

# FY2021 Annual NOAA Ocean Exploration Competitive Grants Fiscal Report

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## Introduction

NOAA Ocean Exploration is the only federal program solely dedicated to exploring the global ocean, closing prominent gaps in our basic understanding of U.S. deep waters and the seafloor, and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology and a wide array of funding mechanisms, NOAA Ocean Exploration explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. These mechanisms range from NOAA-operated NOAA Ship *Okeanos Explorer*, competitive grants, investments in cooperative institutes, and collaboration with various federal, state, academic, philanthropic, and private-sector entities.

Through the annual ocean exploration competitive funding opportunity (program authority 33 USC 3403(a)), NOAA Ocean Exploration solicits and funds project proposals that advance ocean exploration, technology, and marine archaeology. These funding opportunities have supported more than 250 lab-based and/or expedition-based projects since its inception in 2001. Throughout the history of the program, NOAA Ocean Exploration's competitive grants program has supported over 90 entities and 167 principal investigators (PIs).

This report highlights NOAA Ocean Exploration's Fiscal Year 2021 (FY21) funding opportunity and provides select summary data for prior funding years (FY17-21) to demonstrate trends.

## Fiscal Year 2021 Year in Review

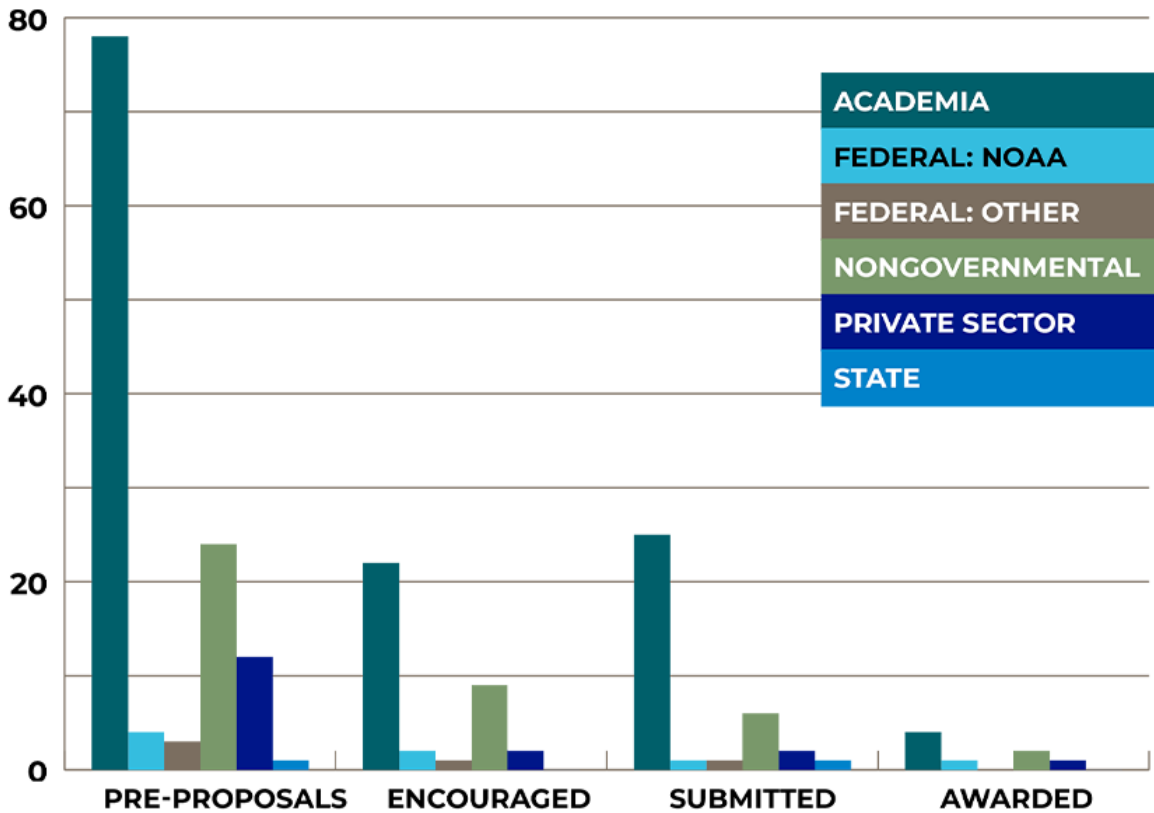
### Overview and Summary Metrics

For the FY21 funding opportunity, NOAA Ocean Exploration priorities included interdisciplinary baseline characterizations of unknown or poorly known deep-ocean areas, processes, and resources; technological innovation or novel application to advance deep-ocean exploration

