

IMPLEMENTATION OF THE DEEP SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM

2008 – 2009



NOAA

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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).

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For more information about this report or to request a copy, please contact: NOAA's Coral Reef Conservation Program, National Marine Fisheries Service, Office of Habitat Conservation. 1315 East-West Highway, Silver Spring, Maryland 20910. Tel: 301-713-4300.

Or visit:

http://www.nmfs.noaa.gov/habitat/2010_deepcoralreport.pdf

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This report includes a series of maps showing known locations of structure-forming deep-sea corals in selected U.S. regions. These maps represent an initial data product of the Deep Sea Coral Research and Technology Program. These initial maps are presented in the report for illustrative purposes, and are not meant to be used for management purposes. Due to the resolution of these maps, a single point may include more than one record. The Program expects to begin analysis of the underlying data in 2010.

The data do not represent density of coral cover but rather known locations of coral that have been compiled by the Program to date and reported by different coral Orders. Compilation of existing data has just begun, so information on many orders is incomplete. Reported coral locations are limited to where fishing or research has occurred. Thus, areas where no corals are shown on a map may reflect either an absence of corals or an absence of sampling. The origin of data varies, including NMFS bottom trawl survey and fisheries observer program databases, fishery management council databases, research cruise results, museum collections and literature citations. A listing of the data sources for the regional maps is found at the end of this report.

The boundaries for the U.S. Exclusive Economic Zone shown on the maps are for illustrative purposes only and are not intended to reflect areas claimed by the U.S.

ABOUT THIS REPORT

In January 2007, the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (P.L. 109-479) was enacted, reauthorizing the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) (MSA), and including 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 Regional Fishery Management Councils, “biennial reports to Congress and the public on steps taken by the Secretary of Commerce to identify, monitor, and protect deep-sea coral areas, including summaries of the results of mapping, research and data collection performed under the program.” The first Report to Congress (NOAA 2008) was submitted in 2008 (<http://www.nmfs.noaa.gov/habitat/rtc.pdf>). This is the second biennial report in fulfillment of that requirement.

In Fiscal Year (FY) 2009, NOAA’s National Marine Fisheries Service (NMFS) received \$1.5 million to begin implementation of the Deep Sea Coral Research and Technology Program. The Deep Sea Coral Research and Technology Program is being developed and implemented under the auspices of NOAA’s Coral Reef Conservation Program and in collaboration with NOAA’s NMFS; National Ocean Service (NOS); Office of Oceanic and Atmospheric Research (OAR); and National Environmental Satellite, Data, and Information Service (NESDIS); in consultation with the eight Regional Fishery Management Councils; and in coordination with other Federal agencies and educational institutions. This report summarizes activities initiated by NOAA with FY 2009 Deep Sea Coral Research and Technology Program funding.

In addition to the Deep Sea Coral Research and Technology Program, multiple NOAA programs, such as National Marine Sanctuaries, Ocean Exploration and Research, Fisheries Science Centers, Fishery Management Program, and the National Centers for Coastal Ocean Science, support exploration, research and management activities critical to understanding and managing trust resources, including but not limited to deep-sea corals. Annual budget support for these complementary deep-sea coral activities varies based on programmatic priorities. This report provides a brief summary by region of the important research, conservation, and management actions that have taken place since the first Report to Congress in 2008.



EXECUTIVE SUMMARY

This is the second biennial Report to Congress and the public on Implementation of the Deep Sea Coral Research and Technology Program, established under the authority of Section 408 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The report, prepared by the National Oceanic and Atmospheric Administration (NOAA) in consultation with the Regional Fishery Management Councils, summarizes activities initiated with fiscal year (FY) 2009 Deep Sea Coral Research and Technology Program funding. It also briefly summarizes critical, complementary activities by other NOAA programs to support exploration, research and management of deep-sea coral ecosystems that have taken place since the first Report to Congress was submitted in 2008.

NOAA's Strategic Approach to Deep-Sea Coral and Sponge Ecosystems

In 2009, NOAA developed a *Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation* (NOAA, in review). The Strategic Plan addresses the requirements of the Deep Sea Coral Research and Technology Program, but is broader and covers all of NOAA's relevant mandates, programs and activities related to these ecosystems for FY 2010–2019. The primary goal of the Strategic Plan is to improve the understanding, conservation, and management of deep-sea coral and sponge ecosystems.

The Deep Sea Coral Research and Technology Program

In FY 2009, NOAA received \$1.5 million to begin implementation of the Deep Sea Coral Research and Technology Program. The first year saw an integrated set of activities designed to inform the management of deep-sea coral ecosystems:

- The Program began a 3-year mapping and research effort in the Southeast United States, developed in consultation with the South Atlantic Fishery Management Council. New deep-sea coral areas were discovered during the first year's field season, providing new information relevant to the Council's proposed deepwater Coral Habitat Areas of Particular Concern (C-HAPCs).
- The Program began development of a national capability to manage data and information on deep-sea coral and sponge ecosystems.
- The Program supported smaller projects in most U.S. regions to analyze existing information that can inform management of U.S. deep-sea coral ecosystems, to analyze and map the distribution and intensity of fishing activities using gears that may damage deep-sea corals in Federal waters, and to develop methods to improve identification of coral and sponge bycatch in fisheries.

Complementary Activities to Identify, Monitor, and Protect Deep-Sea Coral Areas

The Congressional mandate for a Deep Sea Coral Research and Technology Program signaled recognition of the considerable work that multiple NOAA programs (e.g., National Marine Sanctuaries, Ocean Exploration and Research, Fisheries Science Centers, Fishery Management Program, and National Centers for Coastal Ocean Science) have conducted for years on these critical ecosystems. The Deep Sea Coral Research and Technology Program continues to leverage past and ongoing activities conducted by its NOAA partners. NOAA continues to work with the Regional Fishery Management Councils and numerous other partners to explore, study, and manage deep-sea coral ecosystems. These activities are implemented by other NOAA programs that build upon longstanding partnerships. Major actions that have taken place in 2008 and 2009 include the following:

- In September 2009, the South Atlantic Fishery Management Council recommended protection of five deepwater C-HAPCs. If approved by the Secretary of Commerce, this action will protect 24,215 square miles of habitat (twice the size of Maryland) containing the most extensive deep-sea stony coral reefs known in the northwest Atlantic.
- In the U.S. Pacific, three new Marine National Monuments were designated in 2009. Although largely unexplored, important deep-sea coral communities are expected to occur in these regions.
- In September 2008, NOAA Office of Ocean Exploration and Research, Minerals Management Service, and U.S. Geological Survey embarked on a 4-year effort to explore deep-sea coral sites in the deep Gulf of Mexico and characterize their biology, ecology, and genetic connectivity. In both 2008 and 2009, major expeditions involving scientists from various agencies and universities were conducted from NOAA ships.
- Habitat conservation efforts with the potential to provide significant protection to deep-sea coral communities are currently under development by the New England Fishery Management Council.
- NOAA is expanding national and international partnerships, including work with the Department of State, to implement a 2006 United Nations resolution to protect vulnerable marine ecosystems on the high seas from destructive fishing practices.

Next Steps

FY 2010 Activities: In FY 2010 Congress appropriated an additional \$1 million, for a total of \$2.5 million, for the Deep Sea Coral Research and Technology Program. The Program will continue the second year of field science activities in the Southeast United States, and initiate a new 3-year field science effort off the U.S. West Coast. Smaller-scale investments will be implemented in other U.S. regions, designed to address other requirements of the Program, including identifying the locations of deep-sea corals, monitoring activities at these locations, and performing associated data management.

Outreach to Councils: NOAA will also continue to extend its outreach efforts to engage with the Regional Fishery Management Councils. In particular, NOAA will further encourage the Councils to evaluate areas known to contain deep-sea corals for protection as allowed under discretionary provisions of the MSA.

Links to Ocean Policy: The Deep Sea Coral Research and Technology Program supports the implementation strategy outlined in the Interim Report of the Interagency Ocean Policy Task Force, particularly its emphasis on ecosystem-based management, comprehensive marine spatial planning, and regional ecosystem protection.



CHAPTER 1: INTRODUCTION

The first *Report to Congress on the Implementation of the Deep Sea Coral Research and Technology Program* (NOAA 2008) outlined the nature and importance of deep-sea coral communities and the threats they face. The Report also identified NOAA's authorities to study and manage these ecosystems and proposed an approach to implement the Deep Sea Coral Research and Technology Program (the Program) called for in Section 408 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (see Appendix 1).

Building on the first report, this 2010 report identifies NOAA's strategic approach toward deep-sea coral and sponge ecosystems, and describes the first year of implementation of the Deep Sea Coral Research and Technology Program. The Report also briefly summarizes critical complementary activities funded by other NOAA programs and partners to support science and management of deep-sea coral ecosystems in 2008 and 2009 in each U.S. region. Lastly, the Report provides a brief update on important international conservation efforts in which NOAA has been a partner. NOAA's approach recognizes existing and emerging threats to these ecosystems (see Box 1) and builds partnerships to address them.

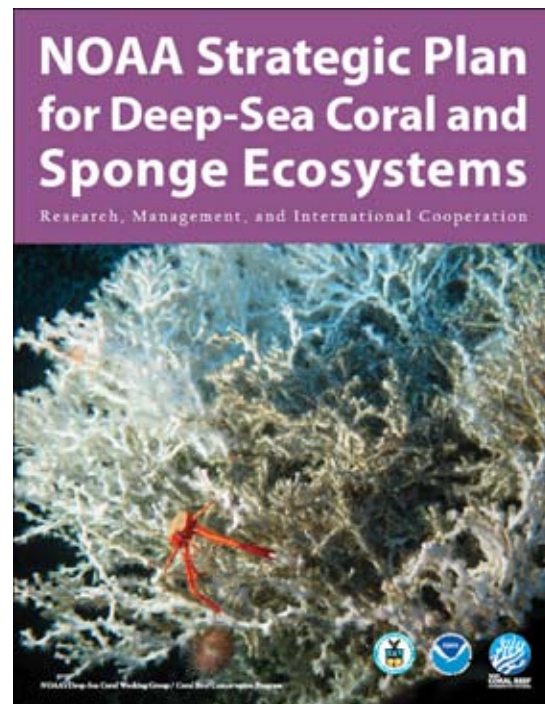
The major structure-forming coral taxa addressed in this report are outlined in Appendix 2. Further background on deep-sea coral ecosystems can be found in Roberts et al. (2009) and in the *State of Deep Coral Ecosystems of the United States* (Lumsden et al. 2007).

NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation

In 2009, NOAA developed a *Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation* (NOAA, in review). The Strategic Plan identifies goals,

objectives, and approaches to guide NOAA's research, management, and international cooperation activities on deep-sea coral and sponge ecosystems for FY 2010 – 2019. This plan integrates research and conservation needs and is intended to be a flexible, evolving document that allows NOAA and its partners to address new management challenges and priorities as appropriate. The primary goal of this Strategic Plan is to improve the understanding, conservation, and management of deep-sea coral and sponge ecosystems.

The Strategic Plan addresses the requirements of the Deep Sea Coral Research and Technology Program, but is broader in scope and addresses all of NOAA's relevant mandates and programs. As such, this plan has the potential to influence a much larger realm of NOAA activities beyond the Program.



NOAA developed a strategic plan for deep-sea coral and sponge ecosystems in 2009.

Photo credit: S.W. Ross et al.

Box 1. Threats to Deep-Sea Corals

The *State of Deep Coral Ecosystems of the United States* (Lumsden et al. 2007) and the first Report to Congress (NOAA 2008) summarized knowledge on the major threats to deep-sea coral ecosystems in general, and to these ecosystems in each U.S. region in particular. These reports concluded that damage from bottom trawling was the greatest threat to deep-sea coral ecosystems in areas where trawling is allowed and overlaps deep-sea coral habitats. Fishing with other gear that contacts the bottom (e.g., traps and pots, bottom-set longlines, and bottom-set gill nets) was generally the next most serious threat.

Damage to deep-sea coral habitats by fishing gear continues to be a major concern. Such threats are manageable with appropriate gear restrictions in areas where corals are likely to occur. For example, the potential expansion of such fishing into deep-sea coral areas in the South Atlantic Fishery Management Council's jurisdiction would be significantly curtailed if the proposed Deepwater Coral Habitat Areas of Particular Concern (C-HAPCs) are implemented (see section 3.1).

Deep-sea coral ecosystems also may face adverse impacts from energy exploration and development, deployment of cables and pipelines, and other human activities that disturb the seafloor. Potential new activities or emerging threats with potential consequences for deep-sea corals include the following:

- Geographic expansion of the Outer Continental Shelf Oil and Gas Leasing Program, which could include new areas with significant deep-sea coral habitats.
- Deep-sea mining of cobalt-rich crusts on seamounts at depths where deep-sea corals occur.
- Ocean acidification due to increased atmospheric CO₂, which lowers the saturation states of the calcium carbonate minerals used to form supporting skeletal structures in many major groups of marine organisms, including corals. This change in ocean chemistry will reduce the ability of corals to produce calcium carbonate skeletons (calcification) and build reefs.



Red tree corals (Primnoa sp.) are periodically caught in bottom trawl gear in Alaskan waters. This specimen was caught during the NOAA Fisheries groundfish stock assessment survey in Dixon Entrance, Gulf of Alaska. Photo Credit: R. Lauth, Alaska Fisheries Science Center



Table 1. Summary of Objectives from NOAA's Draft Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation	
GOAL	OBJECTIVES
Exploration and Research	<ol style="list-style-type: none">1. Locate and characterize deep-sea coral and sponge ecosystems.2. Understand the biology and ecology of deep-sea corals and sponges.3. Understand the biodiversity and ecology of deep-sea coral and sponge ecosystems.4. Understand the extent and degree of impact to deep-sea coral and sponge ecosystems caused by fishing and other human activities.5. Understand past oceanic conditions and predict the impacts of climate change using deep-sea corals.
Conservation and Management	<ol style="list-style-type: none">1. Protect areas containing known deep-sea coral or sponge communities from impacts of bottom-tending fishing gear.2. Protect areas that may support deep-sea coral and sponge communities where mobile bottom-tending fishing gear has not been used recently, as a precautionary measure.3. Develop regional approaches to further reduce interactions between fishing gear and deep-sea corals and sponges.4. Enhance conservation of deep-sea coral and sponge ecosystems in National Marine Sanctuaries and Marine National Monuments.5. Assess and encourage avoidance or mitigation of adverse impacts of non-fishing activities on deep-sea coral and sponge ecosystems.6. Provide outreach and coordinated communications to enhance public understanding of these ecosystems.
International Cooperation	<ol style="list-style-type: none">1. Promote international partnerships to conserve deep-sea coral and sponge ecosystems through the sustainable management of deep-sea fisheries activities impacting those resources.2. Ensure that international trade of deep-sea coral and sponge species, and their parts and products, is sustainable.3. Increase international exploration and research of deep-sea coral and sponge ecosystems.

The objectives under each of the three goals laid out in the Strategic Plan are shown in Table 1. The Exploration and Research goal identifies the role of research in management. NOAA's exploration and research on deep-sea coral and sponge ecosystems are designed to provide decision-makers with sound scientific information that will enable effective ecosystem-based management decisions. The Conservation and Management goal lays out objectives and approaches that NOAA will undertake to enhance protection of deep-sea coral and sponge ecosystems working with the Regional Fishery Management Councils, National Marine Sanctuaries, and other Federal agencies and partners. NOAA's strategy

for managing deep-sea coral and sponge ecosystems is centered on the authority provided to NOAA through the MSA and the National Marine Sanctuaries Act. Because NOAA, in partnership with the Regional Fishery Management Councils, is the Federal agency responsible for managing fisheries in the exclusive economic zone (EEZ), managing fishing threats to these ecosystems is one of the primary focuses of the Strategic Plan. The International goal describes NOAA's participation in international activities to study and conserve vulnerable marine species and ecosystems in the deep sea, including deep-sea coral and sponge ecosystems.

CHAPTER 2: DEEP SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM – FISCAL YEAR 2009 ACTIVITIES

2.1 OVERVIEW

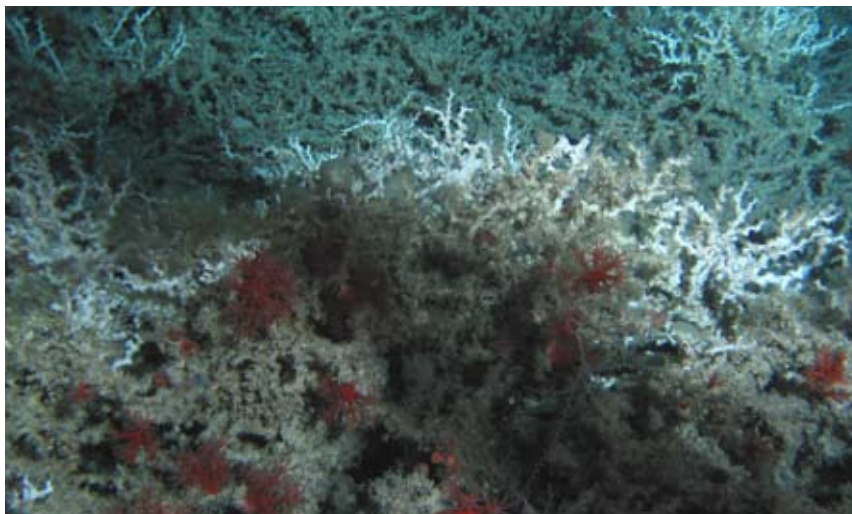
The Deep Sea Coral Research and Technology Program (the Program) is being implemented by NMFS, NOS, OAR, and NESDIS under the auspices of the NOAA Coral Reef Conservation Program. The Program is an integrated effort that consists of analysis and management of existing data and information as well as new field research and mapping initiatives.

Funding Provided to Implement the Deep Sea Coral Research and Technology Program in 2009

Funding to implement the inaugural year of the Deep Sea Coral Research and Technology Program totaled

\$1,500,000 in FY 2009. This funding came from a NOAA budget line item entitled Sustainable Habitat Management.

Table 2 lists the activities the Program initiated in 2009, along with the specific MSA provisions addressed. Individual activities are summarized in the following sections. Most Program activities have just begun implementation, so the summaries represent interim reports of results. Many of these projects leveraged significant outside funding and involved partners from other Federal agencies, nongovernmental organizations, and universities.



