	High
EBSM.5 Evaluate the Need and Feasibility of Modifying the Sanctuary Boundary	(5.1) Evaluate the need and feasibility for modifying the sanctuary boundary.	Low

EBSM.1 Objective—Establish a Science Review Framework

Background. A science review framework is needed to ensure that the sanctuary is using the best available, highest quality science for decision-making. The framework will consist of three parts: a science advisory working group, a sanctuary science symposium and a research consortium.

Strategies (3) To Establish a Science Review Framework

(1.1) Work with the advisory council to establish a science advisory working group. A science working group of the advisory council will assist in developing a science plan, thereby setting parameters for identifying and meeting key science needs. Scientific and technical membership will be drawn from area universities, research organizations and government agencies and will have representation covering the biological, geo-physical and societal disciplines. The working group will advise the advisory council, which will in turn advise the sanctuary superintendent on research and monitoring issues and provide assistance with developing a research and monitoring plan.

Priority: High
Status: Planned, 2008
Activities:

1.1.1 Develop a science plan that details the research, monitoring, and modeling activities necessary to carry out the sanctuary mission and inform management decisions (see Strategies EBSM 3.1-3.4).
Status: Planned, 2009

(1.2) Convene a sanctuary science symposium. SBNMS will organize a symposium on sanctuary science to assist with reviewing the results of research in the sanctuary on essential protection issues that inform EBSM. The science symposium will further knowledge of the sanctuary ecosystem by fostering interaction and appropriate collaborative research between users and researchers on topics such as marine mammal acoustics, prey dynamics, oceanography, water quality, fish movement, etc. This should be a biennial symposium in which to share knowledge with the advisory council, SBNMS staff, academic and government scientists, stakeholder organizations and other interested parties on a regular and timely basis.

Priority: Medium
Status: Planned, 2009

(1.3) Form a science consortium. SBNMS will serve as secretariat for an informal body that will ensure productive collaboration through timely dissemination of the research and monitoring results produced by the sanctuary. The consortium will be open to individuals who are committed to understanding how the sanctuary functions and who can contribute to furthering that understanding. An email/list serve or website will foster the sharing of ideas and posting of results (see Strategy EBSM 2.2).

Priority: Low
Status: Planned, 2009

EBSM.2 Objective—Establish an Information Management System

Background. An information management system will be established to process, synthesize, and analyze scientific data by building upon the sanctuary's existing infrastructure capacity with outside software expertise. The objective is to develop a well-designed information management and dissemination tool to facilitate science-based EBSM. The system should be designed so that information can be widely accessible to sanctuary staff, scientists, decision makers and the public. By setting up a database on an in-house server, SBNMS will expand the range and uses of existing data.

Strategies (2) To Establish an Information Management System

(2.1) Design and implement an information management system. The system will need to meet specified requirements related to data input, data access by various users, metadata, analysis, etc. It will afford internal use by SBNMS staff and subsequent access by the public (see Strategy EBSM 2.2).

<u>Priority</u>: High
<u>Status</u>: Planned, 2008
<u>Activities</u>:

2.1.1 Establish a quality assurance/quality control program. The program will ensure the integrity and quality of the data from collection to archiving.
<u>Status</u>: Planned

2.1.2 Establish a full-time data manager. A data management specialist is needed to manage and administer this system.
<u>Status</u>: Planned, 2009

(2.2) Design and implement a web portal for public access to databases. This tool will make data accessible to the public within a reasonable timeframe, while maintaining the security of the NOAA network.

<u>Priority</u>: Low
<u>Status</u>: Planned, 2009

EBSM.3 Objective—Understand Ecosystem Structure and Function

Background. Ecosystem structure refers to the arrangement of ecosystem components (physical and biological) over spatial and temporal scales. Ecosystem function refers to the processes of the ecosystem such as predation, succession and competition that in turn can mediate ecosystem structure. EBSM requires knowledge of what components make up the sanctuary ecosystem and what processes influence the arrangement of the components.

Strategies (4) To Understand Ecosystem Structure and Function

(3.1) Define and operationalize the term ecological integrity. As a concept, ecological integrity is location and scale dependent; it implies a sound or whole condition in both an intuitive and technical sense. It refers to the structural status and functioning of an ecological system (e.g., SBNMS). It considers human interactions and is the central concept to applying EBSM.

[Note: A draft definition of ecological integrity has been proposed by the Zoning Working Group for advisory council consideration. "Ecological integrity is defined as the degree to which the system is structurally intact and functionally resilient within the context of historical baselines. Structurally intact means that the native parts of the system are maintained as well as their relationships. Functional resilience is the system's ability to resist changes caused by human or environmental perturbations, or should change occur, to recover over time".]

<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

3.1.1 Develop an operational definition of ecological integrity that can be evaluated and monitored over time. The definition requires sufficient objectivity and specificity, such that its measurement can be quantified and the determination of status can be unequivocal.
<u>Status</u>: Ongoing

3.1.2 Develop metrics for monitoring and evaluating ecological integrity. This activity involves developing biological and socio-economic indices based on the definition that are sufficiently robust for routine application, yet reliable across some set scale of the sanctuary and in the face of environmental variability.
<u>Status</u>: Ongoing

3.1.3 Develop appropriate measures of biological diversity and identify those processes that mediate patterns of diversity. This activity aims to evaluate various measures of diversity and to determine which ones most appropriately reveal the effectiveness of management actions.
<u>Status</u>: Ongoing

(3.2) Develop programs to monitor and evaluate ecological integrity within the sanctuary. The suite of metrics developed will be monitored periodically to reveal the status of diversity measures, key ecological processes and human uses in the sanctuary.

<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

3.2.1 Develop an ecological monitoring program that will discern changes in the natural systems of the sanctuary and which will afford a comprehensive understanding of the site's ecological integrity. One objective of the monitoring program is to determine the efficacy of any zones implemented in the sanctuary for purposes of EBSM.
<u>Status</u>: Ongoing

3.2.2 Develop a human-use monitoring program to fully understand the types and level of use of the sanctuary, the spatial and temporal distribution of use, the use adjacent to currently closed areas and the impacts of regulations on use patterns. The program should provide adequate spatial resolution to reconstruct with statistical confidence the distribution of human impacts relative to habitat. The program should discern socio-economic impacts and incorporate traditional knowledge so that social capital can be an integral component

of EBSM. Monitoring could be done by automated information systems (AIS), vessel monitoring systems (VMS), radar, refinement of vessel trip reports (VTR), call-in systems and standardized shipboard surveys. Activities will be implemented in cooperation with NOAA Fisheries Service, USCG and the affected public.
<u>Status</u>: Ongoing

3.2.3 Establish an integrated ocean observing system in the sanctuary to collect real-time information at multiple depths on oceanographic and biological variables identified to aid EBSM. The observing system could be a subset of the Gulf of Maine Ocean Observing System (GoMOOS) and would be implemented remotely through a combination of component surface and seafloor sensors and satellites.
<u>Status</u>: Ongoing

(3.3) Establish research programs directed at informing EBSM. Research programs will complement monitoring programs by investigating ecological processes that explain the patterns identified from monitoring. The science advisory working group should advise on questions to be answered by various research programs (see Strategy EBSM 1.1).
<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

3.3.1 If appropriate, develop collaborative research programs with recreational and commercial fishing organizations. Collaborative programs will help answer specific questions about the ecology of the sanctuary and its use. Potential examples include the Massachusetts Fishermen's Partnership (MFP) Fishermen's Initiative for Scientific Habitat and Ecosystem Research (FISHER) project within the SBNMS.
<u>Status</u>: Ongoing

3.3.2 Classify and map benthic habitats. The SBNMS currently has high-resolution multi-beam imagery of the entire sanctuary. However, benthic habitats have not been classified or mapped based on the multi-beam data and ground-truthing data (e.g., video, sediment sampling and other means). Habitat classification and mapping would greatly facilitate planning and resource management efforts.
<u>Status</u>: Ongoing

3.3.3 Conduct research to understand movements of organisms relative to seascape features within the sanctuary and movement between the sanctuary and surrounding waters. This effort would include completing ongoing research, including cooperative research to tag and track Atlantic cod and expand the research to include other species.
<u>Status</u>: Ongoing

3.3.4 Conduct research to understand the effects of natural disturbance (e.g., storm and tidal events) on seascapes and seafloor habitats. Topographic complexity is mediated by natural as well as anthropogenic disturbance. This research will discern the characteristics of natural disturbance, such as the maximum depth affected by storm waves.
<u>Status</u>: Planned, 2009

3.3.5 Quantify pollutant loadings to sanctuary waters and apply findings to EBSM. See objectives and strategies in the Water Quality action plan for related context.
<u>Status</u>: Planned, 2010

(3.4) Develop models that provide a predictive capability to better understand sanctuary dynamics and to guide EBSM. Models are powerful tools for synthesizing and visualizing data from monitoring and directed research and for simulating past, current or future conditions in SBNMS. As our knowledge of the marine environment is often limited by the difficulties and costs associated with both vessel-based and underwater research, it is important to maximize the predictive utility of the data we do gather and characterize the uncertainty surrounding our samples. These tasks are best addressed through modeling, which allows managers to utilize empirical data to form conclusions and quantify the associated level of uncertainty.

Because threats to sanctuary resources are often immediate, managers often need to make decisions based on the best available data. Models can help to identify directions for future research that will reduce uncertainty in areas important to decision-making. Models are useful in guiding both sanctuary-sponsored research and proposals from the greater research community towards the creation of substantive policy.
<u>Priority</u>: Medium
<u>Status</u>: Planned, 2011
<u>Activities</u>:

3.4.1 Develop a dynamic ecosystem model linking patterns of habitat and species diversity with ecological processes. The science advisory working group and advisory council will review the model and make recommendations to the sanctuary superintendent on its limits and capabilities.
<u>Status</u>: Planned, 2011

3.4.2 Develop a model(s) that predict(s) larval recruitment, dispersal and connectivity between habitats within, and to and from habitats external to, the sanctuary. The model should clarify the role that SBNMS plays in larval recruitment by identifying sources, sinks, rates of movement and concentrations of larvae using data from various sources.
<u>Status</u>: Planned, 2011

3.4.3 Develop an internal oceanographic circulation model for the sanctuary that interfaces with other models to tie together local, regional and larger-scale patterns. Development of this model is essential to understand and predict egg and larval transport, and the fate and effect of nutrients and pollutants.

Status: Planned, 2011

EBSM.4 Objective—Protect Ecological Integrity

Background. The primary goal of EBSM is to protect the ecological integrity of the sanctuary. No single action is sufficient to protect the integrity of the system short of making the entire sanctuary a no-take wilderness area, which is not the intention. The purpose of this objective is to implement a set of complementary strategies that together will ensure the integrity of the ecosystem.

Strategy (1) To Protect Ecological Integrity

(4.1) Continue to convene the zoning working group of the advisory council established in 2005 to: (1) evaluate the adequacy of existing zoning schemes in SBNMS, (2) address the scientific requirements to meet the goals of EBSM and, if needed (3) develop a modified zoning scheme including consideration of fully protected reserves. The zoning working group will review and evaluate data and information, as it becomes available through various venues (e.g., Omnibus Essential Fish Habitat process, sanctuary efforts) and will make recommendations to the advisory council. The advisory council will evaluate the recommendations and advise the sanctuary superintendent regarding the adequacy of existing zoning measures. The working group will be asked to make its recommendations within two years of the publication date of the Federal Register Notice notifying the public of the availability of the final management plan. [See Strategy EA 2.1] Appendix Q provides details on the membership and charge of the zoning marking group. Appendix R provides information on existing marine resources management zones that overlap the sanctuary.

Priority: High

Status: Ongoing

EBSM.5 Objective—Evaluate the Need and Feasibility of Modifying the Sanctuary Boundary

Background. The southern end of Jeffreys Ledge is included within the boundary of the SBNMS, whereas the majority of Jeffreys Ledge lies outside of the sanctuary. Jeffreys Ledge is an important habitat and resource area for many of the same species that frequent the sanctuary, but is a profoundly different habitat type. The seafloor habitat of Jeffreys Ledge consists primarily of bedrock rather than the sand, gravel, and mud habitats that principally comprise the SBNMS. Those differences aside, marine mammals will in the course of a feeding season frequent both the sanctuary and Jeffreys Ledge in search of forage species particularly herring. Large pelagic fish do the same as do many of the groundfish species. The two geographic areas are ecologically intertwined and could be considered one integral system. Based on this rationale, much public comment during scoping called for expanding the boundary of the sanctuary to include Jeffreys Ledge.

The SBNMS is well-suited as a sanctuary in that it was established in an area used preferentially by humpback whale juveniles and mature females (Robbins, 2007). These classes typically play important roles in large mammal population dynamics (Robbins, 2007), the first because of its sensitivity to environment and/or population density and the second because of its importance to population growth. While humpback whales presently have broad legislative protection in the U.S. waters of the GoM, the sanctuary provides an opportunity for focused management, including research, monitoring and enforcement. However, despite the appropriateness of its location, the size of SBNMS does not encompass the range of any individual humpback whale.

Proposals have been made to extend the SBNMS boundaries to the north to include more of Jeffreys Ledge (as noted above). However, Robbins (2007) indicates that the choice of areas would not have equal results where humpback whales are concerned. Adults move between all of the GoM areas studied, but the areas of particular importance to SBNMS whales were the Great South Channel and western Georges Bank. An extension to the south would incorporate the most common alternate summer habitat of SBNMS humpback whales, as well as an important habitat for juveniles and an area of routinely high humpback whale density (Figure 45a this document). Extension to the north would encompass fewer humpback whales, but a slightly different demographic than is presently observed in the sanctuary. Although both areas lie adjacent to the SBNMS, the relative importance of each area should be considered when evaluating the need for sanctuary boundary modification.

During management plan preparation, suggestions have been made to extend the sanctuary boundary to the east and north to include all or more of the “Level 3” habitat closed area established within the Western Gulf of Maine Closure Area (WGoMCA) (Figure 15). This area is closed indefinitely on a year-round basis to all bottom-tending mobile gear, bottom-tending gillnets, clam and scallop dredges, and shrimp trawls and includes a sizeable portion (approximately 50%) of Jeffreys Ledge. The WGoMCA currently overlaps 22% of the sanctuary along the eastern boundary and is serving as a relatively unimpacted reference site for sanctuary research. Refer to the sidebar “Seafloor Habitat Recovery and Monitoring Project” in the section on Resources State in the Sanctuary.

In considering sanctuary boundary modification to include the “Level 3” portion of the WGoMCA, the following relationships could apply. Total boundary length and boundary-to-area ratio are smaller for conservation strategies that emphasize a single protected area versus those that allocate the same amount of habitat area among two or more sites (Cooke and Auster, 2006). A single large protected area in the sanctuary might be favored over several smaller ones for a number of reasons (Fogarty, 1999; Dayton *et al.*, 2000), including reduced socio-economic impact of habitat protection. Smaller boundary-to-area ratios also tend to reduce movement rates of mobile organisms from inside an area to outside (Polacheck, 1990; Lindholm *et al.*, 2001). Thus larger areas may offer more protection to their inhabitants, particularly if exploitation occurs right on the boundary, as is occurring in the sanctuary (Figure 88, 2001–2002 survey period). On the other hand, multiple sites increase both redundancy and the likelihood of including greater biodiversity.

The examples provided above are not specific recommendations. Instead, the discussion serves as a framework for fostering dialogue and envisioning some criteria that might be considered in evaluating sanctuary boundary modification within the context of ecosystem-based sanctuary management.

Strategies (1) To Evaluate the Need and Feasibility of Modifying the Sanctuary Boundary

(5.1) Evaluate the need and feasibility of modifying the sanctuary boundary to be more effective in achieving EBSM. The purpose of this strategy is to determine whether said or pertinent other modifications in the sanctuary boundary are warranted to better achieve ecosystem-based sanctuary management.

<u>Priority</u>: Low
<u>Status</u>: Planned, 2009

Table 39. Estimated costs for EBSM action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Ask the advisory council to establish a science advisory working group.	0.5	0.5	0.5	0.5	0.5	2.5
(1.2) Convene a sanctuary science symposium.	0.0	2.0	0.0	2.0	0.0	4.0
(1.3) Form a science consortium.	0.0	1.0	1.0	1.0	1.0	4.0
(2.1) Design and implement an information management system.	2.0	40.0	70.0	50.0	40.0	202.0
(2.2) Design and implement a web portal for public access to databases.	0.0	0.0	2.0	0.0	0.0	2.0
(3.1) Define and operationalize the term ecological integrity.	0.0	0.0	0.0	0.0	0.0	0.0
(3.2) Develop programs to monitor and evaluate ecological integrity within the sanctuary.	500.0	650.0	700.0	700.0	700.0	3250.0
(3.3) Establish research programs directed at informing EBSM.	30.0	60.0	60.0	50.0	50.0	250.0
(3.4) Develop models that afford a predictive capability to better understand sanctuary dynamics and to guide EBSM.	0.0	40.0	40.0	10.0	10.0	100.0
(4.1) Continue to convene the zoning working group of the advisory council to: (1) evaluate the adequacy of existing zoning schemes in SBNMS, (2) address the scientific requirements to meet the goals of EBSM, and if needed (3) develop a modified zoning scheme including consideration of fully protected reserves.	1.0	10.0	0.0	0.0	0.0	11.0
(5.1) Evaluate the need and feasibility of modifying the sanctuary boundaries to include Jeffrey's Ledge.	0.0	0.0	0.0	0.0	3.0	3.0
Total Estimated Annual Cost	**533.5**	**803.5**	**873.5**	**813.5**	**804.5**	**3828.5**
*Cost estimates exclude federal labor costs.						

Table 40. Performance measures for EBSM action plan.			
Desired Outcome(s) For This Action Plan			
The ecological integrity of the SBNMS is restored as a subset of a healthy functioning Gulf of Maine ecosystem.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, personnel and projects will be in place to implement an ecosystem-based management program.	A community ecologist and database management technician will be hired.	Program personnel dedicated to ecosystem-based management: 0	Protect Resources
By 2009, a science advisory working group will be convened to help develop a revised science plan.	A revised SBNMS science plan will be developed.	Revision of existing science plan: 0	Protect Resources
By 2010, management protocols are in place to ensure that the ecological integrity of 22%* of the sanctuary will be fully restored.	Ecosystem-based management indicators will be established and monitored.	Percent of the sanctuary that is fully restored: 0	Protect Resources
* The WGoMCA restricting the use of bottom mobile fishing gear and gillnets overlaps with approximately 22% of the eastern portion of the sanctuary.			

Ecosystem Alteration Action Plan

Issue Statement

The Ecosystem Alteration (EA) Action Plan (AP) makes recommendations to reduce or mitigate anthropogenic perturbations in SBNMS, as distinguished from impacts due to natural disturbance. Anthropogenic or human imposed impacts include the laying of submarine pipelines and cables, fishing activities, pollution and degradation of water quality, ocean dumping and marine debris, disposal of dredged materials, introduction of exotic species, offshore mariculture and coastal development activities. This action plan focuses on the laying of pipelines and cables and fishing activities. Other sources of ecosystem alteration are treated variously in other action plans, such as for ecosystem based management, water quality and interagency cooperation.

Goal

The goal of the EA AP is to reduce or mitigate identifiable impacts on key sanctuary resources due to human activities.

Objectives

The EA AP has three objectives and associated strategies to reduce or prevent ecosystem alteration (Table 41).

- EA.1—Reduce Ecological Impacts from the Laying of Submarine Cables and Pipelines
- EA.2—Reduce Alteration of Benthic Habitat by Mobile Fishing
- EA.3—Reduce Ecological Impacts of Biomass Removal by Fishing

The estimated costs for implementation of the EA AP are indicated in Table 42. The performance measures are listed in Table 43.

Table 41. Objectives, associated strategies, and priorities for EA action plan.

Objective	Strategy	Priority
EA.1 Reduce Ecological Impacts from the Laying of Submarine Cables and Pipelines	(1.1) Establish minimum criteria for special use permit applications for the laying of cables and pipelines.	Low
EA.2 Reduce Alteration of Benthic Habitat by Mobile Fishing	(2.1) Develop a process to establish reference areas that serve as benchmarks for discerning human and natural impacts on habitat alteration.	High
	(2.2) Develop a science plan to assess and mitigate benthic habitat alteration.	High
EA.3 Reduce Ecological Impacts of Biomass Removal by Fishing Activity	(3.1) Minimize bycatch and discard of all species, in all fisheries (commercial and recreational), by all gear types.	High
	(3.2) Determine the effects of biomass removal of targeted species by commercial and recreational fishing on the ecological integrity of the sanctuary.	High
	(3.3) Develop a management strategy with NOAA Fisheries Service and the NEFMC to evaluate and protect an optimal forage base to maintain the ecological integrity of the sanctuary.	High

EA.1 Objective—Reduce Ecological Impacts from the Laying of Submarine Cables and Pipelines

Background. Public scoping raised concerns over the appropriateness of laying submarine cables and pipelines in the sanctuary. The proximity of the SBNMS to Boston increases the probability that the sanctuary will face future cable or pipeline proposals. The laying of cables and pipelines results in permanent or long-term emplacement of equipment and materials on or in the seabed. The risk of ecosystem alteration posed by pipelines is often considered several orders of magnitude greater than that posed by fiber optic cables, because pipelines are not as easily buried as cables and because the material they carry could pose harm if leaked to the environment.

The laying of cables and pipelines is a prohibited activity in the SBNMS under the existing alteration of the seabed regulation. However, prohibited activities can be permitted on a case-by-case basis. In August of 2000, the NMSP issued an Authorization/Special Use Permit (SUP) to 360Networks, Inc. [dba 360atlantic (USA) Inc.] to allow the laying of a high-capacity fiber optic cable to traverse approximately 12.1 miles (19.8 kilometers) within the sanctuary. The high resolution, multi-beam topography map of the sanctuary was utilized to route the cable through soft sediments. An environmental impact statement was prepared prior to the issuance of the permit. In 2002, 360Networks Inc. filed for bankruptcy. The cable was later purchased by Columbia Ventures Corporation [dba Columbia Ventures US Acquisition LLC ("CVC USA")] and is currently permitted to that firm.

[Note: The spatial extent of impacts from the laying of the fiber optic cable in SBNMS has been assessed and compared to the spatial extent of impacts from a single 4.5m width scallop dredge towed at 2.5m per second fished in the sanctuary. The total spatial extent of the area impacted by the laying of the fiber optic cable (0.0594 sq km) is the equivalent to 88 minutes spent fishing with a standard scallop dredge in the GoM. This represents 0.0027% of the sanctuary area. By comparison, work by Auster *et al.,* (1996) for the entire GoM suggests that for 78% of the sanctuary area, i.e., excluding the WGoMCA overlap within the sanctuary, nearly every square kilometer is dragged by mobile fishing gear at least once per year on average. Refer to Figure 111a in this document for corroborating findings specific to the SBNMS. (see Objective EA.2)].

Strategies (1) To Reduce Ecological Impacts from the Laying of Cables and Pipelines

(1.1) Establish minimum criteria for special use permit applications for the laying of cables and pipelines. The following conditions for issuance of a permit should apply for the laying of cables or pipelines within SBNMS:

- Appropriate mitigation and pre- and post-monitoring to assess impacts to sanctuary resources will be performed by an independent contractor hired by the sanctuary at permittee expense.
- The Environmental Impact Statement required of the applicant for a permit should ensure that cable and pipeline routing does not hinder pre-existing compatible uses.
- The sanctuary shall have the option of having the cable or pipeline removed at permittee expense, rather than leaving it in situ at end of serviceable life and in cases of permit violation.
- The applicant should be required to post a performance bond to ensure that permit safeguards are met.
  Priority: Low
  Status: Planned, 2008

EA.2 Objective—Reduce Alteration of Benthic Habitat by Mobile Fishing

Background. Review of scientific literature and preliminary results of related studies indicates that bottom mobile gears (scallop dredges and groundfish otter trawls) commonly fished in the SBNMS impose the greatest anthropogenic impact on benthic habitats. This impact is evidenced by the loss or dispersal of physical features (e.g., piled boulder reefs and sand waves), or the loss of structure-forming organisms (e.g., hydroids, sponges, anemones, and bryozoans). Generally, these alterations have led to changes in the biomass, species diversity, age and size composition and productivity of the associated biota (Jennings and Kaiser, 1998; Collie, *et al*. 2000); changes that substantially alter the structure and function of biological communities.

Key factors affecting such changes include the type of bottom fishing gear, level of fishing effort, the spatial distribution of the fishing effort and the physical and biological characteristics of the bottom where fishing is conducted (McGee, 2004; Stevenson, 2004). Once a benthic habitat has been degraded by initial fishing pressure, it is not necessarily continuously degraded by continued fishing pressure. Although continued pressure does not allow the habitat to recover, it might retain sufficient productivity to remain viable as a commercial fishery (M. Kaiser, University of Wales, presentation to EA WG, 2004), but not fulfill all of its prior ecological functions.

Among specific benthic habitats, hard bottom (boulder and gravel) and mud substrata appear to be the most sensitive to the removal of physical and biological structure by mobile fishing gear, with coarse sand demonstrating the least impact (McGee, 2004; Stevenson, 2004). In SBNMS, the make-up of substratum type is approximately 38% boulder and gravel, 28% mud and 34% sand (SBNMS, unpublished data). By this measure, approximately two-thirds (66%) of the sanctuary's benthic habitat is particularly vulnerable to the disturbance of bottom mobile fishing gear.

Typically, winter storms with strong winds from the northeast generate sufficient bottom currents to re-suspend sediments only at depths less than 85 m (NOAA, 2006). The majority (75%) of SBNMS is below the zone of natural perturbation by storm events. This means that direct physical disturbance of benthic habitats in the majority of the sanctuary occurs by anthropogenic activities (e.g., cable laying, bottom mobile fishing gear) rather than natural causes.

<u>**Groundfishing Effort within SBNMS**</u>. Substantial changes have occurred to groundfish fisheries since SBNMS was designated in 1992. At the time of designation, there was no limit to the number of days a vessel could fish. In 2004, most small groundfish fleet permit vessels were reduced to approximately 53 groundfish days-at-sea (DAS); that number was reduced to approximately 48 DAS in 2006.

Effort reduction actions taken by NOAA Fisheries Service and the NEFMC have likely decreased the frequency with which bottom otter trawl vessels fish the sanctuary. This could decrease the frequency with which some bottom habitats are trawled. Alternatively, DAS reductions could cause the larger vessels that currently bypass the sanctuary to fish closer to shore to reduce transit time. This could increase their fishing activities in the sanctuary.

Fishing restrictions have also reduced the spatial area available to bottom otter trawlers and probably provide a greater degree of protection to certain key habitats. However, the deep mud habitat (greater than 85 meters depth) is particularly sensitive and vulnerable to constant disturbance by bottom trawling and is not well represented within the areas closed to bottom impact gear.

A series of 'rolling closures' limit groundfishing in all or parts of SBNMS during certain specified months. The Western Gulf of Maine Closure Area (WGoMCA) prohibits bottom otter trawling and scallop dredging year-round in approximately 22% of the sanctuary. The Western GoM Habitat Closure, an area contained within the WGoMCA, provides additional restrictions.

While the substantive steps taken by NOAA Fisheries Service and the NEFMC to rebuild over-fished groundfish stocks in the WGoM may have the additional benefit of reducing benthic habitat alteration by mobile bottom fishing gears in the sanctuary, these measures are not entirely adequate to protect the structure and functional integrity of biological communities in the sanctuary.

For example, research conducted by the sanctuary within the "sliver" (i.e., area of sanctuary that overlaps with the WGoMCA) indicates that recovery from fishing of biological communities associated with mud seafloor habitat occurs on the order of a decade. And yet, seasonal "rolling closures" overlapping the sanctuary allow bottom dragging over sanctuary mud habitats annually. The rate of perturbation that occurs under rolling closures does not protect the structure and integrity of the biological communities associated with this habitat in the sanctuary. However, the rolling closures may be effective as a management tool to rebuild groundfish stocks.

Strategies (2) To Reduce Alteration of Benthic Habitat by Mobile Fishing

(2.1) Develop a process to establish reference areas that serve as benchmarks for discerning human and natural impacts on habitat alteration. There currently are no places within the sanctuary that can serve as true reference areas in the absence of direct human impacts. The WGoMCA, while serving as a relatively unimpacted site, is still subject to some fishing activities (Figure 107d). The lack of reference areas compromises NOAA's ability to effectively manage, because there is no undisturbed, 'research' or 'control' area to serve as a baseline for differentiating the effects of human activities from natural disturbance. Reference areas are also needed to understand the processes of habitat recovery and the associated mechanisms of biological succession that lead to the establishment of mature benthic communities. [Note: This strategy will be addressed by the outcome of Strategy EBM 4.1, which addresses establishing a zoning working group to consider issues including reference areas.]

<u>Priority</u>: High
<u>Status</u>: Ongoing

(2.2) Develop a science plan to assess and mitigate benthic habitat alteration. Conduct and/or encourage research resulting in a greater understanding of benthic habitat alteration and ways to mitigate impacts from mobile bottom fishing gears. The research should be directed at determining how benthic habitats and their associated biological communities are structured and function in the presence and absence of fishing.

Priority: High
Status: Planned, 2009
Activities:

2.2.1 Continue to conduct and encourage additional research on the impacts of bottom mobile gears on ecosystem alteration compared to other anthropogenic impacts and natural disturbance.
Status: Ongoing

2.2.2 Continue to conduct and encourage research to determine spatial patterns of fishing effort in the sanctuary, identify changes in effort over time and space, and assess how those changes may have impacted sanctuary resources.
Status: Ongoing

2.2.3 Conduct and/or encourage research to determine how changes in benthic habitat impact the recruitment and survival of commercial and non-commercial species.
Status: Planned, 2008

2.2.4 Encourage research on the development or improvement of low-impact mobile bottom fishing gear that is 'environmentally sustainable'. Gear mitigations that leave benthic habitats and their associated physical and biogenic structure largely intact are more likely to be compatible with the mission, goals and objectives of the sanctuary.
Status: Planned, 2008

EA.3 Objective—Reduce Ecological Impacts of Biomass Removal by Fishing Activity

Background. Biomass removal includes the targeted capture of commercial species above legally set minimum size/age thresholds; the bycatch and discard of unintended species caught across all size/age classes; and, the removal of species that function as important prey within the ecosystem. Biomass removal also includes structure-forming invertebrates comprising biogenic habitats damaged by fishing. The degree of ecosystem alteration by fishing depends on the scale of total biomass removal, the species-specific survival rate of the bycatch discarded, and the relative abundance of those species constituting both catch and bycatch.

Current information is inadequate to sufficiently understand the specific effects of biomass removal by fishing on the structuring and functioning of biological communities within SBNMS. However, it is highly likely that extraction has caused severe declines or shifts in some, but perhaps not all, ecosystem components and reduced the ecological integrity of the sanctuary. A fishery-independent, long-term, standardized database collected on the eastern Scotian Shelf off Nova Scotia revealed that during the past four decades, coherent, community-level reduction in body size, biomass and physiological condition have occurred in the resident demersal fish species (Choi *et al*., 2004). One of the leading hypotheses offered by the authors to explain the poor health of the resident groundfish was energy depletion in the system associated with the enormous biomass removal due to fishing.

Predators. The selective removal of top predators in large numbers (with attendant reduction in size and age structure of the species population) by commercial and recreational fishing has cascading effects on trophic (food web) dynamics that reshape the structure of biological communities and reduce ecological integrity. This effect is well documented in the scientific literature generally (e.g., Pauly *et al.,* 1998; Tegner and Dayton, 1999) and the North Atlantic specifically (Myers and Worm, 2003; Pauly and McLean, 2003; Lotze and Milewski, 2004; Frank *et al.,* 2005). The pervasive and disproportionate removal of larger, older fish among groundfish species in the GoM is indicated as a source of ecosystem dysfunction (e.g., Jackson *et al.,* 2001; Steneck *et al.,* 2004). In this larger context it is crucial to recognize that, while being commercially valuable, groundfish species function as ecologically important predators.

Atlantic cod act as keystone predators and formerly dominated northern hemisphere marine ecosystems (Frank *et al*., 2005). As a marketable commodity, this species has been heavily exploited for centuries, particularly so in the last 50 years. The modeling of cod biomass on Canada's Scotian Shelf using historical records indicates that adult biomass today is a mere remnant (4%) of what it was in 1852, in an area known to have been fished since at least 1539 (Rosenberg *et al*., 2005). Stellwagen Bank has been fished for cod since at least 1614 (Claesson and McKenzie, 2005), and cod stocks there today are over-fished by current standards.

Examination of fish size-structure in SBNMS over a 38-year period (1963–2000) revealed that the maximum length of 17 species of commercially and biologically important groundfish species all showed decreasing trends. For seven of the species (white hake, goosefish, winter flounder, silver hake, cod, yellowtail flounder, and haddock), decreases in maximum length ranged from 15% to 49%; maximum length of cod decreased by 27% (Crawford and Cook, in preparation). When later data were added (2001–2005), there was improvement in the abundance of large individuals of cod and haddock that is consistent with lower fishing mortality. Other species (particularly the flatfishes) showed signs of a reversing trend in maximum size but are still of concern.

Prey. Atlantic herring (*Clupea harengus*), American sand lance [sand eel] (*Ammodytes dubius*) and Atlantic mackerel (*Scomber scombrus*) are key prey components of the SBNMS food web. The harvest of these prey species and the unintended impacts such removals might have on the local abundance of higher trophic level predators is likely consequential (Overholtz and Link, 2006). These predator species include marine mammals (numerous of which are threatened or endangered), seabirds, and medium and large fishes (e.g., cod [*Gadus morhua*], Atlantic bluefin tuna [*Thunnus thynnus*]). Many of these predators are drawn to, and depend heavily on, the forage base that the sanctuary affords.

While managed fisheries for Atlantic herring and Atlantic mackerel exist in the GoM, there is no directed management of American sand lance in the western North Atlantic, nor does a commercial fishery for sand lance exist in that area (Overholtz *et al*., 2000). Because these prey species are important forage for whales, sea birds and popular fish species (Overholtz and Link, 2006), their being available and abundant in the sanctuary bears greatly on ecosystem function and the successful provision of ecosystem services (among them whale watching, commercial, charter/party boat, and recreational fishing).

Local depletion of Atlantic herring as a critical food source attracting and sustaining sanctuary wildlife is not a primary consideration in the development of regional fishery management plans. Trophic interactions and total consumption requirements of dependent wildlife are not explicitly considered in stock assessment models underlying these plans, rather predation is subsumed within the natural mortality rate. Yet the consumption of herring by upper trophic level predators (marine mammals, seabirds and piscivorous fish) in the GoM may have exceeded the estimate of natural mortality used in stock assessment models by more than fourfold in 1991 (Read and Brownstein, 2003).

While the amount of herring harvested from the sanctuary varies greatly year-to-year, landings can be relatively large (1mil.–17mil. lbs.) (NMFS/NEFSC VTR data, 1997-2005). Refer to Section IV. Resource States - Reduced Forage Base in this document for an expanded rationale why fishing for herring in the sanctuary is a concern. The sanctuary's goal is not management of the herring stock, but rather the goal is to avoid disruption and depletion of prey fields by fisheries in this local area of critically important foraging habitat. This goal extends to sand lance as well.

Sand Lance. Sand lance availability is dependent on environmental conditions and predator-prey interactions, which can be highly variable and difficult to predict (Fogarty *et al*., 1991; Nelson and Ross, 1991). The availability of sand lance is associated with the species mix and abundance of its principal larval predators - herring and mackerel (Sherman *et al*., 1981). Herring has exhibited a dramatic increase in population in recent years, and it is uncertain how the ecosystem-shift favoring small pelagic species factors into the rate of predation on sand lance. While two species of sand lance frequent Massachusetts waters (Winters and Dailey, 1988), *Ammodytes dubius* predominates offshore within the sanctuary (L. Kaufman, Boston Univ., personal communication, 2006).

There is the possibility that sand lance spawn in the sanctuary, where they deposit their eggs in sand habitats. What is seen as cyclic availability commonly attributed to coastwide movement, may partly be due to variations in year-class strength associated with local inter-annual spawning and recruitment success. While the principal offshore species of sand lance differ between the western (*A. dubius*) and eastern North Atlantic (*A. marinus*), their known biology is similar. Although sand lance larvae drift with currents, once metamorphosed at around six months, sand lance do not show extensive horizontal movements, but tend to remain associated with a particular patch of substrate (Gauld and Hutcheon, 1990; Pedersen *et al*., 1999), where they are susceptible to local depletion by fishing.

The sand lance (*A. marinus*) is the target of the largest single-species fishery in the North Sea with the total allowable catch (TAC) being set at 1 million tons per year (ICES, 1998). The Department of Fisheries and Oceans Canada has identified sand lance (*A. dubius*) as one of the major unexploited fish resources of the northwest Atlantic (http://www.dfo-mpo.gc.ca/zone/underwater_sous-marin/SandLance/sandlanc_e.html). While there is yet no fishery for sand lance in the GoM, if one were to develop the sanctuary area would certainly be targeted because of its historical high level of sand lance abundance. Sand lance occur within the SBNMS at higher levels of abundance than in any other area of the southern GoM (Figure 46 of the document).

The facts that (1) metamorphosed sand lance do not make extensive horizontal movements and are susceptible to local depletion, that (2) they are a keystone prey species and a principal component of the sanctuary ecosystem forage base important to dermersal and predatory pelagic fishes, seabirds and marine mammals, and that (3) they are an important predictor of the relative abundance of important cetacean species (endangered humpback and fin whales and protected minke whales) which frequent the sanctuary, all make it prudent to consider prohibiting fishing for sand lance in the sanctuary. The sanctuary merits and requires a higher standard of resource protection than other parts of the GoM, and the lack of a current fishery for sand lance should be seen as an advantage where important protection of an entire food web can be taken at no economic cost.

Bycatch. Bycatch is the unintentional capture of non-target species of fish, marine mammals, turtles, sea birds and invertebrates. Bycatch and discarding is a major component of the impact of fisheries on marine ecosystems and a significant source of collateral biological damage. Not only are the stocks of discarded species affected, but entire trophic webs and habitats may be disrupted to the point of greatly altering their structure and function at the community and ecosystem levels (Alverson and Hughes, 1996; Crowder and Murawski, 1998; Morgan and Chuenpagdee, 2003). The conservation problems associated with bycatch are well documented by the scientific community (e.g., Alversen *et al*., 1994; Hall, 1996; Kaiser and de Groot, 2000; Kelleher, 2005).

An analysis of discarded bycatch in the USA in 2002-2003 indicates that the shrimp and bottom trawl fisheries were responsible for 72 percent of the total discards by gear type, and the crustacean and demersal (groundfish) fisheries were responsible for 86 percent of the discards by target species type (Harrington *et al.,* 2005). These gear types and target species types are prevalent among the fisheries prosecuted in the SBNMS. The northeast fisheries discard to landings ratio was 0.49 overall, among the highest in the nation, while the northeast groundfish discard to landings ratio was 1.790 (Harrington *et al.,* 2005). This ratio indicates that discards of groundfish (e.g., spiny dogfish, skates, monkfish, hake) on a tonnage basis amounted to almost two times the landed catch.

Unfortunately, high bycatch rates can be found in fisheries that are currently struggling to rebuild, such as the New England groundfish fishery (Murawski *et al*., 1997), and some of the discard can be due to management requirements, not just fishing practices (Harrington *et al*., 2005). The most pressing and effective means of addressing problems of bycatch and associated ecosystem impacts is eliminating over-capitalization and over-fishing (Pauly *et al*., 2002). The most successful programs include clear financial incentives for fishermen to minimize bycatch by reducing costs or increasing value (Branch *et al*., 2005; Gilman *et al*., 2005). Change to more selective fishing gear continues to be an essential element of bycatch reduction programs.

More selective gear can mean higher-value landings for fishermen at potentially lower costs (Clucas and James, 1997; Crowder and Murawski, 1998). Examples of gear changes that improve catch value and reduce bycatch in certain circumstances are the conversion of trawl fisheries to traps, switching from dragging to longlining in selected areas (NMFS, 2003), and the mandated use of larger mesh throughout the net or in panels to release certain sizes or species (Kelleher, 2005). Different gear modifications can have strikingly different impacts on catch rates for both bycatch and target species (Hall and Mainprize, 2005). The use of more selective gear requires specific incentives to improve selectivity and disincentives to limit unwanted levels of bycatch.

Strategies (3) To Reduce Ecological Impacts of Biomass Removal by Fishing Activity

(3.1) Minimize bycatch and discard of all species, in all fisheries (commercial and recreational), by all gear types. Bycatch of target and non-target species should be minimized in the SBNMS to help restore species populations, food web complexity and the structure and function of biological communities.

Priority: High
Status: Planned, 2010
Activities:

3.1.1 Promote cooperative research with fishing organizations and fishery management agencies into methods to greatly reduce or eliminate all types of bycatch through gear modification.
Status: Planned, 2010

3.1.2 Convene periodic workshops to gather, assess and disseminate information concerning the ability of particular gear modifications to achieve desired goals in bycatch reduction.
Status: Planned, 2010

3.1.3 Ask the advisory council to form a working group to recommend criteria for 'environmentally' sustainable fishing gear.
Status: Planned, 2010

3.1.4 Develop and implement outreach and education programs, in partnership with relevant fishery organizations to promote environmentally sustainable gear methodologies as determined by SBNMS.
Status: Planned, 2010

3.1.5 Explore incentives to encourage fishermen to demonstrate the use of environmentally sustainable gear, such as through purchase assistance, operating subsidies or providing other means of acquisition.
Status: Planned, 2010

3.1.6 Coordinate with fishery management agencies, fishing groups and nongovernmental organizations (NGO's) to develop a 'study fleet' of all vessel types fishing in the sanctuary. The purpose of the fleet would be to understand the differential rate of capture and composition of bycatch, and how the bycatch differs spatially and temporally. Data could be made available directly to the sanctuary or through a third party entity that would protect the individual identity of the contributors.
Status: Planned, 2010

(3.2) Determine the effects of biomass removal of targeted species by commercial and recreational fishing on the ecological integrity of the sanctuary. NOAA Fisheries Service has employed closed areas, effort reduction and gear modifications as tools to rebuild stocks of marketable species. These tools directly address population level effects of fishing as measured by rates of mortality, growth, reproduction and recruitment, for example. There is little to no understanding of how the removal of commercially and ecologically important fish/shellfish species, notably groundfish and lobsters, impacts the structure and functioning of biological communities within the sanctuary (e.g., how is biological diversity mediated by predation and competition, what habitat-related species assemblages constitute climax communities, etc.).

Priority: High
Status: Planned, 2010
Activities:

3.2.1 Establish historical baselines for fish populations in the sanctuary to develop the historical context for the area's marine ecology and to assess the degree of ecosystem alteration. Determination of baselines will require archival research and study of the historical ecology of the sanctuary area back to colonial times and will draw on five primary sources: (1) early exploration narrative accounts, (2) scientific survey logbooks, (3) U.S. Fish Commission publications, (4) monthly fishery statistical bulletins for the northwest Atlantic, and (5) fishermen accounts and interviews.
Status: Ongoing

3.2.2 Coordinate with NOAA Fisheries Service and NEFMC in their attempts to rebuild and manage viable species populations of commercial fish/shellfish in the sanctuary area. Work to ensure that stock rebuilding efforts also help restore the biological communities associated with these species and the ecological integrity of the sanctuary.
Status: Planned, 2009

3.2.3 Coordinate with NOAA Fisheries Service and NEFMC to conduct/encourage research into the characteristics (e.g., species, size, number, and degree of discard) of fish caught by recreational fishing within the sanctuary.
Status: Planned, 2009

(3.3) Develop a management strategy with NOAA Fisheries Service and the NEFMC to evaluate and protect an optimal forage base to maintain the ecological integrity of the sanctuary. Forage species such as Atlantic herring, squid, sand lance (sand eels) and Atlantic mackerel are an essential trophic resource for larger fishes, marine mammals and sea birds. Historically these prey species have been seasonally abundant in the sanctuary and have attracted numerous major predator species. The abundance of these predator species (e.g., large whales, bluefin tuna and cod) is central and crucial to supporting commercial fishing, ecotourism and recreation in the sanctuary. Directed fisheries on these prey species may be decreasing local abundance of both prey and predators, thereby degrading the ecological integrity of SBNMS and diminishing the sanctuary's fuller utility.
Priority: High
Status: Planned, 2009
Activities:

3.3.1 Recommend that NOAA Fisheries Service consider implementing a permanent ban on the exploitation of sand eels (*Ammodytes spp.*) within the SBNMS.
Status: Planned, 2008

3.3.2 Monitor and assess the results of Amendment 1 to the Atlantic Herring Fishery Management Plan as it relates to reduced prey availability due to extraction from the sanctuary.
Status: Planned, 2008

3.3.3 Conduct/encourage research to determine the functional importance of prey species within the sanctuary environment and to ascertain how the fisheries for prey species affect the ecological integrity of the sanctuary.
Status: Planned, 2008

3.3.4 Conduct/encourage research to understand the inter-relationships between, and the population dynamics of, sand lance, mackerel and herring within the sanctuary.
Status: Planned, 2008

3.3.5 Conduct/encourage research to understand the inter-annual variability in abundance of sand lance and what environmental factors drive this variability within the sanctuary.
Status: Planned, 2008

Table 42. Estimated costs for EA action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Establish minimum criteria for permit applications for the laying of cables and pipelines.	0.0	0.0	0.0	0.0	0.0	0.0
(2.1) Develop a process to establish reference areas that serve as benchmarks for discerning human and natural impacts on habitat alteration.	1.0	2.0	15.0	2.0	2.0	22.0
(2.2) Develop a science plan to assess and mitigate benthic habitat alteration.	0.0	0.0	0.0	0.0	0.0	0.0
(3.1) Minimize bycatch and discard of all species, in all fisheries (commercial and recreational), by all gear types.	0.0	0.0	0.0	0.0	0.0	0.0
(3.2) Determine the effects of the biomass removal of targeted species by commercial and recreational fishing on the ecological integrity of the sanctuary.	2.0	10.0	10.0	10.0	10.0	42.0
(3.3) Develop a management strategy with NOAA Fisheries Service and the NEFMC to evaluate and protect an optimal forage base to maintain the ecological integrity of the sanctuary.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**3.0**	**12.0**	**27.0**	**13.0**	**13.0**	**68.0**
*Cost estimates exclude federal labor costs.						

Table 43. Performance measures for EA action plan.

Performance Measures	Means of Evaluation	Baseline	NMSP Measure
Desired Outcome(s) For This Action Plan			
Ecosystem alteration resulting from human activities is reduced.			
By 2009, the sanctuary will complete study on the relative impact of mobile bottom gear on seafloor habitats compared to other anthropogenic impacts and natural disturbances over a decade.	SBNMS will finalize report on the results of the Seafloor Habitat Recovery Monitoring Program (SHRMP).	Years of results from SHRMP: 6 of 10 planned	Protect Resources
By 2011, 50% of the bottom otter-trawl and dredge fishermen in the sanctuary will be using fishing gear that reduces bycatch and habitat impacts.	SBNMS will partner with NMFS and NEFMC to keep track of the number of commercial fishing vessels using reduced-impact gear.	Percent of bottom otter-trawl and dredge fishermen using reduced-impact gear: 0*	Protect Resources
By 2009, the key forage species in the sanctuary, sand lance (sand eels) and Atlantic herring, will be protected from local depletion.	SBNMS will document results of consultation with NMFS NERO and NEFMC on steps taken to prevent local depletion of key forage species within the sanctuary.	Controls to prevent local depletion of key forage species within the sanctuary: 0	Protect Resources

* It is understood that gear currently in use in these fisheries represents a reduction in impact relative to the recent past. However, the baseline is calculated with respect to current conditions and efforts to improve upon them.

Water Quality Action Plan

Issue Statement

The Water Quality (WQ) Action Plan (AP) makes recommendations to address water quality concerns within SBNMS. Point and non-point sources of pollution, both sea and shore-based, may be degrading the quality of the sanctuary's waters. NOAA must ensure that the quality of water within its boundary and in surrounding areas does no harm to the site's living marine and cultural resources. The following two needs were identified: to assess water quality and circulation to characterize baseline conditions, and to reduce pollutant discharges and waste streams that may be negatively impacting sanctuary resources.

Goal

The goal of the WQ AP is to monitor, assess and maintain water quality in the sanctuary for the protection of living and cultural resources and to foster cooperation with cross-jurisdictional partners that are charged with understanding, protecting and enhancing water quality.

Objectives

The WQ AP has two objectives and associated strategies to assess and improve water quality in the sanctuary (Table 44).

- WQ.1—Assess Water Quality and Circulation
- WQ.2—Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary

The estimated costs for implementation of the WQ AP are indicated in Table 45. The performance measures are listed in Table 46.

Table 44. Objectives, associated strategies, and priorities for WQ action plan.

Objective	Strategy	Priority
WQ.1 Assess Water Quality and Circulation	(1.1) Develop and Implement a Water Quality Monitoring Plan.	High
	(1.2) Characterize the contaminant loading to the sanctuary from sources.	Low
	(1.3) Encourage research and monitoring of endocrine disrupters and their effects on sanctuary resources.	Low
WQ.2 Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary	(2.1) Reduce threats to sanctuary water quality from vessel wastewater discharges (other than ballast water).	High
	(2.2) Reduce ballast water exchanges in the sanctuary.	High
	(2.3) Reduce impacts of municipal and other shore-based waste water streams.	Low
	(2.4) Develop contingency plans to address actions and responsibilities to Remediate catastrophic water quality events in the sanctuary and support programs that prevent water pollution events.	Medium

WQ.1 Objective—Assess Water Quality and Circulation

Background. The sanctuary's water quality monitoring program (albeit limited) has been in place for several years primarily to determine whether the MWRA outfall, which began operating in September 2000, was causing increased nutrient loading and eutrophication in the sanctuary. The MWRA outfall discharges over 300 million gallons daily; it is located twelve miles offshore of the mouth of Boston Harbor and nine miles from the western boundary of the sanctuary. Several other waste water treatment facilities discharge into Massachusetts Bay to the north and west of the sanctuary as well. In 2001, SBNMS added four stations to MWRA's existing five stations within the sanctuary to leverage resources and standardize information for integration with ongoing monitoring. The four additional stations are sampled in August and October, coincident with two of the six MWRA surveys conducted each year.

The water quality sampling includes measurements of physical variables (salinity, temperature, density), nutrients, chlorophyll and dissolved oxygen, as well as phytoplankton and zooplankton. The four additional sanctuary stations are strategically placed to detect nutrient inputs to the sanctuary from the GoM (notably discharges from the Merrimack River) to the north and from the MWRA outfall to the west. The data contribute to inferences about fine scale ocean circulation patterns and water column productivity in SBNMS, and are used in the 3-dimensional model that has been developed by MWRA to understand how the system might respond to increased or decreased levels of nutrients, dilution of outfall discharge and dispersion.

Much of the pollution reaching the sanctuary comes from non-point sources or from distant point sources that are not easy to control. Air pollution from power plants, some as far away as the Midwest, discharge a variety of chemicals onto the Massachusetts Bay, some of which are accumulated by organisms. In addition, the sanctuary area is heavily traveled by commercial and recreational vessels and cruise ships that discharge wastes during their voyages. Other sources of contamination include clean dredged material dumped under EPA permit at the MBDS located adjacent to the sanctuary's western boundary, and disturbances during the laying of underwater pipes and cables (only one of which crosses the sanctuary). Of concern are the cumulative impacts of these multiple sources that may affect the resources of the sanctuary.

Strategies (3) To Assess Water Quality and Circulation

(1.1) Develop and Implement a Water Quality Monitoring Plan. A water quality monitoring plan for SBNMS will: (1) highlight priority areas for implementation of a monitoring program, (2) review current oceanographic modeling and new technologies that may provide additional supporting information, (3) integrate data into models to assess the health of the sanctuary and (4) identify the need to translate scientific data into information for managers and the public.

Priority: High
Status: Planned, 2009
Activities:

1.1.1 Work with the advisory council to establish a science and technical working group of the advisory council to advise the advisory council, which will in turn advise the sanctuary superintendent, on water quality issues. The working group will review the existing monitoring program and related collaborations, identify specific monitoring questions and help the sanctuary develop a monitoring and research plan. The plan will: (1) evaluate the MWRA outfall and other sources of contaminants and pollutants; (2) present the results and analysis of the current monitoring program and incorporate findings into recommended management actions, as appropriate; (3) coordinate water quality monitoring with other monitoring and research activities within the sanctuary and the sanctuary system (e.g., system-wide monitoring); (4) develop a monitoring program to sample sanctuary waters after episodic pollution events (such as a MWRA failure and/or storm-water overflows); (5) examine the cause and effect relationship between shore-based point source discharges and impacts to the

sanctuary ecosystem, including discussion of air deposition and non-point source urban runoff, and (6) evaluate the use and utility of models (e.g., harmful algal blooms [HAB], Bays Eutrophication Model [BEM]).
Status: Planned, 2008

(1.2) Characterize the contaminant loading to the sanctuary from respective sources. Monitoring programs are most effective when they are designed around specific questions. Without understanding the loading of nutrients, metals, organic chemicals and other pollutants from respective sources (air, vessels, outfalls, and other activities), it is difficult to develop a monitoring program that will provide useful results and identify ways to answer some of the more challenging ecosystem-based questions.
Priority: Low
Status: Planned, 2010

(1.3) Encourage research and monitoring of endocrine disrupters and their effects on sanctuary resources. Current research indicates that endocrine disruptors (e.g., polychlorinated biphenyls [PCBs], polynuclear aromatic hydrocarbons [PAHs], pesticides) may pose detrimental effects on sanctuary resources and suggests the need for vigilance and continued research. Endocrine disruptors may enter the sanctuary through numerous sources, including sewage outfalls, runoff and air deposition.
Priority: Low
Status: Planned, 2011

WQ.2 Objective—Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary

Background. Recognizing that the sanctuary is home to many endangered marine mammals, seabird, turtle and fish species, and is a place where fish are caught for human consumption and where visitors seek recreation, it is critical to protect water quality. The first two strategies that follow discuss efforts to reduce water pollution threats from vessel discharges that are part of regular vessel operation. The third strategy addresses sanctuary involvement in the reduction of threats from sewage effluents and other shore-side wastewater streams. The fourth strategy focuses on response to or prevention of catastrophic events, such as oil and other hazardous spills or releases of raw sewage.

