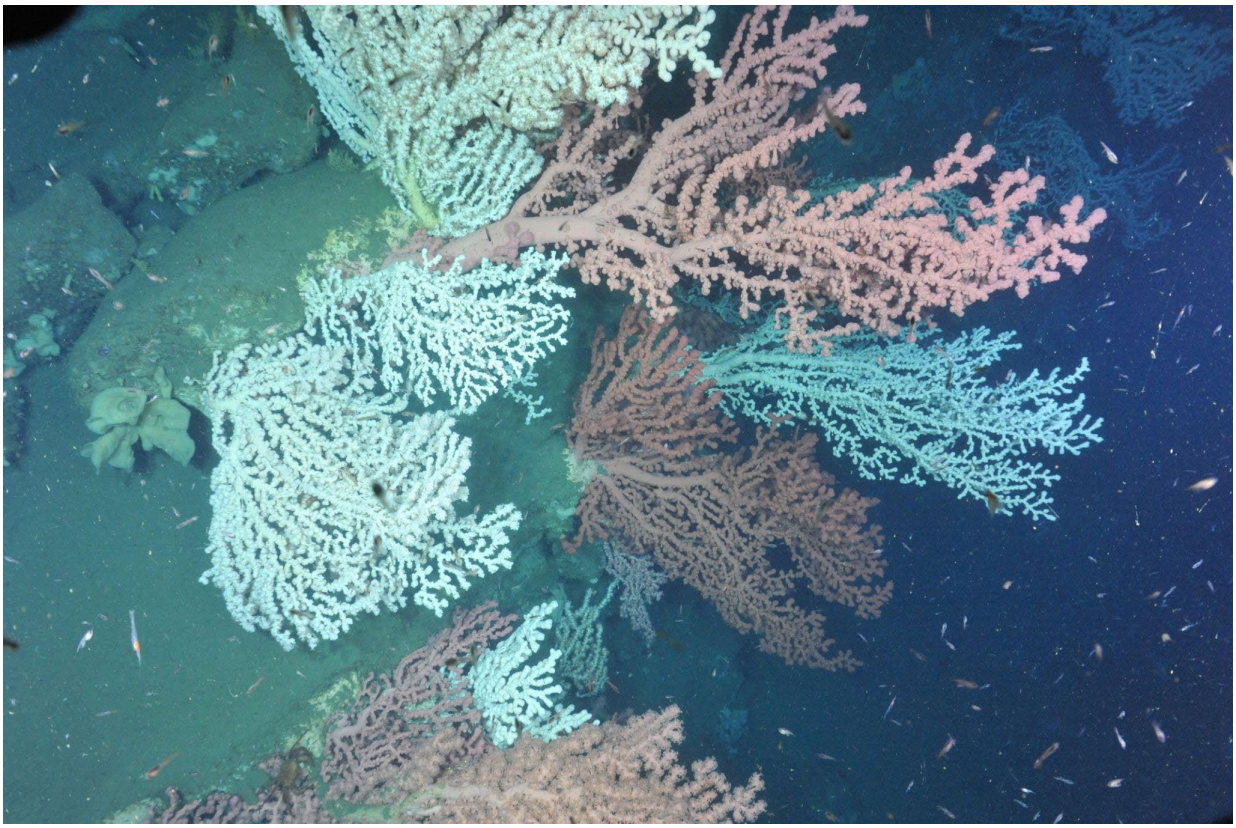
Deep Sea Coral Research and Technology Program
Science Plan for the DSCRTP Northeast Research Initiative: 2023-2026

July 2024



Cover Photo: Bubblegum corals in Heezen Canyon. Credit: 2014 Bigelow-ROPOS U.S.-Canada Northern Neighbors Transboundary Collaboration.

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NOAA Deep Sea Coral Research and Technology Program Objectives

Deep-sea corals and sponges (DSCS) can live for hundreds or thousands of years, creating important biogenic habitats and supporting remarkably complex communities in deep waters around the globe (Hourigan et al. 2017, Roberts et al. 2009). Their habitat ranges from 6 m to more than 6,000 m below the ocean surface, with a working minimum depth of 50 m. In U.S. waters, deep-sea corals and sponges exist on continental shelves, slopes, canyons, and seamounts. Their full geographic extent is still unknown due to extensive seafloor areas lacking adequate exploration. The complex structures created by corals and sponges provide habitat for many fish (Husebø et al. 2002) and invertebrate species, including commercially important species (e.g., rockfish, shrimp, and crab [Auster 2005]). They are very vulnerable to anthropogenic impacts (e.g., fishing gear, global warming, ocean acidification) and are slow to recover – if they can recover at all – from disturbance. In addition to their value as habitat, some deep-sea corals and sponges produce chemicals of great biomedical potential.

The National Oceanic and Atmospheric Administration (NOAA) established the Deep Sea Coral Research and Technology Program (DSCRTP) under the authority of the Magnuson-Stevens Fishery Conservation and Management Act, as reauthorized in 2007. The goal of the DSCRTP is to provide scientific information needed to manage and protect deep-sea coral and sponge ecosystems throughout the United States (NOAA 2008, Hourigan 2009). To facilitate this mission, the DSCRTP works with partners to support multi-year regional fieldwork initiatives and targeted projects centered on conducting new research, assimilating historic data, and making results public in support of DSCS ecosystem management. The DSCRTP supports a rotating initiative program across each U.S. National Marine Fisheries Service (NOAA Fisheries) region on an approximate 6-year cycle. The regionally-led initiatives include surveys to better understand the spatial distribution of DSCS habitats as well as research on DSCS life histories and their contributions to biodiversity, habitat suitability modeling, and assessments of impact of human activities on DSCS. A national-level data management infrastructure underlies the regional initiatives, assuring DSCRTP-supported data are accessible to the public.

Northeast Deep-sea Coral Initiative Overview

In 2023, DSCRTP began a four-year research initiative in the Northeast Region, the area under the jurisdiction of the New England Fishery Management Council (NEFMC) and the Mid-Atlantic Fishery Management Council (MAFMC). The objective of the Northeast Deep-sea Coral Initiative is to obtain scientific information that will inform the management, conservation, and protection of deep-water coral and sponge ecosystems throughout the region. Specifically, the initiative will strive to collect information that is most urgently needed by the agencies that manage deep-sea coral ecosystems, particularly the NEFMC, MAFMC, NOAA, and U.S. Fish and Wildlife Service (USFWS). Projects to be supported should (1) be relevant to management of DSCS ecosystems in the region, (2) address priority research questions identified during the 2023 initiative priority scoping workshop referenced below, and (3) be achievable within the budget and 2023-2026 timeframe. Similar to previous deep-sea coral research initiatives, supported activities will consist of research expeditions to survey, sample, and map DSCS ecosystems, as well as data and sample analyses in line with Northeast goals. Priority will be placed on activities that partner with others and leverage additional resources. During the ramp-up year in 2023, research objectives were scoped, prioritized, and planned for the following field-intensive years, 2024 and 2025, with the final year 2026 set to conclude outstanding data analyses, database submissions, publications, etc.

