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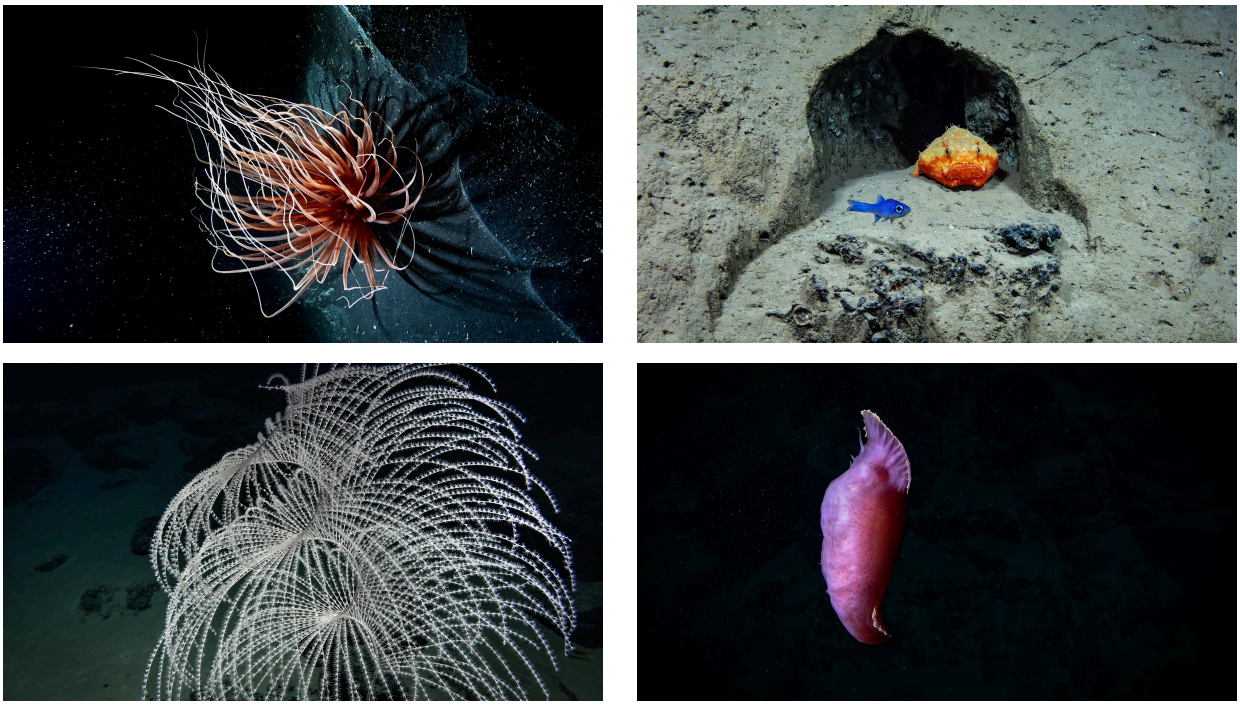
Expedition Report: EX2502, Beyond the Blue: 2025 ROV and Mapping Shakedown



Images courtesy of Global Foundation for Ocean Exploration, EX2502, Beyond the Blue: 2025 ROV and Mapping Shakedown Expedition

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Abstract

From March 17 - March 27, 2025, Honolulu, Hawai‘i to Honolulu, Hawai‘i, NOAA Ocean Exploration conducted the Beyond the Blue: 2025 ROV and Mapping Shakedown expedition (EX2502), a shakedown expedition around the main Hawaiian Islands. EX2502 mapped 4,183 sq. km of seafloor (4,183 in the U.S. Exclusive Economic Zone). All data associated with this expedition have been archived and are publicly available through the NOAA archives.

Region of Operation: Hawai‘i

Ports: Honolulu, Hawai‘i to Honolulu, Hawai‘i

Bounding Coordinates: -157.0524769, 20.4356744, -159.0933627, 21.6233740

Expedition Dates: March 17 - March 27, 2025

Expedition Type: ROV and Mapping Shakedown

Theme Keywords: marine archeology, deep-sea corals, Beyond the Blue, ocean mapping, calibration, marine geology

Place Keywords: Hawai’i, Central Pacific

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1. Introduction

NOAA Ocean Exploration is dedicated to exploring the unknown ocean, unlocking its potential through scientific discovery, technological advancements, and data delivery. By working closely with partners across public, private, and academic sectors, we are filling gaps in our basic understanding of the marine environment. This allows us to collectively protect ocean health, sustainably manage marine resources, accelerate our national economy, better understand the changing environment, and enhance appreciation of the importance of the ocean in our everyday lives.

With priority placed on exploration of deep waters and the waters of the U.S. Exclusive Economic Zone (EEZ), NOAA Ocean Exploration applies the latest tools and technologies to explore previously unknown areas of the ocean, making discoveries of scientific, economic, and cultural value. By making collected data publicly available in increasingly innovative and accessible ways, we provide a unique and centralized national resource of critical ocean information. And, through live exploration video, online resources, training and educational opportunities, and public events, we share the excitement of ocean exploration with people around the world and inspire and engage the next generation of ocean scientists, engineers, and leaders.

NOAA Ocean Exploration uses NOAA Ship *Okeanos Explorer* to conduct much of this work. Data collected by NOAA Ocean Exploration on *Okeanos Explorer* in the main Hawaiian Islands will contribute to *Beyond the Blue: Illuminating the Pacific* campaign, a collaborative, multifaceted science campaign designed to raise collective knowledge, understanding, and appreciation of waters in the Pacific Islands region through coordinated mapping and exploration expeditions, data management and sharing, strategic partnerships, and outreach and engagement. Throughout *Beyond the Blue*, NOAA Ocean Exploration and campaign partners will work to create and maintain meaningful relationships to improve collaboration across the U.S. government, with local communities and stakeholders through thoughtful engagement, inclusive collaboration, and public-private partnerships. Building upon previous work in the region, including the 2015 - 2017 Campaign to Address Pacific Monument Science, Technology, and Ocean NEeds (CAPSTONE) and work sponsored by NOAA Ocean Exploration through the NOAA Ocean Exploration Cooperative Institute (OECI) and Ocean Exploration Trust, this campaign is intended to provide a foundation of information relevant to a variety of sectors and communities, all with the aim of building our collective knowledge of the Pacific Islands region.

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

2. Expedition Overview

From March 17 to March 27, 2025, NOAA Ocean Exploration and partners conducted a telepresence-enabled ocean exploration expedition on *Okeanos Explorer* to evaluate and calibrate mission systems for the 2025 field season, as well as collect critical baseline information and improve knowledge about unexplored and poorly understood deepwater areas off the coast of Hawai'i.

Previous expeditions in this region include EX0909, EX1001, EX1002, EX1003, EX1005, EX1006, EX1503L2, EX1503L3, EX1504, EX1505, EX1601, EX1602, EX1607, EX1608, EX1609, EX1701, EX1705, EX1706, EX1707, EX1708, EX1709, EX2041, EX2402, EX2403, EX2404, EX2405, EX2406, EX2501, NA115, NA114, NA109, NA110, NA102, NA101, NA099, and NA100. Expeditions with prefix "NA" indicate expeditions on E/V *Nautilus*.

During the 11 days at sea, 4,183 sq. km of bathymetric data were collected in areas with poor existing data quality (see **Figure 1**). Section 5 provides details about the expedition schedule and unplanned events. A station log detailing the location of each operation conducted is provided as a supplemental file to this expedition report.

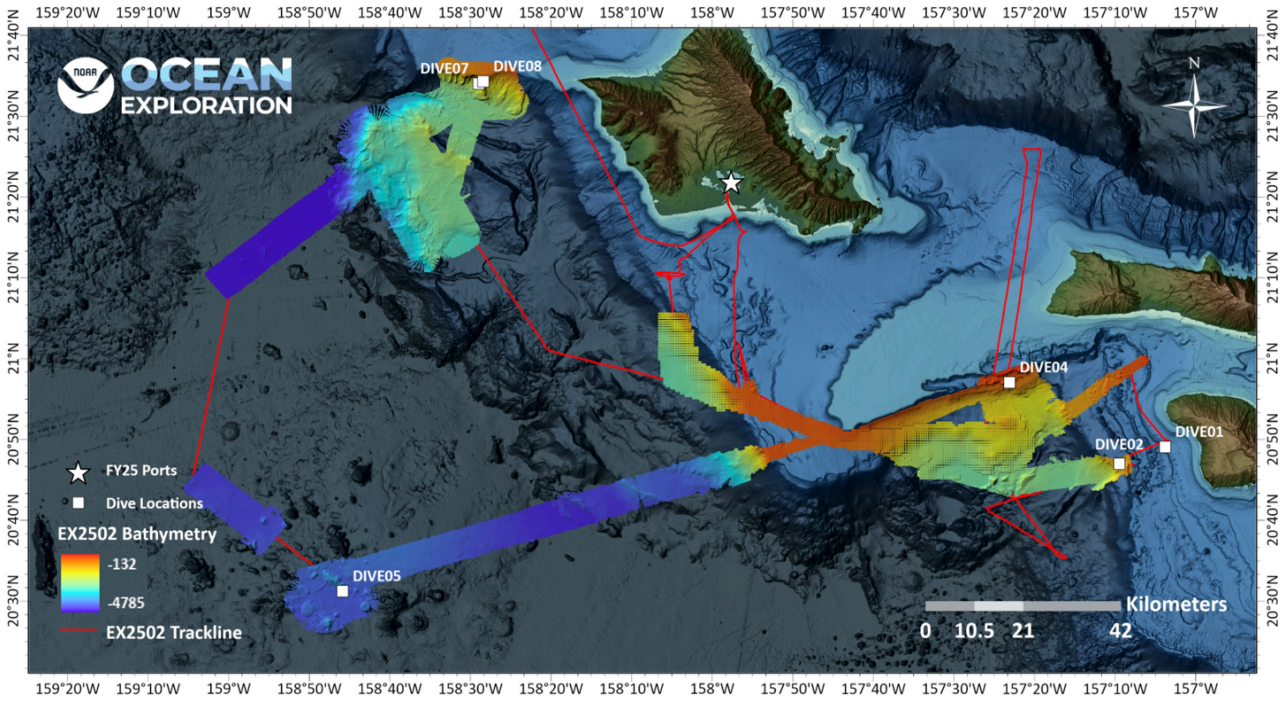

Figure 1. Map showing EX2502's track, dive locations, and bathymetric data collected. Note that DIVE03 and DIVE06 have been removed in accordance with underwater cultural heritage restricted data protocol. Waterdepth bathymetric color bar units are in meters.

