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Cruise Report: EX-17-11 Gulf of Mexico 2017 (ROV and Mapping)

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Ocean Exploration and Research

Cruise Report: EX-17-11
Gulf of Mexico 2017 (ROV and Mapping)

Gulf of Mexico

Key West, Florida to Pascagoula, Mississippi
November 29, 2017 - December 21, 2017

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Abstract

From November 29, 2017 to December 21, 2017, the NOAA Office of Ocean Exploration and Research (OER) and partners conducted a telepresence-enabled ocean exploration expedition on NOAA Ship *Okeanos Explorer* to collect critical baseline data and information and to improve knowledge about unexplored and poorly understood deepwater areas of the Gulf of Mexico. The *Gulf of Mexico 2017* (EX-17-11) expedition was part of a series of expeditions between 2017 and 2018 that explored deepwater areas in the Gulf of Mexico. During 23 days at sea, 17 remotely operated vehicle (ROV) dives were completed off the Western Florida Escarpment and in the central and western Gulf of Mexico. Over 93 hours of ROV bottom time were logged at depths between 300 and 2,321 meters. Over 20,000 square kilometers of seafloor were mapped. A total of 138 biological and 11 geological samples were collected. The expedition gathered over 280,000 live video views worldwide and the OER website received over 35,600 views. A core onshore science team of over 80 participants from around the world collaborated and supported real-time ocean exploration science. The data associated with this expedition have been archived and are publicly available through the NOAA Archives.

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1. Introduction

By leading national efforts to explore the ocean and make ocean exploration more accessible, the NOAA Office of Ocean Exploration and Research (OER) is filling gaps in basic understanding of deep waters and the seafloor, providing deep-ocean data, information, and awareness. Exploration within the U.S. Exclusive Economic Zone (EEZ) and international waters as part of the Seabed 2030 (https://www.ncei.noaa.gov/news/seabed-2030-map-gaps, last accessed October, 2020) efforts to produce a bathymetric map of the world ocean floor by 2030 supports key NOAA, national, and international goals to better understand and manage the ocean and its resources.

Using the latest tools and technology, OER explores unknown areas of the deep ocean. NOAA Ship *Okeanos Explorer* is one such tool. Working in close collaboration with government agencies, academic institutions, and other partners, OER conducts deep-sea exploration expeditions using advanced technologies on *Okeanos Explorer*, mapping and characterizing areas of the ocean that have not yet been explored. Collected data about deep waters and the seafloor—and the resources they hold—establishes a foundation of information and fills gaps in the unknown.

All data collected during *Okeanos Explorer* expeditions adhere to federal open-access data standards and are publicly available shortly after an expedition ends. This ensures the delivery of reliable scientific data needed to identify, understand, and manage key elements of the ocean environment.

Exploring, mapping, and characterizing the U.S. EEZ are necessary for a systematic and efficient approach to advancing the development of ocean resources, promoting the protection of the marine environment, and accelerating the economy, health, and security of our nation. As the only federal program dedicated to ocean exploration, OER is uniquely situated to lead partners in delivering critical deep-ocean information to managers, decision makers, scientists, and the public—leveraging federal investments to meet national priorities.

2. Expedition Overview

The *Gulf of Mexico 2017* (EX-17-11) expedition was part of a series of expeditions between 2017 and 2018 that explored deepwater areas in the Gulf of Mexico from November 29, 2017, to December 21, 2017. Other cruises in this region include *Canal Transit and Gulf of Mexico Mapping* (EX-17-10), *Gulf of Mexico Mapping Technology Demonstration* (EX-18-02), and *Gulf of Mexico 2018* (EX-18-03). EX-17-11 was designed to provide timely, actionable information

to support decision-making based on reliable and authoritative science. Certain data were used to inform some of the 13 recently established HAPCs in the Gulf of Mexico (https://www.fisheries.noaa.gov/bulletin/noaa-fisheries-announces-designation-habitat-areas-particular-concern-deep-water-coral, last accessed October 2020) Like other OER expeditions, it also served as an opportunity for the nation to highlight the uniqueness and importance of deepwater environments.

2.1 Rationale for Exploration

Despite the Gulf of Mexico's proximity to land and the significant industrial footprint in the area, there is still much to explore. The Gulf contains a wide range of habitats and interesting geological features ranging from brine pools to coral gardens and canyons to mud volcanoes. The Gulf also contains significant submerged cultural heritage sites that have yet to be explored. Over the three Gulf of Mexico expeditions, OER explored many of these habitats.

As with previous *Okeanos Explorer* expeditions, NOAA worked with the scientific and resource management communities to characterize high-priority exploration targets. EX-17-11 used the ship's deepwater mapping and water column systems (Kongsberg EM 302 multibeam sonar, Simrad EK60 split-beam fisheries sonars, Knudsen 3260 Chirp sub-bottom profiler [SBP] sonar, and Teledyne Acoustic Doppler Current Profilers [ADCPs]), NOAA's dual-body deepwater ROV, and a high-bandwidth satellite connection for real-time ship-to-shore communications. ROV dives included high-resolution visual surveys and limited sampling. Operations focused on water depths between 250 and 3,500 meters. This expedition helped establish a baseline of data and information in several remote regions to catalyze further exploration, research, and management activities. Throughout EX-17-11, live video and data from ROV dives and multibeam operations were shared in real time with shore-based participants and the public. As part of the planning for this expedition, NOAA collaborated with the scientific and management communities to assess the exploration needs and data gaps in unknown and poorly known areas of the Gulf of Mexico.

Data and information from this expedition will help to improve understanding of the deep-ocean habitats of the Gulf of Mexico. It will also inform deep-sea management plans for habitat areas of particular concern (HAPCs), Marine Protected Areas (MPAs), and National Marine Sanctuaries; support local scientists and managers seeking to understand and manage deep-sea resources; and stimulate subsequent exploration, research, and management activities.

This expedition also contributed to the ongoing collaboration with the NOAA Office of National Marine Sanctuaries (ONMS) Maritime Heritage Program, BOEM, the U.S. Geological Survey (USGS), the NOAA National Marine Fisheries Service (NMFS), and the NOAA Deep Sea Coral Research and Technology Program (DSCRTP).

2.2 Objectives

The expedition addressed scientific themes and priority areas put forward by NOAA scientists and resource managers including NOAA Office of National Marine Sanctuaries, the Gulf of Mexico Fishery Management Council (GMFMC), BOEM, USGS, and the broad ocean science community. The primary objective of the expedition was to explore deepwater areas offshore Florida, Alabama, Mississippi, Louisiana, and Texas to provide baseline data and information to support science and management needs. A detailed summary of expedition objectives can be found within the *EX-17-11 Gulf of Mexico (ROV and Mapping) Project Instructions* (https://repository.library.noaa.gov/view/noaa/17345, last accessed October, 2020).

Specifically, this expedition sought to:

- Identify and map vulnerable marine habitats—particularly high-density deep-sea coral and sponge communities.
- Explore areas relevant to resource managers such as Essential Fish Habitats (EFH), HAPCs, National Marine Sanctuaries and their potential expansion areas.
    - Specific HAPCs in which dives happened in or near include: South Reed, Pulley Ridge, Long Mound, Mississippi Canyon 885, Mississippi Canyon 751, AT 357, Garden Banks 299, Green Canyon 852, Green Canyon 140 and 272 and Green Canyon 234
    - Explore the diversity and distribution of benthic habitats—including bottom fish habitats and deep-sea coral communities;
    - Collect data on: habitat size and extent, animal diversity, and density;
    - Focus close-up imaging operations on potential new, rare, and poorly documented animals as well as dominant members of the communities;
    - Collect and preserve biological samples of potential new species, new records, dominant community members (if not easily recognized), and other animals to aid in site characterization;
    - Investigate biogeographic patterns of deep-sea ecosystems and connectivity across the Gulf of Mexico.
- Explore U.S. maritime heritage by investigating sonar anomalies and characterizing shipwrecks.
- Acquire a foundation of ROV, sonar, and oceanographic data to better understand the characteristics of the water column and the fauna that live there.

- Collect high-resolution bathymetry in areas with no (or low-quality) sonar data.
    - Continue to refine specimen processing procedures.
- Ground-truth acoustic data using video imagery and characterize associated habitat.
- Engage a broad spectrum of the scientific community and public in telepresence-based exploration.
- Successfully conduct operations in conjunction with shore-based Exploration Command Centers (ECCs) and remote science team participants.
- Create and provide input into standard science products to provide a foundation of publicly-accessible data and information products to spur further exploration, research, and management activities.
- Acquire a foundation of ROV, sonar, and oceanographic data to better understand the characteristics of the water column and fauna that live there.

3. Participants

EX-17-11 included onboard mission personnel as well as shore-based science personnel who participated remotely via telepresence technology. See Tables 1 and 2 for lists of onboard and shore-based personnel who supported EX-17-11.

Table 1. EX-17-11 Onboard Mission Team Personnel

Name (First, Last)	Title	Affiliation
Brian Kennedy	Expedition Coordinator	OER
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Diva Amon	Science Lead	Natural History Museum of London/UCAR
Michael White	Mapping Lead	OER/Cherokee Federal
Daniel Freitas	Mapping Watch lead	UCAR
Lauren Jackson	Sample Data Manager	NOAA National Centers for Environmental Information (NCEI)
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Table 2. EX-17-11 Shore-based Science Team Members

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4. Methodology

To accomplish its objectives, EX-17-11 used:

- OER's Dual-bodied ROV system (ROVs *Deep Discoverer* and *Seirios*) to conduct daytime seafloor and water column surveys, as well as to collect a limited number of samples to help further characterize the deepwater fauna and geology of the region.

- NOAAS *Okeanos Explorer's* Sonar systems (Kongsberg EM 302 multibeam sonar, Knudsen Chirp 3260 SBP, Simrad EK60 and EK80 split-beam sonars, and Teledyne ADCPs) to conduct mapping operations at night and when the ROVs were on deck.
- A high-bandwidth satellite connection to provide real-time ship-to-shore communications (telepresence).

All environmental data collected by NOAA must be covered by a data management plan to ensure they are archived and publicly accessible (NAO 212-15 and Procedural Directives, https://nosc.noaa.gov/EDMC/nao_212-15.php, last accessed October 2020). The data management plan for EX-17-11 is in Appendix A.

4.1 ROV Seafloor Surveys

ROV dive operations supported the expedition objectives in Section 2.2 and included high-resolution visual surveys of seafloor and water column habitats as well as geological and biological sampling. During each dive, the ROVs descended to the seafloor and then moved from waypoint to waypoint, documenting the geology and biology of the area. Most ROV dives were approximately 8-10 hours, conditions and logistics permitting. Dives were primarily conducted during the day (operations described in detail by Quattrini et al., 2015 and Kennedy et al., 2019). Additional information about the general process of site selection, collaborative dive planning, scientific equipment on the ROVs, and the approach to benthic exploration used on *Okeanos Explorer* can be found in Kennedy et al. (2019).

Onboard and shore-based scientists identified (to the best of their ability) encountered organisms to the lowest taxon possible based on data available during real-time assessment. Additionally, they provided geological interpretations of the observed substrate throughout each ROV seafloor survey. These geological and biological observations were recorded using Ocean Networks Canada's SeaTube v1.

For water column exploration, a series of transects were performed during vehicle ascent following the completion of the benthic/seafloor exploration. Transects primarily targeted the deep scattering layer and the waters directly above and below it. Specific transect depths were decided each day during ROV descent through an evaluation of the Simrad EK60 data; ROV conductivity, temperature, depth (CTD) data; and the acoustically-determined position of the deep scattering layer. Additionally, when seafloor depth allowed, a set of deeper transects were also completed at various depth intervals. The length of time of the transects varied between 20 and 50 minutes at each depth, depending on the specific objectives for water column exploration, conditions, and seafloor depth. Specific transect depths and times are

noted in each dive summary (see Section 7.1.1).

4.2 Sampling Operations

A limited number of geological and biological samples were collected on the seafloor using ROV *Deep Discoverer*'s five chamber suction sampler and two manipulator arms in conjunction with the geological and biological collection boxes. The primary goal of the sampling operations was to collect voucher samples to be made publicly available for site characterization.

For each sample collected, the date, time, latitude, longitude, depth, salinity, temperature, and dissolved oxygen (DO) content were recorded at the time of collection. Geological samples were acquired for age dating and geochemical composition analysis. Biological collections targeted samples that represented potential new species, range extensions of animals not previously known to occur in the region, dominant species at the site, and/or rare morphotypes. Samples targeted to contribute to Gulf of Mexico connectivity studies were also collected.

After vehicle recovery, samples were examined for associated organisms, labeled, photographed, and entered into a database with all relevant metadata. Any associated organisms found were separated from primary samples and processed separately as "associate" samples.

Geological samples were air dried and placed in rock bags or small containers, depending on the size of the sample. At the conclusion of the *Okeanos Explorer* 2018 expeditions, they were shipped to the Marine and Geology Repository at Oregon State University (OSU) where they will be photographed and entered into the university's online database. Thin and polished sections were made for each hard-rock sample. Descriptions and photos are included in the database.

Biological samples were subsampled for inclusion in the Smithsonian Institution's National Museum of Natural History (USNM) Biorepository for future barcoding and DNA extraction. For this purpose, a small subsample, consisting of not more than 1 cm^2 of tissue, was removed from the original sample and placed in 95% analytical grade ethanol (EtOH).

For most of the biological samples, the remainder of the sample was also preserved in 95% EtOH. Some of the samples from seep sites were also frozen for isotope analysis. For select taxa, vouchers or subsamples were preserved in 10%, 5%, or 4% buffered formalin per recommendation from taxonomic experts and guidance provided by the Smithsonian Institution's USNM. Full details of the preservation of each biological sample are in the associated metadata record. All voucher samples and subsamples from EX-17-11 were shipped

to the Smithsonian Institution's USNM for long-term archival and public access.

4.3 Acoustic Operations

Acoustic operations included Kongsberg EM 302 multibeam, Simrad EK60 and EK80 split-beam, Knudsen Chirp SBP, and Teledyne ADCP data collection. A detailed description of the NOAA Ship *Okeanos Explorer* mapping capabilities are available in the 2017 NOAA Ship *Okeanos Explorer* Survey Readiness Report, archived in the NOAA Central Library. The schedule of mapping operations included overnight transits and whenever the ROVs were on deck. Lines were planned to maximize edge matching of existing data or filling of data gaps in areas with incomplete bathymetry coverage. In regions with no existing data, exploration transit lines were planned to optimize potential discoveries. Targeted mapping operations were conducted on and west of the Western Florida Escarpment, Southeast of DeSoto Canyon, and in the Central Gulf of Mexico. When possible, focused mapping of the ROV dive sites occurred during overnight mapping operations prior to the dive. Mapping operations and results are further detailed in White et al., "Mapping Data Acquisition and Processing Summary Report: EX-17-11, Gulf of Mexico 2017 (ROV & Mapping," https://doi.org/10.25923/s606-0s63, (last accessed October 2020)

4.3.1 Multibeam Sonar (Kongsberg EM 302)

Multibeam seafloor mapping data were collected using the Kongsberg EM 302 sonar, which operates at a frequency of 30 kilohertz (kHz). Multibeam mapping operations were conducted during all overnight transits between ROV dive sites. Multibeam data quality was monitored in real time by acquisition watchstanders. Ship speed was adjusted to maintain data quality as necessary.

Whenever possible, transits were designed to maximize coverage over seafloor areas with no previous high-resolution mapping data. In these focus areas, line spacing was generally planned to ensure 30% overlap between lines at all times. Cutoff angles in the Seafloor Information System (SIS) software were generally adjusted on both the port and starboard sides to ensure the best balance between data quality and coverage. Overnight surveys were also completed in areas that were previously mapped with a lower-resolution multibeam sonar system.

Additionally, multibeam mapping operations were conducted directly over planned ROV dive sites to collect seafloor mapping data to help refine dive plans. These operations collected data on seafloor depth (bathymetry), seafloor acoustic reflectivity (seafloor backscatter), and water column reflectivity (water column backscatter).

Background data used to guide exploratory multibeam mapping operations included mapping data collected during *Okeanos Explorer* cruises, notably EX-17-10, EX-14-03 Leg 3, EX-14-02 Legs 1 & 2, EX-12-03, EX-12-02 Legs 1-3, EX-11-06, EX-11-05, EX-11-04,; NOAA Ship *Nancy Foster* cruises NF-1708 Leg 1, NF-08-15-OE; and *Northern Resolution* NR01-1. The BOEM Northern Gulf of Mexico Deepwater Bathymetry Grid from 3D Seismic (https://www.boem.gov/oil-gas-energy/mapping-and-data/map-gallery/boem-northern-gulf-mexico-deepwater-bathymetry-grid-3d, last accessed October, 2020) was also used to plan multibeam surveys. Some dive planning and mapping operations were conducted using bathymetric grids created using all available bathymetry archived at NCEI and their Autogrid tool (https://www.ngdc.noaa.gov/maps/autogrid, last accessed October, 2020). Sandwell and Smith (2014) satellite altimetry data were also used to plan operations.

4.3.2 Sub-Bottom Profiler (Knudsen Chirp 3260 SBP)

The primary purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to image sediment layers underneath the seafloor to a maximum depth of about 80 m below the seafloor, depending on the specific sound velocity of the substrate. The SBP was operated simultaneously with the multibeam sonar during mapping operations to provide supplemental information about the sedimentary features underlying the seafloor.

4.3.3 Split-beam Sonars (Simrad EK60)

Okeanos Explorer is equipped with five split-beam Simrad EK60 general purpose transceivers. The frequencies of the EK60 are 18, 38, 70, 120, and 200 kHz. These sonars were calibrated on the EX-18-02 cruise in the Gulf of Mexico. Note that the EX-18-02 cruise happened after EX-17-11, therefore certain data users are encouraged to use the calibration values from EX-18-02 since those values will be more accurate for Gulf of Mexico waters. During the 2018 EK60 calibration it was found that the 38 kHz EK60 was not operating as expected and was not calibrated. Users are cautioned that these data may be inaccurate and are encouraged to consult the 2018 EK60 Calibration Report archived in the NOAA Central Library (https://repository.library.noaa.gov/view/noaa/21418, last accessed October, 2020).

These sonars were used continuously throughout EX-17-11 during both overnight mapping operations and daytime ROV operations. The sonars provided calibrated target strength measurements of water column features such as dense biological layers and schools of fish. These sonars also helped to detect gaseous seeps on the seafloor. EK60 data were also used during midwater transects of ROV dives to detect the depth of the deep scattering layers, which are aggregations of biological organisms in the water column.

4.3.4 Acoustic Doppler Current Profiler (Teledyne Workhorse Mariner and Teledyne Ocean Surveyor ADCPs)

Okeanos Explorer is equipped with two ADCPs: a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). The ADCPs provide information on the speed and direction of currents underneath the ship. They were used throughout ROV dives to support safe deployment and recovery of the vehicles. The ADCPs were not used during multibeam mapping due to sonar interference with the EM 302.

4.3.5 Expendable Bathythermograph (XBT) Systems

Expendable bathythermographs (XBTs) were collected at least every four hours, or more frequently as oceanographic conditions dictated, and applied in real time using SIS. Sound speed at the sonar head was determined using sound speed from a SVP-70 probe at the sonar head and compared to derived sound speed values from the ship's onboard flow-through thermosalinograph (TSG).

4.4 Conductivity, Temperature, and Depth (CTD)

Conductivity, temperature, and depth measurements were collected by two different methods. The most frequent method was with the integrated ROV CTD system. This system records CTD and associated sensors on every dive. The second method was with a dedicated CTD lowered with a winch to provide better information on the critical properties of the water column. Additional sensors installed on both of the CTDs include measured light scattering spectroscopy (LSS), DO, and oxygen reduction potential (ORP).

4.5 Sun Photometer Measurements

OER gathers limited at-sea measurements aboard *Okeanos Explorer* to support a NASA-led, long-term research effort that assesses marine aerosols. As time allowed on cloud-free days, onboard personnel collected georeferenced sun photometer measurements for the Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers that measures atmospheric aerosol properties around the world. MAN complements AERONET by conducting sun photometer measurements on ships of opportunity to monitor aerosol properties over the global ocean.

5. Clearances and Permits

Pursuant to the National Environmental Policy Act (NEPA), OER is required to include in its planning and decision-making processes appropriate and careful consideration of the potential environmental consequences of actions it proposes to fund, authorize, and/or conduct. The companion manual for NOAA Administrative Order 216-6A (https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf, last accessed October, 2020) describes the agency's specific procedures for NEPA compliance.

An environmental review memorandum was completed for all NOAA Ship *Okeanos Explorer* expeditions in 2017, in accordance with Section 4 of the Companion Manual, in the form of a categorical exclusion (CE) worksheet. Based on this review, a CE was determined to be the appropriate level of NEPA analysis necessary, as no extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement. A copy of the CE Evaluation Worksheet can be found in Appendix B.

