NOAA FISHERIES

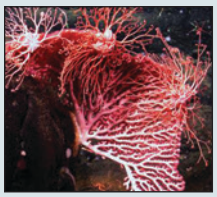
Deep Sea Coral Research and Technology Program

2020 Report to Congress

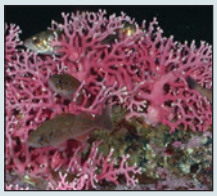
Black corals often resemble bushes or trees. Some black corals may be the *world's oldest living marine creatures*. This black coral off Hawaii was estimated to be more than 4,000 years old.

Deep-sea stony corals range from small individual cups to large branching species, like this colony off eastern Florida, that form extensive deep-water reefs *growing up to 300 feet tall over millennia*.

Gold corals, some of which have been harvested for jewelry, are unique in that they grow on the skeletons of other deep-sea corals and can *live for thousands of years*.



Gorgonians, like this fan-shaped colony of red coral on a California seamount, are among the most diverse. There are *nearly as many known deep-sea coral species as shallow coral species*.



Lace corals are only distantly related to other corals. Most deep-sea corals grow extremely slowly. Once damaged, corals and the communities they support *may take centuries to recover*, if they recover at all.

Sea pens are related to gorgonians but unlike most other deep-sea corals, they live in soft sediments where they form large fields. Along with sponges, corals form the *most important living habitats in the deep sea*.

"The cooperation and collaboration with NOAA's Deep Sea Coral Research and Technology Program and Office of Ocean Exploration and Research over the past years to map, explore, and discover new complex deepwater ecosystems in the South Atlantic region continues to validate and reinforce the Council's conservation of the most extensive deepwater ecosystem in the world. Who needs to go to Mars when every new dive into the abyss illuminates a world of wonder and discovery in systems that in some cases have been building over thousands of years?" — Jessica McCawley, South Atlantic Fishery Management Council Chair

FRONT COVER: Vermillion rockfish with gorgonian coral on the northeast wall of Santa Cruz Canyon in Channel Islands National Marine Sanctuary. Image courtesy of NOAA and Marine Applied Research and Exploration. BACK COVER: A rare sighting of orange stony coral located at 500 meters depth at Many Mounds on the West Florida slope. Image courtesy of NOAA Southeast Deep Coral Initiative and Pelagic Research Services.

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2020 Report to Congress

Developed Pursuant to Section 408 of the Magnuson-Stevens Fishery Conservation and Management Act, as Amended by Public Law 109-479 in 2007

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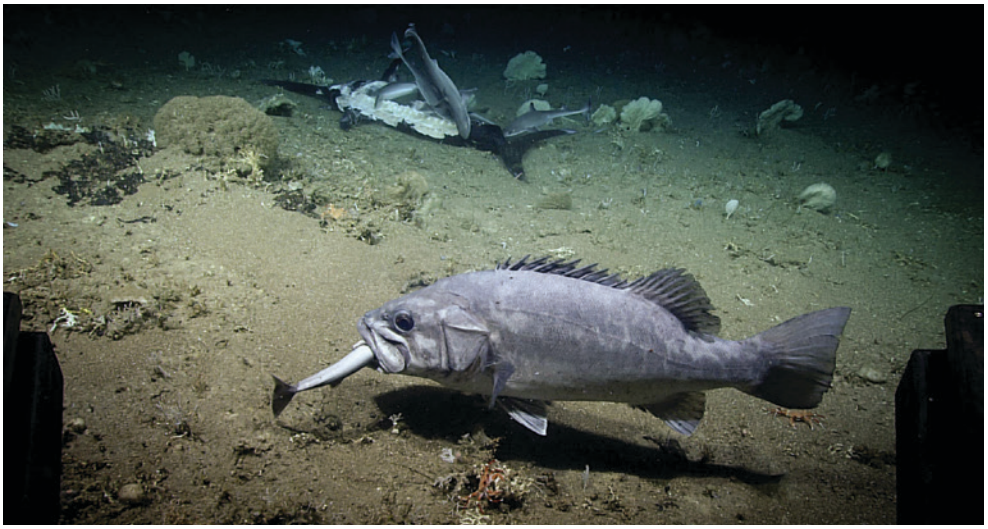
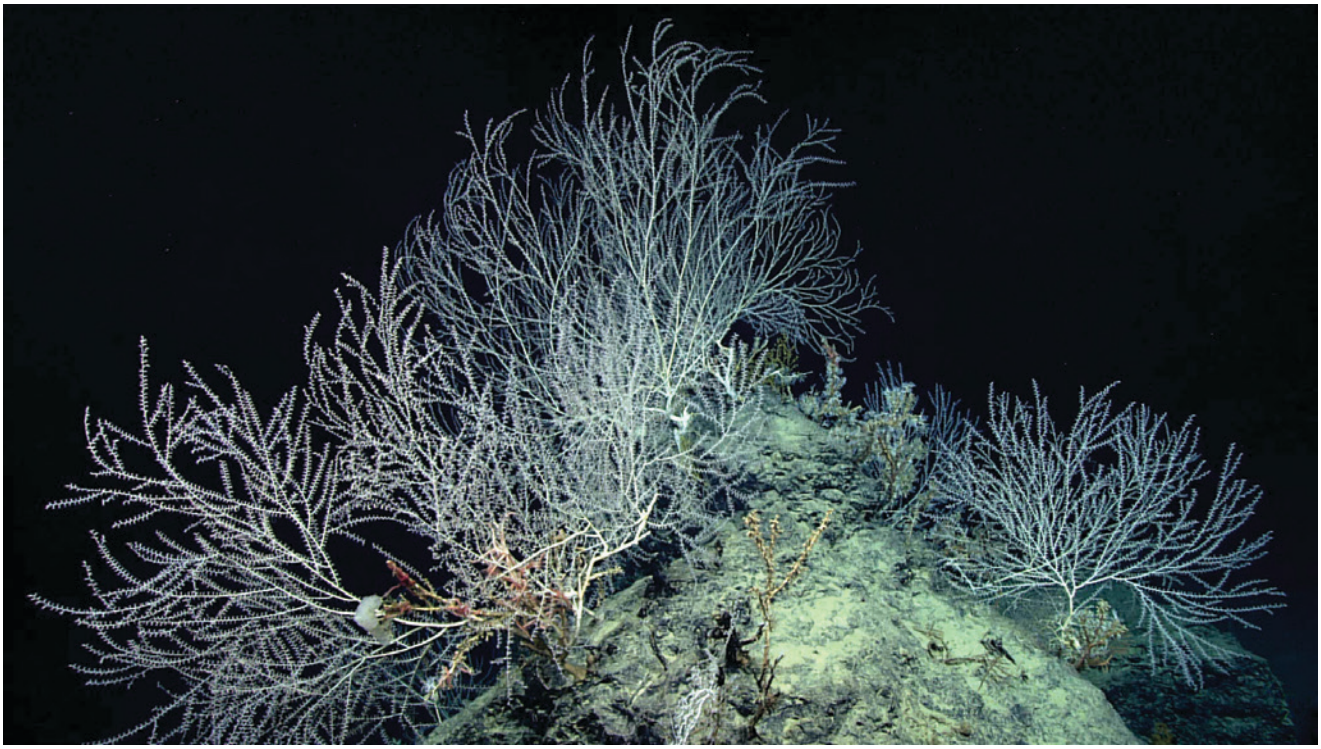


A commercially targeted wreckfish captures and eats a shark in front of a newly fallen billfish in a field of corals and sponges off South Carolina. Image courtesy of the NOAA Office of Ocean Exploration and Research.

