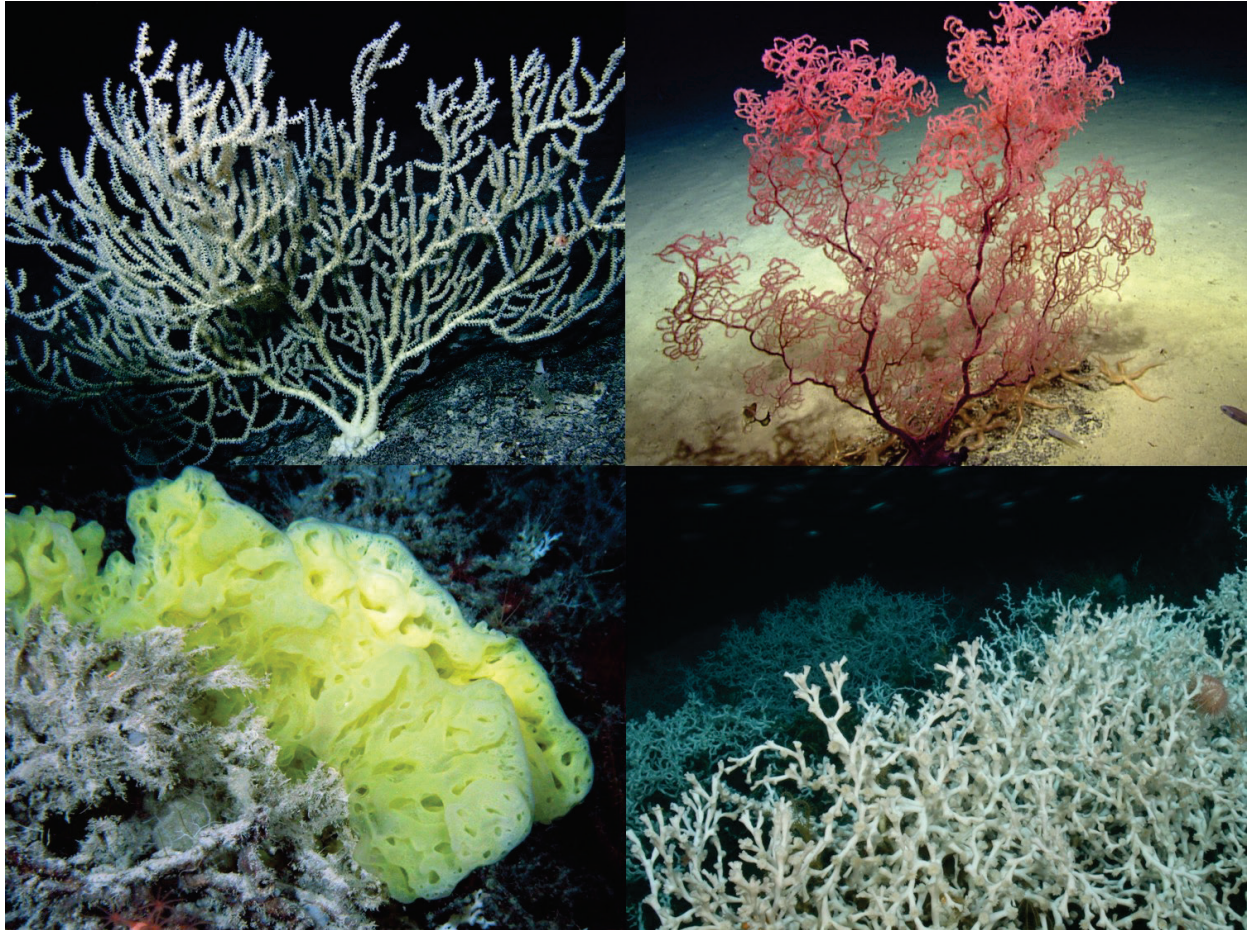


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# Science Plan for the Southeast Deep Coral Initiative (SEDICI): 2016-2019



NOAA Technical Memorandum  
NOS NCCOS 230  
March 2017

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# Science Plan for the Southeast Deep Coral Initiative (SEDCI): 2016-2019

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NOAA Technical Memorandum NOS NCCOS 230

March 2017



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Assistant Administrator

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# SCIENCE PLAN FOR THE SOUTHEAST DEEP CORAL INITIATIVE (SEDCI): 2016-2019

## **1. Introduction**

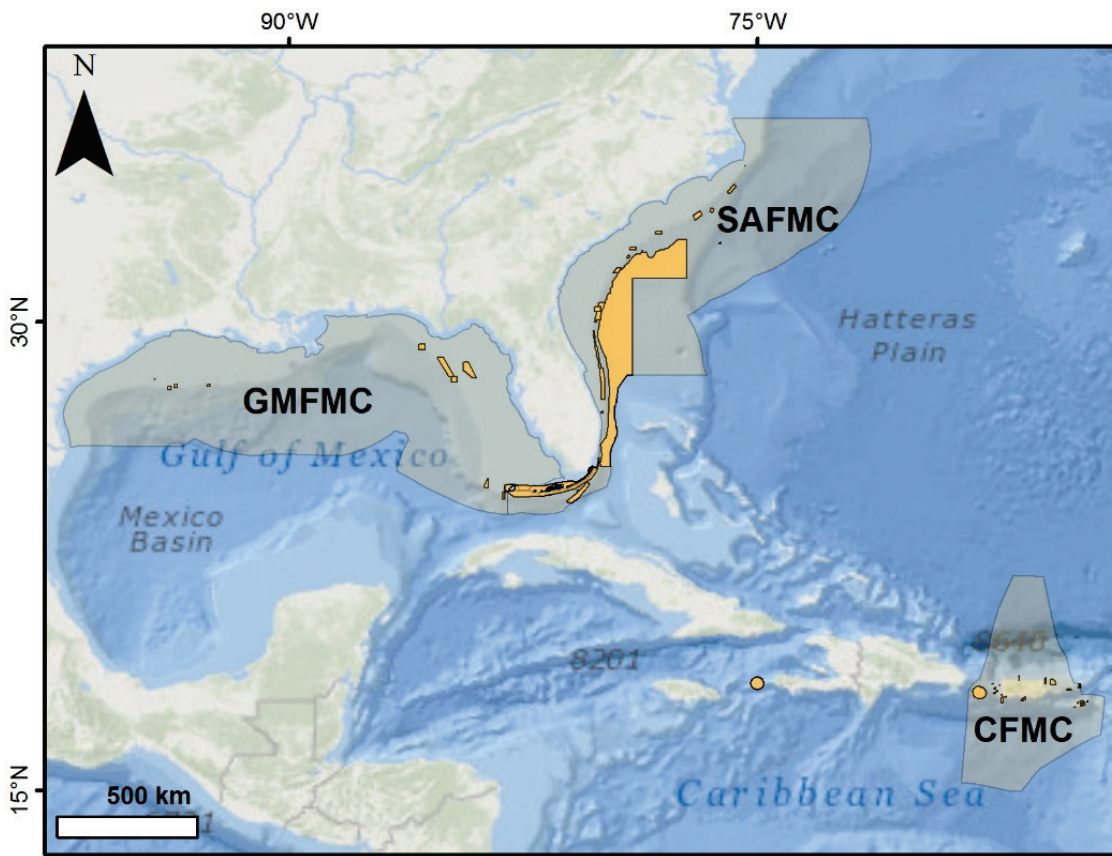
### ***1.1 NOAA DSCRTP objectives***

In 2009, the National Oceanic and Atmospheric Administration (NOAA) launched the Deep-Sea Coral Research and Technology Program (DSCRTP) following the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act. The goal of the DSCRTP is to provide scientific information needed to manage, conserve and protect deep-sea coral and sponge ecosystems throughout the United States (NOAA 2008; Hourigan 2009). The Program is guided by the NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems and aims to (1) support NOAA's role in managing fishing impacts by addressing threats to deep-sea coral ecosystems, (2) support conservation of deep-sea ecosystems in national marine sanctuaries, and (3) integrate expertise and resources across NOAA (NOAA 2010). The DSCRTP works in collaboration with fishery management councils, national marine sanctuaries, other federal agencies, and academic partners to support studies that analyze information on (1) deep-sea coral ecosystems, (2) fishing intensity in areas that impact deep-sea corals, and (3) bycatch of corals and sponges in deep-water fisheries (NOAA 2010). In addition to these studies, the DSCRTP supports multi-year fieldwork initiatives in priority regions centered on collecting new information that is relevant to the management and conservation of deep-sea coral and sponge ecosystems.

Since its inception, the DSCRTP has funded targeted fieldwork initiatives in the U.S. South Atlantic (2009-2011), the West Coast (2010-2012), Alaska (2012-2014), the Northeast (2013-2015), and the U.S. Pacific Islands (2015-2017). For clarification, deep-sea corals, also known as cold-water corals, are defined as azooxanthellate (heterotrophic) corals generally found at depths below 50 m (Cairns 2007; NOAA 2010). As a result of lacking photosynthetic zooxanthellae, deep-sea corals are found in darker and typically deeper depths than light-dependent (autotrophic) mesophotic corals. The latter are typically found at depths between 30-50 m, but may extend to depths as deep as 150 m in some locations with high water clarity (Puglise et al. 2009; Kahng et al. 2010). Thus, while mesophotic and deep-water coral ecosystems may be found at overlapping depths, they can be differentiated by whether they are dominated by corals that depend on photosynthetic zooxanthellae. In this regard, DSCRTP-funded research focuses on different coral ecosystems than those supported by other NOAA efforts, such as the NOAA Coral Reef Conservation Program (CRCP), which focuses on shallow-water coral reefs (<30 m), or research efforts on mesophotic coral ecosystems supported by various NOAA offices including the National Centers for Coastal Ocean Science (NCCOS), the Office of National Marine Sanctuaries (ONMS) and the National Marine Fisheries Service (NMFS).

## 1.2 Southeast Deep Coral Initiative (SEDCI)

In 2016, the DSCRTP began a four-year research initiative in the Southeast Region, an area including the federal waters of the U.S. South Atlantic, the Caribbean Sea and the Gulf of Mexico (Figure 1). This area corresponds to the cumulative extent of the jurisdictions of three fishery management councils, including the Caribbean Fishery Management Council (CFMC), the Gulf of Mexico Fishery Management Council (GMFMC), and the South Atlantic Fishery Management Council (SAFMC). As a first step towards launching this new research initiative, the DSCRTP and the Southeast Fisheries Science Center conducted a science priorities scoping workshop in St. Petersburg, Florida in November 2015. This workshop brought together experts from NOAA, fishery management councils, the Bureau of Ocean and Energy Management (BOEM), the U.S. Geological Survey (USGS), academic institutions and others to prioritize potential research activities on deep-sea coral and sponge ecosystems in the Southeast Region. Discussions at the workshop led to the publication of a workshop report, which outlined priority (1) management issues, (2) geographic areas, and (3) research questions relating to deep-sea coral ecosystems in each of the three geographic regions that the Southeast Deep Coral Initiative (SEDCI) will operate in 2016-2019 (Schull et al. 2016). The most important management issues, research questions and generalized study areas identified during the workshop are listed for each geographic region in sections 2-4 below.



**Figure 1.** Map showing the three geographic regions in which the Southeast Deep Coral Initiative will operate in 2016-2019. The area corresponds to the jurisdiction of three fishery management councils, shown in gray. Areas where deep-sea coral and sponge ecosystems are protected through fishing restrictions are shown in orange.

The workshop laid the foundation for the development of a NOAA science team that will oversee the activities of the SEDCI. In September 2016, the science team met in Charleston, South Carolina to refine priorities of the initiative (Appendix A), and build the framework for a science plan. Following the meeting, the science team held bi-monthly conference calls and completed two surveys (Appendices B-C) to develop further content for the plan. The purpose of this science plan is to outline a general strategy for the execution and completion of the most important research activities conducted under the SEDCI. While we acknowledge that this science plan is a living document, and that some of its details will inevitably change throughout the initiative, the plan outlines the general approach and activities that will be conducted in each of the three geographic regions. As in previous DSCRTP initiatives in other regions (see above), activities supported by the 2016-2019 SEDCI will consist of (1) research expeditions that will survey, sample and map deep-sea coral and sponge ecosystems throughout the Southeast Region, and (2) research projects (or small projects in the parlance of the DSCRTP) focused on data or sample analyses, and producing products that will support the goals of SEDCI and DSCRTP.

## **2. U.S. Caribbean Region**

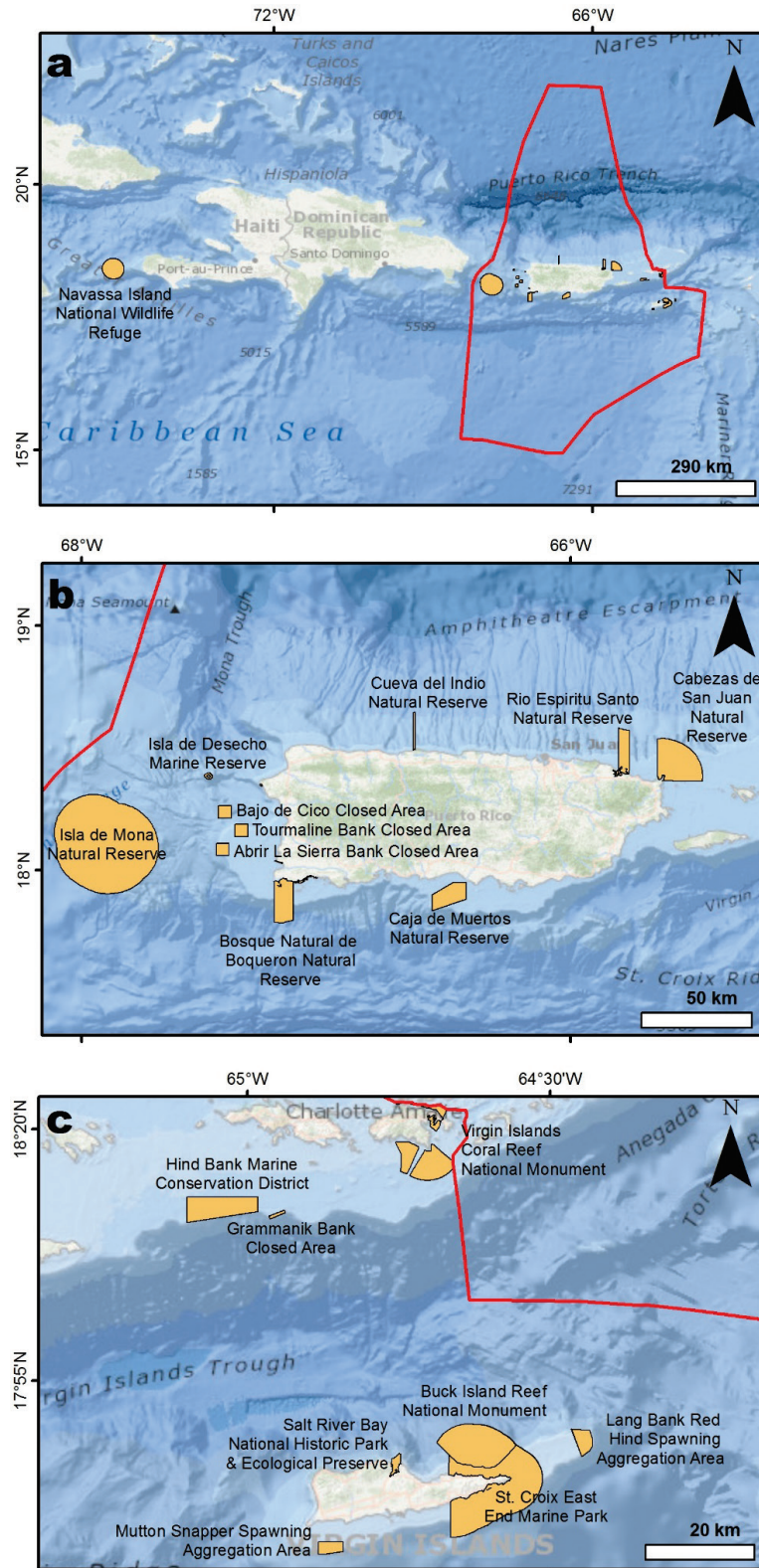
### ***2.1 Geographic setting***

The jurisdiction of the CFMC includes the U.S. federal waters around Puerto Rico and the U.S. Virgin Islands (Figure 2). It extends from nine nautical miles offshore of the islands in the Commonwealth of Puerto Rico and three nautical miles offshore of the islands in the Territory of the U.S. Virgin Islands, to the boundary of the U.S. exclusive economic zone (EEZ). The U.S. Caribbean Region is bounded by international waters to the north of Puerto Rico, by Venezuela to the south, by the British Virgin Islands to the east, and by the Dominican Republic to the west. The territorial jurisdiction of the U.S. Caribbean also includes the waters offshore of the uninhabited island of Navassa, which is located 30 nautical miles west of Haiti and managed by the U.S. Fish and Wildlife Service (Figure 2).

### ***2.2 Past research***

There have been several recent efforts to survey deep-sea habitats in the U.S. Caribbean. However, only few of these surveys have been annotated for deep-water corals and sponges, highlighting the need for data rescue. This is particularly relevant for ROV surveys at depths shallower than 300 m, which have been supported by NCCOS since 2004, and resulted in 384 dives to date using the ROV *Phantom S2* and the ROV *Mohawk 18*. However, the majority of these dives have been limited to depths shallower than 100 m, and only 84 of these occurred at depths deeper than 150 m. Surveys in waters deeper than 300 m are far more scarce, and include surveys led by the Harbor Branch Oceanographic Institute (HBOI) using the human occupied vehicles (HOV) *Johnson Sea-Link I* and *II* in 1989-1996 (25 dives; J. Reed pers. comm.), the E/V *Nautilus* ROV *Hercules* in 2013 (seven dives; Ten Brink et al. 2014), and the NOAA Ship *Okeanos Explorer* ROV *Deep Discoverer* in 2015 (12 dives; Kennedy et al. 2015).





**Figure 2.** U.S. Caribbean exclusive economic zone (EEZ; red line), showing areas where deep-sea coral and sponge ecosystems are protected through fishing restrictions (orange polygons) in **a.** U.S. waters, **b.** around Puerto Rico, and **c.** the U.S. Virgin Islands.

### ***2.3 Threats***

Many of the threats faced by deep-sea coral ecosystems in other parts of the country, such as bottom trawling and oil and gas exploration, do not occur in the U.S. Caribbean (Lutz & Ginsburg 2007; Rooper et al. 2016). Thus, threats to deep-sea corals in the U.S. Caribbean are minimal in comparison to those of the Gulf of Mexico and South Atlantic, where bottom-contact fishing gears are used (see below). The main concern relating to deep-water corals in the U.S. Caribbean are potential impacts from the deep-water snapper fishery, which operates using bottom longlines and targets fish that inhabit 100-500 m depths (García-Sais 2005; Heileman 2011). Exactly how much these fisheries impact deep-sea coral ecosystems in the U.S. Caribbean is unknown, but there is concern given that some deep-water snappers are found in similar depths and environments as deep-sea corals (García-Sais 2005; Heileman 2011; Schull et al. 2016). Cable laying is an additional concern relating to deep-water corals in the U.S. Caribbean, given that the region is a major hub for submarine cables connecting the continental United States and South America (Jayewardene & Carrubba 2016).

### ***2.4 Management priorities***

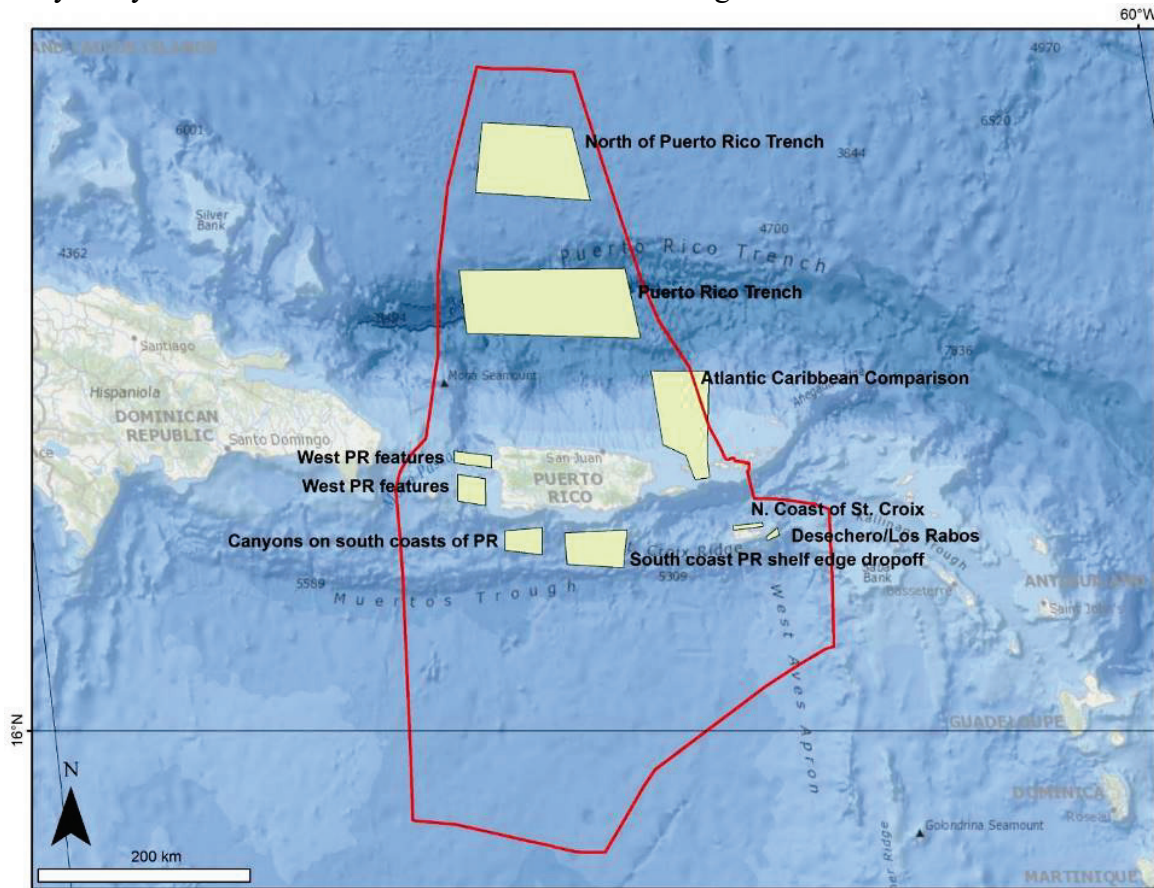
There are no national marine sanctuaries in the U.S. Caribbean, but several marine protected areas (MPAs) managed by different federal and territorial agencies protect deep-water coral ecosystems in the region. These include several no-take MPAs, the largest of which are the Navassa Islands National Wildlife Refuge managed by the U.S. Fish and Wildlife Service, the Buck Island Reef National Monument managed by the National Park Service, and the Hind Bank Marine Conservation District managed by the NOAA National Marine Fisheries Service (Figure 2). Currently, there are no proposals to establish new deep-sea MPAs in the U.S. Caribbean or expand existing ones. In this regard, most of the management priorities relating to deep-sea corals are centered on collaborating with commercial fishers to identify locations where deep-sea coral ecosystems exist, as well as understanding potential impacts from the deep-sea snapper fishery and cable laying activities.

### ***2.5 Research priorities***

Given the abundance of ROV dives that have not yet been annotated for deep-water corals and sponges, one of the main research priorities for the U.S. Caribbean is analyzing existing video data. Additionally, there is a need to survey areas that have not been previously surveyed in order to gain a basic understanding of the species identity, geographic location and potential anthropogenic impacts to deep-water coral and sponge ecosystems (Schull et al. 2016). The most important research questions in the U.S. Caribbean identified during the 2015 science priorities workshop (Schull et al. 2016) were:

- Where are deep-sea coral and sponge ecosystems located?
- Do deep-sea coral ecosystems exist in areas that are fished for deep-water snappers?
- What are the most significant anthropogenic impacts to deep-sea coral and sponge ecosystems, particularly at mesophotic depths?

In addition to prioritizing research questions, participants of the science priorities workshop also identified study areas that should be prioritized for future deep-sea coral research in each region. Priority study sites for the U.S. Caribbean are shown in Figure 3 below.



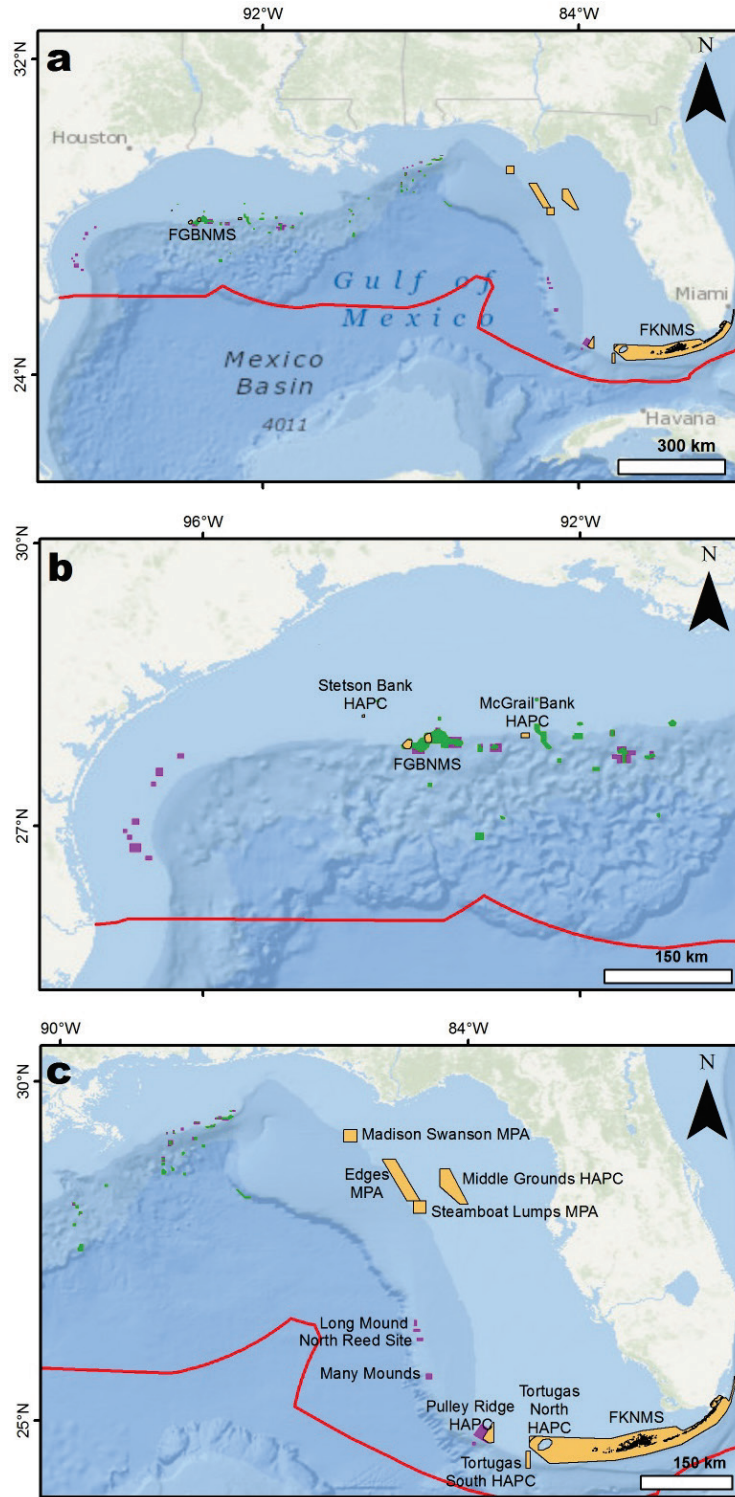
**Figure 3.** Map showing general areas that should be prioritized for future research (yellow polygons) in the U.S. Caribbean, as identified by participants of the 2015 science priorities workshop. The U.S. EEZ is shown in red.