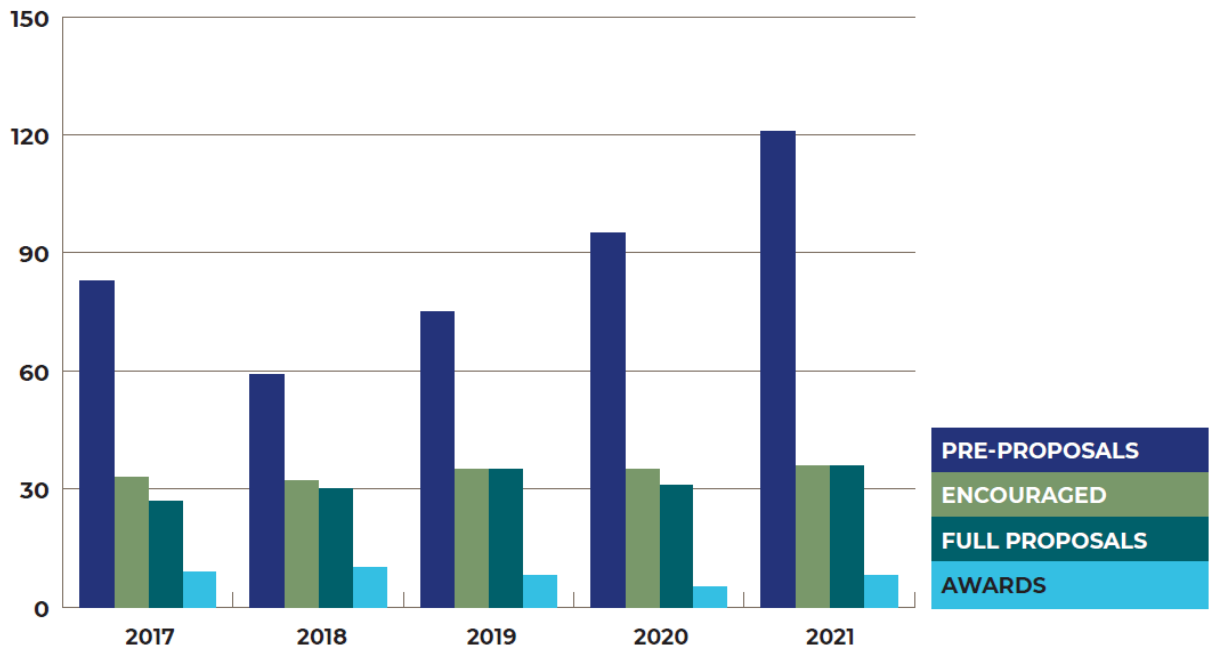
objectives; and discovery and initial characterization of underwater cultural heritage. Further information can be found in funding opportunity number NOAA-OAR-OER-2021-2006431.

In FY21, NOAA Ocean Exploration:

- Received 121 pre-proposals (\$64,034,115), encouraged 36 full proposals (\$17,498,583), received 36 full proposals (\$17,554,775), and recommended 8 proposals for funding (see **Figure 1**), each between \$217,505 and \$746,671, totalling \$3,458,228. The number of pre-proposals received showed an increasing trend in both number of submissions and requested funds for FY17-21 (see **Figure 2**).
- Funded 2 general ocean exploration proposals, 3 technology proposals, and 3 marine archaeology proposals.
- Funded 166 ship/submersible days at sea.
- Funded 8 principal investigators (PIs) from academic (4), federal (1, NOAA), nongovernmental (2), and private sector (1) entities.
- Directly supported 9 graduate and undergraduate students.
- Funded 33 entities across 15 U.S. states and 1 international organization.
- Leveraged almost \$2 million in external support secured by funded PIs as shared costs, in-kind contributions, etc.
- Supported 32 personnel for a cumulative total of 151 personnel months.



**Figure 1.** Distribution of FY21 NOAA Ocean Exploration funding opportunity pre-proposals received, pre-proposals encouraged to submit as full proposals, full proposals received, and proposals awarded funding across different sectors of ocean exploration, including academic, federal (NOAA and other), nongovernmental (e.g., philanthropic), private sector, and state entities.



**Figure 2.** Distribution of NOAA Ocean Exploration funding opportunity pre-proposals received, pre-proposals encouraged to submit as full proposals, full proposals received, and projects awarded funding, FY17-21.

