OCEAN EXPLORATION COOPERATIVE INSTITUTE

oeci

EXPLORING THE NATION'S BLUE FRONTIER

Impact Report

YEAR FIVE

July 1, 2023 - June 30, 2024

OCEAN EXPLORATION

Table of Contents

Acronym List

ADCP - Acoustic Doppler Current Profiles

AUV - Autonomous Underwater Vehicle

B2OE - Bridge to Ocean Exploration

CCRI - Community College of Rhode Island

CTD - Conductivity, Temperature, Depth

DAP - Deep Autonomous Profiler

DWH - Deep Water Horizon

EWG - OECI's Education Working Group

ISC - Inner Space Center

JSU - Jackson State University

MDBC - Mesophotic Deep Benthic Communities

mROV - Medium ROV

NASA - National Aeronautics and Space Administration

NOAA - National Oceanic and Atmospheric Administration

NMSAS - National Marine Sanctuary of American Samoa

OECI - Ocean Exploration Cooperative Institute

OET - Ocean Exploration Trust

PIHMNM - Pacific Islands Heritage Marine National Monument

PMNM - Papahānaumokuākea Marine National Monument

ROV - Remotely Operated Vehicle

RUMI - Real-time Underwater Modeling and Imaging

SAS - Synthetic Aperture Sonar

TU - Tuskegee University

UNH - University of New Hampshire

URI - University of Rhode Island

URI - GSO - University of Rhode Island - Graduate School of Oceanography

U.S. EEZ - United States Exclusive Economic Zone

USM - University of Southern Mississippi

USV - Uncrewed Surface Vehicle

WHOI - Woods Hole Oceanographic Institute

Photo Credit: Ocean Exploration Trust (OET)

Ocean Exploration Cooperative Institute

OECI is an integrated ocean exploration program that leverages the unique, world-class knowledge and expertise of its affiliates—OET, UNH, URI-GSO, USM and WHOI —and NOAA Ocean Exploration.

Our mission is to explore the three billion acres of underwater territory of the U.S. Exclusive Economic Zone. OECI investigates the nation's submerged resources, develops and deploys new exploration technologies, and inspires and prepares the next generation of blue economy professionals.

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WOODS HOLE OCEANOGRAPHIC INSTITUTION · University of New Hampshire · THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Note From The Executive Director: Dr. Adam Soule

The famed *Challenger* Expedition (1872-1876) was the inaugural expedition of modern oceanography. At the time, it was the most scientifically productive expedition ever undertaken and by the measure of how much it increased our knowledge of the oceans, will likely never be matched within the same time frame. Over a period of five years, this expedition circumnavigated the globe, measured the deepest part of the ocean (Challenger Deep in the Mariana Trench), and cataloged over 4,000 new species. Equally as important, the *Challenger* Expedition pioneered many new technologies and applied them to ocean exploration, including new tools to dredge the deep ocean, winches to lower equipment, devices for sampling seawater, and lines to measure depths greater than had previously been attempted.

The Ocean Exploration Cooperative Institute - or OECI - has now completed its first five years. Although the scientific bar set by the *Challenger* Expedition over the same duration is extremely high, I feel that the we have done an outstanding job to advance ocean exploration with the same commitment by venturing into previously unknown areas of the ocean, pushing the boundaries of technology, and communicating those results as broadly and deeply as possible. Much like the *Challenger* Expedition, OECI's initial work has been characterized by steady progress exploring unknown regions coupled with rapidly advancing technologies that make exploration activities more efficient.

In the early years, OECI acquired new technologies, such as the UNH *DriX* USV. With time, this vehicle was augmented for deep-water exploration through academic-commercial partnerships and combined with other advancing robotic vehicles like WHOI's *Mesobot* AUV for cooperative robotic exploration. OECI advanced this robotic team working in tandem from concept to testing and has now been operationalized for from-ship and from-shore routine operations. These vehicles and other OECI technologies now routinely supplement exploration operations from OET E/V *Nautilus*, which over the first five years of OECI has enabled: mapping over 530,000km^2 of seafloor in the U.S. EEZ (greater than the size of California) and over 300 deployments of uncrewed systems for ocean exploration. In contrast to the *Challenger* Expedition that was conducted by a select few, telepresence supported by the URI ISC has enabled livestreams of OECI exploration, which have been viewed a staggering 5,000,000 times to date.

By connecting OECI exploration to the research community, public, and federal stakeholders, we seek to encourage the broadest possible use of exploration data. This results not only in greater discovery of new species, geological processes, and ecosystem functions through live connections to scientists ashore, but it also recognizes that exploration is best achieved by a broad, interdisciplinary team. To that end, OECI has sought meaningful training and engagement with future explorers. One form of this engagement is OET's active partnerships with local communities of the waters we explore. This includes communicating with students in local languages, inviting participation of local scientists and educators, and conducting ship tours in ports of call for local communities. Likewise, B2OE at USM has made connections with regional partners TU and JSU for in-depth training of future explorers at each of OECI affiliates. Lastly, the URI B2OE experiential learning program with CCRI seeks to use ocean exploration to launch students into Blue Economy careers.

