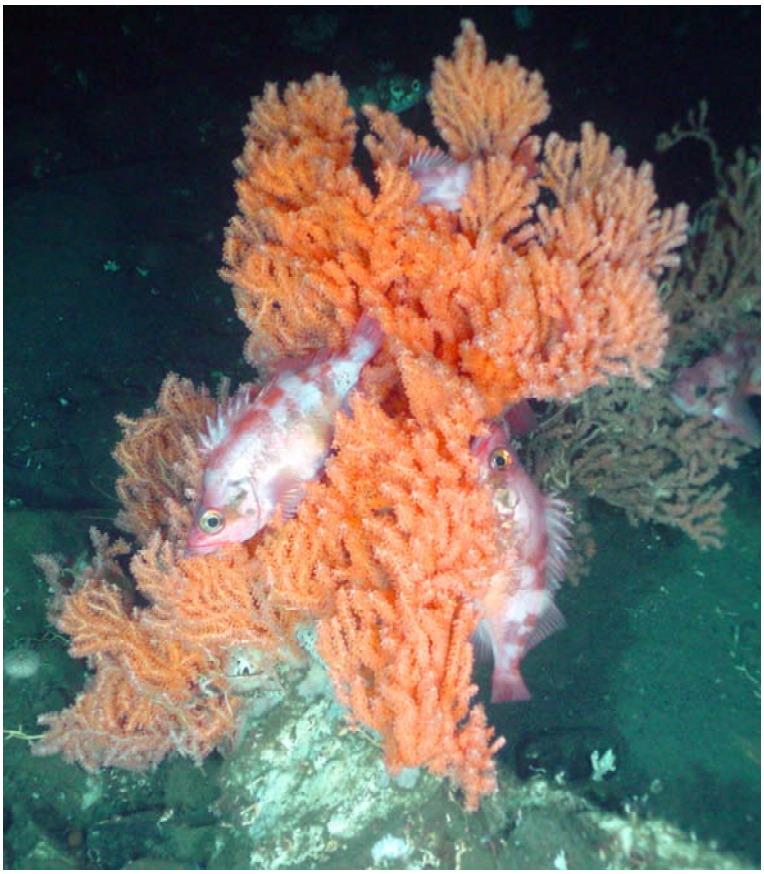
Report to Congress on the

Implementation of the Deep Sea Coral Research and Technology Program



U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Coral Reef Conservation Program

March 2008
Silver Spring, Maryland

This document was produced by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, in consultation with Regional Fishery Management Councils, to fulfill requirements of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (P.L. 109-479).

Date: March 2008

For more information about this report or to request a copy, please contact:
NOAA's Coral Reef Conservation Program, NOAA, National Marine Fisheries Service, Office of Habitat Conservation; 1315 East West Highway, Silver Spring, Maryland 20910. Tel: 301-713-0299.
Or visit http://www.nmfs.noaa.gov/habitat/rtc.pdf

Cover: Rockfish take refuge among the branches of a deep sea gorgonian coral in Olympic Coast National Marine Sanctuary. Photo credit: NOAA Olympic Coast National Marine Sanctuary

Table of Contents

Executive Summary v

List of Acronyms viii

1. Purpose 1

2. Nature of Deep Sea Coral Communities 1

3. Importance of Deep Sea Corals 2

4. Threats to Deep Sea Coral Ecosystems 3

5. NOAA Authorities 4

6. Current Knowledge and Knowledge Gaps 5

7. Recent Conservation and Management Actions 7

- **NOAA and the Councils** 8
- **Federal Interagency Cooperation** 14
- **International Activities** 15

8. Conclusions and Next Steps 17

References 20

Appendices 25

- **Appendix 1. Deep Sea Coral Areas in the U.S. EEZ with Limited Protection from Interactions with Fishing Gear** 25
- **Appendix 2. Measures Implemented by RFMOs to Protect VMEs Including Deep Sea Coral Habitats Beyond National Jurisdiction** 29
- **Appendix 3. President Bush's Memorandum on Sustainable Fisheries and Destructive Fishing Practices. October 3, 2006** 30

Figures 32

- **Figure 1. Known Locations of Major Deep Sea Corals in Waters of the U.S. Atlantic** 32

Figure 2. Known Deep Sea Coral Locations in the Northeast U.S. with Management Areas 33

Figure 3. SAFMC Proposed Deepwater Coral HAPCs 34

Figure 4. Gulf of Mexico Habitat Areas of Particular Concern 35

Figure 5. Deep Sea Corals in the U.S. Caribbean and Adjacent Areas..... 36

Figure 6. Deep Sea Precious Coral Beds in the Hawaiian Archipelago 37

Figure 7. Known Locations of Deep Sea Corals Off the U.S. West Coast ... 38

Figure 8. Locations of West Coast Groundfish EFH Conservation Areas . 39

Figure 9. Survey sites for deep sea corals and sponges in the Olympic Coast National Marine Sanctuary. 40

Figure 10. Deep Sea Coral Locations in Alaska..... 41

Figure 11. Areas of Alaska with some restrictions on fishing activities. 42

Figure 12. NPFMC Proposed Habitat Conservation Areas in the Bering Sea 43

Executive Summary

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA) includes a requirement to establish the "Deep Sea Coral Research and Technology Program." Section 408 (b) of the reauthorized Act tasked NOAA with submitting, in consultation with the Fishery Management Councils, "biennial reports to Congress and the public on steps taken by the Secretary to identify, monitor, and protect deep sea coral areas, including summaries of the results of mapping, research and data collection performed under the program." This is the first biennial report in fulfillment of that requirement.

The report was prepared by the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), under the auspices of the Coral Reef Conservation Program and in collaboration with NOAA's National Ocean Service; Office of Oceanic and Atmospheric Research; Office of International Affairs; National Environmental Satellite, Data, and Information Service; and the eight Regional Fishery Management Councils. Because the Deep Sea Coral Research and Technology Program had no dedicated funding in its first year of operation, implementation was limited to activities accomplished as part of, or in association with, other existing programs.

Following are key findings, recent NOAA activities, and recommendations.

Findings:

- Research over the past decade has revealed that deep sea corals (also known as cold-water corals) form habitats of high biological diversity in the deeper ocean (generally between 50 and 2,000 meters) on continental slopes, canyons, and seamounts, including many areas in the U.S. exclusive economic zone (EEZ).

- Deep sea coral assemblages are vulnerable to damage from bottom-tending fishing gears, especially bottom-trawling, but also may be affected by energy exploration and development, deployment of cables and pipelines, and other human activities that disturb the sea floor. Recovery from damage may take decades to centuries, as most deep sea corals grow slowly.

- NOAA has research expertise and statutory authority to protect and manage deep sea coral communities in waters under U.S. jurisdiction pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended in 2006, and the National Marine Sanctuaries Act.

- Significant gaps in knowledge about deep sea corals remain, including the location of many deep sea coral assemblages and most aspects of their biology and ecology. For example, questions remain as to why deep sea corals occur where they do, their role as habitat for other species (including managed fish stocks and protected species), their vulnerability and resilience to human impacts, and their responses to climate change and ocean acidification.

Recent Activities:

- In 2006, NOAA, in partnership with the Regional Fishery Management Councils, protected from bottom-trawling over 500,000 square miles of vulnerable benthic habitats designated as essential fish habitat (EFH) in the U.S. Pacific. The protections, pursuant to the MSA, are intended to minimize adverse effects from fishing on EFH. Included in those protected areas are major deep sea coral habitats, many of which are also designated as habitat areas of particular concern (HAPCs) through the EFH authority.

- In 2007, NOAA published *The State of Deep Coral Ecosystems of the United States*, an assessment of deep sea coral ecosystems in U.S. waters, including the biology of deep sea corals and their associated species, their spatial distribution, the stressors that may threaten their survival, current management measures, and regional priorities for future research. The peer-reviewed report serves as a primary source document for this Report to Congress and helps fulfill the first requirement of the Deep Sea Coral Research and Technology Program—"to identify existing research on and known locations of deep sea corals...."

- Major habitat conservation efforts are currently underway through the North Pacific, New England, and South Atlantic Fishery Management Councils. Councils are primarily relying on the EFH authority to recommend habitat protection measures and have not yet used their new discretionary authority under the MSRA to recommend designating zones to protect deep sea corals from fishing impacts. Further progress in employing the new authority will depend, in part, on improved information on the location and ecology of these resources.

- NOAA is expanding partnerships nationally and internationally to understand and protect deep sea corals:
    - In April 2007, the Joint Subcommittee on Ocean Science and Technology established an Interagency Board on Deep Sea Coral and Other Vulnerable Marine Ecosystems co-chaired by NOAA and the Department of the Interior.
    - NOAA and the State Department are actively engaged in efforts to implement a 2006 United Nations resolution to protect vulnerable marine ecosystems on the high seas from destructive fishing practices.

Next Steps and Recommendations:

- In 2008, NOAA will develop a *Deep Coral and Sponge Research and Management Strategic Plan* to guide research, management, and international cooperation activities as they relate to deep coral and sponge communities. The Plan will provide a framework for implementing the Deep-Sea Coral Research and Technology Program.

- NOAA has requested $1.5 million in the President's Fiscal Year 2009 budget to advance implementation of the Deep Sea Coral Research and Technology Program in the following areas:

- Conducting research on the ecology of deep sea corals and associated faunal assemblages, including those associations between corals and managed fish stocks through all life stages.
- Identifying and mapping the locations of deep sea coral communities.
- Mapping the distribution and intensity of fishing practices known to impact deep sea coral communities.
- Assessing and analyzing bycatch of deep sea corals caught in fishing activities.
- Integrating and managing deep sea coral data in national and international GIS databases.

- NOAA recommends that the Regional Fishery Management Councils evaluate areas for protection known to contain deep sea corals as allowed under discretionary provisions of the MSA as amended. An initial list of areas with limited protection from interactions with fishing gear is included in Appendix 1. Many of the areas listed are being considered for designation as HAPCs, which could afford additional protection for these areas from human activities including fishing.

- NOAA recognizes that deep sea sponge ecosystems can play similar ecological roles and face similar threats to deep sea coral ecosystems. NOAA intends to include research and conservation of deep sea sponge habitats along with efforts to study and conserve deep sea coral habitats.

List of Acronyms

AIHCA	Aleutian Island Habitat Conservation Area
CFMC	Caribbean Fishery Management Council
CoRIS	Coral Reef Information System
CRCA	Coral Reef Conservation Act of 2000
CRCP	Coral Reef Conservation Program
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
FMC	Fishery Management Councils
FMP	Fishery Management Plan
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
HAPC	Habitat Area of Particular Concern
HBOI	Harbor Branch Oceanographic Institution
IUU Fishing	Illegal, unregulated and unreported fishing
JSOST	National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology
MAFMC	Mid-Atlantic Fishery Management Council
MPAs	Marine Protected Areas
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSRA	Magnuson-Stevens Fishery Conservation and Management Reauthorization Act
NEFMC	New England Fishery Management Council
NESDIS	National Environmental Satellite, Data, and Information Service
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPFMC	North Pacific Fishery Management Council
NRC	National Research Council
NURC	National Undersea Research Center
OAR	Office of Oceanic and Atmospheric Research
PFMC	Pacific Fishery Management Council
RFMO/A	Regional Fishery Management Organizations and Agreements
SAFMC	South Atlantic Fishery Management Council
SSC	Scientific and Statistical Committee
UNCW	University of North Carolina at Wilmington
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
USVI	United States Virgin Islands
VMEs	Vulnerable Marine Ecosystems
WPFMC	Western Pacific Fishery Management Council

1. Purpose

On January 12, 2007, the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (P.L. 109-479) (MSRA) was enacted and included a requirement to establish the "Deep Sea Coral Research and Technology Program." Section 408 (b) of the reauthorized Act tasked NOAA with submitting, in consultation with the Fishery Management Councils, "biennial reports to Congress and the public on steps taken by the Secretary to identify, monitor, and protect deep sea coral areas, including summaries of the results of mapping, research and data collection performed under the program." This is the first biennial report in fulfillment of that requirement.

2. Nature of Deep Sea Coral Communities

Deep sea corals, also referred to as "cold-water corals," are a taxonomically and morphologically diverse collection of organisms (see Box 1) distinguished by their occurrence in deeper or colder oceanic waters. The calcified skeletons of certain branching stony coral species form large reef-like structures in deep water. Gorgonians, gold corals, and black corals often have branching tree-like forms and either occur singly or form thickets of many colonies. The three-dimensional features formed by many deep sea corals provide habitat for numerous fish and invertebrate species and, like shallow-water tropical corals, appear to enhance the biological diversity of many deepwater ecosystems.

Deep sea corals lack symbiotic algae (zooxanthellae) characteristic of most reef-building shallow water tropical corals. Unlike their shallow water relatives, which rely heavily on photosynthesis by their symbionts to produce food, deep sea corals assimilate plankton and organic matter for much of their energy needs. They generally grow much more slowly than their shallow water counterparts.

Deep sea corals occur in cold oceanic waters worldwide from near the surface to 6,000 meters in depth; however, most are found between 50 and 2,000 meters.[1] Deep sea coral habitats are located primarily on rocky bottoms along continental shelves, slopes, canyons, ocean ridges, and seamounts. The U.S. Exclusive Economic Zone (EEZ) has many locations with extensive deep sea coral populations (Lumsden et al. 2007). The importance of these ecosystems and their vulnerability to human impacts has stimulated research, monitoring, mapping, and conservation efforts.

In addition to deep sea corals, sponges provide important three-dimensional structure in many deep water benthic communities. Many sponge species have similar habitat preferences to deep sea corals, may be found at similar locations, and are thought to play similar ecological roles. Although much less is known about deep sea sponges, they have been identified as habitat for managed fish stocks in certain regions and face many of the same threats as deep sea corals.

[1] The term "deep sea" usually refers to depths greater than 200 m, however structure-forming corals that lack symbiotic zooxanthellae occur over a broader range of depths.

NOAA has committed to expanding efforts to understand and conserve deep sponge habitats (Federal Register 2005).

Box 1. MAJOR DEEP SEA CORAL GROUPS (Phylum Cnidaria) [1]

Class	Subclass	Order	Common Name	Additional Information
Anthozoa—corals, sea anemones, sea pens	Hexacorallia	Scleractinia	Stony corals	A few species form deep-water reef-like structures known as bioherms, coral banks, or lithoherms.
		Zoanthidea	Gold corals	Only zoanthids in the family Gerardiidae form rigid skeletons.
		Antipatharia	Black corals	Many branching forms. Certain species harvested for jewelry in Hawaii.
	Octocorallia	Alcyonacea	True soft corals	Most are not major structure-forming species.
		Gorgonacea	Gorgonians, sea fans, sea whips	Many branching forms. At least 12 families contain major structure-forming species.
		Pennatulacea	Sea pens	Unlike other species, sea pens are found on soft sediments. Contribution as habitat and to biodiversity is not well understood.
Hydrozoa—hydroids and hydromedusae	Hydroidolina	Anthoathecatae-(Family Stylasteridae)	Stylasterids or lace corals	Can form branching colonies. May be confused with stony corals but the resemblance is superficial.

[1] More detailed information on the taxonomic classification of deep sea corals can be found in Hourigan et al. (2007).

3. Importance of Deep Sea Corals

As our understanding of deep sea coral communities and ecosystems has increased, so has our appreciation of their value. Deep sea coral communities can be hot-spots of biodiversity in the deeper ocean, making them of particular conservation interest. Stony coral "reefs," as well as thickets of sea fans or black corals and aggregations of lace corals often have large assemblages of associated fauna. Deep sea corals may function in ways very similar to their tropical counterparts, providing enhanced feeding opportunities for species, hiding places from predators, nursery areas for juveniles, fish spawning aggregation sites, and attachment substrate for sedentary invertebrates.

The high biodiversity associated with deep sea coral communities is intrinsically valuable, and may provide significant opportunities for chemical and biological research on marine organisms. For example, several deep water sponges have been shown to contain bioactive compounds of pharmaceutical interest; as mentioned above, sponges are often associated with deep sea coral communities. Deep sea bamboo corals are being investigated for their medical potential in bone grafts and other biomedical applications (Ehrlich et al. 2006). A number of deep sea corals are also of commercial importance; in particular, black, pink, and red corals are the basis for a large jewelry industry. For example, black coral is the "state gem" of Hawaii.