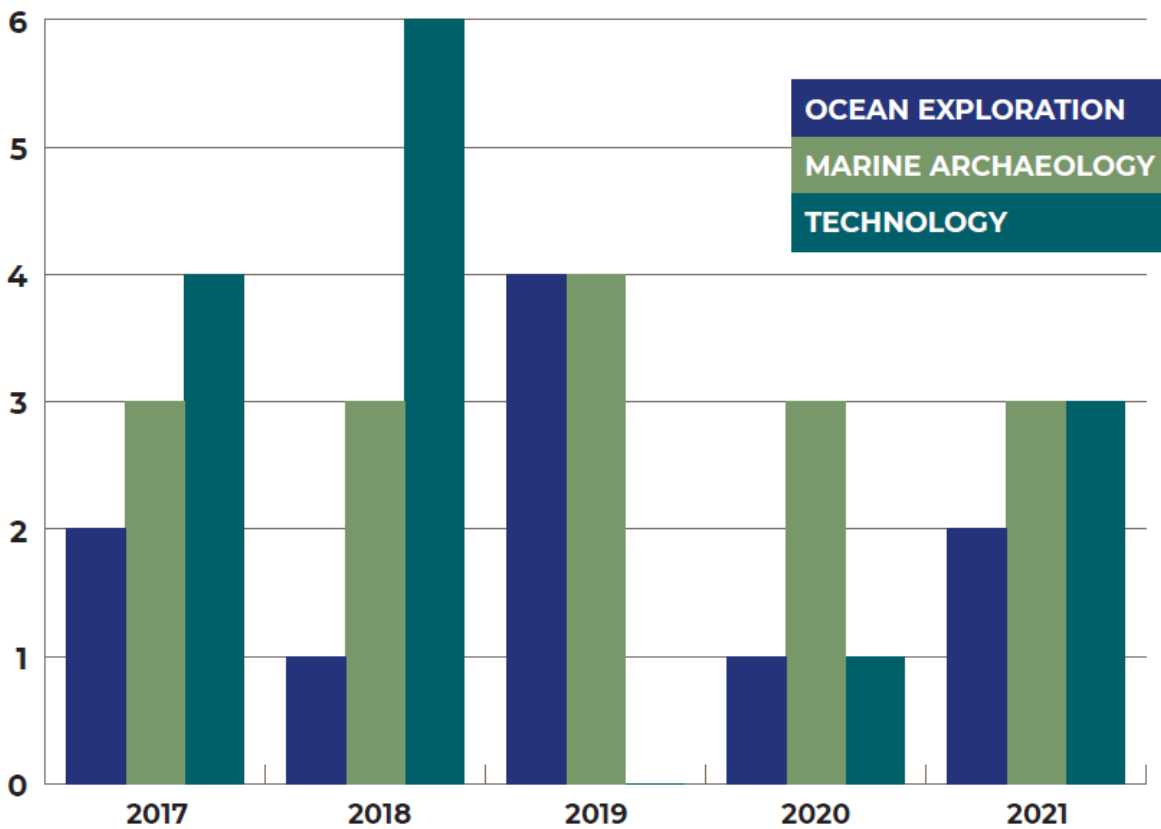
The eight projects funded through the Ocean Exploration Fiscal Year 2021 Funding Opportunity are noted in **Table 1**. More details about each project are in **Appendix A**.

**Table 1.** Funded projects for the Ocean Exploration Fiscal Year 2021 Funding Opportunity (arranged alphabetically by project title).

Project Title	PI, Entity	Theme	Expected Close Out
Accelerating Ocean Exploration Through Cloud-Native Processing of Active Ocean Sonar Data	Wu-Jung Lee, University of Washington	Technology	June 2023
Field Validation of Novel Low-Cost Underwater Robot for Deepwater Exploration and Characterization	Matthew Johnson-Roberson, University of Michigan	Technology	June 2023