As OECI turns the page to its next five years, we seek to further accelerate our progress in close collaboration with NOAA Ocean Exploration. The same provocation that led to the *Challenger* Expedition remains to this day – a great and unknown ocean. OECI will continue exploring the nation's Blue Frontier with rigor, seeking to enhance, improve, and advance our technologies and skills.

Photo Credit: University of Illinois Urbana-Champaign

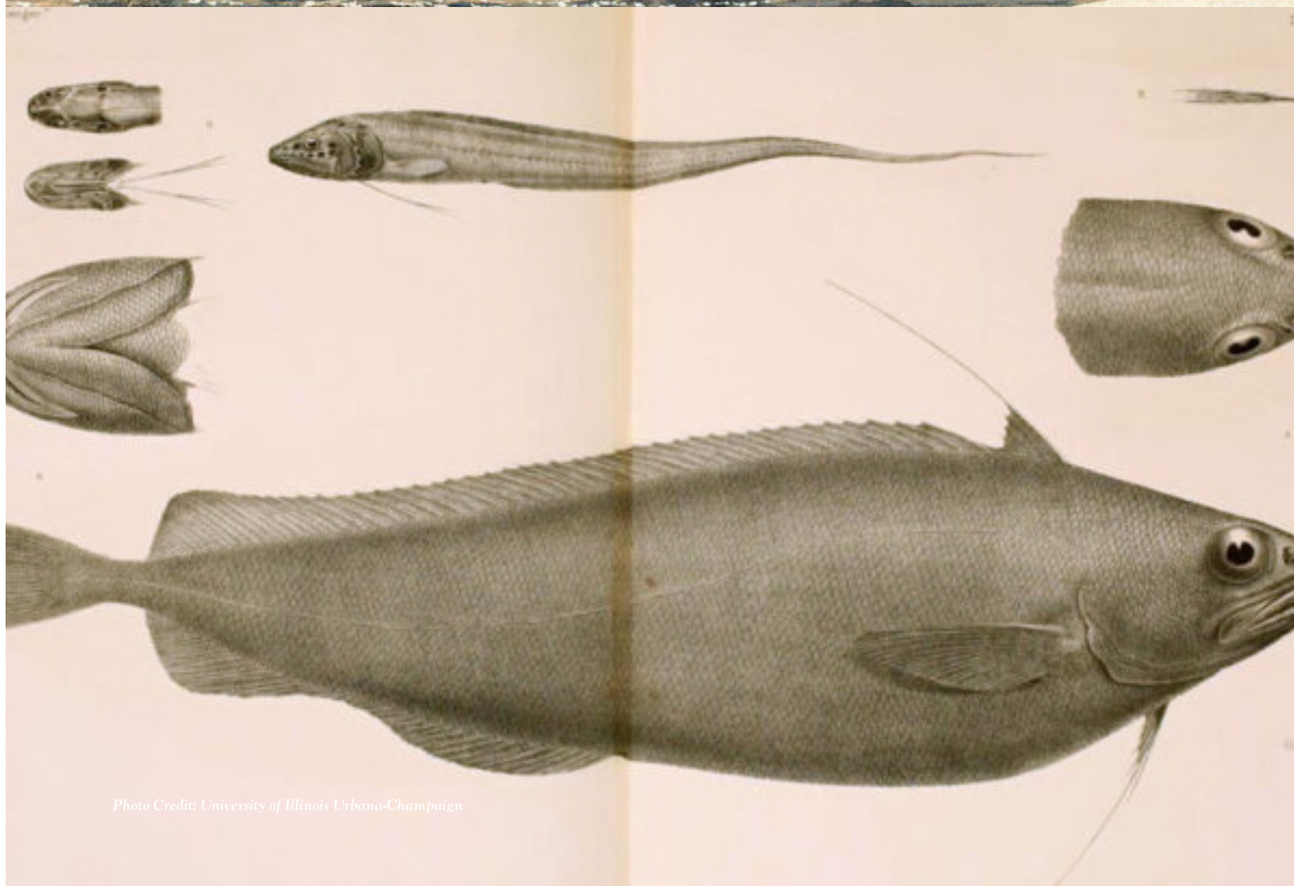


Photo Credit: University of Illinois Urbana-Champaign

EXPEDITIONS

Planning & Partnerships

Expeditions would not be possible without extensive planning and collaboration from NOAA Ocean Exploration and all OECI-affiliate institutions. We also appreciate the support of our partners across NOAA, in industry, academic institutions outside of the OECI, philanthropic institutions, and government agencies with missions aligned with OECI. Lastly, we are grateful for the ocean exploration community that provides scientific support for OECI expeditions.

All Photo Credits: OET

Photo Credit: OET

Deep Sea Biodiversity & Ancient Seamount Exploration Near Johnston Atoll

NA153

August 2 - 29, 2023

Seamounts near Johnston Atoll in the PIHMNM were investigated through nine ROV dives. Observations of varied seamount lava morphologies potentially challenge the existing models for how volcanic seamounts are constructed. Biological samples collected during ROV dives represented hundreds of species, including 14 species that were previously undiscovered or new to this geographical region.