Strategies (4) To Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary

(2.1) Reduce Threats to sanctuary water quality from vessel wastewater discharges (other than ballast water). The sanctuary is an area of special national significance and has the responsibility to maintain the highest possible water quality. Any contribution of pollutants from waste streams constitutes potential threats to the safety of sanctuary resources. Understanding the potential impacts of these waste streams is critical in the development of best management practices for water quality.
Priority: High
Status: Planned, 2009
Activities:

2.1.1 In addition to disseminating information on the current sanctuary regulations addressing discharge of black water, oily bilge water, hazardous chemicals, solid wastes, and fish wastes in excess of quantities produced by traditional fishing methods within the sanctuary, encourage vessels transiting sanctuary waters to abstain from other discharge through voluntary compliance. Include a reporting component within the guidelines for vessels to provide documentation on discharge locations.
Status: Planned, 2009

2.1.2 Seek designation of the sanctuary as a No Discharge Area (NDA) under relevant law.
Status: Planned, 2009

2.1.3 Develop an outreach campaign with industry and recreation organizations to encourage 'green' or environmentally sustainable boating and cruising. The objective is to obtain compliance on a voluntary SBNMS NDA for all waste streams except engine cooling water.
Status: Planned, 2010

2.1.4 Support development of pump-out facilities for both large and small vessels and support creative solutions in ports and harbors that host vessels that visit the sanctuary.
Status: Ongoing

2.1.5 Develop a directed research program that examines the cause and effect relationship between discharges/waste water streams and impacts to the ecosystem.
Status: Planned, 2011

(2.2) Reduce ballast water exchanges in the sanctuary. Current efforts in the Northeast are focusing on a regional ballast water management plan which includes identification of scientifically based alternative ballast water exchange zones, actions for ports and harbors and increased pressures for compliance with current voluntary ballast water management efforts. Because of the potential introduction of exotic species and other threats to the ecological integrity of the sanctuary, it is important to reduce (if not outright prohibit) ballast water exchanges in and near the sanctuary.
Priority: High
Status: Planned, 2009
Activities:

2.2.1 Encourage prevention of introductions of invasive species through development of ballast water exchange guidelines for the sanctuary through memorandum of understanding with cruise lines and the shipping industry and other shipping related sources.
Status: Planned, 2009

(2.3) Reduce impacts of municipal and other shore-based waste water streams. The MWRA outfall is the largest anthropogenic point source of nutrient inputs to the Massachusetts Bay system. While scientific studies indicate that effluent discharges from the MWRA outfall are not a nutrient concern to Massachusetts Bay and SBNMS, there is discussion and concern over levels of chlorine discharge in the immediate area of the outfall diffusers. Added demands on this system, and/or the addition of new sewage outfalls into Massachusetts Bay; however, may introduce additional nutrients and pollutants that could affect the sanctuary. Cumulative impacts of all waste streams are also unknown at this time and should be monitored.

MWRA's NPDES permit requires an annual report to the sanctuary reviewing any effects on sanctuary resources by the MWRA outfall effluent. Any new or expanded waste streams entering Massachusetts Bay, which might affect sanctuary resources, will need a National Pollutant Discharge Elimination System (NPDES) permit and should incorporate sanctuary monitoring and reporting components developed in consultation with the sanctuary.

Priority: Low
Status: Planned, 2010
Activities:

2.3.1 Review and comment on all NPDES requests for municipal wastewater streams that may impact sanctuary waters, and require sanctuary monitoring and reporting components to any NPDES permit.
Status: Planned, 2009

2.3.2 Continue to provide representation on the MWRA Outfall Monitoring Science Advisory Panel (OMSAP) to track actions that may have impacts on the sanctuary.
Status: Ongoing

(2.4.) Develop contingency plans to address actions and responsibilities to remediate catastrophic water quality events in the sanctuary and support programs that prevent water pollution events. The sanctuary has worked with the USCG and NOAA's Hazardous Materials Office to develop contingency plans for oil spills and other hazardous material spills that may occur in SBNMS (see Strategies IC 2.2 and 2.3). Continued coordination in this effort is essential for the future protection of sanctuary water quality and resources in the event of a spill.

Other significant and possibly catastrophic events may occur involving other pollutants, most significantly the MWRA outfall and the release of partially treated or raw sewage. MWRA's emergency response plan for the outfall covers the possibility of catastrophic failure from natural hazards, including coastal storms (e.g., hurricanes, tornadic events, northeasters and earthquakes).

[Note: The cumulative effects of even small events may also have a detrimental effect on sanctuary water quality, including such activities as lightering (the transfer of petroleum-based matter, which is illegal in the sanctuary) and small vessel collisions with the accompanying release of stored fuel products. In these cases, prevention is the preferred route as opposed to containment and cleanup.]

Priority: Medium
Status: Ongoing
Activities:

2.4.1 Continue to work with the USCG and NOAA Hazardous Materials Office in the updating of oil spill and hazardous material spill contingency plans for the sanctuary.
Status: Ongoing

2.4.2 Work with MWRA to develop a sanctuary component to its emergency response plan for the outfall and make this information transparent to the public.
Status: Planned, 2009

Table 45. Estimated costs for WQ action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Develop and implement a water quality monitoring plan	0.0	20.0	0.0	0.0	0.0	20.0
(1.2) Characterize the contaminant loading to the sanctuary from sources.	15.0	10.0	10.0	10.0	10.0	55.0
(1.3) Encourage research and monitoring of endocrine disrupters and their effects on sanctuary resources.	0.0	15.0	25.0	25.0	0.0	65.0
(2.1) Reduce threats to sanctuary water quality from vessel wastewater discharges (other than ballast water).	0.0	10.0	15.0	0.0	0.0	25.0
(2.2) Reduce ballast water exchanges in the sanctuary.	0.0	0.0	0.0	0.0	0.0	0.0
(2.3) Reduce impacts of municipal and other shore-based waste water streams.	0.0	0.0	0.0	0.0	0.0	0.0
(2.4) Develop contingency plans to address actions and responsibilities to remediate catastrophic water quality events in the sanctuary and support programs that prevent water pollution events.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**15.0**	**55.0**	**50.0**	**35.0**	**10.0**	**165.0**
*Cost estimates exclude federal labor costs.						

Table 46. Performance measures for WQ action plan.			
Desired Outcome(s) For This Action Plan			
Water quality in the sanctuary is monitored, assessed, and improved for the protection of living marine and cultural resources.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, 50% of documented commercial passenger vessels will adhere to new guidelines on reducing discharges in the sanctuary.	SBNMS will track the number of companies that adhere to guidelines by contacting them directly.	Commercial passenger vessels adhering to guidelines: 0	Water Quality
By 2009, data from the water quality monitoring program will be made available to the public via internet by at most six months after collection.	SBNMS will track the time elapsed between collection of water quality monitoring data and posting of same data online.	Water quality monitoring data available to public: 0	Water Quality
By 2009, a science and technical working group will be convened to help develop a water quality monitoring plan.	A SBNMS water quality monitoring plan will be developed.	Existing water quality monitoring plan: 0	Water Quality
By 2010, the sanctuary will be designated as a No Discharge Area (NDA)	NDA status will be achieved.	Provisions to control vessel wastewater discharges in sanctuary: 0	Water Quality
By 2010, ballast water exchange guidelines to prevent introduction of invasive species will be established.	SBNMS will enter into formal agreements with cruise line and shipping interests that transit the sanctuary.	Provisions to control ballast water exchanges in sanctuary: 0	Water Quality

Marine Mammal Protection

1. Marine Mammal Behavioral Disturbance
2. Marine Mammal Vessel Strike
3. Marine Mammal Entanglement

The marine mammal fauna of SBNMS are diverse and have significant ecological, aesthetic and economic value to the communities of New England. For many of these species, some of which are threatened or highly endangered, waters of the sanctuary serve as primary habitat for critical activities that include feeding and nursing. The sanctuary is a high-use area for commercial and recreational vessel traffic that can cause disturbance to or collide with whales, and commercial fisheries in the sanctuary are identified entanglement risks.

Three action plans underscore public scoping concerns regarding marine mammal protection in the sanctuary. The Marine Mammal Behavioral Disturbance (MMBD) Action Plan establishes a framework to address the potential for marine mammal harassment and behavioral disturbance resulting from whale watching, tuna fishing, aircraft overflights and noise pollution. The Marine Mammal Vessel Strike (MMVS) Action Plan identifies means to assess and reduce marine mammal vessel collision that cause serious injury and mortality. The Marine Mammal Entanglement (MME) Action Plan characterizes the threat of marine mammal entanglement with fishing gear. Each plan formulates methods to work with user groups and cross-jurisdictional partners to minimize risk.

Marine Mammal Behavioral Disturbance Action Plan

Issue Statement

The Marine Mammal Behavioral Disturbance (MMBD) Action Plan (AP) makes recommendations to reduce the risk of behavioral disturbance and harassment of marine mammals resulting from the following activities: whale watching, tuna fishing, aircraft overflights and noise pollution. SBNMS serves as a major feeding ground for seven species of endangered, threatened and protected whales and smaller cetaceans. The sanctuary is also a high use area for commercial and recreational vessel traffic and, consequently, a high-risk area for marine mammal disturbance by human-induced activities within and around the sanctuary.

Goal

The goal of the MMBD AP is to strengthen the protection of marine mammals, particularly the threatened and endangered large whales, by assessing and minimizing behavioral disturbance and harassment and by fostering cooperation with agencies having cross-jurisdictional responsibilities that affect them.

Objectives

The MMBD AP has three objectives and associated strategies to reduce the risk of behavioral disturbance and harassment of marine mammals (Table 47).

The objectives are as follows:

- MMBD.1—Reduce Marine Mammal Behavioral Disturbance and Harassment by Vessels
- MMBD.2—Reduce Marine Mammal Behavioral Disturbance and Harassment by Noise
- MMBD.3—Reduce Marine Mammal Behavioral Disturbance and Harassment by Aircraft

The estimated costs for implementation of the MMBD AP are indicated in Table 48. The performance measures are listed in Table 49.

Table 47. Objectives, associated strategies, and priorities for MMBD action plan.

Objective	Strategy	Priority
MMBD.1 Reduce Marine Mammal Behavioral Disturbance and Harassment by Vessels	(1.1) Develop and implement management measures that mitigate behavioral disturbance and risk to whales due to vessel speed and close approach.	High
	(1.2) Develop a process to consider prohibiting vessels from transiting through humpback whale bubble clouds and/or nets.	High
	(1.3) Conduct risk assessment on other activities that could disturb marine mammals.	Low
	(1.4) Develop a research program to better understand vessel interactions with whales.	High
MMBD.2 Reduce Marine Mammal Behavioral Disturbance and Harassment by Noise	(2.1) Establish a Marine Noise Consortium to identify noise sources and possible effects.	High
	(2.2) Develop a marine acoustics research program to establish baseline noise levels and long-term noise budgets.	High
	(2.3) Develop a policy framework for investigating and mitigating noise impacts within SBNMS.	High
MMBD.3 Reduce Marine Mammal Behavioral Disturbance and Harassment by Aircraft	(3.1) Identify information gaps and gather data on overflight activities to determine whether they disturb marine mammals.	Low
	(3.2) Develop outreach advisories with NOAA Fisheries Service to inform the aviation community regarding overflight in proximity to whales.	Low

MMBD.1 Objective—Reduce Marine Mammal Behavioral Disturbance and Harassment by Vessels

Background. This objective is principally directed at the activities of vessels less than 300 gross tons, which include whale watching, certain commercial fishing (e.g., tuna harpoon and trolling), and recreational vessels that actively seek to approach whales. This does not imply that larger vessels are of no concern, and they are addressed more directly under the Marine Mammal Vessel Strike action plan. Noise disturbance is addressed under MMBD.2.

There are more than fifteen commercial whale watch companies operating in SBNMS, with more than twenty boats departing multiple times daily from April through November. Commercial whale watching has the potential to be the most effective means of providing experiential education to visitors in the sanctuary and, thereby, further the sanctuary's conservation and outreach goals. More than a million people visit the sanctuary yearly aboard these platforms, which is approximately the same number of people that annually visit the New England Aquarium (NEAQ) in Boston.

There is increasing concern regarding the short-and long-term impacts of whale watching on the targeted large whales. Impact studies worldwide have shown: changes in ventilation rate (Baker, 1988), avoidance behavior (Donovan, 1986), changes in habitat use (Corkeron, 1995) and abandonment of key habitat (Glockner-Ferrari and Ferrari, 1990) in relation to whale watching. There is also the risk of whales being struck by vessels that approach too close. These concerns are compounded by the increase in popularity of whale watching, not just on commercial vessels, but privately owned recreational vessels as well.

In an attempt to minimize the impacts of whale watching, NOAA established regional guidelines in the Northeast in 1985. The guidelines were published in 1999 and remain in effect today; the guidelines are voluntary and difficult to enforce. A recent study conducted over several years in the sanctuary indicates that compliance with the guidelines is extremely low across the commercial whale watch fleet (*Wiley et al., 2006*). Because the fleet did not adhere to the guidelines, it was not possible to determine if the guidelines were effective. The high degree of non-compliance, however, indicates that whale watching 'guidelines' cannot be relied upon as a voluntary measure to reduce the risk of behavioral disturbance within the sanctuary.

While the compliance study was directed at commercial whale watch vessels, behavioral disturbance is understood to be a larger problem including whale watching by privately-owned vessels as well. Recreational vessels are often sighted in close proximity to whales. The fast speed at which these vessels can travel impairs the operator's ability to respond quickly and safely to surfacing whales. The vessel's low height above the water reduces the horizon for observation and, therefore, is more susceptible to glare, which further impedes timely detection.

Other activities that may contribute to behavioral disturbance of large whales, based on reports and observations of whale watch naturalists, include tuna fishing and recreational vessels moving through bubble clouds and bubble nets made by feeding humpback whales, and close approaches by recreational watercraft. Tuna fishermen have stated that they target whales and whale watching boats in the sanctuary because of the possible presence of sand lance and herring on which baleen whales and tuna feed (pers comm. MMBD WG, 2004).

Strategies (4) To Reduce Marine Mammal Behavioral Disturbance and Harassment by Vessels

(1.1) Develop and implement management measures that mitigate behavioral disturbance and risk to whales due to vessel speed and close approach. Marine mammals within the SBNMS are the focus of both commercial and recreational whale watching. SBNMS will consider regulating whale watching in the sanctuary based on the following concerns: (1) past incidents in which commercial whale watch vessels and private boaters have struck whales; (2) complaints that vessel operations appeared to disrupt patterns of normal behavior (e.g., separating mothers from dependent calves, preventing whales from surfacing in 'bubble clouds' made during foraging bouts, etc.), and (3) the documented non-compliance with NOAA whale watching guidelines by the commercial whale watch fleet.

Regulations seem warranted because the sanctuary was created in large part to safeguard Stellwagen Bank's historic importance as a feeding area and nursery for threatened and endangered whales. Existing technology has proven reliable and effective in measuring vessel speed and distance relative to whales and can be used in enforcement. Regulation by SBNMS would be conducted in cooperation and consultation with NOAA Fisheries Service NERO.

Priority: High
Status: Planned, 2009
Activities:

1.1.1 Establish criteria for speed controls/restrictions. Document, analyze and assess information pertinent to understanding the relationship between vessel speed and whale strike. Consider amending sanctuary regulations to include resource protection measures associated with vessel speed.
Status: Planned, 2009

1.1.2 Establish criteria for close approach. Document, analyze and assess information pertinent to risk to whales due to close approach of vessels. Consider amending sanctuary regulations to include resource protection measures associated with close approach distance.
Status: Planned, 2009

1.1.3 Establish a SBNMS Naturalist Certification program. Sanctuary-certified naturalists on commercial whale watch vessels would provide the sanctuary with a corps of trained experts, who can provide sanctuary outreach to a large segment of the public. Development of a sanctuary-certified naturalist program would benefit from the cooperation and involvement of education partners and the whale watch industry in project design and implementation. Sanctuary naturalist certification would create added market value for participating companies.
Status: Planned, 2009

1.1.4 Establish a SBNMS Commercial Whale Watch Operator Certification program. The safe operation of commercial whale watch vessels in proximity to endangered/threatened whales is needed to guard against behavioral disturbance and vessel strike. The development of a sanctuary-certified operator program would be based on the cooperation and involvement of vessel captains/owners to benefit from their experience, critical skills and knowledge. Sanctuary operator certification would create added market value for participating companies.
Status: Planned, 2009

1.1.5 Consider establishing a SBNMS Commercial Whale Watch Special Use Permit (SUP). The SUP would require that all permittees acquire and hold both the SBNMS Commercial Whale Watch Naturalist Certificate and the SBNMS Commercial Whale Watch Operators Certificate. If the sanctuary were to adopt whale watch regulations, the SUP would allow permittees limited close approach to whales in a manner similar to that prescribed in the current NOAA whale watch guidelines.
Status: Planned, 2009

1.1.6 Consider establishing a SBNMS Education Partnership Accord with commercial whale watch companies whose vessels operate under the SBNMS Commercial Whale Watch SUP. The SBNMS Education Partnership Accord would provide the means to leverage and promote sanctuary outreach through cooperative product branding and cross-merchandizing with participating whale watch companies operating under terms of the SBNMS SUP. The program would be conducted under the symbol-use authorizing provisions of the National Marine Sanctuaries Act, in cooperation with the non-profit National Marine Sanctuary Foundation. Outreach products could potentially include, but not be limited to, CDs, books, posters, logo mementos and apparel, etc. Standards for content and quality assurance would be established by the NMSP, in consultation with DOC.
Status: Planned, 2009

1.1.7 Investigate the possibility of establishing a SBNMS Small-Grants Whale Watch Education/Outreach program. A competitive, annual small-grants program would be explored for sanctuary-certified naturalists working on vessels operating under the SBNMS Commercial Whale Watch SUP. The grants would be awarded as an incentive to improve education and outreach aboard sanctuary certified whale watch boats.
Status: Planned, 2009

(1.2) Develop a process to consider prohibiting vessels from transiting through humpback whale bubble clouds and/or nets. Vessels transiting bubble clouds or bubble nets may strike large whales or disrupt critically important feeding behaviors. Whales actively engaged in capturing elusive prey by these behaviors may be inattentive to other activities in their environment and could be particularly susceptible to being struck by a transiting vessel.

Priority: High

Status: Planned, 2008

(1.3) Conduct risk assessment on other activities that could disturb marine mammals. Additional activities that have the potential to affect critical whale behaviors include motorized personal watercraft and kayaks in proximity to whales, and planes and airships. Many of these activities have been managed in other areas (e.g., Alaska, Hawaii). The sanctuary should assess and understand their possible impacts and, if necessary, manage these activities in SBNMS.

Priority: Low

Status: Planned, 2010

(1.4) Develop a research program to better understand vessel interactions with whales. Research can provide necessary information to inform future protective efforts by the sanctuary. [Note**:** Information on short-and long-term impacts of vessels and their associated noise on whales is particularly needed (see Objective MMBD.3—Establish Protocols for Noise Disturbance in the Vicinity of Whales).]

Priority: High

Status: Ongoing

Activities:

1.4.1 Monitor the number of whale watch vessels (e.g., commercial and recreational) using the sanctuary to determine trends in whale watching activity over time. Continue to conduct standardized trackline survey studies to monitor the spatial and temporal distribution of whales and vessels in the sanctuary.

Status: Ongoing

1.4.2 Encourage species recognition and individual identification studies of whales, as such studies provide an opportunity to determine the long-term impacts of behavioral disturbance.

Status: Ongoing

1.4.3 Encourage partner institutions and agencies to consider how existing data and shared scientific interests might be better applied to understanding the impacts of behavioral disturbance on whales.

Status: Ongoing

1.4.4 Investigate research strategies to determine short-term and cumulative impacts of human activities on whales, including but not limited to assessing harassment and disruption of marine mammals (i.e., to better define approach protocols).

Status: Ongoing

1.4.5 Investigate non-invasive tagging programs to provide a more continuous record of whale behavior.

Status: Ongoing

MMBD.2 Objective—Reduce Marine Mammal Behavioral Disturbance and Harassment by Noise

Background. People and marine animals use sound in the sea to accomplish many tasks. Because light travels relatively short distances in the ocean, sound is often used for such basic activities as finding food or a mate, navigating and communicating. For that reason, the oceans are filled with sound generated by a variety of natural sources, including not only marine life but also abiotic sources such as breaking waves, earthquakes, wind and rain. Underwater sound is also generated by a variety of anthropogenic sources, such as vessels, military sonar, oil and gas drilling and some oceanographic research technologies. The background 'omnipresent' sound in the ocean is called ambient noise. The primary sources of ambient noise vary with the frequency. For example, vessels primarily generate noise between 20-500 Hz, whereas ambient noise between 500-100,000 Hz is mostly due to spray and bubbles associated with breaking waves.

Current knowledge about the effects of sound on marine animals relies heavily on experimentation with small numbers of individuals in captivity and/or post-hoc evaluation of mortality events in the wild, in which cause-and-effect is often impossible to determine. Due to their charismatic nature, their use of sound for communication, and their protected status, marine mammals have been the focus of increasing levels of attention and controversy associated with the possible adverse effects of noise in the marine environment. Marine mammals have been shown to manifest behavioral changes in the presence of certain types of noise (Erbe C., 2002; Frankel and Clark, 2002; Patenaude *et al*., 2002; Richardson and Wursig, 1997). Exposure to anthropogenic noise can impact cetaceans by masking biologically important sounds (e.g., intraspecific communication and localization of prey resources), provoking avoidance or attraction, causing temporary or permanent hearing damage and, in extreme cases, death (Yost, 1994; Richardson *et al*., 1995).

In its 2003 report (one of three devoted to sound sources and marine mammals), the U.S. National Research Council (NRC) Committee on the Potential Impacts of Ambient Noise in the Ocean on Marine Mammals concluded that concern surrounding anthropogenic sound and marine mammals was warranted, given: (1) the threatened and endangered status of many marine mammals; (2) the identified importance of sound in the lives of marine mammals; (3) the potential for harm from excessive noise; and (4) the paucity of data with regards to the amount of sound introduced into the oceans by human activity and its potential impact on marine mammals (National Research Council of the National Academies, 2003).

The NRC's report recommended the establishment of 'noise budgets', defined as the sum of the relative contributions made by identified sound sources to the total sound field (National Research Council of the National Academies, 2003). The report further recommended that 'noise budget' determinations for various parts of the ocean should include representations of seasonal and spatial/temporal differences. Finally, the NRC specifically identified the need to define the sound contribution of different vessel types within the major category of shipping. While the report's focus was global, many of its insights and recommendations are applicable at the sanctuary level to provide a local understanding of the issue. Insights achieved at the local level can then be used to inform the larger issue at national and international levels.

Numerous anthropogenic sources of underwater sound produced both within and in the waters surrounding SBNMS contribute to the sanctuary's ambient noise budget. Commercial, recreational, military and research vessels all contribute to ambient underwater noise in the sanctuary, whether directly through their marine operations (e.g., engines, props and electronics) or indirectly through the activities they perform (e.g., towing and dredging). Whales are known to aggregate in and near the existing traffic separation scheme (i.e., shipping lanes to and from the Port of Boston) and their long-term acoustic exposure to vessel traffic may represent a source of chronic impact. The operations of fishing vessels regularly overlap the distribution of cetaceans in the sanctuary and may be an additional source of repeated acoustic disturbance. In addition, some vessels, such as commercial and private whale watching boats, preferentially expose large whales to noise as a byproduct of routine and frequent close approaches, creating another opportunity for chronic exposure. Finally, because low-frequency sounds from industrial and commercial activities taking place or proposed within the waters of Massachusetts and Cape Cod Bays, and even the greater GoM, can retain their intensities over long distances, such activities contribute or will contribute to the levels of low frequency sound in the sanctuary.

Characterizing the status of the sanctuary's acoustic environment and identifying potential threats to sanctuary resources are essential, both to meeting the NMSA objectives for each site and to developing partnerships both within NOAA and between agencies to implement ecologically-holistic, ecosystem-based management of sanctuary resources. The following strategies provide the framework to assess and mitigate anthropogenic noise in SBNMS occurring at levels: (1) where behavioral disturbance is clearly evident; and (2) when behavioral disturbance is not apparent, but where animals have habituated to detrimental noise levels.

Strategies (3) To Reduce Marine Mammal Behavioral Disturbance and Harassment by Noise

(2.1) Establish a Marine Noise Consortium to identify noise sources and possible effects. The sanctuary will sponsor a Marine Noise Consortium (or work with other potential sponsoring agencies or institutions) to examine and promulgate research on noise in and around the sanctuary and its effects on marine mammals. Recognizing the need for independent targeted research and for maintaining the scientific integrity of data sets, members of the Marine Noise Consortium would agree to partner with the sanctuary and would make raw data available through an established data-use policy.

<u>Priority</u>: High
<u>Status</u>: Ongoing

(2.2) Develop a marine acoustics research program to establish baseline noise levels and long-term noise budgets. Measure and evaluate baseline values and variation in background noise levels from sources (activities) within or propagating into the sanctuary. The marine acoustic research program should be an extension of the sanctuary's current ocean observing system (2005) for large scale monitoring and mapping of noise within SBNMS, identifying noise sources and evaluating potential impact on marine mammals.

<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

2.2.1 Install and monitor a hydrophone array on the seafloor covering at least 50% of the sanctuary area and maintain and manage the resulting data set to: (1) determine current noise levels; (2) monitor and document long-term noise budgets; and (3) provide a record of noise levels coincident with critical events such as ship strikes and cetacean strandings to evaluate the potential impact from specific noise sources on marine mammals.
<u>Status</u>: Ongoing

2.2.2 Implement a tagging program to evaluate the potential for acoustic exposure and animal responses to acoustic stimuli.
<u>Status</u>: Ongoing

(2.3) Develop a policy framework for investigating and mitigating noise impacts within SBNMS. Given increased scientific and public concern over the impact of anthropogenic sounds on marine mammals, develop a marine acoustics policy framework for SBNMS that: (1) addresses the potential for harm to marine mammals from excessive noise; (2) contends with the paucity of data on the amount of sound introduced into the oceans by human activity and its associated impacts on marine mammals; (3) identifies opportunities for collaboration with sound producers (e.g., vessel owners/operators) in mitigating and/or monitoring their impacts on sanctuary resources; and (4) highlights the possible utility of sanctuaries as case studies for establishing domestic and international policies pertaining to noise in the marine environment.

<u>Priority</u>: High
<u>Status</u>: Ongoing

MMBD.3 Objective—Reduce Marine Mammal Behavioral Disturbance and Harassment by Aircraft

Background. Submarine sound levels generated by aircraft overflight depend on receiver depth underwater and altitude, aspect and strength of the noise source. The auditory systems of baleen whales are thought to be sensitive to low-frequency underwater sounds, based on the predominantly low frequency of their calls, their auditory anatomy and their observed reactions to various low frequency sounds (*Ketten, 2000*).

In contrast, dolphins have insensitive underwater hearing below 1 kHz, but acute hearing at frequencies greater than 10 kHz. Dolphins received levels of low-frequency tones 18 meters below the sea surface from aircraft flying directly overhead at an altitude of 160 meters; these tones were well below their auditory thresholds and presumably inaudible (*Ketten, 2000*). Acoustic research associated with overflight noise should be directed at acoustic impacts on large baleen whales in the sanctuary.

SBNMS has no overflight restrictions and no studies on aircraft disturbance have been conducted in the sanctuary area. Overflight concerns include fixed-wing aircraft, helicopter and airship disturbance. The lack of overflight restrictions may result in undue disturbance to marine mammals.

Strategies (2) To Reduce Marine Mammal Behavioral Disturbance and Harassment by Aircraft

(3.1) Identify information gaps and gather data on overflight activities to determine whether they disturb marine mammals. No studies on aircraft disturbance due to overflight have been conducted in the vicinity of SBNMS and no baseline data exist.

Priority: Low
Status: Ongoing
Activities:

3.1.1 Work with the FAA to produce a descriptive database to document and portray overflight patterns in the vicinity of SBNMS by planes, helicopters, airships and other aircraft.
Status: Planned, 2010

(3.2) Develop outreach materials or messages with NOAA Fisheries Service to inform the aviation community regarding overflight in proximity to whales. There are no site-specific overflight regulations in SBNMS. However, the NOAA Northeast Regional Guidelines on approach to marine mammals cover both vessels and aircraft (see Background MMBD 1). The NOAA approach guidelines stipulate that aircraft should maintain a minimum altitude of 1,000 feet over water. Additionally, the Code of Federal Regulations (50 CFR 224.103 (c)) for North Atlantic right whales prohibit "approach (including by interception) within 500 yards (460 meters) of a right whale by vessel, aircraft, or any other means." The NOAA approach guidelines and regulations are not reflected in FAA publications.

Priority: Low
Status: Planned, 2009
Activities:

3.2.1 NOAA National Ocean Service and NOAA Fisheries Service should approach the FAA to change FAA Overflight Regulations Title 14, Part 91 Subpart B (Flight Rules) section 91.119 (c). The flight rule reads: "(c) *Over other than congested*

Table 48. Estimated costs for MMBD action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Develop and implement management measures that mitigate behavioral disturbance and risk to whales due to vessel speed and close approach	35.0	50.0	50.0	50.0	50.0	235.0
(1.2) Develop a process to consider prohibiting vessels from transiting through humpback whale bubble clouds and/or nets.	0.0	2.0	2.0	1.0	1.0	6.0
(1.3) Conduct risk assessment on other activities that could disturb marine mammals.	0.0	0.0	0.0	0.0	0.0	0.0
(1.4) Develop a research program to better understand vessel interactions with whales.	0.0	175.0	175.0	175.0	100.0	625.0
(2.1) Establish a Marine Noise Consortium to identify noise sources and possible effects.	5.0	4.0	4.0	4.0	4.0	21.0
(2.2) Develop a marine acoustics research program to establish baseline noise levels and long-term noise budgets.	65.0	250.0	250.0	250.0	150.0	965.0
(2.3) Develop a policy framework for investigating and mitigating noise impacts within SBNMS.	75.0	75.0	75.0	0.0	0.0	225.0
(3.1) Identify information gaps to gather additional data on overflight activities to understand the potential disturbance of marine mammals.	0.0	0.0	0.0	0.0	0.0	0.0
(3.2) Develop outreach materials or messages with NOAA Fisheries Service to inform the aviation community regarding overflight in proximity to whales.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**180.0**	**556.0**	**556.0**	**480.0**	**305.0**	**2,077.0**
*Cost estimates exclude federal labor costs.						

Table 49. Performance measures for MMBD action plan.

Performance Measures	Means of Evaluation	Baseline	NMSP Measure
Desired Outcome(s) For This Action Plan			
The behavioral disturbance and harassment of marine mammals by human activities is minimized.			
By 2010, the sanctuary will develop and implement a whale watching management program that reduces the risk of behavioral harassment.	Management measures will be in effect that could include regulatory controls, certification requirements, special use permitting and partnership accords.	Number of management measures: 1 (approach guidelines and MMPA and ESA)	Protect Resources
By 2009, SBNMS will complete implementation of a noise-monitoring program covering 50-85% of the sanctuary, with a representative noise budget subsequently being calculated within two-five years.	SBNMS will deploy up to ten Automatic Recording Units (ARUs) for at least 12 months with data collected, managed, and analyzed.	Number of ARUs : 0	Site Characterization
By 2011, SBNMS will complete most fieldwork and analyses associated with non-invasive whale tagging projects.	Data analyses will provide a more continuous record and understanding of whale behavior relative to vessels and noise.	Number of completed studies: 0	Protect Resources

areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure." FAA should consider revising the rule, for example, to delete the word 'or' following the word 'vehicle' and insert "or marine mammal, except where more restrictive regulations prevail." The agency differences in minimum overflight altitude also need to be addressed and resolved.
Status: Planned, 2010

3.2.2 Work with pilot associations to include SBNMS notation and current NOAA Fisheries Service Northeast Region overflight guidelines on aeronautical charts and information materials.
Status: Planned, 2010

3.2.3 Evaluate the need for sanctuary regulations to govern the operation of airplanes, helicopters, airships, and other aircraft in the presence of marine mammals.
Status: Planned, 2010

Marine Mammal Vessel Strike Action Plan

Issue Statement

The Marine Mammal Vessel Strike (MMVS) Action Plan (AP) makes recommendations to reduce the risk of collision between vessels and marine mammals that cause injury or mortality to the animals, harm to operators and damage to vessels. Ship strikes represent one of the two major threats that are likely to prevent the recovery of critically endangered North Atlantic right whales and endangered humpback whales. Efforts in the U.S. have attempted to slow vessel speeds and to create an 'early warning system' to inform mariners of locations of right whales. Despite efforts to date, vessel strikes continue to kill and injure right whales at a level that compromises the species' survival. Concern in recent years has intensified as marine traffic has come to involve larger and faster vessels.

Goal

The goal of the MMVS AP is to assess the occurrence and potential of collision to marine mammals; determine the means to mitigate collision through research, education and appropriate management; and foster cooperation with cross-jurisdictional agency partners that affect marine mammals.

Objectives

The MMVS AP has three objectives and associated strategies to reduce collision, and the potential for collision, to marine mammals by commercial ships as well as those vessels not actively engaged in approaching whales for viewing (Table 50). [Note: Vessels actively engaged in viewing are discussed in Objective MMBD.1.]

- MMVS.1—Reduce Risk of Vessel Strike between Large Commercial Ships and Whales
- MMVS.2—Reduce Risk of Vessel Strike through Speed Restrictions
- MMVS.3—Support and Develop Research Programs to Reduce the Risk of Vessel Strike

The estimated costs for implementation of the MMVS AP are indicated in Table 51. The performance measures are listed in Table 52.

Table 50. Objectives, associated strategies, and priorities for MMVS action plan.		
Objective	**Strategy**	**Priority**
MMVS.1 Reduce the Risk of Vessel Strike between Large Commercial Ships and Whales	(1.1) Consult with NOAA Fisheries Service on their proposed strategy to reduce ship strike to North Atlantic right whales and evaluate how such measures would affect the sanctuary.	High
	(1.2) Develop, demonstrate and evaluate the SBNMS Information and Reporting Center.	High
	(1.3) Determine the conservation benefit of reconfiguring the existing Traffic Separation Scheme (TSS) within the sanctuary to reduce the risk of ship strike to whales.	High
MMVS.2 Reduce the Risk of Vessel Strike through Speed Restriction on Vessels	(2.1) Institute year-round voluntary speed restrictions for all vessels operating in the sanctuary.	High
MMVS.3 Support and Develop Research Programs to Reduce the Risk of Vessel Strike	(3.1) Work with NOAA Fisheries Service to support their ongoing database of all known vessel strikes in and around the sanctuary.	High
	(3.2) Work with NOAA Fisheries Service to institute a toll free number to enable callers to anonymously report vessel strikes in the sanctuary.	Medium
	(3.3) Investigate research strategies to determine responses of whales to approaching vessels.	High
	(3.4) Conduct year-round monitoring to identify type, size, route and speed of vessels in the sanctuary.	High
	(3.5) Investigate use of forward-looking sonar or other real-time detection technologies.	Low

Background. Data from Jensen and Silber (2003) indicate that the SBNMS area is a 'hot spot' for vessel strikes along the eastern seaboard of the United States, with approximately nine percent (26/292) of the world-wide data reported from the sanctuary area (including Cape Cod Bay and Boston Harbor).[1] In SBNMS, reported vessel collisions occur with four endangered species (humpback, finback, sei and North Atlantic right whales) and one protected species (minke whales). Most strikes involve humpback whales (39%, 13/33) and fin whales (27%, 9/33).[2] Notably, vessel strikes are the leading cause of human-induced mortality in critically endangered right whales (Knowlton *et al*., 2001).

Vessel strikes in the sanctuary are reported throughout the year. However, 76% (25/33) occur between May and August, a time when whales and opportunistic observations increase; 39% (13/33) of these reported strikes resulted in mortality or serious injury. Commercial whale watch vessels were involved in 27% (9/33) of the strikes; private recreational boats were involved with 12% (4/33); and, large commercial ships (e.g., container ship or ferry) struck 9% (3/33) (Jensen and Silber, 2003). Observations of ship struck whales, other than those actually hit by commercial whale watching vessels, are not biased by observations made possible by observers on whale watching trips because most records are generated from beach cast carcasses or carcasses floating at sea.

Possible factors contributing to vessel strikes include: (1) the density of whales and vessels; (2) the ability of whales and vessel operators to detect each other; and (3) the ability of whales or vessel operators to maneuver to avoid collisions. Any type of vessel is capable of causing a fatal strike, but the intensity of the collision depends on the size (tonnage) of the vessel and the speed at which it is traveling.

Where vessel type is known, the majority of reported whale collisions on a world-wide basis are from the U.S. Navy/USCG (14.9% of the 292 strikes) and commercial whale watch boats (14.2% of the 292 strikes) (Jensen and Silber, 2003). These data are affected by disproportionate reporting. For example, it is standard operating practice for the U.S. Navy and USCG to report a strike, and commercial whale watch vessel operators or passengers are more likely to be aware of, and report, a collision than other sources.

Apart from this information, there is a paucity of specific data regarding vessel collisions with whales, as the vast majority of strikes go undetected or unreported. When whale mortality is recognized as resulting from vessel strike, (i.e., as determined by necropsy of a beached whale) identifying the specific vessel or vessel type is difficult.

MMVS.1 Objective—Reduce the Risk of Vessel Strike between Large Commercial Ships and Whales

Background. Large commercial ships—defined as those vessels with a weight of greater than 300 gross tons, or tugs and barges with a combined weight of more than 300 gross tons—represent a distinct class of vessels. Large commercial

1 These numbers do not include information from supplemental sources.

2 Investigations of the sanctuary working group on this issue identified additional vessel strike events that occurred between 1984 and 2003 that were not included in Jensen and Silber (2003). Therefore this analysis is based on 33 events, as opposed to the 26 contained in Jensen and Silber (2003). These data are presented in Exhibit MMVS.1 of the Marine Mammal Vessel Strike Working Group report posted on the sanctuary website.

ships are separated from other vessel types due to issues of maneuverability (i.e., their inability to take sudden actions to avoid collisions with whales).

Strategies (3) To Reduce the Risk of Vessel Strike between Large Commercial Ships and Whales

(1.1) Consult with NOAA Fisheries Service on their proposed strategy to reduce ship strike to North Atlantic right whales and evaluate how such measures would affect the sanctuary. North Atlantic right whales are critically endangered and should be accorded special consideration. NFS has developed a Right Whale Ship Strike Reduction Program to reduce collision risk between right whales and commercial ships while minimizing adverse impacts on the shipping industry. Possible plans involving SBNMS include a nearby "area to be avoided" on the eastern side of Cape Cod Bay during the winter and early spring, and speed limitations for all vessels 65 feet and over in an area north of Race Point (including a portion of the sanctuary) from 1 April to 15 May.

Priority: High
Status: Ongoing
Activities:

1.1.1 SBNMS should review the adequacy of risk reduction measures contained in the NOAA Fisheries Service vessel strike risk reduction plan for North Atlantic right whales. If review finds the plan inadequate to reduce risk to right whales in SBNMS, then the sanctuary should make recommendations to strengthen risk reduction measures.
Status: Ongoing

(1.2) Develop, demonstrate and evaluate the SBNMS Information and Reporting Center. The SBNMS should create a pilot project to assess the feasibility of developing the SBNMS Marine Mammal Information and Reporting Center (MMIRC) based on use of the Automatic Identification System (AIS). The project would: (1) investigate the ability of the MMIRC to identify and provide information to ships entering the SBNMS; (2) identify the actions of the vessels based on the information provided; (3) assess the adequacy of whale sighting and reporting information; and (4) evaluate the efficacy of the MMIRC for reducing the risk of vessel/whale collisions. If the pilot project determines the MMIRC to be an effective way of reducing risk of collision, the sanctuary should consider establishing the program as an ongoing management tool.

Priority: High
Status: Planned, 2009

(1.3) Determine the conservation benefit of reconfiguring the existing Traffic Separation Scheme (TSS) within the sanctuary to reduce the risk of ship strike to whales. An effective way to reduce vessel collisions with whales is to separate them in space and/or time. Moving the TSS in the sanctuary from high whale use areas to low use areas would achieve that objective.

Priority: High
Status: Completed[3]

Activities:

1.3.1 Conduct analyses to determine whether safer routes could be recommended for large commercial ship passage through the SBNMS. Identify routing to reconfigure the existing TSS into the Port of Boston and, thereby, reduce potential whale strikes by large commercial vessels transiting the sanctuary.
Status: Completed

1.3.2 Collaborate with the NOS General Counsel International, NOAA Fisheries Service and the USCG to develop a proposal to the International Maritime Organization (IMO) to reconfigure the current TSS and reduce the potential for whale strikes by large commercial vessels transiting the sanctuary.
Status: Completed

MMVS.2 Objective—Reduce the Risk of Vessel Strike by Speed Restrictions

Background. Fast moving vessels pose inherent risks to marine mammals and other sanctuary resources. The SBNMS wants to consider a range of ways to restrict vessel speed to prevent interactions with and damage to those resources. The sanctuary also wants to evaluate a range of speeds that may be appropriate under different conditions while recognizing that vessel safety considerations are important.

When right whales and, in some instances, other endangered whales are known to be present in an area, NOAA Fisheries Service and the USCG issue notices to mariners requesting that they travel at 10 knots or less. Such notices are based on knowing the presence of endangered whales and are ephemeral as whales move.

The SBNMS is considering developing generic voluntary speed restrictions that would apply to all vessels operating within the sanctuary. These would likely allow for faster speeds than specific guidance when endangered whales are known or likely to be present. At those times, the more restrictive speed limits would apply. Voluntary SBNMS restrictions would augment measures by (1) NOAA Fisheries Service (i.e., measures to reduce interactions between North Atlantic right whales and large commercial ships), and (2) possible SBNMS speed controls/restrictions addressing marine mammal behavioral disturbance by whale watching and other vessels (see Strategy MMBD 1.1). The sanctuary would review and evaluate the effectiveness of the voluntary speed restriction at the end of five years or sooner if new information becomes available.

Strategy (1) To Reduce the Risk of Vessel Strike across all Vessel Categories

(2.1) Institute year-round voluntary speed restrictions for all vessels operating in the sanctuary. Examination of available data on vessel speeds representing customary practice in the sanctuary indicates that 20 knots is an approximate mean maximum cruising speed for most whale watch vessels, commercial fishing boats, party and charter fishing

[3]Refer to vessel strike subsection on p. 114 for explanation.

vessels, and many of the larger personal recreation boats. Data examined include 20-year records maintained by the Whale Center of New England for the commercial whale watch fleet and recent preliminary evaluation of Automatic Identification System vessel tracks for large commercial vessels collected by SBNMS.

A voluntary recommendation to reduce all vessel speeds throughout the year in SBNMS waters would serve to complement proposed regulations by NOAA Fisheries Service as analyzed in the Draft Environmental Impact Statement (DEIS) to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy and NOAA Fisheries Service and USCG notices to mariners. The proposed regulations would apply to non-federally owned or operated vessels that are over 65 feet in length. Speed reductions would be largely restricted to areas and time periods in Northeast waters when right whales, based on visual sighting records, are predicted to be most prevalent.

Two of the proposed Seasonal Management Areas in the ship strike proposed regulations overlap the SBNMS, and would result in speed restrictions within a maximum of 63% of the sanctuary during 2 months of the year and have no coverage in the sanctuary during 7.5 months of the year. The SBNMS's collaborative passive acoustic research efforts with NOAA Fisheries Service (NEFSC and NERO) and Cornell University's Bioacoustics Research Program is providing increasing evidence that right whales predictably utilize sanctuary waters during periods and within areas for which proposed speed restrictions would not apply. In addition, the SBNMS is concerned with risks of injury associated with smaller vessel traffic operating at higher overall speeds and largely outside of the recently shifted TSS. Thus, year-round generic guidelines for all vessels operating within the sanctuary would supplement NOAA Fisheries Service's ship strike strategy within sanctuary waters.

The voluntary speed restriction complements a suite of possible management actions that if implemented would lower the risk of collision further. These include: (1) requiring vessels to reduce speed within proximity of whales (see Strategies MMBD 1.1 and MMVS 1.1); (2) prohibiting vessels from transiting through humpback whale bubble clouds and/or nets (see Strategy MMBD 1.2); (3) realigning the TSS in the sanctuary (see Strategy MMVS 1.3); and, (4) vessel speed restrictions implemented through NOAA Fisheries Service's North Atlantic Right Whale Ship Strike Reduction Strategy. Implementation of this voluntary speed restriction would be by means of Strategy POE 1.2.

Priority: High

Status: Planned, 2009

MMVS.3 Objective—Support and Develop Research Programs to Reduce the Risk of Vessel Strikes

Background. There is a paucity of detailed data regarding vessel collisions with whales. In order to minimize the risk of collision to whales, it is important that the sanctuary gain a greater understanding of the nature of the risk to both the

Table 51. Estimated costs for MMVS action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Consult with NOAA Fisheries Service on their proposed strategy to reduce ship strike to North Atlantic right whales and evaluate how such measures would affect the sanctuary.	0.0	0.0	0.0	0.0	0.0	0.0
(1.2) Develop, demonstrate and evaluate the SBNMS Information and Reporting Center.	20.0	15.0	25.0	10.0	10.0	80.0
(1.3) Determine the conservation benefit of reconfiguring the existing TSS within the sanctuary to reduce the risk of ship strike to whales.	0.0	0.0	0.0	0.0	0.0	0.0
(2.1) Institute year-round voluntary speed restrictions for all vessels operating in the sanctuary.	5.0	5.0	0.0	0.0	0.0	10.0
(3.1) Work with NOAA Fisheries Service to support their ongoing database of all known vessel strikes in and around the sanctuary.	0.0	0.0	0.0	0.0	0.0	0.0
(3.2) Work with NOAA Fisheries Service to institute a toll free number to enable callers to anonymously report vessel strikes in the sanctuary.	0.0	1.0	1.0	1.0	1.0	4.0
(3.3) Investigate research strategies to determine responses of whales to approaching vessels.	0.0	175.0	175.0	175.0	100.0	625.0
(3.4) Conduct year-round monitoring to identify type, size, speed, and route of vessels in the sanctuary.	50.0	25.0	25.0	25.0	25.0	150.0
(3.5) Investigate use of forward-looking sonar or other real-time detection technologies.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**75.0**	**221.0**	**226.0**	**211.0**	**136.0**	**869.0**
*Cost estimates exclude federal labor costs.						

Table 52. Performance measures for MMVS action plan.			
Desired Outcome(s) For This Action Plan			
The occurrence of vessel collisions with marine mammals is minimized.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, SBNMS will monitor 100% of large ships (>300 gross ton) traversing the Sanctuary, including their location, speed, time of arrival at and departure from port.	SBNMS will track ship traffic traversing the sanctuary using Automatic Identification System (AIS) data and analyze compliance with ship strike mitigation strategies (NMFS.)	Percent of large ships being monitored: 0	Living Marine Resources
By 2008, SBNMS will propose new routing measures for large ships to reduce by 50% or more the risk of ship strikes to large whales in the Traffic Separation Scheme (TSS) for the Port of Boston	SBNMS will keep track of the development of new routing measures in collaboration with the U.S. Coast Guard and the IMO.	Present risk of ship strikes within the TSS (as measured by the number of whales seen in the TSS).	Living Marine Resources
By 2009, SBNMS will institute voluntary speed restrictions for all vessels operating in the sanctuary.	SBNMS will track vessel speed remotely by AIS and on-the-water monitoring.	Existing speed controls (other than whale watch approach guidelines): 0	Living Marine Resources

whales and vessels. This can be accomplished by investigating the behavior of whales, the behavior of ships, and their behavioral interaction.

Strategies (5) To Support and Develop Research Programs to Reduce the Risk of Vessel Strikes

(3.1) Work with NOAA Fisheries Service to support their ongoing database for all known vessel strikes in and around the sanctuary. It is necessary to continue monitoring and recording vessel strikes to determine trends and develop detailed baselines to assess effectiveness of management actions.

Priority: High
Status: Ongoing

(3.2) Work with NOAA Fisheries Service to institute a toll free number to enable callers to anonymously report vessel strikes in the sanctuary. Currently, an 800-number is not available to the public to assist the reporting of vessel strikes.

Priority: Medium
Status: Planned, 2008

(3.3) Investigate research strategies to determine responses of whales to approaching vessels. Research is needed to understand how whale behavior relates to the probability of vessel collisions. Such information would help prescribe management approaches to mitigate the risk of vessels striking whales.

Priority: High
Status: Ongoing

(3.4) Conduct year-round monitoring to identify type, size, route and speed of vessels in the sanctuary. The sanctuary will continue periodic trackline survey studies to monitor the spatial and temporal distribution of whales and all vessel types in the sanctuary; it will continue to implement its AIS to record speed and routing of large commercial ships in real time and to archive data acquired for systematic analysis; and it will monitor trends in vessel use (e.g., vessel types and numbers using the sanctuary, new vessel designs, etc.) over years.

Priority: High
Status: Ongoing

(3.5) Investigate use of forward-looking sonar or other real-time detection technologies. This effort would notify vessels of whales in their path; however, potential issues of concomitant behavioral harassment would have to be addressed.

Priority: Low
Status: Planned, 2010

Marine Mammal Entanglement Action Plan

Issue Statement

The Marine Mammal Entanglement (MME) Action Plan (AP) makes recommendations to reduce the risk of entanglement of marine mammals in fishing gear in the sanctuary. The concern extends to sea turtle and sea bird entanglement. The immediate effects of entanglement can include mortality, serious injury, minor injury, or possibly no injury. The long-term effects can include deteriorating health, behavioral disruptions, decreased reproductive ability, or may have no impact.

Goal

The goal of the MME AP is to assess and minimize the risk of entanglement of marine mammals, sea turtles and sea birds in the sanctuary; promote methods to successfully disentangle animals; foster cooperation with cross-jurisdictional agency partners; and educate sanctuary users regarding the issue.

Objectives

The MME AP has three objectives and associated strategies to improve the success of disentanglement efforts and to reduce the risk of entanglement of marine mammals (Table 53).

- MME.1—Aid Disentanglement Efforts
- MME.2—Reduce Marine Mammal Interaction with Trap/Pot Fisheries
- MME.3—Reduce Marine Mammal Interaction with Gillnet Fisheries

The estimated costs for implementation of the MME AP are indicated in Table 54. The performance measures are listed in Table 55.

Table 53. Objectives, associated strategies, and priorities for MME action plan.		
Objective	**Strategy**	**Priority**
MME.1 Aid Disentanglement Efforts	(1.1) Maximize the degree to which entangled animals in the sanctuary are sighted and reported.	High
	(1.2) Maximize ability of vessels and aircraft to stand-by entangled animals.	High
	(1.3) Undertake activities leading to improved understanding and prevention of entanglement events in SBNMS and improvements in disentanglement technology.	Medium
MME.2 Reduce Marine Mammal Interaction with the Trap/Pot Fishery	(2.1) Obtain gear modifications.	High
	(2.2) Serve as test-bed to develop and demonstrate low-risk fishing gear.	Medium
MME.3 Reduce Marine Mammal Interaction with the Gillnet Fishery	(3.1) Obtain gear modifications.	High
	(3.2) Develop research programs.	Medium

MME.1 Objective—Aid Disentanglement Efforts

Background. Entanglement in fishing gear is a primary threat to endangered, threatened and protected whales in the western North Atlantic. While it is not always apparent where a whale became entangled, there is a high co-occurrence of baleen whales and fixed fishing gear within the sanctuary (Wiley *et al*., 2003). Since 1985, 57 confirmed large whale entanglements have been reported within the SBNMS boundaries including a five-mile buffer around the borders (Morin, personal communication, 2004; NFS Large Whale Entanglement Reports).

The marine mammal species reported to interact with fisheries include: baleen whales and trap (e.g., lobster, crab, and hagfish) and gillnet fisheries; small cetaceans (e.g., harbor porpoise or white-sided dolphin) and gillnet fisheries; and pinnipeds (e.g., harbor seals) and gillnet and trap fisheries. Because of potential impacts to marine mammals from entanglements, most fixed-gear fishermen (e.g., trap and gillnet fisheries) are required under Federal Take Reduction Plans to use modified gear and comply with time and area closures to reduce entanglements.

Approximately half (48-65%) of Gulf of Maine (GOM) humpback whales (Robbins and Mattila, 2001) and three quarters (76%) of critically endangered North Atlantic right whales (Knowlton *et al*., 2005) display scars indicative of past entanglement. Seabirds and sea turtles are also at risk. Entanglements can result in fatalities due to drowning, infection, restricted mobility, starvation and stress. Entanglement can potentially reduce the reproductive success of animals surviving the event (Robbins and Mattila, 2001).

In some cases, whales can be released from entanglements. This process is known as "disentanglement" and NOAA Fisheries Service authorized the Atlantic Large Whale Disentanglement Network (ALWDN) to facilitate disentanglement success. The Provincetown Center for Coastal Studies (PCCS) holds a NOAA Fisheries Service permit (as part of ALWDN) to disentangle large whales and operates a disentanglement network with NOAA Fisheries Service along the entire eastern seaboard of the United States. Disentanglement success is highly dependent on vessels maintaining contact with or 'standing-by' entangled animals. Without such stand-by, disentanglement teams have great difficulty relocating animals reported as entangled, greatly increasing the cost and risk of the effort.

Seventy-four percent of entangled whale sightings originate from the commercial whale watch fleet. Other reporting groups include fishermen, aerial surveys and existing entanglement network members (D. Morin, personal communication, 2004). Disentanglement can be aided by sanctuary-specific efforts such as increasing sighting and reporting efficiencies, and by developing incentives (or requirements) that increase the likelihood that passing vessels will stand-by entangled whales.

Public scoping comments indicated that marine mammal entanglement in the SBNMS was a serious problem and suggested that fishermen should be involved in the mitigation process. The sanctuary will work in partnership with various agencies, industries and organizations to report and respond to entangled whales. This effort will increase the degree to which entangled whales within the SBNMS are sighted, reported, and assisted.

Strategies (3) To Aid Disentanglement Efforts

(1.1) Maximize the degree to which entangled animals in the sanctuary are sighted and reported. Animals can only be released from gear if they have been observed and then reported to the proper authorities. The sanctuary should develop policies and practices that encourage the sighting and reporting of entangled animals. In addition, a complete record of entanglements is needed to properly document the severity of the problem and to implement timely mitigation measures.