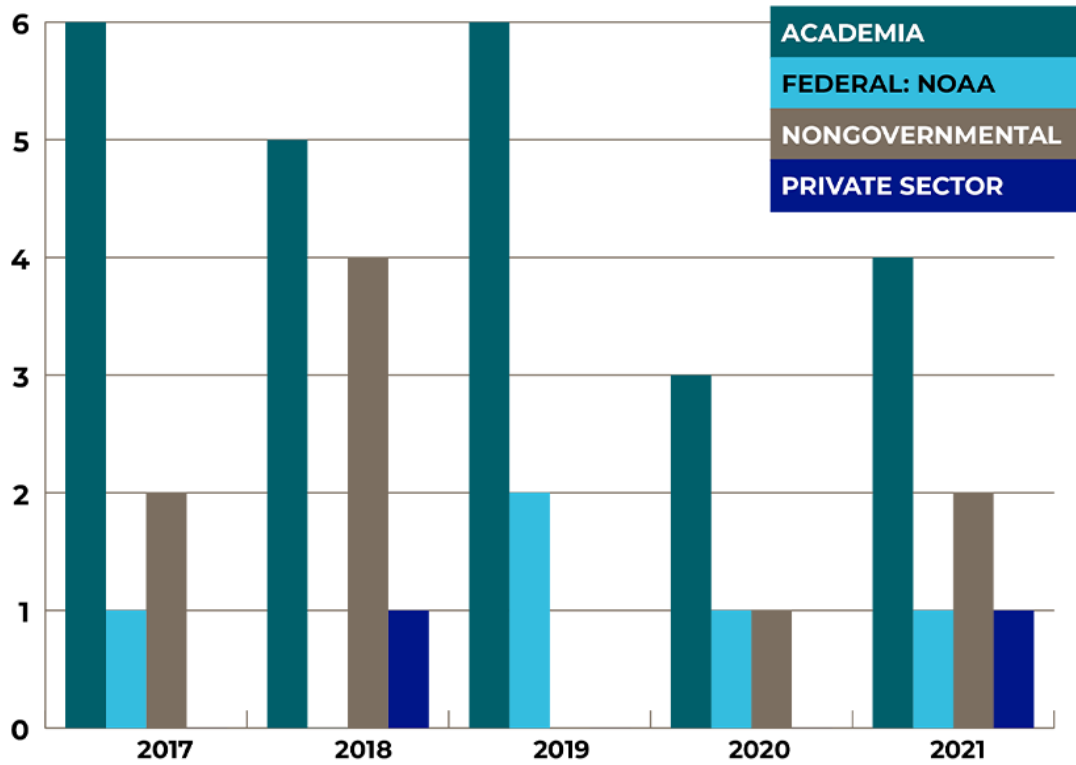
Project Title	PI, Entity	Theme	Expected Close Out
Illuminating Pelagic and Benthic Biodiversity in Deep Waters of Puerto Rico	Andrea Quattrini, Smithsonian Institution National Museum of Natural History	Ocean Exploration	June 2023
Machine Learning for Automated Detection of Shipwreck Sites From Large Area Robotic Surveys	Katharine A. Skinner, University of Michigan	Technology	June 2023
Marine Archaeological Investigation and Mapping of the Paleo-Suwannee River, Eastern Gulf of Mexico	Vincent Lecours, University of Florida	Marine Archaeology	June 2023
Microbial Ecosystem Services on Seamounts Around Papahānaumokuākea Marine National Monument	Beth N. Orcutt, Bigelow Laboratory for Ocean Sciences	Ocean Exploration	June 2023
Multi-Tiered Autonomous Vehicle-Based Survey of New and Proposed Great Lakes National Marine Sanctuaries	Russ Green, NOAA Office of National Marine Sanctuaries	Marine Archaeology	June 2022
Our Submerged Past: Exploring Inundated Late Pleistocene (10,600-17,000 years ago) Caves in Southeast Alaska with SUNFISH	Kristof Richmond, Sunfish, Inc.	Marine Archaeology	June 2023

Each year, NOAA Ocean Exploration attempts to balance the distribution of funds across the three themes (ocean exploration, technology, and marine archaeology). Final allocation of funds is based on the number of project proposals received in each of the three focus areas. Both the theme ranking and overall competition rank are evaluated. **Figure 3** shows the distribution of awards by theme for FY17-21.