Deep sea coral communities have been identified as habitat for certain commercially important fishes. In Alaska, commercially valuable species of rockfish, shrimp, and crabs use coral habitat for protection from predators and as feeding areas (Krieger and Wing 2002). Husebø et al. (2002) documented a higher abundance and larger size of commercially valuable redfish, ling, and tusk in Norwegian waters in coral habitats compared to non-coral habitats. *Oculina* reefs off Florida have been identified as essential fish habitat (EFH) for Federally managed species, as have gorgonian-dominated deep sea coral communities off Alaska and the U.S. West Coast. In other cases, linkages between commercial fisheries species and deep sea corals remain unclear (Auster 2005; Tissot et al. 2006) and may be more indirect.

Deep sea gorgonian and stony coral species have proven useful in reconstructing historic global climate and oceanographic conditions (Risk et al. 2002; Williams et al. 2006). The calcium carbonate skeletons of deep sea corals incorporate trace elements and isotopes that reflect the physical and chemical conditions in which they grew. Skeletons of living deep sea corals have been dated to be more than 1,000 years old, and dead corals forming deep banks have been radiocarbon-dated to be more than 40,000 years old. Stable isotopes incorporated in skeletons can provide a record of past temperatures, and analyses of deep sea coral skeletal microchemistry allow researchers to reconstruct past oceanic conditions. The worldwide distribution of many deep sea corals permits observations and comparisons across broad ranges of time and space.

4. Threats to Deep Sea Coral Ecosystems

Deep sea corals are generally slow-growing and fragile, making them and their associated communities vulnerable to human-induced impacts, particularly physical disturbance. With the exception of a few areas (e.g., the *Oculina* Banks), the full extent of habitat degradation resulting from these threats is largely unknown.

Disturbances to deep sea coral communities from bottom-tending fishing gear, especially bottom trawl gear, are the best documented and pose the most widespread threat (Rogers 1999; Koslow et al. 2000; Hall-Spencer et al. 2001; Fosså et al. 2002; Roberts 2002; Grehan et al. 2005; Wheeler et al. 2005; Waller et al. 2007). Disturbances from bottom trawls and dredges have also been documented in U.S. waters (e.g., Krieger 2001; Koenig et al. 2005; Stone 2006) and are considered the major threat to deep corals in most U.S. regions where such fishing is allowed (Hourigan et al. 2007). The National Research Council (2002) concluded that bottom trawling

and dredging reduce habitat complexity by removing or damaging the physical structure of the seafloor and by causing changes in species composition.

Other activities that can directly impact deep sea coral communities include other bottom-set fishing gears (e.g., gillnets and longlines); coral harvesting; oil, gas, and mineral exploration and extraction; and submarine cable/pipeline deployment (Freiwald et al. 2004; Hourigan et al. 2007). Invasive species, climate change, and ocean acidification represent additional potential threats that have not been adequately explored. The extent of impact from these activities and the type of stressors that cause the most degradation vary among regions.

5. NOAA Authorities

NOAA has the statutory authority and scientific expertise to take a lead role in locating, mapping, characterizing, understanding, protecting, and managing deep sea coral ecosystems. Additionally, the President's Ocean Action Plan directs agencies to "research, survey and protect deep sea coral communities." NOAA manages deep sea corals under two primary authorities:

- **Magnuson-Stevens Fishery Conservation and Management Act (MSA)** (U.S.C. 1801 *et seq.*) Under the MSA, NOAA manages fisheries in Federal waters through Fishery Management Plans (FMPs) developed in conjunction with the Regional Fishery Management Councils. To date, NOAA and the Councils have addressed fishery interactions with deep sea coral communities by minimizing adverse effects of fishing practices on areas that have been identified and described as essential fish habitat (EFH), by reducing fisheries bycatch of coral, and by managing the harvest of deep sea coral species (e.g., precious corals). The MSA was amended by the **Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006,** Public Law 109-479 (MSRA), and now provides NOAA additional science and management authorities related to deep sea coral communities. The MSRA directs the Secretary of Commerce, in consultation with appropriate Regional Fishery Management Councils and in coordination with other Federal agencies and educational institutions, to establish a Deep Sea Coral Research and Technology Program (see Box 2). MSRA also authorizes Councils to designate zones to protect deep sea corals from damage caused by fishing gear under FMP discretionary provisions.

- **National Marine Sanctuaries Act (NMSA)** (16 U.S.C. 1431 *et seq.*). The NMSA authorizes NOAA to identify and protect nationally significant habitats and resources throughout U.S. waters. Deep sea corals are known to exist within the boundaries of eight National Marine Sanctuaries: Stellwagen Bank, Florida Keys, Flower Garden Banks, Channel Islands, Monterey Bay, Gulf of the Farallones, Cordell Bank, and Olympic Coast. The area encompassed by the Hawaiian Islands Humpback Whale National Marine Sanctuary also includes deep sea coral habitat, but this Sanctuary's mandate currently is limited to sustaining a safe and healthy habitat for the North Pacific stock of humpback whales that seasonally visit the area.

Box 2. MSA SECTION 408. DEEP SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM

(a) IN GENERAL- The Secretary, in consultation with appropriate regional fishery management Councils and in coordination with other federal agencies and educational institutions, shall, subject to the availability of appropriations, establish a program--

(1) to identify existing research on, and known locations of, deep sea corals and submit such information to the appropriate Councils;
(2) to locate and map locations of deep sea corals and submit such information to the Councils;
(3) to monitor activity in locations where deep sea corals are known or likely to occur, based on best scientific information available, including through underwater or remote sensing technologies and submit such information to the appropriate Councils;
(4) to conduct research, including cooperative research with fishing industry participants, on deep sea corals and related species, and on survey methods;
(5) to develop technologies or methods designed to assist fishing industry participants in reducing interactions between fishing gear and deep sea corals; and
(6) to prioritize program activities in areas where deep sea corals are known to occur, and in areas where scientific modeling or other methods predict deep sea corals are likely to be present.

(b) REPORTING- Beginning 1 year after the date of enactment of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Secretary, in consultation with the Councils, shall submit biennial reports to Congress and the public on steps taken by the Secretary to identify, monitor, and protect deep sea coral areas, including summaries of the results of mapping, research, and data collection performed under the program.

Several other mandates may provide additional authorities for NOAA to take action to conserve deep sea corals:

- Endangered Species Act (16 USC 1531 *et seq.*).
- Fish and Wildlife Coordination Act (16 USC 661-666e).
- Deep Seabed Hard Mineral Resources Act (30 USC 1404 *et. seq.*).
- American Antiquities Act (16 USC 431-433).

6. Current Knowledge and Knowledge Gaps

NOAA supports deep sea coral research through activities conducted by several NOAA program offices and through collaborations with other Federal agencies, the Regional Fishery Management Councils, and external university partners. In FY 2007, no dedicated funds were appropriated for the Deep Sea Coral Research and Technology Program, and therefore implementation was limited to activities accomplished as part of, or in association with, other existing programs.

NOAA recently completed and published a comprehensive assessment of the state of knowledge regarding U.S. deep sea coral ecosystems: *The State of Deep Coral Ecosystems of the United States: 2007* (Lumsden et al. 2007). This peer-reviewed volume addresses the first requirement of the Deep Sea Coral Research and Technology Program, "to identify existing research on, and known locations of, deep sea corals and submit such information to the appropriate Councils." The report, released in December 2007, represents the first effort by NOAA (in partnership with other Federal, academic and non-governmental partners) to bring together available information on the abundance and distribution of structure-forming deep sea corals that occur in U.S. waters at depths greater than 50 meters.

Over the past few years, NOAA has increased activities to locate, study, and protect deep sea corals. The following issues were identified as critical information needed to enable better understanding and improve management of deep sea coral ecosystems (McDonough and Puglise 2003; Puglise et al. 2005; MAFAC 2005; Hourigan et al. 2007):

- **Locating, mapping, and characterizing deep sea coral habitats.** As a first step in building an information base, deep sea coral habitats must be located and mapped. Baseline assessments are needed to characterize deep sea corals in terms of their geographic distribution, diversity, abundance, and associated environmental conditions. The absence of this basic knowledge hampers the effective management of human interactions with these communities. There is a significant need to improve abilities to target areas suspected of containing deep sea corals, given the high costs of deep sea field studies. Therefore, scientific modeling tools need to be improved and models developed to predict where deep sea coral communities are likely to occur.

- **Understanding the taxonomy, biology, life histories, and ecology of deep sea coral species.** Many deep sea coral species are undescribed or described by only the most rudimentary information. Taxonomic, systematic, and genetic analyses must be expanded to facilitate identification of specimens collected during surveys and monitoring activities. Fundamental data regarding growth, reproduction, physiology, and ecology of major structure-forming deep sea species have yet to be gathered. Such information is important for understanding ecological requirements, distribution, resilience to stress, and rates of recovery from damage.

- **Understanding the biodiversity and ecology of deep sea coral communities.** Deep sea coral habitats represent hot-spots of biological diversity in the deep ocean. Inventories of fish and invertebrate species that utilize these habitats are needed, as well as an understanding of the role deep sea corals play in sustaining and supporting healthy fisheries and ecosystems. Such research is necessary to improve understanding of how different species depend on deep coral habitats during various stages of their lifecycles. This increased understanding helps identify important habitats that may be designated as EFH and habitat areas of particular concern (HAPCs).

- **Understanding impacts caused by fishing and other human activities.** Mapping deep sea coral habitats in relation to fishing effort, coral bycatch, and other potential

disturbances is crucial for identifying locations of potential impacts and framing studies about the nature and magnitude of such activities. Many human activities are expanding into deeper waters. Documenting their effects on seafloor habitats provides a foundation for developing sound policy and making wise management decisions. Additionally, there is a need for basic research to understand recently recognized threats to these ecosystems, such as invasive species, climate change and ocean acidification.

- **Using deep sea corals to assess past ocean and climate conditions and improve climate change models.** Deep sea corals provide windows into past environmental conditions in the deep ocean and insights for prospective analyses of future changes that may result from climate change. Analyses and validations of growth and microchemistry of deep sea corals in the field and the laboratory, along with high-quality oceanographic data, are needed for reconstructing past global oceanographic conditions and, by association, climate conditions.

Deep sea coral habitats, unlike their shallow water counterparts, require specialized underwater technologies (e.g., multibeam sonar, laser-line scans, remotely operated vehicles, human occupied submersibles, autonomous underwater vehicles, and advanced technical diving) to identify, map, understand, and manage them (Puglise et al. 2005). Integration and management of large geographic datasets is necessary to ensure that information from NOAA's exploration and research activities on deep sea corals are available to the research and management communities. Building institutional capacities in advanced underwater technologies and data management will be necessary to expand exploration and research activities related to deep sea coral ecosystems.

7. Recent Conservation and Management Actions

NOAA's undersea research capabilities, in cooperation with academic, Federal, and international partners, have put NOAA at the forefront of deep sea coral research and technology. Recent research has begun to reveal the extent and ecological importance of deep sea coral communities as well as the threats they face, and thereby has catalyzed conservation action. NOAA is the principal Federal agency responsible for management of living marine resources within the U.S. Exclusive Economic Zone (EEZ) where most U.S. deep sea coral communities occur.

The Regional Fishery Management Councils have been active in protecting deep sea coral habitat. Beginning in the early 1980s, when the South Atlantic Fishery Management Council recommended establishment of the world's first area to protect deep sea corals (the *Oculina* Banks HAPC off Florida) and the Western Pacific Fishery Management Council recommended closing the Pacific Islands EEZ to bottom-trawling, the Councils have been increasingly aware of the vulnerability of deep sea coral assemblages to bottom fishing practices. They have relied on tools like closed areas and gear modifications to address these impacts. With the passage of the 1996 Sustainable Fisheries Act, Councils were required to describe and identify EFH for fisheries and minimize, to the extent practicable, adverse effects on such habitat caused by fishing. A number of Councils identified specific deep sea coral habitat as EFH, and the areas

protected increased. In 2006, NOAA approved Council recommendations to protect over 500,000 square miles of vulnerable benthic EFH in the Pacific.

The following summaries—developed by NOAA in conjunction with the Regional Fishery Management Councils—focus on new management activities conducted by NOAA and its partners since the signing of the MSRA in January 2007. These activities were conducted and funded under MSA and National Marine Sanctuary Act authorities that pre-dated the MSRA, and were not necessarily directed specifically toward deep sea coral conservation needs. Activities authorized under the new Deep Sea Coral Research and Technology Program would complement and enhance ongoing EFH and Sanctuary conservation work. For more detailed descriptions of the distributions of deep sea corals, specific threats within each U.S. region, management efforts, and research priorities, see Lumsden et al. (2007).

NOAA and the Councils

A. New England and Mid Atlantic Region – Maine to Cape Hatteras

The Northeast has numerous deep sea coral habitats, composed primarily of gorgonians, which appear to be most numerous on rocky areas associated with canyons along the continental shelf and Georges Bank slopes, in rocky habitats in the northern Gulf of Maine, and on the New England Seamount chain extending from Georges Bank southeast for about 684 miles (1,100 km) to the eastern end of the Bermuda Rise (Watling et al. 2003; Auster 2005; Packer et al. 2007; Stiles et al. 2007) (see Figure 1 and 2). The Northeast also has a long history of both deep sea scientific research and extensive trawl fisheries.

The New England Fishery Management Council (NEFMC) has authority over fisheries in Federal waters off Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. The Mid-Atlantic Fishery Management Council (MAFMC) covers fisheries off New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and part of North Carolina. The Councils share management responsibilities for the monkfish and dogfish Fishery Management Plans (FMP).

Nearly 4,000 square miles (more than 10,000 km^2) in the NEFMC region have been designated as Habitat Closed Areas to protect EFH from the impacts of harmful fishing activities (Figure 2). The use of mobile bottom-tending gears (bottom-trawls and scallop and clam dredges) is prohibited in most of these areas. These closures were created to minimize the adverse impacts of fishing on EFH, but they may indirectly protect deep sea corals. Deep sea corals and sponges are known to occur in Oceanographer Canyon and Lydonia Canyon located on the southern flank of Georges Bank. In 2005, the two Councils closed these canyons—an area totaling 155 square miles (400 km^2)—to fishing for monkfish using bottom-contact gear. In 2007, MAFMC also approved the closure of these canyons to vessels trawling for squid, mackerel, and butterfish to further protect EFH.

In the past year the NEFMC, with technical assistance from NOAA, worked to increase knowledge of and protection for deep sea corals. The Council currently is engaged in reviewing and updating its EFH identifications and descriptions and management actions through a two-phase process. The first phase included revising EFH descriptions and designation of 15 deep sea canyons and portions of two seamounts as Habitat Areas of Particular Concern (HAPCs). These contain structure-forming organisms (e.g., deep sea corals and sponges) recognized by the Council as unique habitats important to conservation and sustainable fisheries management. In the second phase, the NEFMC will analyze the impacts of fishing on EFH and recommend appropriate management measures to be implemented within the HAPCs or elsewhere. The aim is to minimize the adverse effects of fishing to EFH. Final action on the HAPC designations and on associated management measures to protect deep sea corals will not come into force until the second phase is completed.

B. Southeast – Cape Hatteras to South Florida

Within U.S. waters, deep sea stony coral reefs reach their greatest abundance and development in the Atlantic south of Cape Hatteras (Ross and Nizinski 2007) (see Figure1). The South Atlantic Fishery Management Council (SAFMC) has authority over fisheries in Federal waters in this region, which includes the waters off North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida, including the Florida Keys. In 1984 the SAFMC recommended, and NMFS established, the *Oculina* HAPC—the world's first marine protected areas specifically designed to protect deep sea corals.

To guide conservation and management of deep sea coral ecosystems in the South Atlantic and to support mandates in the MSRA, the SAFMC voted to approve a Deepwater Research and Monitoring Plan in March 2007. The plan has two phases: mapping and describing areas harboring deep sea corals and understanding the ecological role of these unique systems. In June 2007, the SAFMC collaborated with NOAA, Gray's Reef National Marine Sanctuary, the University of North Carolina Wilmington/National Undersea Research Center (UNCW/NURC), the Harbor Branch Oceanographic Institution (HBOI), and state partners to collect new information on deepwater coral habitats in the southeast. Information gathered supports the proposed designation of three Deepwater Coral HAPCs off southern North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida (Figure 3). The proposed HAPCs will be accompanied by measures designed to protect a number of important features with deep sea coral habitats. For example, surveys off Florida revealed the presence of coral pinnacles 90 meters high and sinkholes 100 meters deep.

