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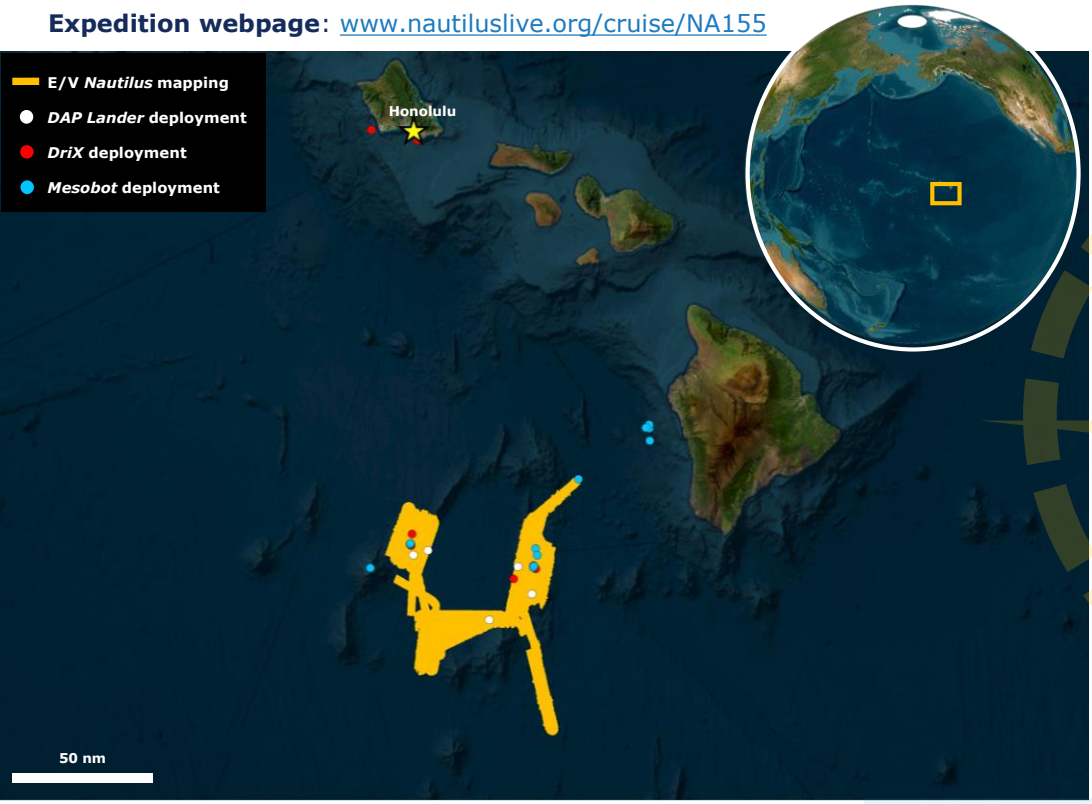
EXPLORING THE NATION'S BLUE FRONTIER

OCEAN EXPLORATION COOPERATIVE INSTITUTE MULTI-VEHICLE EXPLORATION (NA155)

October 1– 19, 2023

Geographic Focus: Geologists Seamounts, south of the Main Hawaiian Islands
Main Operations: Deployments of *DriX*, *Mesobot*, and *Deep Autonomous Profiler (DAP) Lander*
Sponsor: NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute
Expedition webpage: www.nautiluslive.org/cruise/NA155



18 days at sea
5 *DAP Lander* deployments
10 *DriX* deployments
19 *Mesobot deployments*
425 hours of multi-vehicle explorations
6,195 km^2 of seafloor mapped
248 eDNA samples collected
66 live ship-to-shore interactions
3,139 ship-to-shore participants
>42,500 live stream views
>514,000 highlight video views
>1,2 million social media views

OVERVIEW

On October 1-19, 2023, E/V *Nautilus* conducted the third annual telepresence-enabled expedition focused on integrating multiple emerging exploration technologies from partner institutions of the Ocean Exploration Cooperative Institute (OECI). The expedition combined the complementary exploration capabilities of uncrewed surface vehicle *DriX* from the University of New Hampshire, autonomous underwater vehicle *Mesobot* from Woods Hole Oceanographic Institution, the *Deep Autonomous Profiler Lander* from the University of Rhode Island, alongside E/V *Nautilus*' mapping capabilities. During 18 days at sea, these state-of-the-art technologies were used to explore the seafloor and overlying water column of the Geologists Seamounts, a poorly known group of seamounts located south of the Main Hawaiian Islands. A total of 32 scientists, engineers and educators representing 7 different institutions sailed on the expedition, and were supported by 18 professionals that participated remotely via telepresence technology.

MULTI-VEHICLE SUMMARY

The expedition included multi-vehicle explorations during a combined 425 hours at sea, including several periods when *DriX*, *Mesobot*, and the *Deep Autonomous Profiler Lander* were all simultaneously deployed, while E/V *Nautilus* was conducting independent seafloor mapping operations for up to 37 kilometers away. Guided by fisheries sonar data collected by *DriX*, *Mesobot* was directed into specific portions of the water column and collected targeted visual surveys and sampling operations. Deployments of the *Deep Autonomous Profiler Lander* added visual data on the seafloor down to depths of 4,000 meters, in addition to environmental data throughout the water column on each deployment. Collectively, these multi-vehicle explorations surveyed midwater ecosystems associated with seamounts from the sea surface to the seafloor, gaining important new information on the spatial and temporal dynamics of these largely unstudied ecosystems.

