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Expedition Report: EX-22-01
2022 ROV and Mapping Shakedown (ROV and Mapping)

Gulf of Mexico
Pascagoula, Mississippi, to Key West, Florida
February 23-March 3, 2022

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Abstract

From February 23-March 3, 2022 (Pascagoula, Mississippi, to Key West, Florida), NOAA Ocean Exploration conducted a shakedown of the remotely operated vehicle (ROV), video, telepresence, and sampling operations as well as mapping and positioning systems aboard NOAA Ship *Okeanos Explorer*. The ROV engineers tested and calibrated ROVs *Deep Discoverer* and *Seirios*' ROV motor controllers, auto position software, lighting system, hydraulic system, ME-20 low-light camera, high-definition ancillary ROV cameras, and sector-scanning sonar and tested shoreside-piloting capabilities of ROV *Deep Discoverer*. Shakedown and readiness operations for the EM 304 multibeam sonar system included a GNSS Azimuth Measurement Subsystem calibration, patch test, speed-noise test, coverage extinction data collection, and integration and testing of the newly installed SeaPath 380-R3. In total, the expedition team conducted seven ROV dives ranging from 490 to 3,420 m in depth and collected 4,926 square km of acoustic data during transits and calibrations. The expedition explored the West Florida Shelf and the Straits of Florida offshore the U.S. southeastern coast. The expedition confirmed the location of a shipwreck target thought to be an historically significant 19th century whaler. Corals and sponges were observed at four out of the seven surveyed dive sites, with three of the seven containing a high diversity of benthic species. A total of 12 samples were collected: 3 geological, 3 biological, and 6 commensal (not including blank samples). In addition to the shakedown, science, and exploration successes, mission personnel also participated in a virtual conference (Ocean Sciences Meeting, 2022) while underway. This report summarizes the expedition, including mapping operations and outreach activities. All data associated with this expedition have been archived and are publicly available through the NOAA archives.

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1. Introduction

NOAA Ocean Exploration is the only federal program dedicated to exploring the deep ocean, closing prominent gaps in our basic understanding of U.S. deep waters and the seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, NOAA Ocean Exploration explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, we allow scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. To better understand our ocean, NOAA Ocean Exploration makes exploration data available to the public. This allows us, collectively, to more effectively maintain ocean health, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

NOAA Ocean Exploration's expeditions on NOAA Ship *Okeanos Explorer* contribute to the National Strategy for Exploring, Mapping, and Characterizing the United States Exclusive Economic Zone and Seabed 2030.

1.1 Atlantic Seafloor Partnership for Integrated Research and Exploration

Data collected during expeditions on NOAA Ship *Okeanos Explorer* from 2018 to 2022 directly contribute to the Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE), a major multiyear, multinational collaborative field program focused on raising collective knowledge and understanding of the North Atlantic Ocean. ASPIRE builds on the momentum of past U.S. campaigns and international initiatives to support ecosystem-based management of marine resources. ASPIRE also provides information relevant to NOAA's emerging Blue Economy priorities, which, in addition to ocean exploration, are seafood production, tourism and recreation, marine transportation, and coastal resilience.

2. Expedition Overview

From February 23, 2022 to March 3, 2022, NOAA Ocean Exploration and partners conducted a shakedown of remotely operated vehicles (ROVs) *Deep Discoverer* and *Seirios* and mapping and positioning mission systems on NOAA Ship *Okeanos Explorer* in the Gulf of Mexico and Straits of Florida between Pascagoula, Mississippi, and Key West, Florida. This was a change to EX-22-01's

original plan, which was for a 10-day ROV and mapping shakedown expedition between Key West, Florida, and Key West, Florida, from February 15-26, 2022 (Galvez et al., 2022). Due to logistical needs, COVID-19 cases, and potable water tank issues, the plan for EX-22-01 was changed to a nine-day ROV and mapping shakedown expedition between Pascagoula, Mississippi, and Key West, Florida.

In addition to systems evaluation, NOAA Ocean Exploration and partners conducted telepresence-enabled ocean exploration to collect critical baseline information and improve knowledge about unexplored and poorly understood deepwater areas of the canyons and slopes of the West Florida Shelf and Straits of Florida, providing timely, usable, accessible data and information based on reliable and authoritative science. Like other ASPIRE expeditions, it also served as an opportunity for NOAA to highlight the uniqueness and importance of deepwater environments.

2.1 Rationale for Exploration

System shakedowns are conducted at the beginning of each field season to ensure smooth operations during the expeditions that follow. ROV shakedowns are designed to stress test every component of the ROV, computer, data, mapping, and telepresence systems. They are also designed to be flexible with where and when to dive to ensure that troubleshooting and repair of systems takes top priority.

As part of the planning for this expedition, NOAA Ocean Exploration collaborated with the scientific and management community to assess the exploration needs and data gaps in unknown and poorly known areas of the Gulf of Mexico and the Straits of Florida. To define the operating area for this expedition, NOAA Ocean Exploration considered the 2018 call for input, results from the 2018 ASPIRE Workshop (NOAA, 2018), and priorities from resource managers.

Data and information from this expedition will help improve our understanding of the deep-ocean habitats of the West Florida Shelf and the connections between communities throughout 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 Maritime Heritage Program, the Bureau of Ocean Energy Management (BOEM), and NOAA Fisheries' Deep Sea Coral Research and Technology Program.

2.2 Objectives

This expedition's operations were primarily focused on the shakedown and operational readiness of ROV and mapping operations aboard *Okeanos Explorer*. In addition to engineering objectives related directly to the ROVs and mapping equipment, objectives also included the preparedness of existing and new telepresence capabilities and training of new personnel. Overnight operations included mapping using the ship's suite of sonars. When possible, ROV and mapping operations were conducted in priority areas for exploration based on input from the wider science community, including NOAA scientists and resource managers, BOEM and SEARCH Inc. scientists, and ocean scientists from academia.

2.2.1 Acoustic Mapping Objectives

- Strategic Transit
    - Conduct strategic transits that junction with prior areas to maximize data collection over previously unmapped areas where possible.
- EM 304 Multibeam Sonar Objectives
    - Confirm all previously surveyed vessel offsets are properly accounted for.
    - Confirm functionality of EM 304 and integration with all ancillary systems.
    - Ensure all software/firmware versions are up to date and functional.
    - Confirm triggering and synchronization settings.
    - Conduct impedance testing of the EM 304 while alongside.
    - Conduct GNSS Azimuth Measurement Subsystem (GAMS) calibration.
    - Conduct geometric calibration of the system (patch test), including deep roll verification lines.
    - Collect backscatter normalization lines over the previously established reference areas around the Straits of Florida.
    - Conduct speed/noise tests to assess how vessel speed affects noise levels at the receive array.
    - Assess swath coverage via extinction testing while transiting off the continental shelf.
- Knudsen 3260 Sub-Bottom Profiler Objectives
    - Confirm functionality and integration with all ancillary systems.
- Sound Speed Profiling Objectives
    - Conduct comparison casts between the Seabird 9/11Plus conductivity, temperature, and depth (CDT), Deep Blue expendable bathythermographs (XBTs), and CastAway CTD.
    - Assess functionality of newly refurbished XBT autolauncher.
    - Test functionality of all XBT handheld launchers.

    - Compare Reson SVP 70 and Seabird 45 thermosalinograph surface sound speed data.
- Acoustic Doppler Profiler Objectives
    - Confirm functionality of both the 38 and 300 kHz systems.
- K-Sync Objectives
    - Evaluate existing settings to ensure optimization of the K-Sync and minimization of interference between sonars.
- Seapath 380 Objectives
    - Evaluate the installation of the Seapath 380 inertial measurement system.
    - Compare data from the Seapath system and the Applanix Position and Orientation System for Marine Vessels (POS MV).
- Miscellaneous
    - Train new expedition coordinator.
    - Update all mapping-related standard operating procedures.
    - Complete 2022 mapping systems readiness report.