The SAFMC also completed two projects related to deep sea corals in 2007. A high-resolution DVD about the deep sea coral banks of the southeast region was completed in August. It introduces the subject of deep sea coral habitats off the southeastern U.S. and reviews research conducted to date. The SAFMC also completed an initial compilation of benthic habitat mapping information. The project, begun in 2001, involved acquisition, integration, and distribution of existing bottom habitat information for the South Atlantic Bight outer continental shelf and upper continental slope, including information on the locations of deep sea corals. The project was conducted in cooperation with the South Carolina Department of Natural Resources,

UNCW, the Georgia Department of Natural Resources, HBOI, and the Florida Fish and Wildlife Research Institute.

C. Gulf of Mexico – South Florida to Texas

The northern Gulf of Mexico is home to major *Lophelia pertusa* reefs and other deep sea corals (Brooke and Schroeder 2007). The Gulf of Mexico Fishery Management Council (GMFMC) has authority over fisheries in the Federal waters of the Gulf of Mexico off Texas, Louisiana, Mississippi, Alabama, and the west coast of Florida. The GMFMC has developed a Coral and Coral Reef FMP under which the harvest of all corals, with the exception of a limited harvest of some corals (gorgonians), is prohibited. The Council also recommended, and NMFS established multiple, HAPCs within its identified EFH and additional protections for shallow water coral and sponge communities (e.g., the Florida Middle Grounds and the Flower Garden Banks and McGrail Bank off the coasts of Texas and Louisiana; Figure 4). The Council has established a special Coral Scientific and Statistical Committee to review new areas that might be designated as HAPCs and recommend measures to minimize fishing impacts to these areas.

The Flower Garden Banks National Marine Sanctuary includes three banks in the northwestern Gulf of Mexico, and includes zooxanthellate corals occurring from the crest to at least 52 meters, as well as deeper communities of octocorals and black corals. Regulations implementing FMPs developed by the GMFMC, in cooperation with the Sanctuary govern fishing within the Sanctuary. In addition to the Sanctuary, selected deeper banks were designated as HAPCs within EFH in 2006 based on the occurrence of deeper water corals.

D. U.S. Caribbean Region – U.S. Virgin Islands, Puerto Rico, and Navassa Island

The U.S. Caribbean includes the waters surrounding Puerto Rico, the U.S. Virgin Islands (USVI), and Navassa Island. Navassa Island is managed as a U.S. Fish and Wildlife Service National Wildlife Refuge. The Caribbean Fishery Management Council (CFMC) has authority over fisheries in Federal waters surrounding the Commonwealth of Puerto Rico and the USVI. NMFS manages corals under the Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the U.S. Virgin Islands FMP developed by the CFMC, and regulations implementing theses FMPs prohibit bottom tending gear and anchoring in six seasonally closed areas to protect coral habitat at depths beyond 30 meters. Management of three of these areas is shared with the Government of the Commonwealth of Puerto Rico.

NOAA—in collaboration with the CFMC, the National Park Service, and the USVI and Puerto Rico territorial governments—is exploring and characterizing habitats down to 300 meters (NOAA 2007). In 2007, the R/V *Nancy Foster* surveyed two of the three managed areas off the west coast of Puerto Rico, producing bathymetry and video showing zooxanthellate coral growth at over 90 meters. Beyond these efforts, there has been limited research on true deep sea corals (i.e., species that lack symbiotic zooxanthellae) in waters of the U.S. Caribbean (Lutz and

Ginsberg 2007) (see Figure 5). The Council is considering protection of Bajo de Cico—an area west of Puerto Rico that may contain deep sea coral resources.

E. U.S. Pacific Islands – Hawaii and the United States Pacific Islands

Compared to the state of knowledge of similar resources off the continental United States, the deep sea coral resources of the Hawaiian Archipelago are poorly studied, and almost nothing is known of the deep sea coral resources of the other U.S. Pacific Islands. Gorgonians and black corals are the principal structure-forming species on deep Hawaiian slopes and seamounts (Parrish and Baco 2007). The Western Pacific Fishery Management Council (WPFMC) has authority over fisheries in most Federal waters around the State of Hawaii, the Territory of American Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Island possessions. Many of the uninhabited U.S. Pacific islands are managed by the U.S. Fish and Wildlife Service as National Wildlife Refuges. The fisheries in Federal waters over which the Council has authority have the oldest and most comprehensive restrictions designed to protect coral reef habitats from adverse impacts of fishing gear of any region in the United States. In 1983, the Council recommended, and NMFS implemented a prohibition on the use of trawl gear, bottom-set long-lines, and bottom-set gill nets—all identified as threats to deep sea corals—within all waters in their region of the U.S. EEZ.

Hawaii has had the only significant U.S. commercial harvests of black and precious corals: black, pink, and gold corals occur throughout the Hawaiian Archipelago (Figure 6). These resources have been managed since 1981 through regulations implementing the WPFMC's Precious Corals FMP and complementary State of Hawaii administrative rules. Research begun in 2001 and supported by WPFMC discovered an invasive soft coral, *Carijoa riisei* that had overgrown and killed over 50 percent of commercial black coral colonies in the Auau Channel (Kahng and Grigg 2005). Surveys of the same areas in 2006 suggest the impact of *C. riisei* on black corals has not worsened from previous surveys, and the situation may have stabilized or abated slightly (WPRFMC 2006). The extent of impacts of *C. riisei* on black corals beyond the Auau channel is unknown. The Council is working with researchers from the University of Hawaii's Institute of Marine Biology to define reproductive characteristics of black corals to further guide management of the species.

The Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands is the nation's largest comprehensively protected marine area. It is managed jointly by three co-trustees—the Department of Commerce; Department of the Interior and the State of Hawaii. The Monument contains rich deep sea coral resources. In November 2007, a collaborative research cruise by NOAA and the Hawaii Undersea Research Laboratory discovered new deep sea coral and sponge beds 1,000 to 2,000 meters below the surface.

F. U.S. West Coast Region – Washington, Oregon, and California

The seafloor off Washington, Oregon, and California contains extensive deep sea coral communities as documented in NOAA trawl survey catch records, supplemented by museum collections and underwater vehicle exploration (Whitmire and Clarke 2007; Figure 7). The Pacific Fishery Management Council (PFMC) has authority over fisheries in Federal waters of this region. The Council, working with other authorities in the region, has recommended several management measures to minimize adverse impacts from fishing that have benefited deep sea coral habitats, including marine protected areas, reductions in fishing effort, and gear restrictions. In June 2006, NOAA implemented the PFMC's comprehensive plan to protect EFH for groundfish (PFMC 2005, 2006) (see Figure 8). The plan was developed in collaboration with non-governmental organizations (NGOs), the fishing industry, and the National Marine Sanctuary Program to focus largely on pristine or untrawled habitat and habitats such as deep sea corals that are vulnerable to impacts from human activities. Over 130,000 square miles (336,700 km^2) are now protected from impacts from bottom trawls, with selected areas protected from all fishing gears that contact the bottom. Gear restrictions include coast-wide prohibitions on gear types known to have a high impact on benthic habitats, including dredge gear, beam trawl, and large footrope bottom trawl. The establishment of HAPCs and publication of recommended conservation measures (PFMC 2005) also allows NOAA to put extra focus on these areas in conducting consultations on the impacts of Federal activities other than fishing on EFH.

NOAA manages five National Marine Sanctuaries (NMS) on the West Coast: the Channel Islands NMS, the Monterey Bay NMS, the Gulf of the Farallones NMS, the Cordell Bank NMS, and the Olympic Coast NMS. All contain deep sea corals. NOAA has proposed incorporating Davidson Seamount — a volcanic seamount that is home to over 20 species of deep sea corals, as well as large sponge fields and deep sea fishes — into the Monterey Bay National Marine Sanctuary. Incorporating the Davidson Seamount would provide additional protection from impacts other than fishing and highlight the seamount's importance.

In July 2007, NOAA published a report on observations of deep sea coral and sponge assemblages in the Olympic Coast National Marine Sanctuary (Brancato et al. 2007) (see Figure 9). In September 2007, Olympic Coast Sanctuary staff presented preliminary findings of their deep sea coral/sponge information to the PFMC and stated they would supply the new coral data as it is processed. On the basis of the Sanctuary's information, the environmental group Oceana requested that the PFMC initiate an interim EFH review process to protect the newly discovered coral and sponge assemblages. In addition, Oceana asked NOAA, working with the Council, to take emergency regulatory action to protect deep sea glass sponges in Grays Canyon off Grays Harbor, Washington. The PFMC will address Oceana's requests when they review EFH designations in 2008.

In 2007 the National Marine Sanctuary Program and the Olympic Coast Sanctuary began working with the four coastal treaty tribes of Washington State (Makah, Quileute, Hoh, and Quinault) and with the State of Washington to collaborate on mutual research and resource management interests. This new Intergovernmental Policy Council (IPC) has stated that one priority concern is deep sea coral and sponge communities and their relationships to the

Federally recognized usual and accustomed fishing areas of the respective tribes. As co-managers of the fishery resource within the sanctuary, the IPC has expressed an interest in both the long-term research needs related to the distribution, abundance, and ecological role of corals and the implications for fishery management.

G. Alaska Region – Gulf of Alaska, Bering Sea, and the Aleutian Islands

The U.S. EEZ around Alaska includes the Gulf of Alaska, Aleutian Islands, and Eastern Bering Sea in the Pacific, and the Chukchi and Beaufort Seas in the Arctic. Deep sea corals appear to be rare in the Arctic, but are an important structural component of other Alaskan marine ecosystems (Figure 10) (Stone and Shotwell 2007). U.S. gorgonian deep sea corals reach their highest diversity in the Aleutian Islands, often forming structurally complex "coral gardens" with lace corals, sponges, and other sedentary taxa. Many of these corals and sponges are unidentified and many are probably examples of undescribed species. The North Pacific Fishery Management Council (NPFMC) has authority over fisheries in the 900,000-square-mile (2,330,989 km²) EEZ off Alaska.

In 2006, NOAA approved measures recommended by the Council to minimize the adverse effects of fishing on EFH, closing nearly 380,000 square miles (over 980,000 km^2) to bottom trawling. These areas, along with existing fisheries closures (Figure 11) are thought to include significant deep sea coral habitats on seamounts, continental slopes, and ocean ridges. Within this suite of measures, the Aleutian Islands Habitat Conservation Area (AIHCA) prohibits the use of non-pelagic trawl fishing gear in designated areas of the Aleutian Islands to reduce the effects of fishing on deep sea corals, sponges, and hard bottom habitats, while allowing historically-fished areas to remain open. Covering approximately 370,000 square miles (over 950,000 km²), the AIHCA represents the largest effort to conserve relatively undisturbed bottom habitats in the nation. In March 2007, the Alaska Board of Fisheries adopted regulations at the request of NOAA and the NPFMC to apply management measures of the AIHCA to state-managed fisheries in both state and Federal waters. Ongoing work will assess the change in deep sea coral bycatch by commercial fishing vessels as a result of the conservation measures.

In 2006, five additional closures were implemented that protect deep sea coral habitat, encompassing almost 17,000 square miles (44,000 km^2): the Aleutian Islands Coral Habitat Protection Areas, Bowers Ridge Habitat Conservation Zone, Alaska Seamount Habitat Protection Areas, Gulf of Alaska Coral Habitat Protection Areas, and the Gulf of Alaska Slope Habitat Conservation Areas. Within these areas, fishing with bottom contact gear by Federally permitted vessels is prohibited in the Habitat Protection Areas, fishing with non-pelagic trawl gear is prohibited in the Habitat Conservation Areas, and fishing with mobile bottom contact gear is prohibited in the Habitat Conservation Zone.

In 2007, the NPFMC recommended new measures to protect benthic fish habitat in the Bering Sea from the potential effects of bottom trawling and to provide the opportunity to further study the effects of such trawling on bottom habitat. These measures would include areas closed to bottom trawling in locations that have not been previously fished with such gear and in nearshore

bottom habitat areas that support subsistence marine resources (Figure 11). Measures adopted by the Council would also establish the Northern Bering Sea Research Area for studying the impacts of bottom trawling on benthic habitat. True soft corals are the major species occurring in these areas (Stone and Shotwell 2007), and the closures were not designed specifically to protect deep sea corals. In February 2008, NOAA issued a proposed rule that would implement the Bering Sea habitat conservation measures and requested public comment. The Council also endorsed efforts by the trawl industry to develop gear modifications that raise the trawl sweeps off the bottom. In a separate effort, a NOAA scientist participated in a 2007 Greenpeace-funded expedition to explore benthic habitat on the Bering Sea shelf break and slope that documented some deep sea coral and sponge habitats in the Pribilof and Zhemchug Canyons.

Federal Interagency Cooperation

NOAA partners with other Federal agencies to increase understanding of and protection for deep sea corals. In April 2007, the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology (JSOST) established an Interagency Board on Deep Sea Coral and other Vulnerable Marine Ecosystems. NOAA co-chairs the Board with the Department of the Interior's Minerals Management Service (MMS). The Board has identified and begun work on major opportunities for enhanced interagency collaboration in the Gulf of Mexico and on international issues related to vulnerable marine ecosystems in areas beyond national jurisdiction. The Board will coordinate interagency review of NOAA's *Deep Coral and Sponge Research and Management Strategic Plan*.

NOAA has also partnered on research and mapping with other Federal agencies, particularly the Department of the Interior's U.S. Geological Survey (USGS) and MMS to advance deep sea coral conservation and research. NOAA and USGS developed a Cold-Water Coral Geographic Database. The first version, which included deep sea coral occurrences in the Gulf of Mexico and Western Atlantic, was completed in 2007. NOAA has partnered with the United Nations Environment Program (UNEP) World Conservation Monitoring Centre to support development of a Global Cold-Water Coral Database that incorporates data from the NOAA/USGS database (http://bure.unep-wcmc.org/marine/coldcoral/Run.htm).

In 2007, NOAA and MMS continued joint exploration and study of deep sea coral and hydrocarbon seep communities in the Gulf of Mexico. This collaboration is reflected in recent and upcoming reports on deep stony corals in the Gulf (MMS 2007; USGS in prep.) and provides the basis for developing a follow-on project in which NOAA, MMS, and USGS will collaborate.

Also in 2007, NOAA teamed with the Institute for Exploration, Immersion Presents, and the U.S. Navy for an expedition in the northwest Gulf of Mexico. The mission explored deep hard bottom formations used as habitat for fish and benthic organisms. It combined on-site and remote science, education, and outreach activities and involved two surface ships and the Navy nuclear-powered submarine NR-1.

International Activities

In the late 1990s, the international community began to recognize the need for more measures to protect deep sea coral ecosystems. Efforts through the United Nations General Assembly (UNGA) culminated in a December 2006 Sustainable Fisheries Resolution (Box 3) that calls upon States and Regional Fisheries Management Organizations and Agreements (RFMO/As) to ensure the sustainable management of fish stocks and the protection of vulnerable marine ecosystems (VMEs), including seamounts, hydrothermal vents and cold-water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain.

Box 3. UNITED NATIONS GENERAL ASSEMBLY SUSTAINABLE FISHERIES RESOLUTION 61/105 (2006)

The UNGA Resolution calls upon RFMO/As to:

- Assess whether individual bottom fishing activities would have significant adverse impacts on VMEs and, if so, manage such fishing to prevent such impacts or not authorize it to proceed;
- Identify VMEs and determine if bottom fishing would cause significant adverse impacts to either the VMEs or the long term sustainability of deep sea fish stocks through, among others, by improving scientific research, data collection and sharing, and through new and exploratory fisheries;
- Close areas to bottom fishing where VMEs are known to occur or are likely to occur based on the best available scientific information, and not allow such fishing to proceed unless conservation and management measures are in place to prevent significant adverse impacts on VMEs;
- Cease bottom fishing if a VME is encountered and report the location so that appropriate measures can be adopted in respect of the relevant site; and
- Make the relevant measures adopted in accordance with resolution 61/105 public.

The text calls for RFMO/As to comply with these provisions no later than December 31, 2008. States participating in negotiations to establish new RFMO/As competent to regulate bottom fisheries should implement interim measures, consistent with the above provisions, by December 31, 2007. Further, flag States should adopt and implement the above measures or cease authorizing bottom fishing in areas where there is no competent RFMO/A or where no interim measures have been adopted in conjunction with new RFMO/A negotiations.