*A Lophelia reef explored in 2009 in the southeast U.S.
Photo credit: S. Ross et al.,
NOAA/USGS DISCOVERE
Cruise*



Table 2. Projects and activities funded to implement the Deep Sea Coral Research and Technology Program in FY 2009		
Project Title	MSA Sec. 408 Provision	Funding Provided
Field Research and Mapping of Deep-Sea Coral Ecosystems		
Southeast U.S. Deep-Sea Coral Research and Mapping	(a) 2, 4	\$1,013,500
Southeast U.S. Deep-Sea Coral Research Priorities Workshop	(a) 1, 2, 4	\$20,000
West Coast Research Coordination Workshop	(a) 1,2,4	\$15,000
Database Development and GIS Analysis		
U.S. National Deep-Sea Coral Data and GIS Management	(a)1,2,3,4	\$150,000
Enhancing the West Coast Regional Deep-Sea Coral Database	(a)1,2,3,4	\$12,000
Projects to Inform Conservation through the Analysis of Existing Data and Information		
Deriving Deep-sea Coral and Sponge Distribution Data from Archived Video Records	(a) 1,2	\$15,000
Analysis of AUV Sonar Data from Deepwater Coral Habitats off Eastern Florida	(a) 1,2	\$15,000
Analysis and Distribution of Deepwater Commercial Fisheries Species (Golden Crab, Tilefish, Royal Red Shrimp) in Deepwater Coral Habitats off Eastern Florida	(a) 1	\$10,000
Integrating Mapping and Fisheries Data for Deep-Sea Coral Habitats off South Carolina and Georgia	(a) 1,2	\$15,000
Flower Garden Banks National Marine Sanctuary Deep Coral Investigations	(a) 1	\$15,000
Deep-Sea Coral Community Research off California	(a) 1,2	\$15,000
Using Cordell Bank as a Model to Conduct Fine-Scale Deep-sea Coral Predictive Habitat Modeling	(a) 1,5	\$15,000
Analysis of Fishing Intensity and Deep-Sea Coral Bycatch		
Mapping the Intensity of Fishing in the Northeast Using Gears That May Damage Deep-Sea Corals	(a) 1,3	\$30,000
Analysis of Fishing Intensity and Potential Deep-Sea Coral Impacts in the US South Atlantic and Gulf of Mexico Regions	(a) 1,3	\$36,000
Mapping the Distribution and Intensity of Bottom Trawling Effort Along the California Coast from 1997 to 2008, with Impacts on Deep-Sea Corals	(a) 1,3	\$32,637
Taxonomic and Genetic Identification of Fisheries Bycatch of Deep-Sea Corals during the 2009 West Coast Groundfish Bottom Trawl Survey	(a) 1,3,4	\$40,243
A Field Guide to the Deepwater Sponges of the Aleutian Islands Archipelago	(a) 1,3	\$20,750
Program Coordination		
Hollings Fellowship	(a) & (b)	\$28,370
		\$1,500
TOTAL		\$1,500,000

2.2 FIELD MAPPING AND RESEARCH

Background

In FY 2009, NOAA began a 3-year mapping and research effort focused on the deep-sea coral ecosystems of the Southeast U.S. Activities completed during the first year addressed MSA requirements to locate and map locations of deep-sea corals (Sec. 408(a)(2)) and conduct research on deep-sea corals and related species (Sec. 408(a)(4)) – providing key information needed to protect deep-sea coral habitats in this region. A key component of the process was coordination with the South Atlantic Fishery Management Council (SAFMC) to determine specific areas to target and issues to address.

The Southeast U.S. (outer continental shelf and slope off the Carolinas to Florida: the SAFMC Region) was selected as the initial area for field operations under this national program based on the importance of its deep-sea coral habitats and the ability of the research to inform conservation efforts. The region contains the most extensive and well developed deep-sea stony coral reefs in U.S. waters, as well as an abundance of other coral habitats (e.g., gorgonians, black and gold corals).



Lophelia reef surveyed on the 2009 submersible cruise.
Photo Credit: S. Ross et al., NOAA/USGS DISCOVERE Cruise



The Johnson Sea Link submersible emerges with the microlander on the front.
Photo Credit: L. Baird, NOAA/USGS DISCOVERE Cruise



Box 2: How NOAA plans for field activities to study deep-sea corals under the Deep Sea Coral Research and Technology Program

Research on, and conservation of, deep-sea coral ecosystems has lagged behind similar efforts on shallower systems. There are a variety of reasons for this, including that the extent of these ecosystems was generally unknown until the last 15 years. Also, these ecosystems are relatively inaccessible; research requires expensive, specialized equipment and presents logistical constraints not encountered in near-shore shallow zones.

In order to be effective with limited resources and to help ensure the Program has a significant conservation impact in a particular region, major investments (i.e., more than \$750,000) in new deep-sea coral field research and mapping will be targeted to a single geographic area over at least a 3-year period. The rationale for this approach reflects the high cost of deep-sea field operations. The Program will expand into a new region after three years, or as additional funding becomes available. As noted above, smaller-scale investments will continue to support projects across the nation.

For FY 2009, the Southeast U.S. (South Atlantic Fishery Management Council Region) was chosen as the first focal area. In FY 2010, the Program expects to receive an additional \$1,000,000, which will allow new field work initiatives to expand to a second region, notably the U.S. West Coast (Pacific Fishery Management Council Region).

The SAFMC has been proactive in working to conserve these areas by establishing deepwater Coral Habitat Areas of Particular Concern (C-HAPCs) where the use of all bottom-damaging fishing gear would be prohibited. The proposed areas encompass more than 24,000 square miles (> 60,000 km², about twice the size of Maryland) containing deep-sea coral ecosystems. Much of the fundamental science underpinning the proposed C-HAPCs was funded by NOAA programs over the past ten years. In addition, the SAFMC is also proposing designation of “allowable fishing areas” for the golden crab (*Chaceon fenneri*) and deepwater shrimp fisheries which occur within and in the vicinity of the C-HAPCs, respectively. However, accurate maps of the majority of these areas, including the locations of deep-sea coral habitats, do not currently exist and the SAFMC is particularly concerned with direct and indirect impacts from fishing activities on deep-sea coral ecosystems in the region.

Deep-Sea Coral Exploration and Research Priorities Workshop

In July 2009, NOAA convened a Deep-Sea Coral Exploration and Research Priorities Workshop for the Southeast U.S., in Wilmington, North Carolina, where scientists and resource managers identified and

prioritized critical information needs to improve our understanding of deep-sea coral and sponge ecosystems to help inform management. The workshop helped NOAA ensure that the research activities address management needs, maximize opportunities to utilize regional expertise, and leverage and complement existing regional efforts. Workshop participants represented a broad range of stakeholders, including the Federal government, SAFMC, academia, private industry and nongovernmental organizations (NGO). The principal outcome of this workshop was a list of research priorities.

The three highest priorities identified by the participants were to:

- Map and characterize deep-sea coral habitats in the proposed deepwater C-HAPCs.
- Understand species and coral habitat relationships and the factors that control or influence them.
- Identify and assess areas impacted by fishing and non-fishing activities.

The Southeast workshop report will be available at: <http://coralreef.noaa.gov>. A Research Priorities Workshop for the U.S. West Coast was held in January 2010.

FY 2009 Field Science Activities

An integrated research and mapping program was developed with four field research missions funded in FY 2009:

- Submersible Cruise: A cruise aboard the Harbor Branch Oceanographic Institute (HBOI) R/V *Seward Johnson*, utilizing the *Johnson Sea Link* (JSL) submersible.
- Mapping Cruise 1: A multibeam mapping survey cruise with the NOAA Ship *Nancy Foster*.
- Benthic Lander Cruise: A cruise to deploy an underwater observatory (benthic lander) with University of North Carolina at Wilmington (UNCW); and
- Mapping Cruise 2: A multibeam mapping survey with University of South Florida (USF).

The near-term goal was to collect information for the SAFMC to use in refining the border of the C-HAPC. The mapping cruises were designed to identify potential deep-sea coral habitats in the C-HAPC and guide the Program's research efforts in FY 2010 and FY 2011.

Submersible Cruise

In August 2009, the Program's initial cruise off Cape Canaveral, Florida was completed aboard the R/V *Seward Johnson*. The primary operations included 22 dives in the JSL manned submersible on known or suspected deep-sea coral sites along the margin between the Stetson-Miami Terrace C-HAPC and the allowable fishing areas (Map 7). Data were collected at 108 stations and supplemented with ship-based oceanographic sampling and biological collections. Additional information on methods and results is available in the cruise report (Ross 2009).

The primary research goals of the cruise were to (1) identify and characterize deep-sea coral habitats, and (2) to collect samples and observations necessary to better understand the ecology of the structure-forming corals and the relationship of associated species to these habitats.

The preliminary conclusions from this cruise indicate the three inshore sites (400 – 540 m depths) and southern most deep sites (680 – 750 m depths) had the most structurally complex coral habitats. The shallower inshore sites were some of the most biologically interesting and diverse ones. These sites were characterized by large colonies of living *Lophelia*

Box 3: NOAA's collaborative partnerships in deep-sea coral field research

In the FY 2009 Deep Sea Coral Research and Technology Program field activities in the Southeast U.S., NOAA collaborated with numerous partners and will continue to do so in the future. These collaborations allowed the Program to utilize methodologies comparable to those used in research conducted by partners in the Gulf of Mexico and across the Atlantic, adding international value to the research conducted. Many of these collaborations provided significant leverage against NOAA expenditures and afforded cost savings for all parties involved. At the Federal level, four NOAA line offices were involved along with the U. S. Geological Survey (USGS) and the Minerals Management Service (MMS). Academic partners included UNCW, USF, College of Charleston, Florida Atlantic University, Temple University, and the Oregon Institute of Marine Biology. NGOs and international partners included Marine Conservation Biology Institute, HBOI, the Scottish Association for Marine Science, and the Royal Netherlands Institute for Sea Research. Research operations were coordinated through NOAA's new Cooperative Institute for Ocean Exploration, Research, and Technology.



pertusa and *Madrepora oculata* as well as an abundant and diverse assemblage of fishes and large invertebrates. Golden crab, an important fisheries species managed under the SAFMC Golden Crab Fishery Management Plan (FMP), were common on these inshore sites and often observed in close association with the corals. These inshore sites are within the depth range of the golden crab allowable fishing zones as designated in the Council's proposed Comprehensive Ecosystem-Based Amendment 1. The southern most deep sites were also characterized by extremely high invertebrate biodiversity.

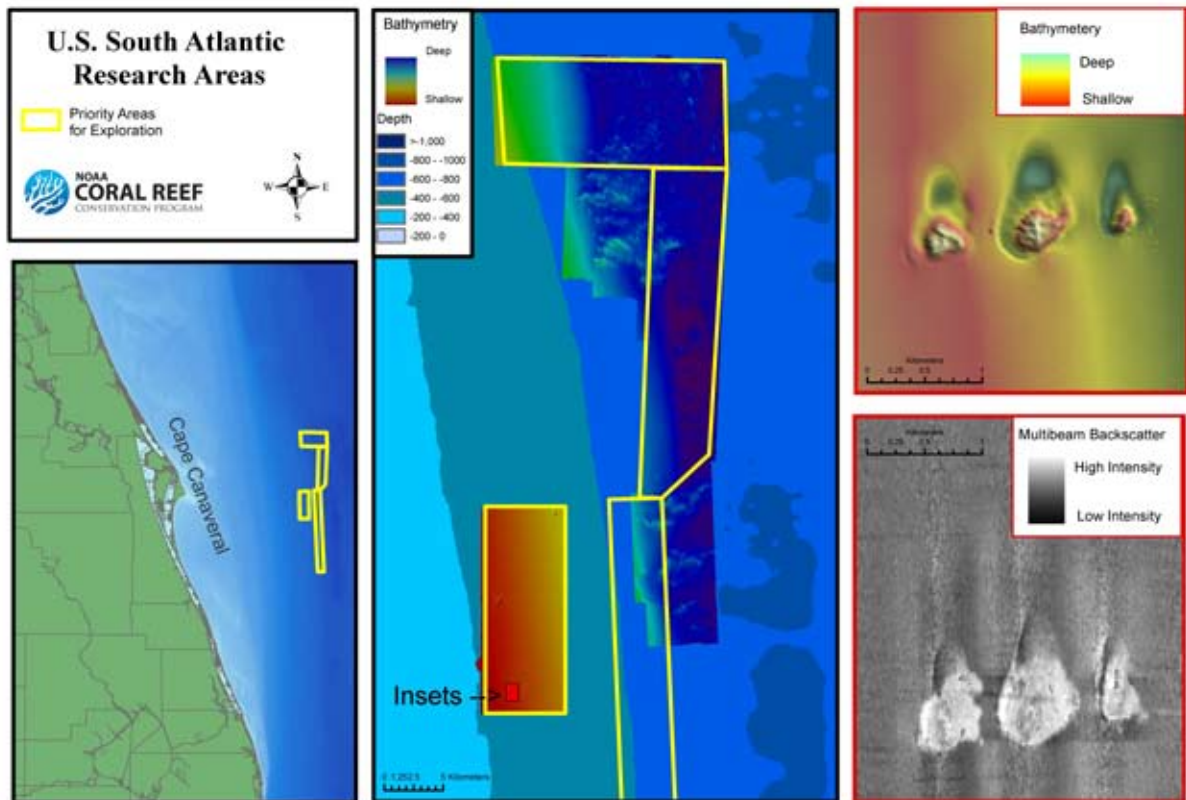
The least well developed coral habitats occur in the deep northern most and central stations (700 – 760 m depths), and appear to support fewer invertebrates. Coral mound formations on these sites were almost completely covered with mostly dead *L. pertusa* coral. Most sites exhibited a well developed sponge

community composed of many species. Black corals and bamboo corals appeared to be rare in all of the areas surveyed.

Benthic animals associated with the corals were frequently observed feeding upon various midwater animals (e.g., crabs eating midwater fishes). As in past observations, several fish species appeared to be exclusively associated with coral habitat. Although identifications of all species collected are yet to be completed, it appears likely that several undescribed species of invertebrates were collected.

In addition to meeting the primary goals of the cruise, the interdisciplinary scientific team conducted a number of associated studies and collections that will provide a fuller understanding of these ecosystems:

- Corals were collected to measure coral growth



Map 1: Multibeam imagery of priority deep-sea coral sites off Cape Canaveral, FL, collected by the NOAA Ship Nancy Foster in September 2009. Large map shows multibeam bathymetry of areas surveyed. Inset shows a close up of multibeam bathymetry and backscatter for three shallower coral pinnacles. Lighter color on the backscatter imagery indicates hard substrata. Submersible dives on these pinnacles showed extensive deep-sea coral cover.

Box 4: Benthic landers are long-term observatories on the seafloor

While submersibles and remotely operated vehicles (ROVs) provide information about a habitat at a specific moment in time, monitoring long-term variations in oceanographic parameters is necessary to place this snapshot information into an ecological context. The benthic lander provides this type of long-term data.

In December 2009, landers were placed in a well-studied deep-sea coral ecosystem in the northern Cape Lookout C-HAPC, and will be recovered after six months. The landers, equipped with cameras, will continuously measure near-bottom temperature, salinity, the amount of particles in the water column, current speeds, and current directions.

The 2009 field season also tested the Sùil na Mara (Scotts Gaelic for 'Eye of the Sea') microlander, a small aluminum platform designed to be deployed from submersibles or large ROVs in areas of rough substrata and the high current velocities associated with deep-sea coral habitats.



A microlander was deployed during the August 2009 submersible cruise off the Southeast U.S.

Photo Credit: S. Ross et al., NOAA/USGS DISCOVERE Cruise

and determine their reproductive biology.

Colonies of the three dominant reef-building coral species (*Lophelia pertusa*, *Madrepora oculata*, and *Enallopsammia profunda*) were retained alive from several JSL dives.

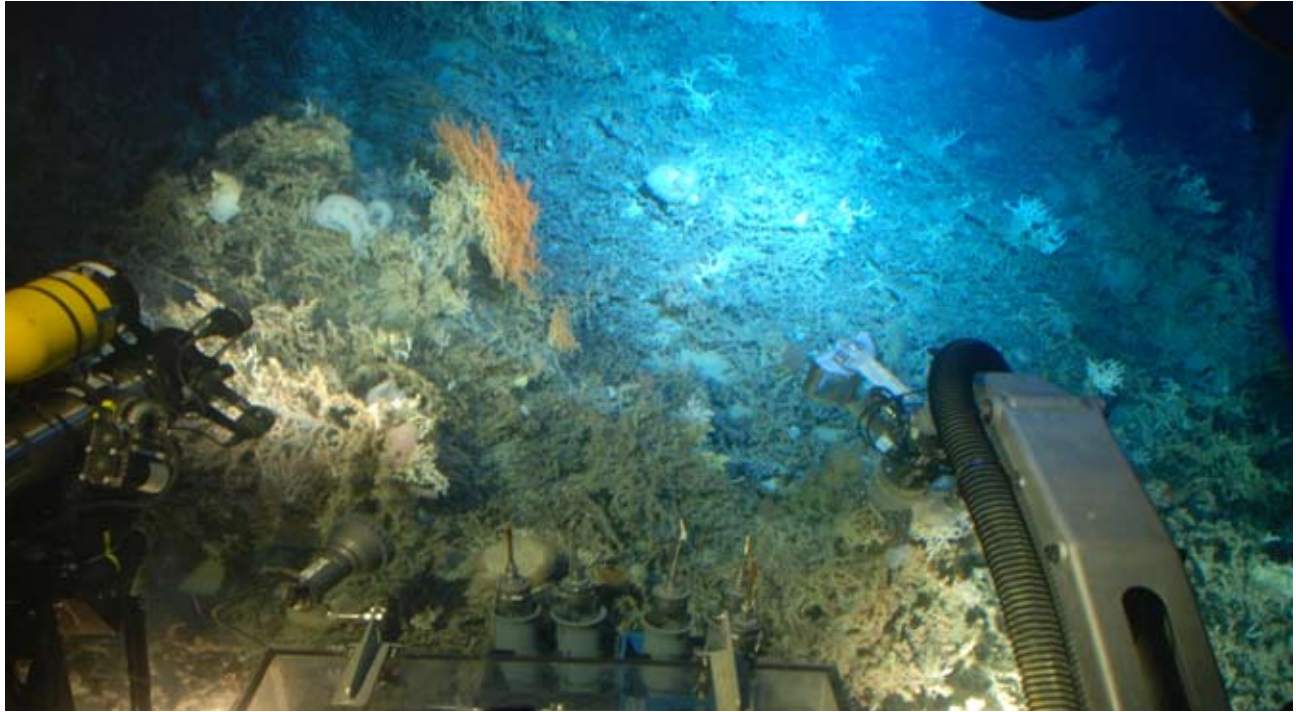
- Tissue samples were collected from 70 taxa for stable isotope analyses. Results from these analyses will help elucidate food webs and energy flow through deep-sea coral ecosystems.
- Tissue samples from 33 taxa were collected for genetic studies to understand connectivity and population dynamics among deep reef

ecosystems. This region off the east coast of central Florida was poorly sampled in previous cruises and represented a critical area between previously studied areas in the Northeastern Atlantic and Gulf of Mexico.

- At least 28 taxa were sampled for microbiology and/or biomedical screening – studies that may discover new biomedical compounds.
- The cruise tested a new, small lander (Box 4). The “Microlander” Sùil na Mara was deployed for 30 hour sessions on two different deep-sea coral habitats. Preliminary data revealed highly variable bottom currents with regular tidal signals in bottom currents and temperature.

Mapping Cruise 1

Scientists from NOAA and UNCW used multibeam sonar to map a total area of 225 square miles (580 km²) along the western edge of the C-HAPC off central Florida from the NOAA Ship *Nancy Foster* in September 2009 (Map 1). Numerous limestone pinnacles and ridges were located in the area roughly 47 miles (75 km) offshore between Cape Canaveral and Ft. Pierce, FL. The resulting maps



*The submersible extends a manipulator arm to collect samples.
Photo Credit: S. Ross et al., NOAA/USGS DISCOVERE Cruise*

from this survey will inform selection of dive sites for future manned and unmanned observations, as well as contribute new information to the SAFMC for potential adjustment of C-HAPC boundaries.

