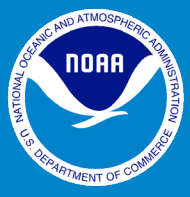

Ocean Exploration and Research

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Expedition Cruise Report

Cruise EX-15-04 Leg 3—2015 Hohonu Moana: Exploring the Deep Waters off Hawai‘i (ROV/Mapping)

August 28 to September 3, 2015

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Abstract

EX-15-04-L3 was a combined remotely operated vehicle (ROV) and mapping expedition in the Main Hawaiian Islands (MHI), including the Geologist Seamounts located 100 miles south of Honolulu, HI. This expedition was funded entirely by NOAA's Deep-sea Coral, Research, and Technology Program (DSCRTP) and therefore prioritized DSCRTP interests, deviating somewhat from NOAA Office of Ocean Exploration and Research's (OER) typical community-driven exploration mode with NOAA Ship *Okeanos Explorer* (*EX*). The expedition took place between August 28 and September 3, 2015, during which six remotely operated vehicle (ROV) dives were conducted. Three of these took place off the islands of O'ahu and the Big Island, and focused on the commercially valuable precious corals fishery in Hawai'i. Three other dives were conducted off McCall, Swordfish, and Ellis Seamounts in the Geologists Seamounts group; two previously unknown high-density coral and sponge communities were discovered and explored during this expedition. There were 189 types of animals recorded during this expedition, including 17 that are potential new species or records for the region. A number of these were collected for further analysis, along with 11 rock samples to provide more information about the origin and age of the seamounts, lava flows, and geological features investigated during this expedition. Mapping operations acquired data over 6,400 square kilometers of seafloor, including crucial backscatter data on McCall and Ellis Seamounts.

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1. Introduction

The NOAA Office of Ocean Exploration and Research (OER) is the only U.S. federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor, and delivering the ocean information needed to strengthen the economy, health, and security of our nation. Using the latest tools and technology, OER 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, OER allows 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. From this exploration, OER makes the collected data needed to understand our ocean publicly available, so we can maintain the health of our ocean, 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 Ship *Okeanos Explorer* (*EX*) is the only U.S. federal vessel dedicated to exploring our largely unknown ocean for the purpose of discovery and the advancement of knowledge. America's future depends on understanding the ocean. Exploration supports NOAA mission priorities and national objectives by providing a broad diversity of data and information about the deep ocean to anyone who needs it.

In close collaboration with government agencies, academic institutions, and other partners, OER conducts deep-sea exploration expeditions using advanced technologies on *EX*. From mapping and characterizing previously unseen seafloor to collecting and disseminating information about deep waters and seafloor—and the resources they hold—this work establishes a foundation of information and fills data gaps. Data collected on the ship 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. 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. Project Background

2.1 CAPSTONE: the Campaign to Address Pacific monument Science, Technology, Ocean NEeds

CAPSTONE: the **C**ampaign to **A**ddress **P**acific Monument **S**cience, **T**echnology, and **O**cean **Ne**eds, was a three-year effort designed to provide critical new information on the deepwater resources within the U.S. National Marine Monuments and Sanctuaries located throughout the Pacific. The primary goal of all *EX* expeditions in this campaign is to obtain baseline characterizations of the very poorly known deepwater areas and resources in these extensive marine protected areas (MPAs).

2.2 *2015 Hohonu Moana* (EX-15-04) Expedition Overview

EX-15-04 L3 was one of a series of NOAA Ship Okeanos Explorer expeditions from 2015 to 2017 planned to contribute to NOAA's multi-year Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE). NOAA priorities for the CAPSTONE campaign included a combination of science, education, outreach, and open data objectives that will support management decisions at multiple levels. CAPSTONE was a 3-year effort designed to provide critical new information on the deep water resources within the U.S. marine national monuments and sanctuaries located throughout the Pacific. The primary goal of all *Okeanos Explorer* expeditions in this campaign was to obtain baseline characterizations of the very poorly known deep water areas and resources in these extensive marine protected areas.

Figure 1 provides an overview image of the mapping and ROV operations during the 2015 *Hohonu Moana* expedition. A total of 85,700km^2 of seafloor was mapped and 37 ROV dives were completed in the MHI, PMNM, and the JAU of the PRIMNM. EX-15-04 L3 operations focused on NOAA Pacific Islands Fisheries Science Center (PIFSC) instrument recovery around the Main Hawaiian Islands, a dive in support of a coral disturbance/recovery study on substrate formed by lava flows off South Point of the Big Island, and several dives at the Geologists Seamounts in support of National Marine Fisheries Service Pacific Islands deep-sea coral

priorities. The primary goal for this expedition was to recover instruments, fill in some data gaps to wrap up prior work, and collect baseline data to support priority NOAA science and management needs. The primary mapping objective for EX-15-04 L3 in the Main Hawaiian Islands was to obtain EM 302 multibeam sonar backscatter data on Ellis and McCall seamounts in the Geologists Seamounts group, which lacked existing sonar backscatter information. A complete list of cruise objectives is available in the Project Instructions document for the cruise available at http://doi.org/10.7289/V5DB7ZVQ (Last Accessed September 2020).

The EX-15-04 L3 expedition was a 7-day expedition that started on August 28, 2015 and ended on September 3, 2015. The cruise started and ended in port facilities in Pearl Harbor in Honolulu, HI. The expedition included 24-hour per day operations, with daytime ROV dives supported with shore-side participation via telepresence technology and overnight mapping operations.

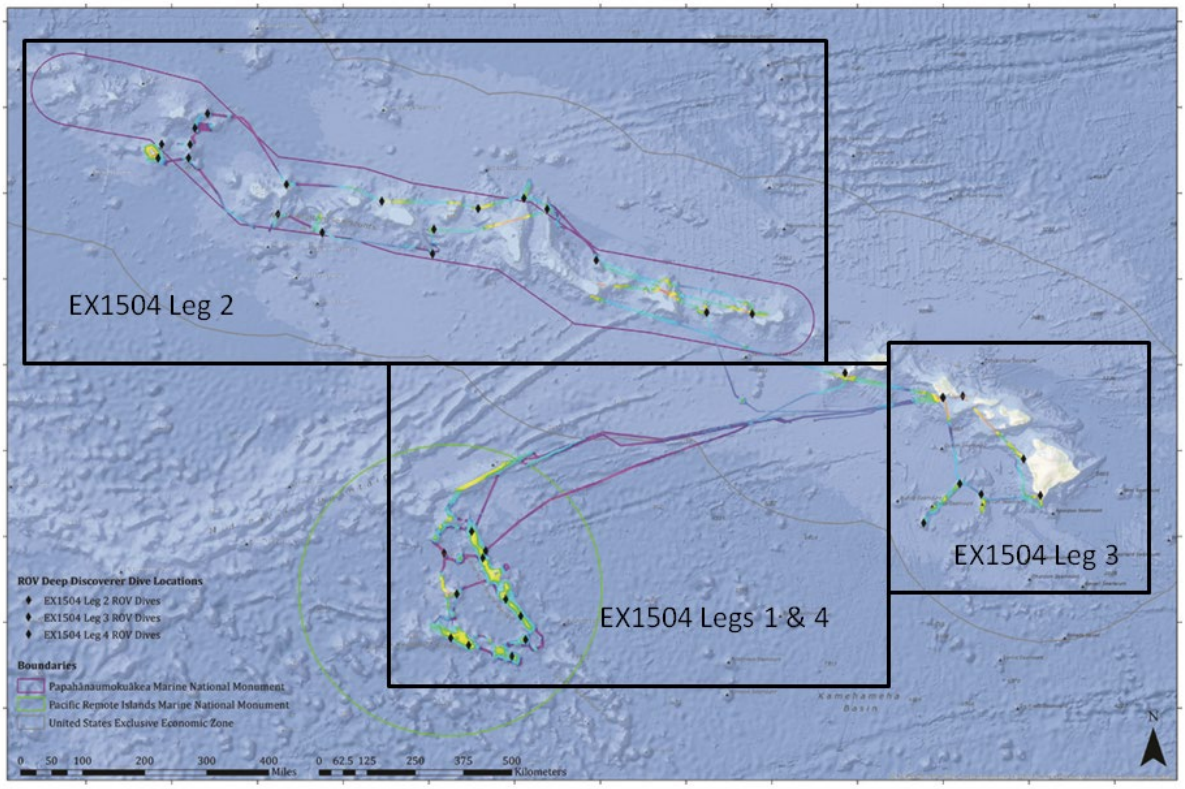


Figure 1. *Summary of the mapping and ROV dives conducted during the 2015 Hohonu Moana expedition.*

2.3 Objectives for EX-15-04-L3

EX expeditions in general have a large number of objectives that can be categorized as being either programmatic or scientific in nature. Typically, programmatic objectives (i.e.,

operations, telepresence, data management, education, and outreach) are common to all expeditions whereas science objectives are specific to a particular expedition or set of expeditions. Below are brief descriptions of the programmatic and science objectives for EX-15-04-L3.

2.3.1 Programmatic Objectives

a) Mapping and ROV and Operations

Mapping objectives during each *EX* expedition are to collect high-resolution acoustic data from all three types of sonars: EM 302 multibeam, EK60 echo sounder, and 3.5 kHz subbottom profiler. Mapping data were acquired during transits, as well as on specific targets identified by the science team. Data from these systems were processed onboard as quickly as possible in order to generate daily mapping products that supported ROV operations. Data quality was expected to be high, as a result of proper instrument maintenance, careful planning of the surveys, and appropriate calibration of the instruments. For example, standard operating procedures for the multibeam sonar were to obtain sound velocity profiles at regular intervals, no longer than 3-4 hours, using expendable bathythermographs (XBTs).

ROV objectives during each *EX* expedition are to obtain high-quality video and sensor data on exploration targets to achieve the scientific objectives. This most often involves surveying benthic habitats and features in priority areas (e.g., deep corals and related benthic ecosystems, canyons, and seamounts), as well as occasionally surveying in midwater for water column organisms. Benthic surveys are not only used to characterize the habitats in each target area, but also to ground-truth the acoustic data with visual data (i.e., video). In 2015, the ROV was fitted with hydraulically-activated sample boxes that permitted ROV pilots to collect limited rock and biological specimens for the first time. The sample box, which can hold live specimens, is sealed so the water temperature stays cold; some organisms have difficulty managing temperature and pressure changes while surfacing Training of ROV pilots and navigators in the use of the ROV manipulators and new sample boxes was an additional objective of this expedition.

Additional information about how OER conducts community-driven, telepresence-enabled ocean exploration can be found in Cantwell et al (2020). For a summary of all CAPSTONE operations, campaign objectives, and initial results, please see Kennedy et al (2019).

b) Telepresence

Telepresence objectives were to provide real-time, high-quality video and audio during ROV dives to as wide a shoreside audience as possible. This audience included the general public, students, and researchers—the latter of whom were either passively watching or actively participating in the dives via teleconference or instant messaging. Telepresence was used to help achieve the science objectives by extending the science team well beyond those onboard the ship. Telepresence objectives also included the establishment of new Exploration Command Centers (ECCs), including those in the operating region at the University of Hawai'i (UH) at Mānoa and the NOAA Inouye Regional Center (IRC) in Honolulu, which helped achieve the education and outreach objectives through live ship-to-shore events.

c) Data Management

Data management objectives were to collect, process, distribute, and archive expedition data as quickly and efficiently as possible. Effective data management provided a foundation of publicly accessible information products to spur further exploration, research, and management activities; it also stimulated interest in the deep-sea environment and the excitement of exploration. Each year, new methods and new equipment, such as video encoders, are tried and tested in an effort to improve data management activities. During 2015, a data management objective was to create and test a new sample database needed to capture and archive sensors and other important types of data associated with the collection of physical specimens.

d) Education and Outreach

Education and outreach objectives included the engagement of the general public in ocean exploration through live video and a variety of other web-based products, both during and after each expedition. Web content includes topical essays written before the expedition, daily updates, web logs, highlight videos, still imagery, and mapping products—all of which are posted on the OER website (http://oceanexplorer.noaa.gov/okeanos/welcome.html)(Last Accessed September 2020). Other education and outreach objectives included exposure for the expedition's via media events including ship tours for journalists, students, and VIPs, and through Reddit Ask Me Anything (AMA) events from the ship. Educational experiences were also achieved through school tours to ECCs during live broadcasts, as well as public presentations by science team members after the expeditions were completed.

2.3.2 Science Objectives

The primary goals for this expedition were to recover instruments, fill data gaps, and collect new baseline data to support priority NOAA DSCRTP science and management needs. EX-15-04-L3 operations focused on:

- NOAA Pacific Islands Fisheries Science Center (PIFSC) instrument recovery around the MHI;
- A dive in support of a study on disturbance and recovery of precious corals on substrate formed by lava flows off of the South Point of the Big Island of Hawai'i;
- Several dives at the Geologists Seamounts in support of the National Marine Fisheries Service (NMFS) Pacific Islands deep-sea coral priorities.

Additional science objectives and hypothesis for further consideration and exploration during this cruise, as identified by DSCRTP, were as follows:

a) Recover previously deployed NMFS instruments

Deep-sea corals are naturally patchy, making their location difficult to predict. We know they settle and grow in current-swept, hard-bottom areas. As suspension feeders, they eat the organic material carried by the passing water column. For that reason, corals grow on underwater ridges, along ledges, and in other areas where bottom flow is constrained and moves more rapidly, delivering food at a higher rate. Areas with a high density of corals are often found growing at a depth, and on substrate, that is similar to an adjacent area without corals; the reason for this is not known. The boundaries we see may just be the edge of growth for the coral patch at that point in time, or it could be some limitation in the suitability of the environment for corals to settle and grow (temperature, water flow, particulate load, etc.). To provide a means to compare environmental factors that might influence the settlement and growth of coral patches, instruments were placed by the Hawai'i Undersea Research Laboratory (HURL) *Pisces* submersibles in prior years to collect data—both in and adjacent to coral beds. One of the objectives of this expedition was to locate and recover current meters that logged data on currents measures at important reef sites to better understand the conditions occurring in these habitats.

a) Mapping objectives

The primary mapping objective for EX-15-04-L3 in the MHI was to obtain EM302 backscatter data on Ellis and McCall Seamounts in the Geologists Seamounts group. These seamounts have been partially mapped using Multibeam sonar but corresponding backscatter data did not exist over these seamounts.

b) Discovery and baseline characterization of large-scale, high-density deep-sea coral and sponge communities within and outside the Monuments

This objective was based on the premise that large-scale, high-density coral and sponge communities are among the most important deep-sea communities to protect against anthropogenic disturbance, and thus are important deepwater biological resources in the Monuments. In the central Pacific, only a small number of these communities with linear extents exceeding 1 km in distance had been discovered. These could be categorized into: 1) shallower precious coral communities (i.e., 350-550 m), and, 2) deeper non-precious coral and sponge communities (i.e., >1,000 m). A number of precious coral communities have been well documented within the Hawaiian Archipelago, particularly in the MHI, due to the availability of submersibles operated by HURL for the last 30 years. However, the few known deeper, non-precious coral communities have not been well documented. Critical information about the lower depth limit is missing since these communities extend below the maximum HURL submersible operating depth of 2,000 m.

Within each of these two types of communities, a few species of corals and sponges were common to most, if not all, but many other species were not, which resulted in each community having a unique faunal composition. Knowing the variability—both within and between these communities—is critical to understanding how they form, where they form, and how best to protect them.

c) Exploration of ridges as potentially suitable topography for the development of large-scale, high-density coral and sponge communities

Deep-sea corals and sponges live in an aphotic environment and, therefore, are obligate filter feeding animals. The efficiency by which they feed and grow is believed to be directly related to the direction and velocity of bottom currents, which, in general, are moving laterally across the seafloor. For this reason, these animals are often found where bottom currents are accelerated, such as around obstacles in the path of the currents, or where there are constriction points, such as deep channels. It also follows that for large communities to develop, there need to be large areas where bottom currents are accelerated.

Rift zone ridges are a common feature of many seamounts. To date, all large-scale high-density coral and sponge communities in the central Pacific have been discovered over this type of topography. **Figure 2** shows an example of a seamount having six of these ridges radiating out in different directions from the central summit area.