Photo Credit: OET

Ala ʻAumoana Kai Uli - ROV exploration of the Papahānaumokuākea Marine National Monument

NA154

September 1 - 28, 2023

Prior to this expedition, the northwestern corner of the PMNM was the least explored area within the monument. Through mapping and ROV dives, cultural and natural resources were observed, including three aircraft carriers from the Battle of Midway. The visit to these historically significant artifacts (over 43 hours at depths below 5,000 m) was supported via telepresence with maritime historians, delegates from the Japanese Embassy, and NOAA Scientists.

Photo Credit: Nova West

Ocean Exploration Cooperative Institute Multi-Vehicle Exploration

NA155

October 1 - 19, 2023

The third annual multi-vehicle expedition explored the Geologist Seamounts, south of the Hawaiian Islands, with 425 hours of multi-vehicle operations. *DriX, Mesobot,* and the DAP operated simultaneously to investigate previously unexplored areas of the seafloor and the poorly characterized mid-water. Learn more about the technology and operational advancements of this expedition in the NA155 feature article (page 12).

Photo Credit: Nova West

Hawai'i Crescent Mapping

NA157

November 7 - 17, 2023

On this telepresence enabled expedition, the E/V *Nautilus* mapped bathymetry and backscatter at abyssal depths around the Geologist Seamounts. The mapping was augmented by the DAP which was used to observe the seafloor and to collect water and eDNA samples. The E/V *Nautilus* also conducted its first seabird survey during this expedition. The survey aimed to observe the density and abundance of seabirds offshore with 76 hours of observation and 22 species of birds documented.

LOOKING AHEAD: YEAR 6 EXPEDITIONS IN 2024

What's Next

The E/V *Nautilus* embarks on an ambitious Pacific Ocean exploration in 2024, utilizing cutting-edge technology to investigate deep-sea habitats. The vessel will then conduct two expeditions in American Samoa deploying a suite of autonomous vehicles. Finally, the *Nautilus* will support U.S. Government initiatives in Palau by undertaking three expeditions with ROVs and other technologies.

Community Engagement

Photo Credit: OET

Mapping

Photo Credit: Nova West

DAP Deployment

Photo Credit: Nova West

Physical Samples

Photo Credit: Valerie Finlayson

TECHNOLOGY AND OPERATIONS

Photo Credit: Pablo Sobron

From Concept to Operations: Science-Driven Multi-Vehicle Expeditions

Over the past three years, OECI has conducted multi-vehicle technology challenges onboard the E/V *Nautilus* in order to advance the capacity of ocean exploration. These expeditions have focused on testing and expanding operational capabilities, troubleshooting the simultaneous deployment of two or more vehicles working towards independent and/or cooperative goals, and determining how to best target unexplored areas of the ocean such as the mid-water. These tech challenge expeditions have enabled OECI to move from concept to operation of effective and efficient multi-vehicle missions. Now, OECI has the understanding and established experience to conduct science-driven, cooperative multi-vehicle missions.

The latest tech challenge expedition builds on two previous, successful multi-vehicle missions. On NA155, UNH's *DriX*, WHOI's *Mesobot*, and URI's DAP were deployed simultaneously. With the addition of Starlink onboard the *DriX*, over-the-horizon, autonomous operations were possible, with *DriX* ranging 37 km away from the E/V *Nautilus*. Starlink also enabled communication through *DriX* to *Mesobot* (while subsea), allowing the development of a new mid-water sampling method: Verified Directed Sampling. In real time, *DriX* would autonomously collect sonar data from the surface and guide Mesobot to the best eDNA sampling location in the mid-water. Meanwhile, OET's E/V *Nautilus* was 37 km away conducting seafloor mapping operations, independent of the two robotic systems working on mid-water exploration.

The tech challenge expeditions have been integral to expanding OECI's operational capabilities. With continued investment by NOAA Ocean Exploration, OECI has been able to go from concept and demonstration, to rudimentary data collection, and now, initial operating capability. 2024 will be the fourth iteration of the tech challenge and will be completely driven by science. Vehicle constraints are no longer the limiting factor, sampling needs and location constraints are what drive mission planning.

The future of the tech challenge expeditions will involve behind-the-scenes work to make this operational model broadly available for NOAA Ocean Exploration and any other interested parties through standard software and telecommunications developments.

From Space to Subsea: Non-destructive Chemical Analysis of the Seafloor

The seafloor is vast and mostly unexplored. The typical method of collecting samples for chemical analyses requires removing specimens (rock or biological) from the seafloor with ROVs for detailed laboratory analysis. With OECI support, Impossible Sensing adapted a piece of analytical equipment originally designed for space exploration to conduct *in situ* chemical analyses on the seafloor. The Raman and fluorescence laser spectrometer, which is capable of measuring crystalline materials, biological molecules, and dissolved ions, was developed by Impossible Sensing through NASA funding and was tested during NA149.

