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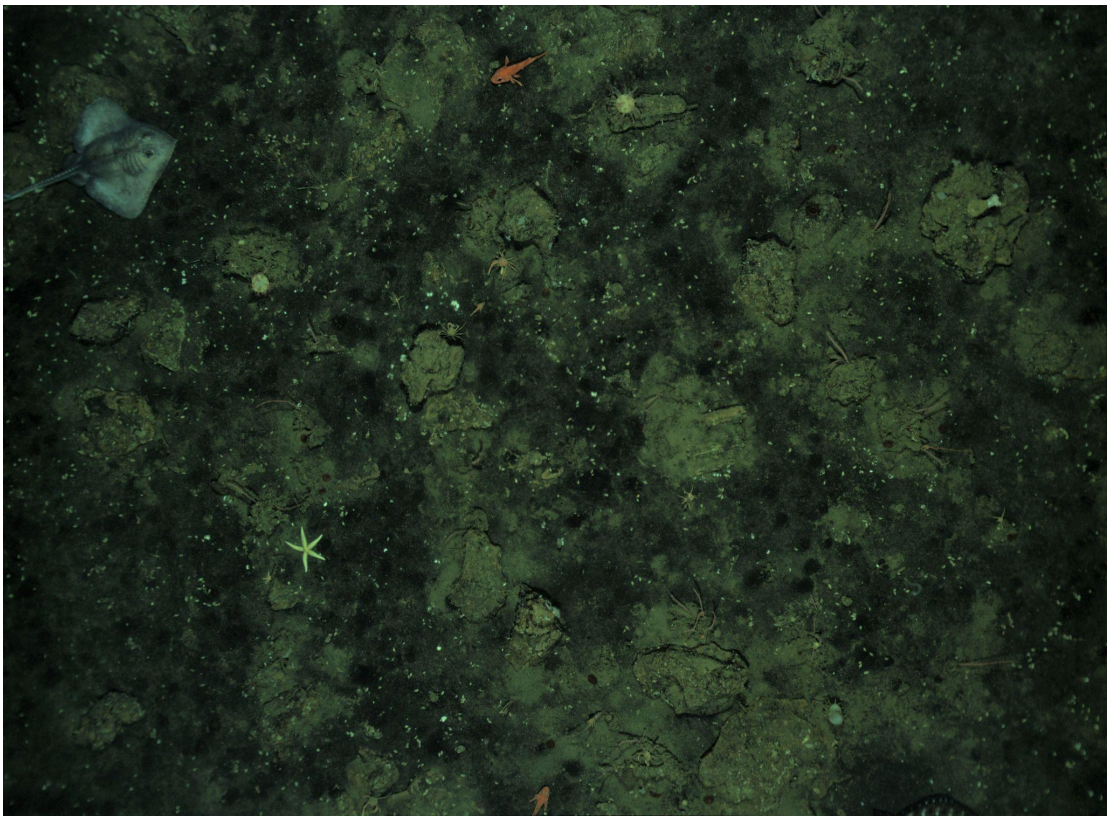
Expedition Report: EX2308, EXPRESS: Exploration of Central California Coast



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Abstract

From October 21 - November 10, 2023 (San Francisco, California, to San Francisco, California), NOAA Ocean Exploration conducted the EXPRESS: Exploration of Central California Coast expedition (EX2308), an Autonomous Underwater Vehicle (AUV) and mapping expedition to the central Californian coast. Operations during this 21-day expedition included the completion of five autonomous AUV dives, which were conducted in water depths ranging from 296 m to 1954 m for approximately 67 hours of mission time. EX2308 also mapped 23,599 sq. km of seafloor, 23,584 sq km were within 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 All data associated with this expedition have been archived and are publicly available through the NOAA archives.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: California, Pacific Ocean

Ports: San Francisco, California, to San Francisco, California

Bounding Coordinates: 33.6440388889, -124.1729305556, -119.1934305556, 38.6935944444

Expedition Dates: October 21 - November 10, 2023

Expedition Type: AUV, Mapping, and Technology Demonstration

Theme Keywords: EXPRESS, autonomous underwater vehicle, AUV, technology, Chumash, mapping

Place Keywords: Channel Islands, California, Pacific, Rodriguez Seamount

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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, collectively, to protect ocean health, sustainably manage our marine resources, accelerate our national economy, better understand our changing environment, and enhance our 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 videos, 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 NOAA Ship *Okeanos Explorer* off the central Californian Coast will contribute to EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS). EXPRESS is a multiyear, multi-institution cooperative research campaign in deep-sea areas off California, Oregon, and Washington, including the continental shelf and slope. EXPRESS data and information are intended to guide the wise use of living marine resources and habitats, inform ocean energy and mineral resource decisions, and improve offshore hazard assessments.

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 October 21 to November 10, 2023, NOAA Ocean Exploration and partners conducted a telepresence-enabled ocean exploration expedition on *Okeanos Explorer* to collect critical baseline information and improve knowledge about unexplored and poorly understood deepwater areas of the Central California Coast (EX2308). Previous expeditions in this region include EX2208, EX2301, and EX2307.

Two AUVs from the University of Southern Mississippi (USM), funded by NOAA Ocean Exploration through the the Ocean Exploration Cooperative Institute (OECI), were used during EX2308 to aid in the characterization of the Chumash Heritage National Marine Sanctuary. During the 21 days at sea, there were five successful autonomous underwater vehicle (AUV) dives and 23,599 sq. km of bathymetric data were collected (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. The names, roles, and affiliations of science team members who participated in EX2308 are found in **Appendix A**.

Figure 1. Map showing EX2308's track, five autonomous underwater vehicle dive sites, and bathymetric data collected. *Note: Only four sites are shown due to two dive sites overlapping at the same location.*

2.1 Rationale for Exploration

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 unknown and poorly known areas of the central California coast. To define the operating area for this expedition, NOAA Ocean Exploration considered the 2022 and 2023 calls for input, results from EXPRESS meetings and workshops, and known priorities from resource managers and scientific stakeholders in the region.

The continental shelf, slope, and deepwater regions offshore California, Oregon, and Washington 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.

Mapping and exploring these deep waters results in critical baseline information that can be integrated into EXPRESS 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 will inform deep-sea management plans for habitat areas of particular concern, marine protected areas, and national marine sanctuaries. The publicly accessible data collected during EX2308 supports the needs of local scientists and managers seeking to understand and manage deep-sea resources, stimulate subsequent exploration, research, and management activities.

This expedition contributed to ongoing collaborations with NOAA National Marine Sanctuaries, the Bureau of Ocean Energy Management (BOEM), the U.S. Geological Survey (USGS), the Coastal Band of the Chumash Nation, and the EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS) research campaign.