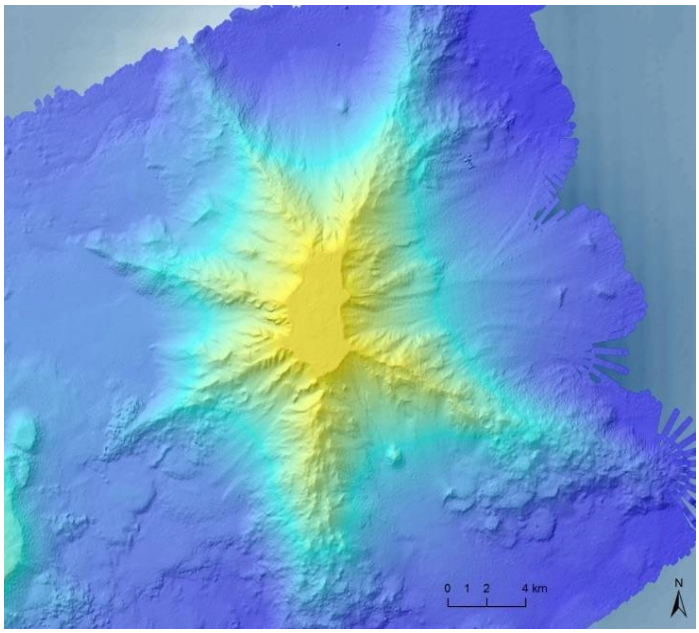


Figure 2: *Unnamed seamount east of Pearl and Hermes Atoll in PMNM.*

Each of these ridges provides a consistently oriented barrier to bottom current flow for 10 or more kilometers of distance, which should result in topographically-induced upwelling leading to current acceleration. The dominant bottom flow component at depths below 1,000 m is the principal lunar semi-diurnal tidal constituent (M_2) tide (Carter., personal communication, 2015). It follows that the relative orientation of a ridge to the local direction of the M_2 tide would influence the magnitude of topographically-induced upwelling, and thus the magnitude of current acceleration.

d) Surveying and characterizing manganese crust habitats and their communities within the Prime Crust Zone

The central Pacific has been designated as the Prime Crust Zone (PCZ), considered to be an important location on the planet for mining cobalt-rich ferro-manganese crusts (i.e., FeMn crusts). The depth distribution for commercially valuable FeMn-crust mining is 800-2,500 m (Hein, Conrad, and Dunham, 2009). Acquiring a better understanding of these regions, habitats, and communities will help inform future management decisions, identify sensitive habitats, and coral and sponge communities.

e) Discovery of potential new records and new species of corals and sponges

The central Pacific is one of the most remote locations on earth and, due to expense and logistical considerations, is also one of the least explored. As a result, it is believed that a large number of species have yet to be documented in this area. Their discovery and identification provide critical information for taxonomic relationships and species

distributions, as well as provide new information that may lead to more accurate definitions of the world's biogeographical provinces.

f) Geologic History of Central Pacific Seamounts

Central Pacific seamount chains have provided crucial information for the field of plate tectonics. The Hawaiian-Emperor seamount chain has been the most important of these for interpreting the movement of the Pacific Plate. Recently acquired multibeam data in the northern end of PMNM revealed that this chain appears to be intersecting with an older seamount chain that arose during the late Cretaceous, which complicates estimates of geologic age and mantle plume duration. In the MHI, the Geologists Seamounts, located 160 km south of O'ahu, are likely believed to be of Cretaceous origin, but not all of these seamounts have been sampled and they form a very unusual circular pattern that is difficult to interpret. It is therefore of interest to sample other seamounts in this group to potentially help explain their origin.

3. Methods

3.1. Equipment

The two types of equipment typically used during *EX* expeditions are sonars and ROVs. Additional detail about the methods of all CAPSTONE operations can be found in Kennedy et al. (2019).

3.1.1 Sonars

At the time of EX-15-04-L3, *EX* had three scientific sonars that were operated simultaneously during mapping operations: 1) a Kongsberg 30 kHz (EM 302) multibeam system, 2) a Kongsberg 18 kHz (EK60) split-beam fisheries sonar, and 3) a Knudsen Chirp 3260 (3.5 kHz) subbottom profiler (SBP) sonar.

The EM302 multibeam sonar was used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from some target, whether that's the seafloor or bubbles in the water column. The EM302 is a deepwater multibeam system designed to map in depths ranging from approximately 200-7,000 m.

The EK60 split-beam echo sounder was used to collect information about the water column, such as gas plume or seep sites, and to obtain information about biomass. The

EK60 sonar is used as a quantitative scientific echosounder to identify water column acoustic reflectors—typically biological scattering layers, fish, or gas bubbles—providing additional information about water column characteristics and anomalies.

The SBP is a low-frequency sonar designed to provide echogram images of surficial geological sediment layers to a maximum depth of about 80 m below the seafloor. The SBP is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor.

XBTs (Deep Blue produced by Lockheed Martin) were deployed to obtain sound velocity profiles to help calibrate the multibeam system and ensure accurate bathymetric mapping. XBT operations were conducted every three to six hours, at an interval defined by prevailing oceanographic conditions to correct multibeam data for changes in sound speed in the water column, and were applied in real time using the Seafloor Information System (SIS). Sound speed at the sonar head was determined using a Reson sound velocity probe (SVP-70), and salinity measurements near the transducers were taken using the ship's flow-through thermosalinograph (TSG).

3.1.2 ROVs

EX is equipped with NOAA's custom-built, dual-body, 6,000 meter-rated ROV that comprises two interconnected vehicles: *Deep Discoverer* (*D2*) and *Seirios. Seirios* is directly cabled to the ship and is, therefore, subjected to the vertical movements of the ship from surface swell. *D2* is laterally tethered to *Seirios* and is, therefore, largely isolated from surface conditions. This is a fundamental purpose of a dual-body design system.

D2 has five high-definition (HD) cameras, five standard-definition cameras, and 24 light-emitting diode (LED) lights that bring 144,000 lumens to the seafloor—resulting in some of the highest quality deep-sea footage in the industry. Four custom-built lighting swing arms allow for the position and angle of the light to be adjusted for optimal imaging. *D2* also has two manipulator arms, a Schilling Orion arm and a Kraft Predator arm. The Kraft arm is more dexterous and is outfitted with custom-built jaws that allow for delicate work like sample collection, detaching small sample fragments, and equipment deployment or recovery. The Orion arm is used as a backup; this arm is also outfitted with the color calibration card. At the beginning of each dive, the HD video cameras on *D2* are color-corrected and white-balanced with the use of this card.

Seirios has one HD camera, five standard-definition cameras, and 18 LED lights that add 108,000 lumens to *D2's* lighting. The vehicles work in tandem, with *D2* surveying the seafloor, and *Seirios* providing additional lighting and situational awareness, as well as dampening the movement of the ship. Both vehicles have a Sea Bird 9/11+ CTD with dissolved oxygen (DO) sensors.

3.2. Operations

During all CAPSTONE expeditions, *EX* operations were conducted continuously around-the-clock and involved either 24-hour-per-day mapping (i.e., mapping only cruises) or both sonar mapping and ROV dives. For dive planning purposes, existing gridded bathymetry data were viewed in collaboration with the onshore science team as the ROV was being recovered each day. Dive tracks for the next day were then planned, plotted in 3D, and shared with the on-board and shoreside teams prior to the next dive.

3.2.1 Onboard Operations

Mapping operations were initiated as soon as the ship left port and continued each day as soon as the ROVs were secure on deck around 1700. Mapping continued throughout the night until the ship arrived at the next dive site, generally around 0600. Transit surveys were conducted to fill as many data gaps as possible while still ensuring the ship arrived at the dive site on time. Site surveys were conducted at a number of locations when permitted by a shorter transit between dive sites. The mapping and science leads worked together to develop the mapping line plans for these sites since these surveys in particular were carried out in support of science objectives.

All three sonars were operated simultaneously during mapping operations, with the acquisition of multibeam data generally being the priority for line planning. However, acquiring the SBP data was the priority at several sites—two guyots and a crater—while acquiring the EK60 data was prioritized during the ascent phase of two dives when midwater transects were being conducted. Sound velocity profiles were obtained with XBTs every few hours as standard protocol to ensure the quality of the multibeam data. A total of 17 XBT casts were completed during the expedition.

ROV operations were conducted during daylight hours, generally starting with the ship arriving on site at 0600, the ROV entering the water around 0830 GMT, and the ROV exiting the water around 1700 GMT. This schedule generally yielded approximately eight

hours of video per dive that included both midwater and seafloor footage, the proportions which depended on time spent during descents and ascents. CTD data were collected during each dive via the CTD sensors onboard both the *Seirios* sled and *D2*. Both geological and biological samples were collected during the seafloor portion of each dive using *D2*'s manipulators. These samples were placed into the sample boxes and retrieved by the onboard science team after the ROV had been secured on deck. Samples were processed immediately in the ship's lab. For details please see Section 3.3.3 (Samples and Sample Data) of this report.

3.2.2 Shoreside Operations

The current operating model for *EX* cruises is based on telepresence-enabled participation whereby the small onboard science team is augmented by a much larger shoreside science team located around the world (Cantwell et al., 2020). When this model was first implemented from 2010 to 2012, all of the shore-based scientists were co-located at only a few ECCs around the U.S., where they actively participated in the planning and execution of dives. This first effort was called the core participation model because it only accommodated a limited core group of shoreside participants. Subsequently, this model was replaced by a distributed participation model when the ship's video and audio communication became accessible from any location with an Internet connection (Elliott et al., 2014; Cantwell et al., 2020). This enabled many geographically-dispersed scientists to actively participate in the dives from their offices or even their own homes. In this paradigm, digital communications such as email and instant messaging replaced person-to-person discussions and idea exchanges that naturally occur when a group is stationed together. The benefit of this distributed model was that the size of the science team was much larger.

For CAPSTONE expeditions, a hybrid of the core and distributed models occurred. In this case, shoreside participation involved small core teams stationed across the country in ECCs in addition to a larger geographically distributed team. This hybrid participation model still benefited from the information exchange and collaboration networks that developed during the use of the distributed model. However, it also benefited from the advantages of having ECCs that included higher Internet2 speeds enabling simultaneous display of all the video feeds being sent off the ship.

3.3. Data Collection

The categories of data collected during all CAPSTONE expeditions included 1) sonar data from all three types of sonars, 2) video data from the various cameras mounted on *D2* and

Seirios, 3) samples collected during the dives and sample data recorded while the samples were being processed, 4) environmental and tracking data from the CTDs and Tracklink system on *D2* and *Seirios*, 5) biological and geological observations from participants that were captured on the dive audio or in the Eventlog, and 6) shipboard meteorological and oceanographic sensors. When possible, opportunistic exploration data are also collected, when time and resources allow, in order to maximize the scientific benefit of the expedition to NOAA and the nation. Additional details about Surveys of Opportunity supported during EX-15-04 are provided in Section 6.2 and Appendix A.

3.3.1 Sonar Data

Throughout each expedition, multibeam data quality was monitored in real time by acquisition watch standers. Line spacing was planned to ensure 25-30% overlap between adjacent lines of multibeam sonar swaths. Cutoff angles in SIS were generally set between 60° and 70° on both the port and starboard sides. Ship speed was adjusted to maintain data quality as necessary and as transit time to the next dive site allowed. All multibeam sonar data collected during the expedition were fully processed according to established onboard procedures and was archived with the NOAA's National Centers for Environmental Information (NCEI). Additional details about data archival can be found in Section 5 of this report. Raw multibeam bathymetry data files were acquired by SIS, and were imported into Teledyne Computer Aided Resource Information System (CARIS). In CARIS, attitude and navigation data stored in each file were checked, and erroneous soundings were removed using CARIS Swath Editor and Subset Editor. Once per day, cleaned, gridded bathymetric data were exported to American Standard Code for Information Interchange (ASCII) text files (y,x,z) at 50-meter cell size in World Geodetic System 1984 (WGS84 datum). The ASCII files were then used to create Fledermaus Scientific Data (SD) objects. These SD objects were then exported to Geotiff and Google Earth Keyhole Markup language Zipped (KMZ) files, which were copied to the shore-side file transfer protocol (FTP) on a daily basis to support shoreside scientist participation. For more detailed information about the sonar systems, see the ship's 2015 Survey Readiness Report: https://repository.library.noaa.gov/view/noaa/23493 (Last Accessed: September 2020).

3.3.2 Video Data

The primary data set collected during the EX-15-04-L3 ROV dives was HD video, which is recorded and archived in several different formats and resolutions. The dives are recorded in their entirety at 720p, five megabit-per-second (Mbps). In addition to the full dive recording, a subset of the video collected is preserved in ProRes 4.2.2. 1080i,

145 Mbps. These ProRes highlight clips were selected by the onboard videographers to capture: the seafloor habitats and features imaged any time the ROV slowed, stopped, or zoomed in to take a closer look at a feature of interest; features and habitats of interest to the participating science team; and other "best of" imagery. . The video clips are time coded to Universal Time Coordinated (UTC) time to coordinate with all data products collected on the ship.

In addition to the video itself, at least one frame grab was taken from each ProRes clip that was representative of that video segment for the purpose of discoverability. ProRes clips were then compressed for archiving.

3.3.3 Samples and Sample Data

EX-15-04-L3 was the second *EX* expedition during which geological samples and biological voucher specimens were acquired. These collections were carried out to improve scientific understanding of the geologic history and deepwater fauna of the Geologists Seamounts. Until the previous expedition, EX-15-04-L2, *EX* operations had operated under a no sampling policy for telepresence-enabled ROV operations, pending completion of an open-access sampling protocol. Although this protocol was still being developed, a limited number of rocks and deepwater animals were collected due to high interest by NOAA and academic scientists and managers. These were limited to very selective, exploratory specimens that had the potential to contribute significant scientific discoveries.

Sampling was generally constrained to two rocks and two biological specimens per ROV dive, the latter of which were primarily focused on corals and sponges. This constraint was imposed primarily as an effort to balance the way dive time was used for collecting, close-up imagery, and surveying. Only biological specimens suspected of being new species or new records for Hawaiian waters were targeted, and only pieces or small branches of larger animals were removed. Loose basalt rocks were targeted that had a minimal amount of attached organisms and FeMn crust. Both rocks and biological specimens were collected using the *D2*'s Kraft manipulator and placed into custom-designed retractable collection boxes located at the front of the vehicle (**Figure 3**). At the exact time of collection, data on the date, time, latitude, longitude, depth, temperature, DO concentration, and identification for each sample was collected. This data was used both to create sample labels on waterproof paper that would physically accompany the sample, as well as to populate the fields in the database record for that sample (see below).

Once *D2* and *Seirios* were recovered and secured on deck, the on-board science team removed the samples and carried them into the ship's lab for immediate processing. All samples, both rocks and biological specimens, were first photographed with their labels and a size scale to document their initial appearance and condition prior to being dried or being placed in preservative (**Figure 3**). Any commensal organisms found on either the rocks or biological specimens were then separated and documented. Rocks were weighed and placed into a tray with their labels for drying, while all biologic specimens were preserved in ethanol. Just prior to preservation, a small aliquot was removed from many of the biological specimens for genetic analysis. Each aliquot was processed according to a protocol and using a kit provided by researchers with the Ocean Genome Legacy (OGL) Center at Northeastern University.

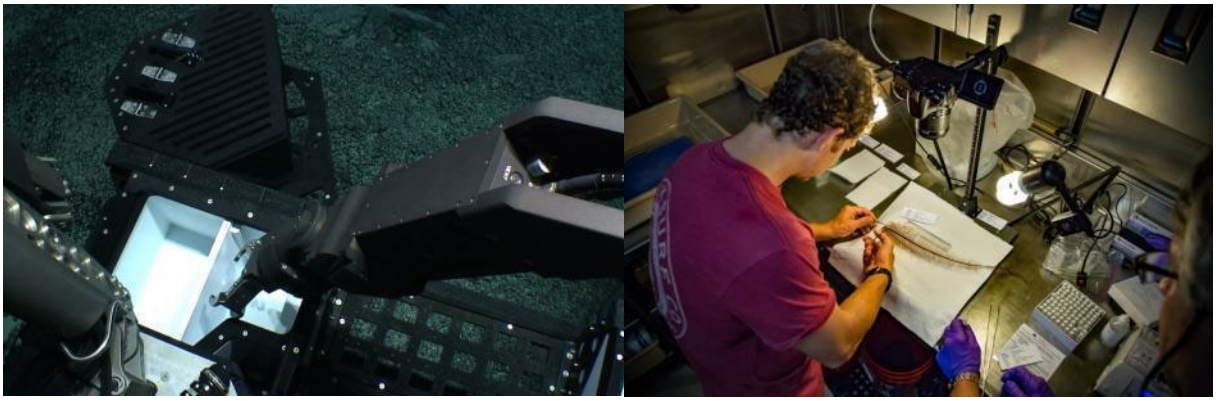


Figure 3. *Left: Manipulator arm and sampling box of the ROV Deep Discoverer, which were used to collect samples during ROV seafloor surveys. Right: Processing of collected specimens in the wet lab of NOAA Ship Okeanos Explorer.*

For recording the collection data for each of these biological and geological samples, a customized Microsoft (MS) Access database created by NCEI was used. Specifically. The database was named the Sampling Operations Database Application (SODA) and its fields were populated for each sample as it was being processed in the ship's lab. Collection data included the information provided in the NOAA Scientific Computer System (SCS) snapshot along with expedition and dive numbers, sample condition, subsample identifications including OGL vial numbers, commensal organisms that were removed from each sample, weight of the rock samples, and sample photo numbers.