As a first step towards launching this research initiative in 2023, the Northeast Fisheries Science Center (NEFSC) led a science priorities scoping workshop at the Marine Biological Laboratory in Woods Hole, Massachusetts. This workshop brought together approximately 60 experts from across NOAA as well as the NEFMC, MAFMC, USFWS, Bureau of Ocean Energy Management (BOEM), Fisheries and Oceans Canada (DFO), Smithsonian, academia, National Resources Defense Council, The Nature Conservancy, and industry technology companies. Discussions at the workshop centered around priority management issues, geographic areas, and research questions relating to deep-sea coral ecosystems off the U.S. northeastern coast. Follow-up outreach was also conducted to gather further input from those participating remotely or unable to attend.

Previous Research

A number of previous deep-sea coral research efforts have taken place in the Northeast region, including the first DSCRTP-supported Northeast Regional Initiative of 2013-2015. Priorities for this Regional Initiative were developed during a 2011 priority scoping workshop. Related campaigns that have added regional knowledge include the 2012-2013 Atlantic Canyons Undersea Mapping Expeditions and Atlantic Seafloor Partnership for Integrated Research and Exploration. Past research activities have included locating and characterizing deep-sea coral habitats; investigating the biology, biodiversity and ecology of deep-sea corals, with focus on improving species identification and investigating connectivity; and characterizing human impacts on these ecosystems. These goals were developed collaboratively between NEFSC, the NOAA Fisheries Greater Atlantic Regional Fisheries Office, Mid-Atlantic Regional Council on the Ocean, NEFMC, and MAFMC. Research efforts carried out during the Initiative included extensive multibeam mapping of the Atlantic canyons, deep-sea coral habitat suitability modeling, field expeditions to the canyons, including transboundary work in collaboration with DFO, and field expeditions to the Gulf of Maine. In total, the Initiative carried out 9 cruises, featuring both remotely operated vehicle (ROV) and towed camera work, designed to characterize regional communities and collect images, specimens, and records for the NOAA Deep-Sea Coral and Sponge National Database and Map Portal, as well as additional research (Table 1). The work has resulted in seven publications to date (see Appendix B) and the collected data contributed to the designation of protected areas covering 177,076 km^2 of seafloor.

Other research in this region included additional survey cruises outside of the DSCRTP-supported Northeast Regional Initiative (but may have included DSCRTP funding):

- 2010-2017 BOEM funded Deep-water Canyons Study, focusing on Baltimore and Norfolk canyons (as well as Accomac and Washington canyons) in the southern mid-Atlantic Bight (e.g., Brooke and Ross 2014, Brook et al. 2017).
- 2012 *TowCam* cruise to several Northeast submarine canyons to ground-truth the recent deep-sea coral habitat suitability model and high-resolution bathymetric maps created from newly collected multibeam data.
- 2012 Waitt Institute funded cruise with autonomous underwater vehicles (AUVs) to investigate deep-sea corals on Physalia Seamount (Kilgour et al. 2014).
- 2013, 2014, 2019, 2021 NOAA Ship *Okeanos Explorer* surveys of Northeast submarine canyons and seamounts (EX1304, EX1404, EX1905, EX2104); 2021 dives in Hudson and Toms Canyons (EX2103).
- 2014, 2017, 2019 NOAA Ship *Bigelow*/ROV ROPOS joint U.S./Canadian characterizations of seafloor communities in the cross-boundary Gulf of Maine region and continental margin.
- Additional work from academic and federal research teams in the region that benefited from, or contributed to, the Initiative includes investigations of coral reproduction in the Gulf of

Maine (Fountain et al. 2019), work on habitat suitability modeling (Kinlan et al. 2020), and characterization of patterns of phylogeography (Quattrini et al. 2015).

Table 1: Summary of cruises conducted during the 2013-2015 Northeast Deep-sea Coral Initiative. Note that annotations are not done for trawl samples, and specimens are not collected during camera tows. Cruise summaries and annotations of observed corals, sponges, and fish were submitted to the DSCRTP and linked here or available at https://repository.library.noaa.gov/.

Cruise ID	Location	Dives		
		Number of surveys	Specimens collected	Annotations completed
HB1302	New England Canyons	22 Camera tows		14,036 records
CT1307	Western Jordan Basin, Outer Schoodic Ridge	40 Camera tows		2318 records
EX1304L2	New England Canyons	15 ROV dives		22,649 records
HB1402	U.S./Canada Canyons, Gulf of Maine	16 ROV dives	100	8639 records
CT1407	Western Jordan Basin, Outer Schoodic Ridge	21 ROV dives	134	7940 records
HB1404	Mid-Atlantic Canyons	25 Camera tows		11,427 records
HB1504	New England Canyons	20 Camera tows		5006 records
CT1507	Outer Schoodic Ridge, Mount Desert Rock, Georges Basin	26 Camera tows		1388 records
Sea Pen	Gulf of Maine	21 Trawls	117	NA

Northeast Deep-sea Coral Research Initiative Priorities

Research priorities were established during the scoping workshop (outlined above). Based on the presentations by academic and institutional partners, feedback during the breakout and plenary discussion sessions, and discussions around previous research, both geographic and data collection priorities were identified. The Initiative Steering Committee synthesized the input and

identified a more specific set of priorities. These research objectives are outlined in the following sections.

Geographic Overview of Priority Regions

The Northeast Region includes federal waters from Maine to North Carolina, and encompasses areas within the jurisdictions of the NEFMC and the MAFMC. This broad geographic area includes a variety of unique habitats hosting DSCS ecosystems. These range from hard bottom areas in the relatively shallow Gulf of Maine to numerous canyons across continental shelf margin, to four offshore seamounts. As identified during the Northeast Initiative priority scoping workshop (MacDonald et al. 2023), specific priority areas within the region include 1) the Gulf of Maine, 2) the Northeast Canyons and Seamounts Marine National Monument, and 3) Mid-Atlantic canyons, including Hudson Canyon, currently proposed as a National Marine Sanctuary. Each of these geographic areas face unique management challenges which the Initiative can contribute valuable data to solve.

Gulf of Maine

Coral gardens[1] discovered in the few visual surveys undertaken to-date in the Gulf of Maine are the closest to shore and shallowest in the entire Northeast region, and some of these corals are genetically distinct from deeper offshore communities. Furthermore, the Gulf of Maine is one of the fastest warming bodies of water in the U.S., and corals are very sensitive to changes such as temperature and carbonate chemistry (Pershing et al. 2015, Farr et al. 2021). For these reasons, the Benthic Ecology Subgroup under the National Strategy for Ocean Mapping, Exploration, and Characterization Interagency Working Group on Ocean Exploration and Characterization determined that for the Atlantic coast, the Gulf of Maine is the number one priority (IWG-OEC 2022). The forthcoming offshore wind development leasing in the Gulf of Maine also creates urgency to expand coral habitat knowledge of the area.