2.2.2 ROV Engineering Objectives

- Load and re-integrate ROVs *Deep Discover* and *Seirios*.
- Review ROV launch, recovery, and emergency procedures with ROV team and ship's crew to facilitate training for new personnel and refresher training for experienced personnel.
- Complete a series of ROV dunk tests to practice launch and recovery evolutions.
- Run an ROV dive simulation to review launch and recovery operations including aft deck controls, dynamic positioning system, and emergency recovery training as needed with new personnel and/or as requested by NOAA Ocean Exploration or the commanding officer.
- Test the ultrashort baseline (USBL) positioning system dockside. Calibration is not needed this year.
- Conduct pilot practice with the manipulator arms for sampling and temperature probing.
- Dive at progressively deeper depths starting at approximately 500 m and finishing as deep as possible in the region over the course of five or more dives.
- Test the ROV systems (including new transformer housings and new Doppler Velocity Log (DVL)) and conduct pilot training when diving on benthic exploration targets and on a maritime heritage target.
- Conduct ROV operations in the water column. Continue refining midwater imaging standard operating procedures with new lighting first tested during Fiscal Year 2021 and potentially use the ME20 low-light camera.

- Continue refining Blueview multibeam imaging sonar operations for obstacle avoidance and potential data products (e.g., maritime heritage imagery).
- Test the piloting capabilities of *Deep Discoverer* from shore over the VSAT.

2.2.3 Video/Telepresence Engineering Objectives

- Test terrestrial and high-speed satellite links.
- Verify that Global Foundation for Ocean Exploration (GFOE)-managed telepresence systems perform as expected.
- Test GFOE-managed telepresence systems with the Inner Space Center for 10-bit HDR video if WOWZA update goes through.
- Test all subsea video equipment on *Deep Discoverer* and *Seirios* and ensure their proper integration into the video system. Ensure proper field of view and angles for all newly installed cameras.
- Test all shipboard video equipment (hangar, deck cameras, wire camera, etc.) and ensure their proper integration into the video system.

2.2.4 Data Management Objectives

- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.
- Follow underwater cultural heritage standard operating procedures for any maritime heritage sites that may be explored and document during the expedition.
- Test remote access to onboard sample data management computer systems.
- Verify GFOE-managed data systems perform as expected.
- Update standard operating procedures to reflect GFOE-managed network changes.
- Install and test the Ocean Networks Canada server and subsequently test new data visualizations available through SeaTube V3.
- Prepare file manifest with checksums for data transfers to shore.
- Complete sensor reports for each dive.
- Test, troubleshoot, and evaluate new live ship operations ArcOnline map.

2.2.5 Science Objectives

- Dive on underexplored areas within the U.S. Southeast region.
- Test ArcOnline access and utility for field use on ROV expeditions.
- Acquire data on deepwater habitats on the southeastern U.S. continental margin to support priority science and management needs.

- Identify, map, and explore the diversity and distribution of benthic habitats, including fish habitats, deep-sea coral and sponge communities, chemosynthetic communities, and biological communities that colonize or aggregate around shipwrecks.
- Explore U.S. maritime heritage by identifying and investigating sonar anomalies as well as characterizing shipwrecks.
- Investigate biogeographic patterns of deep-sea ecosystems and connectivity across the southeastern U.S. continental margin for use in broader comparisons of deepwater habitats throughout the Atlantic basin.
- Map, survey, and sample geological features within the southeastern U.S. continental margin to better understand the geological context of the region and improve knowledge of past and potential future geohazards.
- Collect high-resolution bathymetry in areas without modern bathymetric coverage.
- Acquire a foundation of ROV, sonar, and oceanographic data to better understand the characteristics of the water column and fauna that live there.
- Engage a broad spectrum of the scientific community and the public in telepresence-based exploration.
- Provide publicly accessible data and information products to spur further exploration, research, and management activities.

2.2.6 Remote Science and Exploration Command Center Objectives

- Test new technologies, including SeaTube sensor visualization, to enhance shoreside participant situational awareness during dives.
- Continue to test remote access to sample data management systems and workflow.
- Enable participants on shore to engage remotely as primary engineering objectives allow.

2.2.7 Ship Objectives

- Continue to build familiarity with *Okeanos Explorer*'s dynamic positioning system.
- Conduct wardroom-specific aft conn training, focusing on deployment and recovery of the ROV as well as emergency procedures for loss of ship's propulsion during an ROV dive.
- Conduct deck department specific training focusing on deployment and recovery of the ROV.
- Review the ethanol emergency procedures with the science party.
- Practice and discuss a man overboard drill during ROV recovery.
- Practice and discuss an emergency ROV recovery drill.

3. Participants

EX-22-01 included onboard mission personnel as well as shore-based science personnel who participated remotely via telepresence. See **Table 1** for the onboard personnel who supported EX-22-01. See **Table 2** for the shore-side personnel who supported EX-22-01. Appendix A contains the shore-based science participants.

Table 1. EX-22-01 onboard mission team personnel.

Name	Title	Affiliation
Kimberly Galvez	Expedition Coordinator	NOAA Ocean Exploration/FedWriters
Sam Candio	Mapping Lead	NOAA Ocean Exploration/STC[1]
Thomas Morrow	Mapping Lead (training)	NOAA Ocean Exploration/FedWriters
Karl McLetchie	Global Foundation for Ocean Exploration Operations Manager	Global Foundation for Ocean Exploration
Lars Murphy	Engineering Team	Global Foundation for Ocean Exploration
Todd Gregory	Engineering Team	Global Foundation for Ocean Exploration
Mark Durbin	Engineering Team	Global Foundation for Ocean Exploration
Chris Wright	Engineering Team	Global Foundation for Ocean Exploration
Andy Lister	Engineering Team	Global Foundation for Ocean Exploration
Bobby Mohr	Engineering Team	Global Foundation for Ocean Exploration
Chris Ritter	Engineering Team	Global Foundation for Ocean Exploration
Art Howard	Engineering Team	Global Foundation for Ocean Exploration
Roland Brian	Video Engineering Team	Global Foundation for Ocean Exploration
Andrew O'Brien	Engineering Team	Global Foundation for Ocean Exploration
Caitlin Bailey	Video Engineering Team	Global Foundation for Ocean Exploration
Evan Spalding	Engineering Team (Intern)	Global Foundation for Ocean Exploration
Jonathan Allen	Engineering Team (Intern)	Global Foundation for Ocean Exploration
Christa Rabenold	Communication Specialist	NOAA Ocean Exploration/UCAR[2]
Anna Lienesch	Sample Data Manager	NOAA National Centers for Environmental Information/Cooperative Institute for Satellite Earth System Studies (CISESS)

Name	Title	Affiliation
Trish Albano	Internship Program Coordinator	NOAA Ocean Exploration/National Marine Sanctuary Foundation

[1]Science and Technology Corporation, [2]University Corporation for Atmospheric Research

Table 2. EX-22-01 onshore mission team personnel.

Name	Title	Affiliation
Kevin Jerram	Mapping Watchstander	UCAR[2]

4. Methodology

To accomplish its objectives, EX-22-01 used:

- NOAA Ocean Exploration'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, including water samples for environmental DNA (eDNA) processing, to help further characterize the deepwater fauna and geology of the region.
- Sonar systems (Kongsberg EM 304 multibeam sonar, Knudsen 3260 sub-bottom profiler, Simrad EK60 and EK80 split-beam sonars, and Teledyne acoustic Doppler current profilers) 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. The data management plan for EX-22-01 is in "Project Instructions: EX-22-01, 2022 ROV and Mapping Shakedown (ROV and Mapping)" (Galvez et al., 2022).

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 operating the objectives while surveying the biology and geology of the seafloor. Each ROV dive was approximately 8-10 hours, conditions and logistics permitting. Dives were conducted during the day (operations are described in detail in Quattrini et al., 2015 and Kennedy et al., 2019). 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 each organism encountered 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. These data will be quality controlled and quality assured at the University of Louisiana at Lafayette by ASPIRE science advisor Dr. Scott France and his laboratory.

For water column exploration, a series of transects were performed, primarily targeting the deep scattering layer and the waters directly above and below it. A bioluminescence agitator was created and operated during water column exploration with the ME-20 low-light camera for the purpose of detecting bioluminescence in the water column. Shore-based scientists identified organisms along transects based on data available during real-time assessment.