OER conducted an analysis on the potential impacts to marine mammal species as a result of Okeanos Explorer's oceanographic research and seafloor mapping under the Marine Mammal Protection Act (MMPA). It was determined that, due to the high-frequencies, narrow beam widths, relatively low source levels of the onboard sonars, and transient nature of the expeditions, it is unlikely that activities aboard Okeanos Explorer would meet the definition of harassment under the MMPA.

As required under Section 7 of the Endangered Species Act (ESA), OER conducted an informal consultation with the NMFS Office of Protected Resources to request their concurrence with OER's biological evaluation determining that NOAA Ship *Okeanos Explorer* operations conducted as part of SEDCI may affect, but are not likely to adversely affect, ESA-listed marine species. The informal consultation was completed on July 13th 2017, when OER received a signed letter from the Regional Administrator of the NOAA Southeast Regional Office (SERO), stating that NMFS concurs with OER's determination that conducting the proposed SEDCI cruises are not likely to adversely affect ESA-listed marine species (Appendix C). OER has completed consultation with NOAA's Habitat Conservation Division on potential SEDCI impacts of OER's operations to Essential Fish Habitat (EFH). They concurred that OER's operations would not adversely affect EFH, provided adherence to OER's proposed procedures and their guidance stated in the EFH consultation letter (Appendix D).

6. Schedule and Map

EX-17-11 operations were completed over 23 days at sea, from November 29 2017 to December 21, 2017. The ship departed from Key West, Florida, and returned to port in Pascagoula, Mississippi. See Table 3 for a day-by-day breakdown of EX-17-11. There were 21 scheduled dives, with 17 dives achieved (see Table 6 for details). ROV dives planned on December 6, 7, 8, and 15 were all cancelled due to weather. See Figure 1 for a map of EX-17-11's track, dive sites, and bathymetry collected.

Much of the Gulf of Mexico within the U.S. EEZ is divided by lease blocks managed by the U.S. Bureau of Ocean Energy Management (BOEM) (https://www.boem.gov/gulf-mexico-region-leasing-information, last accessed October 2020). Individual lease blocks are named by alphabetical letters followed by numerical digits (e.g., *GB299*). These will be *italicized* to indicate a lease block name. Some names were used to refer to ROV dive locations.

Table 3. EX-17-11 schedule

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			11/28 Mobilization at Key West, Florida.	11/29 Depart Key West, Florida. Overnight transit mapping.	11/30 Dive 01 "South Reed." Overnight mapping.	12/01 Dive 02 "Escarpment Canyon." Overnight mapping.
12/02 Dive 03 "Okeanos Ridge." Overnight mapping.	12/03 Dive 04 "Long Mounds." Overnight mapping.	12/04 Dive 05 "Incised Escarpment Ridge" and Midwater Exploration. Overnight mapping	12/05 Dive 06 "Smooth Escarpment Ridge." Overnight mapping.	12/06 Dive cancelled, weather. 24-hour mapping operations.	12/07 Dive cancelled, weather. 24-hour mapping operations	12/08 Dive cancelled, weather. 24-hour mapping operations.
12/09 Dive 07 "Wreck 15377." Overnight mapping. Restricted data.	12/10 Dive 08 "*AT251*." Overnight mapping	12/11 Dive 09 "Henderson Ridge Mid-South (*AT401*)." Overnight mapping.	12/12 Dive 10 "Green Canyon Area, St. Tammany Basin (*GC939*)." Overnight mapping.	12/13 Dive 11 "*KC560*." Overnight mapping.	12/14 Dive 12 "Wreck 15727 (*KC530*)" and Midwater Exploration. Overnight mapping.	12/15 Dive cancelled, weather. 24-hour mapping operations.

12/16 Dive 13 “Tunica Mound (*GB299*).” Overnight mapping.	12/17 Dive 14 “Penchant Basin (*CG276*).” Overnight mapping.	12/18 Dive 15 “Penchant Basin (*MC796*)” and Midwater Exploration. Overnight mapping.	12/19 Dive 16 “Dauphin Dome (*MC388*)” and Midwater Exploration. Overnight mapping.	12/20 Dive 17 “Horne Dome (*MC036*).” Overnight Mapping	12/21 Arrive, Pascagoula, Mississippi.	12/22 Demobilization.

Figure 1. Map showing EX-17-11’s track, 17 ROV dive sites (white dots), and bathymetry data collected.

7. Results[1]

Metrics for EX-17-11’s major exploration and scientific accomplishments are summarized in Tables 4 and 5. More detailed results are presented in the subsections that follow.

[1] If you are unable to access the results noted here, contact ex.expeditioncoordinator@noaa.gov.

Table 4. Summary of exploration metrics for EX-17-11

Exploration Metrics	Totals
Days at sea	23
Days at sea in U.S. EEZ	23
Linear km mapped by EM 302	4,600
Square km covered by EM 302	20,657*
Square km covered by EM 302 in U.S. EEZ	20,510
Vessel CTD casts	1
XBT casts	68
ROV dives	17
ROV dives in U.S. EEZ	17
Maximum ROV seafloor depth (m)	2321.5
Minimum ROV seafloor depth (m)	300
Total time on bottom (hhmmss)	93:45:10
Water column survey time (hhmmss)	03:45:00
Total ROV time (hhmmss)	130:12:53

*The square km mapped has been recalculated and updated since the publication of White et al., 2020. The statistic recorded here is the most accurate at the time of this report publication.

Table 5. Summary of scientific metrics for EX-17-11

Scientific Metrics	Totals
Total samples	149
Biological samples (primary)	32
Biological associate samples	71
Biological Sub-samples	35
Geological samples	8
Geological associate samples	3
Actively participating scientists, students, and resource managers	82

7.1 ROV Survey Results

Depth ranges explored during the 17 ROV surveys were between 300 and 2321.5 meters. During the 17 dives, the ROVs spent a total of 93:45:10 hours on the bottom and 03:45:00 hours conducting water column exploration (see Table 5 for more cumulative results). See Table 6 for dive-specific information for each of the dives. Dive 07 at "Wreck 15377" was completed under OER Underwater Cultural Heritage (UCH) procedures and some of the resultant data is publicly restricted. Contact ncei.info@noaa.gov for restricted data access.

Dive 05 at "Incised Escarpment Ridge" included midwater exploration transects at 900, 700, 500, and 300 meters. Dive 12 at "Wreck 15725 (*KC530*)" included midwater exploration transects at depths of 1,000, 900, 800, 700, 600, 500, 400, and 300 meters. Dive 15 at "Penchant Basin (*MC796*)" included midwater transects at 400 and 300 meters. Dive 16 at "Dauphin Dome (*MC388*)" also included midwater transects at 900, 700, 500, and 300 meters.

Table 6. Summary information for the 17 ROV dives conducted during EX-17-11. BOEM lease block names are italicized, e.g. *AT251*

Date (yyyy mmdd)	Dive #	Site Name	On Bottom Latitude (decimal minutes)	On Bottom Longitude (decimal minutes)	Max Depth (m)	Dive Duration (hh:mm:ss)	Bottom Time (hh:mm:ss)
20171130	1	"South Reed"	24°, 39.093' N	083°, 54.619' W	817	6:15:30	5:08:57
20171201	2	"Escarpment Canyon"	24°, 37.260' N	084°, 06.173' W	2321.5	7:59:13	5:14:57
20171202	3	"Okeanos Ridge"	25°, 40.779' N	084°, 37.226' W	741.2	7:55:48	6:51:8
20171203	4	"Long Mounds"	26°, 26.688' N	084°, 45.647' W	413.6	7:55:41	7:24:19
20171204	5	"Incised Escarpment Ridge"	27°, 21.228' N	085°, 26.193' W	2234.5	9:55:31	5:50:5

20171205	6	"Smooth Escarpment Ridge"	28°, 00.222' N	086°, 26.391' W	2095.9	7:47:27	5:35:24
20171209	7	"Wreck 15377"	Restricted	Restricted	Restricted	5:01:23	4:02:33
20171210	8	"*AT251*"	27°, 42.873' N	088°, 26.670' W	2170.2	7:11:14	4:43:9
20171211	9	"Henderson Ridge Mid-South (*AT401*)"	27°, 31.529' N	089°, 41.984' W	1182.8	8:09:40	6:44:50
20171212	10	"Green Canyon Area, St. Tammany Basin (*CG939*)"	27°, 02.659' N	091°, 11.557' W	1635.0	7:52:14	6:04:49
20171213	11	"*KC560*"	26°, 25.350' N	092°, 21.049' W	2074.8	8:08:03	5:53:17
20171214	12	"Wreck 15727 (*KC530*)"	26°, 25.885' N	093°, 49.668' W	1567.6	7:59:4	1:18:12
20171216	13	"Tunica Mound (*GB299*)"	27°, 42.210' N	092°, 13.224' W	415.6	4:55:43	4:22:38
20171217	14	"Penchant Basin (*CG276*)"	27°, 39.899' N	091°, 20.624' W	805.4	6:45:28	5:07:35
20171218	15	"Penchant Basin (*MC796*)"	28°, 09.036' N	089°, 45.685' W	618.0	7:59:22	6:23:38
20171219	16	"Dauphin Dome (*MC388*)"	28°, 36.755' N	088°, 10.438' W	1932.1	10:14:21	6:12:10

20171220	17	"Horn Dome (*MC036*)"	28°, 57.938' N	088°, 11.697' W	1075.1	8:07:11	6:47:29

During the 17 ROV dives hundreds of different species of animals were observed, including several potential new species, new records for the region, and several significant range extensions. Several organisms were also seen alive for the first time. Some observations of note included:

- Novel, rare, and unusual deep-sea fishes, including a marine smelt at a shallow depth of 900 meters (2,953 feet);
- Several swordfish observed at depth, including one feeding;
- Feather star gardens on hard substrates previously undocumented in the Gulf of Mexico and Western Atlantic;
- The first record of the crinoid family Hyocrinidae (a probable new species) in the tropical Western Atlantic, and a likely new and locally abundant species of Thalassometridae;
- At least four species of carnivorous sponges.

EX-17-11 ROV Dives 01, 03, 04, 10 and 13 surveyed five HAPCs proposed by the GMFMC in order to collect critical baseline information to inform science and management needs. Four of these sites, Dives 01, 03, 04 and 10, hosted high-density deep coral and sponge communities and one (Dive 10) had extensive chemosynthetic communities.

ROV Dives 09, 10, 13, 15, 16 and 17 also explored six FGBNMS proposed expansion zones to collect critical baseline information to inform science and management needs. High-diversity and density coral and sponge communities were discovered at two of the areas, including a spectacular *Madrepora oculata*-dominated coral garden. Chemosynthetic communities, including brine rivers, large mussel beds, and asphalt seeps were observed in five of these proposed expansion zones.

A variety of geologic features were investigated including cold seeps, mud volcanoes, asphalt seeps, and brine pools. Highlights include:

- Conducted several dives to gather geological data to better understand the geological composition and origin of the Florida Escarpment.
- Discovered at least 20 previously unknown chemosynthetic habitats. These included methane seeps (some with visible methane hydrate), asphalt seeps, and brine rivers. Most of these had associated chemosynthetic communities that included large

siboglinid tubeworm bushes and extensive mussel beds. There were also many areas of reduced sediments and bacterial mats. Asphaltic and authigenic carbonate outcrops hosting large filter-feeding communities were also observed in geologically active areas.

7.1.1 Select highlights and representative images from EX-17-11 ROV dives

The following sections describes highlights from all dive sites. Observations described below include geologic, biologic and anthropogenic highlights from each dive. ROV video and images were collected from both water column and seafloor surveys. For a more in depth description of each ROV dive, please access dive summary and data here: https://www.ncei.noaa.gov/waf/okeanos-rov-cruises/ex1711/, last accessed October 2020)

Dive 01 "South Reed"

- Large aggregations of shortfin squid (*Illex* sp.).
- Observed a giant deep-sea isopod pill bug (*Bathynmous gigantus*) and several species of decapod crustaceans, including *Chaceon fenneri* (golden crab), *C. quinquedens* (red crab), royal red shrimp (*Pleoticus robustus*), and *Nematocarcinus* sp.
- Several species of carnivorous sponges were observed.
- Unconsolidated sediment as seen in Image 1, changing to exposed rock as ROVs moved up escarpments.
- On the second escarpment observations included stony corals *Lophelia pertusa*, *Madrepora occulata*, and solitary cup corals, as well as the octocorals *Acanthogorgia* sp., *Paramuricea* sp., and *Pseudoanthomastus* sp. Many of these hosted commensals.

Image 1: From Dive 01, two blind white lobsters (Acanthacoris caeca) share a burrow.

Dive 02 "Escarpment Canyon"

- Observed thousands of glass sponges (Euplectellidae) on exposed carbonate substrates, see Image 2.

- Large coral colonies (Isididae spp., Chrysogorgiidae spp., and *Corallium* sp.) on corners and promontories, many of these had commensals.
- Observed a live larvation, argonaut shell and polychaete worm that had incorporated a number of pteropod shells into its tube.
- Marine debris was encountered throughout the dive.

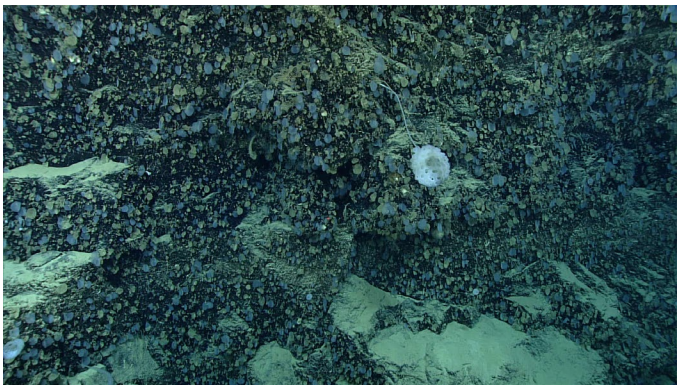

Image 2: Dive 02, Thousands of Euplectellidae sponges were observed on exposed rock outcrops

Dive 03 "Okeanos Ridge"

- Observed striking carbonate structures (Image 3), including caves, pillars, and even an "amphitheater," created when numerous slabs calved off a low wall.
- Corals observed during the dive included at least five species of black corals; the octocorals *Chrysogorgia* sp., *Acanthogorgia* sp., *Pseudoanthomastus* sp., *Plumarella* sp., and *Isididae* sp.; and the stony corals *Madrepora oculata*, *Lophelia pertusa*, and *Enallopsammia* sp.
- Two mating pairs of golden crabs (*Chaceon fenneri*), a *Gracilechinus* urchin and a *Circeaster* sea star preying on octocorals, and a wood fall (possibly bamboo), which served as habitat for animals such as gastropods and shrimp.
- Notable water-column observations included two swordfish, a swimming pycnogonid (sea spider), and two cutlass fish (*Benthodesmus tenius*).

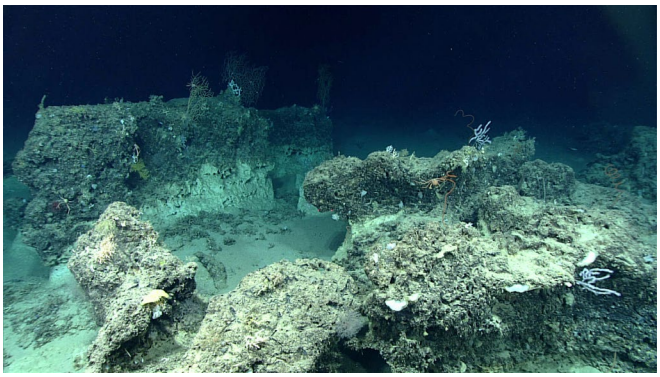

Image 3: Dive 03, throughout the dive exposed carbonate rock inhabited by coral and sponges were observed

Dive 04 "Long Mounds"

- Observed a live pterobranch.
- Dive consisted of unconsolidated sediments which transitioned to exposed outcrops at the top of a ridge
- On the top of the ridge there was a diverse suspension-feeding community composed of many bamboo and black corals, transitioning to a field of bamboo corals
- Observed a congrid eel that captured and ate a smaller fish (*Serranidae* sp.), a glimpse of a swordfish, orange slimeheads (Image 4) a shallow xenophyophore, a young basket star (*Gorgonocephalidae* sp.)

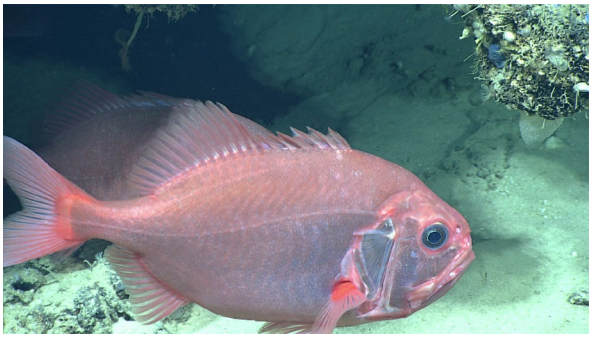

Image 4: During Dive 04 Darwin slimeheads along with numerous other fish species were observed.

Dive 05 "Incised Escarpment Ridge"

- Dive was marked by steep slopes that were both sedimented and exposed, resulting in high species diversity.
- First observation of *Umbellula* sp. Octocoral during EX-17-11.
- Observed several glass sponges, see Image 5 for an example.
- Three species of sea cucumbers, shrimp, a xenophyophore, a few fish, and spoon worm feeding tracks were seen.

- Areas of exposed carbonate rock upslope were colonized by several sponge species, including a number of dead glass sponges with extensive communities of soft coral, barnacles, brittle stars, and amphipods growing on the stalks.
- Midwater highlights included diverse assemblage of organisms, including larvaceans, shrimp, siphonophores, salps, fishes, and several different species of hydromedusae (Image 6) and ctenophores.

Image 5: A stalked glass sponge observed on Dive 05 provided a habitat for gooseneck barnacles, brittle stars and anemones

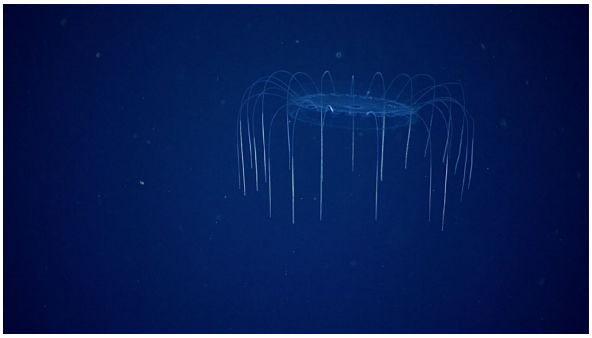

Image 6: During the water column ROV surveys on Dive 05 this hydromedusa was observed

Dive 06 "Smooth Escarpment Ridge"

- The escarpment had very reduced promontories which resulted in near-vertical slopes.
- Much of the dive consisted of near-vertical, ferromanganese-encrusted cliff wall, which coincided with an increase in abundance and diversity of organisms
- Observed a number of exposed plateaus with sessile communities composed of corals, sponges, and an abundance of crinoids belonging to six or seven different families. An example is in Image 7.

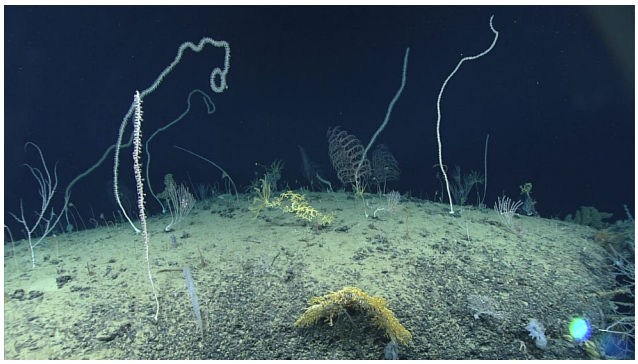

Image 7: From Dive 06, an example of the sessile sponge and coral communities observed throughout the dive

Dive 07 "Wreck 15377"

- Conducted a full survey of the wreck, collected imagery to generate a 3D mosaic survey, and documented biology living on the wreck. 3D digital reconstruction can be found here: https://sketchfab.com/BOEMArchaeology, last accessed October 2020) courtesy of BOEM.
- Based on initial analysis, archaeologists believe the ship likely post-dates 1830 to perhaps mid-century and was likely a merchant vessel, built for distance and capacity over speed.
- Observed depth markings on the hull indicating much of the wreck was buried (Image 8)
- Observed hundreds of "duckbill" Nettastomatidae eels, many spiny crabs (*Rochinia crassa*), and *Chaunax* fish. There were also remnants of naval shipworm (possibly *Teredo*) calcareous burrows in the wooden ribs.
- Observed many thick bacterial mats and occasional Lamellibrachia tubeworms indicated the presence of a chemosynthesis-based ecosystem, likely from the degradation of the wood structure.

Image 8: Dive 07, metal draft marks on the stern of the wreck suggest much of the wreck remains buried.