### **3. U.S. Gulf of Mexico Region**

#### ***3.1 Geographic setting***

The jurisdiction of the GMFMC includes the U.S. federal waters in the Gulf of Mexico between Texas and the westernmost extension of the Florida Straits (Figure 4). It extends from the edge of state waters, located nine nautical miles offshore of the coasts of Louisiana, Mississippi, Alabama, Texas and West Florida, to the boundary of the U.S. EEZ. The region is bounded by Mexico in most of the western part of the Gulf, and by Cuba for most of the eastern section of the Gulf. The U.S. Gulf of Mexico is also bounded by two sections of international waters located in the central part of the basin.





**Figure 4.** U.S. Gulf of Mexico EEZ (red line) showing areas where deep-sea coral ecosystems are protected through fishing restrictions (orange polygons) in **a.** the entire U.S. Gulf of Mexico, **b.** the western, and **c.** the eastern section of the region. These include the Flower Garden Banks National Marine Sanctuary (FGBNMS) and the Florida Keys National Marine Sanctuary (FKNMS). Areas proposed as expansion alternatives for the FGBNMS are shown in green, and proposed habitat areas of particular concern (HAPC) in purple.

### 3.2 Past research

Deep-water ecosystems in the Gulf of Mexico have been the focus of several recent research efforts, in addition to long-term fisheries monitoring. Since 2007, at least 52 research expeditions have taken place in the region, including surveys targeting the deep-water continental slope, mesophotic reef habitats on the continental shelf, and surveys performed in response to the *Deepwater Horizon* oil spill (reviewed by Boland et al. 2016). These studies were multi-year investigations that focused primarily on the ecology of *Lophelia pertusa* and its associated species (Cordes et al. 2008; Lessard-Pilon et al. 2010). While these recent efforts have greatly increased our understanding of deep-water ecosystems in the Northwestern Gulf of Mexico, several areas within the Gulf remain relatively unexplored, such as extensive areas on the West Florida Shelf, where ROV observations, mapping data and habitat suitability models predict widespread occurrence of deep-sea coral communities (Kinlan et al. 2013; Boland et al. 2016).

### 3.3 Threats

Deep-water coral and sponge ecosystems in the Gulf of Mexico face a variety of anthropogenic threats, and are among the least protected in the country (Boland et al. 2016; Rooper et al. 2016). In contrast to most of the rest of the United States, oil and gas development is extensive in the Gulf of Mexico, particularly in the western part, where the seafloor has been heavily altered through the construction of pipelines and platforms (Brooke & Schroeder 2007). While these artificial structures can provide habitat for deep-water benthic species like corals, their installation can impact deep-water fauna, and oil spills remain a looming threat. The *Deepwater Horizon* oil spill in 2010 impacted marine ecosystems in the Northern Gulf of Mexico, including some documented impacts on corals at depths below 50 m (Silva et al. 2015; Etnoyer et al. 2016), and as deep as 1,800 m (White et al. 2012; Fisher et al. 2014). In addition to oil and gas development, fishing with bottom-contact gear is a major threat to the benthic fauna of the region. Less than 1% of the U.S. EEZ in the Gulf of Mexico is currently protected from bottom-contact fishing gear, less than any other region in the United States (Rooper et al. 2016).

### 3.4 Management priorities

There are two national marine sanctuaries in the U.S. Gulf of Mexico, the Flower Garden Banks National Marine Sanctuary (FGBNMS) and the Florida Keys National Marine Sanctuary (FKNMS). While the largest portion of these sanctuaries lies in shallow waters (<50 m), both contain deeper areas (>50 m) where deep-sea coral and sponge communities occur. Additionally, the U.S. Gulf of Mexico contains several habitat areas of particular concern (HAPC) where deep-sea coral and sponge ecosystems are protected through fishing restrictions (Figure 4). The most pressing management priorities relating to deep-water corals in the Gulf of Mexico are obtaining information to evaluate current proposals to (1) expand the FGBNMS, and (2) create new deep-water HAPCs in the Gulf (Figure 4). In June 2016, the FGBNMS released a draft environmental impact statement, which presents five alternatives for sanctuary expansion (ONMS 2016). The preferred alternative 3 would add 15 banks to the FGBNMS, all of which have extensive areas below 50 m, and would increase the size of FGBNMS from 145.58 km<sup>2</sup> to 992.46 km<sup>2</sup> (ONMS



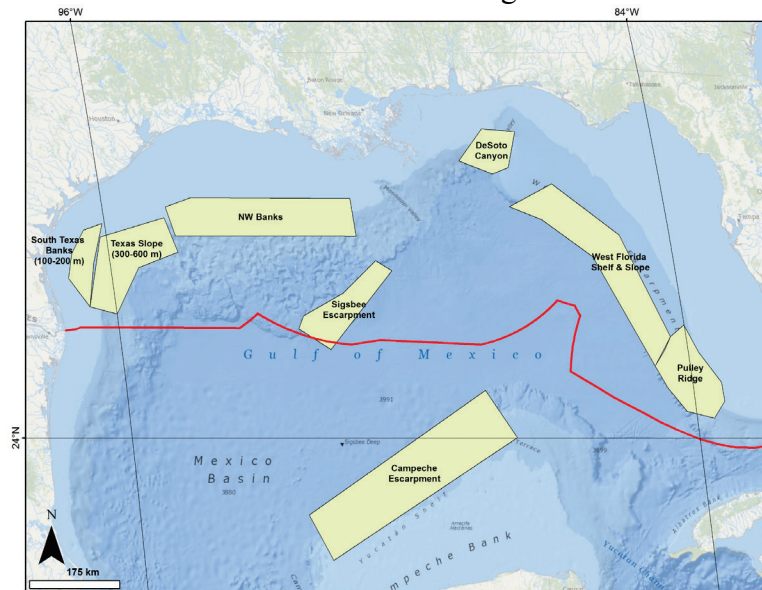
2016). Expansion alternatives 4 and 5 include several additional deep-sea banks, many of which lie in waters deeper than 300 m (ONMS 2016). Obtaining baseline information on these features is urgently needed in order to evaluate the various FGBNMS expansion proposals (ONMS 2016). Additionally, the GMFMC is currently evaluating multiple proposals to create new deep-water HAPCs in the Gulf of Mexico, particularly on the West Florida Shelf (Figure 4), and has requested more information to support their establishment (GMFMC 2013; Fisheries Leadership & Sustainability Forum 2015). Finally, information on deep-water habitats in the region also has management relevance to BOEM for potential inclusion into oil and gas protective measures.

### 3.5 Research priorities

Priority research questions identified for the U.S. Gulf of Mexico during the 2015 science priorities workshop (Schull et al. 2016) were:

- What is the extent of the distribution of deep-sea coral and sponge ecosystems?
- What interactions (past, present and future) occur between fishing gear (e.g., golden crab, red crab, royal red shrimp, wreckfish and barrelfish) and deep-sea coral ecosystems?
- What buffer distances should be implemented between deep-sea coral and sponge ecosystems and human activities?
- What sites could serve as sentinel sites to better understand the effects of climate change?
- Which seafloor features in the Northern Gulf of Mexico are in need of mapping, ground truthing and characterization? How accurate are existing habitat suitability models?
- What drives community differences between low-relief vs. high-relief habitats?
- What is the connectivity between coral ecosystems at different depths?

Priority study sites in the Gulf of Mexico are shown in Figure 5.



**Figure 5.** Map showing general areas that should be prioritized for future research (yellow polygons) in the Gulf of Mexico, as identified by participants of the science priorities workshop. The U.S. EEZ is shown in red. Note that the Campeche Escarpment located outside the U.S. EEZ was identified as a priority because it is mostly unexplored, has high habitat suitability for deep-sea corals, and is an important area for genetic connectivity studies.

## **4. U.S. South Atlantic Region**

### ***4.1 Geographic setting***

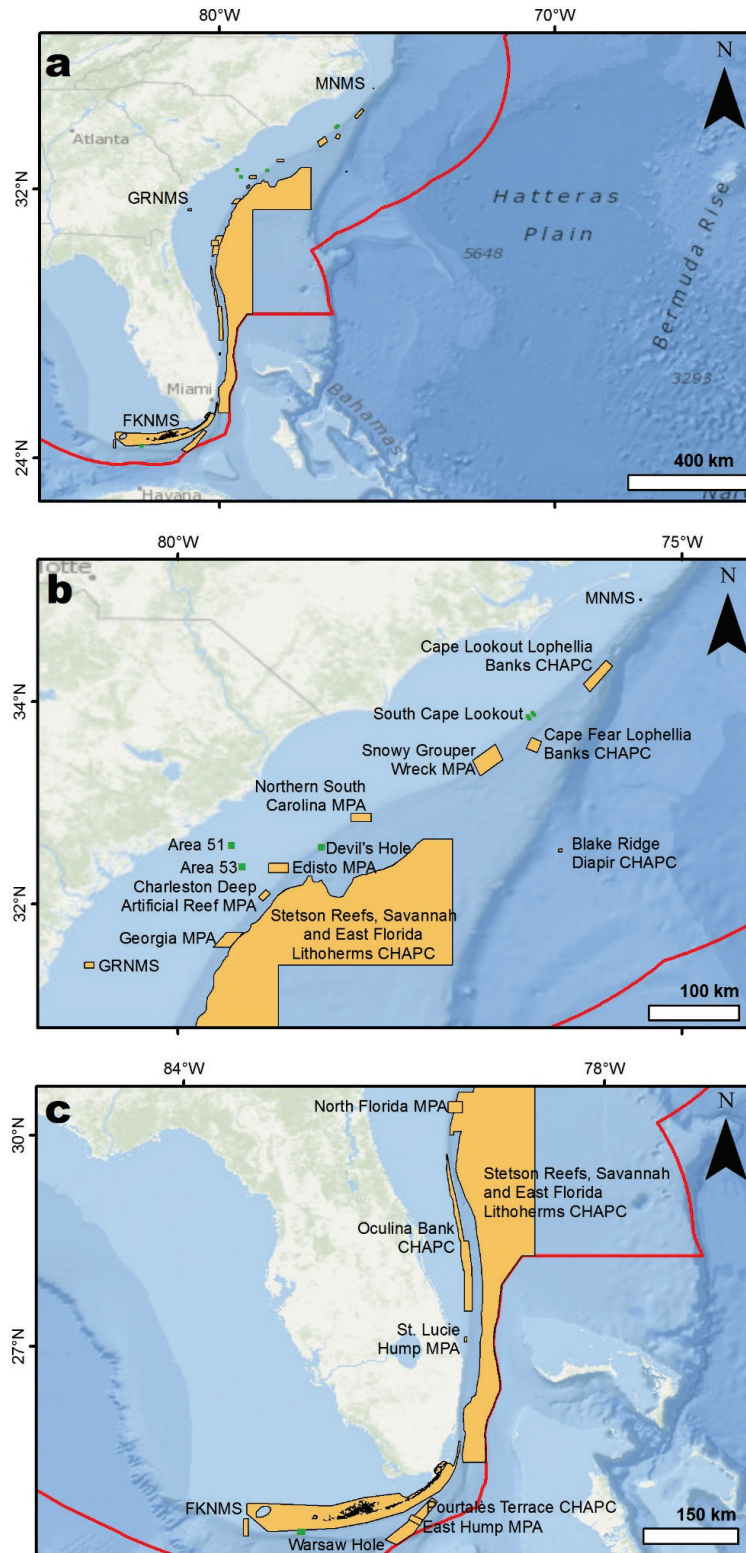
The jurisdiction of the SAFMC includes the U.S. federal waters off the southeastern coast of the United States between the northern border of North Carolina to the southwestern extension of the Florida Straits (Figure 6). It extends from three nautical miles offshore of the coasts of North Carolina, South Carolina, Georgia and Florida, to the boundary of the U.S. EEZ. Between North Carolina and Georgia, it is bounded by international waters. Off southeastern Florida, the region is bounded by the Bahamas, and off southern Florida by Cuba.

### ***4.2 Past research***

The U.S. South Atlantic contains the most extensive documented *Lophelia pertusa* and *Oculina varicosa* deep-sea coral ecosystems in the country (Hain & Corcoran 2004; Ross & Nizinski 2007), and have been the focus of several previous fieldwork efforts. These include work supported by HBOI and the NOAA National Undersea Research Program dating back to the 1980s (Reed et al. 2013), the NOAA Office of Ocean Exploration (OER) since 2001 (Partyka et al. 2007), and the first regional fieldwork initiative supported by the DSCRTP in 2009-2011. These previous efforts have greatly increased our understanding of deep-water coral and sponge ecosystems in the U.S. South Atlantic, as well as informed the implementation of HAPCs and other protection measures in the region (see Reed et al. 2013). However, given the large extent of deep-sea coral ecosystems in the U.S. South Atlantic (Hain & Corcoran 2004), many areas still remain unexplored. Nevertheless, previous fieldwork efforts created a great wealth of baseline information in the U.S. South Atlantic, on which the SEDCI will build its research activities.

### ***4.3 Threats***

The main threat to deep-sea coral ecosystems in the region is bottom trawling (Ross & Nizinski 2007; Reed et al. 2007; Reed et al. 2013). Although large areas in the U.S. South Atlantic are protected from bottom-contact fishing gear, including the largest deep-water HAPC in the country (Figure 6), cumulatively only 12% of the seafloor in this region is protected from bottom trawling (Rooper et al. 2016). Oil and gas exploration, as well as cable laying may represent additional threats in the future (Reed et al. 2013). Since 1984, a moratorium on oil and gas development has prevented impacts from these activities in the region (Ross & Nizinski 2007; Reed et al. 2013). However, in 2010 the U.S. government announced its intention to open the South Atlantic and Mid-Atlantic planning areas to oil and gas exploration. While these plans were cancelled after the 2010 *Deepwater Horizon* oil spill, if the moratorium is lifted, oil and gas development may represent an additional threat to deep-sea coral ecosystems in the region.



**Figure 6.** U.S. South Atlantic EEZ (red line), showing the Grays Reef and Monitor National Marine Sanctuaries (GRNMS, MNMS) and areas where deep-sea coral and sponge ecosystems are protected (orange polygons) in **a.** the entire U.S. South Atlantic, **b.** the northern, and **c.** the southern section of the region. Proposed special management zones (SMZ) for the deep-water grouper and snappers are shown in green.

#### 4.4 Management priorities

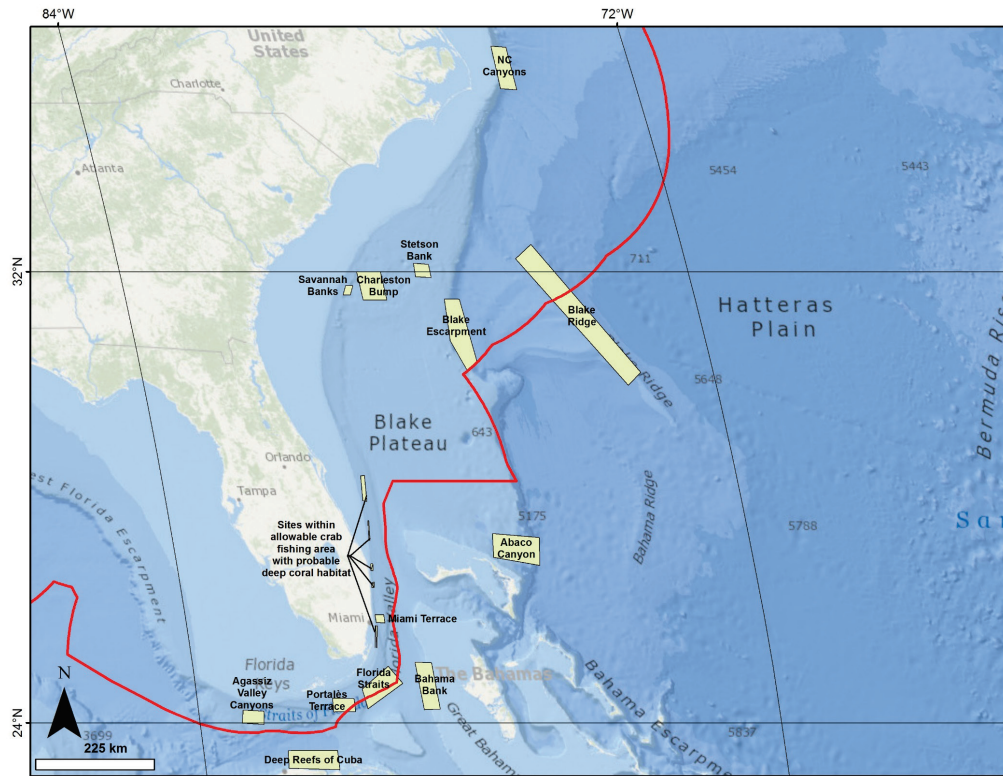
There are three national marine sanctuaries in the U.S. South Atlantic, the Monitor Marine National Sanctuary (MNMS), the Grays Reef National Marine Sanctuary (GRNMS) and the Florida Keys National Marine Sanctuary (FKNMS). MNMS protects the wreck of the civil war ship *Monitor* that lies at a depth of 67 m, and is overgrown by small amounts of corals and sponges (ONMS 2013). GRNMS protects a coral reef that lies in waters shallower than 24 m, and therefore does not contain deep-sea coral habitat. In contrast, FKNMS contains areas towards its southwestern extension with depths approaching 580 m, which lie within the depth range of deep-water coral and sponge ecosystems. In addition to these sanctuaries, the region contains eight MPAs, the *Oculina* Bank HAPC and five deep-water coral HAPC, where deep-sea coral and sponge ecosystems are protected from most bottom-contact fishing gear (Figure 6). Furthermore, the SAFMC is currently evaluating proposals to create five special management zones (SMZ) to protect spawning sites for snappers and groupers (NOAA 2016). Two of these proposed SMZs are artificial reefs at depths shallower than 35 m, whereas the other three are all natural reefs located at depths deeper than 50 m, and thus potential habitats for deep-water corals and sponges (Figure 6). The SAFMC currently requires more information to support the establishment of these SMZs (NOAA 2016). Additional management priorities are centered on mapping and characterizing areas where deep-water coral ecosystems exist throughout the region, as well as understanding the extent of fishing efforts in these areas (SAFMC 2008).

#### 4.5 Research priorities

Previous deep-sea research campaigns have generated a great amount of baseline information in the U.S. South Atlantic (Partyka et al. 2007; Reed et al. 2013). As a result, many basic research questions, such as what species are present in the region, have been addressed to some extent. Nevertheless, the U.S. South Atlantic contains the most extensive *Lophelia pertusa* and *Oculina varicosa* ecosystems in the country (Hain & Corcoran 2004), many of which remain completely unexplored. Priority research questions identified for the U.S. South Atlantic during the science priorities workshop (Schull et al. 2016) were:

- What drives community structure differences between sites?
- How are populations connected and what factors shape genetic connectivity?
- How do communities differ inside and outside of marine protected areas?
- Does upwelling and variability in other ocean conditions impact communities?
- What topographic features are associated with deep-sea coral communities?
- What interactions (past, present and future) occur between fishing gear (e.g., golden crab, rock shrimp, royal red shrimp and wreckfish) and deep-sea coral and sponge ecosystems?
- How accurate are deep-sea coral habitat suitability models, particularly for structure-forming taxa?

Priority study sites in the U.S. South Atlantic identified during the science priorities workshop are shown in Figure 7.



**Figure 7.** Map showing general areas that should be prioritized for future research (yellow polygons) in the U.S. South Atlantic, as identified by participants of the science priorities workshop. The U.S. EEZ is shown in red. Note that several areas located outside the U.S. EEZ were prioritized due to their importance for studies on connectivity, climate change and fishing impacts (see Schull et al. 2016).

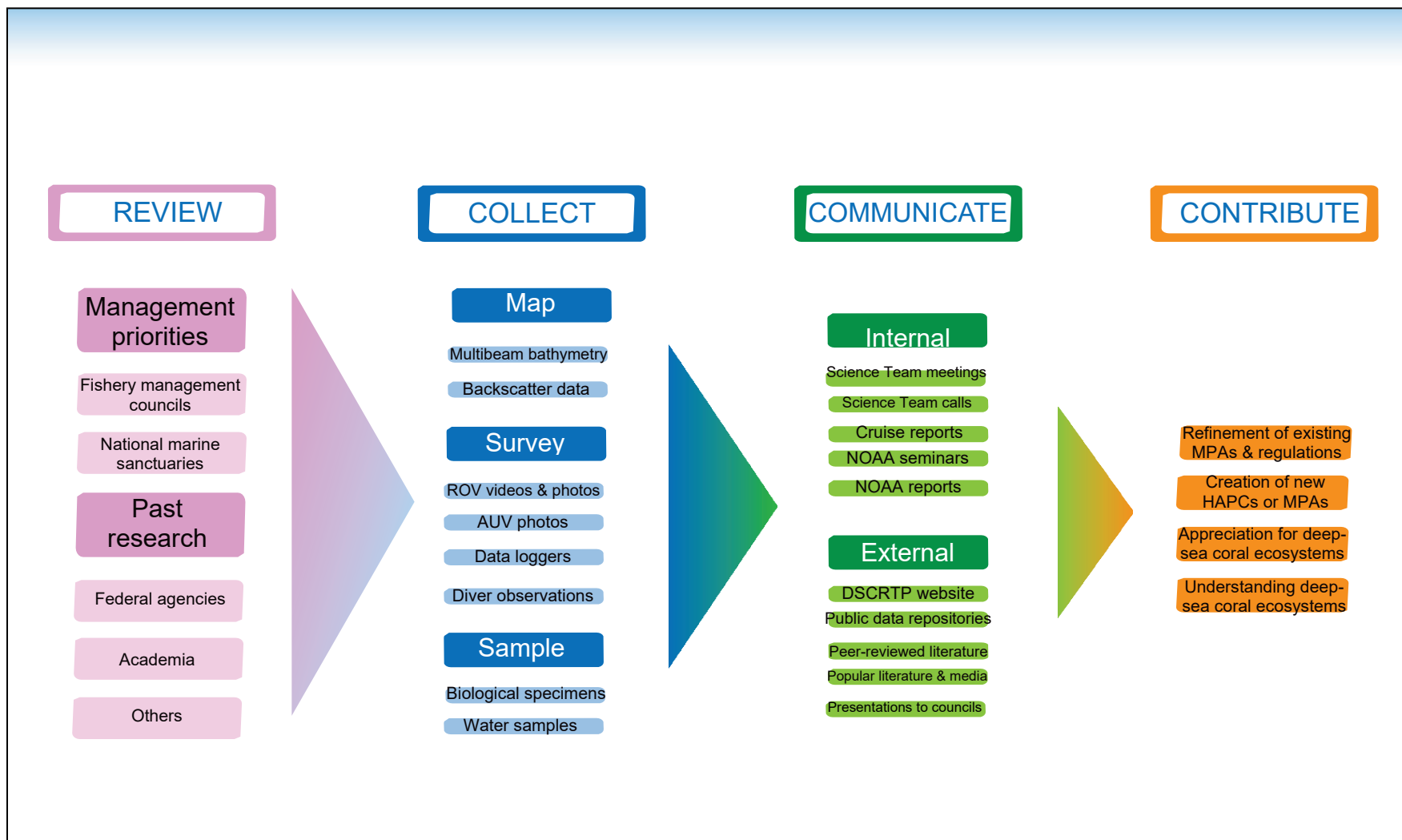
## 5. Objective

The objective of the SEDCI is to obtain scientific information that will further the management, conservation and protection of deep-water coral and sponge ecosystems throughout the Southeast Region. Specifically, the initiative will strive to collect information that is most urgently needed by the agencies that manage deep-sea coral ecosystems throughout the region, particularly the fishery management councils and national marine sanctuaries. Furthermore, the initiative will focus its efforts on addressing the priority research questions outlined in the science priorities workshop report (Schull et al. 2016).

### 5.1 Approach

In order to meet its objective, the SEDCI will need to first *review* past research efforts, as well as consult with fishery management councils and national marine sanctuaries in order to identify management priorities relating to deep-sea coral and sponge ecosystems throughout the Southeast Region (Figure 8). A large portion of this was accomplished as part of the science priorities workshop in November 2015 (Schull et al. 2016). However, fishery management councils and national marine sanctuaries will be consulted regularly throughout the initiative in





**Figure 8.** Diagram of the general approach of the Southeast Deep Coral Initiative: 2016-2019.

order to obtain up to date information on what data is needed to support management efforts. Additionally, the SEDCI will strive to thoroughly review past research efforts in order to design field surveys that build on as opposed to duplicate past research.

After reviewing past research and management priorities, the initiative will *collect* information, which will consist of mapping, surveying and sampling deep-water habitats (Figure 8). However, we realize that the collection of data by itself is not sufficient, and that we will need to effectively *communicate* that information both internally and externally. Only then can the SEDCI *contribute* to the management, conservation and protection of deep-sea coral and sponge ecosystems (Figure 8). The effective communication will include the synthesis of datasets into products that are accessible both internally within NOAA, as well as more broadly to external partners. Only through this directed approach will the initiative have the ability to provide a real contribution to the management, conservation and protection of deep-sea coral and sponge ecosystems throughout the Southeast Region. Examples of improved management include the refinement of management strategies, which will ultimately require the increased appreciation for the value of deep-sea coral and sponge ecosystems by diverse stakeholders.

## 5.2 Criteria for prioritizing projects

Given limitations in budget and time, the SEDCI will need to carefully prioritize projects that will be supported. These projects should (1) be relevant to the management of deep-sea coral and sponge ecosystems in the Southeast Region, (2) address the priority research questions identified during the 2015 science priorities workshop (Schull et al. 2016), and (3) be achievable within the budget and time limitations of the initiative (Figure 9). Only those projects meeting all of those criteria should be supported. Furthermore, these three criteria should be used to rank potential projects. The highest priority projects will be those identified as the most easily achievable with the available resources, have the highest relevance to management, and address most of the priority research questions (Figure 9).



**Figure 9.** Diagram of criteria used to evaluate potential projects to be supported by the Southeast Deep Coral Initiative. Given resource limitations, those projects meeting all criteria (orange area) will be prioritized.

## **6. Work plan of activities that will be supported by the SEDCI**

Similar to previous DSCRTP initiatives in other regions, activities supported by the SEDCI will consist of (1) research expeditions which will survey, sample and map deep-sea coral and sponge ecosystems, and (2) research projects focused on analyzing data or samples. Both of these activities will include the development of products, which are the focus of section 7. Research expeditions that will be supported by the SEDCI are outlined in section 6.1 and summarized in Table 1. Research projects are described in section 6.2 and summarized in Table 2.

### ***6.1 Research expeditions***

Research expeditions will map deep-sea habitats, and collect quantitative video or photo data in order to characterize deep-sea coral and sponge communities. Specifically, research expeditions will collect data on the diversity, abundance, extent and health of deep-sea coral communities using visual surveys. A detailed description of generalized methods used to characterize deep-sea coral communities using ROVs is presented in Appendix D.

Additionally, SEDCI research expeditions will collect data on fishing impacts on deep-water coral and sponge ecosystems. For this purpose, wherever possible field surveys will be performed in both areas that are protected from bottom-contact fishing gear, and in areas that are exposed to fishing. The data will be used to characterize deep-sea coral habitat (*sensu* Yoklavich et al. 2011; Etnoyer et al. 2014), and to ground truth existing habitat suitability models (e.g., Kinlan et al. 2013).

Images and other data (environmental, navigation and mapping) will be archived at the NOAA National Centers for Environmental Information (NCEI). Observations of corals and sponges will be archived and distributed through NOAA's National Database of Deep-Sea Corals and Sponges. It is important to point out, however, that not every single coral or sponge recorded during SEDCI research expeditions will necessarily be archived in the National Database of Deep-Sea Corals and Sponges. Instead, SEDCI efforts will focus on submitting corals and sponge recorded during transects or on still images to the database (see Appendix D).