Names, roles, and affiliations of science team members, both on ship and shore, are in **Appendix A**.

2.1 Rationale for Exploration

While the primary goal of this expedition was to ensure mission system readiness for the 2025 field season aboard the NOAA Ship *Okeanos Explorer*, the data collected is of value to the greater scientific community. As part of the planning for this expedition, NOAA Ocean Exploration collaborated with the ocean science and management communities to assess exploration needs and data gaps in poorly known areas of the main Hawaiian Islands. To define the operating area for this expedition, we considered the 2025 call for input and known priorities from local partners.

The deepwater regions offshore Hawai'i are rich environments, home to deep-sea corals, chemosynthetic communities, and other sensitive habitats, as well as marine geohazards that threaten coastal communities with earthquakes, landslides, and tsunamis. Among these environments are vast energy resources in the form of seafloor minerals, wind, and waves, and underwater cultural heritage sites that are steeped in maritime history.

Mapping and exploring these deep waters results in critical baseline information that can be integrated into Beyond the Blue campaign core datasets to help guide wise use of living marine resources and habitats, inform ocean energy and mineral resource decisions, and improve offshore natural hazard assessments.

Data and information from this expedition can support local scientists and managers seeking to understand and manage deep-sea resources, and stimulate subsequent exploration, research, and management activities.

This expedition contributed to ongoing collaborations with the NOAA Office of National Marine Sanctuaries, SEARCH Inc, and Naval History and Heritage Command, and the Air Sea Heritage Foundation.

2.2 Objectives

The primary objective of this expedition was to evaluate the preparedness of mission systems for the 2025 field season. In addition to conducting engineering dives to meet ROV shakedown objectives, EX2502 addressed scientific themes and priority areas put forward by NOAA

scientists and partners, including SEARCH Inc., the NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, the Air Sea Heritage Foundation, the Naval History and Heritage Command, the University of Hawai'i, and the broad ocean science and management communities. Briefly, this expedition sought to:

- Ready the ship, equipment, and personnel for the objectives of the FY25 field season.
- Integrate and test the ROVs through engineering dives
- Conduct calibrations of mapping systems
- Train mission personnel needed to make the field season successful
- Collect high-resolution bathymetry in areas with no or low-quality mapping data.
- Map, survey, and sample geological features within the Main Hawaiian Islands to better understand the geological context of the region.
- Acquire a foundation of sonar and oceanographic data to better understand the characteristics of the water column and fauna that live there.
- Collect water samples (for eDNA analysis) as dictated by expedition priorities and for public access.
- Identify, map, and explore the diversity and distribution of benthic habitats, including fish habitats, deep-sea coral and sponge communities, chemosynthetic communities, and biological communities that colonize or aggregate around shipwrecks.
- Explore U.S. maritime heritage by identifying sonar anomalies as well as characterizing shipwrecks through ROV dives.
- 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.

A full list of expedition objectives is in "Project Instructions: EX2502: 2025 ROV and Mapping Shakedown" (Hoy, 2025).

3. Methodology

The primary systems used throughout EX2502 to accomplish objectives were:

- Sonar systems (Kongsberg EM 304 multibeam sonar, Knudsen 3260 sub-bottom profiler, Simrad EK60 and EK80 split-beam sonars, and Teledyne acoustic Doppler current profilers) to conduct seabed and water column mapping operations.
- A high-bandwidth satellite connection to provide real-time ship-to-shore communications (telepresence).

The following sections further detail the equipment and procedures used by NOAA Ocean

Exploration during expeditions on *Okeanos Explorer*.

3.1 Acoustic Operations

Acoustic operations included Kongsberg EM 304 multibeam sonar, Simrad EK60 and EK80 split-beam sonar, Knudsen 3260 sub-bottom profiler, and acoustic Doppler current profiler (ADCP) data collection to map the seafloor, sub-seafloor, and water column. Standard survey operations include concurrent collection of multibeam, split-beam, and sub-bottom sonar data synchronized using a Kongsberg Synchronization Unit (K-Sync) with the EM 304 set as the master. The ADCPs were secured during standard surveying operations due to interference with other sonars, but were used to collect data when entering and exiting port.

Mapping operations were planned to maximize edge matching of existing data or to fill data gaps in areas with incomplete bathymetric coverage. In regions with no existing data, lines were optimized for potential discoveries and to complete relatively large continuous areas to support interpretation of features from bathymetry and backscatter. Targeted mapping operations were conducted around the Main Hawaiian Islands. Mapping operations were conducted whenever ROV operations were not in progress.

More information about general equipment calibration procedures, data collection, processing, reporting, and archiving is in the “NOAA Ocean Exploration Deepwater Exploration Mapping Procedures Manual” (Hoy et al. 2020).

Shakedown and readiness operations included a GNSS Azimuth Measurement Subsystem calibration, a EM304 MKII multibeam sonar patch test which was processed for both the POS MV and Seapath positioning and attitude systems, and a speed-noise test (**Figure 2**). Additional information, including results for system calibrations, can be found in the “2025 NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report'' (Warren et al., 2025).

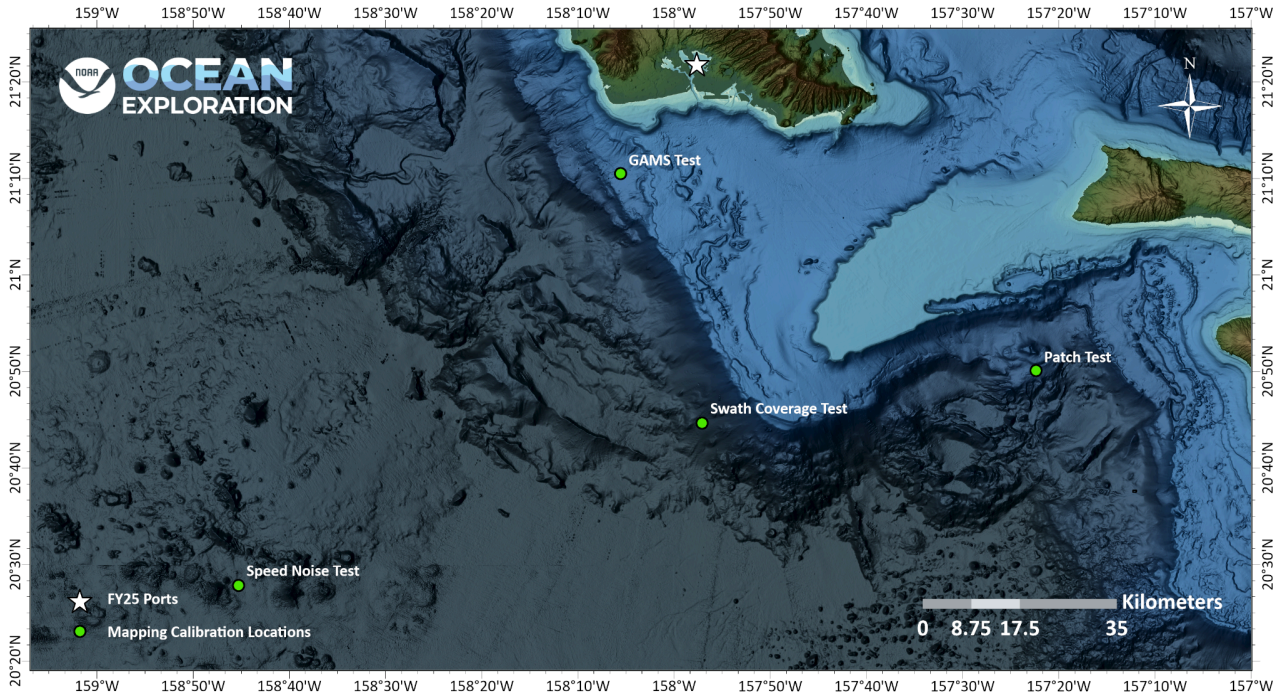

Figure 2. Overview of the locations of major calibrations and testing done during EX2401. For additional information about the location of these stations, please see the *Okeanos Explorer* Live Operations Map.

3.1.1 Equipment and Data Collection Methods

Detailed descriptions of mapping equipment, annual calibrations, and capabilities on *Okeanos Explorer* are in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2025" (Warren et al., 2025). Any deviations from the readiness report are noted in the following sections.

Supplemental files may be added to the readiness report throughout the year if changes to the equipment are made, such as mid-season calibrations. So, users of mapping data from EX2502 should refer to the 2025 readiness report to see if any supplemental files report changes that may affect their analysis.

3.1.1.1 Multibeam Sonar

Okeanos Explorer is equipped with a 26 kHz Kongsberg EM 304 MKII multibeam sonar. The multibeam sonar was used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Bathymetric and seafloor backscatter data are stored in .kmall files as beam-averaged backscatter values and as full time-series values (snippets) within each beam. Water column backscatter data are stored separately in .kmwcd files.