The Gulf of Maine stretches from the western tip of Nova Scotia to Cape Cod in the south and Georges Bank to the east, encompassing waters under both Canadian and U.S. jurisdictions. The Gulf encompasses a wide variety of benthic features and substrates, including large, deep basins, extensive soft sediment areas (mostly mud), and hard bottom including cobble, boulders, and large rocky ridges and outcrops. These heterogenous and often patchy habitats support diverse biological communities. While deep-sea corals have been documented in the Gulf since the late 19th century, the size and distribution of these communities appears to have been shrinking over time (Auster et al. 2015). Work in 2013-2015 documented extensive coral gardens in the Jordan Basin, Mount Desert Rock, Outer Schoodic Ridge, Lindenkohl Knoll, and Georges Basin, with much of the coral occurring at depths between about 160-250 m (Fig. 1).

[1] Coral gardens are defined as areas where non-reef- forming corals are among the dominant fauna and occur at densities higher than surrounding patches (Bullimore et al. 2013, Packer et al. 2017).

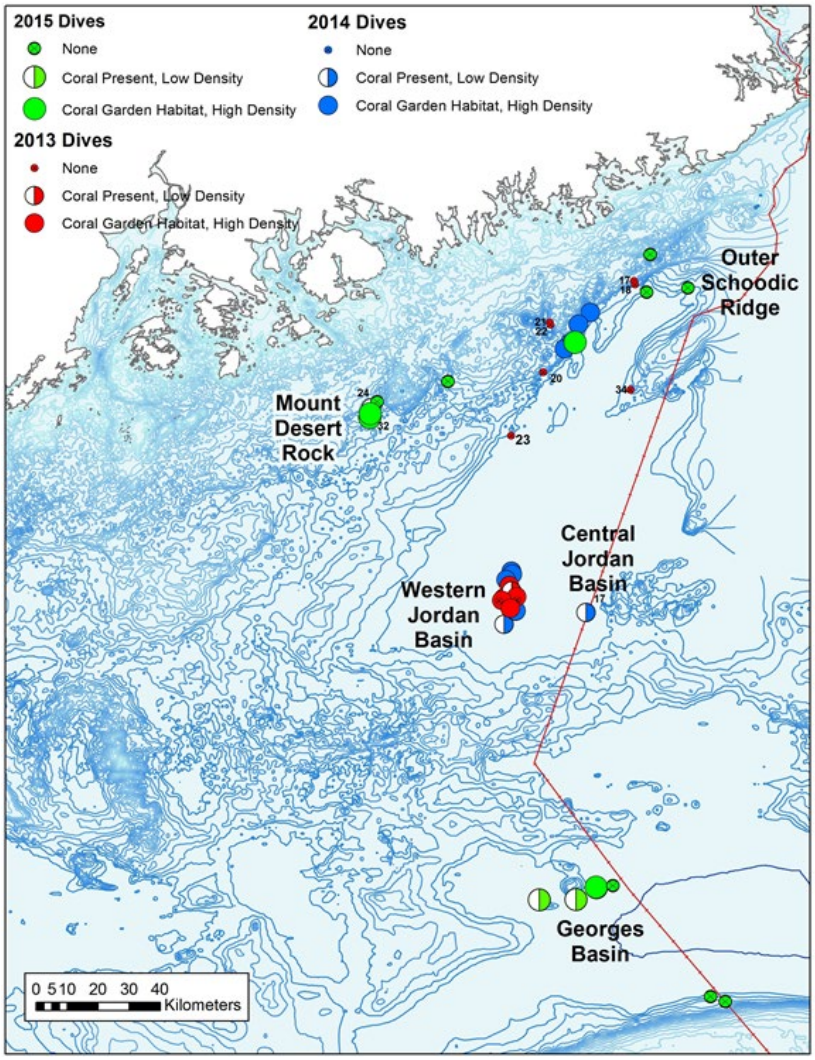

Figure 1. Map of the eastern Gulf of Maine with the U.S./Canada boundary line drawn in red. Red (2013), blue (2014), and green (2015) circles indicate whether coral was observed and at what level of density: small dots for absent, half circles for low density, and full shaded circles for high density coral gardens.

Compared to the offshore submarine canyons, continental slope, and seamounts, the Gulf has low coral diversity with predominantly two species of structure-forming gorgonians, *Paramuricea* and *Primnoa*. *Paramuricea* is more abundant overall, occurring on flat rocky areas and especially slopes, including areas adjacent to features as well as open muddy areas containing gravel, sand-gravel, and smaller rock outcrop features (Auster et al. 2015). *Primnoa* is usually found on the steeper slopes of outcrops, often in incredibly high densities. *Primnoa* populations here are genetically distinct from those in the far offshore canyons. Compared to the deepwater canyons, many more commercially important fish and shellfish species occur in the Gulf as well as more instances of fishing gear impacts. The results of these surveys led to the establishment of coral protection areas within the Gulf.

Potential sampling sites within the Gulf of Maine, including Outer Schoodic Ridge, Jordan Basin, and areas south of Jordan Basin near the border, were identified as priority sites. Additional work in Jordan Basin in general, and near the Canadian border in particular, could help define the boundaries of coral areas as well as support collaborations with Canadian partners to conserve DSCS habitats on both sides of the border.

Northeast Canyons and Seamounts Marine National Monument and Other New England Canyons

The Northeast Canyons and Seamounts Marine National Monument is 130 miles southeast of Cape Cod, MA and contains two distinct geographic units. The first unit on the shelf margin covers three canyons (Oceanographer, Gilbert, and Lydonia), while the second unit covers four offshore seamounts (Bear, Physalia, Retriever, and Mytilus). The Monument was designated in 2016 and is co-managed by the USFWS and NOAA. The canyons feature hard substrate on their steep walls providing suitable habitat for DSCS communities, and are hotspots of biodiversity.

There are several priorities involving representative canyons and seamounts within the Monument as well as some of the adjacent New England canyons, which include to (1) increase our understanding of the biological connectivity between the Monument canyons, the adjacent canyons, the seamounts, and biogeographic breaks in the region; (2) survey the relatively shallow heads of the canyons within the Monument, which have been recently protected from fishing and compare them to the other, unprotected adjacent canyon heads to assess fisheries and other anthropogenic impacts; (3) focus on Oceanographer Canyon and Bear Seamount, the most explored/surveyed canyon and seamount off the Northeast U.S. coast, to revisit/resurvey previously sampled sites for signs of temporal stability of their coral/sponge habitats. In addition, the potential and desire to survey additional canyons throughout the New England region to increase geographic coverage is also supported.