Observations of fishes will be included in DSCRTP site characterization reports (see below), including any visual records of invasive lionfish, which have been recorded to depths of 300 m, and are of interest to management throughout the Southeast Region (Johnston et al. 2015; Gittings et al. 2017). We will strive to conduct data analyses while at sea or immediately following research expeditions, and complete these no later than one year following an expedition. The majority of expeditions will be conducted in 2016-2018, so that the efforts in the last year can focus on summarizing results of all research activities and writing the final report.

#### **6.1.1 - 2016 Expedition to North Carolina Canyons**

On August 24-September 7, 2016 OER, the Northeast Fisheries Science Center (NEFSC), and SEDCI provided support for a 15-day expedition aboard the NOAA Ship *Pisces*. Led by Martha Nizinski, the expedition surveyed deep-water canyons off North Carolina using the autonomous

underwater vehicle (AUV) *Sentry* operated by the Woods Hole Oceanographic Institute (WHOI). The SEDCI supported the expedition by providing funds in support of contracts for the AUV *Sentry* and data analysis. Three AUV dives were conducted during the expedition, one in Pamlico Canyon and two in Hatteras Canyon, for a total bottom time of 51.7 h and a linear distance surveyed of 70.92 km. Close to 59,000 still images were collected during the expedition, which will be processed by Mike Rhode (ECS Federal, LLC) to quantify the benthic fauna. In addition to AUV surveys, the expedition included the collection of multibeam and backscatter data, CTDs and four monocoore samples, the latter of which will be processed by Amanda Demopoulos (USGS).

#### 6.1.2 - 2016 Expedition to Northwestern Gulf of Mexico

On September 4-8, 2016 the SEDCI supported a five-day expedition aboard the R/V *Manta*. Led by Emma Hickerson, the expedition surveyed banks in the Northwestern Gulf of Mexico using the ROV *Mohawk* operated by the UNCW-UVP. Funds provided by the SEDCI paid for five days of ship time of the R/V *Manta*, which leveraged five days of ROV operations at no additional cost to the project. During the expedition, 28 ROV dives were completed to depths between 61-192 m. These dives targeted seven different banks around FGBNMS (Parker, Bryant, Bouma, Rezak, Sidner, Tressler and Elvers) and focused on collecting information to characterize the Northwestern Gulf of Mexico, including sites within proposed expansion of the FGBNMS (ONMS 2016). Over 2,800 still images were collected, which will be processed by Travis Sterne (FGBNMS) to quantify the benthic fauna on the banks. Additionally, 16 black corals and two octocoral samples were collected during the expedition. Mercer Brugler at the City University of New York (CUNY) will process the black coral samples for taxonomic and phylogenetic analyses in collaboration with Dennis Opresko at the National Museum of Natural History, Smithsonian Institution. David Hicks at the University of Texas at Rio Grande Valley (UTRGV) will process the octocoral samples for genetic analyses.

#### 6.1.3 - 2017 Expedition to U.S. Caribbean

In 2017, the NOAA Ship *Nancy Foster* was scheduled to conduct a 12-day expedition to the U.S. Caribbean led by Tim Battista. The expedition was originally scheduled for March 29-April 9, 2017. However, the expedition had to be postponed indefinitely due to engine problems with the ship, and it is currently unknown whether the expedition can be rescheduled in 2017. If the expedition does occur, it will focus on collecting multibeam bathymetry and backscatter data in order to create habitat characterization maps for the region. Additionally, limited ROV surveys will be conducted in select areas in order to ground truth habitat characterization maps derived from the mapping data. The ROV *Phantom S2* (300 m depth rating) will be used for these surveys. Support for this expedition is provided by NOAA's Coral Reef Conservation Program (CRCP), and the SEDCI will provide in kind contributions in the form of data analyst Daniel Wagner, who will participate in the expedition and process ROV video data.

**Table 1.** Planned research expeditions to be supported by NOAA Deep-Sea Coral Research and Technology Program's Southeast Deep Coral Initiative in 2016-2019.

<b>Vessel</b>	<b>Science lead</b>	<b>Region</b>	<b>Prospective dates</b>	<b>Operations</b>	<b>DSC RTP support</b>
<b>2016</b>					
<i>Pisces</i>	Martha Nizinski	South Atlantic	8/24-9/7	AUV & mapping	AUV & data analysis contracts
<i>Manta</i>	Emma Hickerson	Gulf of Mexico	9/4-9/9	ROV (<300 m)	Ship time
<b>2017</b>					
<i>Nancy Foster</i>	Tim Battista	Caribbean	12 days TBD	Mapping & ROV (<300 m)	In kind coral data analyst
<i>Manta</i>	Emma Hickerson	Gulf of Mexico	7/22-7/27, 7/29-8/3	ROV (<300 m)	Ship time
<i>Nancy Foster</i>	Peter Etnoyer	Gulf of Mexico	8/12-8/24	ROV (300-800 m) & mapping	ROV contract
<i>Nancy Foster</i>	Peter Etnoyer	South Atlantic	8/27-8/31	Mapping	In kind data analysts
<i>Pisces</i>	Martha Nizinski	South Atlantic	8/28-9/8	AUV & mapping	AUV contract
<b>2018</b>					
<i>Manta</i>	Emma Hickerson	Gulf of Mexico	10 days TBD	ROV (<300 m)	Ship time
<i>Okeanos Explorer</i>	Daniel Wagner	TBD	TBD	ROV (500-6000 m) & mapping	Mission-related costs
<i>Nancy Foster</i>	TBD	Caribbean or South Atlantic (TBD)	TBD	Mapping, ROV and/or technical SCUBA diving	Mission-related costs
<b>2019</b>					
<i>Okeanos Explorer</i>	Daniel Wagner	TBD	TBD	ROV (500-6000 m) & mapping	Mission-related costs



#### 6.1.4 - 2017 Expeditions to Northwestern Gulf of Mexico

In 2017, the FGBNMS will conduct two 5-day expeditions to survey deep-water banks in the Northwestern Gulf of Mexico using the R/V *Manta* and the ROV *Mohawk*. Led by Emma Hickerson, the expeditions will focus on characterizing deep-water banks in the Northwestern Gulf of Mexico. Partners for the characterization work include Mercer Brugler (CUNY), Dennis Opresko (National Museum of Natural History), and David Hicks (UTRGV). Additionally, the expeditions will collect information needed to evaluate expansion proposals for the FGBNMS. The two expeditions are scheduled for July 22-27, 2017 and July 29-August 3, 2017. The SEDCI will support the expeditions by providing funds to pay for R/V *Manta* ship time, and these funds will leverage ROV *Mohawk* at no additional cost to the project.

#### 6.1.5 - 2017 Expedition to Gulf of Mexico

In August 2017, the NOAA Ship *Nancy Foster* will conduct deep-water surveys in the Gulf of Mexico led by Peter Etnoyer. Currently scheduled for August 12-24, 2017, the 13-day expedition will focus on conducting ROV surveys, and mapping data that will help evaluate current proposals for the expansion of the FGBNMS, as well as the potential creation of new HAPCs by the GMFMC (see Figure 4). Specifically, the expedition will target sites on the West Florida Shelf, such as Many Mounds, Long Mounds and the Pulley Ridge, all of which are currently being considered for creation new HAPCs by the GMFMC. Additionally, the expedition will target some of the deeper (300-800 m) sites that are being considered for expansion of the FGBNMS as part of their alternatives 4 and 5 (ONMS 2016), all which are too deep to be surveyed with the ROV *Mohawk* which is available for other FGBNMS monitoring efforts.

The expedition will start in Galveston, Texas and end in St. Petersburg, Florida. ROV surveys will target sites between 300-800 m depths, and thus focus on deeper reefs than those surveyed by the ongoing mesophotic research efforts in the FGBNMS. The SEDCI will provide funds to contract an ROV, as well as data analysts who will process the video and mapping data

#### 6.1.6 - 2017 Expedition to U.S. South Atlantic

On August 27-31, 2017 the NOAA Ship *Nancy Foster* is scheduled for a five-day expedition from St. Petersburg, Florida to Charleston, South Carolina. Led by Peter Etnoyer, this expedition will focus on collecting multibeam bathymetry and backscatter data in priority areas identified by the SAFMC, specifically in a small area located ~50 km off Cape Canaveral bordering the east side of the *Oculina* Bank HAPC (Appendix A). Depths of this area are 100 m on average, and thus well suited for the shallow-water mapping systems of the NOAA Ship *Nancy Foster*. Other SAFMC mapping priority areas located in deeper waters (<800 m; see Appendix A), and thus better suited for other ships (e.g. NOAA Ship *Okeanos Explorer*) that only have deep-water mapping systems. Data collected during this expedition will not only be relevant to the SAFMC and the SEDCI, but also to other work in the region. The SEDCI will support this expedition by providing data analysts to process mapping data.

#### 6.1.7 - 2017 Expedition to North Carolina Canyons

On August 28-September 8, 2017 the NOAA Ship *Pisces* will return to the North Carolina Canyon region to follow up on work performed during the 2016 expedition. Led by Martha Nizinski, the 12-day expedition will focus on surveying Pamlico, Keller and Hatteras Canyons using the AUV *Sentry*. Quantitative benthic data collected during the expedition will be processed by Mike Rhode (ECS Federal, LLC) with assistance from Daniel Wagner. NOAA's OER and the SEDCI will support the expedition by providing funds to contract the AUV *Sentry*. Shiptime for the NOAA Ship *Pisces* will be provided by the NEFSC.

#### 6.1.8 - 2018 Expedition to Northwestern Gulf of Mexico

Building on expeditions in 2016 and 2017, the SEDCI will support a third year of fieldwork in the Northwestern Gulf of Mexico in 2018. As in previous years, the 2018 expedition will be led by Emma Hickerson, and characterize deep-water banks in the Northwestern Gulf of Mexico, as well as collect information needed to evaluate expansion proposals for the FGBNMS. The expedition will be aboard the R/V *Manta* and use the ROV *Mohawk*. DSCRTP funds will be used to pay for the ship time on the R/V *Manta*, and leverage the ROV *Mohawk* at no additional cost to the project.

#### 6.1.9 - 2018 Expeditions to U.S. Caribbean, South Atlantic and/or Gulf of Mexico

In 2018, the NOAA Ship *Okeanos Explorer* will return to the Atlantic. While the 2018 schedule for the ship has not been finalized, OER anticipates that the *Okeanos Explorer* will conduct both ROV (500-6,000 m) and mapping (250-6,000 m) operations in the U.S. Caribbean, South Atlantic and/or the Gulf of Mexico in 2018. NMFS, NOS and OER have pending 2018 requests in the NOAA vessel prioritization, allocations and scheduling system (PASS). These requests are both for fieldwork in the U.S. South Atlantic and the Caribbean/Gulf of Mexico aboard the NOAA Ship *Okeanos Explorer*. The SEDCI will advocate for these expeditions to NOAA leadership by highlighting the highly collaborative, cross-line office approach of the SEDCI. Funds have been set aside in the 2018 budget of the SEDCI to pay for a subset of mission-related costs on the NOAA Ship *Okeanos Explorer*. This is consistent with the approach taken by the DSCRTP fieldwork initiative in the Pacific Islands, where the NOAA Ship *Okeanos Explorer* supported numerous deep-sea coral surveys (Kelley et al. 2016).

As previous research expeditions aboard the NOAA Ship *Okeanos Explorer*, science priorities and the selection of specific sites to be surveyed on future expeditions on this ship will include wide input from diverse stakeholders, including potential partners outside of this initiative. The SEDCI will participate in this process as much as possible in hopes of being able to secure data from these expeditions that support the objectives of SEDCI.

#### 6.1.10 - 2018 Expeditions to U.S. Caribbean or South Atlantic

In addition to expeditions aboard the NOAA Ship *Okeanos Explorer*, the SEDCI hopes to secure additional ship time on the NOAA Ship *Nancy Foster* in 2018. Separate ship time requests have been submitted to PASS for work in the U.S. Caribbean and South Atlantic, in hopes of securing ship time in at least one of these two regions. Funds have been set aside in the 2018 budget to pay for mission-related costs. If the 2018 requests for the NOAA Ship *Nancy Foster* are successful, surveys could include mapping, ROV or technical SCUBA diving. The latter would survey depths to 100 m, and allow for the collection of many more samples (~50/dive) than can be collected by an ROV (<10/dive). In this regard, adding a technical SCUBA component to the expedition would address the need for physical samples, which was highlighted as one of the main priorities during the 2015 science priorities workshop (Schull et al. 2016).

#### 6.1.11 - 2019 Expeditions to U.S. Caribbean, South Atlantic and/or Gulf of Mexico

While the 2019 schedule of the NOAA Ship *Okeanos Explorer* has not been determined, NMFS, NOS and OER will request ship time for additional work in the U.S. Caribbean, South Atlantic and Gulf of Mexico. If these requests are successful, additional ROV and mapping surveys will be possible. Funds have been set aside in the 2019 budget to pay for mission-related costs.

### **6.2 Research projects (or small projects in the parlance of DSC RTP)**

#### 6.2.1 - Deep-sea species guide

As in most regions, the deep-sea fauna of the Southeast Region is poorly known, and no comprehensive species guidebooks are currently available to help researchers identify species that occur in the region. Previous DSC RTP fieldwork initiatives created species identifications guides to the deep-sea sponges of Alaska (Stone et al. 2011) and the deep-water benthic fauna of the Pacific Islands (NOAA, OER 2016). Other international initiatives have developed free iTunes-compatible applications like *Deep-Sea ID*, which provide photos and other taxonomic information to help with the identification of diverse deep-sea taxa. Recognizing the importance of these references, participants of the 2015 science priorities workshop identified the creation of a species guide as one of the top priorities for the SEDCI (Schull et al. 2016).

The objective of this project is to create a photographic guide of the most common fauna associated with deep-sea coral and sponge ecosystems in the Southeast Region. The guide will consist of high-quality, *in situ* photos of deep-sea corals and sponges, but may also contain images of associated fauna. These images will be shared with scientists participating in SEDCI fieldwork to ensure that species names are used consistently throughout the effort. Furthermore, the species guide will be shared more widely via a web-accessible platform (*Deep-Sea ID* and World Register of Deep-Sea Species), in order to provide a tool that can be used by the broader scientific community, as well as for education and outreach purposes. The project will be led by Daniel Wagner, but will include wide participation from the science team, as well as from external partners with taxonomic expertise. A detailed description of the project is presented in See Appendix E.

**Table 2.** Research projects that will be supported by the NOAA Deep-Sea Coral Research and Technology Program's Southeast Deep Coral Initiative in 2016-2019.

<b>Project</b>	<b>Lead</b>	<b>Region</b>	<b>Project dates</b>	<b>DSCRTP support</b>
Species guide	Daniel Wagner	All	11/1/2016-12/31/2019	Travel and salary for data analyst
Geodatabase	Tim Battista & Daniel Wagner	All	11/1/2016-12/31/2017	In kind data analysts provided at no cost
Environmental monitoring	Peter Etnoyer	All	8/1/2016-12/31/2019	Supplies, travel, salary, water chemistry subcontract
Modeling support	Matt Poti	All	1/1/2017-12/31/2019	Salary for data analysts
Fishery/citizen science	Jen Schull	Caribbean	1/1/2017-12/31/2019	Equipment and salary for data analyst
Data mining HBOI archives	John Reed	South Atlantic	5/1/2016-12/31/2019	Salary for data analysts
Data mining NCCOS archives	Tim Battista	Caribbean	5/1/2016-12/31/2019	Salary for data analyst
Data mining FGBNMS archives	Travis Sterne	Gulf of Mexico	5/12/2016-4/30/2019	Salary and travel for data analyst
Data mining OER Caribbean archives	Daniel Wagner	Caribbean	1/1/2017-12/31/2017	In kind data analyst provided at no cost
Data mining 2010 <i>Pisces</i> archives	George Sedberry	South Atlantic	5/12/2016-09/30/2017	Salary for data analyst

### 6.2.2 - Geodatabase

Reviewing past research efforts is the first step in any research program. Therefore, we propose to conduct a thorough review of past deep-sea surveys in the Southeast Region, and compile this information into a GIS geodatabase that will be shared with scientists participating in fieldwork of the SEDCI, as well as more broadly via an online mapping service (e.g., ESRI online). In contrast to past DSCRTP fieldwork initiatives, the 2016-2019 SEDCI will target a much larger geographic area, and includes some areas surveyed during previous efforts. Reviewing the spatial

distribution of previous surveys will allow the science team to target fieldwork activities and avoid duplicating past research efforts.

This project will create a GIS geodatabase that includes information from previous deep-sea explorations in the Southeast Region including (1) submersible/ROV dives, (2) mapping surveys, (3) collected specimens and observations of deep-sea corals and sponges, (4) deep-sea coral habitat suitability models, and (5) boundaries of existing and proposed marine protected areas. Tim Battista and Daniel Wagner will co-lead the project, which will include several collaborators from NCCOS' Biogeography Branch. See appendix F for a detailed description of the project.

### 6.2.3 - Environmental monitoring

Deep-sea corals and sponges are sensitive animals subject to several natural stressors, such as fluctuations in temperature, dissolved oxygen and carbonate saturation. Natural variability of these parameters is poorly documented in deep-sea coral environments. Understanding this natural variability is one of the first steps necessary for understanding how deep-sea coral ecosystems might be impacted by climate change. This project will collect new high-quality, *in-situ* environmental data in the Southeast Region, process the data using software filters, and make data publicly available through NOAA web portals.

This project will seek to collect (1) high-resolution temperature data at several key sites where deep-sea coral communities occur, and (2) CTD data and water samples for ocean acidification work. Temperature loggers will be deployed and recovered opportunistically in the FGBNMS and U.S. Caribbean regions during DSC RTP-funded expeditions. Once data loggers are recovered, data will be plotted for reports and uploaded to public repositories at NOAA Coral Reef Watch in order to extend the vertical range of present studies (<http://coralreefwatch.noaa.gov/satellite/index.php>).

The ocean acidification project will deploy a CTD-rosette to 1500 m depth for a series of water column profiles. Samples will be collected opportunistically on SEDCI expeditions, fixed and shipped to the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) for water chemistry measures. Aragonite saturation data will be plotted for reports and uploaded to the public repository at AOML (<http://www.coral.noaa.gov/accrete/oaps.html>).

This project will expand our ability to measure the variability of climate-related parameters in deep water, and thereby provide insights into potential impacts on deep-sea coral ecosystems from climate change. The project addresses specific climate-related research questions posed during the science priorities workshop (Schull et al. 2016). The project will be led by Peter Etnoyer in collaboration with other NOAA partners. A detailed description of this project is presented in Appendix G.

### 6.2.4 - Modeling support for the SEDCI

The goal of this project is to create a set of habitat suitability models to support the SEDCI. Existing deep-sea coral habitat models developed at NCCOS for the Southeast Atlantic and Gulf

of Mexico (Kinlan et al. 2013) will be supplemented by the development of a similar set of models for the U.S. Caribbean, and an additional genus model (*Leiopathes*) for the Gulf of Mexico and South Atlantic. This project will bring modeling in all three regions of the SEDCI to a common level. Subsequently, models will be used to help select sites for exploration, with a goal of testing and validating model predictions, determining accuracies of the models, and helping to synthesize field survey results into a broader spatial context useful for conservation and management planning. The project will be led by Matt Poti and a detailed description is presented in Appendix H.

#### 6.2.5 - Fishery/citizen science

The main concern relating to deep-sea corals and sponges in the U.S. Caribbean are potential impacts from the deep-water snapper fishery. However, exactly how much this fishery impacts deep-sea coral and sponge communities in the U.S. Caribbean is unknown. This project will work collaboratively with Puerto Rican fishermen to deploy low-cost underwater video cameras along with fishing gear to explore bottom habitats associated with deep-water fisheries. Puerto Rican fishermen have shown great interest in participating in such research efforts. The goal of the project is to glean introductory information about important deep-water habitats in the U.S. Caribbean, in order to focus more in-depth habitat characterization research in the future. The project will address two of the main priorities of the DSCRTP, including the collection of information on fishing intensity, and potential bycatch of corals and sponges in deep-water fisheries. Jen Schull will lead the project in collaboration with Steve Smith at the University at Miami. A detailed description of this project is presented in Appendix I.

#### 6.2.7 - Data mining existing data archives

In addition to collecting new data, the SEDCI will also focus its efforts on processing data from previous fieldwork and making those datasets publicly available. In particular, SEDCI will seek to retrieve records of deep-sea corals and sponges from previous fieldwork supported by HBOI, NCCOS, FGBNMS, OER and the NOAA Ship *Pisces*. Data retrieved from these sources will be made available through the NOAA National Database of Deep Sea Corals and Sponges. Specifically, these geo-referenced records will include information on scientific species names, location (i.e., latitude, longitude, depth), environmental data (e.g., temperature, salinity, oxygen concentration), as well as images of the organisms where available (see Hourigan et al. 2015 for a detailed description). Data mining projects will draw existing data from a diverse pool of partners, including NOAA Cooperative Institutes and academic partners, several of which are listed below. Additional datasets and partners may be added to SEDCI data mining projects in 2018 and 2019.

John Reed will lead the retrieval of coral and sponge records from HBOI archives. This will include the compilation of deep-water coral and sponge records from several NOAA-funded cruises conducted since 2011 (see Appendix J). Most of those surveys have already been analyzed and published, and this project will therefore not involve re-analyzing those videos or photos. Rather, this project will query the existing HBOI database, and retrieve deep-sea coral and sponge records that have not yet been submitted to the National Database of Deep-Sea Coral

and Sponges. Once those records are identified, they will be reformatted and prepared for submission to the National Database.

Tim Battista will lead the NCCOS data mining effort. The NCCOS data archives include ROV data collected during NCCOS-funded expeditions to the U.S. Caribbean aboard the NOAA Ship *Nancy Foster* in 2004-present (see Appendix K). Most of those ROV videos have not yet been annotated for deep-sea corals and sponges, and this project will involve retrieving deep-sea coral and sponge records from those surveys and submitting them to the National Database.

Travis Sterne will lead the FGBNMS data mining project. The FGBNMS data archives include over 25,000 images collected between 2011-present (see Appendix L). While some of those surveys have already been annotated for deep-sea corals and sponges, not all of them have, and many records have not yet been submitted to the National Database. This will be one of the main outputs of this project (see Appendix L).

George Sedberry will lead the *Pisces* data mining project. The project will retrieve records from a 2010 expedition aboard the NOAA Ship *Pisces* that explored deep-water habitats off Georgia and South Carolina using the ROV *Phantom* (see Appendix M). Many of those surveys have already been annotated for deep-sea corals, sponges and fishes, and this project will seek to prepare those records for submission to the National Database.

Daniel Wagner will lead the OER data mining efforts. The OER data mining project will retrieve coral and sponge records from 12 OER-funded dives by the ROV *Deep Discoverer* off Puerto Rico in 2015. These dive surveys have not yet been analyzed for deep-sea corals and sponges, which will be the main objective of this project. In addition to the ROV *Deep Discoverer*, OER funded 7 dives using the ROV *Hercules* of the E/V *Nautilus* in the U.S. Caribbean in 2013. Graduate student Steve Auscavitch is processing this dataset as part of his dissertation research in Erik Cordes' laboratory at Temple University. Upon completion of the project, Daniel Wagner will provide assistance in uploading those records onto the National Database.

## **7. Deliverables and products**

The efforts by the SEDCI will not only focus on the collection of data, but also on synthesizing data into reports that can be used by managers, policy makers and scientists, as well as archiving data in repositories that are publicly available. In this regard, SEDCI will adhere to the policies and procedures outlined in the NOAA plan for increasing public access to research results (NOAA 2015), which was developed in direct response to meet the requirements of the White House Office of Science and Technology Policy (OSTP 2013). According to the NOAA publication requirements, scientific data resulting from federally-funded, unclassified research should be made publicly available within a timely manner, typically no later than two years after data are collected or created (NOAA 2015). This is consistent with the data management plans required for research supported by the National Science Foundation (NSF).

The SEDCI will meet these federal requirements by publishing data generated as part of expeditions and small projects in various publicly available repositories (Table 3). Exceptions of this include new discoveries of potentially sensitive data, such as locations of submerged



archaeological resources (e.g., historic shipwrecks) or aggregations of commercially valuable fishery resources. Should SEDCI research discover such potentially sensitive data, it will pass this information to the appropriate federal agencies to determine how to best disseminate it. Additionally, the NOAA National Database for Deep-Sea Corals and Sponges, which will be used to make several SEDCI datasets publicly available (Table 3), already has provisions to address certain issues on the release of potentially sensitive data (Hourigan et al. 2015). For example, legal requirements preclude making certain observations publicly available, such as geographically-specific data on fisheries bycatch. Furthermore, there may be reasons not to publicly release certain geographically-specific data on vulnerable species. The DSCRTP has protocols for addressing these requirements on a case by case basis, while still retaining the ability to utilize the records for management purposes (see Hourigan et al. 2015).

The products, submission process and ultimate repositories for each type of data deliverable that will be generated as part of the SEDCI are summarized in Table 3. Appendix N provides detailed guidance on information that will be submitted to the DSCRTP and how to submit each product.

**Table 3.** Data products to be generated by expeditions and small projects of the Southeast Deep Coral Initiative in 2016-2019.

<b>Data product type</b>	<b>Ultimate repository</b>	<b>Point of contact</b>	<b>Submission process</b>
Coral, sponge and fish observations (and linked photos)	NOAA National Database for Deep Sea Corals	Expedition and data mining project leads	Email <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a> using Excel template ( <a href="#">link</a> )
ROV/AUV videos and photos	NCEI	Expedition leads	Hard drive mailed to Matt Dornback, 1021 Balch Blvd. #1003, Stennis Space Center, MS 39529
Navigation data (ROV, AUV and supporting ship)	NCEI	Expedition leads	Hard drive mailed to Matt Dornback, 1021 Balch Blvd. #1003, Stennis Space Center, MS 39529
Multibeam bathymetry and backscatter data	NCEI	Expedition leads	Hard drive mailed to Matt Dornback, 1021 Balch Blvd. #1003, Stennis Space Center, MS 39529
Cruise reports	DSCRTP (internal only)	Expedition leads	Email <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a>
Outputs from modeling project	NCCOS	Matt Poti	Email <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a>
Site characterization reports (appended to SEDCI final report)	DSCRTP website	Expedition leads	Email <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a>

<b>Data product type</b>	<b>Ultimate repository</b>	<b>Point of contact</b>	<b>Submission process</b>
Final SEDCI report	DSCRTP website	Daniel Wagner	Email <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a>
Biological specimens collected during research expeditions (with subsample for genetic work)	National Museum of Natural History, Smithsonian Institution	Expedition leads	Specimens and metadata mailed to Geoff Keel, Smithsonian Institution, MRC 534, 4210 Silver Hill Rd., Suitland, MD 20746. Genetic subsample to be mailed to Meredith Everett, NOAA NWFSC, 2725 Montlake Blvd. East, Bldg. EAST, Seattle, WA 98112.
Peer-reviewed publications	Scientific journals (TBD)	All	Variable by journal. Authors should also email PDF of article to <a href="mailto:robert.mcguinn@noaa.gov">robert.mcguinn@noaa.gov</a>
Photos from species identification project	<i>Deep Sea ID</i> & WORDSS	Daniel Wagner	Email <a href="mailto:deepsea@marinespecies.org">deepsea@marinespecies.org</a>
GIS geodatabase of past explorations	ESRI online	Tim Battista & Daniel Wagner	Ken Buja will upload upon completion. Link to online database will be widely distributed.
Aragonite saturation data from environmental monitoring project	NOAA Coral Reef Watch Ocean Product Suite & NCEI	Peter Etnoyer	Peter Etnoyer will work with Derek Manzello to upload to <a href="http://www.coral.noaa.gov/accrete/oaps.html">http://www.coral.noaa.gov/accrete/oaps.html</a> and email metadata to <a href="mailto:matt.dornback@noaa.gov">matt.dornback@noaa.gov</a>
Temperature data from environmental monitoring project	NOAA Coral Reef Watch	Peter Etnoyer	Peter Etnoyer will work with Mark Eakin to upload to <a href="http://coralreefwatch.noaa.gov/satellite/index.php">http://coralreefwatch.noaa.gov/satellite/index.php</a>
Video from fishery/citizen science project	NCEI	Jen Schull	Hard drive mailed to Matt Dornback, 1021 Balch Blvd. #1003, Stennis Space Center, MS 39529
Popular literature and news stories	News stories	Daniel Wagner	Variable by publication

## **8. Contributions to the broader community**

### ***8.1 List of desired samples and data to support external research***

In addition to the deliverables and data products outlined in the previous section, the SEDCI will strive to collect data and samples opportunistically that will benefit the broader scientific community. For this purpose, the initiative will create an online survey, where researchers can identify samples needed for their ongoing research, along with protocols for collection and preservation of those samples. The online survey will be widely distributed to known deep-sea researchers (e.g., participants of 2015 DSCRTP science priorities workshop, attendants of 2016 International Deep Sea Coral Symposium, NOAA Ship *Okeanos Explorer* mailing list) prior to the 2017 field season. In order to ensure wide distribution of the survey, we will further encourage all survey respondents to forward the survey to their collaborators and partners. Upon survey completion, we will summarize the survey results into a list of desired samples that will be shared with the expedition leads of SEDCI expeditions (Table 1) along with photographs of desired species to be sampled. While we realize that list of desired samples will likely surpass our ability to collect, we will do our best to collect data and samples opportunistically that will benefit the larger scientific community. Furthermore, we will deposit collected samples at the National Museum of Natural History, Smithsonian Institution (see Appendix D), so that these are available for further study to qualified researchers from around the world.