The laser spectrometer was mounted on the ROV *Hercules* and deployed from E/V *Nautilus* near Kingman Reef and Palmyra Atoll in the South Pacific. The benefits of *in situ* analysis are clear. With the ROV-mounted laser spectrometer, samples on the seafloor were not disturbed, and thanks to an innovative design feature, samples could be analyzed at distances up to five meters. This effort represented the first subsea deployment of the instrument on a mobile platform and enabled survey-like measurements across areas of interest. The system experienced growing pains, as any new technology does, but the excellent on-board engineering team from Impossible Sensing, supported by shoreside engineers, was able to work through the challenges. The data do not yet replace traditional methods of sampling, but they represent an important step towards non-invasive chemical analysis. In addition, the deployments found new measurements of interest that the system is capable of including: direct and continuous measurement of sulfate in the water column during ROV descent and ascent.

It is through collaboration with private and government entities that OECI continues to advance ocean exploration and push the boundaries of new and existing technologies' operational capabilities.

Looking Ahead: Deeper Exploration with the DAP and the Hadal Profiler

The challenge of exploring the ocean only increases with depth. Thus, the abyssal (3,000 - 6,500 m) and hadal (> 6,000 m) regions are characterized by very few observations. OECI is committed to advancing technologies that can reach those depths - and withstand the extreme hydrostatic pressures - as they represent unique and important realms of the ocean (e.g., trenches). In year six of OECI activities, we will deploy two vehicle systems that will provide important glimpses into the abyss. These are the autonomous Hadal Profiler developed by the University of Hawaii at Manoa and the DAP developed by URI - GSO. Each system is capable of reaching full ocean depth (11,000 m) and can make complementary observations and collect samples along the way. These technologies will provide new insight into largely unknown deep ocean processes, including carbon flux and storage.

Photo Credit: OET

DATA

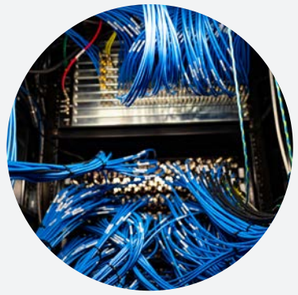


Photo Credit: Nova West

Data Accessibility and Visualization with RUMI

The RUMI project brings ROV data to life in an open-world video game format. This innovative data visualization tool provides a new pathway for anyone outside of the ocean exploration realm to interact with the seafloor. The RUMI team processes and incorporates data generated by OET's new Widefield Camera Array to create the 3D game environment. The goal of the project is to develop an automated data processing pipeline that integrates ROV sensors, bathymetry, video and still images into an interactive and explorable 3D environment. Currently, high-resolution models of landscape-scale reef features are explorable via an ROV *Hercules* simulator, and bathymetry data are integrated into a fully georeferenced virtual world.

RUMI is already a robust tool, but there is still more to be done. The team will remain busy as they further refine elements of data workflow and quality. According to project lead Jonathan Fiely, "these are the fun parts - tackling integration of video streams, species ID annotations, SeaLog and a phylogenetic tree taxonomic discovery widget that helps visualize encountered biodiversity across different dives." Fiely could not accomplish this without his team, which includes B2OE student alum Nathan Lannon. Lannon has contributed greatly to the RUMI project by leading efforts to establish a programmatic framework for how RUMI displays data in Unreal Engine.

The potential for RUMI to give students, the public, or anyone interested a first person perspective, as if they are the ROV on the seafloor collecting the data, is an extremely unique and powerful tool. It is through experiences like these that we can create a connection between people and the ocean in hopes that all people become engaged and interested in ocean exploration.

Data that Make a Difference: Carbon Sequestration

The Carbon Sequestration project's first expedition, led by Dr. Chris Hayes at USM, took place in early April 2024 with five days at sea off the coast of Mississippi. The project investigated carbon flux with depth in muddy shelf margins. These areas are home to mesophotic reefs which rely on sinking carbon as a food source. Hayes set out on the R/V *Point Sur* from Gulfport, MS, with a team of USM graduate students to collect water samples at various depths using McLane large volume water sampling pumps.

The team collected samples at three separate locations - one test location and two suspected mesophotic reef locations. The reef locations correlate with salt domes or carbonate mounds which provide enough elevation to keep the reef in a clean, or less muddy, environment. The team deployed three McLane pumps for the first time, which collect ~200 L of water per hour of pumping. Preliminary observations indicated that sites further from the shelf are influenced by sediment transport from the slope break on the shelf margin.

The ocean represents a critical sink for excess heat and carbon in the atmosphere, but the fate of carbon once it passes through shallow waters is not well known. Carbon transport and sequestration in the deep ocean is viewed as a potential climate mitigation solution. OECI, through projects like this, is helping to define the baseline conditions and capacities of deep carbon transport and sequestration. Carbon is a food source in deeper waters and thus an important component of the health and stability of deep-sea ecosystems.