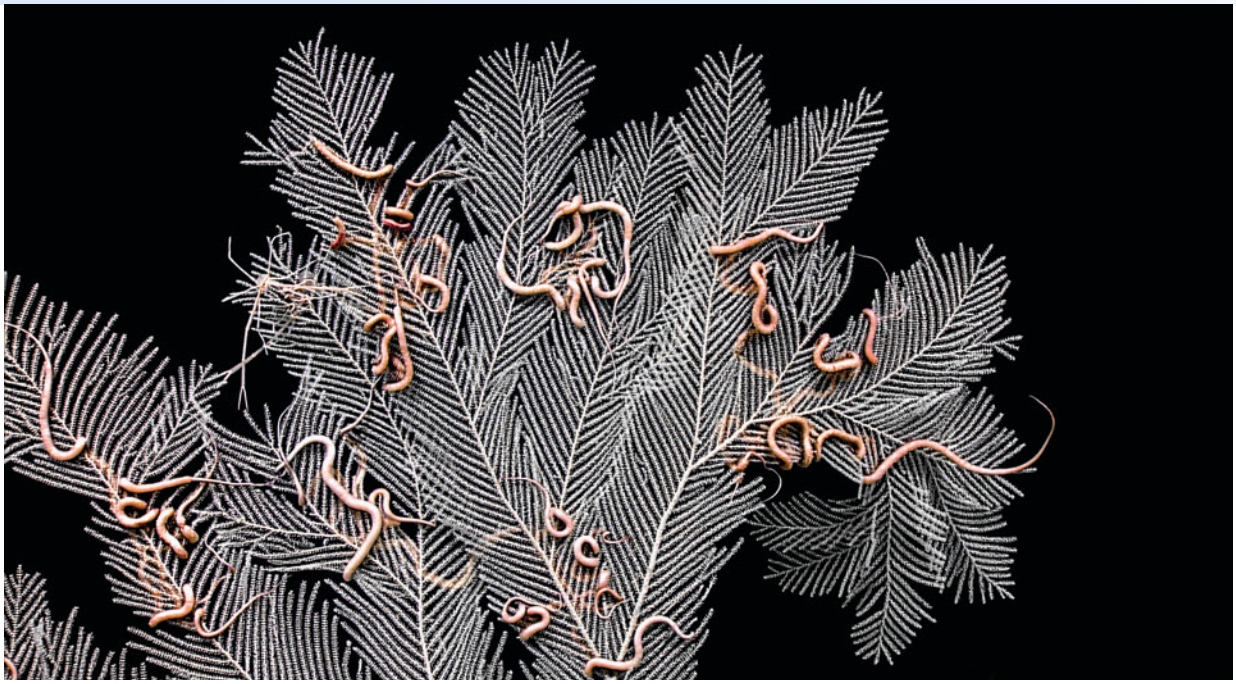
Overview

Deep-sea corals create habitat for countless species off every coastal state in the country, offering significant ecological value and supporting a number of U.S.-managed fishery species. These productive habitats provide spawning grounds for commercially important fish, such as grouper, snapper, sea bass, and rockfish, as well as shrimp and crab. They also provide shelter for an unknown number of species that are new to science, many of which could be useful in ways we do not yet understand. NOAA's Deep Sea Coral Research and Technology Program, herein referred to as Program, is the nation's only federal research program dedicated to increasing scientific understanding of deep-sea coral ecosystems. The Program works closely with the nation's eight regional fishery management councils to address key fishery management needs and inform decision-making. The Program's research also supports resource management in other sectors of the ocean economy, including aquaculture, renewable energy, and potential future resource uses such as deep-sea mining. Each sector requires knowledge of deep-sea coral locations to mitigate damage to these valuable and vulnerable habitats.

This report summarizes fiscal year 2018 and 2019 activities that supported management decisions, improved our understanding of deep-sea coral communities, and prioritized partnerships to enhance operational efficiency and effectiveness. Operating through NOAA Fisheries' Office of Habitat Conservation, and funded at approximately $2.3 million annually to support national-scale research, the Program collaborates widely to cost-effectively study the role of corals in support of deep-sea ecosystems.



High densities of bamboo corals and glass sponges were observed on the West Florida Escarpment at a depth of 7,900 feet. This discovery is among the deepest high-density communities recorded in the Gulf of Mexico. Image courtesy of the NOAA Office of Ocean Exploration and Research.



Sea fan with brittle star associates south of St. Thomas in the U.S. Caribbean. Living on a sea fan may help these brittle stars access more food than they could on the seafloor. Image courtesy of the NOAA Office of Ocean Exploration and Research.

Supporting Management Decisions

Over its decade of operations, the Program has worked closely with fishery management councils and other resource managers to conduct research that has informed numerous management actions. Program data informed habitat conservation decisions in 2018-2019 by the Pacific, New England, and Gulf of Mexico Fishery Management Councils. These councils proposed new fishing regulations that would enhance conservation of more than 160,000 mi^2 of seafloor habitats—most designed explicitly to protect deep-sea corals—and reopen approximately 3,000 mi^2 of less vulnerable habitat to fishing. Program data also informed boundary expansions, condition reports, expedition planning, and/or outreach and educational materials for seven national marine sanctuaries.

Managers in every region of the United States have now used the Program's discoveries and scientific findings to make informed decisions about fishing regulations, protected area boundaries, aquaculture planning, precious coral harvest management, and more. Ultimately, the Program provides information that helps fishery management councils and other natural resource managers take actions to enhance the sustainability of deep-water fisheries and other ocean uses, while conserving vulnerable and biologically-diverse habitats.

Improving Understanding of Deep-Sea Coral Communities

The Program supports new research to improve scientific understanding of deep-sea coral communities and the ecosystems they support. In 2018-2019, researchers discovered rich and diverse coral habitats and described 21 new deep-sea coral species in the Western Pacific, North Pacific, Pacific, and Caribbean regions. To aid discovery of coral communities and our understanding of species distributions, NOAA and partners mapped 55,000 mi^2 of previously poorly understood seafloor.

Building Partnerships to Enhance Efficiency and Effectiveness

With new management challenges on the horizon—such as ocean acidification, climate change, and expanding human activities in the deep sea—partnerships are more valuable than ever before. These alliances enable us to efficiently and effectively pursue joint priorities by leveraging complementary areas of expertise and resources. Working together makes the difference between simply locating unknown deep-sea corals and better understanding genetic identification, aging, damage and recovery assessment, population connectivity, and habitat prediction. With an improved understanding of these

Timeline of Regional Initiatives

The Program operates by rotating through regional research initiatives. Currently, each region receives approximately $2.4 million over 4 years to improve our knowledge of deep-sea corals and the ecosystems they support. The Program is funded annually at approximately $2.3 million. This report covers activities and management results in 2018-2019 (highlighted in gray).