Benthic Lander Cruise

In early December, the *R/V Cape Hatteras* deployed two benthic landers for long-term observations on deep-sea coral banks off North Carolina and conducted a variety of other sampling (Box 4). These landers were recently recovered after monitoring conditions for a year at deep-sea coral sites in the Gulf of Mexico in a separate MMS/USGS/NOAA program. These landers were developed in partnership with the Royal Netherlands Institute for Sea Research, and are an important first step in an effort to standardize sampling techniques throughout the Atlantic basin.

Mapping Cruise 2

A team of USF geologists specialized in seafloor mapping will conduct an additional mapping cruise in the C-HAPC in early 2010. It is anticipated 450 – 600 square miles (1200-1500 km²) of habitat will be mapped during this cruise. The target area, approximately 47 miles (75 km) off the east coast of central Florida, is adjacent to the area surveyed during the first mapping cruise. Efforts are underway to maximize the cost effectiveness of this operation by matching a compatible survey vessel with multibeam mapping equipment designed for the water depths here.

Outreach Efforts

To enhance public understanding of these spectacular ecosystems and the science conducted to understand them, an outreach team representing NOAA,

SAFMC, HBOI, UNCW and USGS was formed to publicize FY-2009 research efforts. Press releases were generated for the program in general and the cruises specifically. Members of the press and local management agencies were invited aboard the R/V *Seward Johnson* during the JSL submersible cruise, where the scientists could explain their research. This event resulted in an NBC Nightly News feature and articles in newspapers across the nation. Through the partnerships on this program, daily logs from the submersible cruise were made available online through USGS' DISCOVERE website:
<http://fl.biology.usgs.gov/DISCOVERE/index.html>.

Plans for FY-2010 and FY-2011

Planning for FY-2010 and FY-2011 operations in the Southeast U.S. is well underway. Ship time has been secured for three NOAA research cruises in FY 2010. This will allow significant leverage of program funds and an increased operational tempo. The primary mission will be an ROV cruise aboard the NOAA flagship *Ronald H. Brown*. A second research cruise is planned aboard the NOAA Ship *Pisces*. The third cruise will continue the mapping efforts aboard the NOAA Ship *Nancy Foster*. Mapping targets and research goals for all cruises will be selected with input from the SAFMC with particular consideration given to the research priorities identified at the July 2009 workshop. FY-2011 efforts will be guided by results from the FY-2009 and FY-2010 research. Existing collaborations will be strengthened and new collaborations begun. One exciting direction is a greater linkage with the Trans-Atlantic Coral Ecosystem Study (TRACES). TRACES is an international collaboration of coral scientists and a partnership with this established group will significantly expand NOAA's capabilities (more in Section 3.3).



2.3 ANALYSIS AND MANAGEMENT OF EXISTING DATA AND INFORMATION

The new field science activities supported under the Deep Sea Coral Research and Technology Program provide the opportunity for dedicated, longer term research and mapping of deep-sea coral ecosystems. However, because of the costs and logistic constraints of working in the deep sea, the Program will only be able to conduct field operations in a few high priority areas.

MSA Section 408 (a)(1) directs NOAA “to identify existing research on, and known locations of, deep-sea corals and submit such information to the appropriate Councils.” To carry out this mandate, NOAA will analyze data, integrate new findings, and make data available to managers in usable formats.

NOAA has supported deep-sea exploration and research conducted by several NOAA program offices and through collaborations with other Federal agencies, the Regional Fishery Management Councils, and external university partners. Other sources of information, such as museum collections and NMFS research trawl surveys provide additional data on the distribution of deep-sea corals. While much of this work was not specifically directed toward deep-sea coral ecosystems, analysis of previous research can provide valuable information to inform management and to guide future field efforts. Identification of new deep-sea coral areas will continue to depend upon visual ground-truthing. Analyses of existing information, however, complement and add value to this work, and can be conducted at a much lower

cost and in more areas than it would be possible to mount new field expeditions.

Managing both existing and new data and information is critical in order to ensure that data are accurate, reliable, secure, understandable, and available in appropriate formats for use by researchers, managers and the public. Thus the development of geographic information system (GIS) databases for use by the research, management, and education communities is essential. NOAA will build on experience from its Coral Reef Information System and on existing database partnerships to provide access to NOAA deep-sea coral and sponge data and information including metadata, links to online data (e.g., regional map servers), products, and publications.

In FY 2009, the Deep Sea Coral Research and Technology Program began to address these requirements through two related efforts:

1. Deep-sea coral database and GIS development
2. Projects that inform conservation through the analysis of existing coral data

The following are summaries of individual activities. In most cases, these projects have just begun and only preliminary results are available.

ANALYSIS AND MANAGEMENT OF EXISTING DATA AND INFORMATION – DEEP-SEA CORAL DATABASE AND GIS DEVELOPMENT

National Deep-Sea Coral Data and GIS Management

\$150,000

Project Goal Ensure that data and information acquired by the Deep Sea Coral Research and Technology Program are accurate, reliable, secure, and understandable; and that they are made available to managers, Regional Fishery Management Councils, researchers, and the public in a useful manner.

Management Application Making accurate information and value-added products available to managers is critical to ensuring the Program has the greatest conservation impact.

Summary This activity addresses the primary needs for data management and GIS analysis to support the activities of the Deep Sea Coral Research and Technology Program:

1. Collect and integrate available information on the status and distribution of deep-sea coral and sponge ecosystems.
2. Develop approaches and tools to analyze and display information on the activities that may impact deep-sea coral ecosystems. Primary focus will be on interactions with commercial fisheries.
3. Lead the development of a NOAA Deep Sea Coral Research and Technology Program data management plan to be integrated and implemented within the Coral Reef Conservation Program Data Management Plan.
4. Produce maps and conduct spatial analysis and predictive modeling to support deep-sea coral conservation.
5. Maintain coordination and consistency for GIS and data management matters associated with field activities off the U.S. Southeast and West coasts.

The maps of deep-sea coral locations included in this Report represent a first product from these efforts. This is a significant enhancement over the capabilities and products available when the first Report to Congress was prepared in 2007.



Rockfish take refuge among the branches of a deep-sea gorgonian coral in the Olympic Coast National Marine Sanctuary.
Photo Credit: OCNMS



Fish associate with the Oculina coral habitat off Florida.
Photo Credit: L. Horn, NOAA Undersea Research Center at UNCW



Enhancing the West Coast Regional Deep-Sea Coral Database

\$12,000

Project Goal Enhance the usefulness and accessibility of deep-sea coral data collected by NMFS and its partners

Management Application This project will provide data on the location and bycatch of corals and sponges to inform Pacific Fishery Management Council and NOAA management efforts.

Summary This project enhances the existing Northwest Fisheries Science Center regional database on coral and sponge observations off the West Coast. Much of the framework for such a database already exists; however, several enhancements are required to meet the needs of future analysis, reporting, and data requests. These enhancements include references to the Integrated Taxonomic Information System serial numbers to ensure proper taxonomic associations, improved tracking of samples sent for genetic analysis or taxonomic identification, and common query structures to facilitate faster responses to data requests. In addition, results of common queries will be served on a regional data portal, the Pacific Coast Ocean Observing System (PaCOOS) West Coast Habitat Server (<http://pacoos.coas.oregonstate.edu/>). To date, the project team has created many query structures and made NMFS survey data available through the PaCOOS server. More data, specifically from surveys conducted in the five west coast sanctuaries, will be added as appropriate. The team is also developing a new specimen tracking system. Initial outputs from these efforts are included in Maps 3 and 10.



Baskets stars (Gorgonocephalus sp.) attached to bubble gum coral (Paragorgia arborea) on the Davidson Seamount at 1497 meters.

Photo Credit: NOAA/MBARI 2006

PROJECTS TO INFORM CONSERVATION THROUGH THE ANALYSIS OF EXISTING DATA AND INFORMATION

Deriving Deep-Sea Coral and Sponge Distribution Data from Archived Video Records in Northeast U.S.

\$15,000

Project Goal Develop and test a rapid image “mining” protocol to review archived underwater images and video for locations of deep-sea corals and sponges, and add these to the existing NOAA/USGS east coast deepwater coral database.

Management Application “Mining” data from existing archives has the potential to locate deep-sea corals more quickly and cheaply than would be possible through field research. The New England Fishery Management Council is currently developing management alternatives for protecting deep-sea corals that can benefit from this information.

Summary Decades of submersible and ROV operations in the EEZ off the east coast (over 5,000 dives; see Figure 1) have produced video and still photos that have yet to be fully examined to reveal deep-sea coral and sponge habitats. This project will access the archive collections of imagery at various institutions (e.g., Woods Hole Oceanographic Institute (WHOI), University of Connecticut) to delineate the distribution and abundance of key coral and sponge taxa. The project team is developing a rapid image “mining” protocol, testing the approach using these image archives, and adding to the existing NOAA/USGS east coast deepwater coral database. Work is underway and focused on Gulf of Maine deep basin and Georges Bank submarine canyon environments. To date, still imagery from dives of the *Johnson-Sea-Link* and *Alvin* submersibles in the 1970s and early 1980s have revealed several gorgonian- and sea pen-dominated communities. Review of archived video from 1960s-80s will commence soon.

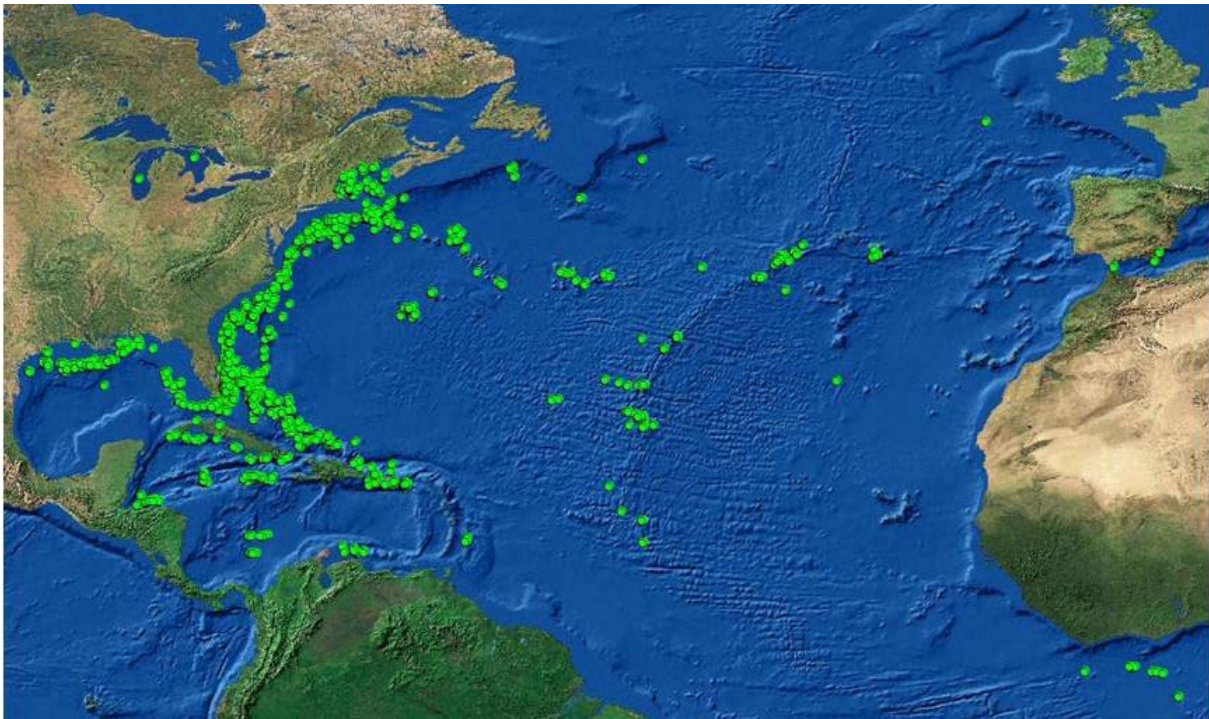


Fig. 1: Submersible and ROV dive sites in the Atlantic with archived video and still imagery data that could reveal additional information on the locations of deep-sea corals.

Source: D. Stevenson, P. Auster



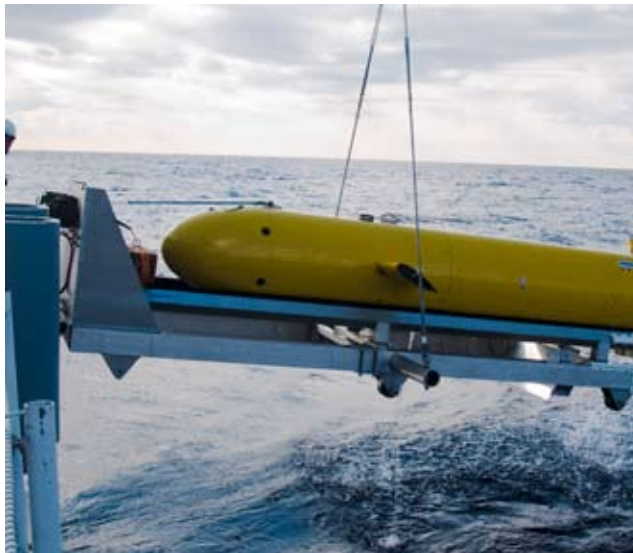
Analysis of Autonomous Underwater Vehicle (AUV) Sonar Data from Deepwater Coral Habitats off Eastern Florida

\$15,000

Project Goal Analyze sonar data (sidescan and multibeam) that was collected with an AUV in 2008 within the Deepwater C-HAPCs and the *Oculina* Habitat Area of Particular Concern (HAPC) in the South Atlantic Fishery Management Council region

Management Application This project will identify potential deep-sea stony coral reef habitat and thus guide future research and inform management of the presence of sensitive habitats.

Summary A number of deep-sea coral sites off eastern Florida were discovered during AUV sidescan and multibeam surveys in 2008. The total area surveyed in 2008 was 60.5 square miles and consisted of 240 miles of AUV track lines. The Deep Sea Coral Research and Technology Program submersible cruise in 2009 found selected sites to contain some of the greatest concentrations of living coral yet observed in the western Atlantic. This project will re-analyze the sonar data to provide higher-resolution maps of these sites that can reveal additional information on potential coral locations. Thus far, a number of the sidescan and multibeam mosaics have been completed. Additional analysis of these and similar AUV data will be processed to characterize the distribution of deepwater habitats. In addition, the integration of centimeter-scale bathymetric and backscatter maps and ground-truthing data (consisting of video transects and bottom samples taken during submersible dives) will allow for habitat mapping of the deepwater reefs with unprecedented resolution.



*The Eagle Ray AUV was used to map the Oculina Bank in 2006.
Photo Credit: A. Alexander*



*The Eagle Ray AUV was used to map the Oculina Bank in 2006.
Photo Credit: A. Alexander*

Analysis and Distribution of Deepwater Commercial Fisheries Species (Golden Crab, Tilefish, Royal Red Shrimp) in Deepwater Coral Habitats off Eastern Florida **\$10,000**

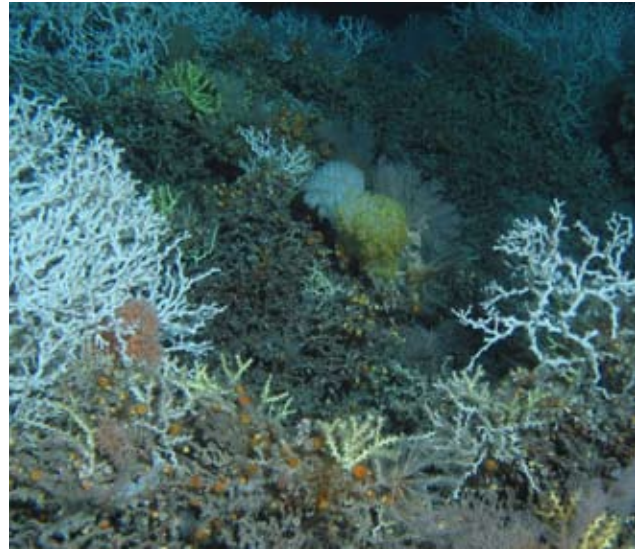
Project Goal Provide data on the distribution and abundance of the commercially caught golden crab, tilefish, and royal red shrimp in relation to deep-sea coral ecosystems in the Southeast U.S.

Management Application Results of this project will assist EFH description and identification for these commercial species and inform management efforts to reduce fisheries interactions with deep-sea coral habitats.

Summary This project will review video archives collected from over 100 submersible dives between 2005 and 2009 in the South Atlantic Region for the occurrence of the golden crab (*Chaceon fenneri*), tilefish (*Lopholatilus chamaeleonticeps* and *Caulolatilus microps*), and royal red shrimp (*Pleoticus robustus*) in deepwater coral ecosystems. A database of submersible and ROV dives has been compiled and entered into GIS to select which dives to analyze for this project. The project will also incorporate observations of these commercial species from the 2009 Deep Sea Coral Research and Technology Program cruise. The SAFMC is also contributing to this project, allowing the analysis of videotapes from additional submersible dives.



A golden crab observed from the submersible during the 2009 cruise.
Photo Credit: S. Ross et al., NOAA/USGS DISCOVERE Cruise



Lophelia coral and associated species observed during the 2009 cruise.
Photo Credit: S. Ross et al., NOAA/USGS DISCOVERE Cruise



Integrating Mapping and Fisheries Data for Deep-Sea Coral Habitats off South Carolina and Georgia \$15,000

Project Goal Process and analyze multibeam sonar and fisheries data to detect deep-sea coral habitats that can be used to delineate Essential Fish Habitat (EFH) off South Carolina and Georgia, and provide methodologies for more rapid assessment of areas during future data gathering expeditions.

Management Application The products generated through this project will support management actions by providing new tools for identifying and mapping potential deep-sea coral habitats. Mapping of coral habitat is essential for meeting the management goals of the SAFMC, so that permitted fishing areas can be designated that minimize impacts on corals.

Summary This project consists of three primary tasks: (1) analyzing available multibeam sonar and backscatter data to construct seafloor and habitat characterization maps (currently underway); (2) identifying areas of existing and potential deep-sea coral habitat; and (3) overlaying and relating existing fisheries data to these newly generated habitat maps. The products will support management actions by providing habitat and fishery managers a stronger mechanism for identifying potential deep-sea coral habitat and supporting future NOAA conservation planning, using sonar-derived datasets and algorithms.



Conger eel and squat lobster are frequently observed in Lophelia reefs.
Photo Credit: S. Ross et al.

Flower Garden Banks National Marine Sanctuary Deep-Sea Coral Investigations**\$15,000**

Project Goal Analyze imagery obtained by ROV in order to document and understand the biological components of deepwater communities in the northern Gulf of Mexico.

Management Application This project will inform revisions to the proposed boundary expansion of the Flower Garden Banks National Marine Sanctuary. The results will also be valuable in MMS decisions on oil and gas activities.

Summary This project analyzes the imagery captured from the May 2009 ROV cruise at the Flower Garden Banks National Marine Sanctuary. The project team at the sanctuary has developed a photolog of 536 high-resolution digital still images. Each image is inventoried for the biological components. A biological characterization scheme is applied to the images, which will lead to biological zonation maps for locations that currently do not have this level of information. An interactive GIS map is also being developed to show more than 9,000 images at over 200 dive sites. The georeferenced ROV survey tracks, with a selection of images taken along each track are provided online at: http://www.ncddc.noaa.gov/website/google_maps/FGB/mapsFGB.htm.