At the end of the expedition, the science team lead, took custody of the rocks and biological specimens, transporting them to his laboratory at the University of Hawai‘i, which served as a staging area for shipping the samples to their final repositories. Once there, all the labels for the rocks and specimens were cross-checked with the data

captured in SODA. Following this step, the ethanol in each of the biological specimens was refreshed and selected sponges and corals were then split, so one piece would remain in the Hawaiian Islands at the Bernice Pauahi Bishop Museum (BM), while the larger piece would be sent to the Smithsonian Institution's National Museum of Natural History (USNM). All biological specimens were subsequently provided to these two repositories. The rock samples from all three EX-15-04 expeditions were crated together and shipped to the Oregon State University (OSU), where they were incorporated into the NOAA collection within the OSU Marine and Geology Repository (MGR) (http://osu-mgr.org/noaa-ex/).

3.3.4 Environmental and Tracking Data

The *D2* environmental data collected during each dive were provided to the NCEI archive as raw Seabird .hex files. The *D2* tracking data were exported from Tracklink as text files. In order to make these data types more accessible to interested researchers, the science team processed all of the CTD and tracking data and merged them together in simple to use comma-separated values (CSV) files. These files were provided to both OER and DSCRTP for distribution.

3.3.5 Eventlog

During ROV dives, participating researchers communicate between ship and shore using an Eventlog. The Eventlog is a persistent chat room where all comments, discussions, and requests are logged and provided a UTC timestamp UTC that can later be correlated to the operations, location, and data feeds collected by the ship. The chat server facilitates the first-order annotation of expedition activities, serving as a digital version of scientists' daily logs and enabling input from multiple users. Eventlog users are encouraged to use codes, which are three to five letter shorthand codes that were used to standardize and speed the recording of observations in the Eventlog. The set of dive codes during this expedition cruise can be found at: http://oceanexplorer.noaa.gov/okeanos/collaboration-tools/im-eventlog/dive-codes.html (Last Accessed September 2020).

3.3.6 Post-cruise Scientific Annotations

At the conclusion of the expedition, a detailed analysis and quality assurance/ quality control of the ROV video collected was carried out at the University of Hawai'i's Hawaii Undersea Research Laboratory, under the direction of the lead scientist and supported by DSCRT. The annotation creation process analyzed video from benthic exploration using Video Annotation and Reference System (VARS), created by the Monterey Bay

Aquarium Research Institute and customized for the University of Hawai'i. VARS was used to generate records of animals from ROV dive video captured while on the seafloor. Animal records were catalogued and characterized with their in situ environmental data including habitat, substrate, water chemistry, and geographic location. Animals were identified using the OER Benthic Deepwater Animal Identification Guide (https://oceanexplorer.noaa.gov/okeanos/animal_guide/animal_guide.html, Last Accessed September 2020).

Additional information about the annotations collected during CAPSTONE expeditions can be found in Kennedy et al., 2019.

3.3.7 Survey of Opportunity Data

During all EX-15-04 expeditions, data were collected as time allowed for the National Aeronautics and Space Administration (NASA)-led, long-term Maritime Aerosol Network (MAN) research effort. Observations were made by mission personnel (as time allowed) with a sun photometer instrument provided by the NASA MAN program. Resulting data were delivered to the NASA MAN primary investigator Alexander Smirnov by the expedition coordinator. All collected data were archived and made publically available at: http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html (Last Accessed September 2020)

The full survey of opportunity description is available in Appendix A.

4. Results

A total of 85,700km^2 of seafloor was mapped and 37 ROV dives were completed in the MHI, PMNM, and the JAU of the PRIMNM during the 2015 *Hohonu Moana* expedition. Below is the summary of operations and findings for EX-15-04-L3 expedition.

4.1 EX-15-04-L3 Operations

EX-15-04-L3 was jointly supported by OER and DSCRTP. The cruise plan called for seven days at sea and seven ROV dives; however, the first dive had to be aborted at the surface due to a malfunction with the A-frame. Although the ROV entered the water, it did not descend before being recovered. The other six ROV dives were successfully completed and utilized telepresence-enabled, shore-based science participation (**Figure 4**, **Table 1**).

This DSCRTP funded cruise had significant differences from typical *EX* exploration projects. At the request of DSCRTP, three dives (Dive 2, Dive 3, and Dive 7) were conducted in support of ongoing research projects instead of OER's *EX* community-driven exploration model. However, shoreside science participation via telepresence was still supported, as is typical for OER expeditions and cruises. Consequently, shoreside scientists had less input during the planning of these dives than they would normally have had during typical exploration dives. These dives also took place at depths of 300-500 m, which was shallower than the OER ROV's typical operating depth. The other three dives (Dive 4, Dive 5, and Dive 6) were exploratory and deeper (954-2,700 m), returning to the typical *EX* community-driven exploration dive model and focusing on the main CAPSTONE priorities of surveying for large, dense coral and sponge communities on FeMn-crusted ridges. The dive sites were located on three previously unexplored Geologists Seamounts: McCall, Swordfish, and Ellis Seamounts, located approximately 160 km south of Honolulu.

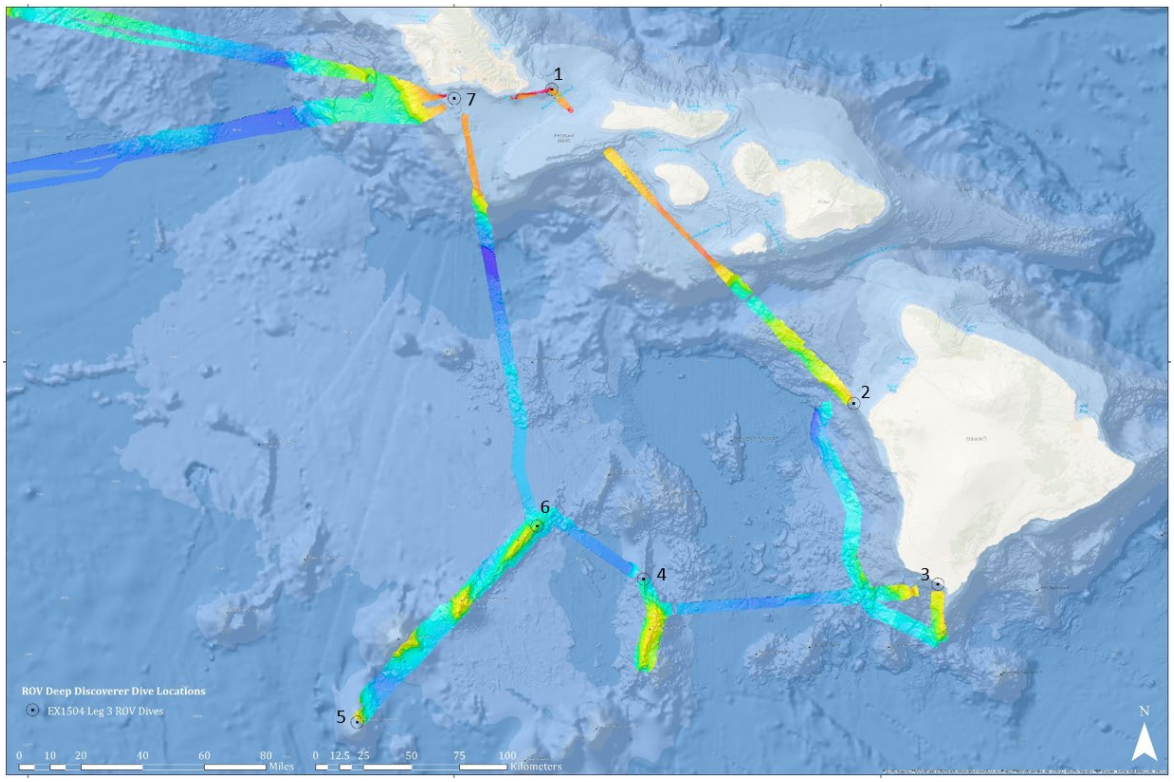


Figure 4. *Map showing the locations of the six successful ROV dives conducted during the EX-15-04-L3 cruise in the Main Hawaiian Islands and Geologists Seamounts. Dive 1 was aborted at the surface.*

4.1.1 Calendar of Events

Table 1 provides a calendar of events for each dive supported by the summary statistics for each dive found in **Table 2**.

Table 1. Calendar of Events during EX-15-04-L3

Date	Location	Operations
28-Aug-15	Pearl Harbor, O‘ahu	Start of Expedition & ROV Dive 1
29-Aug-15	Kona, Hawai‘i	ROV Dive 2 & Transit Mapping
30-Aug-15	South Point, Hawai‘i	ROV Dive 3 & Transit Mapping
31-Aug-15	McCall Seamount	ROV Dive 4 & Transit Mapping
1-Sep-15	Swordfish Seamount	ROV Dive 5 & Transit Mapping
2-Sep-15	Ellis Seamount	ROV Dive 6 & Transit Mapping
3-Sep-15	South O‘ahu to Pearl Harbor	ROV Dive 7 & End of Expedition

4.1.2 Expedition Daily Logs

August 28, 2015, Leg 3 Commences
NOAA Ship *EX* departed Pearl Harbor, O‘ahu, about 0930 this morning to commence Leg 3 of the *2015 Hohonu Moana* expedition. All sonars were turned on for the short transit to the Dive 1 location, and seas were calm. A safety meeting was held in the morning for new personnel, followed by an all hands meeting for mission personnel to go over the science plan, operating modes, and other key cruise topics prior to Dive 1.

The first dive was planned for the afternoon at Makapu‘u, located about six nautical miles off the easternmost point of O‘ahu. After deploying the ROV, a problem was discovered with the hanging block and the vehicles were quickly recovered. The team spent the afternoon troubleshooting the block, and the dive was cancelled. Mapping transit operations commenced in the evening and the ship is currently en route to “Keāhole” off the west coast of the Big Island for Dive 2 of the expedition, planned for the morning of August 29, 2015. As a precaution, all sonars were turned off for approximately two hours during the overnight transit over Penguin Bank, which is in the Hawaiian Islands Humpback Whale National Marine Sanctuary.

August 29, 2015, Dive 2: “Keāhole”

Dive 2 was conducted today off the Kona Coast of the Big Island of Hawai‘i at the “Keāhole” precious coral bed. During the dive, the team recovered an acoustic current meter and three flow meters that were deployed in 2012 to collect data about the environmental conditions surrounding these deep-sea coral communities. We also investigated nearby, previously marked coral colonies and conducted close-up imaging for comparison to photographs taken over three years ago. Two biological specimens (a black coral and a bamboo coral) were collected and 10 scientists participated remotely.

August 30, 2015, Dive 3: Kona Coast

Dive 3 of the expedition was conducted along a 450-meter contour at the southern end of the Kona Coast of the Big Island of Hawai‘i; the objective was to survey a lava flow of a known age (1,868) to see what coral community had grown in the years since the flow had formed. Overnight mapping operations moved west from Dive 3 near the Big Island to the Dive 4 site on McCall Seamount.

August 31, 2015, Dive 4: McCall Seamount

Dive 04 was conducted on McCall Seamount and was the first dive during this cruise on the group of topographic features referred to as the Geologists Seamounts. The dive surveyed the crest of a sharp ridge that extended north of the seamount at a depth of 2,700 m. Overnight mapping operations moved northwest from Dive 4 on McCall Seamount to the Dive 5 site on Swordfish Seamount. Backscatter data was collected over Ellis Seamount (where Dive 6 will be conducted) during the transit to Swordfish Seamount.

September 1, 2015, Dive 5: Swordfish Seamount

Dive 5 of this expedition was the first dive ever conducted on Swordfish Seamount, located in the Geologists Seamounts group. The dive plan was to survey the upper crest of the ridge-shaped summit at a depth of approximately 1,000 m to search for corals and sponges. Three rocks (basalt and carbonate), two corals, and a sponge were collected during the dive. There were 14 scientists who participated remotely. Following the dive on Swordfish Seamount, mapping operations were conducted during transit to the Dive 6 location at Ellis Seamount. Complementing the previous night's work, the focus of multibeam mapping was on gathering data for a high-quality backscatter mosaic of Ellis Seamount.

September 2, 2015, Dive 6: Ellis Seamount

Dive 6 was the first dive ever conducted on Ellis Seamount, located in the Geologists Seamounts group. The objective of this dive was to survey a rift zone ridge, coming off

the northern end of the seamount, for corals and sponges in order to gather more information on whether high-density communities can be found on ridge topography. From beginning to end, the dive observed high densities of coral colonies (the most dominant taxa were species of Keratoisis, Isidella, and Acanella), which were present as full-size, mature colonies throughout the survey track. Following completion of the dive on Ellis Seamount, underway mapping was conducted during the overnight transit to Pearl Harbor to pick up VIPs early on Thursday morning.

September 3, 2015 Dive 07: USS S-19 *Submarine*
EX arrived at Pearl Harbor at approximately 0630 this morning, and several VIPs were brought onboard via small boat. These VIPs included a staffer for the Hawaiian U.S. Representative Tulsi Gabbard and two Daniel K. Inouye Asia-Pacific Center for Security Studies (APCSS) members. NOAA regional maritime archaeologist, Hans Van Tilburg (ONMS), and NCEI's Susan Gottfried also came onboard for the day. Underwater Cultural Heritage (UCH) protocols were implemented for today's dive.

Sonars were secured and no data was collected during the transit to and from the USS *S-19* submarine for Dive 7. Dive 7 visited the hull of the World War I submarine, USS *S-19*, which now rests on the bottom, at 414 m in the middle of a sand expanse. A complete survey of the full deck area of the USS *S-19* hull was conducted, with attention to the deep-sea coral community growing on it, looking for any evidence of recent arrival of the parasitic gold coral. A previously deployed flow meter instrument was recovered, and the team practiced deployment and recovery of a mock-up tilt meter instrument to inform future operations.

Following completion of the dive, the ship made its way back into port in Pearl Harbor and was secured at Ford Island in the late afternoon. Onboard personnel spent the day processing data and preparing end-of-cruise documentation.

4.1.3 Data Collected

During the expeditions, 12 terabytes (TB) of data were collected including multibeam, subbottom, EK60, CTD, video, images, and associated dive and video products in the mapping data report at https://doi.org/10.25923/vv2r-qw07 (Last Accessed September 2020). EX-15-04-L3 was a combined ROV and mapping expedition, and even though mapping only took place at night, 6,400 km^2 of EM302 multibeam data were collected. Knudson sub-bottom and EK60 water column data were obtained along the entire expedition track, which extended between O'ahu, the Big Island, and the Geologists Seamounts. A total of just over 70 hours of video was recorded during six *D2* dives,

ranging in depth from 379 m to 2,715 m. EX-15-04-L3 was the second cruise where samples and sampling data were collected. During this cruise, 26 samples (17 biological specimens and 11 rocks) and their associated collection data were acquired.

Table 2: EX-15-04-L3 Dive Summary

ROV Dive No.	Location	Date	Region	On Bottom Position	Off Bottom Position	Max Depth (m)	Length (HH:MM)	Focus
1	Makapuʻu Point	8/28	Hawaiʻi-Oʻahu	aborted	aborted	0	0:00	Precious Coral Communities
2	"Keāhole"	8/29	Hawaiʻi-Big Island	19.80492781 -156.1258464	19.80145702 -156.1262195	393	6:47	Precious Coral Communities
3	South Point	8/30	Hawaiʻi-Big Island	18.95849338 -155.7315525	18.94580569 -155.7132974	454	6:41	Precious Coral Communities
4	McCall Seamount	8/31	Hawaiʻi-Geologists Seamounts	18.98285434 -157.1115605	18.9763786 -157.1108966	2712	4:54	FeMn Crust, Coral & Sponge Communities, Ridge Topography
5	Swordfish Seamount	9/1	Hawaiʻi-Geologists Seamounts	18.31254079 -158.4554609	18.3054695 -158.4546352	1076	6:53	FeMn Crust, Coral & Sponge Communities, Ridge Topography
6	Ellis Seamount	9/2	Hawaiʻi-Geologists Seamounts	19.23150267 -157.6118337	19.2274625 -157.6154917	2152	4:38	FeMn Crust, Coral & Sponge Communities, Ridge Topography
7	USS *S-19* Submarine	9/3	Hawaiʻi-Oʻahu	Confidential*	Confidential*	403	2:50	Precious Coral Communities

** NOAA adheres to the policies of the Federal Archaeology Program and has responsibility under Federal law to preserve and protect historically significant, or potentially significant, cultural resources. This includes keeping information relating to the location or character of cultural resources confidential. If you would like to request access to withheld data on the USS* S-19 *submarine, please fill out the OER Program Data Access Request Form, available in Section 5.1 OER Data Discovery Tools of this report. Additional queries can be sent to: oer.info.mgmt@noaa.gov.*

4.1.4 List of Participants

Participation on EX-15-04-L3 involved 21 at-sea mission personnel and 26 shore-side scientists engaging either by audio commentary or instant messaging via the expedition chat room. At-sea personnel included the expedition coordinator, mapping specialists, ROV engineers, video engineers, data specialists, and onboard scientists. Shore-based science team members participated from remote ECCs and from their home locations. Lists of these participants are provided in **Table 3 and 4** below.