NOAA, in partnership with the State Department, has been actively involved in regional negotiations to implement the provisions of the 2006 UNGA resolution. Appendix 2 shows steps adopted by several RFMOs to protect vulnerable marine ecosystems, including deep sea corals. In addition, the U.S. is currently participating in negotiations to establish two new regional fisheries management organizations or arrangements to manage bottom fisheries: one in the Northwest Pacific and one in the South Pacific. In 2007, both organizations agreed to interim

non-binding provisions that are fully consistent with UNGA resolution 61/105, as well as provisions for data collection and monitoring, and measures to freeze current bottom fishing, both in terms of effort or catch and areas fished. The U.S. efforts on these issues have been guided by the President's Memorandum to the Secretaries of State and Commerce (Appendix 3), which highlights the importance of addressing destructive fishing practices that destroy the long-term natural productivity of fish stocks or habitats such as seamounts, corals, and sponge fields for short term gain.

The U.S. is working through the Food and Agriculture Organization of the United Nations to develop technical guidelines on the management of deep-sea fisheries in the high seas, including criteria for identifying VMEs, including deep sea corals, beyond areas under national jurisdiction and the impacts of fishing activities on such ecosystems, in order to facilitate the adoption and the implementation of conservation and management measures by RFMO/As and flag States pursuant the UNGA Resolution 61/105. In February 2008, the U.S. participated in a Technical Consultation to finalize International Guidelines for the Management of Deep-Sea Fisheries in the High Seas.

Pursuant to the MSRA, NMFS published regulations codifying the legislative definition of "Illegal, Unreported and Unregulated (IUU) fishing," which includes fishing activities that have an adverse impact on seamounts, hydrothermal vents, and cold water corals located beyond national jurisdiction, for which there are no applicable conservation or management measures or in areas with no applicable international fishery management organization or agreement. The Department of Commerce, in consultation with the Department of State and other relevant agencies, is developing regulations to implement measures of the Act addressing IUU fishing, including proposed additions to the legislative definition.

The U.S. is working through the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) to address the impacts of trade on deep sea corals. All black, hydrozoan, and stony corals are included in Appendix II of CITES. These listings allow trade under permit but are designed to ensure the harvest and trade is legal and non-detrimental to wild populations. In 2007, NOAA, working with the Department of State and the Department of Interior's U.S. Fish and Wildlife Service, prepared a U.S. proposal to add precious red and pink corals of the genus *Corallium* to CITES Appendix II. This proposal was narrowly defeated in the CITES 14th Conference of the Parties in June 2007. The U.S. will consider re-submission of a listing proposal to the next CITES Conference of the Parties based on the results of two planned technical workshops.

NOAA is working actively with the State Department and other agencies in other fora, including the International Coral Reef Initiative, Census of Marine Life, and International Council for the Exploration of the Sea (ICES) to enhance understanding and conservation of deep sea coral and other deep sea ecosystems. NOAA chairs the Northwest Atlantic Fishery Organization/ICES Working Group on Deepwater Ecology, which is compiling a database and map of areas where biological research/survey, including deep sea coral research, has occurred in the deep water of the North Atlantic.

8. Conclusions and Next Steps

Exploration and research by NOAA and others have revealed that deep sea corals form habitats of remarkable biological diversity along continental shelves, slopes, and seamounts around the world. Their potential biological, economic, and commercial importance make them national and international assets of particular conservation interest. To this end, the National Research Council, Pew Commission, and U.S. Commission on Ocean Policy recommended enhanced research on and protection of deep sea corals. The President's *Ocean Action Plan* calls for increased efforts to "research, survey, and protect deep sea coral communities." In response to these recommendations and calls to action, Congress authorized establishment of a Deep Sea Coral Research and Technology Program under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, Public Law 109-479 (MSRA).

This report reflects NOAA's growing understanding of the importance of deep sea coral ecosystems, and NOAA's commitment to ensuring their enhanced conservation. NOAA has both the statutory authority and the capacity to improve understanding and management of these systems.

NOAA is developing a *Deep Coral and Sponge Research and Management Strategic Plan* to guide implementation of the Deep Sea Coral Research and Technology Program. The *Strategic Plan* will identify goals, priorities, and approaches to guide NOAA's research, management, and international cooperation activities as they relate to deep sea coral and sponge communities and the ecosystems of which they are part. The primary goal of the *Strategic Plan* is to improve research, conservation, and management of deep sea coral and sponge communities, while balancing long-term uses of the marine ecosystem with maintenance of biodiversity. The *Strategic Plan* builds upon research and conservation priorities NOAA has identified internationally, nationally, and within each region.

Although important management measures have been implemented recently, much more needs to be done. NOAA has requested $1.5 million in the President's Fiscal Year 2009 Budget to begin to implement priority activities of the Deep Sea Coral Research and Technology Program:

1. ***Identify existing research on, and known locations of, deep sea corals.***
NOAA has made significant strides in bringing together existing information through *The State of Deep Coral Ecosystems of the United States.* Expanding these efforts to analyze data, integrate new findings, and make data available in usable formats will require development of GIS databases for use by the research, management, and education communities. NOAA will build on experience form NOAA's Coral Reef Information System (CoRIS) and on existing database partnerships with USGS and UNEP's World Conservation Monitoring Centre.

2. ***Locate and map the distribution and abundance of deep sea corals.***
NOAA and the Regional Fishery Management Councils have identified mapping and characterization of deep sea coral habitats as a basic requirement for an ecosystem approach to management. This will require significant resources and dedicated ship-based mapping surveys to locate deep sea coral communities, including high-resolution acoustic mapping

with ground-truthing and finer scale characterization via remotely operated vehicles or submersibles and other instruments. High-resolution mapping will build on existing low-resolution data and predictive models. NOAA has identified particular needs for mapping deep sea coral areas off the southeastern U.S. and within existing National Marine Sanctuaries. NOAA plans to begin this effort with one deep sea coral mapping, characterization and research cruise. Thorough mapping and characterization in a region will require research conducted over multiple years.

3. *Monitor activities in locations where deep sea corals are known or are likely to occur.*

NOAA, assisted by recommendations from the Regional Fishery Management Councils, has primary responsibility for managing fisheries in the U.S. EEZ. In many regions, certain fishing practices, especially the use of mobile bottom-tending gear, can adversely affect deep sea corals and the marine organisms associated with them. Bycatch of deep sea corals provides important information on the location of corals and impacts of these fisheries.

In cooperation with fishing industry participants, NOAA will use currently collected information to map the distribution and intensity of fishing practices known to impact deep sea coral communities and analyze reports of coral bycatch (all efforts would ensure appropriate confidentiality of fishing statistics). A pilot project on the West Coast to train observers in deep sea coral and sponge identification for documenting bycatch is yielding promising results and should be expanded to other regions. Subsequent efforts could build upon interagency partnerships to expand mapping and monitoring to human activities other than fishing that are likely to impact deep sea corals.

4. *Conduct research, including cooperative research with fishing industry participants, on deep sea corals and related species, and on survey methods.*

Research conducted in association with dedicated mapping and characterization cruises will focus on the ecology of deep sea corals and their role and function in supporting various life stages of managed fish stocks. Understanding the role that deep corals play in supporting sustainable fisheries and healthy fish populations is a priority for NOAA. NOAA will also coordinate and integrate analysis of relevant information from mapping and research efforts conducted under other mandates. Identifying technologies to assist with locating and characterizing deep sea coral communities, and working with partners to develop such capabilities is a long-term NOAA priority.

5. *Develop technologies or methods to assist fishing industry participants in reducing interactions between fishing gear and deep sea corals.*

NOAA currently works with fishing industry participants on technologies to reduce bycatch and gear damage to habitats. Given the fragility of deep sea coral habitats and the expected long recovery times, priority under the Deep Sea Coral Research and Technology Program will be given to approaches that help participants avoid deep sea coral areas, to complement technological efforts underway through other programs.

Program activities will be prioritized in areas where management needs are greatest and where deep sea corals are known to occur or where scientific modeling or other methods predict deep

sea corals are likely to be present. Where necessary management measures should minimize human impacts to the currently known resources.

NOAA recommends that the Regional Fishery Management Councils evaluate areas for protection known to contain deep sea corals as allowed under discretionary provisions of the MSA as amended (Box 4). An initial list of areas with limited protection from interactions with fishing gear is included in Appendix 1. Many of the areas listed are being considered for designation as HAPCs, which could afford additional protection for these areas from human activities including fishing.

Box 4. MSA SECTION 303(b) AS AMMENDED BY THE MAGNUSON-STEVENS FISHERIES CONSERVATION AND MANAGEMENT ACT OF 2006. DICRETIONARY PROVISIONS OF FISHERY MANAGEMENT PLANS TO ALLOW DEEP SEA CLOSURE AREAS

303 (b) DISCRETIONARY PROVISIONS.--Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, may—…

(2) (A) designate zones where, and periods when, fishing shall be limited, or shall not be permitted, or shall be permitted only by specified types of fishing vessels or with specified types and quantities of fishing gear;

(B) designate such zones in areas where **deep sea corals** are identified under section 408, to protect **deep sea corals** from physical damage from fishing gear or to prevent loss or damage to such fishing gear from interactions with deep sea corals, after considering long-term sustainable uses of fishery resources in such areas;

In addition to domestic activities, NOAA will continue to work with international partners to enhance understanding and conservation of vulnerable marine ecosystems, including deep sea coral and sponge ecosystems. NOAA and the State Department will continue to actively engage in negotiations to protect these ecosystems in various RFMO/As and through other regional and multilateral organizations.

NOAA recognizes that deep sea sponges can play ecological roles similar to those of deep sea corals, thus contributing to ocean biodiversity. Deep sea coral and sponge ecosystems also face similar threats. The vulnerability of deep sea sponge fields to destructive fishing practices was recognized in the President's 2006 Memorandum (Appendix 3). NOAA plans to collect complementary information, if available, on high biodiversity, deep sea sponge habitats.

References

Auster PJ (2005) Are deep-water corals important habitats for fishes? Pages 747-760 in Freiwald A, Roberts JM (eds.) Cold-water Corals and Ecosystems, Springer-Verlag, Berlin Heidelberg

Brancato MS, Bowlby CE, Hyland J, Intelmann SS, Brenkman K (2007) Observations of deep coral and sponge assemblages in Olympic Coast National Marine Sanctuary, Washington. Cruise Report: NOAA Ship *McArthur II* Cruise AR06-06/07. Marine Sanctuaries Conservation Series NMSP-07-03. NOAA National Marine Sanctuary Program, Silver Spring, Maryland

Ehrlich H, Etnoyer P, Litvinov SD, Olennikove M, Domaschke H, Hanke T, Born R, Meissner H, Worch H (2006) Biomaterial structure in deep-sea bamboo coral (Gorgonaceas: Isididae): perspectives for the development of bone implants. Materialwissenschaft und Werkstofftechnik 37(6):553-557

Fosså JH, Mortensen PB, Furevik DM (2002) The deep-water coral *Lophelia pertusa* in Norwegian waters: distribution and fishery impacts. Hydrobiologia 471:1-12

Federal Register (FR) 2005. Notice of NMFS Decision and Response to Public Comments on the Oceana Deep-Sea Coral and Sponge Rulemaking Petition. (Vol. 70 No. 131; 39700-39714) July 11, 2005.

Freiwald A, Fosså JH, Grehan A, Koslow T, Roberts JM (2004) Cold-water coral reefs. United Nations Environment Programme-World Conservation Monitoring Centre. Cambridge, UK

Grehan AJ, Unnithan V, Olu-Le Roy K, Opderbecke J (2005) Fishing impacts on Irish deepwater coral reefs: Making a case for coral conservation. Pages 819-832 in Barnes PW, Thomas JP (eds.), Benthic habitats and the effects of fishing. American Fisheries Society Symposium 41, Bethesda, Maryland

Hall-Spencer J, Allain V, Fosså JH (2001) Trawling damage to northeast Atlantic ancient coral reefs. Proceeding of the Royal Society of London Series B 269:507-511

Hecker B, Blechschmidt G (1980). Final historical coral report for the canyon assessment study in the Mid- and North Atlantic areas of the U.S. outer continental shelf: epifauna of the northeastern U.S. continental margin. Appendix A. In: Canyon Assessment Study. U.S. Department of Interior Bureau of Land Management, Washington, DC, USA, No. BLM-AA551-CT8-49.

Hecker B, Logan DT, Gandarillas FE, Gibson PR (1983). Megafaunal assemblages in Lydonia Canyon, Baltimore Canyon, and selected slope areas. Pages 1-140. In: Canyon and slope processes study: Vol. III, biological processes. Final report for U.S. Department of Interior, Minerals Management Service. No. 14-12-001-29178.

Hourigan TF, Lumsden SE, Dorr G, Bruckner AW, Brooke S, Stone RP (2007) Deep Coral Ecosystems of the United States: Introduction and National Overview. Pages 1-65 in Lumsden SE, Hourigan TF, Bruckner AW, Dorr G (eds.), The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Husebø A, Nøttestad L, Fosså JH, Furevik DM, Jørgensen SB (2002) Distribution and abundance of fish in deep-sea coral habitats. Hydrobiologia 471:91-99

Kahng SE, Grigg RW (2005) Impact of an alien octocoral, *Carijoa riisei*, on black corals in Hawaii. Coral Reefs 24:556-562

Koenig CC, Shephard AN, Reed JK, Coleman FC, Brooke SD, Brusher J, Scanion KM (2005) Habitat and fish populations of the deep-sea *Oculina* coral ecosystem of the Western Atlantic. Pages 795-805 in Barnes PW, Thomas JP (eds.), Benthic habitats and the effects of fishing. American Fisheries Society Symposium 41, Bethesda, Maryland

Koslow JA, Boehlert GW, Gordon JDM, Haedrich RL, Lorance P, Parin N (2000) Continental slope and deep-sea fisheries: implications for a fragile ecosystem. ICES Journal of Marine Science 57:548-557

Krieger KJ (2001) Coral (*Primnoa*) impacted by fishing gear in the Gulf of Alaska. Pages 106-116 in Willison et al. (eds.) Proceedings of the First International Symposium on Deep-Sea Corals, Ecology Action Centre and Nova Scotia Museum, Halifax, Nova Scotia

Krieger KJ, Wing BL (2002) Megafaunal associations with deepwater corals (*Primnoa* spp.) in the Gulf of Alaska. Hydrobiologia 471:83-90

Lumsden, SE, Hourigan TF, Bruckner AW, Dorr G (eds.) (2007) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Lutz SJ, Ginsburg RN (2007) State of Deep Coral Ecosystems in the Caribbean Region: Puerto Rico and the U.S. Virgin Islands. Pages 307-365. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). Available online at: http://www.nmfs.noaa.gov/msa2007

Marine Fisheries Advisory Committee (MAFAC) (2005) Cold Water Coral Report, MAFAC Meeting. Honolulu, Hawaii, January 11-14, 2005.

McDonough JJ, Puglise K (2003) Summary: Deep-Sea Corals Workshop. International Planning and Collaboration Workshop for the Gulf of Mexico and the North Atlantic Ocean.

Galway, Ireland, January 16-17, 2003. U.S. Dep. Commerce, NOAA Tech. Memo, NMFS-F/SPO-60

Minerals Management Service (MMS) (2007) Characterization of Northern Gulf of Mexico Deepwater hard-Bottom Communities with Emphasis on *Lophelia* Coral. http://www.gomr.mms.gov/homepg/regulate/environ/techsumm/rec_pubs.html

National Research Council (NRC) (2002) Effects of trawling and dredging on seafloor habitat. National Academy Press, Washington D.C.

