doi: 10.25923/ykmv-b048

Ocean Exploration and Research

Cruise Report: EX1705, Mountains in the Deep-Exploring the Central Pacific Basin (ROV and Mapping)

American Sāmoa, Cook Islands, High Seas, and the Pacific Remote Islands Marine National Monument (Jarvis Island and Kingman Reef Units)

Pago Pago, American Sāmoa to Honolulu, Hawai'i
(April 27 - May 19, 2017)

Contributors:
Kasey Cantwell, Expedition Coordinator, NOAA Office of Ocean Exploration & Research
DelWayne Bohnenstiehl, Science Lead, North Carolina State University
Scott C. France, Science Lead, University of Louisiana at Lafayette
Michael P. White, Mapping Lead, NOAA Office of Ocean Exploration & Research
Amanda N. Netburn, Sample Data Manager & Water Column Lead, NOAA Cooperative Institute for Ocean Exploration, Research & Technology
Amy Bowman, Web Coordinator & Technical Editor, NOAA Office of Ocean Exploration and Research

March 31, 2020

NOAA Office of Ocean Exploration and Research
1315 East-West Hwy, SSMC3 RM 10210
Silver Spring, MD 20910

Abstract

The Mountains in the Deep Expedition (EX1705), conducted from April 27, 2017, to May 19, 2017, onboard NOAA Ship *Okeanos Explorer*, collected valuable new information to support management and science needs throughout the Central Pacific Basin. Operations were conducted in American Samoa and the National Marine Sanctuary of American Samoa, the Cook Islands' Marae Moana marine park, and in the Jarvis Island and Palmyra Atoll and Kingman Reef Units of the Pacific Remote Islands Marine National Monument (PRIMNM as part of the Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE). During 23 days at sea, the expedition team conducted 12 remotely operated vehicle (ROV) dives—ranging in depth from 230 m and 4,573 m—and mapped over 36,800 km^2 of seafloor, an area larger than the US state of Maryland. Although the expedition encountered weather and technical issues, there were several significant discoveries and accomplishments, including the first high-resolution mapping data over a number of features. In several instances, we found significant differences when compared to satellite altimetry data—with multiple instances of an approximate 1,000-meter variation. This expedition also documented 11 high-density communities for the first time, seven of which were high-density deep-sea coral and sponge communities. Other high-density communities included polychaete tube worms, holothurians, and multiple instances of sea urchins. Beyond benthic surveys, this expedition also conducted the first ever midwater exploration in the Jarvis Island and Palmyra Atoll and Kingman Reef Units of the PRIMNM, and in the vicinity of the northern Manihiki Plateau. This report summarizes operations conducted during EX1705, presents data collected, and provides a high level overview of initial findings.

This report can be cited as follows:
Cantwell, K, France, SC, Bohnenstiehl, DR, White, MP, Netburn, AN., and Bowman, A. (2019). Cruise Report: EX1705, Mountains in the Deep-Exploring the Central Pacific Basin (ROV and Mapping). Office of Ocean Exploration and Research, Office of Oceanic & Atmospheric Research, NOAA, Silver Spring, MD 20910. OER Expedition Rep. 17-05, 92 p. doi: https://doi.org/10.25923/ykmv-b048

For further information direct inquiries to:
NOAA Office of Ocean Exploration and Research
1315 East-West Hwy, SSMC3 RM 10210
Silver Spring, MD 20910
Phone: 301-734-1014
Fax: 301-713-4252
Email: oceanexplorer@noaa.gov

Ocean Exploration and Research

Table of Contents

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* 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 NOAA Ship *Okeanos Explorer*. 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.

1.2 Expedition Overview

The Mountains in the Deep: Exploring the Central Pacific Basin expedition (EX1705) was the eighth in a series of expeditions as part of the "Campaign to Address Pacific monument Science, Technology, and Ocean Needs" (CAPSTONE). CAPSTONE is a major, multi-year effort to collect a foundation of baseline information in unknown and poorly known deepwater areas of U.S. marine protected areas in the central and western Pacific Ocean.

Pacific Remote Islands Marine National Monument (PRIMNM)

Located south and west of Hawai'i, PRIMNM includes approximately 1,269,065 km^2 of submerged lands and waters (U.S. Fish and Wildlife Service; NOAA). The unique ecosystems inside the Monument include Baker, Howland, and Jarvis Island; Johnston, Wake, and Palmyra Atoll; and Kingman Reef. The seven islands and atolls are also designated as national wildlife refuges and sustain a diversity of species including corals, fishes, shellfish, marine mammals, seabirds, land birds, insects, and vegetation not found anywhere else in the world (NOAA, 2019A). Only recently have scientists visited the deep waters of the Monument, as CAPSTONE has brought opportunities for exploration. EX1705 conducted the deepest ROV operations to date in the Palmyra Atoll and Kingman Reef Unit of PRIMNM, as well as the first deepwater ROV operations in the Jarvis Island Unit of PRIMNM.

Cook Islands and Marae Moana: Cook Islands Marine Park

The Cook Islands are comprised of 15 islands, of which 12 are inhabited and three are uninhabited. The multiple-use Cook Islands Marine Park was initially announced in 2012 and was expanded in 2016 to include the entire Exclusive Economic Zone—an area of 1.1 million km^2 (Evans, 2017). The park was named Marae Moana: Cook Islands Marine Park, which translates to “Sacred Ocean”. Its purpose is to promote sustainable development and balance economic growth with conservation of the ocean’s natural assets (Evans, 2017).

National Marine Sanctuary of American Sāmoa (NMSAS)

NMSAS is located in the cradle of Polynesia’s oldest culture and is thought to support the greatest diversity of marine life in the National Marine Sanctuary System (NOAA 2019A). The sanctuary is comprised of six protected areas, covering 35,175 km^2 of nearshore coral reef and offshore open ocean waters across the Samoan Archipelago. The sanctuary protects extensive coral reefs, including some of the oldest and largest Porites coral heads in the world, deepwater reefs, hydrothermal vent communities, and rare marine archaeological resources (NOAA 2019A). Additionally, the sanctuary encompasses important fishing grounds, the southernmost point in the United States, and waters surrounding one of the world’s smallest atolls. The sanctuary contains some of the most spectacular tropical reef ecosystems in the world and is the most remote location within the National Marine Sanctuary System (NOAA 2019A). NOAA co-manages the sanctuary with the American Sāmoa Government and works closely with communities adjacent to the sanctuary, all within the context of Samoan cultural traditions and practices. The sanctuary’s mission requires a rigorous, objective, scientific foundation to understand ecosystem structure and function; evaluate the status of sanctuary resources; examine the socioeconomic impacts of management actions; and implement effective, sustainable, and adaptive management strategies. The sanctuary prioritizes the establishment of baseline conditions, the development of long-term monitoring programs, and ecosystem-based management. Issues currently facing the sanctuary include crown-of-

thorns starfish removal, introduced (alien and invasive) species, marine debris, and climate change (NOAA 2019A).

Rationale for Exploration

Large areas of PRIMNM, Marae Moana: Cook Islands Marine Park, and the high seas are unmapped with modern sonar, which presents a challenge for resource managers. Mapping efforts revealed previously unknown seamounts and other geological features, providing insight into the volcanic plume processes, seamount formation and wasting.

Data from this expedition will help to improve our understanding of the deep-ocean habitats of the Central Pacific Basin and of the connections between communities at different seamounts and hydrothermal vent sites. Data and information from the expedition provide critical knowledge for the development of deep-sea management plans for MPAs; support local scientists and managers seeking to understand and manage deep-sea fisheries resources; and supply a foundation of information to stimulate subsequent exploration, research, and management activities.

1.3 Objectives

The expedition addressed science themes and priority areas put forward by NOAA scientists and resource managers, American Sāmoa and Cook Islands management agencies, and the broad ocean science community. The primary objective of the expedition was to survey deepwater areas in and around PRIMNM, the Cook Islands, and American Sāmoa in order to provide baseline information to support management and science needs. Specifically, this expedition sought to:

- Acquire data to support priority Monument and protected area science and management needs;
- Identify and map vulnerable marine habitats—particularly high-density deep-sea coral and sponge communities;
- Explore the diversity of benthic habitats and features (e.g., seamounts, deep-sea coral communities, bottomfish habitats);
- Investigate biogeographic patterns of deep-sea ecosystems and connectivity across Pacific seamounts and throughout remote Pacific marine protected areas;
- Investigate the geology of Pacific seamounts, constraining their morphology, age, and potential relevance to plate tectonic and plume processes;
- Collect high-resolution bathymetry in areas with no (or low quality) mapping data;
- Acquire a foundation of sonar and oceanographic data to better understand the characteristics of the water column in remote areas;
- Engage a broad spectrum of the scientific community and the public in telepresence-based exploration;
- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

1.4 List of Participants

As with previous NOAA Ship *Okeanos Explorer* expeditions, the EX1705 expedition included the mission personnel who participated in the expedition from aboard NOAA Ship *Okeanos Explorer*, as well as shore-side science personnel who participated in the expedition remotely via telepresence technology. A list of participating personnel can be found in Tables 1 and 2.

At-Sea Mission Personnel

Table 1. Names, roles and affiliation of the mission team onboard the NOAA Ship *Okeanos Explorer* EX1705 expedition.

Name	Title	Affiliation
Kasey Cantwell	Expedition Coordinator	NOAA Office of Ocean Exploration and Research
Scott C. France	Biology Science Lead	University of Louisiana at Lafayette / UCAR
Del Bohnenstiehl	Geology Science Lead	North Carolina State University / UCAR
Amanda N. Netburn	Sample Data Manager	Cooperative Institute for Ocean Exploration, Research and Technology
Michael White	Mapping Lead	NOAA Office of Ocean Exploration and Research
Kevin Jerram	Mapping Watch Lead	UCAR/UNH CCOM
Bobby Mohr	Engineering Team	Global Foundation for Ocean Exploration
Fernando Aragon	Engineering Team	Global Foundation for Ocean Exploration
Joshua Carlson	Engineering Team	Global Foundation for Ocean Exploration
Andy Lister	Engineering Team	Global Foundation for Ocean Exploration
Levi Unema	Engineering Team	Global Foundation for Ocean Exploration
Jeffrey Laning	Engineering Team	Global Foundation for Ocean Exploration
Sean Kennison	Engineering Team	Global Foundation for Ocean Exploration
Chris Ritter	Engineering Team	Global Foundation for Ocean Exploration
Don Liberatore	Engineering Team	Global Foundation for Ocean Exploration
Dan Rogers	Engineering Team	Global Foundation for Ocean Exploration
Emily Narrow	Engineering Team	Global Foundation for Ocean Exploration
Caitlin Bailey	Engineering Team	Global Foundation for Ocean Exploration
Roland Brian	Engineering Team	Global Foundation for Ocean Exploration
Annie White	Engineering Team	Global Foundation for Ocean Exploration
Bob Knott	Engineering Team	Global Foundation for Ocean Exploration
Neah Baechler	Mapping Watchstander	UCAR
Amy Bowman	Web Coordinator	NOAA Office of Ocean Exploration and Research

Table 2. Name, affiliation, email of the shore-based science team who participated in EX1705.

Name	Affiliation	Email
Abby Lapointe	University of Hawai'i at Mānoa	abbylap@hawaii.edu
Alain Murphy	Cook Islands	alain.murphy@gmail.com
Alistair Grinham	The University of Queensland	a.grinham@uq.edu.au
Allison Miller	University of Guam	a33miller@gmail.com
Amanda Netburn	NOAA OER	amanda.netburn@noaa.gov
Amber Hale	McNeese State University	ahale@mcneese.edu
Amy Baco-Taylor	Florida State University	abacotaylor@fsu.edu
Asako Matsumoto	Planetary Exploration Research Center (PERC), Chiba Institute of Technology (Chitech)	amatsu@gorgonian.jp
Astrid Leitner	University of Hawai'i at Mānoa	Aleitner245@gmail.com, aleitner@hawaii.edu
Atuatasi-Lelei Peau	NMS American Sāmoa	Atuatasi-Lelei.Peau@noaa.gov
Brendan Roark	Texas A&M University	broark@geos.tamu.edu
Brian Greene	Association for Marine Exploration	bgreene@hawaii.edu
Brian Peck	USFWS	brian_peck@fws.gov
Bruce Mundy	NOAA NMFS Pacific Islands Fisheries Science Center	Bruce.Mundy@noaa.gov
Charles Messing	Nova Southeastern University	messingc@nova.edu
Chris Mah	Dept. of Invertebrate Zoology, NMNH Smithsonian Institution	brisinga@gmail.com
Christopher Kelley	University of Hawai'i at Mānoa	ckelley@hawaii.edu
Craig Smith	University of Hawai'i at Mānoa	craigsmi@hawaii.edu
Danielle Dodge	FAU Harbor Branch	ddodge2015@fau.edu
Deborah Glickson	National Academies of Sciences, Engineering, and Medicine	dglickson@nas.edu, dglickson@yahoo.com

Dhugal Lindsay	JAMSTEC	dhugal@jamstec.go.jp
Di Tracey	NIWA	Di.Tracey@niwa.co.nz
Dianna Franklin	NIWA	-
Diva Amon	University of Hawai'i at Mānoa	divaamon@gmail.com
Emil Petruncio	U.S. Naval Academy	petrunci@usna.edu
Erica Albright	Harbor Branch Semester by the Sea Undergraduate	ealbright2014@fau.edu
Erin Easton	Ecology and Sustainable Management of Oceanic Islands	erineeaston@gmail.com
Gregor Eberli	University of Miami	geberli@rsmas.miami.edu
Hand Breath	Penn State	bkh5174@psu.edu
Heidi Hirsh	NOAA NMFS PIRO Marine National Monuments Program	heidi.hirsh@noaa.gov
Hidaka-Umetsu Mitsuko	JAMSTEC	mitsukou@jamstec.go.jp
Jacqueline Evans	Cook Islands Office of the Prime Minister	jacqui.evans@cookislands.gov.ck
Jaymes Awbrey	University of Louisiana, Lafayette	jawbrey@louisiana.edu
Jeffrey Drazen	University of Hawai'i at Mānoa	jdrazen@hawaii.edu
Jenn Casselle	Univ California Santa Barbara	caselle@ucsb.edu
Jessica Robinson	Ocean Networks Canada	jrobinson@uvic.ca
Joseph Paulin	NMS American Sāmoa	joseph.paulin@noaa.gov
Kasey Cantwell	NOAA OER	kasey.cantwell@noaa.gov
Katie Musser	University of Louisiana at Lafayette	katielynnmusser@gmail.com
Ken Sulak	USGS emeritus	ksulak@usgs.gov
Kevin Kocot	The University of Alabama	kmkocot@ua.edu
Kristen Mello	The Center for Coastal and Ocean Mapping	kmello@ccom.unh.edu

Les Watling	University of Hawai'i at Mānoa	watling@hawaii.edu
Mackenzie Gerringer	University of Hawai'i at Mānoa	mgerring@hawaii.edu
Madeline Rubio	HBOI	mrubio2015@fau.edu
Malcolm Clark	NIWA	Malcolm.Clark@niwa.co.nz
Mareike Sudek	NMS	mareike.sudek@gmail.com
Mary Wicksten	Texas A&M University	Wicksten@bio.tamu.edu
Michael Parke	NOAA PIFSC	michael.parke@noaa.gov
Michelle Kelley	NIWA	Michelle.Kelly@niwa.co.nz
Natalie Summers	University of Hawai'i at Mānoa	nsummers@hawaii.edu
Nicole Morgan	Florida State University	nmorgan@fsu.edu
Nolan Barrett	FAU Harbor Branch Oceanographic Institute	barrettnh@g.cofc.edu
Peter Auster	Mystic Aquarium & University of Connecticut	peter.auster@uconn.edu
Rachel Bassett	NCCOS Deep Coral Ecology Lab	rachel.bassett@noaa.gov
Randi Rotjan	Boston University	rrotjan@bu.edu
Rhian Waller	University of Maine	rhian.waller@maine.edu
Rob Sherlock	MBARI	robs@mbari.org
Robert Carney	Louisiana State University	rcarne1@lsu.edu
Sadie Mills	NIWA	
Santiago Herrera	Lehigh University	sherrera@alum.mit.edu
Sara Bashah	University of Miami	nbashah@rsmas.miami.edu
Sergi Taboada	The Natural History Museum of London	sergiotab@gmail.com
Shirley Pomponi	HBOI-FAU CIOERT	spomponi@fau.edu
Sonia Rowley	University of Hawai'i at Mānoa	srowley@hawaii.edu
Stephanie Bush	MBARI	sbush@mbari.org

Ocean Exploration and Research

Steve Auscavitch	Temple University	steven.auscavitch@temple.edu
Timothy Shank	Woods Hole Oceanographic Institution	tshank@whoi.edu
Tina Molodtsova	P.P. Shirshov Institute of Oceanology RAS	tina@ocean.ru; tina.molodtsova@gmail.com

2. Methodology

In order to accomplish its objectives, the expedition made use of NOAA Ship *Okeanos Explorer*'s:

(1) dual-bodied ROV system (ROVs *Deep Discoverer* and *Seirios*) to conduct daytime seafloor surveys, as well as to collect a limited number of specimens to help further characterize the deepwater fauna and geology of the region;
(2) mapping systems (Kongsberg EM 302 multibeam sonar, Knudsen 3260 sub-bottom profiler, Kongsberg EK60 single beam sonars, and Teledyne Acoustic Doppler Current Profilers) to conduct mapping operations at night and when the ROV was on deck; and
(3) high-bandwidth satellite connection for real-time ship-to-shore communications.

2.1 ROV Seafloor Surveys

ROV dive operations were conducted to support the expedition objectives, including characterizing bottomfish and precious coral habitats, deep-sea coral habitats, seamounts, and fracture zones. Information about the general process of site selection, collaborative dive planning, scientific equipment on the ROVs, and the approach to benthic exploration used on the Okeanos Explorer can be found in Kennedy et al. (2019). During each dive, the ROVs Deep Discoverer and Seirios operated as a two-body system and descended to the seafloor and then moved from waypoint to waypoint, documenting the geology and biology of the area. Onboard and shore-based scientists identified each encountered organism to the lowest possible taxon. For this purpose, scientists used the online pilot version of the OER Benthic Deepwater Animal Identification Guide (http://oceanexplorer.noaa.gov/okeanos/animal_guide/animal_guide.html, accessed March 2020), as well as the online HURL animal guide https://www.soest.hawaii.edu/HURL/HURLarchive/guide.php, accessed March 2020). Additionally, onboard and shore-based scientists provided geological interpretations of the observed substrate throughout each ROV seafloor survey. Information to access Dive summary of each dive is included as Appendix A.

2.2 Specimen Collections

A limited number of geological and biological samples were collected on the seafloor using the manipulator arms and biological and geological collection boxes on ROV *Deep Discoverer.* For each collected specimen, the date, time, latitude, longitude, depth, salinity, temperature, and dissolved oxygen content were recorded at the time of collection. Geological specimen collections targeted samples for age dating and geochemical composition. Biological specimen collections targeted samples that represented potential new species, range extensions of animals not previously known to occur in the region, or dominant species in the area.

Once specimens were brought back onto the deck of the ship, they were examined for commensal organisms, labeled, photographed, and inventoried into a database containing all relevant metadata. Any commensal organisms found were separated from the sample and processed separately. Geological samples were air dried and placed in rock bags. These samples were then shipped to the Marine Geology Repository at Oregon State University after the 2017 expeditions, where they were analyzed in the laboratory for their chemical composition and geologic age. Biological samples were processed for DNA extractions using a kit provided by the Ocean Genome Legacy (OGL). For this purpose, a small subsample, consisting of not more than 1 cm^2 of tissue, was removed from the original sample and processed using the OGL DNA extraction kit. For most collected specimens, the remainder of the biological sample was preserved in 95% ethanol. Some of these specimens were also frozen. For select taxa, vouchers or subsamples were preserved in 10% buffered formalin for future histological examinations, with some of the subsamples transferred to 70% ethanol after three days. Full details about specimens collected during EX1705 can be found in Section 6.4.

At the conclusion of the 2017 expeditions, all DNA samples were sent to OGL for DNA sequencing and storage, whereas the biological specimens preserved in ethanol and formalin will be sent to the National Museum of Natural History, Smithsonian Institution, for taxonomic identification and permanent storage. Some corals and sponges may also be subsampled for accession at the Bernice Pauahi Bishop Museum in Honolulu, Hawai'i.

2.3 Seafloor Mapping

Mapping operations included Kongsberg EM 302 multibeam, Kongsberg EK60 singlebeam, Knudsen sub-bottom profile, and Acoustic Doppler Current Profiler (ADCP) data collection. The schedule of operations included overnight transit mapping and mapping whenever the ROV was on deck. Lines were planned to maximize either edge matching of existing data or data gap filling in areas where existing bathymetry coverage existed. In regions with no existing data, exploration transit lines were planned to optimize potential discoveries. Targeted mapping operations were conducted in the vicinity of: (1) American Sāmoa, (2) Marae Moana: Cook Islands Marine Park, (3) the Jarvis Island Unit of PRIMNM,

and (4) the Palmyra Atoll and Kingman Reef Unit of PRIMNM. All data from this expedition will be archived according to the EX1705 data management plan (Appendix B).

2.3.1 Multibeam Sonar (Kongsberg EM 302)

Multibeam seafloor mapping data were collected using the Kongsberg EM 302 sonar, which operates at a frequency of 30 kHz. Multibeam mapping operations were conducted during all overnight transits between ROV dive sites, which were designed to maximize coverage over seafloor areas with no previous high-resolution mapping data whenever feasible. Overnight surveys were also completed in some areas that were previously mapped with a lower resolution multibeam sonar system. Additionally, multibeam mapping operations were conducted directly over planned ROV dive locations in order to collect seafloor mapping data to help refine dive plans. Multibeam mapping operations collected data on seafloor depth (i.e., bathymetry), seafloor acoustic reflectivity (i.e., seafloor backscatter), and water column reflectivity (i.e., water column backscatter).

2.3.2 Sub-Bottom Profiler (Knudsen Chirp 3260)

The primary purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to image sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The sub-bottom profiler was operated simultaneously with the multibeam sonar during mapping operations in order to provide supplemental information about the sedimentary features underlying the seafloor.

2.3.3 Split-beam Sonars (Kongsberg EK60)

NOAA Ship *Okeanos Explorer* is equipped with five Kongsberg EK60 split-beam sonar transducers operated at frequencies of 18, 38, 70, 120 and 200 kHz. These sonars were used continuously (aside from the 38 kHz, which interferes with the multibeam during mapping operations) throughout the cruise during both overnight mapping operations and daytime ROV operations. The sonars provided calibrated target strength measurements on water column features such as dense biological layers or schools of fish. These sonars can also help detect the presence of gaseous seeps emanating from the seafloor. Data collected using the EK60 sonars were used during midwater transects of ROV dives to detect the depth of the deep scattering layers due to aggregations of biological organisms in the water column.

2.3.4 Acoustic Doppler Current Profiler (Teledyne Workhorse Mariner ADCP)

NOAA Ship *Okeanos Explorer* is equipped with two ADCPs: a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). However, only the 300 kHz ADCP was operational during this expedition. This ADCP had a reliable range of approximately 60 meters throughout the expedition and provided information on the speed and direction of currents underneath the ship. It was used throughout ROV dives to support safe deployment and recovery of the vehicles.

2.4 Sun Photometer Measurements

OER gathers limited at-sea measurements aboard NOAA Ship *Okeanos Explorer* in order to support a NASA-led, long-term research effort that assesses marine aerosols. Onboard personnel collected georeferenced sun photometer measurements on sunny days during the expedition in order to collect data to support the Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers which measure atmospheric aerosol properties around the world. MAN compliments AERONET by conducting sun photometer measurements on ships of opportunity in order to monitor aerosol properties over the global ocean. Sun photometer measurements were conducted as time allowed on cloud-free days.

3. Clearances and Permits

The expedition was planned and conducted by NOAA, as an agency of the U.S. federal government, in partnership with NOAA National Marine Fisheries Service (NMFS) Pacific Islands Regional Office Marine National Monument Program. We did not require a permit to work in PRIMNM. This project also involved Marine Scientific Research, as defined by the United Nations Law of the Sea Convention, in the waters of Kiribati and the Cook Islands. Copies of the diplomatic notes approving exploration activities can be found in Appendices C and E.

A request to conduct operations in NMSAS was submitted and received (permit #NMSAS-2017-001). Please see Appendix C for the full text.

A request to conduct operations and collect samples in the territorial waters of American Sāmoa was submitted to the Department of Marine and Wildlife Resources. The permit was received on January 19, 2017—full text is included in Appendix C.

A permit to conduct exploration activities inside of Marae Moana: Cook Islands Marine Park was requested and received (permit # 05/17). Please see Appendix C for the full text.

Pursuant to the National Environmental Policy Act (NEPA), NOAA OER is required to include in its planning and decision-making processes appropriate and careful consideration of the potential environmental consequences of actions it proposes to fund, authorize, and/or conduct. NOAA's Administrative Order (NAO) 216-6A Companion Manual (https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf, accessed March 2020) describes the agency's specific procedures for NEPA compliance. Among these is the need to review all proposed NOAA-supported field projects for their environmental effects. An environmental review analysis was completed for this expedition in accordance with Section 4 of the Companion Manual. Based on this review, a categorical exclusion was determined to be the appropriate level of NEPA analysis for this expedition, as no

extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement.