Mid-Atlantic Canyons

The Mid-Atlantic region has 13 major and numerous minor submarine canyons, which vary in size and complexity. These canyons include features formed by ancient river systems, as well as by erosional processes such as slides and turbidity currents. Five of the major canyons, Hudson, Wilmington, Baltimore, Washington, and Norfolk, have been the subject of previous research and surveys (i.e., Obelcz et al. 2014, Brooke et al. 2017). Hudson Canyon, the largest canyon off the U.S. east coast, is of particular interest to the Initiative as it has been proposed as a new National Marine Sanctuary. It features steep relief (>1000m at the shelf edge), a prominent shelf-valley, and extends far seaward of the continental slope (Obelcz et al. 2014). The shallow head has been well surveyed (Pierdomenico et al. 2015, 2017), but few corals were found; the rest of the Canyon has had few coral/sponge surveys or records of occurrence. Proposed work in Hudson Canyon will provide much needed contemporary data to support sanctuary designation.

Research Focus Themes

Participants attending the Initiative scoping workshop identified research focus areas following three themes: Biological Priorities, Habitat Characterization, and Management Priorities. Biological priorities included collection of additional samples to support natural history, genetics, and taxonomy research. Additional sampling of target species including *Desmophyllum* spp., *Paragorgia*, and *Paramuricea* were highlighted. The group proposed using a targeted species list to direct sampling for specific projects including population connectivity, life history and reproduction, characterization of coral associates, and taxonomic sampling to fill in data gaps. The application of novel sampling technologies such as environmental DNA (eDNA) to characterize and monitor deep-sea coral communities was also discussed.

Habitat Characterization priorities included general habitat characterization (i.e., building off the revised Coastal and Marine Ecological Classification Standard [CMECS]), a focus on fish associations, and work investigating pelagic-benthic coupling. Additionally, high quality mapping data tied to habitat characterization is needed for the development and improvement of species distribution and habitat suitability models for the region. Previous research in the area focused on

exploration, so survey priorities in this Initiative were proposed to target fewer regions (identified above) with more in depth data collection that could help elucidate the habitat drivers of deep-sea coral distribution and diversity.

Management priorities discussions during the workshop highlighted sanctuaries, the Monument, Council actions, economic valuation and quantification of associated fish species, and wind energy siting. Management-relevant data needs included the quantification of fish usage or association with deep-sea coral communities, assessing potential use of these habitats as nursery zones for commercially important species, addressing data and potential monitoring needs in protected areas, producing data products in support of the Monument and proposed Sanctuary, assessing the capacity of deep-sea coral communities for recovery, and addressing the potential impacts of wind energy development on deep-sea coral communities.

Northeast Deep-sea Coral Research Initiative Objective

The objective of the 2023-26 Northeast Deep-sea Coral Initiative is to support research that addresses management needs and contributes to the conservation and protection of DSCS throughout the Northeast region. This scientific research plan strives to address the information needed to understand and conserve important DSCS habitats and to leverage additional partnerships to integrate research priorities and resources. The focus is on field research and collection of new information on DSCS taxonomy, distribution, diversity, and life history traits, as well as natural and induced habitat changes. Specifically, research will address the priorities identified in the Northeast Deep-sea Coral Initiative priorities workshop report (MacDonald et al. 2023).

Approach

To accomplish the objective, the Northeast Deep-sea Coral Initiative Steering Committee will align identified research priorities from the workshop with proposed projects. They will examine previously conducted coral and sponge research in the Northeast and consult with scientists, NEFMC, MAFMC, industry stakeholders, and local communities periodically as new or changing priorities develop. A combination of chartered commercial vessels, research cruises on NOAA ships and commercial vessels, and partnerships with federal, state, and non-governmental organization partners will be used to accomplish the fieldwork goals and objectives.

The Northeast Deep-sea Coral Initiative will map, survey, and sample deep-water habitats. The information collected will be synthesized into products accessible to a broad audience and effectively communicated both internally and externally. Throughout the Northeast Deep-sea Coral Initiative, regular communication between the initiative's science team, the Councils, and the DSCRTP will ensure that the initiative provides a real contribution to the management and informed protection of DSCS ecosystems throughout the Northeast.

Criteria for Prioritizing Projects

Research priorities for the 2023-2026 Northeast Deep-sea Coral Initiative were identified based on a combination of biological, physical and management data needs. Projects addressing the priorities identified at the workshop were solicited from steering committee members and other principal investigators.

Work Plan of Activities Supported by the Northeast Deep-sea Coral Initiative

The Northeast Deep-sea Coral Initiative will support a variety of work to better characterize DSCS and their associates and ecosystems (Fig. 3). This work will include efforts to better map specific habitats where accurate bathymetric information is lacking, research expeditions to survey DSCS habitats and collect specimens, and targeted research projects to characterize these ecosystems and species. The Northeast Deep-sea Coral Initiative will carry out this work directly, as well as leverage both Federal and academic partnerships.

Field Expeditions

Research expeditions will occur primarily on NOAA and NOAA-partner (e.g., R/V *Connecticut*) vessels. Research cruises planned with confirmed/awarded ship time are detailed below. However, since ship time has yet to be awarded for fiscal year (FY) 2025, cruises proposed for the second year of field activities are tentative and represent the best possible estimate of potential days at sea for FY 2025. Due to potential shifts in the Office of Marine and Aviation Operations' FY 2024 budget, changes to vessel time may occur between the time of writing and initiation of fieldwork. Depending on the availability of vessels and staff, the following activities may occur during field missions: seafloor mapping, visual surveys via ROV and/or autonomous underwater vehicle (AUV), specimen sampling and preservation, and collection of supplemental environmental information. Also, whenever possible, field expeditions will be enhanced with small projects and experiments to address additional research priorities determined during the Initiative's priorities scoping workshop, and will include student trainees whenever possible for education and outreach.

Mapping

FY 2024 Mapping by NOAA Ship *Hassler* in the Gulf of Maine

The Northeast Deep-sea Coral Initiative is supporting bathymetric and backscatter mapping operations in the Gulf of Maine to fill in critical gaps in the Northeast region. These data are critical to both novel modeling efforts for the Gulf of Maine (discussed below) as well as to inform planning and executing ROV and AUV surveys. Working with the NOAA Office of Coast Survey, the Northeast Deep-sea Coral Initiative is funding 15 days at sea to support mapping by NOAA Ship *Hassler*, with an additional 10 days being leveraged via funding from the National Ocean Service. This cruise is scheduled to take place in August 2024, and will not require direct personnel support from the Initiative. The proposed mapping area includes the area within the Gulf of Maine Wind Energy Area adjacent to the Saildrone mapping polygon (Fig. 2). Overlap with Saildrone and *Hassler* mapping allows for comparison of the data being obtained from both platforms. At the time of writing, the final *Hassler* mapping area is still being refined. Bathymetric data will be processed by the Office of Coast Survey and used by the Initiative for further cruise planning and by BOEM for planning in the wind energy infrastructure development.