2.2 Objectives

EX2308 was executed as part of an OECI project leveraging the USM AUVs *Mola Mola* and *Eagle Ray*. Specific information about each AUV can be found in sections 3.2.1 and 3.2.2 below. This

expedition addressed scientific themes and priority areas put forward by NOAA scientists and partners, including USGS, BOEM, NOAA National Marine Sanctuaries, the Coastal Band of the Chumash Nation, and the broad ocean science and management communities. The primary objective of the expedition was to explore deepwater areas along the central California coast and within the boundaries of the Chumash Heritage National Marine Sanctuary to provide baseline information to support science and management needs. This expedition sought to:

- Utilize *Eagle Ray* to collect high-resolution bathymetry and sub-bottom profiler data in areas with no or low-quality mapping data.
- Image benthic habitats with *Mola Mola*'s VOYIS stereo-camera and 3-D imaging system.
- Investigate biogeographic patterns of deep-sea ecosystems and connectivity across the central Californian Coast for use in broader comparisons of deepwater habitats throughout Californian waters.
- Map geological features within the central Californian Coast to better understand the geological context of the region.
- Acquire a foundation of AUV, sonar, and oceanographic data to better understand the characteristics of the water column and fauna that live there.
- Identify, map, and explore the diversity and distribution of benthic habitats, including fish habitats, deep-sea coral and sponge communities, chemosynthetic communities, and biological communities that colonize or aggregate around shipwrecks.
- Explore U.S. maritime heritage by identifying and investigating sonar anomalies as well as characterizing shipwrecks.
- 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: EX2308 2023 EXPRESS: Exploration of Central California Coast " (Cuellar 2023).

3. Methodology

The primary systems used throughout EX2308 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, and provide situational awareness for AUV operations.
- The University of Southern Mississippi's two AUVs *Mola Mola* and *Eagle Ray* to conduct benthic stereo-imagery mosaics and high-resolution multibeam and subbottom profiler

surveys, respectively.

- 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 MKII 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, as well as to provide operational information for AUV dives. Standard survey operations include the concurrent collection of multibeam, split-beam, and sub-bottom sonar data synchronized using a Kongsberg Synchronization Unit (K-Sync) with the EM 304 MKII 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 and during AUV operations. During AUV operations, the EM 304 MKII multibeam sonar, split-beam sonars, and Knudsen sub-bottom profiler were secured to allow the ADCPs to collect data and not interfere with AUV operations or sensors.

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 the interpretation of features from bathymetry and backscatter. Targeted mapping operations were conducted off the central California coast Mapping operations were carried out during overnight transits and other intervals between AUV dives.

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).

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 2023” (Candio et al. 2023). 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 EX2308

should refer to the 2023 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. 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 to 65°/65° 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 MKII transducer and were monitored inSIS 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 one of them fails. Positioning/attitude data were applied to the multibeam data in real-time. The primary system used will be noted in the processing logs.

Multibeam mapping operations were conducted directly over planned AUV dive sites to collect seafloor mapping data to help refine dive plans. Targeted surveys were conducted at approximately 8 kts off the California coast to collect high-resolution bathymetry to assist in the planning of AUV dives, down to 2000 m in depth. This data was used to design detailed ingress and egress plans for the AUV to avoid potential hazards and maximize the coverage of each of their systems.

Background data used to guide multibeam mapping operations included: the NOAA Deep Sea Coral and Sponge Map Portal, locations of previous dives performed by NOAA Ocean

Exploration and EXPRESS partners, and previous multibeam surveys synthesized in the Global Multi-Resolution Topographic surface (GMRT) and NOAA's National Center for Environmental Information's multibeam mosaic.

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 to identify the target strength of water column acoustic reflectors (e.g., deep scattering layers, fish, and gas bubbles from seeps), providing additional information about water column characteristics and anomalies.

Calibrations were performed during EX2305, and these calibration values were most appropriate for the EX2308 dataset. The calibration files are archived with the sonar data, and the calibration report is available as a supplemental file to the 2023 mapping readiness report (Candio et al. 2023). The sonars were active during all mapping operations and secured during AUV 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. The ADCPs were used to gather data prior to AUV deployments to assess currents in support 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. A crossline was not run during EX2308 due to a lack of collection of contiguous bathymetric surfaces and other operational priorities.

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 a .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 EX2308.

Location	Start of Expedition 10/21/2023	End of Expedition 11/10/2023
Forward	15’ 0’’	14’ 9’’
Aft Starboard	14’ 3.5’’	14’ 4.5’’
Aft Port	13’ 10.5’’	14’ 5.5’’

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). No CTDs were deployed on EX2308.

3.1.3 Data Collection and Processing Software

Table 2 provides a list of the data collection and processing software versions used during EX2308.

Table 2. Versions of data collection and processing software used during EX2308.

Software	Purpose	Version
SIS	EM 304	5.11.1
EK80	EK suite	21.15.2
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04
AMVERSEAS	Autolaunch XBT	9.3.6
WinMK21	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Qimera	Bathymetry	2.5.3
FMGT	Backscatter	7.10.3
FM Midwater	Water Column	7.9.4
Sound Speed Manager	Sound Speed Profiles	2023.0.7
NRCan (SegJp2)	Sub-Bottom	1.0
Fledermaus 7	Visualization/Data Analysis	7.8.12

3.2 AUV Operations

Five AUV dives were conducted during EX2308, two with the large AUV *Eagle Ray* (**Figure 2)** and three with the smaller AUV *Mola Mola* **(Figure 3)**. Between the two AUVs, a total of 2 days, 18 hours, and 55 minutes of dive time was accrued, with 2 days, 6 hours, and 11 minutes by *Eagle*

Ray and 12 hours and 44 minutes with *Mola Mola*. Additional information is included in the dive summaries for each dive, included as supplemental files with this document. The specifications and scientific payloads of each vehicle are listed below. Dive locations for each vehicle can be seen in **Figure 4.**