DRIX SUMMARY

The expedition included ten deployments of *DriX* for a combined time of over 188 hours, during which *DriX* mapped over 476 square kilometers of seafloor to depths of 3,000 meters. Additionally, *DriX* collected water column mapping data over a length of 586 kilometers of ocean habitat. This data was used to direct *Mesobot* into specific midwater environments during paired vehicle operations. For this purpose, software was developed that allowed *Mesobot* to automatically follow specific acoustic layers in the water column. Key to the success of the mission were recent *DriX* updates, including its new Starlink satellite internet system, which allowed *DriX* to operate up to 37 kilometers away from E/V *Nautilus*. In addition to freeing up the ship to conduct independent seafloor mapping operations, these updates also allowed *DriX* to be operated remotely by personnel at the University of New Hampshire.

MESOBOT SUMMARY

Mesobot was deployed 19 times over the course of the expedition, often in tandem with *DriX*, during which it surveyed midwater environments for close to 91 hours at depths down to 850 meters. A Wi-Fi connection was established between *Mesobot* and *DriX*, which allowed the vehicles to conduct collaborative operations farther away from E/V *Nautilus*, including one directed sampling mission that was led remotely by scientists ashore at Woods Hole Oceanographic Institution. Using its two new high-resolution video cameras and employing new strategies to decrease avoidance, *Mesobot* recorded more midwater organisms and in more detail than ever before. In addition to collecting high-resolution video, *Mesobot* was equipped with two eDNA multi-samplers and a radiometer that collected continuous environmental data on each deployment.

DEEP AUTONOMOUS PROFILER SUMMARY

The expedition included five deployments of the *Deep Autonomous Profiler Lander* down to 4,000 meters for a combined time of over 73 hours. Continuous video, CTD environmental and passive acoustic data was collected during each deployment, in addition to water samples for the study of eDNA. While technical difficulties limited the number of deployments, each deployment surveyed the entire water column from surface to seafloor, thereby adding important information about the links of benthic and pelagic ecosystems.

ENVIRONMENTAL DNA SAMPLING SUMMARY

A total of 248 eDNA samples were collected during the expedition, including 186 collected using autonomous samplers mounted on *Mesobot,* and 62 samples obtained by filtering water collected by the Niskin bottles mounted on the *Deep Autonomous Profiler Lander*. *Mesobot* eDNA sampling consisted of vertical transects at depths ranging from 20-800 meters, including both daytime and nighttime surveys to characterize differences due to diel vertical migration of midwater organisms. Samples were also collected above, within, and below layers of acoustic backscatter identified on *DriX* and then targeted by *Mesobot*. Samples collected from the *Deep Autonomous Profiler Lander* spanned depths between 20-4,000 meters, thereby providing a complete cross section of midwater ecosystems associated with offshore seamounts.




EDUCATION & OUTREACH

Highlight videos from the expedition were viewed over 514,623 times, and live video feeds garnered another 42,533 views. OET's TikTok account gained over one million views during the expedition, plus posts on Instagram, Twitter, Facebook, and LinkedIn reached over 271,000 impressions. While at sea, the team created 8 new education and outreach products and hosted 66 live ship-to-shore interactions with schools, community events, and professional meetings, reaching over 3,100 people in 19 US states, American Samoa and Canada. Early expedition results were featured in five media stories.

BROADER IMPACTS

Expedition activities were conducted in unexplored areas, thus contributing directly to the U.S. National Strategy for Ocean Mapping, Exploration, and Characterization, Seabed 2030, and the UN Decade of Ocean Science for Sustainable Development. In particular, expedition activities focused on surveying midwater environments, which represent by far the largest and least explored part of our ocean. By combining the complimentary exploration capabilities of *DriX*, *Mesobot*, *Deep Autonomous Profiler Lander* and E/V *Nautilus*, this mission continued to expand the capabilities for multi-vehicle ocean exploration, thereby helping to catalyze the force-multiplier of autonomy. Expedition activities also advanced NOAA priorities particularly those of the NOAA Uncrewed Systems Strategy, NOAA 'Omics Strategic Plan, and NOAA Education Strategic Plan. Finally, the knowledge and data collected on this mission is an essential precursor to future explorations and discoveries, particularly those seeking to advance our knowledge of the largely unstudied midwater environment.

DATA ACCESS

Data collected on this expedition will be sent to repositories for analysis, archiving and public distribution. Data collected by E/V *Nautilus* and *DriX* will be sent to the Marine Geoscience Data System and Rolling Deck to Repository. Data and samples collected by *Mesobot* will be processed and archived at Woods Hole Oceanographic Institution. Data collected by the *Deep Autonomous Profiler Lander* will be submitted to the National Centers for Environmental Information and the Open Portal to Underwater Soundscapes. Highlight images, background information, and educational materials developed during the expedition are available via the expedition website.

ACKNOWLEDGMENTS

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