Dive 08 "AT251"

- Conducted the dive on a seismic anomaly identified by BOEM.
- Observed blackened sediment with bacterial mats, tube worms and areas of mussel shells indicative of chemosynthetic communities (Image 9).
- Searched for two bubble plumes identified in overnight mapping surveys
- Observed numerous burrowing echinoids and a few carbonate outcrops that hosted anemones, corallimorphs and cup corals.

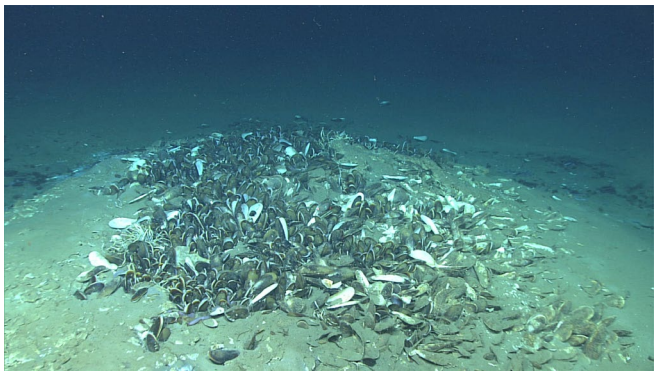

Image 9: Dive 08, mussel shells typically associated with chemosynthetic activity

Dive 09 "Henderson Ridge Mid-South (AT401)"

- Conducted ROV surveys to ground truth five possible locations of bubble plumes identified in overnight multibeam surveys.
- Observed evidence of chemosynthetic activity at some of the locations, including reduced sediments, bacterial mats, and the shells of dead chemosynthetic mussels.
- During the second half of the dive, discovered large colonies of *Paramuricea* sp., *Madrepora oculata*, *Clavularia rudis*, and *Enallopsammia* sp. Nearly all of the coral communities were confined to asphalt extrusions and carbonate outcrops (Image 10)
- Observed an area of liquid asphalt seepage as seen in Image 11 with a small community of tubeworms (*Lamellibrachia* sp.), as well as a previously unknown methane bubble stream that hosted a chemosynthetic community of bacterial mats, mussels (*Bathymodiolus* sp.), shrimp, eelpout fish, and a variety of other organisms

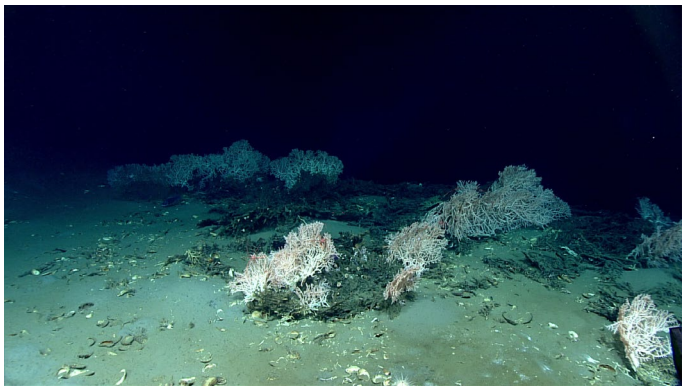

Image 10: Example of large coral colonies observed on Dive 09.

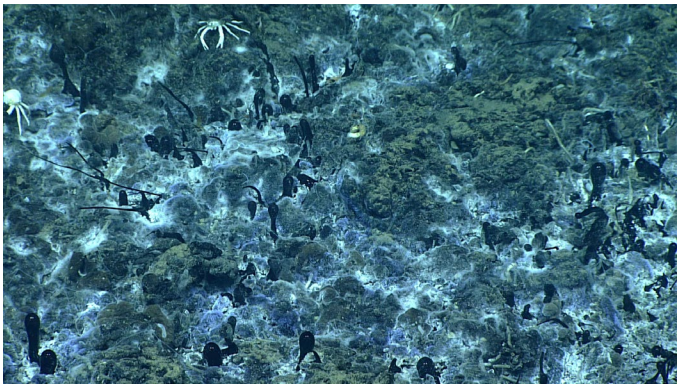

Image 11: Dive 09, natural liquid asphalt seepage

Dive 10 "Green Canyon Area, St. Tammany Basin (CG939)"

- Conducted an ROV survey to explore a series of seep targets identified in multibeam data.
- Discovered a brine pool fringed by chemosynthetic mussels (*Bathymodiolus brooksi*) (Image 12).

- Bacterial mats, king crabs, several species of tubeworms, squat lobsters, shrimp, and amphipods were also observed near the brine pool.
- Discovered two additional areas of seepage surrounded by mussel beds and other associated fauna, including one that was quite extensive.
- Observed a community of tubeworms, squat lobsters, and shrimp on an outcrop of authigenic carbonate.
- Observed methane hydrate in several locations.

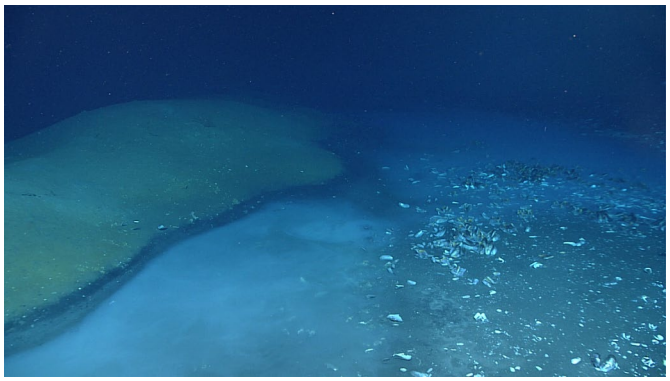

Image 12: On Dive 10 a brine pool with mussel shells was discovered.

Dive 11 "KC560"

- Observed a brine river with blackened reduced sediment (Image 13), white bacterial mats, and a range of species, including chemosynthetic mussels (*Bathymodiolus* sp.), tubeworms (*Lamellibrachia* sp.), filter-feeding polychaete worms, shrimp, squat lobsters, anemones, amphipods, and unknown waving polychaete worms.
- Sedimented areas were interspersed with carbonate outcrops colonized by corals and sponges
- Observed zoanthids, glass sponges, *Chaceon quinquedens* red crabs, tube-dwelling anemones, and barnacles

Image 13: On Dive 11 the ROVs landed near a brine river surrounded by tube worms.

Dive 12 "Wreck 15727 (KC530)"

- Dive was conducted to investigate a potential archaeological target from a side scan survey. The target was discovered to be a derelict shipping container (Image 14) with a surrounding debris field consisting of old residential appliances.
- Observed a number of corals and hydroids growing on the container.
- The later portion of the dive was spent completing midwater surveys.

- Ctenophores, siphonophores (Image 15), medusae, fishes, and shrimp, as well as single-celled and colonial protists were all observed during the midwater surveys.

Image 14: During Dive 12, a side scan target supplied by BOEM originally thought to be an archeological target was discovered to be a derelict shipping container.

Image 15: An example of a siphonore observed on Dive 12 during a series of midwater column transects.

Dive 13 "Tunica Mound (GB299)"

- During the first portion dive observed largely gently sloping, sedimented seafloor.
- During the second portion of the dive small carbonate outcrops with surrounding rubble were observed.
- Fish species observed included Darwin's slimehead, conger eels, and a scorpionfish.
- Other organisms observed included shrimp and ampharetidae polychaete worms near a woodfall, *Stichopathes* sp. antipatharia whips and brisingid sea stars (Image 16).

Image 16: During Dive 13 this rock outcrop of unknown origin covered in brisingid sea stars was discovered.

Dive 14 "Penchant Basin (CG276)"

- Substrate was composed of largely unconsolidated sediment (Image 17) with intermittent carbonate outcrops, burrows and mounds
- A number of different fish species were observed along with ctenophores, jellies and siphonophores.
- Observed several elasmobranch (cartilaginous fish) egg cases attached to the octocorals and antipatharians, indicating that these corals are a nursery for elasmobranchs

Image 17: Dive 14, a tripod fish on unconsolidated sediment characteristic of the dive.

Dive 15 "Penchant Basin (MC796)"

- Dive 15 was dominated by heavily bioturbated, sedimented seafloor (Image 18)
- Only two areas of hard substrate were observed.
- Organisms included squat lobsters, crabs, deposit-feeding ophiuroids, sea stars, and holothurians and giant isopods (*Bathynomus giganteus*) in burrows and depressions, as well as partly buried in the sediment. At least two species of cerianthid anemones were also abundant throughout the dive.
- Fish were abundant throughout the dive.

- Two midwater transects were complete at the end of the dive, during which a constellation fish (Valenciennellus tripunctlatis) and dense marien snow were observed.

Image 18: Burrows and bioturbated unconsolidated sediment characteristic of the benthic portion of Dive 15.

Dive 16 "Dauphin Dome (MC388)"

- Dive 16 was conducted to investigate a number of BOEM seismic anomalies and water-column targets detected in multibeam surveys
- 10 previously undiscovered methane seeps with small associated chemosynthetic communities were discovered.
- Around the seeps were dense bushes of tubeworms (*Escarpia* sp. and *Lamellibrachia* sp.), some of which were parasitized by polychaete worms.
- These 'bushes' (Image 19) were home to a variety of organisms including two species of polychaete worms, squat lobsters, snails, mussels, zoanthids, ophiuroids, actiniarians, hydroids, and large swarms of copepods.

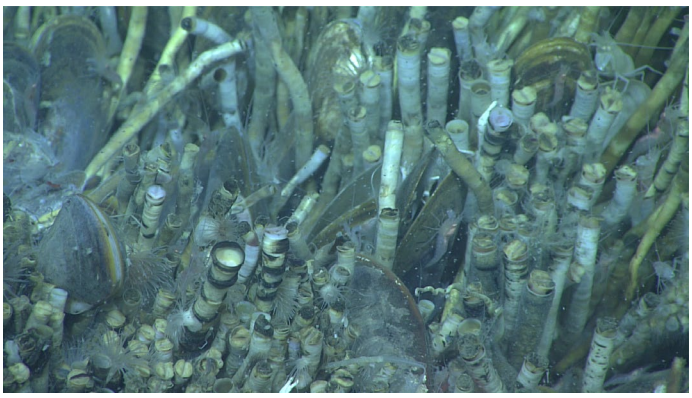

Image 19: 'Bushes' of tube worms and mussels observed on Dive 16 formed habitats for a variety of other organisms.

Dive 17 "Horn Dome (MC036)"

- During the entire dive areas of hydrocarbon seepage, first detected in the multibeam water column data, were observed.
- Four previously unknown cold water seeps were discovered.
- Methane hydrate forming bubbles were observed at several locations.
- Hydrate was yellow in color (Image 20), indicating impurities in the gas hydrate or an oily coating on the surface of the hydrate, something that has been seen in other parts of the Gulf of Mexico.
- All of the seeps had small associated chemosynthetic communities composed of live and dead vesicomyid clams partially buried within the sediment and many eelpouts resting on the seafloor.

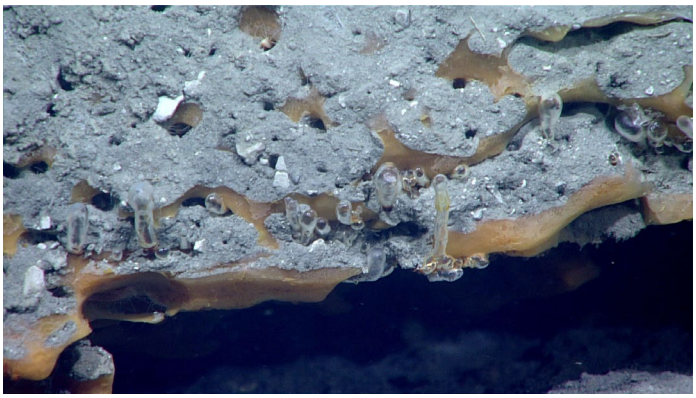

Image 20: Yellowish solid methane hydrate sublimates into bubbles observed on Dive 17.

7.1.1 Accessing ROV Data

OER Digital Atlas

ROV data from EX-17-11 are archived at NCEI and available through OER's Digital Atlas (https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm, last accessed October, 2020). To access these data, click on the Search tab, enter "EX1711" in the Enter Search Text field, and click Search. Click on the point that represents EX-17-11 to access data options. In the pop-up window, select the ROV Data Access tab for links to the ROV dive data, which is organized by dive.

ROV Dive SummariesIndividual ROV dive summaries and associated ROV dive data are archived at NCEI and available on their *Okeanos Explorer* website (https://www.ncei.noaa.gov/waf/okeanos-rov-cruises/ex1711/ last accessed October 2020).[2]

[2] ROV dive summaries are typically available 90 days after an ROV cruise. For access in the interim, contact ex.expeditioncoordinator@noaa.gov.

ROV Dive Video

To search, preview, and download dive video for *Okeanos Explorer*, go to the OER Video Portal (https://www.nodc.noaa.gov/oer/video/ last accessed October 2020).

SeaTube v2

OER works closely with Ocean Networks Canada to implement SeaTube v2 (https://data.oceannetworks.ca/SeaTubeV2), a web-based annotation interface for ROV operations on expeditions aboard *Okeanos Explorer*. SeaTube v1 is the digital equivalent to a scientist's logbook. SeaTube v2, the next version, is now used by onboard and shore-based scientists to log real-time observations on a variety of topics. To watch a video of a dive and search and export annotations, click on the Videos tab and select "NOAA," "2017," "Gulf of Mexico 2017," and 'dive name' under the Expeditions collapsible menu.

7.2 Sampling Operations Results

A total of 149 samples were collected during EX-17-11: eight primary geological samples and three geological associate samples (see Table 5 for more cumulative results). See Table 7 for full details of the geological samples collected.

Table 7. Inventory of geological samples collected during EX-17-11

Dive Number	Sample #	Sample ID	Site Name	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
03	EX1711_D03_02G	Limestone carbonate	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	2.63
04	EX1711_D04_02B_A03	Limestone rock	"Long Mounds"	20171203	192012	26.45	-84.76	381.14	0.69
05	EX1711_D05_05G	Limestone rock	"Incised Escarpment Ridge"	20171204	185620	27.35	-85.43	1915.12	3.29
06	EX1711_D06_01G	Carbonate rock	"Smooth Escarpment Ridge"	20171205	152021	28	-86.44	2092.08	1.47
06	EX1711_D06_03G	Fossilized coral	"Smooth Escarpment Ridge"	20171205	181526	28.01	-86.44	1892.64	0.37
09	EX1711_D09_02G	Carbonate rock	"Henderson Ridge Mid-South (*AT401*)"	20171211	164223	27.53	-89.7	1169.1	2.63
10	EX1711_D10_01B_A02	Carbonate rock	"Green Canyon Area,	20171212	211213	27.05	-91.19	1581.81	0.06

			St. Tammany Basin (*GC939*)						
11	EX1711_D11_02B_A01	Sediment	"*KC560*"	20171213	213200	26.43	-92.36	2033.33	N/A
13	EX1711_D13_02G	Rock	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	0.51
14	EX1711_D14_01G	Carbonate Rock	"Penchant Basin (*CG276*)"	20171217	200237	27.66	-91.35	785.22	N/A
16	EX1711_D16_01G	Authigenic carbonate rock	"Dauphin Dome (*MC288*)"	20171219	162756	28.61	-88.17	1930.49	1.63

There were 32 biological samples that were purposely collected (primary samples) as well as 71 biological samples that were incidentally collected (associate samples), for a total of 103 samples. From both primary and associate samples, 35 subsamples were taken for DNA analysis. In total, with the addition of the subsamples, all biological samples amounted to 138 individuals. See Table 8 for full details of the biological samples collected, not including the subsamples.

Table 8. Inventory of biological samples collected during EX-17-11

Sample #*	Field ID	Site Name	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temperature (C)	Dissolved Oxygen (mg/l)
EX1711_D01_01B	Lace bryozoan	"South Reed"	20171130	172531	24.65	-83.91	790.04	34.9	6.08	4.62
EX1711_D01_02B	Carnivorous sponge *Chondrocladia (Chondrocladia) verticillata*	"South Reed"	20171130	182054	24.65	-83.91	734.94	34.9	6.12	4.58
EX1711_D01_02B_A01	Polynoidae	"South Reed"	20171130	182054	24.65	-83.91	734.94	34.9	6.12	4.58
EX1711_D01_02B_A02	Polynoidae	"South Reed"	20171130	182054	24.65	-83.91	734.94	34.9	6.12	4.58
EX1711_D01_02B_A03	Ophiuroidea	"South Reed"	20171130	182054	24.65	-83.91	734.94	34.9	6.12	4.58
EX1711_D01_03B	Black coral	"South Reed"	20171130	195641	24.66	-83.91	699.53	34.9	6.91	4.12
EX1711_D01_04B	*Acanthogorgia* sp. (purple)	"South Reed"	20171130	201106	24.66	-83.91	692.49	34.9	6.92	4.11
EX1711_D01_05B	Cladorhizidae sponge	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A01	*Madrepora* sp.	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A02	Ophiuroidea	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11

EX1711_D01_05B_A03	Demospongiae sponge (pink)	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A04	?*Bathypsammia* sp. cup coral (orange)	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A05	*Eunice* sp.	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A06	Astrorhizacea	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A07	Hydroid	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D01_05B_A08	?Chrysogorgiidae	"South Reed"	20171130	203543	24.66	-83.91	676.37	34.9	6.95	4.11
EX1711_D02_01B	Cladorhizidae sponge	"Escarpment Canyon"	20171201	154009	24.62	-84.1	2312.58	34.98	4.35	6.58
EX1711_D02_01B_A01	Polychaeta A	"Escarpment Canyon"	20171201	154009	24.62	-84.1	2312.58	34.98	4.35	6.58
EX1711_D02_01B_A02	Polychaeta B	"Escarpment Canyon"	20171201	154009	24.62	-84.1	2312.58	34.98	4.35	6.58
EX1711_D02_02B	Euplectellidae	"Escarpment Canyon"	20171201	180514	24.62	-84.1	2224.74	34.97	4.35	6.54
EX1711_D02_03B	Isididae (?*Caribisis* sp.)	"Escarpment Canyon"	20171201	183013	24.62	-84.1	2219.84	34.97	4.35	6.54
EX1711_D02_04B	*Corallium* sp.	"Escarpment Canyon"	20171201	190455	24.62	-84.1	2211.35	34.97	4.34	6.54
EX1711_D02_05B	Bathycrinidae	"Escarpment Canyon"	20171201	192027	24.62	-84.1	2209.32	34.97	4.36	6.54
EX1711_D02_05B_A01	Antedonidae	"Escarpment Canyon"	20171201	192027	24.62	-84.1	2209.32	34.97	4.36	6.54
EX1711_D02_05B_A02	Hydroid (solitary)	"Escarpment Canyon"	20171201	192027	24.62	-84.1	2209.32	34.97	4.36	6.54
EX1711_D02_05B_A03	Sabellidae	"Escarpment Canyon"	20171201	192027	24.62	-84.1	2209.32	34.97	4.36	6.54
EX1711_D02_05B_A04	Feather star (juvenile)	"Escarpment Canyon"	20171201	192027	24.62	-84.1	2209.32	34.97	4.36	6.54
EX1711_D03_01B	*Chrysogorgia* sp.	"Okeanos Ridge"	20171202	181713	25.68	-84.62	701.18	34.9	6.26	4.47
EX1711_D03_01B_A01	Chirostylidae legs	"Okeanos Ridge"	20171202	181713	25.68	-84.62	701.18	34.9	6.26	4.47
EX1711_D03_02G_A01	Polychaeta (bristle worm)	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	34.9	6.34	4.42
EX1711_D03_02G_A02	*Acesta* sp.	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	34.9	6.34	4.42
EX1711_D03_02G_A03	Encrusting sponge	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	34.9	6.34	4.42
EX1711_D03_02G_A04	Polychaeta (medusa worm)	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	34.9	6.34	4.42
EX1711_D03_02G_A05	Bryozoan	"Okeanos Ridge"	20171202	190451	25.68	-84.62	693.2	34.9	6.34	4.42
EX1711_D03_03B	Plexauridae	"Okeanos Ridge"	20171202	204110	25.68	-84.62	665.65	34.84	6.65	4.26