Table 3: EX-15-04-L3 At-sea Mission Personnel

Name	Role	Affiliation
Elliott, Kelley	Expedition Coordinator	NOAA OER (CollabraLink)
Sowers, Derek	Mapping Lead	NOAA OER (ERT, Inc.)
Raymond, Annie	Mapping Watch Lead	NOAA OCS PHB
Reser, Brendan	Data Engineer	NOAA National Coastal Data Development Center (NCDDC) DGIT
Kelley, Chris	Science Co-Lead	UH at Mānoa
Parrish, Frank	Science Co-Lead	NOAA NMFS PIFSC
Woodard, Katharine	Scientist/Data Manager	NOAA NCEI
Ritter, Chis	ROV Engineer	University Corporation for Atmospheric Research (UCAR)
Wright, Dave	ROV Engineer	UCAR
O'Brian, Andy	ROV Engineer	UCAR
Mohr, Bobby	ROV Engineer	UCAR
Lanning, Jeff	ROV Engineer	UCAR
Bingham, Brian	ROV Dive Supervisor	UCAR

Smithee, Tara	Video Engineer	UCAR
Gregory, Todd	ROV Engineer	UCAR
Carlson, Joshua	ROV Engineer	UCAR
Rogers, Dan	Video Engineer	UCAR
Howard, Art	Video Engineer	UCAR
Biscotti, Joe	Video Engineer	UCAR
O'Brien, Andy	Data Engineer	UCAR
Relph, John	Video Data	NCEI

Table 4: EX-15-04-L3 Shore-based Science Team

Name	Affiliation	Email	Participation Location/Mode
Asako Matsumoto	Tokyo, Planetary Exploration Research Center/Chiba Institute of Technology (PERC/CIT)	amatsu@gorgonian.jp	Tokyo/Chat
Amy Baco-Taylor	Harbor Branch Oceanographic Institute (HBOI), Florida State University (FSU)	abacotaylor@fsu.edu	HBOI ECC/Audio & chat
Scott France	University of Louisiana at Lafayette (ULL)	france@louisiana.edu	ULL/Audio & Chat
Christopher Mah	USNM	brisinga@gmail.com	USNM/Audio

Tina Molodtsova	P.P. Shirshov Institute of Oceanology (PPSIO)	tina@ocean.ru	USNM & Paris/Chat
Nicole Morgan	HBOI, FSU	nbmorgan11@gmail.com	HBOI ECC/Chat
Andrea Quattrini	U.S. Geological Survey (USGS)	aquattrini@usgs.gov	Chat
John R. Smith	UH	jrsmith@hawaii.edu	UH ECC/Audio & Chat
Jonathan Tree	UH	jtree@hawaii.edu	UH ECC/Audio & Chat
Michael Garcia	UH	mogarcia@hawaii.edu	UH ECC/Audio
Bruce Mundy	IRC, NOAA	bruce.mundy@noaa.gov	IRC ECC/Audio & Chat
Brendan Roark	Texas A&M University-Corpus Christie (TAMU-CC), TAMU	broark@geos.tamu.edu	TAMU/Audio & Chat
Mike Ford	NOAA, NMFS	Michael.ford@noaa.gov	Audio & Chat
Michael Parke	IRC, NOAA	Michael.Parke@noaa.gov	IRC ECC/Audio
Steve Auscavitch	Temple	steven.auscavitch@temple.edu	Temple/Chat
Mary Wicksten	TAMU	wicksten@bio.tamu.edu	TAMU/Audio
Rachel Bassett	NOAA National Ocean Service (NOS)/National Centers for Coastal Ocean Science/Center for Coastal Environmental Health	rachel.bassett@noaa.gov	Chat

	and Viomolecular Research (NCCOS/CCEHBR)		
Daniel Wagner	IRC, NOAA	Daniel.Wagner@noaa.gov	Chat
Sam Kahng	Hawai'i Pacific University (HPU)	skahng@hpu.edu	UH ECC/Audio
Meagan Putts	HPU	puttsmr@eckerd.edu	UH ECC/Audio
Daniel Warren	Oceaneering International	djwarren@oceaneering.com	Chat
Kim Faulk	Geoscience Earth and Marine Services (GEMS)	Kim.Faulk@f-e-t.com	Chat
Jennifer McKinnon	East Carolina University (ECU)	MCKINNONJE@ecu.edu	Chat
Melanie Damour	Bureau of Ocean Energy Management (BOEM)	melanie.damour@boem.gov	Chat
Frank Cantelas	NOAA OER	Frank.cantelas@noaa.gov	Chat

4.2 EX-15-04-L3 Findings

Below is a brief summary of the findings from this cruise broken into three categories: sonar, ROV video, and environmental data collected by the ROV CTD.

4.2.1 Sonar

During the cruise, 6,400 km^2 of seafloor were mapped. All of the multibeam data acquired during this cruise was over previously mapped areas, previously known bathymetric features were confirmed. However, the existing data on two of the Geologists Seamounts—McCall and Ellis Seamounts—lacked backscatter, which was subsequently acquired during this cruise. Targeted surveys were conducted on these two features, the results of which are shown in **Figure 5**. Time constraints prevented

complete coverage at both sites; however, the data that were collected will be incorporated into a MHI backscatter synthesis available at: http://www.soest.hawaii.edu/HMRG/multibeam/backscatter.php (Last Accessed September 2020).

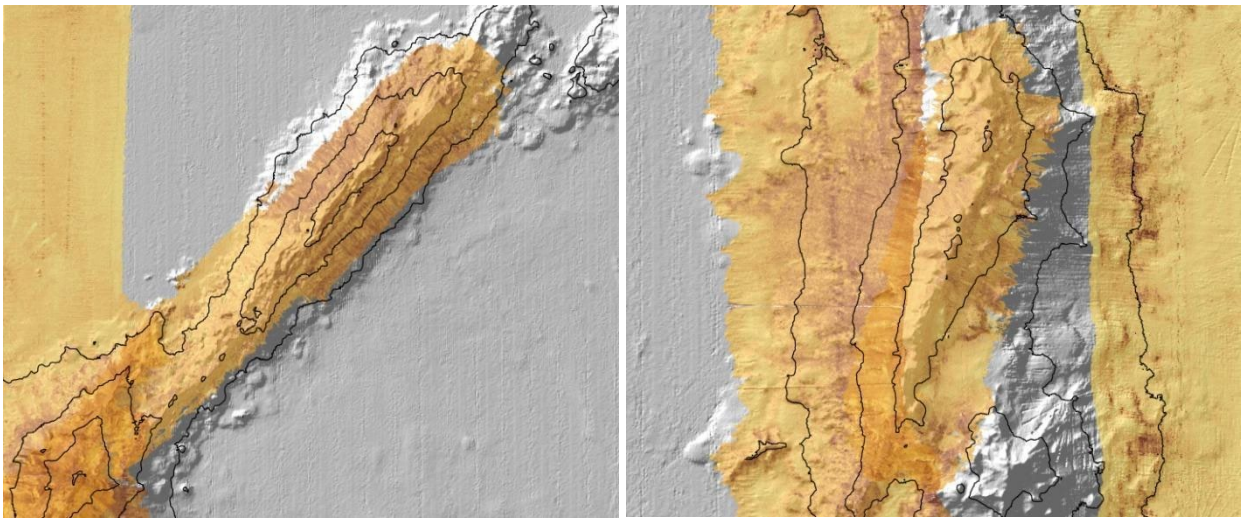


Figure 5: *New backscatter data obtained on Ellis Seamount (left) and McCall Seamount (right).*

4.2.2 ROV

The six ROV dives conducted during this expedition yielded a total bottom time of 32:48:20 hours and a linear survey distance of 2377 km. ROV dive summaries are included as Appendix B. At least 189 different species were observed and recorded during the dives, which included 17 species that were potential new species or records for the Hawai‘i region, including two that were recorded during the previous expedition leg. Two of these dives (Dives 2 and 7) off of the Big Island and O‘ahu relocated and recovered instruments that had been deployed several years prior during manned submersible dives. These were the first instrument recoveries made by *D2* (**Figure 6**). Colonies of precious Hawaiian gold coral (*Kulamanamana haumeaae*), located near the instruments, were imaged in order to obtain growth rate data (**Figure 6**). All data collected by the *EX* are archived and publicly available via NCEI online archives for each cruise. Data can be accessed using the links found in Section 5 of this report.

Dive 7 was also conducted on the hull of the World War I submarine, USS *S-19*, was intentionally scuttled in 1938 and now serves as relatively new (~75 yrs old) hard substrate for deep corals to colonize (**Figure 7**). The intact hull provides a unique glimpse of a community of pioneer settlement in deep corals. Besides conducting a

survey of the coral community, time was spent to allow NOAA marine archeologists to make observations on the condition of the vessel.

A third dive off of the Big Island was used to obtain transect data about the colonization and growth of corals on lava flow substrates of known ages. Because this area had previously been explored and the coral community characterized, the ROV was able to move more rapidly over the bottom to complete a transect of over 2,600 m distance, a record for *D2* (typical D2 transect lengths are < 1000 m).

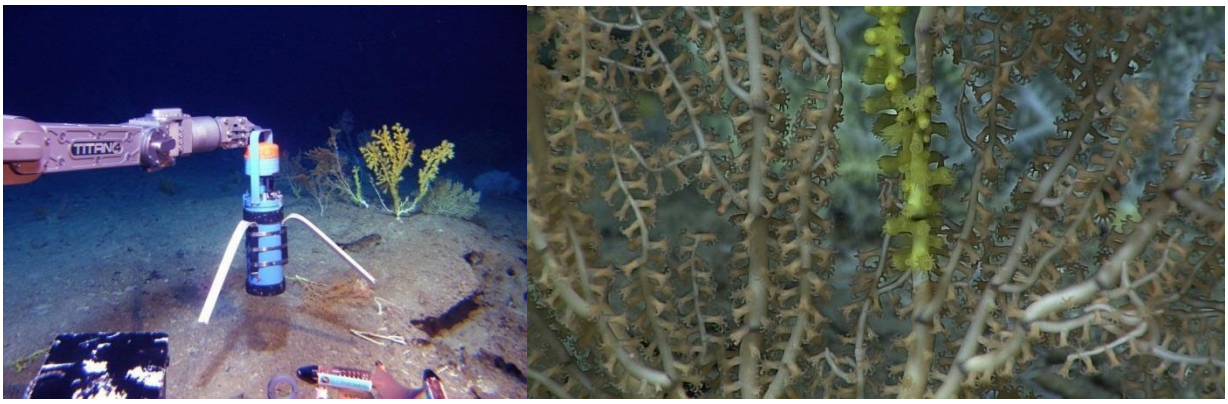


Figure 6. *Recovery of an acoustic current meter with particulate sensor and thermograph (left) and gold coral in the process of overgrowing a bamboo coral (right).*

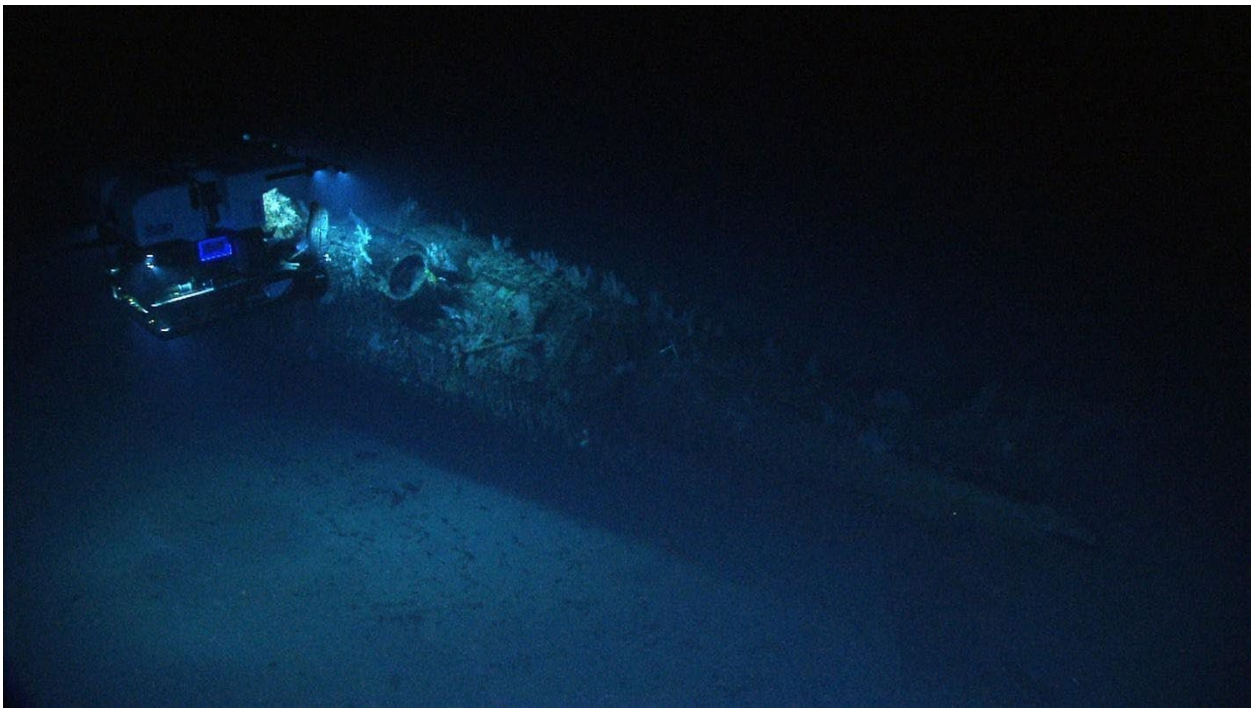


Figure 7. *D2 examining the USS* S-19 *submarine scuttled off of O'ahu in 1938.*

Dive 4, Dive 5, and Dive 6 were conducted on ridge type seamounts, again exploring the hypothesized relationship between ridge topography and large, high-density coral and sponge communities. Similar to findings from EX-15-04-L2, we did not find such a community on the ridge crest of McCall Seamount, but did find these communities on the crests of both Swordfish and Ellis Seamounts (**Figure 8**). Depth was again implicated as determinant for ridge community development, since the dive on McCall Seamount was significantly deeper (2,700 m) than the dives on Swordfish (1,071 m) and Ellis (2,135 m) Seamounts. Depth may also be a factor in determining the constituents of ridge communities, since those on Swordfish and Ellis Seamounts were completely different. The Swordfish Seamount community was more varied—with large numbers of plexaurids, acanthogorgiids, and coralliids—whereas isidids were dominant on Ellis Seamount. Substrate consolidation was clearly another potential factor, since abundant solid rock was found on the crests of both Swordfish and Ellis Seamounts, but not on McCall Seamount.