An example of deep coral habitat at the Flower Garden Banks National Marine Sanctuary, typical of the northwest Gulf of Mexico habitats. Image includes gorgonians, black corals, echinoderms, sponges, and deepwater fishes.

Photo Credit: FGNMS/NURC-UNCW



Deep-Sea Coral Community Research off California

\$15,000

Project Goal Analyze data on the occurrence of deep-sea corals and other biogenic habitats from a NOAA – USGS partnership

Management Application Information from this project will inform NOAA and Pacific Fishery Management Council’s review of essential fish habitat (EFH) and help identify vulnerable deep-sea coral areas.

Summary This project examines video footage and still images recorded by a towed camera on surveys from previous years off central and southern California. By reviewing these images, the project team is groundtruthing the habitat maps and verifying the distribution of deep-sea coral communities. The camera surveys were a collaboration between NOAA and USGS to interpret habitat maps generated with high-resolution sonar data as part of the California Seafloor Mapping Program.

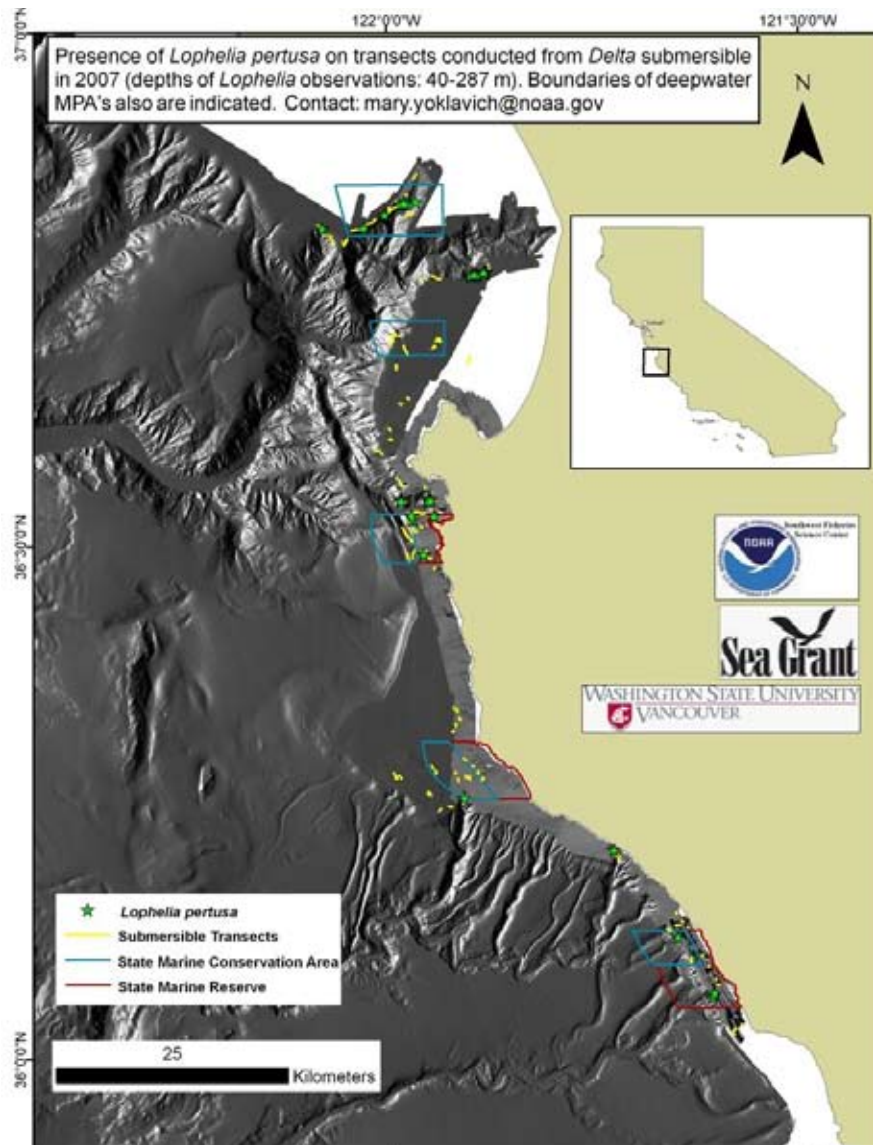


Figure 2: *Lophelia pertusa* locations observed from the Delta submersible.

Source: M. Yoklavich

Using Cordell Bank as a Model to Conduct Fine-Scale Deep-Sea Coral Predictive Habitat Modeling

\$15,000

Project Goal Refine and validate models of deep-sea coral distribution and enhance understanding of the geographic distribution of two dominant species of corals

Management Application Using predictive models, this project provides a cost-effective approach to target areas of deep-sea coral habitat for research and for conservation.

Summary This project uses updated geospatial analysis tools to refine GIS models that predict the locations of lace corals and gorgonians at Cordell Bank National Marine Sanctuary. The project team will also evaluate the models' ability to predict the presence of deep corals in other suitable rocky habitats. Additionally, the project team analyzed the range of two lace coral species (*Stylaster californicus* and *S. venustus*) and confirmed their overlap at Cordell Bank.

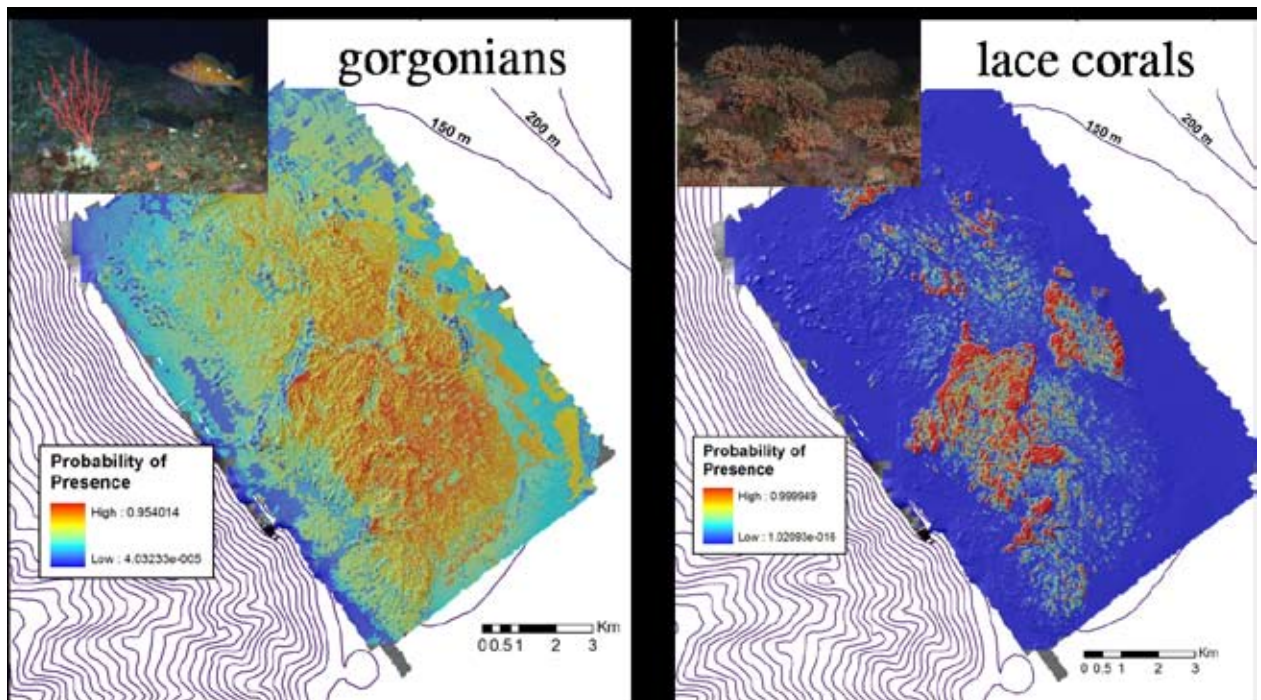


Figure 3: Preliminary model results illustrating the contrasting patterns of predicted habitat use and distribution for gorgonians and lace corals across the rocky feature of Cordell Bank off California. Results indicate that lace corals and gorgonians occupied different niches. Lace corals were restricted to a small proportion of the Bank with distinct habitat features, while gorgonians were more broadly distributed. Source: L. Etherington, CBNMS



2.4 ANALYSIS OF FISHING INTENSITY AND DEEP-SEA CORAL BYCATCH

Understanding the geographic distribution and effects of human activities that may adversely affect deep-sea coral and sponge ecosystems is a key priority for developing and implementing management strategies. The MSA directs NOAA to “monitor activities in locations where deep-sea corals are known or are likely to occur.” In many regions, fishing practices that use bottom-tending gear, especially bottom trawling, pose the most widespread threat likely to damage deep-sea coral communities. NOAA, assisted by recommendations from the Regional Fishery Management Councils, has primary responsibility for managing fisheries in the U.S. EEZ. Therefore, monitoring and providing information to manage these activities and their impacts is a top priority for the program.

Investigating the relationship between known locations of deep-sea corals and fishing activities that may damage them requires knowledge of the location of corals and the location and intensity of fishing activities. There are several methods for assigning fishing activities to a specific location. Fishing activity can be directly observed through on-board observers trained by NOAA or through electronic methods. A second approach is through self-reporting of fishing location by fishermen. This information can be collected either through dockside interviews or through logbooks and trip reports submitted by fishermen. Finally, vessel monitoring systems (VMS)

locate fishing activity through analysis of position information, vessel velocity, and other variables relayed to satellites.

In FY 2009 the program supported five projects that analyze fisheries activities. The first three projects summarized in this section use existing information to analyze and map the distribution and intensity of fishing activities conducted with bottom-contact fishing gear in Federal waters off the U.S. Northeast, Southeast, Gulf of Mexico, and California. NOAA protects all confidential information (such as the location of fishing activity) received, collected, maintained, or used by the agency as required by law.

The remaining two projects improve NOAA’s ability to identify West Coast deep-sea corals and Alaskan sponges that occur as bycatch in Federally-managed fisheries. Measuring bycatch is not a reliable method of sampling deep-sea corals. This is because only a small proportion of the broken corals are likely to be retained in bottom trawls, while other gears (e.g., bottom-set longlines and traps) may damage corals but have minimal bycatch. Nevertheless, bycatch records can provide some indication of where corals occur and are often the only measure of fisheries impact. Improving the recovery of information on deep-sea corals and sponges that is derived from bycatch will help to understand and reduce fisheries impacts to deep-sea corals and associated ecosystems.

MONITORING ACTIVITIES – ANALYZING FISHING INTENSITY AND BYCATCH

Mapping the Intensity of Fishing in the Northeast Using Gears That May Damage Deep-Sea Corals \$30,000

Project Goal Analyze fishing activity by bottom gears that may damage deep-sea corals and investigate fishery-independent and fishery-dependent data sources for potential georeferenced deep-sea coral bycatch.

Management Application This effort allows NOAA to understand where fishing occurs in relation to deep-sea coral habitat, and to quantify deep-sea coral bycatch in the groundfish and shellfish surveys. These data can inform the development of approaches that reduce deep-sea coral bycatch in specific fisheries.

Summary To map the intensity of bottom fishing, the project team is currently assessing the accuracy of vessel trip reports against other fishery-dependent data sources such as on-board observer databases and data from VMS equipment installed on vessels. The trip reports record the location of fishing activity, and the VMS data can show whether a vessel is fishing or transiting. To date, the project team has analyzed the 2007 vessel trip reports from 157,330 trips by 3,242 vessels. Of these, 282 trips by 175 vessels were also matched to the data in VMS and observer databases. In the next step, the team will investigate the remaining data and determine ways to increase the overlap among the different data sources. The New England Fishery Management Council Habitat Plan Development Team members and staff are partnering in this project.



*Deep-sea Corallium and Trachythela corals with brittle stars, crinoids, and sponges.
Photo Credit: Mountains in the Sea Research Team and Institute for Exploration*

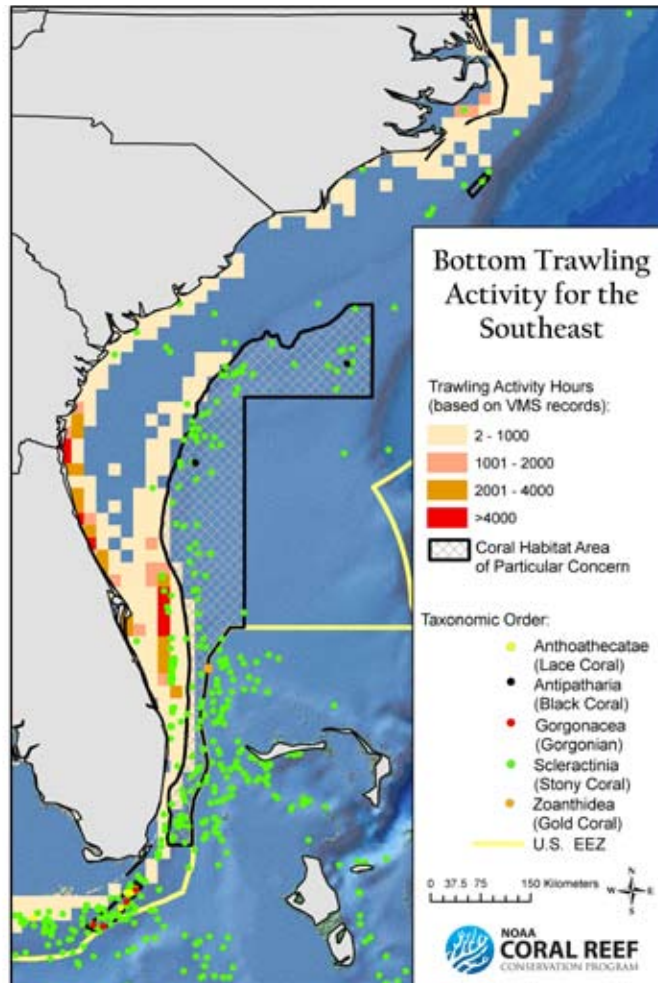


Analysis of Fishing Intensity and Potential Deep-Sea Coral Impacts in the US South Atlantic and Gulf of Mexico Regions \$36,000

Project Goal Map deep-sea fishing effort across the U.S. South Atlantic and Gulf of Mexico Fishery Management Council regions using VMS, permit, and catch/effort data.

Management Application This effort will increase NOAA's ability to identify fishing patterns and manage activities that are potentially threatening to deep-sea coral and sponge communities.

Summary This project will develop a database to integrate information from multiple sources to understand and map the location of deep-sea fishing activities. The types of data to be incorporated range from vessel registrations, fishing permits, VMS data, logbooks, to fish landing statistics. The project team has identified the relevant data sources (e.g., NMFS Office of Law Enforcement) and created a model to integrate the various datasets. Eventually, this integrated database will allow NOAA to query data across all systems and receive a comprehensive view of when, where, and what type of fishing occurs within the southeast region in near real-time, while retaining the confidentiality of fishing statistics required by law (Map 2).



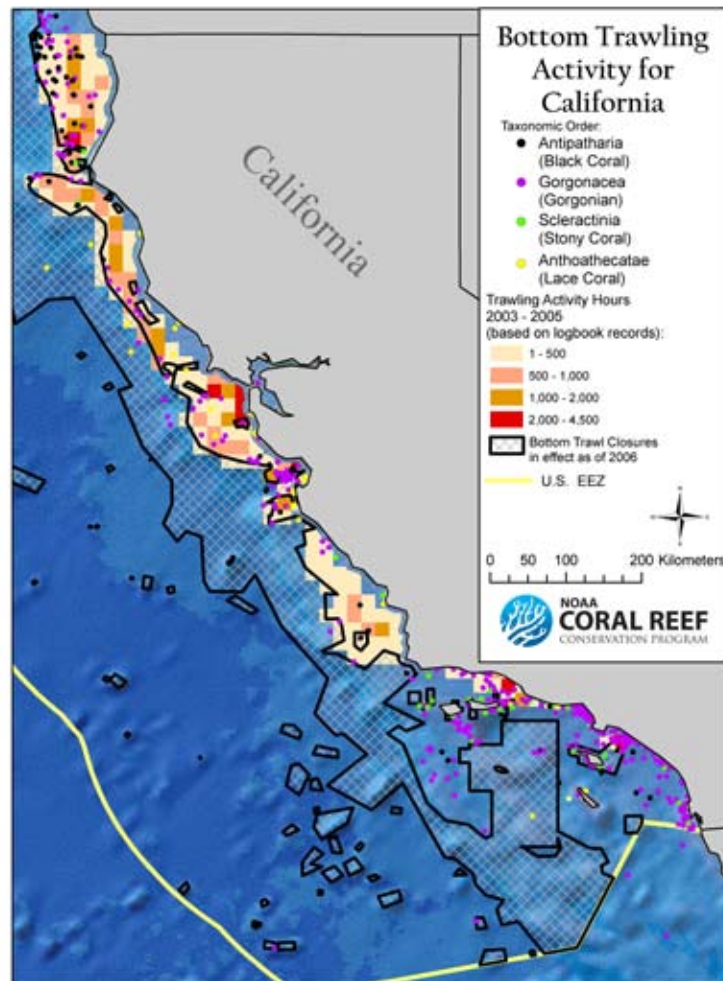
Map 2: Bottom trawling activity and the locations of structure-forming deep-sea corals off the Southeast U.S. This map provides an example of the types of analysis being conducted under this project. Bottom-trawling activity was derived from an analysis of VMS tracks with vessel velocities expected for trawling activities and aggregated by 10' reporting grids. See Map 5 for description of deep-sea coral locations.

Mapping the Distribution and Intensity of Bottom Trawling Effort Along the California Coast from 1997 to 2008, with Impacts on Deep-Sea Corals \$32,637

Project Goal Create maps of the distribution and intensity of bottom trawling along the California coast

Management Application Finer-resolution information on the location of bottom trawling will inform management measures to benefit both deep-sea coral habitats and the fishing community.

Summary This project will use the start and end locations of trawl tows recorded in California trawl-fishing logbooks to create maps of the distribution and intensity of bottom trawling along the California coast. In 2009, the project team created preliminary maps of trawling through 2005 overlaid with the locations of deep-sea corals observed during groundfish trawl surveys. These maps show some areas of heavy trawl activity and other areas with little or no trawl activity near suspected or known locations of deep-sea corals. The team will next map the changes in trawling activity after the 2004 fleet reduction and 2006 EFH closures as well as coral records from other sources.



Map 3: Bottom trawling activity (2003 to 2005) and the locations of structure-forming deep-sea corals off California. This map shows an initial analysis of commercial bottom trawl activities based on trawl set and recovery points aggregated by 10' reporting grids. Trawl data are from 2003 to 2005. Cross-hatched areas represent trawl closures for bycatch-reduction purposes and the EFH closures that went into effect in June 2006. Subsequent analyses will look at how bottom trawl effort has changed since the 2006 closures. See Map 10 for description of deep-sea coral locations.