3.2.1 AUV *Eagle Ray*

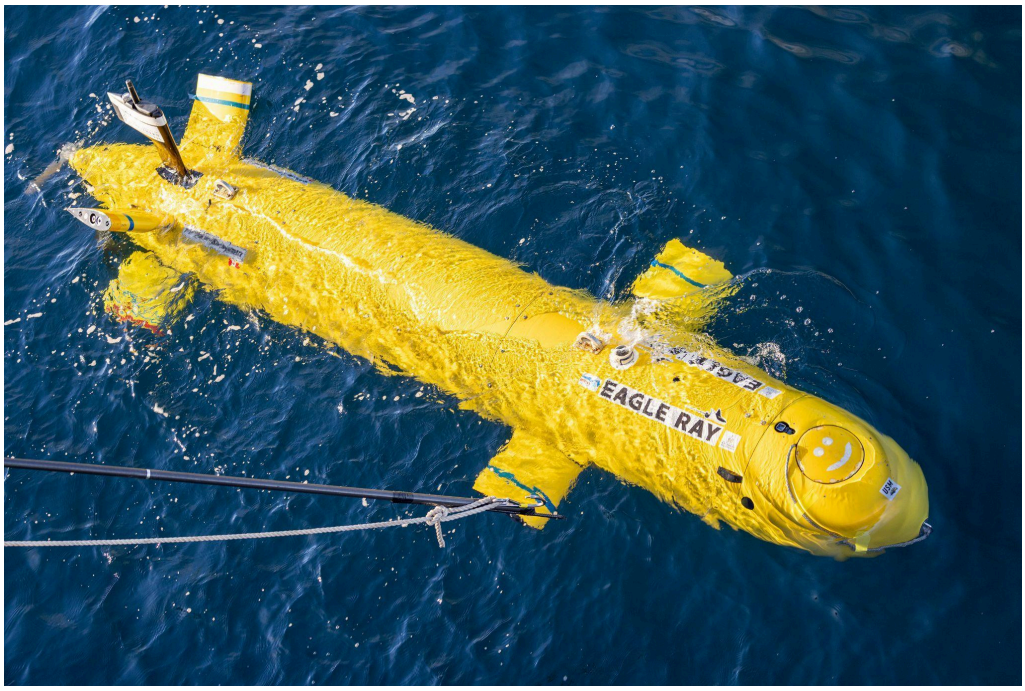

Figure 2. University of Southern Mississippi's autonomous underwater vehicle *Eagle Ray*. *Image courtesy of Art Howard, Global Foundation for Ocean Exploration/NOAA Ocean Exploration, 2023 EXPRESS: Exploration of Central California Coast.*

Max Depth: 2200 m

Size: 5 m length, 0.7 m diameter

Mass: 900 kg

Endurance: Up to 30 hrs, 180 km

Scientific payload: Norbit Wideband Multibeam Sonar (WBMS) multibeam echosounder (400 kHz), GeoAcoustics polarity-preserving CHRIP subbottom profiler (3.5 - 12 kHz), SeaBird FastCAT CTD, Ocean Floor Geophysics magnetometer

Navigation: IxBlue Phins C7 internal navigation system, Bortek 500 kHz DVL, Masterclock with GNSS receiver and time server, Paroscientific depth sensor, Kongsberg forward-looking altimeter

Maneuvering: Single thruster, fore planes and aft planes allowing rapid pitched transit to survey altitude and stable have-mode altitude-keeping

Communications/Tracking: Surface - Ubiquiti 2.4 GHz ethernet radio, Xeos combined Iridium tracking and strobe beacon. Submerged - Sonardyne AvTrak 6 combined USBL tracking transponder and acoustic modem

Batteries: 30 kWh Li-ion 18 Onyx 48V modules with pressure housing

3.2.2 *Mola Mola*

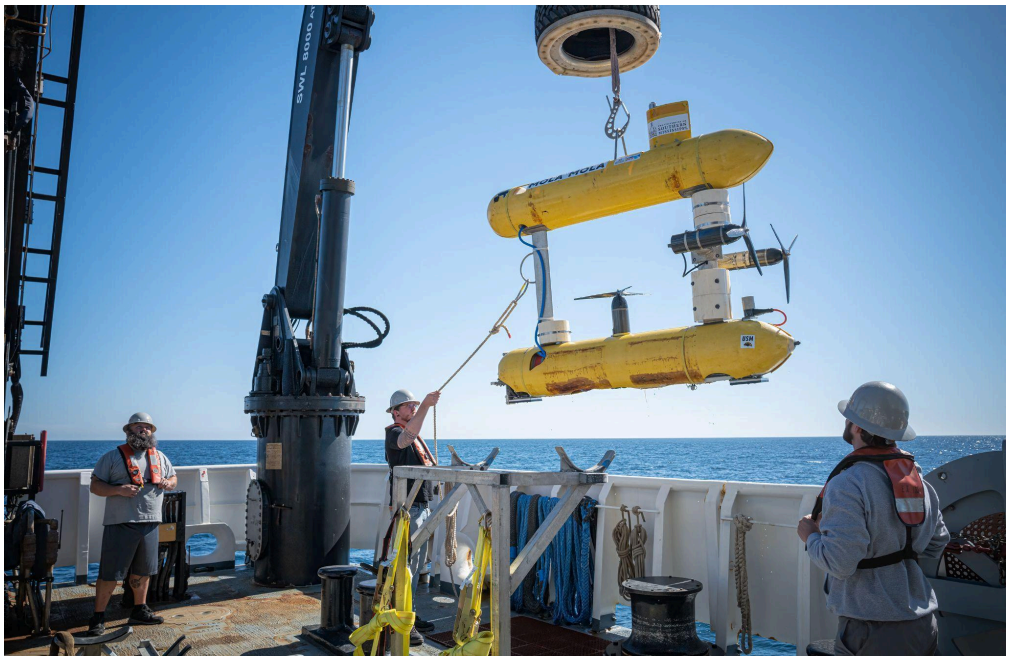

Figure 3. University of Southern Mississippi's autonomous underwater vehicle *Mola Mola* being recovered after a dive by NOAA Ship *Okeanos Explorer* deck crew. *Image courtesy of Art Howard, Global Foundation for Ocean Exploration/NOAA Ocean Exploration, 2023 EXPRESS: Exploration of Central California Coast*

Max Depth: 2000 m

Size: 2 m length, 1.5 m height

Mass: 225 kg

Endurance: Up to 8 hours

Scientific payload: Voyis Insight Micro, consisting of a color still camera, fore-and-aft LED arrays, and a laser-line bathymetry system

Navigation: IxBlue Phins III inertial navigation system, Teledyne RDI 1.2 MHz DVL, Master-clock combined with GNSS receiver and time server, Paroscientific depth sensor, Tritech forward-looking altimeter

Maneuvering: 3 magnetically-coupled thrusters, electromagnetic-operated descent weight system, passive stability in pitch and roll for uniformity of optical data

Communications/Tracking: Surface - Ubiquiti 2.4 GHz ethernet radio, Xeos combined Iridium tracking and strobe beacon. Submerged - Sonardyne AvTrak 6 combined USBL tracking transponder and acoustic modem

Batteries: Kraken SeaPower 50V52 pressure tolerant battery - 2.6 kWh at 52 V (nominal)

Figure 4. Map showing EX2308's autonomous underwater vehicle dive locations. *Note: Only four sites are shown due to two dive sites overlapping at the same location (A01 and A04).*

3.3 Sampling Operations

No samples were collected on EX2308.

3.4 Conductivity, Temperature, and Depth

No CTD measurements were conducted on EX2308 due to damage to the CTD frame and the need to mount the AUV USBL pole assembly in the space typically reserved for the over-boarding davit of the CTD sensor.

3.5 Sun Photometer Measurements

NOAA Ocean Exploration gathers limited at-sea measurements aboard *Okeanos Explorer* to support a NASA-led, long-term research effort that assesses marine aerosols. As time allowed on cloud-free days, onboard personnel collected georeferenced sun photometer measurements for the Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers that measure atmospheric aerosol properties around the world. MAN complements AERONET by conducting sun photometer measurements on ships of opportunity to monitor aerosol properties over the global ocean. Four sun photometer measurements were taken during EX2308 on cloudless days.