<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

1.1.1 Collaborate with NOAA Fisheries Service NERO and Massachusetts Division of Marine Fisheries (MADMF) to develop a mechanism that allows commercial whale watching vessels operating under the proposed SBNMS special use permit (see Activity MMBD 1.1.5), if that system is set up, to approach right whales within the 500-

yard exclusion zone for the purpose of assessing possible entanglement and identifying individuals through photo-identification procedures.
Status: Planned, 2009

(1.2) Maximize ability of vessels and aircraft to stand-by entangled animals. Without adequate capacity to track the location of an entangled animal, visible contact with the animal may be lost, rendering disentanglement impossible.

Priority: High
Status: Planned, 2008
Activities:

1.2.1 Convene a meeting of the PCCS, NOAA Fisheries Service NERO, commercial whale watch operators, and naturalists to provide training and informational materials for standing by entangled whales.
Status: Planned, 2008

1.2.2 Provide incentives for commercial whale watch boats to stand-by an entangled whale for a minimum of 45 minutes as a means to ensure adequate documentation and to reduce the search area for the network responder. Incentives having potential market value for participating companies may include official certificates of appreciation, photographs of vessels standing by entangled whales, postings on the sanctuary website, etc.
Status: Planned, 2008

1.2.3 Develop a protocol by which research, state or federal government vessels or aircraft working in the SBNMS report their presence to the PCCS and are available to standby.
Status: Planned, 2008

1.2.4 Encourage NFS to continue Level One ('eyes-on-the-water') funding to train the public in order to aid disentanglement efforts through sighting and standing by entangled whales.
Status: Ongoing

1.2.5 Work with NOAA Fisheries Service and NEFMC to allow commercial fishing vessels to stand-by entangled whales without losing Days at Sea (DAS) time. Fishermen can play a critical role in the detection and stand-by of entangled whales in the sanctuary. However, new fishery management regulations to reduce fishing effort limit how much time a fisherman can spend at sea. A fisherman, who stands-by an entangled whale, is using his/her time allotment of DAS, making such stand-by activity unlikely to occur. If time used by fishermen standing-by entangled whales did not count against their DAS allotment, participation by fishermen would be improved.
Status: Ongoing

(1.3) Undertake activities leading to improved understanding and prevention of entanglement events in SBNMS and improvements in disentanglement technology. Activities should be conducted to improve ability to identify gear types involved in specific entanglement events, provide data to support case documentation and lead to improvements in disentanglement technology. All activities involving gear marking would be conducted in collaboration with NOAA Fisheries Service to coordinate with systems already in place.

Priority: Medium
Status: Planned, 2009
Activities:

1.3.1 Investigate a gear marking system to identify the type of gear in which whales are entangled.
Status: Planned, 2009

1.3.2 Work with the appropriate fishery management agencies to require that surface indicators of fishing gear are marked to aid in quick and unambiguous identification of gear type.
Status: Planned, 2010

1.3.3 Partner with PCCS, NOAA Fisheries Service and other parties to support research, development and demonstration of improved disentanglement technology.
Status: Planned, 2010

MME.2 Objective—Reduce Marine Mammal Interaction with the Trap/Pot Fishery

Background. Trap/pot directed fisheries that co-occur with large numbers of baleen whales in the SBNMS are identified entanglement risks (Wiley *et al*., 2003a; 2003b). The American lobster and mixed species (e.g., whelk, hagfish and Jonah crab) trap/pot fisheries, a subset of which occurs within the SBNMS, are classified by NFS as Category I and II fisheries, respectively. Category I fisheries are those that have frequent mortality or serious injury of one or more species of marine mammals. Category II fisheries are those that have occasional mortality or serious injury of one or more species of marine mammals. Marine mammals that are known to or have the potential to interact with these fisheries include four species that utilize the sanctuary: finback whales, humpback whales, minke whales, and North Atlantic right whales—all of which are threatened or endangered, and/or protected.

[Note: When released by NFS, SBNMS should review the adequacy of the risk reduction measures contained in the final Atlantic Large Whale Take Reduction Plan (ALWTRP). If the review indicates that the risk reduction measures are inadequate to reduce risk to large whales in SBNMS, the sanctuary should work through its membership to the ALWTRT process to make recommendations to strengthen the risk reduction measures.]

Strategies (2) To Reduce Marine Mammal Interaction with the Trap/Pot Fishery

(2.1) Obtain gear modifications. The goal of gear modification is to reduce the probability of entanglement and/or reduce serious injury or mortality of large whales that become entangled in trap/pot fisheries. By restructuring the fishing gear or modifying the way it is used, the safety of marine mammals can be increased without restricting access of the fisheries to target resources (e.g., shellfish or finfish).

Priority: High
Status: Planned, 2008
Activities:

2.1.1 Work with the appropriate fishery management agency(s) to promulgate new regulations requiring, within five years, all current and future trap/pot fisheries to use sinking groundline within the SBNMS.
Status: Planned, 2008

2.1.2 Work with the appropriate fishery management agency(s) to promulgate new regulations requiring 600 lb breaking strength of buoy weak links in trap/pot gear fished in SBNMS. This measure would complement existing state and federal regulations applying to the Cape Cod Bay critical habitat for right whales.
Status: Planned, 2008

(2.2) Serve as test-bed to develop and demonstrate low-risk fishing gear. The sanctuary should serve as a test-bed for developing and demonstrating innovative, low-risk fishing gear to reduce the risk of entanglements. Effective gear modification could then be exported to other areas of concern within the Gulf of Maine. For example, the GoM Ocean Observing System (GoMOOS) buoy data were used to provide current values in a study in the sanctuary that looked at the profiles and dynamics of ground-lines and end-lines, both as scaled-models in the laboratory and at full-scale in the field (*Lyman and McKiernan, 2004*).

Priority: Medium
Status: Planned, 2009
Activities:

2.2.1 Conduct surveys to determine areas of potential interaction between marine mammals and fisheries. This effort will serve as the foundation for a risk assessment of entanglement in the sanctuary, and identify high-risk areas where low-risk fishing gear should be tested.
Status: Ongoing

2.2.2 Help develop and demonstrate new low-risk technologies in collaboration with NOAA Fisheries Service, MADMF, fishermen and conservationists. The sanctuary could act as a testing ground for promising new risk-reduction technologies.
Status: Planned, 2010

2.2.3 Assess the feasibility of modifying vertical lines (e.g., breaking strength, number) to minimize the risk of entanglement.
Status: Planned, 2009

MME.3 Objective—Reduce Marine Mammal Interaction with the Gillnet Fishery

Background. NOAA Fisheries Service observer data indicates that several species of pinnipeds (seals) and odontocetes (dolphins and porpoises) are taken incidentally by gillnets within SBNMS. Additionally, large whales are known to interact with gillnets; published and anecdotal evidence indicate that these entanglements occur within the SBNMS (Weinrich, 1999).

NOAA Fisheries Service classifies the northeast sink gillnet fishery as a Category I fishery. Category I fisheries are those which have frequent mortality or serious injury of one or more species of marine mammals. Known marine mammals killed or injured in gillnets include: North Atlantic right whales, humpback whales, Atlantic white-sided dolphins, common dolphins, harbor porpoise and several species of seals, all of which inhabit the SBNMS and some of which are endangered.

Approximately 40 day-boat, gillnet vessels departing from southern Maine to Plymouth, MA, fish primarily in the northern section of the sanctuary (gillnet fishermen's estimate, MME Working Group Action Plan, 2004). Historically, gillnet fishing within SBNMS has occurred year-round, with the height of fishing activity during the summer months. Currently, federal fishing regulations restrict or prohibit gillnet fishing within SBNMS at various times of the year. In order to assess the entanglement risk, the sanctuary should work in partnership with various agencies, industries, and organizations to address and investigate the entanglement risk posed by the northeast sink gillnet fishery.

[Note: To date, NOAA Fisheries Service has not finalized the ALWTRP. SBNMS should review the adequacy of risk reduction measures contained in ALWTRP and the Harbor Porpoise Take Reduction Plan (HPTRP). If the review indicates that the plans are inadequate to reduce risk to marine mammals in SBNMS, sanctuary staff should work through established Take Reduction Teams and with NOAA Fisheries Service to make recommendations to strengthen the risk reduction measures.]

Strategies (2) to Reduce Marine Mammal Interaction with Gillnet Fisheries

(3.1) Obtain gear modifications. The goal of gear modification is to reduce serious injury or mortality of marine mammals entangled by the northeast sink gillnet fisheries. In this way, the safety of marine mammals is increased without restricting access of the fisheries to their target resource.

Priority: High
Status: Planned, 2009
Activities:

3.1.1 Work with NOAA Fisheries Service on an expedited basis to implement gillnet modifications as outlined in the Dynamic Area Management (DAM) requirements consistent with the modifications considered in the ALWTRP's scheme. The modifications would apply to sinking groundlines,

weak link breaking strength, and use of weak links in gillnet panels. The modifications should be required throughout the SBNMS on a year-round basis, not just seasonally.
Status: Planned, 2008

3.1.2 **Work with NOAA Fisheries Service to develop an incentive program for gillnet fishermen to help them convert their gear to incorporate weak links and sinking groundlines.**
Status: Planned, 2009

(3.2) Develop research programs. The sanctuary should serve as a test-bed for innovative research. For example, data from the GoMOOS buoy in the sanctuary were used to provide current values in a study that looked at the profiles and dynamics of groundlines and endlines both as scaled-models in the laboratory and at full-scale in the field (Lyman and McKiernan, 2004). Gear modifications that appear to be functional in this type of controlled setting could be tested within the SBNMS for a more realistic assessment of its operation. Gear modifications found effective within the SBNMS could serve as an example to the Atlantic Large Whale Take Reduction Team for possible use on a regional scale.
Priority: Medium
Status: Planned, 2009
Activities:

3.2.1 **Assess the feasibility of using reduced-strength weak links (e.g., 600 lbs.) in gillnet panels.**
Status: Planned, 2009

3.2.2 **Investigate the feasibility of reducing the vertical profile of gillnets in the water column as an entanglement risk-reduction measure (e.g., tie-downs, fewer vertical meshes, replacing float line with lead line) in collaboration with gillnet fishermen and other agencies.**
Status: Planned, 2009

3.2.3 **Research whale behaviors in the water column to better understand the mechanism of entanglement.**
Status: Ongoing

3.2.4 **Evaluate the risk reduction contributed by harbor porpoise take-reduction measures versus fisheries management time-and-area closures.**
Status: Planned, 2009

3.2.5 **Assess the feasibility of modifying vertical lines (e.g., breaking strength, number) to minimize entanglement risk.**
Status: Planned, 2009

3.2.6 **Develop new low-risk technologies in collaboration with NOAA Fisheries Service, Massachusetts Dept. of Marine Fisheries (MADMF), fishermen and conservationists.** The sanctuary could act as a testing ground for promising new risk-reduction technologies.
Status: Planned, 2010

3.2.7 **Conduct surveys to identify areas of potential interaction between marine mammals and gill net fishing to identify temporal, seasonal, and effort trends.** The survey should identify high-risk times and locations where low-risk fishing gear should be tested.
Status: Ongoing

Table 54. Estimated costs for MME action plan.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Maximize the degree to which entangled animals in the sanctuary are sighted and reported.	0.0	10.0	10.0	10.0	10.0	40.0
(1.2) Maximize ability of vessels and aircraft to stand-by entangled animals.	0.0	0.0	0.0	0.0	0.0	0.0
(1.3) Undertake activities leading to improved understanding and prevention of entanglement events in SBNMS and improvements in disentanglement efforts.	175.0	175.0	175.0	175.0	175.0	875.0
(2.1) Obtain gear modifications.	0.0	0.0	0.0	0.0	0.0	0.0
(2.2) Serve as test-bed to develop and demonstrate low-risk fishing gear.	0.0	0.0	0.0	0.0	0.0	0.0
(3.1) Obtain gear modifications.	0.0	0.0	0.0	0.0	0.0	0.0
(3.1) Obtain gear modifications.	0.0	0.0	0.0	0.0	0.0	0.0
Total Estimated Annual Cost	**175.0**	**185.0**	**185.0**	**185.0**	**185.0**	**915.0**
*Cost estimates exclude federal labor costs.						

Table 55. Performance measures for MME action plan.			
Desired Outcome(s) For This Action Plan			
The entanglement of marine mammals in commercial fishing gear is minimized and methods to successfully disentangle animals are operationalized.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, 85% of detected entangled whales will have vessels standing by until the disentanglement team arrival.	SBNMS will work with the Provincetown Center for Coastal Studies to track the rate of stand by.	Percent of entangled whales having vessels standing by until the disentanglement team arrival: 65	Living Marine Resources
By 2010, 100% of fixed gear fishermen using the sanctuary will be required to use gear that minimizes entanglement risk with marine mammals, as a result of coordination with NMFS.	SBNMS will partner with NMFS, USCG, and MEP to monitor the participation rate of commercial fishermen in programs aimed at replacing fishing gear with low-entanglement-risk gear.	Percent of fixed gear fishermen using the sanctuary that are required to use gear that minimizes entanglement risk with marine mammals: 0	Living Marine Resources

Maritime Heritage Management

1. Maritime Heritage

Maritime heritage focuses on understanding the sanctuary's past maritime landscape. SBNMS sits astride the gateway to historic ports that surround Massachusetts Bay, ports that have been centers of maritime activity in New England for over 400 years since the colonial period. The shipwrecks and submerged archaeological sites in the sanctuary are tangible connections to New England's history; they are nonrenewable gateways to the past that need protection for current and future generations.

The Maritime Heritage (MH) Action Plan affirms NOAA's dedication to conserving America's maritime heritage by conducting scientific research, monitoring, exploration and educational programs. The action plan formalizes the foundation of a maritime heritage program at the sanctuary; addresses the need to systematically inventory, assess, and characterize historical resources; establishes a management framework for protecting maritime heritage resources while facilitating compatible use; focuses attention on interpreting maritime heritage to the public; and responds to historical resources which might be environmental threats.

Maritime Heritage Action Plan

Issue Statement

The Maritime Heritage (MH) Action Plan (AP) makes recommendations for the inventory and assessment of historical resources, the management and protection of historical resources, and MH interpretation. The AP addresses sanctuary-specific historical resource assessment, management, protection, and MH outreach and education requirements; it fulfills the NOAA NMSP and the NOAA Maritime Heritage Program (MHP) strategic plans; and it complies with the President's Preserve America Executive Order (E.O.13287) tasking NOAA with preserving and protecting historic resources in the agency's care, including shipwrecks.

Goal

The goal of the MH AP is to inventory, assess, protect, manage, and interpret prehistoric and historic archeological resources in the sanctuary. Appropriate sites shall be nominated to the National Register of Historic Places (NRHP).

Objectives

The MH AP has five objectives and associated strategies to achieve its goal (Table 56).

- MH.1—Establish a Maritime Heritage Program
- MH.2—Inventory, Assess, and Characterize Historical Resources
- MH.3—Protect and Manage Historical Resources
- MH.4—Develop and Implement a MH Outreach and Education Program
- MH.5—Assess Shipwrecks and other Submerged Objects for Potential Hazards

The estimated costs for implementation of the MH AP are indicated in Table 57. The performance measures are listed in Table 58.

To date, four shipwrecks at three sites in the sanctuary are listed on the National Register of Historic Places.

Table 56. Objectives, associated strategies, and priorities for MH action plan.

Objective	Strategy	Priority
MH.1 Establish a Maritime Heritage Program	(1.1) Develop the foundation and infrastructure for a MH program and integrate the MH program into existing sanctuary programs.	High
	(1.2) Identify and pursue additional sources of funding beyond the NMSP.	High
	(1.3) Identify and form partnerships, relationships, and MOU with entities that have specialized knowledge and abilities that support the documentation and interpretation of the sanctuary's MH.	Medium
MH.2 Inventory, Assess and Characterize Historical Resources	(2.1) Characterize prehistoric and historic use patterns to assist with the location of historical resources through the identification and collection of historical, archaeological, and anthropological documentation.	High
	(2.2) Conduct systematic field surveys to locate, identify, and inventory historical resources.	High
	(2.3) Assess historical resources for their NRHP eligibility and nominate appropriate sites to the NRHP.	High
	(2.4) Characterize historical resources within SBNMS.	High
MH.3 Protect and Manage Historical Resources	(3.1) Implement a management system that protects historical resources while allowing for uses compatible with resource protection.	High
	(3.2) Implement an assessment protocol to assign sanctuary historical resources to the appropriate category.	High
	(3.3) Identify partnerships and relationships for site monitoring and compliance of historical resources permits and regulations.	Medium
	(3.4) Develop and implement an interpretive enforcement program.	High
	(3.5) Develop and implement a mooring buoy system on historical resources in collaboration with affected parties and regional scuba diving charter operators.	Medium
	(3.6) Implement the NMSP Permitting Guidelines for archaeological research (i.e., survey and inventory permit and archaeological research permit).	High
	(3.7) Develop and implement collection and conservation policies for artifacts previously recovered from SBNMS before and after designation.	Low
MH.4 Develop and Implement a Maritime Heritage Outreach and Education Program	(4.1) Identify and partner with regional museums, through MOU/Agreements, to conduct MH exhibits and other outreach programs.	High
	(4.2) Develop and implement an artifact documentation and curation program through partnerships and relationships with local or regional maritime museums.	Low
MH.5 Assess Shipwrecks and Other Submerged Objects for Potential Hazards	(5.1) Establish an inventory of shipwrecks and submerged objects, inside and outside of SBNMS boundaries that may pose environmental threats to resources.	Medium
	(5.2) Coordinate information exchanges pertaining to shipwrecks and other submerged objects as environmental threats with NOAA's HAZMAT division and the NMSP for the development of the SHIELDS and RUST database systems.	Medium
	(5.3) Identify shipwrecks and other submerged sites to be examined with remote sensing technology and report findings to state and federal trustees.	Medium
	(5.4) Establish a monitoring program for shipwreck and submerged sites that have been located and are considered a threat to SBNMS. Develop protocols for site evaluation and a timeline for future site monitoring.	Medium

MH.1 Objective—Establish a Maritime Heritage Program

Background. SBNMS holds a rich variety of historical resources. In the past, fishermen in the sanctuary have recovered paleontological remains representing a period when portions of Stellwagen Bank were dry land during the last ice age approximately 14,000 years ago. These findings suggest that there is also the potential for discovering prehistoric cultural remains. However, most of the known historical resources consist of historic shipwrecks.

Spanning the mouth of Massachusetts Bay, SBNMS represents the current and historic gateway to several of America's oldest ports. Vessels entering and leaving Gloucester, Salem, Boston, Plymouth and Provincetown traversed the sanctuary's waters. As such, historical records indicate that several hundred vessels sank in the vicinity of the sanctuary.

The extent of SBNMS's archaeological inventory is just beginning to be known. Archaeological research has utilized remote sensing technology to locate historical resources. Local researchers have also divulged the locations of several sites, including the *Portland*, *Frank A. Palmer*, and *Louise B. Crary*. In total over a dozen shipwrecks have been located, many of which are potentially eligible for or listed on the NRHP.

The NMSP is placing increased emphasis on the development of MH programs to inventory, assess, manage, and protect heritage sites within the sanctuaries. This AP initiates a comprehensive MH program that will systematically fulfill the NMSA mandate, while fostering cooperative relationships with other groups conducting similar or compatible research.

NMSP regulations (§ 922.3 Definitions) define historical resource as, "Any resource possessing historical, cultural, archaeological or paleontological significance, including sites, contextual information, structures, districts, and objects significantly associated with or representative of earlier people, cultures, maritime heritage, and human activities and events. Historical resources include "submerged cultural resources," and also include "historical properties," as defined in the National Historic Preservation Act, as amended, and its implementing regulations, as amended."

Strategies (3) To Establish a Maritime Heritage Program

(1.1) Develop the foundation and infrastructure for a MH program and integrate the MH program into existing sanctuary programs. This effort will provide a framework for the development, operation and future expansion of SBNMS's maritime heritage program pursuant to the NMSA and in coordination with the National Historic Preservation Act (NHPA). This includes at the least a full-time maritime archaeologist on staff and the familiarization of all SBNMS staff with MH.

<u>Priority</u>: High
<u>Status</u>: Ongoing

(1.2) Identify and pursue additional sources of funding beyond the NMSP. Due to limited funding, it is necessary to pursue external sources of funding to support MH efforts such as: exhibitry; historical, anthropological and archaeological research; archaeological fieldwork; outreach and education; and, curation and conservation.

<u>Priority</u>: High
<u>Status</u>: Ongoing

(1.3) Identify and form partnerships, relationships, and Memoranda of Understanding (MOU) with entities that have specialized knowledge and abilities that support the documentation and interpretation of the sanctuary's MH. Developing relationships will facilitate the documentation and interpretation of the sanctuary MH by bringing together advanced technologies and abilities not otherwise available to the sanctuary.

<u>Priority</u>: Medium
<u>Status</u>: Ongoing

MH.2 Objective—Inventory, Assess and Characterize Historical Resources

Background. The NHPA requires federal agencies, such as NOAA, to inventory historic and archaeological resources under their jurisdiction and to nominate potentially eligible sites to the NRHP. SBNMS will follow the guidelines of the NHPA and the NMSA to methodically research, survey, document, assess, and characterize the heritage resources within its jurisdiction.

Strategies (4) To Inventory, Assess and Characterize Historical Resources

(2.1) Characterize prehistoric and historic use patterns to assist with the location of historical resources through the identification and collection of historical, archaeological, and anthropological documentation. Prior to conducting expensive fieldwork to locate historical resources, SBNMS will expand its knowledge of human use patterns to refine its search methodology.

<u>Priority</u>: High
<u>Status</u>: Ongoing
<u>Activities</u>:

2.1.1 Establish relationships and partnerships with foreign, federal, tribal, state, local, non-governmental and private organizations and individuals to identify historical resources within SBNMS.
<u>Status</u>: Ongoing

2.1.2 Conduct historical, archaeological, and anthropological research to identify potential historical resource locations, including soliciting oral histories and information from divers, researchers, and fishermen.
<u>Status</u>: Ongoing

2.1.3 Establish a spatial database to inventory, assess and characterize historical resources.
<u>Status</u>: Ongoing

(2.2) Conduct systematic field surveys to locate, identify and inventory historical resources. Utilizing research conducted in Strategy 2.1, potential historical resources will be investigated using appropriate methodologies.

Priority: High
Status: Ongoing
Activities:

2.2.1 Establish partnerships and relationships with federal, tribal, state, local, non-governmental and private organizations and individuals to utilize the most sophisticated and appropriate technologies available to conduct historical resource surveys.
Status: Ongoing

2.2.2 Record archaeological site positions in the historical resources database and NOAA's Archaeological Database (ARCH).
Status: Ongoing

2.2.3 Periodically reassess known archaeological sites to record changes to the site from biological and/or anthropogenic processes.
Status: Ongoing

(2.3) Assess historical resources for their NRHP eligibility and nominate appropriate sites to the NRHP. The NHPA requires federal agencies, such as NOAA, to inventory historic and archaeological resources under their jurisdiction and to nominate potentially eligible sites to the NRHP.
Priority: High
Status: Ongoing

(2.4) Characterize historical resources within SBNMS. Characterization synthesizes the results of the inventory and assessment to understand the overall significance of historical resources in the sanctuary and how they relate to broad patterns of history.
Priority: High
Status: Ongoing

MH.3 Objective—Protect and Manage Historical Resources

Background. One of the purposes and policies of the NMSA is "to enhance public awareness and understanding, appreciation, and wise and sustainable use of the marine environment and the natural, historical, cultural, and archaeological resources of the National Marine Sanctuary System." To carry out this policy, SBNMS will develop and implement a maritime heritage management system to provide archaeological sites an increased level of protection from human impacts. To the extent compatible with the primary goal of resource protection, use of these resources will be facilitated by allowing access to appropriate sites and by mitigating the impacts of human uses through permitting.

Strategies (7) To Protect and Manage Historical Resources

(3.1) Implement a management system that protects historical resources while allowing for uses compatible with resource protection. The management system will consist of two parts based on specific goals and criteria. Sanctuary historical resources will be categorized, on a case-by-case basis, as a 'historic site' or a 'heritage preserve' as follows:
Priority: High
Status: Planned, 2009
Activities:

3.1.1 Establish historic sites. A site must be a sanctuary historical resource that may be eligible for or listed on the National Register of Historic Places. The site must be structurally stable, durable and capable of hosting increased visitation without adversely impacting the site's structural or archaeological integrity. Public access will be facilitated to the extent practicable and to the extent compatible with maritime heritage resource protection.

Adequate measures will be developed to protect historic sites from activities that have high potential for harming the sites' archaeological or structural integrity. At a minimum, voluntary guidelines for site avoidance will be issued for traditional and experimental fishing operations. Amendment of sanctuary regulations will be considered to include resource protection measures for historic sites.
Status: Planned, 2009

3.1.2 Establish heritage preserves. A site must be a sanctuary historical resource and be listed on the NRHP. Human activities must have a high potential for negatively impacting the site's archaeological and/or structural integrity. Additional protection for exceptional historical resources having a high degree of fragility and archaeological integrity will be provided.

Heritage preserves will delimit an area around exceptional historical resources within which human activities that have a high potential for harming the sites' archaeological or structural integrity will be restricted or prohibited. Amendment of sanctuary regulations will be considered to include resource protection measures for heritage preserves.
Status: Planned, 2009

(3.2) Implement an assessment protocol to assign sanctuary historical resources to the appropriate category. SBNMS will develop a rigorous site assessment protocol to determine the maritime heritage management category (established in Strategy 3.1) in which a newly discovered sanctuary historical resource should be placed.
Priority: High
Status: Planned, 2009

(3.3) Identify partnerships and relationships for site monitoring and compliance of historical resource permits and regulations. The constant on-the-water presence of state and federal law enforcement agencies, researchers, divers, whale watchers and fishermen extends the sanctuary's surveillance capabilities.
Priority: Medium
Status: Planned, 2009

(3.4) Develop and implement an interpretive enforcement program. Interpretive law enforcement will inform users about the sanctuary and its regulations through the distribution of educational outreach information. A greater MH focused enforcement effort should lead to consistent enforcement awareness and compliance in the sanctuary.

Priority: High
Status: Ongoing

(3.5) Develop and implement a mooring buoy system on historic sites in collaboration with affected parties and regional scuba diving charter operators. Mooring buoys may be emplaced to protect historic sites from anchor damage and facilitate safe scuba diving.
Priority: Medium
Status: Planned, 2009

(3.6) Implement the NMSP Permitting Guidelines for archaeological research (i.e., survey and inventory permit and archaeological research permit). Permits are a management tool to ensure protection of historical resources.
Priority: High
Status: Planned, 2008

(3.7) Develop and implement collection and conservation policies for artifacts previously recovered from SBNMS before and after designation. Policies need to be developed that clarify the disposition of these artifacts and their conservation.
Priority: Low
Status: Planned, 2009

MH.4 Objective—Develop and Implement a Maritime Heritage Outreach and Education Program

Background. MH presents a unique avenue to educate the public about broader cultural themes and traditions of the GoM through the use of websites, exhibits, and other outreach tools. (For additional outreach and education strategies, see the Outreach and Education AP.)

Strategies (2) To Develop and Implement a MH Outreach and Education Program

(4.1) Identify and partner with regional museums, through MOU/Agreements, to conduct MH exhibits and other outreach programs. Partnerships will provide a means for information-sharing to the public and user groups on the importance of resource protection and stewardship ethics.
Priority: High
Status: Ongoing

(4.2) Develop and implement an artifact documentation and curation program through partnerships and relationships with local or regional maritime museums. This program will solicit information from the public and document artifacts previously recovered from the SBNMS.
Priority: Low
Status: Planned, 2009

MH.5 Objective—Assess Shipwrecks and Other Submerged Objects for Potential Hazards

Background. SBNMS is required to identify, assess and monitor MH sites that may pose an environmental threat to resources inside and outside of the sanctuary. Information pertaining to submerged sites as environmental threats is provided to: (1) NOAA's Hazardous Materials (HAZMAT) division; (2) the NMSP for the development of the Sanctuaries Hazardous Incident Emergency Logistics Database System (SHIELDS); and (3) the Resources and Under Sea Threats (RUST) database systems.

Strategies (4) To Assess Shipwrecks and Other Submerged Objects for Potential Hazards

(5.1) Establish an inventory of shipwrecks and submerged objects, inside and outside of SBNMS boundaries that may pose environmental threats to resources. This effort will coordinate with affected and associated parties while taking into account that some of these threats might be historical resources.
Priority: Medium
Status: Ongoing
Activities:

- **5.1.1 Review documentation from established databases.**
  Status: Ongoing
- **5.1.2 Identify, develop, and collaborate with partners doing similar research.**
  Status: Ongoing
- **5.1.3 Interview researchers, divers, and fishermen.**
  Status: Ongoing

(5.2) Coordinate information exchanges pertaining to shipwrecks and other submerged objects as environmental threats with NOAA's HAZMAT division and the NMSP for the development of the SHIELDS and RUST database systems. The SHIELDS and RUST database systems are being developed to provide a clearinghouse for all submerged environmental threats.
Priority: Medium
Status: Ongoing

(5.3) Identify shipwrecks and other submerged sites to be examined with remote sensing technology and report findings to state and federal trustees. Once suspected environmental threats are identified SBNMS will investigate these sites with remote sensing technology.
Priority: Medium
Status: Planned

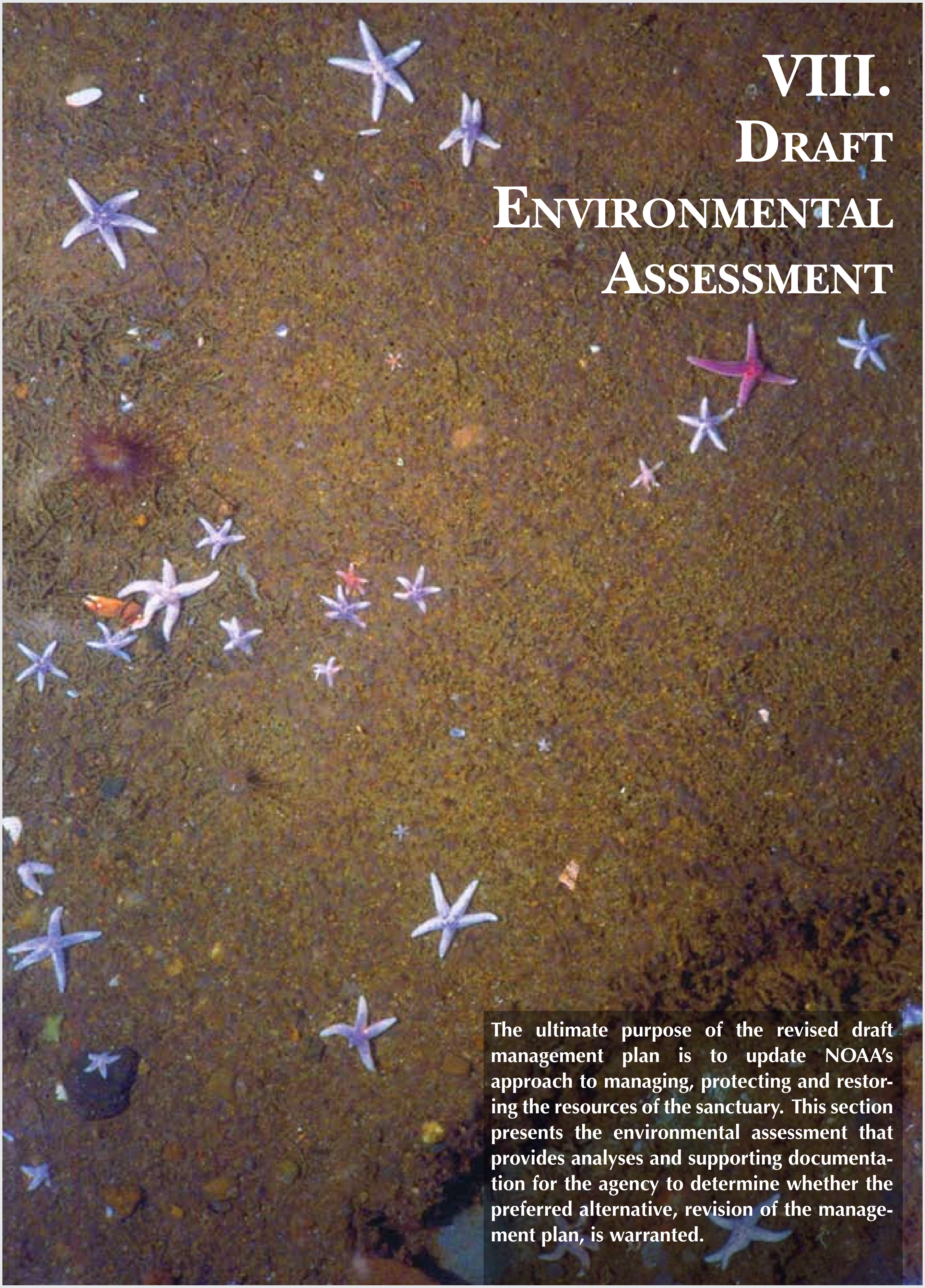
(5.4) Establish a monitoring program for shipwreck and submerged sites that have been located and are considered a threat to SBNMS. Develop protocols for site evaluation and a timeline for future site monitoring. Monitoring of suspected environmental threats will provide the sanctuary with a baseline by which changes to these sites can be assessed and appropriate action taken before environmental damage.
Priority: Medium
Status: Planned

TABLE 57. ESTIMATED COSTS FOR MH ACTION PLAN.

Strategy	Estimated Cost ($000)*					Total Estimated 5 Year Cost
	YR 1	YR 2	YR 3	YR 4	YR 5	
(1.1) Develop the foundation and infrastructure for a MH program and integrate the MH program into existing sanctuary programs.	100.0	100.0	100.0	50.0	50.0	400.0
(1.2) Identify and pursue additional sources of funding beyond the NMSP.	0.0	0.0	0.0	0.0	0.0	0.0
(1.3) Identify and form partnerships, relationships, and MOU with entities that have specialized knowledge and abilities that support the documentation and interpretation of the sanctuary's MH.	0.0	0.0	0.0	0.0	0.0	0.0
(2.1) Characterize prehistoric and historic use patterns to assist with the location of historical resources through the identification and collection of historical, archaeological, and anthropological documentation.	0.0	0.0	0.0	0.0	0.0	0.0
(2.2) Conduct systematic field surveys to locate, identify, and inventory historical resources.	50.0	50.0	50.0	50.0	50.0	250.0
(2.3) Assess historical resources for their NRHP eligibility and nominate appropriate sites to the NRHP.	0.0	0.0	0.0	0.0	0.0	0.0
(2.4) Characterize historical resources within the SBNMS.	0.0	0.0	0.0	0.0	0.0	0.0
(3.1) Implement a management system that protects historical resources while allowing for uses compatible with resource protection.	0.0	0.0	0.0	0.0	0.0	0.0
(3.2) Implement an assessment protocol to assign sanctuary historical resources to the appropriate category.	0.0	0.0	0.0	0.0	0.0	0.0
(3.3) Identify partnerships and relationships for site monitoring and compliance of historical resource permits and regulations.	0.0	0.0	0.0	0.0	0.0	0.0
(3.4) Develop and implement an interpretive enforcement program	1.0	1.0	1.0	1.0	1.0	50.0
(3.5) Develop and implement a mooring buoy system on historical resources in collaboration with affected parties and regional scuba diving charter operators	1.0	5.0	7.0	7.0	7.0	27.0
(3.6) Implement the NMSP Permitting Guidelines for archaeological research (i.e., survey and inventory permit and archaeological research permit).	0.0	0.0	0.0	0.0	0.0	0.0
(3.7) Develop and implement collection and conservation policies for artifacts previously recovered from SBNMS before and after designation.	0.0	0.0	0.0	0.0	0.0	0.0
(4.1) Identify and partner with regional museums, through MOU/Agreements, to conduct MH exhibits and other outreach programs.	0.0	10.0	15.0	15.0	15.0	55.0
(4.2) Develop and implement an artifact documentation and curation program through partnerships and relationships with local or regional maritime museums.	0.0	0.0	5.0	10.0	15.0	30.0
5.1) Establish an inventory of shipwrecks and submerged objects, inside and outside of SBNMS boundaries that may pose environmental threats to resources.	0.0	0.0	0.0	0.0	0.0	0.0
(5.2) Coordinate information exchanges pertaining to shipwrecks and other submerged objects as environmental threats with NOAA's HAZMAT division and the NMSP for the development of the SHIELDS and RUST database systems.	0.0	0.0	0.0	0.0	0.0	0.0
(5.3) Identify shipwrecks and other submerged sites to be examined with remote sensing technology and report findings to state and federal trustees.	0.0	2.0	2.0	1.0	1.0	6.0
(5.4) Establish a monitoring program for shipwreck and submerged sites that have been located and are considered a threat to SBNMS. Develop protocols for site evaluation and a timeline for future site monitoring.	0.0	15.0	10.0	10.0	10.0	45.0
Total Estimated Annual Cost	**152.0**	**183.0**	**190.0**	**144.0**	**149.0**	**818.0**
*Cost estimates exclude federal labor costs.						

Table 58. Performance measures for MH action plan.

Desired Outcome(s) For This Action Plan			
Prehistoric and historic archaeological resources are managed and protected.			
Performance Measures	**Means of Evaluation**	**Baseline**	**NMSP Measure**
By 2010, five of the eligible historical resources will be nominated to the National Register of Historical Places (NRHP).	SBNMS will keep track of the percent of eligible resources that are nominated to the NRHP.	Number of historical resources nominated to the NRHP: 4	Shipwrecks
By 2010, as part of the Maritime Heritage (MH) management program, all located historical resources will be categorized through SBNMS site assessment protocol.	SBNMS will track the number of identified shipwrecks that have been categorized through the MH management program.	Number of classified shipwrecks: 0	Shipwrecks



VIII. Draft Environmental Assessment

The ultimate purpose of the revised draft management plan is to update NOAA's approach to managing, protecting and restoring the resources of the sanctuary. This section presents the environmental assessment that provides analyses and supporting documentation for the agency to determine whether the preferred alternative, revision of the management plan, is warranted.

Purpose and Need

Need for action

Congress designated the Gerry E. Studds Stellwagen Bank National Marine Sanctuary (sanctuary or SBNMS) through the Oceans Act of 1992 (November 4, 1992; Public Law 102-587 at section 2202). In 1993, the National Oceanic and Atmospheric Administration (NOAA) issued final regulations and released a final management plan and environmental impact statement (EIS) to implement this designation (NOAA 1993).

Section 304(e) of the National Marine Sanctuaries Act (NMSA) requires NOAA to review its management plans for national marine sanctuaries every five years and to evaluate the substantive progress toward implementing the management plans and goals for each sanctuary, especially the effectiveness of site-specific management techniques (16 U.S.C. 1434(e)). Pursuant to this requirement, NOAA initiated its five-year management plan review (MPR) in 1998, in cooperation with members of the Sanctuary Advisory Council. The MPR was delayed two years due to a change in sanctuary management and was continued in 2002 with an additional round of scoping meetings in the fall of 2002. The State of the Sanctuary Report, published in June 2002, set the stage for the scoping meetings and public comment period that ended on October 18, 2002.

The MPR revealed that many of the initial goals and objectives of the 1993 management plan had been met; however, in some areas these goals and objectives were non-specific and general in scope and/or based on limited scientific knowledge. New information about the natural and cultural resources of the sanctuary and the human uses of the resources made it apparent to NOAA that the plan is out-of-date and outmoded. NOAA decided to incorporate this new knowledge by developing a new approach to management. Consequently, NOAA developed a new vision, mission, and statement of goals and objectives to guide management. In addition, NOAA has revised the content and formatting requirements for national marine sanctuary management plans. These structural elements were not employed in the 1993 management plan.

Purpose for taking action

The ultimate purpose of the revised draft management plan is to update NOAA's approach to managing, protecting, and restoring the resources of the sanctuary pursuant to the purposes and policies of the NMSA, which are:

(1) to identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System;

(2) to provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities;

(3) to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes;

(4) to enhance public awareness, understanding, appreciation, and wise and sustainable use of the marine environment, and the natural, historical, cultural, and archeological resources of the National Marine Sanctuary System;

(5) to support, promote, and coordinate scientific research on, and long-term monitoring of, the resources of these marine areas;

(6) to facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of the resources of these marine areas not prohibited pursuant to other authorities;

(7) to develop and implement coordinated plans for the protection and management of these areas with appropriate Federal agencies, State and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas;

(8) to create models of, and incentives for, ways to conserve and manage these areas, including the application of innovative management techniques; and

(9) to cooperate with global programs encouraging conservation of marine resources.

Description of Proposed Action and Alternatives

The original 1993 Final Management Plan/Final Environmental Impact Statement described a number of alternatives for the management framework of the sanctuary, including differing boundary options, regulatory options, and management regimes. Extensive analyses of possible environmental and socioeconomic impacts were conducted for each alternative before the current boundaries, regulations, and management regime were selected. The 1993 plan can be viewed online at http://stellwagen.noaa.gov/management.

For this revision, NOAA considered the options of preparing an entirely new management plan or minimally revising the current management plan. As discussed in the "Need for Action" section, awareness of new issues affecting sanctuary management and the fulfillment of most of the prior plan's objectives necessitated the development of a new plan. Additionally, NOAA decided that this revision would be a non-regulatory management plan that establishes a policy framework for future management actions.

This environmental assessment provides analyses and supporting documentation for the agency to determine whether a Finding of No Significant Impact is warranted. For this determination, only two alternatives are being considered: leaving the current management plan in place or revising the current management plan to reflect those changes, as noted above. The preferred alternative is to revise the management plan. A discussion of each of the alternatives follows.

No-action alternative

This alternative would maintain the 1993 management plan despite its outdated format and inclusion of completed tasks, along with the nominal list of goals and objectives. The no-action alternative does not infer a secession of management in the sanctuary. Management actions described in the existing management plan, such as regulations, educational and research activities, and enforcement actions, would continue.

Alternative 1—Preferred Alternative

This alternative proposes a revision of the current management plan. The revised plan updates the vision, goals, and objectives to better reflect the new paradigm of sanctuary management within the National Marine Sanctuary Program (NMSP); removes old tasks and incorporates new and planned management strategies and activities (Section II); reformats the document so it is in line with the preferred format; lays out performance measures with which to better evaluate the sanctuary management's effectiveness; and lays the groundwork for potential future regulatory actions addressing high priority issues.

Specifically, changes made to the management plan include:

- An updated description of natural and cultural resources (Sections III and IV);
- A new vision and mission statement (Section VII);
- An updated statement of goals and objectives to reflect the new vision and mission statements and current status of sanctuary resources and efforts;
- A restructuring of the management plan into a series of action plans (based on resource conservation issues) in keeping with the templates of current sanctuary management plans (Section VII); and
- A new set of outcomes and performance indicators included (Section VII);

Action plans (APs) are detailed five-year plans that address an issue or problem in the sanctuary. Action plans are issue-driven, not program- or thematically-driven, and are composed of a collection of strategies sharing common management objectives. They provide an organized structure and process for implementing strategies, including a description of the requisite activities, organizations involved, and requirements necessary for either full or partial implementation. The following action plans form the backbone of the proposed revised management plan:

Administrative Capacity and Infrastructure Action Plan (ADMIN AP)

The ADMIN AP provides recommendations to strengthen the sanctuary's base-level staffing, facilities infrastructure and program support to effectively meet the basic needs of sanctuary management. Emphasis is placed on the human and physical infrastructure and financial resource requirements of the site.

Interagency Cooperation Action Plan (IC AP)

The IC AP addresses public scoping comments concerning clarification of overlapping agency responsibilities, and interagency coordination and effectiveness. This AP provides the framework to help clarify the roles, responsibilities, and relationships among associated agencies in order to strengthen resource protection within the sanctuary as well as improve interagency communication.

Public Outreach and Education Action Plan (POE AP)

The POE AP makes recommendations to resolve issues including low name recognition of the sanctuary, need for better information dissemination through leveraged partnerships and public education through programming support. The POE AP is predicated on developing outreach and education tools that serve to help achieve sanctuary management goals and objectives.

Compatibility Determination Action Plan (CD AP)

One of the purposes of the NMSA is to facilitate those uses of the sanctuary that are compatible with the primary objective of resource protection. The CD AP addresses issues raised by public scoping comments concerning the need to clarify, justify, and recommend an approach NOAA should take in performing compatibility analyses of human uses of the sanctuary. This AP describes a framework for how to develop a compatibility analysis. It does not make any determination regarding the appropriateness of any specific sanctuary use, current or potential, nor does it recommend any actions that affect the outcome of other APs recommended by other working groups.

Ecosystem-Based Sanctuary Management Action Plan (EBSM AP)

The EBSM AP includes recommendations for comprehensive ecosystem protection, restoration and protection of biological diversity, zoning including no-take zones, ecosystem-based management practices and consideration of boundary modification. The AP does not propose any regulatory changes.

Ecosystem Alteration Action Plan (EA AP)

The EA AP includes recommendations to reduce or mitigate anthropogenic perturbations in the sanctuary, as distinguished from impacts due to natural disturbance. Anthropogenic, or human imposed impacts, include the laying of submarine pipelines and cables, fishing activities, pollution and degradation of water quality, ocean dumping and marine debris, disposal of dredged materials, introduction of exotic species, offshore mariculture and coastal development activities. This action plan focuses on the laying of pipelines and cables and fishing activities. Other sources of ecosystem alteration are treated variously in other action plans, such as for ecosystem based management, water quality and interagency cooperation. The AP does not propose any regulatory changes.

Water Quality Action Plan (WQ AP)

The WQ AP includes recommendations to address water quality concerns within the sanctuary. Point and non-point sources of pollution, both sea and shore-based, may be degrading the quality of the sanctuary's waters. NOAA must ensure that the quality of water within its boundary and in surrounding areas does no harm to the site's living marine and cultural resources, i.e., pursuant to section 922.142(a)(i) and (ii) of the regulations. The following two needs were identified: to assess water quality and circulation to characterize baseline conditions, and to reduce pollutant discharges and waste streams that may be negatively impacting sanctuary resources. The AP does not propose any regulatory changes.

Marine Mammal Behavioral Disturbance Action Plan (MMBD AP)

The MMBD AP includes recommendations to reduce the risk of behavioral disturbance and harassment of marine mammals resulting from the following activities: whale watching, tuna fishing, aircraft overflights and noise pollution. The sanctuary serves as a major feeding ground for seven species of endangered, threatened and protected whales and smaller cetaceans. The sanctuary is also a high use area for commercial and recreational vessel traffic and, consequently, a high-risk area for marine mammal disturbance by human-induced activities within and around the sanctuary.

Marine Mammal Vessel Strike Action Plan (MMVS AP)

The MMVS AP includes recommendations to reduce the risk of collision between vessels and marine mammals that cause injury or mortality to the animals, harm to operators and damage to vessels. Ship strikes represent one of the two major threats that are likely to prevent the recovery of critically endangered North Atlantic right whales and endangered humpback whales. Efforts in the U.S. have attempted to slow vessel speeds and to create an 'early warning system' to inform mariners of locations of right whales in and near shipping channels. Despite efforts to date, vessel strikes continue to kill and injure right whales at a level that compromises the species' survival. Concern in recent years has intensified as marine traffic has come to involve larger and faster vessels.

Marine Mammal Entanglement Action Plan (MME AP)

The MME AP includes recommendations to reduce the risk of entanglement of marine mammals in commercial fishing gear in the sanctuary. The concern extends to sea turtle and sea bird entanglement. The immediate effects of entanglement can include mortality, serious injury, or minor injury that when combined with other factors may have significant consequences. The long-term effects can include deteriorating health, behavioral disruptions, or decreased reproductive ability.

Maritime Heritage Management Action Plan (MHM AP)

The MHM AP includes recommendations for the inventory and assessment of historical resources, the management and protection of historical resources, and MH interpretation. The AP addresses sanctuary-specific historical resource assessment, management, protection, and MH outreach and education requirements; it fulfills the NOAA NMSP and the NOAA Maritime Heritage Program (MHP) strategic plans; and it complies with the President's Preserve America Executive Order (E.O.13287) tasking NOAA with preserving and protecting historic resources in the agency's care, including shipwrecks.

Affected Environment

The existing management plan and environmental impact statement for the Sanctuary (NOAA 1993) contains a complete description of the sanctuary environment, including natural and cultural resources and human uses. Section I: Sanctuary Setting of the revised management plan updates the information provided in the 1993 plan with substantial new findings and information. These documents are incorporated by reference into this environmental assessment and briefly summarized below.

Boundary

The sanctuary boundary encompasses 638 square nautical miles (approximately 2181 square kilometers) of ocean waters and the submerged lands thereunder, over and surrounding the submerged Stellwagen Bank and additional submerged features, at the mouth of Massachusetts Bay. The boundary encompasses the entirety of Stellwagen Bank; Tillies Bank to the northeast of Stellwagen Bank; and southern portions of Jeffreys Ledge to the north of Tillies Bank. Portions of the sanctuary are co-terminus with the state waters of the Commonwealth of Massachusetts. The entire sanctuary lies in federal waters (Figure 9). See Appendix R for a listing of boundary coordinates.

Sanctuary Resources

The sanctuary's complex seafloor topography influences current flow and site productivity. Site productivity is seasonal with the overturning and mixing of ocean waters from deeper strata producing a complex and rich system of overlapping midwater and benthic habitats. This heightened seasonal productivity supports 22 species of marine mammals, 34 species of seabirds, and over 80 fish species.

The sanctuary serves as a critical feeding ground for numerous whales and other marine mammals, several of which are endangered. It may also be an important nursery area for certain of these species. The sanctuary's multiple habitat types support a high diversity of fish species and an impressive assemblage of invertebrates. And, its rich forage base provides productive habitat for a wide variety of coastal and pelagic seabirds.

For a full description of sanctuary resources see Section II.

Environmental Consequences

No-action alternative

Taking no action would result in no change of the current management regime of the sanctuary. The 1993 management plan/environmental impact statement contains a full analysis of the environmental impacts of each alternative discussed therein. Taking no action would result in no additional socioeconomic impacts to those already associated with the operation of the sanctuary. The existing management plan/environmental impact statement contains a full analysis of the socioeconomic impacts of each alternative discussed therein.

Alternative 1: Proposed action

The revised management plan would make no boundary or regulatory changes; however, existing non-regulatory programs would be updated and enhanced, and new ones would be launched. NOAA expects this would have a positive environmental effect, by increasing protection of resources through interagency cooperation, by reaching more people and expanding the stewardship message of the sanctuary. The revised plan itself does not enable any of these activities listed in the action plans to take place; they could take place without the revision under current regulatory and statutory authority, as well as under the current management plan. The sanctuary management plan proposes to develop processes to consider future regulatory actions, which would include the appropriate NEPA analysis and formal public input at appropriate times in the future. The environmental impacts of each action plan are described below.

Administrative Capacity and Infrastructure Action Plan

The ADMIN AP would provide the framework for the organizational structure and functions of the sanctuary to address marine resource protection, research and monitoring, exploration, evaluation, and education and outreach. This administrative framework also would ensure that sanctuary management activities are coordinated between disciplines at the sanctuary and with activities administered at the NMSP level. Because of its administrative nature, this AP would not result in significant positive or negative environmental impacts. In addition, actions described in this AP would all meet the NOAA requirements for a categorical exclusion under NEPA[1], which is further indication of the absence of significant environmental impacts.

Interagency Cooperation Action Plan

The IC AP would clarify the roles, responsibilities, and relationships among associated agencies in order to strengthen resource protection, research and education/outreach within the sanctuary as well as improve interagency communication. Because of its consultative nature, this AP would not result in significant positive or negative environmental impacts. In addition, actions described in the AP would all meet the NOAA requirements for a categorical exclusion under NEPA[2], which is further indication of the absence of significant environmental impacts.

Public Outreach and Education Action Plan

The IC AP would clarify the roles, responsibilities, and relationships among associated agencies in order to strengthen resource protection, research and education/outreach within the sanctuary as well as improve interagency communication. Because of its consultative nature, this AP would not result in significant positive or negative environmental impacts. In addition, actions described in the AP would all meet the NOAA requirements for a categorical exclusion under NEPA[3], which is further indication of the absence of significant environmental impacts.

Compatibility Determination Action Plan

The CD AP would describe how NOAA would determine the compatibility of human uses of sanctuary resources. This AP would establish a framework and process to develop a compatibility analysis. It would not make any determination regarding the appropriateness of any specific sanctuary use, current or potential. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Ecosystem-Based Sanctuary Management Action Plan

The EBSM AP could result in beneficial impacts to the environment by addressing the need for comprehensive ecosystem protection; conservation of biological diversity; zoning in the sanctuary, including no-take zones; ecosystem-based management practices; and boundary modification. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Ecosystem Alteration Action Plan

The EA AP could result in beneficial impacts to the environment by addressing ecosystem alteration(s) that result from human activities. In particular, this AP will focus on reducing impacts to the ecosystem from the laying of cables and pipelines, reducing habitat alteration by mobile fishing gear and reducing ecosystem impacts of biomass removal by fishing activity. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

1 NOAA Administrative Order 216-6 §6.03c.3(i)

2 NOAA Administrative Order 216-6 §6.03c.3(i)

3 NOAA Administrative Order 216-6 §6.03c.3(i)

Water Quality Action Plan

The WQ AP would describe how NOAA would address water quality within the sanctuary. Concerns of particular importance addressed by this AP are the development of a better understanding and assessment of water quality and circulation, and a reduction of pollutant discharges and waste streams that may be negatively impacting sanctuary resources. Actions described in this AP could result in beneficial impacts to the environment by potentially reducing harmful discharges in the sanctuary. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Marine Mammal Behavioral Disturbance Action Plan

The MMBD AP would describe how NOAA would address the potential harassment, including behavioral disturbance, of marine mammals resulting from the following activities: whale watching, fishing, aircraft overflights, and noise generation. Actions described in this AP could result in beneficial impacts to the environment by minimizing the incidence of behavioral disturbance to the marine mammals that frequent the waters of the sanctuary. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate the potential impacts in a meaningful way. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Marine Mammal Vessel Strike Action Plan

The MMVS AP would describe actions NOAA would take to minimize collisions between marine mammals and vessels, which can cause injury or mortality to marine mammals and humans, and damage to vessels. Actions described in this AP could result in beneficial impacts to the environment by decreasing the occurrence of marine mammal vessel strikes in the sanctuary. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Marine Mammal Entanglement Action Plan

The MME AP would describe actions NOAA would take to minimize the entanglement of marine mammals in commercial fishing gear. Actions described in this AP could result in beneficial impacts to the environment by decreasing the occurrence of marine mammal entanglements in the sanctuary. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate potential impacts. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts

Maritime Heritage Management Action Plan

The MHM AP would address three primary issues relating to the sanctuary's MHR: the need for inventory and assessment; the lack of a plan for management and protection; and the lack of interpretation. This AP describes actions NOAA would take to prevent threats to maritime heritage resources and, indirectly, to the surrounding area. All actions ensuing from this AP will undergo the appropriate NEPA analysis when NOAA has developed the proposal enough to evaluate the potential impacts in a meaningful way. To consider potential environmental impacts of this AP would be purely speculative. This AP would not, in and of itself, result in significant positive or negative environmental impacts.