Regional Initiative	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
South Atlantic															
West Coast															
Alaska															
Northeast															
U.S. Pacific Islands															
Southeast (South Atlantic, Gulf of Mexico, U.S. Caribbean)															

elements, we can advance the state of deep-sea science and carry out NOAA's mission to understand our ocean, share knowledge and information, and conserve and manage ecosystems and resources.

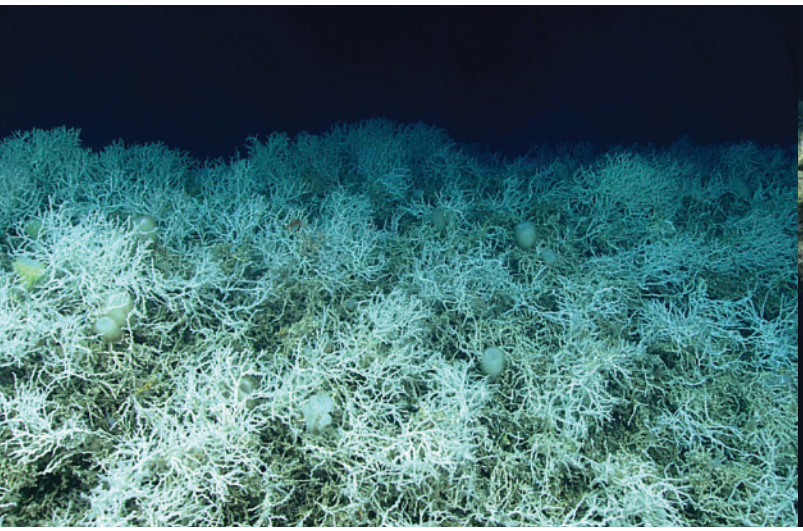
We have had the honor and will continue to work with many partners, including NOAA's National Centers for Environmental Information, National Centers for Coastal Ocean Science, Office of Ocean Exploration and Research, Office of National Marine Sanctuaries, Fisheries Science Centers, and Fisheries Regional Offices. Our external partners include U.S. regional fishery management councils, Bureau of Ocean Energy Management, United States Geological Survey, Fisheries and Oceans Canada, Ocean Exploration Trust, and numerous universities, tribes, industry groups, and non-governmental organizations.

A portion of the many partners involved in NOAA's deep-sea coral research efforts.

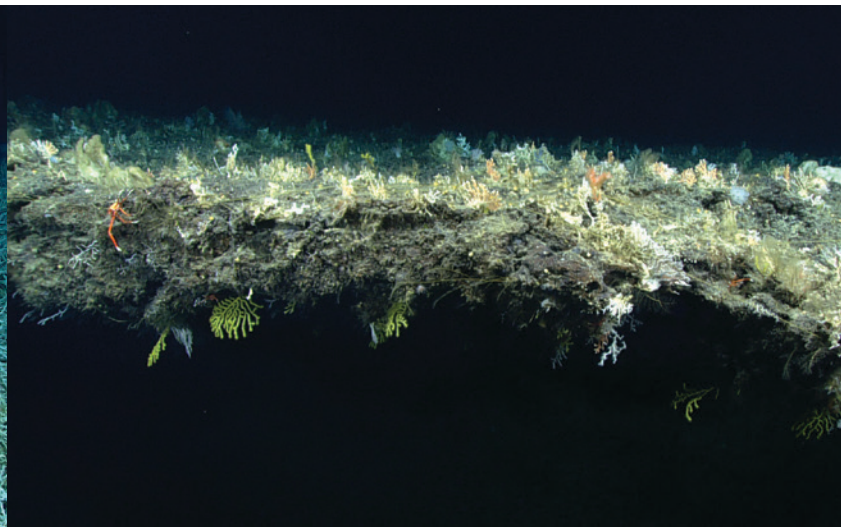
Focus on the Southeast United States

Results from our research efforts are enabling the Gulf of Mexico, South Atlantic, and Caribbean Fishery Management Councils to refine seafloor protections while allowing sustainable fisheries to thrive. The Program's collaborative 4-year research initiative in the deep waters off the U.S. Southeast coast, co-led by the National Centers for Coastal Ocean Science, accomplished the following.

- In 2018, the Gulf of Mexico Fishery Management Council approved **21 new Habitat Areas of Particular Concern**. Thirteen of these areas, covering 304 mi^2, include regulations to protect deep-sea corals from damaging fishing gear. Boundaries were largely informed by Program-sponsored data collection, and include the first coral habitats deeper than 650 feet to be protected in the Gulf. This result is one of the most enduring outcomes of the initiative.
- Resource managers used Program data to exclude known and predicted deep-sea coral locations from **newly permitted golden crab harvest areas** off the west coast of Florida.
- Recent expeditions off the U.S. Southeast coast revealed the **most expansive areas of deep-sea coral reefs yet discovered** in U.S. waters. One recently discovered region off the east coast of Florida, extending more than 200 miles, with a width of 35 miles in some areas, encompasses thousands of large deep-sea coral reefs. These and other discoveries will be available to inform upcoming management decisions by the South Atlantic Fishery Management Council.
- Production of the **first regional habitat suitability models** (that identify likely and potential locations of deep-sea corals) will aid the Caribbean Fishery Management Council in upcoming decision-making.
- Researchers documented more than **10,000 new observations of corals and sponges** during 2018-2019, and are still analyzing data for more exciting discoveries.