3.6 Novel Technologies and Opportunistic Tools

Two AUVs from the University of Mississippi, funded by the Ocean Exploration Cooperative Institute (OECI), were used during EX2308 to aid in the characterization of the Chumash Heritage National Marine Sanctuary that is currently under consideration. These two AUVs each focus on different modes of operation and data collection. *Eagle Ray*, a 5 m long AUV equipped with multibeam sonar, subbottom profiler, and magnetometer, excels in covering large distances over long-duration missions (approximately 24 hrs). *Mola Mola* is a much smaller, 2 m long AUV that specializes in serving as a camera and 3-D laser platform for detailed inspection of the seafloor using a Voyis Insight Micro imaging system. The combination of these two vehicles allowed for both wide feature mapping and close-in inspection and photo mosaic collection of areas of interest.

4. Environmental and Historical Compliance

General records of multi-expedition environmental and historical compliance are in the “NOAA Ship *Okeanos Explorer* FY23 Field Season Instructions” as appendices and supplemental files (Cuellar 2023).

Overviews of expedition-specific compliance activities are provided below. Copies of associated records of compliance are in **Appendix B**.

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 2023 in accordance with Section 4 of the companion manual in the form of a categorical exclusion worksheet. Based on this review, a categorical exclusion was determined to be the appropriate level of NEPA analysis necessary, as no extraordinary circumstances existed that required the preparation of an environmental assessment or environmental impact statement. NOAA Ocean Exploration is preparing a programmatic environmental assessment to cover future expeditions.

NOAA Ocean Exploration requested an Essential Fish Habitat (EFH) consultation for expeditions on NOAA Ship Okeanos Explorer to the Pacific Ocean region for operations during the 2023 field season. The Letter of Acknowledgement was received on August 3, 2022, from the Assistant Regional Administrator for the NOAA Office of Habitat Conservation stating that these expeditions will not adversely impact EFH.

NOAA Ocean Exploration requested a permit for operations within the National Marine Sanctuaries (NMS), which was granted on March 20, 2023. EX2308 operations took place within Greater Farallones NMS, Channel Islands NMS, Cordell Bank NMS, and areas of the Chumash Heritage NMS.

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*.) 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, no underwater cultural heritage activities were conducted.

Details about NOAA Ocean Exploration's maritime heritage policies are in the 2023 Field Season instructions as supplemental files (Cuellar 2023).

5. Schedule

Table 3 provides a day by day breakdown of EX2308 (details are in **Table 4**).

Table 3. EX2308 schedule.

Date (UTC)	Activity
10/17	Mobilization in San Francisco, California
10/18	Mobilization in San Francisco, California
10/19	Mobilization in San Francisco, California
10/20	Mobilization in San Francisco, California
10/21	Depart San Francisco, California, and transit to *Mola Mola* ballasting location, conducting ballasting operations.
10/22	*Mola Mola* dive cancelled due to Phins INS issue and incoming weather. Commence transit mapping south towards Chumash Heritage NMS priority areas. Live interaction Land Acknowledgement performed.
10/23	Transit mapping. Live interaction Land Acknowledgement performed.
10/24	Transit and weather avoidance mapping. Live interaction Land Acknowledgement performed.
10/25	*Mola Mola* dive cancelled due to weather. Transit mapping. Live interaction Land Acknowledgement performed.
10/26	*Mola Mola* Dive A01 at Santa Lucia Bank. AUV recovered after approximately 2 hours due to mission progression waypoint error. Recovered PMEL ocean buoy that had broken anchor. Live interaction Live Acknowledgement performed and live ship-to-shore with Coastal Band Chumash community members and Channel Islands National Marine Sanctuary at Cabrillo High School Aquarium.
10/27	Weather avoidance and transit mapping.
10/28	Small boat transfer near Ventura, California to drop off Chumash cultural liaisons. Ballasting of AUV *Eagle Ray* and deployment of Dive A02 south of Santa Cruz Island, Channel Islands, California on a glass sponge reef.
10/29	Recovery of *Eagle Ray* from A02. Transit and focused mapping over Rodriguez Seamount.

Date (UTC)	Activity
10/30	Aborted dives from both *Mola Mola* and *Eagle Ray*. *Mola Mola* suffered from navigation issues with its INS and *Eagle Ray* encountered an issue with its power switch after launch and could not be rebooted by radio communications. The vehicle was monitored overnight to facilitate morning recovery on Oct. 31st.
10/31	Recovery of *Eagle Ray* following nighttime abort. *Mola Mola* dive aborted due to INS issue. Relaunch of *Eagle Ray* on overnight dive A03 on Rodriguez Seamount.
11/01	Recovery of *Eagle Ray* following dive on Rodriguez Seamount. Gapfill and transit mapping
11/02	Gapfill mapping
11/03	Gapfill and transit mapping
11/04	*Mola Mola* static testing and deployment on dive A04. Loss of INS alignment, vehicle ran transect rather than 60x60m box seeking waypoint 'home' location. *Mola Mola* recovered after surface command sent. Successful test of XBT Autolauncher from OMAO-managed mapping system.
11/05	Gapfill mapping.
11/06	Transit mapping.
11/07	Mapping operations were performed using a new switchover workflow to the OMAO-managed system. Mapping data recording secured for testing and troubleshooting after switchover.
11/08	OMAO-managed mapping acquisition system testing. No AUV dive due to transit to last dive location.
11/09	*Mola Mola* dive A05 in Greater Farallones National Marine Sanctuary and continued testing on OMAO-managed acquisition system and network.
11/10	Arrival in San Francisco, California; demobilization efforts begin.
11/11	Demobilization.

6. Results

This section details the results of EX2308. 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 EX2308.

Metrics	Totals
Days at Sea	21
Days at Sea in U.S. Waters	21

Metrics	Totals
Linear km Mapped by EM 304 MKII	3264
Sq. km Mapped by EM 304 MKII	23599
Sq. km Mapped by EM 304 MKII in U.S. Waters >200m	23584
Vessel CTD Casts	0
XBT Casts	75
AUV Dives	5
AUV Dives in U.S. Waters	5
Maximum AUV Seafloor Depth (m)	1954
Minimum AUV Seafloor Depth (m)	459
AUV Voyis Camera Area Covered (*Mola Mola)* (m)	0.007 km^2
AUV Multibeam Area Covered (*Eagle Ray)* (m)	28.6 km^2
Total AUV Time (hh:mm:ss)	66:55:00

EX2308: Exploration of Central California Coast AUV and Mapping was a 21-day telepresence-enabled expedition to collect critical information and acquire data on priority exploration areas along the central California coast and in and around the Chumash Heritage National Marine Sanctuary. Exploration consisted of mapping and autonomous underwater vehicle (AUV) targeting features of interest including glass sponge reefs, seamounts, and other areas along the continental shelf. Mapping and AUV data collected during this expedition filled data gaps in the region and will contribute to the National Ocean Mapping, Exploration and Characterization (NOMEC) strategy, the EXPRESS campaign, and the Chumash Heritage National Marine Sanctuary.