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 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 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 transatlantic 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. These samples will be shipped to the Marine and Geological Repository at Oregon State University after the conclusion of the NOAA Ocean Exploration field season aboard *Okeanos Explorer*. The samples will be photographed, and their data will be entered into the university's online database. Thin and polished sections will be made for each hard-rock sample. Descriptions and photos are included in the database.

Biological samples were subsampled for inclusion in the Smithsonian's National Museum of Natural History 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% ethanol. 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's National Museum of Natural History. Full details of the preservation of each biological sample are in the associated metadata record. All voucher samples and subsamples were shipped to the Smithsonian's National Museum of Natural History for long-term archiving and public access.

During this expedition, as many as five 1.7 liter water samples per dive (when applicable) were collected in ROV Niskin bottles for environmental DNA (eDNA) processing. Full details of the timing and associated collection data for each water sample are in the metadata record. Water samples were filtered, and filters with DNA fixed, on ship. For each set of samples, a negative control of tap water was processed at the same time. All filters with DNA were shipped to the Smithsonian's National Museum of Natural History for further processing, long-term archiving, and public access.

4.3 Acoustic Operations

Acoustic operations included Kongsberg EM 304 multibeam, Simrad EK60 and EK80 split-beam, Knudsen sub-bottom profiler, and acoustic Doppler current profiler (ADCP) data collection (Candio et al., 2022). 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 in the Gulf of Mexico and the Straits of Florida.

4.3.1 Multibeam Sonar (Kongsberg EM 304)

Multibeam seafloor mapping data were collected using the Kongsberg EM 304 sonar, which operates at a frequency of 30 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 bathymetric grids created using all available bathymetry archived at NOAA's National Centers for Environmental Information (NCEI) and their Autogrid tool. Sandwell and Smith satellite altimetry data were also used to plan operations.

4.3.2 Sub-Bottom Profiler (Knudsen Chirp 3260)

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 sub-bottom profiler 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 and EK80)

Okeanos Explorer is equipped with five split-beam transducers, three Simrad EK60 general purpose transceivers and two Simrad EK80 wideband transceivers. The frequencies of the EK60 are 18, 38, 120, and 200 kHz. The frequency of the EK80 is 70 kHz.

These sonars were used continuously throughout EX-22-01 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. EK60 and EK80 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 304.

4.3.5 Expendable Bathythermograph (XBT) Systems

Expendable bathythermographs (XBTs) were collected every six hours to generate water column sound velocity profiles that were applied in real time to multibeam sonar data collection using SIS. Sound speed at the sonar head was determined using sound speed from a flow-through thermosalinograph (TSG).

4.4 Conductivity, Temperature, and Depth

Conductivity, temperature, and depth (CTD) measurements were collected with the integrated ROV CTD system. This system records data from the CTD and associated sensors on every dive. Additional sensors installed on the ROV CTD include measured light scattering (LSS), dissolved oxygen (DO), and oxygen reduction potential (ORP).

5. Clearances and Permits

5.1 Environmental Clearances and Permits

Pursuant to the National Environmental Policy Act (NEPA), NOAA Ocean Exploration 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 describes the agency's specific procedures for NEPA compliance.

An environmental review memorandum was completed for all *Okeanos Explorer* expeditions in 2021 in accordance with Section 4 of the companion manual in the form of a categorical exclusion worksheet (Maxon, A., 2022). Based on this review, a categorical exclusion 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. NOAA Ocean Exploration is preparing a programmatic environmental assessment to cover future expeditions.

NOAA Ocean Exploration 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 beamwidths, 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), NOAA Ocean Exploration conducted an informal consultation with NOAA Fisheries' Office of Protected Resources to request their concurrence with our biological evaluation determining that *Okeanos Explorer* operations conducted as part of ASPIRE may affect, but are not likely to adversely affect, ESA-listed marine species. In a letter dated February 3, 2021 (carried over from 2021; see Appendix B), the chief of the ESA Interagency Cooperation Division in NOAA Fisheries' Office of Protected Resources wrote that NOAA Fisheries concurs with our determination that proposed ASPIRE expeditions are not likely to adversely affect ESA-listed marine species.

In addition, NOAA Ocean Exploration consulted with NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO) on potential impacts of ASPIRE operations to essential fish habitat (EFH) in the Greater Atlantic Region for the 2022 field season under the Magnuson-Stevens Fishery Conservation and Management Act. We received a letter of acknowledgement from GARFO on February 18, 2022, that covers expedition activities through the 2022 field season (see Appendix B).

NOAA Ocean Exploration also consulted with NOAA Fisheries' Southeast Regional Office (SERO) on potential EFH impacts in the Southeast region. We received a letter of acknowledgement from SERO on December 21, 2021 (see Appendix B).

5.2 Maritime Heritage Clearances and Permits

Maritime heritage activities conducted during expeditions on *Okeanos Explorer* are informed by the federal archaeology program, U.S. legislation on the treatment of cultural remains, and the UNESCO Convention for the Protection of the Underwater Cultural Heritage. NOAA Ocean Exploration supports the standards for conducting marine archaeological activities enumerated in the rules in the annex of the UNESCO Convention on the Protection of the Underwater Cultural Heritage.

Preservation and protection of prehistoric and historic maritime heritage resources is the policy of the federal government, and NOAA Ocean Exploration has a responsibility to consider the effects of its activities on these resources. If data are found to be sensitive because they reveal the location of a historically significant cultural resource, Section 304 of the National Historic Preservation Act (NHPA) provides that the head of a federal agency or other public official shall withhold from public disclosure information about the location, character, or ownership of a historic property when disclosure may cause a significant invasion of privacy, risk harm to the historic property, or impede the use of a traditional religious site by Indigenous peoples. This document uses the term maritime heritage to refer to historic and prehistoric traces of human existence that are totally or partially underwater. Further information on NOAA Ocean

Exploration maritime heritage policies are in the "NOAA Ship *Okeanos Explorer* FY22 Field Season Instructions" (Wang, 2021).

6. Schedule and Map

EX-22-01 was a total of nine days at sea, from February 23, 2022, to March 3, 2022. It departed from Pascagoula, Mississippi, and returned to port in Key West, Florida. See **Table 3** for a day by day breakdown of EX-22-01. There were seven scheduled dives with seven dives achieved (see **Tables 6 and 7** for details). See Section 2 for information about unplanned events that affected the expedition's original schedule. See **Figure 1** for a map of EX-22-01's track, dive sites, and bathymetry collected.

Table 3. EX-22-01 schedule

Date (UTC)	Activity
02/08	Mobilization at Pascagoula, MS. ROVs *Deep Discoverer* and *Seirios* loaded onto ship.
02/09	Alongside mobilization.
02/10	Alongside mobilization.
02/11	Alongside mobilization, ROVs partially secured.
02/12	ROVs secured and personnel returned home.
02/20	Mission personnel returned, move aboard day. Alongside mobilization. Restricted to the ship.
02/21	Mission personnel returned, move aboard day. Alongside mobilization. Restricted to the ship.
02/22	Mission personnel returned, move aboard day. Alongside mobilization. Restricted to the ship.
02/23	Depart Singing River, Pascagoula, MS, at 0930. Positional testing of Applanix POS MV and Seapath system. GAMS calibration conducted. Patch test initiated.
02/24	Dive 01: Mississippi Mud (489.7 m). Patch test continued. Transit mapping to Dive 02.
02/25	Dive 02: UCH dive (1,847.3 m). RX speed/noise testing. Transit mapping to Dive 03.
02/26	Dive 03: Canyon Terrace (1,578.3 m). Transit mapping to Dive 04.
02/27	Dive 04: Step Canyon (3,015.9 m). Further RX noise testing. Transit mapping to Dive 05.
02/28	Dive 05: Northern Abyssal Plain and Midwater (3,419.7 m). 3,400 m reference surface. Transit mapping to Dive 06. Some mission personnel participated/ presented virtually for Ocean Sciences Meeting, 2022.
03/01	Dive 06: Southernmost Canyon (1,841.9 m). Mapping operations over Dive 07 site.