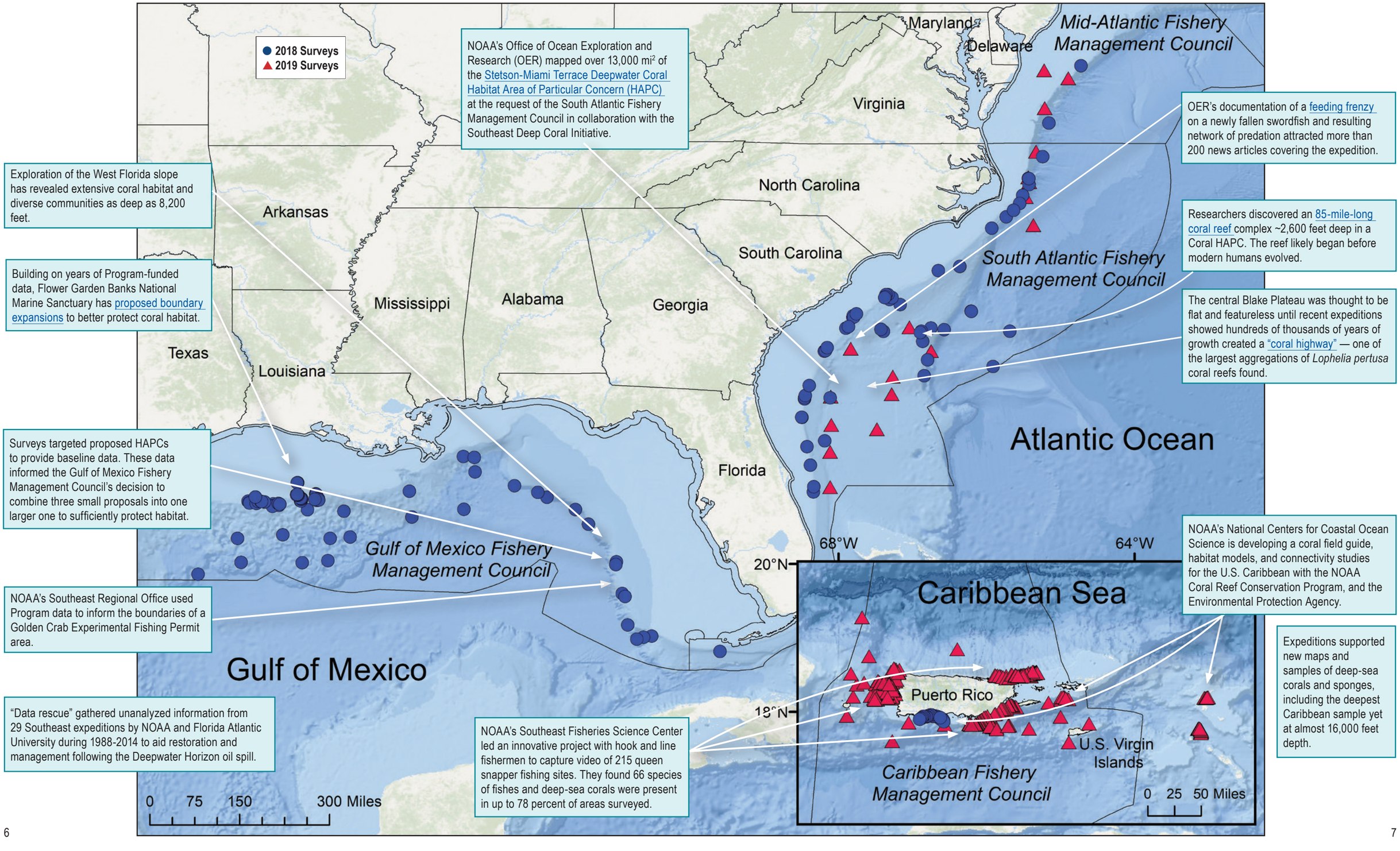


Thickets of stony coral, like these off the east coast of Florida, take millennia to grow and can reach hundreds of feet in height. New coral mounds are discovered each year and collectively create a globally unique ecosystem in Southeast U.S. waters. Image courtesy of the NOAA Office of Ocean Exploration and Research.



Rocky outcrops and overhangs covered with deep-sea corals and sponges in and around the Pourtalès Terrace Habitat Area of Particular Concern, south of the Florida Keys. Image courtesy of the NOAA Office of Ocean Exploration and Research.

Highlights from 2018-2019 Research Activities Across U.S. Southeast Waters



NOAA's Office of Ocean Exploration and Research (OER) mapped over 13,000 mi² of the Stetson-Miami Terrace Deepwater Coral Habitat Area of Particular Concern (HAPC) at the request of the South Atlantic Fishery Management Council in collaboration with the Southeast Deep Coral Initiative.

Exploration of the West Florida slope has revealed extensive coral habitat and diverse communities as deep as 8,200 feet.

Building on years of Program-funded data, Flower Garden Banks National Marine Sanctuary has proposed boundary expansions to better protect coral habitat.

Surveys targeted proposed HAPCs to provide baseline data. These data informed the Gulf of Mexico Fishery Management Council's decision to combine three small proposals into one larger one to sufficiently protect habitat.

NOAA's Southeast Regional Office used Program data to inform the boundaries of a Golden Crab Experimental Fishing Permit area.

"Data rescue" gathered unanalyzed information from 29 Southeast expeditions by NOAA and Florida Atlantic University during 1988-2014 to aid restoration and management following the Deepwater Horizon oil spill.

NOAA's Southeast Fisheries Science Center led an innovative project with hook and line fishermen to capture video of 215 queen snapper fishing sites. They found 66 species of fishes and deep-sea corals were present in up to 78 percent of areas surveyed.

OER's documentation of a feeding frenzy on a newly fallen swordfish and resulting network of predation attracted more than 200 news articles covering the expedition.

Researchers discovered an 85-mile-long coral reef complex ~2,600 feet deep in a Coral HAPC. The reef likely began before modern humans evolved.

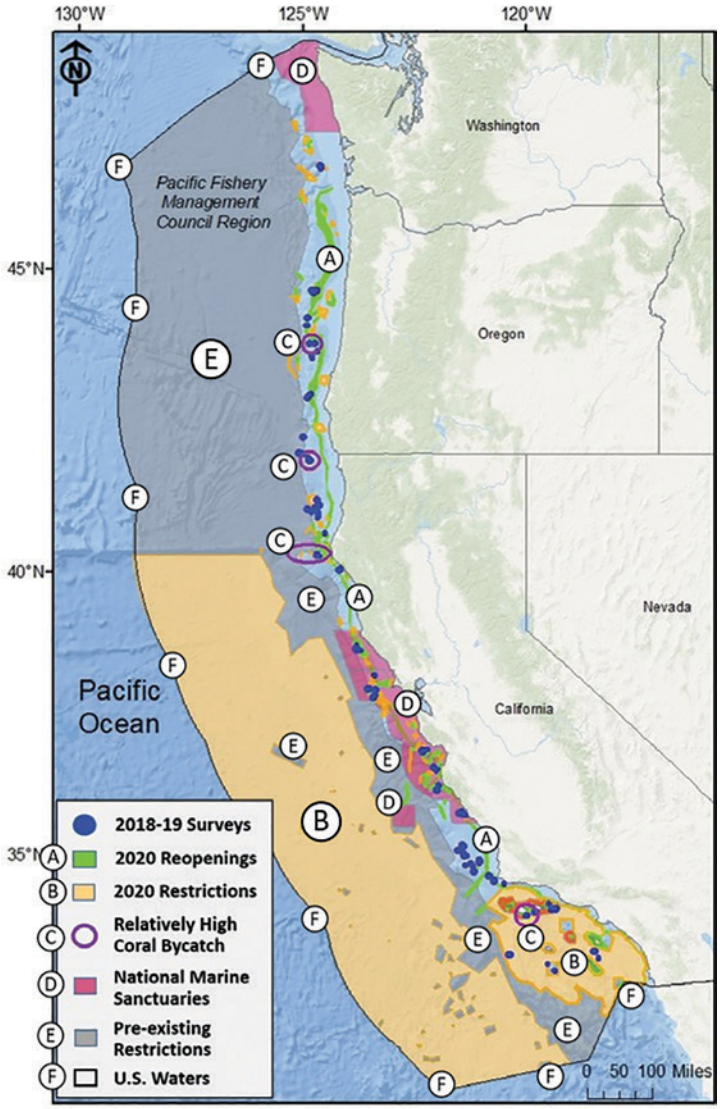
The central Blake Plateau was thought to be flat and featureless until recent expeditions showed hundreds of thousands of years of growth created a "coral highway" — one of the largest aggregations of *Lophelia pertusa* coral reefs found.