Five AUV dives ranging in depth from 459 to 1954 meters covered a distance of 32,175 linear km, collecting detailed multibeam, subbottom, and magnetometer data over a glass sponge reef within the Channel Islands National Marine Sanctuary and the base of Rodriguez Seamount and imagery on Santa Lucia Bank and within the Greater Farallones National Marine Sanctuary. These datasets will contribute to the EXPRESS campaign, characterization of the Chumash Heritage National Marine Sanctuary, and management decisions within both Channel Islands and greater Farallones National Marine Sanctuaries. The full AUV report created by the University of Southern Mississippi is included as a supplemental file to this report.

6.1 Acoustic Operations Results

NOAA Ocean Exploration mapped 23,599 sq. km of seafloor during the 21 days at sea for EX2308. Of the 23,599 sq. km mapped, 23,584 sq. km was deeper than 200 m and within the U.S. EEZ and Territorial Sea.

EX2308 focused many of the days-at-sea on the testing, deployment, and recovery of the USM AUVs *Eagle Ray* and *Mola Mola*. Mapping operations were conducted during transit, weather and vehicle troubleshooting delays, and on dive sites overnight prior to dive deployments the following morning. When possible, bathymetry gaps were prioritized for transit and focused mapping opportunities. Mapping coverage for EX2308 can be seen in **Figure 5** below.

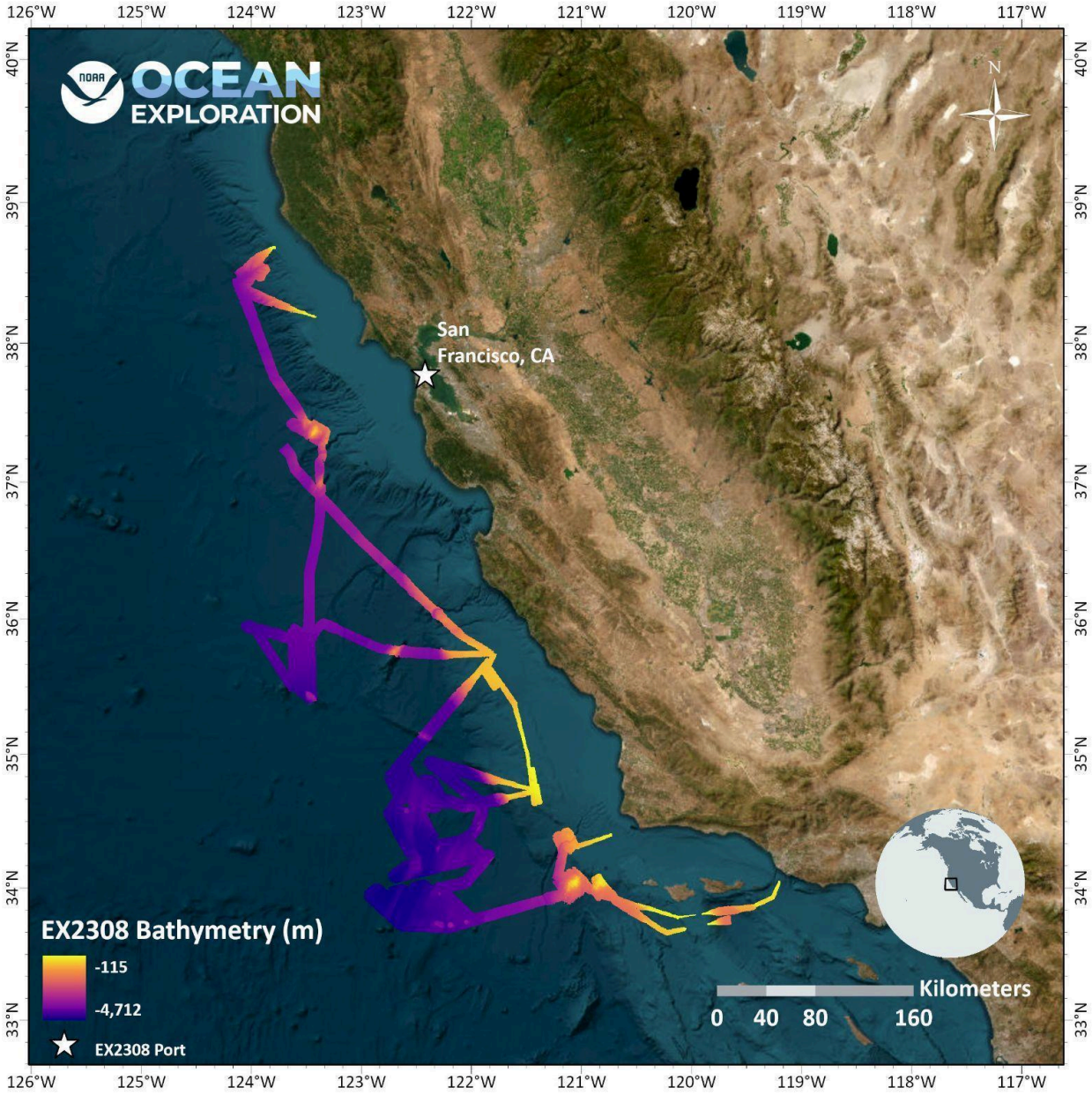

Figure 5. Map showing EX2308's mapping coverage.

Acoustic mapping data are sent to the NOAA archives with a goal of 120 days of the end of an expedition. The 2023 mapping readiness report describes the data archived for each dataset, including file formats (Candio 2023). 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 AUV Operations Results

Depth ranges explored during the 5 AUV dives were between 296 and 1,954 m in depth. **Table 5** contains dive-specific information. *Mola Mola* dives captured still imagery, and *Eagle Ray* collected multibeam, backscatter, subbottom, and magnetometer data.

Table 5. Summary information for the 5 AUV dives conducted during EX2308.

Dive #	Site Name	Date (yyyymmdd)	Launch Latitude (dd)	Launch Longitude (dd)	Max Depth (m)	Dive Duration (hh:mm:ss)	Distance Traveled (m)	Vehicle
A01	Santa Lucia Bank	20231026	34.7279	121.3984	609 m	2:03:00	5 m	*Mola Mola*
A02	Channel Island NMS Sponge Reef	20231028	33.9202	-119.4731	1075 m	25:43:00	14,400 m	*Eagle Ray*
A03	Rodriguez Seamount	20231031	34.0335	-121.0473	1954 m	28:28:00	12,570 m	*Eagle Ray*
A04	Santa Lucia Bank	20231105	34.7251	-121.3974	607 m	4:48:00	2,200 m	*Mola Mola*
A05	Greater Farallones NMS Priority Site	20231109	38.6785	-123.8065	459 m	5:53:00	3,000 m	*Mola Mola*

6.3 Novel Technologies and Opportunistic Tools

The University of Southern Mississippi AUVs *Eagle Ray* and *Mola Mola* were successfully integrated onto *Okeanos Explorer* for EX2308. Several mobilization challenges were overcome, including the creation of a retractable USBL pole mount to communicate with the vehicles while in the water, and the use of the ROV crane and A-frame to extend the *Eagle Ray* Launch and Recovery System (LARS) after it was determined that the A-frame alone would not have enough clearance to properly extend and lower the AUV into the water.