Additional potential mapping efforts

The Steering Committee is working to leverage partnerships to enhance bathymetric and backscatter mapping efforts in the Gulf of Maine. These efforts could include working with BOEM, NOAA Ocean Exploration, Northeast states, the uncrewed systems initiative, or academic partners to secure additional resources for mapping efforts. Possible strategies could include

securing additional ship time aboard a mapping vessel such as NOAA Ship *Hassler*, obtaining funding for additional mapping using the Saildrone platforms, or partnering with academic or cooperative institute based cruises to support mapping in targeted areas if the cruise platform allows. An example of the latter is a collaborative effort being planned by the Ocean Exploration Cooperative Institute with significant input from the NOAA Uncrewed Systems Operations Center, NOAA Ocean Exploration, BOEM, and University of New Hampshire, and $25,000 from the Initiative. Additionally, when using NOAA vessels with mapping capabilities for fieldwork, additional mapping operations may be conducted during portions of the cruise outside of ROV operations or when ROV use is suspended due to weather or mechanical issues.

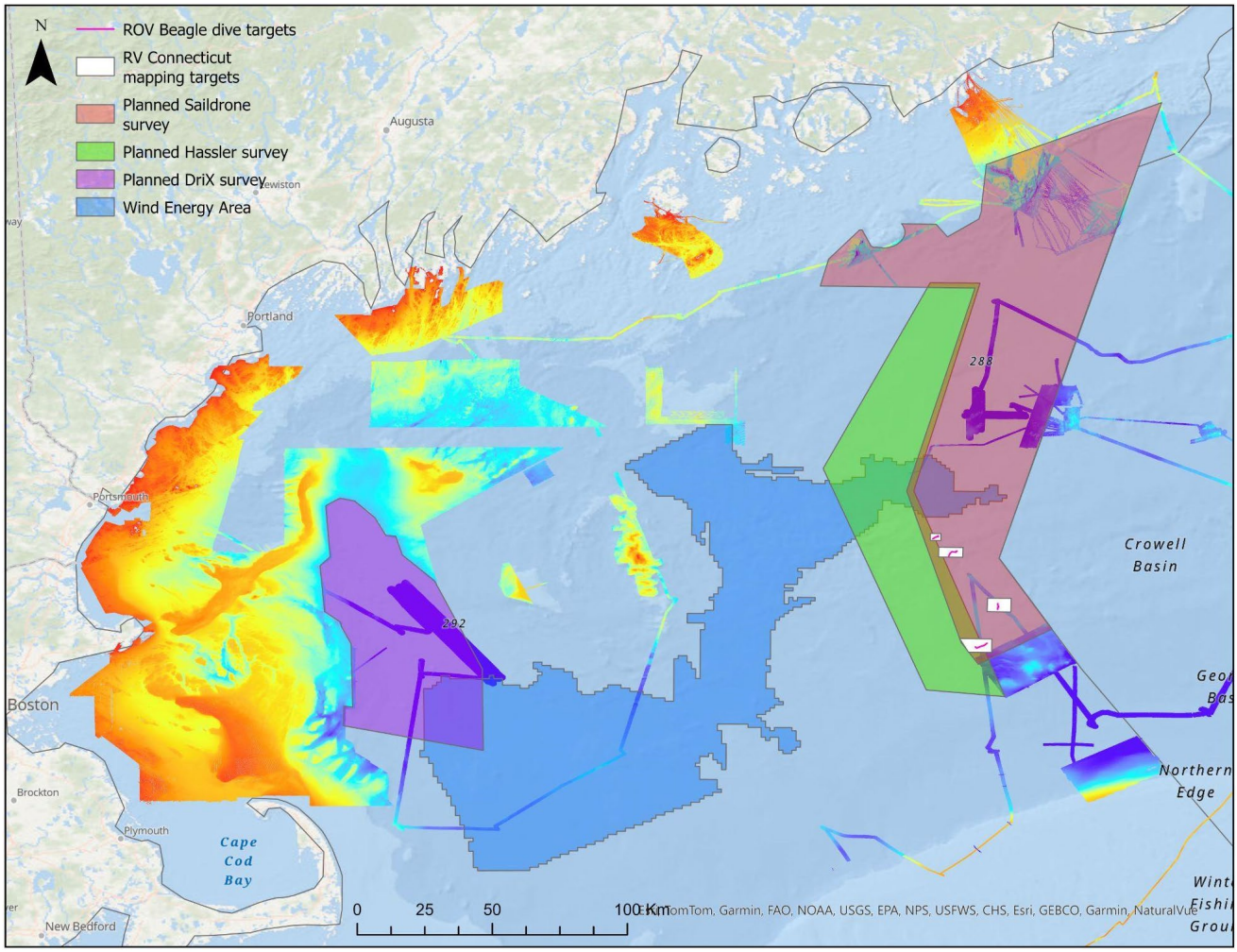

Figure 2. The Gulf of Maine's existing bathymetric information (red-blue scale shaded areas) overlaid with the Final Wind Energy Area (blue shaded area, announced in March 2024), planned Saildrone survey (pink shaded area at the east edge of U.S. waters) planned Hassler *survey (adjacent green shaded area), and planned DriX survey (purple shaded area in the western Gulf). White boxes and pink tracklines within the Saildrone mapped area show targets for ROV dives and finer-scale mapping by the R/V* Connecticut.

Initiative Funded DSCS Visual Surveys

FY 2024

R/V *Connecticut* and ROV *Beagle* - May 29-June 8, 2024 (POSTPONED)

The Northeast Deep-sea Coral Initiative will use the University of Connecticut's vessel, R/V *Connecticut* and the MARE ROV *Beagle* to survey DSCS habitats in the Gulf of Maine. The specific location of dive sites are still in the planning stages at the time of writing, but ship and ROV time has been contracted in partnership with the Ocean Exploration Cooperative Institute (OECI). Possible locations include recently mapped areas containing hard bottom habitat, particularly the "border bumps" south of Jordan Basin, and other soft and hard bottom habitats within the Wind Energy Area. In and near the Jordan Basin Dedicated [coral] Habitat Research Area is also being considered, along with revisiting the Outer Schoodic Ridges Deep-sea Coral Protection Zone to assess if any changes in the habitat have occurred since the last survey nine years ago. Some sites will be chosen to coordinate with the Gulf of Maine portion of the *Bigelow/ROPOS* transboundary cruise (e.g., Jordan Basin, border bumps). This field effort will conduct transects to survey for corals, sponges, associated fish, and invertebrates. When possible, the ROV will also collect and preserve representative samples for identification and other studies such as connectivity; eDNA sampling to confirm species identified are also planned during transects. It is anticipated that students from University of Rhode Island will participate in cruise activities, addressing an OECI priority to support student engagement.