Taxonomic and Genetic Identification of Fisheries Bycatch of Deep-Sea Corals During the 2009 West Coast Groundfish Bottom Trawl Survey \$40,243

Project Goal Augment the collection of voucher specimens (i.e., species inventory) of deep-sea corals on the West Coast to improve coral identification in bycatch and groundfish surveys.

Management Application Understanding of the impacts of fisheries on deep-sea corals will be enhanced by accurate identification of corals encountered in fishing activities.

Summary The project team collected coral specimens during the 2009 West Coast groundfish survey and conducted DNA sequencing of the specimens from the 2007 and 2008 surveys. In addition, the team began creating scanning electron microscope images of some of the specimens to document their morphology. The project team will use these genetic and morphological techniques to identify the coral specimens to the species level, and incorporate the species designations into a coral identification guidebook.



Close-up of primnoid coral (Calyptrophora sp.) and shrimp on the Davidson Seamount off California at 5150 ft (1570 m) depth.

Photo Credit: NOAA/MBARI 2002



A Christmas tree black coral (Antipathes dendrochristos) off southern California at 500 ft (150 m) depth.

Photo Credit: M. Amend, NOAA

A Field Guide to the Deepwater Sponges of the Aleutian Islands Archipelago**\$20,750**

Project Goal Provide a field guide to Aleutian Island sponges that can be used by fisheries observers and researchers.

Management Application This guide will help map the distribution of sponges, quantify and reduce the impacts of trawling on particular species, and guide research on these important components of the ecosystem.

Summary Sponges are common in the bycatch of Alaska bottom trawl fisheries, but the field guides used by fisheries observers to identify bycatch contain inaccurate and incomplete information on sponges. This project will examine hundreds of sponge specimens, including more than 40 species new to science, that NOAA collected between 2003 and 2007 to develop a sponge field guide of the Aleutian Islands. The guide will be available to fishers, fisheries observers and scientists for the 2010 field season, complementing the existing “Field Guide to Alaskan Corals” to record the locations of important benthic invertebrates that provide habitat for other species.



An Alaskan coral garden with several species of gorgonians, lace corals, and sponges.

Photo Credit: A. Lindner

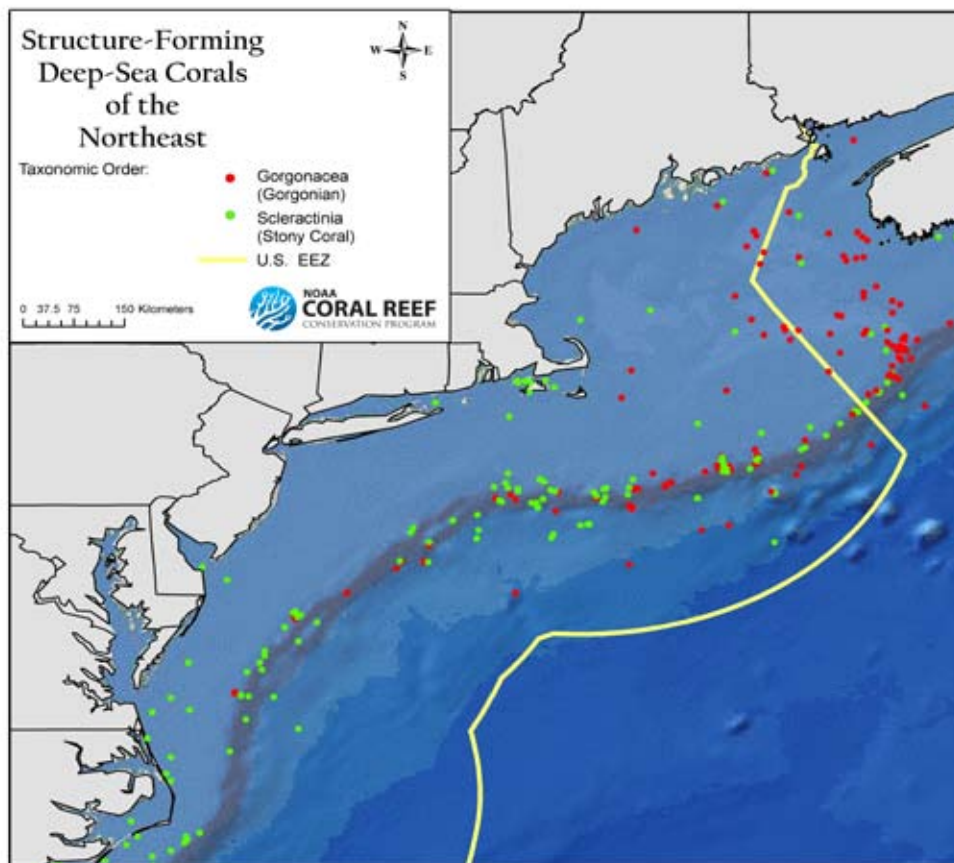


CHAPTER 3: COMPLEMENTARY ACTIVITIES TO IDENTIFY, MONITOR, AND PROTECT DEEP-SEA CORAL AREAS IN 2008 – 2009

NOAA is the principal Federal agency responsible for management of living marine resources within the U.S. EEZ where most U.S. deep-sea coral communities occur. The Congressional mandate for a Deep Sea Coral Research and Technology Program signaled recognition of the considerable work that multiple NOAA programs (e.g. National Marine Sanctuaries, Ocean Exploration and Research, Fisheries Science Centers, Fishery Management Program, and National Centers for Coastal Ocean Science) have conducted for years on these critical ecosystems. The Deep Sea Coral Research and Technology Program continues to

leverage the past and ongoing activities conducted by its NOAA partners.

The following summaries—developed by NOAA in conjunction with the Regional Fishery Management Councils—focus on new management activities and selected research conducted by NOAA and its partners since our first Report to Congress in 2008. These activities complement, and in the future will build upon, the activities funded under the Deep Sea Coral Research and Technology Program described in Chapter 2.



Map 4: Known locations of structure-forming deep-sea corals off the Northeast U.S. The data represent known locations of major structure-forming species of gorgonian and colonial stony corals. Data do not represent density of coral cover but rather known locations and may reflect the limited geographic extent of fishing or research effort. See page 64 for data sources.

3.1 NOAA AND THE COUNCILS

NEW ENGLAND AND MID ATLANTIC REGIONS – 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 (Map 4). 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 FMPs.

The NEFMC is currently developing the Omnibus EFH Amendment 2, which will amend existing EFH designations, analyze the impacts of fishing on EFH, and recommend appropriate management measures to minimize the adverse effects of fishing to EFH. The amendment is scheduled for final Council approval and NMFS implementation in 2011. Phase 1 of the amendment included proposed alternatives for designating 15 deep-sea canyons and portions of two seamounts as HAPCs. Several canyons and both seamounts are known to harbor deep-sea coral habitats (Appendix 3). Final action on the HAPC proposals will not be taken until the Omnibus EFH Amendment is implemented. It is likely that some of the proposed canyon and seamount HAPCs will be modified to become coral protection zones.

In this context, two motions have been passed by NEFMC indicating support for deep-sea coral protection:

February 2008: “to direct the Habitat Plan Development Team to evaluate existing information on deep-sea corals and to develop management options to protect deep-sea coral habitat. It is understood that these options would be independent of any EFH and HAPC designations.”

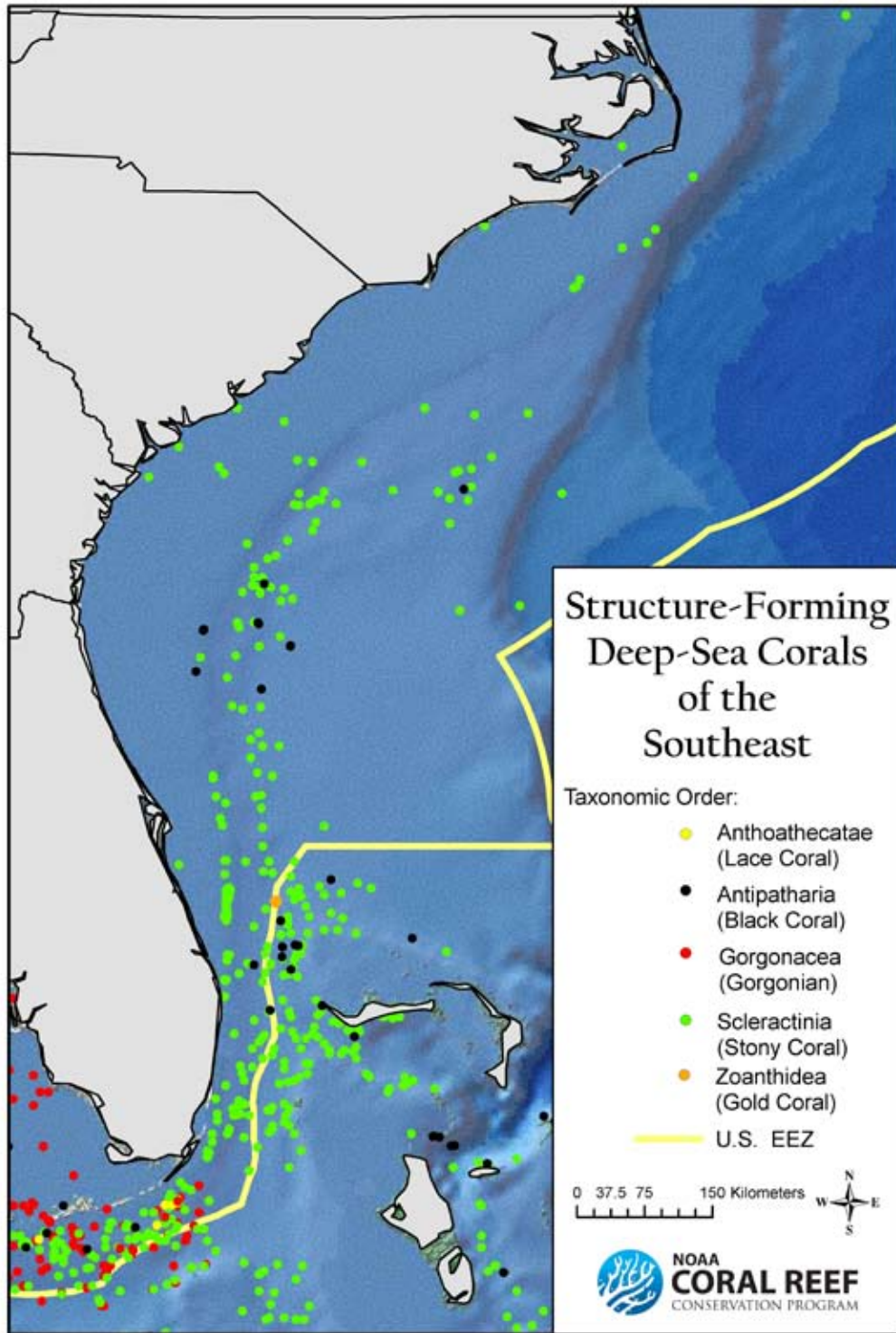
June 2008: “That during phase 2 of the Habitat Omnibus Amendment, the Council will work with the MAFMC to develop protections for deep-sea coral under the authority provided by the reauthorization of the Magnuson-Stevens Reauthorization Act.”

In 2008, on the recommendation of MAFMC and with concurrence by the NEFMC, the Secretary of Commerce approved the closure of portions of Lydonia and Oceanographer canyons on the southern flank of Georges Bank to the use of bottom trawls by commercial fishing vessels that are permitted to catch squid, mackerel, and butterfish. The same areas were closed in 2005 to monkfish trawlers. The primary reason for closing these two areas is to protect EFH for Federally-managed demersal fish species that are adversely impacted by bottom trawls. Closures will also have the corollary effect of minimizing fishing impacts on deep-sea corals often found associated with geographic features such as canyons. In November, 2009, portions of these canyons as well as Veatch and Norfolk canyons were closed to all bottom-trawling to protect EFH for tilefish (Appendix 3). The tilefish closures will be more effective than previous measures at protecting deep-sea corals since they will prohibit all bottom trawling activity.

In December 2009, the MAFMC voted to recommend that NMFS nominate Veatch, Norfolk, Lydonia, and Oceanographer Canyons, which are managed under the tilefish FMP, to the National System of Marine Protected Areas.

Box 5: New England Fishery Management Council analyzes fishing impacts on deep-sea corals

The NEFMC’s Habitat Plan Development Team is developing a model to evaluate the impacts of fishing on EFH. Three groupings of deep-sea corals (sea pens, stony corals, and soft corals/gorgonians), were identified as structural components of fish habitat in the vulnerability assessment. Their susceptibility to and recovery from impacts from five types of fishing gears were estimated, based on knowledge of coral biology and a comprehensive review of the fishing impacts literature. This information was then incorporated in the model. Results of this analysis were released in late 2009 and will be used to develop and analyze management alternatives intended to protect deep-sea corals.



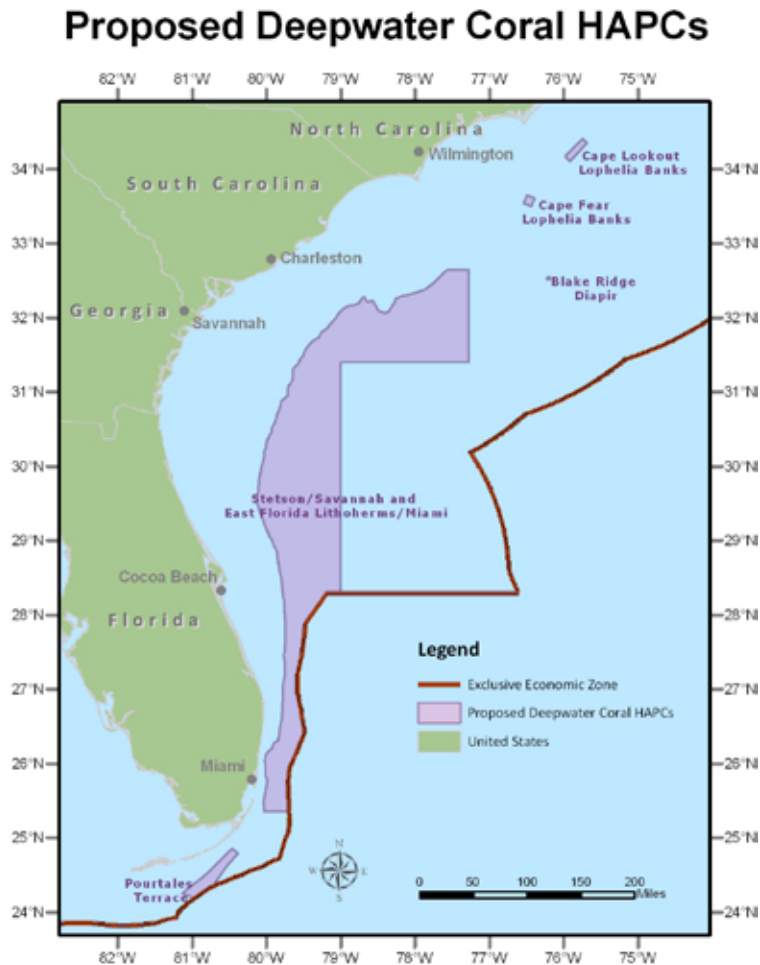
Map 5: Known locations of structure-forming deep-sea corals off the Southeast U.S. The data represent known locations of major structure-forming species of lace corals, black corals, gorgonian corals, colonial stony corals and gold corals. Location data are particularly incomplete for corals other than stony corals. See page 64 for data sources.

SOUTHEAST – CAPE HATTERAS TO SOUTH FLORIDA

As described in Chapter 2, deep-sea stony coral reefs in U.S. waters reach their greatest abundance and development in the Atlantic south of Cape Hatteras (Ross and Nizinski 2007; Map 5). This area was also the first focal region for new field science under the Deep Sea Coral Research and Technology Program. 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 September 2009 the SAFMC voted unanimously to approve a Comprehensive Ecosystem-Based Amendment 1 for submission to the Secretary of Commerce. If approved by the Secretary, this landmark amendment will establish five deepwater Coral Habitat Areas of Particular Concern (C-HAPCs)¹ totaling 24,215 square miles (62,717 km²), protecting complex deepwater coral habitats located off the coasts of the Carolinas, Georgia,



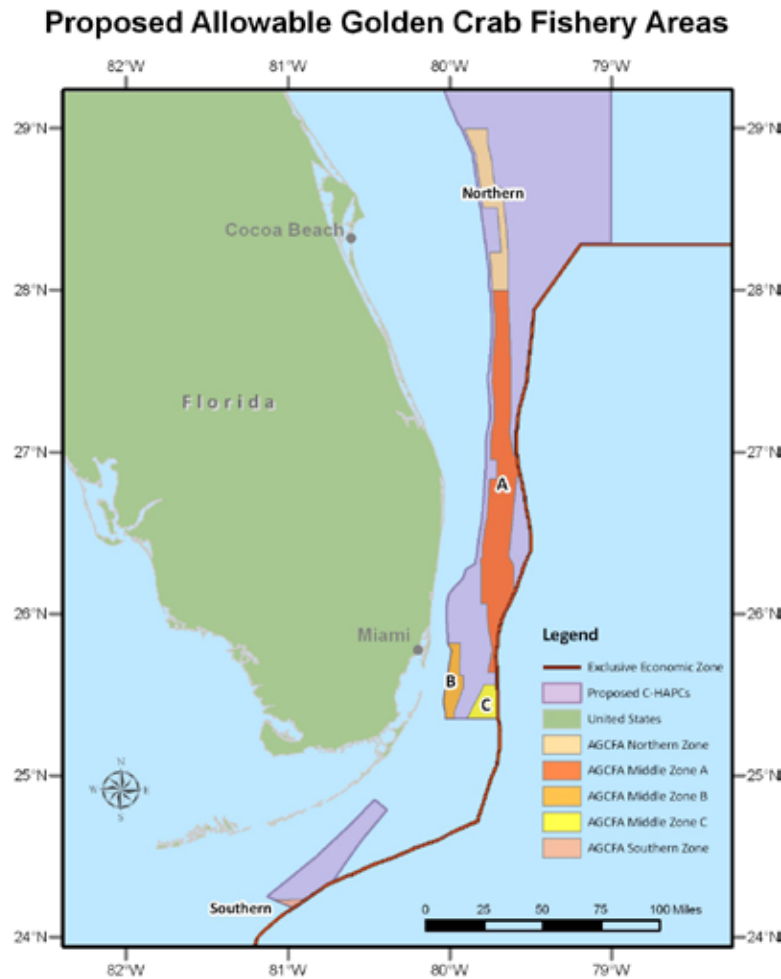
Map 6: South Atlantic Fishery Management Council's proposed Deepwater Coral Habitat Areas of Particular Concern (C-HAPCs). Source: SAFMC

¹ NMFS notes that Coral Habitat Areas of Particular Concern (C-HAPCs) are areas with specific management measures for corals under the South Atlantic Fishery Management Council's Coral, Coral Reef, and Live/Hardbottom Habitat Fishery Management Plan. In contrast, Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPCs) are subsets of EFH for a managed fishery that satisfy the HAPC criteria in the EFH regulatory guidance (50 CFR 5600.815 (a)(8)). The Council's C-HAPCs have not been evaluated against the HAPC criteria identified in the EFH regulatory guidance.



and eastern Florida (Map 6). Regulations being proposed for the C-HAPCs mirror those currently in place for the shallower *Oculina* HAPC off central Florida. Within the C-HAPCs possession of coral species and the use of all bottom damaging gear would be prohibited, including bottom longline, trawl (bottom and mid-water), dredge, pot or trap, or the use of an anchor, anchor and chain, or grapple and chain by all fishing vessels. If approved by the Secretary of Commerce, the Stetson Reefs, Savannah and East Florida Lithoherms, and Miami Terrace (Stetson-Miami Terrace) C-HAPC would represent the largest marine protected area on the U.S. East Coast.