Throughout the expedition, mapping watchstanders monitored multibeam data quality in real time. Ship speed was adjusted to maintain data quality and sounding density as necessary, and line spacing was planned to ensure one-quarter to one-third swath-width overlap between lines, depending on the environmental conditions and impact on the quality of the outer swath regions. Maximum angles in the Seafloor Information System (SIS) were generally left open (75°/75°) during transit to maximize data collection and were adjusted on the port and starboard sides to ensure the best data quality and coverage. If outer beams were returning obviously spurious soundings (e.g., due to attenuation or low grazing angle), beam angles were gradually reduced and monitored closely until a high-quality swath was obtained.

Real-time surface sound speed values were provided by a Reson SV70 sound velocity probe mounted in close proximity to the EM 304 transducer and were monitored in SIS for deviations from the values determined by sound speed casts. Sound speed profiles were collected every six hours or more frequently as dictated by local oceanographic conditions (typically every two hours when operating in more dynamic areas).

Vessel positioning and attitude were measured by Applanix POS MV V5 and Kongsberg Seapath 380 positioning systems during data collection. This redundancy allows for either system to be the primary source of positioning/attitude for the multibeam data in the event that the other system fails. Positioning/attitude data were applied to the multibeam data in real time and were stored in .kmall files. The primary system used is noted in the processing logs.

3.1.1.2 Sub-Bottom Profiler

Okeanos Explorer is equipped with a Knudsen 3260 sub-bottom profiler with a central frequency of 3.5 kHz. This sonar was used to collect echogram images of shallow geological layers underneath the seafloor to a maximum depth of approximately 80 m below the seafloor. Phase, range, and gain were monitored and optimized for data collection. New files were created when changes were made to pulse lengths and/or power settings.

3.1.1.3 Split-Beam Sonars

Okeanos Explorer is equipped with a suite of five Simrad EK60 and EK80 split-beam sonars: three general purpose transceivers (GBTs), the 18, 120, and 200 kHz sonars, and two wide-band transceivers (WBTs), the 38 and 70 kHz sonars. These quantitative scientific echosounders were calibrated in 2024 to identify the target strength of water column acoustic reflectors (e.g., deep scattering layers, fish, gas bubbles from seeps), providing additional information about water column characteristics and anomalies.

Calibrations were performed during EX2401 and these calibration values were most appropriate for the EX2502 dataset. The calibration files are archived with the sonar data, and the

calibration report is available as a supplemental file to the 2024 mapping readiness report (Candio et al., 2024).

The split-beam sonars were used continuously throughout EX2502 during mapping operations.

3.1.1.4 Acoustic Doppler Current Profiler

Okeanos Explorer is equipped with two acoustic Doppler current profilers (ADCPs), a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). Depending on environmental conditions, the 300 kHz system provides ocean current data to a depth of approximately 70 m, and the 38 kHz system provides data to a depth of approximately 1,200 m. Due to a malfunction in the 38kHz system, only the 300 kHz ADCO was used to gather surface current data prior to ROV deployments to support determination of safe operations.

3.1.2 Data Processing and Quality Assessment Methods

3.1.2.1 Multibeam Sonar Bathymetry and Seabed Backscatter

Full-resolution multibeam files (.kmall) were imported into QPS Qimera and then processed and cleaned of noise and artifacts. Outlier soundings were removed using multiple methods, including automatic filtering and/or manual cleaning with the swath and subset editing tools. The default sound speed scheduling method used was “Nearest-in-Time.” If another method was used, it was noted in the multibeam processing log that is archived with the dataset. Gridded digital terrain models were created using the weighted moving average algorithm and were exported in multiple formats using QPS Fledermaus. Daily bathymetric surfaces were created and sent to shore.

A final quality check of the data was performed on shore prior to submission to the archive. This involved additional fine cleaning of soundings and minimization of residual artifacts from sound speed biases and field-cleaning errors.

Each line of cleaned full-resolution data was exported to a .gsf file (Level-01 data). The processed and cleaned files were used to create a static surface in QPS Qimera. This final surface was re-projected to the field geographic WGS84 reference frame in QPS Fledermaus and saved as an .sd file for archiving. Using QPS Fledermaus, this .sd bathymetric grid file was then exported as ASCII .xyz, color .tif, floating point .tif, and Google Earth .kmz files. The .gsf files were used to create daily backscatter mosaics using QPS Fledermaus FMGT.

All products maintain horizontal referencing to WGS84 (G1762) and vertical referencing to the assumed mean waterline (based on the waterline measured during the annual shakedown expedition). The draft values for *Okeanos Explorer* used during the expedition are in **Table 1** for

the purpose of further post-processing, if desired by the user. Positioning data files for post-processing be requested by sending an email to ex.expeditioncoordinator@noaa.gov.

Table 1. *Okeanos Explorer*'s draft at the beginning and end of EX2502

Location	Start of Expedition (03/17/2025)	End of Expedition (03/27/2025)
Forward	16' 8.5''	15' 8.5''
Aft Starboard	15' 9''	15' 10.5''
Aft Port	15' 0.5''	15' 4.5''

3.1.2.2 Multibeam Sonar — Water Column

EM 304 water column files (.kmwcd) were reviewed in QPS FM Midwater or Qimera for anomalies (e.g., gas seeps and hydrothermal plumes). No anomalies were observed during this expedition.

3.1.2.3 Split-Beam Sonars

No anomalies were observed during this expedition. Calibration reports and files are archived with the split-beam data.

3.1.2.4 Sub-Bottom Profiler

Using Natural Resources Canada's SEGYJp2 software, the raw files (.sgy) from the sub-bottom profiler were processed for gain to produce the clearest image of sub-bottom layers. The gain processed files were converted to jpeg images (.jpg) and shapefile tracklines (.shp).

3.1.2.5 Sound Speed

Raw sound speed profiles collected from expendable bathythermographs (XBTs) were processed using HydrOffice Sound Speed Manager and archived as .asvp files.

3.1.3 Data Collection and Processing Software

Table 2 provides a list of the data collection and processing software versions used during EX2502.

Table 2. Versions of data collection and processing software used during EX2502

Software	Purpose	Version
SIS	EM 304	5.12.1
EK80	EK suite	23.6.2

Software	Purpose	Version
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04
AMVERSEAS	Autolaunch XBT	9.3
WinMK21	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Qimera	Bathymetry	2.7.3
FMGT	Backscatter	7.11.1
FM Midwater	Water Column	7.9.5
Sound Speed Manager	Sound Speed Profiles	2024.1.2
NRCan (SegyJp2)	Sub-Bottom	1.0
Fledermaus 7	Visualization/Data Analysis	7.8.12

3.3.3 Water/eDNA Samples

As many as five 1.7 liter water samples per dive were collected in ROV Niskin bottles for eDNA analysis.

Once on board the ship, water samples were filtered using a 0.45 µm filter, and the filters were fixed with DNA/RNA Shield, a preservative that keeps DNA stable at room temperature. For each dive's set of water samples, a negative control of tap water was processed at the same time. Details of the timing and associated collection data for each water sample are in the associated metadata record. All eDNA samples were shipped to the Smithsonian National Museum of Natural History for further processing (DNA extraction and sequencing), long-term archiving, and public access.

4. Environmental and Historical Compliance

Overviews of season-long and expedition-specific compliance activities are provided as supplemental files to this document.

4.1 Environmental Compliance

Pursuant to the National Environmental Policy Act (NEPA), NOAA Ocean Exploration is required to include in its planning and decision-making processes appropriate and careful consideration of the potential environmental consequences of actions it proposes to fund, authorize, and/or conduct. The companion manual (NOAA 2017) for NOAA Administrative Order 216-6A:

Compliance with the National Environmental Policy Act, et al. describes the agency's specific procedures for NEPA compliance.

An environmental review memorandum was completed for all *Okeanos Explorer* expeditions in 2025 in accordance with Section 4 of the companion manual in the form of a categorical exclusion worksheet. Documents and permits can be found in **Appendix B**. Based on this review, a categorical exclusion was determined to be the appropriate level of NEPA analysis necessary, as no extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement. NOAA Ocean Exploration is preparing a programmatic environmental assessment to cover future expeditions.

4.2 Historical Compliance

NOAA Ocean Exploration's maritime heritage-related activities are informed by the Federal Archaeology Program (FAP), U.S. legislation on the treatment of cultural remains, and the UNESCO "Convention for the Protection of the Underwater Cultural Heritage" (UNESCO 2001). Thus, NOAA Ocean Exploration adheres to the research standards and management practices directed by the National Historic Preservation Act of 1966 (NHPA, 54 U.S.C. 300101 *et seq*.), the Sunken Military Craft Act of 2004, and follows the guidelines in the Rules Concerning Activities Directed at Underwater Cultural Heritage, an annex to the "Convention on the Protection of the Underwater Cultural Heritage."

During this expedition, dives were executed on the LST-884 and USS *Nevada*. These dives were planned in partnership with SEARCH, Inc., the Air Sea Heritage Foundation, the U.S. Naval History and Heritage Command, and the University of Hawai'i. These dives followed all NOAA Ocean Exploration underwater cultural heritage standard operating procedures and policies, which are attached to this report as supplemental files. For additional information on historical sites explored during this expedition, please reach out to NOAA Ocean Exploration's Marine Archaeologist, Phil Hartmeyer (phil.hartmeyer@noaa.gov)

5. Schedule

Table 3 provides a day by day breakdown of EX2502, 9 dives were scheduled, 8 dives occurred (details are in **Tables 3 and 4**). The expedition was originally planned to depart Honolulu on 3/14. 3 days at sea were lost due to required schedule changes to accommodate in ship operational readiness training days and mission critical dynamic positioning maintenance requirements. .

Table 3. EX2502 schedule.