Informal consultation was initiated under Section 7 of the Endangered Species Act (ESA), requesting NMFS' Protected Resources Division concurrence with our biological evaluation determining that the 2016 Marianas Expedition and all other planned NOAA Ship *Okeanos Explorer* operations during the 2016-17 expeditions may affect, but are not likely to adversely affect, ESA-listed marine species. The informal consultation was completed on February 3, 2016, when NOAA OER received a signed letter from the Regional Administrator of NMFS Pacific Islands Regional Office, stating that NMFS concurs with OER's determination that conducting proposed NOAA Ship *Okeanos Explorer* cruises are not likely to adversely affect ESA-listed marine species (Appendix D).

OER completed consultation with NOAA's Habitat Conservation Division on potential impacts of our operations to Essential Fish Habitat (EFH). They concurred that our operations would not adversely affect EFH provided adherence to our proposed procedures and their guidance stated in the letter (Appendix D). Additionally Kiribati Diplomatic Clearance (Appendix E) and ARGO Float Permits (Appendix F) were obtained.

4. Expedition Schedule

The expedition was planned for a total of 23 days at sea, from April 27, 2017, to May 19, 2017, departing from Pago Pago, American Sāmoa and ending in Honolulu, Hawai'i. There were 15 scheduled dives, with 12 dives achieved (Table 4). We lost one dive due to a mechanical problem with the ship's dynamic positioning (DP) system and two more dives due to weather. An additional four dives were cut short due to mechanical issues or weather.

Table 3. Schedule of the EX1705, Mountains in the Deep: Exploring the Central Pacific Basin, expedition.

SUN	MON	TUES	WED	THURS	FRI	SAT
4/23	**4/24**	**4/25**	**4/26**	**4/27** **EX Departs** **Dive #1:** **Aunu'u Unit** **Overnight mapping operations**	**4/28** **Transit mapping**	**4/29** **Transit mapping** **Outreach:** OER Professional Development Workshop Interaction

4/30 **Dive #2 -** Te Tukunga o Fakahotu **Overnight mapping operations**	**5/1** **Dive Canceled** **Focused mapping of ridge north of Manihiki Plateau** ARGO 1 deployment @ 19:00 **Outreach:** Reddit "Ask Us Anything"	**5/2** **Dive #3** Te Kawhiti + Water column transects **Overnight mapping operations** **Outreach:** NIWA Interaction	**5/3** **Transit mapping** ARGO 2 deployment @ 06:30 **Outreach:** Live interaction with Cook Islands schools	**5/4** **Dive #4** Kahalewai **Overnight mapping operations** ARGO 3 deployment @ 17:00	**5/5** **Dive #5** Jarvis Island **Overnight mapping operations**	**5/6** **Dive #6** Keli'hananui + Water column transects **Overnight mapping operations**
5/7 **Dive #7** Whaley Seamount **Overnight mapping operations**	**5/8** **Dive #8** Fracture zone **Overnight mapping operations**	**5/9** **Transit Mapping**	**5/10** **Dive #9** Palmyra Seamount **Overnight mapping operations**	**5/11** **Dive #10** Palmyra Atoll **Overnight mapping operations** Transfer of propane to Palmyra via small boat	**5/12** **Dive #11** Kingman Cone **Overnight mapping operations**	**5/13** **Dive #12** Deep Kingman **Overnight mapping operations**
5/14 **Dive canceled** **Focused seamount mapping and transit mapping**	**5/15** **Dive Canceled/ Transit mapping** **Outreach:** Live interaction Tami Lunsford and students Live interaction with Acting NOAA Administrator	**5/16** **Transit mapping** Ship shifts to HST overnight **Outreach:** Facebook live	**5/17** **Transit mapping**	**5/18** **Transit mapping** Expedition team wrap up call **Outreach:** Facebook live	**5/19** **EX arrives in Honolulu, HI** **Outreach:** OAR Assistant Administrator	**5/20** **Mission team departs**

5. Expedition Map

EX1705 operations spanned multiple sections of the U.S. Exclusive Economic Zone (EEZ), NMSAS, the Jarvis Island and Palmyra Atoll and Kingman Reef Units of PRIMNM, the Cook Islands EEZ, and the high seas (Figure 1).

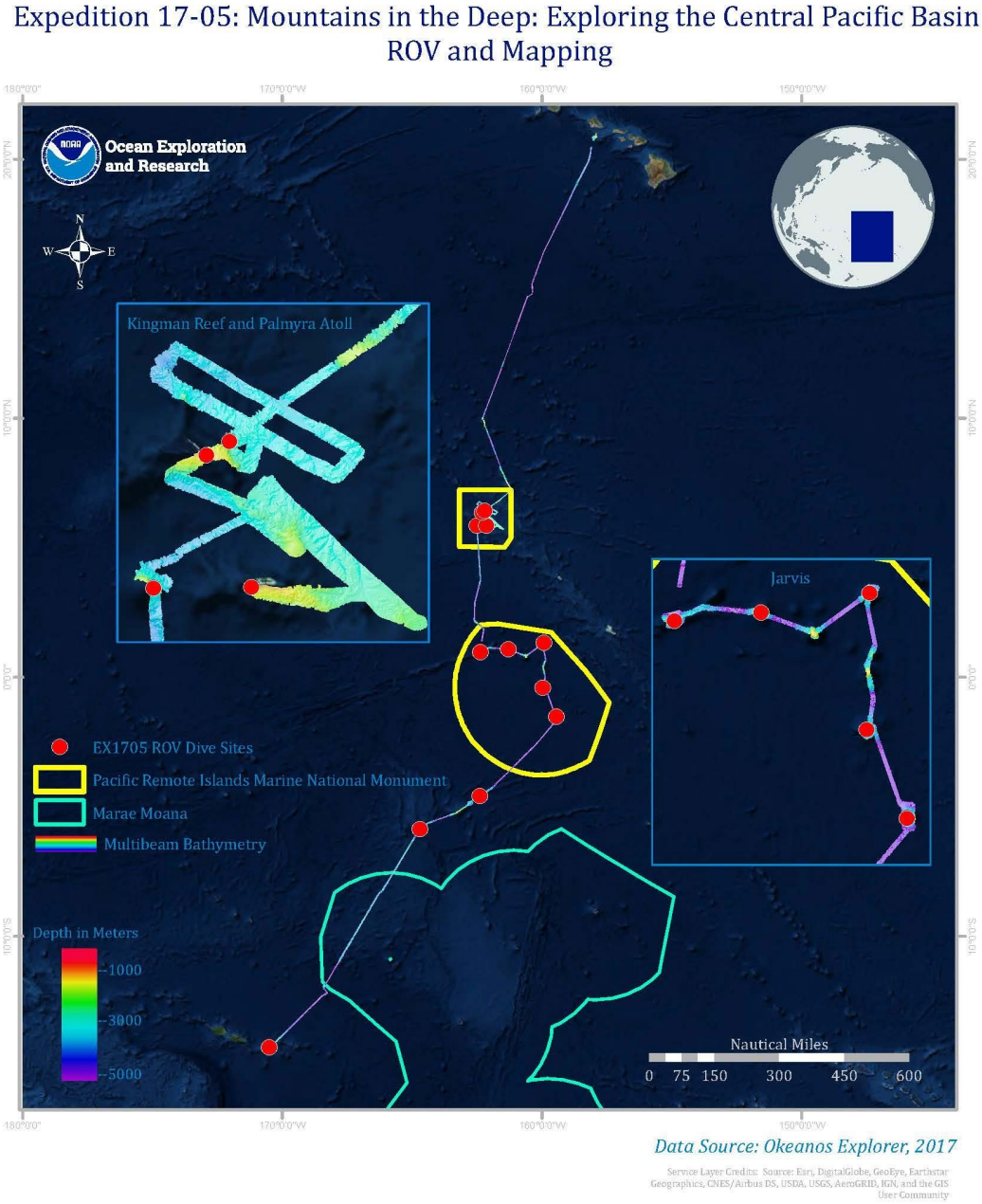


Figure 1. Map showing the locations of the 12 ROV dives and bathymetry data collected during EX1705.

6. Results

Depth ranges explored during ROV surveys were between 230 m and 4,573 m. During the 12 dives, the ROV spent a total of 49:58:06 hours on the bottom and 3:00:00 hours conducting water column exploration.

Table 4. Summary information for the 12 ROV dives conducted during EX1705.

Dive #	Date	Site name	On Bottom Location	Off Bottom Location	Max Depth (m)	Bottom Time	Water Column Transect Time	Dive Duration
1	4/27/17	Aunu'u Unit	14°, 16.892' S; 170°, 30.091' W	14°, 16.887' S; 170°, 30.100' W	291.2	0:19:43		1:49:52
2	4/30/17	“Te Tukunga o Fakahotu”	05°, 51.648' S; 164°, 41.850' W	05°, 51.592' S; 164°, 41.856' W	2495.1	1:52:13		4:59:34
3	5/2/17	“Te Kawhiti o Maui Potiki”	04°, 35.090' S; 162°, 23.932' W	04°, 34.928' S; 162°, 23.774' W	2219.7	5:20:40	80 mins	10:02:59
4	5/4/17	"Kahalewai" Seamount	01°, 30.699' S; 159°, 27.417' W	01°, 30.479' S; 159°, 27.265' W	1700.0	6:00:37		8:08:40
5	5/5/17	Jarvis Island	00°, 23.977' S; 159°, 57.967' W	00°, 23.463' S; 159°, 57.951' W	819.3	7:06:58		8:02:37
6	5/6/17	"Keli'ihananui" Seamount	01°, 19.437' N; 159°, 55.841' W	01°, 19.353' N; 159°, 55.977' W	1934.1	2:54:28	60 mins	8:15:02
7	5/7/17	Whaley Seamount	01°, 04.941' N; 161°, 16.954' W	01°, 04.686' N; 161°, 17.203' W	1103.1	6:28:23		8:12:25
8	5/8/17	Fracture Zone	00°, 58.599' N; 162°, 22.832' W	00°, 58.744' N; 162°, 23.013' W	4573.4	4:43:52		9:58:47
9	5/10/17	West Palmyra Seamount	05°, 51.173' N; 162°, 30.572' W	05°, 51.135' N; 162°, 30.674' W	2171.8	1:48:28		4:19:49
10	5/11/17	South Palmyra Slope	05°, 51.325' N; 162°, 07.979' W	05°, 51.482' N; 162°, 07.993' W	491.7	4:01:44		5:04:36
11	5/12/17	Kingman Cone	06°, 21.911' N; 162°, 18.333' W	06°, 21.944' N; 162°, 18.385' W	1029.1	3:08:44		4:44:36
12	5/13/17	Deep Kingman	06°, 24.993' N; 162°, 12.905' W	06°, 25.149' N; 162°, 13.285' W	2254.6	6:12:16	40 mins	9:49:44

6.1 Geology Summary

6.1.1 Aunu'u Unit, NMSAS

Dive #1 took place in the Aunu'u Unit of NMSAS. The Samoan Islands show a linear age progression, consistent with a hotspot model of volcanism. Growth of the islands of American Sāmoa and Western Sāmoa took place between 5-0.4 Ma on Cretaceous age seafloor (Koppers et al., 2008). Slow subsidence of the islands has created a submerged carbonate reef platform that extends into the modern reef above.

The ROV traversed up a steep wall along the eastern margin of a carbonate reef platform between depths of 290 and 200 m. Small channels or grooves (approximately 20 to 40 cm in width and depth) were spaced up to a few meters apart along the steep wall. Light-colored sediments, sourced from the modern reef, were transported down these channels into deeper water. Demosponges trapping sediments on their upslope side were observed within some of these channels. The carbonate outcrops were massive in appearance, with a slight increase in the size and number of cavities toward the shallower portions of the dive. This provided additional three-dimensional habitat for marine life within the Aunu'u Unit of NMSAS.

6.1.2 Manihiki Plateau

The Manihiki Plateau is a submarine large igneous province that formed prior to 120 Ma in association with a massive plume or hotspot. It was once part of a much bigger volcanic province that included the Ontong Java and Hikurangi Plateaus, which rifted apart not long after they were formed (Taylor, 2006).

Dive #2 was conducted in the northern Manihiki Plateau on the eastern edge of an elongated mesa-shaped feature with a depth of ~1,850 m across its broad summit. Regional bathymetric data show that there are a series of narrow elongate ridges and basins to the south-southeast of the bathymetric feature that may have formed during earlier rifting of the Manihiki Plateau. The dive began at a depth of 2,500 m and touched down on ferromanganese (FeMn)-crusted rocks, some of which appeared to be pillow flows. Light-colored biogenic sediments were accumulated between the rocks, but the upper surfaces of the rocks were largely sediment-free. Moving upslope, the number of loose boulders increased and a weak fracture pattern was noted in the ROV *Seirios* view. Throughout the dive higher densities of suspension-feeding fauna were observed on the top of taller rock outcrops and boulders.

Dive #3 investigated a large ridge structure that connects to the Manihiki Plateau. It is one of a series of similar curvilinear ridges that extend from the northern margin of the plateau. Sea-surface altimetry data indicated that the crest of the ridge was at a depth of ~3,300 m; however, subsequent shipboard multibeam mapping overnight showed that the depth of the ridge crest was ~2,200 m. These new

bathymetric data also revealed a number of small cones and lava flow terraces that document the volcanic nature of this feature. The ROV began on the south side of the ridge and worked upslope, covering a distance of 100 m. The ROV then followed the crest of the ridge for several hundred meters and submitted atop a local high point on the ridge crest. The geology showed mostly in-place outcrops of rock. These rocks were dark in color and covered with FeMn crust; however, pillow-like structures were evident along some sections of the ROV path. Light-colored biogenic sediments filled in the low topography between the outcropping rocks.

6.1.3 Jarvis Island Unit of PRIMNM

Seamounts within the Jarvis Island Unit of PRIMNM are part of the Line Islands linear volcanic chain formed on mid-Cretaceous age seafloor (Davis et al 2002). Recent work has shown that the age of volcanoes is nearly the same along major segments of the chain (90-70 Ma). Such coeval volcanism, over distances of several thousand kilometers, cannot be easily reconciled with a hotspot model.

Dive #4 was conducted on Kahalewai seamount—a volcanic edifice with four prominent ridges extending from its otherwise symmetrical cone and having a summit depth of ~950 m. The dive targeted the prominent south-southwest trending ridge at depths between 1,700 and 1,500 m depth. A thick FeMn crust, covering largely in-place rocks, was evident throughout the dive. Light colored, biogenic sediments were deposited in crevasses and topographic lows. In some of the larger areas of sediment cover, ripples were observed, indicating a dominant flow direction from north to south (this is consistent with the bottom current conditions reported by the ROV pilots). These larger areas of sediment cover provided habitat for sea pen corals. Despite the FeMn crust covering the rock, the ROV imaged collapsed lava tubes and lobate to pillow flow structures in some places.

Dive #6 investigated Keli‘ihananui seamount, a volcanic edifice with a flat-topped summit at a depth of ~1,100 m. Multibeam bathymetry shows a back-tilted block near the base of the eastern face of the volcano, perhaps indicating a previous period of landsliding. The pooling of sediment behind this block, as inferred from the backscatter data, suggests that this feature is not recent. The dive targeted the northern ridge of the seamount, along the margins of this potential slide. The ROV traversed between a depth of 1,950 and 1,750 m. The seafloor in this area has light-colored biogenic sediments interspersed with outcrops of FeMn-crusted rocks having botryoidal textures. Symmetric ripples were developed in some areas and, in places, small amounts of darker sedimentary material were pooled on top of the lighter-colored sediments. These sediments may represent more organic-rich material recently deposited from the upper water column. Despite the FeMn crust covering the rocks, they appeared to be largely in place with morphologies consistent with submarine volcanic flows.

Dive #7 was on Whaley seamount. This seamount has a flat-summit region at a depth of 1,100 m, with several small cones extending from this upper surface. The ROV traversed along the northern side of the largest of these cones, reaching its local peak at 800 m depth. The seafloor in this area has light-colored, biogenic sediments interspersed with outcrops of rock with extensive FeMn crusts. Symmetric ripples, with crests aligned approximately N-S, were present in the more sedimented areas throughout the dive. Given the relatively shallow depth of the summit and its overall morphology, these FeMn crusts are likely covering a carbonate reef material that was formed when the summit of the seamount was at shallower depths.

6.1.4 Clipperton Fracture Zone

Dive #8 took a deep dive into the geologic history of the Pacific seafloor. The ROV descended to depth of 4,600 m along the far western most edge of the Clipperton Fracture Zone. This feature is among the longest tectonic structures on Earth, extending from the Line Islands all the way to the modern East Pacific Rise.

The ROV transited up the south-facing slope of an east-northeast trending ridge along the fracture zone. The scarp was uniform in slope and was largely devoid of sediment, exposing a thick FeMn crust. Based on the overall morphology of the seafloor, there was no indication that the ridge was formed by secondary volcanism associated with the formation of the Line Islands. Rather, this ridge was likely formed in response to transtension or transpression associated with changes in relative plate motion, as this part of the Pacific plate formed. The scarp face, therefore, may represent a tectonic window into the upper ocean crust formed more than 120 million years ago.

6.1.5 Palmyra Atoll and Kingman Reef Unit of PRIMNM

Kingman Reef and Palmyra Atoll are the exposed summits of two seamounts within the Line Islands Volcanic Chain in the central Pacific Ocean. The islands are the last subaerial remnants of a horseshoe-shaped volcanic platform spanning roughly 200 km in diameter. The elevated platform from which the seamounts arise comprises about a dozen individual volcanic centers that have heights exceeding 3,000 m above the nearby abyssal plains. Flat-topped seamounts (guyots) are principally found at depths shallower than 1,300 m, while peaked seamounts are almost exclusively found at greater depths (Eakins et al., 2017). Carbonate material is moved from the islands into deep water via a complex network of submarine canyons (Lyle et al., 2016).

Dive #9 climbed the eastern flank of an unnamed seamount located to the west of Palmyra Atoll between 2,140 m and 2,090 m depth. FeMn-crusted volcanic rocks were exposed on the seafloor. Light-colored

sediments were pooled in small areas with symmetric ripples formed by bottom currents. The dive ended early due to weather. No geological samples were collected.

Dive #10 traversed the southwest margin of the Palmyra Atoll between depths of 490 and 300 m. The average slope was ~40 degrees, as measured from the multibeam; however, steeper sections were observed locally during the dive. The dive crossed submerged reef that was devoid of FeMn-crusted material. Sediments and rubble from the upper carbonate platform were also observed throughout the dive, as were calcified algae chips. Minor amounts of terrestrial wood and leafy plant material were observed as falls.

Dive #11 began at the base of one of several small cones on the flat-topped platform extending to the east-southeast of Kingman Reef. The dive extended between a depth of 1,029 and 990 m. The ROV encountered a flat pavement of FeMn-crusted rock with a very thin dusting of light-colored sediment, suggesting strong currents moving across this shallow platform. Near the base of the cone, larger blocks of rocks were encountered with thicker deposits of sediments pooling their lee side. Given the depth of the seafloor, the FeMn crusts are likely deposited on submerged carbonate reef material.

Dive #12 began in deep water (2,250 m) to the northeast of Kingman reef. The dive extended along the slope of a small cone to a depth of 1,820 m at its summit. FeMn-crusted rocks with small amounts of light colored (biogenic) sediment characterized the seafloor in this region. The overall morphology of the rocks exposed on the seafloor is consistent with volcanic origin; short lava tubes, pillows, and small flow terraces became more evident near the top of the cone. An area of collapse was evident at the summit.

6.2 Biology Summary

6.2.1 Aunu'u Unit of NMSAS

Dive #1 Sessile fauna were sparse and patchy; throughout the dive, overall densities were low. Black corals were the most abundant sessile animal, particularly unbranched wire coral (*Stichopathes* sp., Antipatharia). A number of small (<3 cm) orange cup corals (Scleractinia) were seen during close-ups of the bottom. Other corals observed were all Octocorallia: possible Parisididae, a gorgonian sea fan (?*Paracis* sp.) with chirostylid crab (*Chirostylus* sp.), shrimp and brittle star (Ophiuroidea) associates, and a purple sea fan (?Plexauridae or Gorgoniidae). One zigzag-shaped, elongated skeleton was overgrown with dark zoanthids (Zoanthidea). Observations of sponges were restricted to encrusting blue-colored demosponges and white mound demosponges; most of the latter were observed within erosion channels. Occasional observations of encrusting reddish-purple patches were interpreted as coralline red algae.

Observations of mobile fauna were also sparse. Swarms of pandalid shrimp (*Plesionika* sp.) were observed below overhangs where snapper (*Paracaesio* sp.) were also seen. Other crustaceans observed included a munid squat lobster (*Babamunida* sp.) and a hermit crab (Paguridae). Three species of sea star were seen: Circeaster pullus (Goniasteridae), *Nepanthia* sp. (Asterinidae), and a *Brisingaster* sp. (Brisingidae) that was perched on a black coral whip. Brittle stars (Ophiuroidea) were observed only on coral colonies and not directly on any rock. A small octopus (<10 cm) was observed associated with cavities in the wall.

Among the fishes that were seen were snappers (*Paracaesio* sp.), groupers (*Cephalophilus* sp.), diamond tails (*Grammatonotus*), possible pomfret (Bramidae), bassletts, duckbill (*Chrionema* sp.), and a mesophotic goby (considered an unusual observation for this depth—235 m). The extreme slope we traversed was likely not an optimal habitat for bottom fishes, which prefer ledges and deep crevices for hiding along with lots of prey species. Abandoned fishing gear, mostly long stretches of line, were observed throughout the dive.

6.2.2. Manihiki Plateau

Two—of three planned—dives were conducted on the Manihiki Plateau, both on features dominated by exposed FeMn-crusted rock. The depths explored were similar, but the major geomorphology differed: the dive to Te Tukunga o Fakahotu climbed the slope of a mesa-like structure to ~2,450 m depth, while the dive on Te Kawhiti a Maui Potiki mostly traversed a ridge crest at ~2,200 to 2,000 m depth. There were major differences in the density of the communities between the dive sites, possibly due to the interaction with dominant current flow. All of the octocoral and black coral species seen in very low numbers on Te Tukunga o Fakahotu (Dive #2) were also seen on Te Kawhiti a Maui Potiki (Dive #3), but many additional species were observed on Dive #3 in a high-density coral bed.

Dive #2 Overall fauna were fairly sparse along the dive track, possibly because we dove on the sheltered (west) side of the ridge. The most abundant megafaunal taxa were brisingids (Echinodermata, Asteroidea) and stalked tunicates (?*Culeolus* sp.); smaller box-shaped sessile tunicates were also seen regularly.

Among the sessile fauna, coral and sponge species were observed only as singletons (i.e., a single observation of each species). These included octocorals: *Anthomastus* (a recent recruit of only two polyps); Rock pen (Pennatulacea, ?*Calibelemnon* sp.) with commensal polychaete; three species of bamboo coral (Isididae), one (?*Isidella* sp.) with a brittle star (Ophiacanthidae) positioned on a part of the colony lacking tissue. This observation has now been made a number times and begs the question of whether the ophiuroid causes the loss of tissue, or whether it takes advantage of a bare spot on the colony. Interestingly, the coral tissue above the ophiacanthid showed swellings suggestive of nematocyst

batteries, which could be interpreted as a defensive response to predation. One black coral species (*Trissopathes* sp.) was seen, as were sponges, including several *Pyloderma* demosponges and small carnivorous Cladorhizidae, and glass sponges (Hexactinellida, *Caulophacus* sp.).

No fish was seen during the benthic survey despite patches of soft sediments containing potential prey scattered over the rock. Representatives of all five echinoderm classes were observed and brisingid asteroids were among the most abundant fauna seen throughout dive (none with arms raised). At least four species of crinoids, four species of sea cucumbers (Holothuroidea), two species of seastars (including the commonly observed brisingid and a *Hymenaster* sp.), one sea urchin (Echinoidea, ?*Plesiodiadema* sp.) and at least one species of brittle star (Ophiuroidea; seen on a bamboo coral) were noted.

Other notable fauna were stannomid xenophyophores; burrowing anemone (Actiniaria); munidopsid crabs (Galatheoidea); shrimp (Aristeidae); a tumbling snail (Margaritidae, *Gaza* sp.); and predatory snails (Eulimidae) on the stalk of a crinoid (Bathycrinidae)—along with barnacles and hydroids.

Dive #3 Sessile fauna were abundant and diverse throughout the dive. In particular, bamboo corals (Isididae) comprised a dense forest, with at least many hundreds, if not thousands, of colonies. The dominant species in the forest (possible S1 clade/*Cladarisis* sp.) had the form of an open irregularly branched bush. Many of the colonies were of immense size, taller than the ROV. A sample of the dominant isidid was collected and it was discovered that the colonies were extremely fragile, which supports the tentative ID of *Cladarisis* sp. ("From kladaros, Gr. = easily broken, frail, referring to the brittleness of the axis, causing it to break with the slightest amount of handling," Watling, 2015). Many broken branches and dead colonies were seen scattered in areas of live colonies. Most live colonies had crinoids perched on branches (possibly three different species); on several occasions we encountered upright colonies stripped of tissue and completely covered in crinoids. Other associates of the "*Cladarisis*" included overgrowing zoanthids (at least two species), brittle stars (Ophiacanthidae), and gooseneck barnacles.