NOAA's National Centers for Coastal Ocean Science is developing a coral field guide, habitat models, and connectivity studies for the U.S. Caribbean with the NOAA Coral Reef Conservation Program, and the Environmental Protection Agency.

Expeditions supported new maps and samples of deep-sea corals and sponges, including the deepest Caribbean sample yet at almost 16,000 feet depth.

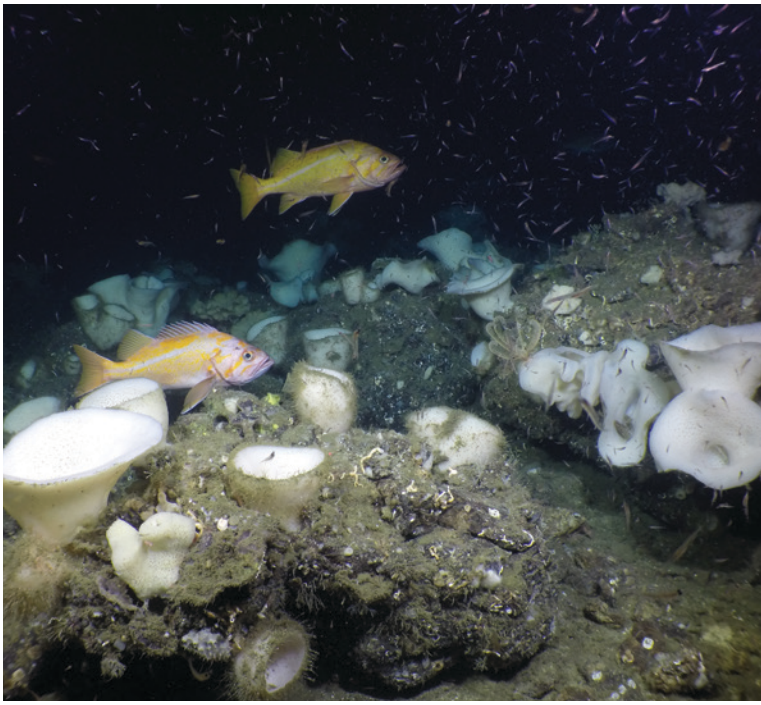
Focus on the West Coast

In 2018, the Program launched a collaborative 4-year research initiative in U.S. West Coast waters, co-led by the Northwest Fisheries Science Center and Channel Islands National Marine Sanctuary. Research was prioritized to better understand deep-sea coral habitat in 1) areas that were under consideration for reopening to or restrictions from fishing, 2) areas with relatively high coral bycatch, and 3) areas within the five West Coast national marine sanctuaries (see map). To date, the following have been accomplished.

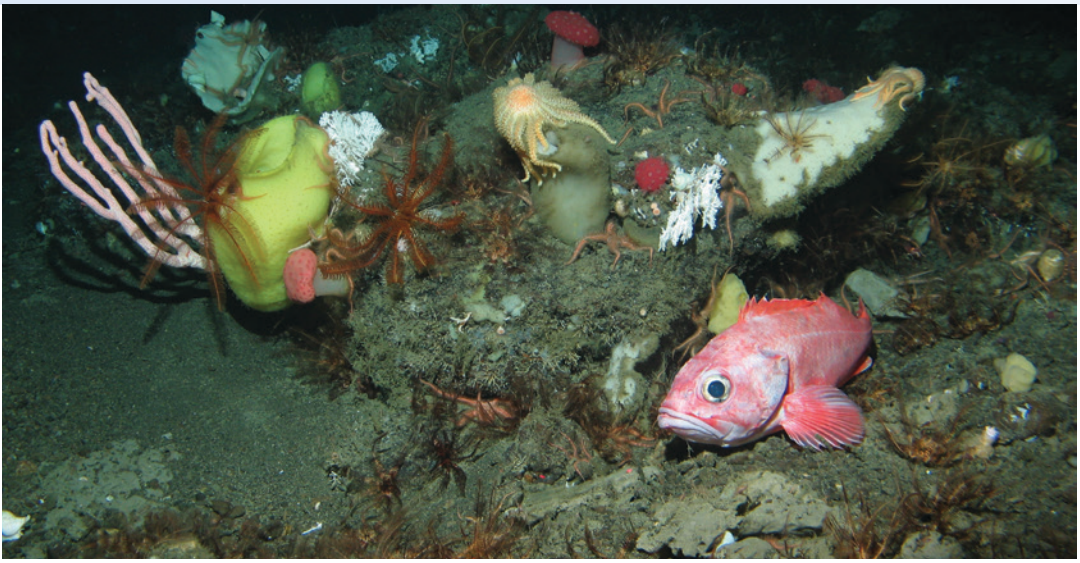


Highlights from 2018-2019 research activities across U.S. West Coast waters, targeted in 1) areas that were under consideration for reopening to or restrictions from seafloor-contact fishing, 2) areas with relatively high coral bycatch, and 3) areas within national marine sanctuaries.

- The Pacific Fishery Management Council voted to **reopen more than 3,000 mi² of historically important fishing grounds, and add more than 10,000 mi² of new fishing closures** to protect important habitat for hundreds of commercial species. As a precautionary measure, an additional **123,000 mi² of unfished deep habitats were closed to seafloor-contact gear to protect deep-sea corals**. These landmark actions, informed by Program data and fishing and conservation groups, present a unique opportunity to study deep-sea coral damage, recovery potential, and habitat management implications.



Two canary rockfish in a field of sponges off Daisy Bank at a depth of 450 feet. Daisy Bank, off the coast of Oregon, was closed to seafloor trawling in 2006, and surveys are now assessing the effects of more than a decade of seafloor protection. Image courtesy of NOAA and the Global Foundation for Ocean Exploration.

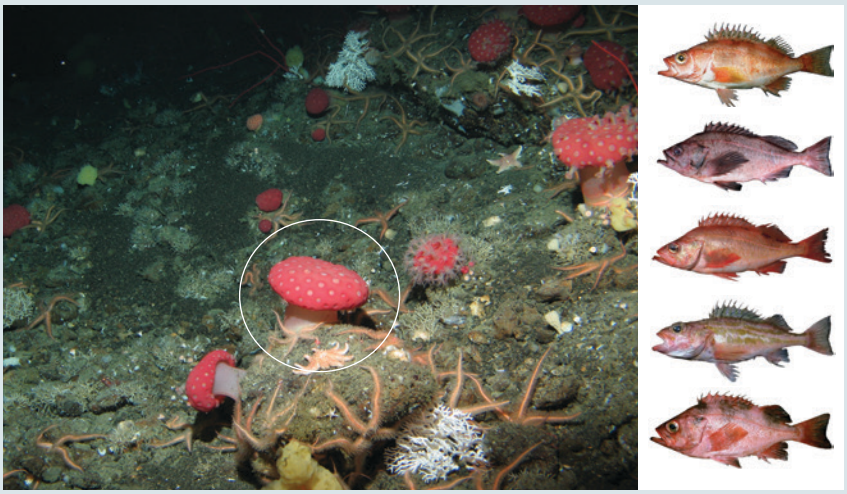


An Aurora rockfish rests near the diverse corals and sponges of Mendocino Ridge off the coast of California. The ridge rises more than 3,200 feet above the ocean floor, and is a site of high coral and sponge bycatch. Image courtesy of NOAA and Marine Applied Research and Exploration.