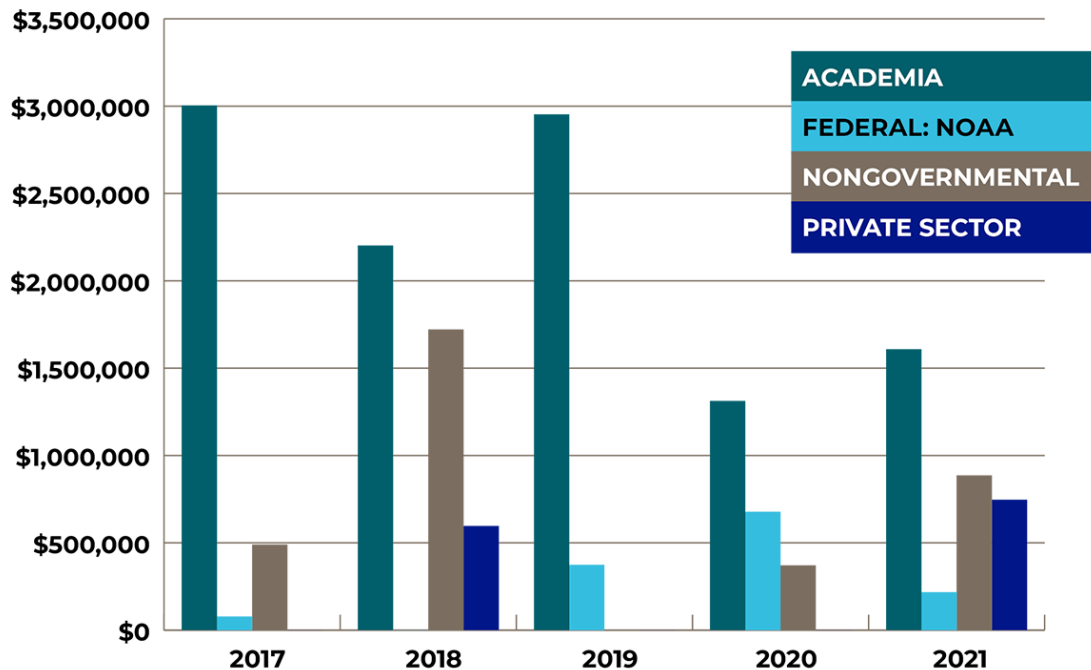


**Figure 3.** Distribution of NOAA Ocean Exploration funding opportunity awards by theme, FY17-21. The FY19 competition did not include a technology theme. Applicants before FY20 were able to select multiple themes, so some projects may be represented in multiple categories.

Between FY17 and FY21, NOAA Ocean Exploration funded proposals received from academia, federal agencies, nongovernmental organizations, and the private sector. Overwhelmingly, academia has received the most funds (see **Figures 4** and **Figure 5** for distribution of awards and funds). Reasons for disproportionate funding may include academics' reliance on grant funding as their primary funding source. NOAA Ocean Exploration recognizes that nongovernmental and private-sector entities have an increasing role in ocean exploration, marine archaeology, and technology development, and NOAA Ocean Exploration continues to consider opportunities to engage these entities.



**Figure 4.** Distribution of NOAA Ocean Exploration funding opportunity awards by sector, FY17-21.

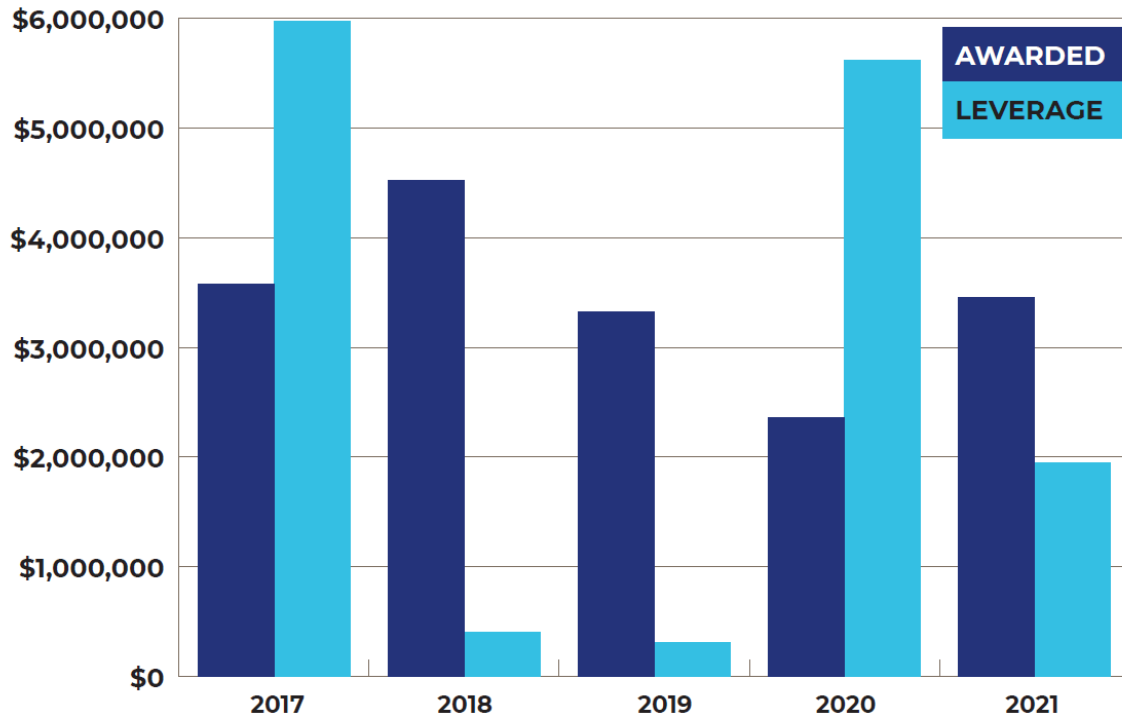


**Figure 5.** Distribution of NOAA Ocean Exploration funding opportunity funds by sector, FY17-21.

In support of these opportunities, NOAA Ocean Exploration encourages interdisciplinary exploration that can be accomplished through partnerships between academia, government agencies, nongovernmental organizations, the private sector, and state entities. In this way, the NOAA Ocean Exploration funding opportunity supports collaboration networks across the entire ocean exploration community.