Conclusion

The preferred alternative, if implemented, will not result in significant positive or negative environmental impacts. Therefore, it qualifies for a categorical exclusion from the requirement to conduct an environmental assessment or environmental impact statement.

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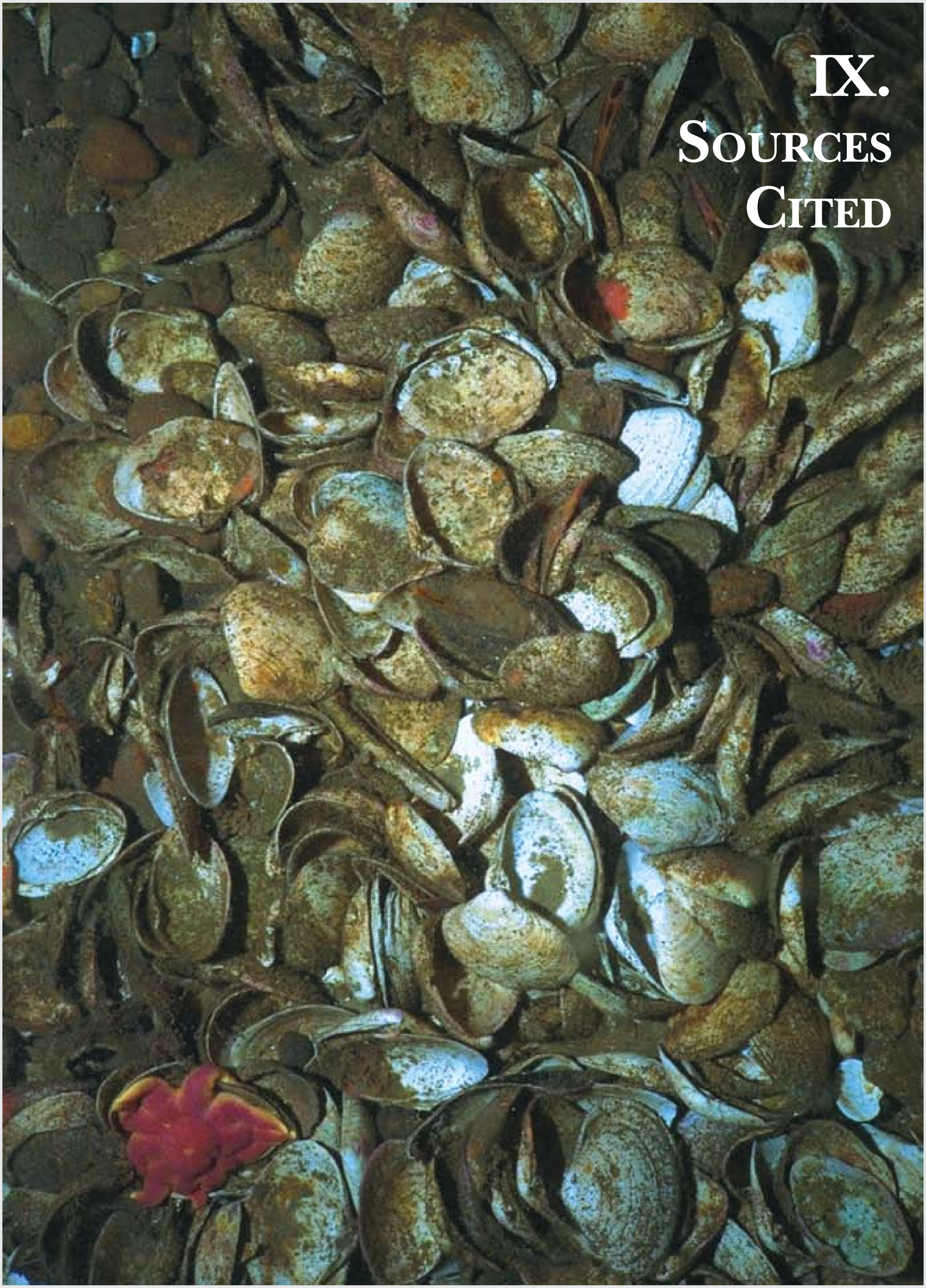

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X. APPENDICES

Appendix A. National Marine Sanctuaries Act

THE NATIONAL MARINE SANCTUARIES ACT

16 U.S.C. 1431 ET. SEQ., as amended by Public Law 106-513

Sec. 301. FINDINGS, PURPOSES, AND POLICIES; ESTABLISHMENT OF SYSTEM.

(a) FINDINGS.--The Congress finds that--

(1) this Nation historically has recognized the importance of protecting special areas of its public domain, but these efforts have been directed almost exclusively to land areas above the high-water mark;

(2) certain areas of the marine environment possess conservation, recreational, ecological, historical, scientific, educational, cultural, archeological, or esthetic qualities which give them special national, and in some instances, international, significance;

(3) while the need to control the effects of particular activities has led to enactment of resource-specific legislation, these laws cannot in all cases provide a coordinated and comprehensive approach to the conservation and management of special areas of the marine environment; and

(4) a Federal program which establishes areas of the marine environment which have special conservation, recreational, ecological, historical, cultural, archeological, scientific, educational, or esthetic qualities as national marine sanctuaries managed as the National Marine Sanctuary System will improve the conservation, understanding, management, and wise and sustainable use of marine resources;

(B) enhance public awareness, understanding, and appreciation of the marine environment; and

(C) maintain for future generations the habitat, and ecological services, of the natural assemblage of living resources that inhabit these areas.

(b) PURPOSES AND POLICIES.--The purposes and policies of this title are--

(1) to identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System;

(2) to provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities;

(3) to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes;

(4) to enhance public awareness, understanding, appreciation, and wise and sustainable use of the marine environment, and the natural, historical, cultural, and archeological resources of the National Marine Sanctuary System;

(5) to support, promote, and coordinate scientific research on, and long-term monitoring of, the resources of these marine areas;

(6) to facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of the resources of these marine areas not prohibited pursuant to other authorities;

(7) to develop and implement coordinated plans for the protection and management of these areas with appropriate Federal agencies, State and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas;

(8) to create models of, and incentives for, ways to conserve and manage these areas, including the application of innovative management techniques; and

(9) to cooperate with global programs encouraging conservation of marine resources.

(c) ESTABLISHMENT OF SYSTEM.-There is established the National Marine Sanctuary System, which shall consist of national marine sanctuaries designated by the Secretary in accordance with this title.

Sec. 302. DEFINITIONS

As used in this title, the term--

(1) "Draft management plan" means the plan described in section 304(a)(1)(C)(v);

(2) "Magnuson-Stevens Act" means the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.);

(3) "marine environment" means those areas of coastal and ocean waters, the Great Lakes and their connecting waters, and submerged lands over which the United States exercises jurisdiction, including the exclusive economic zone, consistent with international law;

(4) "Secretary" means the Secretary of Commerce;

(5) "State" means each of the several States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, American Samoa, the Virgin Islands, Guam, and any other commonwealth, territory, or possession of the United States;

(6) "damages" includes--

(A) compensation for--

(i)(I) the cost of replacing, restoring, or acquiring the equivalent of a sanctuary resource; and (II) the value of the lost use of a sanctuary resource pending its restoration or replacement or the acquisition of an equivalent sanctuary resource; or

(ii) the value of a sanctuary resource if the sanctuary resource cannot be restored or replaced or if the equivalent of such resource cannot be acquired;

(B) the cost of damage assessments under section 312(b)(2);

(C) the reasonable cost of monitoring appropriate to the injured, restored, or replaced resources;

(D) the cost of curation and conservation of archeological, historical, and cultural sanctuary resources; and

(E) the cost of enforcement actions undertaken by the Secretary in response to the destruction or loss of, or injury to, a sanctuary resource;

(7) "response costs" means the costs of actions taken or authorized by the Secretary to minimize destruction or loss of, or injury to, sanctuary resources, or to minimize the imminent risks of such destruction, loss, or injury, including costs related to seizure forfeiture, storage, or disposal arising from liability under section 312;

(8) "sanctuary resource" means any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archeological, scientific, or aesthetic value of the sanctuary;

(9) "exclusive economic zone" means the exclusive economic zone as defined in the Magnuson-Stevens Act; and

(10) 'System' means the National Marine Sanctuary System established by section 301.

Sec. 303. SANCTUARY DESIGNATION STANDARDS

(a) STANDARDS.--The Secretary may designate any discrete area of the marine environment as a national marine sanctuary and promulgate regulations implementing the designation if the Secretary determines that--

(1) the designation will fulfill the purposes and policies of this title;

(2) the area is of special national significance due to-

(A) its conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities;

(B) the communities of living marine resources it harbors; or

(C) its resource or human-use values;

(3) existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area, including resource protection, scientific research, and public education;

(4) designation of the area as a national marine sanctuary will facilitate the objectives in subparagraph (3); and

(5) the area is of a size and nature that will permit comprehensive and coordinated conservation and management.

(b) FACTORS AND CONSULTATIONS REQUIRED IN MAKING DETERMINATIONS AND FINDINGS.--

(1) Factors.--For purposes of determining if an area of the marine environment meets the standards set forth in subsection (a), the Secretary shall consider--

(A) the area's natural resource and ecological qualities, including its contribution to biological productivity, maintenance of ecosystem structure, maintenance of ecologically or commercially important or threatened species or species assemblages, maintenance of critical habitat of endangered species, and the biogeographic representation of the site;

(B) the area's historical, cultural, archaeological, or paleontological significance;

(C) the present and potential uses of the area that depend on maintenance of the area's resources, including commercial and recreational fishing, subsistence uses other commercial and recreational activities, and research and education;

(D) the present and potential activities that may adversely affect the factors identified in subparagraphs (A), (B), (C);

(E) the existing State and Federal regulatory and management authorities applicable to the area and the adequacy of those authorities to fulfill the purposes and policies of this title;

(F) the manageability of the area, including such factors as its size, its ability to be identified as a discrete ecological unit with definable boundaries, its accessibility, and its suitability for monitoring and enforcement activities;

(G) the public benefits to be derived from sanctuary status, with emphasis on the benefits of long-term protection of nationally significant resources, vital habitats, and resources which generate tourism;

(H) the negative impacts produced by management restrictions on income-generating activities such as living and nonliving resources development;

(I) the socioeconomic effects of sanctuary designation;

(J) the area's scientific value and value for monitoring the resources and natural processes that occur there;

(K) the feasibility, where appropriate, of employing innovative management approaches to protect sanctuary resources or to manage compatible uses; and

(L) the value of the area as an addition to the System.

(2) Consultation.--In making determinations and findings, the Secretary shall consult with--

(A) the Committee on Resources of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate;

(B) the Secretaries of State, Defense, Transportation, and the Interior, the Administrator, and the heads of other interested Federal agencies;

(C) the responsible officials or relevant agency heads of the appropriate State and local government entities, including coastal zone management agencies, that will or are likely to be affected by the establishment of the area as a national marine sanctuary;

(D) the appropriate officials of any Regional Fishery Management Council established by section 302 of the Magnuson-Stevens Act (16 U.S.C. 1852) that may be affected by the proposed designation; and

(E) other interested persons.

Sec. 304. PROCEDURES FOR DESIGNATION AND IMPLEMENTATION

(a) SANCTUARY PROPOSAL.--

(1) Notice.--In proposing to designate a national marine sanctuary, the Secretary shall--

(A) issue, in the Federal Register, a notice of the proposal, proposed regulations that may be necessary and reasonable to implement the proposal, and a summary of the draft management plan;

(B) provide notice of the proposal in newspapers of general circulation or electronic media in the communities that may be affected by the proposal; and

(C) no later than the day on which the notice required under subparagraph (A) is submitted to Office of the Federal Register, submit a copy of that notice and the draft sanctuary designation documents prepared pursuant to section 304(a)(2), including an executive summary, to the Committee on Resources of the House of Representatives, the Committee on Commerce, Science, and Transportation of the Senate, and the Governor of each State in which any part of the proposed sanctuary would be located.

(2) Sanctuary Designation Documents.- The Secretary shall prepare and make available to the public sanctuary designation documents on the proposal that include the following:

(A) A draft environmental impact statement pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).

(B) A resource assessment that documents-

(i) present and potential uses of the area, including commercial and recreational fishing, research and education, minerals and energy development, subsistence uses, and other commercial, governmental, or recreational uses;

(ii) after consultation with the Secretary of the Interior, any commercial, governmental, or recreational resource uses in the areas that are subject to the primary jurisdiction of the Department of the Interior; and

(iii) information prepared in consultation with the Secretary of Defense, the Secretary of Energy, and the Administrator of the Environmental Protection Agency, on any past, present, or proposed future disposal or discharge of materials in the vicinity of the proposed sanctuary. Public disclosure by the Secretary of such information shall be consistent with national security regulations.

(C) A draft management plan for the proposed national marine sanctuary that includes the following:

(i) The terms of the proposed designation.

(ii) Proposed mechanisms to coordinate existing regulatory and management authorities within the area.

(iii) The proposed goals and objectives, management responsibilities, resource studies, and appropriate strategies for managing sanctuary resources of the proposed sanctuary, including interpretation and education, innovative management strategies, research, monitoring and assessment, resource protection, restoration, enforcement, and surveillance activities.

(iv) An evaluation of the advantages of cooperative State and Federal management if all or part of the proposed sanctuary is within the territorial limits of any State or is superjacent to the subsoil and seabed within the seaward boundary of a State, as that boundary is established

under the Submerged Lands Act (43 U.S.C. 1301 et seq.).

(v) An estimate of the annual cost to the Federal Government of the proposed designation, including costs of personnel, equipment and facilities, enforcement, research, and public education.

(vi) The proposed regulations referred to in paragraph (1)(A).

(D) Maps depicting the boundaries of the proposed sanctuary.

(E) The basis for the determinations made under section 303(a) with respect to the area.

(F) An assessment of the considerations under section 303(b)(1).

(3) Public Hearing.--No sooner than thirty days after issuing a notice under this subsection, the Secretary shall hold at least one public hearing in the coastal area or areas that will be most affected by the proposed designation of the area as a national marine sanctuary for the purpose of receiving the views of interested parties.

(4) Terms of Designation.--The terms of designation of a sanctuary shall include the geographic area proposed to be included within the sanctuary, the characteristics of the area that give it conservation, recreational, ecological, historical, research, educational, or esthetic value, and the types of activities that will be subject to regulation by the Secretary to protect those characteristics. The terms of designation may be modified only by the same procedures by which the original designation is made.

(5) Fishing Regulations.--The Secretary shall provide the appropriate Regional Fishery Management Council with the opportunity to prepare draft regulations for fishing within the exclusive economic zone as the Council may deem necessary to implement the proposed designation. Draft regulations prepared by the Council, or a Council determination that regulations are not necessary pursuant to this paragraph, shall be accepted and issued as proposed regulations by the Secretary unless the Secretary finds that the Council's action fails to fulfill the purposes and policies of this title and the goals and objectives of the proposed designation. In preparing the draft regulations, a Regional Fishery Management Council shall use as guidance the national standards of section 301(a) of the Magnuson-Stevens Act (16 U.S.C. 1851) to the extent that the standards are consistent and compatible with the goals and objectives of the proposed designation. The Secretary shall prepare the fishing regulations, if the Council declines to make a determination with respect to the need for regulations, makes a determination

which is rejected by the Secretary, or fails to prepare the draft regulations in a timely manner. Any amendments to the fishing regulations shall be drafted, approved, and issued in the same manner as the original regulations. The Secretary shall also cooperate with other appropriate fishery management authorities with rights or responsibilities within a proposed sanctuary at the earliest practicable stage in drafting any sanctuary fishing regulations.

(6) Committee Action.--After receiving the documents under subsection (a)(l)(C), the Committee on Resources of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate may each hold hearings on the proposed designation and on the matters set forth in the documents. If within the forty-five day period of continuous session of Congress beginning on the date of submission of the documents, either Committee issues a report concerning matters addressed in the documents, the Secretary shall consider this report before publishing a notice to designate the national marine sanctuary.

(b) TAKING EFFECT OF DESIGNATIONS.--

(1) Notice.--In designating a national marine sanctuary, the Secretary shall publish in the Federal Register notice of the designation together with final regulations to implement the designation and any other matters required by law, and submit such notice to the Congress. The Secretary shall advise the public of the availability of the final management plan and the final environmental impact statement with respect to such sanctuary. The Secretary shall issue a notice of designation with respect to a proposed national marine sanctuary site not later than 30 months after the date a notice declaring the site to be an active candidate for sanctuary designation is published in the Federal Register under regulations issued under this Act, or shall publish not later than such date in the Federal Register findings regarding why such notice has not been published. No notice of designation may occur until the expiration of the period for Committee action under subsection (a)(6). The designation (and any of its terms not disapproved under this subsection) and regulations shall take effect and become final after the close of a review period of forty-five days of continuous session of Congress beginning on the day on which such notice is published unless in the case of a natural [sic] marine sanctuary that is located partially or entirely within the seaward boundary of any State, the Governor affected certifies to the Secretary that the designation or any of its terms is unacceptable, in which case the designation or the unacceptable term shall not take effect in the area of the sanctuary lying within the seaward boundary of the State.

(2) Withdrawal of Designation.-- If the Secretary considers that actions taken under paragraph (1) will affect the designation of a national marine sanctuary in a manner that the goals and objectives of the sanctuary or System cannot be fulfilled, the Secretary may withdraw the entire designation. If the Secretary does not withdraw the designation, only those terms of the designation or not certified under paragraph (1) shall take effect.

(3) Procedures.-- In computing the forty-five-day periods of continuous session of Congress pursuant to subsection (a)(6) and paragraph (1) of this subsection--

(A) continuity of session is broken only by an adjournment of Congress sine die; and

(B) the days on which either House of Congress is not in session because of an adjournment of more than three days to a day certain are excluded.

(c) ACCESS AND VALID RIGHTS.--

(1) Nothing in this title shall be construed as terminating or granting to the Secretary the right to terminate any valid lease, permit, license, or right of subsistence use or of access that is in existence on the date of designation of any national marine sanctuary.

(2) The exercise of a lease, permit, license, or right is subject to regulation by the Secretary consistent with the purposes for which the sanctuary is designated.

(d) INTERAGENCY COOPERATION.--

(1) Review of Agency Actions.--

(A) In General.--Federal agency actions internal or external to a national marine sanctuary, including private activities authorized by licenses, leases, or permits, that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the Secretary.

(B) Agency Statements Required.-- Subject to any regulations the Secretary may establish each Federal agency proposing an action described in subparagraph (A) shall provide the Secretary with a written statement describing the action and its potential effects on sanctuary resources at the earliest practicable time, but in no case later than 45 days before the final approval of the action unless such Federal agency and the Secretary agree to a different schedule.

(2) Secretary's Recommended Alternatives.--If the Secretary finds that a Federal agency action is likely to destroy, cause the loss of, or injure a sanctuary resource, the Secretary shall (within 45 days of receipt of complete information on the proposed agency action) recommend reasonable and prudent alternatives, which may include conduct of the action elsewhere, which can be taken by the Federal agency in implementing the agency action that will protect sanctuary resources.

(3) Response to Recommendations.--The agency head who receives the Secretary's recommended alternatives under paragraph (2) shall promptly consult with the Secretary on the alternatives. If the agency head decides not to follow the alternatives, the agency head shall provide the Secretary with a written statement explaining the reasons for that decision.

(4) FAILURE TO FOLLOW ALTERNATIVE.- If the head of a Federal agency takes an action other than an alternative recommended by the Secretary and such action results in the destruction of, loss of, or injury to a sanctuary resource, the head of the agency shall promptly prevent and mitigate

further damage and restore or replace the sanctuary resource in a manner approved by the Secretary.

(e) REVIEW OF MANAGEMENT PLANS.--Not more than 5 years after the date of designation of any national marine sanctuary, and thereafter at intervals not exceeding 5 years, the Secretary shall evaluate the substantive progress toward implementing the management plan and goals for the sanctuary, especially the effectiveness of site-specific management techniques and strategies, and shall revise the management plan and regulations as necessary to fulfill the purposes and policies of this title. This review shall include a prioritization of management objectives.

(f) LIMITATION ON DESIGNATION OF NEW SANCTUARIES.-

(1) FINDING REQUIRED.- The Secretary may not publish in the Federal Register any sanctuary designation notice or regulations proposing to designate a new sanctuary, unless the Secretary has published a finding that--

(A) the addition of a new sanctuary will not have a negative impact on the System; and

(B) sufficient resources were available in the fiscal year in which the finding is made to--

(i) effectively implement sanctuary management plans for each sanctuary in the System; and

(ii) complete site characterization studies and inventory known sanctuary resources, including cultural resources, for each sanctuary in the System within 10 years after the date that the finding is made if the resources available for those activities are maintained at the same level for each fiscal year in that 10 year period.

(2) DEADLINE- If the Secretary does not submit the findings required by paragraph (1) before February 1, 2004, the Secretary shall submit to the Congress before October 1, 2004, a finding with respect to whether the requirements of subparagraphs (A) and (B) of paragraph 1 have been met by all existing sanctuaries.

(3) LIMITATION ON APPLICATION- Paragraph (1) does not apply to any sanctuary designation documents for--

(A) a Thunder Bay National Marine Sanctuary; or

(B) a Northwestern Hawaiian Islands National Marine Sanctuary.

(g) NORTHWESTERN HAWAIIAN ISLANDS CORAL REEF RESERVE.-

(1) PRESIDENTIAL DESIGNATION.- The President, after consultation with the Governor of the State of Hawaii, may designate any Northwestern Hawaiian Islands coral reef or coral reef ecosystem as a coral reef reserve to be managed by the Secretary of Commerce.

(2) SECRETARIAL ACTION.- Upon the designation of a reserve under paragraph (1) by the President, the Secretary shall--

(A) take action to initiate the designation of the reserve as a National Marine Sanctuary under sections 303 and 304 of the National Marine Sanctuaries Act (16 U.S.C. 1433);

(B) establish a Northwestern Hawaiian Islands Reserve Advisory Council under section 315 of that Act (16 U.S.C. 1445a), the membership of which shall include at least 1 representative from Native Hawaiian groups; and

(C) until the reserve is designated as a National Marine Sanctuary, manage the reserve in a manner consistent with the purposes and policies of that Act.

(3) PUBLIC COMMENT- Notwithstanding any other provision of law, no closure areas around the Northwestern Hawaiian Islands shall become permanent without adequate review and comment.

(4) COORDINATION- The Secretary shall work with other Federal agencies and the Director of the National Science Foundation, to develop a coordinated plan to make vessels and other resources available for conservation or research activities for the reserve.

(5) REVIEW- If the Secretary has not designated a national marine sanctuary in the Northwestern Hawaiian Islands under sections 303 and 304 of the National Marine Sanctuaries Act (16 U.S.C. 1433, 1434) before October 1, 2005, the Secretary shall conduct a review of the management of the reserve under section 304(e) of that Act (16 U.S.C. 1434(e)).

(6) REPORT- No later than 6 months after the date of enactment of this Act, the Secretary shall submit a report to the Senate Committee on Commerce, Science, and Transportation and the House of Representatives Committee on Resources, describing actions taken to implement this subsection, including costs of monitoring, enforcing, and addressing marine debris, and the extent to which the fiscal or other resources necessary to carry out this subsection are

reflected in the Budget of the United States Government submitted by the President under section 1104 of title 31, United States Code.

(7) AUTHORIZATION OF APPROPRIATIONS- There are authorized to be appropriated to the Secretary of Commerce to carry out the provisions of this subsection such sums, not exceeding $4,000,000 for each of fiscal years 2001, 2002, 2003, 2004, and 2005, as are reported under paragraph (6) to be reflected in the Budget of the United States Government.

Sec. 305. APPLICATION OF REGULATIONS AND INTERNATIONAL NEGOTIATIONS

(a) REGULATIONS.--This title and the regulations issued under section 304 shall be applied in accordance with generally recognized principles of international law, and in accordance with the treaties, conventions, and other agreements to which the United States is a party. No regulation shall apply to or be enforced against a person who is not a citizen, national, or resident alien of the United States, unless in accordance with--

(1) generally recognized principles of international law;

(2) an agreement between the United States and the foreign state of which the person is a citizen; or

(3) an agreement between the United States and the flag state of a foreign vessel, if the person is a crewmember of the vessel.

(b) NEGOTIATIONS.--The Secretary of State, in consultation with the Secretary, shall take appropriate action to enter into negotiations with other governments to make necessary arrangements for the protection of any national marine sanctuary and to promote the purposes for which the sanctuary is established.

(c) INTERNATIONAL COOPERATION.--The Secretary, in consultation with the Secretary of State and other appropriate Federal agencies, shall cooperate with other governments and international organizations in the furtherance of the purposes and policies of this title and consistent with applicable regional and multilateral arrangements for the protection and management of special marine areas.

Sec. 306. PROHIBITED ACTIVITIES

It is unlawful for any person to--

(1) destroy, cause the loss of, or injure any sanctuary resource managed under law or regulations for that sanctuary;

(2) possess, sell, offer for sale, purchase, import, export, deliver, carry, transport, or ship by any means any sanctuary resource taken in violation of this section;

(3) interfere with the enforcement of this title by--

(A) refusing to permit any officer authorized to enforce this title to board a vessel, other than a vessel operated by the Department of Defense or United States Coast Guard, subject to such person's control for the purposes of conducting any search or inspection in connection with the enforcement of this title;

(B) resisting, opposing, impeding, intimidating, harassing, bribing, interfering with, or forcibly assaulting any person authorized by the Secretary to implement this title or any such authorized officer in the conduct of any search or inspection performed under this title; or

(C) knowingly and willfully submitting false information to the Secretary or any officer authorized to enforce this title in connection with any search or inspection conducted under this title; or

(4) violate any provision of this title or any regulation or permit issued pursuant to this title.

Sec. 307. ENFORCEMENT

(a) IN GENERAL.--The Secretary shall conduct such enforcement activities as are necessary and reasonable to carry out this title.

(b) POWERS OF AUTHORIZED OFFICERS.--Any person who is authorized to enforce this title may--

(1) board. search, inspect, and seize any vessel suspected of being used to violate this title or any regulation or permit issued under this title and any equipment, stores, and cargo of such vessel;

(2) seize wherever found any sanctuary resource taken or retained in violation of this title or any regulation or permit issued under this title;

(3) seize any evidence of a violation of this title or of any regulation or permit issued under this title;

(4) execute any warrant or other process issued by any court of competent jurisdiction;

(5) exercise any other lawful authority; and

(6) arrest any person, if there is reasonable cause to believe that such a person has committed an act prohibited by section 306(3).

(c) CRIMINAL OFFENSES-

(1) OFFENSES.- A person is guilty of an offense under this subsection if the person commits any act prohibited by section 306(3).

(2) PUNISHMENT.- Any person that is guilty of an offense under this subsection--

(A) except as provided in subparagraph (B), shall be fined under title 18, United States Code, imprisoned for not more than 6 months, or both; or

(B) in the case of a person who in the commission of such an offense uses a dangerous weapon, engages in conduct that causes bodily injury to any person authorized to enforce this title or any person authorized to implement the provisions of this title, or places any such person in fear of imminent bodily injury, shall be fined under title 18, United States Code, imprisoned for not more than 10 years, or both.

(d) CIVIL PENALTIES.--

(1) Civil penalty.--Any person subject to the jurisdiction of the United States who violates this title or any regulation or permit issued under this title shall be liable to the United States for a civil penalty of not more than $100,000 for each such violation, to be assessed by the Secretary. Each day of a continuing violation shall constitute a separate violation.

(2) Notice.--No penalty shall be assessed under this subsection until after the person charged has been given notice and an opportunity for a hearing.

(3) In Rem Jurisdiction.--A vessel used in violating this title or any regulation or permit issued under this title shall be liable in rem for any civil penalty assessed for such violation. Such penalty shall constitute a maritime lien on the vessel and may be recovered in an action in rem in the district court of the United States having jurisdiction over the vessel.

(4) Review of Civil Penalty.--Any person against whom a civil penalty is assessed under this subsection may obtain review in the United States district court for the appropriate district by filing a complaint in such court not later than 30 days after the date of such order.

(5) Collection of Penalties.--If any person fails to pay an assessment of a civil penalty under this section after it

has become a final and unappealable order, or after the appropriate court has entered final judgment in favor of the Secretary, the Secretary shall refer the matter to the Attorney General, who shall recover the amount assessed in any appropriate district court of the United States. In such action, the validity and appropriateness of the final order imposing the civil penalty shall not be subject to review.

(6) Compromise or Other Action by Secretary.--The Secretary may compromise, modify, or remit, with or without conditions, any civil penalty which is or may be imposed under this section.

(e) FORFEITURE.--

(1) In General.--Any vessel (including the vessel's equipment, stores, and cargo) and other item used, and any sanctuary resource taken or retained, in any manner, in connection with or as a result of any violation of this title or of any regulation or permit issued under this title shall be subject to forfeiture to the United States pursuant to a civil proceeding under this subsection. The proceeds from forfeiture actions under this subsection shall constitute a separate recovery in addition to any amounts recovered as civil penalties under this section or as civil damages under section 312. None of those proceeds shall be subject to set-off.

(2) Application of the Customs Laws.--The Secretary may exercise the authority of any United States official granted by any relevant customs law relating to the seizure, forfeiture, condemnation, disposition, remission, and mitigation of property in enforcing this title.

(3) Disposal of Sanctuary Resources.--Any sanctuary resource seized pursuant to this title may be disposed of pursuant to an order of the appropriate court or, if perishable, in a manner prescribed by regulations promulgated by the Secretary. Any proceeds from the sale of such sanctuary resource shall for all purposes represent the sanctuary resource so disposed of in any subsequent legal proceedings.

(4) Presumption.--For the purposes of this section there is a rebuttable presumption that all sanctuary resources found on board a vessel that is used or seized in connection with a violation of this title or of any regulation or permit issued under this title were taken or retained in violation of this title or of a regulation or permit issued under this title.

(f) PAYMENT OF STORAGE, CARE, AND OTHER COSTS.--

(1) Expenditures.--

(A) Notwithstanding any other law, amounts received by the United States as civil penalties, forfeitures of property, and costs imposed under paragraph (2) shall be retained by the Secretary in the manner provided for in section 107(f)(1) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980.

(B) Amounts received under this section for forfeitures and costs imposed under paragraph (2) shall be used to pay the reasonable and necessary costs incurred by the Secretary to provide temporary storage, care, maintenance, and disposal of any sanctuary resource or other property seized in connection with a violation of this title or any regulation or permit issued under this title.

(C) Amounts received under this section as civil penalties and any amounts remaining after the operation of subparagraph (B) shall be used, in order of priority, to--

(i) manage and improve the national marine sanctuary with respect to which the violation occurred that resulted in the penalty or forfeiture;

(ii) pay a reward to any person who furnishes information leading to an assessment of a civil penalty, or to a forfeiture of property, for a violation of this title or any regulation or permit issued under this title; and

(iii) manage and improve any other national marine sanctuary.

(2) Liability for Costs.--Any person assessed a civil penalty for a violation of this title or of any regulation or permit issued under this title, and any claimant in a forfeiture action brought for such a violation, shall be liable for the reasonable costs incurred by the Secretary in storage, care, and maintenance of any sanctuary resource or other property seized in connection with the violation.

(g) SUBPOENAS.--In the case of any hearing under this section which is determined on the record in accordance with the procedures provided for under section 554 of title 5, United States Code, the Secretary may issue subpoenas for the attendance and testimony of witnesses and the production of relevant papers, books, electronic files, and documents, and may administer oaths.

(h) USE OF RESOURCES OF STATE AND OTHER FEDERAL AGENCIES.—The Secretary shall, whenever appropriate, use by agreement the personnel, services, and facilities of State and other Federal departments, agencies, and instrumentalities, on a reimbursable or nonreimbursable basis, to carry out the Secretary's responsibilities under this section.

(i) COAST GUARD AUTHORITY NOT LIMITED.--Nothing in this section shall be considered to limit the authority of the Coast Guard to enforce this or any other Federal law under section 89 of title 14, United States Code.

(j) INJUNCTIVE RELIEF.--If the Secretary determines that there is an imminent risk of destruction or loss of or injury to a sanctuary resource, or that there has been actual destruction or loss of, or injury to, a sanctuary resource which may give rise to liability under section 312, the Attorney General, upon request of the Secretary, shall seek to obtain such relief as may be necessary to abate such risk or actual destruction, loss, or injury, or to restore or replace the sanctuary resource, or both. The district courts of the United States shall have jurisdiction in such a case to order such relief as the public interest and the equities of the case may require.

(k) AREA OF APPLICATION AND ENFORCEABILITY.--The area of application and enforceability of this title includes the territorial sea of the United States, as described in Presidential Proclamation 5928 of December 27, 1988, which is subject to the sovereignty of the United States, and the

United States exclusive economic zone, consistent with international law.

(l) NATIONWIDE SERVICE OF PROCESS.- In any action by the United States under this title, process may be served in any district where the defendant is found, resides, transacts business, or has appointed an agent for the service of process.

SEC. 308. REGULATIONS.

The Secretary may issue such regulations as may be necessary to carry out this title.

Sec. 309. RESEARCH, MONITORING, AND EDUCATION.

(a) IN GENERAL- The Secretary shall conduct, support, or coordinate research, monitoring, evaluation, and education programs consistent with subsections (b) and (c) and the purposes and policies of this title.

(b) RESEARCH AND MONITORING.-

(1) IN GENERAL.- The Secretary may--

(A) support, promote, and coordinate research on, and long-term monitoring of, sanctuary resources and natural processes that occur in national marine sanctuaries, including exploration, mapping, and environmental and socioeconomic assessment;

(B) develop and test methods to enhance degraded habitats or restore damaged, injured, or lost sanctuary resources; and

(C) support, promote, and coordinate research on, and the conservation, curation, and public display of, the cultural, archeological, and historical resources of national marine sanctuaries.

(2) AVAILABILITY OF RESULTS.- The results of research and monitoring conducted, supported, or permitted by the Secretary under this subsection shall be made available to the public.

(c) EDUCATION-

(1) IN GENERAL.- The Secretary may support, promote, and coordinate efforts to enhance public awareness, understanding, and appreciation of national marine sanctuaries and the System. Efforts supported, promoted, or coordinated under this subsection must emphasize the conservation goals and sustainable public uses of national marine sanctuaries and the System.

(2) EDUCATIONAL ACTIVITIES.- Activities under this subsection may include education of the general public, teachers, students, national marine sanctuary users, and ocean and coastal resource managers.

(d) INTERPRETIVE FACILITIES.-

(1) IN GENERAL.- The Secretary may develop interpretive facilities near any national marine sanctuary.

(2) FACILITY REQUIREMENT.- Any facility developed under this subsection must emphasize the conservation goals and sustainable public uses of national marine sanctuaries by providing the public with information about the conservation, recreational, ecological, historical, cultural, archeological, scientific, educational, or esthetic qualities of the national marine sanctuary.

(e) CONSULTATION AND COORDINATION.- In conducting, supporting, and coordinating research, monitoring, evaluation, and education programs under subsection (a) and developing interpretive facilities under subsection (d), the Secretary may consult or coordinate with Federal, interstate, or regional agencies, States or local governments.

Sec. 310. SPECIAL USE PERMITS

(a) ISSUANCE OF PERMITS.--The Secretary may issue special use permits which authorize the conduct of specific activities in a national marine sanctuary if the Secretary determines such authorization is necessary--

(1) to establish conditions of access to and use of any sanctuary resource; or

(2) to promote public use and understanding of a sanctuary resource.

(b) PUBLIC NOTICE REQUIRED.- The Secretary shall provide appropriate public notice before identifying any category of activity subject to a special use permit under subsection (a).

(c) PERMIT TERMS.--A permit issued under this section--

(1) shall authorize the conduct of an activity only if that activity is compatible with the purposes for which the sanctuary is designated and with protection of sanctuary resources;

(2) shall not authorize the conduct of any activity for a period of more than 5 years unless renewed by the Secretary;

(3) shall require that activities carried out under the permit be conducted in a manner that does not destroy, cause the loss of, or injure sanctuary resources; and

(4) shall require the permittee to purchase and maintain comprehensive general liability insurance, or post an equivalent bond, against claims arising out of activities conducted under the permit and to agree to hold the United States harmless against such claims.

(d) FEES.--

(1) Assessment and Collection.--The Secretary may assess and collect fees for the conduct of any activity under a permit issued under this section.

(2) Amount.--The amount of a fee under this subsection shall be equal to the sum of--

(A) costs incurred, or expected to be incurred, by the Secretary in issuing the permit;

(B) costs incurred, or expected to be incurred, by the Secretary as a direct result of the conduct of the activity for which the permit is issued, including costs of monitoring the conduct of the activity; and

(C) an amount which represents the fair market value of the use of the sanctuary resource.

(3) Use of Fees.--Amounts collected by the Secretary in the form of fees under this section may be used by the Secretary--

(A) for issuing and administering permits under this section; and

(B) for expenses of managing national marine sanctuaries.

(4) WAIVER OR REDUCTION OF FEES.- The Secretary may accept in-kind contributions in lieu of a fee under paragraph (2)(C), or waive or reduce any fee assessed under this subsection for any activity that does not derive a profit from the access to or use of sanctuary resources.

(e) VIOLATIONS.--Upon violation of a term or condition of a permit issued under this section, the Secretary may--

(1) suspend or revoke the permit without compensation to the permittee and without liability to the United States;

(2) assess a civil penalty in accordance with section 307; or

(3) both.

(f) REPORTS.--Each person issued a permit under this section shall submit an annual report to the Secretary not later than December 31 of each year which describes activities conducted under that permit and revenues derived from such activities during the year.

(g) FISHING.--Nothing in this section shall be considered to require a person to obtain a permit under this section for the conduct of any fishing activities in a national marine sanctuary.

Sec. 311. COOPERATIVE AGREEMENTS, DONATIONS, AND ACQUISITIONS

(a) AGREEMENTS AND GRANTS- The Secretary may enter into cooperative agreements, contracts, or other agreements with, or make grants to, States, local governments, regional agencies, interstate agencies, or other persons to carry out the purposes and policies of this title.

(b) AUTHORIZATION TO SOLICIT DONATIONS.--The Secretary may enter into such agreements with any nonprofit organization authorizing the organization to solicit private donations to carry out the purposes and policies of this title.

(c) DONATIONS.--The Secretary may accept donations of funds, property, and services for use in designating and administering national marine sanctuaries under this title. Donations accepted under this section shall be considered as a gift or bequest to or for the use of the United States.

(d) ACQUISITIONS.--The Secretary may acquire by purchase, lease, or exchange, any land, facilities, or other property necessary and appropriate to carry out the purposes and policies of this title

(e) USE OF RESOURCES OF OTHER GOVERNMENT AGENCIES.- The Secretary may, whenever appropriate, enter into an agreement with a State or other Federal agency to use the personnel, services, or facilities of such agency on a reimbursable or nonreimbursable basis, to assist in carrying out the purposes and policies of this title.

(f) AUTHORITY TO OBTAIN GRANTS.- Notwithstanding any other provision of law that prohibits a Federal agency from receiving assistance, the Secretary may apply for, accept, and use grants from other Federal agencies, States, local governments, regional agencies, interstate agencies, foundations, or other persons, to carry out the purposes and policies of this title.

Sec. 312. DESTRUCTION OR LOSS OF, OR INJURY TO, SANCTUARY RESOURCES

(a) LIABILITY FOR INTEREST.--

(1) Liability to united states.--Any person who destroys, causes the loss of, or injures any sanctuary resource is liable to the United States for an amount equal to the sum of--

(A) the amount of response costs and damages resulting from the destruction, loss, or injury; and

(B) interests on that amount calculated in the manner described under section 1005 of the Oil Pollution Act of 1990.

(2) Liability In Rem.--Any vessel used to destroy, cause the loss of, or injure any sanctuary resource shall be liable in rem to the United States for response costs and damages resulting from such destruction, loss, or injury. The amount of that liability shall constitute a maritime lien on the vessel and may be recovered in an action in rem in the district court of the United States having jurisdiction over the vessel.

(3) Defenses.--A person is not liable under this subsection if that person establishes that--

(A) the destruction or loss of, or injury to, the sanctuary resource was caused solely by an act of God, an act of war, or an act or omission of a third party, and the person acted with due care;

(B) the destruction, loss, or injury was caused by an activity authorized by Federal or State law; or

(C) the destruction, loss, or injury was negligible.

(4) Limits to Liability.-- Nothing in sections 4281-4289 of the Revised Statutes of the United States or section 3 of the Act of February 13, 1893, shall limit the liability of any person under this title.

(b) RESPONSE ACTIONS AND DAMAGE ASSESSMENT.-

(1) Response Actions.--The Secretary may undertake or authorize all necessary actions to prevent or minimize the destruction or loss of, or injury to, sanctuary resources, or to minimize the imminent risk of such destruction, loss, or injury.

(2) Damage Assessment.--The Secretary shall assess damages to sanctuary resources in accordance with section 302(6).

(c) CIVIL ACTIONS FOR RESPONSE COSTS AND DAMAGES.—

(1) The Attorney General, upon request of the Secretary, may commence a civil action against any person or vessel

who may be liable under subsection (a) for response costs and damages. The Secretary, acting as trustee for sanctuary resources for the United States, shall submit a request for such an action to the Attorney General whenever a person may be liable for such costs or damages.

(2) An action under this subsection may be brought in the United States district court for any district in which-

(A) the defendant is located, resides, or is doing business, in the case of an action against a person;

(B) the vessel is located, in the case of an action against a vessel; or

(C) the destruction of, loss of, or injury to a sanctuary resource occurred.

(d) USE OF RECOVERED AMOUNTS.--Response costs and damages recovered by the Secretary under this section shall be retained by the Secretary in the manner provided for in section 107(f)(1) of the Comprehensive Environmental Response, Compensation and Liability Act (42 U.S.C. 9607(f)(1)), and used as follows:

(1) RESPONSE COSTS.- Amounts recovered by the United States for costs of response actions and damage assessments under this section shall be used, as the Secretary considers appropriate--

(A) to reimburse the Secretary or any other Federal or State agency that conducted those activities; and

(B) after reimbursement of such costs, to restore, replace, or acquire the equivalent of any sanctuary resource.

(2) OTHER AMOUNTS.- All other amounts recovered shall be used, in order of priority--

(A) to restore, replace, or acquire the equivalent of the sanctuary resources that were the subject of the action, including for costs of monitoring and the costs of curation and conservation of archeological, historical, and cultural sanctuary resources;

(B) to restore degraded sanctuary resources of the national marine sanctuary that was the subject of the action, giving priority to sanctuary resources and habitats that are comparable to the sanctuary resources that were the subject of the action; and

(C) to restore degraded sanctuary resources of other national marine sanctuaries.

(3) Federal-State Coordination.--Amounts recovered under this section with respect to sanctuary resources lying within the jurisdiction of a State shall be used under paragraphs (2)(A) and (B) in accordance with the court decree or settlement agreement and an agreement entered into by the Secretary and the Governor of that State.

(e) STATUTE OF LIMITATIONS- An action for response costs or damages under subsection (c) shall be barred unless the complaint is filed within 3 years after the date on which the Secretary completes a damage assessment and restoration plan for the sanctuary resources to which the action relates.

SEC. 313. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary--

(1) to carry out this title--

(A) $32,000,000 for fiscal year 2001;

(B) $34,000,000 for fiscal year 2002;

(C) $36,000,000 for fiscal year 2003;

(D) $38,000,000 for fiscal year 2004;

(E) $40,000,000 for fiscal year 2005; and

(2) for construction projects at national marine sanctuaries, $6,000,000 for each of fiscal years 2001, 2002, 2003, 2004, and 2005.

Sec. 314. U.S.S. MONITOR ARTIFACTS AND MATERIALS

(a) CONGRESSIONAL POLICY. -- In recognition of the historical significance of the wreck of the United States ship Monitor to coastal North Carolina and to the area off the coast of North Carolina known as the Graveyard of the Atlantic, the Congress directs that a suitable display of artifacts and materials from the United States ship Monitor be maintained permanently at an appropriate site in coastal North Carolina. [P.L. 102-587 authorized a grant for the acquisition of space in Hatteras Village, NC, for display of artifacts and administration and operations of the Monitor National Marine Sanctuary.

(b) DISCLAIMER. --This section shall not affect the following:

(1) Responsibilities Of Secretary.--The responsibilities of the Secretary to provide for the protection, conservation, and display of artifacts and materials from the United States ship Monitor.

(2) Authority Of Secretary.--The authority of the Secretary to designate the Mariner's Museum, located at Newport News, Virginia, as the principal museum for coordination of activities referred to in paragraph (1).

Sec. 315. ADVISORY COUNCILS

(a) ESTABLISHMENT.--The Secretary may establish one or more advisory councils (in this section referred to as an 'Advisory Council') to advise and make recommendations to the Secretary regarding the designation and management of national marine sanctuaries. The Advisory Councils shall be exempt from the Federal Advisory Committee Act.

(b) MEMBERSHIP.--Members of the Advisory Councils may be appointed from among--

(1) persons employed by Federal or State agencies with expertise in management of natural resources;

(2) members of relevant Regional Fishery Management Councils established under section 302 of the Magnuson-Stevens Act; and

(3) representatives of local user groups, conservation and other public interest organizations, scientific organizations, educational organizations, or others interested in the protection and multiple use management of sanctuary resources.

(c) LIMITS ON MEMBERSHIP.--For sanctuaries designated after the date of enactment of the National Marine Sanctuaries Program Amendments Act of 1992, the membership of Advisory Councils shall be limited to no more than 15 members.

(d) STAFFING AND ASSISTANCE.--The Secretary may make available to an Advisory Council any staff, information, administrative services, or assistance the Secretary determines are reasonably required to enable the Advisory Council to carry out its functions.

(e) PUBLIC PARTICIPATION AND PROCEDURAL MATTERS.--The following guidelines apply with respect to the conduct of business meetings of an Advisory Council:

(1) Each meeting shall be open to the public, and interested persons shall be permitted to present oral or written statements on items on the agenda.

(2) Emergency meetings may be held at the call of the chairman or presiding officer.

(3) Timely notice of each meeting, including the time, place, and agenda of the meeting, shall be published locally and in the Federal Register, except that in the case of a meeting of an Advisory Council established to provide assistance regarding any individual national marine sanctuary the notice is not required to be published in the Federal Register.

(4) Minutes of each meeting shall be kept and contain a summary of the attendees and matters discussed.

Sec. 316. ENHANCING SUPPORT FOR NATIONAL MARINE SANCTUARIES

(a) AUTHORITY.- The Secretary may establish a program consisting of--

(1) the creation, adoption, and publication in the Federal Register by the Secretary of a symbol for the national marine sanctuary program, or for individual national marine sanctuaries or the System;

(2) the solicitation of persons to be designated as official sponsors of the national marine sanctuary program or of individual national marine sanctuaries;

(3) the designation of persons by the Secretary as official sponsors of the national marine sanctuary program or of individual sanctuaries;

(4) the authorization by the Secretary of the manufacture, reproduction, or other use of any symbol published under paragraph (1), including the sale of items bearing such a symbol, by official sponsors of the national marine sanctuary program or of individual national marine sanctuaries;

(5) the creation, marketing, and selling of products to promote the national marine sanctuary program, and entering into exclusive or nonexclusive agreements authorizing entities to create, market or sell on the Secretary's behalf;

(6) the solicitation and collection by the Secretary of monetary or in-kind contributions from official sponsors for the manufacture, reproduction or use of the symbols published under paragraph (1);

(7) the retention of any monetary or in-kind contributions collected under paragraphs (5) and (6) by the Secretary; and

(8) the expenditure and use of any monetary and in-kind contributions, without appropriation, by the Secretary to designate and manage national marine sanctuaries.

Monetary and in-kind contributions raised through the sale, marketing, or use of symbols and products related to an individual national marine sanctuary shall be used to support that sanctuary.

(b) CONTRACT AUTHORITY.-- The Secretary may contract with any person for the creation of symbols or the solicitation of official sponsors under subsection (a).

(c) RESTRICTIONS.-- The Secretary may restrict the use of the symbols published under subsection (a), and the designation of official sponsors of the national marine sanctuary program or of individual national marine sanctuaries to ensure compatibility with the goals of the national marine sanctuary program.

(d) PROPERTY OF UNITED STATES.-- Any symbol which is adopted by the Secretary and published in the Federal Register under subsection (a) is deemed to be the property of the United States.

(e) PROHIBITED ACTIVITIES.-- It is unlawful for any person--

(1) designated as an official sponsor to influence or seek to influence any decision by the Secretary or any other Federal official related to the designation or management of a national marine sanctuary, except to the extent that a person who is not so designated may do so;

(2) to represent himself or herself to be an official sponsor absent a designation by the Secretary;

(3) to manufacture, reproduce, or otherwise use any symbol adopted by the Secretary under subsection (a)(1), including to sell any item bearing such a symbol, unless authorized by the Secretary under subsection (a)(4) or subsection (f); or

(4) to violate any regulation promulgated by the Secretary under this section.

(f) COLLABORATIONS- The Secretary may authorize the use of a symbol adopted by the Secretary under subsection (a)(1) by any person engaged in a collaborative effort with the Secretary to carry out the purposes and policies of this title and to benefit a national marine sanctuary or the System.

(g) AUTHORIZATION FOR NON-PROFIT PARTNER ORGANIZATION TO SOLICIT SPONSORS.-

(1) IN GENERAL.- The Secretary may enter into an agreement with a non-profit partner organization authorizing it to assist in the administration of the sponsorship program established under this section. Under an agreement entered into under this paragraph, the Secretary may authorize the non-profit partner organization to solicit persons to be official sponsors of the national marine sanctuary system or of individual national marine sanctuaries, upon such terms

as the Secretary deems reasonable and will contribute to the successful administration of the sanctuary system. The Secretary may also authorize the non-profit partner organization to collect the statutory contribution from the sponsor, and, subject to paragraph (2), transfer the contribution to the Secretary.

(2) REIMBURSEMENT FOR ADMINISTRATIVE COSTS.- Under the agreement entered into under paragraph (1), the Secretary may authorize the non-profit partner organization to retain not more than 5 percent of the amount of monetary contributions it receives from official sponsors under the agreement to offset the administrative costs of the organization in soliciting sponsors.

(3) PARTNER ORGANIZATION DEFINED.- In this subsection, the term `partner organization' means an organization that--

(A) draws its membership from individuals, private organizations, corporation, academic institutions, or State and local governments; and

(B) is established to promote the understanding of, education relating to, and the conservation of the resources of a particular sanctuary or 2 or more related sanctuaries.

SEC. 318. DR. NANCY FOSTER SCHOLARSHIP PROGRAM.

(a) ESTABLISHMENT.- The Secretary shall establish and administer through the National Ocean Service the Dr. Nancy Foster Scholarship Program. Under the program, the Secretary shall award graduate education scholarships in oceanography, marine biology or maritime archeology, to be known as Dr. Nancy Foster Scholarships.

(b) PURPOSES- The purposes of the Dr. Nancy Foster Scholarship Program are--

(1) to recognize outstanding scholarship in oceanography, marine biology, or maritime archeology, particularly by women and members of minority groups ; and

(2) to encourage independent graduate level research in oceanography, marine biology, or maritime archeology.

(c) AWARD.- Each Dr. Nancy Foster Scholarship--

(1) shall be used to support graduate studies in oceanography, marine biology, or maritime archeology at a graduate level institution of higher education; and

(2) shall be awarded in accordance with guidelines issued by the Secretary.

(d) DISTRIBUTION OF FUNDS.- The amount of each Dr. Nancy Foster Scholarship shall be provided directly to a recipient selected by the Secretary upon receipt of certification that the recipient will adhere to a specific and detailed plan of study and research approved by a graduate level institution of higher education.

(e) FUNDING- Of the amount available each fiscal year to carry out this title, the Secretary shall award 1 percent as Dr. Nancy Foster Scholarships.

(f) SCHOLARSHIP REPAYMENT REQUIREMENT- The Secretary shall require an individual receiving a scholarship under this section to repay the full amount of the scholarship to the Secretary if the Secretary determines that the individual, in obtaining or using the scholarship, engaged in fraudulent conduct or failed to comply with any term or condition of the scholarship.

(g) MARITIME ARCHEOLOGY DEFINED- In this section the term `maritime archeology' includes the curation, preservation, and display of maritime artifacts.

Appendix B. Designation Document for the Stellwagen Bank National Marine Sanctuary

On November 4, 1992, the Oceans Act of 1992 became law (Pub. L. 102-587). Section 2202 of Title II of that Act, known as the National Marine Sanctuaries Program Amendments Act of 1992 ("NMSPAA"), designated an area of waters and submerged lands, including the living and non-living resources within those waters, as described in Article II, as the Stellwagen Bank National Marine Sanctuary.

Article I. Effect of Designation

Title III of the Marine Protection, Research and Sanctuaries Act of 1972, as amended (the "Act" or "MPRSA"), 16 U.S.C. 1431 et seq. authorizes the issuance of such final regulations as are necessary and reasonable to implement the designation, including managing and protecting the conservation, recreational, ecological, historical, research, educational and esthetic resources and qualities of the Stellwagen Bank National Marine Sanctuary. Section 1 of Article IV of this Designation Document lists activities of the type that either are to be regulated, or may have to be regulated subsequently in order to protect Sanctuary resources and qualities. Listing does not necessarily mean that a type of activity will be regulated; however, if a type of activity is not listed it may not be regulated, except on an emergency basis, unless Section 1 of Article IV is amended to include the type of activity by the procedures outlined in section 304(a) of the MPRSA.