The addition of the two AUVs offered an opportunity to improve and streamline AUV operations on board *Okeanos Explorer*. Each successive dive improved deck-to-bridge communication, launch and recovery operations, and the integration of ship data streams (navigation, sound speed, etc.) into AUV systems. Overall this integration testings worked to improve efficiencies in the deployment and recovery of the vehicles. The sensors on

board each AUV, a camera and laser system on *Mola Mola,* and multibeam, subbottom, and magnetometer *Eagle Ray,* coupled with each AUVs ability to operate near the ocean floor, allowed the collection of higher resolution data than is capable from the shipboard systems on *Okeanos Explorer* from the surface.

6.4 Engagement

EX2308 engaged with audiences around the world, opening a window of understanding into the deep sea. Highlights included:

- Two representatives from the Coastal Band of the Chumash Nation, Mia Lopez and Keli Lopez, sailed on board for seven days, sharing Indigenous knowledge, observations, and their relationship to the ocean and lands through which *Okeanos Explorer* sailed. Discussions focused on how Indigenous knowledge and Western science are compatible and how both are necessary to properly protect and sustainably manage the ocean.
- Five live interactions and one ship tour were conducted to engage a diversity of audiences. The 5 live interactions featured Land Acknowledgement ceremonies by Mia Lopez, recognizing the lands and waters through which *Okeanos Explorer* was sailing through and the traditional caretakers of these areas. These discussions, often with tribal representative guests calling in from shore, highlighted what's important to tribal members about their ancestral waters and our shared ocean and offered a new perspective of scientific work and the importance of joining regional and community-based knowledge in the expedition planning process. Following the final land acknowledgement, the ship joined a live event at Cabrillo High School Aquarium in Santa Barbara, CA with approximately 50 attendees, to give a short presentation about the work done on board *Okeanos Explorer* and share experiences of shipboard life. This event was co-hosted with Channel Islands National Marine Sanctuary.

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 and Oregon State University sample repositories, unless protected (e.g., data associated with specific maritime heritage sites). All data collected by NOAA Ocean Exploration is is in accordance with the data management plan developed for each expedition to ensure archival and publicly avaialbe best practices are followed.. The data management plan for

EX2308 is found within “Project Instructions: EX2308, EXPRESS: Exploration of Central California Coast ” (Cuellar2023).

The primary tools for accessing data collected during this expedition and archived at NCEI are the EX2308 data landing page, the NOAA Ocean Exploration Data Atlas, and the NOAA Ocean Exploration Video Portal (no video was taken during EX2308). 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 EX2308 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 EX2308 and products documenting expedition results (at the time of writing this report) are provided in **Table 6**. AUV data from *Mola Mola* and *Eagle Ray* within the NCEI data archives.

Table 6. Online locations for direct access to digital data collected during EX2308 and products documenting expedition results (at the time of writing this report).

Data/Product Type	Description
EM 304 MKII Bathymetry and Backscatter Data	EM 304 MKII 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
University of Southern Mississippi AUV Data	Please contact ncei.info@noaa.gov for more information, referencing the EX2308 expedition.
Water Column Data (EM 304 MKII and EK60/EK80)	EM 304 MKII and EK60/EK80 water column data, supporting data, and informational logs are available through NCEI’s Water Column Sonar Data Viewer

Data/Product Type	Description
Knudsen 3260 Sub-Bottom Profiler Data	Sub-bottom data, supporting data, and informational logs are available in NCEI's Trackline Geophysical Data Viewer
ADCP Data	ADCP raw data are available by request from oar.oer.exmappingteam@noaa.gov
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
Sun Photometer Measurements	Sun photometer measurements are available through NASA's Marine Aerosol Network
Reports and Papers	Reports and peer-reviewed papers are available through the NOAA Ocean Exploration Library Guide and the NOAA Institutional Repository

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Appendix A: EX2308 Science Team Members

EX2308 included onboard mission personnel (**Table A1**).

Table A1. EX2308 onboard mission team personnel.

Name	Role	Affiliation
Cuellar, Samuel	Expedition Coordinator	NOAA Ocean Exploration
D'Emidio, Marco	AUV Science Lead	University of Southern Mississippi
Macelloni, Leo	AUV Science Lead	University of Southern Mississippi
Coulson, Anna	Mapping Watch Lead	University Corporation for Atmospheric Research
Freitas, Dan	Mapping Watch Lead	University Corporation for Atmospheric Research
O'Brien, Andy	GFOE Team Lead	Global Foundation for Ocean Exploration
Aragon, Fernando	GFOE Data Engineer	Global Foundation for Ocean Exploration
Murphy, Lars	GFOE Engineer	Global Foundation for Ocean Exploration
Kennison, Sean	GFOE Engineer	Global Foundation for Ocean Exploration
Brian, Roland	GFOE Satellite Engineer	Global Foundation for Ocean Exploration
Howard, Art	GFOE Videographer and Photographer	Global Foundation for Ocean Exploration
Rubim de Assis, Agno	AUV Team	University of Southern Mississippi
Woolsey, Max	AUV Team	University of Southern Mississippi
Jarnigan, Roy	AUV Team	University of Southern Mississippi
Battista, Bradley	AUV Team	University of Southern Mississippi

Appendix B: EX2308 Environmental Compliance Documentation

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

The National Environmental Policy Act (NEPA) Categorical Exclusion worksheet is attached to this document as a supplement.

Figure B1. EFH Consultation Letter

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall Suite 5-100
Sacramento, California 95814

August 3, 2022

Refer to NMFS No: [WCRO-2022-01863]

Genene Fisher
Deputy Director
NOAA Office of Ocean Exploration and Research
Silver Spring, Maryland 20910

Re: Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Deep-Sea Exploration Activities Aboard NOAA Ship *Okeanos Explorer* in 2022-2024

Dear Ms. Fisher:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the NOAA Office of Ocean Exploration and Research's (OER) letter dated July 1, 2022 requesting an abbreviated essential fish habitat (EFH) consultation for the field activities to be conducted aboard the NOAA Ship *Okeanos Explorer* in the West Coast and Alaska Regions in 2022-2024. Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act (FWCA) require federal agencies to consult with us on all actions that may adversely affect EFH and other aquatic resources. The EFH consultation process is guided by the requirements of our EFH regulations at 50 CFR 600 Subpart K, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation process. In support of this consultation process, you provided a notice of the proposed action and your agency's conclusion regarding impacts on EFH. Your request references previously completed EFH consultations between NOAA Fisheries Greater Atlantic and Southeast Regions and OER and NOAA's National Centers of Coastal Ocean Science (NCCOS) for similar research activities conducted in U.S. federal waters of the Gulf of Mexico, South Atlantic Bight and Caribbean in 2018-2020 and activities in the Greater Atlantic Region and Southeast Atlantic from 2019 to 2021. After reviewing the above information, NMFS provides this response pursuant to section 305(b)(4)(A) of the MSA and the FWCA.