### ***8.2 Internship opportunities for undergraduate students***

The NOAA Hollings Scholarship Program provides undergraduate students in science, technology, engineering and mathematics (STEM) fields an opportunity to complete paid 9-week internships in the summer months at a NOAA facility. Funding for these internships is provided by the NOAA Office of Education, and any NOAA staff is eligible to host student interns provided that they can dedicate time to mentor students throughout the internship. The SEDCI will create several internship opportunities for NOAA Hollings Scholars in 2017-2019. This will benefit both the students, who will receive valuable hands-on research experience and mentorship, as well as the SEDCI, which will gain data analysts at low costs to the program.

### ***8.3 Collaborations with OER Education Team***

The SEDCI will work closely with the OER Education Team to engage educators and the general public. The OER Education Team currently provides professional development seminars for formal and informal educators at 15 alliance partners, which include aquariums and informal science centers throughout the country. Through these seminars, the OER Education Team brings STEM content, along with authentic connections to STEM careers, into classrooms nationwide. The SEDCI will collaborate closely with the OER Education Team to help provide content for these seminars. Additionally, SEDCI expeditions will link to and contribute content to the Ocean Explorer education website (<http://oceanexplorer.noaa.gov/edu>), such as new content to the deep-sea coral theme page (<http://oceanexplorer.noaa.gov/edu/themes/deep-sea-corals/>), thereby expanding the reach to educators at the international level.

Furthermore, the SEDCI will work through OER to collaborate with the NOAA Teacher at Sea Program in order to provide educators an opportunity to sail on SEDCI-funded expeditions when berth space is available. The SEDCI, in collaboration with OER, will also provide content for the development of an ‘Every Full Moon’ episode of the *Ocean Today* video series. This will include interviews, video updates and an education component highlighting the Deep-Sea Species Guide to be hosted on the National Museum of Natural History’s Ocean Portal.

## **9. Roles and responsibilities**

The science team of the SEDCI will consist of NOAA staff and NOAA-affiliated staff of three line offices including the National Marine Fisheries Service (NMFS), the National Ocean Service (NOS) and the Office of Oceanic and Atmospheric Research (OAR). The NOAA 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 Table 3.

**Table 3.** Roles and responsibilities of the science team and primary outside partners of the NOAA Deep-Sea Coral Research and Technology Program’s Southeast Deep Coral Initiative in 2016-2019.

Name	Affiliation	Role and responsibility
<b>DSCRTP Leadership</b>		
Tom Hourigan	NMFS/DSCRTP	Review science plan and data products; identify collaborative opportunities; ensure that science plan deliverables are met; communicate need for ship time to NOAA leadership.
Heather Coleman	NMFS/DSCRTP	Communicate with fishery management councils; transfer funds from DSCRTP to offices that will use them; maintain DSCRTP website updates; obtain budget and cruise information from Daniel Wagner.
<b>SEDCI Leadership</b>		
Peter Etnoyer	NOS/NCCOS	Prepare and execute science plan; budget science plan activities; lead 2017 <i>Nancy Foster</i> expeditions to Gulf of Mexico and South Atlantic (planning, execution, data analysis and reporting); oversee coral data analyses of expeditions conducted by initiative; lead environmental monitoring project; contribute to species guide project.
Daniel Wagner	NOS/NCCOS	Draft science plan; contract ROV for <i>Nancy Foster</i> expeditions; provide information of initiative’s activities to DSCRTP; lead species guide project; co-lead GIS geodatabase project with Tim Battista; generate press releases and share media; find ways to showcase accomplishments of initiative to NOAA leadership and outside partners; lead OER Caribbean data mining project; lead <i>Okeanos Explorer</i> expeditions.
Jennifer Schull	NMFS/SEFSC	Coordinate and execute budget with DSCRTP; cooperative institute planning (e.g., CIOERT); lead fishery/citizen science project.

Name	Affiliation	Role and responsibility
<b>SEDCI Science Team</b>		
Tim Battista	NOS/NCCOS	Coordinate ship time requests for NOS; lead U.S. Caribbean cruises (planning, execution, data analysis and reporting); mapping data analyses and archival (NCEI); lead for U.S. Caribbean data mining project.
Andrew David & Stacey Harter	NMFS/SEFSC	Coordinate ship time requests for NMFS; conduct fish data analyses; lead for South Atlantic cruises; contribute fish data to species identification guide project; coordinate with Reed on U.S. South Atlantic work.
Amanda Netburn	CIOERT	Communicate needs of initiative to OER leadership; coordinate OER ship time requests; engage OER media team.
Martha Nizinski	NMFS/NSL	Lead <i>Pisces</i> expeditions in 2016 and 2017 (planning, execution, reporting); contribute to species identification guide; OER coordination.
G.P. Schmahl & Emma Hickerson	NOS/FGBNMS	Lead R/V <i>Manta</i> cruises in 2016-2018 (planning, execution, data analysis and reporting); work with other sanctuaries to keep them informed; coordinate ship time requests for ONMS; contribute to environmental monitoring and species identification projects.
<b>Other Small Project Leads</b>		
Matt Poti	NOS/NCCOS	Lead modeling support project.
Travis Sterne	NOS/FGBNMS	Lead FGBNMS data mining project.
John Reed	HBOI	Lead South Atlantic data mining project; collaborator on species identification guide project; help with planning and execution of fieldwork in Gulf of Mexico and U.S. South Atlantic.
George Sedberry	NOS/ONMS	Lead for data mining project from 2010 NOAA Ship <i>Pisces</i> expedition.
<b>Data Management</b>		
Robert McGuinn	NOS/NCCOS	Support data archival in national database in collaboration with NCEI; prior to cruises contact cruise leads and send out metadata cruise forms; after cruises collect reports and data.
Matt Dornback	NESDIS/NCEI	Archival of data in NCEI databases; prior to cruises contact PIs and send out hard drives; after cruises collect hard drives with data; data management support for cruises.
<b>Fishery Management Council Representation</b>		
Morgan Kilgour	GMFMC	Identify priority information needed by GMFMC; possibly participate in 2017 <i>Nancy Foster</i> expedition to Gulf of Mexico.
Graciela García-Moliner	CFMC	Identify priority information needed by CFMC; provide contacts of potential collaborators in U.S. Caribbean.
Chip Collier	SAFMC	Identify priority information needed by SAFMC.

## **10. Budget**

The total funds available to the SEDCI will be \$400,000 in 2016, \$700,000 in 2017, \$800,000 in 2018, and \$700,000-750,000 in 2019.

## **11. Acknowledgements**

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### **13. Appendices**

**Appendix A.** Summary of science team meetings at the Hollings Marine Laboratory in Charleston on September 27-28, 2016.

**Participants:** *On site:* Jennifer Schull (NMFS/SEFSC), Peter Etnoyer (NOS/CCEHBR), Tim Battista (NOS/CCMA), Heather Coleman (NMFS/DSCRTP), Andrew David (NMFS/SEFSC), Stacey Harter (NMFS/SEFSC), G.P. Schmahl (ONMS/FGBNMS), Emma Hickerson, Martha Nizinski (NMFS/NSL), Amanda Netburn (OER/OEP), Chip Collier (SAFMC), Daniel Wagner (NOS/CCEHBR). *Remotely:* Tom Hourigan (NMFS/DSCRTP), Morgan Kilgour (GMFMC) and Graciela García-Moliner (CMFC).

**Goals:** To build the framework of the science plan for the Southeast Deep Coral Initiative (SEDCI) by (1) reviewing priorities of DSCRTP, fishery management councils, and the Flower Garden Banks National Marine Sanctuary, and (2) outlining research activities that address those priorities.

#### **Introduction to DSCRTP and science plan (Tom Hourigan)**

The science plan should be short and concise, and include the following sections: (1) introduction to geographic area, (2) objectives and scope, (3) list of science team with roles and responsibilities, and (4) list of activities with timeline, budget and deliverables. DSCRTP research activities should be relevant to management, particularly to the fishery management councils and national marine sanctuaries of the region, and leverage existing data and partnerships. Research supported by the DSCRTP targets azooxanthellate coral and sponge ecosystems, and generally focuses on depths below 200 m. Thus, it does not focus on mesophotic coral ecosystems, although there might be overlaps given that both mesophotic photosynthetic corals and azooxanthellate deep-water corals often times occur within close proximity.

The geographic focus of the SEDCI includes the U.S. waters off the southeastern coast (North Carolina to Southern Florida), the Gulf of Mexico and the Caribbean. These waters are under the jurisdiction of three fishery management councils (FMC), including the South Atlantic, Gulf of Mexico and Caribbean FMCs. Additionally, this area includes three national marine sanctuaries (NMS), including Gray's Reef, Florida Keys and Flower Garden Banks NMS. While Gray's Reef NMS is exclusively in shallow waters (<20 m), both the Florida Keys (~580 m max. depth) and Flower Garden Banks (~150 m max. depths) include deep-water reefs.

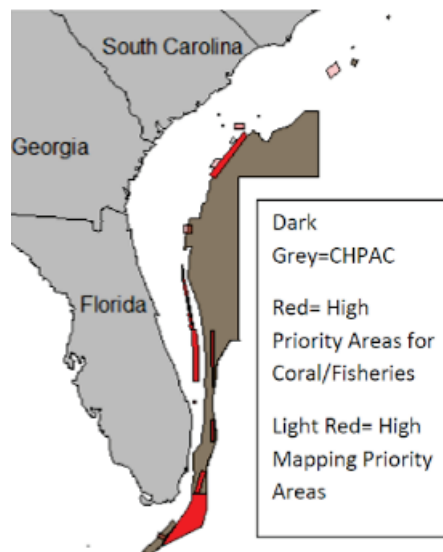
Funding for the activities of the SEDCI is \$400K in 2016, \$700K in 2017, \$800K in 2018 and \$700-750K in 2019. The SEDCI budget needs to encompass all four years of the initiative (2016-2019), and allocate funds for data analysis. The budget will also need to include a ~6% acquisition fee on all contracts. This charge may vary between 1.5-7% depending on the amount and is a new requirement by the NOAA contracting office. The SEDCI will need to get clarification on these values for budgeting purposes.

A high-leveraging opportunity for the SEDCI is a potential partnership between NOAA, BOEM and USGS. If funded, this partnership will provide additional information about deep-sea coral habitats throughout the South Atlantic Bight over the next several years.



### **South Atlantic Fishery Management Council (SAFMC) priorities** (Chip Collier)

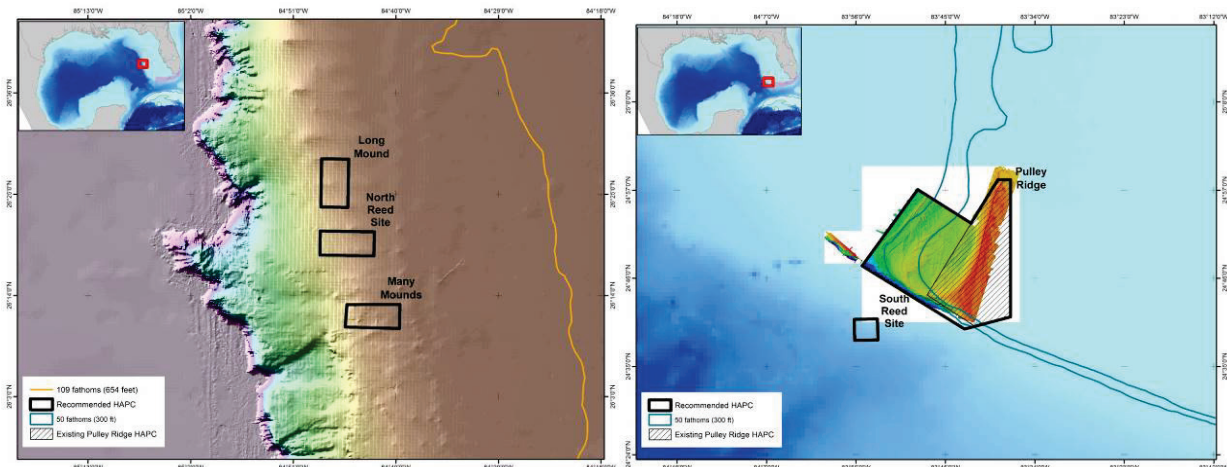
The main priority of the SAFMC is mapping areas that have yet to be mapped, particularly areas of interest to the Golden Crab fishery off the southern coast of South Carolina and southeastern coast of Florida. Additionally, the SAFMC is interested in obtaining information on the biology and ecology of deep-water coral ecosystems in the coral habitat of particular concern (CHAPC), as well as on fishing effort in these areas. The geographic priorities for the SAFMC are shown in the map below.



***Figure 1.** Deep-sea coral priorities of the South Atlantic Fishery Management Council.*

### **Gulf of Mexico Management Council (GMFMC) priorities** (Morgan Kilgour)

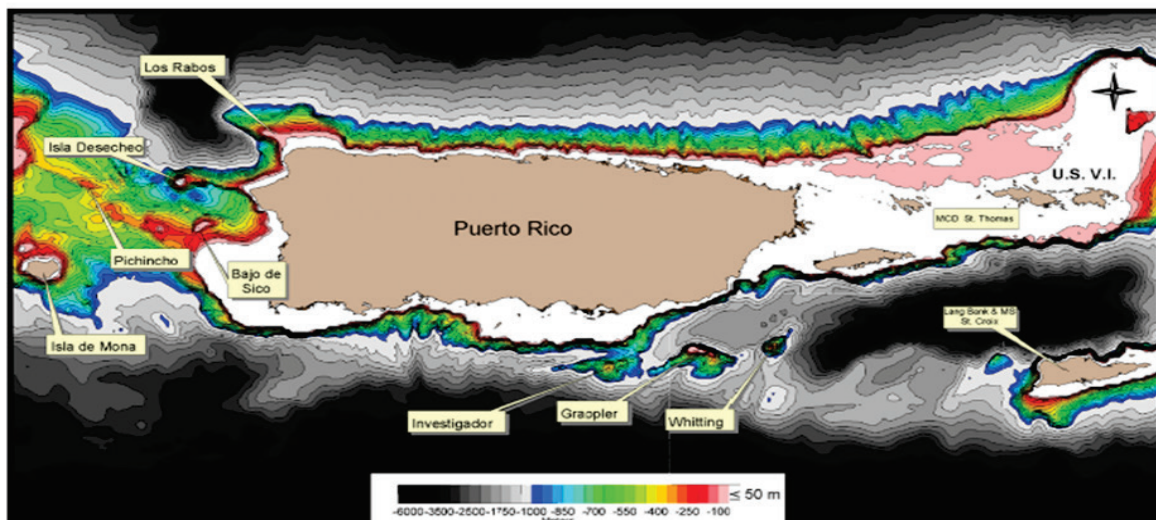
Mapping and visual benthic survey activities in areas of proposed habitats of particular concern (HAPC) are the main priority of the GMFMC. Obtaining information both inside and just outside those proposed areas is of interest to the Council. These include several areas off the West Florida Shelf as shown in the maps below. These sites represent some of the top priorities for the Council out of 40+ sites that were proposed. Most of the other sites are under consideration by Flower Garden Banks National Marine Sanctuary Expansion plan, and would therefore receive more conservation benefits under those authorities. The West Florida Shelf coral assemblage is understudied compared to those sites, and presumably subject to less intense fishing pressure by the bottom trawl industry, and therefore less controversial to fishing groups. Bottom longlines fish the West Florida Shelf with moderate intensity near the Mound region, and much higher intensities near Pulley Ridge.



**Figure 2.** Deep-sea coral priorities of the Gulf of Mexico Management Council.

### **Caribbean Management Council (CFMC) priorities** (Graciela García-Moliner)

The main deep-sea coral priority for the CFMC is obtaining information to support monitoring of MPAs in the region. There are several MPAs in the U.S. Caribbean that are not currently being monitored. Additionally, the CFMC needs help with species identifications of organisms inhabiting deep-water coral ecosystems, converting side-scan sonar data into habitat maps, and information on coral occurrences around fish spawning aggregations. Spatial priorities for the CFMC include areas targeted by the snapper-grouper fishery (~200 m depth) off West Puerto Rico, South Vieques and South St. Thomas. The latter includes the most extensive mesophotic reefs in the Caribbean that start around 30 m depths and extend well beyond 150 m. A 250 m depth-rated ROV (owned by private industry) is locally available for work in the U.S. Caribbean, but needs technical help.



**Figure 3.** Bathymetric map of Puerto Rico and the U.S. Virgin Islands showing the geographical distribution of deep reefs.

**Figure 3.** Deep-sea coral priorities of the Caribbean Fishery Management Council.

### **Review of 2009-2011 DSCRTP Initiative in South Atlantic (Daniel Wagner)**

In 2009-2011, the DSCRTP supported the first regional fieldwork initiative. That initiative focused on the South Atlantic Bight from the northern portion of South Carolina to South Florida. As other DSCRTP initiatives that succeeded it, the 2009-2011 South Atlantic initiative consisted of research expeditions (n=7), and a number of small projects (n=5) focused on analyzing previously collected data or samples.

The seven expeditions supported by the initiative included a total of 61 days at sea, during which deep-water coral habitats were surveyed by manned submersibles and ROVs (n=61), multibeam bathymetry and backscatter (10,100 km<sup>2</sup>), CTD casts (n=27), MOCNESS trawls (n=29), otter trawls (n=7) and plankton tows (n=8). Over 250 biological samples were collected as part of these efforts, including 16 coral samples that were kept alive in aquaria, and 13 sediment grab samples.

Small projects supported by the initiative included (1) development of deep-sea coral habitat suitability models, (2) analysis of AUV sonar data from deep-water *Lophelia* habitats off Eastern Florida, (3) integration of mapping and fisheries data into a GIS database, (4) comparison of VMS commercial fisheries records to deep coral habitats, and (5) studies on the physical properties of skeletons of the stylasterid coral *Stylaster erubescens* from specimens collected on the Charleston Bump.

Research products of the 2009-2011 South Atlantic Initiative included adding over 4,300 new records to the National Database of deep-sea corals, 10 new site characterization reports submitted to the National Database, seven peer-reviewed publications, one M.S. thesis and one undergraduate honors thesis. Data collected during the initiative supported the establishment of the deep-water CHAPC in 2010, as well as the expansions of the deep-water CHAPC and *Oculina* HAPC in 2015. A single ROV dive was conducted in the Gulf of Mexico as part of the 2009-2011 initiative. Information collected during that dive has supported the proposal of a HAPC off Western Florida.

### **Review of 2016 activities**

#### ***2016 DSCRTP-funded expedition to North Carolina Canyons* (Martha Nizinski)**

On August 24-September 7, 2016, Martha Nizinski led an expedition aboard the NOAA Ship *Pisces* to survey North Carolina Canyons using the AUV *Sentry*. The expedition, funded by both OER and the DSCRTP, included a total of three AUV dives including one in Pamlico Canyon and two in Hatteras Canyon. Approximately 71 km of deep-water habitats were surveyed during the expedition. Mike Rhode (ECS Federal LLC) is under contract to analyze the approximately 59,000 images collected. Tropical depressions and Hurricane Hermine broke up and cut short the expedition. However, AUV surveys confirmed the occurrence of deep-sea corals in both canyons.

#### ***2016 DSCRTP-funded expedition to FGBNMS* (Emma Hickerson)**

On September 4-8, 2016, Emma Hickerson led an expedition aboard the R/V *Manta* to survey banks in and around the FGBNMS using the ROV *Mohawk*. The expedition included a total of 28 dives, each approximately 1 h long, during which 68 transects were conducted on seven banks. Surveyed areas include several that support the FGBNMS expansion proposals. The expedition included the participation of students from the City University of New York (CUNY),

who will analyze black coral samples collected during the cruise (n=20), and a University of Texas at Rio Grande Valley (UTRGV) student, who will process octocoral samples collected during the expedition (n=3).

**2016 DSCRTP-funded activities in the U.S. Caribbean** (Tim Batista)

Funding to recover deep-sea coral records from past NCCOS activities in the Caribbean (to 300 m depths) was provided as part of a two-year project (2016-2017) funded by the DSCRTP.

Alyson Kuba is performing the taxonomic identifications and has reviewed data from 2010-2014 in 2016. In 2017, she will review data from 2015-2016, as well as from 2009 and earlier.

NCCOS has 14 days of shiptime in the U.S. Caribbean aboard the NOAA Ship *Nancy Foster* in April 2017. There will be an additional 7 days of shiptime in the area on an EPA cruise in April 2017. These cruises will focus on seafloor mapping, fish acoustics, oceanography and habitat mapping.

**Preview of 2017 DSCRTP-funded activities in the Southeast Region** (Peter Etnoyer)

- 10 days of R/V *Manta* shiptime for research in support of the expansion proposals of the FGBNMS. The SEDCI science team agreed that this a great investment for the initiative, since FGBNMS will match the contribution with 10 days of ROV *Mohawk* time, as well as process the video data.

- 18 days aboard the NOAA Ship *Nancy Foster* in Mid-August 2017 for work in the Western Gulf of Mexico. The group determined that an ROV with 800 m depth capacity should be contracted to survey deeper areas of the Gulf, particularly off Western Florida to support GMFMC HAPC proposals, and deeper areas proposed for FGBNMS expansion (alternatives 4-5). The team needs to determine the ports of call for this expedition to minimize transit time to priority areas. The recommended ports of call in the Southeast Gulf of Mexico are Key West, St. Petersburg, Ft. Meyers and Naples. The recommended ports in the north are Gulfport, Pascagoula, Pensacola and Panama City. Etnoyer will develop a plan for this expedition, and Wagner will work on contracting an ROV for this cruise. The team needs to coordinate the shiptime to maximize days at sea and pursue a one-time contract to fund the ROV.

- Martha Nizinski has 17 days aboard the NOAA Ship *Pisces* on August 25-September 10, 2017. This is a continuation of the 2016 project in the North Carolina canyons (see above), and will again make use of the AUV *Sentry*.

- Funding for the second year of the two-year project to recover deep-sea coral records from past NCCOS activities in the U.S. Caribbean will be provided. Additionally, there is a 14-day cruise in April 2017 aboard the NOAA Ship *Nancy Foster*. This expedition could be supported with cruise participation by Wagner or Etnoyer to help with the taxonomy and quantification of deep-sea coral records.

**Outline of additional research projects** (Peter Etnoyer, Daniel Wagner and group discussion)  
**Research expeditions**

Since 2017 will focus largely on work in the Gulf of Mexico, 2018-2019 should target the U.S. Caribbean and South Atlantic Bight, and address fishery management council priorities in these

two areas. Andrew David and Stacey Harter could help with analyzing fish data from these cruises in 2018-2019. Etnoyer and his lab could help with analyzing coral data from these cruises. It is unknown what ships will be available for this work, and the group needs to strategize on how to get shiptime for work in these two regions. The NOAA Ship *Okeanos Explorer* will be back in the Atlantic in 2018, and could support this work. Additionally, shiptime aboard the NOAA Ship *Nancy Foster* should be requested for the U.S. Caribbean and South Atlantic Bight. The group emphasized that a coordinated strategy working across the various line offices (NMFS, NOS, OAR) should be employed to secure NOAA shiptime for work in these two regions in 2018-2019.

### ***Small projects***

- **Deep-sea coral habitat suitability maps for the U.S. Caribbean.** This project would be analogous to the project funded by the 2009-2011 DSCRTP initiative, which was led by Brian Kinlan and created maps for the Mid-Atlantic, South Atlantic and Gulf of Mexico. The product would consist of a short summary with a series of habitat suitability maps. Brian Kinlan would be a good candidate to lead this effort, and Wagner will consult with him on what he needs to conduct such an analysis for the U.S. Caribbean (mapping data, coral presence/absence data, environmental data, time, funding).

- **Species identification guide of deep-sea corals and sponges,** as well as their associates (fish and invertebrates). Such species guides have previously been produced for deep-sea organisms in Alaska and the Pacific Islands. These could be used as templates for a Southeast species guide. The group needs to develop a template and start compiling images on a shared space (e.g., Google Drive). Partnership with OER should be explored, given that they have created such a guide for the Pacific Islands. Potential products of this project could include both printed and online species identification guides, as well as new species descriptions published in the scientific literature.

- **GIS geodatabase of deep-sea explorations in Southeast Region** including mapping surveys, ROV and submersible dives, collected specimens, as well as existing and proposed MPAs. This information is already available in parts from various sources, but it should be consolidated into a single database. A similar database was developed as part of the CAPSTONE project in the Pacific Islands. It proved particularly useful in planning expeditions aboard the NOAA Ship *Okeanos Explorer*, since that vessel focuses on targeting unexplored areas. A GIS database of past deep-sea explorations in the Southeast Region would be particularly useful to guide activities of the NOAA Ship *Okeanos Explorer* when it returns to the Atlantic in 2018-2019, as well as other research expeditions.

- **Fishery/citizen science project with commercial deep-water snapper fishery.** The CFMC would like to see more work to involve commercial fishermen with collecting data on deep-sea coral, and the SEDCI could support a small project to equip fishermen with GoPro cameras or other data loggers. Jennifer Schull could take the lead on this project and work with the CFMC to identify specific fishermen to include in this project.