Other corals observed included octocorals: *Anthomastus* sp., Rock pen (Pennatulacea, ?*Calibelemnon* sp.), *Chrysogorgia* spp. (at least two species) with chirostylid squat lobster (*Uroptychus* sp.) associates, Paragorgiidae, at least three additional species of bamboo corals (*Jasonisis* sp., whip, Keratoisidinae), Corallidae (sampled), and *Iridogorgia* sp.; and black corals: *Heteropathes* sp., *Bathypathes* sp., *Trissopathes* sp., Antipathidae.

Sponge observations included a possible new species of glass sponge in the genus *Walteria*, a specimen of which was collected, carnivorous Cladorhizidae, and glass sponges (Hexactinellida) *Corbitella* sp., *Saccocalyx* sp., ?*Regadrella* sp., *Walteria* sp., *Dictyaulus* sp., and Bolosominae (Euplectellidae).

Fish were uncommon, but observations included Antimora (Moridae), rattail (Macrouridae), and cusk eel (*Diplacanthopoma* sp., Bythitidae).

Other biological observations included two species of anemone (Actiniaria), munidopsid crabs (Galatheoidea, *Munida* sp.), king crabs (*Paralomis* sp., Lithodidae), shrimp (*Nematocarcinus* sp., Acanthephyridae, another with bopyrid isopod parasite), hermit crabs carrying Epizoanthids (Paguroidea), gooseneck barnacles, three species of seastars (brisingids, corallivorous *Hippasteria* sp. [Goniasteridae] and a *Hymenaster* sp.), sea urchin (Echinothuriidae), and a fourth species or crinoid (on the rock substrate) with 10 arms and tips lacking cirri. Many of the crinoids imaged showed predatory snails (Eulimidae) attached to the arms; two of these snails were preserved from crinoids that were perched on a sampled *Walteria* sponge.

6.2.3 Jarvis Island Unit of PRIMNM

Five dives were conducted in the Jarvis Island Unit of PRIMNM, three on ridges extending from seamounts at different depths, a shallower dive on the flank of Jarvis Island, and an abyssal dive to the Western Clipperton Fracture Zone. There were major differences in density and composition of the communities between the dive sites, particularly—and unsurprisingly—between depth zones. Corals were fairly sparse between 1,700 and 1,500 m depth on "Kahalewai" Seamount, where crinoids were the dominant fauna. On the Jarvis Island slope, the abundance and diversity of fauna was very high. This stark difference, compared to the other dives, was likely a factor of the shallower depths explored and the dive site being on the flanks of an emergent island, where downslope transport of organic matter is likely enhanced compared to deep seamounts.

Dive #4 The dive began with observations of a field of large bamboo coral (Isididae) colonies; species included "*Jasonisis*"/J-clade fans, sparse bush/S1 clade as seen on Dive #3, and large, yellow, open bushes (likely clade S1), including a magnificently large colony from which a branch clipping was sampled. However, the densities of these octocorals never approached the "forest" scale seen on Dive #3 and, for much of the dive, abundant corals were not observed, effectively replaced by crinoids and barnacles as the dominant sessile fauna. The octocorals observed included *Anthomastus*, *Metallogorgia* (with seemingly extra large polyps), *Iridogorgia* sp., primnoids (?*Callogorgia* sp. with asteroschematid ophiuroid), whip bamboo corals (Keratoisidinae)—including some colonies with a single branch, plexaurid fans (?Paramuriceids), *Chrysogorgia* spp., *Coralliidae* sp. (with asteroschematid ophiuroid), rock pen (Pennatulacea, ?*Anthoptilum* sp.), and Paragorgiidae (with a dumbo octopus egg [*Grimpoteuthis sp.*]). *Halipteris* sea pens were abundant in rippled sediment channels set among the exposed rock. A possible *Heteropathes* sp. was the only black coral observed. Sponge observations included several Bolosominae (Euplectellidae) and a Farreidae. Low-growing and encrusting fauna were not uncommon,

represented by purple stoloniferous octocorals (?*Clavularia* sp.), sponges, and barnacles (both pedunculate and sessile), which were very numerous on the rock floor throughout the dive.

For much of the dive, crinoids were the dominant fauna, both feather stars (comatulids and stalked sea lilies); a stalked Proisocrinidae was collected. Many of the stalked crinoids were host to numerous myzostome polychaetes, perhaps gall forming. Sea urchins were also common and abundant throughout the dive, mainly long, curved-spine Aspidodiadematidae (*Plesiodiadema* sp.) and robust-spine *Caenopedina* sp. (Pedinidae), but also two species of leather urchins (Echinothuriidae: *Sperosoma Tromikosoma*). Ophiuroid brittle stars were characteristically common, but an observation of an *Asteronyx* sp. on a bamboo coral was unusual. Other echinoderms included sea cucumbers (Holothuroidea, Synallactidae) and sea stars (Benthopectinidae and *Hymenaster* sp.). Pagurid hermit crabs and chirostylid squat lobsters were common. Other crustaceans included a homolid crab carrying an anemone and a possible Lophogastridae (?Gnathophausiidae). Molluscs seen included a chiton (discovered responsible for leaving characteristic meandering feeding traces on rock surfaces) and an aplacophoran feeding on bamboo coral.

Observations of fishes were limited to a synaphobranchid eel (*Ilyophis* sp.) and small elongate macrourid (*Nezumia* sp.).

Dive #5 This was a stunning dive for biology, both in terms of abundance and diversity—likely in part due to the shallower depth range (~ 800 m) explored compared to other dives in the Jarvis Island Unit of PRIMNM. The sedimented seafloor was littered with dead and broken scleractinian coral branches, likely of the genus *Madrepora*. Many small live clumps of Madrepora were scattered throughout this coral rubble field. The clumps provided perches for crinoids, ophiuroids, chirostylid squat lobsters, and lepadomorph barnacles. The occasional plexaurid sea fan, *Anthomastus* sp. mushroom coral, and Chrysogorgia were seen in this area, as well as a variety of sea stars, sea urchins (Echinothuridae), benthic shrimp, *Geryon* golden crabs, and several fishes, including goosefish (Lophiidae *Lophiodes*), rattails (Macrouridae, Coelorinchus), oreos (Oreosomatidae, *Neocyttus* sp.) and congrid eels (*Bathycongrus* sp.).

More rock outcroppings were encountered upslope and these provided habitat for many interesting sponges, ribbon-like stoloniferous octocorals, cup corals, sea anemones, giant solitary hydroids (Corymorphidae), and ubiquitous brittle stars. We saw more *Geryon* golden crabs, including several females carrying eggs. On exposed carbonate were extensive carpets of small anemones or zoanthids, ledges packed with urchins (?Pedinidae), vertical walls stacked with psolid holothurians (one was collected with the ROV scoop tool), and expanses of polychaete tube thickets that held a variety of fauna (including caprellid amphipods).

At 433 m depth, a most incredible predation event was observed: brittle stars (Ophiotrichidae) raising their arms above the seafloor snagged a squid from the water column, which was eventually subdued by one individual and then lost to another. The squid may have been a midwater vertical migrator, *Abralia* sp. At 415 m, we encountered bamboo coral colonies (?*Isidella*) being overgrown by a yellow zoanthid, perhaps the gold coral *Kulamanamana* sp. At 385 m, we began to encounter vast areas of low-relief that were dense with primnoid fans (?*Thouarella* sp.) and urchins; at least one primnoid colony was observed with two snails (?Ovulidae) in its branches.

The dive culminated in a spectacular colorful tableau at 375 m depth: an eroded carbonate structure that took on the shape of a toadstool topped with densely packed corals, sponges, and mobile animals. The surrounding seafloor was bare, with the exception of hundreds of grazing urchins. A school of Randall's Snapper (*Randallichthys filamentosus*) were seen swimming past the feature.

Other corals observed during the dive included octocorals—a tubiculous ribbon coral (?*Telestula* sp.), *Swiftia*-like Plexauridae, several primnoids, *Chrysogorgia* sp. with chirostylid squat lobsters, bamboo coral; Black coral (Antipatharia)—?*Umbellapathes* sp., *Leiopathes* sp.; stony coral (Scleractinia)—*Enallopsammia* sp.; and multiple species of cup corals—including the very colorful *Trochocyathus* sp.

Many fishes were observed throughout the dive. Especially abundant were congrid eels (*Bathycongrus* sp.) and snake eels (Ophichthidae, *Ophichthus* sp.); the latter have pointed tails they use to dig into sediments to create burrows. Other eels included false moray (*Chlopsis* sp.), duckbill eel (Nettastomatidae), and a pair of bright yellow-striped eels (Myrocongridae). Several cusk eels (Ophidiidae) were seen, including *Pycnocraspedum* sp. and members of the genus *Neobythites*. The *Neobythites* spp. were seen repeatedly and exclusively inside and around corals, the first time we have documented a coral association for this group. Mesophotic fishes such as lantern bellies (Acropomadidae, ?*Synagrops* sp.), deepwater cardinal fishes (*Epigonus* sp.) and barred basslets (Serranidae—*Plectranthias* sp.) were observed. Oreosomatidae (*Neocyttus* sp.) were abundant, and observations of the following fishes were also noted: spikefish (Triacanthodidae *Hollardia* sp.), boarfish (Caproidae *Antigonia* sp.), armoured searobins (*Scalicus* sp.), roughy (*Hoplostethus* sp.), codlings (Moridae *Physiculus* sp. and a black-bodied species), tonguefish (Cynoglossidae), gold-spotted duckbill (*Chrionema chryseres*), several greeneyes (Chlorophthalmidae *Chlorophthalmus* sp.), and a smalltooth sand tiger shark (*Odontaspis ferox*). Shortly before acquiring bottom we observed black scorpionfish (*Ectreposebastes imus*) in the water column drifting head up with their huge pectoral fins stretched out. *E. imus* are vertical migrators; this behavior is uncommon for this group.

Some other notable observations included the poorly known seastar *Tremaster mirabilis,* basketstars (Gorgonocephalidae), *Pleurobranchea* slugs, dorid nudibranchs (*Plocamopherus* sp.) with knob light

organs, an octopus, an *Enallopsammia* coral apparently being grazed upon by echinothurid and histocidarid urchins, cone snails, spatangoid urchins, and an elbow crab (Parthenopidae).

Dive #6 Overall, the sessile fauna were sparse, but octocorals and sponges were seen in places throughout the dive track. Initially, we were on a sedimented bottom that appeared to be fairly heavily covered in possible phytodetritus (light, olive-colored material accumulating in depressions). As we traversed upslope, we began to see rock outcrops and fauna associated with them.

Octocorals observed during the dive included bamboo corals (Isididae)—a whip with a chirostylid squat lobster and a sparsely branched *Keratoisis* sp.; *Metallogorgia melanotrichos*; a purple ribbon-like *Clavularia* sp.; and Acanthogorgiidae. No scleractinian or antipatharian corals were seen. Several different species of octocoral were host to large (relative to coral size) asteroschematid ophiuroids: *Callogorgia* sp., *Paragorgia* sp., and coralliids (both *Hemicorallium* sp. and *Pleurocorallium* sp.); most of these also suffered from overgrowing zoanthids.

A number of sponges were seen, including an unrecognized vase-shaped glass sponge (?Rossellidae), which was collected, a *Polyopogon*-like morph, and euplectellids including *Bolosoma* sp., *Dictyaulus* sp., *Regadrella* sp., and an unknown multi-stalked morph, which was seen multiple times—though all were dead skeletons.

Only six individual fish were seen on the benthic portion of the dive, all cusk eels in the genus *Bassozetus*. Fishes seen in the midwater include hatchetfish, myctophids (laternfish), and gonostomatids (bristlemouths).

Other fauna seen included pagurid crab with anemone, pycnogonid sea spider (*Collossendeis* sp.), octacnedmid tunicate, urchins (*Plesiodiadema* sp.), synallactid holothurians, brisingids, a myxasterid slime star (*Asthenactis* sp.), several crinoids (*Glyptometra* sp., *Pentrametrocrinus* sp., *Proisocrinus rubberimus*), an aplacophoran feeding on a solitary hydroid (Tubulariidae), a velutinid snail, and a murex snail.

Dive #7 Biological communities varied along the dive track in association with the degree of sedimentation, number of rock outcrops, and steeper slopes with more exposed hard substrata. The landing spot was heavily sedimented and rippled; several fishes were seen (see below) as well as a sea pen (?Chunellidae) that had not previously been observed on the expedition. Rock outcrops provided habitat to crinoids, demosponges, long-armed galatheid crabs (Munidopsidae), ?murex snails, and octocorals hosting asteroschematid brittle stars (*Narella* sp., *Paramuricea* sp.).

As we climbed the slope of the cone, widespread sedimented bottom was replaced by dominance of exposed rock. Corals observed on the slope included *Pleurocorallium ?kishinouyei* (with aplacophoran at its base), *Chrysogorgia* spp. (bottlebrush forms hosting chirostylid crabs), *Paramuricea* sea fans (with asteroschematids), many colonies of an unidentified biflabellate primnoid (possibly the morph collected on EX1703), clavulariid ribbon coral, unidentified plexaurid sea fans, *Iridogorgia* sp.; white *Enallopsammia* scleractinians; and black corals (*Hexapathes* sp.). Sponge observations included glass sponges (*Regadrella* sp. and *Caulophacus* sp.) and carnivorous demosponges (Cladorhizidae). Other notable biological observations were corallimorpharians, pagurid crabs, and myxasterid seastars (*Asthenactis* sp.).

Further upslope sediments once again dominated; sea pens (Pennatula), comatulid crinoids, asteroid seastars, tripod fish (*Bathypterois atricolor*), stalked spheronematid sponge and xenophyophores were notable. As rock outcrops again became common, fauna included large stalked crinoids (Proisocrinidae); *Metallogorgia* sp.; many *Paramuricea* spp. sea fans (with asteroschematids) and acanthogorgiids, which could be distinguished by the absence of large asteroschematids on the latter; *Narella* sp. (with asteroschematids); *Victorgorgia* sp. (with aplacophorans at the base of one colony); *Rhodaniridogorgia* sp. (sampled); *Chrysogorgia* sp.; *Anthomastus* sp.; *Enallopsammia* sp.; *Relicanthus* sp. anemone; interesting blue-colored encrusting lobate sponges; and holothurians in intermittent sediment patches. At 1,028 m, we got excellent imagery of a hatchetfish a meter or two off the bottom. We began to have frequent observations of carrier crabs (Homolidae) on the biflabellate primnoids and large geryonid crabs. At 949 m we saw two colonies of soft corals (Nephtheidae), the only true soft corals we have observed thus far on the expedition; no others were observed on this dive. At about 916 m depth we began seeing white *Eunicella* sp. fans, and they became fairly abundant as we approached the top of the cone feature. Closer to the summit *Madrepora* sp. corals were seen, as well as previously unseen (on this dive) species of squat lobsters, sponges, and *Parantipathes* sp. black coral. At the summit crest we saw a large school of oreos (Oreosomatidae) and diverse and abundant corals. A large, mounding demosponge growing around a *Madrepora* sp. colony generated much interest, and a fragment was collected.

The diversity of fishes observed was fairly high, with species from 14 different families: Macrouridae (rattails), Ogcocephalidae (batfishes), Halosauridae (halosaurs), Ipnopidae (tripod fishes), Oreosomatidae (oreos), Lophiidae (goosefishes), Congridae (conger eels), Synaphobranchidae (2/3 subfamilies Synaphobranchinae and Illyophinae), Somniosidae, Bythitidae, Ophidiidae, Sternoptychidae, Gonostomatidae, and one unidentified family. The most abundant fishes were probably the conger eels and oreos, but the most interesting observations (from a rarity standpoint) were of a Pacific Sleeper Shark (*Somniosus pacificus*)—possibly only the fourth time this species has ever been recorded alive—and several batfish and goosefish, which are generally considered rare, but we saw six individuals and four morphotypes. A relatively high abundance of water column fishes (hatchetfish and bristlemouths) were

observed near bottom. Though these are diel vertical migrators, >1,000m is pretty deep for some of these families.

6.2.4 Clipperton Fracture Zone

Dive #8 The biological communities reflected the abyssal depths explored on this dive, with the fauna dominated by black corals (Schizopathidae, *Bathypathes* cf. *alternata*) and sea cucumbers (*Psychropotes longicauda, Amperima* sp. or *Peniagone* sp.*, Orphnurgus* sp.*, Oneirophanta* sp.*, Paleopatides* sp., and other unidentified Deimatidae, Laetmogonidae and Synallactidae). In deeper sediments we saw feeding traces of spatangoid urchins (irregular burrowing urchins), but did not see any individuals on the surface.

Sediments were overlaid by what appeared to be phytodetrital floc, and we saw several accumulations of aciniform spherules; these were hypothesized to either be radiolarian skeletons that had gathered detritus or some other organism. Similar spherules were seen during the EX1605 expedition; here we were able to collect a sample using the ROV shovel tool. While the spherules were recovered intact, they appeared to be hollow when examined on deck; perhaps they are merely collections of detritus that have been "blown" over the sediment surface into these rounded shapes.

On exposed rock were feeding traces that led us to find chitons (Polyplacophora) at 4,543 m. Small (<5 cm diameter) snow-white actiniarian anemone and octacnematid tunicates (at least one with an associated polynoid scale worm) were seen repeatedly. Several bamboo coral whips (*Bathygorgia* sp.) were seen—one was sampled—becoming the second-deepest known collection of a bamboo coral. At 4,514 m we encountered a novel "starburst" cladorhizid carnivorous sponge, almost 60 cm tall, that was collected. Growing from the sponge stalk was a chitinous tube-dwelling anemone (Galatheanthemidae); most known samples in this small family come from trenches (widely distributed around the world).

Fishes from four families were seen, listed here in order of abundance: Ipnopidae (tripod fishes), Ophidiidae (cusk eels *Leucicorus* sp., *Bassozetus* sp., and an unidentified species), Bathysauridae (deep lizardfishes *Bathysaurus mollis*), and Macrouridae (Rattails *Coryphaenoides yaquinae*). The unidentified ophidiid had a very bulbous head and an almost translucent body; it may have been a juvenile. It was remarked as interesting that zoarcids (eelpouts) and synaphobranchids (cutthroat eels) were not observed, despite being known to exist in this environment from past studies in which they have been frequently seen in the Clarion-Clipperton Zone (CCZ) at baited traps.

Other biological observations included actiniarian anemones on sponge stalks, cup corals, brisingids (*Freyastera* sp.), slime star (Pterasteridae) and *Mediaster* sp., mysids, xenophyophores, aristeid shrimp (possible *Cerataspis monstrosus*), lepaedomorph barnacles, small candelabra-shaped bryozoan colonies, a buccinid snail, and fan worms (Polychaeta). During the ROV descent, we observed a possible Dana

octopus squid (*Taningia danae*) at 1,009 m, "beaming" the headlight-like tips of its arms; the bright tips may have been photophores or tissue reflecting light from the ROV.

6.2.5. Palmyra Atoll and Kingman Reef Unit of PRIMNM

Four ROV dives were conducted in the Palmyra Atoll and Kingman Reef Unit of PRIMNM: two at ~2 km depth, one on a cone emerging from a flat-topped platform at ~1,000 m depth, and one on the margin of Palmyra Atoll (490 - 300 m), where oxygen concentration was particularly low (< 1.0 mg/L). Surveyed areas were mostly sparse for sessile fauna but nonetheless diverse in corals, echinoderms, sponges, and fish. A higher density—and diversity—coral community was observed on Dive #11 on the cone feature at ~1,000 m, despite relatively low oxygen (~1.7 mg/L).

Dive #9 Sessile fauna were seen regularly throughout the dive track but were relatively sparse, and only a single fish was seen associated with the bottom (macrourid rattail, probably *Coryphaenoides armatus*, at 2,096 m). At the landing site was a patch of >30 anemones on the face of a rock, along with a corallimorph, stalked glass sponge (*Caulophacus* sp.), bryozoans, comatulid crinoid, and *Culeolus* tunicate (Pyuridae) in the immediate area. Several more *Culeolus* sp. were seen as the dive progressed, as well as many individuals of what we believed to be a low-mound solitary ascidean.

Black corals were the dominant sessile fauna on the dive, with *Bathypathes* sp. most common; close-ups of some showed polynoid polychaetes nestled among polyps on the main axis, a common association for this taxon. One colony showed a pinnule (side branch) stripped of five or six polyps and with an ectoparasitic ascothoracid crustacean. None of the scientists in the NOAA Ship *Okeanos Explorer* science chatroom at the time had previously seen an ectoparasitic ascothoracid, let alone one in the deep sea or one that may have been actively preying on a coral. Ascothoracid species in the genus *Synagoga* are known ectoparasites of antipatharians. Other black corals observed were *Stauropathes* sp., *Parantipathes* sp., *Trissopathes* sp., and two species of *Stichopathes* sp. (including a colony with what appeared to be a dumbo octopus egg attached to a portion of the axis with the tissue removed).

Several *Paragorgia* sp. with asteoschematid ophiuroids were seen, all of which were being overgrown by a yellow zoanthid; initially we saw red color morphs of *Paragorgia* sp., but at 2,120 m these were replaced by white morphs. Other corals observed included sea pens - ?*Calibelemnon* sp. (rock pen), Pennatula (common in sediment patches among the exposed rock bottom), ?*Protoptilum*; chrysogorgiids - *Chrysogorgia* sp. (with chirostylid), *Pleurogorgia* sp., and a *Metallogorgia* sp. skeleton overgrown with hydroids and stalked barnacles and also with what appeared to be a dumbo octopus egg attached; *Anthomastus* sp.; and unbranched bamboo coral. Sponges were infrequent and only hexactinellids were noted: Pheronemadidae, Farreidae (?*Aspidoscopulia* sp.), and Euplectellidae (?*Amphidiscella* sp.), the latter by a skeleton only.

Other biology observations included four species of holothurian, a *Plesiodiadema* sp. urchin, a slime star (*Hymenaster* sp.), Myxasteridae (*Asthenactis* sp.), Ophiacanthidae crawling over the rock surface, a solitary giant hydroid (Corymorphidae), and sessile barnacles aligned in linear rows on vertical edge of rock. A unique predation event was observed at 2,140 m depth: A solasterid sea star (*Lophaster* sp.) was seen perched over, and presumably feeding on, a comatulid crinoid. According to Chris Mah (NMNH), this is the first record of *Lophaster* sp. from this area, the deepest known record for encountering *Lophaster* sp., and the first observation of this genus feeding. Other members of the Solasteridae are known predators of echinoderms.

Dive #10 Overall, the sessile fauna were relatively sparse, more so than the previous two dives on this expedition exploring depths shallower than 1,000 m. This may have been a factor of weak currents in the lee of the major long-term flow and/or because of the extreme low oxygen concentration: < 1.0 mg/L and as low as 0.4 mg/L (and 0.2 mg/L at 270 m depth). However, a good number and diversity of fish observations were made, including several scorpionfish; a congrid eel (?*Bathycongrus* sp.); pointed-snout macrourid rattail (*Coelorinchus* sp.)—a two-barred species that we had not previously seen. After rising above 300 m and seeing O_2 increase to above 1 mg/L, we saw spikefish (*Hollardia* cf *goslinei*), gold duckbill fish (*Chrionema chryseres*), silver dollar dories (*Cyttomimus* sp.), a right eye flounder (Pleurinectidae) well hidden amongst the crustose coralline plate-sediments, a false moray (Chlopsidae), and several oreos (Oreosomatidae genus *Neocyttus*) and beautiful bright groppos (*Grammitonotus* sp.).

On the sediment-draped slope there were many brittle stars, some seastars, and shrimp (*Heterocarpus* sp.). Despite the sediments we observed octocoral (including biflabellate primnoids, acanthogorgiids) and black corals (*Heteropathes* sp., *Trissopathes* sp., *Stichopathes* sp.), and *Enallopsammia* sp. (both yellow and pale white morphs). Several primnoid colonies were seen with zoanthid overgrowth (possibly both *Narella* sp. and *Candidella* sp.), including one that also had several different ophiuroids (Ophiacanthidae and an *Asterothrombus* sp.). At 466 m we encountered a large *Swiftia* sea fan, larger than any *Swiftia* sp. the scientists in the chatroom had ever seen; a sample was collected. Brittle stars and a spider crab (Majoidea) were seen in the branches of the colony. Later we encountered a paragorgiid with many Ophiacanthidae-like brittle stars and a large slug/nudibranch. At 451 m depth we observed many *Coenopedina* urchins with an abandoned fishing line or cable associated with moored instrumentation. Further on, large dislodged carbonate blocks provided substrate for hexactinellid sponges, urchins, paragorgiid bubblegum corals, primnoids, acanthogorgiids, *Victorgorgia* sp., yellow *Enallopsammia* sp., corallimorphs, and a liponemid pom-pom anemone. A platyctenid ctenophore (?*Lyrocteis* sp.) and spider crabs (*Hyastenus* sp.) were seen on a dead octocoral skeleton. At 321 m, we found a large *Leiopathes* black coral with a dense tuft of pedunculate barnacles in the branches. At the end of the dive, we saw under a ledge *Eguchipsammia* scleractinians and a crinoid with striped arms.

Other biological observations: Cidarid urchins (*Histocidaris* sp.) with barnacles on the spines and one in feeding position on a yellow *Enallopsammia* sp., echinothurid urchins, the broken test of a heart urchin, *Mediaster* and *Tremaster* seastars; anemones (Exocoelactinidae), galatheoid squat lobsters (including *Babamunida* sp.), pagurid hermit crabs, shrimp, and cup coral; clusters of polychaete tubes were seen in abundance on the Jarvis Island slope.