Date (UTC)	Activity
3/12	Mobilization in Honolulu, HI
3/13	Mobilization in Honolulu, HI. Deck department and wardroom training.
3/14	Mobilization in Honolulu, HI. Deck department and wardroom training.
3/15	Mobilization in Honolulu, HI. Deck department and wardroom training. Alongside dunk test.
3/16	Mobilization in Honolulu, HI. Deck department and wardroom training. Alongside dunk test, launch and recovery training evolutions.
3/17	Depart Honolulu, transit to USBL calibration site and calibrate USBL. GAMS test, overnight patch test.
3/18	Dynamic positioning ship maneuvering and training. Conducted onboard DP groom with remote Kongsberg support. Overnight speed/noise test. Overnight mapping in transit to Dive 01 site.
3/19	Dive 01 - Lāna‘i (shakedown engineering dive). Overnight mapping in transit to Dive 02 location.
3/20	Dive 02 - Lāna‘i Slope (shakedown engineering dive). Overnight mapping in transit to Dive 03 location, confirm UCH target locations during mapping operations.
3/21	Dive 03 - LST-884 (UCH dive with engineering objectives). Overnight mapping in transit to Dive 04 location.
3/22	Dive 04 - Penguin Bank (shakedown engineering dive). Overnight mapping in transit to Dive 05 location.
3/23	Dive 05 - Deep Squeeze (shakedown engineering dive). Overnight mapping in transit to Dive 06 location, confirm UCH target location during mapping operations.
3/24	Dive 06 - USS *Nevada* (UCH dive with engineering objectives). Overnight mapping in transit to Dive 07 location.
3/25	Dive 07 - Ka‘ena Point (shakedown engineering dive). Overnight watermarking.
3/26	Dive 08 - Ka‘ena Slope (shakedown engineering dive). Overnight watermarking in transit to port.
3/27	Arrive in Honolulu, HI. Demobilization begins.
3/28	Demobilization in Honolulu, HI.

6. Results

This section details the results of EX2502. Metrics for the expedition's major scientific work are in **Table 4.** A station log detailing the location of each operation conducted is provided as a supplemental file to this expedition report.

Table 4. Summary of scientific metrics for EX2502.

Metrics	Totals
Days at Sea	11
Days at Sea in U.S. Waters	11
Linear km Mapped by EM 304	979
Sq. km Mapped by EM 304	4183
Sq. km Mapped by EM 304 in U.S. Waters	4183
XBT Casts	17
ROV Dives	8
ROV Dives in U.S. Waters	8
Maximum ROV Seafloor Depth (m)	4683
Minimum ROV Seafloor Depth (m)	422
Total Time on Bottom (hh:mm:ss)	32:24:37
Water Column Survey Time (hh:mm:ss)	00:25:00
Total ROV Time (hh:mm:ss)	51:32:27
Potential Undescribed or Novel Species and New Records Observed*	0
Dives During Which Living Corals and Sponges were Observed	6
Dives During Which Chemosynthetic Communities were Observed	0
Dives During Which Active Seeps/Vents were Observed	0
Dives During which Diverse Benthic Communities were Observed	3
Total Samples	41
Biological Samples (Primary)	6
Biological Associate Samples	1
Geological Samples (Primary)	1
Geological Associate Samples	0
eDNA Water Samples	30
Actively Participating Scientists, Students, and Resource Managers	16

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

2025 ROV and Mapping Shakedown was an 11-day telepresence-enabled shakedown expedition to ensure mission system readiness for the 2025 field season and to collect opportunistic data on priority exploration areas identified by scientific and resource management communities as time allowed. Major accomplishments are listed below:

Prepared ROV and onboard teams for deployment and recovery operations, confirmed ROV systems are operational, and assessed new workflows

- Mobilization included several dunk tests and launch/recovery training evolutions.
- USBL calibration was conducted before the first ROV dive
- Eight shakedown dives occurred, varying in depth from ~420m to ~4660m.
- Two underwater cultural heritage sites were explored, with full narration and participation from shore-side archaeologists.
- One dive, Penguin Bank, fulfilled both scientific and shakedown objectives as data was collected adjacent to the Hawaiian Islands Humpback Whale National Marine Sanctuary that will support Sanctuary managers in better understanding the deep waters around this important area.

Prepared ship-based mapping sonars for field season

- A patch test was conducted on a known site near Lānaʻi Island, and the results were processed for both the POS-MV and SeaPath positioning systems.
- A GAMS calibration, speed noise tests, and a swath coverage test were performed.
- Confirmed functionality and integration of Knudsen 3260 Sub-Bottom Profiler with all ancillary systems.
- Confirmed functionality of EM 304 multibeam sonar and integration with all ancillary systems.
- Confirmed functionality of both the 300 kHz ADCPs system.

Collected important baseline information to support priority science and management needs, as well as needs identified by the Beyond the Blue campaign and the National Ocean Mapping, Exploration and Characterization (NOMEC) strategy

- Conducted close-up imaging operations on poorly documented organisms and dominant fauna of benthic communities.
- Collected 41 samples for further study, including eDNA water samples, corals, sponges, and geological samples.
- Collected high resolution bathymetry, backscatter, and water column data in areas with no or poor quality data.

6.1 Acoustic Operations Results

NOAA Ocean Exploration mapped 4,183 sq. km of seafloor during the 11 days at sea for EX2502. Of the 4,183 sq. km mapped, 4,183 sq. km was deeper than 200 m and within the U.S. Exclusive Economic Zone and Territorial Sea.

Acoustic mapping data are sent to the NOAA archives within 120 days of the end of an expedition. The 2025 mapping readiness report describes the data archived for each dataset, including file formats (Warren et al., 2025). Information about proprietary software and freeware that can handle the varying data types is in the "NOAA OER Deepwater Exploration Mapping Procedures Manual" (Hoy et al. 2020).

6.2 ROV Operations Results

Depth ranges explored during the 8 ROV dives were between 422 and 4683m. During these dives, the ROVs spent 32:24:37 hours conducting benthic exploration and 00:25:00 conducting water column exploration. **Tables 5 and 6** contain dive-specific information.

Table 5. Summary information for the 8 ROV dives conducted during EX2502

Dive #	Site Name	Date (yyyymmdd)	On Bottom Latitude (dd)	On Bottom Longitude (dd)	Max Depth (m)	Min Depth (m)	Dive Duration (hh:mm:ss)	Bottom Time (hh:mm:ss)
1	Lānaʻi	20250319	20.81794	-157.06318	422.1	401	3:27:33	2:15:47
2	Lānaʻi Slope	20250320	20.78337	-157.15808°	1232.9	1213.9	4:45:14	2:08:41
3	LST-884	20250321	RESTRICTED	RESTRICTED	625.5	609.8	7:32:03	5:27:51
4	Penguin Bank	20250322	20.95105	-157.38511	665	322.1	6:08:49	5:10:34
5	Deep Squeeze	20250323	20.52061	-158.76432	4194.2	4171.9	7:23:12	4:23:30
6	USS Nevada	20250324	RESTRICTED	RESTRICTED	4683.4	4675.7	10:07:30	4:54:37
7	Kaʻena Point	20250325	21.56726	-158.48276	1620.1	1368	5:34:41	3:26:18
8	Kaʻena Slope	20250326	21.57186	-158.47325	1205.1	889	6:33:25	4:37:19

6.3 Sampling Operations Results

Geological, biological, and water samples were collected on the seafloor using ROV Deep Discoverer's manipulator arms and associated tools and stored in the bioboxes, rock boxes, rotary suction sampler jars, and Niskin bottles **(Table 6)**. In addition, a geological sample was

collected for rock type description, and biological samples were collected of organisms that represented potential new species, range or depth extensions, dominant species at a site, and/or rare morphotypes, and to support biological connectivity studies.

At the time of collection, the date, time, latitude, longitude, depth, salinity, temperature, and dissolved oxygen content were recorded for each sample.

After vehicle recovery, samples were examined for associated organisms, labeled, photographed, and entered into the Sampling Operations Database Application (SODA, Gottfried et al. 2023) with all relevant metadata. Any associated organisms found were separated from primary samples and processed separately as "associate" samples.

See **Appendix C** for inventories of all samples collected during EX2502. Detailed information about sampling operations is in the "NOAA Ocean Exploration Sampling Procedures Manual" (Dunn et al. 2023).

Table 6. Summary of scientific sample metrics for the 8 ROV dives conducted during EX2502

Dive #	Site Name	Corals & Sponges	Chemo-synthetic Community	Active Seeps & Vents	Diverse Benthic Community	Primary/ Associate Biological Samples	Primary/ Associate Geological Samples	Water Samples
1	Lānaʻi	No	No	No	No	0/0	0/0	5
2	Lānaʻi Slope	Yes	No	No	No	0/0	0/0	5
3	LST-884	Yes	No	No	Yes	0/0	0/0	0
4	Penguin Bank	Yes	No	No	Yes	2/0	0/0	5
5	Deep Squeeze	Yes	No	No	No	2/0	1/0	5
6	USS Nevada	Yes	No	No	No	0/0	0/0	0
7	Kaʻena Point	Yes	No	No	Yes	0/0	0/0	5
8	Kaʻena Slope	Yes	No	No	Yes	2/1	0/0	5

6.5 Engagement

EX2502 engaged with audiences around the world, opening a window of understanding into the deep sea. Highlights included:

- Live video feeds received over 2,000 views during EX2502
- There were 16 remote participants actively engaged in this expedition

7. Data Access

All data collected during NOAA Ocean Exploration expeditions and associated products are made publicly available via the NOAA archives, NOAA's National Centers for Environmental Information (NCEI), the NOAA Institutional Repository, and the Smithsonian National Museum of Natural History, unless protected (e.g., data associated with specific maritime heritage sites). Data collected by NOAA must be covered by a data management plan to ensure they are archived and publicly accessible. The data management plan for EX2502 is in the "2025 ROV and Mapping Shakedown Project Instructions" (Hoy, 2025).