- **Data mining for deep-sea coral records in the U.S. Caribbean.** The DSCRTP has already funded this work for 2016-2017, and this could continue beyond that timeframe, depending on

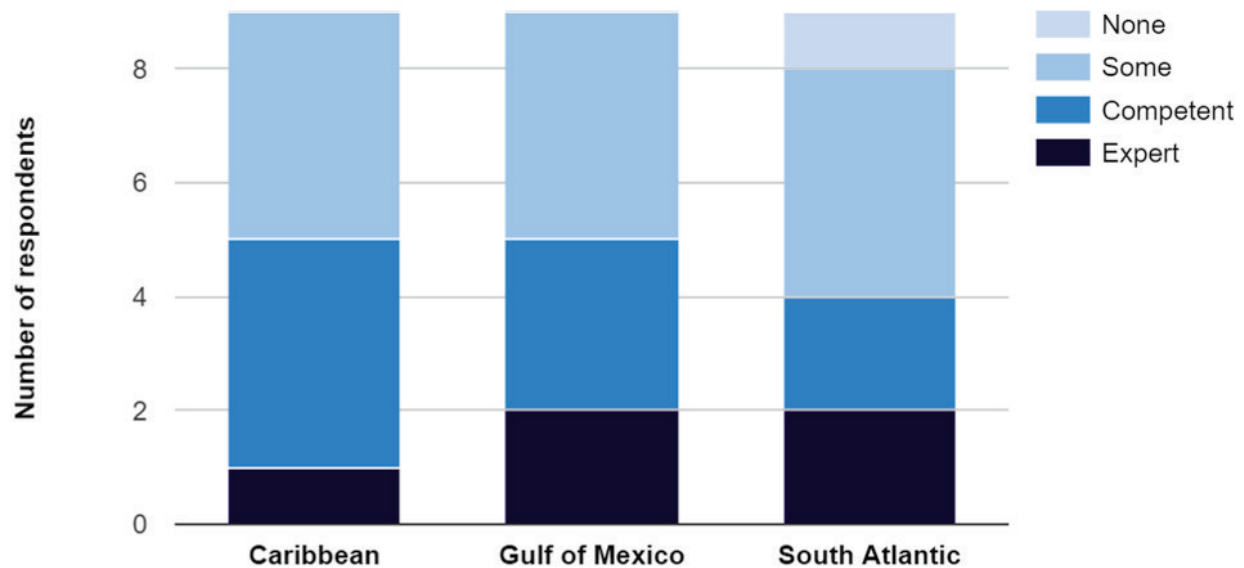
availability of funds. There is a tremendous amount of data available from past expeditions to the U.S. Caribbean aboard the NOAA Ship *Okeanos Explorer* in 2015 and the E/V *Nautilus* in 2013. This could be mined to retrieve records for the national database of deep-sea corals.

**- Environmental monitoring in deep-sea coral and sponge habitats.** The group concluded that the SEDCI should support some climate change work. A portfolio of low cost activities was proposed. For example, [TidBit temperature loggers](#) (\$250 cost, and 300 m depth rating) will be made available for anyone who is interested and has a way to deploy/retrieve them. Emma Hickerson will look into ways to obtain CTD data during ROV expeditions to the Northwestern Gulf of Mexico. Etnoyer and Wagner will explore an ocean acidification vulnerability assessment, and pursue additional opportunities with the University of Miami, the Pacific Marine Environmental Laboratory (PMEL), as well as other academic partners (e.g., Erik Cordes and Furu Mienis).

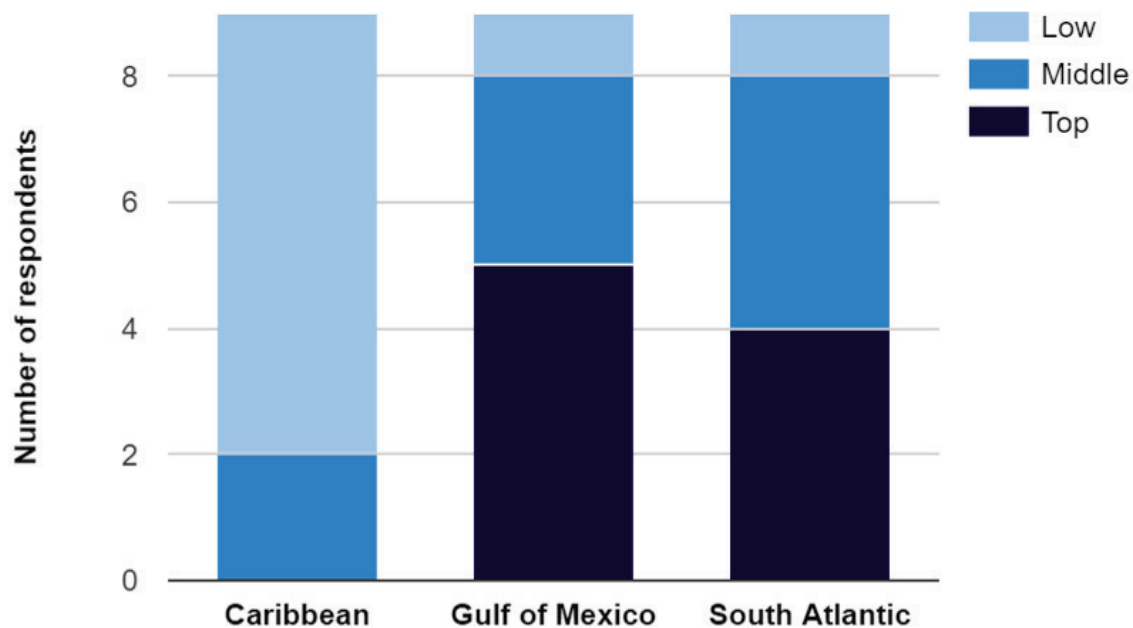


**Appendix B.** Results of a survey completed by science team members of the Southeast Deep Coral Initiative in October 2016. The survey was designed to help prioritize activities in each of the three geographic regions that the SEDCI will operate in 2016-2019.

*1) From 2016-2019 the NOAA Deep Sea Coral Research and Technology Program will fund a new research initiative in the Southeast Region, an area including U.S. federal waters of the Caribbean, Gulf of Mexico and South Atlantic. What is your level of expertise with working in these three geographic areas?*



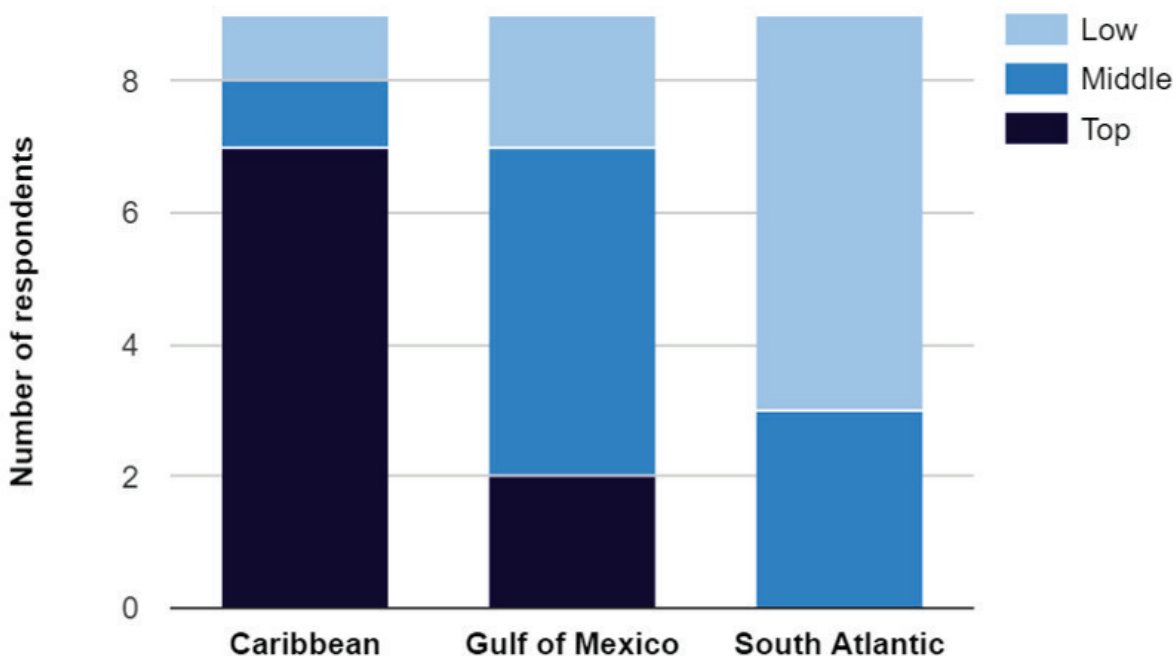
*2) Rank the three geographic regions in terms of where you perceive that Southeast Deep Coral Initiative could have the biggest impact on management of deep-water coral ecosystems in the short term (i.e., within 5 years).*



3) Provide a brief justification for your rankings in the previous question.

High ranking					
Caribbean	N/A				
Gulf of Mexico	- Specific HAPC and FGBNMS expansion proposals				
South Atlantic	- Most advanced management of deep-sea corals in region, which could be refined				
	- Leverage BOEM/USGS/OER partnership				
	- Existing momentum and successful track record for deep-sea coral management				
Low ranking					
Caribbean	- No specific management proposals under consideration				
	- Low threat from fishing				
	- More management challenges				
	- Lack of enforcement of some MPAs				
Gulf of Mexico	- Significant management efforts already underway				
South Atlantic	N/A				

4) Rank the three geographic regions in terms of where you perceive the concerted efforts by the Southeast Deep Coral Initiative will be most likely to answer these research questions in the short term (i.e., within 5 years).

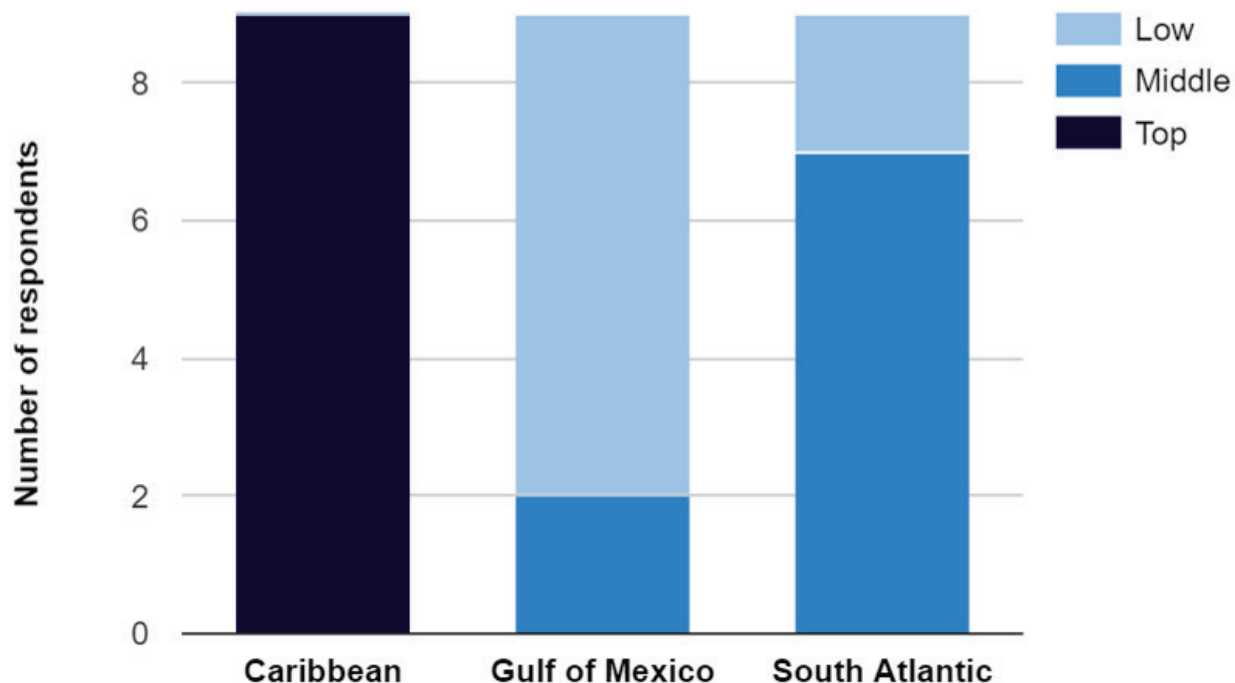


5) Provide a brief justification for your rankings in the previous question.

<i>High ranking</i>					
<b>Caribbean</b>	<ul style="list-style-type: none"> <li>- Questions specific enough that they could be answered (at least in part)</li> <li>- Questions are basic and could be answered by initiative</li> <li>- Largest knowledge gaps, but tools available to address questions</li> <li>- Smaller geographic area</li> </ul>				
<b>Gulf of Mexico</b>	<ul style="list-style-type: none"> <li>- Has best data density</li> <li>- Best infrastructure and availability of resources</li> </ul>				
<b>South Atlantic</b>	N/A				

<i>Low ranking</i>					
<b>Caribbean</b>	<ul style="list-style-type: none"> <li>- Worst infrastructure and availability of resources</li> </ul>				
<b>Gulf of Mexico</b>	<ul style="list-style-type: none"> <li>- Questions involve applying research to management</li> <li>- Questions too broad</li> </ul>				
<b>South Atlantic</b>	<ul style="list-style-type: none"> <li>- Questions on connectivity and community structure are difficult to address and require high sampling effort</li> <li>- Questions difficult to address and too broad</li> <li>- Questions relate to processes; while data could be collected to address these, they are difficult to answer</li> </ul>				

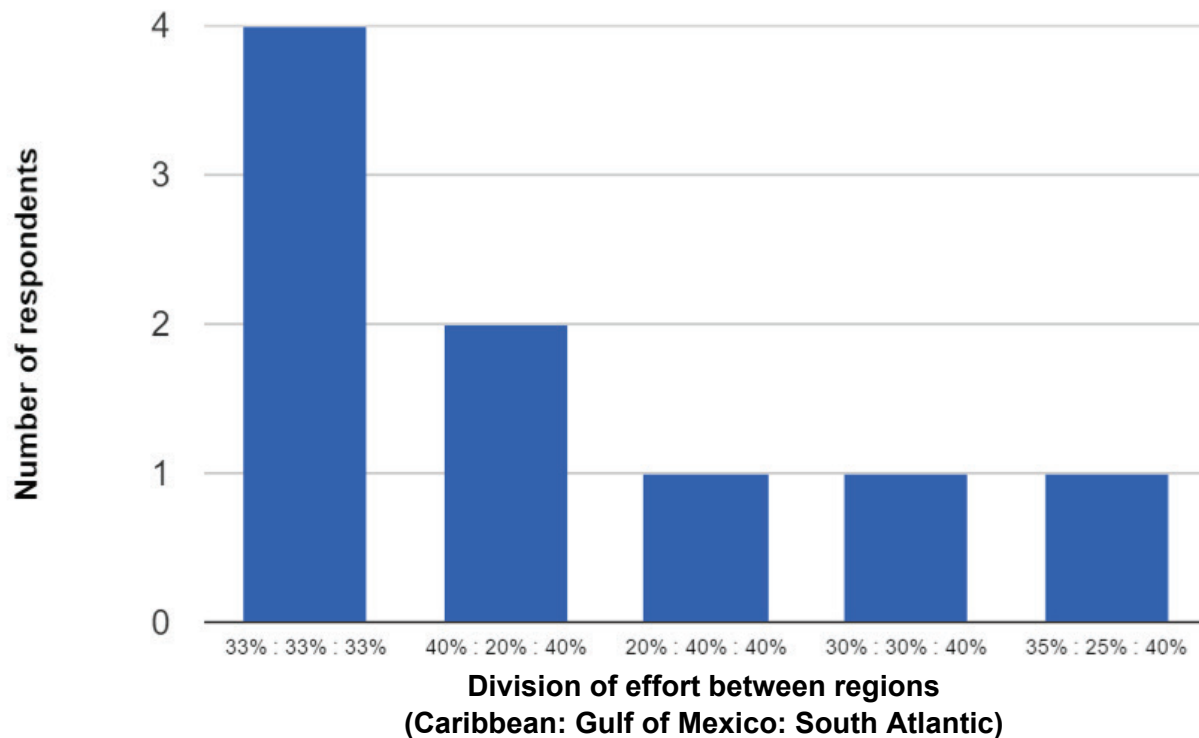
6) Rank the three geographic regions in terms of where you perceive the Southeast Deep Coral Initiative would have the biggest contribution to exploration?



7) Provide a brief justification for your rankings in the previous question.

<i>High ranking</i>					
<b>Caribbean</b>	- Least explored				
	- Many high priority areas have never been surveyed				
<b>Gulf of Mexico</b>	- Western Florida remains mostly unexplored				
<b>South Atlantic</b>	- Largest deep-sea coral reef in U.S., most of which remains unsurveyed				
<i>Low ranking</i>					
<b>Caribbean</b>	N/A				
<b>Gulf of Mexico</b>	- Extensively explored by previous efforts				
	- Extensive funding for explorations (BP settlement, RESTORE, Lophelia II)				
<b>South Atlantic</b>	- Focus of previous DSCRTP initiative				

8) *Considering your answers to all previous questions, how should the level of effort of the Southeast Deep Coral Initiative be divided to meet the management, research, and exploration priorities of the three geographic regions (Caribbean: Gulf of Mexico: South Atlantic)?*



9) *Is there anything else that you would like to add (e.g., comments, concerns) that we should consider when prioritizing activities of the Southeast Deep Coral Initiative in the coming years?*

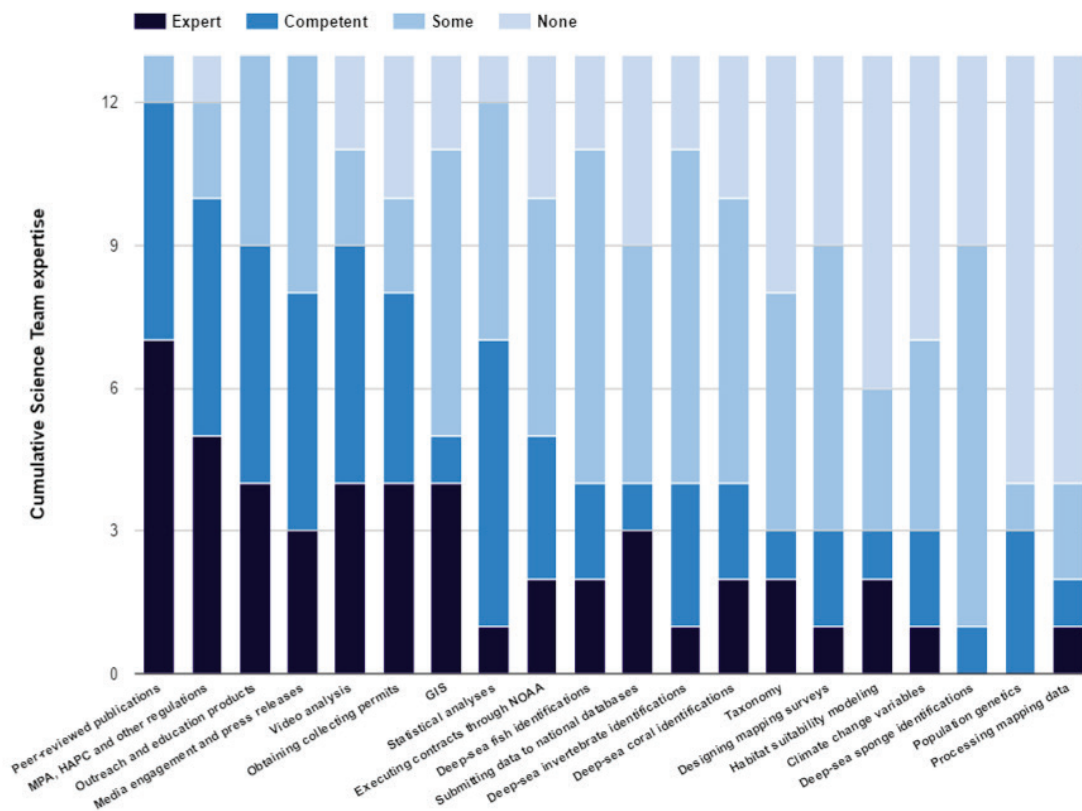
- We should strive to support equal efforts in the U.S. Caribbean, South Atlantic and Gulf of Mexico, but exploit all available resources (e.g., shiptime and partnerships), some of which will not be equally distributed between these areas.
- We should not use funding as a metric for calculating regional shares, we should use effort. We need to take advantage of research opportunities as they are presented (e.g., ships, ROVs, AUVs, other) rather than trying to force things into static percentages.
- The initiative should retain flexibility to take advantage of opportunities, especially opportunities to leverage additional funding or ship time.
- The most pressing region in terms of management is the Gulf, but the SA and Caribbean are more pressing in terms of research and exploration. The program should transition away from Gulf over the course of the initiative, using OER partnership to support work in the SA and Caribbean in 2018-2019.

**Appendix C.** Results of survey completed by science team members of the Southeast Deep Coral Initiative (SEDCI) in October 2016. The survey was designed to identify expertise and expertise gaps of the science team, as well as potential products that could be generated as part of SEDCI.

*1) Survey participants and fields of expertise.*

<b>Respondent</b>	<b>Affiliation</b>	<b>Expertise</b>
Emma Hickerson	NOS/ONMS	MPA regulations, outreach & education, collecting permits, video analysis
G.P. Schmahl	NOS/ONMS	MPA regulations, media engagement, outreach & education, video analysis, collecting permits, executing NOAA contracts
Tim Battista	NOS/NCCOS	GIS, designing mapping surveys and processing data, submitting data to databases, peer-reviewed publications, executing NOAA contracts
Peter Etnoyer	NOS/NCCOS	GIS, submitting data to databases, video analysis, coral IDs, peer-reviewed publications, habitat suitability models, collecting permits
Daniel Wagner	NOS/NCCOS	GIS, coral IDs, outreach & education, taxonomy, peer-reviewed publications, MPA regulations, collecting permits
Brian Kinlan	NOS/NCCOS	GIS, peer-reviewed publications, climate change, habitat suitability models, statistical analyses
Andrew David	NMFS/SEFSC	Video analysis, fish IDs, executing NOAA contracts, MPA regulations, collecting permits
Tom Hourigan	NMFS/DSC RTP	Submitting data to databases, peer-reviewed publications, MPA regulations
Stacey Harter	NMFS/SEFSC	Video analysis, fish IDs, peer-reviewed publications, MPA regulations
Martha Nizinski	NMFS/NSL	Video analysis, invertebrate IDs, peer-reviewed publications, media engagement, taxonomy
Amanda Netburn	OER/OEP	Peer-reviewed publications, media engagement, outreach & education
Heather Coleman	NMFS/DSC RTP	Peer-reviewed publications, outreach & education, MPA regulations
Jen Schull	NMFS/SEFSC	Peer-reviewed publications, media engagement, outreach & education, executing NOAA contracts, collecting permits

2) Please rank your level of expertise for each one of the following fields.



3) Are there any skill sets that you perceive as important to the success of the SEDCI that our science team currently lacks?

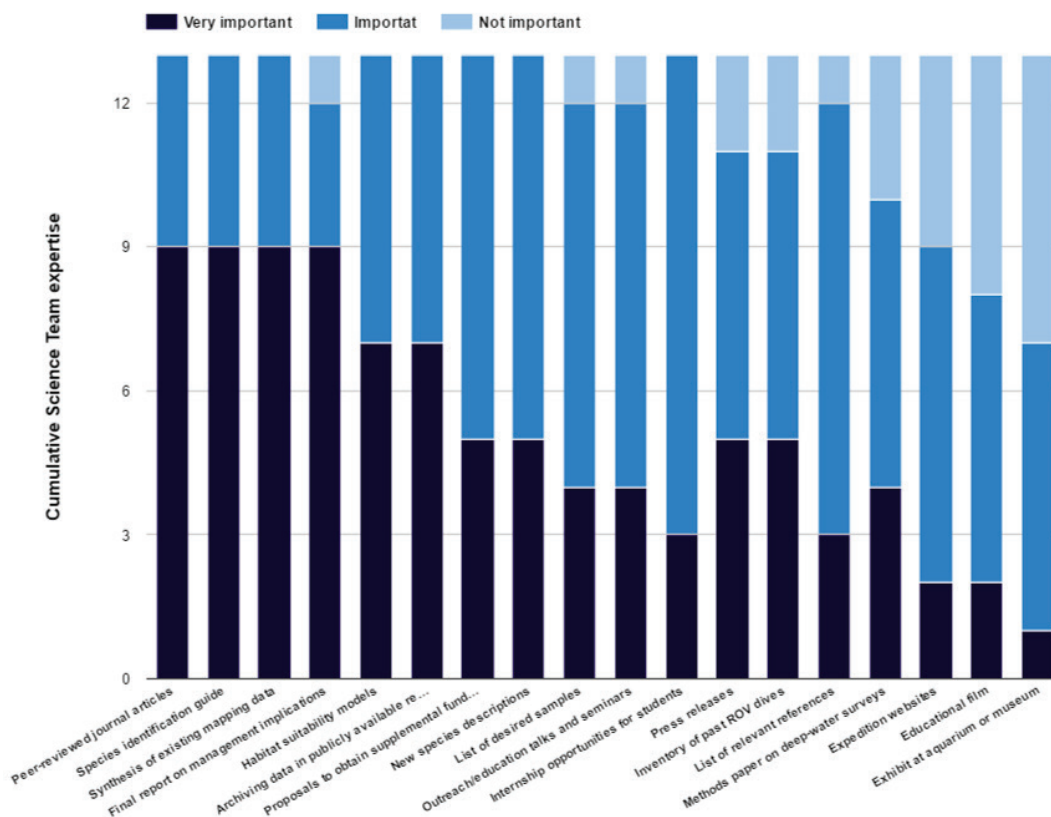
Expertise	TOTAL
Sponge taxonomy	3
Contacts in U.S. Caribbean	2
Outreach and media engagement	2
NOAA deadlines and regulations	1
Population genetics	1
Engagement of NOAA Fleet Allocation Council	1
Web design/hosting website	1



4) What people should we work with to gain the lacking skill sets you identified above?

Field of expertise	Expert
Contacts in U.S. Caribbean	Graciela García-Moliner; academic deep-sea experts
Sponge taxonomy	Shirley Pomponi; Henry Reiswig; other appropriate experts
Outreach and media engagement	OER media team; NOAA headquarters media staff
NOAA deadlines and regulations	NOAA administrative staff
Population genetics	Mercer Brugler; Cheryl Morrison; Meredith Everett; academic deep-sea experts
Engagement of NOAA Fleet Allocation Council	Jeremy Potter; OER; Mike Gallagher
Web design/hosting website	OER media team; qualified students

5) Consider the following products that could be produced as part of our initiative. How important do you think each one of these is to the success of our initiative?



*6) Are there any other tangible products you feel we should produce as part of this initiative?*

- Report and presentations to fishery management councils.
- Report and presentations to national marine sanctuaries.
- Model ground truthing, validation and accuracy assessments.
- Targeted new multibeam and backscatter surveys (particularly in SA and Caribbean).

**Appendix D.** Description of generalized methods used to characterize deep-sea coral habitat, prepared by Peter Etnoyer on behalf of the science team of the Southeast Deep Coral Initiative. Whenever possible, these methods will be employed to collect and process data on the diversity, abundance, extent and health of deep-sea coral and sponge communities.

### **ROV seafloor surveys**

The primary objectives during ROV seafloor surveys are to (1) document benthic fauna (i.e., corals, sponges and fish), (2) collect biological samples, and (3) conduct transects for quantitative analyses. During the period the ROV is on the bottom (i.e., on-bottom to off-bottom), the ROV should transit at <1 m altitude off the bottom, and speed over ground of less than 0.50 knots. The ROV may be equipped with one forward-looking video camera, one forward-looking still camera with strobes, and potentially one downward-looking still camera. Still- and downward-looking cameras are optional. At least one pair of lasers should be visible in the image frame at all times, for scale.

The advantage of digital still images is that they use strobe lighting for best depth of field, and provide high-resolution images with good visibility. In the absence of digital still cameras, framegrabs from the video may be used instead. Still images should be collected at regular intervals, approximately once every 5 sec, from a low-profile camera with parallel lasers in the frame for scale (e.g., 10 cm). Digital still images should be embedded with metadata that provide a time stamp from the digital camera, set to either local time or UTC. The time stamp can be used to match navigation and sensor data from the ROV to observations from the still images.

The video footage should be recorded continuously during the time the ROV is on the bottom, preferably with a video overlay showing longitude, latitude, depth, time, and date. The video camera should be mounted low on the ROV (low-profile), at an oblique angle, slightly downward-looking, in order to allow for the viewing of objects both near and far. This forward oblique video is typically used as the primary data source for subsequent analyses. A downward-looking camera with a separate pair of lasers may be incorporated for precise area measures, and consistency with other studies (e.g., Vinick et al. 2012), but this is not required.