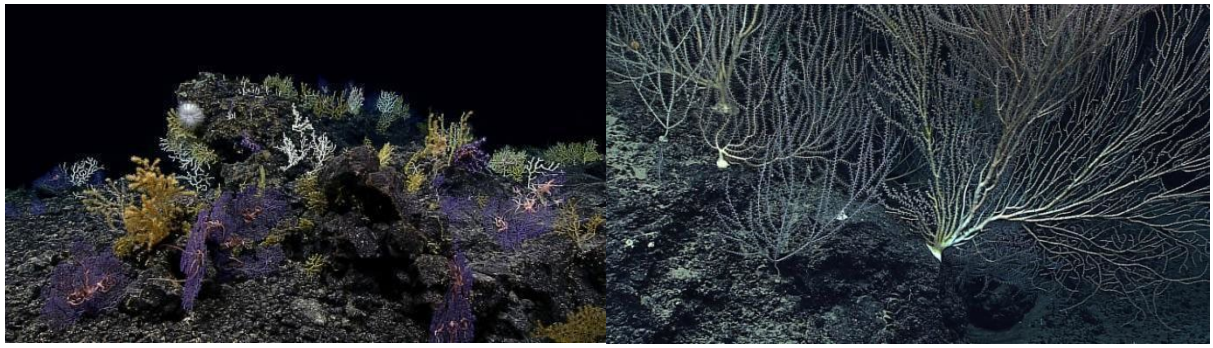


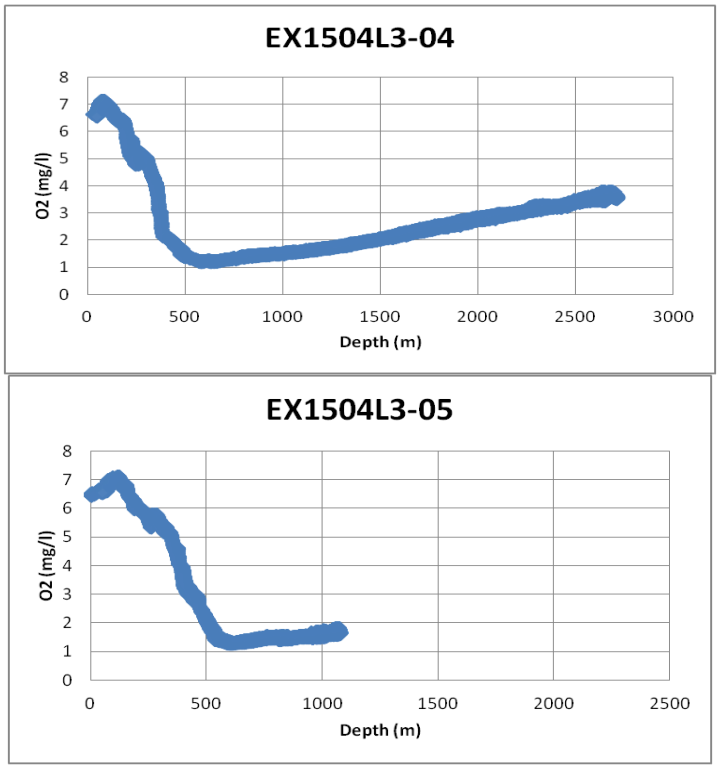
Figure 8. *High-density coral communities discovered on Swordfish (left) and Ellis (right) Seamounts.*

Limited geological and biological collections continued on this expedition yielding 11 rocks totaling 74 kg and 17 animals that included 10 cnidarians (three gorgonians, three black corals, one scleractinian coral, one hydroid, one mushroom coral, one unidentified cnidarian), one glass sponge, three echinoderms (two brittle stars and one urchin), one shrimp, one tunicate, and one polychaete worm (**Figure 9**). The rocks included dead coral carbonate and basalt from the shallow dives off of the Big Island, and both FeMn-crusted basalt—as well as a curious white rock of unknown composition from the seamounts. The rocks collected from the seamounts, once analyzed, may very likely provide new insights into the geologic history of this area. **Table 5** and **6** provide summary data for each rock and biological specimen collected during the expedition.

Figure 9. *Rock sample taken from Ellis Seamount (left) and a black coral sampled off O'ahu during Dive 2 (right).*

4.2.3 Environmental

The CTD data from all six dives has been processed, however only the dissolved oxygen (DO) data from the three seamounts has been examined (**Figure 10**). The depth of the oxygen minima at these sites was found to range from 590 to 631 m, which is significantly shallower than the EX-15-04-L2 dive sites in PMNM.



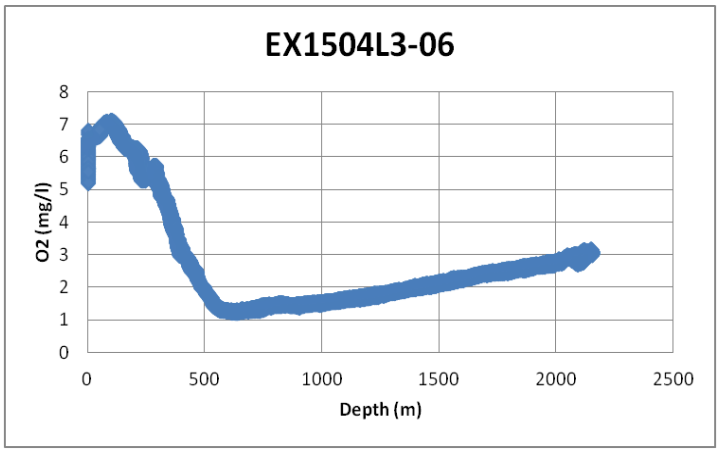


Figure 10. *Dissolved oxygen graphs for the dives on McCall (top), Swordfish (middle) and Ellis (bottom) Seamounts.*

Table 5: Rock Samples Collected During EX-15-04-L3

Sample ID#	Current Identification	Lat	Long	Depth (m)	Archival Location
EX1504L3_20150830T015700_D2_DIVE02_SPEC03GEO	Carbonate	19.80	-156.13	388	OSU
EX1504L3_20150830T200800_D2_DIVE03_SPEC01GEO	Basalt	18.96	-155.73	452	OSU
EX1504L3_20150830T223300_D2_DIVE03_SPEC02GEO	Basalt	18.95	-155.73	450	OSU
EX1504L3_20150831T202700_D2_DIVE04_SPEC01GEO	FeMn-crusted basalt	18.98	-157.11	2699	OSU
EX1504L3_20150901T000500_D2_DIVE04_SPEC03GEO	FeMn-crusted basalt	18.98	-157.11	2643	OSU
EX1504L3_20150901T002300_D2_DIVE04_SPEC04GEO	FeMn-crusted basalt	18.98	-157.11	2634	OSU
EX1504L3_20150901T191700_D2_DIVE05_SPEC01GEO	Basalt	18.31	-158.46	1071	OSU
EX1504L3_20150901T224500_D2_DIVE05_SPEC04GEO	Carbonate	18.31	-158.45	969	OSU
EX1504L3_20150902T001800_D2_DIVE05_SPEC06GEO	Basalt	18.31	-158.45	973	OSU
EX1504L3_20150902T200800_D2_DIVE06_SPEC01GEO	FeMn-crusted basalt	19.23	-157.61	2135	OSU
EX1504L3_20150902T222100_D2_DIVE06_SPEC02GEO	FeMn-crusted basalt	19.23	-157.61	2125	OSU

Table 6: Biological Specimens Collected During EX-15-04-L3

Sample ID#	Initial Identification	Lat	Long	Depth (m)	Archival Location
EX1504L3_20150830T000000_D2_DIVE02	Shrimp				USNM
EX1504L3_20150830T005000_D2_DIVE02_SPEC01BIO	*Chrysopathes* sp.	19.80221	-156.12632	389	USNM, BM, OGL
EX1504L3_20150830T014300_D2_DIVE02_SPEC02BIO	*Keratoisis* sp.	19.80196	-156.12618	393	USNM, BM, OGL
EX1504L3_20150831T234000_D2_DIVE04_SPEC02BIO	*Stauropathes* sp.	18.97833	-157.11036	2647	USNM, BM, OGL
EX1504L3_20150901T002300_D2_DIVE04_SPEC04GEO_C01	Hydrozoa	18.977	-157.11088	2634	USNM, OGL
EX1504L3_20150901T002300_D2_DIVE04_SPEC04GEO_C02	Polychaeta	18.977	-157.11088	2634	USNM
EX1504L3_20150901T004700_D2_DIVE04_SPEC05BIO	Primnoidae			2638	USNM, OGL
EX1504L3_20150901T004700_D2_DIVE04_SPEC05BIO_C01	Ophiuroidea	18.97697	-157.11075	2638	USNM, OGL
EX1504L3_20150901T005700_D2_DIVE04_SPEC06BIO	Schizopathidae	18.977	-157.11071	2638	USNM, OGL
EX1504L3_20150901T191700_D2_DIVE05_SPEC01GEO_C01	Ascidiacea	18.31249	-158.45545	1071	OGL
EX1504L3_20150901T191700_D2_DIVE05_SPEC01GEO_C02	*Caenopedina* sp.	18.31249	-158.45545	1071	USNM
EX1504L3_20150901T204300_D2_DIVE05_SPEC02BIO	*Anthomastus* sp.	18.31122	-158.45475	1013	USNM
EX1504L3_20150901T223400_D2_DIVE05_SPEC03BIO	*Madrepora occulata*	18.309	-158.4544	970	USNM, OGL
EX1504L3_20150901T234400_D2_DIVE05_SPEC05BIO	Lanuginellinae	18.30865	-158.45394	953	USNM, BM, OGL
EX1504L3_20150901T234400_D2_DIVE05_SPEC05BIO_C01	Ophiurida	18.30865	-158.45394	953	USNM
EX1504L3_20150902T001800_D2_DIVE05_SPEC06GEO_C01	Cnidaria	18.30769	-158.45393	973	USNM

EX1504L3_20150903T002000_D2_DIVE06_SPEC03BIO	Isididae				USNM, BM, OGL

5. Data Deposition and Archival

The EX-15-04 Leg 3 Data Management Plan can be found in the EX-15-04 Leg 3 Project Instructions, available at: ftp://ftp.library.noaa.gov/oedv.lib/Okeanos_Explorer_2015_EX1504/doc/Leg_3/EX1504L3_cruise_plan.pdf (Last Accessed September 2020). The *EX*'s Data Types and Product List can be found in Appendix C.

5.1 OER Data Discoverability Tools

All data collected by the *EX* are archived and publicly available within 90 days of the end of each cruise via the NCEI (formerly National Geophysical Data Center (NGDC)) online archives. Data can be accessed via the following websites:

- OER Digital Atlas: http://www.ncddc.noaa.gov/website/google_maps/OE/mapsOE.htm (Last Accessed September 2020)
- OER ROV Data Archives: https://service.ncddc.noaa.gov/rdn/oer-rov-cruises/ex1504l3 (Last Accessed September 2020)

Products created during the cruise, including the ship track, shaded bathymetry, dive locations and tracks, specimen's collection data and images, ships meteorological and oceanographic sensor data, and status data reports can be viewed on the interactive *Okeanos Explorer* Atlas.

Additional data requests are handled through the NOAA Ocean Exploration and Research Program Data Access Request Form which can be found here: https://docs.google.com/a/noaa.gov/forms/d/1pU3jbcV5ffunMKUbYgnA2OK-ZT9qj2Dh6JgZ79TTORM/viewform?formkey=dHAycC1MYndJb0hTdGRaYXAzVTVBdWc6MA&fromEmail=true (Last Accessed August 2020). Additional queries can be sent to: oer.info.mgmt@noaa.gov

5.2 Sonar Data

Sonar data collected onboard NOAA's Ship *EX* undergoes quality assurance/quality control (QA/QC) after a cruise and is then made publicly available through the OER Data Discoverability Tools, the NCEI, and the following websites (Last Accessed: August 2020):

- NCEI (formerly NGDC) Interactive Bathymetry Data Viewer at: http://maps.ngdc.noaa.gov/viewers/bathymetry/
- NCEI (formerly NGDC) Interactive Water Column Sonar Data Viewer at: http://maps.ngdc.noaa.gov/viewers/water_column_sonar/
- NCEI map tool with tracklines showing all publicly available geophysical surveys: https://maps.ngdc.noaa.gov/viewers/geophysics/

5.3 Physical Samples

Biological samples collected during *EX* expeditions are archived in the collections of the Smithsonian Institution USNM. Here, they are catalogued, curated, and made publicly available. Biological samples of invertebrate organisms are archived in the Invertebrate Zoology Collections (https://naturalhistory.si.edu/research/invertebrate-zoology, (Last Accessed August 2020) and information on how to request access to these samples can be found here: https://naturalhistory.si.edu/research/invertebrate-zoology/collections-access/specimen-loans ((Last Accessed August 2020). Biological samples of fishes are archived in the Division of Fishes of the Vertebrate Zoology Collections (https://naturalhistory.si.edu/research/vertebrate-zoology/fishes, (Last Accessed August 2020), and information on how to request access to these samples can be found here: https://naturalhistory.si.edu/research/vertebrate-zoology/fishes/collections-access/specimen-loans (Last Accessed August 2020).

Selected coral and sponge specimens were split; one aliquot was sent to the BM (https://www.bishopmuseum.org/collections-3/invertebrate-zoology/, Last Accessed: August 2020) and another sent to the USNM. If it had been determined that splitting would be too destructive to a particular specimen, it was provided to the USNM intact in order to provide public access to as many researchers as possible.

An additional small tissue sample for genetic analysis was taken of corals, sponges, and all other specimens when doing so would not effectively destroy the specimen. This tissue sample was preserved for later genomic DNA extraction at the OGL Center at Northeastern University (https://www.northeastern.edu/ogl/, Last Accessed August 2020). Information

on how to request access to these results and any remaining DNA samples can be found at: https://www.northeastern.edu/ogl/order/ (Last Accessed August 2020).

All geological samples collected during EX expeditions were sent to the MGR at OSU (http://osu-mgr.org/noaa-ex/, Last Accessed August 2020) where they were described from a petrology perspective (e.g. mineral content, texture, alteration, rock type), photographed, and made publicly accessible. The repository provides photographs (including microphotographs) and online metadata information about each geological specimen. Information on how to request access to these geological samples can be found here: http://osu-mgr.org/request-samples/ (Last Accessed August 2020).

6. Additional Information

6.1 Permits/Clearances

In order to support or conduct Marine Scientific Research within the U.S. exclusive economic zone (EEZ), work funded, authorized, and/or conducted by NOAA must be compliant with the National Environmental Policy Act (NEPA). The NOAA Administrative Order (NAO) 216-6A Companion Manual (https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf , Last accessed August 2020) describes NOAA's specific obligations with regard to NEPA compliance. Among these is the need to review all NOAA-supported projects with respect to their environmental consequences. In compliance with NAO 216-6 and NEPA, a memorandum describing the project's scientific sensors' possible effects on the environment was submitted for the project. As expected with ocean research with limited time or presence in the marine environment, the project has been determined to not have the potential to result in any lasting changes to the environment. As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this was a research project of limited size or magnitude or with only short-term effects on the environment and for which any cumulative effects are negligible, and, as such, the project was categorically excluded from the need to prepare a full-scale NEPA environmental assessment. The categorical exclusion met the requirements of NAO 216-6 and NEPA, and authorizes the Marine Scientific Research conducted for the project (Appendix D).

OER completed an informal consultation with NMFS under Section 7 of the Endangered Species Act (ESA) of 1973 that addressed the potential impacts of project activities to ESA-listed species and critical habitat within the project operating area. A Letter of Concurrence

(LOC) was received from NMFS on July 7, 2015, concurring with OER's determination that EX-15-04-L3 expedition activities would not likely have an adverse effect on ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat, and is included as Appendix E.

A special activity permit (SAP 2016-65) was received on 8/25/2015 from the State of Hawai'i Board of Land and Natural Resources allowing the collection of up to two pieces of live rock, and three samples of black coral (*Myriopathes cf. ulex*, *Antipathes griggi*, and *Antipathes grandis)* in state waters offshore of Ni'ihau and the Big Island of Hawai'i. This permit is included as Appendix F.

7. References

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8. Appendices

Appendix A – Survey of Opportunity Form

NASA Maritime Aerosols Network Survey of Opportunity

Survey or Project Name: Maritime Aerosol Network

Lead Point of Contact (POC) or Principal Investigator (PI): Dr. Alexander Smirnov

Activities Description(s) (Include goals, objectives and tasks):
The Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET) provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the world ocean.