EX1711_D04_01B	Stylasteridae	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_01B_A01	Feather star	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_01B_A02	Anemone	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_01B_A03	Ophiuroidea legs	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_01B_A04	Amphipoda	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_01B_A05	Scale worm	"Long Mounds"	20171203	180022	26.45	-84.76	401.79	35.14	9.61	3.62
EX1711_D04_02B	*Pterobranchia* sp.	"Long Mounds"	20171203	192012	26.45	-84.76	381.14	35.16	9.74	3.61
EX1711_D04_02B_A01	Porifera	"Long Mounds"	20171203	192012	26.45	-84.76	381.14	35.16	9.74	3.61
EX1711_D04_02B_A02	Octocorallia	"Long Mounds"	20171203	192012	26.45	-84.76	381.14	35.16	9.74	3.61
EX1711_D04_02B_A04	Porifera B	"Long Mounds"	20171203	192012	26.45	-84.76	381.14	35.16	9.74	3.61
EX1711_D04_03B	Isididae	"Long Mounds"	20171203	203553	26.45	-84.76	383.36	35.18	9.9	3.61
EX1711_D04_04B	Octocorallia	"Long Mounds"	20171203	210200	26.45	-84.76	383.2	35.18	9.92	3.61
EX1711_D04_04B_A01	Solitary cup coral	"Long Mounds"	20171203	210200	26.45	-84.76	383.2	35.18	9.92	3.61
EX1711_D04_04B_A02	?Barnacle	"Long Mounds"	20171203	210200	26.45	-84.76	383.2	35.18	9.92	3.61
EX1711_D05_01B	Hyocrinidae Crinoid	"Incised Escarpment Ridge"	20171204	164655	27.35	-85.43	2089.49	34.96	4.31	6.54
EX1711_D05_02B	*Chrysogorgia* sp.	"Incised Escarpment Ridge"	20171204	171824	27.35	-85.43	2078.36	34.98	4.3	6.54
EX1711_D05_02B_A01	Ascothoracida	"Incised Escarpment Ridge"	20171204	171824	27.35	-85.43	2078.36	34.98	4.3	6.54
EX1711_D05_03B	*Corallium* sp.	"Incised Escarpment Ridge"	20171204	181754	27.35	-85.43	1971.35	34.98	4.28	6.53
EX1711_D05_04B	Farreidae sponge	"Incised Escarpment Ridge"	20171204	182136	27.35	-85.43	1971.43	34.97	4.29	6.54
EX1711_D05_04B_A01	Scale worm	"Incised Escarpment Ridge"	20171204	182136	27.35	-85.43	1971.43	34.97	4.29	6.54
EX1711_D05_04B_A02	Amphipoda	"Incised Escarpment Ridge"	20171204	182136	27.35	-85.43	1971.43	34.97	4.29	6.54
EX1711_D05_05G_A01	Crinoid	"Incised Escarpment Ridge"	20171204	185620	27.35	-85.43	1915.12	34.97	4.29	6.51
EX1711_D05_05G_A02	Porifera A	"Incised Escarpment Ridge"	20171204	185620	27.35	-85.43	1915.12	34.97	4.29	6.51

EX1711_D05_05G_A03	Polychaeta	"Incised Escarpment Ridge"	20171204	185620	27.35	-85.43	1915.12	34.97	4.29	6.51
EX1711_D05_05G_A04	Porifera B	"Incised Escarpment Ridge"	20171204	185620	27.35	-85.43	1915.12	34.97	4.29	6.51
EX1711_D05_06B	Acanella	"Incised Escarpment Ridge"	20171204	202517	27.35	-85.43	1863.56	34.97	4.29	6.49
EX1711_D05_06B_A01	Amphipoda	"Incised Escarpment Ridge"	20171204	202517	27.35	-85.43	1863.56	34.97	4.29	6.49
EX1711_D05_06B_A02	Bathypalaemonella	"Incised Escarpment Ridge"	20171204	202517	27.35	-85.43	1863.56	34.97	4.29	6.49
EX1711_D06_02B	Isididae	"Smooth Escarpment Ridge"	20171205	170503	28	-86.44	1963.33	34.97	4.28	6.56
EX1711_D06_03G_A01	?*Stephanoscyphus* sp.	"Smooth Escarpment Ridge"	20171205	181526	28.01	-86.44	1892.64	34.97	4.28	6.52
EX1711_D06_04B	Thalassometridae crinoid	"Smooth Escarpment Ridge"	20171205	195715	28.01	-86.44	1750.19	34.97	4.28	6.49
EX1711_D06_04B_A01	Isididae	"Smooth Escarpment Ridge"	20171205	195715	28.01	-86.44	1750.19	34.97	4.28	6.49
EX1711_D09_01B	Plexauridae	"Henderson Ridge Mid-South (*AT401*)"	20171211	155444	27.53	-89.7	1167.64	34.96	4.35	6.41
EX1711_D09_01B_A01	Lepadomorpha	"Henderson Ridge Mid-South (*AT401*)"	20171211	155444	27.53	-89.7	1167.64	34.96	4.35	6.41
EX1711_D09_01B_A02	Foraminifera	"Henderson Ridge Mid-South (*AT401*)"	20171211	155444	27.53	-89.7	1167.64	34.96	4.35	6.41
EX1711_D09_01B_A03	Polynoidae	"Henderson Ridge Mid-South (*AT401*)"	20171211	155444	27.53	-89.7	1167.64	34.96	4.35	6.41
EX1711_D09_02G_A01	Sipuncula	"Henderson Ridge Mid-South (*AT401*)"	20171211	164223	27.53	-89.7	1169.1	34.97	4.28	6.51
EX1711_D09_02G_A02	Polynoidae	"Henderson Ridge Mid-South (*AT401*)"	20171211	164223	27.53	-89.7	1169.1	34.97	4.28	6.51
EX1711_D09_02G_A03	Bathymodiolus	"Henderson Ridge Mid-South (*AT401*)"	20171211	164223	27.53	-89.7	1169.1	34.97	4.28	6.51

EX1711_D09_02G_A04	Gastropoda	"Henderson Ridge Mid-South (*AT401*)"	20171211	164223	27.53	-89.7	1169.1	34.97	4.28	6.51
EX1711_D09_03B	Stolonifera coral	"Henderson Ridge Mid-South (*AT401*)"	20171211	202707	27.53	-89.71	1133.78	34.95	4.57	6.02
EX1711_D09_03B_A01	Polychaeta	"Henderson Ridge Mid-South (*AT401*)"	20171211	202707	27.53	-89.71	1133.78	34.95	4.57	6.02
EX1711_D09_04B	*Anthothela sp.* coral	"Henderson Ridge Mid-South (*AT401*)"	20171211	205623	27.53	-89.71	1130.1	34.95	4.62	5.96
EX1711_D09_04B_A01	Desmophyllum	"Henderson Ridge Mid-South (*AT401*)"	20171211	205623	27.53	-89.71	1130.1	34.95	4.62	5.96
EX1711_D09_04B_A02	Polynoidae	"Henderson Ridge Mid-South (*AT401*)"	20171211	205623	27.53	-89.71	1130.1	34.95	4.62	5.96
EX1711_D09_04B_A03	Foraminifera	"Henderson Ridge Mid-South (*AT401*)"	20171211	205623	27.53	-89.71	1130.1	34.95	4.62	5.96
EX1711_D10_01B	Actinernus sp. anemone	"Green Canyon Area ,St. Tammany Basin (*GC939*)"	20171212	211213	27.05	-91.19	1581.81	34.97	4.27	6.47
EX1711_D10_01B_A01	Polychaeta	"Green Canyon Area ,St. Tammany Basin (*GC939*)"	20171212	211213	27.05	-91.19	1581.81	34.97	4.27	6.47
EX1711_D11_01B	Isididae	*"KC 560"*	20171213	203651	26.43	-92.36	2056.57	34.98	4.27	6.51
EX1711_D11_02B	Porifera	*"KC 560"*	20171213	213200	26.43	-92.36	2033.33	34.97	4.28	6.5
EX1711_D13_01B	Siboglinidae	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A01	Cirripedia	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A02	Pycnogonida	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A03	Amphipoda	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A04	Polychaeta species A	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A05	Polychaeta species B	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_01B_A06	Polychaeta species C	"Tunica Mound (*GB299*)"	20171216	153158	27.7	-92.22	408.95	35.19	9.87	3.47
EX1711_D13_02G_A01	*Heteropathes americana*	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	35.22	10.12	3.47

EX1711_D13_02G_A02	Ophiuroidea	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	35.22	10.12	3.47
EX1711_D13_02G_A03	Anemone polyp	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	35.22	10.12	3.47
EX1711_D13_02G_A04	Polychaeta	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	35.22	10.12	3.47
EX1711_D13_02G_A05	Bivalve	"Tunica Mound (*GB299*)"	20171216	181731	27.71	-92.22	401.82	35.22	10.12	3.47
EX1711_D14_01G_A01	Brachiopoda A	"Penchant Basin (*CG276*)"	20171217	200237	27.66	-91.35	785.22	34.92	5.83	4.72
EX1711_D14_01G_A02	Porifera	"Penchant Basin(*CG276*)"	20171217	200237	27.66	-91.35	785.22	34.92	5.83	4.72
EX1711_D14_01G_A03	Brachiopoda B	"Penchant Basin(*CG276*)"	20171217	200237	27.66	-91.35	785.22	34.92	5.83	4.72
EX1711_D14_02B	Plexauridae	"Penchant Basin(*CG276*)"	20171217	210642	27.66	-91.35	761.25	34.91	5.91	4.65
EX1711_D14_02B_A01	Amphipoda	"Penchant Basin(*CG276*)"	20171217	210642	27.66	-91.35	761.25	34.91	5.91	4.65
EX1711_D15_01B	Ceriantharia	"Penchant Basin(*MC796*)	20171218	201847	28.16	-89.77	534.83	34.96	7.87	3.73

*Sample numbers with "_A##" indicate associate samples.

7.2.1 Sample Repositories

The following repositories archive samples collected during expeditions on *Okeanos Explorer*.

- Invertebrate Zoology Collections, National Museum of Natural History, Smithsonian Institution, Museum Support Center, MRC 534, 4210 Silver Hill Road, Suitland, MD 20746
  Website: https://invertebrates.si.edu/LoanPolicy.html
- Biorepository, National Museum of Natural History, Smithsonian Institution, Museum Support Center, 4210 Silver Hill Road, Suitland, MD 20746
  Website: https://naturalhistory.si.edu/research/biorepository (last accessed October 2020)
- Marine and Geology Repository, Oregon State University, Burt 346, Corvallis, OR 97331-5503
  Website: http://osu-mgr.org/noaa-ex/ (last accessed October 2020)

7.3 Acoustic Operations Results

During EX-17-11, multibeam mapping operations results included 4,600 linear kilometers (km) mapped and 20,657 km^2 covered (20,510 of these in the U.S. EEZ). No major issues were reported in the acoustic data during acquisition. Select acoustic data from December 9, 2017,

were collected using UCH protocols and have not been cleared for public access by OER. Individuals wishing to access these files can contact ncei.info@noaa.gov.

Figure 2 shows a map of location of sonar anomalies, typically thought to be bubble plumes/cold water seeps, which were geo-picked from the EM 302 water column data. Some of these are new locations and some confirmed historical seep locations. EX-17-11 mapping operations, when possible, included focused overnight mapping of the ROV dive location, examples are shown in Figures 3 and 4 for Dives 14 and 16, respectively.

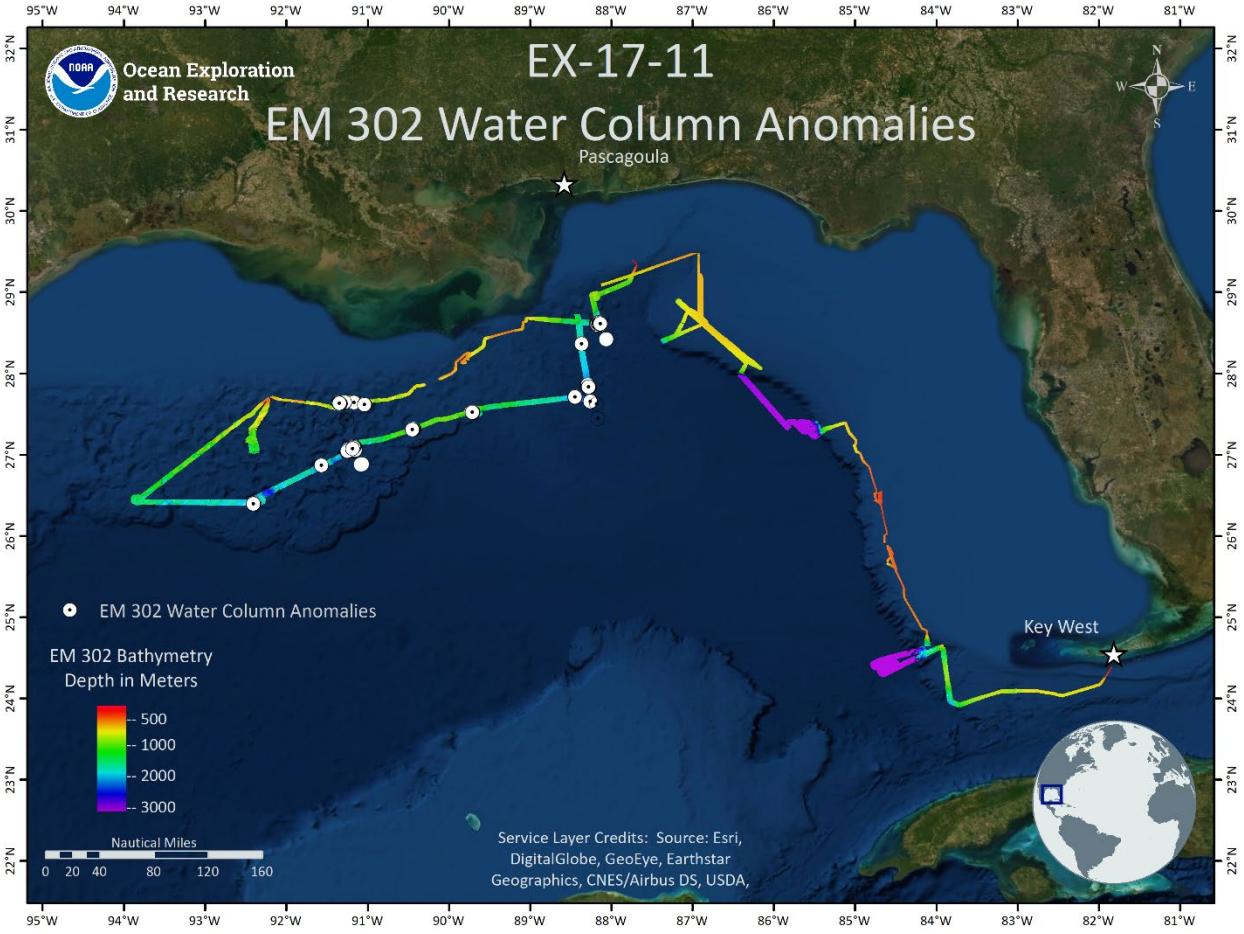

Figure 2. Locations of EM 302 water column anomalies from EX-17-11. In the Gulf of Mexico, these anomalies are typically thought to be cold water seeps/bubble plumes.

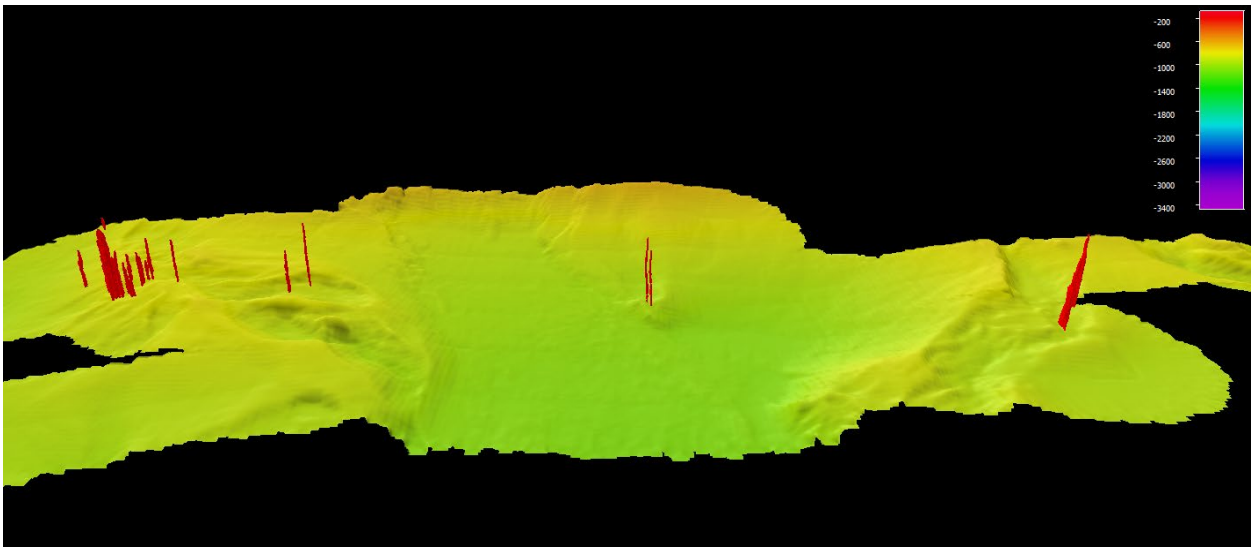

Figure 3. Example of overnight focused mapping over a ROV dive site with water column anomalies identified in the EM 302 data. From Dive 14, "Penchant Basin (*CG276*)." Vertical exaggeration 3x, 60m cell size, depth in meters.

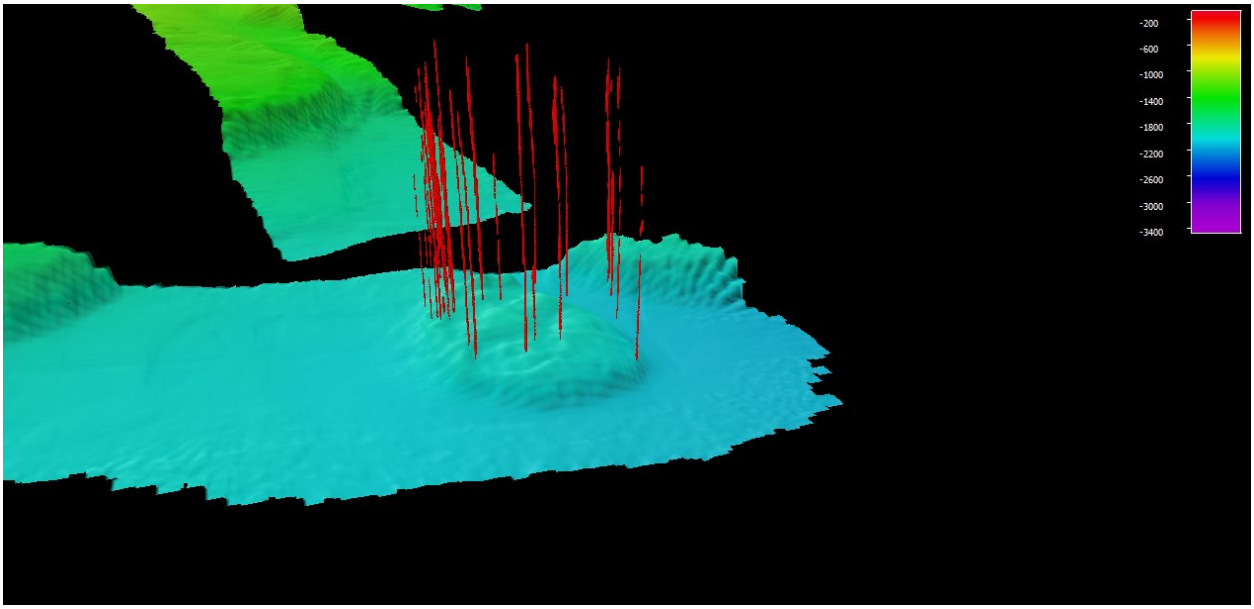

Figure 4. Example of overnight focused mapping over a ROV dive site with water column anomalies identified in the EM 302 data. From Dive 16, "Dauphin Dome (*MC388*)." Vertical exaggeration 3x, 60m cell size, depth in meters.

Figures 5 and 6 display the locations of EK60 and sub-bottom data respectively collected on EX-17-11. No major issues during data acquisition were reported. The EK60 sonars were calibrated during EX-18-02, after this expedition, and the resultant calibrations and report can

be found in the, '2018 NOAA Ship Okeanos Explorer EK60 Calibration Report—Northern Gulf of Mexico,' (https://repository.library.noaa.gov/view/noaa/21418, last accessed October 2020).