Date (UTC)	Activity
	Deep roll verification. Some mission personnel participated/presented virtually for Ocean Sciences Meeting, 2022.
03/02	Dive 07: Southernmost Canyon Ridge 2 (1,749.9 m). ADCP transects over the loop current. Some mission personnel participated/presented virtually for Ocean Sciences Meeting, 2022.
03/03	Arrival in Key West, FL. Mission personnel depart. Some mission personnel participated/presented virtually for Ocean Sciences Meeting, 2022.

Figure 1. Map showing EX-22-01's track, seven ROV dive sites, and bathymetry data collected (depth in meters).

7. Results

Metrics for EX-22-01's major exploration and scientific work are summarized in **Tables 4 and 5**. More detailed results are presented in the subsections that follow.

Table 4. Summary of exploration metrics for EX-22-01.

Exploration Metrics	Totals
Days at sea	9
Days at sea in U.S. waters	9
Linear km mapped by EM 304	829
Square km covered by EM 304	4,926
Square km covered by EM 304 in U.S. waters	4,926
Vessel CTD casts	0
XBT casts	34
ROV dives	7
ROV dives in U.S. waters	7
Maximum ROV seafloor depth (m)	3,419.7
Minimum ROV seafloor depth (m)	489.7
Total time on bottom (hh:mm:ss)	28:12:21
Water column survey time (hh:mm:ss)	02:37:35
Total ROV time (hh:mm:ss)	48:40:32

Table 5. Summary of scientific metrics for EX-22-01: The first five metrics are also included as scientific metrics in Table 6.

Scientific Metrics	Totals
Potential undescribed or novel species and new records observed*	1
Dives during which living corals and sponges were observed	4

Scientific Metrics	Totals
Dives during which chemosynthetic communities were observed	0
Dives during which active seeps/vents were observed	0
Dives during which diverse benthic communities were observed	3
Total samples	16
Biological samples (primary)	2
Biological associate samples	1
Geological samples	2
Geological associate samples	1
eDNA water samples	6
eDNA blank water samples	4
Actively participating scientists, students, and resource managers	79

*Organisms unknown to science or an extension of their known range of geolocation or depth

7.1 ROV Survey Results

Depth ranges explored during the seven ROV surveys were between 489 and 3,349 m. During the seven dives, the ROVs spent a total of 28 hours on the bottom and over 2.5 hours conducting water column exploration. See **Tables 6 and 7** for dive-specific information.

Table 6. Summary information for the seven ROV dives conducted during EX-22-01.

Dive #	Site Name	Date (yyyymmdd)	On Bottom Latitude (dd)	On Bottom Longitude (dd)	Max Depth (m)	Min Seafloor Depth (m)	Dive Duration (hh:mm:ss)	Bottom Time (hh:mm:ss)	Water Column Exploration Time (hh:mm:ss)
01	Mississippi Mud	20220224	29.21250° N	-087.87263° W	489.7	0488.6	3:57:57	2:51:30	0:00:00
02	UCH Dive	20220225	UCH° N	UCH° W	UCH	UCH	8:00:57	5:36:52	0:00:00
03	Canyon Terrace	20220226	28.05065° N	-086.54203° W	1,578.3	1,547.2	5:33:53	3:09:05	0:00:00
04	Step Canyon	20220227	26.82385° N	-085.03012° W	3,015.9	2,875.9	7:54:12	4:26:30	0:00:00
05	Northern Abyssal Plain & Midwater	20220228	25.00573° N	-084.89297° W	3,419.7	3,418.6	7:31:23	0:37:14	1:54:22

Dive #	Site Name	Date (yyyymmdd)	On Bottom Latitude (dd)	On Bottom Longitude (dd)	Max Depth (m)	Min Seafloor Depth (m)	Dive Duration (hh:mm:ss)	Bottom Time (hh:mm:ss)	Water Column Exploration Time (hh:mm:ss)
06	Southernmost Canyon	20220301	24.11736° N	-084.07423° W	1,841.9	1,743.3	7:45:08	5:56:29	0:17:52
07	Southernmost Canyon Ridge 2	20220302	24.13299° N	-084.09953° W	1,749.9	1,688.1	7:57:02	5:34:41	0:25:21

Table 7. Summary of scientific metrics for the seven ROV dives conducted during EX-22-01: Potential undescribed or novel species and new records observed, dives during which living corals and sponges were observed, dives during which chemosynthetic communities were observed, dives during which active seeps/vents were observed, dives during which diverse benthic communities were observed, and samples collected.

Dive #	Site Name	Undescribed Species	Corals & Sponges	Chemo-synthetic Community	Active Seeps & Vents	Diverse Benthic Community	Primary Biological Samples	Associate Biological Samples	Primary Geological Samples	Associate Geological Samples
01	Mississippi Mud	no	no	no	no	no	-	-	-	-
02	UCH Dive	no	no	no	no	no	1	1	-	1
03	Canyon Terrace	no	yes	no	no	no	-	-	-	-
04	Step Canyon	no	yes	no	no	no	-	-	-	-
05	Northern Abyssal Plain & Midwater	no	no	no	no	yes	1	-	-	-
06	Southernmost Canyon	no	yes	no	no	yes	-	-	2	-
07	Southernmost Canyon Ridge 2	no	yes	no	no	yes	-	-	-	-

7.1.1 Accessing ROV Data

NOAA Ocean Exploration's Digital Atlas

ROV data from EX-22-01 are archived at NCEI and available through NOAA Ocean Exploration's Digital Atlas. To access these data, click on the Search tab, enter "EX2201" in the Enter Search Text field, and click Search. Click on the point that represents EX-22-01 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.

NCEI Dataset

The EX-22-01 NCEI dataset (accessed through NOAA Ocean Exploration's Digital Atlas) is an alternate resource for the ship and ROV data collected during the expedition. This dataset contains data collected from shipboard sensors including navigational data, meteorological data (wind), and oceanographic data (bathythermograph, sound velocity probe, thermosalinograph). Additional data include profile data (ASVP, CTD, and XBT), event logs, images, ROV ancillary data, and sample data.

ROV Dive Summaries

Individual ROV dive summaries and associated ROV dive data are archived at NCEI and available on the EX-22-01 pages of the NCEI's *Okeanos Explorer* website. To access the dive summaries, click on the 2022 Expeditions tab at the top of the page and then click on the link to ROV and Mapping Shakedown 2022 – EX2201.

ROV Dive Video

To search, preview, and download dive video for *Okeanos Explorer*, go to the NOAA Ocean Exploration Video Portal.

SeaTube

NOAA Ocean Exploration works closely with Ocean Networks Canada to implement SeaTube, a web-based annotation interface for ROV operations on expeditions aboard *Okeanos Explorer*. SeaTube is the digital equivalent to a scientist's logbook. It is 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 "Expeditions" tree and select "NOAA," "2022," and "NOAA OER EX2201 Shakedown Expedition." To play an individual dive, click the play icon (triangle in a circle) to the left of the dive number and name. To search, select the expedition or individual dive and click the search icon (magnifying glass) to the left of the dive number and name.

7.2 Sampling Operations Results

A total of 16 samples were collected during EX-22-01: 2 geological samples, 2 biological samples, 2 associate samples, and 10 eDNA samples (see **Table 5**).

The geological samples included a rock sample of calcium carbonate with ferro manganese (FeMn) crust and mud-sized sediment. See **Table C1** for full details of the geological samples collected.

There were two biological samples that were purposely collected (primary samples) as well as one sample that was incidentally collected (associate samples). In total, these samples amounted to 3 individuals. The biological samples included barnacles collected from a soda can and a *Solmissus* collected from the midwater. See **Table C2** for full details of the biological samples collected.

Water samples were collected on dives 01, 04, 06, and 07. Five Niskin bottles were available to collect water for eDNA filtering onboard *Okeanos Explorer* (**Table C3**). One blank sample was taken for each day water samples were collected. The blank sample was collected from a water fountain aboard *Okeanos Explorer* right before filtering commenced.