### **Specimen collections**

A limited number of biological specimens will also be collected as vouchers during seafloor surveys using the manipulator arm of the ROV. For each collected specimen, the date, time, latitude, longitude, depth, and any available environmental data (e.g., salinity, temperature, and dissolved oxygen) should be recorded at the time of collection.

Once specimens are brought back onto the deck of the ship, they will be examined for commensal organisms, labeled, photographed and inventoried into a database containing all relevant metadata. Any commensal organisms found on the specimens will be separated from the sample and processed separately. Once photographed and labeled, biological samples will be preserved in non-denatured, 95% ethanol. After cruises, specimens will be sent to the National Museum of Natural History, Smithsonian Institution, for taxonomic identification, archival and permanent storage in their invertebrate collections.

## **ROV transects**

Densities of corals, sponges, and fish will be derived from a series of short ROV transects, ~5-15 min in duration each, corresponding to a linear survey distance of 80-300 m. During each ROV transect, the forward-looking video camera should maintain a wide, fixed frame, and avoid any panning, tilting, or zooming. The still and video cameras should be oriented in a forward oblique position with parallel lasers in the frame for scale (e.g., 10 cm). A down-looking camera oriented perpendicular to the substrate may also be employed during transects, but this is not required. If possible, 3-5 transects should be conducted during each dive, preferably over each predominant habitat type (e.g., soft bottom, hard bottom).

## **Quantification of survey data**

During laboratory analyses of video, all corals, sponges, and fish will be counted from still images and transect intervals. The size class and condition of corals and sponges are derived from a subset of still images (15 min) collected over the course of the dive.

In general, 10-12 benthic digital images will be collected each minute throughout the course of a dive, while the ROV is on the bottom. Each photo filename should be coded with corresponding UTC time and date code (using Stamp 2.8 by Tempest Solutions©) and imported into a MS Access database, which is linked to the ROV sensor and navigation data (e.g., coordinates and depth). Poor and unusable photos (e.g., blurred, black, off bottom) or overlapping photos are removed from the analyses. Images are analyzed by two methods: (1) species occurrence (presence/absence) in still images, and (2) density (number of organisms per 100/m<sup>2</sup>) in transects. Some common species can be identified to genus or species level, but many can often times only be identified to the level of family, order, class or even phyla.

The species occurrence data will be analyzed using an MS Access database. On bottom images are tagged for presence/absence of corals and sponges. Images with species present are tagged with relevant scientific names and counts. A random subset of images (15-20) will be imported into ImageJ software to measure height and width of colonies in each taxon, and to outline areas of injury (i.e., discoloration, bare branches). Health and condition will be assessed in PhotoQuad software using the following categorical for injury: 0 = <1 % injury; 1 = 1–10 % injury; 2 = 10–50 % injury; 3 = 50–90 % injury; and 4 = >90 % injury (White et al. 2012; Etnoyer et al. 2016).

The density of the benthic biota will be estimated from transects by processing the ROV transect data with VLC software. The parallel lasers will be used to calculate the area, or approximate area, of each transect or still image. All corals and sponges in the image with size class >10 cm will be identified to the lowest possible taxa level. Solitary cup corals (which were often quite abundant) will be quantified using the following values: 1 = few (1- 10 individuals), 5 = common (10-20 individuals), 10 = abundant (>20 individuals). Hydroidia and branching Scleractinia will be counted in clusters.

## **Statistical analyses**

The nonparametric analysis of similarity (ANOSIM) global R statistic (Clarke & Green 1988) is commonly employed to test the null hypothesis of no difference in species composition among treatments (e.g., depth, bottom type, locality) using non-metric multidimensional scaling techniques (nMDS) with an underlying Bray–Curtis similarity matrix based on species counts along transects. Similarity percentages (SIMPER) will be calculated using Bray–Curtis distance to identify the taxa contributing significantly to the differences observed. Multivariate analyses will be conducted using PRIMER 6.1 (Clarke & Gorley 2006). Univariate analyses employ the nonparametric Kruskal-Wallis statistic with Tukey’s honest significant difference (HSD) *post hoc* test to test the null hypothesis of no difference.

Density (number of organisms/m<sup>2</sup>) and percent cover are standard measures to quantify abundance. Density values for corals, sponges and fishes are required by DSC RTP-funded programs (Hourigan et al. 2015). Percent cover is an alternative measure determined by analyses of downward-looking images using Coral Point Count with Excel extensions (Kohler & Gill 2006). For this purpose, random points are overlaid on each image, then identified as biota or substrate type. Substrate categories include: soft bottom (unconsolidated sand, mud) and hard bottom, which can be subdivided into: rock (pavement, boulder, ledge), rock rubble (5-20 cm), coral rubble, and framework-building coral (standing coral colonies). Habitat classes may be modified for the region surveyed.

## **Submission of data**

All data will be exported from the MS Access database into a standard MS Excel template ([link](#)), which will then be submitted to the NOAA National Database of Deep-Sea Corals and Sponges (see section 7). The data schema will follow protocols outlined in Hourigan et al. (2015). Presence data will be hosted at the website for geo-referenced display in NOAA’s online map portal. The map portal is a comprehensive digital resource that displays museum records and field surveys in an interactive map environment for research and management applications. The resource is updated quarterly and linked through a map server to other federal and international data portals like the Ocean Biogeographic Information System.

## **Summary of ROV survey methods**

- During the period the ROV is on the bottom (i.e., on-bottom to off-bottom), the ROV should transit <1 m off bottom with a speed over ground of <0.50 knots, with lasers in frame, unless highlight videos are being collected for outreach purposes.
- Underwater video will be viewed in real time on the support vessel by biologists familiar with the local deep-water fauna; field notes will record locality, transect waypoints, weather conditions, ROV operations, and specimen collections.
- Still images will be captured with the digital still or video camera every 5 seconds, or ~12/ min depending on the recycling rates of the strobe.

- A few transects (3-5 transects) will be conducted intermittently during each dive, for a period of 5-15 min each, with a fixed camera and lasers in the frame. The distance covered during this time is approximately 80-300 m. Ideally, transects should occur at the beginning, middle, and near the end of a dive.
- In the laboratory, field notes, still and video images will be reviewed and compiled into an MS Access database, and used to annotate images for corals, sponges, fish, and benthic habitat.
- Still images with target species present will be analyzed using ImageJ and PhotoQuad software to determine size and condition of corals and sponges.
- Video transects will be used for density analysis of corals, sponge, and fish populations. Typically, only the organisms larger than 10 cm will be enumerated for density analysis.
- Down-looking images may be analyzed using Coral Point Count for habitat and percent cover.

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**Appendix E.** Description of species identification project.

**Species identification guide to the fauna associated with deep-sea coral and sponge ecosystems in the Southeast U.S. Region**

**1) Personnel**

***Lead investigators***

- Daniel Wagner, NOAA Affiliate, JHT, Inc. ([daniel.wagner@noaa.gov](mailto:daniel.wagner@noaa.gov))

***Project collaborators***

- Peter Etnoyer, NOAA National Centers for Coastal Ocean Science ([peter.etnoyer@noaa.gov](mailto:peter.etnoyer@noaa.gov))
- Andrew Shuler, NOAA Affiliate, JHT, Inc. ([andrew.shuler@noaa.gov](mailto:andrew.shuler@noaa.gov))
- John Reed, Harbor Branch Oceanographic Institute ([jreed12@fau.edu](mailto:jreed12@fau.edu))
- Emma Hickerson, NOAA Flower Garden Banks National Marine Sanctuary ([emma.hickerson@noaa.gov](mailto:emma.hickerson@noaa.gov))
- Marissa Nuttall, Flower Garden Banks National Marine Sanctuary ([marissa.nuttall@noaa.gov](mailto:marissa.nuttall@noaa.gov))
- Martha Nizinski, NOAA National Marine Fisheries Service National Systematics Laboratory ([martha.nizinski@noaa.gov](mailto:martha.nizinski@noaa.gov))
- Andrew David, NOAA Southeast Fisheries Science Center ([andy.david@noaa.gov](mailto:andy.david@noaa.gov))
- Stacey Harter, NOAA Southeast Fisheries Science Center ([stacey.harter@noaa.gov](mailto:stacey.harter@noaa.gov))

**2) Project duration**

***Start date:*** November 1, 2016

***End date:*** December 31, 2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Salary for data analyst and processing of collected coral specimens for taxonomic identification (possibly Andrew Shuler)
Travel	Travel to institutions with taxonomic expertise (e.g., National Museum of Natural History, Harbor Branch Oceanographic Institute) to consult with taxonomic experts

Funds are requested to pay the salary of a data analyst who will conduct the bulk of the work required to build the species identification guide. In addition to building the species identification guide, the data analyst will also process deep-sea coral samples that will be collected as part of the SEDCI using light and scanning electron microscopy, in order to refine taxonomic identifications. Additionally, we are requesting some travel money for this project, in order to travel to institutions with taxonomic expertise on deep-sea fauna (e.g., National Museum of Natural History, Harbor Branch Oceanographic Institute) and work with their staff.



#### **4) Project summary**

This project seeks to create a species identification guide of the most common fauna inhabiting deep-sea coral and sponge ecosystems in U.S. federal waters of the Southeast Region including the South Atlantic Bight, the Gulf of Mexico and the Caribbean. The guide will consist of *in situ* photos of deep-sea organisms (corals, sponges, fish, and arthropods) along with their taxonomic identification. These images will be shared with scientists participating in DSCRTP-funded fieldwork of the SEDCI in order to ensure that species names are used consistently throughout the effort. Furthermore, the species identification guide will be shared more widely via a web-accessible platform, in order to provide a tool that can be used by the broader scientific community, as well as for education and outreach purposes.

#### **5) Background and rationale**

The deep-sea fauna of the Southeast Region is poorly known and there are currently no species identification guidebooks available to help researchers identify species that occur in the region. Previous DSCRTP-funded fieldwork initiatives created species identifications guides to the [deep-sea sponges of Alaska](#), as well as the [deep-water benthic fauna of the Pacific Islands](#). Other international initiatives led by Natural History Museum have developed free iTunes-compatible applications like the [Deep-Sea ID Guide](#). These references provide an important baseline for future scientific studies by providing the technical and taxonomic framework required to explore questions on biogeographical distributions and other ecological questions. Recognizing the importance of these taxonomic references, participants of the 2015 priority scoping workshop identified the creation of a species identification guide as one of the top priorities for the SEDCI ([Schull et al. 2016](#)).

#### **6) Objectives**

The objective of this project is to create a photographic species identification guide of the most common fauna associated with deep-sea coral and sponge ecosystems in the Southeast Region. The guide will consist of high-quality, *in situ* photos of deep-sea corals and sponges, but may also contain images on their associated fauna, including fishes, arthropods, echinoderms, mollusks and other invertebrates. In addition to *in situ* photos, the guide will also include useful summary information on the geographic and depth distribution of the taxa. The guide will be shared with the Science Team of the SEDCI, as well as more broadly through a peer-reviewed publication (e.g., [Marine Sanctuaries Conservation Series](#), NOAA Technical Memorandum). Additionally, species photos and identifications will be submitted to the existing [Deep-Sea ID Application](#) and the [World Register of Deep-Sea Species \(WORDSS\)](#) for broad dissemination with scientists, educators and others interested in the taxonomy of deep-sea organisms, including collaborators working on other species identification catalogues for the North Atlantic.

#### **7) Approach and methods**

High-quality *in situ* photographs were collected by several previous deep-sea explorations in the Southeast Region. These include expeditions aboard the NOAA Ship *Okeanos Explorer* to Puerto Rico in 2015, the E/V *Nautilus* to Puerto Rico in 2013 and 2014, the R/V *Walton Smith* to Gulf of Mexico in 2014, the R/V *Falkor* to the Gulf of Mexico in 2012, the R/V *Seward Johnson* to the East Florida Shelf in 2005, as well as ongoing expeditions to the Flower Garden Banks National Marine Sanctuary aboard the R/V *Manta*. Images of these expeditions have either been secured and published already (e.g., octocorals in Etnoyer et al. 2016; Quattrini et al. 2014; black

corals in Opresko et al. 2016) or are available through the [OER Digital Atlas](#). Additional images of deep-water fauna will be collected during new research expeditions that will be undertaken as part of the SEDCI in 2016-2019. These images will be reviewed to select the highest quality images that show organisms inhabiting deep-sea coral and sponge ecosystems, focusing on habitat-forming taxa like corals and sponges, but also including their associates. These images will then be identified to the lowest possible taxon in consultation with taxonomic experts at various institutions including the National Museum of Natural History, Texas A&M University, Florida Atlantic University, Florida State University, the University of Puerto Rico and others.

Initially, image files will be named with the species name, depth in meters, location and photograph credit (e.g., *Carijoa riisei*, 62 m Roughtongue Reef, NOAA), and placed on a [shared Google folder](#) accessible to the Science Team of the SEDCI. For this purpose all species names will be checked against the [World Register of Marine Species](#). Prior to each expedition funded by the SEDCI, the complete set of images will be uploaded onto an iPad or other tablet to help onboard scientists with species identifications. For this purpose, images will be grouped by broad taxonomic groups (e.g., corals, sponges, arthropods and fish), as well as geographic area (i.e., Gulf of Mexico, South Atlantic, Caribbean) in order to facilitate identifications. Upon completion of the project, short descriptions of each species will be composed. The species descriptions and *in situ* photographs will then be summarized in a NOAA Technical Memorandum or alternative publication (e.g., [Marine Sanctuaries Conservation Series](#)).

## **8) Product deliverables and timeline**

<b><i>Product</i></b>	<b><i>Product recipient</i></b>	<b><i>Point of contact</i></b>	<b><i>Date completed</i></b>
Images of deep-sea organisms labeled with species names	Science Team and project collaborators via <a href="#">shared Google folder</a>	Science Team	Ongoing
iPad with images of deep-sea organisms labeled with species names	Cruise participants of DSCRTP-funded expeditions via uploading onto tablet	Shuler	Prior to each expedition
Submission of images to existing deep-sea species identification application	<a href="#">Deep-Sea ID application</a> <a href="#">World Register of Deep-Sea Species (WORDSS) website</a>	Wagner & Shuler	12/31/2019
Manuscript with species descriptions and photos	NOAA Technical Memorandum or alternate peer-reviewed publication (e.g., <a href="#">Marine Sanctuaries Conservation Series</a> )	Wagner, Shuler & Etnoyer	12/31/2019

## **9) Contingencies**

The project may require the availability of a dedicated data analyst as a point of contact (possibly Andrew Shuler at CCEHBR) to organize the species photos and synthesize these into a guide. This work could be ancillary to taxonomic identification of samples collected by research expeditions of the SEDCI. The project recognizes that some degree of taxonomic work will be necessary to achieve DSCRTP goals and objectives. Most of the image compilation work will be carried out directly by the lead investigators. If, however, a dedicated data analyst is not available to complete this project, then the PIs will make a concerted effort to identify a graduate student or other data analyst capable of completing this project. Additionally, this project will require assistance from taxonomic experts outside those of the Science Team of the SEDCI. A preliminary list of outside experts with taxonomic expertise of deep-sea fauna is listed in the table below. While no funds are available to support these taxonomic experts, we will try to consult with them to review our species identifications for taxonomic integrity.

<i><b>Taxonomic expert</b></i>	<i><b>Affiliation</b></i>	<i><b>Taxonomic group</b></i>	<i><b>Email</b></i>
Mary Wicksten	Texas A&M University	Arthropods	<a href="mailto:wicksten@bio.tamu.edu">wicksten@bio.tamu.edu</a>
Bob Van Syoc	California Academy of Sciences	Arthropods	<a href="mailto:bvansyoc@calacademy.org">bvansyoc@calacademy.org</a>
Stephen Cairns	National Museum of Natural History	Corals	<a href="mailto:cairnss@si.edu">cairnss@si.edu</a>
Dennis Opresko	National Museum of Natural History	Black corals	<a href="mailto:dmopresko@hotmail.com">dmopresko@hotmail.com</a>
Tina Molodtsova	P.P. Shirshov Institute of Oceanology	Black corals	<a href="mailto:tina@ocean.ru">tina@ocean.ru</a>
Scott France	University of Louisiana at Lafayette	Gorgonians	<a href="mailto:france@louisiana.edu">france@louisiana.edu</a>
Les Watling	University of Hawaii	Gorgonians	<a href="mailto:watling@hawaii.edu">watling@hawaii.edu</a>
Amy Baco-Taylor	Florida State University	Corals	<a href="mailto:abacotaylor@fsu.edu">abacotaylor@fsu.edu</a>
John Reed	Florida Atlantic University	Corals & sponges	<a href="mailto:jreed12@fau.edu">jreed12@fau.edu</a>
Sandra Brooke	Florida State University	Corals	<a href="mailto:sbrooke@fsu.edu">sbrooke@fsu.edu</a>

<i><b>Taxonomic expert</b></i>	<i><b>Affiliation</b></i>	<i><b>Taxonomic group</b></i>	<i><b>Email</b></i>
Chris Kelley	University of Hawaii	Sponges	<a href="mailto:ckelley@hawaii.edu">ckelley@hawaii.edu</a>
Chris Mah	National Museum of Natural History	Echinoderms	<a href="mailto:mahch@si.edu">mahch@si.edu</a>
Charles Messing	Nova Southeastern University	Echinoderms	<a href="mailto:messingc@nova.edu">messingc@nova.edu</a>
Henry Reiswig	University of Victoria	Sponges	<a href="mailto:hmreiswig@shaw.ca">hmreiswig@shaw.ca</a>
Rob Van Soest	Naturalis Biodiversity Center	Sponges	<a href="mailto:rob.vansoest@naturalis.nl">rob.vansoest@naturalis.nl</a>
Shirley Pomponi	Florida Atlantic University	Sponges	<a href="mailto:spomponi@fau.edu">spomponi@fau.edu</a>
Konstantin Tabachnick	P.P. Shirshov Institute of Oceanology	Sponges	<a href="mailto:tabachnick@mail.ru">tabachnick@mail.ru</a>
Ken Sulak	U.S. Geological Survey	Fishes	<a href="mailto:ksulak@usgs.gov">ksulak@usgs.gov</a>
Andrea Quattrini	Harvey Mudd College	Fishes & gorgonians	<a href="mailto:aquattrini@g.hmc.edu">aquattrini@g.hmc.edu</a>

*Appendix F.* Description of geodatabase project.

**Creation of a Geographic Information Systems (GIS) geodatabase of past deep-sea explorations and managed area boundaries in the Southeast Region**

**1) Personnel**

***Lead investigators***

- Tim Battista, NOAA Biogeography Branch ([tim.battista@noaa.gov](mailto:tim.battista@noaa.gov))
- Daniel Wagner, NOAA Affiliate, JHT, Inc. ([daniel.wagner@noaa.gov](mailto:daniel.wagner@noaa.gov))

***Project collaborators***

- Randy Clark, NOAA Biogeography Branch ([randy.clark@noaa.gov](mailto:randy.clark@noaa.gov))
- Chris Jeffrey, NOAA Biogeography Branch ([chris.jeffrey@noaa.gov](mailto:chris.jeffrey@noaa.gov))
- Sarah Hile, NOAA Biogeography Branch ([sarah.hile@noaa.gov](mailto:sarah.hile@noaa.gov))
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- Heidi Burkart, NOAA Biogeography Branch ([heidi.burkart@noaa.gov](mailto:heidi.burkart@noaa.gov))
- Jacob Howell, NOAA Biogeography Branch ([jacob.howell@noaa.gov](mailto:jacob.howell@noaa.gov))
- Katie Watson, NOAA Biogeography Branch ([katie.watson@noaa.gov](mailto:katie.watson@noaa.gov))
- Dan Dorfman, NOAA Biogeography Branch (Task Manager) ([dan.dorfman@noaa.gov](mailto:dan.dorfman@noaa.gov))

**2) Project duration**

***Start date:*** November 1, 2016

***End date:*** December 31, 2017

**3) Types of costs associated with the project**

No additional funds are requested from the DSCRTP for this project, as the salaries and fringe benefits for both PIs are already covered through NCCOS and DSCRTP. Similarly, salaries and benefits for the project collaborators are covered through the Gulf of Mexico Restore Act Project. Furthermore, the PIs and collaborators already have access to computers with GIS software, and therefore no additional equipment or supplies are required.

**4) Project summary**

This projects seeks to create a web-accessible GIS geodatabase that includes information from previous deep-sea explorations in the Southeast Region, including (1) submersible/ROV dives, (2) mapping surveys, (3) museum collections of deep-sea corals and sponges, (4) deep-sea coral habitat suitability models, and (5) boundaries of marine managed areas. This geodatabase will be used to guide the research efforts of the SEDCI throughout the region. Specifically, the geodatabase will be used to identify areas targeted by past research efforts in the Southeast Region, and areas which need to be sampled, surveyed and mapped to meet the objectives of the SEDCI.

**5) Background and rationale**

Reviewing past research efforts is the first step in any research program. We therefore propose to conduct a thorough review of past deep-sea surveys in the Southeast Region, and compile this information into a GIS geodatabase that will be openly accessible via an online mapping service (e.g., ESRI online). In comparison to past research initiatives by the DSCRTP, the 2016-2019

SEDCI will target a much larger geographic area that includes the federal waters of the U.S. South Atlantic, Caribbean and Gulf of Mexico. The region includes several deep-sea areas that have been surveyed by previous dedicated efforts. For instance, the South Atlantic was the focus of a previous DSCRTP initiative in 2009-2011, during which several areas were mapped and surveyed. Additionally, some areas in the Gulf of Mexico were targeted by previous efforts, including the *Lophelia* II study in 2008-2012 and efforts following the *Deepwater Horizon* spill starting in 2010. Similarly, the U.S. Caribbean contains deep-sea areas that were mapped by NCCOS. Reviewing the spatial distribution of these past efforts will allow the science team to guide future research activities. Specifically, the GIS geodatabase will allow for the design of field surveys that build on existing datasets and avoid unnecessary duplication of past efforts. Additionally, boundary information for both existing and proposed marine managed areas will also be included in the GIS geodatabase, thereby allowing the design of studies that are relevant to the management of deep-water coral and sponge ecosystems throughout the Southeast Region.

## **6) Objectives**

The objective of this research project is to build a GIS geodatabase that contains information on previous deep-water explorations in the Southeast Region, as well as boundaries of existing and proposed marine managed areas (i.e., national marine sanctuaries, habitat areas of particular concern, essential fish habitat and other marine protected areas in state and federal waters). Specifically, information on (1) previous submersible/ROV dives, (2) mapping surveys, (3) museum collections of corals and sponges, (4) deep-sea coral habitat suitability models, and (5) marine managed area boundaries will be incorporated into a single GIS geodatabase that will be made available online and distributed to managers and scientists.

## **7) Approach and methods**

Parts of the information that will be compiled into the unified GIS geodatabase are already available from several sources that are described below. Relevant information will be downloaded from each of these sources and incorporated into a unified GIS geodatabase. Once the GIS geodatabase is assembled, it will be uploaded onto a web service for wide distribution. The bulk of the workload for this project will be performed by the project collaborators under the guidance of the project PIs. Approaches for each dataset are briefly described below.

### ***ROV/submersible dives***

We will create an Excel table that contains the following fields for each past ROV/submersible dive in the Southeast Region: (1) ROV/submersible name, (2) dive number, (3) date, (4) start latitude, (5) start longitude, (6) maximum depth, (7) locality, (8) chief scientist name. For this purpose, we will review cruise reports of previous deep-sea expeditions that included ROV or manned submersibles dives in the Southeast Region (e.g., [Partyka et al. 2007](#), [Ross 2009](#), [Sedberry & David 2010](#), [Ross & Brooke 2010](#), [Reed et al. 2011](#), [Reed et al. 2011b](#)), as well as dive site lists available for the *HOV Alvin*, the *ROV Mohawk* and *ROV Phantom*, the *ROV Kraken*, and other deep-water vehicles through the [OER Digital Atlas](#) and other sources. ROV dive site locations conducted in and around the Flower Garden Banks are available through their [interactive map](#). Additionally, we will contact scientists that have previously worked in the region (e.g., John Reed, Andy David, Emma Hickerson, Steve Ross, Sandra Brooke, Eric Cordes, Andrea Quattrini) to update our inventory of ROV and submersible dive site locations in the Southeast Region.



### ***Mapping data (side-scan and bathymetry)***

A large portion of previous mapping surveys in the [South Atlantic](#) and [Caribbean](#) have already been synthesized by NCCOS. Mapping data syntheses for the Flower Garden Banks National Marine Sanctuary, as well as the proposed expansion areas, are available through the [Flower Garden Banks interactive map](#). Additional bathymetry data from the region is available for download from the [NCEI Bathymetry Database](#) and the [OER Digital Atlas](#). Multibeam bathymetry data and side-scan sonar data from the Southeast Region will be downloaded from these sources. Each one of these datasets will then be merged into a separate GeoTIFF file in order to reduce the file sizes.

### ***Undersea feature names***

Place names and point locations for banks, mounds, basins and canyons are well established for the Northwestern Gulf of Mexico. Resources include [GEBCO Place Names](#), Texas A&M University, FGBNMS online GIS, [GulfBase](#) and [NOAA Data Catalog](#).

### ***Unnamed West Florida geological features detected in multibeam data since 2000***

Topographic features on West Florida Shelf (presumably *Lophelia* mounds) were derived from multibeam data collected by the NOAA Ship *Okeanos Explorer* and David Naar (University of South Florida), and these point features were classified based on relief and topographic position index. The features could be named, or coded, and enumerated, explored and characterized. Some additional work remains to be done. The shapefile is [available](#) from a study aboard the NOAA Ship *Okeanos Explorer* in 2014 with Stephanie Farrington, Brian Kinlan and Peter Etnoyer.

### ***National Database of Deep-Sea Corals***

Many deep-sea coral specimen collections and submersible observations are already available through NOAA's [National Database of Deep-Sea Corals](#). For this purpose, corals will be defined as cnidarians within the Classes Anthozoa and Hydrozoa, family Stylasteridae.

### ***Undocumented museum specimens***

We will create an Excel table that contains the following fields for each deep-sea coral or sponge specimen that is archived in museum collections: (1) museum name, (2) specimen number, (3) species identification, (4) collection date, (5) latitude, (6) longitude, (7) depth, (8) locality, and (9) collector. Additionally, we will query the online invertebrate collections at the [National Museum of Natural History \(Smithsonian Institution\)](#), the [Florida Museum of Natural History](#), the [California Academy of Sciences](#), the [Yale Peabody Museum](#), and the [Harvard Museum of Comparative Zoology](#) in order to retrieve records of deep-sea (>50 m) corals and sponge specimens contained within these collections. Furthermore, we will attempt to compile all deep-sea coral and sponge records housed at the [Marine Invertebrate Museum at the University of Miami](#). Those collections are not yet digitized, but might become searchable in the future pending funding requests by the museum. Once the Excel table has been populated with the museum collection of all of these museums, it will be imported into ArcGIS.

### ***Deep-sea coral habitat suitability models***

Deep-sea coral habitat suitability maps were created for both the [South Atlantic](#) and [Gulf of Mexico](#) as part of a previous initiative funded by the DSCRTP. These datasets will be



downloaded and converted into a GeoTIFF file that shows areas of high, medium and low deep-sea coral habitat suitability.

***Marine managed areas (and proposed expansion areas)***

GIS data on marine managed areas in the Southeast Region will be downloaded from the [NOAA MPA Center](#). The data structure of that file be used to add established marine managed areas from other sources including the [South Atlantic Fishery Management Council](#), the [Gulf of Mexico Fishery Management Council](#) and the [Caribbean Fishery Management Council](#). The latter represents a link to a set of coordinates that will need to be converted into a polygon. Additionally, we will add proposed Habitat Areas of Particular Concern (HAPC) for the Gulf of Mexico, which are available through the [Gulf of Mexico Fishery Management Council](#), and proposed expansion areas of the [Flower Garden Banks National Marine Sanctuary](#). The latter link contains a set of coordinates that will need to be converted into polygons of the proposed sanctuary expansion areas.