Dive #11 Despite the flat relief (and low O_2 of ~1.7 mg/L), there were a high number of small yellow acanthogorgiid fans, which, along with the lack of sediment accumulation, suggested relatively high flow through the space between the bases of the cone features. Several urchins (*Plesiodiadema* sp., *Histocidaris* sp.), a pagurid crab carrying an epizoanthid, a rock pen, (?*Calibelemnon* sp.) and others were seen on the flat seafloor. The flatness was interrupted by an occasional rock outcrop, and these were sparsely populated by: a *Zoroaster* seastar draped over the top of a rock, an unusual observation for this taxon; large sessile barnacle; several small anemones; stoloniferous octocoral; and a mini-forest patch of colonial hydroids.

As we reached the base of the cone slope, the relief changed; there were many displaced rocks, boulders, and sediment patches between them. The number and diversity of corals increased dramatically. These included more of the yellow acanthogorgiid fans, the primnoid *Narella* sp., and a large planar isidid (*Jasonisis* sp.), measuring ~1 x 1.2 m, with anemones, brittle stars, crinoids, and benthic ctenophores in its branches. At the massive base of the colony, colonial hydroids grew from exposed skeleton and two gastropods were seen possibly grazing the hydroids. As we moved upslope we began to see yellow plexaurid sea fans (?*Paramuricea* sp.), which could be distinguished from the yellow acanthogorgiids by the large asteroschematid ophiuroids in the branches of the plexaurids. The acanthogorgiids often had a couple of much smaller ophiuroids. Paragorgiids also started appearing— these without zoanthids. We imaged two large primnoid fans (?*Calyptrophora* sp.) that each had a basketstar (Gorgonocephalidae) on them; one of the colonies was being preyed upon by a *Histocidaris* urchin, and the other had some zoanthid overgrowth. Other corals observed: *Parantipathes* sp. (with two chirostylid squat lobsters), rock pen (?*Calibelemnon* sp.), *Metallogorgia* sp., isidid whip, chrysogorgiid. We encountered another *Jasonisis* fan, this one mostly stripped of tissue and being preyed upon by a *Hippasteria* seastar and an echinothurid urchin; hydroids were growing in clumps on the exposed nodes of the isidid skeleton, but not on the internodes. Might hydroid larvae settle preferentially on the proteinaceous nodes, or does the echinothurid preferentially graze the internodes? A large *Hydrodendron* colony (or multiple) was seen growing under a rock overhang and a homolid crab was seen carrying an anemone.

While imaging some of these colonies we were approached by a large smalltooth sand tiger shark (*Odontaspis* sp.); a *Candidella* whip and another basketstar (on an acanthogorgiid colony) could be seen as the shark swam by. Further observations included colonies of *Trissopathes* sp. and *Victorgorgia* sp., and hexactinellid sponges Farreidae and a dead euplectellid (*Regadrella*-like).

The most frequently observed fish were the halosaurs (*Aldrovandia* cf *phalacra*), many of them hanging vertically in the water column. Other fishes seen more than once included oreos (Oreosomatidae, *Neocyttus acanthorhyncus*), cutthroat eels (*Synaphobranchus affinis* and *Synaphobranchus* sp.), and at least two rattail morphotypes (Macrouridae).

We found only a single individual cusk eel (*Lamprogrammus sp.*) and a large silvery Nettastomatidae (duckbill eel), possibly *Venefica* sp., as well as a very large oilfish (Gempylidae, *Ruvettus pretiosus*), a major predator. Two sharks were observed: a small, black deepwater dogfish (Etmopteridae) with a bright eye (perhaps *Centroscyllium nigrum*), and the aforementioned smalltooth sand tiger shark (*Odontaspis ferox*). The latter was a male whose mouth had severe scarring suggesting he had been hooked by a fishing line and then released.

Dive #12 fauna were sparse at the landing site. Within camera only a single *Pleurogorgia* octocoral (with pedunculate barnacles) and several opiacanthid brittle stars were observed. As the ROVs moved a few mobile fauna (possible juvenile slime star *Hymenaster* sp., brisingids) were observed. Sediment pockets around the exposed rock were home to sea pens (*Pennatula* sp., *Umbellula* sp., ?*Scleroptilum* sp.); towards the end of the dive we saw several growth stages of *Umbellula* sp., from a single polyp to two then three, etc. A colonial bryozoan—with a morphology reminiscent of a tube-dwelling sabellid fan worm—was common on exposed rock along the dive track, as well as a smaller fan-shaped colony. Elsewhere on rock surfaces we observed pale *Bathypathes* black corals (with polynoid polychaete), stalked *Culeolus* ascideans. At 2,253 m depth, we encountered a relatively tall stalked carnivorous sponge with thick rays arising from a fleshy body, which had a pink tint to the interior; this was a novel enough morphology for a collection to be made. A polynoid polychaete curled around the sponge stalk was also collected. Later in the dive, we saw a second of these sponges and it, too, had a purple polynoid polychaete on the stalk.

A remarkable discovery—made first at 2,241 m depth, and then observed several times subsequently—was of a gastropod associated with the calyx of a 10-armed stalked crinoid (Bathycrinidae ?*Naumachocrinus* sp.). The snail was at the upper part of the stalk, just below the crinoid calyx, and had extended a large proboscis onto the upper surface of the calyx. Chris Mah (NMNH) communicated that this was reminiscent of figures he had seen of a coprophagus snail (Platyceratidae) known from paleozoic fossils, but thought to be extinct. The crinoid and snail were collected. Further upslope, we observed a different species of ?Bathycrinidae with only five arms; our observation showed no gastropod. Even higher on the slope, we began again to see Platyceratidae-like gastropods on stalked crinoids, some with five arms and one with an arcturid isopod clinging to the stalk. At 1,990 m depth we saw another ?Bathycrinidae with a “Platyceratidae” that was on an egg case and with a second, much smaller snail on its foot; we speculated whether it was a dwarf male fertilizing the eggs. At least three more observations

were made later in the dive of "Platyceratid" snails on egg cases on bathycrinids. We also observed comatulid crinoids with parasitic eulimid gastropods.

Another rare find was the hydromedusae *Ptychogastria* sp., which spends more time attached to the bottom than in the water column. We found one clinging to a rock under an overhang at 1,898 m.

Corals observed were unbranched isidids (the more common resembling *Bathygorgia* sp., though the observations are shallow for that taxon, and "long bones" clade B), a yellow ?*Keratoisis* sp., cf *Candidella gigantea*, red morph *Paragorgia* sp. with zoanthids, white morph coralliid with zoanthids, *Chrysogorgia* sp. with chirostylid crab and an isopod curled around the main axis (specific association seen twice), *Metallogorgia* sp., *Victorgorgia* sp., *Swiftia* sp., paramuriceid, *Stichopathes* black coral, cup coral (Scleractinia), and a *Hydrodendron* hydroid fan.

In addition to the collected cladorhizid, sponges seen included a "pipe-cleaner" morph and a small sunburst morph of cladorhizid, an unidentified demosponge with two "chimney" oscula, and glass sponges in the Euplectellidae (*Saccocalyx* sp., *Bolosoma* sp.) and Hyalonematidae.

At various points along the dive, we observed fecal coils and feeding traces, but it wasn't until 2,237 m that we observed our first purple enteropneust (Torquaratoridae). Seven morphs of holothurian were seen (purple with few podia; pink warty; deep purple; white purple head; orange; poop covered; *Amperina* sp.). Other fauna included octacnematid tunicates, cidarid urchin, cerianthid tube anemones, red stalked crinoid *Proisocrinus ruberrimus* with pair of amphipods, an unidentified lemon-yellow stalked crinoid, spatangoid urchins (?Loveniidae), pterasterid slime star, pagurid hermit crab, corallimorph, Relicanthus, mud stick amphipods (cf *Dyopedos* sp.) and even a swimming polyclad platyhelminth.

When we reached the top of the cone feature we were surprised that rather than an increase in the abundance of sessile fauna, it was virtually barren.

Fishes were few on the dive, and all the ones we saw happened in very quick succession – an oddly clumped distribution. Observations were of a rattail (*Coryphaenoides* sp.), a very large black codling (*Antimora* sp., likely *rostrata*), and two halosaurs (possibly *Halosaurus* sp.).

6.3 Water Column Summary

The bathy- and mesopelagic zones of the central Pacific are highly underexplored, with no prior ROV observations that we know of made in pelagic waters within the operational area of EX1705. The expedition provided an opportunity to take a first look at the pelagic fauna inhabiting these areas, observe

their behaviors in situ, document biodiversity and zonation patterns, and expand the known ranges of animals.

There were two main modes for making water column visual observations on this cruise: (1) Extending ROV dives for dedicated midwater work—midwater transects were conducted on ascent from benthic dives, with surveys conducted at depths informed by ROV CTD and shipboard EK60 data; and (2) augmenting data collection on benthic dives—annotation of organisms encountered and monitoring of EK60 backscatter data during descents/ascents, including reporting in dive summaries and daily summaries.

6.3.1 Extended Dives

Three times during EX1705, bottom time was extended in order to conduct midwater ROV transects. The plan for each set of transects was to spend 10 minutes at seven different depth horizons. Depths were selected ahead of time—based on the bottom depth and interesting features in the CTD and EK60 data (e.g., oxygen minimum, salinity inversions, deep scattering layers)—to survey the upper bathypelagic and mesopelagic water column relatively evenly. At all three sites surveyed, the shallower depths were adapted midway through the transects to accommodate the evening vertical migration of the deep scattering layer, when many of the animals living in the water column migrate to the surface each night to feed. At each of the survey depths, the ROV slowly transited forward maintaining constant depth. When a target was encountered, the ROV stopped to zoom in and image the animal in order to identify the organism and provide time for discussion amongst the science team. Time spent holding position and imaging counted toward the 10 minutes, so these are not true quantitative transects.

Dive #3 Te Kawhiti o Maui Potiki

A total of eight midwater transects were conducted at: 1,800 m, 1,500 m, 1,200 m, 900 m, 710 m, 600 m, 450 m, and 300 m. Diversity was high, and we saw numerous siphonophores, chaetognaths, larvaceans, ctenophores, and jellyfish throughout much of the water column. Some other interesting fauna observed included a *Pelagothuria* (a pelagic sea cucumber) at 1,200 m, a doliod (pelagic tunicate) at 710 m, and a tomopterid polychaete worm at 900 m. We saw a surprising number of fishes, including a snipe eel (*Nemichthyidae*), a bristlemouth *(Cyclothone* sp.), and a hammerjaw (*Omosudis lowei*).

Dive #6 "Keli'ihananui" Seamount

Ten minutes were spent conducting visual surveys at each of six different depths: 1,400 m, 1,200 m, 1,000 m, 750 m, 475 m, and 300 m. At the deepest layer, we saw another *Pelagothuria* (a pelagic sea cucumber), which has been one of the more abundant pelagic species seen on this cruise. This one had an amphipod on it, though we were not able to determine if it was food, a parasite, or a symbiont (non-harmful “hitchhiker”). Other organisms that were seen include a cydippid ctenophore (a comb jelly with a round body shop and two long, trailing tentacles), a copepod, an arrow worm, and a *Halicreatis* jellyfish.

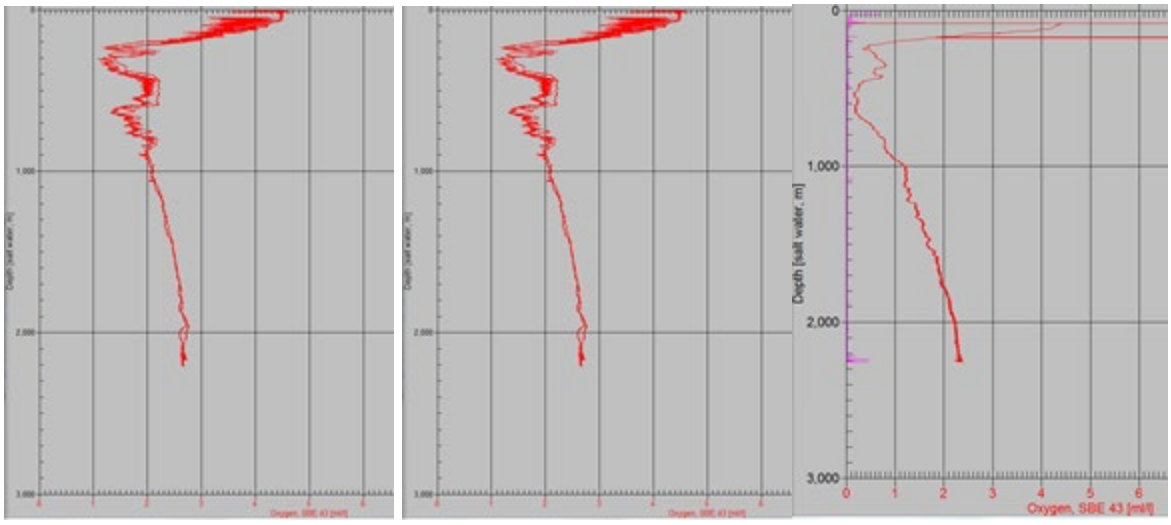
Moving up in the water column, at 1,200 m and 1,000 m, we came across more comb jellies, several additional species of jellyfish (including Halitrephes), two types of siphonophores, an unidentified Anthomedusa, and larvaceans (sea tadpoles), including one larvacean located just next to its recently abandoned "house." At 750 m, we saw a new type of siphonophore, another Pelagothuria, a *Haliscera* jellyfish, and a lobate ctenophore. At our shallowest two depths, we encountered a strong current, making it difficult to hold position, but we saw a layer of fish at ~600-700 m and a shallower layer of siphonophores as we worked our way up to the surface.

Dive #12 Kingman Deep

We originally planned to conduct transects at 7 different depths starting at 1,500 m (1,500 m, 1,200 m, 1,000 m, 800 m, 600 m, 400 m, and 250 m). After completing the second transect at 1,200 m, the winds started picking up and we were informed we would only have time for two more transect depths before recovering the ROV. We decided to target 600 m, which was the core of the oxygen minimum zone with an oxygen concentration around just 0.25 mg/ml, and 300 m, which is where we saw a peak in acoustic backscatter indicating a potentially dense layer of animals. At the bathypelagic depths (below 1,000 m) we saw a white copepod, clear chaetognaths, a transparent sergestid shrimp, a halicreatid jellyfish, and a larvacean. At 600 m, we saw a lot more color and a lot more fish; identified animals included a bright red shrimp, a dark copepod, a large deep red/brown jellyfish, hatchetfish, and a Serrivomer eel. Many of these animals seemed very active, considering the oxygen levels in their environment would be fatal to most other animals. We wrapped up the dive at 300 m, where we saw more fish, some siphonophores, and a hydromedusa jellyfish. Throughout the transects, we encountered multiple targets that we were unable to identify—even to phylum.

Even with only a few horizontal transects at very few depths, we will be able to increase the known distribution range of several species by thousands of kilometers. Some examples of this were a benthic jellyfish (*Ptychogastria sp.)* that has only been seen before in boreal areas (though there is an unconfirmed sighting for Monterey Bay), the first record in the central Pacific for the narcomedusa *Aegina rosea*, and possibly a first record for *Solmissus* as well.

Our minimum oxygen concentrations decreased at each progressive midwater dive from south to north (see Figure 2). Questions remain about how this change in oxygen may have affected the resident organisms.



Dive #3 Dive #6 Dive #12

Figure 2. *Acquisition system display screengrabs to show dissolved oxygen concentrations from Dive #3, Dive #6, and Dive #12.*

6.3.2 Augmenting Data Collection on Benthic Dives

OER expeditions on NOAA Ship *Okeanos Explorer* regularly collect water column backscatter data with a Simrad EK60 Echosounder. With a dedicated midwater scientist onboard, we were able to annotate the midwater portions of most of the dives and monitor the EK60 data to investigate avoidance behaviors.

Some initial observations were that we generally saw very few organisms below 1,000 m. At bathypelagic depths, observations were typically of smaller animals such as copepods. Total abundances in the upper portion of the water column varied a lot. For example, at the nearshore Palmyra site, we saw a very high abundance of organisms throughout the mesopelagic and viewed high numbers of salps in the upper layer of the water column. Not far away, at the nearshore Kingman Atoll site, we saw much lower abundance overall of fauna. In water with bottom depths deeper than 1,000 m, there was typically a broad deep scattering layer from ~250-900 m, with peak scattering in the range of 400-600 m. This peak scattering layer typically coincided with high numbers of ROV observations of fishes, siphonophores, and sergestid shrimps—though it was composed of a generally diverse assemblage.

Avoidance behaviors varied between dives; however, we almost always saw some avoidance within a part of the deep scattering layer (Figures 3 and 4).

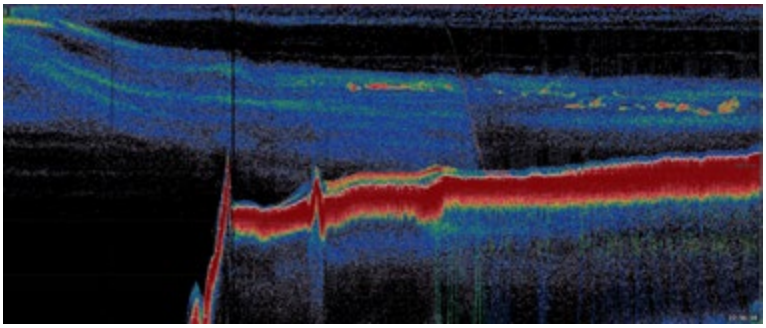


Figure 3. *EK60#1. Strong avoidance in the lower portion of the DSL on Dive #5.*

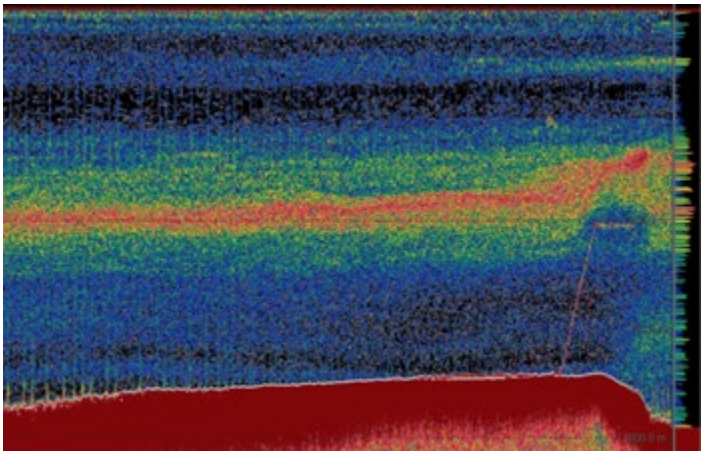


Figure 4. *EK60#2. Avoidance during ascent on Dive #7.*

Interestingly, the tether itself—and not just the ROV—seemed to be the cause of avoidance. This was evident because we sometimes saw part of the DSL disappear after the ROV came through, avoid that layer for the duration of the dive, and then reappear shortly after transiting back up through that depth range (Figures 5 and 6).

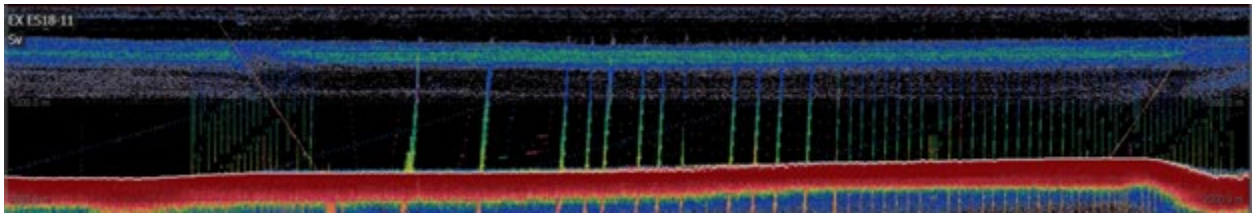


Figure 5*. EK60#3. Dive #4*

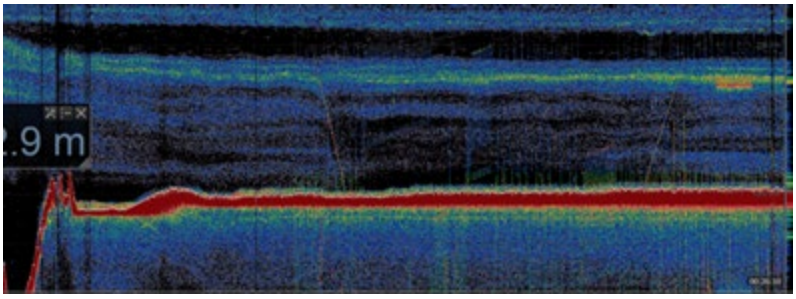


Figure 6. *EK60#4. Dive #11*

6.4 Specimen Collections

A total of 59 samples were collected during the expedition, including 13 geological samples, 27 biological samples, and 19 commensal samples. The geological specimens collected were primarily rocks encrusted with ferromanganese (FeMn), likely sedimentary rocks or and basalts under the crust (Table 5).

Table 5. *Inventory of geological samples collected during EX1705.*

Sample #	Sample ID	Preservation	Site	Date	Time UTC	Lat.	Long.	Depth (m)	Salinity (ppt)	Temp ('C)	Oxygen (mg/l)
DIVE02_SPEC01GEO	Angular rock	dry	Te Tukunga o Fakahotu	20170430	235152	-5.86	-164.7	2483.61	34.67	1.8	4.16
DIVE02_SPEC02GEO	Angular FeMn-crusted rock	dry	Te Tukunga o Fakahotu	20170501	5636	-5.86	-164.7	2446.25	34.67	1.79	4.13
DIVE03_SPEC01GEO	FeMn-crusted angular rock	dry	Te Kawhiti a Maui Potiki	20170502	214305	-4.58	-162.4	2216.28	34.65	2.07	3.75
DIVE03_SPEC04GEO	Angular FeMn-crusted rock	dry	Te Kawhiti a Maui Potiki	20170502	233724	-4.58	-162.4	2167.61	34.63	2.1	3.71
DIVE04_SPEC02GEO	Light Colored Biogenic(?) Sediment	dry, OGL 506, EtOH	Kahalewai	20170504	223426	-1.51	-159.46	1684.15	34.62	2.69	3.18
DIVE04_SPEC03GEO	FeMn-crusted rock	dry	Kahalewai	20170504	231010	-1.51	-159.46	1669.91	34.61	2.71	3.14
DIVE04_SPEC05GEO	FeMn-crusted rock	dry	Kahalewai	20170505	12402	-1.51	-159.45	1606.94	34.62	2.7	3.23
DIVE06_SPEC02GEO	FeMn-crusted rock	dry	Keli‘ihananui	20170506	233731	1.32	-159.93	1833.81	34.63	2.38	3.23
DIVE07_SPEC02GEO	FeMn-crusted rock	dry	Whaley Seamount	20170508	13734	1.08	-161.29	919.32	34.55	5.18	2.56

DIVE08_SPEC01GEO	Dark colored biogenic sediments	dry, OGL 512,EtOH	Fracture Zone	20170508	224803	0.98	-162.38	4572.08	34.7	1.31	5.34
DIVE08_SPEC04GEO	2 rocks	dry	Fracture Zone	20170509	21722	0.98	-162.38	4420.35	34.7	1.33	5.2
DIVE11_SPEC01GEO	FeMn-crusted rock	dry	Kingman Cone	20170512	225041	6.37	-162.31	1023.12	34.56	4.5	1.67
DIVE12_SPEC03GEO	FeMn-crusted rock with bio on it	dry	Kingman Deep	20170513	220250	6.42	-162.22	2237.78	34.65	2.01	3.37

There were 25 biological samples that were purposely collected, as well as 54 samples that were incidentally collected as commensal organisms on other samples. Samples collected included deep-sea corals, sponges, crinoids and a diversity of associates. Most of these specimens are thought to be new species and/or new records for the Central Pacific region.