New England Fishery Management Council (2007) Essential Fish Habitat (EFH) Omnibus Amendment; Phase 1

NOAA (2007) Benthic Habitat Characterization and Bathymetry of Mid-water Habitats in the USVI and Puerto Rico (2007). Project on-line prospectus, accessed July 2007. Available on-line at: http://www8.nos.noaa.gov/nccos/npe/projectdetail.aspx?id=402&fy=2007

Pacific Fishery Management Council (PFMC) (2005) Pacific coast groundfish fishery management plan: essential fish habitat designation and minimization of adverse impacts: Final environmental impact statement. Pacific Fishery Management Council, Portland, Oregon

Pacific Fishery Management Council (PFMC) (2006) Amendment 19 to the Pacific coast groundfish fishery management plan: Essential fish habitat designation and minimization of adverse impacts. Pacific Fishery Management Council, Portland, Oregon

Packer DB, Boelke D, Guida V, McGee LA (2007) State of Deep Coral Ecosystems in the Northeastern U.S. Region: Maine to Cape Hatteras. Pages 195-232. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Parrish FA, Baco AR (2007) State of Deep Coral Ecosystems in the Western Pacific Region: Hawaii and the United States Pacific Islands. Pages 155-194. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Puglise, KA, Brock RJ, McDonough JJ (2005) Identifying critical information needs and developing institutional partnerships to further the understanding of Atlantic deep-sea coral ecosystems. Pages1129-1140 in Freiwald A, Roberts JM (eds.) Cold-water Corals and Ecosystems, Springer-Verlag, Berlin Heidelberg

Risk MJ, Heikoop JM, Snow MG, Beukens B (2002) Lifespans and growth patterns of two deep sea corals: *Primnoa resedaeformis* and *Desmophyllum cristagalli*. Hydrobiologia 471:125-131

Rogers AD (1999) The biology of *Lophelia pertusa* (Linnaeus 1758) and other deep-water reef-forming corals and impacts from human activities. International Review of Hydrobiology 84:315-406

Ross SW and Nizinski MS (2007) State of Deep Coral Ecosystems in the Southeast Region: Cape Hatteras to Southeast Florida. Pages 233-269. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Scanlon KM, Waller RG, Sirotek AR, Knisel JM, and Alesandrini S (in prep.) USGS Cold-Water Coral Geographic Database – Gulf of Mexico and Western North Atlantic, Version 1.0, U.S. Geological Survey Open-file Report OF2007- XXX.

Stiles ML, Yitalo-Ward H, Faure P, Hirshfield MF (2007) There's no place like home: Deep seafloor ecosystems of New England and the Mid-Atlantic. Oceana. Washington D.C. 36 pp.

Stone RP (2006) Coral habitat in the Aleutian Islands of Alaska: depth distribution, finescale species association, and fisheries interactions. Coral Reefs 25:229–238

Stone RP and Shotwell SK (2007) State of Deep Coral Ecosystems in the Alaska Region: Gulf of Alaska, Bering Sea and the Aleutian Islands. Pages 65-108. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Theroux RB, Wigley RL (1998) Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. NOAA Technical Report NMFS-140. Silver Spring, Maryland

Tissot BN, Yoklavich MM, Love MS, York K, Amend M (2006) Benthic invertebrates that form habitat on deep banks off southern California, with special reference to deep sea coral. Fishery Bulletin 104(2):167-181

UN General Assembly Resolution 61/105 (UNGA 61/105) (2006) Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments. Available online at: http://www.un.org/Depts/los/general_assembly/general_assembly_resolutions.htm

U.S. Geological Survey (USGS) in prep. *Lophelia* Reef Megafaunal Community Structure, Biotopes, Genetics, Microbial Ecology, and Geology

Waller R, Watling L, Auster P, Shank T (2007) Anthropogenic impacts on the Corner Rise Seamounts, NW Atlantic Ocean. Journal of the Marine Biological Association of the United Kingdom. 87:1075-1076.

Watling L, Auster P J (2005) Distribution of deepwater alcyonacea off the northeast coast of the United States. Pages 279-296. In: Freiwald A, Roberts JM (eds.) Cold-water Corals and Ecosystems, Springer-Verlag, Berlin Heidelberg

Watling L, Auster P, Babb I, Skinder C, Hecker B (2003) A geographic database of deepwater alcyonaceans of the northeastern U.S. continental shelf and slope. Version 1.0 CD-ROM. National Undersea Research Center, University of Connecticut, Groton, USA

Wheeler AF, Bett BJ, Billett DS, Masson DG, Mayor D (2005) The impact of demersal trawling on northeast Atlantic coral habitats: The case of the Darwin Mounds, United Kingdom. Pages 807-817. In Barnes PW, Thomas JP (eds.), Benthic habitats and the effects of fishing. American Fisheries Society Symposium 41, Bethesda, Maryland

Whitmire CE and Clarke ME (2007) State of Deep Coral Ecosystems of the U.S. Pacific Coast: California to Washington. Pages 109-154. In: Lumsden SE, Hourigan TF, Bruckner AW and Dorr G (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Technical Memorandum CRCP-3, Silver Spring, Maryland

Williams B, Risk MJ, Ross SW, Sulak KJ (2006) Deep-water Antipatharians: proxies of environmental change. Geology 34(9):773-776

Western Pacific Regional Fishery Management Council (WPRFMC) (2006) Black Coral Science and Management Workshop. WPRFMC Report. April 18-19, 2006. Honolulu, Hawaii

Appendices

Appendix 1. Deep Sea Coral Areas in the U.S. EEZ with Limited Protection from Interactions with Fishing Gear

Below is an initial list of areas known to contain aggregations of deep sea corals that currently have limited or no protection from interactions with bottom-tending fishing gear; it is not a complete list of deep sea coral areas. The Councils are considering many of these areas for HAPC designations. The areas were identified through NOAA survey and research cruises, research by academic and Federal partners, and information collected by Regional Fishery Management Council and National Marine Sanctuary processes. Detailed location data for deep sea coral resources associated with these general areas will be made available to the Councils. NOAA will continue to develop the list as research continues and new information on the location of deep sea corals is obtained.

Fishery Management Council (FMC) Region	Identified Area with Deep Sea Corals	Current Status of Protection from Bottom-Tending Fishing Gear Impacts	Reference
New England FMC	Bear Seamount	• NEFMC Proposed HAPC	Packer et al. 2007; NEFMC 2007.
	Retriever Seamount	• NEFMC Proposed HAPC	Packer et al. 2007; NEFMC 2007.
	Heezen Canyon	• NEFMC Proposed HAPC	Hecker and Belchschmidt 1980; Watling et al. 2003 ; Packer et al. 2007; NEFMC 2007
	Lydonia Canyon	• NE & MAFMC monkfish bottom-trawl & gill net closure • MAFMC squid, mackerel, & butterfish bottom-trawl closure	Watling et al. 2003; Packer et al. 2007.
	Oceanographer Canyon	• NE & MAFMC monkfish bottom-trawl & gill net closure • MAFMC squid, mackerel, & butterfish bottom-trawl closure	Watling et al. 2003; Packer et al. 2007.
	Veatech Canyon[2]	• NEFMC Proposed HAPC	Hecker and Belchschmidt 1980; Hecker et al. 1983; Watling et al. 2003; Packer et al. 2007; NEFMC 2007

[2] Deep sea corals were found near the head of this canyon and on nearby slopes, but it is unclear from the literature if deep sea corals have been found in the canyon proper.

Fishery Management Council (FMC) Region	Identified Area with Deep Sea Corals	Current Status of Protection from Bottom-Tending Fishing Gear Impacts	Reference
New England FMC (cont.)	Slope near Alvin Canyon	• NEFMC Proposed HAPC	Hecker and Belchschmidt 1980; Watling et al. 2003; Packer et al. 2007; NEFMC 2007.
	Western Jordan Basin	• No special protections	Auster 2005 and Watling et al. 2003
	Mount Dessert Rock Area	• No special protections	Auster 2005 and Watling et al. 2003
	Georges Tower off the Northern Edge of Georges Bank	• No special protections	Watling and Auster 2005
Mid-Atlantic FMC	Toms/Carteret Canyon	• NEFMC Proposed HAPC	Hecker and Belchschmidt 1980 ; Watling et al. 2003 ; Packer et al. 2007 ; NEFMC 2007.
	Hendrickson Canyon	• NEFMC Proposed HAPC	Hecker et al. 1983 ; Watling et al. 2003 ; NEFMC 2007.
	Baltimore Canyon	• NEFMC Proposed HAPC	Watling et al. 2003; Packer et al. 2007 ; NEFMC 2007
	Norfolk Canyon	• NEFMC Proposed HAPC	Watling et al. 2003; Packer et al. 2007 ; NEFMC 2007
South Atlantic FMC	North Carolina *Lophelia* banks	• SAFMC Proposed HAPC	Ross and Nizinski (2007)
	Stetson Banks	• SAFMC Proposed HAPC	Ross and Nizinski (2007)
	Savannah Banks	• SAFMC Proposed HAPC	Ross and Nizinski (2007)
	Cape Canaveral Banks	• SAFMC Proposed HAPC	Ross and Nizinski (2007)
	Miami Terrace	• SAFMC Proposed HAPC	Ross and Nizinski (2007)
	Pourtales Terrace (shared with GOM Council)	• SAFMC Proposed HAPC	Brooke and Schroeder (2007)
Gulf of Mexico FMC	Pourtales Terrace (shared with SA Council)	• SAFMC Proposed HAPC	Brooke and Schroeder (2007)
	Southwest Florida Slope *Lophelia* lithoherms	• No special protections	Brooke and Schroeder (2007)
	Mississippi-Alabama Pinnacles	• No special protections	Brooke and Schroeder (2007)
	Viosca Knoll	• No special protections	Brooke and Schroeder (2007)
	Mississippi Canyon	• No special protections	Brooke and Schroeder (2007)

Fishery Management Council (FMC) Region	Identified Area with Deep Sea Corals	Current Status of Protection from Bottom-Tending Fishing Gear Impacts	Reference
Gulf of Mexico FMC (cont)	Green Canyon	• No special protections	Brooke and Schroeder (2007)
	Northwest Texas-Louisiana Shelf Banks	• East and West Flower Garden Banks; Stetson Banks and McGrail Bank – Anchoring, bottom trawl gear, bottom longlines, buoy gear, and all traps/pots prohibited to protect coral. • Numerous banks in the NW Gulf of Mexico harbor significant populations of deep water corals, are HAPCs, but do not carry any protection measures. These include, but are not limited to: 29 Fathom, Elvers, MacNeil, Rankin, 28 Fathom, Bright, Geyer, Elvers, Sonnier, Bouma, Rezak, Sidner, Parker, Alderdice, and Jakkula Banks.	GMFMC 2006
Caribbean FMC	Mona Passage – Puerto Rico	• No special protections	Lutz and Ginsberg (2007)
Western Pacific FMC	All areas of the EEZ are protected from bottom-tending gear.	• Areas in the EEZ are protected from bottom-tending gear • Areas within the National Monument are fully protected.	Parrish and Baco (2007)
North Pacific FMC[3]	Bering Sea Slope	• The shelf break and upper slope, including areas of Pribilof and Zhemchug Canyons, contain areas of deep sea corals that currently have no special protections. • Deeper areas near the base of the slope are protected from bottom trawling.	Stone and Shotwell (2007); AFSC (2007)
	Aleutian Island "coral gardens"	• Six Aleutian Island "coral gardens" documented in 2002 were protected in 2006 from all bottom-contact gear, and additional vast areas of seafloor are protected from bottom trawling. • Since 2005, additional coral gardens have been discovered, some of which are in areas not currently protected.	Stone and Shotwell (2007); AFSC (2007)
	Gulf of Alaska Primnoa Coral habitats[4]	• Bottom-contact gear is prohibited from five small areas in the Gulf of Alaska to protect red tree corals (*Primnoa* sp.). Recently surveys in and near the protected areas indicate that significant coral resources are present outside the protected areas.	Stone and Shotwell (2007); AFSC (2007)

[3] NOAA trawl surveys indicate that many deep sea coral habitats occur in the Gulf of Alaska and the Aleutian Island chain. The identified areas are only a few that have received more directed field study using ROVs or submersibles.
[4] Including Fairweather Ground and Shatter Ridge (southwest of Cape Ommaney).

Fishery Management Council (FMC) Region	Identified Area with Deep Sea Corals	Current Status of Protection from Bottom-Tending Fishing Gear Impacts	Reference
Pacific FMC[5]	Olympic Coast National Marine Sanctuary Octocoral, stylasterid and scleractinian (*Lophelia pertusa*) aggregations	• Portions of the Sanctuary are protected from bottom-trawling conducted under regulations implementing PFMC management plans. • Recent surveys discovered deep sea corals outside the no-trawl area.	Brancato et al. 2007; Whitmire and Clarke 2007
	Monterey Canyon (gorgonians)	• Certain areas have no special protections	Whitmire and Clarke 2007
	Astoria Canyon (gorgonians and black corals)	• Certain areas have no special protections	Whitmire and Clarke 2007

[5] NOAA trawl surveys indicate that many deep sea coral habitats occur along the continental shelf edge and slope along the West Coast. The identified areas are only a few that have received more directed field study using ROVs or submersibles.

Appendix 2. Measures Implemented by RFMOs to Protect VMEs Including Deep Sea Coral Habitats Beyond National Jurisdiction

MEASURES			INTERIM MEASURES		
CCAMLR	NAFO	SEAFO	NEAFC	NW Pacific	SPRFMO
Adopted in 2007: - Covers bottom fishing activities (the use of any gear that interacts with the bottom); -Thru 11/08, freezes footprint to areas currently approved for bottom fishing; - Starting 12/1/08, all individual bottom fishing activities are subject to assessment by SC; and - Measure to be reviewed in 2008 (based on SC findings), and in 2009 and biennially thereafter to assess effectiveness of CMMs.	Adopted in 2006: Closure of 4 seamounts to all demersal gear for 2007-2010, w/ option for exploratory fishing based on SC advice Adopted in 2007: Coral Protection measure only -- closed area to all fishing from 1/08 to 12/12; SC to develop data collection program; Com to review in 2012 based on SC advice Plan for 2008: Special meeting in May, 2008 to address measures for VMEs	Adopted in 2006: Closure of 10 seamounts to all fishing activity for 2007-2010, w/ option for exploratory fishing based on SC advice. Adopted in 2007: - Given absence of SC advice, 2006 measure areas remain closed; - Fishing cannot resume until VMEs are identified and mapped and impacts assessed.	Adopted in 2004: Bottom trawling and fishing with static gear prohibited in 4 seamounts 1//1/05-12/31/07 2006 Measure: Collection of data on deep seas species during 2007; to be used by NEAFC WG to propose mgmt measures (Note: NEAFC Annual Meeting is 12-16 Nov 2007)	Adopted 1/07; amended 10/07: Freeze footprint to current bottom fishing effort and seamounts/areas fished; may be exceptions if determined there would be no significant adverse impacts (criteria to be developed); prohibit bottom fishing in areas where VMEs are known/likely to occur by 31 Dec 2008 if c/m measures have not been established to prevent significant adverse impacts; data collection/sharing,; Vessel Monitoring Systems (VMS) (by 12/07).	Adopted 5/07: Freezing fishing effort and areas fished to existing or current levels; data collection/sharing, VMS (by 12/07) and observers (100% on bottom trawlers; others as app.), and prohibit bottom fishing in areas where VMEs are known/likely to occur unless c/m measures established to prevent significant adverse impacts by 30 Sept 2007.

CCAMLR: Convention on the Conservation of Antarctic Marine Living Resources
NAFO: Northwest Atlantic Fishery Organization
SEAFO: Southeast Atlantic Fishery Organization
NEAFC: Northeast Atlantic Fishery Organization
NW Pacific Fishery Organization
SPRFMO: South Pacific Regional Fishery Management Organization

Appendix 3. President Bush's Memorandum on Sustainable Fisheries and Destructive Fishing Practices. October 3, 2006

THE WHITE HOUSE
PRESIDENT
GEORGE W. BUSH

For Immediate Release
Office of the Press Secretary
October 3, 2006

Memorandum for the Secretary of State and the Secretary of Commerce

SUBJECT: Promoting Sustainable Fisheries and Ending Destructive Fishing Practices

It shall be the policy of the United States, in advancing the interests of the American people, to support the maintenance and use of sustainable fisheries (1) as a source of nutritious food for the United States and the rest of the world, and (2) to meet the needs of commercial and recreational fishing. To implement the policy set forth above, the Secretary of State, after consultation with the Secretary of Commerce, shall:

(1) work with other countries and international organizations to eliminate fishing practices that (a) jeopardize fish stocks or the habitats that support them, or (b) provide a commercial advantage to those who engage in such practices that is unfair in comparison with their competitors;

(2) work within Regional Fishery Management Organizations (RFMOs), and through other cooperative arrangements, to establish rules based on sound science to enhance sustainable fishing practices and to phase out destructive fishing practices;

(3) work with other countries to establish new RFMOs, or other cooperative institutional arrangements, to protect ecosystems in high seas areas where no competent RFMO or other arrangement exists, including calling on all nations to protect vulnerable marine ecosystems by prohibiting their vessels from engaging in destructive fishing practices in areas of the high seas where there are no applicable conservation or management measures or in areas with no applicable international fishery management organization or agreement, until such time as conservation and management measures consistent with the goals of the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265, as amended), the United Nations Fish Stocks Agreement, and other relevant instruments are adopted and implemented to regulate such vessels and fisheries;

(4) work with other countries to develop and promulgate criteria to guide the determination of which marine ecosystems are or are not at risk of damage or loss because of destructive fishing practices; and

(5) work with other countries to combat through enhanced monitoring and surveillance, including through the use of Vessel Monitoring Systems and other technologies, fishing that is unlawful, unregulated, and unreported.