Article II: Description of the Area

The Stellwagen Bank National Marine Sanctuary (the "Sanctuary") boundary encompasses a total of approximately 638 square nautical miles (approximately 2181 square kilometers) of ocean waters, and the submerged lands thereunder, over and surrounding the submerged Stellwagen Bank and additional submerged features, offshore the Commonwealth of Massachusetts. The boundary encompasses the entirety of Stellwagen Bank; Tillies Bank to the northeast of Stellwagen Bank; and southern portions of Jeffreys Ledge, to the north of Stellwagen Bank. Portions of the Sanctuary are adjacent to three coastal ocean areas designated by the Commonwealth of Massachusetts as Ocean Sanctuaries. The northwestern border coincides with the North Shore Ocean Sanctuary. The southern border coincides with the seaward limit of Commonwealth jurisdictional waters adjacent to the Cape Cod Bay Ocean Sanctuary; and is also tangential to the Cape Cod Ocean Sanctuary. The western border of the Stellwagen Bank Sanctuary occurs approximately 25 miles east of Boston, Massachusetts. Appendix RR to this Designation Document sets the precise Sanctuary boundary.

Article III: Characteristics of the Area That Give It Particular Value

Stellwagen Bank is a glacially-deposited, primarily sandy feature measuring nearly twenty miles in length, occurring in a roughly southeast-to-northwest direction between Cape Cod and Cape Ann, Massachusetts. It is located at the extreme southwestern corner of the Gulf of Maine, and forms a partial "gateway" to Cape Cod Bay, situated shoreward and southwest of the Bank.

The presence of the Bank feature contributes to a particular combination of physical and oceanographic characteristics which results in two distinct peak productivity periods annually, when overturn and mixing of coastal waters with nutrient-rich waters from deeper strata produce a complex system of overlapping mid-water and benthic habitats. From the time of Colonial settlement, this area has supported an abundant and varied array of fisheries, which continue to provide livelihoods for an active commercial fleet. Important fisheries include bluefin tuna, herring, cod, haddock, winter and summer flounder, silver hake, pollock, ocean pout, lobster, shrimp, surf clam and sea scallop. The commercial value of fish caught (exclusive of bluefin tuna) within Sanctuary waters exceeded $15 million in 1990.

The biological productivity of the Bank also attracts a seasonal variety of large and small cetaceans, several of which are classified as endangered species. The Stellwagen Bank environment provides feeding and nursery areas for humpback, fin, and northern right whales, the latter being the most critically-endangered of all large cetacean species. The photo-identification at Stellwagen Bank of 100 or more individual right whales from a total North Atlantic population estimated in 1990 at approximately 300 to 350 indicates the importance of the Bank to this species. The predictable seasonal presence of these and other cetacean species has generated a growing commercial whalewatch industry, involving more than 40 vessels (over 1.5 million passengers), and producing revenues in excess of $17 million in 1988.

A vessel traffic separation scheme (TSS) crosses directly over Stellwagen Bank, and accommodates approximately 2,700 commercial vessels annually in and out of Boston, Massachusetts. Existing or potential additional human activities involving the Stellwagen Bank environment include dredged materials disposal; sand and gravel extraction; offshore mariculture development; and offshore fixed artificial platform construction.

The uniqueness of the Stellwagen Bank environment as well as its accessibility draws the continuing interest of area scientific institutions, including the Center for Coastal Studies, Cetacean Research Unit, University of Massachusetts, Woods Hole Oceanographic Institution, Marine Biological Laboratory, Manomet Bird Observatory, New England Aquarium, University of Rhode Island and the National Marine Fisheries Service (NOAA). In light of the increasing levels of human activities, several issues such as: interactions between marine mammals and commercial/recreational vessels; immediate, long-term and cumulative impacts on marine mammals from whale-watching vessel activity; and the immediate, long-term and cumulative effects of discharge/disposal operations on the Bank's resources and qualities require coordinated and comprehensive monitoring and research.

Article IV. Scope of Regulations

Section 1. Activities Subject to Regulation

The following activities are subject to regulation under the Act, including prohibition, to the extent necessary and reasonable to ensure the protection and management of the conservation, recreational, ecological, historical, research, educational or esthetic resources and qualities of the area:

a. Discharging or depositing, from within the boundary of the Sanctuary, any material or other matter;

b. Discharging or depositing, from beyond the boundary of the Sanctuary, any material or other matter;

c. Exploring for, developing, or producing oil, gas or minerals (e.g., clay, stone, sand, gravel, metalliferous ores and nonmetalliferous ores or any other solid material or other matter of commercial value ["industrial materials"]) in the Sanctuary;

d. Drilling into, dredging or otherwise altering the seabed of the Sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the Sanctuary;

e. Development or conduct in the Sanctuary of mariculture activities;

f. Taking, removing, moving, catching, collecting, harvesting, feeding, injuring, destroying or causing the loss of, or attempting to take, remove, move, catch, collect, harvest, feed, injure, destroy or cause the loss of, a marine mammal, marine reptile, seabird, historical resource or other Sanctuary resource;

g. Transferring of petroleum-based products or materials from vessel-to-vessel or "lightering", in the Sanctuary;

h. Operation of a vessel (i.e., water craft of any description capable of being used as a means of transportation) in the Sanctuary;

i. Possessing within the Sanctuary a Sanctuary resource or any other resource, regardless of where taken, removed, moved, caught, collected or harvested, that, if it had been found within the Sanctuary, would be a Sanctuary resource;

j. Interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of the Act or any regulation or permit issued under the Act.

Section 2. Emergencies

Where necessary to prevent or minimize the destruction of, loss of, or injury to a Sanctuary resource or quality; or minimize the imminent risk of such destruction, loss or injury, any activity, including those not listed in Section 1 of this Article , is subject to immediate temporary regulation, including prohibition.

Article V. Effect on Leases, Permits, Licenses, and Rights

If any valid regulation issued by any Federal, State or local authority of competent jurisdiction, regardless of when issued, conflicts with a Sanctuary regulation, the regulation deemed by the Director, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, or his or her designee to be more protective of Sanctuary resources and qualities shall govern.

Pursuant to section 304(c)(1) of the Act, 16 U.S.C. § 1434(c)(1), no valid lease, permit, license, approval or other authorization issued by any Federal, State or local authority of competent jurisdiction, or any right of subsistence use or access, may be terminated by the Secretary of Commerce, or his or her designee, as a result of this designation, or as a result of any Sanctuary regulation, if such authorization or right was in existence on the effective date of this designation. However, the Secretary of Commerce, or designee, may regulate the exercise (including, but not limited to, the imposition of terms and conditions) of such authorization or right consistent with the purposes for which the Sanctuary is designated.

In no event may the Secretary or designee issue a permit authorizing, or otherwise approving: (1) the exploration for, development of, or production of industrial materials within the Sanctuary; or (2) the disposal of dredged material within the Sanctuary (except by a certification, pursuant to Section 940.10, of valid authorizations in existence on the effective date of Sanctuary designation). Any purported authorizations issued by other authorities after the effective date of Sanctuary designation for any of these activities within the Sanctuary shall be invalid.

Article VI. Alteration of this Designation

The terms of designation, as defined under Section 304(a) of the Act, may be modified only by the procedures outlined in section 304(a) of the MPRSA, including public hearings, consultation with interested Federal, State, and local agencies, review by the appropriate Congressional committees, and Governor of the Commonwealth of Massachusetts, and approval by the Secretary of Commerce or designee.

Appendix RR. Coordinates.				
Coordinates Based on North American Datun of 1927				
			Loran	
	LATITUDE	LONGITUDE	9960W	9960X
E1	42 45 59.83	70 13 01.77	13,607.19	25,728.57
E2	42 05 35.51	70 02 08.14	13,753.39	25,401.78
E3	42 06 18.25	70 03 17.55	13,756.72	25,412.46
E4	42 06 29.53	70 04 03.36	13,760.30	25,417.53
E5	42 07 02.70	70 05 13.61	13,764.52	25,427.27
E6	42 07 13.80	70 06 23.75	13,770.54	25,434.45
E7	42 07 35.95	70 07 27.89	13,775.08	25,442.51
E8	42 07.42.33	70 08 26.07	13,780.35	25,448.27
E9	42 07 59.94	70 09 19.78	13,784.24	25,455.02
E10	42 08 04.95	70 10 24.40	13,790.27	25,461.28
E11	42 07 55.19	70 11 47.67	13,799.38	25,467.56
E12	42 07 59.84	70 13 03.35	13,806.58	25,474.95
E13	42 07 46.55	70 14 21.91	13,815.52	25,480.62
E14	42 07 27.29	70 15 22.95	13,823.21	25,484.05
E15	42 06 54.57	70 16 42.71	13,833.88	25,487.79
E16	42 07 44.89	70 28 15.44	13,900.14	25,563.22
E17	42 32 53.52	70 35 52.38	13,821.60	25,773.51
E18	42 33 30.24	70 35 14.96	13,814.43	25,773.54
E19	42 33 48.14	70 35 03.81	13,811.68	25,774.28
E20	42 34 30.45	70 34 22.98	13,803.64	25,774.59
E21	42 34 50.37	70 33 21.93	13,795.43	25,770.55
E22	42 35 16.08	70 32 32.29	13,787.92	25,768.31
E23	42 35 41.80	70 31 44.20	13,780.57	25,766.25
E24	42 36 23.08	70 30 58.98	13,772.14	25,766.14
E25	42 37 15.51	70 30 23.01	13,763.69	25,768.12
E26	42 37 58.88	70 30 06.60	13,758.09	25,771.07
E27	42 38 32.46	70 30 06.54	13,755.07	25,774.58
E28	42 39 04.08	70 30 11.29	13,752.75	25,778.35

Appendix C. Key Topics and Issues Identified during Public Scoping for Revision of the Stellwagen Bank Sanctuary Management Plan.

TOPIC 1: HABITAT AND ECOSYSTEM PROTECTION

Issue A: Alteration of Sanctuary Habitat by Human Activity

Issue B: More Detailed Site Characterization and Assessment of Resource Status

Issue C: Need for Comprehensive Ecosystem Protection

Issue D: Need for Compatibility Determinations and Carrying Capacities

TOPIC 2: IMPACTS OF HUMAN ACTIVITIES ON MARINE MAMMALS

Issue A: Need for More Information on Habits and Use of Sanctuary Habitats by Whales and Other Marine Mammals

Issue B: Vessel Strikes on Whales and Other Marine Mammals

Issue C: Whale Harassment and Behavioral Disturbance

Issue D: Entanglement of Whales and Other Marine Mammals in Fishing Gear and Marine Debris

Issue E: Impacts of Vessel Noise and Other Acoustics on Marine Mammals

TOPIC 3: CONDITION OF WATER QUALITY AND CONTAMINANT TRANSPORT

Issue A: No Existing Comprehensive Water Quality Plan

Issue B: Lack of Baseline Water Quality Data Including Toxins and Contaminants

Issue C: Appropriateness of Wastewater Discharge by Vessels

Issue D: Impacts of Municipal Sewage Outfalls and Other Waste Streams

TOPIC 4: LACK OF PUBLIC AWARENESS

Issue A: Low Name Recognition

Issue B: Better Information Dissemination to the Public and User Groups

Issue C: Program Support through Leveraged Partnerships

Issue D: Public Education through Curriculum Development

TOPIC 5: PROTECTION OF SUBMERGED CULTURAL RESOURCES (SCRs)

Issue A: Need for Inventory and Assessment and Comprehensive Characterization of SCRs

Issue B: No Plan for SCR Management and Protection

Issue C: Lack of Public Outreach and Interpretation of SCRs

[Note: The NMSP's Maritime Heritage Program has since substituted the term "Maritime Heritage Resource" for the term "Submerged Cultural Resource," because the new term has broader applicability system-wide.]

TOPIC 6: EFFECTIVE ENFORCEMENT

Issue A: Need Greater Compliance with Regulations

Issue B: New Vessel Types / Activities Require Monitoring

Issue C: Whale Watching Guidelines Need to Become Regulations to Avoid Injury to Marine Mammals

TOPIC 7: ADEQUACY OF ADMINISTRATIVE CAPACITY

Issue A: Base-Level Staffing and Program Support

Issue B: Infrastructure Development and Maintenance

TOPIC 8: SANCTUARY AUTHORITY AND CROSS-JURISDICTIONAL INTERACTION

Issue A: Clarification of Overlapping Agency Responsibilities

Issue B: Inter-Agency Coordination and Effectiveness

Appendix D. List of Current and Former Stellwagen Bank Sanctuary Advisory Council Members (2001-2006)

PUBLIC MEMBERS (VOTING):

RESEARCH (1)

Member: Mason Weinrich
Executive Director and Chief Scientist
The Whale Center of New England
Gloucester, MA

Alternate: Porter Hoagland, Ph.D.
Public Policy Research Specialist
Woods Hole Oceanographic Institute
Woods Hole, MA

RESEARCH (2)

Member: Peter Auster, Ph.D.
Science Director
National Undersea Research Center
University of Connecticut
Groton, CT

Alternate: Judith Pederson, Ph.D.
Manager, Center for Coastal Resources
MIT Sea Grant College Program
Cambridge, MA

CONSERVATION (1)

Member: Susan Farady, J.D.
Ecosystem Protection Project Manager
The Ocean Conservancy
Portland, ME

Alternate: Regina Asmutis-Silvia
Senior Biologist
Whale and Dolphin Conservation Society
Plymouth, MA

CONSERVATION (2)

Member: Priscilla Brooks, Ph.D.
Director, Marine Conservation Program
Conservation Law Foundation
Boston, MA

Alternate: Rachael Taylor
The Nature Conservancy
Boston, MA

Former: Erin Hesket
Senior Program Officer
Wildlife and Habitat Protection Department
International Fund for Animal Welfare (IFAW)
Yarmouthport, MA

Gib Chase,
Wildlife Biologist
Northborough, MA

EDUCATION (1)

Member: Richard Wheeler
Chairman, Board of Trustees
Cape Cod Museum of Natural History
Wareham, MA

Alternate: Sharon Meeker
Marine Education Specialist (ret.)
University of New Hampshire
Sea Grant College Program
Lee, NH

EDUCATION (2)

Member: Peter Borrelli
Executive Director
Provincetown Center for Coastal Studies
Provincetown, MA

Former: Kevin C. Chu, Ph.D.
Sea Education Association
Falmouth, MA

Alternate: Jack Crowley
Executive Director
Massachusetts Marine Educators
Fairhaven, MA

Former: J. Michael Williamson, Ph.D.
Director, WhaleNet and
Associate Professor, Wheelock College
Boston, MA

MARINE TRANSPORTATION

Member: William Eldridge
Owner/Operator
Peabody & Lane Corp./ Mediterranean Shipping Co., Inc.
Boston, MA

Former: Frederick L. Nolan, III
Managing Partner
Boston Harbor Cruises
Boston, MA

Alternate: Captain Martin McCabe
Boston Harbor Pilot
Boston Harbor Pilots Association at Pier 1
East Boston, MA

Former: William Eldridge
Peabody & Lane Corp./ Mediterranean Shipping, Co., Inc.
Boston, MA

RECREATION

Member: Barry Gibson
New England Regional Director
Recreational Fishing Alliance (RFA)
E. Boothbay, ME

Alternate: Michael Sosik, Jr
President
Northeast Charter Boat Captain's Association
Sturbridge, MA

Former: Roger Jarvis
Owner/Captain
Jazz Sport Fishing
Duxbury, MA

WHALEWATCHING

Member: Steve Milliken
Owner
Dolphin Fleet
Eastham, MA

Former: Alan (Jerry) Hill
President
Yankee Fleet
Gloucester, MA

Alternate: William Reilly, III
Director of Safety, Special Projects Manager
Boston Harbor Cruises
Boston, MA

Former: David Slocum
Senior Captain
New England Aquarium Whale Watch
Boston, MA

FIXED GEAR COMMERCIAL FISHING

Member: William Adler
Executive Director
Massachusetts Lobstermen's Association
Scituate, MA

Alternate: David Casoni
Executive Board
South Shore Lobstermen's Association
Plymouth, MA

Former: John W. Pappalardo
Policy Director
Cape Cod Commercial Hook Fishermen's Assoc.
N.Chatham, MA

MOBILE GEAR COMMERCIAL FISHING

Member: Edward Barrett
President
Massachusetts Fishermen's Partnership
Green Harbor, MA

Former: William H. Amaru
Captain
FV Joanne A. III
South Orleans, MA

Alternate: Vito Giacolone
Executive Board
North East Seafood Coalition
Gloucester, MA

Former: Robert B. MacKinnon
President
MA Bay Inshore Ground Fishermen's Association, Inc.
Marshfield, MA

BUSINESS/INDUSTRY

Member: Tim Moll
Vice-President
Brewer Plymouth Marine
Plymouth, MA

Former: Jackson Kent III
Board of Directors
Massachusetts Marine Trades Association, Inc.
Duxbury, MA

Alternate: David Jenson
Manager
Marina Bay Boston Harbor
Quincy, MA

Former: Peter Davidoff
Co-Owner
BOSPORT Docking and Constitution Marina
Boston, MA

AT LARGE (1)

Member: Deborah Cramer
Marine Science Writer
Gloucester, MA

Former: Richard C. Wheeler
Cape Cod Museum of Natural History
Wareham, MA

Alternate: Steven Tucker
Coastal and Marine Resources Program Manager
Cape Cod Commission
Barnstable, MA

Former: *Charles Rasak*
Creative Director
Creative Resources Group
Plymouth, MA

AT LARGE (2)

Member: Sally Yozell
Vice President
Battelle Laboratories (Duxbury Operations)
Duxbury, MA

Alternate: Open

Former: *Dale Brown*
Gloucester Community Representative
Gloucester, MA

Former: *Rob Robertson, Ph.D.*
Dept of Resource Economics
University of New Hampshire
Durham, NH

AT LARGE (3)

Member: Dale Brown
Gloucester Community Representative
Gloucester, MA

Former: *John Williamson*
Fishing Community Activist
Kennebunk, ME

Alternate: Donald Hourihan
Scituate Waterways Commission
Scituate, MA

EX-OFFICIO MEMBERS (GOVERNMENT NON-VOTING):

STATE

Member (1): Major Kathleen Dolan
Massachusetts Environmental Police
Hingham, MA

Former: *Richard A. Murray, Director*
Massachusetts Environmental Police

Member (2): Bruce Carlisle
Assistant Director
Massachusetts Office of Coastal Zone Management
Boston, MA

Former: *Susan Snow-Cotter*
Director, Massachusetts Office of Coastal Zone Management
Boston, MA

Former: *Thomas W. Skinner*
Director, Massachusetts Office of Coastal Zone Management
Boston, MA

Member (3): Paul J. Diodati
Director, Massachusetts Division of Marine Fisheries
Boston, MA
Designee: David Pierce, Ph.D., Deputy Director

FEDERAL

Member (1): Paul J. Howard,
Executive Director
New England Fishery Management Council
Newburyport, MA
Designee: Chris Kellogg, Deputy Director

Member (2): Patricia A. Kurkul
Northeast Regional Administrator
NOAA Fisheries Service
Gloucester, MA
Designee: Kathi Rodrigues, Policy Analyst

Member (3): Rear Admiral Timothy Sullivan
Commander, First Coast Guard District
Boston, MA
Designee: LCDR Edward Marohn

Former: *Rear Admiral Vivian S. Crea*
Commander, First Coast Guard District
Boston, MA

Former: *Rear Admiral David P. Pekoske*
Commander, First Coast Guard District
Boston, MA

Appendix E. List of Stellwagen Bank Sanctuary Advisory Council Meetings Relating to Management Plan Review

Meeting Date	Location	Meeting Purpose
2/11/2002	Plymouth Library, Plymouth, MA	Overview of MPR Process
9/09/2002	The Radisson, Rockland, MA	Overview of Scoping Process
12/16/2002	The Town Hall, Gloucester, MA	Report of Scoping Process
3/27/2003	The Radisson, Woburn, MA	Prioritization of Scoping Issues
6/16/2003	The Radisson, Rockland, MA	Initiation of Working Groups (WG)
10/01/2003	The Clarion, Hull, MA	Review of WG Membership and Guidelines
12/04/2003	The Clarion, Hull, MA	WG Status Reports
02/10/2004	The Radisson, Rockland, MA	Chair and Team Lead WG Reports
06/08/2004	The Sheraton Colonial, Wakefield, MA	MPR Overview and Timetable
10/20/2004	National Academy of Science, Woods Hole, MA	Review and Acceptance of all WG Action Plans (AP)
11/05/2004	The State Room, Boston, MA	Prioritization of AP Strategies
02/15/2005	The Radisson, Plymouth, MA	Compatibility Determination WG status; Formation of Zoning WG
06/09/2005	Museum of Science, Boston, MA	Review and Acceptance of CD AP
07/11/2005	Sanctuary Office, Scituate, MA	Formulation of Sanctuary Vision Statement
11/09/2005	The Commonwealth Museum, Boston, MA	Review of draft Condition Report
1/24/2006	The Sheraton Colonial, Wakefield, MA	Non-Regulatory MP Discussion of Potential Targeted Management Actions
6/12/2006	The Radisson, Rockland, MA	Overview of NMSA and NEPA; Zoning WG “ecological integrity” definition

Appendix F. List of Working Group Members

This appendix lists the members of the 12 working groups established by the Stellwagen Bank Sanctuary Advisory Council to develop draft action plans for consideration by the Advisory Council. For a list of working group meeting dates refer to http://stellwagen.noaa.gov

Members of the Marine Mammal Behavioral Disturbance Working Group		
Name	**Seat**	**Affiliation**
Regina Asmutis-Silvia	Sanctuary Advisory Council Chair	International Wildlife Coalition
Nathalie Ward	Team Lead	Stellwagen Bank National Marine Sanctuary
Scott MacNeil	Shipping	Tractobell LNG Co.
Dave Slocum	Whale Watch	New England Aquarium Whale Watch
Sharon Young	Conservation	U.S. Humane Society
Carole Carlson	Conservation	International Fund for Animal Welfare
Jack Kent	Recreational Use	Massachusetts Marine Trades Association
Donald Hourihan	Tuna Fishing	Tuna Fishing
Brian Hopper	Government	NOAA Fisheries Service, Northeast Regional Office
Dana Hartley	Government	NOAA Fisheries Service, Northeast Regional Office
Kim Amaral	Academic	Woods Hole Oceanographic Institution
Alternates		
Erin Heskett	Conservation	International Fund for Animal Welfare
Ralph Pratt	Tuna Fishing	Tuna Fishing
Technical Advisors		
Phil Clapham	Government	NOAA Fisheries Service, Northeast Fisheries Science Center
Chris Clark	Academia	Cornell University
Joseph Green	Government	NOAA, Office of Law Enforcement
Darlene Ketten	Academia	Woods Hole Oceanographic Institution
Jooke Robbins	NGO	Center for Coastal Studies
Peter Tyack	Academia	Woods Hole Oceanographic Institution
Pat Gerrior	Government	NOAA Fisheries Service, Northeast Region—Protected Resources

Members of the Administration Working Group		
Name	**Seat**	**Affiliation**
Richard Wheeler	Sanctuary Advisory Council Chair	Cape Cod Museum of Natural History
Nathalie Ward	Team Lead	Stellwagen Bank National Marine Sanctuary
Susan Dowds	Museums and Aquariums	New England Aquarium
Lisa Reed	Museums and Aquariums	Mystic Seaport
David Bergeron	Business Associations	Massachusetts Fishermen's Partnerships
Greg Ketchan	Business Associations	Gloucester Community Development Corporation
Dan Morast	Conservation	International Wildlife Coalition
Maggie Geist	Conservation	Association for the Preservation of Cape Cod
David Clapp	Conservation	Massachusetts Audubon Society
Stephanie Murphy	Academic	Woods Hole Oceanographic Institution
John Bullard	Academic	Sea Education Association
Vacant	Academic	
Robin Peach	Conservation	Massachusetts Environmental Trust
Steve Tucker	Cape Cod Commission	Cape Cod Commission

Technical Advisors		
Lori Arguelles	Non-profit	National Marine Sanctuary Foundation
Mary Enstrom	Government	National Marine Sanctuary Programs
Paula Jewell	Government	Massachusetts Bay National Estuary Program
Kathie Abbott	Non-profit	Island Alliance

Members of the Ecosystem Based Sanctuary Management Working Group		
Name	**Seat**	**Affiliation**
John Williamson	Sanctuary Advisory Council Chair	Fishing Community Activist
Ben Cowie-Haskell	Team Lead	Stellwagen Bank National Marine Sanctuary
Peter Auster	Academic	University of Connecticut, National Undersea Research Center
Larry Madin	Academic	Woods Hole Oceanographic Institution
Les Kaufman	Academic	Boston University
Edward Barrett	Fishing Industry	Massachusetts Bay Groundfishermen's Association
Dave Casoni	Fishing Industry	Massachusetts Lobstermen's Association
Jerry Hill	Recreational Use	Yankee Fleet
Tom DePersia	Recreational Use	Big Fish II Sportfishing Charters
Susan Farady	Conservation	The Ocean Conservancy
Priscilla Brooks	Conservation	Conservation Law Foundation
Dierdre Kimball	Government	NOAA Fisheries Service, Northeast Region
Jon Brodziak	Government	NOAA Fisheries Service, Northeast Fisheries Science Center
Paul Howard	New England Fishery Management Council	New England Fishery Management Council
Anthony Wilbur	Government	Massachusetts Coastal Zone Management
David Pierce	Government	Massachusetts Division of Marine Fisheries
Alternates		
David Wiley	Team Lead	Stellwagen Bank National Marine Sanctuary
Elizabeth Soule	Academic	Boston University
Vito Giacolone	Fishing Industry	Massachusetts Bay Groundfishermen's Association
John Carver	Fishing Industry	South Shore Lobstermen's Association
Tom Conley	Recreational Use	Yankee Fleet
Michael Doebley	Recreational Use	Recreational Fishing Alliance
Geoffrey Smith	Conservation	The Ocean Conservancy
Jud Crawford	Conservation	Conservation Law Foundation
Kevin Chu	Government	NOAA Fisheries Service, Northeast Region
Chris Legault	Government	NOAA Fisheries Service, Northeast Fisheries Science Center
Chris Kellogg	New England Fishery Management Council	New England Fishery Management Council
Megan Tyrrell	Government	Massachusetts Coastal Zone Management

Participants of the Ecosystem Alteration Working Group		
Name	**Seat**	**Affiliation**
Porter Hoagland	Sanctuary Advisory Council Chair	Woods Hole Oceanographic Institution
David Wiley	Team Lead	Stellwagen Bank National Marine Sanctuary
Micheal J. Kaiser	Academic	Woods Hole Oceanographic Institution
Robert Steneck	Academic	University of Maine
Les Watling	Academic	University of Maine
Bob Kenney	Academic	University of Rhode Island

Chris Glass	Academic	Manomet Center for Conservation Sciences
Frank Mirarchi	Fishing Industry	Commercial Fisherman
Russell Sherman	Fishing Industry	Commercial Fisherman
Phillip Michaud	Fishing Industry	Commercial Fisherman
Mary Beth Tooley	Fishing Industry	East Coast Pelagics (Herring Fishery)
Richard Ruais	Fishing Industry	East Coast Tuna Association
Jud Crawford	Conservation	Conservation Law Foundation
Geoffrey Smith	Conservation	The Ocean Conservancy
Robert Buchsbaum	Conservation	Massachusetts Audubon Society
Rachael Taylor	Conservation	The Nature Conservancy
Stormy Mayo	Conservation	Center for Coastal Studies
Susan Murphy	National Oceanic and Atmospheric Administration Fisheries	National Oceanic and Atmospheric Administration Fisheries, Northeast Regional Office
Leslie Ann McGee	New England Fishery Management Council	New England Fishery Management Council
Susan Snow-Cotter	Massachusetts Coastal Zone Management	Massachusetts Coastal Zone Management
Alternates		
Ben Cowie-Haskell	Team Lead	Stellwagen Bank National Marine Sanctuary
Richard Taylor	Fishing Industry	Sea Scallop Working Group
Luis Ribas	Fishing Industry	Commercial Fishing
Allison Ferreira	National Oceanic and Atmospheric Administration Fisheries	National Oceanic and Atmospheric Administration Fisheries, Northeast Regional Office
Tom Nies	New England Fishery Management Council	New England Fishery Management Council
Jason Burtner	Massachusetts Coastal Zone Management	Massachusetts Coastal Zone Management
Technical Advisors		
Richard Taylor	Technical Advisor	Sea Scallop Working Group
Allen Michael	Technical Advisor	Allen D. Michael and Associates
David Pierce	Technical Advisor	Massachusetts Department of Marine Fisheries
James Lindholm	Technical Advisor	Pfleger Institute

Members of the Interagency Cooperation Working Group

Name	Seat	Affiliation
Sally Yozell	Sanctuary Advisory Council Chair	Batelle Ocean Sciences (Duxbury Operations)
Ben Cowie-Haskell	Team Lead	Stellwagen Bank National Marine Sanctuary
Kathi Rodrigues	Government	NOAA Fisheries Service, Northeast Region—Habitat Protection
Paul Howard	New England Fishery Management Council	New England Fishery Management Council
Greg Hitchen	Enforcement	U.S. Coast Guard
Andrew Cohen	Enforcement	NOAA Fisheries Service, Northeast Region
Kathleen Dolan	Enforcement	Massachusetts Environmental Police
Tom Fetherstone	Military	U.S. Navy
Tim Timmerman	Government	U.S. Environmental Protection Agency
Andrew Raddant	Government	Department of the Interior—Office of Environmental Policy and Compliance

Tom Fredette	Government	U.S. Army Corps of Engineers
Steve Tucker	Public Interest	Cape Cod Commission
Stephanie Campbell	Legal / Policy	NOAA, Office of the General Counsel
Susan Snow-Cotter	Government	Massachusetts Coastal Zone Management
Alternates		
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Appendix G. Existing Federal and State Authorities Relevant to Stellwagen Bank Sanctuary Protection and Management

Introduction

This appendix presents an overview of the various Federal and State management authorities which provide statutory responsibility for protecting marine resources in the area of the Stellwagen Bank National Marine Sanctuary. The following discussion describes relevant legislative mandates, and the principal administrative measures taken to implement those mandates.

Federal Authorities

Federal statures vary greatly in scope and approach, ranging from broad-based legislation addressing resource conservation and environmental protection (such as the Magnuson Fishery Conservation Management Act), to regulation of specific activities and resources.

Magnuson Fishery Conservation and Management Act (MFCMA) (16 U.S.C. Part 1801 et seq.)

The MFCMA provides for the conservation and management of all fishery resources between 3 and 200 nm (5.6 and 380 km) offshore. The Department of Commerce, NOAA Fisheries Service, is charged with establishing guidelines for and approving fishery management plans (FMPs) prepared by regional fishery management councils for selected fisheries. These plans determine the levels of commercial and sport fishing consistent with achieving and maintaining the optimum yield of each fishery. The waters of the study area are within the jurisdiction of the New England Fishery Management Council (NEFMC).

Benthic continental shelf fishery resources located outside state waters, such as lobster and crabs, are subject to management under the MFCMA. Within Federal waters the MFCMA is enforced by the U.S. Coast Guard (USCG) and NOAA Fisheries Service. The Act empowers the Secretary of Commerce to enter into agreements with any State agency for enforcement purposes in state waters. Such agreements exist between the Massachusetts Environmental Police (MEP) and NOAA Fisheries Service, whereby both parties have been deputized to enforce each other's laws. As a result, Federal enforcement personnel can now enforce State fishery laws within 3 nm (5.6km), and State officers can enforce Federal fishery laws between 3 and 200 nm (5.6 and 370km).

The waters of the sanctuary are within the primary jurisdiction of the NEFMC. However, some fishery management plans (FMPs) developed by the Mid-Atlantic Fishery Management Council and some coastal fishery management plans (CMPs) developed by the Atlantic States Marine Fisheries Commission are also applicable to managing fisheries occurring within the sanctuary.

Fishery management plans are currently in place for: American lobster; Atlantic sea scallop; northern shrimp; multi-species (covering cod, haddock, Pollack, redfish, yellowtail flounder, winter flounder, American plaice, witch flounder, windowpane founder. white hake, red hake, silver hake, and ocean pout); Atlantic salmon; bluefish; summer flounder; butterfish; squid; quahog; surf clam; and mackerel.

Atlantic Tunas Convention Act of 1975 (16 U.S.C. part 971 et. seq.)

The Atlantic Tunas Convention Act authorizes the Secretary of Commerce to implement the recommendations of the International Commission for the Conservation of Atlantic Tunas (ICCAT). This authority has been delegated to the Assistant Administrator for Fisheries. Established in 1969, the Convention is responsible for the management of the Atlantic bluefin tunas (Thunnus thynnus) in the Atlantic Ocean and adjacent seas. After national quotas and other management measures are established by ICCAT, NOAA Fisheries Service establishes quotas and regulations for U.S. commercial and recreational fishing

Atlantic Fisheries Act of 1942 (more commonly known as "Atlantic States Marine Fisheries Compact", Pub. L. 77-539, as amended by Pub. L. 81-721.)

This act authorized the creation of the Atlantic States Marine Fisheries Commission. The Commission is composed of all Atlantic coastal states, each represented by the head of the fisheries administrative agency, a legislative appointee, and a governor's appointee, The Commission provides a forum for discussion and resolution of common fishery problems. Under amendment I of its charter, the states can develop joint management regulations for fishery resources primary in state waters and shared by one or more states. Under contract from the NOAA Fisheries Service, the Commission administers the Federally-funded Interstate Fisheries Management Program. Interstate fisheries management plans include northern shrimp, lobster, striped bass, and summer flounder.

Atlantic Coastal Fisheries Cooperative Management Act, 16 U.S.C. § 5101 et seq. (2001)

The Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) was designed to change the nature and potency of the Atlantic States Marine Fisheries Commission. Its purpose is to support interstate conservation and management of Atlantic coast fisheries through "development, implementation, and enforcement of coastal fishery plans." Coastal fishery management plans (CMPs) must be consistent with national standards provided by the Magnuson Fishery Conservation and Management Act (MFCMA), and the Secretary of Commerce and NMFS are responsible for implementing regulations complementary to CMPs. ACFCMA CMPs operate much like MFCMA FMPs, and they apply to any fishery resource that moves among, or is broadly distributed across, waters under the jurisdiction of one or more States or waters under the jurisdiction of one or more States and the U.S. Exclusive Economic Zone. The ACFCMA shifts regulatory responsibility for such coastal fishery resources to states – and requires those states to implement that responsibility within the framework of the Atlantic States Marine Fisheries Commission – in order to combat the "inconsistent" State and Federal regulations over Atlantic coastal fishery resources. CMPs are currently in place for the following: American eel; horseshoe crab; spot; American lobster; northern shrimp; spotted seatrout; Atlantic croaker; red drum; striped bass; Atlantic herring; scup; summer flounder; Atlantic menhaden; shad and river herring; tautog; Atlantic sturgeon; Spanish mackerel; weakfish; black sea bass; spiny dogfish and coastal sharks; winter flounder; and bluefish.

Endangered Species Act (ESA) (16 U.S.C. Part 1531-1543.)

The Federal Endangered Species program provides protection for listed species of animals and plants in both state water and the waters beyond. The U.S. Fish and Wildlife Service (FWS) and NOAA Fisheries Service determine which species need protection and maintain a list of endangered and threatened species. One of the most significant protections provided by the Endangered Species Act is the prohibition on taking. The term "take" is defined broadly to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct" (16 USC part 1532(19)). The FWS regulations define the term "harm" to mean an act which actually kills or injures wildlife, including significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. The regulations define the term "harass" to mean "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such as extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering" (50 CFR 173).

The Endangered Species Act also provides for the indirect protection of endangered species and their habitats by establishing a consultation process designed to insure that projects authorized, funded or carried out by Federal agencies are not likely to jeopardize the continued existences of endangered or threatened species, or "result in the destruction or adverse modification of habitat of such species which is determined to be critical" (16 USC 1536). Critical habitat areas for endangered species are designated by the FWS and NOAA Fisheries Service. The 1978 amendments to the Act establish a Cabinet level committee authorized to exempt Federal agencies (through an elaborate review process) from compliance with their responsibilities with regard to the jeopardy standard and critical habitat.

Several endangered marine mammal species occur within the sanctuary area, including: the humpback whale, fin whale, northern right whale, sei whale and blue whale. Listed species of marine reptiles include: the leatherback sea turtle (E), loggerhead sea turtle (T), Kemp's (or Atlantic) ridley sea turtle (E), and green sea turtle (T). Marine mammals and marine reptiles listed under the ESA are responsibility of the NOAA Fisheries Service. Listed species of birds occurring within the sanctuary area are: the peregrine falcon (E), bald eagle (E), roseate tern (E), and piping plover (T). These species are the responsibility of the Fish and Wildlife Service.

Marine Mammal Protection Act (MMPA) (16 USC 1361 et. seq.)

The MMPA provides protection to marine mammals in both state waters and the waters beyond. It is designed to protect all species of marine mammals. As specified in the MMPA, the Department of Interior, U.S. Fish and Wildlife Service (FWS), is responsible for the management of polar bears, walrus (a Pinniped), northern and southern sea otters, three species of manatees, and dugong; the Department of Commerce, NOAA Fisheries Service, is responsible for all other marine mammals. The Marine Mammal Commission advises these implementing agencies and sponsors relevant scientific research. The primary management features of the MMPA include: 1) a moratorium on "taking" of marine mammals; 2) the development of a management approach designed to achieve an "optimum sustainable population" (OSP) for all species or population stocks of marine mammals, and 3) protection of populations determined to be "depleted".

The MMPA defines "take" broadly to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct" (16 USC part 1532(19)). The term "harass" has been interpreted to encompass acts unintentional but adversely affecting marine mammals, such as operation of motor boats in waters in which these animals are found. The MMPA allows certain exceptions to the moratorium. First, the Secretary may issue permits for public display or scientific research. Second, the Secretary may grant exemptions for takes of small numbers of marine mammals incidental to other lawful activities. Third, the Secretary may make a special waiver of the moratorium on taking for particular species or populations of marine mammals, provided that the species or population being considered is at or above its determined optimum sustainable population. No such waiver, however, has been granted concerning any marine mammal found in the area of the sanctuary

Marine mammal species whose population is determined to be depleted receive additional protection. Under only limited circumstances may permits be issued for the taking of any marine mammal determined to be depleted, including, but not limited to, scientific research and enhancing the survival or recovery of a species or stock of depleted species.

The 1988 amendments to the MMPA added requirements that observers be carried onboard commercial fishing vessels to determine levels of incidental take of marine mammals. Commercial fishing activities are divided into categories on the basis of gear-type and associated levels of potential incidental take of marine mammals. For example, Category 1 vessels such as gillnetters may have to carry an observer, if requested by NOAA Fisheries Service, and the Secretary of Commerce may place observers on vessels in Categories 2 and 3 with the consent of the vessel owner. This observer program has been in operation since early 1990. Although the authority for its management is with the NOAA Fisheries Service, the day-to-day operational management may be delegated to state and local authorities.

Marine mammal species whose populations are determined to be "depleted" receive additional protection under the MMPA. With exception of scientific research permits, no permits for taking depleted species may be issued. Species occurring within the area of the sanctuary which have been determined to be depleted include the humpback whale, fin back whale, northern right whale, sei whale and blue whale, based on their "endangered" status under the Endangered Species Act.

Migratory Bird Treaty Act (MBTA) (16 USC 703 et. seq.)

The essential provision of the Migratory Bird Treaty Act, which implements conventions with Great Britain, Mexico, Russia, and Japan, makes it unlawful except as permitted by regulations "to pursue, hunt, take, capture, kill… any migratory bird, any part, nest or egg" or any product of any such bird protected by the Convention (16USC 703). The Secretary of the Interior is charged with determining when, and to what extent if at all, and by what means, to permit these activities. Each treaty establishes a "closed season" during which no hunting is permitted. A distinction is made between game and nongame birds. The closed season for migratory birds other then game birds is year-round.

Clean Water Act (CWA) (33 U.S.C. 1251 et. seq.)

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. To varying degrees, navigable waters of the United States, the contiguous zone, and the oceans beyond are subject to requirements of the CWA.

The CWA's chief mechanism for preventing and reducing water pollution is the National Pollutant Discharge Elimination System (NPDES), administered by the Environmental Protection Agency (EPA). Under the NPDES program, a permit is required for discharge of any pollutant from a point source into the navigable waters of the United States, the waters of the contiguous zone, or ocean waters.

Since oil and gas development pursuant to Federal lease sales occur beyond state waters, an NPDES permit from EPA is required for discharges associated with this activity. EPA generally grants NPDES permits for offshore oil and gas development based on published effluent guidelines (40 CFR Part 435). Other conditions beyond these guidelines may, however, be imposed by the regional administrator on a case-by-case basis.

The CWA prohibits the discharge of oil or hazardous substances in quantities that may be harmful to the public health or welfare or the environment, including but not limited to fish, shellfish, wildlife, and public and private property, shorelines and beaches, into or upon the navigable water of the U.S., adjoining shorelines, or into or upon the waters of the contiguous zone, or in connection with activities under the Outer Continental Shelf Lands Act or the Deepwater Port Act of 1974, or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the U.S., except in the case of such discharges into or upon the water of the contiguous zone or which may affect the above-mentioned natural resources, where permitted under the Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships.

When harmful discharges do take place, the National Contingency Plan (NCP) for the removal of oil and hazardous substance discharges (40 CFR Part 300), which is designed to minimize the impacts on marine resources, take effect. The USCG, in cooperation with EPA, administers the NCP. The NCP establishes the organizational framework whereby oil and hazardous substance spills are to be cleaned up. To carry out the NCP, regional plans have been established; the USCG has issued such a plan for Federal Region IX which encompasses the sanctuary area. Under the plan, Coast Guard personnel are to investigate all reported offshore spills, notify the party responsible (if known) of its obligation to clean up the spill, and supervise the clean-up. If the party responsible for the spill does not promptly begin cleanup operations, the Coast Guard may hire private organizations.

The CWA also requires that publicly owned sewage treatment works meet effluent limitations based on effluent reductions attainable through the application of secondary treatment by July 1, 1977 [33 USC 1311(b)(1)]. EPA does have the authority, however, to waive the July 1, 1977 deadline for secondary treatment for discharges into marine waters under certain circumstances (33 USC1311 (h)).

Permits from the Army Corps of Engineers (COE), which are based on EPA guidelines, are required prior to the discharge of dredged or fill materials in navigable waters that lie inside the baseline from which the territorial sea (defined to be three nautical miles off shore) is measured and fill materials into the territorial sea (33 USC 1344; $) CFR 230.2).

Finally, the CWA requires vessels to comply with marine sanitation regulations issued by EPA and enforced by the USCG (33 USC 1322).

Rivers and Harbors Act 1899 (RHA) (33 U.S.C. 401 et. seq.)

Section 10 (33 USC 402) of the RHA prohibits the unauthorized obstruction of navigable waters of the United States. The construction of any structure or any excavation or fill activity in the navigable waters of the U.S. is prohibited without a permit from the COE. Section 13 (33U.S.C. 407) prohibits the discharge of refuse into navigable water of the U.S., but has been largely superseded by the CWA, discussed above.

Ports and Waterways Safety Act (PWSA) (33 U.S.C. 1231 et. seq.)

The Ports and Waterways Safety Act (PWSA), as amended by the Ports and Tanker Safety Act of 1978 (and the Oil Pollution Act of 1990), is designed to promote navigation and vessel safety and the protection of the marine environment. The PWSA applies both in state waters and the waters beyond out to 200 nautical miles.

The PWSA authorizes the U.S. Coast Guard to construct, operate, maintain, improve or expand vessel traffic services and control vessel traffic in ports, harbors, and other waters subject to congested vessel traffic. The Oil Pollution Act of 1990 amends the PWSA to mandate that the USCG "require appropriate vessels, which operate in the areas of a vessel traffic service, to utilize or comply with that service.

In addition to vessel control, the U.S. Coast Guard regulates other navigational and shipping activities. It has promulgated numerous regulations relating to vessel design, construction, and operations designed to minimize the likelihood of as accident and reduce vessel source pollution.

The 1978 amendments of the PWSA establish a comprehensive program for regulating the design, construction, operation, equipping, and banning of all tankers using U.S. ports to transfer oil and hazardous materials. These requirements are, for the most part, in agreement with protocols (passed in 1978) to the International Convention for the Prevention of Pollution from Ships, 1973, and the International Convention on Safety of Life at Sea, 1974.

The U.S Coast Guard is also vested with the primary responsibility for maintaining boaster safety, including the tasks of conducting routine vessel inspections and coordination of rescue operations.

Under the PWSA, the Coast Guard establishes vessel traffic services and systems for ports, harbors and other waters subject to congested vessel traffic. Within the area of the sanctuary, a vessel traffic separation scheme (TSS) has been established directly across Stellwagen Bank, to service the major port of Boston. The PWSA regulations also address vessel design, construction and operation, and are designed to reduce vessel accidents and vessel source pollution.

Act to Prevent Pollution from Ships (APPS) (33 U.S.C. 1901 et. seq.)

The International Convention for the Prevention of Pollution of the Sea by Oil, 1954, and the Oil Pollution Act of 1961 have been superseded by the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the 1978 Protocol relating thereto (MARPOL 73/78) and implemented by the Act to Prevent Pollution from Ships, 1980, as amended in 1982, 1987, (APPS). The APPS, in implementing Annex I of MARPOL 73/78, regulates the discharge of oil and oily mixtures from seagoing ships, including oil tankers. The APPS, in implementing Annex II of MARPOL 73/78, regulates the discharge of noxious liquid substances from seagoing ships. Enforcement of the Act is the responsibility of the USCG.

When more then 12 nautical miles from the nearest land, any discharge of oil or oily mixture into the sea from a ship subject to APPS, other than an oil tanker or from machinery space bilges of an oil tanker subject to APPS, is prohibited except when: 1) the oil or oily mixture does not originate from cargo pump room bilges; 2) the oil or oily mixture is not mixed with oil cargo residues; 3) the ship is not within a Special Area (the sanctuary is not a Special Area for purposes of APPS); 4) the ship is proceeding en route; 5) the oil content of the effluent without dilution is less the 100 parts per million (PPM); and 6) the ship has in operation oily-water separating equipment, a bilge monitor, bilge alarm or combination thereof. 33CFR 151.10 (a).

The restrictions on discharge 12 nautical miles or less from the nearest land are more stringent. Within 12 nautical miles of the nearest land, any discharge of oil or oily mixture into the sea from a ship other than an oil tanker or from machinery space bilge of an oil tanker is prohibited except when: 1) the oil or oily mixture does not originate from cargo pump room bilges; 2) the oil or oily mixture is not mixed with oil cargo residues; 3) the oil content of the effluent without dilution does not exceed 15ppm; 4) the ship has in operation oily-water separating equipment, a bilge monitor, bilge alarm, or combination thereof; and 5) the oily-water separating equipment is equipped with a 15ppm bilge alarm. [NOTE: In the navigable waters of the U.S., the CWA, section 311 (b)(3) and 40 CFR 110 govern all discharges of oil or oil mixtures.] 33CFR 151.10(b).

APPS is amended by the Marine Plastic Pollution Research and Control Act of 1987 (MPPRCA), which implements Annex V of MARPOL 73/78 in the U.S. The MPPRCA and implementing regulations at 33 CFR 151.51 to 151.77 apply to U.S. Ships (except warships and ships owned or operated by the U.S.) everywhere, including recreational vessels, and to other ships subject to MARPOL 73/78 while in the navigable waters or the Exclusive Economic Zone of the U.S. They prohibit the discharge of plastic or garbage mixed with plastic into any waters and the discharge of dunnage, lining and packing materials that float within 25 nautical miles of the nearest land. Other unground garbage may be discharged beyond 12 nautical miles from the nearest land. Other garbage ground to less than one inch may be discharged beyond three nautical miles of the nearest land. Fixed and floating platforms and associated vessels are subject to more stringent restrictions. "Garbage" is defined as all kinds of victual, domestic and operational waste, excluding fresh fish and parts thereof, generated during the normal operations of the ship and liable to be disposed of continuously or periodically except dishwater, gray water and certain substances. 33 CFR 151.05.

Oil Pollution Act of 1990 (OPA) (P.L. 101-380, 33 USC 2701 et. seq.)

The Oil Pollution Act of 1990 (OPA) creates a comprehensive prevention, response, liability, and compensation regime for dealing with vessel and facility-caused oil pollution. The OPA provides for environmental safeguards in oil transportation greater than those existing before its passage by: setting new standards for vessel construction, crew licensing, and manning; providing for better contingency planning; enhancing Federal response capability; broadening enforcement authority; increasing penalties; and authorizing multi-agency research and development. A one billion dollar trust fund is available to cover clean-up coats and damages not compensated by the spiller.

Title I creates a liability and compensation regime for tank vessel and facility-source oil pollution. Any party responsible for the discharge, or the substantial threat of discharge, of oil into navigable waters of adjoining shorelines or the Exclusive Economic Zone is liable for the removal costs and damages, including assessment costs; for injury, destruction, loss, or loss of use of natural resources, injury to or economic losses resulting from destruction of real or personal property; subsistence use of natural resources, net lost government revenues, lost profits or impairment of earning capacity; and net costs of providing increased or additional public services during or after removal activities. NOAA has the responsibility of promulgating damage assessment. Sums recovered by a trustee for natural resource damages will be retained in a revolving trust account to reimburse or pay costs incurred by the trustee with respect to those resources.

Title II makes numerous amendments to conform to other Federal statutes, particularly section 311 of the Clean Water Act, and to the provisions of the Oil Pollution Act.

Title III encourages the establishment of an international inventory of spill removal equipment and personnel.

Title IV is divided into three subtitles: A) Prevention; B) Removal: and C) Penalties and Miscellaneous. Subtitle A gives added responsibility to the Coast Guard regarding merchant marine personnel, including the review of alcohol and drug abuse and review of criminal records prior to issuance and renewal of documentation. It also amends the Ports and Waterways Safety Act to: require the Coast Guard to "require appropriate vessels which operate in an area of vessel traffic service to utilize or comply with that service." and 2) authorize the construction, improvement and expansion of vessel traffic services.

Further, subtitle A establishes double hull requirements for tank vessels. Most tank vessels over 5,000 gross tons will be required to have double hills by 2010, while vessels under 5,000 gross tons will be requires to have a double hull or double containment systems by 2015. All newly constructed tankers must contain a double hull (or double containment systems if under 5,000 gross toms), while existing vessels are phased out over a period of years.

Subtitle B amends subsection 311 (C) of the Clean Water Act, requiring the Federal Government to ensure effective and immediate removal of a discharge, and mitigation or prevention of a substantial threat of a discharge, of oil or hazardous substance into or on the navigable waters, on the adjoining shorelines, into or on the waters of the Exclusive Economic Zone, or that may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the U.S. It also requires a revision and republication of the National Contingency Plan within one year which will include, among other things, a fish and Wildlife response plan developed in consultation with NOAA and U.S. Fish and Wildlife Service. Nothing in subtitle B preempts the rights of States to require stricter standards for removal actions.

Subtitle C alters and increases civil and administrative penalties for illegal discharges and violations of regulations promulgated under the Clean Water Act.

Title VII authorizes an oil pollution research and technology development program, including the establishment of an interagency coordination committee that is chaired by the Department of Transportation and composed of representatives from the Departments of Energy, the Interior, Transportation, Commerce (including NOAA), and Defense, and the Environmental Protection Agency, Federal Emergency Management Agency, National Aeronautics and Space Administration, as well as such other Federal agencies as the President may designate.

Title IX amends the Oil Spill Liability Trust Fund and increases from \$500 million to \$1 billion the amount that can be spent on any single oil spill incident, of which no more then \$500 million may be spent on natural resource damage assessments and claims.

Federal Aviation Act (49 USC 1301 et. seq.)

The Federal Aviation Act gives the Secretary of Transportation broad powers to promote air commerce and to regulate the use of navigable airspace to ensure aircraft safety and efficient use of such airspace. In furtherance of this mandate, the Federal Aviation Administration within the Department of Transportation publishes aeronautical charts which provide a variety of information to pilots, including the location of "sensitive" and "areas which should be avoided." Currently, there are no site-specific regulations for flights over the Stellwagen Bank sanctuary.

Clean Air Act (CAA) (42 USC 7401 et. seq.)

The Clean Air Act (CAA) sets general guidelines and minimal air quality standards on a nationwide basis in order to protect and enhance the quality of the Nation's air resources. States are responsible for developing comprehensive plans for all regions within their boundaries.

Outer Continental Shelf Lands Act (OCSLA) (43 USC 1331 et. seq.)

The Outer Continental Shelf Lands Act, (OCSLA) as amended in 1978 and 1985, establishes Federal jurisdiction over the mineral resources of the Outer Continental Shelf (OCS) beyond 3nm (5.6km) and gives the Secretary of Interior primary responsibility for managing OCS mineral exploration and development. The Secretary's responsibility has been delegated to the Minerals Management Service (MMS).

In unique or special areas, MMS may impose special lease stipulations designed to protect specific geological and biological phenomena. These stipulations may vary among lease sale tracts and sales.

Lessees are required to include, in exploration and development and production plans, specific information concerning emissions and their potential impacts on coastal areas. Such authority includes the enforcement of regulations made pursuant to the OCSLA (30 CFR Parts 250 and 256) and the enforcement of stipulations applicable to particular leases.

In addition to DOI, both the Army Corps of Engineers (COE) and the U.S. Coast Guard (USCG) have responsibility over OCS mineral development to the extent that such development affects navigation (43 USC 1333). The COE is responsible for ensuring, through a permit system, that OCS structures on the OCS are properly marked and that safe working conditions are maintained onboard.

MMS is also charged with supervising OCS operations, including approval of exploration and development and production plans and applications for pipeline rights of way on the OCS.

Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA) (33 USC 1401 et. seq.)

Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, Prohibits: 1) any person from transporting, without a permit, from the U.S. any material for the purpose of dumping it into ocean waters (defined to mean those waters of the open seas lying seaward of the baseline from which the territorial sea is measured) and 2) in the case of a vessel or aircraft registered in the U.S., or flying the U.S. flag, or in the case of a U.S. agency, any person from transporting, without a permit, from any location, any material for the purpose of dumping it into ocean waters. Title I also prohibits any person from dumping, without a permit, into the "territorial sea," or the contiguous zone extending 12 nautical miles seaward from the baseline of the territorial sea, to the extent that it may affect the territorial sea or the territory of the U.S., any material transported from a location outside of the U.S. The EPA regulates, through the issuance of permits, the transportation, for the purpose of dumping, and the dumping of all materials except dredged material; the COE regulates, through the issuance of permits, the transportation, for the purpose of dumping, and the dumping of dredged material. The COE permits are subject to EPA review and approval. Title I also makes it unlawful after December 31, 1991, for any person to dump into ocean waters, or to transport for the purposes of dumping into ocean waters, sewage sludge or industrial waste.

National Historic Preservation Act (NHPA) (16 USC 470 et. seq.)

The NHPA was established to provide a national framework for the preservation of historic properties around the nation. To accomplish this goal, Section 101 of the NHPA authorizes the Secretary of the Interior to maintain a National Register of "districts, sites, buildings, structures, and objects significant in American history, architecture, archeology, and culture." The National Marine Sanctuary Program (NMSP) is required by National Marine Sanctuary Program Regulations (15 CFR Part 922.2) to comply with the Federal Archaeology Program, a collection of laws and standards that includes the National Historic Preservation Act of 1966 (NHPA).

Two sections of the NHPA relate directly to obligations Federal Agencies have to historic and archaeological resources. Section 110 of the NHPA sets out the broad historic preservation responsibilities of a Federal agency. Section 106 of the NHPA, requires a Federal agency to take into account the effects of its undertakings on properties listed or eligible for listing on the National Register.

Any federal agency conducting, licensing, or assisting an undertaking which may affect a property listed or eligible for listing on the National Register must, prior to the action, take into account the effect of the undertaking on the property and provide the Advisory Council on Historic Preservation a reasonable opportunity to comment on the proposed action (16USC 470f). The basic criterion applied by the Advisory Council is whether the undertaking will change the quality of the site's historic, architectural, archeological, or cultural character (36 CFR part 800).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 9601 et. seq.)

The principal purpose of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in the clean-up of hazardous waste sites consists of four fundamental elements. First, CERCLA creates an information gathering and evaluation system to help Federal and State governments categorize hazardous waste sites and prioritize responses. Second, CERCLA provides Federal authority to respond to releases of hazardous substances. Response actions are carried out pursuant to the National Contingency Plan (NCP). Third, CERCLA establishes a Hazardous Substance Trust Fund to pay for removal and remedial actions and related costs. Finally, CERCLA makes persons responsible for hazardous substance releases liable for costs of removal or remedial action incurred by the Federal or State governments; other necessary costs of response incurred by others; damages for injury, destruction or loss of natural resources; and costs of any health assessment or health effects study carried out pursuant to the Act.

State Authorities

Because the Stellwagen Bank National Marine Sanctuary is located entirely outside State territorial waters, State agencies do not have jurisdiction over the area. However, through the following laws, State agencies can influence the quality of the sanctuary environment.

Massachusetts Coastal Zone Management Act of 1972 (Mass. General Laws Chapter 21A, Chapter 6A, sections 2-71, 16 USC 1451 et. seq.)

MCZM is the principal ocean planning and policy agency of the Commonwealth of Massachusetts. Its jurisdiction of particular relevance here is all State territorial waters, and any activity seaward of State territorial waters, that will likely have a direct effect on the coastal zone. The MCZM plan is embodied in the approved 2002 Coastal Management Plan which also articulates a series of 20 enforceable program policies and associated program principles which direct activities or projects proposed for the coastal waters and areas adjacent thereto. The policies deal with a broad range of issues, from protection of critical areas, to port and harbor operations, to offshore oil and gas development. MCZM enforces its program policies through existing Massachusetts statutes and their implementing regulations.

Massachusetts Ocean Sanctuaries Act (Mass. General Laws Chapter 132A, section 12A – 16F, 18)

The Department of Conservation and Recreation (DCR) administers the Ocean Sanctuaries Program. The Massachusetts Ocean Sanctuaries Act prohibits activities that may significantly alter or endanger the ecology or appearance of the ocean, seabed, or subsoil of state ocean sanctuaries or the Cape Cod National Seashore. To accomplish this goal, the Act prohibits: (1) building structures on or under the seabed; (2) construction or operation of offshore or floating electrical generating stations; (3) drilling or removal of sand, gravel (except for the purposes of beach nourishment), other minerals, gases, or oils; (4) dumping or discharge of commercial, municipal, domestic or industrial wastes; (5) commercial advertising; and (6) incineration of solid waste or refuse on vessels within state ocean sanctuary boundaries. These prohibitions may be waived if a finding of "public necessity and convenience" can be made for the proposed project or activity. Under the Ocean Sanctuaries Act, DCR does not issue any licenses or permits, but acts through the regulatory process of other agencies, particularly the Chapter 91 Waterways Program.

Wetlands Protection Act (Mass. General Laws Chapter 131, section 40)

This authority is exercised primarily through the city or town conservation commission, with appeal to the Massachusetts Department of Environmental Protection. The Act protects wetland resources, the functions and attributes therein relevant to the SBNMS may include wildlife habitat, fisheries, "land under the ocean," land containing shellfish, and prevention of pollution. The Act applies to any activity which involves "dredging, filling, altering, or removing" within the State resource area.

Massachusetts Environmental Policy Act (Mass. General Laws Chapter 30, sections 61-62H)

The Massachusetts Environmental Policy Act (MEPA) provides for a coordinated State review of generally large and complicated projects, allowing more efficient collection of essential information covering a wide range of potential adverse environmental impacts. The information collected during the MEPA process is to be used by regulatory agencies in their regulatory reviews. For example, dredging projects involving volumes of dredged material greater than 10,000 cubic yards would be reviewed by MEPA.

Massachusetts Public Waterfront Act (Mass. General Laws Chapter 91)

This authority is primarily involved in the licensing of fill and structures in the tidelands of the Commonwealth of Massachusetts, with a principal regulatory interest in preserving safe navigation and public access.

Massachusetts Clean Water Act (Mass. General Laws Chapter 21, Section 26-53)

Along with delegated authority under provisions of the Clean Water Act at Section 401, the Department of Environmental Protection, Division of Water Pollution Control (DEP-DWPC) reviews discharges into waters of the Commonwealth of Massachusetts. This Act's principal interest is the protection of water quality.

Massachusetts Board of Underwater Archaeological Resources (Mass. General Laws Chapter 6, Sections 179-180; Chapter 9, Section 26; Chapter 11D' Chapter 30, Section 61; Chapter 91, Section 63, 72)

The Board of Underwater Archaeological Resources (BUAR) is responsible for the protection and preservation of underwater archaeological resources in the waters of the Commonwealth of Massachusetts. A permit from the Board is required for activities which affect archaeological resources under their jurisdiction.

Appendix H. Questions and Answers Regarding Regulatory Coordination on Fishing between the National Marine Sanctuary Program and Federal Fishery Management Agencies

(NMSP Frequently Asked questions—March 2004)

1. Does the National Marine Sanctuary Program (NMSP) have authority under the National Marine Sanctuaries Act (NMSA) to regulate fishing activities?

Yes. Section 304(a) of the NMSA provides authority to issue regulations as may be necessary to protect the resources and qualities for which individual sanctuaries were designated. This would include regulations for certain fishing activities if determined necessary to protect sanctuary resources or qualities.

The NMSA has specific requirements as to how any sanctuary fishing regulations are to be developed. Specifically, Section 304(a)(5) of the NMSA requires NOAA to provide the relevant fishery management councils the opportunity to prepare draft sanctuary fishing regulations.

The Council has 120 days to act upon the request by the sanctuary and will use as guidance the national standards of section 301(a) of the Magnuson-Stevens Act to the extent those standards are consistent and compatible with the goals and objectives of the sanctuary. If the draft regulations are found by NOAA to meet the goals and objectives of the sanctuary and the purposes and policies of the NMSA, they will be published as sanctuary regulations under the authority of the NMSA.

The NMSA also states that if the Council declines to make a determination as to the need for fishing regulations in the Sanctuary, makes a determination that is rejected by NOAA, requests that NOAA prepare the draft regulations, or does not prepare the draft regulations in a timely manner, NOAA will prepare the fishing regulations. Regardless of whether the Council or NOAA drafts the sanctuary fishing regulations, NOAA will be responsible for compliance with the NMSA, National Environmental Policy Act, Administrative Procedure Act, and other applicable requirements.

The scope of a sanctuary's regulatory authority is further defined in its designation document. A designation document may need to be changed to allow for some regulations. The NMSA has specific procedures and requirements for changing a term of designation.

2. There are already federal agencies such as the National Marine Fisheries Service (NMFS) as well as state agencies, which regulate fisheries. Why does the NMSP need to be involved in fisheries issues?

The NMSA focuses on ecosystem protection including protection of biological communities and habitats. Fish populations and habitat are integral parts of any Sanctuary's ecosystem. Fish populations also play important roles as predators and prey for a wide range of species.

The National Marine Sanctuary Program (NMSP) recognizes that regulatory authority over fisheries management resides with these other fisheries management agencies.

The Sanctuary has an important role in working with these regulatory agencies regarding fishing matters as they relate to the sanctuaries, as well as working with other partners to develop practical solutions for ecosystem protection.

3. What is a designation document & how does it limit the NMSP's ability to regulate activities?

The NMSA defines the terms of designation of a sanctuary as:

- The geographic area of the sanctuary
- The characteristics of the area that give it conservation, recreational, ecological, historical, research, educational, or esthetic value
- The types of activities that will be subject to regulation to protect those characteristics

At the time of designation of a sanctuary, NOAA lists the activities that may be subject to regulation in the designation document and issues regulations addressing what activities will be regulated. Both the list of activities subject to regulation as well as the regulations themselves can be amended as long as NOAA follows the applicable legal and administrative processes (e.g., the NMSA, National Environmental Policy Act and Administrative Procedure Act) required to do so.

4. What are the key steps and requirements for changing a term of designation?

When changing a term of designation NOAA follows the applicable NMSA procedures for designation of a sanctuary, which are provided in sections 303 and 304 of the Act.

Key steps in this process include:

- Making required determinations and considering factors, as listed in the NMSA
- Conducting required consultations with Congress, Federal, State, and local agencies, the appropriate Fishery Management Council, and other interested persons
- Preparing appropriate designation documents which include an environmental impact statement, resource assessments, maps, revised draft management plan with the proposed changes to the term(s) of designation, basis of determinations, and any proposed regulations
- Providing public notice and opportunity to comment on the proposed designation documents, including holding

at least one public hearing

- Providing the public notice and the proposed designation documents to Congress and the Governor of any State in which the Sanctuary is located
- Publishing notice of the final designation documents and providing notice to Congress and the Governor

Final changes to a term(s) of designation, and implementing regulations, shall take effect and become final after the close of a review period of 45 days of continuous session of Congress.

During this final 45-day review period the Governor has the opportunity to certify to NOAA that the change to the term of designation in unacceptable, in which case the unacceptable term of designation shall not take effect in that part of the sanctuary within the boundary of the state.

5. Can all sanctuaries regulate fishing activities?

Yes, as long as fishing is listed as being subject to regulation in a sanctuary's designation document. If fishing is not so listed, it cannot be regulated without amending the designation document and adhering to the applicable requirements of the NMSA, NEPA, and APA.

Under the NMSA, the relevant fishery management council would be provided the opportunity to draft the sanctuary fishery regulations to achieve the desired resource protection objective.

Any changes to the designation document would be narrowly constructed to address the specific resource protection objective.

6. How does a sanctuary decide to regulate certain fishing activities?

A sanctuary may decide to regulate certain fishing activities during a management plan review or as the need arises. A management plan review is required for every sanctuary every five years and is focused on reassessing the adequacy of protection of all sanctuary resources and qualities. During this process the working groups, Sanctuary Advisory Council and/or public might raise concerns that could lead to a determination that there is a need to regulate some aspects of fishing to protect certain sanctuary resources or qualities from damage or degradation. Outside of a management plan review, the Sanctuary Advisory Council or another constituent may raise, or a sanctuary may otherwise become aware of, an issue that may need to be addressed by regulating certain fishing activities.

During a management plan review, multi-stakeholder workgroups are convened to plan for priority issues, involving fishermen and other parties in developing the recommendations for these groups. The working groups provide a series of recommendations for subsequent review and deliberation by the sanctuary's Advisory Council.

After reviewing the results of the working groups, Sanctuary Advisory Council recommendations, and consultations with agency partners, particularly NOAA Fisheries Service and the relevant fishery management council, a sanctuary may decide to regulate certain fishing activities within the sanctuary. A Sanctuary Advisory Council would also be heavily involved in such a decision and any subsequent action outside of a management plan review.

If this were to occur, a sanctuary might need to amend its designation document to authorize the specific limited NMSA fishing regulation and would have to provide the relevant fishery management council the opportunity to draft such regulations. This entire process is extremely transparent and would not proceed without significant opportunities for public and constituent involvement, including the involvement of the commercial and recreational fishing communities.

7. In addition to direct sanctuary regulations, what other ways are available to regulate fishing in a sanctuary?

In a sanctuary's discussions with NOAA Fisheries Service and the relevant fishery management council or a state fishery management agency, it could be jointly decided that the fishery management council or state could best handle the identified resource protection problem or goal under the Magnuson-Stevens Conservation and Fisheries Management Act.

For example, as three of our California Sanctuaries have progressed through their joint management plan review process, the regulation of krill harvesting has been identified as a significant issue because of krill's importance as a forage species throughout the Pacific coastal region. Those sanctuaries are discussing with the Pacific Fishery Management Council (PFMC) staff whether the PFMC would consider preventing the take of krill under the Magnuson-Stevens Fishery Conservation and Management Act. The sanctuaries could also ask the PFMC to draft sanctuary regulations regarding krill, pursuant to the NMSA.

8. What is the National Marine Sanctuary Program's policy on marine reserves?

The NMSP does not have a policy on marine reserves. Rather, marine reserves are one of a number of tools available to the NMSP to deal with issues and problems. Scientific research has indicated that carefully crafted marine reserves can be effective tools for conservation of biodiversity, but may not always be applicable to every sanctuary. The NMSP believes that any consideration of reserves should and will be a joint effort with the participation of many diverse stakeholders, including strong participation of the fishing community to tap into their extensive knowledge and to consider socioeconomic impacts of alternative reserve designs, as well as participation from other agencies, environmental organizations and the public.

The process described above is outlined in a draft zoning policy undergoing final approval. The NMSP has used zoning as a tool for over twenty years and has at least one type of zone in most sanctuaries.

Appendix I. Regulations

Subpart N–Stellwagen Bank National Marine Sanctuary

Sec. 922.140 Boundary.

(a) The Stellwagen Bank National Marine Sanctuary (Sanctuary) consists of an area of approximately 638 square nautical miles (NM) of Federal marine waters and the submerged lands thereunder, over and around Stellwagen Bank and other submerged features off the coast of Massachusetts. The boundary encompasses the entirety of Stellwagen Bank; Tillies Bank, to the northeast of Stellwagen Bank; and portions of Jeffreys Ledge, to the north of Stellwagen Bank.

(b) The Sanctuary boundary is identified by the following coordinates, indicating the most northeast, southeast, southwest, west northwest, and north-northwest points:

42 deg.45′59.83″N x 70 deg.13′01.77″W (NE);

42 deg.05′35.51″N x 70 deg.02′08.14″W (SE);

42 deg.07′44.89»W x 70 deg.28′15.44»W (SW);

42 deg.32′53.52»N x 70 deg.35′52.38»W (WNW); and

42 deg.39′04.08»N x 70 deg.30′11.29»W (NNW).

The western border is formed by a straight line connecting the most southwest and the west northwest points of the Sanctuary. At the most west-northwest point, the Sanctuary border follows a line contiguous with the three-mile jurisdictional boundary of Massachusetts to the most north-northwest point. From this point, the northern border is formed by a straight line connecting the most north-northwest point and the most northeast point. The eastern border is formed by a straight line connecting the most northeast and the most southeast points of the Sanctuary. The southern border follows a straight line between the most southwest point and a point located at 42 deg.06′54.57»N x 70 deg.16′42.7» W. From that point, the southern border then continues in a west-to-east direction along a line contiguous with the three-mile jurisdictional boundary of Massachusetts until reaching the most southeast point of the Sanctuary. The boundary coordinates are listed in appendix A to this subpart.

Sec. 922.141 Definitions.

In addition to those definitions found at Sec. 922.3, the following definitions apply to this subpart:

Industrial material means mineral, as defined in Sec. 922.3.

Traditional fishing means those commercial or recreational fishing methods which have been conducted in the past within the Sanctuary.

Sec. 922.142 Prohibited or otherwise regulated activities.

(a) Except as specified in paragraphs (b) through (f) of this section, the following activities are prohibited and thus are unlawful for any person to conduct or to cause to be conducted:

(1)(i) Discharging or depositing, from within the boundary of the Sanctuary, any material or other matter except:

(A) Fish, fish parts, chumming materials or bait used in or resulting from traditional fishing operations in the Sanctuary;

(B) Biodegradable effluent incidental to vessel use and generated by marine sanitation devices approved in accordance with section 312 of the Federal Water Pollution Control Act, as amended, (FWPCA), 33 U.S.C. 1322 et seq.;

(C) Water generated by routine vessel operations (e.g., cooling water, deck wash down and gray water as defined by section 312 of the FWPCA) excluding oily wastes from bilge pumping; or

(D) Engine exhaust.

(ii) Discharging or depositing, from beyond the boundary of the Sanctuary, any material or other matter, except those listed in paragraphs (a)(1)(i) (A) through (D) of this section, that subsequently enters the Sanctuary and injures a Sanctuary resource or quality.

(2) Exploring for, developing or producing industrial materials within the Sanctuary.

(3) Drilling into, dredging or otherwise altering the seabed of the Sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the Sanctuary, except as an incidental result of:

(i) Anchoring vessels;

(ii) Traditional fishing operations; or

(iii) Installation of navigation aids.

(4) Moving, removing or injuring, or attempting to move, remove or injure, a Sanctuary historical resource. This prohibition does not apply to moving, removing or injury resulting incidentally from traditional fishing operations.

(5) Taking any marine reptile, marine mammal or seabird in or above the Sanctuary, except as permitted by the Marine Mammal Protection Act, as amended, (MMPA), 16 U.S.C. 1361 et seq., the Endangered Species Act, as amended, (ESA), 16 U.S.C. 1531 et seq., and the Migratory Bird Treaty Act, as amended, (MBTA), 16 U.S.C. 703 et seq.

(6) Lightering in the Sanctuary.

(7) Possessing within the Sanctuary (regardless of where taken, moved or removed from), except as necessary for valid law enforcement purposes, any historical resource, or any marine mammal, marine reptile or seabird taken in violation of the MMPA, ESA or MBTA.

(8) Interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of the Act or any regulation or permit issued under the Act.

(b) The prohibitions in paragraphs (a) (1), and (3) through (8) of this section do not apply to any activity necessary to respond to an emergency threatening life, property or the environment.

(c)(1)(i) All Department of Defense military activities shall be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on Sanctuary resources and qualities.

(ii) Department of Defense military activities may be exempted from the prohibitions in paragraphs (a) (1) and (3) through (7) of this section by the Director after consultation between the Director and the Department of Defense.

(iii) If it is determined that an activity may be carried out, such activity shall be carried out in a manner that avoids to the maximum extent practicable any advance impact on Sanctuary resources and qualities. Civil engineering and other civil works projects conducted by the U.S. Army Corps of Engineers are excluded from the scope of this paragraph(c).

(2) In the event of threatened or actual destruction of, loss of, or injury to a Sanctuary resource or quality resulting from an untoward incident, including but not limited to spills and groundings caused by the Department of Defense, the Department of Defense shall promptly coordinate with the Director for the purpose of taking appropriate actions to respond to and mitigate the harm and, if possible, restore or replace the Sanctuary resource or quality.

(d) The prohibitions in paragraphs (a) (1) and (3) through (7) of this section do not apply to any activity executed in accordance with the scope, purpose, terms and conditions of a National Marine Sanctuary permit issued pursuant to Sec. 922.48 and Sec. 922.143 or a Special Use permit issued pursuant to section 310 of the Act.

(e) The prohibitions in paragraphs (a)(1) and (3) through (7) of this section do not apply any activity authorized by any lease, permit, license, approval or other authorization issued after the effective date of Sanctuary designation (November 4, 1992) and issued by any Federal, State or local authority of competent jurisdiction, provided that the applicant compiles with Sec. 922.49, the Director notifies the applicant and authorizing agency that he or she does not object to issuance of the authorization, and the applicant complies with any terms and conditions the Director deems necessary to protect Sanctuary resources and qualifies. Amendments, renewals and extensions of authorizations in existence on the effective date of designation constitute authorizations issued after the effective date.

(f) Notwithstanding paragraphs (d) and (e) of this section, in no event may the Director issue a permit under Sec. 922.48 and Sec. 922.143, or under section 310 of the act, authorizing, or otherwise approving, the exploration for, development or production of industrial materials within the Sanctuary, or the disposal of dredged materials within the Sanctuary (except by a certification, pursuant to Sec. 922.47, of valid authorizations in existence on November 4, 1992) and any leases, licenses, permits, approvals or other authorizations authorizing the exploration for, development or production of industrial materials in the Sanctuary issued by other authorities after November 4, 1992, shall be invalid.

Sec. 922.143 Permit procedures and criteria.

(a) A person may conduct an activity prohibited by Sec. 922.142 (a) (1) and (3) through (7) if conducted in accordance with scope, purpose, manner, terms and conditions of a permit issued under this section and Sec. 922.48.

(b) Applications for such permits should be addressed to the Director, Office of Ocean and Coastal Resource Management; ATTN: Manager, Stellwagen Bank National Marine Sanctuary, 175 Edward Foster Rd., Scituate, MA 02066.

(c) The Director, at his or her discretion may issue a permit, subject to such terms and conditions as he or she deems appropriate, to conduct an activity prohibited by Sec. 922.142(a) (1) and (3) through (7), if the Director finds that the activity will have only negligible short-term adverse effects on Sanctuary resources and qualities and will: further research related to Sanctuary resources and qualities; further the educational, natural or historical resource value of the Sanctuary; further salvage or recovery operations in or near the Sanctuary in connection with a recent air or marine casualty; or assist in managing the Sanctuary. In deciding whether to issue a permit, the Director may consider such factors as: the professional qualifications and financial ability of the applicant as related to the proposed activity; the duration of the activity and the duration of its effects; the appropriateness of the methods and procedures proposed by the applicant for the conduct of the activity; the extent to which the conduct of the activity may diminish or enhance Sanctuary resources and qualities; the cumulative effects of the activity; and the end value of the activity. In addition, the Director may consider such other factors as he or she deems appropriate.

(d) It shall be a condition of any permit issued that the permit or a copy thereof be displayed on board all vessels or aircraft used in the conduct of the activity.

(e) The Director may, *inter alia*, make it a condition of any permit issued that any data or information obtained under the permit be made available to the public.

(f) The Director may, *inter alia*, make it a condition of any permit issued that a NOAA official be allowed to observe any activity conducted under the permit an/or that the permit holder submit one or more reports on the status, progress or results of any activity authorized by the permit.

Appendix A to Subpart N of Part 922--Stellwagen Bank National Marine Sanctuary Boundary Coordinates

[Appendix Based on North American Datum of 1927]

Point	Latitude	Longitude
E1	42 deg.45'59.83	70 deg.13'01.77
E2	42 deg.05'35.51	70 deg.02'08.14
E3	42 deg.06'8.25	70 deg.03'17.55
E4	42 deg.06'2.53	70 deg.04'03.36
E5	42 deg.07'02.70	70 deg.05'13.61
E6	42 deg.07'13.0	70 deg.06'23.75
E7	42 deg.07'35.95	70 deg.07'27.89
E8	42 deg.07'42.33	70 deg.08'26.07
E9	42 deg.07'59.94	70 deg.09'19.78
E10	42 deg.08'04.95	70 deg.10'24.40
E11	42 deg.07'55.19	70 deg.11'47.67
E12	42 deg.07'59.84	70 deg.13'03.35
E13	42 deg.07'46.55	70 deg.14'21.91
E14	42 deg.07'27.29	70 deg.15'22.95
E15	42 deg.06'54.57	70 deg.16'42.71
E16	42 deg.07'44.89	70 deg.28'15.44
E17	42 deg.32'53.52	70 deg.35'52.38
E18	42 deg.33'30.24	70 deg.35'14.96
E19	42 deg.33'48.14	70 deg.35'03.81
E20	42 deg.34'30.45	70 deg.34'22.98
E21	42 deg.34'50.37	70 deg.33'21.93
E22	42 deg.35'16.08	70 deg.32'32.29
E23	42 deg.35'41.80	70 deg.31'44.20
E24	42 deg.36'23.08	70 deg.30'58.98
E25	42 deg.37'15.51	70 deg.30'23.01
E26	42 deg.37'58.88	70 deg.30'06.60
E27	42 deg.38'32.46	70 deg.30'06.54
E28	42 deg.39'04.08	70 deg.30'11.29

Appendix J. Preliminary Species List for the Stellwagen Bank National Marine Sanctuary

Family	Vernacular Name	Genus	Species	Reference
PHYLUM: PYRROPHYCOPHYTA (dinoflagellates, phytoplankton)				
Ceratiaceae		*Ceratium*	*sp.*	1
Coscinodiscaceae		*Coscinodiscu*	*sp.*	1
Thalassiosiraceae		*Thalassiosira*	*nordenskioldii*	1
PHYLUM: PORIFERA (sponges)				
Clionidae	Boring Sponge	*Cliona*	*celata*	1, 7
Clionidae	Naked sea buterfly	*Clione*	*limacina*	1
Chalinidae		*Gellius*	*arcoferus*	1
Halichondriidae	Breadcrumb Sponge	*Halichondria*	*panicea*	1
Chalinidae	Finger Sponge	*Haliclona*	*oculata*	1
Chalinidae		*Haliclona*	*urceola*	1
Halisarcidae	Slime Sponge	*Halisarca*	*dujardini*	1
Hymedesmiidae		*Hymedesmia*	*sp.*	1
Myxillidae		*Iophon*	*nigricans*	8, 10
Myxillidae		*Iophon*	*pattersoni*	6
Isodictyidae	Palmate Sponge	*Isodictya*	*palmata*	1
Myxillidae		*Leptosia*	*sp.*	8
Leucosoleniidae		*Leucosolenia*	*botryoides*	1
Mycalidae		*Mycale*	*lingua*	1
Myxillidae		*Myxilla*	*fimbriata*	1
Chalinidae	Chalice Sponge	*Phakellia*	*ventilabrum*	1
Hymedesmiidae		*Plocamionida*	*ambigua*	1
Polymastiidae		*Polymastia*	*hispida*	2
Polymastiidae		*Polymastia*	*infrapilosa*	1, 8
Polymastiidae		*Polymastia*	*robusta*	1
Sycettidae		*Scypha*	*ciliata*	1
Spongiidae	Yellow Sponge	*Spongia*	*barbara*	2
Stylocordylidae		*Stylocordyla*	*borealis*	6
Suberitidae		*Suberitechnius*	*hispidus*	1
Suberitidae		*Suberites*	*ficus*	11
Sycettidae		*Sycon*	*ciliata*	2
Subertidae		*Tentorium*	*semisuberites*	6
PHYLUM: CNIDARIA (anemones and corals)				
Gorgonacea		*Acanella*		6
Hormathiidae		*Actinauge*	*feline*	7
Actinostolidae		*Actinostola*	*callosa*	6
Alcyonacea		*Alcyonium*	*sp.*	6
Actinostolidae		*Antholoba*	*perdix*	6
Rhizangiidae		*Astrangia*	*sp.*	6
Actinidae		*Bolocera*	*tuediae*	8, 10
Cerianthidae		*Ceriantheopsis*	*americanus*	6
Cerianthidae		*Cerianthus*	*borealis*	6, 8
Edwardsiidae		*Edwardia*	*sulcata*	6
Epizoanthidae		*Epizoanthus*	*incrustatus*	6
Epizoanthidae		*Epizoanthus*	*sp.*	6

Alcyonacea		*Gersemia*	*rubiformis*	7
Caryophylliidae		*Lophelia*	*pertusa*	6
Metridiidae		*Metridium*	*senile*	6
Gorgonacea		*Paragorgia*	*arborea*	6
Pennatulacea		*Pennatula*	*Aculeata*	6, 12
Gorgonacea		*Primnoa*	*reseta*	6
Pennatulacea		*Stylatula*	*elegans*	6
Actinidae		*Urticina*	*felina*	6
Tubularia		*Tubularia*	*crocea*	7
PHYLUM: CTENOPHORA (comb jellies)				
Pleurobrachiidae	Beroe's comb jelly	*Beroe*	*cucumis*	1
Mertensiidae	Arctic Sea gooseberry	*Mertensia*	*ovum*	1
Pleurobrachiidae		*Pleurobrachia*	*pileus*	1
PHYLUM: NEMERTEA (ribbon worms)				
Amphiporidae		*Amphiporus*	*angulatus*	2
Amphiporidae		*Tachycineta*	*bicolor*	2
PHYLUM: BRYOZOA (moss animals)				
Calloporidae		*Amphiblestrum*	*septentriona*	6
Calloporidae		*Amphiblestrum*	*trifolium*	6
Bugulidae		*Bugula*	*sp.*	7
Candidae		*Caberea*	*ellisii*	6
Scrupocellariidae		*Caberea*	*ellisii*	8, 10
Calloporidae		*Callopora*	*craticula*	6
Calloporidae		*Callopora*	*lineata*	6
Hincksinidae		*Cauloramphus*	*cymbaeformis*	6
Celleporidae		*Celleporaria*	*agglutinans*	6
Cribrilinidae		*Cribrilina*	*punctata*	6
Bugulidae		*Dendrobeania*	*murrayana*	6
Escharellidae		*Disporella*	*sp*	6
Escharellidae		*Escharella*	*abyssicola*	6
Escharellidae		*Escharella*	*ventricosa*	6
Scrupariidae		*Eucratea*	*loricata*	6
Hippodiplosia		*Hippodiplosia*	*americana*	6
Hippodiplosia		*Hippodiplosia*	*hippopus*	6
Hippodiplosia		*Hippodiplosia*	*pertusa*	6
Hippoporinidae		*Hippomenella*	*vellicata*	6
Retiporidae		*Hippoporella*	*hippopus*	6
Hippothoidea		*Hippothoa*	*hyalina*	6
Tubuliporidae		*Idmirdronea*	*atlantica*	6, 8
Microporellidae		*Microporella*	*ciliata*	6
Bryocryptellidae		*Palmicellaria*	*skenei*	6
Smittinidae		*Palmicellaria*	*skenei*	6
Mucronellidae		*Parasmittina*	*trispinosa*	6
Myriaporidae		*Porella*	*reduplicata*	6
Myriaporidae		*Porella*	*smitti*	6
Smittinidae		*Pyripora*	*catenularia*	6
Umbonulidae		*Ragionola*	*rosacea*	6
Bryocryptellidae		*Rhamphostomella*	*bilaminata*	6
Schizoporellidae		*Schizomavella*	*auriculata*	6
Smittinidae		*Smittina*	*bella*	6
Stomachetosellidae		*Stomachetosella*	*sinuosa*	6

Scrupocellariidae		*Tricellaria*	*gracilis*	6
Tubuliporidae		*Tubulipora*		6, 8
Umbanulidae		*Umbonula*	*arctica*	6
PHYLUM: RHYNCHOCOELA (unsegmented worms)				
Tubulanidae		*Rhynchocoela*	*sp.*	4
Lineidae		*Tubulanus*	*sp.*	4
PHYLUM: MOLLUSCA (molluscs)				
Rissoidae		*Alvania*	*sp.*	4
Anomiidae		*Anomia*	*aculeata*	6
Anomiidae		*Anomia*	*simplex*	6
Anomiidae		*Anomia*	*sp*	6
Anomiidae		*Anomia*	*squamula*	1
		Aplacophora	*sp.*	4
Arcticidae	Ocean quahog	*Arctica*	*islandica*	1, 6
Astartidae		*Astarte*	*castanea*	1
Astartidae		*Astarte*	*crenata-subequilatera*	6
Astartidae		*Astarte*	*elliptica*	6
Astartidae		*Astarte*	*quandrans*	6
Astartidae		*Astarte*	*undata*	1, 4
Octopodidae		*Bathypolypus*	*arcticus*	2
Buccinidae	Waved Whelk	*Buccinum*	*undatum*	1
Calliostomatidae		*Calliostoma*	*sp.*	2
Cardiidae		*Cerastoderma*	*pinnulatum*	6
Cardiidae		*Clinocardium*	*ciliatum*	4
Buccinidae	Pygmy Whelk	*Colus*	*pygmaeus*	1
Flabellinidae	Red-gilled nudibranch	*Coryphella*	*rufibranchialis*	1
Mytilidae		*Crenella*	*decussata*	4
Cardiidae		*Cyclocardia*	*borealis*	6
Dendronotidae		*Dendronotus*	*sp.*	1
Onchidorididae		*Doris*	*sp.*	1
Solenidae		*Ensis*	*directus*	6
Epitoniidae		*Epitonium*	*sp.*	2
Hamineidae		*Haminoea*	*solitaria*	4
Ommastrephidae	Short fin squid	*Illex*	*illecebrosus*	1
Ischnochitonidae	Red Chiton	*Ischnochiton*	*ruber*	1
Loliginidae	Long finned squid	*Loligo*	*pealei*	1
Naticidae		*Lunatia*	*heros*	1
Lyonsiidae		*Lyonsia*	*hyalina*	4
Tellinidae		*Macoma*	*balthica*	6
Tellinidae		*Macoma*	*calcarea*	6
Trochidae	Top Shell	*Margarites*	*sp.*	1
Thyasiridae		*Mendicula*	*ferruginosa*	6
Mytilidae	Northern Horse Mussel	*Modiolus*	*modiolus*	1
Montacutidae		*Montacutidae*	*sp.*	4
Myidae		*Mya*	*arenaria*	4
Mytilidae		*Mytilus*	*edulis*	4
Nassariidae		*Nassarius*	*trivitattus*	1
Buccinidae	Ten-Ridged Whelk	*Neptunea*	*lyrata decemcostata*	1
Nuculidae		*Nucula*	*delphinodonta*	4
Nuculidae		*Nucula*	*proxima*	4
Periplomatidae		*Periploma*	*margaritaceum*	4

Veneridae		*Pitar*	*morrhuanus*	6
Pectinidae	Sea scallop	*Placopecten*	*magellanicus*	1
Turridae		*Pyrgocythara*	*plicosa*	4
Solenidae		*Siliqua*	*costata*	6
Mactridae		*Spisula*	*solidissima*	6
Mactridae		*Spisula*	*solidissima*	1
Lottiidae		*Tectura*	*testudinalis*	1
Tellinidae		*Tellina*	*agilis*	4
Thyasiridae		*Thyasira*	*equalis*	6
Thyasiridae		*Thyasira*	*flexuosa*	1
Thyasiridae		*Thyasira*	*gouldii*	6
Thyasiridae		*Thyasira*	*trisinuata*	4
Ischnochitonidae		*Tonicella*	*rubra*	1
Nuculanidae		*Yoldia*	*sp.*	4
PHYLUM: ANNELIDA (segmented worms)				
Ampharetidae		*Ampharete*	*finmarchica*	4
Terebellidae		*Amphitrite*	*sp.*	6
Ampharetidae		*Anobothrus*	*gracilis*	1
Cirratulidae		*Aphelochaeta*	*sp.*	4
Apistobranchidae		*Apistobranchus*	*tullbergi*	4
Trochilidae		*Archilochus*	*colubris*	2
Paraonidae		*Aricidea*	*quadrilobata*	1
Paraonidae		*Aricidea*	*catherinae*	4
Paraonidae		*Aricidea*	*cerrutii*	4
Paraonidae		*Aricidea*	*quadrilobata*	4
Paraonidae		*Aricidea*	*taylori*	4
Maldanidae		*Asychis*	*biceps*	6
Maldanidae		*Axiothella*	*eatenata*	9
Maldanidae		*Axiothella*	*mucosa*	4
Capitellidae		*Capitella*	*capitata*	4
Cirratulidae		*Caulleriella*	*sp.*	4
Chaetopteridae		*Chaetopterus*	*variopedatus*	6
Cirratulidae		*Chaetozone*	*setosa*	1
Apodidae		*Chaetura*	*pelagica*	2
Sabellidae		*Chone*	*infundibuliformis*	1
Cirratulidae		*Cirratulidae*	*sp.*	4
Cirratulidae		*Cirratulus*	*sp.*	6
Paraonidae		*Cirrophorus*	*ilvana*	4
Pectinariidae		*Cistenides*	*sp*	6
Maldanidae		*Clymenella*	*sp.*	1
Cossuridae		*Cossura*	*longocirrata*	1
Cossuridae		*Cossura*	*delta*	4
Cossuridae		*Cossura*	*soyeri*	4
Fringillidae		*Dendroica*	*coronata*	2
Onuphidae	Plumed worm	*Diopatria*	*cupera*	1, 6
Spionidae		*Diospio*	*sp.*	6
Spionidae		*Dipolydora*	*quadrilobata*	4
Spionidae		*Dipolydora*	*socialis*	4
Enchytraeidae		*Enchytraeidae*	*sp.*	4
Phyllodocidae		*Eteone*	*longa*	4
Sabellidae		*Euchone*	*incolor*	4
Eunicidae		*Eunice*	*pennata*	6
Syllidae		*Exogone*	*hebes*	1

Syllidae		*Exogone*	*verugera*	1
Serpulidae	Lacy Tube Worm	*Filograna*	*implexa*	1, 8
Oweniidae		*Galathowenia*	*oculata*	4
Glyceridae		*Glyceridae*	*sp.*	4
Goniadidae		*Goniada*	*maculata*	4
Goniadidae		*Goniadella*	*sp.*	1
Goniadidae		*Goniadella*	*gracilis*	4
Polynoidae		*Harmothoe*	*sp.*	4
Capitellidae		*Heteromastus*	*filiformis*	1
Onuphidae		*Hyalinoecia*	*tubciola*	6
Serpulidae		*Hydroides*	*dianthus*	1
Muscicapidae		*Hylocichla*	*mustelina*	2
Spionidae		*Laonice*	*sp.*	6
Orbiniidae		*Leitoscoloplos*	*sp.*	4
Paraonidae		*Levinsenia*	*gracilis*	4
Lumbrineridae		*Lumbrineris*	*sp.*	6
Maldanidae		*Maldane*	*sarsi*	1, 9
Maldanidae		*Maldane*	*glebifex*	4
Maldanidae		*Maldanopsis*	*elongata*	9
Capitellidae		*Mediomastus*	*ambiseta*	1
Capitellidae		*Mediomastus*	*californiensis*	4
Ampharetidae		*Melinna*	*cristata*	6
Hesionidae		*Microphthalmus*	*sp.*	4
Cirratulidae		*Monticellina*	*baptisteae*	4
Oweniidae		*Myriochele*	*oculata*	1
Sabellidae	Fan Worm	*Myxicola*	*infundibulum*	1, 11, 8, 9
Nephtyidae		*Nephtyidae*	*sp.*	4
Nephtyidae		*Nephtys*	*ciliata*	4
Nephtyidae		*Nephtys*	*incisa*	4
Nereidae		*Nereis*	*grayi*	4
Maldanidae		*Nicomache*	*lumbricalis*	1, 9
Lumbrineridae		*Ninoe*	*nigripes*	4
Onuphidae		*Nothria*	*conchylega*	6
Onuphidae		*Onuphis*	*eremite*	6
Onuphidae		*Onuphis*	*opalina*	6
Onuphidae		*Onuphis*	*quadricuspis*	6
Opheliidae		*Ophelia*	*sp*	1
Opheliidae		*Ophelina*	*acuminata*	4
Oweniidae		*Owenia*	*fusiformis*	4, 9
Onuphidae		*Paradiopatra*	*sp.*	6
Paraonidae		*Paraonis*	*gracilis*	1
Syllidae		*Parapionosyllis*	*longicirrata*	4
Dorvilleidae		*Parougia*	*caeca*	4
Pectinariidae	Trumpet worm	*Pectinari*	*gouldi*	1, 7
Pholoidae		*Pholoe*	*minuta*	1
Phyllodocidae		*Phyllodoce*	*maculata*	4
Phyllodocidae		*Phyllodocidae*	*sp.*	4
Terebellidae		*Polycirrus*	*sp.*	4
Spionidae		*Polydora*	*cornuta*	4
Polygordiidae		*Polygordius*	*sp.*	4
Polynoidae		*Polynoidae*	*sp.*	4
Sabellidae		*Potamilla*	*sp.*	6
Maldanidae		*Praxillella*	*sp.*	9

Maldanidae		*Praxillura*	*longissima*	1
Spionidae		*Prionospio*	*steenstrupi*	1
Dorvilleidae		*Protodorvillea*	*kefersteini*	4
Maldanidae		*Rhodine*	*sp.*	9
Sabellidae		*Sabella*	*sp.*	6
Ampharetidae		*Samythella*	*sp.*	4
Scalibregmatidae		*Scalibregma*	*inflatum*	4
Lumbrineridae		*Scoletoma*	*fragilis*	4
Lumbrineridae		*Scoletoma*	*verrilli*	4
Serpulidae		*Serpula*	*sp.*	1
Sphaerodoridae		*Sphaerodoropsis*	*minuta*	4
Syllidae		*Sphaerosyllis*	*brevifrons*	4
Spionidae		*Spio*	*filicornis*	1
Spionidae		*Spio*	*pettiboneae*	1
Spionidae		*Spio*	*limicola*	4
Chaetopteridae		*Spiochaetopterus*	*sp.*	6
Spionidae		*Spiophanes*	*bombyx*	4
Serpulidae	Spiral Tube Worm	*Spirorbis*	*spirorbis*	1
Fringillidae		*Spizella*	*pusilla*	2
Sternaspidae		*Sternaspis*	*scutata*	1
Terebellidae		*Streblosoma*	*spiralis*	1
Spionidae		*Streblospio*	*benedicti*	4
Syllidae		*Streptosyllis*	*arenae*	4
Syllidae		*Syllides*	*longocirrata*	4
Syllidae		*Syllis*	*alosae*	4
Trichobranchidae		*Terebellides*	*stroemi*	4
Cirratulidae		*Tharyx*	*acutus*	4
Terebellidae		*Thelepus*	*cincinnatus*	1
Trochochaetidae		*Trochochaeta*	*multisetosa*	1
Tubificidae		*Tubificidae*	*sp.*	4
PHYLUM: ARTHROPODA (crabs, lobsters, shrimp)				
Aeginellidae		*Aeginella*	*longicornis*	4
Caprellidae		*Aeginina*	*longicornis*	6
Ampeliscidae		*Aeginellidae*	*sp.*	4
Ampeliscidae		*Ampelisca*	*macrocephala*	6
Ampeliscidae		*Ampelisca*	*vadorum*	4
Eusiridae		*Amphithipsis*	*sp*	6
Anthuridae		*Anoplodactylus*	*lentus*	4
Axiidae		*Axius*	*serratus*	6
Aoridae		*Balanus*	*balanus*	4
Aoridae		*Balanus*	*crenatus*	4
Balanidae	Rough Barnacle	*Balanus*	*hameri*	1
Balanidae		*Brisaster*	*fragilis*	1
Ampeliscidae		*Byblis*	*gaimardi*	1
Bodotriidae		*Calanus*	*finmarchicus*	1
Calliopidae		*Calliopius*	*laeviusculus*	6
Axiidae		*Calocaris*	*templemanni*	6
Bodotriidae		*Campylaspis*	*rubicunda*	6
Calanidae		*Cancer*	*borealis*	1
Cancridae		*Cancer*	*borealis*	6
Cancridae		*Cancer*	*irroratus*	6
Portunidae		*Carcinus*	*maenas*	6

Hipolytidae		*Caridon*	*gordoni*	6
Gammaridae		*Casco*	*bigelowi*	6
Cancridae	Jonah Crab	*Centropages*	*typicus*	1
Centropagidae		*Chiridotea*	*caeca*	1
Chaetiliidae		*Corophium*	*sp.*	1
Clausocalanidae		*Crangon*	*septemspinosis*	1
Crangonidae		*Crangon*	*septemspinosa*	6
Corophiidae		*Crassicorophium*	*crassicorne*	1
unknown		*Decapoda*	*crustacea*	6
Corophiidae		*Desmosomatidae*	*sp.*	4
Crangonidae		*Dichelopandalus*	*leptocerus*	1
Pandalidae		*Dichelopandalus*	*pubescens*	6
Crangonidae		*Dulichia*	*porrecta*	1
Cylindroleberididae		*Edotia*	*montosa*	4
Epimeriidae		*Epimeria*	*loricata*	6
Desmosomatidae		*Erichthonius*	*difformis*	4
Euchaetidae		*Ericthonius*	*sp.*	1
Hipolytidae		*Eualus*	*fabricii*	6
Hipolytidae		*Eualus*	*pusiolus*	6
Euphausiidae		*Euchaeta*	*norvegica*	1
Euphausiidae		*Eudorella*	*pusilla*	1
Eusiridae		*Eusirus*	*cuspidatus*	6
Hippolytidae		*Euthemisto*	*sp.*	1
Geryonidae		*Geryon*	*quinquedens*	6
Caprellidae		*Harloops*	*tubicola*	6
Hyperiidae		*Harpinia*	*propinqua*	1
Nephropidae	American Lobster	*Homarus*	*americanus*	4
Idoteidae		*Hyas*	*coarctatus*	4
Majidae		*Hyas*	*coarctatus*	6
Hyperidae		*Hyperia*	*galba*	6
Hyperidae		*Hyperoche*	*medusarum*	6
Hipolytidae		*Lebbeus*	*groenlandicus*	6
Hipolytidae		*Lebbeus*	*polaris*	6
Hipolytidae		*Lebbeus*	*zebra*	6
Aoridae		*Lembos*	*websteri*	6
Isaeidae		*Leptocheirus*	*pinguis*	4
Ischyroceridae		*Leptocuma*	*sp.*	4
Lithodidae		*Lithodes*	*maja*	6
Leuconidae		*Lysianassidae*	*sp.*	4
Lithodidae		*Meganyctiphanes*	*norvegica*	2
Lysianassidae		*Metopella*	*angusta*	4
Majidae	Toad Crab	*Metridia*	*lucens*	1
Oedicerotidae		*Monoculodes*	*tuberculatus*	6
Nannastacidae		*Oithona*	*sp.*	4
Nephropidae		*Pagurus*	*arcuatus*	1
Oedicerotidae		*Pagurus*	*asadianus*	4
Paguridae		*Pagurus*	*pubescens*	6
Pandalidae		*Pandalus*	*montagui*	6
Pandalidae		*Pandalus*	*propinquus*	6
Pandalidae	Northern pink shrimp	*Pandalus*	*borealis*	1
Oedicerotidae		*Paroediceros*	*lynceus*	6
Paguridae		*Pasiphaea*	*sp.*	1
Pasiphaeidae		*Pasiphaea*	*multidentata*	6

Paguridae	Hairy Hermit Crab	*Petalosarsia*	*declivis*	1
Pandalidae		*Photis*	*sp.*	1
Pandalidae		*Phoxocephalus*	*holbolli*	1
Paramunnidae		*Pleurogonium*	*spinosissimum*	4
Pleustidae		*Pleustes*	*panoplus*	6
Isaeidae		*Podoceropsis*	*nitida*	6
Crangonidae		*Pontophilus*	*norvegicus*	6
Melitidae		*Protomedia*	*fasciata*	6
Phoxichilidiidae	Long-leggedlentil sea spider	*Pseudocalanus*	*mintus*	1
Phoxocephalidae		*Ptilanthura*	*tenuis*	4
Crangonidae		*Sabinea*	*sarsii*	6
Crangonidae		*Sabinea*	*septemcarinata*	6
Crangonidae		*Sclerocrangon*	*boreas*	6
Phoxocephalidae		*Sclerocrangon*	*boreas*	4
Hipolytidae		*Spirontocaris*	*liljeborgii*	6
Hipolytidae		*Spirontocaris*	*spinus*	6
Pleustidae		*Spirontocaris*	*sp.*	4
Pleustidae		*Stegocephalus*	*inflatus*	6
Pleustidae		*Stenopleustes*	*sp*	6
Podoceridae		*Synasterope*	*cushmani*	4
Pseudocumatidae		*Temora*	*longicornis*	4
Stenothoidae		*Thysanoessa*	*sp.*	4
Corophiidae		*Unciola*	*irrorata*	6
Temoridae		*Unciola*	*irrorata*	1
PHYLUM: PHORONIDA (marine worms)				
Phoronidae		*Phoronis*	*sp.*	4
PHYLUM: ECTOPROCTA (moss animals)				
Bugulidae	Spiral Tufted Bryozoan	*Bugula*	*turrita*	1
Scrupocellariidae		*Caberea*	*ellisii*	1
Bugulidae		*Dendrobeania*	*murrayana*	1
Lichenoporidae		*Disporella*	*hispida*	1
Hippothoidae		*Hippothoa*	*hyalina*	1
Tubuliporidae		*Idmidronea*	*atlantica*	1
Schizoporellidae		*Schizomavella*	*auriculata*	1
Tubuliporidae		*Tubulipora*	*lilacea*	1
PHYLUM: BRACHIOPODA (lamp shell)				
Cancellothyrididae	Northern Lamp Shell	*Terebratulina*	*septentrionalis*	1
PHYLUM: ECHINODERMATA (sea stars, cucumbers, urchins)				
Asteriidae	Northern Sea Star	*Asterias*	*vulgaris*	1
		Asteroidea	*sp.*	4
Amphiuridae		*Axiognathus*	*squamatus*	1
Solasteridae	Spiny Sunstar	*Crossaster*	*papposus*	1
Porcellanasteridae		*Ctenodiscus*	*crispatus*	1
Cucumariidae	Orange Footed Cucumber	*Cucumaria*	*frondosa*	1
Echinarachniidae	Common Sand Dollar	*Echinarachnius*	*parma*	1
		Echinoidea	*sp.*	4
Gorgonocephalidae	Northern basket star	*Gorgonocephalus*	*arcticus*	1
Antedonidae		*Hathrometra*	*sp.*	1
Echinasteridae	Blood Sea Star	*Henricia*	*sanguinolenta*	1

Goniasteridae	Horse Star	*Hippasteria*	*phrygiana*	1
Asteriidae		*Leptasterias*	*sp.*	1
Molpadiidae		*Molpadia*	*oolitica*	1
Ophiacanthidae		*Ophiacantha*	*sp.*	1
Ophiactidae	Daisy Brittle Star	*Ophiopholis*	*aculeata*	1
Ophiuridae		*Ophiura*	*robusta*	1
Ophiuridae		*Ophiura*	*sarsi*	1
Poraniidae	Badge Star	*Porania*	*insignis*	1
Psolidae	Scarlet Cucumber	*Psolus*	*fabricii*	1
Psolidae	Psolus sea cucumber	*Psolus*	*fabricii*	1
Psolidae		*Psolus*	*phantapus*	1
Pterasteridae		*Pteraster*	*militaris*	2
Solasteridae	Smooth Sunstar	*Solaster*	*endeca*	1
Asteriidae		*Stephanasterias*	*albula*	1
Strongylocentrotidae	Green Sea Urchin	*Strongylocentrotus*	*droebachiensis*	1
PHYLUM: CHAETOGNATH (arrow worm)				
Eukrohniidae		*Eukrohnia*	*sp.*	1
Sagittidae		*Sagitta*	*elegans*	1
Sagittidae		*Sagitta*	*lyra*	1
PHYLUM: UROCHORDATA (tunicates)				
Polyclinidae	Sea Grape	*Aplidium*	*constellatum*	1
Polyclinidae	New York Sea Grape	*Aplidium*	*pallidum*	1
Ascidiidae		*Ascidia*	*callosa*	1
Pyuridae		*Boltenia*	*echinata*	1
Pyuridae		*Boltenia*	*ovifera*	1
Styelidae		*Botrylloides*	*diegense*	1
Cionidae		*Ciona*	*intestinalis*	1, 8
Styelidae		*Dendrodoa*	*carnea*	1
Didemnidae		*Didemnum*	*albidum*	1
Pyuridae		*Halocynthia*	*pyriformis*	1
Molgulidae	Northern White Crust	*Molgula*	*citrina*	1
Molgulidae		*Molgula*	*manhattensis*	1
Styelidae		*Styela*	*sp.*	1
Polyclinidae		*Synoicum*	*pulmonaria*	1
Didemnidae	Sea Vase	*Trididemnum*	*solidum*	1
PHYLUM: CHORDATA—FISHES				
Alopiidae	Thresher shark	*Alopias*	*vulpinus*	13
Clupeidae	Blueback herring	*Alosa*	*aestivalis*	3
Clupeidae	Alewife	*Alosa*	*pseudoharengus*	3
Clupeidae	American shad	*Alosa*	*sapidissima*	1, 3
Ammodytidae	American sand lance	*Ammodytes*	*americanus*	1, 3
Anarhichadidae	Atlantic Wolfish	*Anarhichas*	*lupus*	1, 3
Gasterosteidae	Fourspine stickleback	*Apeltes*	*quadracus*	3
Argentinidae	Atlantic argentine	*Argentina*	*silus*	3
Ariommatidae	Silver rag	*Ariomma*	*bondi*	3
Agonidae	Alligatorfish	*Aspidophoroides*	*monopterygius*	1, 3
Clupeidae	Atlantic menhaden	*Brevoortia*	*tyrannus*	3
Lotidae	Cusk	*Brosme*	*brosme*	1, 3
Carcharhinidae	Sand tiger shark	*Carcharias*	*taurus*	13
Carcharhinidae	White shark	*Carcharodon*	*carcharias*	13