Table 6. *Inventory of biological samples collected during EX1705.*

Sample #	Date	Field ID	Preservation	Lat.	Long.	Depth (m)	Salinity (ppt)	Temp ('C)	Oxygen (mg/l)	OGL Vial #
DIVE02_SPEC01GEO_A01	20170430	Sponge(?)	EtOH	-5.86	-164.7	2483.61	34.67	1.8	4.16	-
DIVE02_SPEC01GEO_A02	20170430	Bryozoan	EtOH	-5.86	-164.7	2483.61	34.67	1.8	4.16	-
DIVE02_SPEC01GEO_A03	20170430	mixed (branched foram and tube-like structure)	EtOH	-5.86	-164.7	2483.61	34.67	1.8	4.16	-
DIVE02_SPEC02GEO_A01	20170501	Foraminifera	EtOH	-5.86	-164.7	2446.25	34.67	1.79	4.13	-
DIVE02_SPEC02GEO_A02	20170501	unidentified (possibly sponge or foram)	EtOH	-5.86	-164.7	2446.25	34.67	1.79	4.13	-
DIVE02_SPEC02GEO_A03	20170501	*Verrucomorph barnacle*	EtOH	-5.86	-164.7	2446.25	34.67	1.79	4.13	-
DIVE03_SPEC02BIO	20170502	*Bamboo coral with anemone*	EtOH, formalin dip	-4.58	-162.4	2207.88	34.65	2.07	3.67	803
DIVE03_SPEC02BIO_A01	20170502	Anemone	Formalin	-4.58	-162.4	2207.88	34.65	2.07	3.67	805
DIVE03_SPEC03BIO	20170502	*Walteria sponge with associates*	EtOH, dry	-4.58	-162.4	2172.14	34.66	2.11	3.83	804
DIVE03_SPEC03BIO_A01	20170502	*Crinoidea*	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	502

DIVE03_SPEC03BIO_A02	20170502	Crinoidea	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	503
DIVE03_SPEC03BIO_A03	20170502	Eulimidae	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	504
DIVE03_SPEC03BIO_A04	20170502	Eulimidae	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC03BIO_A05	20170502	Isopod	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC03BIO_A06	20170502	*Amphipoda*	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC03BIO_A07	20170502	Amphipoda	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC03BIO_A08	20170502	*Amphipoda*	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC03BIO_A09	20170502	Amphipoda	EtOH	-4.58	-162.4	2172.14	34.66	2.11	3.83	-
DIVE03_SPEC04GEO_A01	20170502	*Sponge(?)*	EtOH	-4.58	-162.4	2167.61	34.63	2.1	3.71	-
DIVE03_SPEC04GEO_A02	20170502	Sponge(?)	EtOH	-4.58	-162.4	2167.61	34.63	2.1	3.71	-
DIVE03_SPEC04GEO_A03	20170502	Sponge(?)	EtOH	-4.58	-162.4	2167.61	34.63	2.1	3.71	-
DIVE03_SPEC05BIO	20170503	*Corallid with ophiuroids*	EtOH, Formalin dip	-4.58	-162.4	2150.53	34.65	2.06	3.7	806
DIVE03_SPEC05BIO_A01	20170503	Ophiuroidea	EtOH	-4.58	-162.4	2150.53	34.65	2.06	3.7	-
DIVE03_SPEC05BIO_A02	20170503	*Ophiuroidea*	EtOH	-4.58	-162.4	2150.53	34.65	2.06	3.7	-
DIVE03_SPEC06BIO	20170503	Zoanthid	EtOH	-4.58	-162.4	2207.88				804
DIVE04_SPEC01BIO	20170504	Yellow Isididae	EtOH, Formalin dip	-1.51	-159.46	1687.15	34.61	2.64	3.21	808
DIVE04_SPEC04BIO	20170505	Yellow stalked crinoid Phrynoerinidae	EtOH	-1.51	-159.45	1636.47	34.62	2.69	3.18	505
DIVE04_SPEC04BIO_A01	20170505	*Unknown*	EtOH	-1.51	-159.45	1636.47	34.62	2.69	3.18	-
DIVE05_SPEC01BIO	20170506	Holothurian Psolidae	EtOH	-0.39	-159.97	532.29	34.59	7.49	2.29	507
DIVE06_SPEC01BIO	20170506	Glass sponge (?Rossellidae) with associates	EtOH, dry	1.32	-159.93	1912.39	34.63	2.37	3.15	809

DIVE06_SPEC01BIO_A01	20170506	Crinoidea	EtOH	1.32	-159.93	1912.39	34.63	2.37	3.15	509
DIVE06_SPEC01BIO_A02	20170506	Ophiuroidea	EtOH	1.32	-159.93	1912.39	34.63	2.37	3.15	508
DIVE06_SPEC01BIO_A03	20170506	Crinoidea	EtOH	1.32	-159.93	1912.39	34.63	2.37	3.15	-
DIVE06_SPEC01BIO_A04	20170506	Aplacophara - Solenogastres	EtOH	1.32	-159.93	1912.39	34.63	2.37	3.15	-
DIVE06_SPEC01BIO_A05	20170506	Amphipoda	EtOH	1.32	-159.93	1912.39	34.63	2.37	3.15	-
DIVE07_SPEC01BIO	20170508	Rhodaniridogorgia	EtOH, Formalin dip	1.08	-161.28	960.02	34.54	5.12	2.56	810
DIVE07_SPEC01BIO_A01	20170508	Unknown	EtOH	1.08	-161.28	960.02	34.54	5.12	2.56	-
DIVE07_SPEC02GEO_A01	20170508	Hard sponge	EtOH	1.08	-161.29	919.32	34.55	5.18	2.56	-
DIVE07_SPEC02GEO_A02	20170508	Foraminifera	EtOH	1.08	-161.29	919.32	34.55	5.18	2.56	511
DIVE07_SPEC02GEO_A03	20170508	*Stoloniferous octocoral*	EtOH	1.08	-161.29	919.32	34.55	5.18	2.56	816
DIVE07_SPEC02GEO_A04	20170508	*Sponges (misc.)*	EtOH	1.08	-161.29	919.32	34.55	5.18	2.56	-
DIVE07_SPEC02GEO_A05	20170508	*Sponge*	EtOH	1.08	-161.29	919.32	34.55	5.18	2.56	-
DIVE07_SPEC03BIO	20170508	*Demosponge*	EtOH, dry	1.08	-161.29	869.92	34.55	5.23	2.49	813
DIVE07_SPEC03BIO_A01	20170508	*Madrepora*	EtOH	1.08	-161.29	869.92	34.55	5.23	2.49	815
DIVE07_SPEC03BIO_A02	20170508	*Ophiuroidea*	EtOH	1.08	-161.29	869.92	34.55	5.23	2.49	510
DIVE07_SPEC03BIO_A03	20170508	*Polychaeta*	EtOH	1.08	-161.29	869.92	34.55	5.23	2.49	-
DIVE07_SPEC03BIO_A04	20170508	*Glass sponge*	EtOH	1.08	-161.29	869.92	34.55	5.23	2.49	814
DIVE07_SPEC04BIO	20170508	*Eunicella sp.*	EtOH	1.08	-161.29	863.28	34.55	5.28	2.48	811
DIVE07_SPEC04BIO_A01	20170508	*Hydrozoa*	EtOH, Formalin	1.08	-161.29	863.28	34.55	5.28	2.48	812
DIVE08_SPEC02BIO	20170509	*Isidid Bathygorgia*	EtOH	0.98	-162.38	4523.5	34.7	1.29	5.44	817
DIVE08_SPEC03BIO	20170509	*Starburst sponge*	EtOH	0.98	-162.38	4514.16	34.7	1.29	5.23	818

DIVE08_SPEC03BIO_A01	20170509	*Anemone*	EtOH	0.98	-162.38	4514.16	34.7	1.29	5.23	819
DIVE08_SPEC03BIO_A02	20170509	*Anemone- Galatheanthemidae*	EtOH	0.98	-162.38	4514.16	34.7	1.29	5.23	820
DIVE08_SPEC04GEO_A01	20170509	*Sponge*	EtOH	0.98	-162.38	4420.35	34.7	1.33	5.2	-
DIVE08_SPEC04GEO_A02	20170509	*sponge*	EtOH	0.98	-162.38	4420.35	34.7	1.33	5.2	-
DIVE10_SPEC01BIO	20170511	*Swiftia*	EtOH	5.86	-162.13	466.13	34.62	8.47	0.62	821
DIVE10_SPEC02BIO	20170511	*Hexapathes*	EtOH	5.86	-162.13	418.39	34.67	8.53	0.64	822
DIVE11_SPEC01GEO_A01	20170512	*Coral*	EtOH	6.37	-162.31	1023.12	34.56	4.5	1.67	823
DIVE11_SPEC01GEO_A02	20170512	*Xenophyophore*	EtOH	6.37	-162.31	1023.12	34.56	4.5	1.67	-
DIVE11_SPEC01GEO_A03	20170512	*Sipunculid(?)*	EtOH	6.37	-162.31	1023.12	34.56	4.5	1.67	-
DIVE11_SPEC01GEO_A04	20170512	*sponge*	EtOH	6.37	-162.31	1023.12	34.56	4.5	1.67	-
DIVE11_SPEC01GEO_A05	20170512	*coral*	EtOH	6.37	-162.31	1023.12	34.56	4.5	1.67	-
DIVE12_SPEC01BIO	20170513	*Starburst demosponge*	EtOH	6.42	-162.22	2252.44	34.61	2.09	3.38	662
DIVE12_SPEC01BIO_A01	20170513	*Polychaeta*	EtOH	6.42	-162.22	2252.44	34.61	2.09	3.38	-
DIVE12_SPEC01BIO_A02	20170513	*Barnacles*	EtOH	6.42	-162.22	2252.44	34.61	2.09	3.38	-
DIVE12_SPEC01BIO_A03	20170513	*Ophiuroidea*	EtOH	6.42	-162.22	2252.44	34.61	2.09	3.38	-
DIVE12_SPEC02BIO	20170513	*Stalked crinoid with snail*	EtOH	6.42	-162.22	2241.64	34.65	2.04	3.19	513
DIVE12_SPEC02BIO_A01	20170513	*Snail*	EtOH	6.42	-162.22	2241.64	34.65	2.04	3.19	-
DIVE12_SPEC02BIO_A02	20170513	*crab*	EtOH	6.42	-162.22	2241.64	34.65	2.04	3.19	-
DIVE12_SPEC03GEO_A01	20170513	*Bryozoan*	EtOH	6.42	-162.22	2237.78	34.65	2.01	3.37	-

6.4.1 Sample Repositories

Details for all repositories that have archived specimens from EX1705 can be found below:

- Invertebrate Zoology Collections, National Museum of Natural History, Smithsonian Institution, Museum Support Center, MRC 534, 4210 Silver Hill Road, Suitland, MD 20746
  Contact: Abigail Reft, ReftAJ@si.edu
  Website: https://invertebrates.si.edu/LoanPolicy.html
- Ocean Genome Legacy Center, Northeastern University, 430 Nahant Road, Nahant, MA 01908
  Contact: Hannah Appiah-Madson, h.appiah-madson@northeastern.edu
  Website: https://www.northeastern.edu/ogl/
- Marine and Geology Repository, Oregon State University
  Burt 346, Corvallis, OR 97331-5503
  Contact: Kevin Konrad, Konradke@geo.oregonstate.edu
  Website: http://osu-mgr.org/noaa-ex/

6.5 Accessing ROV Data

Data from this expedition is available through OER's Digital Atlas: https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm. To specifically access data from this expedition, use the "Enter Search Text" feature on the "Search" tab and type in "EX1705" in the text box available. Click on the dot that represents the expedition (the map will center around this dot), which will provide options for data access. ROV dive data is organized by dive can be found here: https://service.ncddc.noaa.gov/rdn/oer-rov-cruises/ex1705

6.6 Seafloor Mapping

Table 7. Mapping Statistics for EX1705.

Dates	April 27, 2017 - May 19, 2017
Departure Port	Pago Pago, American Sāmoa
Arrival Port	Honolulu, Hawai'i
Days at Sea	23
EM 302 Linear Kilometers Mapped	6,200
EM 302 Square Kilometers Mapped	37,521
EM 302 Number/Data Volume of raw (.all) bathymetric and bottom backscatter files	476 Files/26.3 GBs

EM 302 Number/Data volume of raw (.wcd) water column files	476 Files/94.7 GBs
EK60 Number/Data volume singlebeam files	133 Files/13.8 GBs
Knudsen Sub-bottom Number/Data volume files	366 Files/4.6 GBs
Number of XBT Casts	52
Number of CTD Casts	0

Background data used to guide exploratory mapping operations included mapping data collected during NOAA Ship *Okeanos Explorer* cruises, notably EX1701, Extended Continental Shelf (ECS) data collected by NOAA Ship *Ronald H. Brown* in 2016 near Kingman Reef and Palmyra Atoll (RB1601), ECS data collected by R/V *Kilo Moana* near Kingman Reef and Palmyra Atoll (KM1009), multibeam data collected by NOAA Ship *Hi'ialaka*i (HI-06-04) and data supplied by Alain Murphy from the Manihiki Plateau and areas north of the Cook Islands. Some dive planning and mapping operations were conducted using bathymetric grids created using all available bathymetry archived with National Centers for Environmental Information (NCEI) using NCEI's Autogrid tool. Sandwell and Smith satellite altimetry data was also used to plan operations.

The schedule of operations included overnight transit mapping and mapping operations whenever the ROVs were on deck. Survey lines were planned to maximize either edge matching of existing data or filling in gaps between areas where modern bathymetric coverage existed. In regions with no existing data, exploratory transit or focused survey lines targeted areas to optimize potential discoveries. A summary of mapping statistics from this EX1705 can be found in Table 7. Long transits were completed leaving American Sāmoa to the Manihiki Plateau, from the Manihiki Plateau to the Jarvis Island Unit of PRIMNM , from the Jarvis Island Unit of PRIMNM to the Palmyra Atoll and Kingman Reef Unit of PRIMNM and finally to Honolulu, Hawai'i. Within the Jarvis Island Unit of PRIMNM and the Palmyra Atoll and Kingman Reef Unit of PRIMNM, as well as north of the Manihiki Plateau, focused mapping operations edge matched existing data and targeted potential seafloor features within the satellite bathymetry (Figures 7, 8, 9).

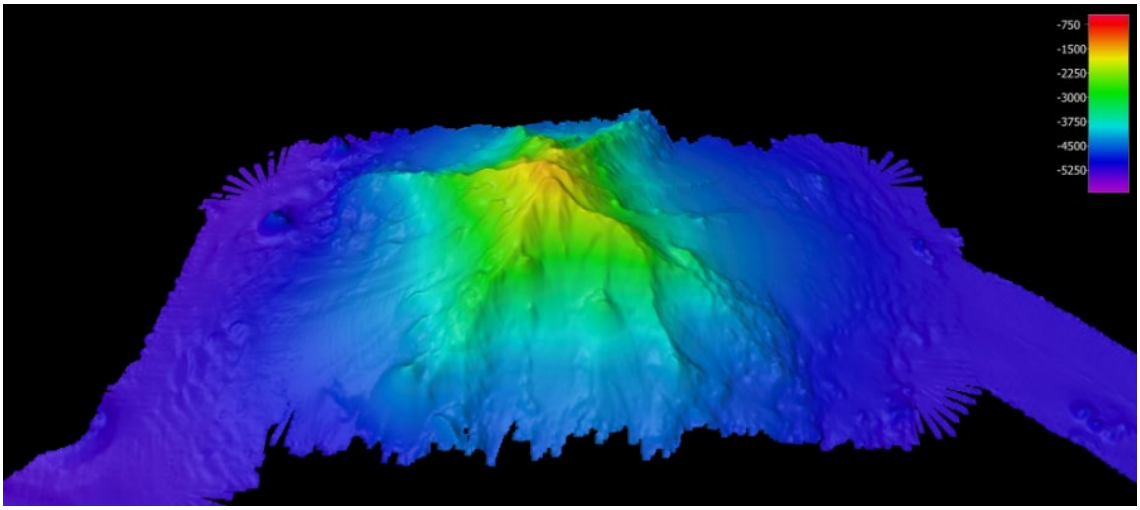


Figure 7. *An approximately ~4,200-meter (~13,800-foot) seamount was mapped - about 11 times the height of the Empire State Building. The unnamed seamount, located inside of the Jarvis Unit of PRIMNM, was referred to as "Kahalewai," has four ridges that radiate outward from the center. Based on altimetry data, this seamount turned out to rise about 1,000 meters (~3,000 feet) higher from the abyssal plain than expected. Figure produced in Fledermaus.*

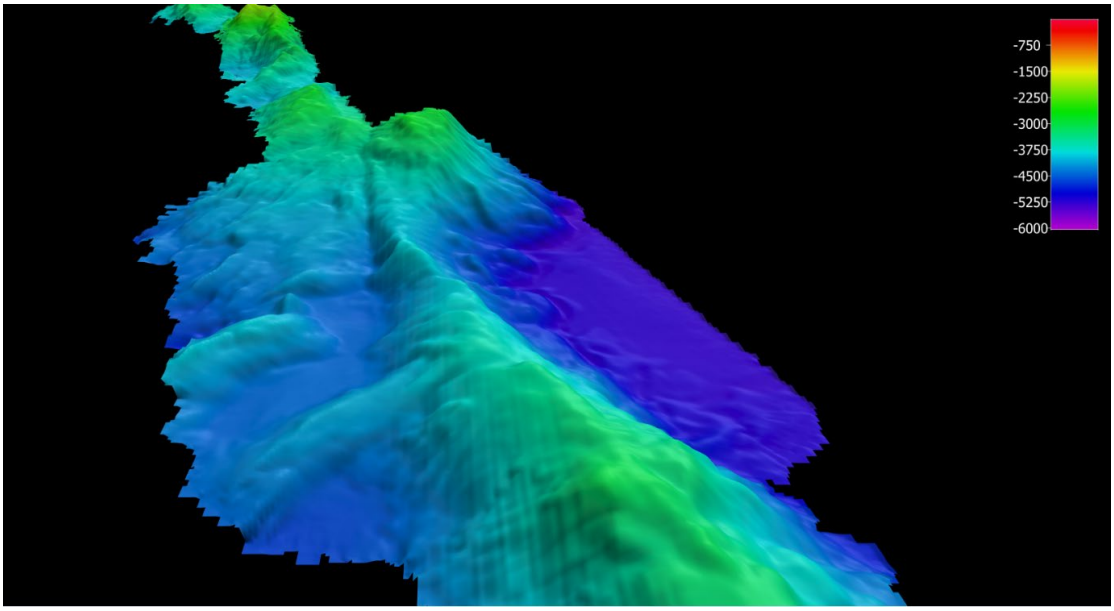


Figure 8*. Data collected in the Jarvis Island Unit of the Pacific Remote Islands Marine National Monument (PRIMNM). This area is east of were the Nova-Canton Trough begins and will be an important aspect in understanding the origins of this seafloor feature. Figure created in Fledermaus.*

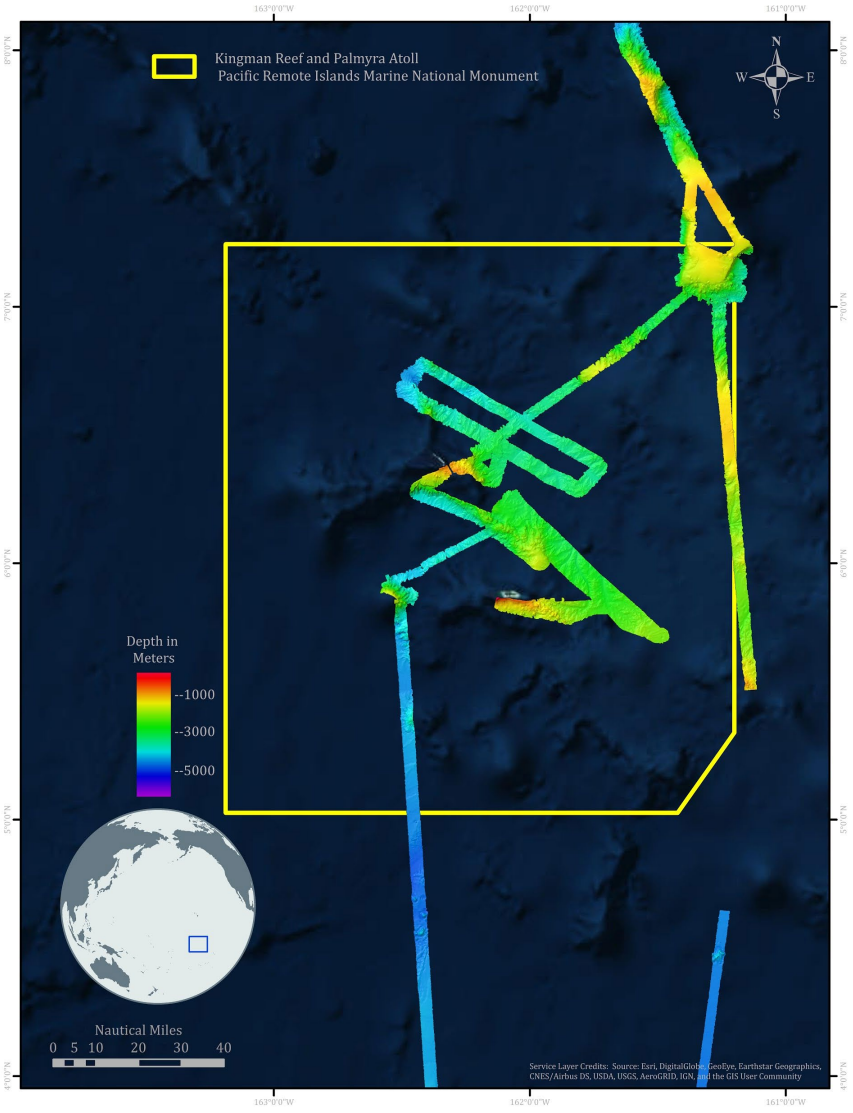


Figure 9. *Combined NOAA Ship* Okeanos Explorer *multibeam coverage from cruises EX1701 and EX1705 within the Palmyra Atoll and Kingman Reef Unit of PRIMNM, boundary outline in yellow. Mapping operations targets gaps within existing multibeam bathymetry coverage.*

Mapping operations included EM 302 multibeam, EK60 split beam, Knudsen sub-bottom profiles, and ADCP data collection. Expendable bathythermographs (XBTs) were collected every six hours and applied in real time using Seafloor Information System (SIS) software. Sound speed at the sonar head was determined using sound speed from a flow through thermosalinograph (TSG).

Throughout the cruise, multibeam data quality was monitored in realtime by acquisition watchstanders. Ship speed was adjusted to maintain data quality as necessary. Much of the mapping was conducted along transit lines to ROV dive sites; however, in places where time allowed, focused surveying was

completed over areas lacking multibeam data. In these focus areas, line spacing was generally planned to ensure 30% overlap between lines at all times. Cutoff angles in SIS were generally adjusted on both the port and starboard sides to ensure the best balance between data quality and coverage.

The ADCPs were always turned off for general mapping operations due to noticeable interference between the Ocean Surveyor 38kHz ADCP, the Workhorse 300kHz ADCP and the EM 302 multibeam. This interference has been documented during previous cruises. The ADCPs were also monitored for temperature spikes that may have been the result of water intrusion and possible precursory evidence of system failure.

During normal mapping operations, data were collected with the EM 302, EK60s, and sub-bottom profiler. During ROV operations, both ADCPs were turned on to provide information on currents in the vicinity of each dive site. Also, during ROV operations, the EK60s were turned on to better understand the interaction between the ROVs and biology in the water column. Some avoidance behavior within the EK60 sonars were observed.

More than 36,800 km^2 of seafloor, an area larger than the state of Maryland, were mapped. Over 4,300 km^2 of mapping data were collected in Marae Moana: the Cook Islands Marine Park. Additional mapping was also conducted over priority areas north of the Cook Islands. The newly acquired mapping data, along with ROV sampling, could indicate a potential geological connection between ridge features and the Manihiki Plateau. Over 7,900 km^2 of mapping data were collected in the Jarvis Island Unit of PRIMNM (Figure 10). When coupled with data from EX-17-02, NOAA OER collected data over every major seamount in the Jarvis Island Unit of PRIMNM (Figure 11).