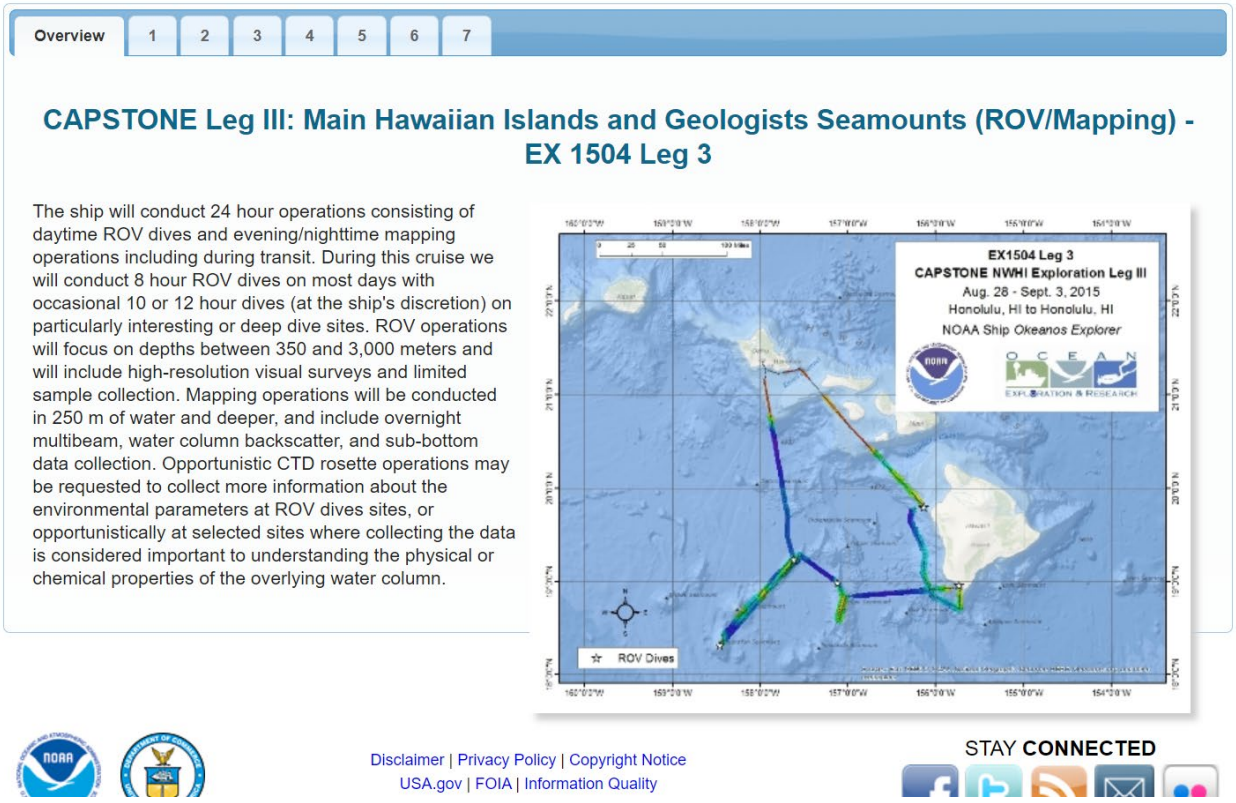
During the cruise the marine aerosol layer observations were collected for the NASA MAN research effort. Observations were made by mission personnel (as time and weather allowed) with a sun photometer instrument provided by the NASA MAN program. Resulting data were delivered to the NASA MAN primary investigator, Dr. Alexander Smirnov, by the expedition coordinator. All collected data were archived and are publicly available at: http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html (Last Accessed September 2020)

Equipment resides on the ship and is stewarded by the Expedition Coordinator.

Appendix B- ROV Dive Summaries

To view and download the full Dive Summaries and the accompanying data for each dive, please visit: https://www.ncei.noaa.gov/waf/okeanos-rov-cruises/ex1504l3/ (Last Accessed September 2020).

Figure 11. A screenshot of the EX-15-04-L3 Dive Summaries overview page.



Appendix C - Data Types and Products List

PRODUCTS AVAILABLE DURING A CRUISE:

A variety of data and products will be collected and/or developed aboard Okeanos Explorer (EX) and at shore-side Exploration Command Centers (ECCs) during the EX 2017 Field Season. Operational products and datasets will be made available to participants during and after the cruise, and can be accessed from several internet-based tools. Below is a summary of products anticipated to be developed for operational uses, product descriptions and information on where to go to access these products during a cruise.

Product	Description	Format	Developer	Developer Location	Access Location	Access Level
OPERATIONS						
Daily Science Team Emails	Brief summary of today's operations and plans and participation info for next two days.	Emails	Science Leads	Ship	Email	Participants/Listserv
Plan of the Day	Plan of the day detailing ship operations	DOCX	Operations Officer	Ship	FTP site / Cruise Data File Server	Participants
SITREPs	Internal Document; Daily status report detailing EX operations	DOCX, PDF	Expedition Coordinator	Ship	FTP Site; Email	OER staff
Mapping						
Raw EM302 Data	Selected full resolution bathymetry and bottom backscatter data. Water column backscatter where appropriate and on a limited basis.	.all, .wcd	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
EK60 Single Beam Data	Raw water column data. Where appropriate, a processed level 2 image.	.raw, Fledermaus .sd, Image (.jpeg, .TIFF)	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants

Sub-Bottom Profiler Data	Raw data. Where appropriate, a processed geo-referenced vertical curtain.	.seg-y, .keb, .kea, GeoTIFF, .sd.	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
Daily mapping progress bathymetry	Site-specific or cumulative daily bathymetry	GeoTIFF; Fledermaus .sd; Google Earth .kmz, ASCII text file, Arc Grid .asc	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
Multibeam backscatter data	Where appropriate, site specific backscatter data (seafloor / water column backscatter as needed)	GeoTIFF, .sd, Tiff	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
Science Operations Products						
ROV Dive Planning Form	Planning form detailing desired ROV Ops including waypoints	DOCX, PDF	Science & ROV Team	Ship	Email; FTP site /Cruise Data File Server	Participants
ROV Dive Summary Form	Summary detailing completed ROV dive, summarizing observations, sample collections and including summary maps	DOCX, PDF	Science & ROV Team	Ship	FTP site / Cruise Data File Server	Participants
ROV Tracklines	File containing XYZ + T (1 min avg.) data of the ROV during a dive.	.csv table, KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants
Hypack Targets	File containing the targets dropped during a dive	KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants

SeaScribe Annotation Log	Scientific observation log noting fauna, geology and other observations from an ROV dive	CSV	Expedition science participants contribute; SeaScribe server auto-generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants
Chat Log	Literally a group chat room with UTC time-coded and stamped observations that are saved and output as .txt files, and as excel files with associated lat, long, and depth for each entry.	TXT, XLSX	Expedition Science Participants contribute; Automated server generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants
Datasets	Raw oceanographic data, SCS, CTD, DO, LSS, ORP, etc.	various	Automated process; STs	Ship	FTP site / Cruise Data File Server	Participants
CTD Rosette Summary Form	Summary detailing completed ROV dive, summarizing observations, sample collections and including summary maps	DOCX	Science Team	Ship	FTP site / Cruise Data File Server	Participants
Imagery						
Raw Video Clips – Low Res	**Video clips from ROV dives, onboard cameras.**	**.mov (H.264 at 1.5 MB at 640x320)**	**Video team**	**Ship**	**FTP site / Cruise Data File Server**	**Participants, Web Coordinator and Science Participants**
Cruise Highlight Video	**OPTIONAL: video highlighting OER mission**	**.mov HR & LR**	**Video Team**	**Ship**	**FTP site / Cruise Data File Server (Low Res Only)**	**Public**
Daily Highlight Videos	**Edited & Scored video of best clips from a specific dive (one per dive)**	**.mov HR & LR**	**Video team**	**Ship**	**FTP site / Cruise Data File Server (Low Res Only)**	**Public**

Custom Video Products	OPTIONAL: One-off products for the OER website and outreach (Timelapses, "Sea Poke" video, etc)	.mov HR & LR	OER Program Personnel	Shore	FTP site / Cruise Data File Server (Low Res Only); OceanExplorer website	Participants
Highlight Imagery	HD Screengrabs; best 10-15 per dive; Edited for sharing online	Color corrected.jpg	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants
Still Images	frame grabs from underwater video which map to the video clips	JPG; TIFF	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants
News Articles	Provides more context or info on expedition events	Online	Various	Various	OceanExplorer Website	Participants/ Public
Sampling						
Daily Sample Report	Daily output from SODA that includes information about every sample, lab preparation, and identifies associated images and video	.pdf	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Daily List of Sampling Associated Images and Video	List of all samples and associated video. This list is used to build the folders of in situ video and stills. Output from the database?	.txt	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
In situ images (via symlinks)	Symbolic links that create a folder of all images associated with a particular sample	JPG via Symlinks	Images - Video team; Identification of Images - Sample Data Manager; Symlinks- Data Manager	Ship	FTP site / Cruise Data File Server	Participants

Video of collection (via symlinks)	Symbolic links that create a folder of all videos associated with a particular sample	.mov via Symlinks	Identification of videos - Sample Data Manager; Symlinks- Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Lab images	Images of samples taken with a color pallet and sample label	RAW, JPG, CR2	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Microscope images	Images taken using a Caltex LX- 100 Series Digital Microscope (when applicable)	JPG	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Microscope video	Video taken using a Caltex LX- 100 Series Digital Microscope (when applicable)	MP4	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Records in ROV Dive Summary Form	Tables located in the dive summary report that includes summary collection information, field ID, preparation, and any relevant notes about the specimen	.docx	Sample Data Manager	Ship	FTP site / Cruise Data File Server (Once Final)	Participants
Final copy of cruise SODA (database)	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants
Final Sampling Table	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants

PRODUCTS AVAILABLE AFTER A CRUISE

The following is a list and descriptions of quality assured products and data to be developed and made available after the cruise. Availability timing depends on level of processing required. All data and products listed below are available for direct access from the OER Digital Atlas / Data Access tab. Documents, data and information are added to the Digital Atlas as they are processed and become available. If you cannot find the data you are looking for, please submit a data request form for assistance from the OER data management team.

Product	Description	Format	Developer	Developer Location	Access Location	Access Level
OPERATIONS						
Cruise Report	Cruise report summarizing the operations and results of the cruise	DOCX, PDF	Expedition Coordinator (with input from team leads)	Shore	OER Digital Atlas; NCEI	Participants
Initial ExpeditionSummary	Initial, first look at the results of the cruise	DOCX	Science, ExpeditionCoordinator	Ship	Email	Partners
Expedition Summary	Summary of major initial expedition findings	PDF	Engagement Team	Shore	OceanExplorer Website	Public
Expedition Infographic	Summary of expedition statistics	PDF	Engagement Team	Shore	OceanExplorer Website	Public
Science Operations Products						
ROV Dive Summary Forms	Summary of dive with operational info, site description and overview of observations	DOCX, PDF	ROV Team, Science Lead	Ship	OER Digital Atlas; NCEI	Participants
CTD Summary Forms	Summary of CTD cast results; detail sample collection	DOCX, PDF	Science Team	Ship and Shore	OER Digital Atlas; NCEI	Participants
Water Column Profile Data	Water Column profiles of sound velocity, XBT, and CTD data collected for mapping.	.asvp, .txt, .cnv	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public

Sampling						
Final Sample Database	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public
Final Sample Summary Table	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public
Sample Layer in Okeanos Explorer Atlas	Geospatial layer in the Okeanos Explorer Digital Atlas that associates the locations of samples with digital data collected	Okeanos Explorer Atlas layer	OER Data Manager	NCEI	Okeanos Explorer Atlas; NCEI	Public
Biologic Samples	Biologic samples collected durign the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser; Smithsonian	University of Hawaii	**Invertebrate Zoology Collection**	Public
Ocean Genome Legacy Samples	Biologic samples preserved for genetic analysis for the Ocean Genome Legacy Project collected durign the cruise are made available through the Northeastern's OGL Project.	Specimen	CAPSTONE Science Adviser; OGL at Northeastern	University of Hawaii	**Ocean Genome Legacy Center**	Public
Geologic Samples	Geologic samples collected durign the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser, Oregon State University	University of Hawaii	**OSU Marine Geology Repository**	Public

Mapping						
Expedition Summary Map	Standard map showing bathymetry data, ROV dive sites, CTD casts and possibly XBTs	PDF	Mapping Team	Ship	OceanExplorer Website; OER Digital Atlas	
Mapping Data Processing Log	Excel sheet of metadata describing mapping data files information, notes, processing checklist, and QC.	Excel Spreadsheet (.xlsx)	UNH (Mapping team)	UNH, Ship, Shore	OER Digital Atlas; NCEI	Public
Level 0 EM302 Data	Raw uncleaned multibeam sonar files.	Raw EM302 multibeam files (.all, .wcd)	UNH (Mapping team), SST	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 0 EK60 Data	Raw EK60 split-beam sonar files.	.bot, .idx, .raw	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 0 Sub-Bottom Profiler Data	Knudsen 3260 Sub- Bottom Profiler sonar data.	.sgy, .keb, .kea	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 1 EM302 Multibeam Data	Edited & cleaned full resolution multibeam bathymetry data by line	.gsf	UNH (Mapping Team)	UNH, Ship	.gst to NCEI, HDCS to NOAA OCS	Public
Level 2 EM 302 Multibeam Bathymetry and Bottom Backscatter Data	Cleaned and gridded bathymetry files at summary 25-100 meter resolution, backscatter mosaics (as available)	gridded data (ASCII .xyz), geotiff (.tif/.tfw or .tif), Fledermaus objects (.sd), Google Earth (.kmz), ArcGIS Grid (.asc), backscatter mosaic images (.tif)	UNH (Mapping team)	UNH, Ship	OER Digital Atlas; NCEI	Public

Level 2 EM302 Multibeam Data Coverage Polygons	Survey coverage shapefile used to calculate square km mapped and to show EX activities on the IOCM SeaSketch site.	ArcGIS shapefile (.shp)	UNH (Mapping team)	UNH	OER Digital Atlas; NCEI	Internal to NOAA
Mapping Data Report	Summary of Mapping operations and accomplishments. Given a DOI # and archived with data.	Doc and PDF	Expedition Mapping Lead	UNH, Shore	OER Digital Atlas; NCEI	Public
Imagery						
Raw Video Clip– Full Res	Video clips from ROV dives, onboard cameras.	.mov (ProRes 422 LT at 145 Mb @ 1920 x 1080)	Video team	Ship	By Request (use data request form)	TBD
Highlight Images	"Best of" compilation of imagery from expedition (Ship and Shore)	JPG (with Excel document containing captions, credit & additional info)	Web Coordinator	Shore	NCEI; OER Website	Participants/ Public
All Expedition Video	All video streamed from the ship to shore will be captured aboard ship and stewarded by NOAA.	digital	Ship	Shore (ISC)	By request (form) Archives	Public
Low resolution video at SeaTube	Deck to deck video, searchable with annotations, with associated environmental data	Digital	ONC / OER	ONC	Web based portal	Public: Viewing, searching. Log in protected: Creating / editing annotations

Appendix D - NEPA Categorical Exclusion Worksheet

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OCEANIC AND ATMOSPHERIC RESEARCH
Office of Ocean Exploration and Research
Silver Spring, MD 20910

August 17, 2015

MEMORANDUM FOR: The Record

FROM: John McDonough
Deputy Director, NOAA Office of Ocean Exploration and Research (OER)

SUBJECT: Categorical Exclusion for NOAA Ship *Okeanos Explorer* Cruise EX-15-04 Leg 3

NAO 216-6, Environmental Review Procedures, requires all proposed projects to be reviewed with respect to environmental consequences on the human environment. This memorandum addresses NOAA Ship *Okeanos Explorer's* scientific sensors possible effect on the human environment.

Description of the Project
This project is part of the NOAA Office of Ocean Exploration and Research's "Science Program" and entails ocean mapping activities, Remotely Operated Vehicle (ROV) Operations, and water column profiling using CTD casts designed to increase knowledge of the marine environment. This Categorical Exclusion addresses NOAA Ship *Okeanos Explorer* cruise EX-15-04 Leg III "CAPSTONE Main Hawaiian Islands and Geologists Seamounts (ROV/Mapping)" led by Kelley Elliott, Expedition Coordinator for NOAA OER. Leg III will be conducted from August 28 to September 3, 2015 with operations focused primarily on deep water areas (greater than 350m) offshore of the Main Hawaiian Islands (Oahu and Hawai'i), at the Geologists Seamounts (McCall, Swordfish and Ellis seamounts), and the vessel transit areas. A tandem 6,000 meter ROV system will be deployed and CTD rosette casts may be conducted during the expedition. The Kongsberg EM 302 multibeam (30 kHz), Kongsberg EK 60 singlebeam (18 kHz), and Knudsen 3260 Sub-Bottom Profiler (3.5 kHz) will be operated during the project. Additionally, expendable bathythermographs (XBTs) will be conducted in conjunction with multibeam data collection. Mapping operations will be conducted primarily in the evening/overnight, and at all times during the transit.

This cruise is entirely funded by NOAA NMFS Deep Sea Coral Research and Technology Program. The overarching goal of the project is to collect data and information to support priority

NMFS Pacific Islands deep-sea coral science and management needs. The first three dives will be used to recover instruments that are presently monitoring environmental conditions on precious coral beds off the islands of Oahu and the Big Island, and to conduct a dive in support of a coral disturbance/recovery study. The next three days will be used to explore for deep sea coral and sponge communities, as well as manganese crust communities in the Geologists seamounts located about 100 miles south of Honolulu. The last dive will be used to recover an instrument that is presently monitoring environmental conditions on precious corals that are covering a scuttled WWI-era submarine, and collect information on the submarine's state of degradation. The information and data generated by this project will lead to a better understanding of the deep water habitats, ecosystems and geologic history of the Hawaiian Islands, providing basic information about the about the rich and unique biological resources and habitats of this region. Ideally, the findings from this cruise will spur further exploration and research and ultimately contribute to effective resource management decisions.