The primary tools for accessing data collected during this expedition and archived at NCEI are the EX2502 data landing page, the NOAA Ocean Exploration Data Atlas, and the NOAA Ocean Exploration Video Portal. Refer to the NOAA Ocean Exploration Data Access web pages for help navigating expedition data. Other resources include the NOAA Ocean Exploration Data (NCEI) ArcGIS online group, which provides access to all NOAA Ocean Exploration geospatial data services managed by NCEI, including the geospatial data layers found in the data atlas, and the NOAA Ocean Exploration Data Management website.

NCEI makes data publicly available over time as quality-control measures are completed, data are released, and publications and related materials are published. Thus, not all data and products will be made available at the same time. To access data and products from EX2502 that aren't yet public, request assistance by submitting a data request form or sending an email to oer.info.mgmt@noaa.gov.

7.1 Digital Data/Product Locations

The locations for directly accessing specific types of digital data collected during EX2502 and products documenting expedition results (at the time of writing this report) are provided in **Table 7**.

Table 7. Online locations for direct access to digital data collected during EX2502 and products documenting expedition results (at the time of writing this report).

Data/Product Type	Description
EM 304 Bathymetry and Backscatter Data	EM 304 bathymetric and backscatter data, supporting informational logs, and ancillary files are available through NCEI's Bathymetric Data Viewer POSPac and BS correction files can be requested from oar.oer.exmappingteam@noaa.gov

Data/Product Type	Description
Water Column Data (EM 304 and EK60/EK80)	EM 304 and EK60/EK80 water column data, supporting data, and informational logs are available through NCEI's Water Column Sonar Data Viewer
Knudsen 3260 Sub-Bottom Profiler Data	Sub-bottom data, supporting data, and informational logs are available in NCEI's Trackline Geophysical Data Viewer
Sound Speed Profiles	Ancillary sound speed profiles are available with the mapping data through NCEI's Bathymetric Data Viewer and the expedition's oceanographic dataset
Oceanographic Dataset	Oceanographic data and products are available from NCEI. These data include data from shipboard sensors, including navigational data, meteorological data (wind), and oceanographic data (bathythermograph, sound velocity probe, thermosalinograph); additional data and products include profile data (CTD and XBT), event logs, images, ROV ancillary data, and sample data
Reports and Papers	Reports and peer-reviewed papers are available through the NOAA Ocean Exploration Library Guide and the NOAA Institutional Repository

7.2 Physical Sample Repositories

The following repository archives samples collected during NOAA Ocean Exploration expeditions on *Okeanos Explorer*. More information about how to access physical samples is on the NOAA Ocean Exploration website.

DNA and eDNA Samples

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

Biological Samples

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

References

Warren, Danielle, Shannon Hoy, Sophie Caradine-Taber, Patricia Albano, Abby Letts. 2025. NOAA Ship Okeanos Explorer Mapping Systems Readiness Report. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. (In Prep).

Hoy, Shannon. 2025. Project Instructions: EX2502: 2025 ROV and Mapping Shakedown. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://doi.org/10.25923/5pm5-fk57.

Hoy, Shannon, Elizabeth Lobecker, Sam Candio, Derek Sowers, Grant Froelich, Kevin Jerram, Rachel Medley, Mashkoor Malik, Adrienne Copeland, Kasey Cantwell, Charlie Wilkins, and Amanada Maxon. (2020). *Deepwater Exploration Mapping Procedures Manual*. NOAA Ocean Exploration, National Oceanic and Atmospheric Administration. United States. https://doi.org/10.25923/jw71-ga98.

NOAA (National Oceanic and Atmospheric Administration). 2017. *Policy and Procedures for Compliance with the National Environmental Policy Act and Related Authorities*. NOAA. United States. https://www.noaa.gov/sites/default/files/2021-10/NOAA-NAO-216-6A-Companion-Manual-03012018%20%281%29.pdf.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2001. Convention for the Protection of the Underwater Cultural Heritage. UNESCO. France. https://unesdoc.unesco.org/ark:/48223/pf0000126065.

Appendix A: EX2502 Science Team Members

EX2502 included onboard mission personnel (**Table A1**) as well as shore-based science personnel (**Table A2**) who participated remotely via telepresence.

Table A1. EX2502 onboard mission team personnel.

Name	Role	Affiliation
Shannon Hoy	Expedition Coordinator	NOAA Ocean Exploration
Trish Albano	Expedition Coordinator (In-Training)	NOAA Ocean Exploration
Abby Letts	Mapping Watch Lead	NOAA Ocean Exploration/NOAA Office of Marine and Aviation Operations
Danielle Warren	Mapping Watch Lead	NOAA Ocean Exploration/University Corporation for Atmospheric Research
Jennifer Green	Sample Data Manager	Mississippi State University/NOAA National Centers for Environmental Information
Caitlin Ruby	Sample Data Manager	Cooperative Institute for Research in Environmental Sciences (CIRES) at University of Colorado/NOAA National Centers for Environmental Information
Sahara Rios-Bonilla	Knauss Fellow	Pennsylvania Sea Grant/NOAA Ocean Exploration
Fernando Aragon	Data Engineer	Global Foundation for Ocean Exploration
Caitlin Bailey	Videographer	Global Foundation for Ocean Exploration
Roland Brian	Video Engineer	Global Foundation for Ocean Exploration
Art Howard	Videographer	Global Foundation for Ocean Exploration
Sean Kennison	Mechanical Engineer	Global Foundation for Ocean Exploration
Jon Mefford	Mechanical Engineer	Global Foundation for Ocean Exploration
Jim Meyers	Data Engineer	Global Foundation for Ocean Exploration
Bobby Mohr	Electrical Engineer	Global Foundation for Ocean Exploration
Chris Ritter	GFOE Team Lead	Global Foundation for Ocean Exploration
Levi Unema	Electrical Engineer	Global Foundation for Ocean Exploration
Chris Wright	Data Engineer	Global Foundation for Ocean Exploration

Table A2. EX2502 shore-based science team members who participated via telepresence.

Name	Role	Affiliation
Emily Crum	Web and Communications Coordinator	NOAA Ocean Exploration
Mike Brennan	Shore-Based Scientist	SEARCH, Inc
Jim Delgado	Shore-Based Scientist	SEARCH, Inc
Terrence Kerby	Shore-Based Scientist	University of Hawai'i (Retired)
Ervan Garrison	Shore-Based Scientist	University of Georgia
Phil Hartmeyer	Shore-Based Scientist	NOAA Ocean Exploration
Russ Matthews	Shore-Based Scientist	Air Sea Heritage Command
Ed Lyman	Shore-Based Scientist	NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary
Eden Zhang	Shore-Based Scientist	National Marine Sanctuary Foundation/NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary

Appendix B: EX2502 Environmental and Historical Compliance Documentation

The Endangered Species Act (ESA) Programmatic Letter of Concurrence covering this expedition is attached to this document as a supplement.

Figure B1. EFH Consultation Letter

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

Jennifer Lukens
Deputy Director
National Oceanic and Atmospheric Administration
Office of Ocean Exploration and Research
Silver Springs, MD 20910

April 1, 2024

Dear: Dr. Lukens:

The National Marine Fisheries Service, Pacific Islands Regional Office (NMFS) received a request for an essential fish habitat (EFH) consultation on March 14, 2024 from NOAA's Office of Exploration and Research (OER) for the "Beyond the Blue" campaign, the fisheries and ecosystem research that OER will conduct and/or fund from 2024 – 2026 across the Pacific region. OER has proposed to include and adhere to best management practices (BMPs) and minimization measures that when implemented would be suitable to ensure that adverse effects to EFH would be minimal. NMFS appreciates the opportunity to review the proposed permit action pursuant to the EFH provisions (Section 305(b) as described by 50 CFR 600.920) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act; 16 U.S.C. 1855(b)). After reviewing the consultation enclosures, we have determined that there may be adverse effects to EFH. We provide conservation recommendations under the EFH provisions within Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to help the permit applicant to avoid and minimize adverse effects to EFH.

Project Description

OER's proposed marine operation activities are intended to support initiatives including the Seabed 2030 and the National Strategy for Ocean Mapping, Exploration, and Characterization. To support these initiatives, the focus of the "Beyond the Blue" campaign will be to fill the gaps in basic understanding of deep-ocean and seafloor data, information, and overall awareness within the U.S. Exclusive Economic Zone (EEZ) and international waters. Work is expected to commence in the Pacific Ocean starting in April 2024, and extend through to December 2026.

Expeditions will be conducted primarily on *Okeanos Explorer*, *Nautilus*, and other vessels of similar or smaller size. Activities will be funded by OER and will provide real-time or near real-

time, open access deep-water oceanographic data that would benefit NOAA, research and education institutions, resource managers, and the general public. These same technologies are also used on other OER supported projects and oceanographic research platforms.

Okeanos Explorer conducts four types of expeditions annually:

1. Mapping survey expeditions: These expeditions conduct 24/7 seafloor mapping using hull-mounted sonars, and conductivity-temperature-density (CTD) rosette casts. Additional technologies are occasionally brought on board to acquire more data in the area of interest;

2. Telepresence-enabled remotely operated vehicle(s) (ROV), uncrewed surface vessel(s) (USV), and autonomous underwater vehicle(s) (AUV) expeditions. During these expeditions, ROV, USVs, and AUVs dives or deployments are conducted for several hours to several days. When the ROV is not in the water, the ship conducts mapping and occasional CTD rosette casts;

3. Shakedown expeditions: These expeditions are to test mapping capabilities; ROV, USV, AUV, and CTD systems; and

4. Technology Testing Expeditions: These expeditions are planned to test novel and emerging technologies.

E/V *Nautilus* conducts very similar cruise types to those above, however more frequently deploys additional scientific equipment including human occupied vehicles, profilers, landers, profiling floats, and other cabled equipment. Other research vessels also conduct these same activities, however, most are not equipped with telepresence technology.