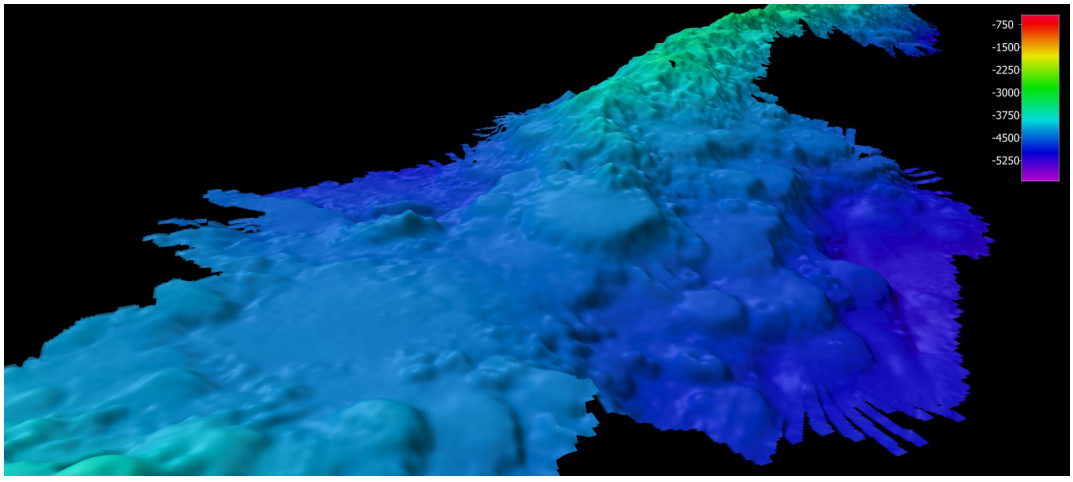


Figure 10. *Mapping data collected between a ridge and a large seamount north of the Manihiki Plateau. These data will help scientists determine whether connections exist between these features and define the geological origin. Mapping data collected using the Seafloor Information System 3D scanning mode. Image made using Fledermaus.*

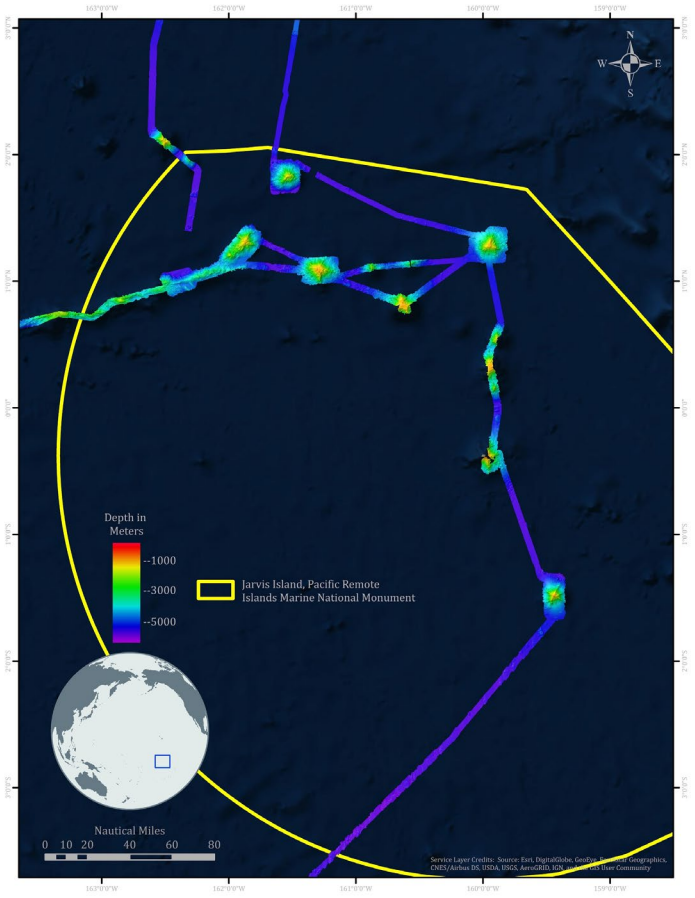


Figure 11. *Combined NOAA Ship* Okeanos Explorer *multibeam coverage from cruises EX1701 and EX1705 within the Jarvis Island Unit of the Pacific Remote Islands Marine National Monument (PRIMNM), outlined in yellow. At the time of these cruises, this was the only publicly available non-transect multibeam bathymetry within the Jarvis Island Unit of PRIMNM.*

Throughout EX1705, troubleshooting continued on the AOML XBT Autolauncher. It was unclear during this cruise if the deck boxes had failed, there were communication problems with the computer, or some combination of additional issues. The EM 302 continued to display 'POS COM1' positioning dropouts. It was unknown at this time what was causing those dropouts, although evidence suggests a potential issue with the buffer boxes either adding or deleting characters from the National Marine Electronics Association (NMEA) string. The EM 302 TRU had to undergo typical troubleshooting, including reseating of transit array (TX) boards and power cycling. Built-in self tests (BISTs) were completed at the end of each ROV dive. During dynamic positioning testing, the onboard team took steps to test the EM 302 3D Scanning Mode over a 'saddle' region between the Manihiki Plateau and a ridge feature. The result is imaged below. Sounding coverage was very dense, although the data did display some erroneous yaw artifacts.

6.6.1 Mapping Data Access

Multibeam Sonar (Kongsberg EM 302)

The multibeam dataset for the expedition is archived at NOAA's NCEI, and accessible from the following online map viewer service (last accessed March 2020): https://maps.ngdc.noaa.gov/viewers/bathymetry/. To access data from this expedition use the "Search Bathymetric Surveys" function, selecting "NOAA Ship OKEANOS EXPLORER" as the Platform Name, "NOAA Office of Ocean Exploration and Research" as the Source Institution, and type "EX1705" in as the Survey ID. Click "OK" and the ship track for the expedition will appear on the map. If you click on the ship track, options to download data will appear.

Sub-Bottom Profiler (Knudsen Chirp 3260)

The sub-bottom profiler was not run during any ROV dive operations, but generally was operated during multibeam mapping operations. Geophysical data for the area covered by the expedition can be located at NOAA's NCEI's online Geophysical Data Viewer (last accessed March 2020): https://maps.ngdc.noaa.gov/viewers/geophysics/. To access data from this expedition use the "Search Marine Surveys" function, and enter "EX1705" in as the Survey ID. Click "OK" and the ship track for the expedition will appear on the map. Click on the ship track for options to download data.

Split-beam Sonars (Kongsberg EK60)

These sonars were used continuously (aside from the 38 kHz frequency that interferes with multibeam operations) throughout the cruise during both overnight mapping operations and daytime ROV operations. EK60 water column data for the expedition can be accessed from the following online data porta (last accessed March 2020)l: https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html. To access data from this expedition, use the "Additional Filters" tool, and select "EX1705" under Survey ID. Click "OK" and the ship track for the expedition will appear on the map. Click on the ship track for options to download data.

Acoustic Doppler Current Profiler (Teledyne Marine Workhorse Mariner ADCP)

ADCP data for the expedition were collected at each ROV dive location, and can be accessed from this data portal (last accessed March 2020): https://www.nodc.noaa.gov/gocd/sadcp_oer_inv.html. This expedition is Accession number 0163984. Data can be found by searching for the Accession number or the cruise identification number, EX1705.

Sun Photometers Measurements

Sun photometer measurements were taken on the expedition as time and a clear sky allowed. More information about AERONET can be found here (last accessed March 2020): https://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html.

6.7 Education and Outreach Activities

While in Pago Pago, American Sāmoa, the EX1705 expedition team engaged over 1,700 people through live events and interactions, in-person presentations, and ship tours. Once underway, the team conducted six live interactions—including with the NOAA Administrator and the NOAA Science Advisory Board. The team also conducted a successful Reddit "Ask Me Anything" which reached millions and was one of the most successful "Ask Me Anything" events ever hosted by NOAA. Additionally, the expedition team conducted two Facebook Live interactions, a first for OER. The live video feeds received over 2.5 million views and content on OER's website received over 71,000 views. The expedition captured the attention of the public around the world with several international news outlets picking up the story. Notable coverage included articles in New Scientist, MSN.com, RadioNZ, New Zealand's Sunday Star-times, UK's Express, 20 Minutes Mexico, Live Science, and Motherboard. Several news outlets covered the expedition in multiple articles. Additionally, this expedition reached millions through OER social media platforms including Facebook, Twitter, Instagram, and YouTube.

7. Summary

EX1705 provided a great depth of baseline information to support management and science needs throughout the Central Pacific Basin. During 23 days at sea, the expedition team conducted 12 ROV dives—ranging in depth from 230 m to 4,573 m—and mapped over 36,500 km^2 of seafloor, an area larger than the state of Maryland. Though the expedition encountered weather and technical issues, there were several significant discoveries and accomplishments, including the following:

- Collected the first high-resolution mapping data over a number of features. In several instances, we found significant differences when compared to satellite altimetry data—with multiple instances of an approximate 1,000-meter variation.
- Completed 12 ROV dives:
    - Three dives in support of bottomfish and precious coral habitats.
    - Eight dives to identify deep-sea coral habitat
    - Eight dives to better understand the geologic history of the Central Pacific Basin
- Discovered 11 high-density communities, seven of which were high-density deep-sea coral and sponge communities. Other high-density communities included polychaete tube worms, holothurians, and multiple instances of sea urchins.
- Collected 79 biological samples—25 primary and 54 commensals—many of which are potentially undescribed species. Sixteen rock samples were collected for use in age-dating and geochemical composition analysis.
- Conducted midwater transects at three sites which documented a diversity of organisms, including dozens of observations of a pelagic holothurian that was previously thought to be rare. These

three sets of transects represented the first ever midwater exploration in the Jarvis Island and the Palmyra Atoll and Kingman Reef Units of PRMNM and in the vicinity of the northern Manihiki Plateau.

- EX1705 had record-high science engagement, with 95 scientists participating in the expedition. Our highest level of participation in a single dive was 53 scientists and we averaged 30 scientists/day. We had participants from Japan, Russia, New Zealand, Canada, Cook Islands, the Netherlands, Australia, and across the US. Several NOAA scientists from NOS, NMFS, OAR and OMAO participated in this expedition.
- Collected over 7.2 TB of data. These data include multibeam, single beam, sub-bottom, ADCP, XBT, CTD and dissolved oxygen profiles, surface oceanographic and meteorological sensors, video, imagery, and associated dive and video products.

Jarvis Island Unit of PRIMNM

- Completed five ROV dives that covered a range of ecosystems including shallow bottomfish habitats, abyssal communities deep in a fracture zone, and three previously unexplored seamounts
- Mapped over 7,900 km^2. When paired with the EX1701 data, EX mapped all or part of every major seamount in the Jarvis Island Unit of PRIMNM— of which previously had no high-resolution mapping data over them—totaling over 16,100 km^2 of newly mapped seafloor.
- Significant video highlights included a trio of brittle stars capturing a squid—the first deepwater observation of this behavior; several observations of a rarely observed pelagic holothurian, five high-density deep-sea coral and sponge communities; and the observation of a rare chitinous anemone.
- The dive at Jarvis Island was considered by many to be the highlight of the expedition. ROV *Deep Discoverer* investigated a biologically diverse ridge off the southeast side of the island. As the ROV transited upslope we documented six small- to medium-sized high-density communities of different organisms with a new group dominating each different depth range. The end of the dive concluded with a school of 26 Randall's snappers.

Palmyra Atoll and Kingman Reef Unit of PRIMNM

- Completed four ROV dives in the vicinity of Palmyra Atoll and Kingman Reef. Surveyed areas were diverse, with dozens of different species of deep-sea corals, echinoderms, sponges, and fishes. Additionally, the expedition team documented a high-density coral community along the slopes of a small cone feature to the east of Kingman Reef.
- Transferred 300 pounds of propane to resupply the Palmyra Atoll Research Station.
- Highlights from the dives in this Unit included documenting a snail predating upon a crinoid that has only previously been known from the fossil record from the Paleozoic era, a benthic jellyfish that is only known from the poles and is the first observation for the Central Pacific, and an unusual observation of a sea star predating upon a crinoid.

Marae Moana: Cook Islands Marine Park and the High Seas

- Acquisition of approximately 4,300 km^2 of mapping data over seafloor in Marae Moana: Cook Islands Marine Park. Additional mapping was conducted over priority areas north of the Cook Islands. Newly acquired multibeam data, along with the ROV sampling, has the potential to indicate a potential connection between ridge features and the Manihiki Plateau.
- Two ROV dives that revealed insight into a poorly understood area just north of the Cook Islands EEZ. Dives explored a large plateau and an extensive ridge feature that documented a previously unknown large scale high-density deep sea coral community.
- Hosted a telepresence interaction with Cook Islands schools, as well as a live telepresence interaction with media and participating scientists at New Zealand's Institute of Water and Atmospheric Research.
- On June 8, 2017, Cook Islands Prime Minister Henry Puna met with OAR Assistant Administrator Craig McLean, at the United Nations Ocean Conference to express appreciation of the work accomplished by the expedition and interest in future collaborations.

American Sāmoa

- Conducted one dive at the Aunu'u Unit of NMSAS. Observations during the dive included snapper, grouper, and several species of coral.
- Mapped 2,700 km^2 of seafloor in the water surrounding American Sāmoa.
- Hosted ship tours for 400 students, teachers, members of the media, and VIPs while in Pago Pago. Additionally, approximately 1,000 Festival of Sites visitors attended presentations and interacted with the expedition team.

8. References

Davis, A.S., Gray, L.B., Clague, D.A., Hein, J.R. (2002). The Line Islands revisited: New 40Ar/ 39Ar geochronologic evidence for episodes of volcanism due to lithospheric extension. Geochemistry, Geophysics, Geosystems 3(3):1–28. doi: 10.1029/2001GC000190

Eakins, B., Barth, G., Scheirer, D., Mosher, D., and Armstrong, A. (2017). Seafloor geomorphology and geology of the Kingman Reef-Palmyra Atoll region, Central Pacific Ocean, Geophysical Research Abstracts, 19, EGU2017-9863.

Evans, J. (2017) Marae Moana: Cook Island Marine Park. United Nations 2017 Global Reporting: https://www.un.org/depts/los/global_reporting/2017_NewZealand/Presentations/Moana_cookislands.pdf

Kennedy, B.R.C., Cantwell K., Malik M., Kelley, C., Potter, J., Elliott, K., Lobecker, E., Gray, L.M., Sowers, D., White, M.P., France, S.C., Auscavitch, S., Mah, C., Moriwake, V., Bingo, S.R.D., Putts, M., and Rotjan, R.D. (2019). The unknown and the unexplored: Insights into the Pacific deep-sea following NOAA CAPSTONE expeditions. *Front. Mar. Sci.* 6:480. doi: 10.3389/fmars.2019.00480

Koppers, A.A.P., Russell, J.A., Jackson, M.G., et al. (2008). Samoa reinstated as a primary hotspot trail. Geology 36(6):435–438. doi: 10.1130/G24630A.1

Lyle, M., Pockalny, R., Polissar, P., et al. (2016). Dynamic carbonate sedimentation on the Northern Line Islands Ridge, Palmyra Basin. Marine Geology 379:194–207. doi: 10.1016/j.margeo.2016.06.005

National Oceanic Atmospheric Administration (2019A). *National Marine Sanctuary of American Samoa,* Office of National Marine Sanctuaries (ONMS). https://americansamoa.noaa.gov/. Accessed May 29, 2019.

U.S. Fish and Wildlife Service (2019). *Pacific Remote Islands Marine National Monument*. https://www.fws.gov/refuge/pacific_remote_islands_marine_national_monument . Accessed: May 29, 2019.

National Oceanic and Atmospheric Administration (2019B). *Pacific Remote Islands Marine National Monument.* https://www.fisheries.noaa.gov/pacific-islands/habitat-conservation/pacific-remote-islands-marine-national-monument . Accessed: May 29, 2019

Taylor, B. (2006). The single largest oceanic plateau: Ontong Java–Manihiki–Hikurangi. Earth and Planetary Science Letters 241:372–380. doi: 10.1016/j.epsl.2005.11.049

Watling, L. (2015). A new genus of bamboo coral (Octocorallia: Isididae) from the Bahamas. Zootaxa 3918 (2): 239-249. doi: 10.11646/zootaxa.3918.2.5

9. Appendices

9.1 Appendix A: Dive Summaries

Dive summaries and associated ROV data from EX1705 can be found here (last accessed March 2020): https://service.ncddc.noaa.gov/rdn/oer-rov-cruises/EX1705

9.2 Appendix B: EX1705 Data Management Plan

Okeanos Explorer (EX1705): American Samoa, Kingman/Palmyra, Jarvis (ROV & Mapping)

Ocean Exploration and Research

OER Data Management Objectives

To ensure that data management standard operating procedures are completed and that the data are publicly accessible within 60-90 days of cruise end.

31-Mar-17 Page 1

1. General Description of Data to be Managed

1.1 Name and Purpose of the Data Collection Project

Okeanos Explorer (EX1705): American Samoa, Kingman/Palmyra, Jarvis (ROV & Mapping)

1.2 Summary description of the data to be collected.

Operations will include the use of the ship's deep water mapping systems (Kongsberg EM302 multibeam sonar, EK60 split-beam fisheries sonars, Knudsen 3260 chirp sub-bottom profiler sonar, and Teledyne Acoustic Doppler Current Profilers), XBT and Underway CTD casts in support of multibeam sonar mapping operations, OER's 6000 m two-body ROV Deep Discoverer and Seirios, and the ship's high-bandwidth satellite connection for continuous real-time ship-to-shore communications.

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

Davisville, mapping survey, multibeam, multibeam backscatter, multibeam sonar, multi-beam sonar, noaa fleet, okeanos, okeanos explorer, R337, Rhode Island, scientific computing system, SCS, single beam sonar, singlebeam sonar, single-beam sonar, sub-bottom profile, water column backscatter, expedition, exploration, explorer, marine education, noaa, ocean, ocean discovery, ocean education, ocean exploration, ocean exploration and research, ocean literacy, ocean research, OER, science, scientific mission, scientific research, sea, stewardship, systematic exploration, technology, transformational research, undersea, underwater, oceans, American Samoa, Kingman Reef, Jarvis Island, Pago Pago, Hawaii, Cook Islands, Kiribati, Pacific Remote Islands Marine National Monument, PRIMNM, Palmyra Atoll, CAPSTONE, Prime Crust Zone, Pacific Monuments and Sancuaries, Central Pacific Seamounts, deep sea minerals, telestream

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

Okeanos ROV Cruises

1.5 Planned or actual temporal coverage of the data.

Dates: 4/27/2017 to 5/19/2017

1.6 Planned or actual geographic coverage of the data.

Latitude Boundaries:	14.28	to	21.37
Longitude Boundaries:	-170.5	to	-154

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

Cruise Plan, Cruise Summary, Data Management Plan, Highlight Images, Quick Look Report, ADCP, CTD (processed), CTD (raw), Dive Summaries, EK60 Singlebeam Data, Expedition Cruise Report, HDCS, Highlight Video, Images, Multibeam (image), Multibeam (processed), Multibeam (product), Multibeam (raw), NetCDF, Raw Video

(digital), Raw video inventory logs, Sample Analysis Reports, Sample Logs, SCS Output (compressed), SCS Output (native), Water Column Backscatter, XBT (raw)

1.8 What platforms will be employed during this mission?

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

2. Point of Contact for this Data Producing Project

Overall POC:	Ms. Kasey Cantwell, Field Operations Specialist, NOAA Office of Ocean Exploration and Research, kasey.cantwell@noaa.gov
Title:	Expedition Coordinator
Affiliation/Dept:	NOAA Office of Ocean Exploration and Research
E-Mail:	kasey.cantwell@noaa.gov
Phone:	301-734-1050

3. Point of Contact for Managing the Data

Data POC Name:	Susan Gottfried, Josh Carlson, Amanda Netburn
Title:	Stewardship Data Manager, Onboard Data Manager, Sampling Operations Data Manager
E-Mail:	susan.gottfried@noaa.gov, joshocar@gmail.com, amanda.netburn@noaa.gov

4. Resources

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

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

unknown

5. Data Lineage and Quality

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

SCS data shall be delivered in its native format as well as an archive-ready, documented, and compressed NetCDF4 format to NCEI-MD; multibeam data and metadata will be compressed and delivered in a bagit format to NCEI-CO

5.2 What quality control procedures will be employed?

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

6. Data Documentation

6.1 Does the metadata comply with the Data Documentation Directive? True

6.1.1 If metadata are non-existent or non-compliant, please explain:

not applicable

6.2 Where will the metadata be hosted?

Organization: An ISO format collection-level metadata record will be generated during pre-cruise planning and published in an OER catalog and Web Accessible Folder (WAF) hosted at NCEI-MS for public discovery and access. The record will be harvested by data.gov.

URL: https://www.ncddc.noaa.gov/oer-waf/ISO/Resolved/2017

Meta Std: ISO 19115-2 Geographic Information with Extensions for Imagery and Gridded Data will be the metadata standard employed; a NetCDF3 standard for oceanographic data will be employed for the SCS data; the Library of Congress standard, MAchine Readable Catalog (MARC), will be employed for NOAA Central Library records.

6.3 Process for producing and maintaining metadata:

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

7. Data Access

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

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

Not Applicable

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

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

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

Org: National Centers for Environmental Information

URL: data.noaa.gov; explore.noaa.gov/digitalatlas

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

Hold Time: no

Authority: not applicable

7.4 Prepare a Data Access Statement

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

8. Data Preservation and Protection

8.1 Actual or planned long-term data archive location:

Data from this mission will be preserved and stewarded through the NOAA National Centers for Environmental Information. Refer to the Okeanos Explorer FY16 Data Management Plan at NOAA's EDMC DMP Repository (EX_FY17_DMP_Final.pdf) for detailed descriptions of the processes, procedures, and partners involved in this collaborative effort.

8.2 If no archive planned, why?

not applicable

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

30-90 days

Okeanos Explorer (EX1705): American Samoa, Kingman/Palmyra, Jarvis (ROV & Mapping)

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

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

8.5 Prepare a Data Use Statement

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

9.3 Appendix C: EX1705 Permits

Cook Islands High Commission

Note No: 097/2016-17

The Cook Islands High Commission presents its compliments to the Embassy of the United States of America and has the honour to enclose copy of research permit issued by the Cook Islands Foundation for National Research, based within the Office of the Prime Minister, for the US flagged marine research vessel the *Okeanos Explorer.*

The research permit covers the period 4th April 2017 to 5th May 2017.

The Cook Islands High Commission avails itself of this opportunity to renew to the Embassy of the United States of America the assurances of its highest consideration.

7 April 2017

WELLINGTON

Cook Islands High Commission Wellington

Encl. Copy of Research Permit

PO Box 12 242, Thorndon, 56 Mulgrave St, Wellington, New Zealand. Ph (04) 472 5126 Fax (04) 472 5121

Open with

PERMIT TO UNDERTAKE

Research in the Cook Islands

This is to certify that: **Mr Russell Craig**

Has permission from the Foundation for National Research to do a research in the Cook Islands from: **4 April 2017 – 5th May 2017**

On the island(s) of: **Research will be done within and North of the Islands EEZ**

The topic of research is: **Campaign to address Pacific Monument Science, Technology and Ocean Needs (CAPSTONE)**

The Cook Islands Associate Researcher is: **Ms Jacqueline Evans**

The following special conditions apply to this research:

- The researcher complies with the Cook Islands Immigration, Ministry of Marine Resources and National Environment Services requirements

- The researcher provides a preliminary report to the Office of the Prime Minister at the earliest

-The researcher provides three (3) hard copies + one (1) e-copy of the final output generated from this research to the Office of the Prime Minister by June 2019.

Permit Issued on: **09 March 2017** Issued by: **Elizabeth Koteka**

CHAIRPERSON

Receipt Number: N/A

Reference Number: 05-17 **Signed:** _____

For enquiries concerning this permit, please quote the Name of the Researcher and the Reference Number to the Chairperson, Foundation for National Research, and Office of the Prime Minister, Rarotonga, and COOK ISLANDS. Phone (682) 29 300, Fax (682) 20 856, or Email: elizabeth.wright@cookislands.gov.ck Website: www.pmoffice.gov.ck

COOK ISLAND RESEARCH COMMITTEE
OFFICE OF THE PRIME MINISTER
PRIVATE BAG, RAROTONGA, COOK ISLANDS
Phone +682 211-50 Facsimile +682 20-856
Email: elizabeth.wright@cookislands.gov.ck Web: www.cook-islands.gov.ck

File ref: 510.3
Letter no: 17-005

09 March 2017

Mr Russel Craig
Program Manager, Okeanos Explorer Explorations
Office of Ocean Exploration and Research
Seattle, WASHINGTON
United States of America

Kia Orana Mr Russell,

RE: APPROVED RESEARCH APPLICATION

I am pleased to advise that the National Research Committee has granted approval for your research titled **"Campaign to address Pacific Monument Science, Technology and Ocean Needs (CAPSTONE)" within and North of the Islands EEZ** from **04 April 2017** to **05 May 2017.**

Enclosed is your research permit issue **# 05/17**

The following conditions listed below have been imposed by the National Research Committee

- **The researcher complies with the Cook Islands Immigration**
- **The researcher provides a preliminary report to the Office of the Prime Minister at the earliest**
- **The researcher provides three (3) hard copies + one (1) e-copy of the final output generated from this research to the Office of the Prime Minister by June 2019.**

Kia Manuia

Elizabeth Wright-Koteka
CHAIRPERSON

PERMIT TO UNDERTAKE

RESEARCH IN THE COOK ISLANDS

This is to certify that: **Mr Russell Craig**

Has permission from the Foundation for National Research to do a research in the Cook Islands from: **April 2017 – May 2017**

On the Island(s) of: **Within and North of the Cook Islands EEZ**

The topic of research is: **Campaign to address Pacific Monument Science, Technology and Ocean Needs (CAPSTONE)**

The Cook Islands Associate Researcher is: **Ms Jacqueline Evans**

The following special conditions apply to this research:

-The researcher complies to the Ministry of Marine Resources and National Environment Services requirements

-The researcher provides three (3) hard copies + one (1) e-copy of the final output generated from this research to the Office of the Prime Minister by June 2017.

Permit Issued on: **09 March 2017** Issued by: **Elizabeth Koteka**

CHAIRPERSON

Receipt Number: **N/A**

Reference Number: 05-17 **Signed:**

For enquiries concerning this permit,
please quote the Name of the Researcher and the Reference Number
to the Chairperson, Foundation for National Research and Office of the Prime Minister,
Rarotonga, and COOK ISLANDS. Phone (682) 29 300, Fax (682) 20 856, or
Email: elizabeth.wright@cookislands.gov.ck Website: www.pmoffice.gov.ck

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

National Marine Sanctuary of American Samoa
P.O. Box 4318
Pago Pago, AS 96799

January 19, 2017

MEMORANDUM FOR: THE RECORD

FROM: Gene Brighouse
National Marine Sanctuary of American Samoa

SUBJECT: Decision Memo for Permit # NMSAS-2017-001

The National Oceanic and Atmospheric Administration's National Marine Sanctuary Program (NMSP) has decided to issue permit number NMSAS-2017-001 to Kelley Elliott for the project entitled: 2017 American Samoa Expedition. This memorandum documents the rationale for this decision and compliance with all required consultations generated by this action.