- **Aquaculture planning** off California avoided known and potential deep-sea coral and sponge habitats by considering Program data, as well as Program-supported models of predicted coral habitats that have not yet been explored.
- Major expeditions to improve understanding of West Coast deep-sea habitats were supported by the Program in partnership with other NOAA offices and federal agencies as a cornerstone of the collaborative Expanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign. One of these expeditions, co-funded by the National Oceanographic Partnership Program, **enabled land-based researchers to view and help guide live surveys of deep-sea coral habitat for the first time on a NOAA Fisheries-led expedition**.
- **Five newly described species of coral** were found in West Coast waters, including one that was observed in three national marine sanctuaries. Program-supported development of new environmental DNA (eDNA) technology has significantly helped advance our understanding of deep-sea coral identification and distribution (see box).

Technological Advances in Species Identification

The Program has supported the development of scientific techniques that advance our ability to detect and identify deep-sea corals, sponges, and associated fishes. Environmental DNA is cellular material shed by every living organism into the water column, and is well-preserved in the cold, dark, salty waters of the deep sea. By analyzing eDNA in conjunction with visual surveys, we can more effectively identify species that are present in or around a particular area. In the future, eDNA analyses will likely be a primary technique to detect species of value without relying on surveys or the collection of organisms.



Analysis of eDNA sampled off the coast of California identified mushroom coral (circled) as the dominant signal, as well as six other coral and five rockfish species not visible in images taken nearby. Coral image courtesy of NOAA and Marine Applied Research and Exploration; fish images courtesy of the NOAA Alaska Fisheries Science Center.

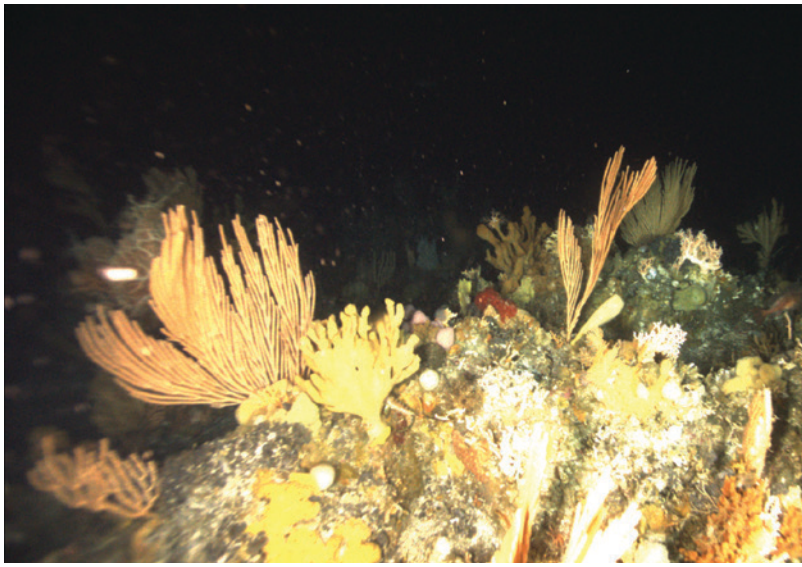
Northeast United States Management Decision

Based on Program-collected information, the New England Fishery Management Council voted to **protect its entire area deeper than ~2,000 feet** from most seafloor-contact gear. If enacted, the Omnibus Deep-Sea Coral Amendment would protect more than 25,000 mi^2, and cover an estimated 75 percent of known and predicted coral locations in and around deep-sea canyons in the region. The amendment would also protect an additional 40 mi^2 of habitat in the Gulf of Maine, and complement recent deep-sea coral protections enacted in the Mid-Atlantic region.

Striped shrimp on bubblegum coral in a Northeast U.S. canyon near large Atlantic Halibut (an endangered species) and derelict fishing gear. Image courtesy of the NOAA Office of Ocean Exploration and Research.

Fish Associations in Alaska

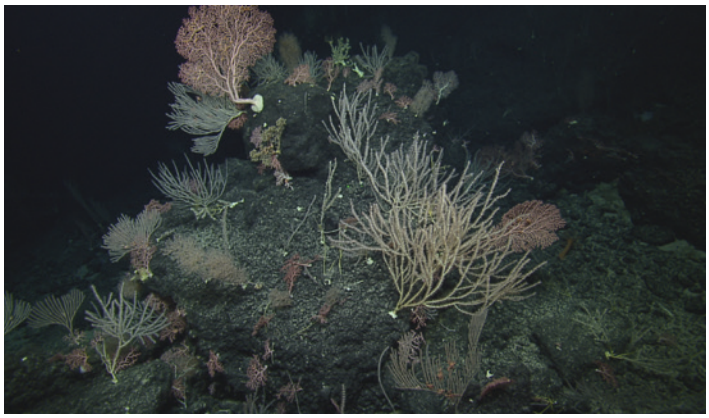
Program-funded research by the Alaska Fisheries Science Center demonstrated a strong association of commercially valuable rockfishes with seafloor structure. The research concluded that **removal of deep-sea corals and sponges is likely to reduce the overall density of rockfishes**. Deep-sea corals and sponges across the region, and surrounding the Aleutian Islands in particular, are valuable for multiple life stages of commercially important rockfishes, as well as Atka mackerel, Pacific cod, and other species.