The SAFMC also recognized the small traditional fisheries targeting golden crab and royal red shrimp that have set their traps and hauled their nets in areas now known to provide suitable habitat for deep-sea corals. Developed in close consultation with these fisheries, the Council’s Comprehensive Ecosystem-Based Amendment proposes “Allowable Golden Crab Fishing Areas” and “Shrimp Fishery Access Areas” within two of the proposed C-HAPCs (Map 7). This action would restrict these fisheries to traditional fishing grounds, providing for the continued existence of these fisheries and the communities they support, while ensuring that they do not expand to areas that have a high potential



Map 7: South Atlantic Fishery Management Council’s proposed C-HAPCs and “Allowable Golden Crab Fishing Areas (AGCFAs).” Source: SAFMC

of harboring deep-sea coral ecosystems. The 2009 science cruises of the Deep Sea Coral Research and Technology Program provided information that may help refine these allowable fishing areas in the future.

These historic conservation actions build on many years of efforts by the SAFMC to develop the

Comprehensive Ecosystem-Based Amendment and support assembly of information on the region's deep-sea coral ecosystems, both the shallower *Oculina* Banks and the deeper *Lophelia* coral reefs.

Other deep-sea coral activities supported by SAFMC are further described in Box 6.

Box 6: More deep-sea coral activities in the Southeast

- The SAFMC, NOAA, and partners held Deepwater Coral Teacher Workshops in Florida (2008) and North Carolina (2009), which trained educators from kindergarten through college on the deep-sea coral ecosystems in the Southeast region. The SAFMC contributed an article on U.S. deepwater coral ecosystems to a special issue of *Currents: the Journal of Marine Education*, featuring the Regional Fishery Management Councils. The issue will publish in spring 2010.
- The SAFMC's online EcoResearch Database provides a catalogue of relevant ecosystem research in the South Atlantic region. This database helps determine information needs and potential data gaps occurring in SAFMC's jurisdiction. Additional spatial footprints for coral-specific research projects were created in 2008-2009.
- In April 2008, NOAA supported a research cruise to the *Oculina* Bank to revisit deep-sea coral habitat restoration experiments deployed in the past decade. Artificial reef structures were deployed in the Sebastian Pinnacles area of the *Oculina* Bank to stimulate new coral growth and provide structure for reef fish. A dive team, equipped with scooters and digital cameras, documented only limited coral growth on the concrete structures and surrounding habitat. The divers also deployed a bio-observatory designed to stay out for six weeks and capture images and sounds on a living *Oculina* Reef.
- In October 2009, the Center for Biological Diversity filed a petition seeking to protect 83 coral species, including the deep-sea ivory coral (*Oculina varicosa*) under the Endangered Species Act. Recent research supported by NOAA has revealed that ivory coral from the *Oculina* Banks deep water area was genetically distinct from other *O. varicosa* in nearby shallow waters and other areas of the Atlantic and Gulf of Mexico (Eytan et al. 2009). On February 10, 2010, NMFS announced a 90-day finding on the petition (Federal Register, Vol. 75, pp. 6616-6621) that concluded that the petition presented substantial scientific or commercial information indicating that the petitioned actions may be warranted for 82 species; the petition failed to present substantial scientific or commercial information indicating that the petitioned action may be warranted for *Oculina varicosa*.



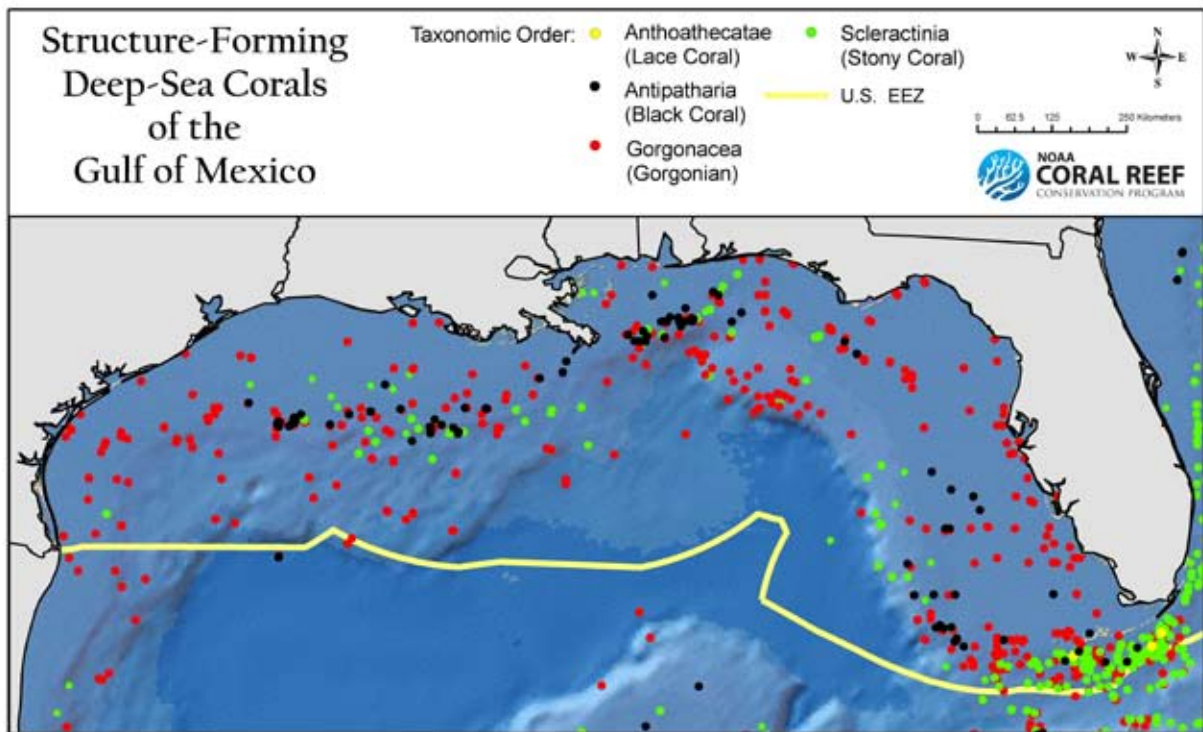
GULF OF MEXICO – SOUTH FLORIDA TO TEXAS

The northern Gulf of Mexico is home to major *Lophelia pertusa* reefs and other deep-sea corals (Brooke and Schroeder 2007; Map 8). Recent compilations of gorgonian records in the Gulf of Mexico (Etnoyer 2009) and new research over the past two years have significantly expanded our knowledge of these resources. 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.

Since the first Report to Congress in 2008, the GMFMC has not taken any specific actions to protect deep-sea coral habitats in its region. The Council's five-year review of EFH is due in 2010, including a

review of existing and potential HAPCs in each of their FMPs.

The Flower Garden Banks National Marine Sanctuary is located in this region. The sanctuary encompasses three banks in the northwestern Gulf of Mexico and is home to zooxanthellate corals occurring from the crest to at least 170 feet (52 m), as well as deeper communities of gorgonians and black corals. NOAA published the first comprehensive Condition Report for the sanctuary, summarizing the conditions and trends for the sanctuary's habitat and living resources. The sanctuary also conducted research cruises in 2008 and 2009 to characterize the deep water habitat on banks inside and outside the sanctuary. The surveys explored geographic features in areas that may be included in a proposed sanctuary expansion. The habitats encountered were dominated by black corals, gorgonians, sponges, and associated biota. The data



Map 8: Known locations of structure-forming deep-sea corals in the northern Gulf of Mexico. The data represent known locations of major structure-forming species of lace corals, black corals, gorgonian corals and colonial stony corals. Location data are particularly incomplete for corals other than stony and gorgonian corals. See page 64 for data sources.

collected are being incorporated into a GIS database, which links the high resolution bathymetry, the georeferenced ROV tracks, still images, and associated inventories of species.

In September 2008, NOAA, MMS, and USGS embarked on a 4-year project to explore new deep-sea coral communities in the deep Gulf of Mexico and to characterize their biology, ecology, and genetic connectivity. In both 2008 and 2009, major expeditions involving scientists from various agencies and universities were conducted from NOAA ships. These expeditions used ROVs to examine ship wrecks and the deep-sea corals colonizing them, as well as to investigate a series of previously unexplored sites along the northern and eastern Gulf of Mexico at depths between 980 and 3,300 feet (300 and 1,000 m). Fish and invertebrate samples were collected on and adjacent to the coral habitat and two benthic landers, designed to collect long-term environmental and biological data, were deployed and retrieved in the vicinity of these deep coral habitats.

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 deeper waters of the region have not been extensively surveyed for deep-sea corals (Lutz and Ginsberg 2007). Deep-sea coral banks have not been reported, but at least 33 species of azooxanthellate deep-sea corals, including the deep water reef builder *Lophelia pertusa*, have been collected from deep reef habitats of the U.S. Caribbean EEZ (García-Sais 2005). The Caribbean Fishery Management Council (CFMC) has authority over fisheries in Federal waters surrounding the Commonwealth of Puerto Rico and the USVI.

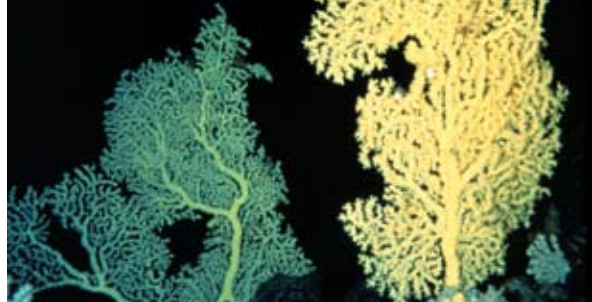
The CFMC has not taken new actions to protect deep-sea coral areas since 2007, but continues to be engaged on habitat issues on shallower coral reefs. The original prohibition on the take of corals from the EEZ

includes the deeper water species such as the black corals. The CFMC has concentrated efforts on the baseline description and characterization of relatively shallow fish spawning aggregation sites (designated as HAPCs under the EFH Generic Amendment to the FMPs) under management. In the near future, other non-managed areas will be also assessed for the first time, which might include deeper areas (e.g., seamount habitats off the west coast of Puerto Rico, where an important deepwater snapper fishery takes place). The Council's five-year review of EFH will be conducted in 2010. NOAA, in collaboration with the CFMC, the National Park Service, and the USVI and Puerto Rico territorial governments, has continued exploring and characterizing habitats down to 3,300 feet (1,000 m).



Corals may be the oldest living marine animals

Research funded by NOAA has revealed that certain deep-sea coral colonies may live for thousands of years. Radiocarbon dating studies have estimated that colonies of gold coral from Hawaii can live for more than 2700 years, while a Hawaiian deep-sea black coral colony was dated to 4265 years (Roark et al. 2009). This longevity and slow growth suggests that recovery from damage may take millennia.



Black coral (Leiopathes sp., left) and gold coral (Gerardia sp., right) in Hawaii

Photo credit: NOAA Hawaiian Undersea Research Lab (left). J. Moore; OAR/National Undersea Research Program; Hawaii Undersea Research Lab (right).

U.S. PACIFIC ISLANDS – HAWAII AND THE UNITED STATES PACIFIC ISLANDS

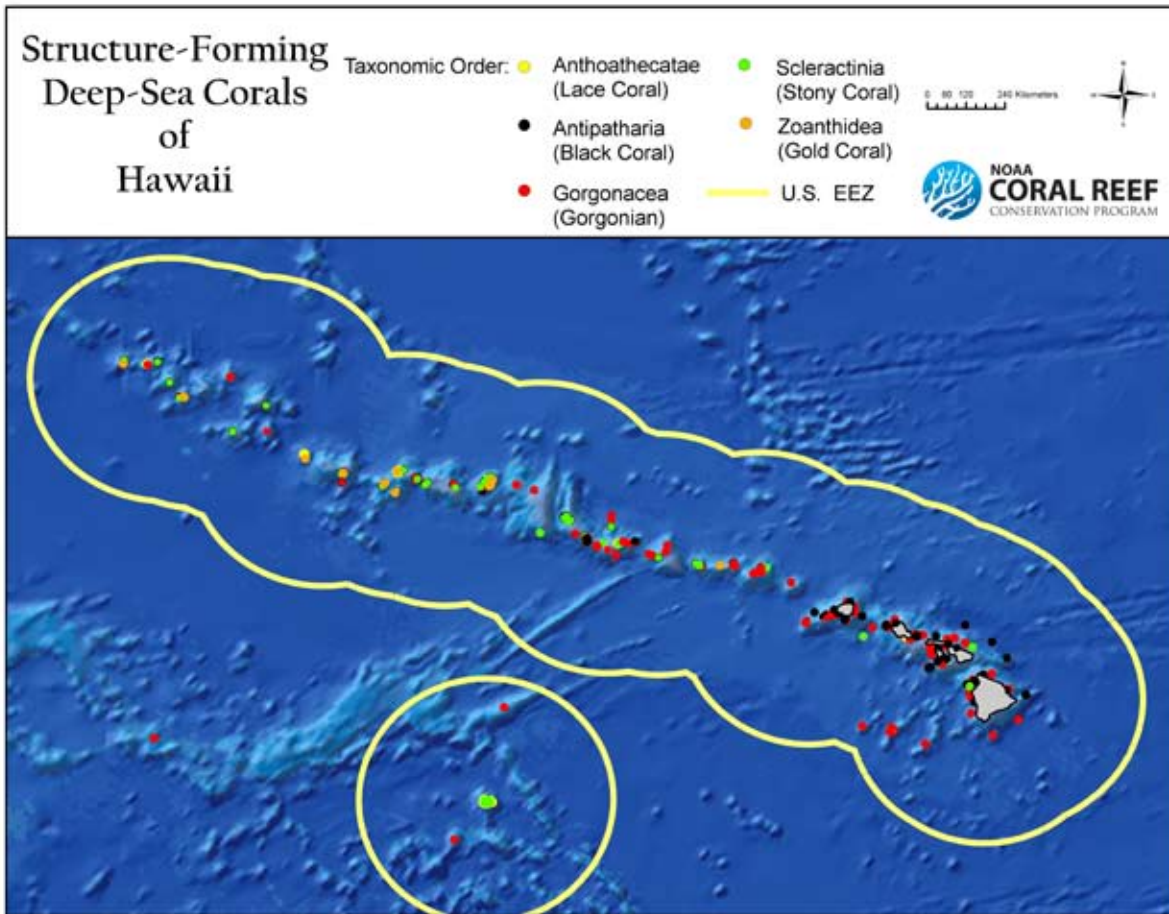
The U.S. EEZ in the Pacific Islands Region covers nearly 2 million square miles of oceans around the State of Hawaii, the Territory of American Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Island possessions, and contains hundreds of seamounts and other deep-sea features. Most studies of deep-sea coral ecosystems here have been limited to the Hawaiian Archipelago (Map 9), 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).

In 2009, three marine national monuments were designated in the central and western Pacific: Marianas Trench, the Pacific Remote Islands, and Rose Atoll, raising their level of environmental recognition and conservation. Destruction or extraction of protected resources within the boundaries of these monuments is now prohibited, as is commercial fishing in the shallower coral reef ecosystem areas of the monuments. Combined, these monuments represent the largest fully protected area in the world, with 195,274 square miles (505,757 km²) conserved, and are expected to contain important deep-sea coral habitats.

Hawaii has had the only significant U.S. commercial harvests of corals for the jewelry business. Corals collected for jewelry - black, pink, and gold corals - occur throughout the Hawaiian Archipelago. These resources have been managed since 1981 through regulations implementing the Western Pacific Fishery Management Council's Precious Corals FMP and complementary State of Hawaii administrative rules.

In September 2008, NMFS placed a 5-year moratorium on the harvest of gold coral in the Western Pacific region. NMFS also designated the Auau Channel as an Established Bed for black coral under the Precious Corals FMP and set a biennial harvest quota for black coral of 11,000 lbs (5,000 kg). The Council recommended these management measures because of uncertainty in the growth estimates of gold coral and the continued pressure of both fishing and the impact of the invasive soft coral, *Carijoa riisei*, on the black coral stocks in the Auau Channel.

The Council has continued to support assessments of black corals in the Auau Channel. These studies have resulted in the redescription of one species of black coral, and development of a time-series study looking at the effects of the invasive soft coral that has overgrown and killed many commercially valuable black coral colonies. The Council has also supported assessments of black coral reproduction and a black coral mapping project using existing data.



Map 9: Known locations of structure-forming deep-sea corals in waters around the Hawaiian Archipelago. The data represent known locations of major structure-forming species of lace corals, black corals, gorgonian corals, colonial stony corals, and gold corals. See page 64 for data sources.



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 and supplemented by museum collection records and underwater vehicle explorations (Whitmire and Clarke 2007). The Pacific Fishery Management Council (PFMC) has authority over fisheries in Federal waters of this region and implemented sweeping measures to protect EFH in areas totaling more than 130,000 square miles (336,700 km²) in 2006.