Serranidae	Black sea bass	*Centropristis*	*striata*	1, 3
Cetorhinidae	Basking shark	*Cetorhinus*	*maximus*	13
Paralichthyidae	Gulfstream flounder	*Citharichthys*	*arctifrons*	3
Clupeidae	Atlantic herring	*Clupea*	*harengus*	1, 3
Cryptacanthodidae	Wrymouth	*Cryptacanthodes*	*maculatus*	3
Cyclopteridae	Lumpfish	*Cyclopterus*	*lumpus*	1, 3
Lotidae	Fourbeard Rockling	*Enchelyopus*	*cimbrius*	1, 3
Cyclopteridae	Atlantic spiny lumpsucker	*Eumicrotremus*	*spinosus*	3
Gadidae	Atlantic Cod	*Gadus*	*morhua*	1, 3
Gasterosteidae	Threespine stickleback	*Gasterosteus*	*aculeatus*	3
Pleuronectidae	Witch flounder	*Glyptocephalus*	*cynoglossus*	1, 3
Scorpaenidae	Blackbelly rosefish	*Helicolenus*	*dactylopterus*	3
Hemitripteridae	Sea raven	*Hemitripterus*	*americanus*	1, 3
Pleuronectidae	American plaice	*Hippoglossoides*	*platessoides*	1, 3
Pleuronectidae	Atlantic Halibut	*Hippoglossus*	*hippoglossus*	1, 3
Carcharhinidae	Shortfin mako	*Isurus*	*oxyrinchus*	13
Carcharhinidae	Porbeagle	*Lamna*	*nasus*	13
Ophidiidae	Fawn cusk eel	*Lepophidium*	*cervinum*	3
Lophiidae	Goosefish	*Lophias*	*americanus*	1, 3
Stichaeidae	Snakeblenny	*Lumpenus*	*lumpretaeformis*	1, 3
Stichaeidae	Daubed shanny	*Lumpenus*	*maulatus*	1, 3
Zoarcidae	Wolf eelpout	*Lycenchelys*	*verrilli*	3
Zoarcidae	Ocean pout	*Macrozoarces*	*americanus*	1, 3
Osmeridae	Capelin	*Mallotus*	*villossis*	1
Sternoptychidae	Pearlsides	*Maurolieus*	*muelleri*	3
Gadidae	Haddock	*Melanogrammus*	*aeglefinus*	1, 3
Zoarcidae	Atlantic soft pout	*Melanostigma*	*atlanticum*	3
Atherinopsidae	Atlantic silverside	*Menidia*	*menidia*	3
Merlucciidae	Silver hake (Whiting)	*Merluccius*	*bilinearis*	1, 3
Gadidae	Tomcod	*Microgadus*	*tomcod*	2
Molidae	Ocean sunfish	*Mola*	*mola*	1
Moronidae	Striped bass (Rockfish)	*Morone*	*saxatilis*	1
Cottidae	Grubby	*Myoxocephalus*	*anaeus*	3
Cottidae	Longhorn sculpin	*Myoxocephalus*	*octodecemspinosus*	1, 3
Cottidae	Shortnose sculpin	*Myoxocephalus*	*scorpius*	3
Myxinidae	Hagfish	*Myxine*	*glutinosa*	1, 3
Nemichthyidae	Slender snipe eel	*Nemichthys*	*scolopaceus*	3
Paralichthyidae	Summer flounder	*Paralichthys*	*denatus*	1
Paralichthyidae	Fourspot flounder	*Paralychthis*	*oblongus*	1, 3
Stromateidae	Butterfish	*Peprilus*	*triacanthus*	1, 3
Ophichthidae	Snake eel	*Ophichthus*	*cruentifer*	3
Pleuronectidae	Winter flounder	*Pleuronectes*	*americanus*	1, 3
Pleuronectidae	Yellowtail flounder	*Pleuronectes*	*ferrungineus*	3, 4
Gadidae	Pollack	*Pollachius*	*virens*	1, 3
Pomatomidae	Bluefish (snapper)	*Pomatomus*	*saltatrix*	1
Carcharhinidae	Blue shark	*Prionace*	*glauca*	13
Triglidae	Northern Sea robin	*Prionotus*	*carolinus*	1, 3
Rajidae	Clearnose skate	*Raja*	*eglanteria*	3
Rajidae	Little skate	*Raja*	*erinacea*	1, 3
Rajidae	Barndoor skate	*Raja*	*laevis*	1
Rajidae	Winter skate	*Raja*	*ocellata*	1, 3
Rajidae	Thorny skate	*Raja*	*radiata*	3
Rajidae	Smooth skate	*Raja*	*senta*	3

Salmonidae	Atlantic salmon	*Salmo*	*salar*	3
Scombridae	Atlantic mackerel	*Scomber*	*scombrus*	1, 3
Scomberesocidae	Atlantic saury	*Scomberesox*	*saurus*	3
Scophthalmidae	Windowpane flounder	*Scophthalmus*	*aquosus*	1, 3
Sebastidae	Redfish	*Sebastes*	*fasciatus*	1, 3
Squalidae	Spiny dogfish	*Squalus*	*acanthias*	1, 3
Sparidae	Scup (Porgy)	*Stenotomus*	*chrysops*	1, 3
Syngnathidae	Pipefish	*Syngnathus*	*fuscus*	1, 3
Labridae	Cunner	*Tautogolabrus*	*adspersus*	1, 3
Scombridae	Bluefin tuna	*Thunnus*	*thynnus*	1
Cottidae	Mustache sculpin	*Triglops*	*murrayi*	3
Stichaeidae	Radiated shanney	*Ulvaria*	*subbifurcata*	3
Phycidae	Red hake	*Urophycis*	*chuss*	1, 3
Phycidae	Spotted hake	*Urophycis*	*regia*	1, 3
Phycidae	White hake	*Urophycis*	*tenuis*	1, 3
PHYLUM: CHORDATA—MARINE REPTILES				
Cheloniidae	Loggerhead turtle	*Caretta*	*caretta*	1
Cheloniidae	Green turtle	*Chelonia*	*mydas*	1
Dermochelyidae	Leatherback turtle	*Dermochelys*	*coriacea*	1
Cheloniidae	Kemp's ridley turtle	*Lepidochelys*	*kempi*	1
PHYLUM: CHORDATA—BIRDS				
Alcidae	Razorbill	*Alca*	*torda*	5
Alcidae	Dovekie	*Alle*	*alle*	5
Anatidae	Common Eider	*Ardea*	*herodias*	5
Anatidae	Atlantic Brant	*Branta*	*bernicla*	5
Laridae	South Polar Skua	*Calidris*	*minutilla*	5
Procellariidae	Cory's Shearwater	*Calonectris*	*diomedea*	5
Laridae	South polar skua	*Catharacta*	*maccormickii*	5
Laridae	Great skua	*Catharacta*	*skua*	5
Alcidae	Black guillemot	*Cepphus*	*grylle*	5
Laridae	Black tern	*Chlidonias*	*niger*	5
Anatidae	Long-tailed Duck	*Clangula*	*hyemalis*	5
Procellariidae	Yellow-nossed albatross	*Diomedea*	*chlororhynchos*	5
Procellariidae	Black-browed albatross	*Diomedea*	*meleanophris*	5
Falconidae	Peregrine Falcon	*Falco*	*peregrinus*	5
Laridae	Atlantic Puffin	*Fratercula*	*arctica*	5
Procellariidae	Northern fulmar	*Fulmarus*	*glacialis*	5
Gaviidae	Common loon	*Gavia*	*immer*	5
Gaviidae	Red-throated loon	*Gavia*	*stellata*	5
Laridae	Herring gull	*Larus*	*argentatus*	5
Laridae	Laughing gull	*Larus*	*articilla*	5
Laridae	Ring-billed gull	*Larus*	*delwarensis*	5
Laridae	Iceland gull	*Larus*	*glaucoides*	5
Laridae	Glaucous gull	*Larus*	*hyperboreus*	5
Laridae	Great Black-backed gull	*Larus*	*marinus*	5
Laridae	Bonaparte's gull	*Larus*	*philadelphia*	5
Anatidae	White-winged scoter	*Melanitta*	*deglandi*	5
Anatidae	Black scoter	*Melanitta*	*negri*	5
Anatidae	Surf scoter	*Melanitta*	*perspicillata*	5
Sulidae	Northern Gannet	*Morus*	*bassanus*	5
Hydrobatide	Wilson's Storm-Petrel	*Oceanites*	*oceanicus*	5

Hydrobatide	Leach's Storm-Petrel	*Oceanodroma*	*leaucorhoa*	5
Phalacrocoracidae	Double-crested cormorant	*Phalacrocorax*	*auritus*	5
Phalacrocoracidae	Great cormorant	*Phalacrocorax*	*carbo*	5
Scolopacidae	Red Phalarope	*Phalaropus*	*fulicaria*	5
Scolopacidae	Red-necked phalarope	*Phalaropus*	*lobatus*	5
Procellariidae	Greater Shearwater	*Puffinus*	*gravis*	5
Procellariidae	Sooty Shearwater	*Puffinus*	*griseus*	5
Procellariidae	Manx Shearwater	*Puffinus*	*puffinus*	5
Laridae	Black-legged kittiwake	*Rissa*	*tridactyla*	5
Anatidae	Red-breasted merganser	*Somateria*	*mollisima*	5
Laridae	Long-tailed jaeger	*Stercorarius*	*longicaudus*	5
Laridae	Parasitic jaeger	*Stercorarius*	*parasiticus*	5
Laridae	Pomarine jaeger	*Stercorarius*	*pomarinus*	5
Laridae	Least tern	*Sterna*	*albifrons*	5
Laridae	Roseate tern	*Sterna*	*dougalii*	5
Laridae	Forster's Tern	*Sterna*	*forsteri*	5
Laridae	Common tern	*Sterna*	*hirundo*	5
Laridae	Royal tern	*Sterna*	*maxima*	5
Laridae	Arctic tern	*Sterna*	*paradisaea*	5
Alcidae	Common Murre	*Uria*	*aalge*	5
Alcidae	Thin-billed murre	*Uria*	*lomvia*	5
Laridae	Sabine's gull	*Xema*	*sabini*	5
PHYLUM CHORDATA—MARINE MAMMALS				
Balaenopteridae	Minke whales	*Balaenoptera*	*acutorostrata*	1
Balaenopteridae	Sei whales	*Balaenoptera*	*borealis*	1
Balaenopteridae	Blue whales	*Balaenoptera*	*musculus*	1
Balaenopteridae	Fin whales	*Balaenoptera*	*physalus*	1
Delphinidae	Common dolphins	*Delphinus*	*delphis*	1
Balaenidae	Northern right whales	*Eubalaena*	*glacialis*	1
Delphinidae	Short-Finned Pilot whales	*Globicephala*	*macrorhynchus*	1
Delphinidae	Long-Finned Pilot whales	*Globicephala*	*melaena*	1
Physeteridae	Sperm whale	*Physeter*	*macrocephalus*	
Delphinidae	Risso's dolphin	*Grampus*	*griseus*	1
Phocidae	Gray seal	*Halichoerus*	*grypus*	1
Delphinidae	White-sided dolphins	*Lagenorhynchus*	*actutus*	1
Delphinidae	White-beaked dolphins	*Lagenorhynchus*	*albirostris*	1
Balaenopteridae	Humpack whales	*Megaptera*	*novaeangliae*	1
Delphinidae	Orca whales	*Orcinus*	*orca*	1
Phocidae	Harbor seal	*Phoca*	*vitulina*	1
Phocidae	Hooded seal	*Cystophora*	*cristata*	
Phocidae	Ringed seal	*Pusa*	*hispida*	
Phocidae	Harp seal	*Phoca*	*groenlandica*	1
Phocoenidae	Harbor porpoises	*Phocoena*	*phocoena*	1
Delphinidae	Striped dolphins	*Stenella*	*coeruleoalba*	1
Delphinidae	Bottlenose dolphins	*Tursiops*	*truncatus*	1

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Appendix K. Description of Typical Waste Discharges in the Stellwagen Bank Sanctuary

Black water, gray water, bilge water, ballast water, hazardous materials and solid waste are the significant types of vessel discharge in the sanctuary. This appendix explains what the wastes are produced from, what they include, how much is produced, and indicates principal regulations pertaining to each type of discharge. The information provided is based on typical cruise ship operations, but these types of discharges are not limited to that class of vessel and can vary in degree and kind.

Black Water

Produced from: vessel sewage. It is more concentrated than land-based sources since it is diluted with less water (3 qts/flush vs. 3-5 gal/flush).

Includes: bacteria, viruses, nutrients, chemicals and deodorants (chlorine, ammonia, formaldehyde).

Production: typical cruise ship produces an est. 210,000 gal/week; no data on other vessels.

Regulations: Federal regulations under the Clean Water Act (CWA) classify sewage as a pollutant. Cruise ships are not subject to the National Pollutant Discharge Elimination System (NPDES) permitting program, which requires land-based facilities to obtain permits for discharges. Section 312 of CWA regulates black water (sewage) from cruise ships where vessels are required to possess a U.S. Coast Guard certified marine sanitation device (MSD).

Specifics:

- requires the use of MSDs for all vessels within 3 nautical miles of the coast.
- vessels over 65 feet must have a type II or type III MSD (type II = standard of 200 fecal coliform per per 100 ml of water discharged; type III unit is to contain sewage until it can be disposed of [i.e., a holding tank]).
- CWA can be applied to any discharge beyond the 3-mile limit that affects water quality within that limit.
- raw sewage can be legally discharged beyond 3 nautical miles.

Gray Water

Produced from: wastewater from sinks, showers, laundry and galleys.

Includes: suspended solids, oil, grease, ammonia, nitrogen, phosphates, copper, lead, mercury, nickel, silver, zinc, detergents, cleaners, other metals, pesticides, medical and dental waste.

Production: typical cruise ship produces an estimated 1,000,000 gal/week; no data on other vessels.

Regulations: Federal regulations do not prohibit discharge in state or U.S. waters, except for the Great Lakes and state waters of Alaska.

Bilge Water

Produced from: fuel, oil, and wastewater from engines and machinery that collects at the bottom of a ships hull, from spills, leaks, routine operations and condensation.

Includes: fuel, oil, fresh and salt water, rags, cleaning agents, paint, metal shavings and live organisms.

Production: typical cruise ship produces an estimated 25,000 gal/week; estimated up to 2 million gallons per day released in U.S. by all vessels.

Regulations: Section 311 of CWA states:

- discharge of oil content < 15 parts oil per one million parts water (ppm) <= 12 nautical miles is prohibited,
- discharges with oil content > 100ppm > 12 nautical miles is prohibited.
- Also discharge of oily waste is addressed under MARPOL and under the Act to Prevent Pollution from Ships (APPS).

Ballast Water

Produced from: Ballast water is used for trim, safety and stabilization of vessels and adapted to loads and sea conditions. The International Maritime Organization, the USCG, Canada and several other countries and states have either voluntary guidance or legislation requiring ballast water management. Because of the lack of alternative treatments, the preferred interim treatment is ballast water exchange in mid-ocean for vessels entering the U.S. Exclusive Economic Zone (EEZ). Unfortunately, it is difficult to access the level of voluntary compliance, even with the mandatory reporting forms. The USCG has a report to Congress that says compliance is very low (NBIC, 2001). In New England, only about 35% of the vessels submit forms, an insufficient number to draw conclusions. Moreover, coastal vessels do not have to report ballast water exchange or submit forms.

Studies indicate that ballast water is one of the major vectors for exotic species introductions. Over 80% of the world's goods are transported by ships that globally discharge approximately 10 billion metric tons of ballast water each year. Over 3,000-7,000 species are carried in ballast tanks daily, and though few become established and fewer become invasive, those that do may cause economic and ecological harm. The greatest concern has been focused on coastal areas where introduced species have dramatically impacted nearshore ecosystems, aquaculture and harbor and port infrastructure.

Unfortunately, once marine organisms are established, it is virtually impossible to remove them. Thus, prevention is the best option for managing introduced species. Current efforts in the northeast are focusing on a regional ballast water management plan as other efforts at the international and national levels move forward. These efforts include identification of scientifically based alternative ballast water exchange zones, actions for ports and harbors, and increased pressures for compliance with current voluntary ballast water management efforts.

Includes: thousands of marine species including larvae, fish eggs, microorganisms.

Production: typical cruise ship uses millions of gallons.

Regulations: No federal regulations. Ballast Water Management for Control of Nonindigenous Species Act in California requires vessels to exchange ballast water in waters beyond 200 nautical miles from land and at least 2,000 meters deep, or to retain all ballast water, but until recently coastal traffic vessels (e.g., those within the EEZ or 200 miles of the coast) are exempt. Cruise vessels are exempt, however new regulations require vessels to exchange ballast before entering the EEZ and to report ballast treatment for coastal traffic vessels.

Hazardous Materials

Produced from: by-products of dry cleaning and photo processing operations, paints and solvents, batteries, fluorescent light bulbs containing mercury, and print shop wastes from cruise ships and metals, oil, solvents and a variety of other materials from other vessels.

Includes: chemicals and dry cleaning agents, photo processing chemicals, paints and solvents, mercury, and inks and dyes from printing processes.

Production: typical cruise ship produces an est. 110 gal/week photo processing chemicals, 5 gal/week of dry cleaning wastes, 10 gal/week of used paint; unknown amounts for other vessels (Royal Caribbean, 2000).

Regulations: RCRA requires hazardous substances be offloaded to land-based treatment or disposal facilities for all cruise ships and other vessels that generate or transport such materials.

Solid Waste

Produced from: normal vessel operations.

Includes: food waste, cans, glass, wood, cardboard, paper and plastic. Also ash of incinerated wastes is discharged at sea. Other waste is disposed on shore and/or recycled on shore. Solid waste can take from weeks to years to dissolve in the ocean depending on the material.

Production: typical cruise ship produces an est. 8 tons/week; no data on other vessels.

Regulations: APPS and CWA. Marine Plastic Pollution and Control Act regulates the disposal of plastic and garbage.

Specifics:

- disposal of plastics is prohibited in any waters
- floating dunnage and packing materials are prohibited in navigable water within 25 nautical miles from land
- other garbage (paper, glass, rags, metal and similar material) is prohibited within 12 nautical miles from shore (unless it is macerated, where it can be disposed of beyond land)

Appendix L. Cetacean and Pinniped Species Descriptions

BALEEN WHALES

Blue whales (*Balaenoptera musculus*), the largest animal on earth measuring up to 100 ft. (33 m), are rarely seen in the sanctuary. Like other mysticetes, blue whales tend to travel alone or in small, short-lived groups. The distribution of blue whales in the western North Atlantic ranges from the Arctic to at least mid-latitude waters (NOAA, 2005a). Small, periodic concentrations of krill on Stellwagen Bank may support a stray blue as it moves to its primary feeding grounds further north, to the Gulf of St. Lawrence during spring and summer. Blue whales are pelagic, primarily found in deep, offshore waters, and are rare in shallow waters. The current minimum estimate for the western North Atlantic stock is 308 whales (NOAA, 2005b).

Fin whales (*Balenoptera physalus*), second to the blue whale in size, are sighted year-round in the sanctuary. They occur widely in the mid-Atlantic throughout the year, with concentrations from Cape Cod north in summer and from Cape Cad south in winter. The GoM and New England coast is a major feeding ground for fin whales from spring to fall. Relatively little is known about the movements and behavior of fin whales: they travel quickly and individuals are difficult to identify in the field, making research a challenge. Photo-identification of fin whales (Agler *et al*., 1993) has begun to clarify their natural history.

The fin whale's unique asymmetrical pigmentation on its lower jaw — black on the left, white on the right — is diagnostic at close range. Most individuals have a "blaze" (swirls) on the right side of the head and a V-shaped chevron across the back behind the blowholes. The pattern of these markings, together with the shape of the dorsal fin, is often used to identify individuals. Tagging and photo-identification studies suggest considerable site fidelity on feeding grounds (NOAA 2006). Segregations seem to occur at least in summer, with larger mature whales arriving at feeding areas earlier, and departing later, than the smaller individuals. Within the GoM, lactating females and their calves primarily occupy, or at times are the only ones occupying, this southern portion of their summer feeding range (Agler *et al*., 1993).

Although fin whales appear to be migratory, their overall broad latitudinal range is confusing and likely complex (Christensen *et al*., 1992). Regular mass movements along well-defined migratory corridors, with specific end-points, have not been documented by sightings. However, acoustic recordings from passive-listening hydophone arrays indicate a southward "flow pattern" in the fall from Labrador-Newfoundland region, south past Bermuda, and into the West Indies (Clark, 1995). It is assumed that fin whales breed in the middle North Atlantic, with mating and calving occurring from November to March; however, the location of their wintering grounds is poorly known (NOAA, 2006). The best population estimate for this species in the western North Atlantic is 2,814 individuals (Waring *et al*., 2001).

Humpback whales (*Megaptera noavaeangliae*) are highly migratory animals, spending spring through fall on feeding grounds in mid- or high-latitude waters, and wintering on calving grounds in the tropics. As with other baleen species in the sanctuary, the abundance of humpbacks may be tied to the abundance of their preferred food, sand lance. In years of low regional sand lance productivity humpbacks may bypass the sanctuary area for more productive areas further north or offshore.

Individual humpbacks are identified by the black and white pigmentation patterns and scars on the underside of their flukes (tails). Photographs of these natural markings have allowed researchers to monitor the movements, health and behavior of individual humpbacks in the GoM since the early 1970s. Photo-identification studies have demonstrated that North Atlantic humpback whales return each spring to specific feeding grounds, such as the GoM (including the sanctuary), Gulf of St. Lawrence, Newfoundland, Labrador, Greenland, Iceland and Norway. The GoM (including sanctuary waters) was identified as a discrete feeding population based on high rates of annual return and low rates of exchange with other oceanic feeding grounds (Katona and Beard, 1990; Katona and Beard, 1991). These data also confirmed exchange between the GoM feeding ground and the West Indies breeding ground (Katona and Beard, 1990).

The study of humpback whales in the sanctuary and the GoM is one of the longest contiguous studies of a baleen whale population anywhere in the world. In the GoM, whale watching data demonstrated that the high return rates of calves to the GoM region reflect maternally-directed site fidelity (Clapham and Mayo, 1987). Despite site fidelity, whales from all feeding grounds migrate to common breeding areas in the West Indies, where they mate and calve (Katona and Beard, 1990). The largest breeding population of North Atlantic humpbacks is found on Silver Bank in the Dominican Republic. NOAA and the Santuario de Mamiferos Marinos de la Republica Dominicana (SMMRD) have collaborated to establish a sister sanctuary relationship between the Stellwagen Bank sanctuary and the SMMRD to protect this resource on both ends of its migratory range.

GoM whale watching data have provided observations on humpback whale reproductive behavior, based upon longitudinal studies of known females (Robbins, 2000). The number of years between successive calves (calving interval) was determined for humpback whales (as well as fin whales and northern right whales) from GoM sightings. Other findings include gross annual rates of calf production in the population, and prediction of discrete events such as weaning. Annual resightings of GoM humpback whales permitted the slow accumulation of information on the age of first reproduction (Robbins, 2000). The North Atlantic humpback whale population has been estimated at 10,400 animals (Smith *et al*., 1999). It is estimated that there are fewer than 7,000 humpbacks in U.S. waters. The best population estimate for the GoM stock is a minimum of 647 whales (NOAA, 2005c).

Sei whales (B*alaenoptera borealis*) have been observed sporadically in the sanctuary in late summer or autumn and are likely related to prey abundance. They have been dubbed "switch hitters" as they have been observed with right whales skim feeding on euphasids and copepods as well as feeding on small fish close to humpback and finbacks. Presence of sei whales may be a good indicator of cyclical changes on Stellwagen Bank. For example, during the summer of 1986 (Schilling *et al*., 1992), whale-watchers were surprised by the fact that very few humpback whales were present on Stellwagen Bank. The population of sand lance, the small fish that makes up the bulk of the humpback's diet there, was exceptionally low. Numbers of copepods, the main source of food for sand lance, exploded in their absence, creating a temporary hot spot for feeding sei and right whales. Perhaps coincidentally, one of the few sightings of a blue whale, another planktivorous species, came from this year as well. The population size of the sei whale in U.S. North Atlantic waters is unknown. In the spring and summer, sei whales occur in the southern end of their range, which includes the GoM and Georges Bank (NOAA, 2006b).

Minke whales (*Balaenoptera acutorostrata*), the smallest baleen whale, are commonly seen in the sanctuary and the GoM in spring and summer. During the fall, there are fewer minke whales in New England waters, while during winter the species appears to be largely absent. The number of minke whales that use the sanctuary changes from year to year and calves are rarely observed (Murphy, 1995). Minke whales usually travel alone or in very loose groups, generally don't create a spout when at the surface and often change direction quickly. All of these characteristics make them a challenge to observe or to individually identify.

Minke whales off the eastern coast of the U.S. are considered to be part of the Canadian East Coast stock. Studies of minkes in other areas indicate that their diet may be more diverse than other local baleen whales, their diet including copepods, krill, capelin, herring, sand lance and squid. The total number of minke whales in the Canadian East Coast population is unknown but a minimum population estimate is 3,113 (NOAA, 2005d).

North Atlantic right whales (Eubalaena glacialis) are critically endangered with a total population estimate between 300 to 350 individuals. Individual right whales are identified by callosities, the rough, light-colored areas found on the top of the head, around the blowholes, chin, jawline and above the eyes. These callosity patterns do not change over the lifetime of the individual.

Seasonal movements are generally between rich summer feeding grounds and warm winter calving grounds with peak migration periods in November/December and March/April. From late winter to early fall, North Atlantic right whale distribution tends to correlate with the location of their preferred copepod prey, *Calanus finmarchicus*. Primary GoM feeding grounds in the spring and early summer, where particularly dense patches of prey occur, include designated critical habitats of Cape Cod Bay and portions of Stellwagen Bank (late winter) and Great South Channel (spring). While whales have been sighted year round in Cape Cod Bay, the peak period of feeding in that area is January to May.

During summer and fall most of the population feeds on different banks in Southeast Canada such as the Bay of Fundy. "Courtship groups" are also seen at this time. Typically, pregnant females, females with young calves, and juveniles, as well as a few atypical individuals migrate seasonally along the eastern seaboard of the U.S. and Canada between calving grounds in the south and feeding areas in the north, generally via near shore waters in the mid-Atlantic. Right whales spend about one-third of their time surface feeding in the Cape Cod/Massachuetts Bay and GoM areas, which may increase ship strike and entanglement risk from buoy line and surface fishing line systems (NOAA, 2006a). It is unknown where the bulk of the non-calving population spends the winter.

TOOTHED WHALES

Sperm whales (*Physeter macrocephalus*), the largest of the toothed whales, grow up to 18 m (60 ft.) in length. Among cetaceans, this species displays the greatest difference in size between males and females. They are usually seen in deep, offshore waters, but they can occur near shore, where the continental shelf is narrow and the water deep, well away from the relatively shallow waters of Stellwagen Bank. Sightings in our area are extremely rare, usually amounting to a stranding of lone individuals along our beaches.

Belugas (*Delphinapterus leucas*) have been sighted in the sanctuary area on occasion. Individuals from the St. Lawrence, Canada, population may follow cold water currents south (as far south as Long Island, NY). In 1971, a medium-sized, white whale with no dorsal fin was spotted inside the Cape Cod Canal. Another sighting occurred in Massachusetts Bay a few years ago.

Orcas (*Orcinus orca*) are the largest delphinid (dolphin). Up to 9 m (30 ft.) in length, these massive predators use the sanctuary and surrounding waters only rarely. Over the years most sightings of orca in our area have occurred in August and September, perhaps tied to the end of the northward run of bluefin tuna. Different social groups of these whales may specialize on different prey items in the GoM, including herring and cod. Almost nothing is known about the North Atlantic orca populations, including where they come from, general movements, social structure, etc. Sightings of orca are sporadic at best; many years may pass between sightings.

Long-finned pilot whales (*Globicephala melaena*) are seasonal residents of the sanctuary area but, like most other toothed whales, their abundance from year to year depends upon the presence of their favored prey. These whales are sexually dimorphic in size and, to some extent, shape. Males tend to be larger than females, growing up to 6 m (20 ft.), and develop a more pronounced 'pothead' and more rounded dorsal fin. They are all black (hence the common name 'blackfish') except for a light anchor patch on the belly between the flippers. Some individuals may have faint gray markings behind the eyes or behind the dorsal fin. As schooling fish migrate inshore during the late summer and fall, so do the squid and pilot whales. Adult female pilot whales may direct the tight knit pods, numbering from less than a dozen to over a hundred, to the changeable feeding grounds. In some populations, pilot whale calves may remain in their maternal pods. To reduce inbreeding, many pods may form massive herds, especially in early summer.

Sightings of pilot whales in the sanctuary can occur throughout the year with a peak in fall. As pilot whales head inshore to forage they can be sighted from land. Such sightings often preclude a mass stranding where entire pods come ashore. Records show that such strandings have occurred throughout history but reactions toward these strandings have changed. Until the 1920s, Cape Cod communities would actively herd pilot whales toward shore or take advantage of strandings for meat and oil. Large-scale human efforts today work at returning the whales to sea or reducing the amount of suffering.

DOLPHINS AND PORPOISES

White-beaked dolphins (*Lagenorhynchus albirostris*) are closely related to the white-sided dolphins and, like them, are found only in the North Atlantic. Little is known about this species as sightings and strandings are quite rare on this side of the Atlantic. Pods tend to be smaller in number than in the white-sided dolphin, and they have been seen moving in echelon formation (side-by-side as a front). Their diet seems to be more tied to squid than fish and sightings may be correlated to the abundance of these invertebrates.

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) were relatively uncommon in our area prior to the late 1970s, and white-beaked dolphins were common. Both of these related species have a somewhat varied diet but differ in their preferences: white-beaked tends to favor squid while white-sides favor small, schooling fish. About two decades ago, sand lance populations exploded in the sanctuary and sightings of white-beaked became rare while white-sides increased.

Pod structure seems to be based upon closely related females, accompanied by calves of all ages and a few unrelated males. These highly mobile groups are not permanent residents of the sanctuary. They range widely throughout the GoM and are sighted where food, such as herring and sand lance, are most abundant. Pods may also join other species of whales during feeding, such as humpbacks and pilot whales. New calves are most commonly seen in May, June and July. Migration is still poorly understood and may be characterized as inshore for winter, offshore for summer. In early fall (August) a few scattered pods may be sighted becoming more common through late fall and winter. By mid-April most pods leave the area, perhaps to more offshore and northern feeding grounds. Mass strandings are most common in fall and spring.

Common dolphins (*Delphinus delphis*) are a more offshore species, preferring the warmer, deeper waters south and east of Georges Bank. It has been dubbed saddle back dolphin due to their dark, saddle-shaped marking on its mid-back. Only a few individuals have been sighted over the years in the sanctuary area, especially during the summer months. Stranded individuals may come ashore during the winter.

Bottlenose dolphins (*Tursiops truncatus*) are large, robust dolphins found in cool water habitats further to the south of the sanctuary. At least two forms of bottlenose exist: the larger offshore populations and the smaller, more familiar inshore populations. It is not clear whether the few live sightings of individuals in the sanctuary area are of the offshore or inshore forms. Both forms occasionally strand along the coasts of Massachusetts Bay and Cape Cod Bay.

Risso's dolphins (*Grampus griseus*) are animals of warmer, deeper waters to the south of the sanctuary. They are believed to be squid hunters and the few sightings of live individuals may represent strays during warm water episodes or during northward movements of their favored prey. A few individuals have been found stranded on Cape Cod beaches.

Harbor porpoises (*Phocoena phocoena*) are among the smallest cetaceans in the world reaching 1.7 m (6 ft.) and 63 kg (140 pounds) in weight. These are coastal animals and are only rarely found transiting the sanctuary area. More often they are spotted around harbors by observers heading out for whale watches or research cruises. They tend to be shy, inconspicuous animals that are difficult to spot. Despite their size and more coastal affinities, harbor porpoises are prodigious divers, reaching down to 230 m (760 ft.) in search of prey. Like most marine mammals, porpoises are opportunistic feeders, taking advantage of whatever is locally abundant. Yet the distribution and movements of porpoises in the GoM seems to be intimately tied to the annual movements of different species of herring. As herring move toward spawning rivers in spring and early summer, harbor porpoises are likely to follow. As the young herring head out to sea so do the porpoises (sightings of porpoises in the GoM are very rare during the winter).

As coastal animals tied to a relatively restricted diet, harbor porpoise populations are susceptible to a variety of human disturbances. Some of the highest concentrations of industrial pollutants have been found in tissue samples of porpoise, including large loads of PCB's and heavy metals. Entanglements in gillnets pose a serious threat to the population throughout the GoM.

SEALS

Harbor seals (*Phoca vitulina*) are the most abundant pinniped species in eastern U.S. waters. They are widely distributed along the coast, preferring sheltered and undisturbed rocky ledge haul-out areas in bays and estuaries from Maine south to Cape Cod, Massachusetts. During the first half of the 20th century, harbor seals bred as far south as Cape Cod Bay, but currently are only seasonal residents in the sanctuary and southern New England (from late September until late May). Breeding occurs from late April until late June, exclusively north of Massachusetts.

Since passage of the Marine Mammal Protection Act in 1972, harbor seal abundance in New England has increased nearly five-fold (NOAA, 2001). NOAA Fisheries Service has not identified harbor seals as a "strategic stock" because the known human-caused mortality and serious injury is below that level thought to inhibit the recovery of the species (n=1,859). In the shallower waters adjacent to Cape Cod, and within the sanctuary, harbor seals feed almost exclusively on sand lance. Data from the NOAA Fisheries Service Observer Program demonstrate that harbor seals are caught and killed in the sanctuary by the sink gillnet fishery, but the total number is not currently known.

Gray seal (*Halichoerus grypus*) occurring in the sanctuary are part of an abundant (143,000) and increasing population that has a distribution from New England to Labrador and is centered on the Sable Island area of Nova Scotia, Canada. NOAA Fisheries Service has not designated gray seals as a "strategic stock" (NOAA, 2001) and no gray seals "takes" were documented in the sanctuary by the NOAA Fisheries Service Observer Program in the years 2000-2002.

Harp seals (*Pagophilus groenlandica*), Hooded seals (*Cystophora cristata*) and Ring seals (Pusa hispida) are ice seals that are generally distributed in and around the pack ice of the North Atlantic Ocean. In late spring after the breeding season, both species migrate north to summer feeding grounds, following the receding ice edge. They share much of their range and habitat in the North Atlantic, although hooded seals tend to live farther offshore and feed in deeper water. Because of this, the hooded and harp species only gather together in the same areas during part of their breeding season (Lavingne and Kovacs, 1988). Over the past decade, there has been an increase of extralimital occurrences of harp and hooded species, extending their range south of their historic northern range along the east coast of North America. It has not been determined, however, whether these occurrences are due to an increase in population abundance or to a shift in habitat use. Sightings of ring seals are rare in the sanctuary.

Go to the following URLs for additional species information:

IUCN Redlist:

http://www.iucnredlist.org/search/search-basic

NMFS Stock Assessment:

http://www.nmfs.noaa.gov/pr/sars/

Appendix M. Northeast Region Whale Watch Guidelines Including the Stellwagen Bank Sanctuary

All whales, dolphins and porpoises in the northeast region are federally protected by the Marine Mammal Protection Act (MMPA) and most large whales in the area are further protected under the Endangered Species Act (ESA). Under these Acts, it is illegal to "harass, hunt, capture or kill" any marine mammal. Prohibited conduct includes any "negligent or intentional act which results in the disturbing or molesting of marine mammals." The following operational procedures are intended to avoid harassment and possible injury to large whales, particularly the finbacks, humpbacks and minke whales commonly seen by vessels engaged in whale watching. Following the guidelines can help protect both you and the whale you wish to watch and keep you from accidentally violating federal law.

****The right whale is protected by separate State and Federal regulations** that prohibit approach within 500 yards of this species. Any vessel finding itself within the 500 yard buffer zone created by a surfacing right whale must depart immediately at a safe slow speed. The only vessels allowed to remain within 500 yards of a right whale are vessels with appropriate research permits, commercial fishing vessels in the act of hauling back or towing gear, or any vessel given prior approval by NOAA Fisheries Service to investigate a potential entanglement.

OPERATIONAL GUIDELINES WHEN IN SIGHT OF WHALES:

2 miles to 1 mile away:

- Reduce speed to 13 knots.
- Post a dedicated lookout to assist the vessel operator in monitoring the location of all marine mammals.
- Avoid sudden changes in speed and direction.
- Aircrafts should maintain a minimum altitude of 1,000 feet over water.

1 mile to ½ mile away:

- Reduce speed to 10 knots.

½ mile or less:

- Reduce speed to 7 knots.
- Maneuver to avoid head-on approach.

CLOSE APPROACH PROCEDURE:

600 feet or closer:

- Parallel the course and speed of moving whales up to the designated speed limit within that distance.
- Do not attempt a head-on approach to whales.
- Approach and leave stationary whales at no more than idle or "no wake" speed, **not to exceed 7 knots**.
- Do not intentionally drift down on whales.
- Vessels in multi-vessel approaches should maintain communication with each other (via VHF channels 9, 13, or 16 for hailing) to coordinate viewing.
- Take into account the presence of obstacles (vessels, structures, fishing gear, or the shoreline). All vessels in close approach must stay to the side or behind the whales so they do not box in the whales or cut off their path.

STAND-BY ZONE *300 feet to 600 feet away:*

- Two vessel limit within the 300- to 600-foot Stand-By Zone at any one time.

CLOSE APPROACH ZONE *100 feet to 300 feet away:*

- One vessel limit.
- Other vessels stand off (up to two vessels in Stand-By Zone – others outside 600 feet).
- If more than one vessel is within 600 feet, the vessel within 300 feet should limit its time to 15 minutes in close approach to whales.

NO INTENTIONAL APPROACH WITHIN 100 FEET.

- Do not approach within 100 feet of whales. If whales approach within 100 feet of your vessel, put engines in neutral and do not re-engage propulsion until whales are observed clear of harm's way from your vessel.

DEPARTURE PROCEDURE

All vessels should leave the whales following the same speed and distance procedures described above.

- In order for vessels to be clear of whales before dark, vessels should cease whale watching and begin their return to port 15 minutes before sunset.

Penalties: A violation of the Marine Mammal Protection Act may result in fines or civil penalties of up to $10,000 or criminal penalties of up to $20,000 plus IMPRISONMENT and/or SEIZURE OF VESSEL and other personal property. A violation of the Endangered Species Act may result in fines or civil penalties of up to $25,000 or criminal penalties of up to $50,000 plus IMPRISONMENT and/or SEIZURE OF VESSEL and other personal property.

CONTACT NUMBERS

Whale Watching Information For more information on the whale watching guidelines or laws pertaining to marine mammals, call: NOAA Fisheries Service, Protected Resources Division: **978-281-9300 x-6505**

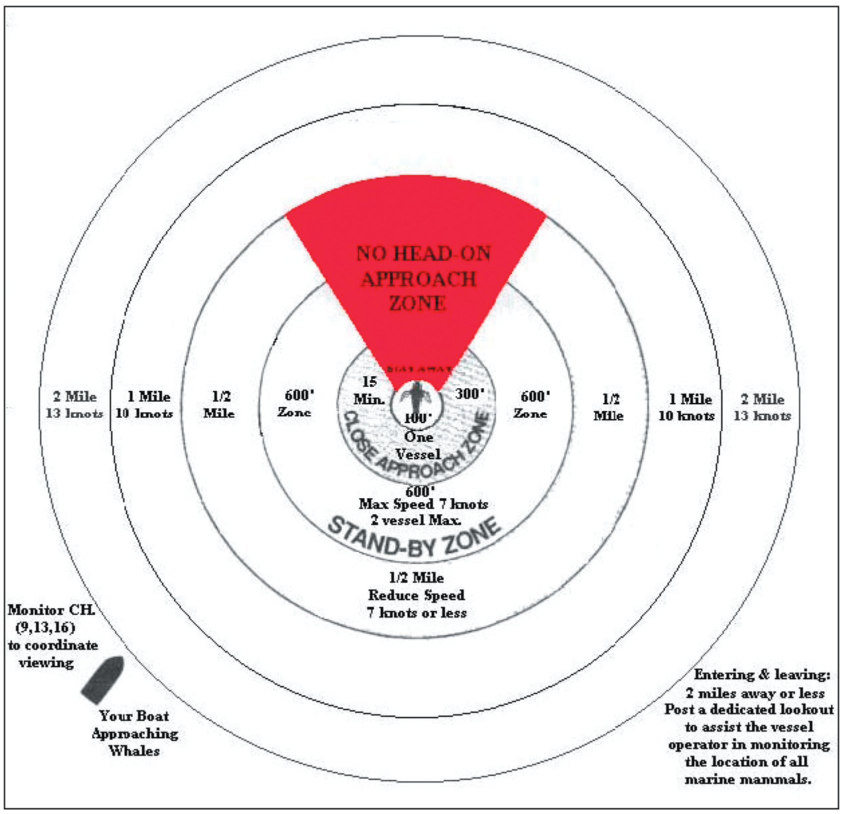
Right Whale Sighting All sightings of a right whale should be called in to the NOAA Fisheries Service Sighting Advisory System: **978-585-8473 (pager)**

Entangled Whale Any sighting of an entangled whale should be reported. Vessels should stand-by and keep the whale in sight until help arrives (an estimated 45 min. or more) or arrange for another vessel to maintain contact with the whale. Disentanglement HOTLINE (weekdays): **800-900-3622** or Disentanglement pager: **508-307-5300** or NOAA Fisheries Service Stranding & Entanglement HOTLINE: **978-281-9351** or USCG on VHF **CH-16**

Entangled Right Whale Maintain 500 yards. To report or get authorization to approach, call: Disentanglement Hotline (weekdays): **800-900-3622** or Disentanglement pager: **508-307-5300** or NOAA Fisheries Service Stranding & Entanglement Hotline: **978-281-9351**

Dead Whale Any sighting of a dead whale should be reported to the NOAA Fisheries Service Stranding & Entanglement Hotline: **978-281-9351**

Potential Violations Any activity that appears to be an intentional or negligent action leading to a collision or harassment incident should be reported to the NOAA Enforcement HOTLINE: **800-853-1964**



Appendix N. Federal Regulations on Approach to Endangered North Atlantic Right Whales

[The following regulations are excerpted from 50 CFR, subpart F, §224.103. For the latest version of these regulations including their coordinates refer to http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale.htm]

(c) *Approaching right whales*

(1) *Prohibitions*. Except as provided under paragraph (c)(3) of this section, it is unlawful for any person subject to the jurisdiction of the United States to commit, attempt to commit, to solicit another to commit, or cause to be committed any of the following acts:

(i) Approach (including by interception) within 500 yards (460 m) of a right whale by vessel, aircraft, or any other means;

(ii) Fail to undertake required right whale avoidance measures specified under paragraph (c)(2) of this section.

(2) *Right whale avoidance measures*. Except as provided under paragraph (c)(3) of this section, the following avoidance measures must be taken if within 500 yards (460 m) of a right whale:

(i) If underway, a vessel must steer a course away from the right whale and immediately leave the area at a slow safe speed.

(ii) An aircraft must take a course away from the right whale and immediately leave the area at a constant airspeed.

(3) *Exceptions*. The following exceptions apply to this section, but any person who claims the applicability of an exception has the burden of proving that the exception applies:

(i) Paragraphs (c)(1) and (c)(2) of this section do not apply if a right whale approach is authorized by the National Marine Fisheries Service through a permit issued under part 222, subpart C, of this chapter (General Permit Procedures) or through a similar authorization.

(ii) Paragraphs (c)(1) and (c)(2) of this section do not apply where compliance would create an imminent and serious threat to a person, vessel, or aircraft.

(iii) Paragraphs (c)(1) and (c)(2) of this section do not apply when approaching to investigate a right whale entanglement or injury, or to assist in the disentanglement or rescue of a right whale, provided that permission is received from the National Marine Fisheries Service or designee prior to the approach.

(iv) Paragraphs (c)(1) and (c)(2) of this section do not apply to an aircraft unless the aircraft is conducting whale watch activities.

(v) Paragraph (c)(2) of this section does not apply to the extent that a vessel is restricted in her ability to maneuver and, because of the restriction, cannot comply with paragraph (c)(2) of this section.

Appendix O. Prioritized Strategy Implementation Based on Funding Scenarios

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
CAPACITY BUILDING						
Administrative Capacity and Infrastructure (ADMIN)						
ADMIN.1 Improve Site Staffing and Support Capabilities for SBNMS Programs	(1.1) Integrate staff capabilities with changing program needs.	H	❍	●	●	●
	(1.2) Hire additional staff and streamline organizational structure.	H	❍	●	■	❍
	(1.3) Enhance operation of the sanctuary advisory council.	H	❍	●	●	❍
ADMIN.2 Maintain and Enhance the Infrastructure of the Site	(2.1) Maintain and acquire vessels as necessary.	H	■	●	■	❍
	(2.2) Work with NMSP to develop and implement a long-range facilities plan that prioritizes opportunities with the town of Scituate.	H	●	●	■	❍
	(2.3) Maintain a database for sanctuary permitting.	H	❍	●	●	●
	(2.4) Meet the equipment needs of an expanded SBNMS diving program.	H	❍	●	■	❍
	(2.5) Develop an effective enforcement program.	H	●	●	■	❍
ADMIN. 3 Develop a SBNMS Volunteer Organization to Support Sanctuary Programs and Enhance Site Visibility	(3.1) Develop SBNMS volunteer program.	H	●	●	■	❍
	(3.2) Maintain and expand the volunteer dive corps activities.	H	●	●	■	❍
	(3.3) Develop and support international exchange of volunteers between SBNMS and other MPAs.	L	■	●	❍	❍
Interagency Cooperation (IC)						
IC.1 Facilitate Cooperation and Coordination Between Agencies	(1.1) Re-establish discussions regarding a possible MOU between the NOAA/SBNMS and the NOAA Fisheries Service, NERO and the NEFMC to facilitate cooperation and coordination.	H	■	●	●	●
	(1.2) Coordinate proposed activities with the NOAA Fisheries Service NERO	H	■	●	●	●
	(1.3) Facilitate cooperative research and outreach between NOAA/SBNMS and the NOAA Fisheries Service, NEFSC.	H	■	●	●	●
	(1.4) Evaluate the MOA between the U.S. Army Corps of Engineers (USACE) and NOAA Fisheries Service for commenting on proposed activities occurring at the Massachusetts Bay Disposal Site (MBDS).	H	■	●	●	●
IC.2 Establish Mechanisms for Improving Information Sharing	(2.1) Provide information via the web on the responsibilities and activities of multiple agencies that have roles pertinent to the SBNMS.	M	■	●	●	●
	(2.2) Provide regular updates to the USCG Area Contingency Plans.	M	■	●	●	●
	(2.3) Establish a mechanism for informal consultation with the EPA, NEFMC, MWRA, MADEP and MACZM Office on water quality issues.	M	■	●	●	❍

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
IC.2 Establish Mechanisms for Improving Information Sharing, continued	(2.4) Update and continue to implement the sanctuary cooperative enforcement program.	H	●	●	■	❍
	(2.5) Continue to convene meetings of the sanctuary advisory council's Interagency Cooperation Working Group.	L	■	●	●	●
	(2.6) Participate in the GoM Council and other regional initiatives.	M	■	●	●	●
	(2.7) Participate on relevant advisory panels of the NEFMC.	H	■	●	●	●
	(2.8) Depiction of sanctuary boundary.	H	●	●	●	●
Public Outreach and Education (POE)						
POE.1 Improve Outreach and Education Capacity to Increase Sanctuary Visibility, Awareness, and Stewardship	(1.1) Produce public outreach products and programs that best address sanctuary visibility needs.	H	■	●	●	●
	(1.2) Develop and implement outreach programs with stakeholder groups to increase sanctuary visibility and promote sanctuary stewardship.	H	■	●	■	❍
	(1.3) Work with NMSP to develop and implement a long-range facilities plan that prioritizes partnering opportunities with interpretive centers and articulates federal funding needs.	H	■	●	■	❍
	(1.4) Establish a Media Outreach Program.	H	■	●	■	❍
POE.2 Improve Capacity for Formal and Informal Education Programs that Support Management Goals	(2.1) Develop an action plan for establishing education partnerships and identify the types of programs and objectives that would best be achieved.	H	■	●	■	❍
	(2.2) Support K-12 Educational Programming.	M	■	●	■	❍
	(2.3) Support Undergraduate and Graduate Education Programming.	M	■	●	■	❍
	(2.4) Support Adult Education Programming.	H	■	●	■	❍
Compatibility Determination (CD)						
CD.1 Develop a Framework for Sanctuary Compatibility Determination	(1.1) Demonstrate the application of S-CAP.	H	■	●	■	❍
	(1.2) Refine S-CAP by incorporating results of ongoing sanctuary monitoring.	M	■	●	■	❍
ECOSYSTEM PROTECTION						
Ecosystem-based Sanctuary Management (EBSM)						
EBSM.1 Establish a Science Review Protocol	(1.1) Establish a science advisory working group.	H	●	●	●	❍
	(1.2) Convene a sanctuary science symposium.	M	■	●	■	❍
	(1.3) Form a science consortium.	L	●	●	●	❍
EBSM.2 To Establish an Information Management System	(2.1) Design and implement an information management system.	H	❍	●	■	■
	(2.2) Design and implement a web portal for public access to databases.	L	❍	●	■	❍
EBM.3 Understand Ecosystem Structure and Function	(3.1) Define and operationalize the term ecological integrity.	H	■	●	■	■

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
EBM.3 Understand Ecosystem Structure and Function, continued	(3.2) Develop programs to monitor and evaluate ecological integrity within the sanctuary.	H	■	●	■	■
	(3.3) Establish research programs directed at informing EBSM.	H	■	●	■	■
	(3.4) Develop models that afford a predictive capability to better understand sanctuary dynamics and to guide EBSM.	M	■	●	■	❍
EBM.4 Protect Ecological Integrity	(4.1) Establish a Zoning WG of the sanctuary advisory council to: (1) evaluate the adequacy of existing zoning schemes in the SBNMS, (2) satisfy the scientific requirements of EBSM, and, if needed, (3) develop a modified zoning scheme including consideration of fully protected reserves.	H	●	●	●	●
EBM.5 Evaluate the Need and Feasibility of Modifying the Sanctuary Boundary	(5.1) Evaluate the need and feasibility of modifying the sanctuary boundaries to include Jeffrey's Ledge.	L	■	●	❍	❍
Ecosystem Alteration (EA)						
EA.1 Reduce Impacts of Laying Cables and Pipelines	(1.1) Establish minimum criteria for special use permit applications for the laying of cables and pipelines.	L	❍	●	❍	❍
EA.2 Reduce Alteration of Benthic Habitat by Mobile Fishing	(2.1) Develop a process to establish reference areas that serve as benchmarks for discerning human and natural impacts on habitat quality.	H	■	●	●	●
	(2.2) Develop a science plan to assess and mitigate benthic habitat alteration.	H	■	●	●	❍
EA.3 Reduce Impacts of Biomass Removal by Fishing Activity	(3.1) Minimize bycatch and discard of all species, in all fisheries (commercial and recreational), by all gear types.	H	■	●	■	■
	(3.2) Determine the effects of the biomass removal of targeted species by commercial and recreational fishing on the ecological integrity of the sanctuary.	H	■	●	■	❍
	(3.3) Develop a management strategy with NOAA Fisheries Service and the NEFMC to evaluate and protect an optimal forage base to maintain the ecological integrity of the sanctuary.	H	■	●	●	●
Water Quality (WQ)						
WQ.1 Assess Water Quality and Circulation	(1.1) Develop and implement a water quality monitoring plan.	H	■	●	■	❍
	(1.2) Characterize the contaminant loading to the sanctuary from sources.	L	■	●	❍	❍
	(1.3) Encourage research of endocrine disrupters and their effects on sanctuary resources.	L	■	●	❍	❍
WQ.2 Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary	(2.1) Reduce threats to sanctuary water quality from vessel wastewater discharges (other than ballast water).	H	■	●	■	❍
	(2.2) Reduce ballast water exchanges in the sanctuary.	H	■	●	■	❍

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
WQ.2 Reduce Pollutant Discharges and Waste Streams That May Affect the Sanctuary, continued	(2.3) Reduce impacts of municipal and other shore-based waste water streams.	L	■	●	❍	❍
	(2.4) Develop contingency plans to address actions and responsibilities to remediate catastrophic water quality events in the sanctuary and support programs that prevent water pollution events.	M	■	●	■	❍
MARINE MAMMAL PROTECTION						
Marine Mammal Behavioral Disturbance (MMBS)						
MMBD.1 Reduce Marine Mammal Behavioral Disturbance by Vessels	(1.1) Develop and implement management measures that mitigate behavioral disturbance and risk to whales due to vessel speed and close approach	H	■	●	●	■
	(1.2) Develop a process to consider prohibiting vessels from transiting through humpback whale bubble clouds and/or nets.	H	■	●	●	■
	(1.3) Conduct risk assessment on other activities that could disturb marine mammals.	L	■	●	❍	❍
	(1.4) Develop a research program to better understand vessel interactions with whales.	H	■	●	■	❍
MMBD.2 Reduce Marine Mammal Behavioral Disturbance by Noise	(2.1) Establish a Marine Noise Consortium to identify noise sources and possible effects.	H	■	●	●	●
	(2.2) Develop a marine acoustics research program to establish baseline noise levels and long-term noise budgets.	H	■	●	●	■
	(2.3) Develop a policy framework for investigating and mitigating noise impacts within the sanctuary.	H	■	●	●	●
MMBD.3 Reduce Marine Mammal Behavioral Disturbance by Aircraft	(3.1) Identify information gaps to gather additional data on overflight activities to understand the potential disturbance of marine mammals.	L	■	●	❍	❍
	(3.2) Develop outreach advisories with NOAA Fisheries Service to inform the aviation community regarding overflight in proximity to whales.	L	●	●	■	❍
Marine Mammal Vessel Strike (MMVS)						
MMVS.1 Reduce the Risk of Vessel Strike Between Large Commercial Ships and Whales	(1.1) Consult with NOAA Fisheries Service on their proposed strategy to reduce ship strike to North Atlantic right whales and evaluate how such measures would affect the sanctuary.	H	●	●	●	●
	(1.2) Develop, demonstrate and evaluate the SBNMS Information and Reporting Center.	H	■	●	■	■
	(1.3) Determine the conservation benefit of reconfiguring the existing Traffic Separation Scheme (TSS) within the sanctuary to reduce the risk of ship strike to whales.	H	■	●	●	●
MMVS.2 Reduce the Risk of Vessel Strike Through Speed Restrictions	(2.1) Institute year-round voluntary speed restrictions for all vessels operating in the sanctuary.	H	■	●	●	❍

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
MMVS.3 Support and Develop Research Programs To Reduce the Risk of Vessel Strikes	(3.1) Work with NOAA Fisheries Service to support their ongoing database of all known vessel strikes in and around the sanctuary.	H	●	●	●	●
	(3.2) Work with NOAA Fisheries Service to institute a toll free number to enable callers to anonymously report vessel strikes in the sanctuary.	M	●	●	●	■
	(3.3) Investigate research strategies to determine responses of whales to approaching vessels.	H	■	●	●	●
	(3.4) Conduct year-round monitoring to identify type, size, speed, and route of vessels in the sanctuary.	H	■	●	●	■
	(3.5) Investigate use of forward-looking sonar or other real-time detection technologies.	L	■	●	■	❍
Marine Mammal Entanglement (MME)						
MME.1 Aid Disentanglement Efforts	(1.1) Maximize the degree to which entangled animals in the sanctuary are sighted and reported.	H	■	●	●	●
	(1.2) Maximize ability of vessels and aircraft to stand-by entangled animals.	H	■	●	●	●
	(1.3) Undertake activities leading to improved understanding and prevention of entanglement events in SBNMS and improvements in disentanglement efforts.	M	■	●	■	■
MME.2 Reduce Marine Mammal Interaction with the Trap/Pot Fishery	(2.1) Require gear modifications.	H	■	●	●	■
	(2.2) Serve as test-bed to develop and demonstrate low-risk fishing gear.	M	■	●	■	■
MME.3 Reduce Marine Mammal Interaction with the Gillnet Fishery	(3.1) Require gear modifications.	H	■	●	●	■
	(3.2) Develop research programs.	M	■	●	■	❍
MARITIME HERITAGE MANAGEMENT						
Maritime Heritage (MH)						
MHR.1 Establish a MHR Program	(1.1) Develop the foundation and infrastructure for a MH program and integrate the MH program into existing sanctuary programs.	H	❍	●	●	●
	(1.2) Identify and pursue additional sources of funding beyond the NMSP.	H	■	●	●	●
	(1.3) Identify and form partnerships, relationships, and Memoranda of Understanding (MOU) with entities that have specialized knowledge and abilities that support the documentation and interpretation of the sanctuary's MHR.	M	●	●	■	❍

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Action Plan/Objective	Strategy	Strategy Prioritization	Partner Requirement	Strategy implementation based on funding		
				Scenario I [1]	Scenario II [2]	Scenario III [3]
MHR.2 Inventory, Assess and Characterize MHR	(2.1) Characterize prehistoric and historic use patterns to assist with the location of historical resources through the identification and collection of historical, archaeological, and anthropological documentation.	H	■	●	■	❍
	(2.2) Conduct systematic field surveys to locate, identify, and inventory historical resources.	H	❍	●	●	■
MHR.2 Inventory, Assess and Characterize MHR, continued	(2.3) Assess historical resources for their NRHP eligibility and nominate appropriate sites to the NRHP.	H	■	●	●	■
	(2.4) Characterize historical resources within the SBNMS.	H	❍	●	●	■
MHR.3 Protect and Manage MHR	(3.1) Implement a management system that protects historical resources while allowing for uses compatible with resource protection.	H	❍	●	●	■
	(3.2) Implement a assessment protocol to establish appropriate site designations for sanctuary historical resources.	H	■	●	●	■
	(3.3) Identify partnerships and relationships for site monitoring and compliance of historical resource permits and regulations.	M	●	●	■	❍
	(3.4) Develop and implement an interpretive enforcement program	H	●	●	■	❍
	(3.5) Develop and implement a mooring buoy system on historical resources in collaboration with affected parties and regional scuba diving charter operators	M	■	●	■	❍
	(3.6) Implement the NMSP Permitting Guidelines for archaeological research (i.e., survey and inventory permit and archaeological research permit).	H	❍	●	●	■
	(3.7) Develop and implement collection and conservation policies for artifacts previously recovered from SBNMS before and after designation.	L	■	●	❍	❍
MHR.4 Develop and Implement a MHR Outreach and Education Program	(4.1) Identify and partner with regional museums, through MOU/Agreements, to conduct MH exhibits and other outreach programs.	H	●	●	■	❍
	(4.2) Develop and implement an artifact documentation and curation program through partnerships and relationships with local or regional maritime museums.	L	●	●	■	❍
MHR.5 Assess Shipwrecks and Other Submerged Objects for Potential Hazards	(5.1) Establish an inventory of shipwrecks and submerged objects, inside and outside of SBNMS boundaries that may pose environmental threats to resources.	M	■	●	■	❍
	(5.2) Coordinate information exchanges pertaining to shipwrecks and other submerged objects as environmental threats with NOAA's HAZMAT division and the National Marine Sanctuary Program for the development of the SHIELDS and RUST database systems.	M	■	●	■	❍
	(5.3) Identify shipwrecks and other submerged sites to be examined with remote sensing technology and report findings to state and federal trustees.	M	■	●	■	❍
	(5.4) Establish a monitoring program for shipwreck and submerged sites that have been located and are considered a threat to SBNMS.	M	■	●	■	❍

BUDGET SCENARIOS: [1] Scenario I (full funding: $2.4M not including federal salaries) [2] Scenario II (20% increase from level funding) [3] Scenario III (level funding: $1.46M)

● Full ■ Partial ❍ None

Appendix P. Stellwagen Bank Sanctuary Cooperative Enforcement Plan

I. Philosophy

The Stellwagen Bank sanctuary's enforcement philosophy is to prevent damage to sanctuary resources through public education and voluntary compliance, as well as through prosecution of violations of the National Marine Sanctuaries Act and its implementing regulations, and other regulations that are applicable.