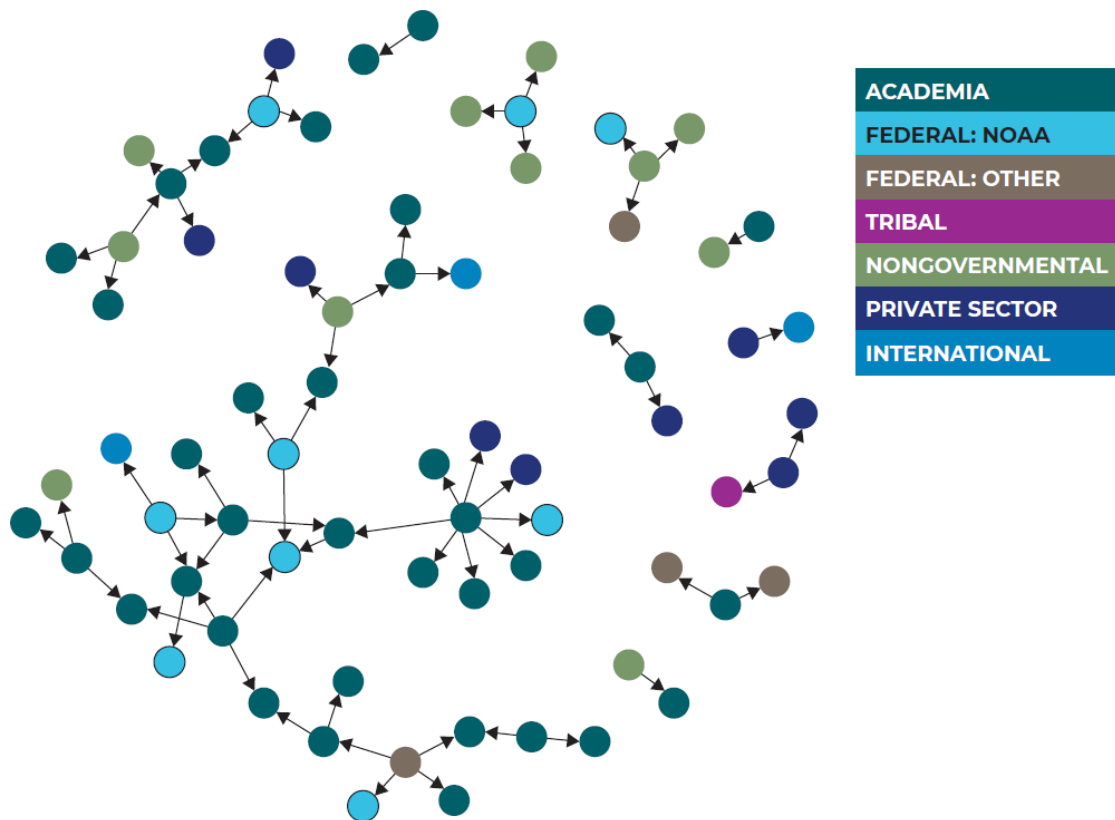
Funded proposals often leverage additional support in the form of cost-sharing, ship time, in-kind contributions, and other services, resources, and personnel time not covered by NOAA Ocean Exploration funding. Funded projects leveraged over \$14 million in additional support between FY17 and FY21 (see **Figure 6**). In FY21, leveraged support included ship time, platform assets, and salary funding. Leveraged support (both technical and monetary) is opportunistic and is controlled by factors external to NOAA Ocean Exploration. Sometimes this support includes funding from other agencies or entities. Leveraged support and outside funding are not required to receive funding via the NOAA Ocean Exploration funding opportunity.





**Figure 6.** Funding awarded via the NOAA Ocean Exploration funding opportunity and support leveraged, FY17-21.

PIs, co-PIs, and other significant contributors funded by NOAA Ocean Exploration between FY17 and FY21 represent a variety of entities both domestically and internationally. **Figure 7** is a visual representation of the collaborative nature of NOAA Ocean Exploration-funded projects and shows the wide reach of NOAA Ocean Exploration’s funding opportunity beyond the 38 principal investigators who were directly funded. The directionality of the arrows in **Figure 7** indicates the direction of collaboration from awarded entities to collaborating entities. Each point in the network represents one entity and may represent multiple projects if awards were given to multiple principal investigators from an entity between FY17 and FY21. This institutional network depicts 66 relationships between 73 unique entities. These collaborations have resulted in the inclusion of sectors that did not directly receive NOAA Ocean Exploration funding between FY17 and FY21, specifically state and foreign entities.