NOAA Ship *Bigelow* and ROV *ROPOS* - July 18-August 1, 2024

The Northeast Deep-sea Coral Initiative will carry out a joint transboundary research cruise with Canadian partners including DFO and Dalhousie University, with additional support leveraged from the USFWS. The focus of this cruise is to conduct ROV dives to survey and collect specimens on both sides of the border in the Gulf of Maine and offshore canyons. Specifically, objectives include to (1) conduct detailed multibeam mapping of selected areas of known and suspected coral habitat in the Gulf of Maine; (2) assess biodiversity; (3) assess deep-sea coral abundance, distribution, size, (4) characterize deep-sea coral habitats using using detailed multibeam maps to guide ROV collections of video and physical samples; (5) collect deep corals for taxonomic, reproduction, and age analyses; (6) collect deep corals and associated fauna for genetic studies (e.g., phylogenetic, phylogeographic, community genetics, and connectivity); (7) validate species distribution models; (8) refine estimates of coral recruitment; and (9) conduct physiological experiments on deep corals. The cruise as currently outlined will include at least two days of work in the New England Canyons and Seamounts Marine National Monument. Other potential targets include areas of suspected DSCS habitat in support of expanding the Canadian Marine Conservation Area network in the Maritimes, newly mapped areas along the border with Canada (in coordination with the R/V *Connecticut* cruise), model-predicted hotspots for *Desmophyllum pertusum*, and areas of interest for conservation on both sides of the border.

FY 2025

Joint Research Cruises with USFWS and ONMS

The Northeast Deep-sea Coral Initiative is planning a research cruise to the Monument in partnership with the USFWS, and a cruise to the proposed Hudson Canyon National Marine Sanctuary in partnership with the NOAA Office of Marine Sanctuaries. This work will be jointly funded to leverage research goals for all programs.

Additional Fieldwork in the Gulf of Maine

With the focus on wind energy development in the Gulf of Maine, additional fieldwork in this area will remain a priority for the Initiative. At the time of writing, ship time requests for additional fieldwork in the Gulf of Maine are currently under review. Possible work includes more mapping and visual surveys to support development of a novel species distribution model for the Gulf, further characterization of habitats within newly mapped areas within the Wind Energy Area, and additional collections to further species characterization.

Targeted Projects

Saildrone Mapping in the Gulf of Maine - FY 2023-24

DSCRTP, NEFSC, and the National Centers for Coastal Ocean Science (NCCOS), in support of the Northeast Deep-sea Coral Initiative, secured funding for bathymetric and backscatter mapping with the Saildrone platform in the Gulf of Maine through an award from the NOAA Office of Marine and Aviation Operations Uncrewed Systems Operations Center. The geographic target is a large polygon (Fig. 2) in the eastern Gulf of Maine to the border. This area lacks high quality bathymetric data, may contain valuable DSCS habitat, and partially falls within BOEM's wind energy area. Funding for the proposal was awarded in early 2023, and mapping of the area by two Saildrone Voyagers began in August 2023 and continued through the beginning of November 2023. During this period, Saildrone mapped 894km^2 at the southern end of the target polygon (Fig. 2), covering approximately 13% of the proposed area overall. Mapping efforts resumed in April 2024 with 45 days of mapping remaining from year 1 funds, and 74 days funded by year 2 of the award and supplementary contributions from NCCOS and the Initiative.

Modeling

A primary goal of the Initiative, in partnership with NCCOS, is the development of new species distribution models for the Gulf of Maine, as well as updated models for the canyons and seamounts. In order to build the Gulf of Maine models, baseline information including high resolution bathymetric data, species observations (presence-absence or abundance data), and environmental data will be collected during surveys. NCCOS representatives on the Steering Committee will assist in fieldwork planning for both surveys and mapping to ensure that appropriate data to support the modeling are collected. While the Initiative will collect data for the development of the new Gulf of Maine models, production and availability of the models is expected to be completed after the conclusion of the Initiative. The updated canyons and seamounts modeling effort is already underway, and early drafts may support the FY 2024 NOAA Ship *Bigelow* cruise, with potential updates incorporating new mapping and observational data collected during the FY 2024 and FY 2025 field seasons.

Habitat Characterization Surveys

These surveys will take place during the fieldwork described above, with annotation of the observations and transects following the fieldwork. Standardized ROV transect surveys will be conducted, with the ROV moving at slow speeds over a given distance. High definition (HD) video, still images, and vehicle tracking data will be collected throughout, as well as environmental data via instrumentation on the vehicle (exact instrument configurations will vary depending on the vehicle used). Survey locations will be determined based on priority geographic areas identified by the Steering Committee, with exact dive locations determined based on the availability of mapping data and local environmental conditions while in the field.

Subsequent to each field season, video and still image data will be annotated for species of corals, sponges, and associated fish and invertebrate taxa, as well as habitat characteristics,

applying the updated CMECS standards. Annotations and associated environmental data from each expedition will be submitted to the Deep-sea Coral Database, along with cruise reports from each cruise. Additionally, these data will be applied to habitat characterization and species distribution modeling efforts.

Biological Sampling

The 2023 science priorities scoping workshop identified collection of additional biological samples as a critical need of the Initiative. Whenever possible, targeted biological sampling will be conducted during ROV surveys. This will be particularly emphasized during fieldwork with larger ROVs capable of collecting larger numbers and sizes of specimens, including the FY 2024 *Bigelow*/*ROPOS* cruise detailed above. Biological collections will include specimens of corals, sponges, invertebrate associates, and eDNA samples. Samples will be collected for investigation of taxonomy, confirmation of species identification, development of DNA voucher libraries, studies of reproduction, genomics, and evaluation of overall species biodiversity. Members of the Initiative will participate in these research efforts directly as well as identify suitable research partners to carry out specific investigations such as population connectivity studies. Physical specimens will be either preserved in ethanol or frozen immediately after collection. Subsamples for DNA analysis will be taken either at the time of collection or before submission to the final repository. Coral, sponge and invertebrate samples will be deposited in the Invertebrate Zoology collection at the Smithsonian Institution. eDNA samples will be filtered and preserved on board in an appropriate preservation buffer such as Longmire's or Zymo DNAShield. eDNA samples will be extracted, analyzed and housed at one of the NOAA Fisheries eDNA labs (*ie* NEFSC or NWFSC), or appropriate academic partner institutions, with the potential to deposit either extracted DNA or remaining buffer-preserved eDNA in the Smithsonian collection as appropriate. Potential targets for eDNA analysis include octocorals, fishes and invertebrates via metabarcoding, or targeted quantification of selected species.

Coral Genomics

The northeastern U.S. canyons and Gulf of Maine ecosystems contain diverse and dense assemblages of cold-water corals. Two genera, *Paramuricea* and *Primnoa*, commonly occur throughout the region. These corals are important foundation species that enhance habitat for economically and ecologically important invertebrates and fishes. Knowledge of the rates and directions of genetic exchange is critical for successful conservation and mitigation of anthropogenic stressors on their populations. Connectivity studies using genomic approaches (i.e., low-coverage whole genome sequencing combined with reference genomes) will help in determining sources and sinks of gene flow in the region while identifying locally-adapted populations to help ensure species' resiliency under global change. Numerous specimens of *Paramuricea* and *Primnoa* will be collected during the FY 2024 *Bigelow*/*ROPOS* cruise detailed above. Preserved samples will be taken to the Smithsonian Institution where they will be processed and analyzed through a partnership between NOAA Fisheries and Dr. Andrea Quattrini.