7.2.1 Sample Repositories

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

Biological Samples

Invertebrate Zoology Collections
National Museum of Natural History
Smithsonian Institution, Museum Support Center
MRC 534, 4210 Silver Hill Road, Suitland, MD 20746

DNA Samples

Biorepository
National Museum of Natural History
Smithsonian Institution, Museum Support Center
4210 Silver Hill Road, Suitland, MD 20746

Geological Samples

Marine and Geology Repository
Oregon State University
Burt 346, Corvallis, OR 97331-5503

7.3 Acoustic Operations Results

The mapping related objectives of EX-22-01 were to assess the mission readiness of the mapping systems through annual testing and calibration and to integrate and evaluate the newly installed Kongsberg Seapath 380-R3 positioning system as an alternative to the Applanix

POS MV positioning system. Operations included a GAMS test for the POS MV, a dockside antenna calibration of the Seapath, separate patch tests using each positioning system to ensure similarly reported angular offsets, RX array speed-noise testing, swath-coverage testing, and accuracy reference surveys conducted at 3,400 m with each positioning system. Results of the mission readiness testing are provided in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2022."

In addition to these calibration objectives, NOAA Ocean Exploration mapped 4,926 square km of seafloor during the nine days at sea for EX-22-01, entirely in areas deeper than 200 m and within the U.S. Exclusive Economic Zone and Territorial Sea. Multibeam bathymetry data coverage is shown in **Figure 2**.

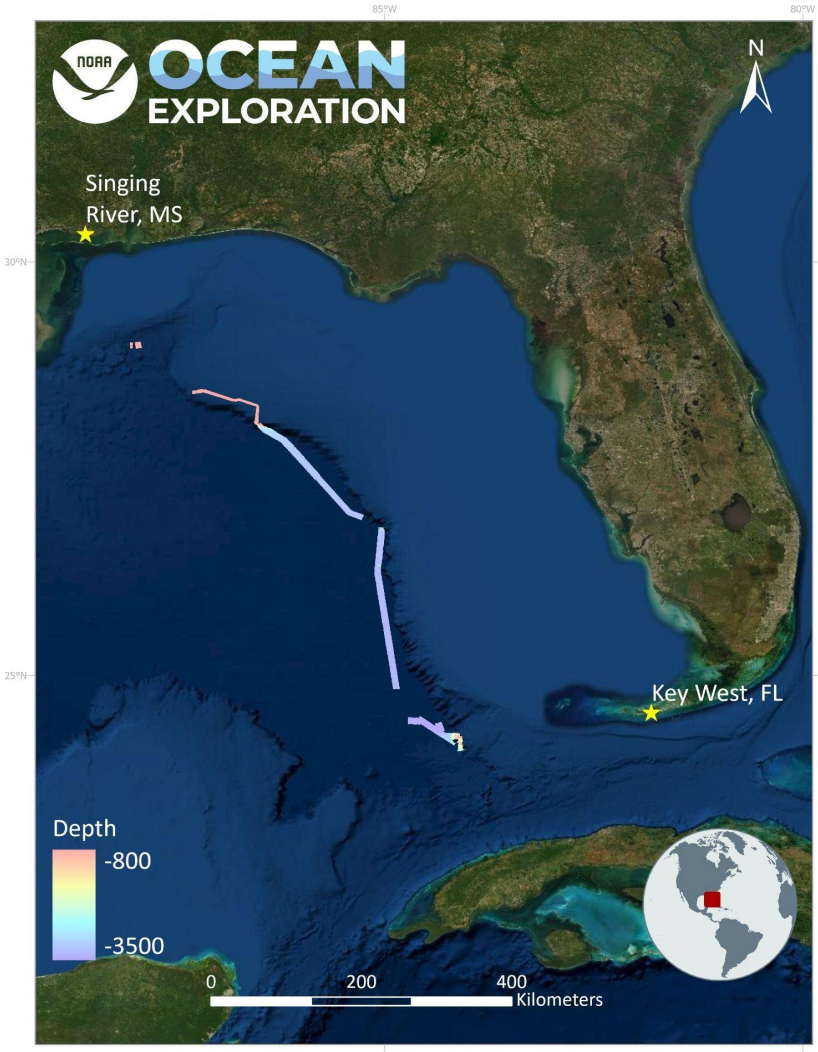

Figure 2. Overview of bathymetric mapping coverage completed during the 2022 ROV and Mapping Shakedown (EX-22-01).

More detailed information about the mapping operations conducted during EX-22-01, including data quality assessments, is in the EX-22-01 mapping data report (Candio et al., 2022).

7.3.1 Acoustic Operations Data Access

Multibeam Sonar (Kongsberg EM 304)

The multibeam dataset for the expedition is archived at NCEI and accessible through their Bathymetric Data Viewer. To access these data, click on the Search Bathymetric Surveys button, select "NOAA Ship Okeanos Explorer" from the Platform Name dropdown menu, and "EX2201" from the Survey ID dropdown menu. Click OK, and the ship track will appear on the map. Click the ship track for options to download data.

Sub-Bottom Profiler (Knudsen Chirp 3260)

The sub-bottom profiler was not run during any of EX-22-01's ROV dive operations, but generally was operated during multibeam mapping operations. These data are archived at NCEI and accessible through the Trackline Geophysical Data Viewer. To access these data, select "Subbottom Profile" under Marine Surveys and click on Search Marine Surveys. In the pop-up window, select "EX2201" in the Filter by Survey IDs dropdown menu. Click OK, and the ship track will appear on the map. Click the ship track for options to download data.

Split-Beam Sonars (Simrad EK60 and EK80)

EK60 and EK80 water column data for EX-22-01 are archived at NCEI and available through the Water Column Sonar Data Viewer. To access these data, click on the Additional Filters button, deselect "All" next to Survey ID, and select "EX2201" from the Survey ID list. Click OK, and the ship track will appear on the map. Click on the ship track for options to download data.

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

ADCP data collected at each ROV dive location are archived at NCEI and available through the Global Ocean Currents Database. Access these data by searching the table for the Expedition identifier "EX2201."

7.4 Conductivity, Temperature, and Depth Measurements

ROV CTD data from EX-22-01 can be found on the EX-22-01 pages on NCEI's Okeanos Explorer website.

7.5 Engagement

EX-22-01 engaged with audiences around the world, opening a window of understanding into the deep sea. Highlights are listed below:

- Live video feeds received nearly 20,000 views, and web content received 4,900 visits during EX-22-01.
- Shakedown expeditions don't typically receive much media coverage. However, the McClatchy newspapers (~30, including *Miami Herald*, *Sacramento Bee*, *Charlotte Observer*) ran a story about the initial shipwreck finding. The later announcement of the discovery of what is likely the wreck of whaling ship *Industry* was featured by over 500 local and national media outlets and websites, including *The New York Times, The Washington Post, CNN, CBS News, ABC News, NBC News, USA Today, People, Boston Globe*, and *The Providence Journal*.

8. Summary

- Conducted seven successful dives on soft bottom, canyons, and a maritime heritage site. The deepest depth achieved with *Deep Discoverer* was 3,419 m.
- Observed a candelabra gorgonian coral during Dive 07. Although dead, it was the first record of this type of coral (dead or alive) seen in the Gulf of Mexico.
- Confirmed the location of a shipwreck thought to be the early 19th century whaler *Industry*.
- Conducted mapping shakedown operations, which included verification of integration of all acoustic sonars, sub-bottom transects, acoustic imaging of the water column, and collection of 4,930 square km of acoustic data during transits and calibrations.
- Coordinated positioning testing with University of Southern Mississippi scientists on shore to compare outputs from the POSMV and Seapath navigational systems.
- Conducted ROV shakedown operations, which included testing and calibration of new ROV motor controllers, auto position software, lighting system, hydraulic system, ME-20 low-light camera, high-definition ancillary ROV cameras, and sector scanning sonar.
- Created and tested the effectiveness of a bioluminescence agitator attached to *Deep Discoverer*.
- Tested the ability of the ME-20 low-light camera to record bioluminescence by gently tickling bamboo coral with the manipulator arm in order to promote bioluminescence (Dive 07).
- Conducted the first ROV shoreside piloting efforts with *Deep Discoverer*.