On average each year, approximately five *Okeanos Explorer* expeditions are dedicated to mapping, while up to four expeditions combine ROV, and/or USVs and AUVs work and overnight mapping. The duration of these expeditions typically range from 7 to 30 days. Shakedown and emerging technology expeditions range from 7 to 30 days in duration. In addition, OER-supported expeditions may be conducted based on available funding and vessel(s) availability.

OER also occasionally supports USV operations that are either dedicated missions deployed from shore, or deployed from a ship. Several of these deployments may be supported by OER each year and each deployment ranges from 1 to 60 days.

Proposed Action Area

The proposed activities will be conducted in unknown and poorly known marine environments around the Central, Southern, Eastern, and Western Pacific Ocean in depths of 656 feet (200 meters) and deeper, and the areas transited by vessels between ports, including but not limited to ports of calls located in North America and the Pacific Islands. Transit mapping operations are also planned between all areas mentioned, including the high seas.

In the Pacific Islands and Central Pacific, NOAA OER will primarily target areas with lower percentage of mapping coverage. Complementary exploration opportunities, activities and operations conducted by partners but funded by OER, will include systematic mapping in Howland/Baker, Jarvis, Wake Island, Johnston Atoll, and American Samoa. Focal areas for the *Okeanos Explorer* are expected to include Kingman and Palmyra and Johnston Atoll, and deep waters surrounding the Northwest Hawaiian Islands and along the Emperor Seamount chain.

Essential Fish Habitat

Pelagic FEP

The marine water column extending from the surface to a depth of 656 feet (200 meters) from the shoreline to the outer limit of the EEZ for eggs and larvae, and to a depth of 3,280 feet (1,000 meters) for adults, in the pelagic environment have been designated as EFH under the Western Pacific Fishery Management Council's Pelagic Fishery Ecosystem Plan.

Pacific Remote Island Area

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from the shoreline to the outer boundary of the EEZ (230 miles), and the seafloor from the shoreline out to a depth of 328 feet (100 meters) around the islands and atolls of the Pacific Remote Islands, have been designated as EFH. As such, the water column and submerged bottom habitats of around each of the Pacific Remote Island Areas are designated as EFH and support various life stages for the management unit species (MUS) identified under the Western Pacific Fishery Management Council's Pacific Remote Island Areas Fishery Ecosystem Plan (FEP). The MUS and life stages found in these waters include: eggs, larvae, juveniles, and adults of Coral Reef Ecosystem MUS, Bottomfish MUS (BMUS), and Crustacean MUS (CMUS); and juveniles and adults of Pelagic MUS (PMUS).

Mariana Archipelago

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from shoreline to the outer boundary of the EEZ, and the seafloor from the shoreline out to a depth of 1,313 feet (400 meters) around each of the Mariana Islands, have been designated as EFH. As such, those waters are designated as EFH and support various life stages for the MUS identified under the Western Pacific Fishery Management Council's Mariana Archipelago Fishery Ecosystem Plan. The MUS and life stages may include eggs, larvae, juveniles, and adults for BMUS, PMUS, and CMUS.

Hawai'i Archipelago

The marine water column from the surface to a depth of 3,280 feet (1,000 meters) from shoreline to the outer boundary of the EEZ, and the seafloor from the shoreline out to a depth of 2,296 feet (700 meters) around each of the Hawaiian Islands, have been designated as EFH. As such, the water column and bottom of the Pacific Ocean near each of the islands and atoll of the Northwestern Hawaiian Islands, and the surrounding waters and submerged lands are designated as EFH and support various life stages for the MUS identified under the Western Pacific Fishery Management Council's Hawai'i Archipelago FEP. The MUS and life stages found in these waters include larvae, juveniles, and adults of BMUS, PMUS, and CMUS.

American Samoa Archipelago

The marine water column extending from the surface to a depth of 3,280 feet (1,000 meters) from the shoreline to the outer limit of the EEZ, and the seafloor to a depth of 1,313 feet around the islands of American Samoa have been designated as EFH. As such, the water column and bottom of the nearshore Pacific Ocean surrounding the islands and atolls in American Samoa are designated as EFH and support various life stages for the MUS identified under the Western Pacific

Fishery Management Council's American Samoa Archipelago FEP. The MUS and life stages found in these waters include: eggs, larvae, juveniles, and adults of BMUS.

Specific types of habitat considered as EFH for the all of the above FEPs include coral reef, patch reef, hard substrate, artificial substrate, seagrass beds, soft substrate, lagoon, estuarine, surge zone, deep slope terraces and pelagic/open ocean.

Potential Adverse Effects

There is the potential for adverse effects to EFH due to vessel transits (including tender boats), from the deployment and recovery of instruments (including ROVs, USVs, etc.), and the collection of biological and geological samples. Adverse effects may be a result of physical damage, turbidity, chemical contamination, and the introduction of invasive species.

Physical Damage/Removal (physical stressor): Physical damage to principle benthic organisms may result in breakage or dislocation (i.e., mortality). Corals are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle and their polyps are easily damaged. Reduction of topographic complexity in the habitats of the coral reef ecosystem reduces biodiversity and productivity (Alvarez-Filip et al. 2009). Literature reviews (Newell et al., 1998; ICES 2016) suggest that the successional marine community requires at least six to eight months to recover back to initial levels after removal.

Turbidity: Increased turbidity can cause smothering of benthic species and block sunlight necessary for species that rely on photosynthesis. For corals, turbidity has been shown to reduce species diversity, change growth patterns, and reduce growth and survival (Rogers 1990). For fish, turbidity is less likely to cause significant impacts because of their mobility, but some effects are still possible. Fish may be displaced from their normal home range which could result in negative intra- and interspecies interactions and impact fitness, leading to lower reproductive success and a lower ability to find prey or avoid predators (Kjelland et al. 2015).

Chemical Contamination (pollution stressor): Chemical pollutants can have a variety of lethal and sublethal effects on habitat-forming marine organisms, including alteration of growth, interference with reproduction, disruption of metabolic processes, and changes in behavior. These adverse effects can cascade through ecosystems, altering species composition and ecosystem functions and services. Some pollutants are environmentally persistent and can take years or even decades to biodegrade, and others can bioaccumulate or biomagnify through the food chain, eventually posing a direct threat to human health. Petroleum contamination can adversely affect coral, with results including mortality, inhibition of reproduction, reduced calcium deposition, alteration of physiological processes, tissue loss, and reduced carbon fixation (Turner and Renegar 2017).

Introduction of invasive species (biological stressor): Introduced species are organisms that have been moved, intentionally or unintentionally, into areas where they do not naturally occur. Invasive species may rapidly increase in abundance to the point that they come to dominate their new environment, creating adverse ecological effects to other species of the ecosystem and the functions and services it may provide (Goldberg and Wilkinson 2004). Invasive species can decrease species diversity, change trophic structure, and diminish physical structure, but adverse effects are highly variable and species-specific.

OER-proposed BMPs

Physical impact to benthic habitat

- All vessels in coastal waters will operate in a manner to minimize propeller wash and seafloor disturbance, and transiting vessels should follow deep water routes, as practicable.
- Except in an emergency, the vessel will not anchor while at sea.
- Vessels will avoid anchoring on hard-bottom and coral habitat.
- Vessels will avoid anchoring in areas containing seagrass or eelgrass.

Turbidity

- Whenever possible, cabled instruments deployed will not be allowed to contact the seafloor. Those that do contact the seafloor will only do so for the minimal time required to achieve scientific objectives.
- The vessel will employ the use of dynamic positioning during ROV dives, or other vehicle/instrument operations that would otherwise require anchoring.
- Vehicles/instruments will be operated in a manner to avoid seafloor disturbance, and setting the vehicles/instruments on the seafloor will be held to a minimum. For those situations when the vehicle/instrument does make contact with the seafloor, visual observations will be made to confirm that the area the vehicle/instrument is set down on does not include corals or other fragile animals that can reasonably be avoided.
- 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.
- Landers will not be deployed in, or adjacent to, areas with benthic environments designated as EFH or Habitat Areas of Particular Concern (HAPC).
- OER will not conduct operations with these types of bottom-impacting AUVs in designated EFH and HAPC

Introduction of invasive species

- Avoid discharge of ballast water in designated protected habitats.
- All vessels will use anti-fouling coatings.
- Clean hull regularly to remove aquatic nuisance species.
- Avoid cleaning of hull in protected habitats.
- After each instrument/vehicle is used, the vehicles/instruments will be brought back onboard and thoroughly sprayed with freshwater and allowed to air dry before the next dive. Though marine organisms should not survive this process, the instruments/vehicles are thoroughly inspected prior to every dive and checked for the presence of biological organisms to prevent the spread of invasive species from one location to another.

Vessel waste and discharge

- All vessels operating in areas where protected habitats are known to be present in the region will continue to follow the International Convention for the Prevention of Pollution from Ships discharge protocols.

- The use of detergents and other pollutants which may be washed into the marine environment will be avoided or held to a minimum.
- Avoid use of cleaners with nonylphenols.

OER Determination

OER has determined that implementation of the various BMPs listed above during the 2024 – 2026 fisheries and ecosystem research conducted and/or funded by OER will be sufficient to avoid or minimize adverse effects to EFH. OER seeks NMFS concurrence with this determination.