Education, Outreach, and Communications

Education, outreach, and communications will span both field and shore based work carried out by the Initiative. These efforts will include the participation of both graduate and undergraduate students in planned fieldwork. Students will take part in both FY 2024 research expeditions, and will aid in managing ROV dives, collection and preservation of samples, and other fieldwork. These data and samples will be used in data products produced by the Initiative, as well as in the students' own research. The Steering Committee is also working with a City University of New York graduate student on a NOAA fellowship who will be engaging with the NCCOS modeling

team working on model development for the canyons and Gulf of Maine. This work will be included as a chapter in their dissertation.

Telepresence capabilities will be included for both FY 2024 cruises. The inclusion of telepresence will allow the research teams to present directly to the public during field expeditions. This type of engagement has been used effectively by other NOAA teams and partners such as NOAA Ocean Exploration's *Okeanos Explorer* missions to increase public awareness and interest.

Working with NOAA communications teams, the Initiative will also produce communications products including mission logs, press releases, social media engagement, and related materials to document their ongoing work. With a range of management concerns in the region, including wind energy, management plan development for the New England Canyons and Seamounts Marine National Monument, and the proposal for the Hudson Canyon National Marine Sanctuary, there is considerable political and public interest in the Initiative, and timely communications products will be key for driving engagement.

Deliverables and Data Management

Data Management Plan

It is crucial to note that any field mission supported (in full or part) by the Initiative is done so with the expectation and understanding that the cruise-lead or chief scientist will ensure that the required data products are budgeted for and contributed to the DSCRTP's National Database, with the type of products dependent upon the level of support. The data team, Robert McGuinn (robert.mcguinn@noaa.gov), and Arvind Shantharam (arvind.shantharam@noaa.gov) will connect with cruise-leads during cruise planning to provide guidance and facilitate the collection of data. The data team will also offer guidance post-cruise to facilitate database submissions. Documentation detailing data requirements is also available online (Fieldwork Data and Reporting Guidance, Checklist and Timeline for Science Team Data Deliverables).

Data to be archived includes all video and still image data as well as environmental data collected by both the ROV and ship. The DSCRTP data team will help the project leads archive the data in appropriate repositories at the NOAA National Centers for Environmental Information (NCEI), including but not limited to DSCRTP's National Database. Model products, such as GIS layers of the model predictions and environmental covariates, will also be archived at NCEI. Biological specimens collected during the initiative will be archived at the Smithsonian Institution, and if possible the Initiative team will seek to archive eDNA material as well. Any genetic sequence data generated as part of the Initiative will be archived at the National Center for Biotechnology Information. All sequence data will be provided and archived in machine readable open access text formats that are standard for DNA data. Accession numbers associated with samples included in the DSCRTP National Database will be submitted to this database for inclusion as part of the associated records.

All data generated by this proposal will be made public no later than the publication date of a peer-reviewed article based on the data, or within a reasonable time from collection, determined by the Steering Committee and DSCRTP. If additional time is required due to unforeseen circumstances or need for additional analysis time, the project leads, Steering Committee, and DSCRTP will track progress towards data release.

Upon completion of this research, the results may be published in relevant, peer-reviewed journals or as NOAA Technical Memos, as appropriate. Pre-publication manuscripts will be submitted to the NOAA Central Library Institutional Repository and will be made compliant with section 508 guidelines. Any supplemental materials such as supplemental tables and charts will also be provided to

NCEI where relevant. Final publications will be published as open-source resources to maximize their availability to the public. As the opportunity arises to include this research as part of relevant scientific meetings, we will seek to participate and present results of this research.

Deliverables and Products

Bathymetric Mapping Products for the Gulf of Maine

New high resolution bathymetric data from multiple sources including NOAA Ship *Hassler*, Saildrone, and data collected over the course of Initiative field research will be produced and archived with NCEI following guidelines established by the recently completed Standard Ocean Mapping Protocol. These data will greatly expand the high resolution bathymetric data available for this region, which is comparatively data poor, especially in the far offshore areas of the Gulf. Applications for these data include planned modeling efforts, ROV dive planning, data to inform BOEM in wind energy siting, and habitat data that can inform potential conservation efforts. Additional products that may follow these mapping efforts include comparison of mapping technologies (i.e., shipboard vs. autonomous) to inform future mapping survey efforts and provide guidance on optimal methods for given survey types and locations.

Species Distribution Models

The Initiative will support development of a new species distribution model for the Gulf of Maine, as well as updated models for the canyons and seamounts after conclusion of the Initiative. The Initiative, with guidance from the NCCOS modeling team, will support gathering baseline information including high resolution bathymetric data, species observations and absence data, and environmental data to support model development. NCCOS representatives on the Steering Committee will assist in fieldwork planning for both surveys and mapping to ensure that data appropriate to model development are collected.

Cruise Reports

After each cruise, a short report summarizing the field efforts, including metadata (i.e., number of dives, transects, etc.), notable observations, number of samples, and any challenges (i.e., equipment breakdown or weather conditions) will be prepared. Report length and format may be determined by the Principle Investigator, provided the document is sufficiently detailed to summarize cruise activities conducted. These reports will be submitted to DSCRTP and the data team as part of the data archive process.

Deep-sea Coral and Associate Observations

Annotations of deep-sea corals and sponges, and associated fishes and invertebrates will be recorded and submitted to relevant repositories, including DSCRTP's National Database, along with recorded habitat information. Where possible, ancillary observations, such as fish-habitat associations, assessments of DSCS health or condition, and measurement of physical/chemical properties of the ocean will be summarized and reported to DSCRTP.

Scientific Publications and Additional Products

As additional projects and Principal Investigators (PIs) are identified during the Initiative, additional publication opportunities including life history, taxonomy, population and species connectivity, coral-fish associations, and data rescue will be identified. PIs will coordinate with the

Steering committee to gather relevant samples and information, and ensure timely publication of research results.

Wrap-up Workshop and Final Report

A wrap-up workshop will be organized in the final year of the Northeast Deep-sea Coral Initiative (FY 2026). This workshop will allow Initiative participants to reflect on the successes and challenges of the Initiative, report on the status of outstanding tasks or database submissions, and summarize Initiative accomplishments. A final report will be submitted to DSCRTP.

Roles and Responsibilities

The Northeast Deep-sea Coral Initiative science team consists of NOAA and affiliated staff from multiple line offices. The science team will conduct a large portion of the work required to complete the research expeditions and projects outlined above, and will seek advice and support from experts outside of NOAA as necessary. The roles and responsibilities of each member of the NOAA science team and primary outside partners are outlined in the table below.