- Trained the entire ROV team in the pilot, copilot, navigator roles.
- Trained a new expedition coordinator in at-sea roles.
- Enhanced the VSAT's connection, making it speedy and reliable to allow for new mission abilities, including preparing and completing the telecommunication needs for shoreside piloting.
- Tested a new VPN while training new personnel for sample data management through the remote sample data manager system.
- Updated the mapping lead, expedition coordinator, and sample data manager at sea standard operating procedures for ROV expeditions.
- Provided training to ship officers on ROV deployment and recovery, aft control, and the new DP system.

9. References

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Appendix A: Shore-Based Science Participants

Table A1. EX-22-01 shore-based science team members.

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Appendix B: EX-22-01 Permits and Clearances

Figure B1. Endangered Species Act letter of concurrence

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

February 3, 2021
Refer to NMFS No: OPR-2021-00095

Dr. Alan Leonardi
Director
Office of Ocean Exploration and Research
1315 East West Highway
Silver Spring, Maryland 20910

RE: Concurrence Letter for the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean Exploration and Research's Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the NOAA Ship *Okeanos Explorer* for the 2021 Field Season

Dear Dr. Leonardi:

On January 14, 2021, the National Marine Fisheries Service (NMFS) received your request for a written concurrence that the NOAA Office of Ocean Exploration and Research's (OER) marine operation activities on the NOAA ship *Okeanos Explorer* for the 2021 field season under the Endangered Species Act (ESA) 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 was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 C.F.R. §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). A complete record of this informal consultation is on file at NMFS Office of Protected Resources in Silver Spring, Maryland.

Background and Consultation History

Previous consultations for NOAA's Office of Ocean Exploration and Research's marine operation activities on the NOAA Ship *Okeanos Explorer* were concluded in 2020, 2019, and 2018 (NMFS 2018a; NMFS 2018b; NMFS 2019; NMFS 2020). Each of these consultations assessed NOAA OER's bathymetric mapping activities in the North Atlantic Ocean. Although similar in scope, these activities differed slightly by geographic location and/or consisted of new sonar technologies added to the NOAA Ship *Okeanos Explorer*. Critical habitats for the following species were proposed since the conclusion of these consultations and may be in the action area of the 2021 survey: lobed star coral (*Orbicella annularis*), boulder star coral (*Orbicella franksi*), mountainous star coral (*Orbicella faveolata*), pillar coral (*Dendrogyra cylindrus*), and rough cactus coral (*Mycetophyllia ferox*), see 85 FR 76302, November 27, 2020.

Action Agency's Effect Determinations

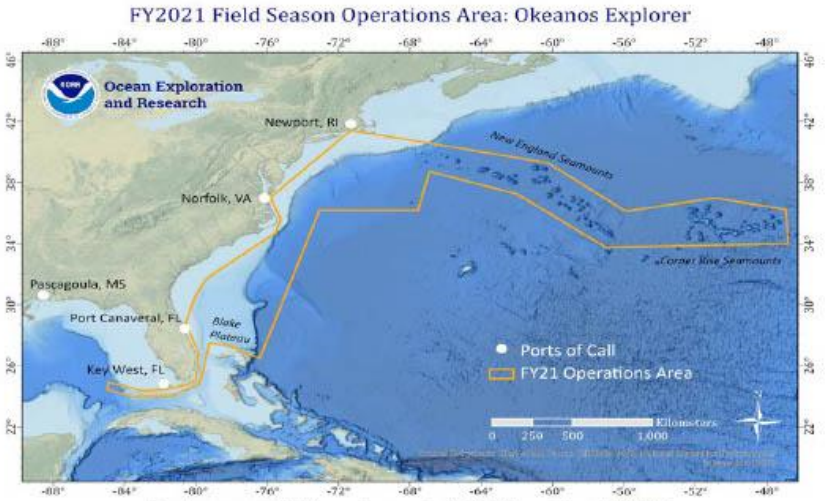
The 2018 to 2019 NOAA OER Biological Evaluation (BE) contained information regarding species and DPSs that may also be affected by the proposed marine operation activities on the NOAA ship *Okeanos Explorer* during the 2021 field season. Your staff provided an analysis and effects determinations for newly proposed ESA-listed coral critical habitat via email for the 2021 request for consultation on January 27, 2021. In the 2018 BE and the 2021 consultation initiation request, you concluded that the marine operation activities on the NOAA ship *Okeanos Explorer* were not likely to adversely affect ESA-listed species or their proposed or designated critical habitat within the action area.

Proposed Action and Action Area

Although still within the Gulf of Mexico and North Atlantic Ocean, the proposed action area is not the same as that for the 2020 consultation. The 2021 survey area includes additional marine environments within the U.S. exclusive economic zone (EEZ) off the coast of South Carolina extending north to New Jersey and along the New England Seamounts. Other proposed survey areas off the coast of Florida, Georgia and New England were included in the marine operation activities consulted on in 2020 and are contained in the 2021 survey area as well.

In addition to new survey areas, NOAA's Office of Ocean Exploration and Research plans to use additional sonar technology, the Teledyne Blueview Sonar, which was not used in the 2020 survey.

Figure 1. NOAA OER FY 2021 Field Season Action Area



Overview map of the field operations area for NOAA OER expeditions in FY2021.

Affected ESA-listed Species and Designated/Proposed Critical Habitat

Based on the information submitted by your office for the 2021 survey, although new areas will be surveyed, we determined that all ESA-listed species consulted on during the 2018, 2019 and 2020 field season would be the same for the 2021 field season. Furthermore, the additional information you provided related to the frequency and source levels of the Teledyne Blueview Sonar system indicated that it will operate at a frequency range (900 kHz to 2,250 kHz), which is outside of the hearing range for ESA-listed species in the action area. Therefore, the addition of this sonar technology to the cruise will not result in additional effects to ESA-listed species.

For this reason, this consultation considers only the potential effects to the proposed coral critical habitats from the 2021 survey.

Effects of the Action

"Effects of the action" has been recently revised to mean all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. § 402.02; see also 50 C.F.R. § 402.17).

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 extremely unlikely to occur, insignificant, or wholly beneficial. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. For an effect to be extremely unlikely to occur, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did affect a listed species), but it is very unlikely to occur.

Based on the information submitted by your office, we determined that all newly proposed coral critical habitat would experience the same impacts from the survey as critical habitat that is currently designated for elkhorn and staghorn coral in the action area. This is due to the survey depths of the cruise, which are planned to occur at depths greater than 250 meters, well below the depth distributions for all of the ESA-listed corals that have proposed critical habitat in the action area (See Figure 2). For this reason, we believe the effects of the cruise such as potential stressors associated with vessel transit and operation will be extremely unlikely to occur as previously determined for elkhorn and staghorn coral designated critical habitat. Therefore, the proposed 2021 surveys may affect, but are unlikely to adversely affect proposed coral critical habitat.

Figure 2. Depth distributions for ESA-listed corals with proposed critical habitat in the action area (85 FR 76302).

Species	Reef Environment	Depth Distribution	US Geographic Distribution
Dendrogyra cylindrus	most reef environments	1 to 25 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Mycetophyllia ferox	most reef environments	5 to 90 m	Southeast Florida from Broward County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Orbicella annularis	most reef environments	0.5 to 20 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella faveolata	most reef environments	0.5 to 90 m	Southeast Florida from St. Lucie Inlet in Martin County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella franksi	most reef environments	5 to 90 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa

Conclusion

Based on this analysis, NMFS concurs with NOAA OER that the effects of the proposed action may affect, but are not likely to adversely affect proposed coral critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by the NOAA Office of Ocean Exploration and Research or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) take occurs; (b) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this consultation; (c) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not previously considered in this consultation; or (d) if a new species is listed or critical habitat designated that may be affected by the action (50 C.F.R. §402.16). In the case of this consultation, because the effects of the proposed action on proposed critical habitat for ESA-listed Atlantic/Caribbean corals have been considered in this consultation, we do not anticipate the need for reinitiation should the designation be finalized.