Looking Ahead: The Future of Cloudmap

UNH's Cloudmap project has investigated how multibeam bathymetry might take advantage of cloud computing to more efficiently and effectively convert ocean data into ready-to-use ocean intelligence. After three years of development, Cloudmap is ready for real-world testing. This innovative project enables the transfer of raw (unprocessed) multibeam bathymetry data to cloud storage and utilizes computation-on-demand, allowing multiple users to simultaneously edit multibeam datasets. These tools not only lead to more efficient and collaborative mapping data processing, but also enable up- and down-scaling of computational infrastructure for data processing that was not previously possible. Furthermore, the team has pioneered the ability to process these data in virtual reality, potentially providing a more intuitive environment for working with three-dimensional information.

Photo Credit: Holly P

EDUCATION AND ENGAGEMENT

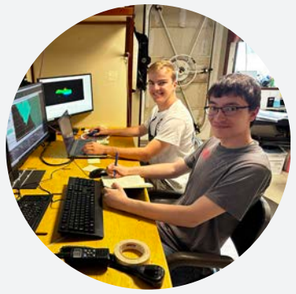


Photo Credit: NOAA

On the 'Other Side' of Bridge to Ocean Exploration

As URI's B2OE program grows, so does its impact. Each year the program has reached more students (four students in the 2022 cohort, five in the 2023 cohort, and nine in 2024 cohort), and each year the B2OE alumni are exposed to more Blue Economy opportunities.

Tim Melendez, Nathan Lannon, and Gabriella Torres (2024 B2OE alums) have all transitioned from the B2OE experiential learning program to summer internship positions. In addition to continuing his work in the URI Davies' Lander Lab, Melendez participated in an OECI expedition in the Gulf of Maine aboard the R/V *Connecticut* to support baseline mapping and habitat data collection for critical offshore wind lease decisions. Melendez was exposed to seafloor mapping, life at sea, and new potential career paths. Lannon has continued his work on the RUMI project this summer and will soon transition to another internship with an ocean robotics company. Lannon credits his B2OE experience for helping him secure the robotics internship. Torres pursued a media project documenting and promoting the B2OE experience in collaboration with the ISC at URI.

Regardless of the career path these students take, the skills they learned during B2OE and Blue Economy internships will contribute to making them valuable members of the workforce.

SeaPerch

Staff members from NOAA Ocean Exploration and OECI attended RoboNation's International SeaPerch Challenge competition held at the University of Maryland in May 2024. The SeaPerch competition brings together groups of middle school and high school students that team up locally to build a small ROV from a kit. NOAA Ocean Exploration and OECI were both title sponsors of the event and provided grounding for the competitors in the real-world application of ROVs.

Over two days, 174 teams from across the globe competed and gained insight into deep-sea exploration through the Challenge Course modeled after real-world OECI exploration. Teams deployed their ROVs in an olympic-sized pool and collected gas samples from a 'seafloor' vent , deposited rock samples into a sample elevator, and collected temperature data among other tasks. During pool-side judging, the NOAA Ocean Exploration and OECI team witnessed extreme ingenuity, perseverance, and high spirits from all of the participating students. After the competition, teams had the opportunity to engage with ROV pilots onboard the E/V *Nautilus* in a telepresence Q&A session.

SeaPerch is an excellent venue to amplify Blue Economy career opportunities to excited and creative members of the future workforce.

B2OE at USM

USM's internship program is in its fourth year! This program, based at USM's Marine Education Center, aims to increase awareness of Blue Economy career paths in marine and ocean sciences. The program has grown to include regional partners JSU along with TU and hosted ten interns from early June to mid August 2024.

This summer, students worked on a range of research projects focused on aquaculture, wetland investigation, microplastics, and sensor integration on uncrewed surface vessels. The internship culminated in a symposium where the students presented their research and findings to mentors, peers, members of OECI, and faculty from USM, JSU, and TU.