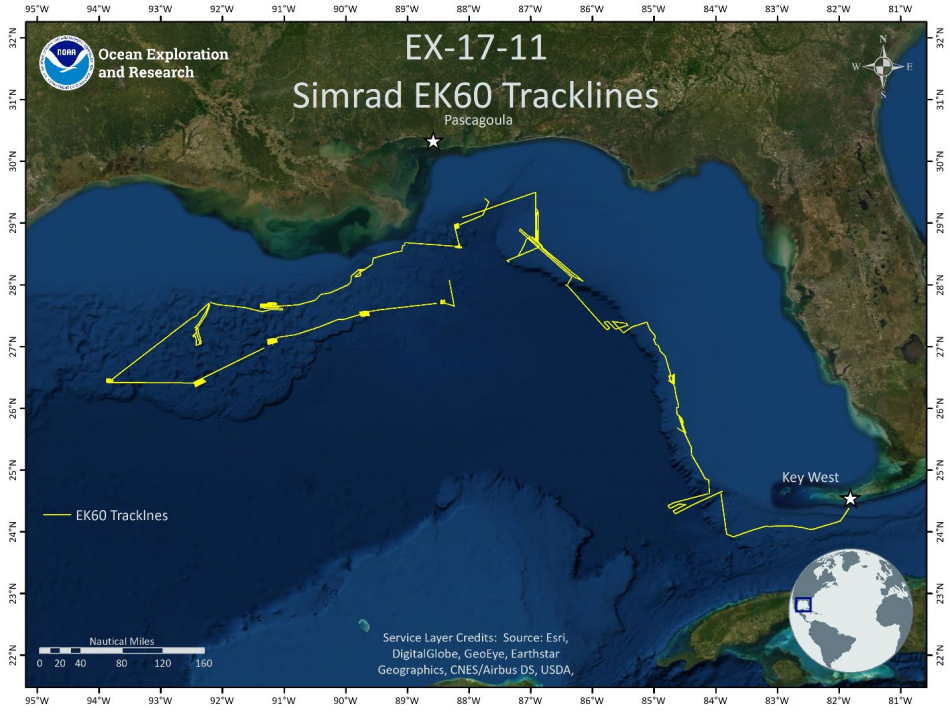

Figure 5. Simrad EK60 split-beam sonar data tracklines (in yellow) collected during EX-17-11.

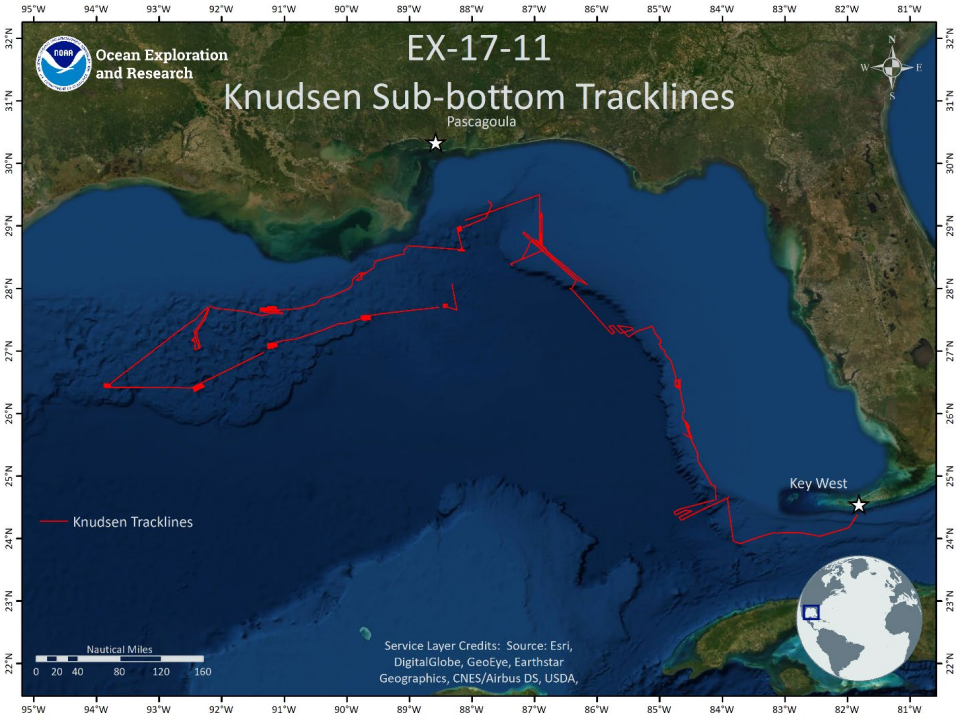

Figure 6. Sub-bottom profiler data tracklines (in red) collected during EX-17-11.

Additional information about the mapping conducted during EX-17-11, including data quality assessments, is in the Mapping Data Acquisition and Processing Summary Report EX-17-11, Gulf of Mexico 2017 (ROV & Mapping), White et at., 2020 (https://repository.library.noaa.gov/view/noaa/23721, last accessed October 2020)

7.3.1 Acoustic Operations Data Access

Multibeam Sonar (Kongsberg EM 302)

The multibeam dataset for the expedition is archived at NCEI and accessible through their Bathymetric Data Viewer (https://maps.ngdc.noaa.gov/viewers/bathymetry/). To access these data, click on the Search Bathymetric Surveys button, select "NOAA Ship Okeanos Explorer" from the Platform Name dropdown menu, and "EX-17-11" from the Survey ID dropdown menu. Click OK, and the ship track for the cruise will appear on the map. Click the ship track for options to download data. The Digital Object Identifier (DOI) for EX-17-11 EM 302 water column data is: http://doi.org/10.7289/V5W957HS (last accessed October 2020)

Sub-Bottom Profiler (Knudsen Chirp 3260)

The SBP was not run during any of EX-17-11's ROV dive operations, but generally was operated during multibeam mapping operations. Sub-bottom data, supporting data, and informational

logs will be available in the NCEI Data Archives accessible at https://www.ngdc.noaa.gov/ (last accessed October 2020). For any challenges accessing SBP data, send an inquiry to ncei.info@noaa.gov requesting access to EX-17-11 Knudsen Chirp 3260 sub-bottom raw and processed data.

Split-beam Sonars (Simrad EK60)

EK60 water column data for EX-17-11 are archived at NCEI and available through their Water Column Sonar Data Viewer (https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html). To access these data, click on the Additional Filters button, deselect "All" next to Survey ID, and select "EX-17-11" from the Survey ID list. Click OK, and the ship track for the cruise will appear on the map. Click on the ship track for options to download data. The DOI for EK60 data is: http://doi.org/10.7289/V54T6GN6 (last accessed October 2020).

Acoustic Doppler Current Profilers (Teledyne Marine Workhorse Mariner and Teledyne Ocean Surveyor ADCPs)

Teledyne Marine Workhorse Mariner and Teledyne Ocean Surveyor ADCP data collected before and during ROV dive operations are archived at NCEI and are available through their Global Ocean Currents Database at https://www.nodc.noaa.gov/gocd/sadcp_oer_inv.html (Last accessed October 2020). For any issues accessing the ADCP data please contact ncei.info@noaa.gov.

7.4 Conductivity, Temperature, and Depth (CTD) Measurements

CTD profile data from EX-17-11 are archived at NCEI and available through OER's Digital Atlas (https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm, last accessed October 2020). To access these data, click on the Search tab, enter "EX1711" in the Enter Search Text field, and click Search. Click on the point that represents EX-17-11 to access data options. In the pop-up window, select the Data Access tab for a link to download the CTD profile data.

ROV CTD data can be found with the dive summaries on the *Okeanos Explorer* website (https://www.ncei.noaa.gov/waf/okeanos-rov-cruises/ex1711/ last accessed October 2020).

7.5 Sun Photometer Measurements

Sun photometer measurements are available through NASA's MAN (https://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html). Access these data by searching the table for "2017," "Okeanos Explorer," and "Gulf of Mexico." Click on the links to download the data. (Note: There may be more than one entry for *Okeanos Explorer* in a region in a given year.)

7.6 Engagement

EX-17-11 engaged with audiences around the world, opening a window of understanding into the deep sea. Table 9 contains details regarding live interactions with the onboard science team. Highlights are listed below:

- Live video feeds received over 280,000 views, and web content received 35,600 visits during EX-17-11.
- Eight live interactions were conducted to engage a diversity of audiences (see Table 9 for details about these and other similar events).
- Over 13 news/web articles covered EX-17-11. Stories appeared in international, national, and local media outlets and on websites throughout the country. This coverage amplified the impact of the expedition, increasing the audience reached.
- A seminar was given in person at the South Carolina Aquarium to promote Gulf of Mexico exploration and science on November 29, 2017.
- A Facebook Live event was completed on December 12, 2017.

Table 9. Engagement live interaction metrics

Group Name	Date	Onshore Participants
Aquarium of the Pacific	December 2, 2017	19
Shedd Aquarium	December 2, 2017	23
NOAA Gulf Regional Council	December 7, 2017	30
Center for Coastal and Ocean Mapping Seminar	December 8, 2017	30
Facebook Live event	December 12, 2017	6,000 views
Exploratorium	December 16, 2017	20
Media Lab at Inner Space Center	December 20, 2017	10
South Carolina Aquarium	Throughout	150-200

8. Summary

The Gulf of Mexico 2017 expedition was a 23-day telepresence-enabled expedition to collect critical information and acquire data on priority exploration areas identified by ocean management and scientific communities. The goal of the expedition was to use ROV dives and seafloor mapping operations to increase the understanding of the deep-sea ecosystems in these areas to support management decisions. Major accomplishments from this expedition are summarized below. A downloadable PDF version of summary accomplishment can be found here: https://oceanexplorer.noaa.gov/okeanos/explorations/ex1711/logs/summary/media/1711-summary.pdf (last accessed October 2020).

The expedition conducted 17 ROV dives, ranging in depth from 300 to 2,321 meters (984 to 7,615 feet) to explore the diversity and distribution of deep-sea habitats and associated marine communities in the Gulf of Mexico basin. Operations focused on characterizing deep-sea coral and sponge communities; bottom fish habitats; shipwrecks; and chemosynthetic habitats such as cold seeps, mud volcanoes, asphalt seeps, and brine pools. Midwater exploration, at depths ranging from 300 to 900 meters (984 to 2,953 feet), was also conducted on four dives to investigate the diversity and abundance of the largely unknown pelagic fauna. Highlights from the expedition include:

- Observed commercially important species including fishes (silver roughy and Darwin's slimehead) and invertebrates (golden crab, red crab, and royal red shrimp).
- Collected 103 biological samples (32 primary and 71 associated and commensal taxa on both geological and biological samples), several of which may be undescribed species.
- Documented at least nine high-density and high-diversity coral and sponge communities.
- Surveyed the wreck of an early 19th-century copper-clad merchant vessel carrying artifacts including glass bottles, ceramic and porcelain vessels, remnants of a suction bilge pump with cast-iron flywheels, an anchor, and a cast-iron stove. Carried out a series of video transects along and across the forepart of the wreck to supply imagery for a 3D digital reconstruction (https://sketchfab.com/BOEMArchaeology, last accessed October 2020) of the wreck (courtesy of BOEM). Chemosynthetic fauna were observed within the wreck, likely from the presence of the degrading wood structure.
- Collected more than 13.1 TB of data, including multibeam, single beam, sub-bottom, ADCP, XBT, CTD, and DO profiles; surface oceanographic and meteorological sensor information; and video, imagery, and associated dive and video products. All of the data from this expedition are publically available through national archives.

- Engaged with audiences around the world, opening a window to the deep sea. Highlights include:
    - Shared the live video feeds of the expedition with the public worldwide via the Internet, with the live video receiving more than 280,000 views via the OER YouTube channel. Expedition content on the OER website received over 35,600 views.
    - Conducted a successful Facebook live question-and-answer session that received ~6,000 views, while guests responded to over 24 questions.
    - Received news and media coverage by various sources including MSN, Daily Mail, Business Insider, IFL Science, and others.
    - Conducted six live telepresence interactions with various groups including the Aquarium of the Pacific, Shedd Aquarium, NOAA Gulf Regional Council, University of New Hampshire's Center for Coastal and Ocean Mapping, The Exploratorium, and members of the MIT Media Lab.

9. References

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Quattrini, A.M., Nizinski, M.S., Chaytor, J.D., Demopoulos, A.W.J., Roark, E.B., France, S.C., Moore, J.A., Heyl, T., Auster, P.J., Kinian, B., Ruppel, C., Elliott, K.P., Kennedy, B.R.C., Lobecker, E., Skarke, A., and Shank, T.M. (2015). Exploration of the canyon-incised continental margin of the northeastern United States reveals dynamic habitats and diverse communities. *PLoS One, 10*(10). https://doi.org/10.1371/journal.pone.0139904

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White, M.P., Roy, L., Freitas, D. (2020). Mapping Data Acquisition and Processing Summary Report: Cruise EX-17-11 Gulf of Mexico 2017. Office of Ocean Exploration and Research, Office of Oceanic & Atmospheric Research, NOAA, Silver Spring, MD 20910. https://doi.org/10.25923/s606-0s63

Appendix A: EX-17-11 Data Management Plan

Data Management Plan

Okeanos Explorer (EX1711): Gulf of Mexico (ROV and Mapping)

Ocean Exploration and Research

OER Data Management Objectives

To investigate ways to include data QA/QC from the submersibles in the standard operating procedures; to test new procedures for sampling operations involving specimen chain of custody; to collect and provide access to total cruise data metrics in an online location.

13-Nov-17 Page 1

1. General Description of Data to be Managed

13.1 Name and Purpose of the Data Collection Project

Okeanos Explorer (EX1711): Gulf of Mexico (ROV and Mapping)

13.2 Summary description of the data to be collected.

Operations will include the use of the ship's deep water mapping systems (Kongsberg EM302 multibeam sonar, EK60 split-beam fisheries sonars, Knudsen 3260 chirp sub-bottom profiler sonar, and Teledyne Acoustic Doppler Current Profiler), XBT and CTD casts in support of multibeam sonar mapping operations, OER's two-body ROV Deep Discoverer and Seirios, and the ship's high-bandwidth satellite connection for continuous real-time ship-to-shore communications.

13.3 Keywords or phrases that could be used to enable users to find the data.

expedition, exploration, explorer, marine education, noaa, ocean, ocean discovery, ocean education, ocean exploration, ocean exploration and research, ocean literacy, ocean research, OER, science, scientific mission, scientific research, sea, stewardship, systematic exploration, technology, transformational research, undersea, underwater, Davisville, mapping survey, multibeam, multibeam backscatter, multibeam sonar, multi-beam sonar, noaa fleet, okeanos, okeanos explorer, R337, Rhode Island, scientific computing system, SCS, single beam sonar, singlebeam sonar, single-beam sonar, sub-bottom profile, water column backscatter, Gulf of Mexico, Essential Fish Habitats, National Marine Sanctuaries, benthic habitats, bottom fish habitats, deep sea coral communities, sponge communities, biogeographic patterns, deep sea ecosystems, water column characterization

13.4 If this mission is part of a series of missions, what is the series name?

Okeanos ROV Cruises

13.5 Planned or actual temporal coverage of the data.

Dates: 11/29/2017 to 12/21/2017

13.6 Planned or actual geographic coverage of the data.

Latitude Boundaries:	23.7	to	30.2
Longitude Boundaries:	-97.2	to	-80.9

1.7 What data types will you be creating or capturing and submitting for archive?

Cruise Plan, Cruise Summary, Data Management Plan, Highlight Images, Quick Look Report, CTD (processed), CTD

1.7 What data types will you be creating or capturing and submitting for archive?

Cruise Plan, Cruise Summary, Data Management Plan, Highlight Images, Quick Look Report, CTD (processed), CTD (product), CTD (raw), Dive Summaries, EK60 Singlebeam Data, Expedition Cruise Report, Floating Point GeoTIF, HDCS, Highlight Video, HL Video captions/credits, Images, Multibeam (processed), Multibeam (product)Multibeam (raw), NetCDF, Raw Video (digital), Sample Analysis Reports, Sample Logs, SCS Output (compressed), SCS Output (native), Side Scan Sonar (raw), Sub-Bottom Profile data, Temperature data, Water Column Backscatter, XBT (raw)

1.8 What platforms will be employed during this mission?

NOAA Ship Okeanos Explorer, Deep Discoverer ROV, SEIRIOS Camera Sled

2. Point of Contact for this Data Producing Project

Overall POC:	Brian Kennedy
Title:	Telepresence Lead
Affiliation/Dept:	NOAA Office of Ocean Exploration and Research
E-Mail:	brian.kennedy@noaa.gov
Phone:	706-540-2664

3. Point of Contact for Managing the Data

Data POC Name:	Joshua Carlson, Lauren Jackson, Susan Gottfried
Title:	Onboard/Shoreside Data Manager, Sample Data Manager, Stewardship Data Manager
E-Mail:	joshocar@gmail.com, lauren.jackson@noaa.gov, susan.gottfried@noaa.gov

4. Resources

4.1 Have resources for management of these data been identified? True

4.2 Approximate percentage of the budget devoted to data management. (specify % or "unknown")

unknown

5. Data Lineage and Quality

5.1 What is the processing workflow from collection to public release?

SCS data shall be delivered in its native format as well as an archive-ready, documented, and compressed NetCDF3 format to NCEI-MD; multibeam data and metadata will be compressed and delivered in a bagit format to NCEI-CO

5.2 What quality control procedures will be employed?

Quality control procedures for the data from the Kongsberg EM302 is handled at UNH CCOM/JHC. Raw (level-0) bathymetry files are cleaned/edited into new data files (level-1) and converted to a variety of products (level-2). Data from sensors monitored through the SCS are archived in their native format and are not quality controlled. Data from CTD casts and XBT firings are archived in their native format. CTDs are post-processed by the data management team as a quality control measure and customized CTD profiles are generated for display on the Okeanos Atlas (explore.noaa.gov/okeanosatlas).

6. Data Documentation

6.1 Does the metadata comply with the Data Documentation Directive?

6.1.1 If metadata are non-existent or non-compliant, please explain: True not applicable

6.2 Where will the metadata be hosted?

Organization:	An ISO format collection-level metadata record will be generated during pre-cruise planning and published in an OER catalog and Web Accessible Folder (WAF) hosted at NCEI-MS for public discovery and access. The record will be harvested by data.gov.
URL:	www.ncddc.noaa.gov/oer-waf/ISO/Resolved/2017/
Meta Std:	ISO 19115-2 Geographic Information with Extensions for Imagery and Gridded Data will be the metadata standard employed; a NetCDF3 standard for oceanographic data will be employed for the SCS data; the Library of Congress standard, MAchine Readable Catalog (MARC), will be employed for NOAA Central Library records.

6.3 Process for producing and maintaining metadata:

Metadata will be generated via xml editors or metadata generation tools.

7. Data Access

7.1 Do the data comply with the Data Access Directive? True

7.1.1 If the data will not be available to the public, or with limitations, provide a valid reason.

Not Applicable

7.1.2 If there are limitations, describe how data are protected from unauthorized access.

Account access to mission systems are maintained and controlled by the Program. Data access prior to public accessibility is documented through the use of Data Request forms and standard operating procedures.

7.2 Name and URL of organization or facility providing data access.

Org:	National Centers for Environmental Information
URL:	www.ncei.noaa.gov

7.3 Approximate delay between data collection and dissemination. By what authority?

Hold Time:	data shall be released as soon as possible after the cruise end
Authority:	not applicable

7.4 Prepare a Data Access Statement

No data access constraints, unless data are protected under the National Historic Preservation Act of 1966.

8. Data Preservation and Protection

8.1 Actual or planned long-term data archive location:

Data from this mission will be preserved and stewarded through the NOAA National Centers for Environmental Information. Refer to the Okeanos Explorer FY17 Data Management Plan at NOAA's EDMC DMP Repository (EX_FY17_DMP_Final.pdf) for detailed descriptions of the processes, procedures, and partners involved in this collaborative effort.

8.2 If no archive planned, why?

not applicable

8.3 If any delay between data collection and submission to an archive facility, please explain.

60-90 days

8.4 How will data be protected from accidental or malicious modification or deletion?

Data management standard operating procedures minimizing accidental or malicious modification or deletion are in place aboard the Okeanos Explorer and will be enforced.

8.5 Prepare a Data Use Statement

Data use shall be credited to NOAA Office of Ocean Exploration and Research.

Appendix B: EX-17-11 Categorical Exclusion Evaluation Worksheet

Form Version: September 2017

Categorical Exclusion (CE) Evaluation Worksheet

Project Identifier: EX-17-11

Date Review Completed: 11/13/2017

Completed by: Brian Kennedy, Expedition Coordinator

OAR Functional Area: OER

Worksheet File Name: 2017-11-OER-CE-EX1711

Step 1. CE applicability

1. **Is this federal financial assistance, including via grants, cooperative agreements, loans, loan guarantees, interest subsidies, insurance, food commodities, direct appropriations, and transfers of property in place of money?**

   no

2. **What is the proposed federal action?**
   The proposed action is to collect baseline mapping data using the NOAA Ship Okeanos Explorer's sonar systems and to conduct baseline characterizations of unexplored areas using NOAA's two-body remotely operated vehicle (ROV) and CTD rosette system on the NOAA Ship Okeanos Explorer. ROV operations will include collection of detailed high resolution imagery, collection of limited biological and geological samples, and digital sensor data collection.
   The expedition will conduct operations in the US Exclusive Economic Zone (EEZ) in the Gulf of Mexico and potentially in international waters of the Gulf of Mexico, commencing on November 29, 2017 in Key West FL (24° 33.86'N, 81° 48.01'W) and concluding on December 22, 2017 in Pascagoula MS, Hawaii (30° 20.36'NN, 88° 34.50'W) to. See Project Instructions EX-17-11 for more details.