Further, to implement the policy set forth above, the Secretary of State, after consultation with the Secretary of Commerce, shall carry out diplomatic activities for the purposes of (a) ending destructive fishing practices, and (b) promoting rules based on sound science to support sustainable fisheries and to end destructive fishing practices.

As used in this memorandum, the term "destructive fishing practices" are practices that destroy the long-term natural productivity of fish stocks or habitats such as seamounts, corals, and sponge fields for short term gain.

This memorandum shall be implemented consistent with applicable law and subject to the availability of appropriations. It is intended only to improve the internal management of the executive branch and is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by a party against the United States, its departments, agencies, entities, officers, employees, or agents, or any other person.

GEORGE W. BUSH

# # #

Figures

Figure 1. Known Locations of Major Deep Sea Corals in Waters of the U.S. Atlantic

The data represent known locations of major structure-forming species of gorgonian, stony, and stylasterid deep sea corals included in the USGS and (Scanlon et al. in prep; Watling et al. (2003) databases. Data do not represent density of coral cover but rather known locations and may reflect fishing or research effort. Location data are particularly incomplete for corals other than stony corals in the Gulf of Mexico.

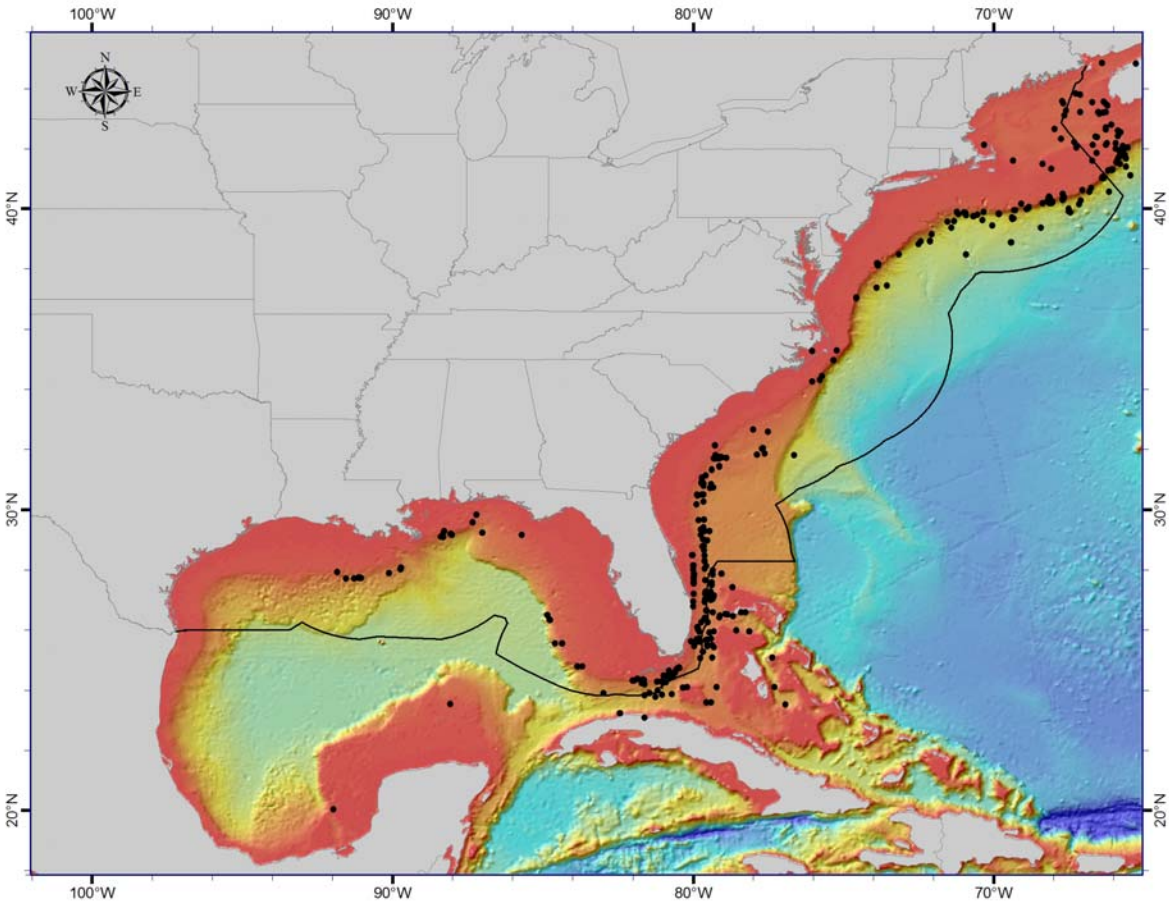


Figure 2. Known Deep Sea Coral Locations in the Northeast U.S. with Management Areas

(Packer et al. 2007)

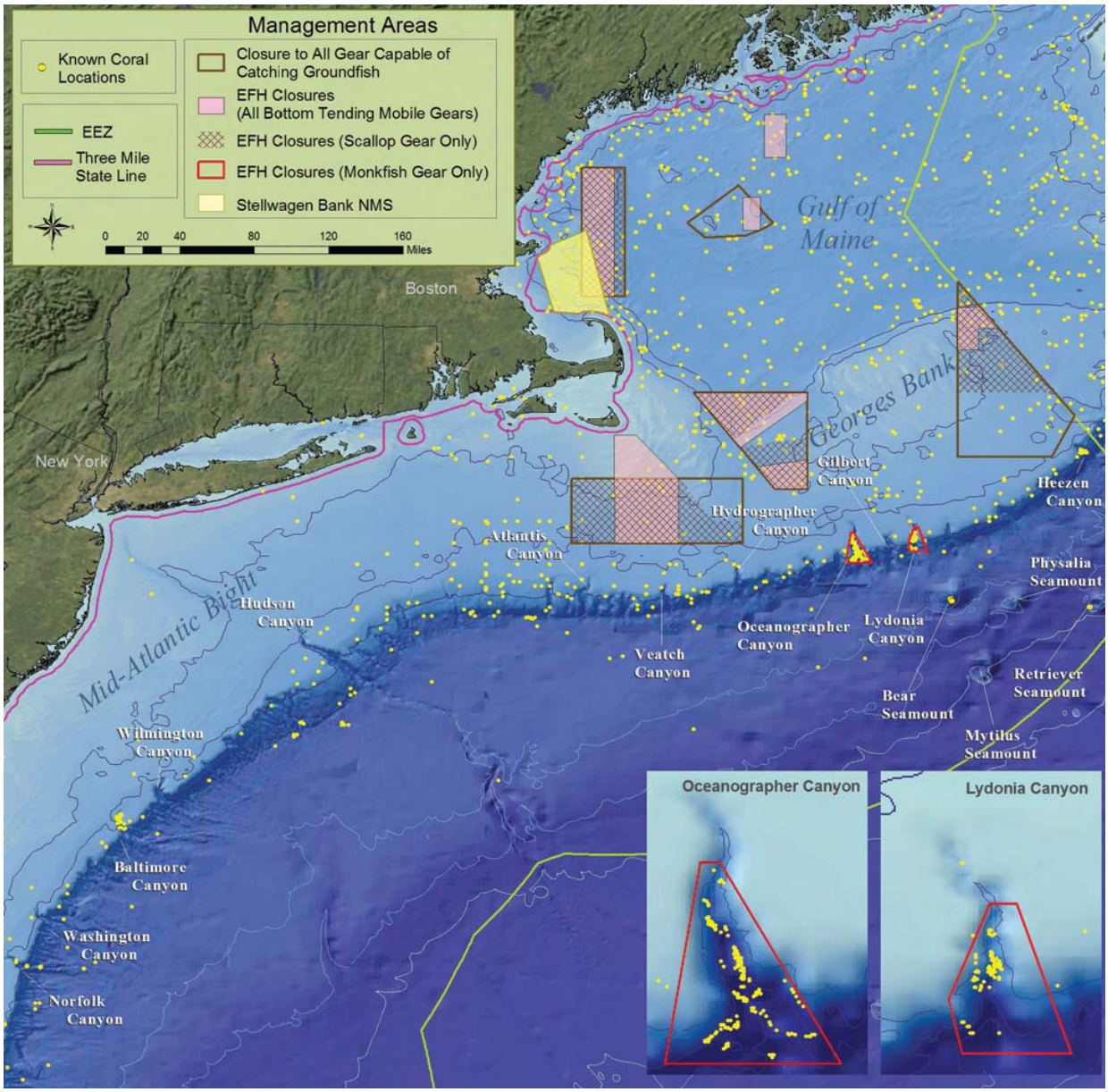


Figure 3. SAFMC Proposed Deepwater Coral HAPCs

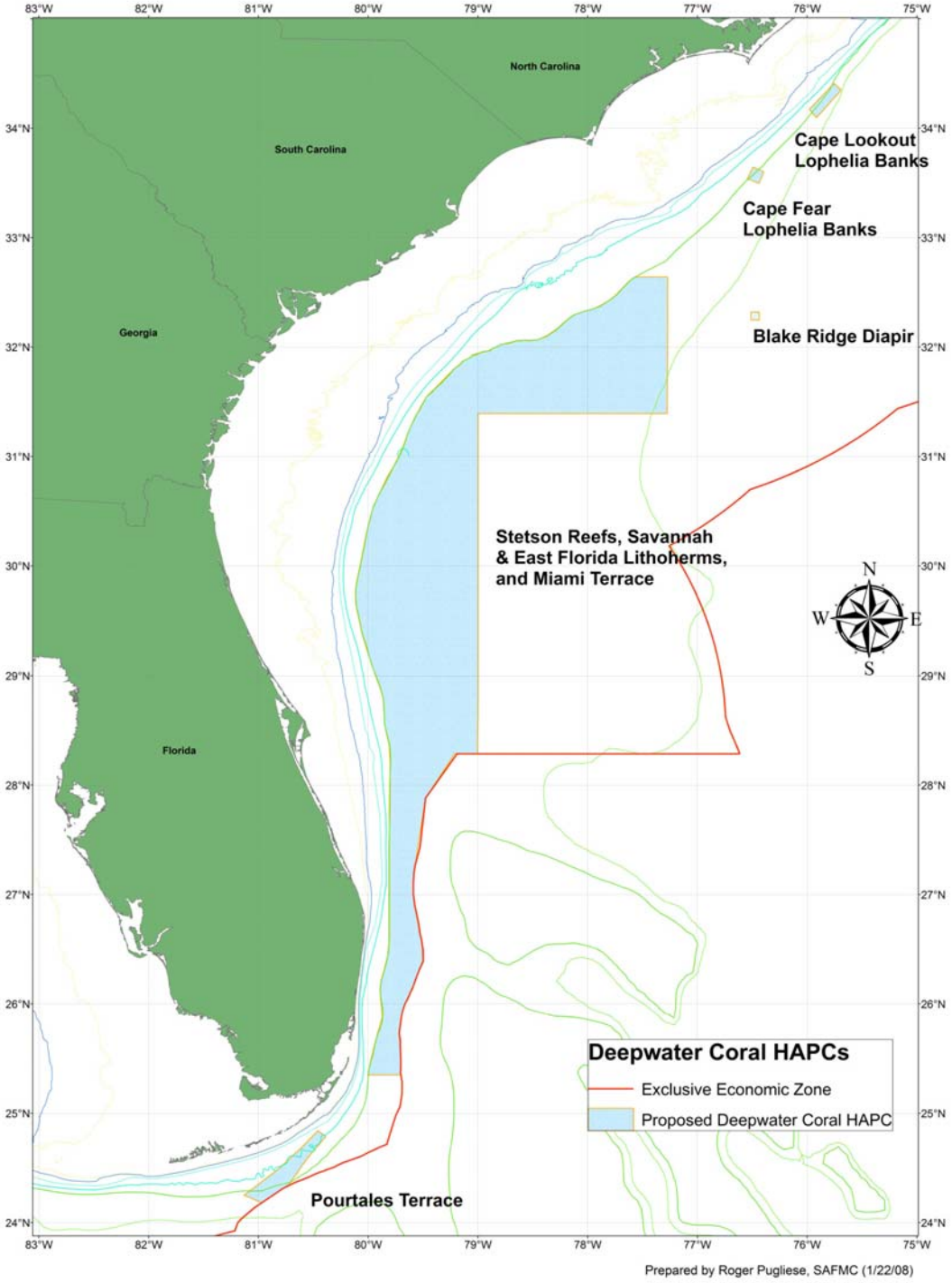


Figure 4. Gulf of Mexico Habitat Areas of Particular Concern

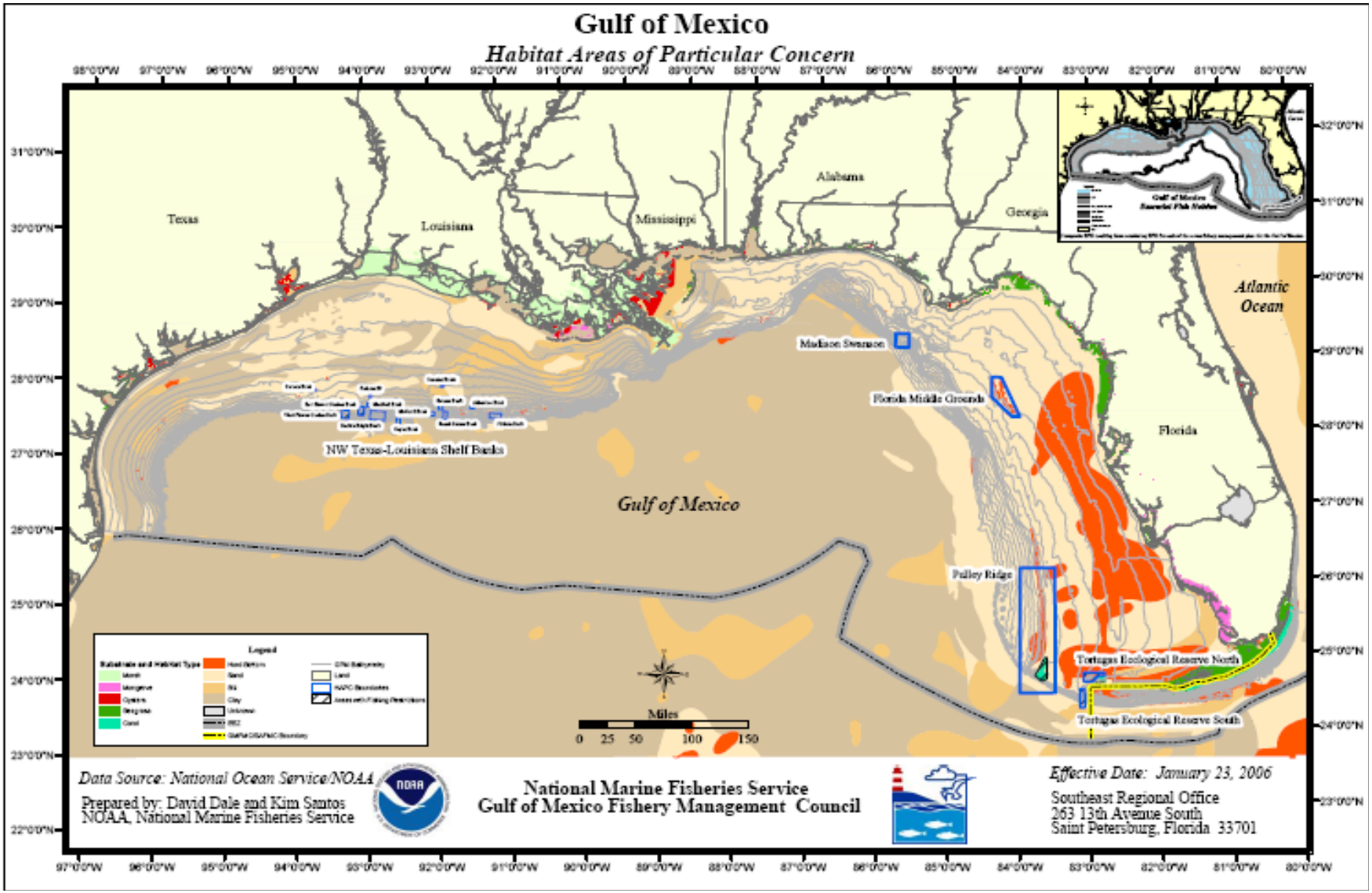


Figure 5. Deep Sea Corals in the U.S. Caribbean and Adjacent Areas

(Lutz and Ginsburg 2007)