We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and designated critical habitat. If you have any questions on this consultation, please contact me at (301) 427-8495 or by email at cathy.totorici@noaa.gov or Jonathan Molineaux at (301) 427-8440 or by email at jonathan.molineaux@noaa.gov.

Sincerely,

TORTORICI.CATHRYN.ELISA.1365826850 Digitally signed by TORTORICI.CATHRYN.ELISA.1365826850 Date: 2021.02.03 14:54:44 -05'00'

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

cc: Amanda Maxon
Environmental Compliance Contractor
Office of Ocean Exploration and Research

Literature Cited

NMFS. 2018a. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: FPR-2018-9276. National Marine Fisheries Service Office of Protected Resources, Silver Spring.

NMFS. 2018b. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation for Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: FPR-2018-9284.

NMFS. 2019. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the National Oceanic and Atmospheric Administration Ship Okeanos Explorer for the 2018 through 2019 Field Seasons. Reference Number: OPR-2019-01058.

NMFS. 2020. Concurrence Letter for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research's Reinitiation of Section 7 Consultation Pursuant to the Endangered Species Act for Marine Operation Activities on the Ship Okeanos Explorer for the 2020 Field Season. Reference Number: OPR-2020-00374.

Figure B2. NOAA Fisheries Greater Atlantic Regional Fisheries Office letter of acknowledgement

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

February 18, 2022

MEMORANDUM FOR: Terence Lynch, Deputy Director (Acting)
NOAA Office of Exploration and Research (OER)

FROM: Assistant Regional Administrator, Habitat and Ecosystem Services

SUBJECT: Essential Fish Habitat (EFH) Consultation for deep-sea exploration activities aboard NOAA Ship *Okeanos Explorer* in 2022

This responds to your request for an abbreviated EFH consultation for the field activities to be conducted aboard the NOAA Ship *Okeanos Explorer* in the Greater Atlantic and Southeast Regions in 2022. Your request supplements a previously completed EFH consultations between NOAA Fisheries Greater Atlantic and Southeast Regions and NOAA's National Centers of Coastal Ocean Science (NCCOS) for research activities to be conducted in U.S. federal waters of the Gulf of Mexico, South Atlantic Bight and Caribbean in 2018-2020 and activities in the Greater Atlantic Region and Southeast Atlantic from 2019 to 2021. These previous consultations covered a smaller geographic area, shorter time frame, and subset of operations as this request, which intends to cover all activities to be conducted by NOAA Ship *Okeanos Explorer* in the Greater Atlantic Region, Gulf of Mexico, Caribbean and South Atlantic in 2022.

Although plans for the 2022 field seasons are still being developed and are contingent on budget, staffing and available days at sea, the 2022 fieldwork focuses on deep-water explorations off the U.S. East Coast, especially deep-water areas of the Blake Plateau and South Atlantic, Puerto Rico, U.S. Virgin Islands, and nearby Caribbean, the New England Seamount Chain, and the Mid-Atlantic Ridge in the areas north and south of Ponta Delgada in the Azores Archipelago of Portugal. Like previous expeditions in the Gulf of Mexico, western Atlantic, and Pacific, NOAA will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration including deep water mapping systems such as multibeam, single beam, sub-bottom profilers and acoustic Doppler current profiler (ADCP) sonar systems, the ship's conductivity-temperature-depth (CTD) sampling rosette and underway CTD, remotely operated vehicles (ROV), and high-bandwidth satellite connection for real-time ship to shore communications.

The action areas covered by this request encompass the marine environments in the Gulf of Mexico, Caribbean, High Seas, North Atlantic, South Atlantic, and transit areas between ports, including, but not limited to, Port Canaveral, Florida; Pascagoula, MS; Key West, FL; San Juan, Puerto Rico; Newport, Rhode Island; St. Johns, Newfoundland, Canada; Horta, Faial, Azores; and St. Thomas, U.S. Virgin Islands. All mapping, CTD and ROV operations are expected to be

in waters at depths of 200 m and greater, with the majority of cruise activities in water depths of 500 m and greater. Transit mapping operations are planned between all areas mentioned, including the high seas.

As specified in the Magnuson Stevens Fishery Conservation and Management Act (MSA), EFH consultation is required for federal actions that may adversely affect EFH. The Greater Atlantic and Southeast Regions have reviewed information provided on the proposed activities as well as the protective measures and best management practices incorporated into the action. In our joint assessment of the overall activity including the experimental design, the nature of collection, and the scope of the proposed activities, we have no additional EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the MSA. Further EFH consultation on this action is not necessary unless future modifications are proposed and that you determined those actions may result in an adverse impact to EFH.

Be advised that the harvest and possession of coral is prohibited under the current fishing regulations in the Gulf of Mexico, South Atlantic and Caribbean. Although the nature of work conducted as part of the *Okeanos Explorer* field activities is not considered a regulated fishing activity under the MSA, NOAA OER may wish to contact the Southeast Region's Sustainable Fisheries Divisions to determined if a Letter of Acknowledgement (LOA) for scientific research activities is advised. LOAs are issued by NOAA Fisheries under the authority of the MSA in situations where research activities would normally be in violation of federal fisheries regulations. By issuing the LOA, NOAA Fisheries acknowledges that the activities proposed are scientific research and are therefore exempt from fishing regulations developed under the MSA. Additional information on scientific research and exempted permits can be found on the Southeast Region's Sustainable Fisheries Division website. In the Greater Atlantic Region, there is a prohibition on the use of certain types of bottom tending gear within the Frank R. Lautenberg Deep Sea Coral Protection Area and the Georges Bank Deep Sea Coral Protection Area. The biological collection methods planned as part of the field studies do not appear to conflict with these gear prohibitions, however, OER may wish to contact the Greater Atlantic Region's Sustainable Fisheries Division to determine if an LOA or Scientific Collection Permit is warranted. Additional information on scientific research and exempted permits can be found on the Greater Atlantic Region's Sustainable Fisheries Division website.

If we can be of further assistance regarding EFH please contact Karen.Greene@noaa.gov in the Greater Atlantic Region or David.Dale@noaa.gov in the Southeast Region.

cc: GAR/HESD- K. Greene
SERO/HCD - P. Wilber, D. Dale
NOAA OER – A Maxon

Figure B3. NOAA Fisheries Southeast Regional Office letter of acknowledgement

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
https://www.fisheries.noaa.gov/region/southeast

12/27/2021

F/SER28:SS

Ms. Amanda Maxon
NOAA Office of Ocean Exploration and Research
Silver Spring, MD 20910
Amanda.Maxon@noaa.gov

Dear Ms. Maxon:

This letter of acknowledgement (LOA) recognizes the sampling activities outlined in your December 7, 2021, request as scientific research conducted by a scientific research vessel in accordance with the definitions and guidance at 50 CFR 600.10 and 600.745(a). As such, the proposed activities are not subject to fishing regulations at 50 CFR Part 622 or other fishing regulations promulgated in accordance with the Magnuson-Stevens Fishery Conservation and Management Act.

NOAA Fisheries understands that the purpose of the project is to conduct deep-sea research and exploration activities in U.S. federal waters, among other areas, during upcoming expeditions aboard NOAA Ship *Okeanos Explorer*. Activities are currently scheduled to start in Key West, Florida, on February 15, 2022, and end in San Diego, California, on September 30, 2022 (see Table 1). The geographic areas to be targeted during the expedition include deep-water (>250 meters [m]) areas in the exclusive economic zone (EEZ) in the Gulf of Mexico, South Atlantic, and U.S. Caribbean and include, but are not limited to, unexplored areas that are predicted to be suitable habitat for deep sea corals and sponges, inter-canyon areas, and gas seeps.

Specifically, these efforts will use deep-water mapping, water column characterization systems, and remotely operated vehicles (ROV) to explore and characterize deep-water areas. Limited biological sampling operations (4-9 specimens/dive) will be conducted during the ROV expeditions. This LOA recognizes the ROV operations (detailed below) as scientific research conducted by a scientific research vessel, and thus outside the scope of the fishing regulations described above.