Name	**Affiliation**	**Roles/Responsibilities**
James Vasslides	NOAA Northeast Fisheries Science Center	Initiative Lead for the NEFSC, oversee research efforts and student projects, ensure management goals are met
Dave Packer	NOAA Northeast Fisheries Science Center	Steering Committee, PI for *R/V Connecticut* cruise to Gulf of Maine
Michael Rhode	Lynker (contracted to NEFSC)	Initiative Research Coordinator, annotation and analysis of visual survey data
Martha Nizinski	NOAA Fisheries Office of Science & Technology, Smithsonian Institution	Steering Committee, PI for *Bigelow/ROPOS* cruise, sample collections and management, taxonomy, analysis of visual survey data
Matt Poti	NOAA National Centers for Coastal Ocean Science	Steering Committee, species distribution modeling
Corrine Kane	NOAA Greater Atlantic Regional Fisheries Office	Steering Committee, coordinating telepresence messaging
Marianne Randall	NOAA Greater Atlantic Regional Fisheries Office	Steering Committee
LeAnn Hogan	NOAA Office of National Marine Sanctuaries	Steering Committee
Alice Stratton	NOAA Office of National Marine Sanctuaries	Steering Committee
Ashley	NOAA Ocean Exploration	Steering Committee

Marranzino		
Pace Wilber	NOAA Fisheries Southeast Regional Office	Steering Committee
Heather Coleman	NOAA Fisheries Deep Sea Coral Research & Technology Program	Steering Committee, DSCRTP liaison
Meredith Everett	NOAA Northwest Fisheries Science Center	Steering Committee, coral eDNA studies
Rhian Waller	University of Gothenburg	Coral reproduction studies
Andrea Quattrini	Smithsonian Institution	Coral genomics
Cheryl Morrison	United States Geological Survey	Coral genomics

Budget

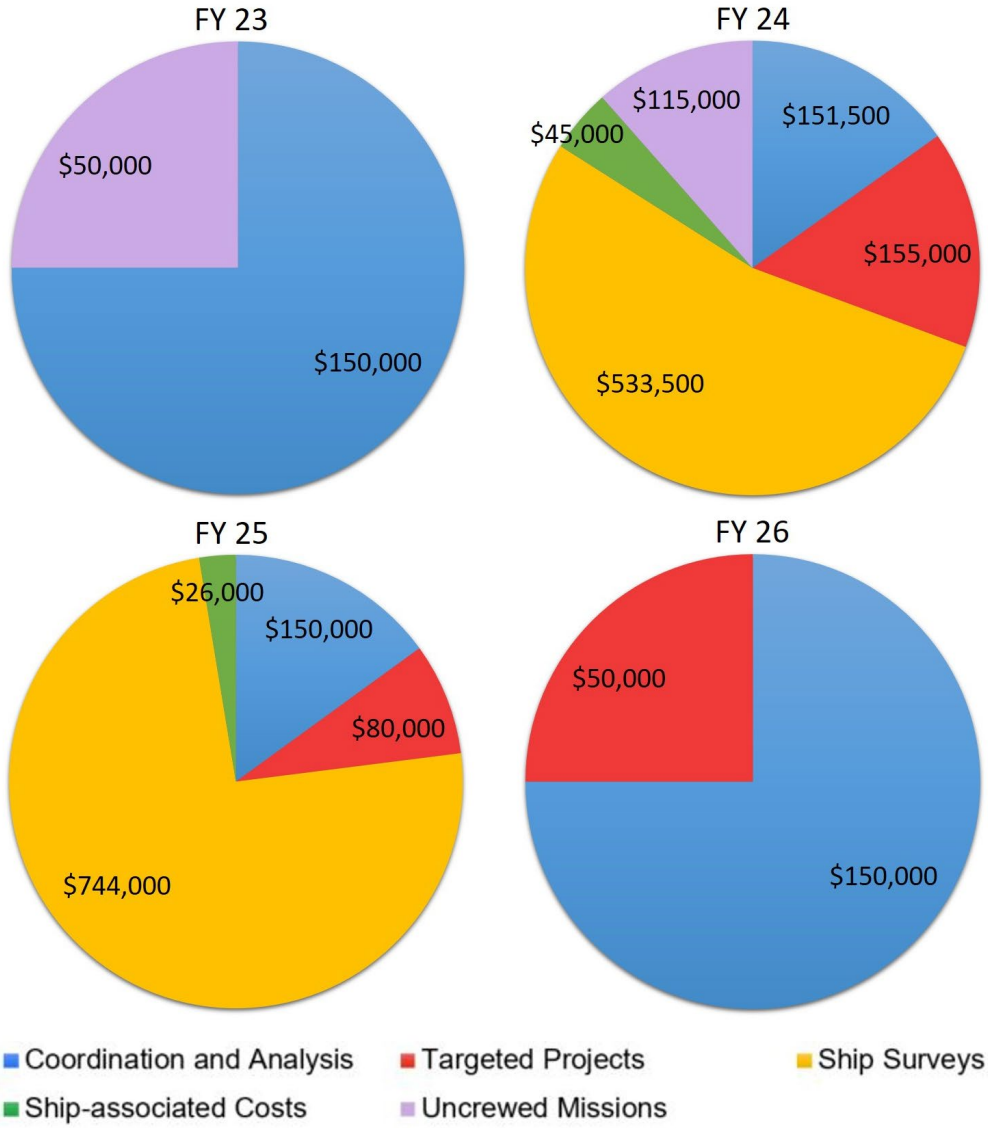

Figure 3. Breakdown of project costs for 2023 - 2026. Initiative coordination and analysis mostly pertains to personnel time, targeted projects cover small non-cruise costs such as genetic analyses, ship surveys encompass mapping and ROV surveys, ship-associated costs cover mapping and telepresence, and uncrewed missions include Saildrone and DriX mapping efforts. The FY 2024 budget is subject to change and the FY 2025-2026 budgets are estimated.

Acknowledgements

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Appendix A: Acronyms and Abbreviations

Acronym	Definition
AUV	autonomous underwater vehicle
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classification Standard
DFO	Fisheries and Oceans Canada
DSCRTP	Deep Sea Coral Research and Technology Program
DSCS	deep-sea coral and sponge
eDNA	environmental DNA
FY	fiscal year
MAFMC	Mid-Atlantic Fishery Management Council
NCCOS	National Centers for Coastal Ocean Science
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NOAA	National Oceanic and Atmospheric Administration
R/V	research vessel
ROPOS	Remotely Operated Platform for Ocean Sciences
ROV	remotely operated vehicle
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Appendix B: 2013-2015 Northeast Deep-sea Coral Initiative Publications

Auster, P.J., Kilgour, M., Packer, D., Waller, R., Auscavitch, S., and Watling, L. 2013. Octocoral gardens in the Gulf of Maine (NW Atlantic). Biodiversity 14:4: 193-194, DOI: 10.1080/14888386.2013.850446.

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