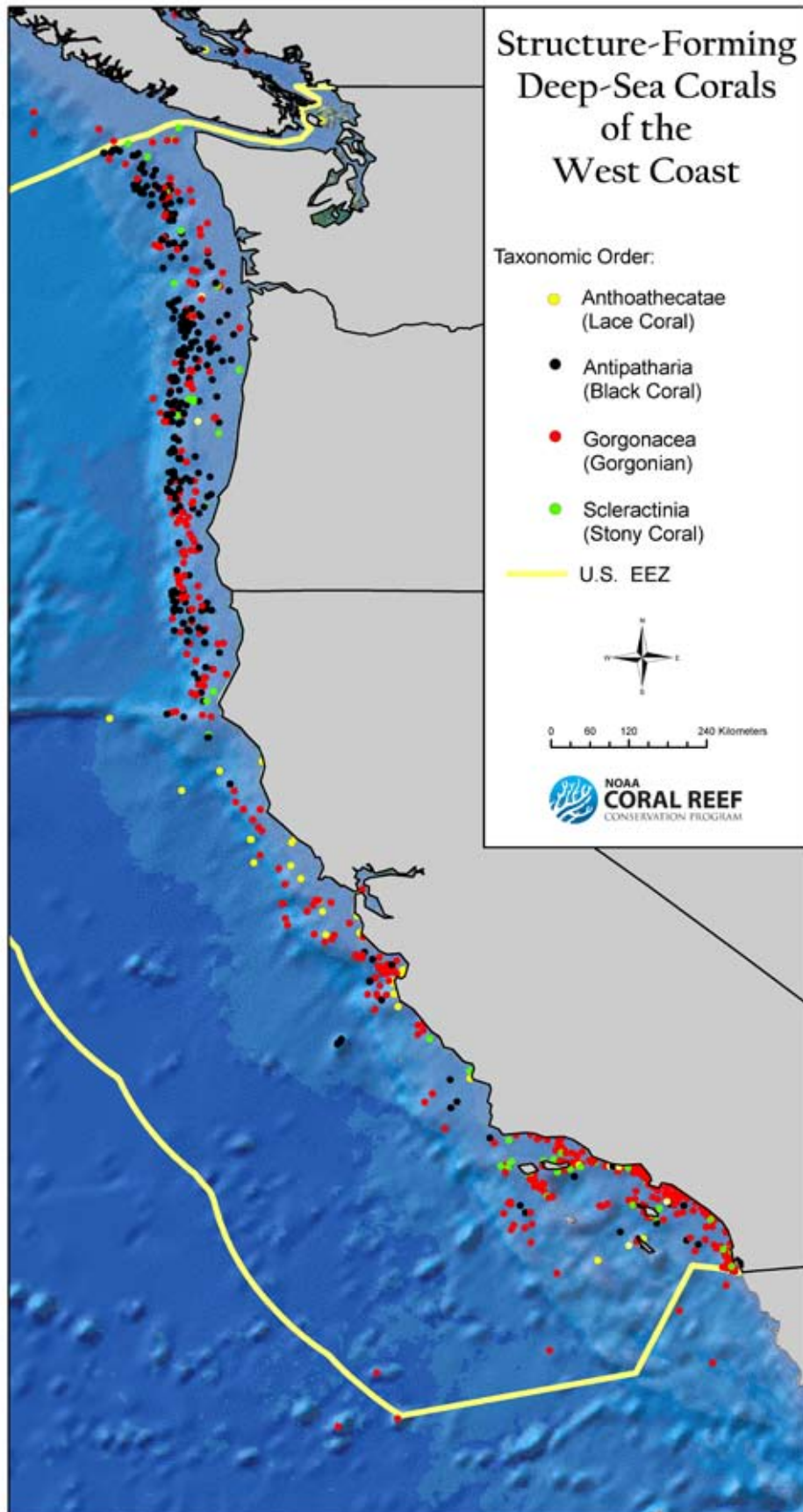
PFMC has not taken additional actions to protect deep-sea coral habitats along the West Coast since the first Report to Congress in 2008. The Council has formed an Essential Fish Habitat Review Committee to review and recommend modifications in the designation of groundfish EFH and HAPCs. The committee received a proposal from the NGO Oceana to protect newly discovered deep-sea coral habitats in the Olympic Coast National Marine Sanctuary (NMS) and sponge reefs off the coast of Washington. The Council has tabled the consideration of this proposal until a five-year review of groundfish EFH in 2011.

NOAA manages five National Marine Sanctuaries on the West Coast: the Channel Islands, Monterey Bay, Gulf of the Farallones, Cordell Bank, and Olympic Coast NMS. All contain deep-sea corals. In 2008, NOAA incorporated Davidson Seamount — a volcanic seamount that is home to more than 20 species of deep-sea corals, as well as large sponge fields and deep-sea fishes — into the Monterey Bay

NMS, providing additional protection on top of the EFH bottom-gear closure.

To the north, the Olympic Coast National Marine Sanctuary collaborated with Canadian colleagues for a joint ROV survey for deep-sea coral and sponge communities in a July 2008 cruise conducted aboard the Canadian Coast Guard vessel *John P. Tully*. The cruise consisted of two legs, one in Dixon Entrance at the border between Alaska and British Columbia, and the other at the border between Washington and British Columbia, including within the sanctuary. Corals were documented at several new sanctuary sites around the trough of the Juan de Fuca Canyon.

In July 2009, NOAA Office of Ocean Exploration and Research and National Marine Sanctuaries leveraged field trials associated with the NOAA ship *Okeanos Explorer* to complete a backlog of multibeam mapping critical to meeting Sanctuary needs. During the field trials, NOAA personnel mapped a large swath of seafloor off the coast of northern California and Washington, including areas within Cordell Bank, Gulf of the Farallones, and Olympic Coast NMS. Bathymetry and backscatter data were collected mainly in waters deeper than 600 feet (200 m), including continental slope and canyon habitats (e.g., Bodega Canyon). Data are currently being analyzed by NOAA and USGS to create habitat map layers that will allow the agencies to predict the types of seafloor communities in different locations. This new habitat information will help guide NOAA's research and resource protection efforts, including planning for West Coast research activities for FY 2010 under the Deep Sea Coral Research and Technology Program.



Map 10: Known locations of structure-forming deep-sea corals off the U.S. West Coast. The data represent known locations of major structure-forming species of lace corals, black corals, gorgonian corals, and colonial stony corals. See page 64 for data sources.



ALASKA REGION – GULF OF ALASKA, BERING SEA, AND THE ALEUTIAN ISLANDS

Alaska has some of the richest deep-sea coral habitats in the world, much of which yet to be explored. 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 (more than 980,000 km²) to bottom trawling in the Aleutian Islands and Gulf of Alaska, including many areas known or suspected to harbor deep-sea corals.

In 2008, additional conservation measures were implemented to protect EFH 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

also included areas closed to bottom trawling in locations that have not been previously fished with such gear (e.g., Bering Sea Habitat Conservation Area) and in nearshore bottom habitat areas that support subsistence marine resources. True soft corals are the major species occurring in these areas (Stone and Shotwell 2007). Although the closures were not designed specifically to protect deep-sea corals, they represent precautionary measures by the NPFMC to conserve habitats.

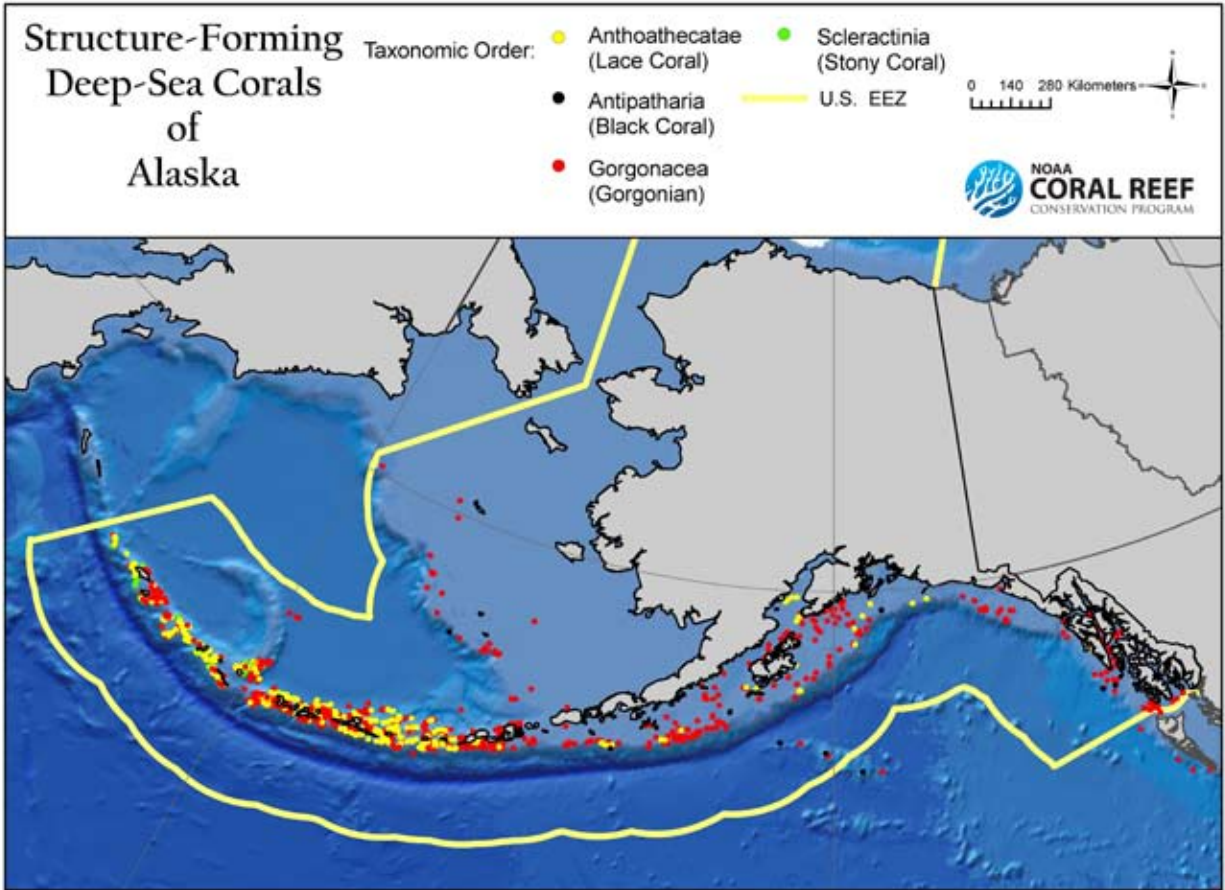
In the past two years, the NPFMC has not taken any additional actions specific to deep-sea coral protection. While the Council adopted an Arctic FMP in 2009, which was approved by the Secretary of Commerce and closed the entire Arctic area to commercial fishing, current information, though incomplete, does not indicate the occurrence of significant deep-sea coral resources in the U.S. Arctic.



Large primnoid coral loaded with brittle stars on Dickens Seamount. Photo Credit: Gulf of Alaska cruise, 2004. NOAA Office of Ocean Exploration



Large Paragorgia coral with galatheid crabs on Pratt Seamount at 800 meters depth. Photo Credit: Gulf of Alaska cruise, 2004. NOAA Office of Ocean Exploration



Map 11: Known locations of structure-forming deep-sea corals off Alaska. The data represent known locations of major structure-forming species of lace corals, black corals, gorgonian corals, and colonial stony corals. Location data are particularly incomplete for corals other than stony and gorgonian corals. See page 64 for data sources.



3.2 FEDERAL INTERAGENCY COOPERATION

NOAA partners with other Federal agencies to increase understanding of and protection for deep-sea coral ecosystems. Since 2007, coordination on deep-sea coral issues has been facilitated through the Interagency Board on Deep-sea Coral and other Vulnerable Marine Ecosystems established by the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology. NOAA co-chairs the Board with MMS. The Board has focused on four major areas:

- Coordinating interagency review of major strategic documents.
- Enhancing coordination and planning of major research programs on deep-sea corals, in particular on interagency collaborative research in the northern Gulf of Mexico.

- Coordinating U.S. interagency science advice on international negotiations and processes related to deep-sea ecosystems.
- Providing information exchange and outreach on Federal programs to study and conserve deep-sea ecosystems.

NOAA continues to partner on specific deep-sea coral research and mapping activities with other Federal agencies, particularly USGS and MMS, especially in the Gulf of Mexico as described above. NOAA and USGS have also continued collaboration on a Cold-Water Coral Geographic Database (Scanlon et al. 2009).



Scientists on the August 2009 deep-sea coral cruise in the Southeast U.S. came from NOAA, USGS, and many other organizations. The JSL submersible is in the background.

Photo Credit: NOAA/USGS

3.3 INTERNATIONAL ACTIVITIES

Since the first Report to Congress in 2008, NOAA in coordination with the Department of State and numerous other partners has continued to participate in bilateral and multilateral efforts to understand and protect deep-sea corals and other vulnerable deep-sea ecosystems. For example, NOAA was a cosponsor of the 4th International Symposium on Deep-sea Corals, held in New Zealand in December 2008, and of the International Council on the Exploration of the Seas (ICES) Symposium on Issues Confronting the Deep Oceans, held in the Azores, Portugal, in April 2009. Other NOAA efforts in international fora addressed fishing impacts, coral trade, marine protected areas, seabed mining, and collaborative research as follows.

HIGH-SEAS FISHING IMPACTS

In the late 1990s, the international community began to recognize the need for more measures to protect deep-sea coral ecosystems. Most initial conservation efforts focused on deep-sea coral habitats within the EEZs of individual countries (reviewed by Hourigan 2008). In contrast, action to protect deep-sea coral ecosystems on the high seas was limited and largely

uncoordinated until December 2006, when the United Nations General Assembly (UNGA) adopted Sustainable Fisheries Resolution 61/105. This resolution called upon States and Regional Fisheries Management Organizations and Agreements (RFMO/As) to take a series of action 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.

Since the 2008 Report to Congress, NOAA has continued to work, in collaboration with the State Department and in consultation with stakeholders, towards the protection of VMEs, in accordance with the 2006 UNGA Resolution 61/105. In 2008, as a result of strong U.S. leadership, the United Nations Food and Agriculture Organization adopted the *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas*. The Guidelines, which are consistent with domestic management approaches, are intended to assist RFMO/As in their adoption

Box 7: More on high seas fishing

Fishing activities that have an adverse impact on deep-sea corals and other VMEs located beyond national jurisdiction, for which there are no applicable conservation or management measures or in areas with no applicable RFMO/As are defined as illegal, unreported, and unregulated fishing under the High Seas Driftnet Fishing Moratorium Protection Act (Moratorium Protection Act), as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act.

NOAA is currently revising the regulations for the High Seas Fishing Compliance Act, which establishes a system of permitting, reporting, and regulation for U.S. vessels fishing on the high seas. One aspect of the revisions will be to ensure that the U.S. is fully compliant with the relevant bottom fishing sections of UNGA Resolution 61/105. Currently, by policy, all U.S. fishing activities on the high seas must be reviewed for their potential environmental impacts; the revised regulations will codify this requirement. No U.S. vessels were authorized to bottom fish on the high seas in 2009.



and implementation of conservation and management measures pursuant to Resolution 61/105, including criteria for identifying VMEs and assessing the impacts of fishing activities on such ecosystems.

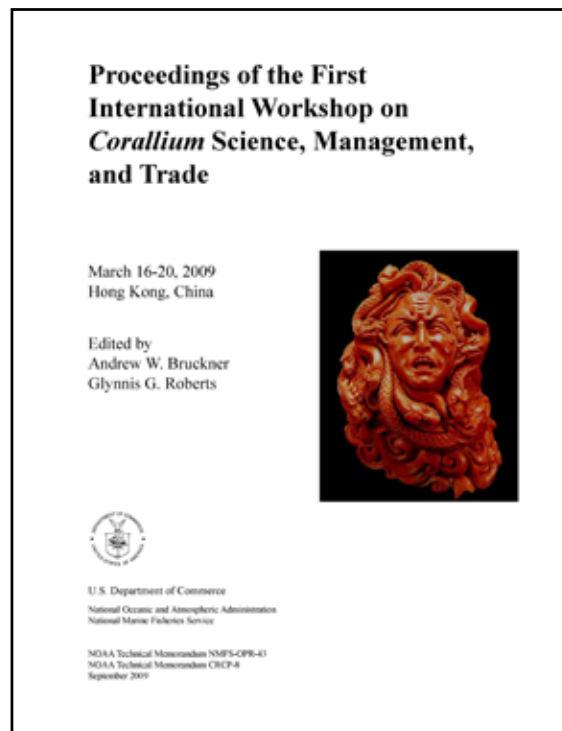
RFMO/As have adopted a number of measures to protect VMEs including deep-sea corals. Measures taken through early 2009 are reviewed in a report by the United Nations Secretary General (UNGA 2009), and additional actions have been taken by several RFMOs in 2009 after the report was released. Furthermore, the U.S. continues to participate in negotiations to develop two new RFMAs to manage bottom fisheries: one in the North Pacific and one in the South Pacific, which have adopted interim measures consistent with UNGA Resolution 61/105. The negotiations for the South Pacific RFMO successfully agreed a Treaty text in November 2009.

In 2009, the UNGA reviewed the implementation of Resolution 61/105 and recognized that, while important progress has been made, further actions are urgently needed to respond fully to the Resolution. Specific calls for action are detailed in Appendix 4.

DEEP-SEA CORAL TRADE

Deep-sea corals in the genus *Corallium*, also known as red and pink precious corals, are harvested around the world for jewelry and curios. In 2007, the U.S. proposed listing these corals on Appendix II under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES Appendix II lists species that are not necessarily threatened with extinction now, but that may become so if trade is not closely controlled. International trade is permitted for species listed in CITES Appendix II if the exporting country makes findings that harvest of the species was legal and that the trade is sustainable. All black, hydrozoan, and stony corals are already included in Appendix II of CITES.

In 2009, NOAA helped organize and fund workshops in Hong Kong and Italy to resolve a number of challenges in implementing and enforcing a potential Appendix II listing for *Corallium* and to determine if adequate biological data were available for *Corallium* populations to demonstrate that the taxa had declined to levels required for listing the species in



NOAA published the proceedings of the First International Workshop on Corallium Science, Management, and Trade in 2009.

CITES. International experts from governments, academia, NGOs, and the CITES Secretariat shared information on the coral's biology, fisheries and trade and discussed issues that could improve the effectiveness of a potential CITES Appendix II listing. Proceedings of the Hong Kong workshop (Bruckner and Roberts 2009) have been published. Based on these workshops, the U.S. and the European Union cosponsored a proposal to add precious red and pink corals of the genus *Corallium* to CITES Appendix II. This proposal will be considered at the 2010 CITES Conference of the Parties.

ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT DEEP-SEA HABITATS

In 2008, the Conference of Parties to the Convention on Biological Diversity adopted scientific criteria for identifying ecologically or biologically significant marine areas in need of protection in open-ocean waters and deep-sea habitats, and scientific guidance for designating representative networks of marine protected areas. Although the U.S. is not a party to the convention, NOAA experts, working with the Department of State, provided scientific input into the development of these criteria/guidelines. NOAA has subsequently contributed to the follow-on process to identify ecologically and biologically significant marine areas with particular considerations for deep-sea corals, which States and RFMOs can consider when developing management measures.

SEABED MINING

Mining the deep seafloor for metals is not yet a viable commercial enterprise. However, the last two years have seen increased interest and investment in mineral exploitation. Potential targets for seabed mining include cobalt-enriched crusts, which occur as thin layers on the flanks of volcanic islands and seamounts at 3,300 to 8,200 feet (1,000 to 2,500 m) depths, where deep-sea corals also occur. Mineral exploitation outside areas of national jurisdiction would be governed by guidelines set forth by the International Seabed Authority, established under the United Nations Convention on the Law of the Sea. Although not a Party to the Convention, or a member of the Authority, the U.S. has been active in

providing scientific expertise to their work. In 2009, the Authority considered a proposal to establish a network of areas in the Central Pacific Ocean where no exploration or mining activity should take place. It also made further progress on the elaboration of draft regulations on prospecting and exploration for cobalt-rich ferromanganese crusts.

INTERNATIONAL COLLABORATIVE RESEARCH

NOAA has actively participated with other U.S., European, and Canadian partners in planning for a Transatlantic Coral Ecosystem Study (TRACES). TRACES is a scientific program being developed to investigate deep-sea corals found along the continental shelf break and slope, and in association with canyons and seamounts, in the North Atlantic Ocean. In 2009, the partners completed a TRACES Science Plan.

NOAA also continues to work with the Census of Marine Life and ICES to enhance understanding and conservation of deep-sea corals and other deep-sea ecosystems. NOAA currently chairs the Northwest Atlantic Fisheries Organization/ICES Working Group on Deepwater Ecology, which is providing advice on management efforts to protect VMEs in the North Atlantic.