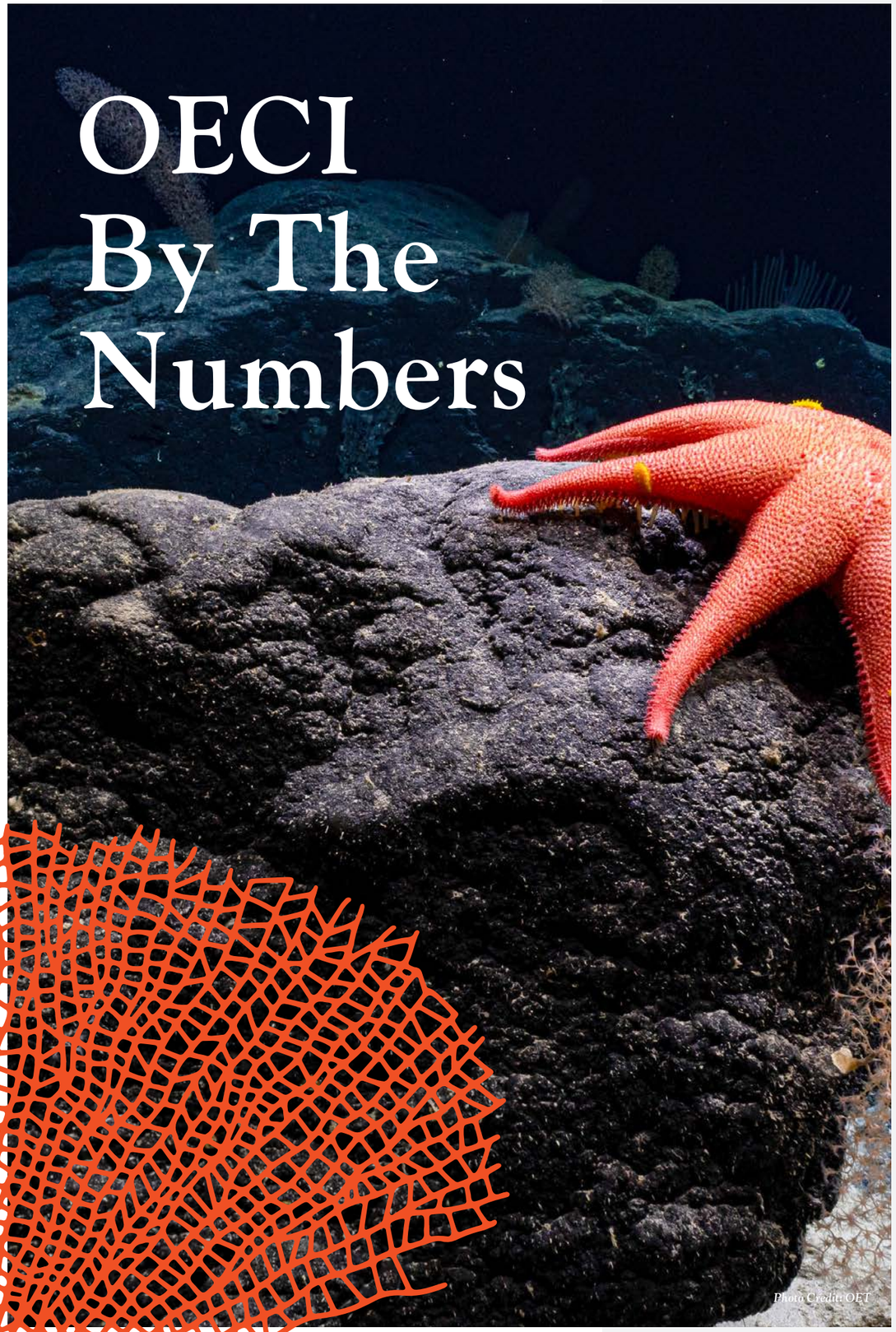
Pacific Island Community Engagement

The Pacific Island Community Engagement project, led by OET, continues efforts to establish partnerships in American Samoa and Palau by co-designing and co-developing expeditions in fall 2024 that address federal priorities and are locally relevant. In March, the project team organized a visit to American Samoa to meet with partners and deepen relationships. During the visit, the project team and the NMSAS co-hosted a workshop to convene community members, educators, and agency representatives for their input about how the science, education, and outreach capabilities of E/V *Nautilus* and other OECI technologies may be applied to best address community needs. Beyond the workshop, the OET team met with additional stakeholders, including briefing Governor Lemanu Peleti Mauga on the upcoming expeditions and meeting with Fata Brian Kaio, Samoa Consul General. A highlight of the week was the participation of a delegation from Palau International Coral Reef Center, advancing collaboration of the teams within the sister sanctuaries of Palau National Marine Sanctuary and NMSAS. Engaging with the regional and local partners, including active involvement in expeditions, leads to better outcomes that are relevant to the stakeholders and see greater uptake into policy and management decisions.

Looking ahead: Outreach Accelerator

OECI EWG Outreach Accelerator project will focus on expanding OECI's presence at education-focused conferences in 2025. Attending conferences, such as the North American Association for Environmental Education, National Marine Educators Association, and SeaPerch to name a few, will allow EWG members to more broadly share marine educational resources with educators through conference participation and the development of a mobile booth display.

Photo Credit: Jesse Kastler



OECI By The Numbers

The table below represents OECI Year 5 activities and all OECI efforts up to 06/30/24.

	OECI Year 5	OECI Cumulative Years 1-5
Expeditions Completed	9	50
Days at Sea	149	807
Seafloor Mapped (km^2)	129,155	544,831
Unmanned Systems Deployments	75	345
Hours of Subsurface Video	623	2,800
Subsurface Images	72,472	451,679
Technology Transitions	6	47
Samples Collected	818	4,284
Students Supported	43	213
K-12 Students Reached	19,773	64,912
Members of the Public Reached (in-person)	1,920	5,986
Media Stories	1,680	3,112
Live Stream Views	557,810	5,258,065
Video Highlight Views	2,292,721	8,926,751

OECI MESOPHOTIC AND DEEP BENTHIC COMMUNITIES RESTORATION PROJECTS

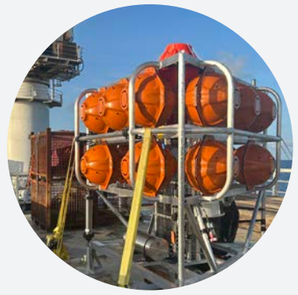


Photo Credit: Andrew Davies

MDBC Background

Mesophotic and deep benthic habitats, seafloor areas that see little to no sunlight, faced an unprecedented threat to the continental shelf and slope from Texas to Florida when the *Deep Water Horizon (DWH)* oil spill released approximately 134 million gallons of oil over an 87-day span in 2010. In 2019, the *DWH* Trustees for the Open Ocean Restoration Area selected four Mesophotic and Deep Benthic Communities (MDBC) restoration projects—focused on mapping and habitat modeling, coral propagation, habitat assessment, and active management - to be implemented in the region.