Mapping

The acquisition of high-resolution seafloor mapping data is an essential precursor to making significant biological, geological, archaeological and oceanographic discoveries. The *Okeanos Explorer* cruises will collect seafloor mapping data to supplement previous multibeam mapping in the region. These maps form the basis for selecting ROV dive targets. NOAA Ship *Okeanos Explorer* has three scientific sonars that are configured to operate simultaneously without interference: a 30 kHz multibeam echosounder (Kongsberg EM 302), an 18 kHz singlebeam echosounder (Kongsberg EK60), and a 3.5 kHz sub-bottom profiler (Knudsen Chirp 3260). Sonar operations with all three systems running simultaneously are planned to occur continuously throughout the day and night except when the ROV is deployed or CTD operations are occurring. Additionally, expendable bathythermographs (XBTs) will be deployed at regular intervals in association with multibeam data collection. All of these systems are routinely used by this exploration vessel.

Bridge Officers and Watch Standers will be on watch during all hours and will look for marine mammals and other observable species potentially sensitive to the sound of the sonars. If cetaceans are sighted, knowledgeable personnel would follow established best management practices to minimize disturbance. If cetacean species are present within 400 m of the ship, the vessel will stop until the animals depart the area.

Multibeam

Multibeam sonar data will produce high-resolution bathymetry and acoustic backscatter maps. These maps will provide critical baseline information to scientists and resource managers interested in identifying and expanding our understanding of the important biological habitats and ecological connections in the Hawaiian Archipelago. Additionally, the data collected will help scientists better understand the size and character of seafloor habitats in the area, allowing for improved targeting of future exploration and research, including the selection of sites for further investigation with a ROV.

Expendable bathythermographs (XBT):

XBTs are deployed to obtain sound velocity profiles. The profiles are required to calibrate the multi-beam system and ensure accurate bathymetric mapping. During the Leg III ROV cruise, mapping operations would be conducted mainly at night in transit to the next dive location,

resulting in a total of 2 XBT deployments in a 24-hour period, or an estimated 14 XBTs during the duration of the cruise. The very fine wire connecting the XBT probe to the ship is extremely easy to break by hand once the probe reaches maximum depth. The minimal tensile strength of the wire should represent a minimal entanglement risk for marine animals. The expended materials are unlikely to result either in any significant environmental impacts to the sea floor or in a significant degradation of marine water quality. Over a period of years, these materials would degrade, corrode, and become incorporated into the sediments.

Single Beam and Split Beam Sonar:
The Kongsberg EK 60 (18 kHz) single beam is used to collect information about the water column, such as at gas plume or seep sites, and to obtain information about biomass. The EK60 split-beam sonar is used as a quantitative scientific echosounder to identify water column acoustic reflectors - typically biological scattering layers, fish, or gas bubbles – providing additional information about water column characteristics and anomalies. Fishery scientists have developed methods to analyze EK60 data to support fish stock assessment (e.g. Atlantic herring, pollock, capelin) and to predict hot spots of large fish in coral reefs. Split beam sonars are also being used to help develop "acoustic signatures" of different marine species, which will greatly enhance existing efforts to assess abundance, distribution, and behavior using remote sensing methods. Additionally, split beam sonars are being used to generate gaseous seep flux rates and their contribution to ocean and atmospheric chemistry.

Sub Bottom Profiler:
The primary purpose of this Knudsen Chirp 3260 (3.5 kHz) sonar is to provide echogram images of surficial geological sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The Sub Bottom Profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor. Collecting this data in the Leg III operating area may provide improved insights into the geology of the region.

CTD Rosette Operations
The CTD rosette instrument does not emit an acoustic signal and is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, oxygen reduction potential). The system would be lowered to a maximum depth of 6800 m by an embedded scientific winch and wire while the vessel would be stopped and hold station using dynamic positioning. The average time to conduct a CTD cast varies from one to several hours depending on water depth (the CTD is lowered through the water column at 60m/min). CTD casts are not currently planned during this cruise by may be conducted at selected sites including locations where ROV dives are conducted to allow for an improved understanding of the environmental conditions by measuring the physical or chemical properties of the water column overlying or hosting a particular habitat. The CTD would not touch the seafloor and would have limited time and presence in the marine environment.

ROV Operations
ROV cruises would use the ROV system to retrieve previously deployed instruments that are currently monitoring environmental conditions on precious coral beds off the islands of Oahu and

the Big Island, to conduct a dive in support of a coral disturbance/recovery study, and to explore for deep sea coral and sponge communities, as well as manganese crust communities in the Geologists seamounts located about 100 miles south of Honolulu. The dives will enable scientists and managers to have a better understanding of known, sensitive deep sea coral and sponge habitats to enable more effective management decisions. ROV dives are planned at the Geologists Seamounts to conduct interdisciplinary site characterization at priority sites on never before visited seamounts. Interdisciplinary site characterization would be achieved by visually surveying priority targets while simultaneously acquiring environmental data with in situ sensors (CTD and Dissolved Oxygen) mounted on the ROVs. ROV targets include seamount summits, flanks and rift zone ridges where high density deep water coral and sponge communities are likely to occur.

The *Okeanos Explorer* is equipped with OER's dedicated, fully integrated, two-body ROV system. ROV operations are conducted primarily during daylight hours while the vessel is stopped and holds station using dynamic positioning. ROV operations will typically take place within several meters of the seafloor, and are conducted in a way to minimize seafloor disturbances. During Leg III, up to 7 deployments of the ROV would occur during the expedition, resulting in 56 hours total dive time (~8 hours for each dive).

During these dives, limited sampling operations are planned to collect very selective specimens with the ROV that have the potential to contribute significant scientific discoveries. Biological specimen collections will focus on deep sea corals and sponges (and their incidentally collected commensals). Only biological specimens suspected of being new species or new records for Hawaiian waters will be targeted. When possible, only a sub-sample will be taken of biological specimens (e.g., only a piece or branch of corals and sponges will be collected, not the entire organismal community). Selective rock specimens, that have the potential to contribute significant scientific discoveries, as outlined in the expedition goals, will also be targeted. These are expected to include rocks from seamounts and manganese-coated rocks. When possible, rock samples will be selected in a way to minimize disturbance to the surrounding environment and to minimize the take of attached organisms.

Permits

OER has also completed an informal consultation with NOAA's National Marine Fisheries Service (NMFS) under section 7 of the Endangered Species Act of 1973 that addresses the potential impacts of project activities to ESA-listed species and critical habitat within the project operating area. A Letter of Concurrence was received from NMFS on July 7, 2015, concurring with OER's determination that EX-15-04 cruise 1-4 activities are not likely to adversely affect ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat.

Although the proposed action will occur within a geographic area with unique characteristics, i.e., sensitive ecosystems and historic/cultural resources, it has been determined that the characterization and monitoring undertaken by this project will not pose the possibility of significant impact and, hence, do not warrant preparation of an EA or EIS, as prescribed in NAO 216.6 Section 5.05c. Arguably, such natural and cultural resources need to be clearly identified, inventoried, assessed and monitored in order for managers to effectively manage and protect them.

Effects of the Project

As expected for ocean research with limited duration or presence in the marine environment, this project will not have the potential for significant impacts. Knowledgeable experts who are aware of the sensitivities of the marine environment will conduct the at-sea portions of this project. The potential gains or beneficial effects of the project seem to outweigh any potential adverse effects. This expedition will provide data and information on known and poorly understood deep water habitats contained within the U.S. Exclusive Economic Zone (EEZ). This work will provide essential information for further research, exploration, conservation and management of marine habitats within the U.S. EEZ.

As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude and will not result in individually or cumulatively significant impacts on the quality of the human environment. Specifically, this research cruise would have only short-term effects with the principle goals of natural resource inventories and environmental monitoring over a wide geographic area. Furthermore, this action would not be subject to any of the exceptions for categorical exclusion provided at NAO 216-6 section 5.05c. As such, this project is categorically excluded from the need to prepare a NEPA environmental assessment.

Signed: John Mcdonough Digitally signed by John Mcdonough DN: cn=John Mcdonough, o=Ocean Exploration, ou=NOAA/OAR, email=john.mcdonough@noaa.gov, c=US Date: 2015.08.17 09:43:53 -04'00' Date:_____

John McDonough, Acting Director

Appendix E - ESA Section 7 Letter of Concurrence

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawaii 96818
(808) 725-5000 • Fax: (808) 725-5215

JUL 07 2015

Dr. John J. McDonough
Deputy Director
National Oceanic and Atmospheric Administration
Office of Ocean Exploration and Research
Silver Spring, MD 20910

Dear Dr. McDonough:

This letter responds to your June 10, 2015 Request for Consultation by the NOAA Office of Exploration and Research (OER) regarding efforts aboard the NOAA vessel *Okeanos Explorer* that would include four telepresence-enabled ocean exploration cruises from July to September 2015, to collect critical baseline information to meet NOAA science and management needs within the Hawaiian Archipelago and offshore Johnston Atoll. You have requested our concurrence under Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 et seq.), with your determination that the proposed action may affect but is not likely to adversely affect green, hawksbill, leatherback, olive ridley, and north Pacific loggerhead sea turtles; Main Hawaiian Islands false killer whale distinct population segment, humpback whales, blue whales, fin whales, sei whales, sperm whales, north Pacific right whales, the Indo-West Pacific distinct population segments of the scalloped hammerhead shark, Hawaiian monk seals, and monk seal critical habitat.

Proposed Action/Action Area: The proposed activities are described in the OER request for consultation and the associated biological evaluation (CAPSTONE 2015). In summary, the proposed action consists of activities to explore and improve understanding of the distribution and diversity of deep water habitats. The activities would occur during four different research cruises aboard the Okeanos Explorer scheduled between July – October 2015. No activities would occur on land. Up to 60 individuals (20 rotating scientists/technicians on 3 expedition legs) would be authorized to conduct mapping and ROV surveys using the vessel's multibeam, single beam and subbottom profiling sonar systems, conducting conductivity-temperature depth (CTD) casts, and deploying an ROV.

The action area covered by this biological evaluation encompasses the marine environment of the Papahānaumokuākea Marine National Monument (PMNM); the marine environment around Johnston Atoll in the Pacific Remote Islands Marine National Monument (PRIMNM); the marine environment around Ni'ihau, Oahu and the big island of Hawai'i; the Geologists

Seamounts located about 100 miles south of Honolulu; and the vessel transit areas between Honolulu, Hawai'i and these locations where ESA-listed marine species or their habitats may be impacted by the proposed activities.

Within the PMNM, focused operations are planned from Middle Bank on the southern border of the Monument northwest reaching up to Pearl and Hermes Atoll. Within the Johnston Atoll portion of PRIMNM, focused operations are planned at Horizon tablemount, through both the Karin and Johnston Seamount chains, and offshore of Johnston Atoll. Operations offshore of Oahu are planned on the south and southeast side of the island, and on the west/southwest side of the Hawai'i.

Species That May Be Affected: OER has determined that the proposed action may affect but is not likely to adversely affect green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Caretta caretta*), olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*), North Pacific right whales (*Eubalaena japonica)*, the Indo-West Pacific distinct population segment of the scalloped hammerhead shark (*Sphryna lewini*), Hawaiian monk seals (*Neomonachus schauinslandi*), and Hawaiian monk seal critical habitat. Detailed information about the biology, habitat, and conservation status of sea turtles can be found in their recovery plans and other sources at http://www.nmfs.noaa.gov/pr/species/turtles/. The same can be found for Hawaiian monk seals and cetaceans at http://www.nmfs.noaa.gov/pr/species/mammals/; and for scalloped hammerhead sharks at http://www.fpir.noaa.gov/PRD/prd_scalloped_hammerhead_shark.html.

Critical Habitat: The proposed action would take place within designated monk seal critical habitat. Critical habitat was designated under the ESA for the Hawaiian monk seal on April 30, 1986 and revised on May 26, 1988. Designated critical habitat includes all beach areas, lagoon waters, and ocean waters out to a depth of 20 fathoms around Kure Atoll; Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, Maro Reef, and Nihoa Island. On June 2, 2011, NMFS proposed revising critical habitat for monk seals by extending the current designation out to the 500 meter depth contour and including Sand Island at Midway Island but this proposal is not yet final.

Analysis of Effects: In order to determine that a proposed action is not likely to adversely affect listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint USFWS-NMFS Endangered Species Consultation Handbook: (1) insignificant effects relate to the size of the impact and should never reach the scale where take occurs; (2) discountable effects are those that are extremely unlikely to occur; and (3) beneficial effects are positive effects without any adverse effects (USFWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species, as is described in detail in the OER

consultation request. The OER determined that the risk of collisions with vessels and the risk of entanglement would be discountable; and that the risk from exposure to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges would result in insignificant effects on ESA-listed sea turtles, marine mammals and the scalloped hammerhead shark, and that the potential effects of the proposed action to designated or proposed critical habitat would also be insignificant.

Considering the information and assessments presented in the OER consultation request, and in the best scientific information available about the biology and expected behaviors of the ESA-listed marine species considered in this consultation; NMFS agrees that: 1) the list of ESA-listed species and critical habitats potentially exposed to the effects of the action is correct, 2) the suite of identified stressors is comprehensive, and 3) the assessment of exposure risk and significance of exposure to those stressors is accurate. Therefore, NMFS agrees that the risk of collisions with vessels and the risk of entanglement would be discountable for marine mammals, sea turtles and the scalloped hammerhead shark; and that those animals would be unlikely to respond to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges, and if perchance a response were to occur, it would be temporary in nature and never reach the scale where it would affect the individual's health, and as such, cause insignificant effects; and that the action would have insignificant effects on critical habitat.

Conclusion: NMFS concurs with your determination that the proposed cruises of the Okeanos Explorer are not likely to adversely affect ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat. This concludes your consultation responsibilities under the ESA for species under NMFS's jurisdiction. However, this consultation focused solely on compliance with the ESA. Additional compliance review that may be required of NMFS for this action (such as assessing impacts on Essential Fish Habitat) would be completed by NMFS Habitat Conservation Division in separate communication, if applicable.

ESA Consultation must be reinitiated if: 1) a take occurs; 2) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the identified action.

If you have further questions please contact Richard Hall on my staff at (808) 725-5018. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

Michael D. Tosatto
Regional Administrator

Appendix F – State of Hawaii DLNR Special Activity Permit 2016-64

State of Hawai'i
Department of Land & Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawai'i 96813

SPECIAL ACTIVITY PERMIT
(SAP) 2016-64
Issued: 8/25/2015
Expires: 8/24/2016

The State of Hawaii BOARD OF LAND AND NATURAL RESOURCES ("Board") through its DEPARTMENT OF LAND AND NATURAL RESOURCES ("Department"), under Section 187A-6, Hawaii Revised Statutes, and other applicable laws, hereby grants permission for certain activities involving aquatic organisms belonging to the people of Hawaii and issues a SPECIAL ACTIVITY PERMIT (SAP) to:

KELLEY ELLIOT ("Permittee")
NOAA Office of Ocean Exploration and Research
1315 East-West Highway, SSMC3 Room 10236
Silver Spring, MD 20910

This permit is issued, subject to the general and special conditions, to collect the following marine species listed in the table below using a remotely operated vehicle (ROV) in waters off the islands of Hawai'i and Ni'ihau for research on life history.

This permit, signed by authorized representative of the Department of Land and Natural Resources (the Department), authorizes the permittee, and assistants designated on the final page(s) of, or attachments to, this permit, to engage in activities otherwise prohibited by law, subject to the conditions, which **TAKE, CATCH, POSSESS, TRANSPORT, OR KILL** certain aquatic life from waters of the State, as follows below in Table 1:

COMMON NAME	SPECIES	LIMITS see Special Conditions	LOCATIONS see Special Conditions
Live Rock	*n/a*	2 (pieces)	Hawai'i and Ni'ihau (Water depth = 200 ft.-6000 ft.)

Black coral (Dense Feathery Black Coral, Hawaiian Black Coral, Grand Black Coral)	*(Myriopathes cf. ulex, Antipathes griggi and Antipathes grandis)*	2 pieces (any size)	Hawai'i and Ni'ihau (Water depth = 200 ft.-6000 ft.)

This Permit is subject to the following terms and conditions.

CONDITIONS

Part I. GENERAL

A. This Permit is effective when the following processes have been completed.

1. Each assistant must be listed at the end of this Permit.

2. The Permittee and each assistant must read the Permit completely; acknowledge that he or she understands and agrees to abide by the conditions of the Permit, and sign both copies of the Permit as provided.