NMFS Concerns

NMFS expects that many potential adverse effects from the "Beyond the Blue" campaign will be reduced when implementing the OER-imposed BMPs. However, NMFS remains concerned that there is a risk of unavoidable loss of EFH due to the potential degradation of the quality of EFH from direct physical impacts from the potential use of anchors. To further avoid and minimize the risk to EFH in the project area, NMFS offers the conservation recommendations below.

Conservation Recommendations

NMFS offers the following conservation recommendation to the OER pursuant to 50 CFR 600.920 so that potential adverse effects from the proposed project activities are avoided, minimized, offset for, or otherwise mitigated:

Conservation Recommendation 1: Inspect all equipment prior to beginning work each day to ensure the equipment is in good working condition, and there are no contaminant (e.g., oil, fuel) leaks. Work must be stopped until leaks are repaired and equipment is cleaned.

Conservation Recommendation 2: All AUV and submersible missions will have a plan that details the mission, geographic locations, and deployment and retrieval plans to minimize the potential for collisions and groundings and ensure proper retrieval.

Conservation Recommendation 3: As possible, a spill response kit should be kept on all boats while in operation in order to be able to respond rapidly in the event of a spill (gas, oil, etc.).

Conclusion

Please be advised that regulations (Section 305(b)(4)(B)) to implement the EFH provisions of the Magnuson-Stevens Act require that federal activities agencies provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the activities. A preliminary response is acceptable if final activities cannot be completed within 30 days. The final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If the response is inconsistent with our EFH Conservation Recommendations, an explanation of the reason for not implementing the recommendations must be provided.

NMFS greatly appreciates the OER' efforts to comply with the EFH provisions of the Magnuson-Stevens Act for the proposed Jarvis Island project. NMFS has determined that while the OER' proposed mitigation measures will help to avoid and minimize adverse effects to EFH, some unavoidable loss may still occur. NMFS provides the EFH conservation recommendation as described above to help OERS ensure that adverse effects to EFH included coral reef resources are avoided, minimized, offset for, or otherwise mitigated.

Please do not hesitate to contact Richard Hall at 808-725-5018 and or richard.hall@noaa.gov should you have any questions, comments, or require additional technical assistance.

Sincerely,

Gerry Davis
Assistant Regional Administrator
Habitat Conservation Division

cc by e-mail: Kelly Suhre, NOAA OER
Amanda Maxon, NOAA OER
Malia Chow, NOAA NMFS PIRO HCD
David Delaney, NOAA NMFS
Richard Hall, NOAA NMFS PIRO HCD PIRO HCD

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Figure B2. NEPA Categorical Exclusion Worksheet

Categorical Exclusion (CE) Evaluation Worksheet

Project Identifier: EX2502

Date Review Completed: 2/18/2025

OAR NEPA Project Lead: Amanda Maxon, Environmental Compliance Specialist, Contractor, NOAA Office of Ocean Exploration and Research

OAR Functional Area: OER

Worksheet File Name: 2025-02-OER-E3-EX2502

Step 1. CE applicability

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

   no

2. **What is the proposed federal action?**

   The proposed action is for NOAA's Office of Exploration and Research (OER) to complete an ROV and Mapping Shakedown expedition focused on exploring deep waters (greater than 250 m for ROV operations and greater than 200 m for mapping operations) in U.S. waters off Hawaii and nearby high seas. EX2502 2025 ROV and Mapping Shakedown will use NOAA Ship Okeanos Explorer (EX) to conduct operations 24 hours per day and consist of remotely operated vehicle (ROV) dives, mapping operations (primarily overnight), and full shore-based participation via telepresence. Expedition operations will include using NOAA Ship Okeanos Explorer's deepwater mapping systems (Kongsberg EM 304 multibeam sonar, EK60/EK80 split-beam sonars, Knudsen 3260 Chirp sub-bottom profiler, and Teledyne acoustic Doppler current profiler), expendable bathythermograph (XBTs) in support of multibeam sonar mapping operations, conductivity, temperature, depth profiler (CTD) casts, OER's two-body ROV system (Deep Discoverer and Seirios), and high-bandwidth satellite connection for continuous ship-to-shore communications.

   EX2502 2025 ROV and Mapping Shakedown will commence on March 14, 2025 from

1

Honolulu, Hawaii and will conclude in Honolulu, Hawaii on March 27, 2025 for around 13 days at sea. The exact start and end dates may vary by a few days to several weeks depending on weather and other logistical considerations. EX2502 will focus on operations exploring deep waters (greater than 250 m for ROV operations and greater than 200 m for mapping operations) in U.S. waters off Hawaii. Operations will be conducted 24 hours a day, and may consist of mapping operations, conductivity, temperature, and depth (CTD) operations, and full shore-based participation via telepresence. While ROV operations would only occur during the day. The action has independent utility and has not been inappropriately segmented from a larger federal action for review.

3. **Which class of CE in Appendix E of the NAO 216-6A Companion Manual is applicable to this action and why?**
    a. E3: Activities to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner.
    b. The topical scope for this action is consistent with the CE number E3 in Appendix E of the Companion Manual to NOAA Administrative Order (NAO) 216-6A: to collect aquatic, terrestrial, and atmospheric data in a non-destructive manner. The expedition will use remote sensing, video, images, and a limited number of physical samples to collect baseline information on unexplored deep-water (>250m) areas off the U.S. waters off Hawaii and nearby high seas The use of conductivity, temperature, and depth instruments or a moving vessel profiler from a platform, including the deployment of XBTs and cup shrinking activities for scientific purposes. The expedition will potentially conduct calibrations of mapping sonars which will involve no permanent physical, chemical, or biological changes to the environment in areas deeper than 200 meters in depth. In addition during EX2502, operations deployment, operation, and retrieval of a limited number of ROVs, ASVs, AUVs, buoys, moorings, or similar instrumentation to conduct non-destructive sampling and collection of data from those instruments once installed, including physical, chemical, and biological measurements, and visual data will take place during the expedition. The limited number of biological and geological samples collected will follow OER's Best Management Practices and procedures to ensure the wellbeing and protection of organisms in and near the areas of operations. Operations, deployment, and retrieval of these technologies and operations will follow industry standards and applicable provisions under ESA, MMPA, MBTA, MSA, NMSA, and other local/specific regional regulations.

Step 2. Extraordinary Circumstances Consideration

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

The actions of NOAA Ship Okeanos Explorer will primarily take place in remote deep-sea (>200m) areas located offshore of Hawaii and within the high seas. All operations are underwater and will have no human presence in the area besides those onboard the EX2502. The vessel will transit through different depths as it moves from the ports of call to the areas of operations in deeper waters. These actions do not involve any procedures or outcomes known to result in impacts on human health and safety.

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

While the Okeanos Explorer is operating within the U.S. EEZ and high seas where the majority of operations would take place, the effects will be negligible, as acoustic mapping, ROV operations, and XBTs, and would not cause any permanent impact on the seabed or within the water column. Operations are well documented and planned following the accepted best management practices for all operations onboard the vessel to ensure that the level of impact is below minor to the point of being barely detectable. The expedition operations are developed and planned to meet scientific objectives of the scientific systems, in particular the ROV and Mapping systems, onboard the Okeanos Explorer. Additionally, operations and plans are reviewed before any actions are taken on the area of interest in order to determine the potential for adverse effects on the area.

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

The activities are not likely to have a negative effect on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA. According to NOAA Fisheries, there are 22 ESA endangered and threatened species found within the Pacific Islands region. Okeanos Explorer operations will abide by the Best Management Practices and Mitigation Measures developed in collaboration with the various regulatory and federal agencies to ensure that operations in these sectors would not result in any activities having adverse effects on the species or habitats protected under ESA, MMPA, MSA, NMSA, or MBTA. Mitigation measures and Best Management Practices are provided to the expedition coordinators and the ship before operations are taken to ensure the operations activities follow the actions developed to minimize or limit adverse effects on species or habitats in the proposed action area.

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

   The expedition operations will be in compliance with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it) to ensure generation, use, storage, transport, and disposal of such substances will not result in significant impacts.

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

   The proposed marine activities will not result in adverse or indirect effects that cannot be resolved through applicable regulatory processes since we will not be operating within areas listed or eligible properties, lands, natural resources or sites under the umbrella of protection referenced above.

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

   NOAA Ship Okeanos Explorer will be operating in the remote and offshore areas of the U.S. EEZ and high seas during EX2502. Operations will occur in the U.S. EEZ and in adjacent waters where there are no communities within or near the geographic scope of the expedition due to activities primarily operating in areas greater than 200 meters in depth. The expedition does not involve actions known or likely to result in adverse impacts on health or the environment of minority or low income communities.

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

During EX2502, NOAA Ship Okeanos Explorer will make landfall in no additional areas other than Honolulu, Hawaii. The ship and OER mission team will comply with all applicable local and federal regulations regarding the prevention or spread of invasive species. At the completion of every ROV dive or CTD cast, the equipment will be thoroughly rinsed with fresh water and completely dried to prevent spreading organisms from one site to another. Also, the Engineering Department aboard NOAA Ship Okeanos Explorer attends yearly Ballast Management Training in accordance with NOAA Form 57-07-13 NPDES VGP Annual Inspection and Report to prevent the introduction of invasive species

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

OER has taken measures to ensure that any effects on species or habitats protected by the ESA, MMPA, MSA or NMSA meet the definition of negligible. The proposed actions will not result in any Federal, State, or local law violations or requirements imposed for protection of the environment. OER received a ESA Programmatic Letter of Concurrence and Project Design Criteria letter (NMFS No: OPR-2021-03453) dated March 14, 2022 from the NMFS ESA Interagency Cooperation Division for ESA Section 7 that concurs with OER's determination that the proposed action may affect, but is not likely to adversely affect ESA-listed species and their designated or proposed critical habitat in the action areas. A reinitaiton of the ESA Programmatic is currently being processed by ESA's Office of Protected Resources for additional technologies, species, and locations not covered under the initial ESA or letter of concurrence. The ESA Programmatic Letter of Concurrence and its Project Design Criteria will be provided in the EX2502 expedition report.