3. **Which class of CE in Appendix E of the NAO 216-6A Companion Manual is applicable to this action and why?**
   a. E3: Activities to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner.

b. This exploratory expedition will use remote sensing, video, imagery and a limited number of samples to collect baseline information on unexplored areas of the Gulf of Mexico

Step 2. Extraordinary Circumstances Consideration

4. Would the action result in adverse effects on human health or safety that are not negligible?

No. The NOAA Ship Okeanos Explorer will be operating in deep sea areas of the Gulf of Mexico during EX-17-11, an expedition which is part of the Southeast Deep Coral Initiative (SEDCI), (see Table 1 of EX-17-11 Project Instructions: Bounding coordinates of the EX-17-11 operating area) This action does not involve any procedures or outcomes known to result in impacts on human health and safety more than would be negligible.

5. Would the action result in adverse effects on an area with unique environmental characteristics that are not negligible?

This survey/expedition will conduct operations near the Florida Keys and Flower Gardens National Marine Sanctuaries, but not within sanctuary boundaries. OER is working closely with Sanctuaries staff to ensure impacts will be less than negligible.

The expedition is being planned and conducted in partnership with NOAA National Marine Fisheries Service (NMFS), National Centers for Coastal Ocean Science (NCCOS), Deep Sea Coral Research and Technology Program (DSCRTP), Florida Keys NMS and Flower Gardens Banks NMS, Gulf of Mexico Fisheries Management Council and the Bureau of Ocean Energy Management (BOEM). OER will use input from theses management authorities that are familiar with these areas to ensure no more than negligible effects on these areas with potentially unique environmental characteristics.

6. Would the action result in adverse effects on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA that are not negligible?

OER and the National Centers for Coastal Ocean Science (NCCOS) have taken measures to ensure that any effects on species or habitats protected by the ESA, MMPA, MSA or NMSA meet the definition of "negligible". In June 2017, a request from NCCOS was submitted to the NMFS PIRO Protected Resources Division to initiate consultation under Section 7 of the ESA for all Southeast Deep Coral Initiative (SEDCI) cruises. Accompanying this request was a biological assessment that described the planned operations proposed for 2017-2019 expeditions in the

Gulf of Mexico and the South Atlantic that identified all ESA-listed species, including corals, in the vicinity of the operations. On August 17, 2017, NCCOS received a letter that concurred with its determination that these 2017-2019 operations are not likely to adversely affect ESA-listed species. The ESA Section 7 concurrence letter is provided as an Appendix in the Project Instructions document for EX-17-11.
Given the offshore focus area of our work, it is improbable that we will encounter marine mammals protected under the MMPA or sea birds protected under the MBTA. If we did encounter any marine mammals or seabirds, our effect would be negligible because of the best management practices to which we adhere to avoid or minimize environmental effects.
NCCOS also initiated a request for a Magnuson-Stevens Essential Fish Habitat (EFH) consultation for this same series of cruises and subsequently received a determination that the proposed cruises will not reduce the quality and/or quantity of EFH, provided adherence to the OER proposed procedures and the NMFS guidance were both conveyed via letter from Virginia Fay Assistant Regional Administrator, NMFS Habitat Conservation Division on June 22, 2017.

7. **Would the action result in the potential to generate, use, store, transport, or dispose of hazardous or toxic substances, in a manner that may have a significant effect on the environment?**

No. The cruise operations will be in compliance with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or superseding OMAO procedures) to ensure generation, use, storage, transport, and disposal of such substances will not result in significant impacts.

8. **Would the action result in adverse effects on properties listed or eligible for listing on the National Register of Historic Places authorized by the National Historic Preservation Act of 1966, National Historic Landmarks designated by the Secretary of the Interior, or National Monuments designated through the Antiquities Act of 1906; Federally recognized Tribal and Native Alaskan lands, cultural or natural resources, or religious or cultural sites that cannot be resolved through applicable regulatory processes?**

During EX-17-11, we will be conducting ROV dives on sonar anomaly targets believed to be shipwrecks. If these anomalies are confirmed to be significant shipwrecks, they can potentially be eligible for listing on the National Register of Historic Places. OER conducts non-invasive surveys of archaeology targets and protects the location of sensitive cultural heritage sites (UCH). Appendix H of the EX-17-11 project instructions includes OER's standard operating procedures for UCH sites. This expedition is being planned in conjunction with the NOAA Office of National Marine Sanctuaries' Maritime Heritage Program and the Bureau of Ocean Energy

Management (BOEM). Staff from the Maritime Heritage Program and BOEM will participate in UCH operations to ensure that operations are non-invasive and compliant to all applicable regulations.

9. Would the action result in a disproportionately high and adverse effect on the health or the environment of minority or low-income communities, compared to the impacts on other communities (EO 12898)?

No, the NOAA Ship Okeanos Explorer will be operating in deep sea areas of the Gulf of Mexico (see Table 1, EX 17-11 Project Instructions). There are no human communities within the geographic scope of the cruise, and when nearshore, operations will be conducted several miles offshore. The cruise does not involve actions known or likely to result in adverse impacts on human health.

10. Would the action contribute to the introduction, continued existence, or spread of noxious weeds or nonnative invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of the species?

No. During EX-17-11 the ship will not make landfall in areas other than commercial ports. The ship and OER mission team will comply with all applicable local and federal regulations regarding the prevention or spread of invasive species. At the completion of every ROV dive or CTD cast, the systems will be thoroughly rinsed with fresh water, completely dried and checked for the presence of biological organisms to prevent spreading organisms from one site to another. Also the Engineering Department aboard the NOAA Ship Okeanos Explorer attends yearly Ballast Management Training in accordance with NOAA Form 57-07-13 NPDES VGP Annual Inspection and Report to prevent the introduction of invasive species.

11. Would the action result in a potential violation of Federal, State, or local law or requirements imposed for protection of the environment?

The proposed action will not result in any violations of Federal, State, or local law or requirements imposed for protection of the environment. The survey coordinator obtained (or are in the process of obtaining) authorizations and/or consultations pursuant to applicable laws.

See responses to questions #4, 5, 6, and 7 for details.

12. Would the action result in highly controversial environmental effects?

No. The exploration activities will be localized and of short duration in any particular area at any given time. Given this project's scope and breadth, no notable or lasting changes or highly controversial effects to the environment will result.

13. Does the action have the potential to establish a precedent for future action or an action that represents a decision in principle about future actions with potentially significant environmental effects?

No. While each cruise contributes to the overarching goal of exploring, mapping, and sampling the ocean, every cruise is independently useful and not connected to subsequent cruises.

14. Would the action result in environmental effects that are uncertain, unique, or unknown?

No. The techniques and equipment used are standard for this type of field activity.

15. Does the action have the potential for significant cumulative impacts when the proposed action is combined with other past, present and reasonably foreseeable future actions, even though the impacts of the proposed action may not be significant by themselves?

By definition, actions that a federal agency classifies as a categorical exclusion have no potential, individually or cumulatively, to significantly affect the environment. This cruise is consistent with a class of CE established by NOAA, and there are no extraordinary circumstances for this action that may otherwise result in potentially significant impacts.

CE Determination

☑I have determined that a Categorical Exclusion is the appropriate level of NEPA analysis for this action and that no extraordinary circumstances exist that would require preparation of an environmental assessment or environmental impact statement.

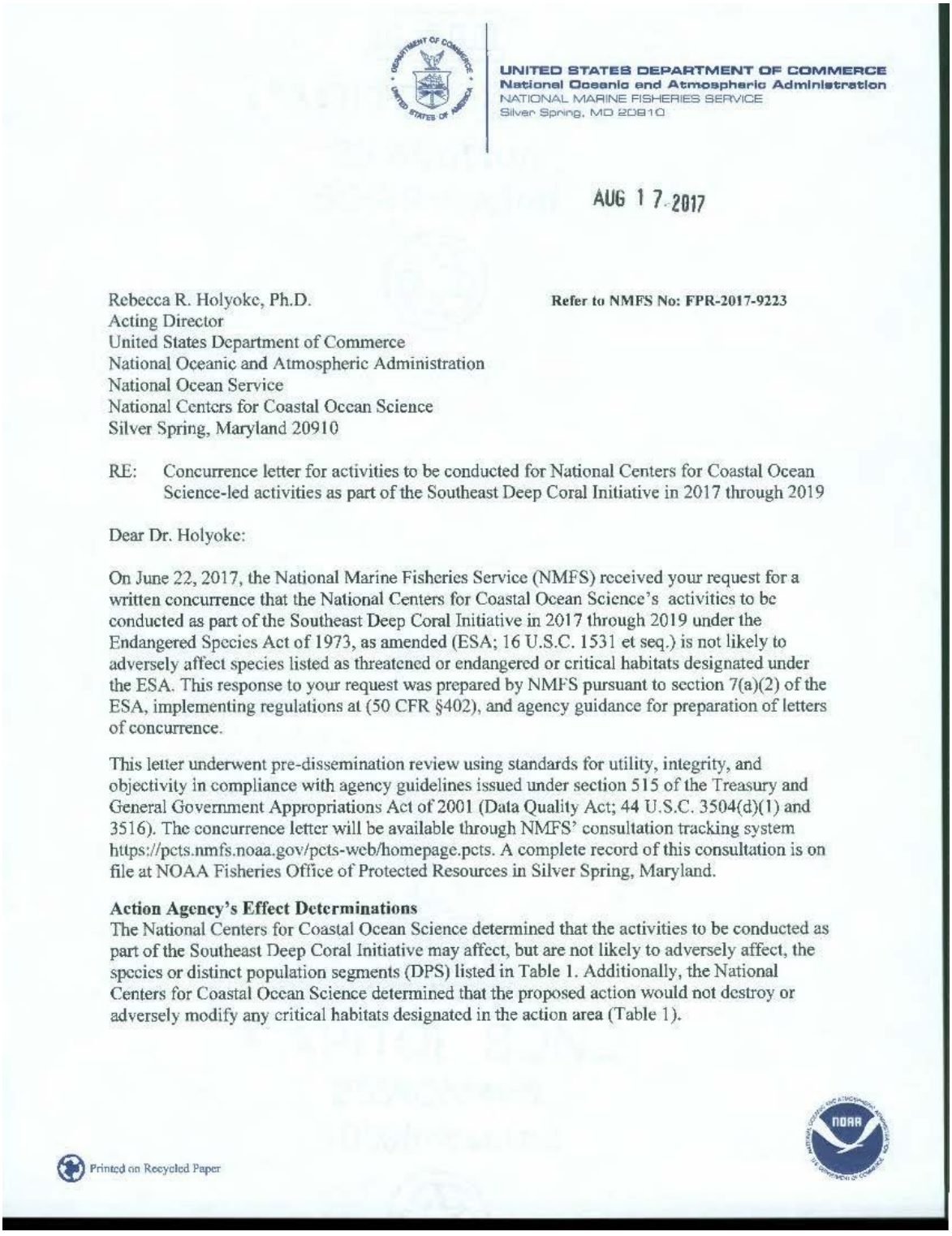
☐I have determined that an environmental assessment or environmental impact statement is required for this action.

Signature: RUSSELL.CRAIG.W.JR.1380652656 Digitally signed by RUSSELL.CRAIG.W.JR.1380652656 Date: 2017.11.13 13:49:45 -08'00'

Signed by: Craig Russell, Program Manager, EX Expeditions

Date Signed: November 13, 2017

Appendix C: EX-17-11 Endangered Species Act Section Letter of Concurrence



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

AUG 17 2017

Rebecca R. Holyoke, Ph.D.
Acting Director
United States Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
National Centers for Coastal Ocean Science
Silver Spring, Maryland 20910

Refer to NMFS No: FPR-2017-9223

RE: Concurrence letter for activities to be conducted for National Centers for Coastal Ocean Science-led activities as part of the Southeast Deep Coral Initiative in 2017 through 2019

Dear Dr. Holyoke:

On June 22, 2017, the National Marine Fisheries Service (NMFS) received your request for a written concurrence that the National Centers for Coastal Ocean Science's activities to be conducted as part of the Southeast Deep Coral Initiative in 2017 through 2019 under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) is not likely to adversely affect species listed as threatened or endangered or critical habitats designated under the ESA. This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 CFR §402), and agency guidance for preparation of letters of concurrence.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with agency guidelines issued under section 515 of the Treasury and General Government Appropriations Act of 2001 (Data Quality Act; 44 U.S.C. 3504(d)(1) and 3516). The concurrence letter will be available through NMFS' consultation tracking system https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at NOAA Fisheries Office of Protected Resources in Silver Spring, Maryland.

Action Agency's Effect Determinations
The National Centers for Coastal Ocean Science determined that the activities to be conducted as part of the Southeast Deep Coral Initiative may affect, but are not likely to adversely affect, the species or distinct population segments (DPS) listed in Table 1. Additionally, the National Centers for Coastal Ocean Science determined that the proposed action would not destroy or adversely modify any critical habitats designated in the action area (Table 1).

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Table 1. Action agency determinations for species and critical habitat.

Species	ESA Status	Critical Habitat	Action Agency Determination
Marine Mammals			
Blue whale (*Balaenoptera musculus)*	Endangered	N/A	Not likely to adversely affect
Fin whale (*Balaenoptera physalus)*	Endangered	N/A	Not likely to adversely affect
Sei Whale (*Balaenoptera borealis*)	Endangered	N/A	Not likely to adversely affect
Bryde's whale, Gulf of Mexico subspecies (*Balaenoptera edenii*)	Endangered	N/A	Not likely to adversely affect
Sperm whale (*Physeter macrocephalus*)	Endangered	N/A	Not likely to adversely affect
North Atlantic Right whale (*Eubalaena glacialis*)	Endangered	No effect	Not likely to adversely affect
Marine Reptiles			
Green turtle (*Chelonia mydas*) – North Atlantic DPS	Threatened	No effect	Not likely to adversely affect
Hawksbill turtle (*Eretmochelys imbricata)*	Endangered	No effect	Not likely to adversely affect
Kemp's ridley turtle (*Lepidochelys kempii*)	Endangered	N/A	Not likely to adversely affect
Leatherback turtle (*Dermochelys coriacea*)	Endangered	No effect	Not likely to adversely affect
Loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	Threatened	No effect	Not likely to adversely affect
Marine and Anadromous Fishes			
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)	Threatened	No effect	Not likely to adversely affect
Smalltooth sawfish (*Pristis pectinata*) – U.S. portion of range DPS	Endangered	No effect	Not likely to adversely affect
Nassau grouper (*Epinephelus striatus*)	Threatened	N/A	Not likely to adversely affect
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	Endangered	No effect	Not likely to adversely affect
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	Endangered	No effect	Not likely to adversely affect
Oceanic whitetip shark (*Carcharhinus longimanus*)	Proposed Threatened	N/A	Not likely to adversely affect
Giant manta ray (*Manta birostris*)	Proposed Threatened	N/A	Not likely to adversely affect

Species	ESA Status	Critical Habitat	Action Agency Determination
Marine Invertebrates			
Elkhorn coral (*Acropora palmata*)	Threatened	No effect	Not likely to adversely affect
Staghorn coral (*Acropora cervicornis*)	Threatened	No effect	Not likely to adversely affect
Pillar coral *(Dendrogyra cylindrus)*	Threatened	N/A	Not likely to adversely affect
Mountainous star coral *(Orbicella faveolata)*	Threatened	N/A	Not likely to adversely affect
Boulder star coral *(Orbicella franksi)*	Threatened	N/A	Not likely to adversely affect
Lobed star coral (*Orbicella annularis*)	Threatened	N/A	Not likely to adversely affect
Rough cactus coral (*Mycetophyllia ferox*)	Threatened	N/A	Not likely to adversely affect

Proposed Action and Action Area
The NOAA Deep-Sea Coral Research and Technology Program identified research needs in the U.S. Federal waters of the South Atlantic Bight, the Caribbean Sea, and the northern Gulf of Mexico. The National Centers for Coastal Ocean Science proposes to fund a three-year project to collect information on the deep-water corals found in these areas to provide scientific information to manage, conserve, and protect deep-sea coral and sponge ecosystems. The proposed action will survey the species and abundance of deep-water corals and sponges to inform proposals for new managed areas in the region. The proposed action will:

1) Survey deep-sea coral ecosystems using remotely operated vehicles.
2) Map deep-water habitats using multibeam echosounders.
3) Sample the physical and chemical properties of the water column via the deployment of conductivity, temperature, and depth casts and collection of water samples.

The study will target several non ESA-listed species of deep-water corals. "Deep-water corals" here are regarded as those at depths greater than 50 meters. These include *Lophelia pertusa*, *Leiopathes glaberrima*, and other coral members of the Cnidarian orders Gorgonacea, Antipatharia, Alcyonacea, and Scleractinia. Deep-water sponge species will also be sampled: Classes Demospongiae, Hexactenellidae, Calcarea, and Homoscleromorpha. *Lophelia pertusa*, and *Leiopathes glaberrima* are typically found at depths between 300 and 1,000 meters. The other coral members of the Cnidarian orders are found at depths greater than 50 meters, as are the deep-water sponge species.

The study will involve vessel operations aboard two vessels; the vessel used will depend upon the area for the particular cruise and the availability of the vessel at a given time. The two cruises in August 2017 will be conducted aboard the NOAA Ship *Nancy Foster*. The later cruises in 2018 and 2019 will be conducted on board either the NOAA Ships *Nancy Foster* or the NOAA *Okeanos Explorer*, depending on availability and proximity to the sampling site.

Researchers will use either of two remotely operated vehicles (ROVs) to collect samples from target coral species and collect video imagery. The ROV used for each cruise will depend on the ship used. It is still being determined what type of ROV will be used for cruises aboard the NOAA Ship *Nancy Foster*. For cruises aboard the NOAA Ship *Okeanos*, the researchers will use the two-bodied ROV Deep Discoverer and Serios. Each of the proposed ROVs are equipped with acoustic telemetry devices (a transponder unit, a receiving beacon, and an altimeter) which are used to locate the ROV during use. The transponder units emit signals at between eight and 30 kilohertz, and the receiving beacons also transmit signals in the mid-frequency range (21.5 to 43.2 kilohertz). The ROV may also use high-frequency imaging sonar (675 kilohertz) and an altimeter (500 kilohertz).

Active acoustic sources would be part of the proposed action. There will be a few different hull-mounted multi-beam echosounders used by the research vessels. The proposed action would use different multibeam echosounders because each has a unique operational depth and will thus be able to ensonify the seafloor at a variety of depths. On board the NOAA Ship *Nancy Foster*, three devices may be used. The Reson 712 SV2 has a dual frequency of 200 kilohertz or 400 kilohertz, with an optimal depth range of five to 250 meters. The Simrad EM 1002 operates at 95 kilohertz, and has an optimal depth of 200 to 1,000 meters. The Kongsberg/Simard EK60 operates at 38, 120, and 200 kilohertz. The NOAA Ship *Okeanos* has two mutli-beam echosounders. The Kongsberg EM-302 operates at 30 kilohertz, with an optimal range of 250 to 7,000 meters. The NOAA Ship *Okeanos* also uses a Kongsberg/Simrad EK60. During operation, the power setting for all devices is at the lowest possible level (approximately 190 to 210 dB re: 1 µPA with a duty cycle set to 10 to 30 hertz).

The ROV will move along pre-determined transects; dives last about two to six hours. The ROV will be tethered at all times. The ROV and the vessel will be moving at between 0.5 and one knot while the ROV is deployed. About six samples will be collected during each dive, and there will be between one and three dives per day. During sample collection, the ROV will hover about one meter from the bottom to avoid making contact with substrate. Coral samples will be collected by a cutting tool on the ROV. Samples will be about ten to 50 centimeters long, cut from the distal branches of each targeted coral colony.

During cruises, researchers would also use a conductivity, temperature, and depth (CTD) cast to collect water samples and characterize the chemical and physical properties of the water around deep-water coral and sponge ecosystems. The CTD Sea Bird Electronics-32 (SBE-32) is a device, 3.25 feet in diameter and four feet tall, that holds 12 five liter bottles on a carousel. The bottles are programmed to open and collect water at different depths. It weighs 69 kilograms, and is lowered into the water by a power winch. An SBE 9-11 sensor is attached to the CTD SBE-32, and it is used to take water measurements for parameters like temperature, depth, conductivity, pressure, and dissolved oxygen.

The study will be conducted for three years, with cruises typically taking place in the summer (May through September). The first two cruises will take place in August 2017, with one 13-day cruise and one five-day cruise. The first 2017 cruise will leave and return to St. Petersburg, Florida, and focus on surveying the deep-sea coral habitats off West Florida, in the Gulf of Mexico. The second 2017 cruise will leave St. Petersburg and end in Charleston, South Carolina, focusing on deep-sea corals off East Florida. The cruises for 2018 and 2019 are still being planned, and could occur in the South Atlantic, northern Gulf of Mexico, and the Caribbean. The

National Centers for Coastal Ocean Science expects that there will be four surveys per year in 2018 and 2019.