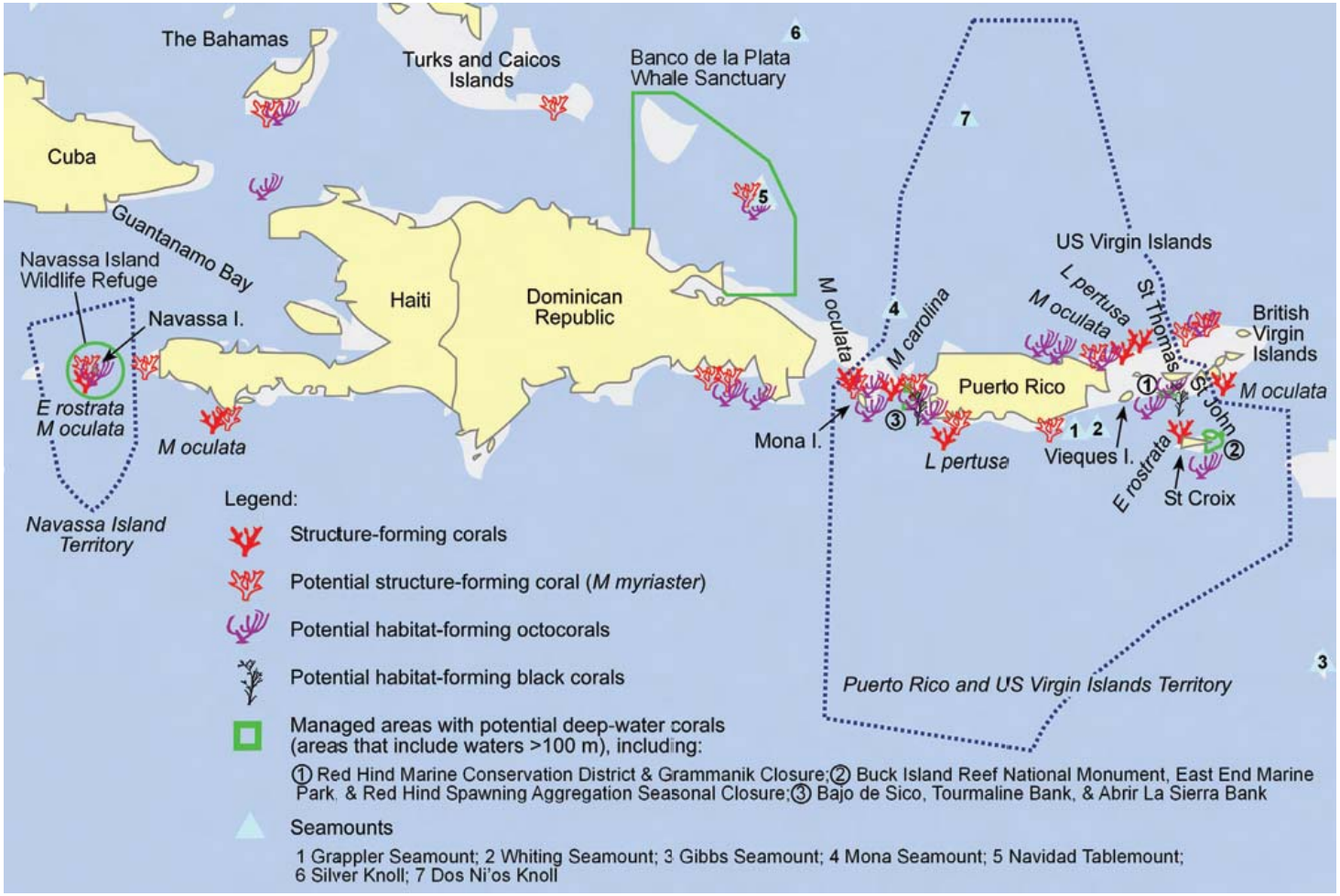


Figure 6. Deep Sea Precious Coral Beds in the Hawaiian Archipelago

Pink (*Corallium sp.*) and gold (*Gerardia sp.*) coral beds. (Figure from Parrish and Baco, 2007; photo credit: Hawaii Undersea Research Laboratory)

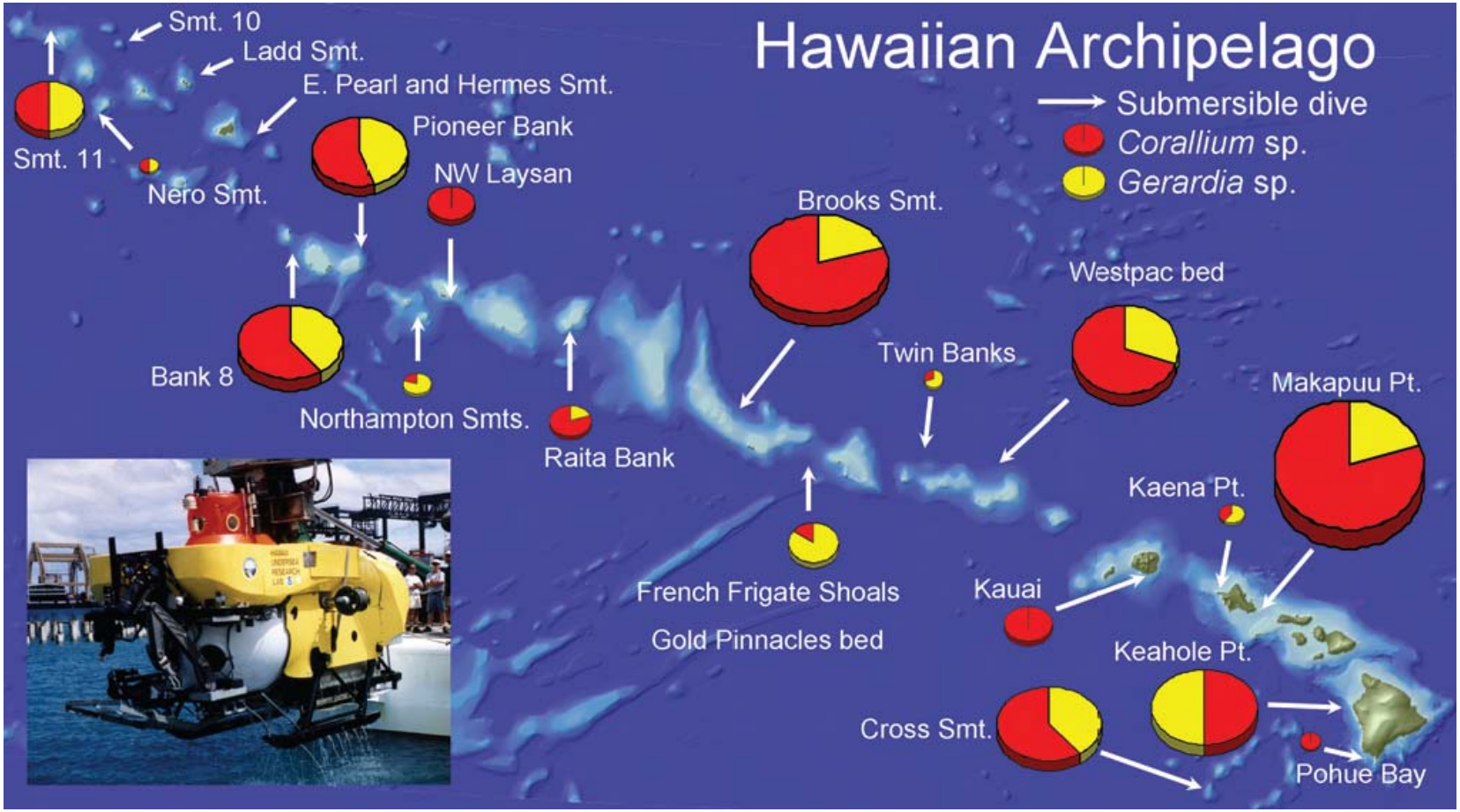


Figure 7. Known Locations of Deep Sea Corals Off the U.S. West Coast

Area shown does not include sea pens. (See Whitmire and Clarke 2007 for data sources.)

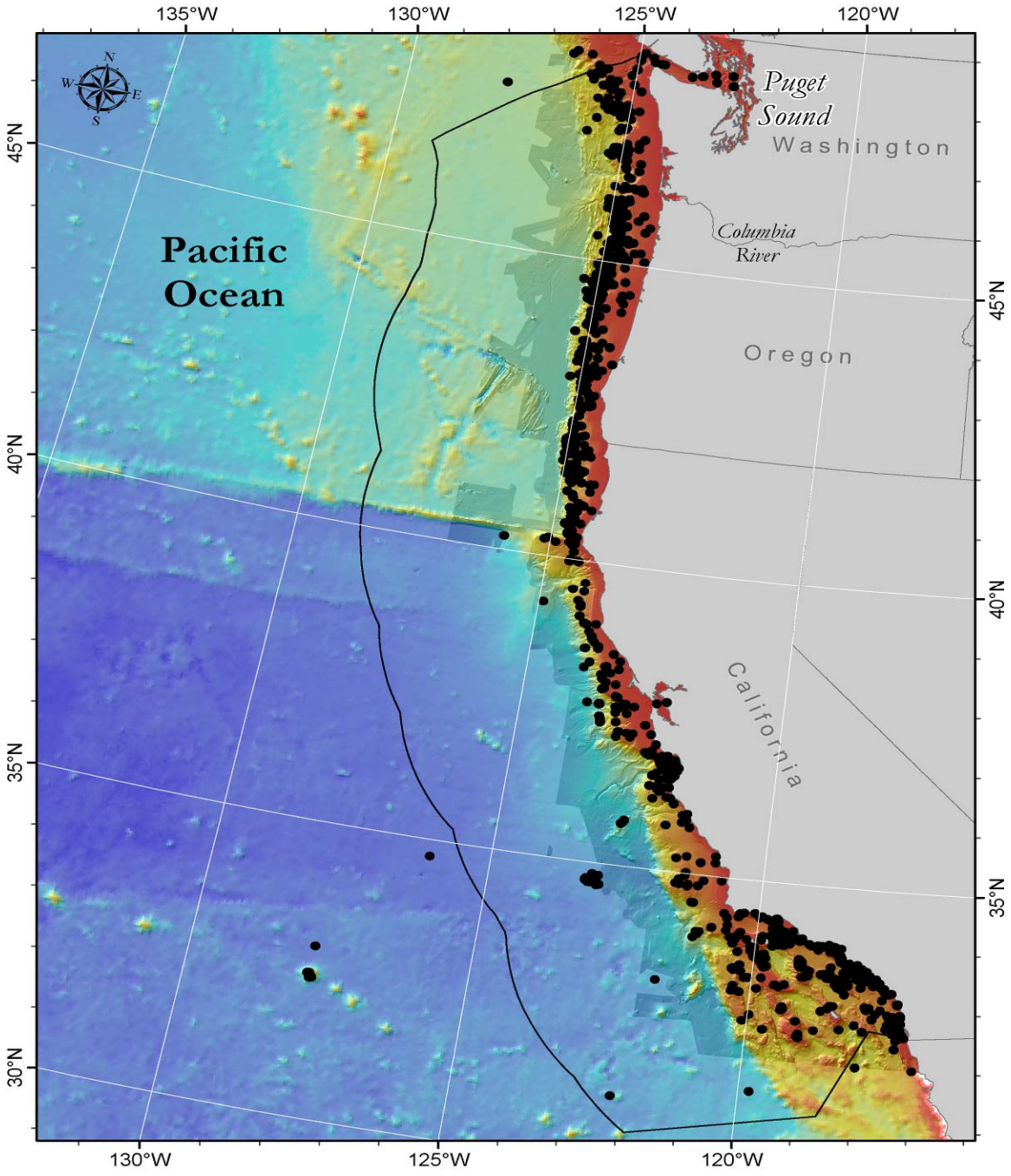


Figure 8. Locations of West Coast Groundfish EFH Conservation Areas

(PFMC 2006)

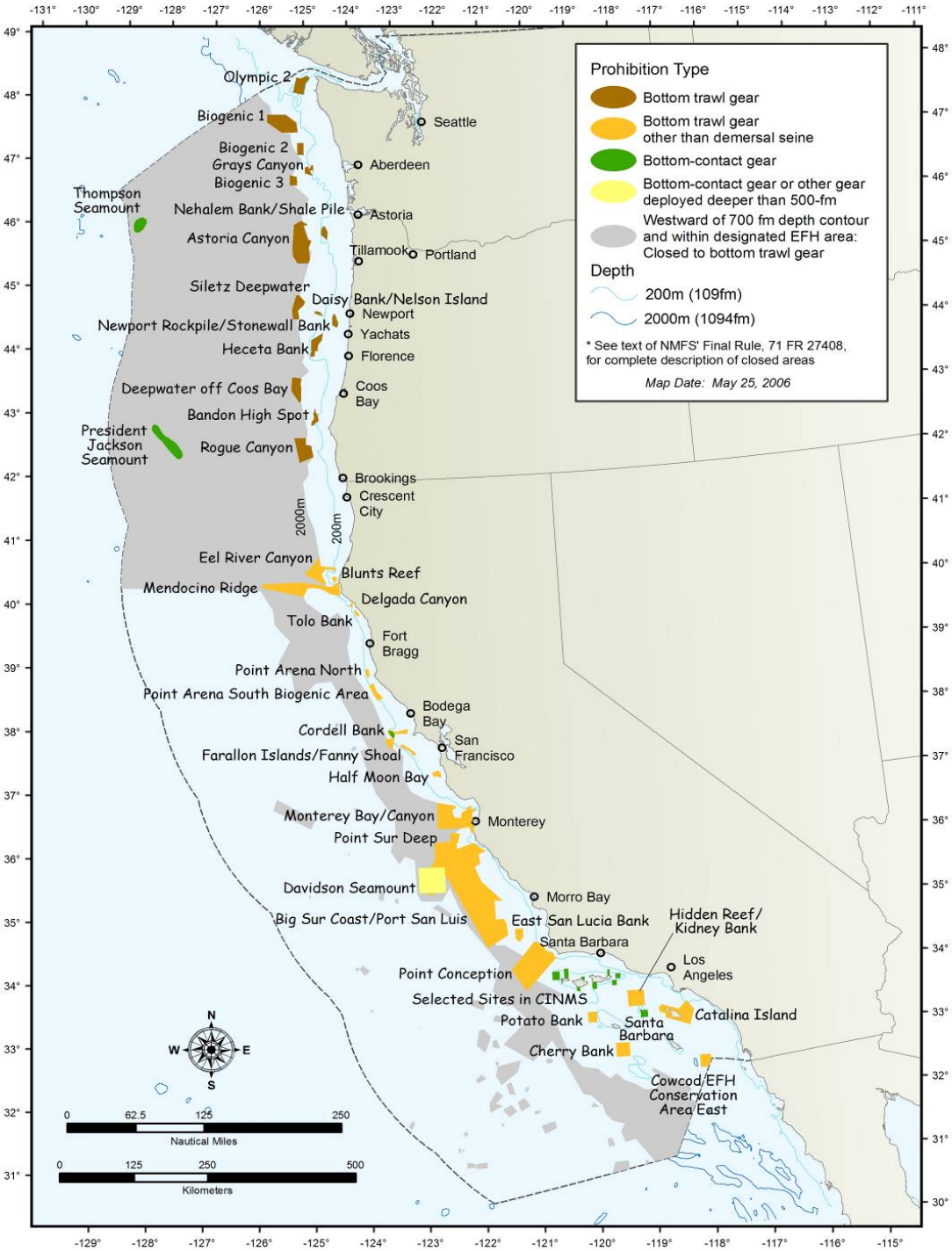


Figure 9. Survey sites for deep sea corals and sponges in the Olympic Coast National Marine Sanctuary.