Led by NOAA and the Department of Interior, the MDBC projects bring together federal, academic, and nonprofit partners to help restore these habitats. OECI and affiliates at USM, WHOI, and URI collaborate with the MDBC team–from deploying AUVs to collect high resolution bathymetric data to conducting at-sea telepresence broadcasts to share this restoration work with people in the region and around the world.

Habitat Characterization to Support Restoration, Management, and Protection

In situ environmental data, such as CTD, ADCP, and turbidity data, are critical to guide and evaluate restoration efforts for the mesophotic and deep benthic communities injured by the *DWH* oil spill. Benthic landers, designed and deployed by URI marine biologist Dr. Andrew Davies, are uniquely equipped to collect these various types of data in harsh, deep-sea environments for years at a time. The data collected by the landers arm MDBC scientists with the environmental variables that define the ecological niches for species of interest. Davies' team built and deployed two new landers, *Optimus and Bender*, in March and April 2024. These landers will be recovered in 2025.

To complement the long-term data collected by the URI landers, USM designed "Mesolanders," which are named for their size, that collect data over shorter periods of time, approximately 5 - 25 days depending on project objectives. Within the past year, USM engineers designed and constructed two Mesolanders that will be deployed during the next expedition season.

Physical sediment samples help complete the environmental picture, constraining spatial and temporal extents of natural events and those induced by humans. USM has led the effort to collect soft-sediment samples around the *DWH*-affected area. Two expeditions onboard the R/V *Point Sur* collected sediment cores, which will be used to characterize soft-sediment communities. These samples help characterize functional ecosystem components spanning trophic levels, provide data on the ecological health of impacted and reference areas, and identify indicator taxa and communities to assist with monitoring benthic habitats and their recovery trajectories.

Coral Propagation and Technology

OECI activities led by URI's Dr. Carlos Prada and Dr. Brennan Phillips are investigating the biology of mesophotic corals and developing ROV technology, including a carousel-based UV cure system, to support mesophotic coral propagation. This work is filling knowledge gaps related to coral species most affected by the *DWH* disaster, including *Muricea pendula, Swiftia exserta,* and *Thesea nivea*. The team is developing and testing techniques to restore octocoral populations using naturally occurring coral recruitment and coral colony propagation using fragmentation techniques.

During one MDBC expedition on the M/V *Island Intervention* this past year, the team successfully deployed 139 coral fragments, using both an ROV and saturation divers from the U.S. Navy Experimental Diving Unit. Combined with the efforts from previous missions, the team has now transplanted a total of 330 coral fragments, with divers performing *in situ* fragmentation and ex situ fragmentation performed using ROVs (that is, bringing source colonies to the ship, fragmenting them on the ship, and returning the fragments to the seafloor). The team also tested effects across the three heavily affected species of different restoration methodologies, testing coral fragment sizes (< 7 cm and > 10 cm), glue types, and habitat effects (hard vs. soft sediments).

High Precision AUV Mapping

Restoration activities require detailed knowledge of the seabed including its shape, substrate type, and suitability for habitation. Although these characteristics may be known at a broad scale, OECI activities supporting the MDBC projects have focused on producing data with AUVs that bring the seafloor into much finer focus.

WHOI's REMUS 600 AUV

WHOI's REMUS 600 AUV participated in two expedition legs aboard NOAA Ship *Pisces*, collecting mapping and ground-truthing data within the MDBC restoration area. These data provide fundamental information to validate predictive habitat models, prioritize and support protection, and management activities and target locations for direct restoration. The vehicle was equipped to collect high resolution bathymetric data and imagery using SAS and a laser line scanning and imaging system capable of collecting micro-bathymetry to identify attached biota on substrates. This enabled the project team to discover an area of the seafloor colonized by corals where a model previously predicted a low probability of coral colonization, improving both direct observations of MDBC habitats and predictive modeling capabilities.

USM's AUV Eagle Ray

USM's *Eagle Ray* was utilized on expeditions aboard the R/V *Point Sur* expedition that took place in May of 2024 to collect high resolution multibeam bathymetry and backscatter of *DWH* wreck site. AUV *Eagle Ray* surveyed the area around the wreck and the wellhead ten years post-*DWH*.

Looking Ahead: Medium Science-Class ROV Build

As MDBC restoration projects advance, ready access to ROVs is imperative for development of coral propagation techniques, ground-truthing of habitat maps and validation of predictive habitat models, deployment and recovery of seafloor instrumentation, and characterization and long-term monitoring of undisturbed, injured, and recovering ecosystems. To that end, OECI is collaborating with the MDBC restoration teams on the construction of a new mROV aimed at supporting MDBC objectives. The new vehicle represents a cross-OECI effort with design and construction led by WHOI, operations led by USM, and management led by URI. The vehicle build is also being supported by NOAA Ocean Exploration who recognizes the community need for greater ROV access. The software powering the ROV is developed by GreensealQ and will enable a new generation of modularity with simplified equipment and sensor integration for science ROVs as well as support for remote operations of the mROV that will enable smaller and more nimble operations teams as the vehicle is deployed from a range of ships and research vessels.