Action Area

The study would take place in three regions of the Southeast U.S. Federal waters: the northern Gulf of Mexico, the South Atlantic Bight, and the Caribbean Sea. The deep-water coral research activities could take place in existing (in orange on the maps) or proposed (in green and purple on the maps) marine managed areas. Areas proposed for inclusion in the marine managed areas would be prioritized for sampling over already-existing marine managed areas.

Gulf of Mexico

The areas prioritized for survey in the northern Gulf of Mexico include those in the Flower Garden Banks National Marine Sanctuary, off Alabama, Mississippi, Louisiana, and Texas (Figure 1). Other potential areas for research include the waters around the Florida Keys National Marine Sanctuary and additional areas off Florida.

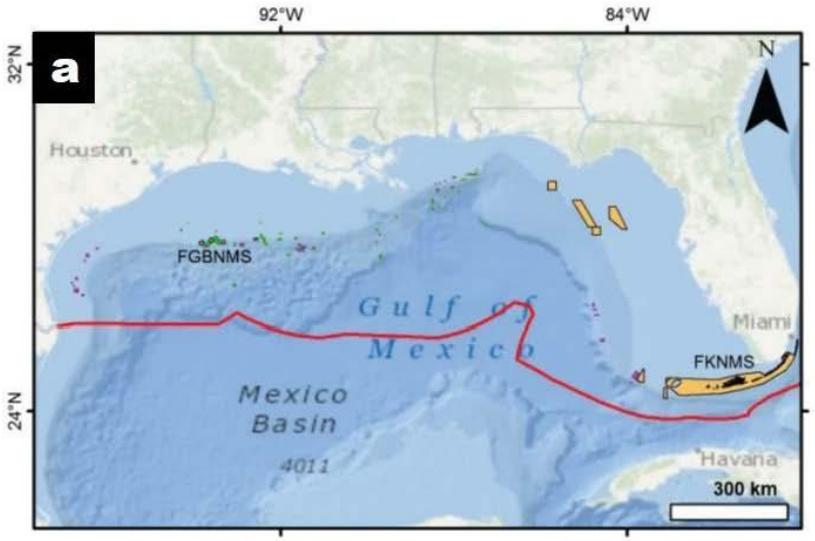

Figure 1. Map of proposed survey areas in the Gulf of Mexico. Areas prioritized for surveys include the Flower Garden Banks National Marine Sanctuary (FGBNMS) and the Florida Keys National Marine Sanctuary (FKNMS).

South Atlantic Bight

The areas surveyed in the South Atlantic Bight would include those off the coast of North Carolina, south around the Florida Peninsula (Figure 2). Sites proposed for inclusion in marine managed areas include those near Gray's Reef National Marine Sanctuary, off Georgia, and the Monitor National Marine Sanctuary, off North Carolina.

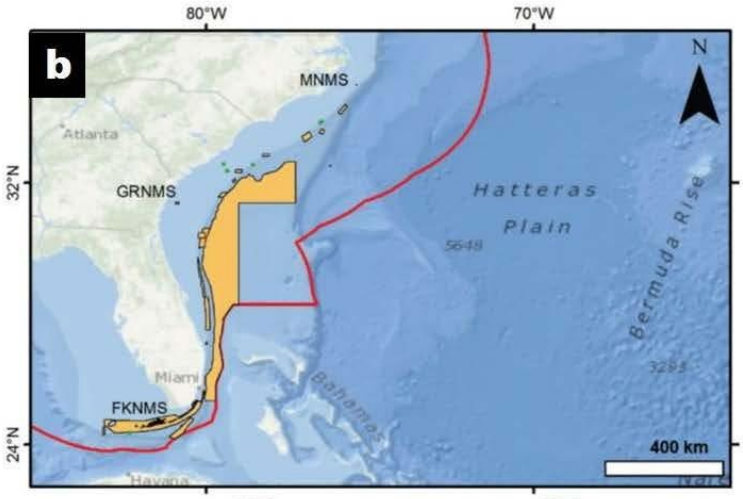

Figure 2. Map of proposed survey areas in the South Atlantic Bight. Areas prioritized for surveys include the Florida Keys National Marine Sanctuary (FKNMS), the Gray's Reef National Marine Sanctuary (GRNMS), and the Monitor National Marine Sanctuary (MNMS).

Caribbean Sea

The areas surveyed in the Caribbean Sea will include those waters around the U.S. Virgin Islands, Puerto Rico and its surrounding islands such as Vieques, Culebra, Mona, Desecheo, and Monito (Figure 3). Surveys may also take place around the Navassa Island National Wildlife Refuge, a small, uninhabited island west of Haiti administered by the U.S. Fish and Wildlife Service.

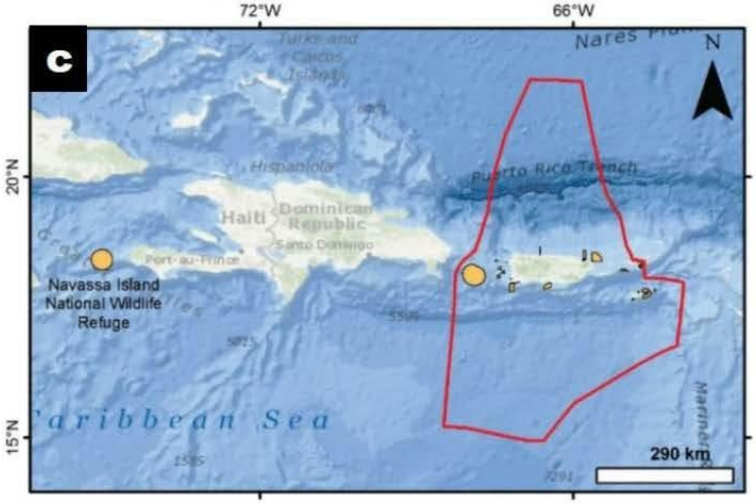

Figure 3. Map of proposed survey areas in the Caribbean.

Neither NMFS nor the Office of Coast Survey identified any interrelated or interdependent activities associated with the proposed action.

Minimization Measures
The National Centers for Coastal Ocean Science's activities would include the same protective measures described and analyzed in the 2013 Biological Opinion (see description in Consultation History). These measures are as follows:

- Minimize vessel disturbance and ship strike potential
  - Reduced speeds (less than 13 knots) when transiting through ranges of ESA-listed cetaceans (unless otherwise required, e.g., NOAA Sanctuaries)
  - Reduced speeds (less than 13 knots) while transiting through designated critical habitat (unless slower speeds are required, e.g., less than 10 knots in right whale designated critical habitat and management areas)
  - Trained observers aboard all vessels; 100 percent observer coverage
  - Species identification keys (for marine mammals, sea turtles, as applicable) will be available on all vessels
- Minimize noise
  - Reduced speed (see above)
  - Multibeam surveys using ≥ 50 kilohertz frequencies, lowest possible power and ping-rate
  - Single beam surveys using ≥ 30 kilohertz frequencies, lowest possible power and ping-rate, and 12° beam angle.
  - Reduce use of active acoustics as much as possible. Active acoustic sources should be used only when required for navigation or data collection and should be used at the lowest source level and highest frequency available that is suitable for the purpose.
- Minimize vessel discharges (including aquatic nuisance species)
  - Meet all Environmental Protection Agency Vessel General Permits and Coast Guard requirements[1].
  - Avoid discharge of ballast water in designated critical habitat.
  - Use anti-fouling coatings.
  - Clean hull regularly to remove aquatic nuisance species.
  - Avoid cleaning of hull in critical habitat.
  - Avoid cleaners with nonylphenols.
  - Rinse anchor with high-powered hose after retrieval.
- Minimize anchor impact to corals, seagrass or other designated habitat (e.g., Essential Fish Habitat)
  - Use designated anchorage area when available
  - Use mapping data to anchor in mud or sand, to avoid anchoring on corals

[1] See requirements for Vessels General Permits at: https://www.epa.gov/npdes/vessels-vgp

    - Avoid anchoring in seagrass critical habitat
    - Minimize anchor drag
- Avoid collecting bottom samples in seagrass designated critical habitat
    - There will be no bottom sample collections of any kind conducted during this cruise
- Cetaceans
    - Avoid approaching within 200 yards (182.9 meters), 500 yards for right whales.
    - Avoid critical habitat, when possible.
- Sea Turtles and Manatees
    - Avoid approaching within 50 yards.
- Entanglement Protective Measures
    - Use stiff line materials for towing and keep taut during operations to reduce potential for entanglement
    - Reduce knots in the line as much as possible
    - Clearly mark lines in the event an animal does become entangled so that NMFS experts can identify the gear.
- Habitat Protection
    - Avoid contact of gear, towed or lowered, with the sensitive bottom habitat (e.g., submerged aquatic vegetation and hard bottom)

ESA-Listed Species and Designated Critical Habitat Not Affected by the Proposed Action
Upon review of their known range and overlap with the proposed action, we have determined that the following species will not be affected by the proposed action: Gulf sturgeon, smalltooth sawfish, and ESA-listed corals. These species will not be considered further.

Gulf sturgeon could occur within the northern Gulf of Mexico action area. Gulf sturgeon are found in coastal rivers in Florida, Alabama, Mississippi, and Louisiana throughout most of the year, moving into the Gulf of Mexico between September and November to forage over winter. During winter, gulf sturgeon are typically found in nearshore waters two to four meters deep (Fox et al. 2002). Since the research activities will take place primarily in waters greater than 50 meters deep, we do not expect gulf sturgeon to be exposed to the stressors associated with ROV operation and coral sampling. The vessels used for the sampling cruises may transit through waters occupied by gulf sturgeon. However, the proposed action would take place during the summer, when gulf sturgeon are in rivers, not the Gulf of Mexico. Therefore, we do not expect gulf sturgeon to be exposed to stressors associated with vessel activity. We have determined that there will be no effect to gulf sturgeon as a result of the proposed action.

In the United States, smalltooth sawfish are typically found in shallow coastal waters around southern Florida up to ten meters deep (NMFS 2010). Since the proposed action will take place in waters greater than 50 meters deep, we do not expect smalltooth sawfish to be exposed to the proposed action. We have determined that there will be no effect to smalltooth sawfish as a result of the proposed action.

In their concurrence request, the National Centers for Coastal Ocean Science identified several species of ESA-listed invertebrates that may be affected by the proposed action. These species included: mountainous star coral (*Orbicella faveolata*), rough cactus coral (*Mycetophyllia ferox*),

boulder star coral (*Orbicella franksi*), lobed star coral (*Orbicella annularis*), pillar coral (*Dendrogyra cylindrus*), staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*).

Upon examining the current known range of each of these species and the extent of the action area, we determined that these ESA-listed corals occur in some parts of the action area. ESA-listed corals occur in the Caribbean and Florida Keys; there is no confirmed presence of ESA-listed corals in the northern Gulf of Mexico region (Veron 2014). The proposed action is focusing on corals in the deep-water environment at depths greater than 50 meters. ESA-listed corals found in the Caribbean and Florida Keys are found at depths shallower than the proposed action area (Table 2), so we do not expect any ESA-listed coral species to be exposed. Because the proposed action would take place in an environment where we do not expect ESA-listed corals to occur, we conclude that there is no effect of the action to ESA-listed corals.

Table 2. Depth ranges of ESA-listed coral species found in the Caribbean.

ESA-listed Coral Species	Depth	Source
Elkhorn Coral	Usually less than 6 meters; up to 20 meters	(NMFS 2015)
Staghorn Coral	0 to 30 meters	(NMFS 2015)
Mountainous Star Coral	Typically 10 to 20 meters; up to 40 meters	(Holstein et al. 2015)
Boulder Star Coral	1 to 30 meters	(Brainard 2011)
Lobed Star Coral	1 to 30 meters	(Brainard 2011)
Pillar Coral	1 to 25 meters	(Aronson 2008a)
Rough Cactus Coral	5 to 30 meters	(Aronson 2008b)

Several areas of critical habitat have been designated throughout the action area. Designations for smalltooth sawfish, Gulf sturgeon, and the proposed Atlantic sturgeon critical habitat are in shallow coastal areas or in rivers. These areas will not be affected by the proposed action, which will take place in the oceanic, deep-water environment. These areas will not be considered further.

Affected ESA-listed Species and Designated Critical Habitat

The proposed action has the potential to affect ESA-listed species that occur in the waters of the South Atlantic Bight, Caribbean Sea, and Gulf of Mexico. Species or designated critical habitat that may overlap the action area are included in Table 3. Because the action would occur in three distinct areas, each with its own variety of ESA-listed resources, not all species or critical habitat would be affected by the action at any one time. We have identified the potentially affected resources in the table by the three areas: Gulf of Mexico, South Atlantic Bight, and Caribbean Sea.

Table 3. Potentially affected ESA-listed species and designated critical habitat.

Species	ESA Status	Critical Habitat	Recovery Plan	Survey area where species are most likely to be affected
Marine Mammals				
Blue whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998	Gulf of Mexico, South Atlantic, Caribbean
Fin whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	75 FR 47538	Gulf of Mexico, South Atlantic, Caribbean
Sei whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	76 FR 43985	Gulf of Mexico, South Atlantic, Caribbean
Bryde's whale Gulf of Mexico subspecies (*Balaenoptera edenii*)	E -- 81 FR 88639	-- --	-- --	Gulf of Mexico
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	59 FR 28805 and 81 FR 4837	70 FR 32293	South Atlantic
Sperm whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584	Gulf of Mexico, South Atlantic, Caribbean
Marine Reptiles				
Green turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	63 FR 28359	Gulf of Mexico, South Atlantic, Caribbean
Hawksbill turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	57 FR 38818	Gulf of Mexico, South Atlantic, Caribbean
Kemp's Ridley turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	75 FR 12496	Gulf of Mexico, South Atlantic, Caribbean
Leatherback turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	63 FR 28359	Gulf of Mexico, South Atlantic, Caribbean
Loggerhead turtle, (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39856	63 FR 28359 74 FR 2995	Gulf of Mexico, South Atlantic, Caribbean
Fishes				
Nassau grouper (*Epinephelus striatus*)	T – 81 FR 42268	-- --	-- --	Caribbean
Scalloped hammerhead shark (*Sphyrna lewini*) Central and Southwest Atlantic DPS	T -- 79 FR 38213	-- --	-- --	Caribbean
Atlantic sturgeon, (*Acipenser oxyrinchus*	T -- 77 FR 5879	81 FR 35701 (Proposed)*	-- --	South Atlantic

Species	ESA Status	Critical Habitat	Recovery Plan	Survey area where species are most likely to be affected
oxyrinchus) Gulf of Maine DPS				
Atlantic sturgeon, (*Acipenser oxyrinchus oxyrinchus*) New York Bight DPS	E -- 77 FR 5879	81 FR 35701 (Proposed)*	-- --	South Atlantic
Atlantic sturgeon, (*Acipenser oxyrinchus oxyrinchus*) Chesapeake DPS	E -- 77 FR 5879	81 FR 35701 (Proposed)*	-- --	South Atlantic
Atlantic sturgeon, (*Acipenser oxyrinchus oxyrinchus*) Carolina DPS	75 FR 61904	81 FR 36077 (Proposed)*	-- --	South Atlantic
Atlantic sturgeon, (*Acipenser oxyrinchus oxyrinchus*) South Atlantic DPS	75 FR 61904	81 FR 36077 (Proposed)*	-- --	South Atlantic
Oceanic whitetip shark (*Carcharhinus longimanus*)	T -- 81 FR 96304 (Proposed)	-- --	-- --	Gulf of Mexico, South Atlantic, Caribbean
Giant manta ray (*Manta birostris*)	T -- 82 FR 3694 (Proposed)	-- --	-- --	Gulf of Mexico, South Atlantic, Caribbean

*Critical habitat has been designated, but it will not be affected by the proposed action.

Consultation History

On June 1, 2017, the National Centers for Coastal Ocean Science submitted a memorandum requesting a letter of concurrence under the ESA for activities to be conducted on the NCCOS-led field activities to be conducted as part of the Southeast Deep Coral Initiative in 2017 through 2019. On June 22, 2017, the National Centers for Coastal Ocean Science submitted a revised memorandum with additional information. The National Centers for Coastal Ocean Science have requested our concurrence that these activities are not likely to adversely affect ESA-listed species or designated critical habitat. NMFS Office of Protected Resources responded on the same date that it received all necessary information.

Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the ESA-listed species or designated critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR §402.02). The applicable standard to find that a proposed action is not likely to adversely affect ESA-listed species or designated critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the

impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

Effects of the Action: Vessel Activity
The 2013 biological opinion identified several stressors associated with the Office of Coast Survey's hydrographic surveys in coastal waters. These included vessel activity (strike, acoustic disturbance, vessel presence, discharges, and introduction of aquatic nuisance species). These stressors pose risks to ESA-listed whales, sea turtles, and fishes.

Stressor: Vessel Strike
Because the vessel would move at a very slow speed during the survey, a strike of marine mammals or sea turtles would be improbable and extremely unlikely. Further, adherence to observation and avoidance procedures is also expected to avoid vessel strikes for marine mammals and sea turtles. We also expect ESA-listed fishes to move away from the vessel, and thus a strike would be extremely unlikely. Therefore, effects from vessel strikes during the survey would be discountable for ESA-listed fishes, whales, and sea turtles.

Stressor: Acoustic Disturbance and Vessel Presence
When a vessel transits to and from the survey areas, potential effects on the ESA-listed species include vessel strikes, acoustic disturbance, and disturbance from the vessel's presence. Combined vessel noise and presence could cause slight marine mammal or sea turtle response or behavioral interruptions, but they would be minor and temporary as the vessel moves away from any marine mammals or sea turtles. The distance between the vessel and observed marine mammals and sea turtles, per avoidance protocols, would also minimize the potential for acoustic disturbance from engine noise. Therefore, effects from acoustic disturbance or presence associated with vessels would be insignificant for ESA-listed whales and sea turtles.

ESA-listed fishes such as all five Atlantic sturgeon DPSs, Nassau grouper, Central and Southwest Atlantic DPS scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays might occur in the action area and be exposed to the stressors associated with vessel activity.

Central and Southwest Atlantic DPS scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays occupy tropical and subtropical oceanic waters. Oceanic whitetip sharks can be found at the ocean surface, but most frequently stay between 25.5 and 50 meters deep (Carlson and Gulak 2012; Young 2016). Giant manta rays are found at depths less than ten meters during the day (Miller 2016). Scalloped hammerhead sharks can be found to depths of 1,000 meters. We expect that scalloped hammerhead sharks, giant manta rays, and whitetip oceanic sharks will, for the most part, be at depths where there will be minimal risk of vessel strike or exposure to noise.

When in the marine environment, Atlantic sturgeon adults and sub-adults typically occupy shallow marine waters, less than 15 meters deep (Dunton et al. 2015; Erickson et al. 2011). The proposed action would take place in summer months, placing Atlantic sturgeon largely out of the area where most of the vessel activity and research will occur.

Nassau grouper typically associate with coral reefs, with juveniles occupying shallow reef habitat, and adults occupying deep reefs (NMFS 2013). The vessels in use for the proposed action would be too large to enter shallow waters, and we expect that any exposed Nassau grouper would move away from the vessels.

The vessel's passage past an ESA-listed fish would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor is insignificant. Therefore, we conclude that acoustic interference from engine noise is not likely to adversely affect any ESA-listed fishes.

Stressor: Discharges
The potential for discharges via fuel or oil leakages is extremely unlikely. An oil or fuel leak would likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. Because the potential for fuel or oil leakage is extremely unlikely to occur, we find that the risk from discharges to any ESA-listed species is discountable.

Stressor: Aquatic Nuisance Species
To minimize the risk of aquatic nuisance species introduction, personnel would: avoid discharge of ballast water in designated critical habitat; use anti-fouling coatings; clean the hull regularly to remove aquatic nuisance species (but avoid doing so in critical habitat), and rinse the anchor with a high-powered hose after retrieval. These protective measures go beyond the requirements of the Vessel and Small Vessel General Permits[2], as described in the mitigation measures above. Furthermore, the vessels would not transit outside of the United States; therefore, they would not introduce foreign aquatic nuisance species. Given the protective measures, it is highly unlikely that the vessels would transfer aquatic nuisance species to any ESA-listed species during the proposed action. We find that the risk from aquatic nuisance species to any ESA-listed species is discountable.

Conclusion
Therefore, we conclude that the effects from vessel activity, pollution by oil or fuel leakage, and risk of aquatic nuisance species introduction are insignificant or discountable, and not likely to adversely affect ESA-listed marine mammals, sea turtles, or fishes.

Effects of the Action: Deployment and Operation of Survey Equipment

The proposed action includes the operation of equipment such as the remotely operated vehicles and CTD casts that could be potential stressors for ESA-listed species. The ROVs will be used to collect coral samples, and the CTD casts will be used to collect water samples and data.