This figure shows remotely-operated vehicle dive sites from a 2006 research cruise in relation to the boundary of the PFMC Olympic 2 Conservation Area where bottom trawling is prohibited (Brancato et al. 2007, Figure 4). Deep sea corals were documented at 14 out of 15 completed sites (in green) including five sites outside the conservation area.

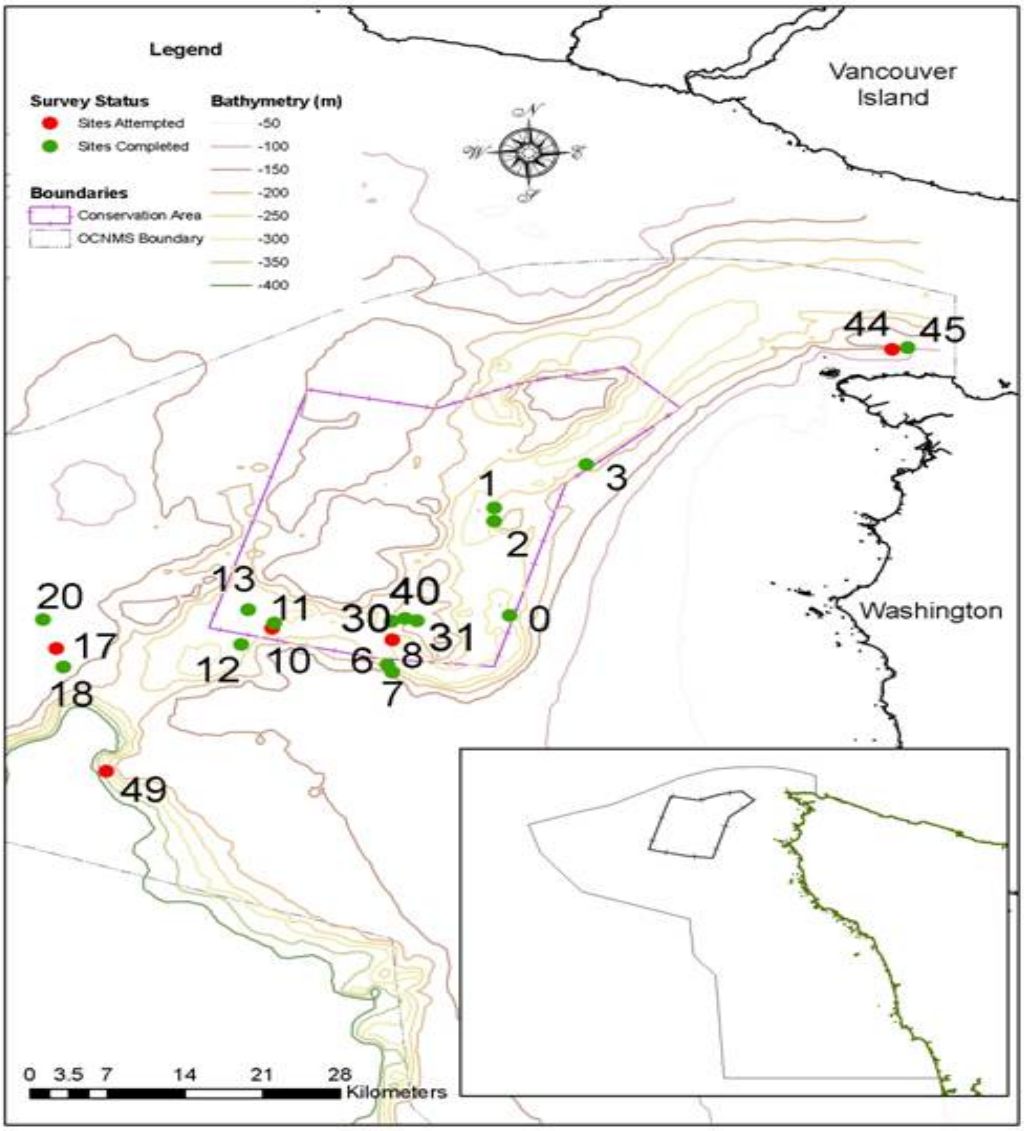


Figure 10. Deep Sea Coral Locations in Alaska

The data represent known locations of both soft and hard deep sea corals (excluding sea pens). Data do not represent density of coral cover but rather known locations and may reflect fishing or research effort. The origin of data in Alaska includes Resource Assessment and Conservation Engineering Division (RACE) Groundfish Survey data and the Northern Pacific (NORPAC) observer database.

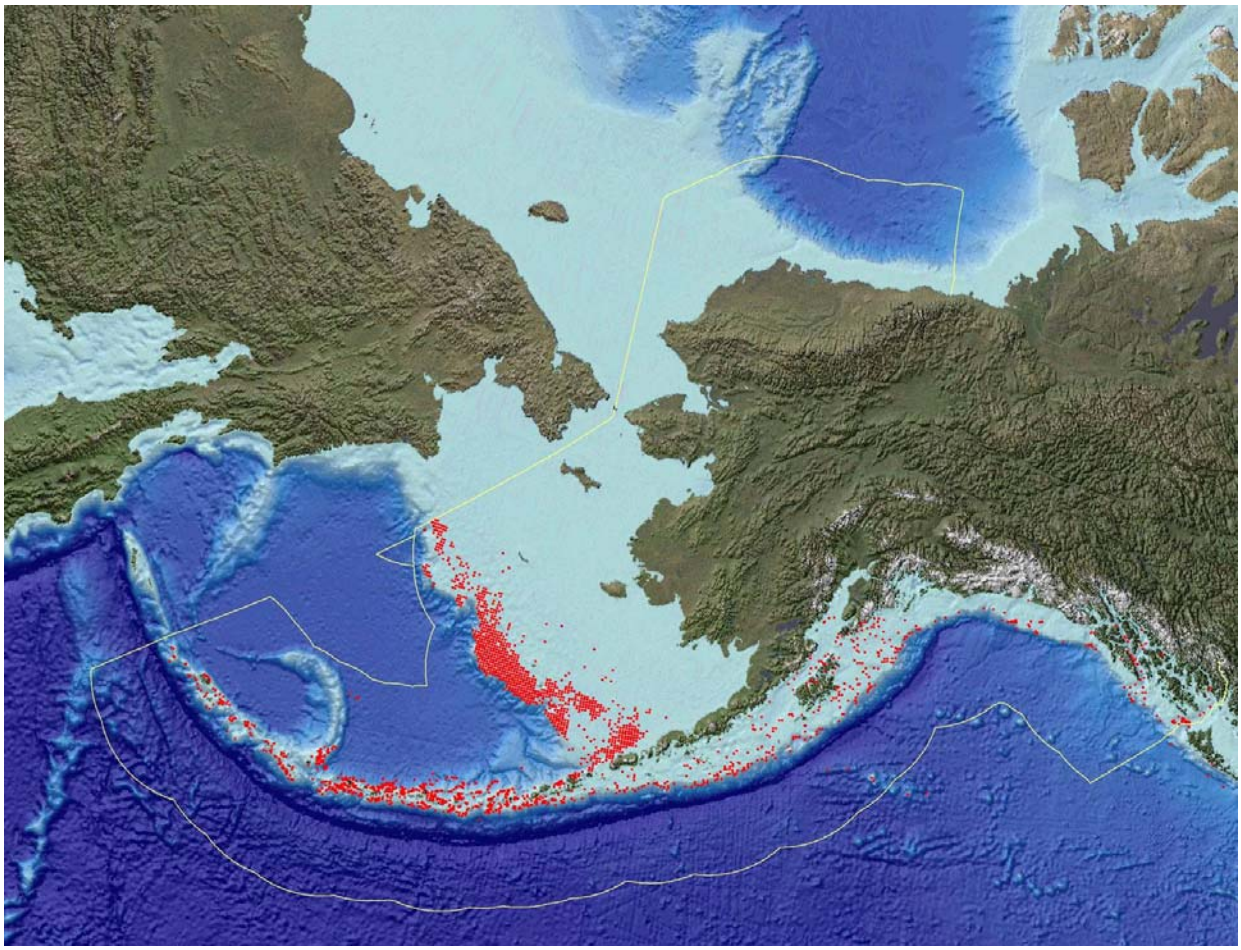


Figure 11. Areas of Alaska with some restrictions on fishing activities.

Map Credit: Cathy Coon, NPFMC.

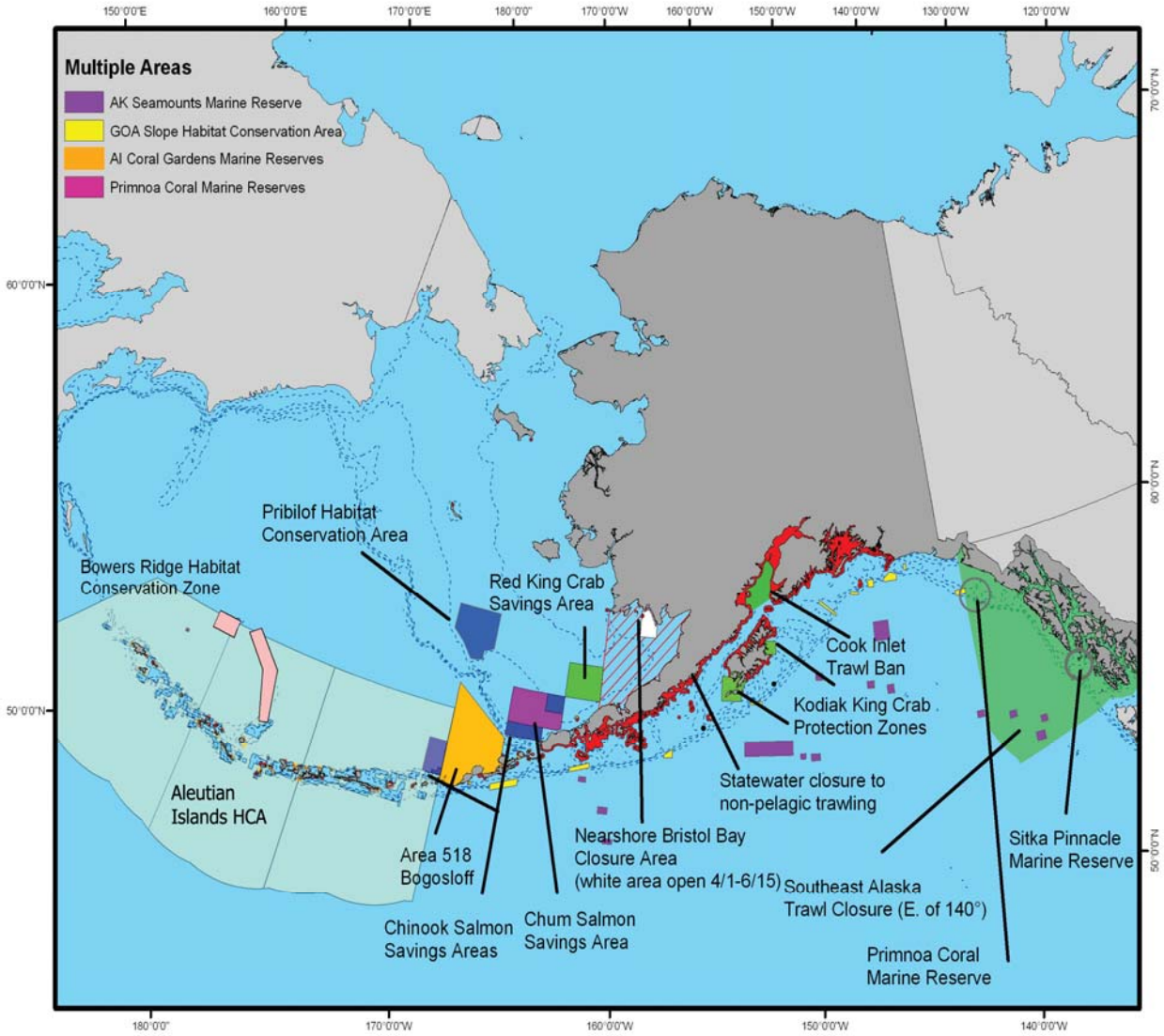
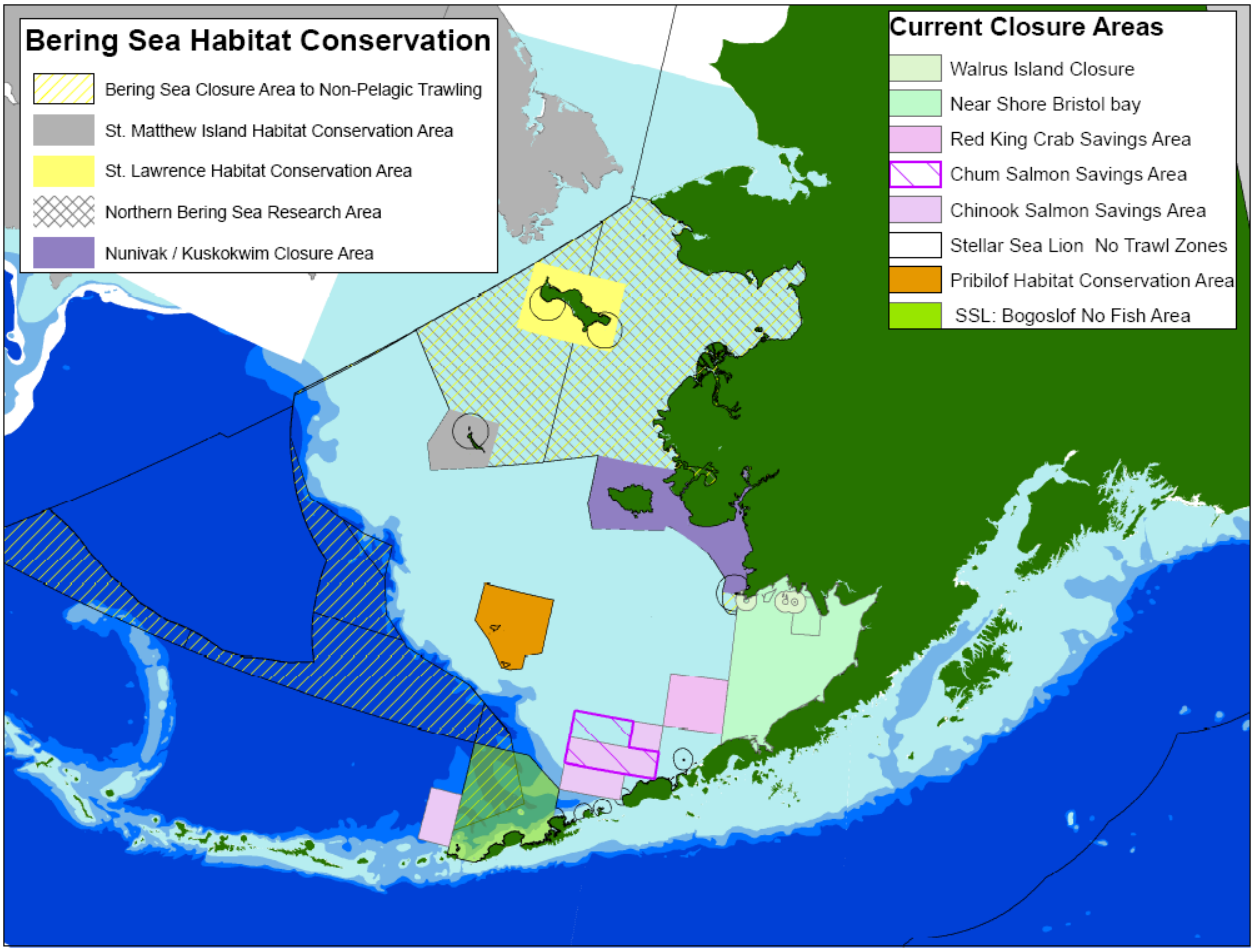


Figure 12. NPFMC Proposed Habitat Conservation Areas in the Bering Sea

Map Credit: NPFMC.