CHAPTER 4: CONCLUSIONS AND NEXT STEPS

FY 2009 marked the beginning of funded activities under the MSA-authorized Deep Sea Coral Research and Technology Program (MSA Sec. 408). Appropriations were received in the second quarter, and many activities are just getting underway. The Program has conducted successful deep-sea coral mapping and field research operations in the Southeast U.S. that were developed in consultation with the South Atlantic Fishery Management Council. This research confirmed the presence of important deep-sea coral communities in one area that is part of the Council's proposals to protect more than 24,000 square miles of habitat through the establishment of deepwater Coral Habitat Areas of Particular Concern (C-HAPCs). The Council's Comprehensive Ecosystem-Based Amendment 1 containing these provisions has been submitted to the Department of Commerce for final approval.

NOAA has not yet analyzed new information on deep-sea coral locations, and therefore no new deep-sea coral areas have been identified in this report (Appendix 3). NOAA is developing a coordinated national data management approach that will assist in the identification, analysis and distribution of management-relevant data on deep-sea coral ecosystems.

Fiscal Year 2010 and Beyond: NOAA's *Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation* (NOAA, in review) provides an overall framework for NOAA's deep-sea coral program activities in the coming years. In FY 2010, the President's budget request and Congress' appropriation for NOAA included an additional \$1 million, for a total program of \$2.5 million. Planned activities include the following:

- The Program will continue the second year of field science activities in the Southeast U.S., targeting the deepwater *Lophelia* coral reef ecosystems in the South Atlantic Council's recommended C-HAPCs.

- Increased funding will allow NOAA to expand field science activities to deep-sea coral habitats off the U.S. West Coast (Box 8).
- These multi-year field efforts will be complemented by smaller-scale investments in all regions, designed to address other requirements of the Program through analysis and management of existing information, outreach, and other high-value targeted activities. NOAA expects to modestly increase the resources available to these high-value, lower-cost initiatives in 2010 and to begin efforts to model the predicted distributions of deep-sea corals.
- In FY 2010, NOAA will also extend its outreach efforts to engage with the Regional Fishery Management Councils on deep-sea coral issues. In particular, NOAA will further encourage the Councils to evaluate areas for protection known to contain deep-sea corals as allowed under discretionary provisions of the MSA as amended, including the areas included in Appendix 3.

As the Deep Sea Coral Research and Technology Program moves forward, it will continue to emphasize collaborative approaches and leverage the critical complementary activities funded by other NOAA programs and external partners to support exploration, research and management of deep sea coral ecosystems. This will include enhancing the comparability of methods, sharing of data, and leveraging resources among programs to maximize the conservation impact for deep-sea coral ecosystems.

The Program expects to conduct 3-year field research and mapping activities in the Southeast U.S. (FY 2009-2011) and West Coast (FY 2010 – 2012). Given the high cost of deep-sea field operations, a 3-year effort will allow preliminary research on only the highest priority deep-sea coral areas in a portion of these large geographic regions. The Program plans to shift

Box 8: Field research off the West Coast

In FY 2010, the Program will begin a 3-year field research effort designed to inform management decisions as they relate to deep-sea coral habitats. The West Coast was chosen as the second focal area based primarily on the following criteria:

- PFMC is scheduled to review its EFH designations in 2011, many of which were designed to protect biogenic habitats including deep-sea corals. NOAA and PFMC have been petitioned by Oceana to protect recently discovered deep-sea coral (see Appendix 3) and sponge areas off Washington, but have identified that additional information is needed to understand the extent of such habitats before the existing FMPs are amended.
- The region includes five National Marine Sanctuaries with rich deep-sea coral resources, all of which have identified the need for increased information on these habitats. All five sanctuaries are currently reviewing and updating their management plans, and pending legislation calls for sanctuary expansions at the Cordell Bank and the Gulf of the Farallones sanctuaries. These efforts would be informed by this research. The ability to address management needs of multiple NOAA Line Offices in this region was considered an important plus.
- The region is known to have extensive and important gorgonian and black coral habitats, but much of the current information is limited to observations from NMFS trawl surveys. Targeted ROV and AUV studies have the potential to provide valuable new information on these habitats.

funding to new regions by FY 2012 and 2013. In consultation with the Regional Fishery Management Councils, the Program has developed criteria to identify the future priority geographic regions for new field research. Based on the criteria, the next regions for major new field activities under the Program would be Alaska (North Pacific Fishery Management Council Region) and the Northeast U.S. (New England and Mid-Atlantic Fishery Management Council Regions).

The Program will look for opportunities to enhance international cooperation on deep-sea coral science. One of the greatest challenges in the implementation of measures to protect vulnerable marine ecosystems on the high seas is a lack of information on the distribution of these ecosystems in most regions. NOAA and the Department of State will continue to actively engage in various RFMO/As and through other regional and multilateral organizations to protect these ecosystems. While the Deep Sea Coral Research and Technology Program is a domestic program, it offers an opportunity to leverage U.S. expertise to help meet international conservation goals.

NOAA is a leading participant in the development of the National Ocean Policy called for by President Obama in June 2009. The Deep Sea Coral Research and Technology Program is designed to support the Ocean Policy's implementation strategy, particularly its emphasis on ecosystem-based management, comprehensive marine spatial planning, and regional ecosystem protection.



A NOAA scientist adjusting the ROPOS ROV on a cruise off the West Coast.

Photo Credit: Olympic Coast NMS



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LIST OF ACRONYMS

AUV	Autonomous underwater vehicle
C-HAPC	South Atlantic FMC's deepwater Coral Habitat Area of Particular Concern
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CFMC	Caribbean Fishery Management Council
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
FMC	Fishery Management Council
FMP	Fishery Management Plan
FY	Fiscal Year
GIS	Geographic information system
GMFMC	Gulf of Mexico Fishery Management Council
HAPC	Habitat Area of Particular Concern
HBOI	Harbor Branch Oceanographic Institute
ICES	International Council for the Exploration of the Sea
JSL	<i>Johnson Sea Link</i> submersible
MAFMC	Mid-Atlantic Fishery Management Council
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MMS	Minerals Management Service
NEFMC	New England Fishery Management Council
NESDIS	National Environmental Satellite, Data, and Information Service
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPFMC	North Pacific Fishery Management Council
OAR	Office of Oceanic and Atmospheric Research
PaCOOS	Pacific Coast Ocean Observing System
PFMC	Pacific Fishery Management Council
RFMO/A	Regional Fishery Management Organizations and Agreements
ROV	Remotely operated vehicle
SAFMC	South Atlantic Fishery Management Council
TRACES	Trans-Atlantic Coral Ecosystem Study
UNCW	University of North Carolina at Wilmington
UNGA	United Nations General Assembly
USF	University of South Florida
USGS	U. S. Geological Survey
USVI	United States Virgin Islands
VME	Vulnerable marine ecosystem
VMS	Vessel monitoring system
WHOI	Woods Hole Oceanographic Institute

APPENDICES

APPENDIX 1. 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.



APPENDIX 2. MAJOR DEEP-SEA CORALS

Deep-sea corals, also referred to as cold-water corals, are a taxonomically and morphologically diverse collection of organisms distinguished by their occurrence in deep or cold oceanic waters. The calcified skeletons of certain branching stony coral species, such as *Lophelia pertusa*, can form large reef-like structures in deepwater. Gorgonians, gold corals, and black corals often have branching tree-like forms and either occur singly or form thickets of many colonies. Deep-sea corals lack symbiotic algae (zooxanthellae). 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 their energy needs. They generally grow much more slowly than their shallow-water counterparts. The following table includes the major groups of deep-sea corals referred to in this Report.

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 deepwater 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	Hyroidolina	Anthoathecatae (Family Stylasteridae)	Stylasterids or lace corals	Can form branching colonies. May be confused with stony corals but the resemblance is superficial.

¹ Source NOAA (2008). More detailed information on the taxonomic classification of deep-sea corals can be found in Hourigan et al. (2007).

APPENDIX 3. DEEP-SEA CORAL AREAS IN THE U.S. EEZ WITH LIMITED PROTECTION FROM INTERACTIONS WITH FISHING GEAR

Below is the initial list, excerpted from the first Report to Congress (NOAA 2008), of areas known to contain aggregations of deep-sea corals that currently have limited or no protection from interactions with bottom-tending fishing gear. Areas whose status has changed or where significant steps have been taken to increase protection (e.g., Council action) since 2008 are highlighted in blue. 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.

The Deep Sea Coral Research and Technology Program has just begun additional analysis of areas, and no new deep-sea coral areas have been identified for this report. This is not a complete list of deep-sea coral areas. 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	<ul style="list-style-type: none"> • NE & MAFMC monkfish bottom-trawl & gill net closure • MAFMC squid, mackerel, & butterfish bottom-trawl closure • MAFMC closed to bottom-trawling to protect tilefish EFH. • NEFMC Proposed HAPC 	Watling et al. 2003; Packer et al. 2007; MAFMC 2008a; MAFMC 2008b (final rule effective 2009); NEFMC 2007.
	Oceanographer Canyon	<ul style="list-style-type: none"> • NE & MAFMC monkfish bottom-trawl & gill net closure • MAFMC squid, mackerel, & butterfish bottom-trawl closure • MAFMC closed to bottom-trawling to protect tilefish EFH. • NEFMC Proposed HAPC 	Watling et al. 2003; Packer et al. 2007; MAFMC 2008a; MAFMC 2008b (final rule effective 2009); NEFMC 2007.



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.)	Veatch Canyon ¹	<ul style="list-style-type: none"> • MAFMC closed to bottom-trawling to protect tilefish EFH • NEFMC Proposed HAPC 	Hecker and Belchschmidt 1980; Hecker et al. 1983; Watling et al. 2003; Packer et al. 2007; MAFMC 2008b (final rule effective 2009); NEFMC 2007
	Slope near Alvin Canyon	<ul style="list-style-type: none"> • NEFMC Proposed HAPC 	Hecker and Belchschmidt 1980; Watling et al. 2003; Packer et al. 2007; NEFMC 2007.
	Western Jordan Basin	<ul style="list-style-type: none"> • No special protections 	Auster 2005 and Watling et al. 2003; Auster (unpublished)
	Mount Dessert Rock Area	<ul style="list-style-type: none"> • No special protections 	Auster 2005 and Watling et al. 2003
	Georges Tower off the Northern Edge of Georges Bank	<ul style="list-style-type: none"> • No special protections 	Watling and Auster 2005
Mid-Atlantic FMC	Toms/Carteret Canyon	<ul style="list-style-type: none"> • NEFMC Proposed HAPC 	Hecker and Belchschmidt 1980 ; Watling et al. 2003 ; Packer et al. 2007 ; NEFMC 2007.
	Hendrickson Canyon	<ul style="list-style-type: none"> • NEFMC Proposed HAPC 	Hecker et al. 1983 ; Watling et al. 2003 ; NEFMC 2007.
	Baltimore Canyon	<ul style="list-style-type: none"> • NEFMC Proposed HAPC 	Watling et al. 2003; Packer et al. 2007 ; NEFMC 2007
	Norfolk Canyon	<ul style="list-style-type: none"> • MAFMC closed to bottom-trawling to protect tilefish EFH. NEFMC Proposed HAPC 	Watling et al. 2003; Packer et al. 2007; MAFMC 2008; NEFMC 2007
South Atlantic FMC	North Carolina <i>Lophelia</i> banks	<ul style="list-style-type: none"> • SAFMC Proposed Cape Lookout and Cape Fear <i>Lophelia</i> Banks C-HAPCs 	Ross and Nizinski 2007; SAFMC 2009
	Stetson Banks	<ul style="list-style-type: none"> • SAFMC Proposed Stetson Reef, Savannah and East Florida Lithoherms and Miami Terrace C-HAPC (Stetson-Miami Terrace C-HAPC) . Imagery from the 2009 research cruise off Cape Canaveral for two high-relief sites within the proposed Stetson-Miami Terrace C-HAPC between two of the "Allowable Golden Crab Fishing Areas" revealed very healthy cover of <i>Lophelia pertusa</i>. Almost 100% were live colonies. While these sites were already contained within the proposed C-HAPC, no groundtruthing had yet taken place. 	Ross and Nizinski 2007; SAFMC 2009
	Savannah Banks		Ross and Nizinski 2007; SAFMC 2009
	Cape Canaveral Banks		Ross and Nizinski 2007; SAFMC 2009
	Miami Terrace		Ross and Nizinski 2007; SAFMC 2009
	Pourtales Terrace (shared with Gulf of Mexico Council)		<ul style="list-style-type: none"> • SAFMC Proposed Pourtales Terrace C-HAPC

¹ 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
Gulf of Mexico FMC ²	Pourtales Terrace (shared with South Atlantic Council)	• SAFMC Proposed C-HAPC	Brooke and Schroeder 2007
	Southwest Florida Slope <i>Lophelia</i> 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
	Green Canyon	• No special protections	Brooke and Schroeder 2007
	Northwest Texas-Louisiana Shelf Banks	<ul style="list-style-type: none"> • East and West Flower Garden Banks; Stetson Bank and McGrail Bank – Anchoring, bottom trawl gear, bottom longlines, buoy gear, and all traps/pots prohibited to protect coral. East and West Flower Garden Banks and Stetson Bank are part of the Flower Garden Banks National Marine Sanctuary. • 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 2005 (final rule effective 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.	<ul style="list-style-type: none"> • Areas in the EEZ are protected from bottom-tending gear • Areas within the National Monument are fully protected. 	Parrish and Baco 2007

² In addition to the deep-sea coral areas identified here, there are likely also azooxanthellate deep-sea corals associated with the deeper areas of Pulley Ridge and the North and South Tortugas Ecological Reserves. The Tortugas Ecological Reserves and portions of Pulley Ridge have been designated as HAPCs by the GMFMC, and bottom trawl gear, bottom longlines, buoy gear, and all traps and pots are prohibited to protect coral.



Fishery Management Council (FMC) Region	Identified Area with Deep-sea Corals	Current Status of Protection from Bottom-Tending Fishing Gear Impacts	Reference
North Pacific FMC ³	Bering Sea Slope	<ul style="list-style-type: none"> • 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”	<ul style="list-style-type: none"> • 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 areas have been discovered, some of which are in areas not currently protected. 	Stone and Shotwell 2007; AFSC 2007
	Gulf of Alaska <i>Primnoa</i> coral habitats ⁴	<ul style="list-style-type: none"> • Bottom-contact gear is prohibited from five small areas in the Gulf of Alaska to protect red tree corals (<i>Primnoa</i> sp.). Recently surveys in and near the protected areas indicate that other coral resources are present outside the protected areas. 	Stone and Shotwell 2007; AFSC 2007
Pacific FMC ⁵	Olympic Coast National Marine Sanctuary Octocoral, stylasterid and scleractinian (<i>Lophelia pertusa</i>) aggregations	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • Certain areas have no special protections 	Whitmire and Clarke 2007
	Astoria Canyon (gorgonians and black corals)	<ul style="list-style-type: none"> • Certain areas have no special protections 	Whitmire and Clarke 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).

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 4. UNITED NATIONS GENERAL ASSEMBLY SUSTAINABLE FISHERIES RESOLUTION (2009)

The 2009 UNGA Sustainable Fisheries Resolution (64/72) was adopted on December 4, 2009. Among its provisions, the Resolution recognizes the actions taken by States and RFMO/As to give effect to Resolution 61/105, but considers that further actions are needed to strengthen its implementation. In this regard, the Resolution calls upon States and RFMO/As to:

- conduct assessments called for in 61/105, consistent with the Guidelines, and to ensure that vessels do not engage in bottom fishing until such assessments have been carried out
- conduct further marine scientific research and use the best scientific and technical information available to identify where VMEs are known to occur or are likely to occur and adopt conservation and management measures to prevent significant adverse impacts on such ecosystems consistent with the Guidelines, or close such areas to bottom fishing until conservation and management measures have been established
- establish and implement appropriate encounter protocols, including definitions of what constitutes evidence of an encounter with a vulnerable marine ecosystem, in particular threshold levels and indicator species, based on the best available scientific information and consistent with the Guidelines
- enhance efforts to cooperate to collect and exchange scientific and technical data and information related to the implementation of the measures called for in the relevant paragraphs of Resolution 61/105 and the 2009 resolution to manage deep sea fisheries in areas beyond national jurisdiction and to protect VMEs from significant adverse impacts of bottom fishing by, inter alia exchanging best practices and developing, where appropriate, regional standards with a view to examining current scientific and technical protocols and promoting consistent implementation of best practices across fisheries and regions

The Resolution also encourages States and RFMO/As to develop or strengthen data collection standards, procedures and protocols and research programs for identification of vulnerable marine ecosystems, assessment of impacts on such ecosystems, and assessment of fishing activities on target and non-target species.

The UNGA also decided to conduct another review in 2011 of actions taken by States and RFMO/As to protect VMEs and sustainably manage deep-sea fisheries in response to the actions called for in Resolution 61/105 as well as the 2009 Resolution, and will include, as part of that review, a 2-day workshop to allow for broader participation in the review process.



DATA SOURCES FOR THE MAPS

Northeast (Map 4):

Scanlon et al. (in press)

Dave Packer, NOAA Northeast Fisheries Science Center (see also Packer et al. 2007)

Watling et al. (2003)

Southeast (Map 5):

Scanlon et al. (in press)

Andre Freiwald, University of Erlangen (provided by the Marine Conservation Biology Institute – MCBI)

John Reed, Florida Atlantic University/HBOI (provided by MCBI)

Gulf of Mexico (Map 8):

Scanlon et al. (in press)

Peter Etnoyer, NOAA Center for Coastal Environmental Health and Biomolecular Research

Andre Freiwald, University of Erlangen (provided by MCBI)

Deepwater Program: Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology, Minerals Management Service, TDI Brooks International (provided by MCBI)

West Coast (Map 9):

Curt Whitmire, NOAA Northwest Fisheries Science Center (see also Whitmire and Clarke 2007)

Southern California Coastal Water Research Project (via Curt Whitmire)

NMFS-PaCOOS

Marine Conservation Biology Institute

Etnoyer and Morgan 2003

Stephen Cairns, Smithsonian Institution (provided by MCBI)

California Academy of Sciences (provided by MCBI)

Monterey Bay Aquarium Research Institute (provided by MCBI)

Monterey Bay National Marine Sanctuary (provided by MCBI)

Alaska (Map 10):

Bob Stone, NOAA Alaska Fisheries Science Center - Resource Assessment and Conservation Engineering (RACE) Division

Marine Conservation Biology Institute

Etnoyer and Morgan 2003

Stephen Cairns, Smithsonian Institution (provided by MCBI)

Hawaii (Map 11):

Etnoyer and Morgan 2003

Chris Kelly, Hawaii Undersea Research Laboratory

Southeast Fishing (Map 2):

Carlos Rivero, NOAA Southeast Fisheries Science Center

West Coast Fishing (Map 3):

Janet Mason, NOAA Southwest Fisheries Science Center

http://www.nmfs.noaa.gov/habitat/2010_deepcoralreport.pdf

NOAA

Biennial Report to Congress on the
Deep Sea Coral Research and Technology Program

U.S. Secretary of Commerce
Gary Locke

Under Secretary of Commerce for Oceans and
Atmosphere and Administrator,
National Oceanic and Atmospheric Administration - NOAA
Jane Lubchenco, Ph.D.

Assistant Administrator for Fisheries
Eric C. Schwaab

www.nmfs.noaa.gov

National Marine Fisheries Service
1315 East-West Highway
SSMC 3, F/HC, Room 14228
Silver Spring, MD 20910

U.S. Government - 2010