The *Okeanos Explorer* is equipped with a two-body ROV system capable of diving to 6,000 m depth. During ROV operations, the two ROVs are connected to each other by a 30 m long tether and attached to the ship by an 8,200 m armored fiber-optic cable providing power and telemetry to the two vehicles. ROV operations will be conducted only during daylight hours, while the *Okeanos Explorer* is stopped and holding station using dynamic positioning (no anchoring). ROV operations typically take place within several meters of the seafloor and are conducted in a manner that minimizes seafloor disturbances. Up to 40 ROV dives are anticipated during the EX22-06 cruise, which will occur throughout the EEZ of Portugal, the high seas, and the U.S. EEZ off the U.S. Virgin Islands (USVI) and Puerto Rico. The number of ROV dives is

dependent on the Expedition Coordinator running the expedition and the number anticipated to occur in the U.S. EEZ is unknown at this time.

Sampling operations will be conducted using the ROV's manipulator arm and suction sampler. Biological collections will focus on new species or new records for the region, the dominant type of organism (such as a coral or sponge) present in a habitat, and samples to support connectivity studies. When possible, only a sub-sample will be collected from each specimen (e.g., only a piece, fragment, or branch of corals and sponges), not the entire organism. Coral specimens to be collected during these expeditions include members of the *Antipatharian* and *Scleractinian* orders, which may include coral species for which harvest is prohibited in U.S. Caribbean federal waters (50 CFR 622).

This LOA is separate and distinct from any permit or consultation required by the Marine Mammal Protection Act, the Endangered Species Act (ESA), or any other applicable law. Under 50 CFR 600.745(a), NOAA Fisheries is required to inform you that such a permit may be required and should be obtained from the appropriate agency prior to embarking on the activity.

Reporting Injured or Entangled Marine Mammals
If a marine mammal is observed sick, entangled, stranded, injured, or dead, please immediately call 877-942-5343 (Continental U.S.), 787-538-4684 or 787-645-5595 (Puerto Rico Marine Mammal Stranding Hotline), or 340-713-2422 (USVI Marine Mammal Stranding Hotline) for assistance. If a marine mammal is killed or injured during this research project, please cease all research activity and remove gear from the water column until the NOAA Fisheries Southeast Regional Office (SERO) Protected Resources Division Marine Mammal Branch (1-727-824-5312) is consulted.

Reporting ESA-listed Species Interactions
Please immediately report any ESA-listed species interactions to the NOAA Fisheries SERO Protected Resources Division Branch at 727-824-5312.

Copies of this LOA and the scientific research plan for the project should be onboard the vessel during all sampling activities.

Please send a copy of any cruise report or other publications resulting from the scientific research activity to the Director, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, Florida 33149-1003.

Sincerely,

BERNHART.DAVID.M.1066125889
2021.12.27 11:11:52 -05'00'

for Andrew J. Strelcheck.
Regional Administrator

cc: F/SEFSC, F/EN3

Table 1. Scheduled start and end dates and ports of call for the *Okeanos Explorer* 2022 deep-water mapping expeditions.

Cruise	Start Port	Start Date	End Port	End Date	Cruise Objectives	Samples Collected
EX-22-01	Key West, FL	2/15/2022	Port Canaveral, FL	2/26/2022	Mapping and ROV Shakedown*	No
EX-22-02	Port Canaveral, FL	3/5/2022	San Juan, Puerto Rico	3/25/2022	Mapping	No
EX-22-03	San Juan, Puerto Rico	4/2/2022	Newport, RI	4/26/2022	Mapping and Drop Cam	No
EX-22-04	Newport, RI	5/10/2022	St. Johns, Newfoundland Canada	56/2/2022	Mapping	No
EX-22-05	St. Johns, Newfoundland Canada	6/10/2022	Horta, Faial Azores	7/4/2022	ROV and Mapping	Yes**
EX-22-06	Horta, Faial Azores	7/12/2022	St. Thomas, USVI	8/5/2022	ROV and Mapping	Yes
EX-22-07	St. Thomas, USVI	8/13/2022	San Diego, CA	9/3/2022	Canal transit	No
EX-22-08	San Diego, CA	9/11/2022	San Diego, CA	9/30/2022	Mapping	No

* Every *Okeanos Explorer* operating season starts with an at-sea "shakedown," when all of the ship's mission systems undergo rigorous tests to ensure everything is performing properly and that the ship is fully ready for the field season and will collect the highest-quality data possible.
** No dives will occur in the U.S. EEZ during this cruise segment; ROV dives will occur in the Canadian EEZ, the High Seas, and the Portugal EEZ.

Appendix C: Inventories of Geological, Biological, and eDNA Water Samples

Table C1. Inventory of geological samples collected during EX-22-01.

Dive #	Site Name	Sample #*	Sample ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
02	UCH Dive	EX2201_D02_01B_A01	Mud	Washed and dried	n/a	20220225	16:48:27	n/a	n/a	n/a	0.025
06	Southernmost Canyon	EX2201_D06_01G	Ferromanganese encrusted carbonate rock	Washed and dried	Characteristic of site	20220301	17:29:33	24.11739	-84.07403	1824.7	0.122
06	Southernmost Canyon	EX2201_D06_03G	Ferromanganese encrusted carbonate rock	Washed and dried	Characteristic of site	20220301	20:43:46	24.11875	-84.07347	1744.6	0.128

*Geological sample numbers with "_A##" indicate associate samples.

Table C2. Inventory of biological samples collected during EX-22-01.

Dive #	Site Name	Sample #*	Field Sample ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temp (C)	Dissolved Oxygen (mg/l)
02	UCH Dive	EX2201_D02_01B	Thoracica	EtOH	n/a	20220225	16:48:27	n/a	n/a	n/a	35.00	4.30	6.67
02	UCH Dive	EX2201_D02_01B_A01	Barnacle	EtOH	n/a	20220225	16:48:27	n/a	n/a	n/a	35.00	4.30	6.67
05	Northern Abyssal Plain & Midwater	EX2201_D05_01B	*Solmissus*	5% Formalin	Characteristic of site	20220228	21:10:27	24.3955	-84.8848	752.8	34.93	7.44	3.97

*Biological sample numbers with "_A##" indicate associate samples.

Table C3. Inventory of water samples collected for eDNA during EX-22-01.

Dive #	Site Name	Sample #	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temp (°C)	Dissolved Oxygen (mg/l)
01	Mississippi Mud	EX2201_D01_01W	Longmire's	eDNA	20220224	20:43:41	29.21242	-87.87331	489.5	34.95	7.94	3.71
01	Mississippi Mud	EX2201_D01_BLANK	Longmire's	eDNA	20220224	n/a	n/a	n/a	n/a	n/a	n/a	n/a
04	Step Canyon	EX2201_D04_01W	Longmire's	eDNA	20220227	19:55:10	26.83447	-85.05290	2,912.5	34.97	4.36	6.63
04	Step Canyon	EX2201_D04_02W	Longmire's	eDNA	20220227	20:53:58	26.83506	-85.05232	2,864.6	34.97	4.37	6.62
04	Step Canyon	EX2201_D04_03W	Longmire's	eDNA	20220227	20:58:39	26.83507	-85.05234	2,864.9	34.93	4.43	6.62
04	Step Canyon	EX2201_D04_BLANK	Longmire's	eDNA	20220227	n/a	n/a	n/a	n/a	n/a	n/a	n/a
06	Southernmost Canyon	EX2201_D06_02W	Longmire's	eDNA	20220301	17:31:18	24.11742	-84.07404	1,823.7	34.98	4.31	6.72
06	Southernmost Canyon	EX2201_D06_BLANK	Longmire's	eDNA	20220301	n/a	n/a	n/a	n/a	n/a	n/a	n/a
07	Southernmost Canyon Ridge 2	EX2201_D07_01W	Longmire's	eDNA	20220302	17:55:02	24.13214	-84.09389	1,738.1	34.97	4.31	6.68
07	Southernmost Canyon Ridge 2	EX2201_D07_BLANK	Longmire's	eDNA	20220302	n/a	n/a	n/a	n/a	n/a	n/a	n/a