**8) Product deliverables and timeline**

<b><i>Product</i></b>	<b><i>Product recipient</i></b>	<b><i>Point of contact</i></b>	<b><i>Date completed</i></b>
Excel table with deep-sea coral and sponge records from the National Database	Project personnel	Daniel Wagner	November 15, 2016
Excel table with museum specimens of deep-sea corals and sponges	Project personnel	Daniel Wagner	November 15, 2016
Shapefiles with boundaries existing and proposed marine managed areas	Project personnel	Daniel Wagner	November 15, 2016
Excel table with ROV/submersible dives	Project personnel	Daniel Wagner	November 15, 2016
Shapefiles with existing habitat suitability models of Gulf of Mexico and South Atlantic	Project personnel	Daniel Wagner	November 15, 2016
Inventory of existing mapping datasets in Southeast Region (bathymetry and backscatter)	Project personnel	Project collaborators	TBD
GeoTIFF with existing mapping data in Southeast Region (see inventory above)	Project personnel	Project collaborators	TBD
GIS geodatabase (all datasets, desktop accessible)	Science Team	Tim Battista and Daniel Wagner	June 2017
Web-accessible GIS geodatabase	ESRI online	Ken Buja	July 1,

<i>Product</i>	<i>Product recipient</i>	<i>Point of contact</i>	<i>Date completed</i>
			2017
Distribution of link to web-accessible GIS geodatabase	DSCRTP, FGBNMS, Councils	Daniel Wagner	July 31, 2017
Submission of new deep-sea coral and sponge records to the National Database	DSCRTP	Daniel Wagner	December 31, 2017
Gap analysis of existing specimens of ongoing haplotype diversity studies ( <i>Swiftia</i> and <i>Hypnogorgia/Muricea pendula</i> ) to determine areas that need to be sampled	Peter Etnoyer	Daniel Wagner	July 31, 2017
Gap analysis of multibeam data in FGBNMS expansion areas to determine what areas need to be mapped	Science Team	Project collaborators	July 31, 2017
Comparison of existing habitat suitability models (Kinlan et al. 2013) to areas with known occurrences of important taxa ( <i>Lophelia</i> , <i>Leiopathes</i> , etc.)	Science Team	Daniel Wagner	July 31, 2017

Retrieval of the data from the above mentioned sources will commence in November 2016. These datasets will then be compiled into a GIS geodatabase that is expected to be completed prior to the start of the 2017 fieldwork season in April 2017. The GIS geodatabase will then be uploaded for wide distribution via an online mapping service (e.g., ESRI online), which will be completed by July 2017. Once uploaded, a link to the online geodatabase will be widely distributed to deep-sea coral managers and scientists in the Southeast Region, including the DSCRTP, the SEDCI Science Team, fishery management councils, and national marine sanctuaries. Additionally, all deep-sea coral and sponge records contained within the GIS geodatabase will be compared to the [National Database of Deep-Sea Corals](#). Any records that are not contained within the national database will be submitted to the DSCRTP by the end of 2017.

## **9) Contingencies**

The only foreseeable problem that could arise is the availability of the project collaborators due to other duties. In that case, as much of the work as possible will be carried out directly by the PIs. If the collaborators become entirely unavailable, then the PIs will make an effort to identify a graduate student or other data analysts capable of completing this project. In such a scenario, funds will be requested in order to cover the salary and benefits for a dedicated analyst in 2017.

**Appendix G.** Description of environmental monitoring project.

**Environmental Monitoring in Southeast U.S. Deep-Sea Coral Habitats**

**1) Personnel**

***Lead investigators***

- Peter Etnoyer, NOAA National Centers for Coastal Ocean Science ([peter.etnoyer@noaa.gov](mailto:peter.etnoyer@noaa.gov))

***Project collaborators***

- Emma Hickerson, NOAA FGBNMS ([emma.hickerson@noaa.gov](mailto:emma.hickerson@noaa.gov))

- Marissa Nuttall, Flower Garden Banks National Marine Sanctuary ([marissa.nuttall@noaa.gov](mailto:marissa.nuttall@noaa.gov))

- Kim Yates, USGS, ([kyates@usgs.org](mailto:kyates@usgs.org))

- Leslie Wickes, Southeast Ocean and Coastal Acidification Network ([lesliewickes@secoora.org](mailto:lesliewickes@secoora.org))

- Derek Manzello, NOAA AOML ([derek.manzello@noaa.gov](mailto:derek.manzello@noaa.gov))

**2) Project duration**

***Start date:*** August 1, 2016

***End date:*** August 31, 2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Salary for data analyst
Equipment	Rental of CTD rosette
Supplies	Sensors, syntactic foam, reflective tape, nylon rope, dive weights and zip ties for construction of temperature loggers; costs of laboratory water chemistry for OA parameters = pH, TA, DIC, salinity, nutrients.
Travel	Federal travel to and from CHS and MIA

NOAA lead investigators may be able to contribute in-kind salary and benefits in exchange for new data that supports ongoing initiatives. Funds for the CTD-rosette are proposed for NOAA Ship *Nancy Foster* in 2017 and 2018. Matching funds are from the on-board CTD rosette on NOAA Ship *Okeanos Explorer*. The anticipated supplies include (1) materials to construct 9-12 new temperature loggers for deployment in Flower Garden Banks and the U.S. Caribbean; and (2) costs of laboratory water chemistry to measure and report OA parameters (pH, TA, DIC, salinity, nutrients) for 12-24 water column profiles collected over the course of the 2-year field research timeframe.

#### **4) Project summary**

Our work will help establish a baseline to assess seasonal environmental change in the Western Atlantic deep sea. Warming seas and acidifying oceans are a source of concern for fisheries management and marine conservation, but too little information is available from deep-sea coral environments to assess the vulnerability of corals to deep-water climate change and the vertical range and extent of any threats to coral health.

This project proposes standard, low-cost methods to measure temperature at mesophotic depths (30-150 m) and aragonite saturation in deeper water (300-1500 m) adjacent to deep-water coral aggregations in order to generate new public data. Warming seas are among the top threats facing the oceans, but few temperature sensors are deployed in deep water (> 30-40 m) coral environments, and few ROV surveys are conducted to assess the health of deep-water corals. Ocean acidification has been identified as a problem for deep-sea scleractinian corals. The high acidity and high dissolved inorganic carbon of the deep-sea coral environments (200-1500 m) of the Loop Current and the Gulf Stream ecosystems make this a natural laboratory to study the effects of ocean acidification on deep-sea organisms.

We propose to monitor environmental changes in mesophotic zone reef ecosystems in Flower Garden Banks and the U.S. Caribbean. The project will assess natural and anomalous temperature cycles in order to determine the biological response and vulnerability of these organisms to ocean warming. We also propose to study the health and condition of deep-sea *Lophelia pertusa* scleractinian corals in the South Atlantic Bight to assess potential evidence of a shoaling aragonite saturation horizon that may threaten these ecosystems now or in the future.

#### **5) Background and rationale**

Deep-sea corals and sponges are sensitive animals subject to several natural stressors, such as fluctuations in temperature, dissolved oxygen, and carbonate saturation, as well as anthropogenic stressors like sedimentation and oil pollution. Natural variability is poorly documented in and around deep-sea coral environments, and is one of the first steps in trying to understand how deep-sea coral ecosystems will be impacted by climate change. To address this problem, this project will generate new high-quality, *in-situ* environmental data in the Southeast Region, clean and process the data using software filters, and then make them publicly available through NOAA web portals with ancillary metadata.

The SEDCI will benefit from the environmental monitoring project through increased human capacity to measure climate change parameters in deep water and through better understanding of the potential impacts of climate change on deep-sea coral ecosystems. The project addresses specific climate-related research questions posed by experts to the scientific committee during the scientific workshop in St. Petersburg, Florida in November 2015.

#### **6) Objectives**

This project will deploy 9-12 new temperature sensors in the Flower Garden Banks region and the U.S. Caribbean, from 40-150 m depth, in order to extend the vertical range of present studies over the course of 1-2 years. The data will augment ongoing shallow-water temperature records to answer the question, how deeply in the water column do surface anomalies penetrate?

The project will repeatedly deploy a CTD-rosette to 1500 m depth for a series of water column profiles from the shelf break to the shelf slope collected over a two-year time frame. Funds are requested to finance the costs of laboratory water chemistry for ocean acidification parameters (pH, TA, DIC, salinity, nutrients) for 12-24 water column profiles (100-200 water samples) collected over the course of the two-year field research time frame.

## **7) Approach and methods**

This project will deploy several new temperature loggers in the Flower Garden Banks region and the U.S. Caribbean, in order to extend the vertical range of present monitoring studies associated with Coral Reef Watch. The loggers will be deployed over the side of the boat or with an ROV in a low-relief area with few obstructions. The loggers will be recovered using an ROV or burn wire releases. Temperature data will be downloaded and plotted for reports, then uploaded to public repository at [NOAA Coral Reef Watch website](#).

The SEDCI ocean acidification project plans to deploy a CTD-rosette to 1500 m depth for a series of water column profiles at intervals on the order of 5, 25, 50, 100, 150, 250, 500, 1000, 1500 m depth aboard the NOAA Ship *Nancy Foster* expedition in August 2017. Samples will also be opportunistically collected aboard the NOAA Ship *Okeanos Explorer* in 2018 and 2019, if possible. Water samples will be shipped following established safety guidelines by the United States Geological Survey (USGS) for water chemistry measures, working in coordination with Southeast Ocean and Coastal Acidification Network (SOCAN).

A workshop held by SOCAN in March 2017 established shellfish (primarily oysters), shallow and deep coral reefs as key species for environmental monitoring of aragonite saturation in marine environments. The SOCAN workshop specifically identified a need to collect water samples directly adjacent to cold-water scleractinian corals. This was identified as the top priority for deep-sea corals. Sampling at *Lophelia pertusa* reefs (300-800 m depth) and *Oculina vericosa* reefs (~80-100 m) off the coast of Melbourne, FL and near the Gulf Stream are a priority. Water and biological samples could be feasibly accomplished using the ROV *Deep Discoverer* aboard the NOAA Ship *Okeanos Explorer*. Dr. Kim Yates (USGS) can provide supplies needed for water sampling, including chemicals, and can analyze samples for carbonate chemistry. Through this SEDCI project, aragonite saturation data will be downloaded and plotted for reports and then uploaded to public repository at AOML. The project will seek partnerships with the NOAA Ocean Acidification program, SOCAN, and others, in order to leverage additional resources for this project and accomplish shared goals.

## **8) Product deliverables and timeline**

<b><i>Product</i></b>	<b><i>Product recipient</i></b>	<b><i>Point of contact</i></b>	<b><i>Date completed</i></b>
OA records for AOML database	NOAA AOML	Derek Manzello	August 2019
Temperature data	NOAA Coral Reef Watch	Mark Eakin	August 2019

Datasets of aragonite saturation to 1500 m depth, long-term datasets of temperature change over 1-2 years, CTD plots, temporal plots, site characterization reports.

### **9) Contingencies**

The availability of a CTD-rosette is one limitation, but should be overcome by good planning. Weather is a contingency, but a CTD-rosette can be deployed in higher sea states and under marginal conditions that might prevent the launch of an ROV. Loss of temperature loggers is a possibility, but we will deploy duplicates and map their coordinates precisely. Equipment malfunctions are always possible.

*Appendix H.* Description of modeling support project.

**Modeling support for the Southeast Deep Coral Initiative**

**1) Personnel**

***Lead investigators***

Matthew Poti, NOAA/NOS/NCCOS Affiliate ([matthew.poti@noaa.gov](mailto:matthew.poti@noaa.gov))

Tim Battista, NOAA/NOS/NCCOS Federal ([tim.battista@noaa.gov](mailto:tim.battista@noaa.gov))

***Project collaborators***

Peter Etnoyer, NOAA/NOS/NCCOS Federal ([peter.etnoyer@noaa.gov](mailto:peter.etnoyer@noaa.gov))

Laughlin Siceloff, NOAA/NOS/NCCOS Affiliate ([laughlin.siceloff@noaa.gov](mailto:laughlin.siceloff@noaa.gov))

Randy Clark, NOAA/NOS/NCCOS Federal ([randy.clark@noaa.gov](mailto:randy.clark@noaa.gov))

Bryan Costa, NOAA/NOS/NCCOS Federal ([bryan.costa@noaa.gov](mailto:bryan.costa@noaa.gov))

**2) Project duration**

***Start date:*** 1/17/2016

***End date:*** 12/31/2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Federal FTE travel	Travel for Federal personnel to participate in model testing/validation and related mapping cruises, and regular trips to Charleston and Stennis Space Center for face-to-face meetings among collaborators and their staff. Some travel will be supported by NCCOS base.
Contract labor	Equivalent of 1 mid-level predictive modeling /spatial analyst working at 50% time per year for four years (split cost with contributions from NCCOS discretionary & reimbursable sources).
Contract travel	Travel for contract personnel to participate in model testing/validation and related mapping cruises, and regular trips to Charleston and Stennis Space Center for face-to-face meetings among collaborators and their staff (split cost with contributions from NCCOS base, discretionary & reimbursable sources).
Contract computing resources	Pro-rated cost of computing time and data storage on our high-performance cluster computing facility in the Microsoft Azure cloud. Substantial amount supported by NCCOS and NOS CIO base and discretionary funds.

Funds are requested from DSCRTP to support application and testing of predictive habitat models as part of the SEDCI. This effort will include (1) the application of existing predictive habitat models developed at NCCOS from 2011-2013 to site selection and cruise planning, (2)



the development of new models to bring all three sub-regions of the Southeast to a similar level, (3) the testing and validation of model predictions, and (4) the use of models to help synthesize and generalize results of field surveys. Models are expected to serve as a valuable integrative tool for the SEDCI.

To these ends, funds are requested for contract labor support at NCCOS for new model development where required, model application to field site selection and evaluation, and model validation. Funds are requested for contract high-performance computing services to support development of new predictive habitat models for the U.S. Caribbean and *Leiopathes* model for the Gulf of Mexico. Funds are also requested for contract and federal travel for planning and coordination related to predictive habitat modeling, as well as to serve as members of the science team on certain key research cruises where model testing/validation is identified as a primary research goal.

This project takes advantage of substantial external resources to reduce costs to DSCRTP. The reason for this is leveraging of substantial resources from the base, discretionary, and reimbursable components of NCCOS's portfolio, as well as past DSCRTP investments. NCCOS funding sources that will contribute to this leverage include:

- NCCOS Reimbursable: BOEM SE Deep Coral
- NCCOS Reimbursable: BOEM Gulf Deep Coral
- NCCOS Base: NCCOS/CCMA base will provide support for federal FTE salaries, federal and some contract travel, some contract computing, and all supplies/equipment as described in the budget table above
- NCCOS Discretionary: NCCOS discretionary funds will be sought to supplement contributions from reimbursable sources to contract labor and travel and contract computing resources

Past DSCRTP investments that will be leveraged to reduce the cost of the present proposal include:

- Gulf of Mexico Deep Sea Coral Modeling studies (FY12, FY13)
- Gulf of Mexico Deep Coral/Fishing Effort Overlap study (FY15)
- U.S. South Atlantic Deep Sea Coral Modeling study (FY11)
- Deep Coral Data Rescue in U.S. Caribbean (FY15, FY16)

#### **4) Project summary**

The goal of this project is to support a comprehensive integration of predictive habitat modeling results into the SEDCI. Existing deep-sea coral habitat models developed at NCCOS for the U.S. South Atlantic and Gulf of Mexico will be supplemented by development of a similar set of models for the U.S. Caribbean, and one additional important genus model (*Leiopathes* spp.) for the Gulf of Mexico and South Atlantic. This will bring modeling in all three sub-regions of the Greater Southeast to a common level. Subsequently, models will be used to help select sites for

exploration, with a goal of testing and validating model predictions, developing a model accuracy assessment, and helping to synthesize and generalize field survey results into a broader spatial context useful for conservation and management planning. Finally, models will be overlaid with summaries of fishing effort for fisheries with potential deep-sea coral habitat impacts, in order to identify areas of spatial overlap between fishing and coral habitat, and thereby enhance usefulness of both models and field surveys to deep-sea coral habitat management and conservation.

## **5) Background and rationale**

Because of the patchy nature of deep-sea coral distribution and the time and expense of deep-sea coral habitat exploration, models are essential tools to generalize from field survey results to the comprehensive spatial information needed for effective deep-sea coral habitat management and conservation. Predictive habitat modeling combines large suites of potential habitat variables with data on deep-sea coral presence locations in order to create predictive maps of the relative suitability of different areas for the different deep-sea coral groups of interest and management regions. Such maps have proven useful both to the ocean exploration and deep-sea coral science communities and to fishery management councils and other management and conservation planning bodies over the past 5 years. However, the utility of such models is greatly increased when predictions have been field tested (ground truthed) in order to validate models and to present a rigorous quantitative assessment of model performance (accuracy assessment). Such information also contributes to improved future models.

Over the period from 2011-2013, NCCOS developed deep-sea coral predictive habitat models for the U.S. South Atlantic and Gulf of Mexico sub-regions of the Greater Southeast. These included most of the deep-sea coral groups of interest and importance to the DSCRTP and fishery management councils. However, one important group was not modeled for the Gulf of Mexico due to lack of data: *Leiopathes* spp. Due to additional data collected since 2013, a *Leiopathes* model is now possible and will be developed as part of this project. Also, no regional deep-sea coral models currently exist for the U.S. Caribbean, but an FY15-FY16 DSCRTP funded small project and recent work by the NOAA Ship *Okeanos Explorer* has made U.S. Caribbean deep-sea coral models possible. Thus, the same methods used by NCCOS to develop the Southeast and Gulf of Mexico deep coral habitat models will be used to develop a similar set of models for the U.S. Caribbean.

Once deep-sea coral models have been synchronized across sub-regions through the efforts above, we will coordinate with field survey PIs to test, validate, and develop accuracy assessments of models throughout the Southeast Region. We will also provide tools for evaluating potential sites of maximum conservation concern by overlaying patterns of bottom fishing with deep-sea coral habitat predictions, building on an FY15 DSCRTP small project for the Gulf of Mexico. This will enable targeting of field surveys in areas of maximal management and conservation impact, as well as placing field survey results in a broad, integrative spatial context with direct links to management and conservation spatial planning.

## **6) Objectives**

See above.

## **7) Approach and methods**

The MaxEnt presence-only modeling approach for deep-sea coral predictive habitat modeling is described in detail in Bauer et al. 2016 and Kinlan et al., in review. This approach is identical to that used to develop previous models in the U.S. South Atlantic and Gulf of Mexico. This same approach will be used to develop a *Leiopathes* model for the Gulf of Mexico and models of deep-sea coral taxonomic groups of interest in the U.S. Caribbean.

Poti has previously conducted model accuracy assessment and integration of model predictions with regional field survey efforts in the U.S. Northeast/Mid-Atlantic (2012-2015), in the U.S. South Atlantic (2014-2016; for hard-bottom model predictions developed using the same MaxEnt method), and in the Gulf of Mexico (2014 NOAA Ship *Okeanos Explorer* cruises). Model performance will be assessed by receiver operating characteristic (ROC) curve analysis, assessment of positive and negative predictive value, and other model accuracy statistics useful in the application of model results. Testing these models will enhance their value to fishery management councils and other planning bodies tasked with deep-sea coral management/conservation.

Methods for overlaying fishing effort patterns with deep-sea coral model predictions are described in a forthcoming report (expected February 2017) on the FY15 DSCRTP funded small project on fishing effort and predicted deep-sea coral habitat overlap in the Gulf. The same methods will be broadened to areas where similar data exist in the U.S. Caribbean and South Atlantic.

## **8) Product deliverables and timeline**

<b><i>Product</i></b>	<b><i>Product recipient</i></b>	<b><i>Point of contact</i></b>	<b><i>Date completed</i></b>
<i>Leiopathes</i> spp. predictive habitat model for Gulf of Mexico	DSCRTP, SEDCI Research Coordinator, Expedition leads	Matt Poti	February 2017
Predictive habitat models for U.S. Caribbean deep-sea coral taxonomic groups of interest	DSCRTP, SEDCI Research Coordinator, Expedition leads	Laurie Bauer, Tim Battista	February 2018
Plan for model testing and validation	DSCRTP, SEDCI Research Coordinator, Expedition leads	Matt Poti	April 2017

<b><i>Product</i></b>	<b><i>Product recipient</i></b>	<b><i>Point of contact</i></b>	<b><i>Date completed</i></b>
Results of model testing and validation: accuracy assessment, report on reliability of model predictions of deep-sea coral habitat based on independent field ground truthing	DSCRTP, SEDCI Research Coordinator, all involved PIs, fishery management council contacts, other users of models	Matt Poti	Summer/Fall 2020 (after all field work completed and analyzed)
Report, maps and statistics on overlap of predicted deep-coral habitat suitability and bottom fishing effort in the Greater Southeast region (where required data available)	DSCRTP, SEDCI Research Coordinator, all involved PIs, fishery management council contacts, other users of models in fishery management context	Laughlin Siceloff	February 2017 (Gulf of Mexico) December 2017 (U.S. South Atlantic) May 2018 (U.S. Caribbean)

## **9) Contingencies**

We have significant flexibility to coordinate our contract labor around changes in the timing of cruises. Any delays to the modeling timeline will immediately be communicated to the SEDCI Science Team to determine if other projects will be affected. It will be relatively easy to mitigate such delays because of the flexibility of our cloud computing resources which allow us to complete modeling tasks more rapidly if necessary by allocating more cloud resources during crunch periods.

*Appendix I.* Description of fishery/citizen science project.

**Exploration of benthic habitats in Puerto Rico using underwater cameras deployed by deep-water snapper fishermen**

**1) Personnel**

***Lead investigators***

Jennifer Schull, NOAA Southeast Fisheries Science Center ([jennifer.schull@noaa.gov](mailto:jennifer.schull@noaa.gov))

***Project collaborators***

Steven G. Smith, University of Miami ([sgsmith@rsmas.miami.edu](mailto:sgsmith@rsmas.miami.edu))

**2) Project duration**

***Start date:*** Jan 1, 2017

***End date:*** Dec 31, 2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Salary and benefits for data analyst in 2019
Supplies	10 GoPro cameras and housings + shipping

It is likely that we can procure GoPro cameras from NOAA or partner offices, but that is undetermined at this point.

**4) Project summary**

This project will work collaboratively with Puerto Rican deep snapper fishery to deploy low-cost, simple underwater video cameras along with deep-water line-fishing gear to explore bottom habitats associated with these deep-water fisheries. The goal of the project is to use a simple, low-cost method to glean some introductory information about important deep-water habitats to help focus more in-depth habitat characterization research in the future.

**5) Background and rationale**

Very little is known about the deep-water habitats of the U.S. Caribbean, yet there is a lucrative, thriving deep-water snapper and grouper fishery in the region that depends on productive deep-water habitats. In the priority setting workshop for the SEDCI, the CFMC expressed that one of their priorities was to better understand the habitats underlying the deep-water snapper and grouper fishing grounds. Likewise, the NOAA Deep Sea Coral Research and Technology Program focuses on conserving important deep-water coral and sponge communities associated with fisheries.

The SEDCI has embraced a tiered approach for this program need. The first tier will be to use a low-cost, simple technology, working collaboratively with fishermen, to get a snapshot of the habitats targeted by this fishery. With the information learned from this project, the science team can evaluate the best way to explore and characterize target habitats with more sophisticated mapping and visualization gear. By working collaboratively with the fishing community and in partnership with the University of Miami, RSMAS, we hope to gain rapport and trust with the fishery and contribute to the sustainability of these important fishery resources. The fisheries we will target with this project are the deep-water snapper fisheries in Puerto Rico. Silk, vermillion and black-fin snapper are targeted at the 30-150 m range, and queen snapper are targeted in the 150-450 m range.

## **6) Objectives**

The goal of the project is to use a simple, low-cost method to glean introductory information about important deep-water habitats in U.S. Caribbean waters to help focus more in-depth habitat characterization research in the future.

## **7) Approach and methods**

We will partner with the University of Miami, RSMAS to conduct this project. Steve Smith is a Saltonstall-Kennedy Grantee working on a project to design a fishery-independent sampling program for the deep-water fisheries of Puerto Rico. We will partner with this project by providing low-cost, simple video cameras to deploy with fishing gear during the experimental phase of the Saltonstall-Kennedy project (Jan-Feb 2017) when the PIs and their contractors are observing fishing operations to define a standard fishing sample. Experimental fishing is slated to occur for eight days (~4 sites per day) in the waters east, north and west of Puerto Rico where the fishery traditionally operates. The hope is that camera deployments will provide a view of the habitats being targeted by this fishery.

This project bears uncertainty, however, because we are still (1) exploring appropriate camera housings and connection methods to drop with the fishing gear, and (2) uncertain if there will be enough ambient light at depth to see the underlying habitat. From similar projects we anticipate that we may have visibility in the 150-300 m range, especially during mid-day. However, the potential benefits of the project outweigh the risks. By partnering with the Saltonstall-Kennedy project, we drastically reduce the cost of conducting this small project and increase the probability of success in multiple habitats. Furthermore, any habitat data we may assimilate from this project will be of high use for prioritizing future mapping and characterization work in the region. Finally, if the project is successful, it could easily be expanded or replicated in future years to obtain additional information. Salary for a data analyst is requested in the 2019 budget for this purpose.

## **Potential Gear to use includes:**

Hooker Electric Housings: in-line with fishing activity:

<http://hookerelectric.com/more-hooker-electric-products/deep-sea-camera-housing/>

Group B Aluminum Housings (rated to 1,500 m):

<https://www.tindie.com/products/GroupBinc/extreme-depth-underwater-housing-for-gopro/>

Group B Go Benthic Housings (rated to 2,600 m rating):

<https://www.tindie.com/products/GroupBinc/gobenthic-specialized-camera-housing-for-gopro/>

Deep Golum (rated to 300 m):

<http://www.golemgear.com/p-658-deep-golem-gopro2-camera-housing-rated-to-1000ft.aspx>

<http://www.golemgear.com/p-686-gopro3-deep-housing-for-hero3-camera-rated-to-1000ft.aspx>

Nimar deep dive housing (rated to 200 m):

[https://www.bhphotovideo.com/c/product/1140433-](https://www.bhphotovideo.com/c/product/1140433-REG/nimar_nihero_underwater_deep_dive_housing.html/mode/gsa)

[REG/nimar\\_nihero\\_underwater\\_deep\\_dive\\_housing.html/mode/gsa](https://www.bhphotovideo.com/c/product/1140433-REG/nimar_nihero_underwater_deep_dive_housing.html/mode/gsa)

## **8) Product deliverables and timeline**

<i><b>Product</b></i>	<i><b>Product recipient</b></i>	<i><b>Point of contact</b></i>	<i><b>Date completed</b></i>
Video footage of habitats associated with deep-water snapper fishing areas in Puerto Rico	Matt Dornback, NCEI	Jennifer Schull	TBD
Narrative describing visible habitats and organisms from video footage	Robert McGuinn, DSC RTP	Jennifer Schull	Within 6 months of data collection

## **9) Contingencies**

As mentioned above, this project does have risks. It is possible that turbidity or insufficient ambient light will preclude the collection of usable video footage. Camera gear may be lost. Bad weather may delay the project but will likely not cancel it.