3. The Permit becomes valid when signed by an authorized representative of the Department and the Department returns one validated copy to the Permittee.

4. The Permittee agrees to notify the Division of Aquatic Resources ("Division") immediately of any change in assistants. Additional persons may be added as assistants in the manner provided in this Permit.

5. The Permittee agrees to obtain the Division's prior written approval before conducting any activity which would be prohibited if not authorized under this Permit (i.e. request in advance changes to permit conditions).

6. This Permit does not in any manner render the Department or the State of Hawai'i liable in any way for claims of personal injury or property damage which may arise or result from activity authorized by this Permit. The Permittee or all assistants agree to hold the Board and State harmless against any and all claims of injury, death or damage resulting from acts or omissions under this Permit.

7. This Permit conveys authority ONLY of the Department's jurisdiction over aquatic resources: The Permittee is and remains responsible for obtaining all other permission from other applicable authorities, including owners of and tenants of private lands; other divisions of the Department; other local, State and Federal agencies. This permit authorizes activities involving aquatic organisms protected by Federal law only with appropriate Federal authorization.

8. The Permittee and each assistant are individually responsible and accountable for his or her actions while performing activities authorized by this Permit. The Permittee is also responsible and accountable for the actions of each assistant.

9. This Permit is not transferrable and not assignable to another person.

10. The Permittee or assistant must carry a copy of this permit on location while performing activities authorized by this Permit.

11. Authority granted by this Permit ends on the "Expiration Date" on the first page of this permit; within one month of the expiration date, the Permittee agrees to return this permit to the Division with the Activity Report completed for the full duration of this permit, reporting results of all activities under this permit in the form provided with this permit. **All additional photo-documentation, geo-references or results of analysis should be compiled into an annual report** in format provided by permittee (see Special Conditions E. Notice, section 5, Annual Report).

12. The Permittee and assistants agree to provide access to data obtained under this permit upon request of the Division, to provide the Division one copy of each report prepared with such data and published for distribution, and to allow Department staff to inspect on Permittee's premises organisms collected under this permit.

13. Violation of any condition of this permit by any person may be cause for immediate revocation of the permit; the person responsible may be subject to penalty as provided by law; violation may be cause also for denial of future permit applications.

14. The Permittee may request change of a condition or conditions of this permit by writing to the Division; if approved by the Department, the Division will issue an attachment ("Amendment") which shall become part of, and amend terms of, this permit. The Department may impose

additional conditions to, or restrictions of, this permit by written notice to the Permittee.

Part II. SPECIAL CONDITIONS

A. General Statement: This permit authorizes collecting, possessing and transporting the marine life listed in Table 1 for research purposes, subject to the conditions of this permit. Authorized is the use of an ROV (remotely operated vehicle) for the taking of live rock and black coral fragments or colonies as listed in Table 1.

B. **Locations:** All activity will occur within water depths of 200 ft. to 6000 ft. around the islands of Hawai'i and Ni'ihau. Organisms and live rock will be collected and transported to the NOAA research vessel, *Okeanos* Explorer for analysis. Collecting activities under this permit is limited to waters of the islands of Hawaii and Ni'ihau and is expressly prohibited at the following locations. Permittee is authorized to collect live rock and black coral fragments or colonies from the islands of Hawai'i and Ni'ihau.

Island of MAUI	**Island of O'AHU**	**Island of HAWAI'I**
Kahului Harbor FMA[1]	Ala Wai Canal FMA	Hilo Bay FMA
Honolua-Mokuleia MLCD[2]	Diamond Head SFMA	Kealakekua Bay MLCD
Molokini MLCD	Haleiwa Harbor FMA	Kailua Bay FMA
Ahihi-Kinau NAR[3]	Hanauma Bay MLCD	Kawiahae Harbor FMA
	Heiea Kea FMA	Old Kona Airport MLCD
Island of LANA'I	Kapalama Canal FMA	Lapakahi Bay MLCD
Manele Harbor FMA	Paiko Lagoon Wildlife Refuge	Puako FMA
Manele-Hulopoe MLCD	Pupukea MLCD	Waiakea PFA[4]
	Waialua Bay FMA	Wailea Bay MLCD
Island of MOLOKA'I	Waikiki MLCD	Wailuku River FMA

Kaunakakai Harbor FMA		Wailoa River FMA
Island of KAUA'I		Waiopae Tidepools MLCD
Ahukini Pier FMA		West Hawaii Regional
Hanamaulu Bay FMA		Fishery Management Area
Kapaa Canal FMA		(comprising 9 Fish
Waikaena Canal FMA		Replenishment Areas)
Waimea Pier & Bay FMA		

[1] FMA -Fisheries Management Area; [2] MLCD - Marine Life Conservation District; [3]NAR - Natural Area Reserve; [4] PFA - Public Fishing Area

C. **Gear:** Permittee is authorized to use an ROV (remotely operated vehicle) for the taking of live rock and black coral fragments or colonies as listed in Table 1.

D. **Activities.**

Collection of coral fragments and biopsies. Permittee is authorized to collect two samples any size (per location) of live rock samples as listed in Table 1. via use of an ROV (remotely operated vehicle) from the waters of Hawai'i and Ni'ihau. Permittee is authorized to collect two samples any size of black coral fragments or colonies as listed in Table 1. via use of an ROV (remotely operated vehicle) from the waters of Hawai'i and Ni'ihau.

Preservation of samples. Permittee is authorized to preserve fragments or samples as listed in Table 1. by fixative or deep freeze. All samples not processed during permit duration will be held in freezer for future analysis or sent to institutions to be identified in final report.

1. Collecting and transport activities under authority of this permit must be supervised directly, on site, by either the permittee or their appointed representative (who must be a signatory of this permit).

2. An **Aquatic Invasive Species (AIS) Mitigation Plan** will be filed with the Division prior to conducting any collection under this permit. The Plan will include methods and protocols to minimize AIS or disease movement through gear, supplies and activities of the permittee. Permittee must take actions to verify that collection tools have been disinfected before use if previously used in collection activities.

3. No extractive or impact-causing activities will be done on (or immediately adjacent to) any intact, attached coral colony measuring larger than 1 m longest diameter. Specific efforts will be made to avoid damage to any large (> 0.5 m) colonies of living coral.

4. Regulated species as listed in Table 1. ONLY will be collected or impacted by any activities conducted under this permit.

5. The Division may require the Permittee to accommodate the presence of an observer specified by the Division during permitted activities. A record will be kept of each collection comprising specific location (GPS), date, species and amount collected. Photo-documentation will be made prior to and immediately after collection. These records will be made available to the Division upon request.

E. Notice:

1. Collecting generally - the Permittee must give notice, in form specified by the Department, to DAR (808-587-2270) and to the Department's Division of Conservation and Resources Enforcement (DOCARE, 808-453-3567), at least 2 hours prior to initial commencement of any series of collection activities taken place under this permit.

2. Mass mortality - the Permittee must notify DAR Oahu (587-2270 or 587-0100) within one day of

    a. Any instance of major damage caused to coral or other marine natural resources as a result of collection or other research activities conducted under this permit.

b. Fragmentation - This permit **authorizes** fragmentation of select coral colonies as listed in Table 1.

c. Rare Species - The following *Porites* species require special permission from the Division prior to collection under this permit: *Porites pukoensis*, *Porites duerdeni*, *Porites studeri*. The following *Montipora* species require special permission from DAR prior to collection under this permit: *Montipora dilitata*. The following *Pocillopora* species require special permission from DAR prior to collection under this permit: *Pocillopora ligulata, Pocillopora molokensis*.

3. Gear and Methods: Use of any chemical substances pursuant to Section 188-23, Hawai'i Revised Statutes, electrical shocking devices, or explosives remains expressly prohibited.

4. Use of Organisms: Organisms collected under authority of this permit may not be used for personal consumption or sale; organisms collected under this permit may not be traded, bartered or loaned to other individuals, institutions or entities;

   a. Written approval must be obtained from the Division prior to

      i. Purchasing or any other acquisition of regulated organisms (regardless of origin) alive from any other party,

      ii. Transporting any live organism (regulated or not) between islands.

      iii. Exchanging or donating any organisms collected under this permit to any other person, party or organization;

   b. The permittee may not convey in any fashion (including, but not limited to, selling, trading, or giving) any regulated coral (live or dead) to any person or party in Hawai'i that does not already have a permit from the Department authorizing possession of same and without direct, written approval from the Division;

5. **Annual Report:** Upon expiration, the permittee must provide to the Division a final written report summarizing results of collecting activity carried out under this permit and the analysis of the data:

   a. The annual report should provide a written explanation as to how the collection (and other activities) of a fully-protected marine

species is benefiting the State of Hawai'i in general and specifically, the improved management of the species.

b. The final report must describe, in form specified by the Department,

i. **Species name and total quantities and sizes** of all regulated and non-regulated specimens collected under this permit.

ii. **Results of chemical, genetic, phsiological or statistical analysis of data** (if possible/applicable).

iii. **GPS coordinates/documentation** of location of each sample or action conducted (only one GPS point needed per 500 m sampling radius)

iv. **Photo-documentation** of a representative sample of each species

a. Photo-documentation of 1 **representative sample per live rock/lava rock/coral sample or species** and Photo-documentation of 1 **representative example per sampling methodology.** Each representative sample should include the following photos; **For fragments/colonies/live rock:** photo of actual sample/fragment. **For sampling method:** photo-documentation of ROV.

c. An inventory (species list) of organisms (dead or alive) present at the facility or with the permittee the end of the report period, in form acceptable to the Division, must accompany the annual report;

d. The annual report is due at the Division's Honolulu office within three months (90 days) after expiration of the permit or as otherwise instructed by the Division.

6. Ownership of Biogenetic Resources. The State holds legal title to the natural resources and biogenetic resources gathered from state lands, including submerged lands. See Haw. Op.Atty.Gen. Opinion No. 03-03 (April 11, 2003). Biogenetic resources refers to the genetic material or composition of the natural resources and other things connected to, or gathered from public lands. See

Davis v. Green, 2 Haw. 327 (1861); United States v. Gerber, 999F.2d 1112 (7th Cir. 1993).

7. Use of Tissue Samples and Biogenetic Resources. The permittee may not convey in any fashion (including, but not limited to, selling, trading, or giving) any tissue samples to any person or party in Hawai`i that does not already have a permit from the Department authorizing possession of same and without written approval from DAR.

a. **this permit authorizes** Kelley Elliot/ NOAA/ Dr. Frank Trusdell to **transport** live rock/lava rock samples listed in Table 1 from deep ocean surveys off Hawaii Island or Ni'ihau to Christopher Kelley (ckelley@hawaii.edu), University of Hawai'i, 1000 Pope Rd., MSB 229, Honolulu, HI 96822 and for preparation, documentation and initial geological analysis and to the Marine Geology Repository, Oregon State University, 104 CEOAS Admin Building, Corvallis, Oregon 97331-5503 for geological analysis.

b. **this permit authorizes** Kelley Elliot/ NOAA/ Steve Cairns to **transport** samples of black coral obtained from ROV dives listed in Table 1 out of Hawai'i to the following institutions and **authorizes** the following institutions to **receive** samples of black coral obtained from ROV dives listed in Table 1. from **Kelley Elliot/ NOAA/ Steve Cairns**:
   i. National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, MRC 163, Washington, DC 20013

8. **Use of Biopsies or Tissue Samples**: Tissue samples taken under authority of this permit may be used only for scientific study or educational purposes **ONLY**, except as authorized by prior written approval of DAR.

VALIDATING SIGNATURE

SUZANNE D. CASE, Chairperson
Board of Land and Natural Resources

cc: DLNR Division of Conservation and Resources Enforcement
(X) DOCARE and DAR (Kauai-Ni'ihau)
(x) DOCARE and DAR (Hawaii)

ACKNOWLEDGING SIGNATURES

By signature below, I attest that I have read and understand the General and Special Conditions of Special Activity Permit SAP 2016-64 and that, further, I agree to comply with all of these conditions when collecting under authority of this permit.

KELLEY ELLIOT
Primary Permittee

Designated Assistants

Sign: Print name:	Sign Print name:
Sign: Print name:	Sign Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:

Additional Assistants

Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:
Sign: Print name:	Sign: Print name:

ACTIVITY REPORT

Results of all activities performed under authority of this permit must be reported on this form (or copies) within one month after the permit expires (see first page). Use as many sheets as you need. Submit the report to the Division of Aquatic Resources at 1151 Punchbowl Street, Room 330, Honolulu, HI 96813.

Date	Location	Common or Scientific Name	Quantity Collected*	Size Collected	Disposition of Specimens

Permittee Signature

Kelley Elliot
Name

_____
Signature

_____
Date

*If salvaged (collected because the specimen was dead or injured already), please detail circumstances: condition (dead, or describe extent of injury), how or from whom the specimen was obtained.

Appendix G—Acronyms

3D—Three-dimensional
AERONET—Aerosol Robotic Network
AMA—Reddit's Ask Me Anything
APCSS—Daniel K. Inouye Asia-Pacific Center for Security Studies
ASCII—American Standard Code for Information Interchange
BOEM—Bureau of Ocean Energy Management
BM—Bernice Pauahi Bishop Museum
CAPSTONE—NOAA's Campaign to Address Pacific monument Science, Technology, and Ocean NEeds
ONMS – Office of National Marine Sanctuaries
CARIS—Teledyne Computer Aided Resource Information System
CCEHBR—Center for Coastal Environmental Health and Biomolecular Research
CIT—Chiba Institute of Technology
CSV—Comma-separated values
CTD—Conductivity, temperature, and depth
D2—ROV Deep Discoverer
DNA—Deoxyribonucleic acid
DO—Dissolved oxygen
DSCRTP—NOAA's Deep-sea Coral, Research, and Technology Program
ECC—Exploration Command Center
ECU—East Carolina University
EEZ—Exclusive economic zone
ESA—Endangered Species Act
EX—NOAA Ship Okeanos Explorer
FeMn—Ferromanganese
FSU—Florida State University
FTP—File transfer protocol
GEMS—Geoscience Earth and Marine Services
HBOI—Harbor Branch Oceanographic Institute
HD—High-definition
HEX—. hex file
HPU—Hawai'i Pacific University
HURL—Hawai'i Undersea Research Laboratory
IUCN—International Union for Conservation of Nature
IRC—NOAA's Inouye Regional Center
JAU—Johnston Atoll Unit
Kbps—Kilobit-per-second
KMZ—Keyhole Markup language Zipped
LED—Light-emitting diode
M2—Principal lunar semi-diurnal tidal constituent
MAN—NASA's Maritime Aerosol Network
MB—Megabyte
Mbps—megabit-per-second

MGR—Marine Geology Repository
MHI—Main Hawaiian Islands
MPA—Marine protected area
MS—Microsoft
NAO—NOAA Administrative Order
NASA—National Aeronautics and Space Administration
NCCOS—NOAA National Centers for Coastal Ocean Science
NCDDC—NOAA National Coastal Data Development Center
NCEI—National Centers for Environmental Information
NEPA—National Environmental Policy Act
NGDC—NOAA's National Geophysical Data Center
NMFS—NOAA's National Marine Fisheries Service
NOAA—National Oceanic and Atmospheric Administration
NOC—NOAA's Network Operations Center
NOS—NOAA's National Ocean Service
OER—NOAA's Office of Ocean Exploration and Research
OGL—Ocean Genome Legacy
OPSNET—Operations Network
OSU—Oregon State University
PCZ—Prime Crust Zone
PERC—Planetary Exploration Research Center
PI—Principal Investigator
PIFSC—Pacific Islands Fisheries Science Center
PMNM—Papahānaumokuākea Marine National Monument
POC—Point of contact
PPSIO—P.P. Shirshov Institute of Oceanology
PRIMNM—Pacific Remote Islands Marine National Monument
QA/QC—Quality assurance/quality control
ROV—Remotely operated vehicle
SBP—Subbottom profiling
SCS—NOAA Scientific Computer System
SD—Scientific Data
SI—Smithsonian Institution
SIS—Seafloor Information Software
SODA—Sampling Access Database Application
SVP—Sound velocity probe
TAMU—Texas A&M University
TAMU-CC—Texas A&M University-Corpus Christi
TB—Terabytes
TSG—Thermosalinograph
UCAR—University Corporation for Atmospheric Research
UCH—Underwater Cultural Heritage
UH—University of Hawai‘i
ULL—University of Louisiana at Lafayette
USGS—U.S. Geological Survey
USNM—National Museum of Natural History

UTC—Universal Time Coordinated
VSAT—Very Small Aperture Terminal
WSG84 datum—World Geodetic System 1984
XBT—Expendable bathythermograph