BACKGROUND

Project Summary:
NOAA Ship Okeanos Explorer is the nation's first and only federal vessel with a mandate to systematically explore our mostly unknown ocean for the purpose of discovery and the advancement of knowledge. Operating under a partnership with NOAA's Office of Ocean Exploration and Research and the Office of Marine and Aviation Operations, the 2017 CAPSTONE American Samoa Expedition is a part of a major multi-year foundational science effort focused on deepwater areas of U.S. marine protected areas (MPAs) in the central and western Pacific. The overarching goal of the CAPSTONE project is to extend and improve the understanding of the distribution and diversity of deepwater habitats within MPAs, and collect data and information to support priority monument and sanctuary science and management needs.

Data and information from the Expeditions will provide a foundation of publicly-accessible baseline information to improve management and spur further exploration and research. Like previous expeditions in the Gulf of Mexico, western Atlantic, Hawai'i and Indonesia, NOAA will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration. Operations will use the ship's deep water mapping systems, NOAA's 6000m remotely operated vehicles (ROV), underway CTD, CTD rosette, and a high-bandwidth satellite connection for real-time ship to shore communications.

We propose to conduct activities in and around the National Marine Sanctuary of American Samoa to explore and improve understanding of the distribution and diversity of deep water habitats. The activity would occur during five cruises from February 1 to April 30, 2017. Operations will be focused in 250 m and deeper. No activities would occur on land.

Direct impacts:
A standard suite of operations are conducted on Okeanos Explorer and have 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 is 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. Full details of the potential short-term impacts are described in the attached Categorical Exclusion.

Indirect impacts:
No indirect impacts on sanctuary resources will result from this activity.

Cumulative impacts:
A standard suite of operations are conducted on Okeanos Explorer and have 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 is 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. Full details of the potential short-term impacts are described in the attached Categorical Exclusion.

Site-specific impacts and review criteria:
Activity shall be conducted with adequate safeguards for the environment. Environment shall be returned to, or will regenerate to, the condition which existed before the activity occurred.

NATIONAL ENVIRONMENTAL POLICY ACT

Categorical Exclusion:
After reviewing NOAA Administrative Order (NAO) 216-6, including the criteria used to determine significance, the NMSP has concluded that the issuance of this permit would not have a significant effect, individually or cumulatively, on the human environment. Further, we have determined that the proposed action is categorically excluded from the requirement to prepare an environmental assessment or environmental impact statement in accordance with Section 6.03c.3(a) Research Program of NAO 216-6, specifically:

The proposed research activity is of limited size and magnitude and, based on analysis of past projects in the permitted activity area, has been found to have negligible cumulative effects. I certify that this action is not likely to result in significant impacts as defined at 40 CFR 1508.27 and is not an exception to this CE category as defined by section 5.05c of NAO 216-6.

Based on this, the NMSP has concluded that an environmental assessment is not warranted for the issuance of this permit.

MAGNUSON-STEVENS ACT / ESSENTIAL FISH HABITAT

Section 305(b) (2) of the Magnuson-Stevens Fishery Conservation and Management Act requires any federal action agency to complete an Essential Fish Habitat consultation for any action authorized by the agency that may adversely affect EFH. The issuance of this permit will

adversely impact designated EFH within National Marine Sanctuary of American Samoa. Therefore, consultation with NMFS Pacific Islands Regional Office was conducted on November 30, 2016. Recommendations to minimize or mitigate for impacts to EFH have been taken into consideration and incorporated into the final action.

MARINE MAMMAL PROTECTION ACT

The issuance of this permit is not likely to result in the take of any marine mammal protected under the Marine Mammal Protection Act. Therefore, a separate permit to take a marine mammal is not required.

COASTAL ZONE MANAGEMENT ACT

The NMSP has determined that the proposed activity is not reasonably likely to affect any land or water use or natural resource of the coastal zone of American Samoa. In addition, national marine sanctuary permits and authorizations are not listed under the American Samoa Coastal Zone Management Program (CZMP) as activities that generally require a consistency determination. Furthermore, American Samoa CMP has not contacted the NOAA Office of Ocean and Coastal Resource Management with a request to review this permit. Therefore, a federal consistency determination is not required for this action.

ENDANGERED SPECIES ACT

The NMSP has determined that the proposed activity is not likely to adversely affect ESA-listed marine species. Consultation with the National Marine Fisheries Service Pacific Islands Regional Office as required by Section 7 of the Endangered Species Act was conducted on January 14, 2016. Recommendations generated through consultation have been taken into consideration and incorporated into the final action.

NATIONAL HISTORIC PRESERVATION ACT

Section 106 of the National Historic Preservation Act requires federal agencies to consider the impact of their actions on historic properties. The NMSP has determined that the proposed activity is not likely to affect any historic properties. No consultations with the Advisory Council on Historic Preservation, State Historic Preservation Officer, or Tribal Historic Preservation Officer were conducted.

OTHER CONSULTATIONS

No other consultations were required or considered for this action.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

National Marine Sanctuary of American Samoa
P.O. Box 4318
Pago Pago, AS 96799

NATIONAL MARINE SANCTUARY of AMERICAN SAMOA
RESEARCH PERMIT

Permittee:
Ms. Kelley Elliott
NOAA Office of Ocean Exploration and Research (OER
1315 East-West Hwy
SSMC3 Room 10262
Silver Spring, MD 20910

Permit Number: NMSAS-2017-001
Effective Date: February 1, 2017
Expiration Date: April 30, 2017

Project Title: 2017 American Samoa Expedition

This permit is issued for activities in accordance with the National Marine Sanctuaries Act (NMSA), 16 USC §1431 *et seq.*, and regulations thereunder (15 CFR Part 922). All activities must be conducted in accordance with those regulations and law. No activity prohibited in 15 CFR Part 922 is allowed except as specified in the activity description below.

Subject to the terms and conditions of this permit, the National Oceanic and Atmospheric Administration (NOAA), Office of National Marine Sanctuaries (ONMS) hereby authorizes the permittee listed above to conduct research activities within National Marine Sanctuary of American Samoa (NMSAS or sanctuary). All activities are to be conducted in accordance with this permit and the permit application received January 03, 2017. The permit application is incorporated into this permit and made a part hereof; provided, however, that if there are any conflicts between the permit application and the terms and conditions of this permit, the terms and conditions of this permit shall be controlling.

Permitted Activity Description:
The following activities are authorized by this permit:

Permitted research activities utilizing methods as described in the research application include: Damaging, destroying or possessing any invertebrate, coral, bottom formation or marine plant; Alteration of seabed; collection of bottom-dwelling species throughout the sanctuary.

Specimens to be collected are very unlikely to already reside in a repository as the dives and collections are discovery-based. Only very selective specimens that have the potential to contribute significant scientific discoveries will be collected during ROV operations. Biologic samples will focus on potential new species or new records for the region, and the dominant morphotype animal (such as a coral or sponge) in a habitat. 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, only a sub-sample will be taken of biologic specimens (e.g., only a piece or branch of corals and sponges will be collected, not the entire organism). 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. All samples will be preserved onboard and made freely and publicly accessible to the science community through National Repositories.

No further violation of sanctuary regulations is allowed.

Permitted Activity Location:
The permitted activity is allowed only in the following location(s):

Throughout the sanctuary.

Special Terms and Conditions:

The permittee may not anchor within the Sanctuary boundaries.

The permittee may not permanently mark any of the reefs.

The permittee shall submit an annual report of all activities conducted under this permit to the NMSAS Permit Coordinator no later than one year from completion of field activities. The report should include a synopsis of research results to date, as well as information regarding daily activities such as location (latitude and longitude) and depth of surveys, discovery or disturbance of historical artifacts, or equipment lost. Appropriate photographs that may be used by NOAA are appreciated, and will be credited to the photographer.

Any scientific publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under permit number NMSAS-2017-001. Additionally, the permittee and his/her respective institution(s) are required to acknowledge during any media coverage (press releases, video/photo, or other means) that the research activities occurred within the NMSAS and under permit.

NOAA reserves the right to place an observer aboard the ship engaged in operations conducted under this permit. The NOAA observer(s) may document the permittee's activities for the purpose of determining whether the permitted activities are conducted in accordance with the terms and conditions of this permit and the applicable statute and regulations. The NOAA observer(s) may also provide limited advice and technical assistance, if requested by the permittee. The NOAA observer(s) will not be present for the purpose of safety of permittees, nor for the purpose of approval of activities not specifically authorized by this permit.

General Terms and Conditions:

1. Within 30 (thirty) days of the date of issuance, the permittee must sign and date this permit for it to be considered valid. Once signed, the permittee must send copies, via mail or email, to the following individuals:

Gene Brighouse Superintendent National Marine Sanctuary of American Samoa P.O. Box 4318 Pago Pago, AS 96799 Gene.Brighouse@noaa.gov	National Permit Coordinator NOAA Office of National Marine Sanctuaries 1305 East-West Highway (N/ORM6) SSMC4, 11th Floor Silver Spring, MD 20910 nmspermits@noaa.gov

2. It is a violation of this permit to conduct any activity authorized by this permit prior to the ONMS having received a copy signed by the permittee.

3. This permit may only be amended by the ONMS. The permittee may not change or amend any part of this permit at any time. The terms of the permit must be accepted in full, without revision; otherwise, the permittee must return the permit to the sanctuary office unsigned with a written explanation for its rejection. Amendments to this permit must be requested in the same manner the original request was made.

4. All persons participating in the permitted activity must be under the supervision of the permittee, and the permittee is responsible for any violation of this permit, the NMSA, and sanctuary regulations for activities conducted under, or in junction with, this permit. The permittee must assure that all persons performing activities under this permit are fully aware of the conditions herein.

5. This permit is non-transferable and must be carried by the permittee at all times while engaging in any activity authorized by this permit.

6. This permit may be suspended, revoked, or modified for violation of the terms and conditions of this permit, the regulations at 15 CFR Part 922, the NMSA, or for other good cause. Such action will be communicated in writing to the applicant or permittee, and will set forth the reason(s) for the action taken.

7. This permit may be suspended, revoked or modified if requirements from previous ONMS permits or authorizations issued to the permittee are not fulfilled by their due date.

8. Permit applications for any future activities in the sanctuary or any other sanctuary in the system by the permittee might not be considered until all requirements from this permit are fulfilled.

9. This permit does not authorize the conduct of any activity prohibited by 15 CFR § 922, other than those specifically described in the "Permitted Activity Description" section of this permit. If the permittee or any person acting under the permittee's supervision

conducts, or causes to be conducted, any activity in the sanctuary not in accordance with the terms and conditions set forth in this permit, or who otherwise violates such terms and conditions, the permittee may be subject to civil penalties, forfeiture, costs, and all other remedies under the NMSA and its implementing regulations at 15 CFR Part 922.

10. Any publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under National Marine Sanctuary Permit NMSAS-2017-001 and be sent to the ONMS officials listed in general condition number 1.

11. This permit does not relieve the permittee of responsibility to comply with all other federal, state and local laws and regulations, and this permit is not valid until all other necessary permits, authorizations, and approvals are obtained. Particularly, this permit does not allow disturbance of marine mammals or seabirds protected under provisions of the Endangered Species Act, Marine Mammal Protection Act, or Migratory Bird Treaty Act. Authorization for incidental or direct harassment of species protected by these acts must be secured from the U.S. Fish and Wildlife Service and/or NOAA Fisheries, depending upon the species affected.

12. The permittee shall indemnify and hold harmless the Office of National Marine Sanctuaries, NOAA, the Department of Commerce and the United States for and against any claims arising from the conduct of any permitted activities.

13. Any question of interpretation of any term or condition of this permit will be resolved by NOAA.

Your signature below, as permittee, indicates that you accept and agree to comply with all terms and conditions of this permit. This permit becomes valid when you, the permittee, countersign and date below. Please note that the expiration date on this permit is already set and will not be extended by a delay in your signing.

Kelley R. Elliott 1-26-17

Ms. Kelley Elliott Date
NOAA Office of Ocean Exploration and Research (OER

1-19-17

Gene Brighouse Date
Superintendent
National Marine Sanctuary of American Samoa

0 document(s) attached.

Ocean Exploration and Research

DEPARTMENT OF MARINE AND WILDLIFE RESOURCES
AMERICAN SAMOA GOVERNMENT
P.O. BOX 3730
Pago Pago, AS 96799 U.S.A.

SCIENTIFIC STUDY & COLLECTION PERMIT APPLICATION

This application must be completed prior to all scientific studies requiring the observation, collection, handling, &/or manipulation of live or dead entities of both marine and wildlife species whether in part or in whole.

NAME OF APPLICANT: Kelley P. Elliott
ADDRESS: 1315 East-West Hwy, SSMC3 RM 10262, Silver Spring, MD 20910, USA
EMAIL ADDRESS: Kelley.Elliott@noaa.gov
INSTITUTIONAL AFFILIATION: U.S. Department of Commerce, National Oceanic and Atmospheric Instution, Office of Ocean Exploration and Research
INSTITUTIONAL ADDRESS: 1315 East-West HWY, SSMC3 10th Floor, Silver Spring MD 20910

TITLE OF STUDY: 2017 CAPSTONE American Samoa Expedition

OBJECTIVES OF STUDY:
NOAA Ship *Okeanos Explorer* is the nation's first and only federal vessel with a mandate to systematically explore our mostly unknown ocean for the purpose of discovery and the advancement of knowledge. The 2017 CAPSTONE American Samoa Expedition is a part of a major multi-year foundational science effort focused on deepwater areas of U.S. marine protected areas (MPAs) in the central and western Pacific. The overarching goal of the multi-year CAPSTONE project is to extend and improve the understanding of the distribution and diversity of deepwater habitats within MPAs, and collect data and information to support priority monument and sanctuary science and management needs.

The fundamental driver of the multi-leg American Samoa Expedition is to better understand unknown and poorly known areas of our ocean which include diverse living marine resources, and unique geologic phenomena. Data and information from the cruises will build on previous work, and provide a foundation of baseline data to improve management and spur further exploration and research. NOAA priorities for the work include a combination of science, education, outreach, and open data objectives that will support management decisions at multiple levels.

- Acquire data to support priority Monument and Sanctuary science and management needs;
- Explore the diversity of benthic habitats and features (e.g. seamounts, hydrothermal vents, deep-sea coral habitats, bottom fish habitats);
- Identify and map vulnerable marine habitats – particularly high-density deep-sea coral and sponge communities;

- Investigate the geologic history of Pacific seamounts, including potential relevance to plate tectonics and subduction zone biology and geology; and
- Engage a broad spectrum of the scientific community and public in telepresence-based exploration; and
- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

Operations will use the ship's deep water mapping systems, NOAA's 6000m remotely operated vehicles (ROV), Conductivity Temperature Depth (CTD) rosette, underway CTD, and a high-bandwidth satellite connection for real-time ship to shore communications. Like previous expeditions in the Gulf of Mexico, western Atlantic, Hawai'i and Indonesia, NOAA will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration. Data and information from the Expedition will be made publicly available to provide a foundation of publicly-accessible baseline information to improve management and spur further exploration and research.

We propose to conduct activities within the American Samoa Exclusive Economic Zone, including within the Rose Atoll Marine National Monument, the National Marine Sanctuary of American Samoa and within territorial waters to explore and improve understanding of the distribution and diversity of deep water habitats. The activity would occur during five cruises from February 1 to April 30, 2017. Operations will be focused in 250 meters and deeper. No activities would occur on land.

DESCRIPTION OF SPECIMEN(S) TO BE COLLECTED, IF ANY:
During ROV operations, only very selective specimens that have the potential to contribute significant scientific discoveries will be collected. On average only 4-6 total biological and geological specimens will be collected per dive. Biologic samples will focus on potential new species or new records for the region, and the dominant morphotype animal (such as a coral or sponge) in a habitat. When possible, only a sub-sample will be taken of biologic specimens (e.g., only a piece or branch of corals and sponges will be collected, not the entire organism). 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. All samples will be preserved onboard and made freely and publicly accessible to the science community through National Repositories.

Water samples may also be collected using our CTD rosette instrument. The CTD instrument package is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, oxygen reduction potential). At least one, and potentially several, CTD casts are planned for this cruise. CTD casts would 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. No water samples have been requested at this time, however if they are requested and collected they would likely be frozen for later analysis. The results from any analysis would be made publicly available.

DESCRIBE COLLECTION METHODS TO BE USED:

ROV Operations: biological and geological specimens

The purpose of conducting ROV operations is to conduct interdisciplinary site characterization at priority targets in American Samoa. Interdisciplinary site characterization would be achieved by visually surveying priority targets while simultaneously acquiring environmental data with in situ sensors mounted on the ROVs (conductivity, temperature and depth; dissolved oxygen; light scattering; and oxygen reduction potential). ROV targets include seamounts, hydrothermal vents, deep-sea coral and sponge communities and bottom fish habitats. The combined dives will enable scientists and managers to have a better understanding of the diversity and distribution of deep water habitats in American Samoa including the Rose Atoll Marine National Monument and National Marine Sanctuary of American Samoa, and should contribute to enhanced protection of these resources.

The *Okeanos Explorer* is equipped with a dedicated, fully integrated, two-body ROV system. ROV operations are conducted primarily during daylight hours while the vessel is stopped and holding 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. On occasion, the ROV is set down on the seafloor in order to acquire very close imagery of habitats or features of interest or to collect samples. The ROV also has a temperature probe that may be shallowly inserted into the seafloor sediment to measure the depth or temperature of features of interest.

During these dives, limited sampling operations are planned with the ROV to collect very selective specimens that have the potential to contribute significant scientific discoveries. These specimens would be collected using the ROV's manipulator arms or scoop. Biological specimen collections will focus on potential new species or new records for the region, and the dominant morphotype animal (such as a coral or sponge) in a habitat. 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 organism). 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. On average only 4-6 total biological and geological specimens will be collected per dive.

CTD Rosette: water samples and sensor data

Water samples may also be collected using our CTD rosette instrument. The CTD instrument package is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, oxygen reduction potential). The instrument is attached to an open cylindrical steel frame approximately 1.15 m in diameter and 1.4 m high with a 24-position rosette carousel containing 24 2.5 L Niskin bottles for collecting water samples. 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 casts varies from one to several hours depending on water depth (the CTD is

Ocean Exploration
and Research

lowered through the water column at 60m/min). CTD casts would 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. No water samples have been requested at this time, however if they are collected they would likely be frozen for later analysis. The results from any analysis would be made publicly available.

Mapping Operations: acoustic data

The ship will conduct sonar mapping operations at all times during non-ROV or non-CTD rosette operations throughout the cruise. NOAA Ship *Okeanos Explorer* has a suite of scientific sonars, each with a unique exploration application. All of these systems are routinely used by the ocean science community and have provided invaluable scientific data for oceanographers, marine researchers and managers. Each sonar's acoustic signal is designed to be narrowly focused to provide precise information about a specific, narrowly defined area of the seafloor or water column beneath the ship. The sonars include a Kongsberg EM302 30 kHz multibeam system; 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz and 333 kHz Kongsberg EK60 split-beam fisheries sonars (the 333 kHz and 38 kHz will not be operational since we don't currently have the hardware general purpose transceiver to run it, but is included just in case); a Knudsen 3.5 kHz chirp sub-bottom profiler sonar; and 300 kHz and 38 kHz Teledyne Acoustic Doppler Current Profilers (ADCPs). The multibeam maps broad swaths for seafloor bathymetry/backscatter and water column feature detection (e.g. gaseous seeps), the split-beam sonars gather calibrated target strength measurements of biologic and gaseous targets in the water column, the sub-bottom profiler provides data useful for interpreting sub-seafloor geology, and the ADCPs provide information about current velocity and direction at various depths through a water column profile. Additionally, expendable bathythermographs (XBTs) and the ship's UnderwayCTD (UCTD) will be deployed at regular intervals in association with multibeam data collection. All of these systems are routinely used by this exploration vessel.

DURATION OF STUDY OR COLLECTION PERIOD:

The activity would occur during five cruises from February 1 to April 30, 2017. The requested dates cover a conservative estimate of the timing that NOAA Ship *Okeanos Explorer* will arrive in American Samoa and can commence work in the region, through a few days after the last cruise departs and is likely to conduct work in American Samoa. During the cruises, 15 deployments of the ROV are planned in American Samoan waters, resulting in 120 hours total dive time (~8 hours for each dive). The Expedition cruise legs, dates and focus areas are below:

EX-17-01 (January 18 – February 10, 2017): 24-day mapping cruise from Honolulu, HI to Pago Pago, American Samoa with focused mapping work in: Kingman/Palmyra and Jarvis units of the Pacific Remote Islands Marine National Monument (PRIMNM); the Pheonix Islands Protected Area (PIPA) part of Kiribati; Tokelau and Swains Island Unit of the National Marine Sanctuary of American Samoa (NMSAS).

EX-17-02 (February 16 – March 2, 2017. Pago Pago, American Samoa - Apia, Samoa): 14-day cruise with daytime remotely operated vehicle (ROV) dives and overnight CTD rosette and mapping operations focused on American Samoan waters.

EX-17-03 (March 7 - 29, 2017. Apia, Samoa - Apia, Samoa): A 23-day cruise with daytime remotely operated vehicle dives and overnight CTD rosette and mapping operations focused on PIPA and the Howland/Baker Unit of the PRIMNM. One dive is planned in the Swains Island unit of the National Marine Sanctuary of American Samoa at either the start or end of the cruise.

EX-17-04 (April 4 – April 21, 2017. Apia, Samoa - Pago Pago, American Samoa): An 18-day mapping cruise focused on American Samoa including unmapped or poorly mapped areas of the Rose Atoll Marine National Monument and National Marine Sanctuary of American Samoa deeper than ~250m.

EX-17-05 (April 27 – May 19, 2017. Pago Pago, AS to Honolulu, HI): A 23-day cruise with daytime remotely operated vehicle (ROV) dives and overnight CTD rosette and mapping operations focused on the Cook Islands and the Jarvis and Kingman/Palmyra Units of the PRIMNM. One dive is planned in or just outside of the Aunu'u Unit of the National Marine Sanctuary of American Samoa at the start of the cruise.

SPECIFIC LOCATION(S) OF STUDY &/or COLLECTING/SAMPLING AREA(S):
Mapping, ROV and CTD rosette operations will focus in depths generally between 250 and 6,500 meters, with some mapping planned. CTD rosette operations have been requested in waters south of Tutuila and at Vailulu'u seamount. No activities would occur on land.

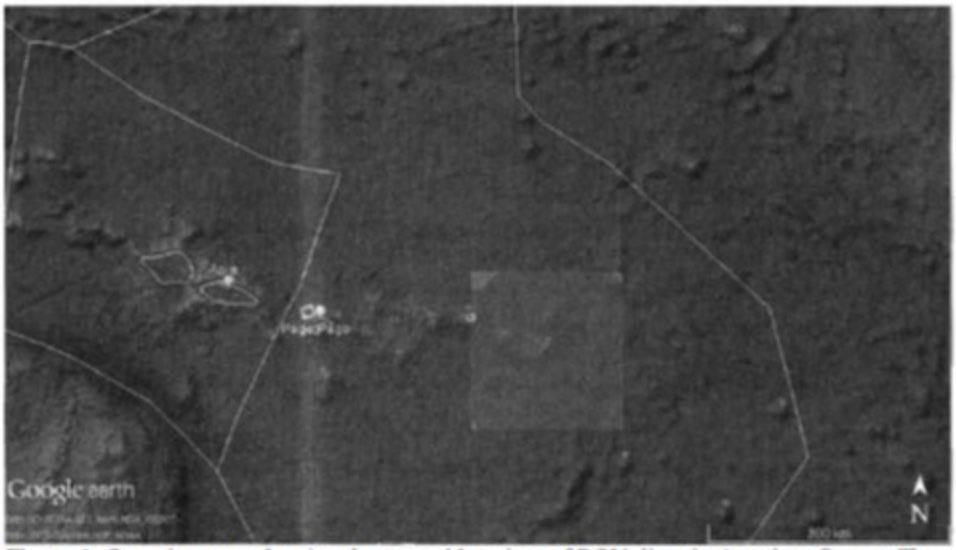


Figure 1: Overview map showing the general locations of ROV dives in American Samoa. The red dots are the draft locations of ROV dive sites, and where samples would be collected. The yellow boxes are priority areas for focused mapping surveys. Focused overnight mapping operations will be planned during the cruise based on available time. The light blue polygons are the boundaries of the Rose Atoll Marine National Monument and National Marine Sanctuary of

American Samoa. The green labelled dots are the port locations of Pago Pago, American Samoa and Apia, Samoa. The white line is the publicly available Exclusive Economic Zone of American Samoa and Samoa.