**Figure 7.** Collaboration network of principal investigators, co-principal investigators, and other significant contributors funded via the NOAA Ocean Exploration funding opportunities, FY17-FY21.

## Grants Closeout During FY21

Eight grants were closed out during FY21. The final reports and publications for these projects will be archived with the [NOAA Institutional Repository](#) once available.

## Acknowledgments

The authors would like to thank those staff members who contributed to the “FY2021 Annual NOAA Ocean Exploration Competitive Grants Fiscal Report.” We would like to especially thank the Fiscal Year 21 awardees; the NOAA Ocean Exploration competitive grants team of Caitlin Adams, Chris Beaverson, Frank Cantelas, Katharine Egan, Steve Hammond, Phil Hartmeyer, Chrissy Ortiz, and Joyce Woodford, whose support makes this program possible; Christa Rabenold for editorial support; Matt King for his document design expertise; and Anna Lienesch for ensuring that this report is publicly available in the NOAA Central Library and is readily accessible.

## Sources for Additional Information

Searchable online table for past NOAA Ocean Exploration funding opportunity projects from FY14 through present: <https://oceanexplorer.noaa.gov/about/funding-ops/ffo-recipients.html>

NOAA Ocean Exploration and Research bibliography:  
<https://library.noaa.gov/Research-Tools/Subject-Guides/OERbibliography>

More information about NOAA Ocean Exploration's competitive grants program and contacts:  
<https://oceanexplorer.noaa.gov/about/funding-ops/welcome.html>

## Appendix A: Abstracts of FY21 Funded Projects

**Title:** Accelerating Ocean Exploration Through Cloud-Native Processing of Active Ocean Sonar Data

**Principal Investigator:** Wu-Jung Lee, University of Washington

**Theme:** Technology

**Abstract:** Scientists commonly use active sonar systems to collect data about mid-trophic level animals like zooplankton and small fish, which play an important role in the marine ecosystems. Echosounders, or fish-finders, are high-frequency sonar systems that emit pulses of sound and record the reflections from animals, the seabed, and other objects. These instruments have been proven to be more efficient and effective for collecting data over a large survey area or a long time period than many other sampling methods, such as underwater imaging and net trawls. This technology has been widely adopted by the ocean science and commercial fishing communities and more recently has been integrated with autonomous vehicles, resulting in a massive amount of data. However, these datasets can be difficult to analyze and are often underutilized. This team will address this issue by developing data standards, a streamlined data processing workflow, and software tools that capitalize on recent advancements in cloud computing technologies to efficiently transform large quantities of ocean sonar data into information that is useful for exploring, monitoring, and managing living marine resources.

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**Title:** Field Validation of Novel Low-Cost Underwater Robot for Deepwater Exploration and Characterization

**Principal Investigator:** Matthew Johnson-Roberson, University of Michigan

**Theme:** Technology

**Abstract:** Deep-sea corals provide habitat for a wide variety of marine life. Despite their importance to the environment, little is known about them and the threats to their survival. Deep-sea data collection is expensive, and annotation and analysis of underwater imagery is time consuming. To help advance the protection of deep-sea coral ecosystems, this team will improve and validate a new, low-cost, open-source, autonomous underwater vehicle (AUV) and develop automatic annotation software. They will test the AUV and collect data at a site in Hawaiian waters that is known for its high diversity and density of corals. Data collected will be used to generate photometric 3D reconstructions of the seafloor and for the development of the software. This project will benefit the scientific community in two key ways: It will make deep-sea exploration more accessible to the larger scientific community and will increase the speed of data analysis and availability.

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**Title:** Illuminating Pelagic and Benthic Biodiversity in Deep Waters of Puerto Rico

**Principal Investigator:** Andrea Quattrini, Smithsonian Institution National Museum of Natural History

**Theme:** Ocean Exploration

**Abstract:** Deepwater habitats off the coast of Puerto Rico, including submarine canyons, ridges, and banks, are likely home to a wide variety of marine life, including commercially important species and species new to science. Yet, these habitats remain some of the least explored areas of the U.S. Exclusive Economic Zone. To better understand the biodiversity from the surface to the seafloor and what shapes it, this research team will use new technologies for water sampling, soft-bodied animal collection, low-light imaging, and 3D/virtual reality imaging to explore and characterize Puerto Rico's deep sea. Data collected will serve as a baseline to detect and address future changes to better preserve the long-term health of the region's vulnerable marine ecosystems and fisheries.