Given the offshore focus of most of our proposed work, it was determined that it is not likely that we will encounter marine mammals protected under the MMPA, or sea birds protected under the MBTA as they are often found in territorial and state waters. If we did encounter any such protected animals, our impacts would be negligible because of the best management practices that were developed with relevant agencies that we adhere to avoid or minimize environmental impacts. These best management practices and project designed criteria are outlined in the EX2502 project instructions and expedition report.

OER requested an Essential Fish Habitat (EFH) consultation under section 304 of the Magnuson-Stevens Fishery Conservation and Management Act for expeditions conducted by NOAA Ship Okeanos Explorer starting in April 2024 thru December 2026 field season in the Central, Southern, Eastern, and Western Pacific Ocean. The EFH Letter of Concurrence was received on April 1, 2024 from the Assistant Regional Administrator for the NOAA Office of

Habitat Conservation Division stating that the FY24 through FY26 expeditions will not adversely impact EFH. This letter will additionally be included in the EX2502 expedition report.

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

No, the exploration activities are considered small and minimal following the best available information about the effects of the equipment to support the determination that activities would be localized and be short in duration in any particular area at any given time with no notable or lasting changes to the environment. Given the project's scope and breadth, no notable or lasting changes or highly controversial effects to the environment by mapping operations conducted onboard Okeanos Explorer. Any effects would be small and considered minimal as the vessel transits through the area of interest continuously using acoustic sound sources, which have been analyzed to determine the effects that may occur during operations.

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

The decision to take this action will not result in growth-inducing changes, compel future actions with potential impacts, or foreclose options for future actions. Each expedition is independently useful and is not connected to subsequent federal actions.

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

The techniques and equipment used are standard for this type of field study, and the effects are well known and assessed to determine whether the actions may result in environmental effects that are uncertain, unique, or unknown.

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

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

CE Determination

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

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

OAR Decision Maker's Name: Jennifer Lukens

OAR Decision Maker's Position/Title: Deputy Director, NOAA Ocean Exploration

Date Signed: LUKENS.JENNIFER.LEIGH.1365832583 Digitally signed by LUKENS.JENNIFER.LEIGH.1365832583 Date: 2025.02.21 10:41:35 -05'00'

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

Tables C1, C2, and C3 provide inventories of the geological, biological, and water samples for eDNA analysis collected during EX2502. Detailed sample inventories are available from the NCEI archive via the Ocean Exploration Data Atlas.

Table C1. Inventory of geological samples collected during EX2502.

Dive #	Site Name	Sample #	Sample ID	Preservation	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Weight (kg)
5	Deep Squeeze	EX2502_D05_02G	Basaltic lava	Dried	Geology	20250323	224629	20.522324	-158.763634	4178.583008	1.480000019

Table C2. Inventory of biological samples collected during EX2502.

Dive #	Site Name	Sample #*	Field Sample ID	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temp (C)	DO (mg/L)
4	Penguin Bank	EX2502_D04_02B	Umbellapathes	70% EtOH	Characteristic of Site, Rare Fauna	20250322	234929	20.953616	-157.388092	526.3369751	34.26800156	6.484000206	1.588999987
5	Deep Squeeze	EX2502_D05_04B	Solmissus	5% Formalin	Characteristic of Site	20250323	230501	20.52212	-158.763751	4172.051758	34.68600082	1.462000012	4.644999981
5	Deep Squeeze	EX2502_D05_07B	Pyrosoma	70% EtOH	Dominant Fauna	20250324	014204	20.522491	-158.763613	671.5059814	34.35499954	5.671000004	1.125
8	Ka'ena Slope	EX2502_D08_01B	Hexactinella	70% EtOH	Characteristic of Site	20250326	202247	21.570472	-158.47495	1183.040039	34.53499985	3.463999987	1.868000031
8	Ka'ena Slope	EX2502_D08_01B_A01B	Polychaeta	70% EtOH	Associate	20250326	202247	21.570472	-158.47495	1183.040039	34.53499985	3.463999987	1.868000031

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

Table C3. Inventory of water samples collected for eDNA analysis during EX2502.

Dive #	Site Name	Sample #	Preservative	Collection Rationale	Date (yyyymmdd)	UTC Time (hhmmss)	Latitude (dd)	Longitude (dd)	Depth (m)	Salinity (ppt)	Temp (C)	Dissolved Oxygen (mg/l)
1	Lanai	EX2502_D01_01W	DNA/RNA Shield	eDNA	20250319	232829	20.820733	-157.064375	176.4290009	34.92200089	19.54199982	6.193999767
1	Lanai	EX2502_D01_02W	DNA/RNA Shield	eDNA	20250320	021252	20.821093	-157.066042	131.7579956	35.0359993	21.53000069	6.237999916
1	Lanai	EX2502_D01_03W	DNA/RNA Shield	eDNA	20250320	021312	20.821095	-157.066004	122.0189972	35.11199951	22.44300079	6.369999886
1	Lanai	EX2502_D01_04W	DNA/RNA Shield	eDNA	20250320	021329	20.821109	-157.065978	115.685997	35.09999847	23.00399971	6.427999973
1	Lanai	EX2502_D01_05W	DNA/RNA Shield	eDNA	20250320	021345	20.821126	-157.065943	106.5479965	35.08100128	23.20199966	6.464000225
2	Lanai Slope	EX2502_D02_01W	DNA/RNA Shield	eDNA	20250320	231944	20.783159	-157.155378	1224.151001	34.54000092	3.490999937	1.79400003
2	Lanai Slope	EX2502_D02_02W	DNA/RNA Shield	eDNA	20250320	234618	20.782515	-157.155574	1222.369995	34.5359993	3.529999971	1.774999976
2	Lanai Slope	EX2502_D02_03W	DNA/RNA Shield	eDNA	20250321	000249	20.782364	-157.155415	1219.984009	34.53499985	3.539000034	1.753999949
2	Lanai Slope	EX2502_D02_04W	DNA/RNA Shield	eDNA	20250321	004349	20.782711	-157.15544	1186.124023	34.52799988	3.694000006	1.70599997
2	Lanai Slope	EX2502_D02_05W	DNA/RNA Shield	eDNA	20250321	005018	20.782672	-157.155458	1004.312988	34.49000168	4.311999798	1.460999966
4	Penguin Bank	EX2502_D04_01W	DNA/RNA Shield	eDNA	20250322	215702	20.952752	-157.386986	624.5269775	34.34899902	5.762000084	1.202000022
4	Penguin Bank	EX2502_D04_03W	DNA/RNA Shield	eDNA	20250322	225852	20.953413	-157.3881	555.7860107	34.30799866	6.105999947	1.29400003
4	Penguin Bank	EX2502_D04_05W	DNA/RNA Shield	eDNA	20250322	235044	20.953598	-157.388115	527.6740112	34.26599884	6.501999855	1.610999942
4	Penguin	EX2502_D0	DNA/RNA	eDNA	20250323	014115	20.954764	-157.389607	367.2219849	34.15000153	8.657999992	3.490999937

	Bank	4_06W	Shield									
4	Penguin Bank	EX2502_D04_07W	DNA/RNA Shield	eDNA	20250323	020005	20.95506	-157.389829	337.5090027	34.15299988	9.812999725	4.40199995
5	Deep Squeeze	EX2502_D05_01W	DNA/RNA Shield	eDNA	20250323	214849	20.52128	-158.764536	4191.018066	34.68600082	1.465000033	4.68599987
5	Deep Squeeze	EX2502_D05_03W	DNA/RNA Shield	eDNA	20250323	225018	20.522052	-158.763645	4177.821777	34.68600082	1.465000033	4.75
5	Deep Squeeze	EX2502_D05_05W	DNA/RNA Shield	eDNA	20250323	230802	20.522048	-158.763666	4169.861816	34.68899918	1.463000059	4.738999844
5	Deep Squeeze	EX2502_D05_06W	DNA/RNA Shield	eDNA	20250323	235643	20.521861	-158.764072	3003.141113	34.66899872	1.549999952	3.959000111
7	Kaʻena Point	EX2502_D07_01W	DNA/RNA Shield	eDNA	20250326	012518	21.569739	-158.476387	1353.853027	34.55500031	3.137000084	2.029000044
7	Kaʻena Point	EX2502_D07_02W	DNA/RNA Shield	eDNA	20250326	013824	21.569902	-158.476231	1323.901978	34.54800034	3.249000072	1.963999987
7	Kaʻena Point	EX2502_D07_03W	DNA/RNA Shield	eDNA	20250326	014820	21.569331	-158.476506	1280.759033	34.5379982	3.417999983	1.911000013
7	Kaʻena Point	EX2502_D07_04W	DNA/RNA Shield	eDNA	20250326	014930	21.569305	-158.476484	1241.295044	34.52799988	3.573999882	1.848999977
7	Kaʻena Point	EX2502_D07_05W	DNA/RNA Shield	eDNA	20250326	015045	21.569251	-158.476487	1200.671997	34.52199936	3.743000031	1.792000055
8	Ka'ena Slope	EX2502_D08_02W	DNA/RNA Shield	eDNA	20250326	202548	21.57047	-158.474949	1183.682007	34.5340004	3.47300005	1.860999942
8	Ka'ena Slope	EX2502_D08_03W	DNA/RNA Shield	eDNA	20250326	235147	21.570795	-158.473792	949.7130127	34.46900177	4.484000206	1.557000041
8	Ka'ena Slope	EX2502_D08_04W	DNA/RNA Shield	eDNA	20250327	002318	21.570883	-158.473659	896.8109741	34.44200134	4.718999863	1.452999949