II. Mission

The mission of sanctuary enforcement is to ensure compliance with the National Marine Sanctuaries Act (16 USC §1431 et seq.), the regulations of the sanctuary (15 CFR §922), and other applicable regulations.

III. Approach

The sanctuary is committed to "interpretive" law enforcement with an emphasis on community-oriented policing and problem solving. In general, interpretive law enforcement strives to achieve voluntary compliance of regulations through public outreach. A consistent high-visibility presence on the water and proactive contacts with users shoreside are the hallmarks of this approach.

IV. Authority

Section 307 of the National Marine Sanctuaries Act (NMSA) authorizes the Secretary of Commerce to conduct enforcement activities for carrying out the Act, specifies civil penalties, powers of authorized officers, use of the personnel, services, and facilities of State and other Federal agencies on a reimbursable or non-reimbursable basis, and provides for the recovery of penalties by the Secretary. The Secretary has delegated enforcement authority to the Administrator of the National Oceanic and Atmospheric Administration (NOAA), who assigned the NOAA Office of Law Enforcement (OLE) with responsibility to conduct enforcement actions.

V. Cooperating Agencies

A successful enforcement program requires cooperation between State and Federal agencies. The primary agencies involved in this enforcement plan are the Stellwagen Bank National Marine Sanctuary and the NOAA OLE and Protected Resources Division (PRD). The United States Coast Guard and the Massachusetts Environmental Police may become part of the enforcement program depending on their resources, priorities, and the development of a memorandum of understanding. Additionally, the U.S. Coast Guard auxiliary and the sanctuary volunteers can assist with the outreach component of the interpretive enforcement program.

VI. Needs

The Stellwagen Bank sanctuary needs the following enforcement capabilities:

- Regular patrol of the sanctuary waters including distribution of enforcement educational outreach packages
- Detection, investigation, and prosecution of violations
- Twenty-four hour response capability (sea or air)
- Deputization training and updates
- Inter/intra-agency coordination and coordination of enforcement assets
- Administrative, legal and technical support
- Enforcement outreach to affected commercial and recreational users

VII. Strategy

The above needs will be met via the following plan elements:

A. Planning

The Sanctuary Superintendent and designee of the Special Agent in Charge (SAC) shall confer no later than July 31 each year on the effectiveness of current enforcement efforts and programs within the sanctuary and shall identify desired funding initiatives for the next fiscal year.

An annual strategic enforcement plan shall be developed by April 1 of each year by the Superintendent, Sanctuary Protected Resources Enforcement Coordinator (EC), Sanctuary Enforcement Liaison (SEL), PRD liaison and MEP liaison. This plan will describe enforcement objectives for the year and how they will be met. The plan will include an outreach component.

Regular patrol schedules shall be established jointly between the SEL, EC and the MEP liaison for each month by no later than the 10th day of the preceding month. Patrol schedules will be subject to change, and all changes shall be coordinated through the SEL.

Tactical planning sessions may be convened ad hoc or conducted during monthly patrol planning sessions described in item c. of this section. Tactical planning sessions shall be directed by the EC and the SEL and will be the forum for production of most response action plans.

B. Management

Overall supervision of the Stellwagen Bank sanctuary Enforcement Program will be the joint responsibility of the sanctuary Superintendent and the EC.

Daily management of the sanctuary Enforcement Program will require close coordination between the SEL, the EC, and the NMFS PRD liaison.

The EC will directly supervise the tactical assets employed for general patrol, surveillance, investigations, inspection and field interaction with the public.

The scope of assistance and authority of MEP performing Federal enforcement action in support of the sanctuary will be defined in a Memorandum of Understanding and Cooperative Enforcement Agreement between the sanctuary, NMFS, and the MEP (see section D).

C. Personnel and Duties

1. Sanctuary Superintendent

- Supervises the Sanctuary Enforcement Liaison.
- Reviews overall implementation of the sanctuary Enforcement Program and directs/recommends changes as appropriate.
- Identifies short and long-term threats to sanctuary resources that may require enforcement action.
- Coordinates with the DSAC and EC to ensure that sanctuary enforcement and outreach concerns are addressed.
- Meets with the NOAA General Counsel for Enforcement and Litigation (GCEL), NMFS NE PRD and DSAC on an as needed basis to ensure adequate legal support for sanctuary/NMFS NE PRD case management.
- Reviews/recommends candidates for Sanctuary Enforcement Agent (SEA).
- Approves sanctuary enforcement expenditures.
- Approves MOU development or revisions and annual strategic enforcement plans.

2. EC

- Reports to DSAC.
- Coordinates with the Sanctuary Superintendent to ensure that sanctuary enforcement concerns are addressed.
- Supervises the Sanctuary Enforcement Agent(s) (SEA).
- Supervises daily coordination of sanctuary enforcement efforts between the State, NOAA including OLE and PRD, and the U.S. Coast Guard (USCG).
- Reviews overall sanctuary Enforcement Program and directs/recommends changes as appropriate.
- Develops and manages enforcement program budget.
- Oversees agreements and serves as COTR on all enforcement contracts.
- Works in partnership with SEL and MEP liaison to jointly develop patrol schedules, response action plans and interpretive enforcement programs.
- Manages enforcement MOU development, revision and implementation.
- Coordinates deputization training for SEOs.
- Supervises investigation of potential sanctuary violations.
- Meets with the Sanctuary Superintendent, NMFS NE PRD and GCEL on an as needed basis to ensure adequate legal support for sanctuary/PRD case management.
- Attends Protected Resources Enforcement Team meetings as required.
- Primary responsibility for responding to government and public inquiries about the sanctuary Enforcement Program in coordination with SEL.

3. SEL

- Reports to the Sanctuary Superintendent on the status of the EP and concerns.
- Maintains coordination / communication link between SEA, Sanctuary Superintendent, and the Education Coordinator.
- Responds to government and public inquiries about the sanctuary Enforcement Program.
- Provides coordination for administrative and technical support for enforcement activities (e.g., data gathering, logistics, field support, fiscal management).
- Attends Protected Resources Enforcement Team meetings as required.
- Assists the EC with training of SEO's.

4. SEA(s)

- Reports to the EC.
- Conducts duties directly related to sanctuary enforcement priorities and NMFS NE PRD enforcement priorities.
- Monitors and inspects activities permitted by the sanctuary.
- Primary responsibility for conducting presentations/briefings describing the sanctuary Enforcement Program in coordination with SEL.
- Coordinates with NOAA GCEL concerning case development and penalty recovery.
- Prepares enforcement program status reports.
- Conducts surveillance activities.
- Receives Enforcement Action Reports and Offense Investigation Reports from SEOs and the Coast Guard, conducts investigations, and coordinates with NOAA GCEL concerning case development and prosecution.
- Attends Protected Resources Enforcement Team meetings as required.
- Assists with the development of the sanctuary Summary Settlement Schedule

5. SEO(s)

- Reports to the MEP liaison
- Conducts duties directly related to sanctuary enforcement priorities.
- Conducts routine patrols and surveillance.
- Conducts on-the-water outreach activities.

6. PRD liaison

- Meets regularly with EC and SEL
- Contributes to development of annual enforcement plan

- Provides technical assistance to EC for protected resources cases

7. MEP liaison

- Coordinates with EC on patrols
- Contributes to development of annual enforcement plan
- Participates in tactical planning meetings

D. Agency agreements

MEP

A MOU will be developed between NOS, NMFS and the USCG that enables the USCG to enforce the Endangered Species Act and Marine Mammal Protection Act in the sanctuary.

VIII. Acronyms

COTR	Contracting Officer Technical Representative
DSAC	Deputy Special Agent In Charge
EC	Sanctuary Protected Resources Enforcement Coordinator
GCEL	General Council for Enforcement and Litigation
MEP	Massachusetts Environmental Police
MOU	Memorandum of Understanding
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOVA	Notice of Violation and Assessment
OLE	Office of Law Enforcement
PRD	NMFS Protected Resources Division
SAC	Special Agent in Charge
Sanctuary	Stellwagen Bank National Marine Sanctuary
SEA	Sanctuary Enforcement Agent (NMFS)
SEL	Sanctuary Enforcement Liaison
SEO	Sanctuary Enforcement Officer (usually state MEP officer)
SEP	Sanctuary Enforcement Plan
USCG	United States Coast Guard

Appendix Q. Stellwagen Bank Sanctuary Zoning Working Group Charge and List of Members

This appendix describes the establishment of a Zoning Working Group pursuant to the proposed Ecosystem-Based Sanctuary Management Action Plan, as approved by the Sanctuary Advisory Council on October 20, 2004.

NOTE: Given the context of this activity in the Ecosystem-Based Sanctuary Management Action Plan, the intent of this working group is to focus on habitat zoning and ecological function. The bounds are relatively narrow and do not extend to all aspects of potential sanctuary zoning. Other action plans recommend activities to address different zoning considerations (e.g., Marine Mammal Vessel Strike –vessel traffic, approach distance; Water Quality – no discharge).

Origination

Activity 5.1 from the Ecosystem-Based Management Action Plan: Establish a Zoning Working Group (ZWG) to evaluate the adequacy of existing zoning schemes in Stellwagen Bank National Marine Sanctuary to satisfy the scientific requirements and meet the goals of Ecosystem-Based Sanctuary Management (EBSM) as defined by the Ecosystem-Based Management Working Group (EBM WG) in 2004, and if needed, develop a modified zoning scheme (including a consideration of fully protected reserves) to meet those goals and requirements.

Purpose

The ZWG was established by the Sanctuary Advisory Council at its November 2004 meeting for the purpose of reviewing and evaluating data and information as it becomes available through various venues (e.g., New England Fishery Management Council Omnibus Essential Fish Habitat Amendment process, other sanctuary efforts) and making a recommendation to the SAC and ultimately to the sanctuary superintendent. The membership of the ZWG shall be of representative stakeholder groups similar to the EBM WG. The ZWG shall begin meeting in January 2005 in order to efficiently utilize the time that the final management plan is in preparation.

The ZWG shall develop metrics for zone performance based on the objectives of the various zones as determined by the WG. These metrics shall form the foundation of a monitoring program designed to determine the efficacy of the zoning scheme and recommend any needed changes to accomplish the goals of the zoning scheme and EBSM.

The ZWG shall make recommendations to the SAC regarding the zoning scheme within two years of the implementation of the final management plan as defined by the publication date for the Federal Register Notice notifying the public of the availability of the final management plan.

Process

1. ZWG convenes and assigns a subgroup to come up with 2-3 operational definitions of ecological integrity with measurable parameters.
2. Subgroup makes recommendation on definition of ecological integrity appropriate for the sanctuary.
3. ZWG evaluates existing zoning scheme based on agreed upon criteria associated with the scientific requirements and goals of EBSM.
4. ZWG makes recommendation to SAC on adequacy of existing zoning scheme.
5. SAC makes recommendation to superintendent on adequacy of existing zoning scheme and future of the ZWG.
6. If necessary, the ZWG continues deliberations to develop a modified zoning scheme (including a consideration of fully protected reserves) for the purpose of meeting the scientific requirements and goals of EBSM within 2 years of final management plan implementation.

Membership

Chair (1)	John Williamson
Team Lead (1)	Ben Cowie-Haskell
Academics (3)	Les Kaufman, Boston University
	Larry Madin, Woods Hole Oceanographic Institute
	Lew Incze, University of Southern Maine
Fishing Industry (3)	
a. Bottom Mobile Gear	Ed Barrett, Massachusetts Fishermen's Partnership
b. Bottom Fixed Gear	Dave Casoni, Massachusetts Lobstermen's Association
c. Midwater	Mary Beth Tooley, East Coast Pelagics
Recreational Fishing (2)	
a. Charter	Tom DePersia, Stellwagen Bank Charter Fishermen's Association
b. Private	Charles Casella
Conservation (3)	Priscilla Brooks, Conservation Law Foundation
	Susan Farady, The Ocean Conservancy
	Peter Borelli, Provincetown Center for Coastal Studies
At-large (1)	Deborah Cramer, Science Writer
National Marine Fisheries Service (2)	Brian Hopper, Protected Species
	Susan Murphy, Sustainable Fisheries
Mass. Division of Marine Fisheries (1)	David Pierce
Mass. Coastal Zone Management (1)	Kate Killerlain Morrison

Total membership (18)

Appendix R. Existing Marine Resource Management Zones that Overlap the Stellwagen Bank Sanctuary

a. Cape Cod Critical Habitat For The North Atlantic Right Whale

[For coordinates for this area refer to http://www.nero.noaa.gov/nero/regs/]

A critical habitat designation does not set up a preserve or refuge—it merely establishes a geographic area that is critical to the survival of an endangered species. Within this designated critical habitat, Federal agencies must ensure that any actions they authorize (permit), fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat.

b. Western GOM Essential Fish Habitat Closure Area

[The following regulations are excerpted from 50 CFR, subpart F, §648.81. For the latest version of these regulations including their coordinates refer to http://www.nero.noaa.gov/nero/regs/]

No fishing vessel or person on a fishing vessel with bottom tending mobile gear on board the vessel may enter, fish in, or be in the Essential Fish Habitat Closure Areas described below, unless otherwise specified.

c. Inshore Restricted Roller Gear Area

[The following regulations are excerpted from 50 CFR, subpart F, §648.81. For the latest version of these regulations including their coordinates refer to http://www.nero.noaa.gov/nero/regs/]

Rockhopper and roller gear restrictions. For all trawl vessels fishing in the GOM/GB Inshore Restricted Roller Gear Area, the diameter of any part of the trawl footrope, including discs, rollers, or rockhoppers, must not exceed 12 inches (30.5 cm).

d.-g. GOM Rolling Closure Areas

[The following regulations are excerpted from 50 CFR, subpart F, §648.81. For the latest version of these regulations including their coordinates refer to http://www.nero.noaa.gov/nero/regs/]

No fishing vessel or person on a fishing vessel may enter, fish in, or be in; and no fishing gear capable of catching NE multispecies, unless otherwise allowed in this part, may be in, or on board a vessel in GOM Rolling Closure Areas I through V, as described below, for the times specified, except as specified below and or under the transiting provisions.

Exceptions to Rolling Closures - Paragraph (1) above does not apply to persons aboard fishing vessels or fishing vessels:

- That have not been issued a multispecies permit and that are fishing exclusively in state waters;
- That are fishing with or using exempted gear as defined under this part, subject to the restrictions on midwater trawl gear, and excluding pelagic gillnet gear capable of catching multispecies, except for vessels fishing with a single pelagic gillnet not longer than 300 ft and not greater than 6 ft deep, with a maximum mesh size of 3 inches, provided:
- The net is attached to the boat and fished in the upper two-thirds of the water column;
- The net is marked with the owner's name and vessel identification number;
- There is no retention of regulated species; and
- There is no other gear on board capable of catching NE multispecies;
- That are fishing under charter/party or recreational regulations, provided that:

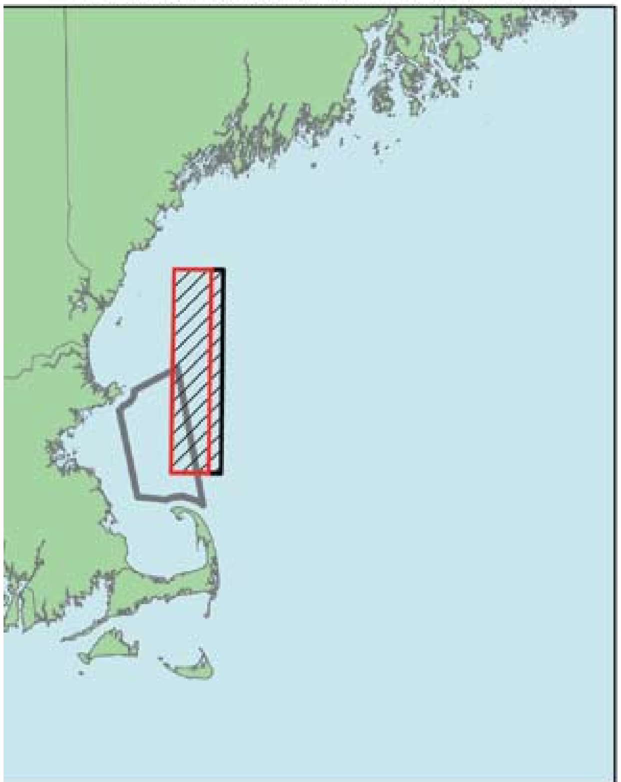
For vessels fishing under charter/party regulations in a Rolling Closure Area described above, provided it has on board a letter of authorization issued by the Regional Administrator, which is valid from the date of enrollment through the duration of the closure or 3 months duration, whichever is greater; for vessels fishing under charter/party regulations in the Cashes Ledge Closure Area or Western GOM Area Closure, described above, provided it has on board a letter of authorization issued by the Regional Administrator, which is valid from the date of enrollment until the end of the fishing year;

- With the exception of tuna, fish harvested or possessed by the vessel are not sold or intended for trade, barter or sale, regardless of where the regulated species are caught;
- The vessel has no gear other than rod and reel or handline on board; and
- The vessel does not use any NE multispecies DAS during the entire period for which the letter of authorization is valid;
- That are fishing with or using scallop dredge gear when fishing under a scallop DAS or when lawfully fishing in the Scallop Dredge Fishery Exemption Area, provided the vessel does not retain any regulated NE multispecies during a trip, or on any part of a trip; or
- That are fishing in the Raised Footrope Trawl Exempted Whiting Fishery,, and in the GOM Rolling Closure Area V.

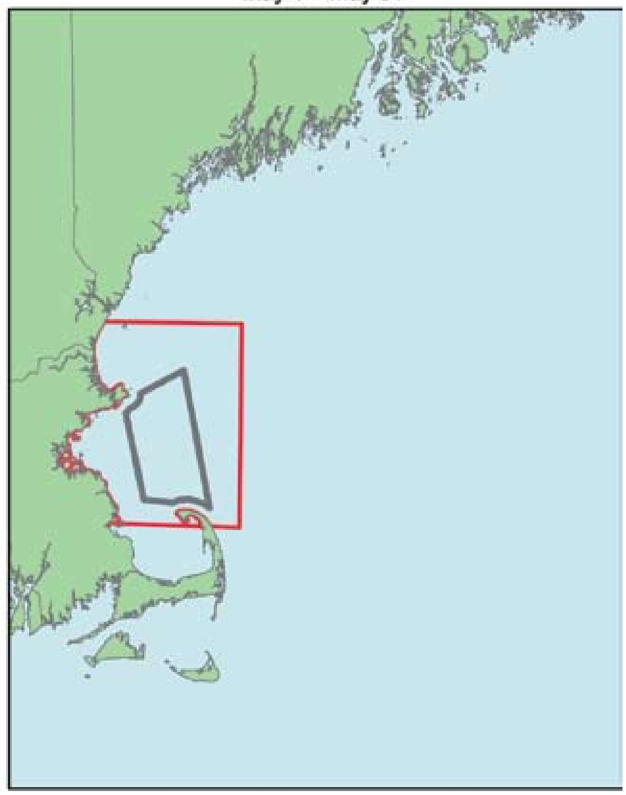
Exempted Gear - With respect to the NE multispecies fishery, means gear that is deemed to be not capable of catching NE multispecies and includes: Pelagic hook and line, pelagic longline, spears, rakes, diving gear, cast nets, tongs, harpoons, weirs, dipnets, stop nets, pound nets, pelagic gillnets, pots and traps, purse seines, shrimp trawls (with a properly configured grate as defined under this part), surfclam and ocean quahog dredges, and midwater trawls.

Midwater Trawl Gear - Trawl gear that is designed to fish for, is capable of fishing for, or is being used to fish for pelagic species, no portion of which is designed to be or is operated in contact with the bottom at any time.

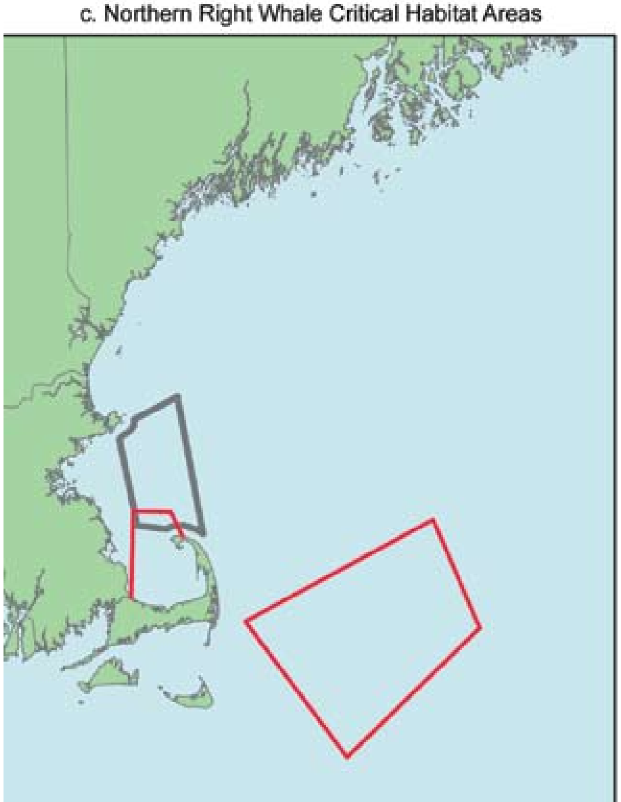
a. Western Gulf of Maine Closure Area & Habitat Closure Area (shown in red) Year Round



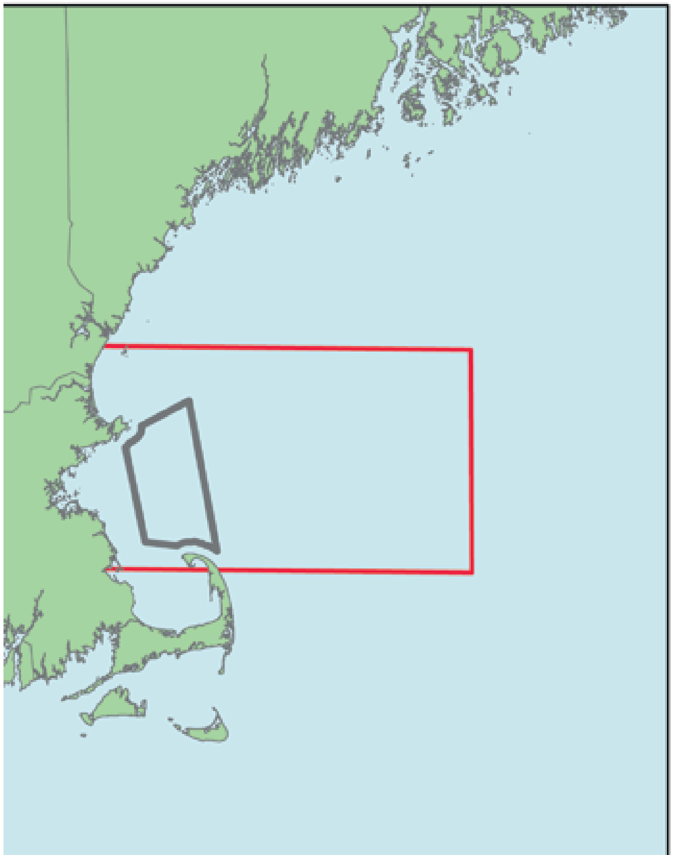
b. Inshore Restricted Roller Gear May 1 – May 31



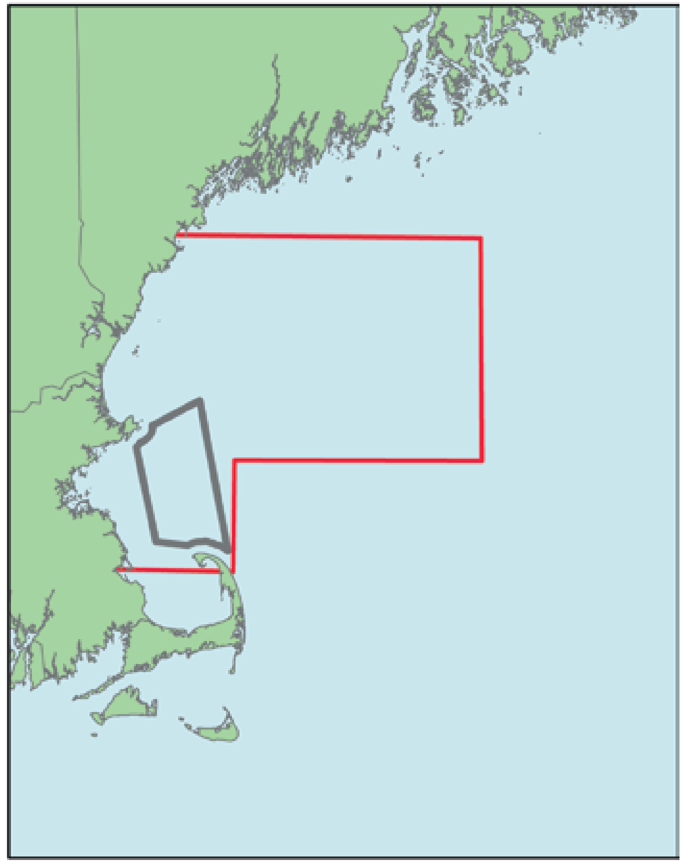
c. Northern Right Whale Critical Habitat Areas



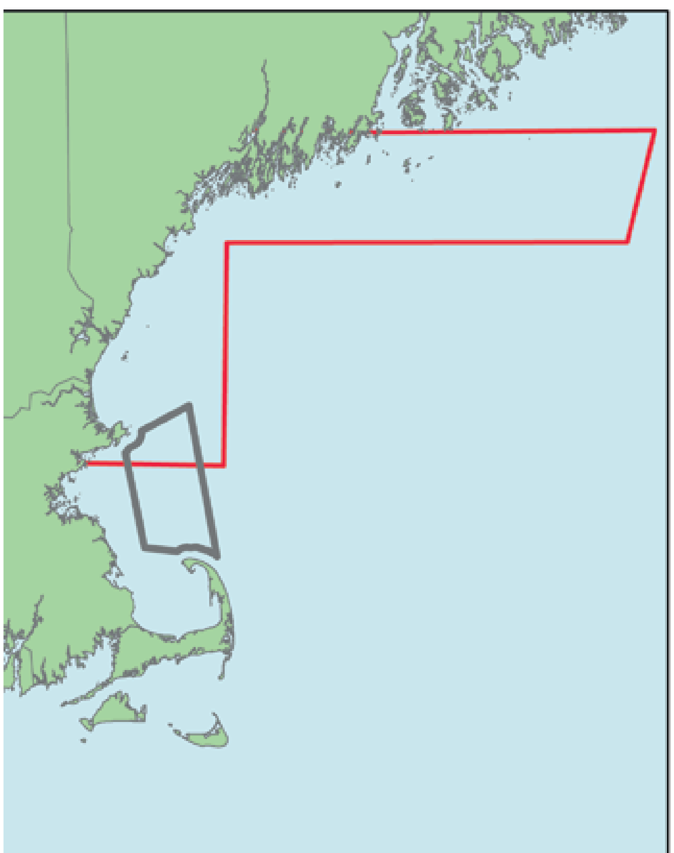
d. Rolling Closure Area 2
April 1 - April 30



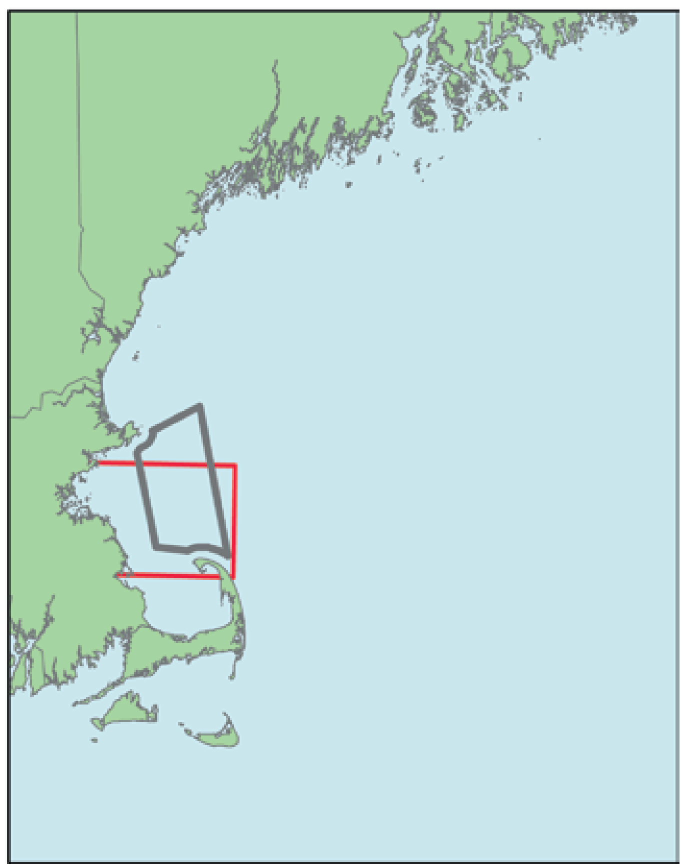
e. Rolling Closure Area 3
May 1 - May 31



f. Rolling Closure Area 4
June 1 - June 30



g. Rolling Closure Area 5
October 1 - November 30



Appendix S. List of Acronyms

Acronym	Meaning
A	
ACRU	Atlantic Cetacean Research Center
ACTVNY	Activities New York
ADMIN	Administrative Capacity and Infrastructure
AIS	Automatic Identification System
ALWTRP	Atlantic Large Whale Take Reduction Plan
AP	Action Plan
ARU	Automatic Recording Units
ASMFC	Atlantic States Marine Fisheries Council
B	
BEM	Bays Eutrophication Model
BHNIP	Boston Harbor Navigation Improvement Project
C	
CD	Compatibility Determination
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COST	Continental Offshore Stratigraphic Test
CRU	Cetacean Research Unit
CSO	Combined Sewer Overflows
CWA	Clean Water Act
D	
DAM	Dynamic Area Management
DAMOS	Disposal Area Monitoring System
DAS	Days at Sea
DWPA	Deep Water Port Act
E	
EA	Ecosystem Alteration
EBM	Ecosystem Based Management
EBSM	Ecosystem-Based Sanctuary Management
ECNASAP	East Coast of North America Strategic Assessment Project
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EIS	Environmental Impact Statement
F	
FAA	Federal Aviation Administration
FADS	Foul Area Disposal Site
FERC	Federal Energy Regulatory Commission
FMC	Fishery Management Council
FMP	Fishery Management Plan
FWPCA	Federal Water Pollution Control Act
G	
GIS	Geographic Information System
GLOBEC Program	Global Ocean Ecosystems Dynamics Program
GoM	Gulf of Maine
GoMLME	Gulf of Maine Large Marine Ecosystem
GoMOOS	Gulf of Maine Ocean Observing System
GoMMPAS	Gulf of Maine Marine Protected Areas
GPS	Global Positioning System
H	
HAB	Harmful Algal Blooms
HAZMAT	Hazardous Materials
HMS	Highly Migratory Species
HPTRP	Harbor Porpoise Take Reduction Plan
I	
ICCAT	International Commission for the Conservation of Atlantic Tuna
IC	Interagency Cooperation
IMO	International Maritime Organization
IWS	Industrial Waste Site
J	
JEA	Joint Enforcement Agreement
L	
LME	Large Marine Ecosystem
LNG	Liquefied Natural Gas
M	
MACZM	Massachusetts Coastal Zone Management
MAFMC	Mid-Atlantic Fisheries Management Council
MARPOL	International Convention for the Prevention of Pollution from Ships
MARAD	Maritime Administration
MBDS	Massachusetts Bay Disposal Site
Massport	Massachusetts Port Authority
MEP	Massachusetts Environmental Police
MFCMA	Magnuson Fishery Conservation and Management Act
MFP	Massachusetts Fishermen's Partnership
MGD	Massachusetts Water per Day
MHR	Maritime Heritage Resources
MOU	Memorandum of Understanding
MOA	Memorandum of Agreement
MITSG	Massachusetts Institute of Technology Sea Grant
MMBD	Marine Mammals Behavioral Disturbance
MME	Marine Mammal Entanglement
MMIRC	Marine Mammal Information and Reporting Center
MMRA	Marine Mammal Research Association
MMS	Mineral Management Service
MMPA	Marine Mammal Protection Act
MMVS	Marine Mammal Vessel Strikes
MOSA	Massachusetts Ocean Sanctuaries Act
MPPRCA	Marine Plastic Pollution Research and Control Act
MPRSA	Marine Protection, Research and Sanctuaries Act
MPR	Management Plan Review
MSD	Marine Sanitation Devices
MSO	Marine Safety Office

MWRA .... Massachusetts Water Resources Authority

N

NAO......................... North Atlantic Oscillation

NDZ......................... No Discharge Zone

NEAQ....................... New England Aquarium

NEFSC...................... Northeast Fisheries Science Center

NEFMC..................... New England Fishery Management Council

NEPA........................ National Environmental Policy Act

NERO....................... Northeast Regional Office (NOAA)

NHPA....................... National Historic Preservation Act

NMFS....................... National Marine Fisheries Service

NMSF....................... National Marine Sanctuary Foundation

NMSA .... National Marine Sanctuaries Act

NMS......................... National Marine Sanctuary

NMSP....................... National Marine Sanctuary Program

NOAA .... National Oceanic and Atmospheric Administration

NOAA's ARCH.......... NOAA's Archaeological Database

NOS .... National Ocean Service

NGO .... Nongovernmental Organization

NPDES .... National Pollutant Discharge Elimination System

NRHP....................... National Register of Historic Places

NSF .... National Science Foundation

NURC UCONN........ National Undersea Research Center at the University of Connecticut

O

OMSAP .... Outfall Monitoring Science Advisory Panel

OPA .... Oil Pollution Act

OPCA....................... Oil Pollution Control Act

OCS .... Office Coast Survey

OCSLA .... Outer Continental Shelf Lands Act

OLE.......................... Office of Law Enforcement

P

PAH.......................... Polynuclear Aromatic Hydrocarbons

PCB .... Polychlorinated Biphenyls

PCCS........................ Provincetown Center for Coastal Studies

POE.......................... Public Outreach and Education

POTW .... Publicly Owned Treatment Works

PWC......................... Personal Water Craft

R

RAS .... Rapid Assessment Survey

RFA .... Recreational Fishing Alliance

ROV .... Remote Operated Vehicle

RUST........................ Resource Under-Sea Threat Database System

RV .... Research Vessel

S

SAC .... Sanctuary Advisory Council

SBNMS..................... Stellwagen Bank National Marine Sanctuary

S-CAP....................... Sanctuary Compatibility Analysis Process

SCUBA .... Self-Contained Underwater Breathing Apparatus

SD .... Standard Deviation

SHIELDS................... Sanctuaries Hazardous Incident Emergency Logistics Database System

SHRMP..................... Seafloor Habitat Recovery Monitoring Program

SMP.......................... Saba Marine Park

SUP .... Special Use Permit

T

TRT .... Take Reduction Team

TSS........................... Traffic Separation Scheme

U

UNH .... University of New Hampshire

UHI .... University of Hawaii

UCONN.................. University of Connecticut

UMaine.................... University of Maine

USCG....................... United States Coast Guard

USGS .... United States Geological Survey

USACE .... United States Army Corps of Engineers

USDOC.................... United States Department of Commerce

USDOD .... United States Department of Defense

USFWS.................... United States Fish and Wildlife Service

V

VERP .... Visitor Experience Resource Protection

VMS .... Vessel Monitoring System

VTR .... Vessel Trip Report

VTSS......................... Vessel Transportation Separation scheme

W

WWAG .... Whale Watch Advisory Group

WCI.......................... Whale Conservation Institute

WCNE...................... Whale Center of New England

WG .... Working Group

WGoMCA .... Western Gulf of Maine Closure Area

WQ .... Water Quality

WWF........................ World Wildlife Fund

Appendix T. Glossary

A

Anadromous species .... is an animal that spawns in freshwater and lives its life in salt water.

Autotrophic .... ability to produce complex organic compounds from simple molecules and an external source of energy, such as light or chemical reactions of inorganic compounds. Autotrophs are considered producers in a food chain.

B

Bacteriophage .... is a virus that attacks bacteria as the primary host

Bathymetry .... water depth measurement information used to produce depth-contoured charts

Benthos .... is the layer of the ocean that is near and/ or at the bottom, only a few feet above the sediment. This is also known as the Benthic Zone.

Biodiversity .... the variability among living organisms from all sources including inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. This is also known as Biological diversity.

Bioinvader .... is a species and organisms that have moved into as areas outside of their natural geographic range.

Biomass .... is the mass of living material in a given area or volume of habitat.

Bioprospecting .... the process by which new, useful applications and products are developed form the natural environment through scientific discovery and research.

C

Catadromous Species .... A fish species that spawns in saltwater but feeds and spends most of its life in estuarine or fresh water

Coccolithiphores .... are small algae covered by calcium carbonate hubcap-like disks called coccoliths. Chalk is made of billions of coccoliths that lithify into rock.

Cryptophyta .... are small biflagellated protoctistids also known as cryptomonads, some of which are autotrophs, others heterotrophs.

Cyclonic storms systems .... a windstorm with a violent whirling movement; a system of rotating winds over a vast area, spinning inward to a low pressure center (counterclockwise in the northern hemisphere) generally causing stormy weather

D

Diatoms .... are a major group of eukaryotic algae, and are one of the most common types of phytoplankton. Most diatoms are unicellular, although some form chains or simple colonies. A characteristic feature of diatom cells is that they are encased within a unique cell wall made of silica.

E

Ecological Integrity .... DRAFT definition provided by Zoning working group (Aug.24, 2006): Ecological integrity is defined as the degree to which the system is structurally intact and functionally resilient within the context of historical baselines. Structurally intact means the native parts of the system are maintained as well as their interrelationships. Functional resilience is the system's ability to resist changes caused by human or environmental perturbations, or should change occur, to recover over time.

Ekman spiral .... a theoretical model of the effect on water of wind blowing over the ocean. The surface layer is expected to drift at an angle of 45* to the right of the wind in the Northern Hemisphere and 45* to the left in the Southern Hemisphere. Water at successively lower layers drifts progressively to the right (N), or left (S), though not a swiftly as the surface flow.

Ekman transport .... the net transportation of water, the sum of layer movement, due to the Ekman spiral. Theoretical Ekman transport is the Northern Hemisphere is 90* to the right of the wind direction

Endangered species ....is a species that is in danger of becoming extinct, that is protected by the Endangered Species Act (EDA).

Endemic ....is restricted to or native to a particular area or region.

Eutrophication ....the process by which nutrient-rich waters bring about a high level of biological productivity that may ultimately lead to reduced dissolved oxygen levels

F

Fauna.....................................animal life of a particular region

Flora ....plant life of a particular region

Foraminifera............................are large amoeboid protoctistids with often beautiful shells (tests) constructed of calcium carbonate. Benthic foraminifera live on the seabottom.

G

Glaciation ....the processes by which glaciers are formed and reformed to create various geological structures.

H

Halocline ....the zone of the ocean in which salinity increases rapidly with depth.

Heterotrophic ....ability to derive nutrition either by eating other things or by photosynthesizing. For plankton, often means absorbing dissolved organic matter directly.

Holozooplankton ....species will spend their entire life suspended in the water.

Hydrography ....is the study, description, and mapping of oceans, lakes, and rivers with an emphasis on navigation.

I

Infaunal ....organisms that live buried in sediments, including a variety of polychaetes, burrowing crustacean, and mollusks

K

Keystone species ....a single species whose activities determine community structure; a species whose presence if critical to that community

L

Lightering ....is the process of transferring fuel from one transportation unit (barge or ship) to a smaller vessel. This is useful when having to deliver oil and gas products to harbors with shallow channels that would not be able to handle a larger tanker vessel.

Local extinction ....is the eradication of any geographically discrete population of individuals while others of the same species or subspecies survive elsewhere.

M

Macrophytes ....refers to large, fleshy plants like seaweeds or seagrasses.

Microhabitat ....refers to both the physical substratum (e.g., sand waves, cobbles, boulders) and any associated structure-forming taxa (e.g., anemones, sponges, amphipod tubes). In addition to the organisms that form them, microhabitats are critical for a variety of fish species at different life history stages.

Mictic ....refers to the mixing of organisms

N

Nanoplankton.........................is the fraction of plankton (small eukaryotic protists) composed by cells between 2-20 μm)

Nektonic ....highly motile organisms, such as fishes and squids that live in, or above, the seagrass canopy

Nonpoint source pollutant .....those pollutant discharges not associated with a specific location (e.g., urban and agricultural pesticide runoff)

Nertic Zooplankton ....are larval stages of various benthic organisms, such as barnacles, worms, bivalve and gastropod mollusks, decapod crustaceans and echinoderms, that spend a short time suspended in the water.

Nor'easter (Northeaster) ....is any energetic extra-tropical cyclone that sweeps the eastern seaboard of North America in winter.

North Atlantic Oscillation ......is a large scale mode of climate variability that has important impacts on the weather and climate of the North Atlantic Region and surrounding continents. It has a significant effect on both temperature and precipitation, this causes a major impact on marine ecosystems. These impacts include sea surface temperature, mixed layer depth, upper ocean heat content, surface Ekman transport, sea ice cover, uptake of gases, altered nutrient balances and primary production. These changes can have a direct impact on the dispersion and growth of marine life

Nutrient mixing ....this is the process of transferring and mixing, of those constituents required by organism for maintenance and growth, of nutrients between the components of a food web.

P

Pelagic ....the realm of open water--also known as the pelagic zone.

Phytoplankton..........................are photosynthetic planktonic algae

Physical Oceanography ....is the aspects of the physical Ocean environment that affects living organisms, such as light, salinity, or temperature.

Picoplankton...........................is the fraction of plankton composed by cells between 0.2 and 2 μm that can be either photosynthetic or heterotrophic

Planktonic ....organisms dependent on water movement and currents as their means of transportation, including phytoplankton, zooplankton, and ichthyoplankton

Point source pollutant ....the discharges of pollutants from a distinct and identifiable source, such as a sewer or industrial pipe

Protists ....are a diverse group of organisms, comprising those eukaryotes that are not animals, plants, or fungi. They are usually treated as the kingdom Protista or Protoctista. The protists are a paraphyletic grade, rather than a natural (monophyletic) group, and do not have much in common besides a relatively simple organization (unicellular, or multicellular without highly specialized tissues). Essentially, the Kingdom Protoctista is made up of organisms which cannot be classified into any other kingdom.

S

Salinity ....a measure of the dissolved solids in seawater, usually expressed in grams per kilogram or part per thousand by weight. Standard seawater has a salinity of 35 0/00 at 0*C (32*F)

Stratification ....is the presence of different and distinct respective horizons within the water column. This is the layering of different factors, such as any physical or biological effects, within the water.

"Strategic Stock" ....This means that the average annual fishing related mortality and serious injury exceeds the number of animals that can be removed form the stock without inhibiting recovery.

T

Thermocline ....the zone of the ocean in which temperature decreases rapidly with depth.

Taxa ....the shortened form of Taxonomic group. It also is a more general term then species when identifying animals.

Threatened species ....plant or animal species believed likely to move into the endangered category in the near future if causal factors at work continue to persist

U

Upwelling ....a circulation pattern in which deep, cold, usually nutrient-laden water moves toward the surface. Upwelling can be caused by winds blowing parallel to shore or offshore.

Appendix U. Metric Conversion Table

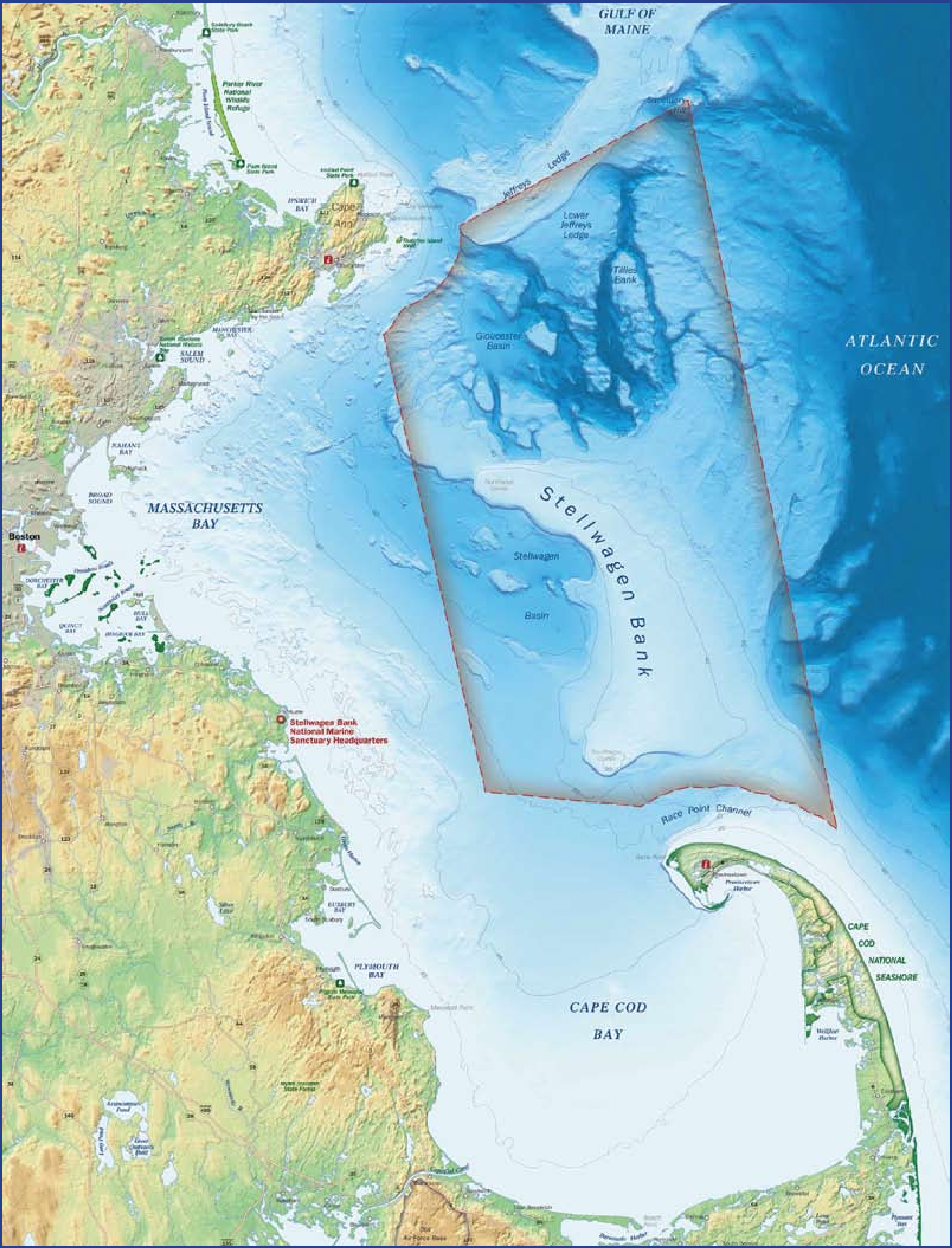
Linear Measurement	Area Measurement
1 foot = 0.3048 meter 1 meter = 3.28084 feet = 0.001 kilometer 1 kilometer = 1,000 meters = 0.621371 statute mile 1 statute mile = 5,280 feet = 1.60934 kilometers = 0.8689 nautical mile 1 nautical mile = 6,076.12 feet = 1.852 kilometers = 1.15078 statute miles	1 acre = 43,560 square feet = 4,046.86 square meters = 0.404684 hectare = 0.0015625 square statute mile 1 hectare = 2.47105 acres = 10, 000 square meters = 0.01 square kilometer = 0,003861 square statute mile 1 square kilometer = 247.105 acres = 100 hectares = 0.386102 square statute mile 1 square stature mile = 640 acres = 258,999 hectares = 2.58999 square kilometers = 0,755 square nautical mile 1 square nautical mile = 847.5443 acres = 3.43 square kilometers = 1.324288 square statute miles
Mass Measurement	**Unit Abbreviations**
1 pound = 0.002 ton = 0.453592 kilogram 1 ton = 2,000 pounds = 0.907185 metric ton 1 kilogram = 2.20462 pounds = 0.001 metric ton	Foot-(ft) Hectare-(ha) Kilometer-(km) Meter-(m) Nautical mile- (nmi) Pound-(lb) Square kilometer-(km2) Square meter-(m2) Square nautical mile-(nmi2) Square statute mile-(mi2) Statute mile-(m)

Notes

Whales and birds feeding at sunset in the Stellwagen Bank National Marine Sanctuary.

Do not follow
where the path may lead.
Go, instead,
where there is no path
and leave a trail.

—Ralph Waldo Emerson



GULF OF MAINE
Jeffreys Ledge
Lower Jeffreys Ledge
Tillies Bank
Gloucester Basin
ATLANTIC OCEAN
Stellwagen Bank
Stellwagen Basin
MASSACHUSETTS BAY
Boston
Cape Ann
Stellwagen Bank National Marine Sanctuary Headquarters
Race Point Channel
CAPE COD BAY
CAPE COD NATIONAL SEASHORE
PLYMOUTH BAY