[2] See requirements for the Vessels General Permit at: https://www.epa.gov/npdes/vessels-vgp

ROVs have acoustic tracking devices on them that emit sound which could detected by and impact ESA-listed species. The effects of sound from the ROV operation will be discussed in the section below.

Stressor: Operation of Remotely Operated Vehicle and CTD Cast
A ROV is an underwater observation vehicle connected to a computer operated by personnel on board the ship. The operator directs the ROV to use its camera to photograph the sea floor. The ROV is tethered at all times. The CTD cast is lowered into the ocean by a power winch and is tethered the entire time.

Possible stressors from the ROV and CTD cast during the proposed activities include entanglement from the tether during operation, equipment strike (which could include hitting coral reefs, substrate, or an ESA-listed species while in the water column).

The ROV is controlled by an operator who would have visual of the surroundings during operation and would avoid interaction with ESA-listed species by navigating the ROV away from the organism, thereby reducing the likelihood that the ROV would strike any ESA-listed resource while in use. In addition to the camera, the ROV has navigational equipment (e.g., depth, heading, altitude), allowing the operator to avoid striking bottom. To reduce the risk of entanglement from the tether attached to the ROV, the Office of Coast Survey proposed mitigation measures. These include using a stiff line material, keeping the line taut during operations and reducing knots in the line as much as possible. Therefore, the risks of strike or entanglement to ESA-listed species from ROV use are discountable.

Unlike the ROV, the CTD cast would not have a camera on it while in use. Before deploying the CTD cast, researchers would use the echosounder to ensure that the water depth is greater than the maximum depth of the CTD cast. This would prevent the CTD cast from striking bottom. While there is some possibility that a CTD cast could strike an ESA-listed species while being lowered into the ocean, we consider that possibility to be extremely unlikely. Another stressor from the CTD cast would be risk of entanglement from the tether. Similar to the ROV, researchers would use a stiff line material, keeping the line taut during operations and reducing knots in the line as much as possible. Therefore, the risks of strike or entanglement to ESA-listed species from CTD cast are discountable.

Stressor: Sound Sources
Devices such as multibeam echosounders and ROVs would be in use and emit sound which could be within the hearing range of ESA-listed whales, sea turtles, and fishes. There are up to five different types of multibeam echosounders that could be used during the proposed action, each with a different operating frequency (Table 4).

Table 4. Operating frequencies of acoustic devices in the proposed action.

Vessel	Device	Operating Frequency
NOAA Ship *Okeanos Explorer*	Kongsberg EM-302	30 kHz
	Kongsberg/Simrad EK-60	38, 120, and 200 kHz
NOAA Ship *Nancy Foster*	Reson 7125 SV2	200 or 400 kHz
	Simrad EM 1002	95 kHz
	Kongsberg EM 710	65 to 100 kHz
	Kongsberg/Simrad EK-60	38, 120, and 200 kHz

The ROVs proposed for use in the proposed action are equipped with various devices used to locate and operate the ROV. The ROVs are equipped with acoustic tracking equipment which operates at frequencies between eight and 30 kilohertz. The ROV or research vessel's acoustic telemetry systems could have transponder units, altimeters, and/or sonar that would operate at frequencies and emit sound that could be within the functional hearing range of ESA-listed sea turtles, fishes, and marine mammals (Table 5).

Table 5. Functional hearing ranges of species in the action area.

Species/Group	Functional Hearing Range	Source
Low frequency cetaceans (Baleen whales)	7 Hz to 25 kHz	(NMFS 2016)
Mid-frequency cetaceans (Toothed whales)	150 Hz to 160 kHz	(NMFS 2016)
Sea turtles (general)	Less than 1 kHz	(Moein et al. 1994)
Loggerhead sea turtles	250 Hz to 750 Hz	(Bartol et al. 1999)
Kemp's ridley sea turtles	100 Hz to 500 Hz	(Ketten and Bartol 2005)
Green sea turtles	100 Hz to 800 Hz	(Ketten and Bartol 2005)
Elasmobranchs (Lemon sharks and horn sharks)	20 Hz to 1,000 Hz	(Casper and Mann 2006)

The functional hearing ranges of ESA-listed sea turtles are not well understood and vary by species. In general, the available information on sea turtle hearing indicates that their hearing thresholds are less than 1 kilohertz (Moein et al. 1994). Loggerhead sea turtles are thought to have a functional hearing range of 250 to 750 hertz (Bartol et al. 1999), Kemp's ridely sea turtles a range of 100 to 500 hertz, and green sea turtles 100 to 800 hertz (Ketten and Bartol 2005). The operating frequencies of the ROV telemetry devices (i.e., transponder units, altimeters, and sonar) and the multibeam echosounders are outside the functional hearing range of ESA-listed

sea turtles, meaning that sound associated with their operation is discountable, therefore, not likely to adversely affect ESA-listed sea turtles.

Mid-frequency toothed whales, including the ESA-listed sperm whale, have a functional hearing range of 150 hertz to 160 kilohertz. The Simrad EM 1002, Kongsberg/Simrad EK-60, and the Kongsberg EM-302 would operate at frequencies within the hearing range of sperm whales.

Sperm whales have been observed in the continental slope waters north of Cape Hatteras, North Carolina, in waters 1000 meters or deeper. Sperm whale densities in this area are higher during summer months (Mullin and Fulling 2004; Waring et al. 2006). The survey would be south of where we expect sperm whales to occur in high densities. As such, we believe it is very unlikely that sperm whales would be exposed to the proposed action. The minimization measures further reduce the likelihood of exposure. Multibeam echosounder transmissions would be suspended when ESA-listed whales are within range. The research vessel would also avoid approaching cetaceans within 200 yards (600 feet). Due to the minimization measures and that it is unlikely that sperm whales would be present in the action area, we conclude that the effects of the proposed action to sperm whales would be discountable, and sperm whales not likely to be adversely affected.

The functional hearing range of ESA-listed baleen whales (Gulf of Mexico Bryde's whale, blue, fin and sei whales) is 7 hertz to 25 kilohertz. The multibeam echosounders operate outside the functional hearing range of these whales, meaning that operation of these devices are not likely to adversely affect ESA-listed baleen whales.

The altimeters (500 kilohertz) and sonar systems (675 kilohertz) associated with the ROVs proposed for use will be outside the functional hearing range of ESA-listed baleen whales. As a result, the risk of effects to ESA-listed baleen whales from exposure to sound associated with the operations of altimeters and sonar systems are discountable, and are not likely to adversely affect these species. However, the transponder units for the acoustic tracking systems are within the hearing range of ESA-listed baleen whales. The transponder units for the acoustic tracking systems operate at between eight and 30 kilohertz or 21.5 and 43.2 kilohertz, putting these devices in the functional hearing range of ESA-listed baleen whales (Gulf of Mexico bryde's, blue, fin and sei whales). We expect that ESA-listed species will avoid the vessel and ROV, minimizing the exposure to sound from the ROV operation and the multibeam echosounders. Generally, we expect that ESA-listed whales to move away from or parallel to the vessel (Hauser and Holst 2009). The minimization measures further reduce the likelihood of exposure. We conclude that the effects of the proposed action to ESA-listed baleen whales would be discountable, and not likely to be adversely affected.

The functional hearing ranges of ESA-listed fishes are not well understood. Oceanic whitetip sharks, scalloped hammerhead sharks, and giant manta rays are elasmobranchs, and although there is no known information on the hearing ability of these species specifically, other species of elasmobranchs have been studied. Hearing ranges of lemon sharks and horn sharks are between 20 hertz and one kilohertz (Casper and Mann 2006), and we assume that the hearing range of oceanic whitetip sharks and giant manta rays are within this range as well. The altimeters, sonar systems, and transponder units for the acoustic tracking system for the ROV are

not in the hearing range of elasmobranchs, and thus not within the range of scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays. The multibeam echosounders all operate at frequencies above one kilohertz, and thus not in the hearing range of ESA-listed sharks.

Information available about the hearing abilities of Atlantic sturgeon come from studies of other species of sturgeon. All five DPSs are considered in this analysis since Atlantic sturgeon from multiple river systems "mix" in the marine environment (Wirgin et al. 2015a; Wirgin et al. 2015b). Meyer et al. (2010) recorded auditory evoked potentials to pure tone stimuli of varying frequency and intensity in lake sturgeon (*Acipenser fulvescens*) have best sensitivity from 50 to 400 hertz. Lovell et al. (2005) also studied sound reception in and the hearing abilities of paddlefish (*Polyodon spathula*) and lake sturgeon in pressure dominated and particle motion dominated sound fields. They concluded that both species were responsive to sounds ranging in frequency from 100 to 500 hertz with lowest hearing thresholds from frequencies in bandwidths between 200 and 300 hertz and higher thresholds at 100 and 500 hertz. Based on this information, we conclude that the multibeam echosounders and the systems associated with the ROVs operate outside the functional hearing range of Atlantic sturgeon. The effects are insignificant, and Atlantic sturgeon are not likely to be adversely affected.

There are limited data on sound production in Nassau grouper; other species of grouper have been studied and summarized here. Nassau grouper sound production, or "grunts", involves contraction of a bilateral post-opercular muscle that is connected to the swim bladder (Hazlett 1962). Nelson et al. (2011) reported on red grouper sound production in Florida using passive acoustic and video monitoring. Red grouper produce low-frequency pulses, broadband pulses and pulse trains, as well as short calls labelled as "growls" with their dominant frequency at about 180 hertz (Nelson et al. 2011). Based on this information, we conclude that the multibeam echosounders and the systems associated with the ROVs operate outside the functional hearing range of Nassau grouper. The effects are insignificant, and Nassau grouper are not likely to be adversely affected.

Due to the minimization measures and the expected avoidance behavior of ESA-listed species, we believe that the proposed use of the multibeam echosounders, ROVs, and those associated sound sources would have insignificant effects, if any, on ESA-listed species. Therefore, the effects from sound associated with ROV use and its operation are not likely to adversely affect ESA-listed whales, sea turtles, or fishes.

Effects of the Action: Designated Critical Habitat

The proposed action may occur within critical habitats that have been designated for loggerhead sea turtle Northwest Atlantic Ocean DPS, green turtle North Atlantic DPS, hawksbill and leatherback sea turtles, elkhorn and staghorn corals, and North Atlantic right whale.

Critical habitat for the Northwest Atlantic Ocean distinct population segment of loggerhead sea turtles is designated in several units off the southeastern coast of the United States, within the proposed action area, specifically, the *Sargassum* habitat. Other units of designated critical habitat for loggerhead sea turtles, such as nearshore reproductive, foraging, breeding, migratory,

or winter units, are outside the action area. The essential biological features for *Sargassum* habitat include:

1. Convergence zones, surface-water downwelling areas, margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Saragassum* community in water temperatures suitable for optimal growth of *Sargassum* and inhabitance of loggerheads.
2. *Sargassum* in concentrations that support adequate prey abundance and cover.
3. Available prey and other material associated with *Sargassum* habitat including plants and cyanobacteria and animals native to the *Sargassum* community.
4. Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., greater than ten meters depth.

The proposed action will involve vessel activity, ROV operation, bathymetric data acquisition, and coral and water sample collection. These activities will not affect the oceanic features, prey abundance, cover, water depth, or other essential biological features for loggerhead *Sargassum* critical habitat. Therefore, we conclude that there will be no effect from the proposed action to loggerhead designated critical habitat.

Critical habitat has been designated for hawksbill sea turtles in Puerto Rico, around the coastal waters adjacent to Mona and Monito Islands, and may be exposed to the proposed action. Critical habitat has been designated for green sea turtles in Culebra Island, Puerto Rico. No primary constituent elements were identified in either designation, but several activities were identified as requiring special management considerations. These include vessel traffic, coastal construction, point and non-point source pollution, fishing activities, dredge and fill activities, and habitat restoration. The proposed action will include vessel activity, and therefore does require special management consideration with regard to hawksbill and green sea turtle designated critical habitat. The rule includes a discussion of vessel traffic potentially affecting designated critical habitat, specifically, propeller dredging and anchor mooring disrupting benthic habitats by crushing coral, breaking seagrass root systems, and severing rhizomes. Recreational boating may also trample seagrass beds and live bottom, and disturb seagrasses and coral. The vessel operators will use mapping data to avoid anchoring on sensitive bottom types like coral reefs and seagrasses. The ROV would be operated to avoid hitting bottom. We believe it is extremely unlikely that the large research vessels, which have a 13.5-foot and 20-foot draft, would be in such shallow waters as to damage benthic habitats with its propeller. We conclude that the proposed action would not destroy or adversely modify designated critical habitat for green and hawksbill sea turtles.

Critical habitat has been designated for leatherback sea turtles in the coastal waters adjacent to St. Croix, U.S. Virgin Islands, and may be exposed to the proposed action. No primary constituent elements were identified in the designation, but several activities were identified as those that might modify critical habitat. These include recreational boating and swimming, and sandmining. The proposed action will include vessel activity, ROV operation, bathymetric data acquisition, and coral and water sample collection. These activities are not identified as ones that

can modify the critical habitat. We conclude that the proposed action would not be likely to destroy or adversely modify designated critical habitat for leatherback sea turtles.

Critical habitat has been designated for elkhorn and staghorn coral in the Florida Keys, Puerto Rico, and the U.S. Virgin Islands. Designated critical habitat for these species is within the action area, specifically the South Atlantic Bight and the Caribbean Sea. The essential biological features for the designation includes substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments. The proposed action will involve vessel activity, ROV operation, bathymetric data acquisition, and coral and water sample collection. These activities will not involve altering the availability or quality of substrate. The researchers will use designated anchorage areas and use mapping data to only anchor in appropriate areas (e.g., mud or sand). We conclude that the proposed action would not be likely to destroy or adversely modify designated critical habitat for elkhorn and staghorn coral.

Critical habitat for North Atlantic right whales is designated within the action area, in the marine waters extending from Cape Fear, North Carolina to approximately 27 nautical miles below Cape Canaveral, Florida. This unit was designated as a calving area for North Atlantic right whales. Essential features for North Atlantic right whale critical habitat include:

- Calm sea surface conditions of Force Four or less on the Beaufort Wind Scale,
- Sea surface temperatures from a minimum of seven degrees Celsius and never more than 17 degree Celsius, and
- Water depths of six to 28 meters, where these features simultaneously co-occur over contiguous areas of at least 231 nautical miles squared of ocean waters during the months of November through April.

The proposed action would not entail activities that affect the essential features of the critical habitat, because the activities would not affect oceanographic conditions. We conclude that the proposed action would not be likely to destroy or adversely modify designated critical habitat for North Atlantic right whales.

Conclusion
Based on this analysis, NMFS concurs with National Centers for Coastal Ocean Science's determination that all effects of the proposed action are not likely to adversely affect the subject ESA-listed species and/or designated critical habitats.

Reinitiation of Consultation
Reinitiation of consultation is required and shall be requested by the Federal agency, or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) new information reveals effects of the action that may affect an ESA-listed species or designated critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the ESA-listed species or designated critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR §402.16).

Please direct questions regarding this letter to Colette Cairns, consulting biologist, NMFS' Office of Protected Resources, at (301) 427-8414 or colette.cairns@noaa.gov.

Sincerely,

Cathryn E. Tortorici
Chief, ESA Interagency Cooperation Division,
Office of Protected Resources

cc: Paula Whitfield; National Centers for Coastal Ocean Science, National Ocean Service

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Appendix D: EX-17-11 Essential Fish Habitat Consultation Letter

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

June 15, 2017 F/SER4:DD

MEMORANDUM FOR: Steven Thur, Ph.D.
Deputy Director, National Centers for Coastal Ocean Science

FROM: Virginia M. Fay /for
Assistant Regional Administrator, Habitat Conservation Division

SUBJECT: Essential Fish Habitat (EFH) Consultation for activities to be conducted as part of the Southeast Deep Sea Coral Initiative in 2017-2019

This responds to the request for an EFH review of the subject action. During this project, National Centers for Coastal Ocean Science (NCCOS) researchers will lead field efforts that will map, survey and sample deep-sea coral ecosystems throughout the Southeast U.S., a region including the U.S. federal waters of the Gulf of Mexico, South Atlantic Bight and Caribbean Sea. These efforts will be conducted on research expeditions aboard the NOAA Ship *Nancy Foster* in 2017-2019 (3 years), as well as on the NOAA Ship *Okeanos Explorer* in 2018-2019 (2 years). Specifically, these efforts will (1) survey deep-sea coral ecosystems using remotely operated vehicles (ROV), (2) map deep-water habitats using multibeam echosounders, and (3) sample the physical and chemical properties of the water column via the deployment of CTD-casts and collection of water samples.

As specified in the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), EFH consultation is required for federal actions which may adversely affect EFH. As the federal action agency in this matter, the NCCOS has determined the proposed activities would not adversely affect EFH. The Habitat Conservation Division (HCD) has reviewed the proposed activities as well as the protective measures and best management practices incorporated into the action. In our assessment of overall activity including the experimental design, nature of the collection, and limited scope of subject activity the HCD has no EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act. Further EFH consultation on this action is not necessary unless future modifications are proposed and you believe that resulting activities may result in adverse impacts to EFH.

Be advised the harvest and possession of coral is prohibited by current federal fishing regulations in the Gulf of Mexico. NCCOS should contact Susan Gerhart (Susan.Gerhart@noaa.gov), Chief of the Southeast Region's Sustainable Fisheries Division Gulf of Mexico Branch, to apply for a letter of acknowledgment (LOA) of scientific research activities. LOAs are issued by the National Marine Fisheries Service (NMFS) under the authority of the MSFCMA for situations where research activities would normally be in violation of federal fishing regulations. The NMFS indicates its acknowledgment by issuing a LOA specifying the activities are scientific research, and therefore, exempt from the fishing regulations developed under the MSFCMA.

cc:
F/SER24 – susan.gerhart@noaa.gov, lauren.waters@noaa.gov
F/SER4 – rusty.swafford@noaa.gov
File

Appendix E: Acronyms

3D—Three-dimensional
ADCP—Acoustic Doppler Current Profiler
AERONET—Aerosol Robotic Network
BOEM—Bureau of Ocean Energy Management
BSEE—Bureau of Safety and Environmental Enforcement
CE—Categorical Exclusion
CTD—Conductivity, temperature, and depth
DCEL—NOAA Deep Coral Ecology Laboratory
DNA—Deoxyribonucleic acid
DO—dissolved oxygen
DOI—Digital Object Identifier
DSCRTP—NOAA Deep Sea Coral Research and Technology Program
ECC—Exploration Command Center
EEZ—Exclusive Economic Zone
EFH—Essential Fish Habitat
ESA—Endangered Species Act
EtOH—Ethyl alcohol, or ethanol
FAU—Florida Atlantic University
FGBNMS—NOAA Flower Garden Banks National Marine Sanctuary
FSU—Florida State University
GEMS—Geoscience Earth & Marine Services
GFOE—Global Foundation for Ocean Exploration
GMFMC—Gulf of Mexico Fishery Management Council
HAPC—Habitat areas of particular concern
HBOI—Harbor Branch Oceanographic Institute
ISC—Inner Space Center
JAMSTEC—Japan Agency for Marine-Earth Science and Technology
kHz—Kilohertz
LSU—Louisiana State University
LSS—Light scattering spectroscopy
MAN—Maritime Aerosol Network
MBARI—Monterey Bay Aquarium Research Institute
MIT—Massachusetts Institute of Technology
MMPA—Marine Mammal Protection Act
MPA—Marine Protected Area

MSU—Mississippi State University
NASA—National Aeronautics and Space Administration
NCCOS—NOAA National Centers for Coastal Ocean Science
NCEI—NOAA National Centers for Environmental Information
NEPA—National Environmental Policy Act
NMFS—NOAA National Marine Fisheries Service
NOAA—National Oceanic and Atmospheric Administration
OAR—NOAA Oceanic and Atmospheric Research
OER—NOAA Office of Ocean Exploration and Research
ONMS—NOAA Office of National Marine Sanctuaries
ORP—Oxygen reduction potential
OSU—Oregon State University
PIFSC—NOAA Pacific Islands Fisheries Science Center
RAS—Russian Academy of Sciences
ROV—Remotely operated vehicle
SBP—Sub-bottom profiler
SEDCI—NOAA Southeast Deep Coral Initiative
SEFSC—NOAA Southeast Fisheries Science Center
SERO—NOAA Southeast Regional Office
SIO—Scripps Institution of Oceanography
SIS—Seafloor Information Software
TSG—Thermosalinograph
TB—Terabytes
UCAR—University Corporation for Atmospheric Research
UCH—Underwater Cultural Heritage
UH—University of Hawai'i at Mānoa
ULL—University of Louisiana at Lafayette
URI—University of Rhode Island
USF—University of South Florida
USGS—U.S. Geological Survey
USM—University of Southern Mississippi
USNM—National Museum of Natural History
UW—University of Washington
XBT—Expendable bathythermographs