**Appendix J.** Description of HBOI data mining project.

**Translation of HBOI deep-sea coral and sponge records for National Database**

**1) Personnel**

***Lead investigators***

John Reed, Harbor Branch Oceanographic Institute ([jreed12@fau.edu](mailto:jreed12@fau.edu))

***Project collaborators***

Peter Etnoyer, NOAA NCCOS ([peter.etnoyer@noaa.gov](mailto:peter.etnoyer@noaa.gov))

Jennifer Schull, NOAA Southeast Fisheries Science Center ([jennifer.schull@noaa.gov](mailto:jennifer.schull@noaa.gov))

Thomas Hourigan, NOAA DSCRTP ([tom.hourigan@noaa.gov](mailto:tom.hourigan@noaa.gov))

**2) Project duration**

***Start date:*** May 12, 2016

***End date:*** December 31, 2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary	Salary and benefits for data analysts John Reed and Stephanie Farrington
Fringe benefits	HBOI fringe benefits
Indirect costs	HBOI indirect cost rate
Administration	HBOI administrative cost rate

**4) Project summary**

This project will support personnel to review, analyze, and compile previously collected video and still image data from benthic surveys of deep-sea coral and sponge communities (azooxanthellate deep-water corals and sponges that occur deeper than 50 m depth) that were collected during NOAA-funded research expeditions in order to incorporate these observations into the National Database of Deep-Sea Corals and Sponges.

**5) Background and rationale**

Data mining of existing data records is a very low cost alternative to collecting new data and was identified as a top priority during the science priorities workshop (Schull et al. 2016).

**6) Objectives**

The primary goal of this project will be to compile records of the presence of deep-water (>50 m depth) sponges and anthozoans from the cruise data archived with HBOI-FAU (John Reed, data

manager) for a subset of NOAA-funded cruises conducted since 2011, and to format those records in a manner that is consistent with DSCRTP database standards and requirements.

## **7) Approach and methods**

The schema for the database is summarized in Hourigan et al. (2015). Records of interest include all habitat forming deep-sea corals (Cnidaria: Anthozoa [Scleractinia, gorgonian Octocorallia, alcyonacean Octocorallia, Antipatharia, Pennatulacea]; and Hydrozoa [Stylasterina]) and sponges (Porifera: Calcarea, Hexactinellida, Demospongiae, Homoscleromorpha). Key parameters of interest include metadata (e.g., PI, contact info, survey ID), vessel, vehicle, date, time of observation, dive number, depth, longitude, latitude, taxonomic identification to lowest taxa possible, with abundance (as counts, density or cover), habitat type, and other notes on observation or sample as available.

Priority datasets include:

1. 2011 DSCRTP-funded cruises:
  - 2011- CIOERT FLoSEE II, Leg 2; NOAA Ship *Nancy Foster*/UConn *Kraken II* ROV: SE U.S., Pourtales Terrace, Florida.
  - 2011 - NOAA Fisheries and CIOERT; NOAA Ship *Pisces* UNCW *Phantom* ROV and NOAA Fisheries *Arc* ROV – SE U.S.-North Florida MPA, *Lophelia* coral site (now incorporated into the CHAPC), northern *Oculina* coral sites (now incorporated into the *Oculina* HAPC), *Oculina* HAPC, St. Lucie Hump MPA, and Miami Terrace (CHAPC).
2. Records of corals or sponges associated with habitats and dives cited in Reed et al. (2013) that are accessible in the CIOERT archives and database. This paper summarized the most extensive data sets for deep-sea coral habitats in the region (147 sites with 241 HOV and ROV dives off SE Florida,) and represents an invaluable historical record. Only records for HBOI/CIOERT NOAA-funded cruises will be analyzed. The majority of these observations are not yet incorporated into the National Database.
3. Records of azooxanthellate corals and sponges from other NOAA-funded research cruises in which John Reed served as PI, including:
  - 2011- CIOERT FLoSEE II, Leg 1 NOAA Ship *Nancy Foster*/UConn *Kraken II* ROV: Pulley Ridge, Gulf of Mexico.
  - South Atlantic Shelf Edge MPA cruises - Three cruises conducted from 2012 to 2014: NOAA Ship *Pisces* Cruise 12-03, July 6-19, 2012; NOAA Ship *Pisces* 13-03, July 2-11, 2013; and NOAA Ship *Nancy Foster* Cruise 14-08; June 18-27, 2014.
4. Other data sets identified by John Reed as appropriate, e.g.,
  - Records from HBOI/JSI dives in *Lophelia* habitats in SW Florida escarpment.

This project will not involve the re-analysis of video and photos. Rather, this project will query the existing HBOI database, and retrieve deep-sea coral and sponge records that have not yet been submitted to the National Database of Deep-Sea Coral and Sponges. Once those records are identified, they will be reformatted and prepared for submission to the national database using the NOAA DSCRTP data management standards (see Hourigan et al. 2015).

**8) Product deliverables and timeline**

<i><b>Product</b></i>	<i><b>Product recipient</b></i>	<i><b>Point of contact</b></i>	<i><b>Date completed</b></i>
New deep-sea coral and sponge records for the National Database	DSCRTP	John Reed	December 31, 2017

**9) Contingencies**

N/A

**Appendix K.** Description of NCCOS data mining project.

**Data-mining deep-sea coral records from ROV missions to the U.S. Caribbean**

**1) Personnel**

***Lead investigators***

Tim Battista, NCCOS Biogeography Branch ([tim.battista@noaa.gov](mailto:tim.battista@noaa.gov))

***Project collaborators***

Brian Costa, NCCOS Biogeography Branch ([brian.costa@noaa.gov](mailto:brian.costa@noaa.gov))

Alyson Kuba, USEC OED ([alyson.kuba@noaa.gov](mailto:alyson.kuba@noaa.gov))

**2) Project duration**

***Start date:*** May 12, 2016

***End date:*** December 31, 2017

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Contract costs to data analysts that will conduct the bulk of this project.

**4) Project summary**

This project will review previously collected ROV data at depths between 50-300 m in the U.S. Caribbean. Deep-sea coral and sponge records from the video data will be retrieved and formatted for submission to the National Database of Deep-Sea Coral and Sponges.

**5) Background and rationale**

In preparation for the DSCRTP field survey focus on the U.S. Caribbean in future years, it is critical to ensure that as many existing records of deep-sea corals are extracted from imagery, quality controlled, and formatted for entry into the National Database of Deep-Sea Corals and Sponges. Over the past decade the NCCOS Biogeography Branch, working with partners at the University of the Virgin Islands, University of Puerto Rico, and the USVI and PR Departments of Natural Resources, has collected a large number of video transects from ROVs operating at depths from 50-300 m. Working with these partners, we propose to classify, extract, QA/QC, and properly format deep-sea coral records from the available database of ROV imagery. Battista and Costa have extensive experience in classification of imagery, identification of corals in the region, and extraction of ancillary oceanographic and physical habitat variables. Their expertise in these procedures will link with partners' expertise in the deep-sea coral taxonomy and ecology of the region, as well as the field conditions and survey design that accompanied collection of this dataset.

## **6) Objectives**

The NCCOS data archives include ROV data collected during NCCOS-supported expeditions to the U.S. Caribbean using the ROV *Mohawk* and *Phantom* in 2005-present. These data archives will be reviewed, and coral and sponge records will be formatted for submission to the National Database of Deep Sea Coral and Sponges.

## **7) Approach and methods**

Standardized identification, classification, and accuracy assessment methods will be employed, and all data will be collated in DSCRTP format and submitted for ingestion into the National Database (Hourigan et al. 2015). Given the large volume of imagery to be processed and the goals of the DSCRTP program, efforts related to this proposed funding will be focused on 1) the deepest records, 2) azooxanthellate corals, and 3) particularly on gorgonians, stylasterids, and black corals for which data are scarce in the U.S. Caribbean Region.

## **8) Product deliverables and timeline**

<i><b>Product</b></i>	<i><b>Product recipient</b></i>	<i><b>Point of contact</b></i>	<i><b>Date completed</b></i>
Catalog of all surveys to be processed with basic metadata	DSCRTP	Tim Battista	One month after funds received
Analysis plan developed in conjunction with DSCRTP, Biogeography Branch, Council, and Partners	DSCRTP	Tim Battista	Two months after funds received
Brief interim report on data mining progress	DSCRTP	Tim Battista	6 months after funds received
Database of extracted coral records provided in DSCRTP format for review	DSCRTP	Tim Battista	10 months after funds received
Coordinate expert review of extracted records	DSCRTP	Tim Battista	TBD
Final submission of reviewed extracted records in DSCRTP format with updated methods/results	DSCRTP	Tim Battista	12-18 months after funds received

## **9) Contingencies**

N/A

**Appendix L.** Description of FGBNMS data mining project.

**Data mining deep-sea coral records from ROV missions to the FGBNMS**

**1) Personnel**

***Lead investigators***

Travis Sterne, NOAA FGBNMS ([travis.sterne@noaa.gov](mailto:travis.sterne@noaa.gov))

***Project collaborators***

- Emma Hickerson, NOAA FGBNMS ([emma.hickerson@noaa.gov](mailto:emma.hickerson@noaa.gov))
- Marissa Nuttall, NOAA FGBNMS ([marissa.nuttall@noaa.gov](mailto:marissa.nuttall@noaa.gov))
- George Schmahl, NOAA FGBNMS ([george.schmahl@noaa.gov](mailto:george.schmahl@noaa.gov))

**2) Project duration**

***Start date:*** May 12, 2016

***End date:*** April 30, 2019

**3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Salary and benefits cover one person for 15 hours per week, and a second person for 5 hours per week. A nominal amount is assigned as in-kind for oversight of contracting for project staff.
Supplies	Miscellaneous supplies.
Travel	Travel to Smithsonian to continue taxonomic work with Dennis Opresko.

**4) Project summary**

NOAA's Flower Garden Banks National Marine Sanctuary has been investigating the Northwestern Gulf of Mexico since 2001 and possesses an extensive record on mesophotic coral ecosystems that exist in the region. Environmental data and geo-referenced photos of benthic habitat and biology existing from previous investigations, as well as investigations scheduled to take place in 2017 and 2018 will be used to generate habitat characterizations maps, as well as predictive habitat models in the Northwestern Gulf of Mexico. While a significant amount of data has been generated, there continues to be expansive areas that remain unmapped and lack ground truthing evidence. The planned cruises will help fill in some of these data gaps following DSCRTP protocols.

The underwater features for which habitat characterization maps will be generated include the following banks: Horseshoe, MacNeil, Rankin, 28 Fathom, Bright, Geyer, Elvers, McGrail, Sonnier, Bouma, Bryant, Rezak, Sidner, Alderdice and Parker.

## **5) Background and rationale**

The historical data used for this project include over 25,000 images collected during more than 400 hours of ROV bottom time by the FGBNMS and its partners. Outside the collection of multibeam and backscatter data, over \$550,000 has been invested in this process. These data have been critical for the efforts by the FGBNMS to put forth a proposal to expand the boundaries of the sanctuary in order to protect these habitats. At present, the biological data have carried the proposal, but the development of habitat maps will assist discussions and efforts in initiating broader protection. The project will further habitat characterization schemes in the Northwestern Gulf of Mexico, as well as aid the FGBNMS in identifying additional areas that may contain ecologically important habitats and species. The SEDCI will receive quantitative habitat data useful for improving the understanding of benthic habitats and populations in the region.

## **6) Objectives**

The primary objectives for this project include to (1) conduct habitat data analysis of historic photo transects collected at the sites listed above, (2) conduct analysis on imagery collected in planned 2017/2018 cruises according to the FGBNMS habitat scheme, (3) generate habitat maps that accurately represent the environments found on the seafloor features of interest using a habitat suitability model, and (4) input density and species data into the DSCRTP data portal.

## **7) Approach and methods**

Existing and planned (2017-2018) geo-referenced data and photographs will be analyzed for biological zone, major habitat, and biology and classified according to the current FGBNMS habitat schema. Habitat data will then be correlated to the geospatial characteristics of their locations. These characteristics will include: (1) longitude, (2) depth, (3) standard deviation of depth, (4) slope, (5) standard deviation of slope, (6) slope difference from the mean, (7) aspect variation, and (8) depth range within 20 m<sup>2</sup>. Additionally, mixed modeling will be applied to the ground truthing survey data to develop predictive habitat suitability maps.

DSCRTP protocols have been and will be followed during the 2016/2017/2018 cruises:

- 3-5 ROV transects at each dive location
- 5 minute transects @ 0.9 km/h, at ~1 m altitude, ~100 m in length
- Collect 15-20 images during each dive, documenting major taxa, with reference lasers at the base of colonies within the frame of view to measure colony size
- Conduct colony counts and confirm species identification on transect video (post processing)
- Conduct fish counts on transect video (real time annotation data utilized)



## **8) Product deliverables and timeline**

<i><b>Product</b></i>	<i><b>Recipient</b></i>	<i><b>Point of Contact</b></i>	<i><b>Date completed</b></i>
Cruise summary	DSCRTP	Travis Sterne	After each cruise
Annual report	DSCRTP	Travis Sterne	End of each year
Site characterization report	DSCRTP	Travis Sterne	End of Project
Deep-sea coral and sponge records for National Database	DSCRTP	Travis Sterne	End of Project

Data will be created and managed by Travis Sterne (FGBNMS, TAMUG), and delivered to the DSCRTP by the end of the project (4/30/19):

- Annual reports (project outcomes, progress, challenges, maps, etc.)
- Georeferenced habitat point data (shapefiles)
- Habitat characterization maps
- Data entry into DSCRTP data portal

## **9) Contingencies**

Data used for this project will be sourced from historical observations made approximately over the last decade. One challenge related to this may include inconsistencies in methodology for data collection. Fortunately, all raw data (photos, cruise annotations) are still intact and can be referenced in the case of discrepancies between habitat descriptions.

*Appendix M.* Description of NOAA Ship *Pisces* data mining project.

## **Iceberg Scours on the Continental Slope of the Southeast U.S.: Habitat for Deep-Sea Corals and Associated Fishes**

### **1) Personnel**

#### ***Lead investigators***

George Sedberry, ONMS ([george.sedberry@noaa.gov](mailto:george.sedberry@noaa.gov))

### **2) Project duration**

***Start date:*** May 12, 2016

***End date:*** September 30, 2017

### **3) Types of costs associated with the project**

<b><i>Cost type</i></b>	<b><i>Description</i></b>
Salary and benefits	Contract costs to graduate student who will perform the bulk of the work

### **4) Project summary**

This project will analyze ROV video recorded from deep-sea coral habitats off South Carolina and Georgia during a cruise aboard the NOAA Ship *Pisces* in 2010. Videos will be analyzed by substrate type, and fishes and sessile invertebrates enumerated within each type. Descriptive statistics and multivariate analyses will be used to determine associations among fish species and between fish species and habitat types.

### **5) Background and rationale**

In 2010, the NOAA Ship *Pisces* conducted an expedition to survey deep-water habitats off Georgia and South Carolina. This DSCRTP-funded cruise used an ROV to collect video footage from rugged bottom topography on the upper slope. This high-relief and complex topography resulted from iceberg scours through sediments on the upper continental slope (175-225 m deep), and the deposit of glacial till during Quaternary (Pleistocene) glaciations (2.58 million years ago to present). Several substrate types occur in the iceberg scour areas and on the nearby continental slope (175-425 m), and include high-relief coral mounds, high-relief hard bottom, low-relief mixed hard and coral bottom, manganese/phosphorite nodules and rock rubble, coral rubble, mixed hard and unconsolidated (sand) sediment, and soft sandy bottom. Several managed and unmanaged fishery species (Snowy Grouper, Blueline Tilefish, Blackbelly Rosefish, Big Roughy and sharks), forage species (Yellowfin Bass), and other fishes occur in association with corals and different substrates. The habitat associations and importance of different habitats to various fish species are poorly known, even for economically valuable or vulnerable fishery species.

## **6) Objectives**

To analyze ROV video data from a 2010 expedition aboard the NOAA Ship *Pisces* that surveyed deep-sea habitats off South Carolina and Georgia. Videos will be analyzed by substrate type, and fishes and sessile invertebrates enumerated within each substrate type. Records will be incorporated into the NOAA Deep-Sea Coral Database and result in a MS thesis by a MS student at Savannah State University.

## **7) Approach and methods**

Videos will be analyzed by substrate type, and fishes and sessile invertebrates enumerated within each type. Descriptive statistics and multivariate analyses will be used to determine associations among fish species and between fish species and habitat types. This work will be performed by a graduate student at Savannah State University (SSU), the oldest public historically black college in Georgia, under direction from the Principal Investigator. Office space and information technology assets will be provided by NOAA's Office of National Marine Sanctuaries, through Gray's Reef National Marine Sanctuary (GRNMS). GRNMS offices are located near the SSU campus, and the PI has an adjunct appointment at the University. SSU will provide in-kind administration of a research assistantship that will be funded by DSC RTP. The University will provide in-kind infrastructure to support the student.

## **8) Product deliverables and timeline**

<i><b>Product</b></i>	<i><b>Recipient</b></i>	<i><b>Point of Contact</b></i>	<i><b>Date completed</b></i>
Records of deep-sea fish and sponges for National Database	DSC RTP	George Sedberry	End of project
MS thesis	Savannah State University	George Sedberry	End of project
Journal article	TBD	George Sedberry	End of project

Products will include distribution records for fish, coral and selected macroinvertebrate species (e.g., sponges). Species distribution records will be incorporated into the NOAA Deep-Sea Coral Data Portal, other biodiversity databases (e.g., OBIS-USA) that the PI has worked with, and the South Atlantic Fishery Management Council's Fishery Ecosystem Plan and associated online GIS databases. The work will result in a MS thesis written by the SSU graduate student, and a journal publication.

## **9) Contingencies**

N/A.

*Appendix N.* Guidance for reporting on fieldwork funded by the NOAA Deep Sea Coral Research and Technology Program.

# Data Management Guide for Data Providers

*Deep Sea Coral Research and Technology Program (DSC-RTP)*

Contact: Robert McGuinn, [robert.mcguinn@noaa.gov](mailto:robert.mcguinn@noaa.gov), (843)-762-8640

## Introduction

The following checklist is a concise summary of the data and documents expected from all field work projects funded by the DSC-RTP. A short description of each deliverable follows the checklist. Examples and templates are also included where appropriate. The Regional Team lead has primary responsibility for all deliverables working closely with the principal investigator (PI) of each activity. This document outlines the *typical* requirements and schedule. Modifications to the required products and delivery schedule should be agreed upon in advance between the Team Lead, PI and DSC-RTP leadership. It is critical that products are delivered in a form *suitable for public release*. Issues regarding the timing of public release of data should also be discussed in advance of field activities.

Questions regarding these requirements should be directed to the DSC-RTP Data Systems Manager: Robert McGuinn, [robert.mcguinn@noaa.gov](mailto:robert.mcguinn@noaa.gov), (843)-762-8640

# Checklist of DSC-RTP Deliverables and Schedule

## Pre-Cruise

- ☐ Fill out data input form (1 per cruise or survey). DSCRTP will follow up post-cruise to capture any changes.

## Within 90 days from the end of the cruise/survey

- ☐ Imagery: videos and photos (in-situ and on deck)
- ☐ Quick look report
  - ☐ One page narrative of cruise/survey results
  - ☐ Dive summary table(s)
  - ☐ Sample log(s)
  - ☐ Dive log(s)
  - ☐ Highlight images
  - ☐ Figure showing geographic extent of activities

## Within 1 year from conclusion of a survey event

- ☐ Conductivity, temperature, depth profiler (CTD) and other sensor data (see note)\*
- ☐ Multibeam bathymetry and backscatter data (see note) \*\*
- ☐ Processed vessel (ship) and vehicle navigation (ROV, AUV, submersible, etc)
- ☐ Coral and sponge records from completed surveys (national database format)

## At the end of the 3 year project period(s)

- ☐ Three year final report
- ☐ Site characterization report(s) (appended to final report)
- ☐ Modeling results

## As available

- ☐ Copies of peer-reviewed and other technical publications from funded activities.

\* NOAA funded CTD and other oceanographic sensor data will be archived at the NOAA National Oceanographic Data Center (NODC) [<http://www.nodc.noaa.gov/>].

\*\* NOAA funded multibeam bathymetry data will be archived at the NOAA National Geophysical Data Center (NGDC) [<http://www.ngdc.noaa.gov/>].

# Guidance on Deliverables

## Pre-cruise or survey

### Data Input Form and Data Management Agreement

**Description:** Each data provider is required to fill out a data input form which includes a data management agreement section. The data input form is meant to capture a detailed description of each data collection effort and will be used to populate formal metadata for archive and retrieval. The data management agreement at the end of the data input form will establish a clear understanding between the data provider and DSC-RTP.

## 90 days after the cruise or survey

### Imagery: videos and photos

**Description:** All in-situ and on deck video and still imagery from the cruise or survey. Images and video should include an overlay showing horizontal and vertical geographic position and date/time (x,y, z, t), or an associated file that includes this information linked to file names. All in-situ photos and videos should be clearly organized by folders named according to the dive ID.

### Quick look report(s)

**Description:** Brief report summarizing cruise accomplishments, highlighting relevant information for management applications, such as species observed, number of events (dives or tows), time on bottom, the number and types of samples collected. Includes sample and dive logs and highlight images with captions.

### Sample log (s)

**Description:** List of all physical specimens collected during the funded activity. Each individual sample log entry should include longitude and latitude in decimal degrees, depth in meters, dive number (EventID), time and date (UTC if possible), with links to still images of the specimen in-situ and on-deck (preferably with scale and SampleID).



## Dive/tow summary table

**Description:** A table that summarizes all dives on a cruise. The table should have one row for each dive and include the following columns: cruiseID, date, dive number (EventID), vehicle, sampling equipment, in water time and position, on bottom time and position, off bottom time and position, out of water time and position

## Dive log(s)

**Description:** A log that describes all of the relevant details for a given dive. The dive log should include the dive number for linking back to all of the information included in the dive summary table.

Within 1 year from conclusion of a survey event

## CTD and other sensor data

**Description:** Conductivity, temperature, depth (CTD) and other oceanographic sensor data from either downcasts made from ship, or instruments mounted on vehicles. NOAA funded CTD and other oceanographic sensor data will be archived at the NOAA National Oceanographic Data Center (NODC) [<http://www.nodc.noaa.gov/>].

## Multibeam bathymetry

**Description:** The “raw” files from the sonar unit for archive and backup purposes. NOAA funded multibeam bathymetry data are required to be archived at the NOAA National Geophysical Data Center (NGDC) [<http://www.ngdc.noaa.gov/>].

## Vessel navigation

**Description:** Horizontal geographic position and time stamp (x,y, t) from the vessel-based navigation system.



## Vehicle navigation (ROV, AUV, submersible, etc)

**Description:** Horizontal and vertical geographic position and time stamp (x,y,z) from the vehicle-based navigation system.

## Site characterization report(s)

**Description:** A detailed and formatted description of the habitat found at each research site/locality in the format provided below.

At the end of the 3 year project period(s)

## Coral and sponge observations for the DSC-RTP National Database

**Description:** Presence only observations for corals, sponges, and fish observed during the funded activity in the prescribed DSC-RTP format, derived from the still photo and video analysis. Please follow the prescribed schema.

At the end of the 3 year project period

## Models and model outputs

**Description:** All software code and copies of inputs, outputs, and reports from models developed under the auspices of DSC-RTP funding. This should include a narrative report as well as a data package with formal metadata. DSC-RTP can assist in the creation of metadata if needed.

## Three year final report

**Description:** A compendium of site characterization reports with additional regional scale analysis and synthesis narrative.

As available

## Copies of publications resulting from funded activities

**Description:** Any publications or technical reports resulting from the funded activities.

## KEY ELEMENTS OF A SITE CHARACTERIZATION

(DOCUMENT VERSION 2015-10-29\_01)

### INTRODUCTION

The Deep-Sea Coral Research and Technology Program (DSC RTP) has the responsibility to identify the location of deep sea corals and to communicate this information to managers and the public. Furthermore, the DSC RTP has the responsibility to characterize areas with deep sea corals and to communicate their significance. To meet this mandate DSC RTP is developing a consistent site characterization framework which can be applied to deep sea coral surveys across the nation.

The site characterization will be applied to field surveys conducted under the DSC RTP and will be an expected deliverable from all imaging based surveys (ROV, AUV, Tow Cam, Etc). The site characterization is composed of an overall "Site Summary" and a set of "Individual Dive Summaries". The Individual Dive Summaries should essentially be the raw material used to build the Site Summary. These are outlined below.

### PURPOSE AND AUDIENCE FOR THE SITE CHARACTERIZATION

The purpose of the site characterization report is to communicate essential information to resource managers. The format is designed to allow for rapid reporting which can make information available to decision makers in a timely manner. ***This process is designed not to interfere with the development of formal scientific publication and does not replace the need for directed research. It is designed to reduce the time lag between survey and scientific analysis by providing an interim product.***

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## SITE SUMMARY

### TITLE PAGE

### INTRODUCTION AND SCIENTIFIC OBJECTIVES

- Narrative overview of purpose and science priorities for site characterization

### OVERVIEW OF SITE

- Overview map with all dive tracks on site
- # of dives per vehicle type (Sub/ROV/AUV)
- Depth range of all dives
- Habitat characterization map (when practical)

### ALL DIVE SUMMARY TABLE (\*INCLUDE A SEPARATE TRANSECT TABLE IF APPLICABLE)

- Date (UTC)
- Method (equipment)
- Dive number (EventID is the corresponding term in the database)
- On-bottom time (UTC)
- Off-bottom time (UTC)
- Start coordinates (lat/long on bottom)
- End coordinates (lat/long off bottom)

- Depth min & max

#### SHORT DIVE SUMMARY NARRATIVE

- Including area surveyed, how many transects/dives, description of habitat

#### IMAGE GALLERY

- Representative and Highlight Images
- Description with scientific names and locality
- Coordinates

#### OTHER SAMPLING (CTD/SAMPLES/ETC.)

#### DESCRIPTIVE SITE OVERVIEW

- Summary of coral and sponge observed (species table)
- Associated species observations (species table)
- Qualitative discussion of site relevance in regional context (ie significance, quality, density)
- Relevant Work (literature or reports)
- Additional Comments

### INDIVIDUAL DIVE SUMMARIES

#### DIVE #

#### SITE NAME

#### GENERAL LOCATION MAP WITH MAP OF DIVE TRACK

#### DIVE OVERVIEW TABLE:

- Project Title and SurveyID (CruiseID)
- Chief Scientist
- Chief Scientist contact information
- Purpose
- Vessel
- Vehicle name (which ROV, etc.)
- Science observers
- Temporal length of video records and video equipment
- Number of still photographic records and photographic equipment
- Positioning system type for vessel and vehicle
- List of names of other sensors or water sampling equipment on board vehicle (CTD, etc.)
- Number of specimen(s) collected
- Additional Information if applicable

#### DIVE DATA TABLE (\*THIS IS SIMPLY A SUBSET OF THE OVERALL DIVE TABLE IN THE SITE SUMMARY)

- Date (UTC)
- Method (equipment)
- Dive number (EventID is the corresponding term in the database)
- On-bottom time (UTC)

- Off-bottom time (UTC)
- Start coordinates (lat/long on bottom)
- End coordinates (lat/long off bottom)
- Depth min & max

#### IMAGE GALLERY

- Representative images
- Description with scientific names and locality
- Coordinates of each image

#### BIOLOGICAL ENVIRONMENT

##### SHORT DESCRIPTION OF GENERAL HABITAT TYPES OBSERVED

##### CORAL, SPONGES, AND FISH WITH ESTIMATES OF THE FOLLOWING

- Density
- Abundance
- Areal extent
- Dominant taxa
- Rare species present
- Fisheries species present

#### PHYSICAL ENVIRONMENT

- Graphical and narrative summary of any physical data (CTD, water samples, etc.)
- General description of substrata (slope/rugosity/composition)
- Evidence of human impacts (if applicable)



United States Department of Commerce

**Wilbur Ross**

Secretary of Commerce

National Oceanic and Atmospheric Administration

**Benjamin Friedman**

Deputy Under Secretary for Operations  
and Acting Administrator

National Ocean Service

**Russell Callender**

Assistant Administrator