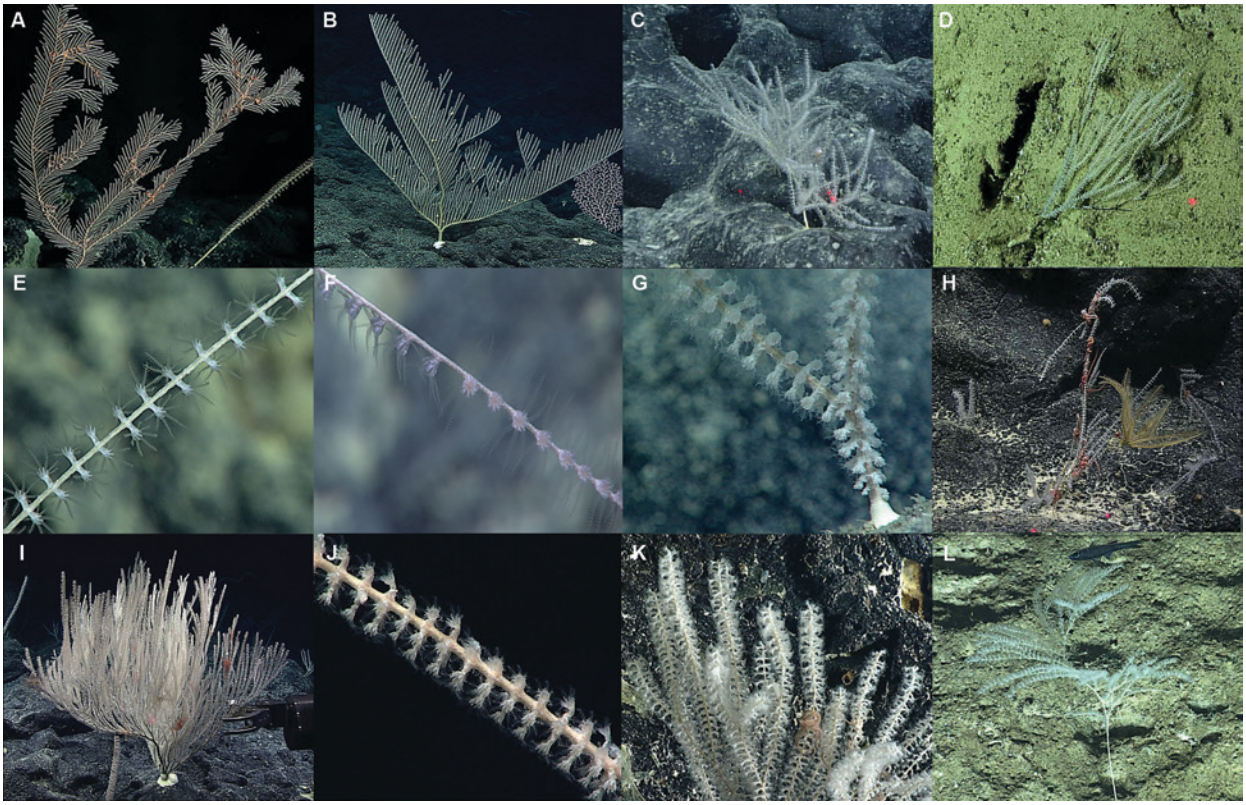
Rich coral and sponge habitat at a depth of 330 feet in the Western Aleutian Islands. Image courtesy of NOAA's Alaska Fisheries Science Center.

U.S. Pacific Islands Discoveries

Program-funded analyses by the University of Hawai'i **documented more than 300,000 previously unknown deep-sea coral and sponge individuals and 66 new high-density communities of significant conservation value**. These observations included eight new carnivorous sponge species and 13 new gorgonian coral species. The Program also partnered with the Ocean Exploration Trust to conduct the first surveys of a seamount chain included in the 2016 expansion of Papahānaumokuākea Marine National Monument. Program-supported discoveries have helped the Western Pacific Fishery Management Council update management of precious coral harvesting.



High-density "garden" of gorgonian corals and biodiversity hotspot on a seamount in Papahānaumokuākea Marine National Monument. Image courtesy of the Ocean Exploration Trust.

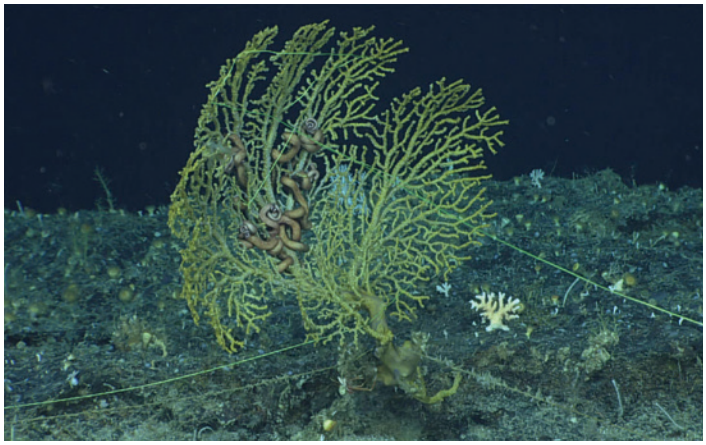


Twenty-one new deep-sea coral species were described in U.S. waters in this reporting period, including (A) *Callogorgia cracentis*, (B) *Calyptrophora lyra*, (C) *Calyptrophora carinata*, (D) *Calyptrophora pourtalesi*, (E) *Calyptrophora distolos*, (F) *Macroprimnoa ornata*, (G) *Narella merga*, (H) Narella fordi, (I) *Narella virgosa*, (J) *Narella calamus*, (K) *Narella aurantiaca*, and (L) *Paracalyptrophora spiralis*.

Securing the Future of Deep-Sea Coral Habitats

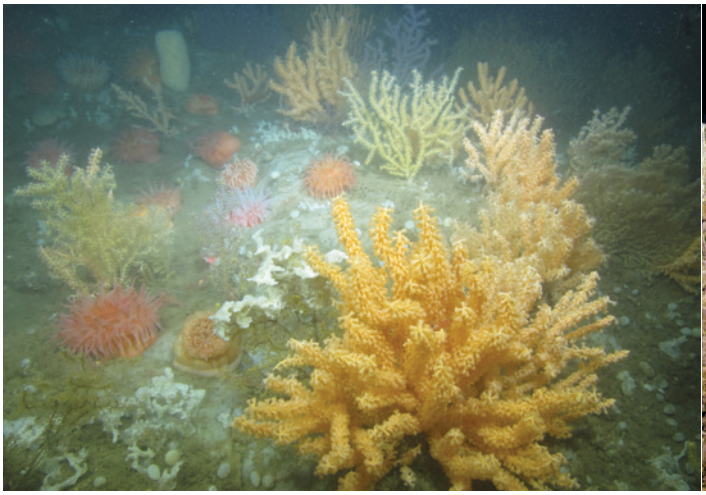
Deep-sea corals are vulnerable to damage from fishing, energy exploration and development, cable deployment, and other activities that disturb the seafloor. For more than a decade, we have made significant progress in locating deep-sea corals and sponges. These advances inform management decisions that may affect vulnerable and valuable coral habitat, while allowing for activities such as fishing in areas where damage is less likely or impactful. New research by the Program and its partners is identifying benefits of these management actions, as well as previously unknown but important deep-sea coral habitat that may be at risk from interactions with seafloor-contact fishing gear.

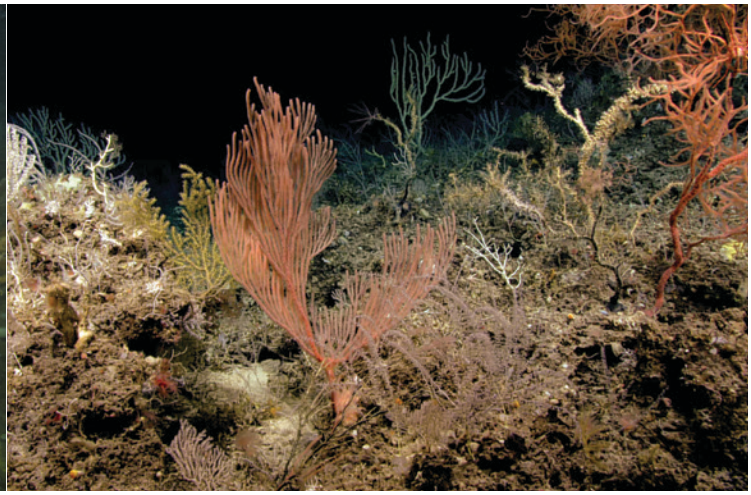
We have yet to explore the majority of the nation's deep seafloor or assess its habitat potential. Most deep-sea corals grow extremely slowly, and some build reefs over hundreds of thousands of years. **Once damaged, corals and the communities they support may take centuries to recover, if they recover at all.** The Program and its partners are committed to continuing research activities that improve our understanding of deep-sea coral communities, and aid resource managers in developing and evaluating management options for these valuable habitats—on which U.S. fisheries and communities depend.