Photo Credit: Carlos Prada

MDBC Activities Supported By OECI

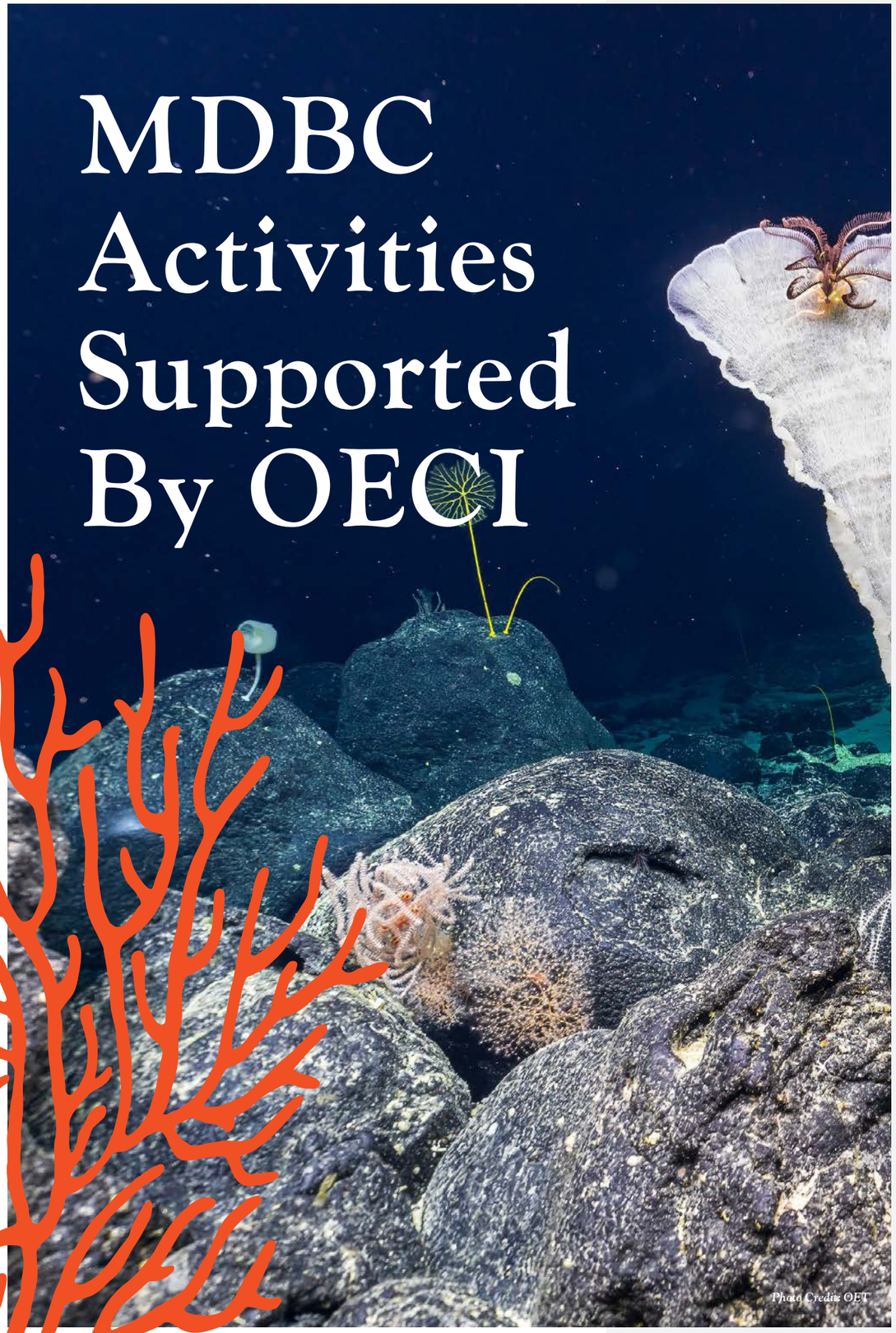


Photo Credit: OET

The table below represents OECI Year 5 activities and all OECI efforts up to 06/30/24.

	Year 5 Totals	OECI Cumulative Years 1-5
Expeditions Completed	13	19
Days at Sea	102	205
Area Mapped (km²)	170	230
UsX Dives	64	123
Hours of Unmanned Systems Deployments	484	3,018
Subsurface Images	1,500	1,500
Samples Collected	1,117	1,979
Interns Supported	4	7
Ship-to-Shore Interactions	36	36
Live Stream Views	2,627	2,627
Video Highlight Views	2,624	2,624

Photo Credit: Nova West

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EXPLORING THE NATION'S BLUE FRONTIER

NOAA OCEAN EXPLORATION