Proposed Action

NOAA Ship *Okeanos Explorer* expeditions in 2022 thru 2024 will contribute to the West Coast Expanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign and the regional Seascape Alaska campaign. EXPRESS is the latest evolution of the multi-year, multi-ship campaign that will help develop mitigation measures for operations occurring in the region and continued support of marine protected areas. Other initiatives include the Nippon Foundation-GEBCO Seabed 2030 initiative and the National Strategy for Ocean Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone (NOMEC), which looks to produce a bathymetric map of the world ocean floor by 2030.

Consistent with previous expeditions in the Gulf of Mexico, western Atlantic, and Pacific, OER will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration including deep water mapping systems. Mapping and remotely operated vehicle (ROV) operations generally occur in water depths of 200 meters (m) and greater. During OER operations, expedition teams would conduct: seafloor, sub-bottom and water column mapping using multibeam, split-beam, sub-bottom profiler and acoustic Doppler current profiler (ADCP) sonar systems; oceanographic data collection primarily using the vessel's CTD rosette and expendable bathythermographs (XBTs); and seafloor and water column data collection using an integrated, two-body ROV system and additional unmanned surface vehicles (USVs) and autonomous underwater

been designated in the project area: Alaska Seamount Habitat Protection Areas, GOA Coral Habitat Areas of Particular Concern and Bowers Ridge Habitat Conservation Zone. As noted previously, there are no additional regulatory protections under the MSA for HAPCs; however, federal projects with potential adverse impacts to HAPC will be more carefully scrutinized during the consultation process.

Effects of the Action

The NMFS West Coast and Alaska Regions have reviewed information provided on the proposed activities, as well as the conservation measures and best management practices incorporated into the action to address adverse effects to EFH. Adverse effects to EFH would include bottom disturbance, increased turbidity, impacts associated with sample collection, and increased sound. However, the proposed action includes measures to avoid, minimize, or otherwise offset those adverse effects to EFH. For instance, to the extent practicable, hard-bottom and other sensitive habitats (e.g., corals, seagrass) would be avoided when anchoring or operating equipment, machinery will maintain an appropriate altitude off the bottom, cameras and other technology will be used to detect and avoid collisions, and speed and the type of equipment used will be adjusted depending upon the environmental conditions. In addition, only portions of specimens will be collected whenever possible to avoid mortality and minimize adverse effects to associated habitats. Increased sound in the marine environment from vessel operation or sonar emissions would only be expected to result in temporary behavioral effects. Therefore, in our joint assessment of the overall activity including the experimental design, the nature of collection, and the scope of the proposed activities, we have no additional EFH conservation recommendations to provide pursuant to Section 305(b)(2) of the MSA.

Supplemental Consultation

Pursuant to 50 CFR 600.920(l), OER must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations.

Fish and Wildlife Coordination Act Comments

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development [16 U.S.C. 661]. The FWCA establishes a consultation requirement for Federal departments and agencies that undertake any action that proposes to modify any stream or other body of water for any purpose, including navigation and drainage [16 U.S.C 662(a)]. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources. The FWCA allows the opportunity to offer recommendations for the conservation of species and habitats beyond those currently managed under the MSA.

As described in the EFH effects analysis, NMFS has determined that bottom habitat, potentially including biogenic and rocky reef habitats, will be negatively impacted by proposed project activities. Given the importance of this habitat to a variety of fish and wildlife species, the proposed conservation measures to avoid or minimize adverse effects to EFH are also considered necessary to address negative impacts to fish and wildlife resources managed under the FWCA.

Thank you for consulting with NMFS and considering our comments. If you have any questions regarding this response, please contact Eric Chavez via email at Eric.Chavez@noaa.gov or Charlene Felkley at Charlene.Felkley@noaa.gov for questions related to the West Coast or Alaska, respectively.

Sincerely,

Ryan J. Wulff
Assistant Regional Administrator
for Sustainable Fisheries
West Coast Region

HARRINGTON.GRETCHEN.ANNE.1365893833 Digitally signed by HARRINGTON.GRETCHEN.ANNE.1365893833 Date: 2022.08.04 14:27:22 -08'00'

Gretchen Harrington
Assistant Regional Administrator
for Habitat Conservation
Alaska Region

Figure B2. National Marine Sanctuaries Permit

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Channel Islands National Marine Sanctuary
University of California Santa Barbara
Ocean Science Education Building 514, MC 6155
Santa Barbara, CA 93106-6155

CHANNEL ISLANDS, CORDELL BANK, GREATER FARALLONES, MONTEREY BAY AND OLYMPIC COAST NATIONAL MARINE SANCTUARIES RESEARCH PERMIT

Permittee:
Kasey Cantwell
NOAA Ocean Exploration
15 East-West Hwy
SSMC3
Silver Spring, MD 20910

Permit Number: MULTI-2022-008
Effective Date: April 1, 2023
Expiration Date: December 31, 2023

Project Title: NOAA Ocean Exploration U.S. West Coast Expeditions

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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 Channel Islands, Cordell Bank, Greater Farallones, Monterey Bay and Olympic Coast National Marine Sanctuaries (CINMS, CBNMS, GFNMS, MBNMS and OCNMS; or sanctuaries). All activities are to be conducted in accordance with this permit and the permit application received September 23, 2022 and all supplemental information provided to sanctuary managers. 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:

- *Discharging or depositing into the sanctuaries remotely operated vehicle (ROV) gravel ballast, expendable bathythermographs (XBTs) and autonomous underwater vehicles (AUVs)*
- *Drilling into or otherwise altering the submerged lands of the sanctuaries with temperature probes, temporary and minor disturbances associated with ROV and AUV operations and collection of biological and geological samples*
- *Abandoning gravel used as ballast on ROVs and XBTs on the submerged lands of the sanctuaries*
- *Moving, removing, taking, collecting, catching, harvesting, disturbing, breaking, cutting, or otherwise injuring, or attempting to move, remove, take, collect, catch, harvest,*

disturb, break, cut, or otherwise injure, any sanctuary resource located more than 3,000 feet below the sea surface within the Davidson Seamount Management Zone

- *Possessing any Sanctuary resource, the source of which is more than 3,000 feet below the sea surface within the Davidson Seamount Management Zone*

These activities would be otherwise prohibited by sanctuary regulations:

15 C.F.R. §§ 922.72(a)(3)(i), 922.82(a)(2), 922.132(a)(2),922.112 (a)(2)(i), 922.152(3), 922.72(a)(4), 922.82(a)(5), 922.132(a)(4), 922.112 (a)(4)(ii), 922.152(5) 922.72(a)(5), 922.82(a)(5), 922.132(a)(4), 922.112 (a)(4)(ii), 922.152(5) 922.132(a)(11)(i), 922.132(a)(11)(ii)

No further activities prohibited by sanctuary regulations are allowed.