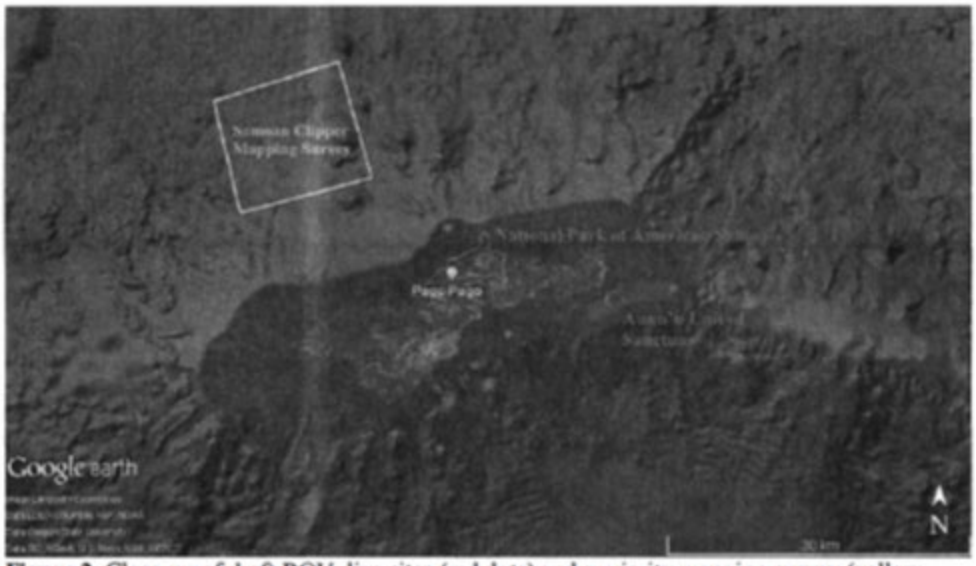


Figure 2. Close-up of draft ROV dive sites (red dots) and a priority mapping survey (yellow polygon) near Tutuila Island. The green polygon is the boundaries of the National Park of American Samoa (which extends to 100m offshore), and the light blue polygon is the Aunu'u unit of the National Marine Sanctuary of American Samoa. The requested sonar mapping survey is to support efforts to find a lost plane and maritime archaeology procedures will be employed during the survey to protect location information.

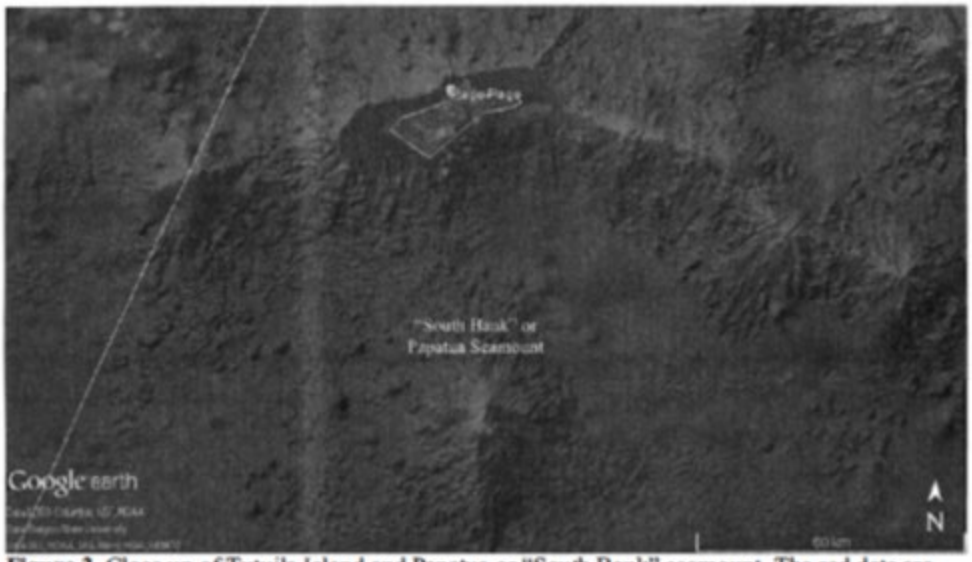


Figure 3. Close up of Tutuila Island and Papatua or "South Bank" seamount. The red dots are the locations of draft ROV dive sites.

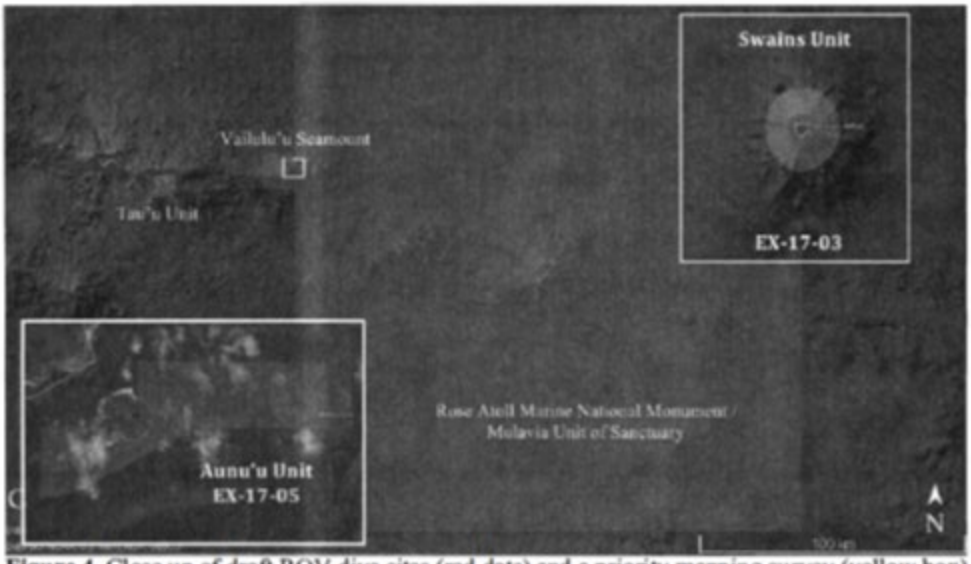


Figure 4. Close up of draft ROV dive sites (red dots) and a priority mapping survey (yellow box) within the National Marine Sanctuary of American Samoa and Rose Atoll Marine National Monument (the light blue boxes).

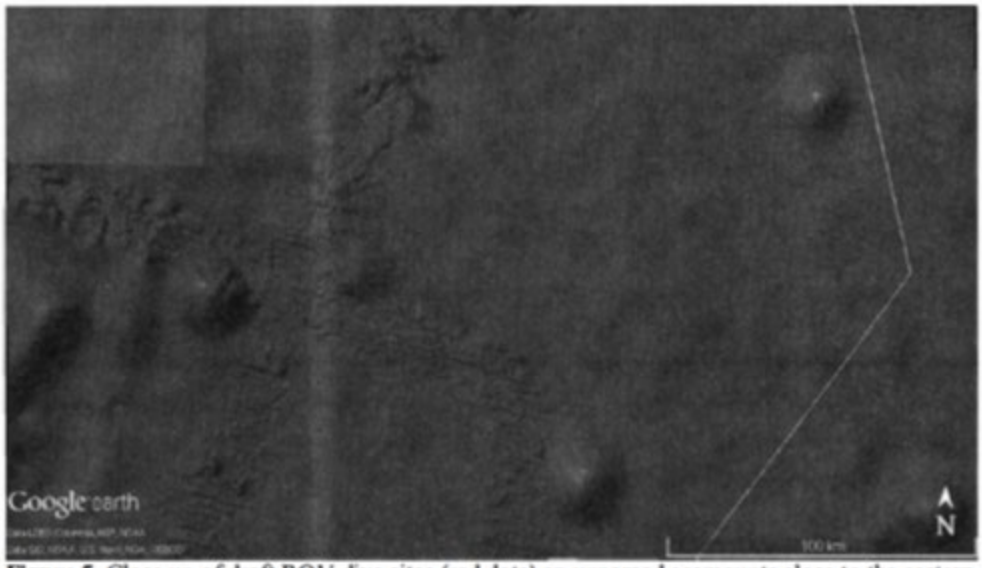


Figure 5. Close up of draft ROV dive sites (red dots) on unnamed seamounts close to the eastern edge of the American Samoa EEZ (white line). The light blue polygon is the southeast corner of Rose Atoll Marine National Monument. Mapping operations will need to be conducted overtop of the seamounts the night/morning prior to the dive to finalize the dive track.

Figure 6. Overview map showing areas where seafloor mapping activities are planned – especially during EX-17-02 and EX-17-04 cruises. The orange polygons are mapping survey

areas requested by the science and management community. Mapping operations will focus on areas 250 meters and deeper.

IF HANDLING &/OR MANIPULATION OF LIVE ANIMALS, DESCRIBE PROTOCOL(S):

ROV Operations:
Once a sample is brought onboard, it will be photographed, documented, and information entered into a sample database. Rocks will be dried and photographed. Aliquots of coral and sponge specimens will be preserved for taxonomic analysis (ethanol), genetic analysis (CHAOS or other buffer), and in some cases, histological examination (10% buffered formalin). All other animals will be preserved in either formalin or ethanol, depending on which preservative is more desirable for the particular taxa.

An additional small tissue sample will be taken of all biological specimens when doing so will not be overly destructive to the specimen. This tissue sample will be preserved onboard for later genomic DNA and RNA extraction at the Ocean Genome Legacy Center (OGL) in Northeastern University.

All samples will remain on the ship until it returns to Honolulu, HI in summer 2017. The samples will then be taken to OER Science Advisor, Dr. Chris Kelley's lab at the University of Hawaii at Manoa for temporary storage. There they will be prepared and transferred to a repository (with preliminary identification provided along with photographs and a deed of gift).

IF SAMPLES COLLECTED WILL BE SUBJECTED TO FURTHER PROCESSING (e.g., genetic analysis or other biochemical analysis, museum prep), DESCRIBE HOW AND WHERE:

All biological and geological samples will be provided to a public repository to be described and made publicly accessible to the scientific research community. Scientists can then request access to the samples to conduct additional analysis, however this is outside the scope of our project.

FINAL DISPOSITION OF SAMPLES OR ANIMALS:
Selected coral and sponge specimens will be split, with one piece going to Bishop Museum in Hawaii, and the other to the Smithsonian to ensure access to as many researchers as possible. If it is determined that splitting will be too destructive to a particular specimen, it will be provided to the Smithsonian Institution intact in order to provide public access to as many researchers as possible. Crustaceans and any other organisms found on the corals and sponges will be provided to the Smithsonian. All other animals will be provided to the Smithsonian.

Tissue samples will be provided to the Ocean Genome Legacy Center (OGL) at Northeastern University. The results of genomic analysis are made publicly available through OGLs website.

All geological samples will be sent to the Oregon State University's Marine Geology Repository to be made publicly accessible. OSU will receive the samples, curate them, describe them from a

petrology point of view (e.g. mineral content, texture, alteration, rock name), microphotograph them and prepare them for future redistribution.

No water samples have been requested at this time, however if they are collected they would likely be frozen for later analysis. The results from any analysis would be made publicly available through the NOAA's National Centers for Environmental Information.

JUSTIFICATION FOR REQUEST TO COLLECT, SAMPLE, HANDLE, &/OR MANIPULATE ANIMALS OF PARTS THEREOF:

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 in areas previously unmapped with sonar or modern sonar, and to supplement previous work. These maps form the basis for selecting ROV dive targets.

ROV dives take the next major step in baseline habitat characterization by using the ROV system to visually investigate unknown and little known deep water habitats within American Samoa identified as priority scientists and managers. CTD casts may be conducted to collect additional information about the physical and chemical properties of the water column, including at sites of interest identified from mapping and ROV investigation.

These dives will be the next step in a baseline habitat characterization, and directly contribute to a better understanding of the deep water habitats, ecosystems and geology of American Samoa. The dives will enable scientists and managers to have a better understanding of the diversity and distribution of deepwater habitats. It is this understanding that enables effective management decisions, and provides continuous support for the monuments, sanctuaries and their protection of these resources. The collective understanding established from the multi-year CAPSTONE expeditions will increase understanding of deep-sea biogeographic patterns across the Central and Western Pacific.

PROJECTED STARTING DATE OF STUDY:

The starting date of the first cruise is January 18th, however the ship will not arrive in American Samoan waters until early February. I have listed project dates of February 1 (the start date) to April 30, 2017. The requested dates cover a conservative estimate of the timing that NOAA Ship *Okeanos Explorer* will arrive in American Samoa and can commence work in the region, through a few days after the last cruise departs and is likely to conduct work in American Samoa. The Expedition cruise legs, dates and focus areas are detailed in the "Duration of Study or Collection Period" section above.

NAME OF LOCAL COLLABORATOR(S) &/OR LOCAL INSTITUTIONAL AFFILIATION,

Local managers have identified many of the priority sites for acoustic mapping and remotely operated vehicle dives in American Samoan waters. The names and affiliations of key partners are included below:

Genevieve (Gene) Brighouse*

National Marine Sanctuary of American Samoa, Superintendent
**We have met with the entire Sanctuary team and will be collaborating with them closely, especially on outreach activities.*

Fatima Sauafea-Le'au
NOAA Fisheries - PIRO
Habitat Conservation Division
American Samoa Field Office

Brian Peck
Rose Atoll Marine National Monument, Superintendent
Rose Atoll National Wildlife Refuge, Manager
US Fish and Wildlife Service

Dr. Tim Clark
Marine Ecologist
National Park of American Samoa

We also met with representatives from other American Samoa agencies in November 2016 to share our draft project plans and request additional input and feedback. This included Dr. Ruth Matagi-Tofiga, Director of the Department of Marine and Wildlife Resources. Other agencies and officials included the Office of Samoan Affairs, the American Samoa Governor's Coral Reef Advisory Group, American Samoa Environmental Protection Agency, and the American Samoa Power Authority.

OTHER COLLABORATING SCIENTISTS:
Dr. Chris Kelley, CAPSTONE Science Advisory, University of Hawaii at Manoa
Dr. Santiago Herrera, Biology Science Team Lead, Lehigh University
Dr. Matthew Jackson, Geology Science Team Lead, University of California Santa Barbara
Elizabeth Lobecker, Physical Scientist/Mapping Lead, NOAA Office of Ocean Exploration and Research

SIGNATURE OF APPLICANT: _____

DATE: Jan. 3, 2017

MAIL or RETURN THIS FORM TO THE ADDRESS ON THE TOP OF THE FRONT PAGE.

FOR OFFICE USE ONLY

APPLICATION SERIES No. _____

DATE APPLICATION RECEIVED: _____

RECEIVED BY: _____

APPLICATION FEE Receipt No. & Amount: _____

REVIEWER'S COMMENTS:

This is an important research initiative to explore and understand the deep-water habitats of American Samoa. These are habitats that are generally out of reach but the technologies borned by this expedition will map and sample environments and living things in the deep.

RECOMMENDED ACTION: Approve

NAME AND SIGNATURE OF REVIEWER: Dr. Domingo Ochavillo

DATE: 9 January 2017

Ocean Exploration
and Research

9.4 Appendix D: Environmental Compliance

Kelley Elliott - NOAA Federal <kelley.elliott@noaa.gov>

EFH Consultation Response for CAPSTONE cruises

Richard Hall - NOAA Federal <richard.hall@noaa.gov> Wed, Nov 30, 2016 at 4:21 PM
To: Kelley Elliott - NOAA Affiliate <kelley.elliott@noaa.gov>
Cc: Ian Lundgren - NOAA Affiliate <ian.lundgren@noaa.gov>, Samantha Brooke <samantha.brooke@noaa.gov>, Kasey Cantwell - NOAA Affiliate <kasey.cantwell@noaa.gov>

Kelley,

On November 14, 2016, the Office of Exploration and Research (OER), through personal communication, initiated a request for an Essential Fish Habitat consultation for a series of cruises by the NOAA Ship *Okeanos Explorer*. The cruises would run from early-December 2016 through late-September 2017, and include the waters around the Main Hawaiian Islands, the Musician Seamounts (north of Hawaii), the American Samoa Archipelago; Johnston, Howland, Baker, Jarvis, Kingman and Palmyra Atolls of the Pacific Remote Islands, and portions of the Cook Islands. The operational minimum depth during the cruises would be 250 m, with the majority of the cruise activities would be in water depths over 500 m.

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855 et seq.) requires review of federally permitted projects for potential impacts to EFH (§305(b)). Pursuant to this authority, I have reviewed and provided comments as necessary for the Habitat Conservation Division of NOAA's Pacific Islands Regional Office.

The proposed cruises are the final legs of the larger 2-year Campaign to Address Pacific Monuments Science, Technology and Ocean Needs (CAPSTONE Project), which is designed to improve the understanding of the distribution and diversity of deepwater habitats within the Pacific monuments and protected areas.

The primary activities to be conducted during this series of cruises would be: remotely operated vehicle (ROV) dives to conduct engineering trials and sonar calibration and testing during two shakedown cruises scheduled for the waters of the Main Hawaiian Islands (no biological or geological samples would be collected); and mapping and ROV dives in the waters of American Samoa, West Samoa, the Pacific Remote Islands, the Musician Seamounts, and portions of the Cook Islands. Five cruises would be dedicated mapping cruise, resulting in 92 days of constant mapping, while six cruises would be combined ROV and mapping cruises which would result in approximately 96 ROV dives and 110 days of overnight mapping. Other activities to be performed during the cruises would include: deployment and recovery of a conductivity-temperature-depth (CTD) sampling rosette and underway CTDs, and possible deployment of Argo floats to acquire ocean chemistry data. During ROV dives various biological and geological samples would be collected.

In order to avoid/minimize impacts to EFH, the OER and the *Okeanos Explorer* have proposed to institute the following procedures:

- The vessel would employ the use of dynamic positioning during ROV dives (no anchoring);
- ROVs would be operated in a manner to avoid seafloor disturbance, and setting the ROV on the seafloor will be held to a minimum. For those situations when the ROV does make contact with the seafloor, visual observations will confirm that the area is sand, mud, or hard-bottom;
- Sample collections would be limited (typically 4 - 6 total rocks and primary biological specimens per dive) that represent new species, new records, or the dominant morphotype animal in a community. Clonal biological specimens (corals, sponges) would be subsampled; and
- Instruments deployed to collect water samples and current data (except for expendable instruments) would not be allowed to contact the seafloor;

In addition to the management practices proposed by OER and the *Okeanos Explorer*, NMFS provides the following guidance to further avoid/minimize impacts to EFH from the proposed cruise activities and vessel operations:
1. Except in an emergency, the vessel should not anchor while at sea;
2. The vessel should adhere to MARPOL discharge regulations at all times during the proposed cruises;
3. The ROV should be thoroughly rinsed between dives, allowed to dry, and checked for the presence of biological

organisms to prevent the spread of invasive or non-endemic species from one location to another.
4. The use detergents and other pollutants which may be washed into the marine environment should be avoided or held to a minimum;

Based on my review of the documents provided, and through our personal communications, NOAA Fisheries has determined that the proposed cruises of the NOAA Ship *Okeanos Explorer* would not adversely affect EFH provided adherence to OER proposed procedures and the NMFS guidance made above. Thank you for the opportunity to review the plans for the upcoming field season of the *Okeanos Explorer*, and to provide our comments. This completes your obligation to consult with our office with regards to EFH for this series of actions. If you have any questions or comments feel free to contact me at your convenience.

--
Richard Hall
Fishery Policy Analyst
Pacific Islands Regional Office
NOAA Inouye Regional Center
1845 Wasp Blvd., Building 176
Honolulu, HI 96818
808-725-5018

9.4 Appendix E: Kiribati Diplomatic Clearance

FA: 48/12/053

The Ministry of Foreign Affairs and Immigration of the Republic of Kiribati presents its compliments to the Embassy of the United States of America and with reference to the Embassy's Note No. KR-065-2016, has the honour to convey the Government of the Republic of Kiribati's approval for conducting marine scientific research during the period of 25 January – 15 May 2017 with details described in the aforementioned note.

The Ministry has the further honour to advise the Embassy that no other activities to be conducted beside the proposed activity as per in the Embassy's note. The Ministry would be grateful for the Embassy's assistance to submit final detailed report of the expedition and data collected from the trip.

The Ministry has the honour to attach the approval and conditions from the PIPA for the said vessel.

The Ministry of Foreign Affairs and Immigration of the Republic of Kiribati avails itself of the opportunity to renew to the Embassy of the United States of America the assurance of its highest consideration.

Bairiki
Tarawa

26 January 2017

Embassy of the United States of America
Suva, FIJI

9.5 Appendix F: ARGO Float Permits

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
1315 East-West Highway
Silver Spring, Maryland 20910

JUN 8 2000

MEMORANDUM FOR: Susan B. Fruchter
National Environmental Protection Act Coordinator

FROM: David L. Evans

SUBJECT: Categorical Exclusion, Argo Floats Project

The Office of Oceanic and Atmospheric Research is proposing to deploy Argo floats globally. Through discussions with your office and the General Counsel's Office, it has been determined that the proposed action requires a Categorical Exclusion, not an Environmental Assessment.

The proposed project would provide a consistent, global system operating within the ocean to collect the subsurface observations necessary to complement observations from space. This array will improve our ability to understand the time-varying climate system and to provide reliable ocean state and climate forecasts worldwide.

Because this action will benefit the global community with better, more reliable forecasts with no significant adverse impact to the human environment, this action is categorically excluded under NAO 216-6 from requirements to prepare an environmental document. Please contact Stephen Piotrowicz, from our Office of Scientific Support at 301-713-2465 x 124 if you have any questions regarding this issue.

Attachment

THE ASSISTANT ADMINISTRATOR

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Silver Spring, MD 20910
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH

MEMORANDUM FOR: THE RECORD

FROM: Donald Beran
Acting Director,
Office of Scientific Support

SUBJECT: Categorical Exclusion, Argo Floats

NAO 216-6, Environmental Review Procedures, requires all proposed projects to be reviewed with respect to environmental consequences on the human environment. This memo documents the categorical exclusion of the proposed Argo floats program from the need of an Environmental Assessment.

After reviewing NAO 216-6, including the criteria used to determine significance, we have concluded that the proposed action would not have a significant effect, individually or cumulatively, on the human environment. Further, the Argo float program will not result in any significant impact to marine life for the life of the project. Therefore, we have determined that the proposed action is categorically excluded from the requirement to prepare an environmental assessment or environmental impact statement.

BACKGROUND

To forecast individual storms, warm periods, and other day-to-day events that comprise the weather, meteorologists use observations from an extensive atmospheric observing system: a network of land and ocean surface measurements, and a sparser network of balloon-borne sensors that collect profiles of temperature, humidity, and winds at least once a day. Data collected by these networks enable accurate three- to five-day weather forecasts. Predicting climate, the broad pattern of weather over seasons and years, requires additional observations -- temperature, salinity, and currents within the upper layer of the ocean.

Every few years, the upper layer of the eastern Tropical Pacific Ocean heats up, and remains warm for months. This warming, termed El Niño alters the global atmospheric circulation, and changes the likelihood that many types of extreme weather conditions will occur. La Niña, a cooling of those same waters that sometimes follow an El Niño episode, causes a different set of weather conditions to become more likely. Each affects weather around the world.

NOAA operates the ENSO Observing System, which takes measurements from the ocean surface and its subsurface layers, and reports this information back to forecast centers in real time. Data gathered by this system, complemented by measurements from space, led to successful seasonal climate forecasts for the United

States during the 1997/98 El Niño, six months in advance.

Research has revealed that phenomena in addition to El Niño and La Niña occur in other parts of the global ocean. These also influence year-to-year climate variations. A consistent, global system operating within the ocean to collect the subsurface observations necessary to complement the observations from space is needed. The Office of Oceanic and Atmospheric Research is proposing an array of 3,000 Argo floats to be deployed globally. This array will improve our ability to understand the fluctuating climate system and to provide reliable forecasts worldwide.

The Argo floats will be spaced about 300 kilometers apart. Each float will sink to a typical depth of 2,000 meters. After drifting with the ocean current at that depth for 10 days, it will rise to the surface, measuring the temperature and salinity of the layers as it rises. On the surface, the float will transmit its data and position to an orbiting satellite before returning to depth and beginning another cycle.

Satellites will relay the data received from Argo floats to land based receiving stations. From there, the data will go to a number of scientific teams around the world, who will carry out initial quality control. They will then make the data available for operational forecast centers and scientists in near real time. The observations will be used, together with other available data, to make "weather maps" of the ocean, to initialize climate forecast models for the ocean-atmosphere system, and to improve our understanding of the ocean itself.

Argo will also be a major component of the Global Ocean Observing System (GOOS), an international effort led by the Intergovernmental Oceanographic Commission of UNESCO, the World Meteorological Organization, and the United Nations Environmental Program, with scientific guidance from the International Council of Scientific Unions. Endorsed at the Earth Summit in 1992, GOOS is an international initiative to create a global system for gathering, archiving, and distributing ocean data and derived products with worldwide utility. Its objectives include improving the management of living resources and coastal areas, ensuring safe marine navigation, and assessing the health of the ocean -- as well as laying the basis for improved understanding and forecasting of climate. Argo will provide critical data for this initiative.

This project would not result in any changes to the human environment. As defined in Section 6.03(c)3(a) of NAO 216-6 this is an action of limited size or magnitude and will not have an individual or cumulative significant impact on the quality of the human environment. As such, it is categorically excluded from the need to prepare and Environmental Assessment.

SOPAC

SOUTH PACIFIC APPLIED GEOSCIENCE COMMISSION

Tel : 381139/381377
Fax : 370040/384461
http : //www.sopac.org

Postal Address : SOPAC Secretariat
Private Mail Bag, GPO
Suva, Fiji Islands
Street Address : Mead Road, Suva, Fiji Islands

20 March 2002

Mathieu Belbeoch
ARGO Technical Co-ordinator
8-10 Rue Hermes
Parc Technologique du Canal
31526 Ramonville – Cedex
FRANCE

ARGO FLOAT DEPLOYMENTS IN THE SOPAC REGION

We hereby confirm that concurrence for the deployment of Argo floats has been provided by the following SOPAC member countries, within their EEZ's:

- Cook Islands
- Fiji
- Kiribati
- Marshall Islands
- Nauru
- New Caledonia
- Niue
- Papua New Guinea
- Samoa
- Solomon Islands
- Tonga
- Tuvalu
- Vanuatu

Yours Sincerely

Mohinish Kumar
Financial and Administrative Controller