Old and new fishing line entangled with a coral colony near the Pourtalès Terrace Habitat Area of Particular Concern, south of the Florida Keys. Image courtesy of the NOAA Office of Ocean Exploration and Research.

For more information about the Deep Sea Coral Research and Technology Program's accomplishments, please visit this report's online appendices with information and regional maps describing areas known to support dense deep-sea coral habitats, including those that currently have limited protections.





Examples of deep-sea coral communities discovered by the Program and partners in areas vulnerable to seafloor-contact fishing: a) Dense coral gardens at a depth of 730 feet in the Gulf of Maine's Western Jordan Basin; b) Coral gardens on the edge of the Stetson-Miami Terrace Deepwater Coral Habitat Area of Particular Concern off the east coast of Florida at a depth of 2,500 feet. Images courtesy of NOAA's Northeast Fisheries Science Center/University of Connecticut, and the NOAA Office of Ocean Exploration and Research.

Budget Component	Region	2018 Funding	2019 Funding
Southeast fieldwork	South Atlantic, Gulf of Mexico, Caribbean	$741,147	$690,664
West Coast fieldwork	Pacific	$381,125	$801,400
Pacific Islands fieldwork	Western Pacific	$100,000	-
Genetic identification and data analysis	North Pacific, Pacific, Western Pacific, New England, Mid-Atlantic	$319,810	$138,000
National Database management and data analysis software development	National	$390,000	$281,000
Program coordination	National	$320,851	$343,423
NOAA Fisheries administration	National	$69,272	$66,675
Total		**$2,322,205**	**$2,321,162**

Magnuson-Stevens Fishery Conservation and Management Act 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;

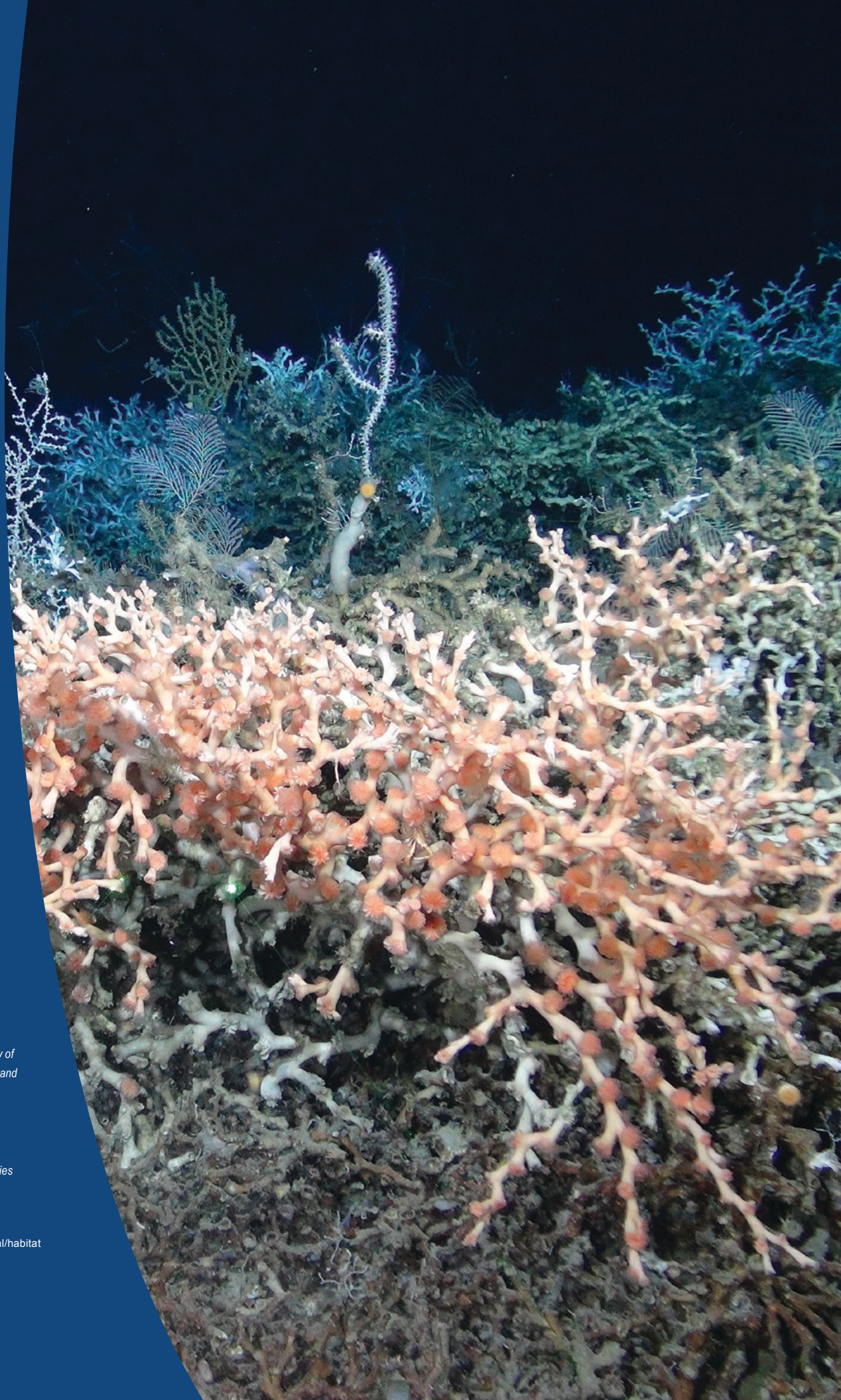
(5) to develop technologies or methods designed to assist fishing industry participants in reducing interactions between fishing gear and deep-sea corals; and

(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.

Link to Online Appendices: https://www.fisheries.noaa.gov/resource/document/deep-sea-coral-research-and-technology-program-2020-report-congress

Link to NOAA Deep-Sea Coral & Sponge Map Portal: https://deepseacoraldata.noaa.gov/



U.S. Department of Commerce
Gina M. Raimondo
Secretary of Commerce

National Oceanic and Atmospheric Administration
Benjamin Friedman
Deputy Under Secretary for Operations, performing the duties of Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

National Marine Fisheries Service
Paul Doremus
Acting Assistant Administrator for Fisheries

April 2021

https://www.fisheries.noaa.gov/national/habitat-conservation/deep-sea-coral-habitat
https://deepseacoraldata.noaa.gov/

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