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

Throughout CINMS, MBNMS, GFNMS, CBNMS and OCNMS in waters deeper than 200 meters.

Special Terms and Conditions:

1. This permit is effective from either April 1, 2023 or the day it is signed by the permittee and delivered to the Permit Coordinator (see General Terms and Condition #1), whichever is later. The executed permit will be valid through December 31, 2023. The permit holder(s) may request an amendment from the CINMS Superintendent a minimum of 60 days in advance of this expiration date, to extend the effective date of this permit. Amendments to this permit cannot be made after expiration.

2. No activity authorized by this permit shall disturb or impact any historical or marine archaeological resources of the sanctuaries. If historical or marine archaeological resources are disturbed or impacted at any time, the permittee shall cease all further activities under this permit and immediately contact the Permit Coordinator(s) for each site.

Point of Contact	Affiliation	Contact Information
Sean Hastings (contact for all work)	**CINMS**	**Sean.Hastings@noaa.gov** (805) 705-1790
Sophie De Beukelaer	MBNMS	Sophie.DeBeukelaer@noaa.gov 831-647-1286
Lilli Ferguson	Northern MBNMS, GFNMS, and CBNMS	Lilli.Ferguson@noaa.gov 415-530-5367
Katie Wrubel	OCNMS	katie.wrubel@noaa.gov (360) 406-2081

3. The equipment authorized by this permit shall be used in accordance with the methods and objectives identified in the original permit application and supplemental information and special terms and conditions included here. Disturbance of any other sanctuary resources is prohibited.

4. The permittee will ensure all research equipment and vessels do not harbor any introduced species, to prevent introduced species from being released within or into the sanctuaries.

5. Ballast discharged during research operations shall only be discarded in areas where there is no visible macrofauna to minimize any benthic impacts.

6. In the event that any non-permitted equipment is abandoned or lost in the sanctuary for any reason, the permittee must notify the CINMS permit coordinator, Sean Hastings (sean.hastings@noaa.gov) at the earliest extent possible. The permittee shall use all available means to locate and recover the affected item(s). The location and description of any equipment abandoned or lost in the sanctuaries for any reason shall also be noted in the annual report with an explanation why the equipment was not recovered.

7. If contacted by Sanctuary Integrated Monitoring Network (SIMoN) staff, the permittee agrees to provide project metadata from these permitted activities to the SIMoN via a web-based interface. The permittee shall provide the information to SIMoN within three (3) months of the request date. See http://www.sanctuarysimon.org for more information.

8. The permittee shall submit an annual report of all activities conducted under this permit to the Permit Coordinator (sean.hastings@noaa.gov) no later than 3 (three) months after the conclusion of the field operations, and no later than March 31, 2024. The report should include information regarding daily activities such as location (latitude and longitude) of samples, discovery or disturbance of historical artifacts, problems encountered, equipment lost, a synopsis of research results to date, and specifically, the report must include:

    - the kg per sanctuary of ballast discharged and abandoned;
    - the number of AUVs and number of AUV missions per sanctuary;
    - the number of XBTs discharged and abandoned per sanctuary;
    - the number and location of temporary and minor disturbances associated with ROV and AUV operations; and
    - the amount and location of biological and geological samples taken per sanctuary.

9. When possible, please log marine mammal and other megafauna sightings in the following apps: Whale Alert or Ocean Alert. If access to the applications is not available please log marine mammal sightings in the marine mammal sightings log sent via email with the permit and provide the completed log after the research cruises or with the annual report.

10. This activity may also require permission from other agencies. The enclosed permit is not valid until all other necessary permits and/or authorizations are obtained. Any direct or

incidental harassment of marine mammals requires a permit from NMFS (contact pr.esa.incidentaltakepermits@noaa.gov) and/or U.S. Fish and Wildlife Service ([USFWS]; contact the Ventura USFWS office at 805-644-1766). Direct or incidental harassment of seabirds requires a permit from the USFWS. Deployment of mooring or surface buoys may require authorization from the US Coast Guard (contact Mike Salsman at michael.j.salsman@uscg.mil). Research conducted within California state waters or California state marine protected areas (MPA) may require permission from the California Department of Fish and Wildlife (contact Lara Slatoff at Lara.Slatoff@wildlife.ca.gov). The use and/or occupation of state-owned lands may require a lease or other authorization from the California State Lands Commission (contact Drew Simpkin at Drew.Simpkin@slc.ca.gov).

11. The permittee will contact the U.S. Naval Air Station Whidbey Island Community Planning & Liaison Officer for the Northwest Training Range Complex (NWTRC) a minimum of 48 hours prior to the planned operations in the Northwest Testing and Training area. The permit holder(s) is required to work with the U.S. Navy to avoid conflicts with naval operations. The current contact is Ms. Kimberly Peacher, who can be reached at (360) 930-4085 (work cell) or kimberly.peacher@navy.mil. The OCNMS Permit Coordinator should be informed of any communication and agreements between the U.S. Navy and the permittee.

12. The permittee will notify the U.S. Coast Guard D11 and D13 Waterways Management Branch of deployment locations and determine whether it is necessary to place a notice in the "Local Notice to Mariners". The Permit Coordinator (see General Terms and Conditions #1), will be informed when this communication has occurred and informed of the determination, and provided with a copy of the "Local Notice to Mariners", if one is issued.

13. The permittee may be required to pay any or all expenses associated with the locating of and/or removal by NOAA or its designee of any equipment that is not recovered by the permittee, including equipment associated with possible whale entanglement issues requiring a federal response.

14. In the unlikely event of an injury or mortality of a marine mammal due to this project, please immediately contact our regional stranding coordinators, Kristin Wilkinson (Washington and Oregon) at (206) 526-4747) or Justin Viezbicke (California), at (562) 980-3230.

15. Any scientific publications and/or reports resulting from activities conducted under the authority of this permit shall identify that the activity was conducted under National Marine Sanctuary Permit MULTI-2022-008. Copies of / links to any publications resulting from work conducted under this permit shall be submitted to Sean.Hastings@noaa.gov. Additionally, the permittee is required to acknowledge during any media coverage (press releases, video/photo, social media, or other means) activities occurred within the sanctuary and under MULTI-2022-008.

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 individual:

   Sean Hastings
   Permit Coordinator
   Channel Islands National Marine Sanctuary
   University of California, Bldg 514, MC 6155
   Santa Barbara, California 93106
   Sean.Hastings@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 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 conjunction 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 Part 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 MULTI-2022-008 and be sent to the ONMS official 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 ONMS, 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 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.

CANTWELL.KASEY.LYNN.1459817855 Digitally signed by CANTWELL.KASEY.LYNN.1459817855 Date: 2023.03.21 16:27:42 -04'00'

21 March 2023

Kasey Cantwell
NOAA Ocean Exploration

Date

Chris Mobley

20 March 2023

Chris Mobley
Superintendent
Channel Islands National Marine Sanctuary

Date