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**Title:** Machine Learning for Automated Detection of Shipwreck Sites From Large Area Robotic Surveys

**Principal Investigator:** Katharine A. Skinner, University of Michigan

**Theme:** Technology

**Abstract:** Shipwrecks can help us better understand our past, but finding and exploring them is time consuming, labor intensive, and expensive, so most of their tales remain untold. This team aims to increase the efficiency and decrease the costs associated with such exploration efforts (and ocean exploration in general) by advancing the autonomous capabilities of underwater vehicles to search for and survey shipwreck sites. To limit the need for human input, they will develop machine learning methods to detect shipwreck sites from sonar data and develop capabilities that enable underwater vehicles to automatically adapt their routes while exploring sites of interest. To test these approaches, the team will use an autonomous underwater vehicle to search for and survey known and potential shipwreck sites in the Thunder Bay National Marine Sanctuary in Lake Huron. Data collected will inform the management and conservation of these important sanctuary resources.

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**Title:** Marine Archaeological Investigation and Mapping of the Paleo-Suwannee River, Eastern Gulf of Mexico

**Principal Investigator:** Vincent Lecours, University of Florida

**Theme:** Marine Archaeology

**Abstract:** Humans have lived in Florida for at least 14,550 years. By studying sites once occupied by the Paleoindians — the first people to enter and inhabit the Americas — we can improve our understanding of how they got here, how they survived, and how they adapted to

environmental changes like sea-level rise. However, much remains to be learned, and these sites are difficult to identify and access. By combining approaches from remote sensing, archaeology, and seafloor mapping to explore the Paleo-Suwannee River channel off Florida's Gulf of Mexico Coast, this team aims to identify and characterize areas of high archaeological significance to inform their future management and conservation. In addition, they will use innovative marine habitat mapping approaches and test new remote sensing methods to improve the discovery and characterization of archaeological sites.

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**Title:** Microbial Ecosystem Services on Seamounts Around Papahānaumokuākea Marine National Monument

**Principal Investigator:** Beth N. Orcutt, Bigelow Laboratory for Ocean Sciences

**Theme:** Ocean Exploration

**Abstract:** Polymetallic ferromanganese crusts found on seamounts frequently include critical minerals that are used in consumer electronics, defense, renewable energy industries, and more. As demand for these resources increases, so does interest in mining them. Yet, little is known about the characteristics of these crusts and the microorganisms that live on and within them. To better understand how these resources interact and their associated ecosystems, this team will explore and characterize mineral and microbial resources of seamounts within the Papahānaumokuākea Marine National Monument that are expected to have high critical mineral content. This project will result in important baseline information regarding the mineral resource potential as well as the parallel living resources of these seamounts and will be used to inform their sustainable use and conservation. This project will be done in partnership with Ocean Exploration Trust.

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**Title:** Multi-Tiered Autonomous Vehicle-Based Survey of New and Proposed Great Lakes National Marine Sanctuaries

**Principal Investigator:** Russ Green, NOAA Office of National Marine Sanctuaries

**Theme:** Marine Archaeology

**Abstract:** Marine transport on the Great Lakes played a central role in the exploration, settlement, economic expansion, and industrialization of the nation. The estimated 6,000 shipwrecks across the five Great Lakes can help us better understand that role. Many of these shipwrecks have yet to be discovered and explored. This team will use an uncrewed aerial vehicle, an autonomous surface vehicle, and an autonomous underwater vehicle to search for shipwrecks at sites within the boundaries of the new Wisconsin Shipwreck Coast (Lake Michigan) and proposed Lake Ontario national marine sanctuaries. Their work, which could include discovery of nationally significant historic sites, such as 18th and 19th century shipwrecks and War of 1812 artifacts, will add to our knowledge of America's past maritime-based economic activities in the Great Lakes and generate valuable new data products

to support resource management efforts, including the establishment and management of national marine sanctuaries.

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**Title:** Our Submerged Past: Exploring Inundated Late Pleistocene (10,600 - 17,000 years ago) Caves in Southeast Alaska with SUNFISH

**Principal Investigator:** Kristof Richmond, Sunfish, Inc.

**Theme:** Marine Archaeology

**Abstract:** Evidence suggests that humans have made the northwest coast of North America their home for at least 17,000 years. The land these First Peoples inhabited is now underwater. Tangible evidence of their presence should be preserved in submerged caves and rock shelters, but these features are difficult to access and have not been formally explored. To learn more about how and when people migrated to the Americas, this team will search for evidence of human occupation on the continental shelf of southeast Alaska in an area that has not been accessible to humans for over 10,000 years. Using the SUNFISH autonomous underwater vehicle, which is designed to operate in complex 3D undersea environments, the team will explore, map, and collect sediment samples from submerged caves and rock shelters. They will then analyze the data and samples collected to further inform our understanding of the past, both human and environmental.