ANNUAL REPORT ON THE NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM FISCAL YEAR 2023

Prepared by the
INTERAGENCY WORKING GROUP
ON THE NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM
of the
OCEAN SCIENCE AND TECHNOLOGY SUBCOMMITTEE
of the
OCEAN POLICY COMMITTEE

OCTOBER 2024

About the Ocean Policy Committee

The Ocean Policy Committee (OPC) was codified by the National Defense Authorization Act for Fiscal Year 2021 to coordinate federal actions on ocean-related matters. The OPC traces its roots to the National Ocean Council created by Executive Order 13547 and the OPC established by Executive Order 13840. The OPC is co-chaired by the Director of the Office of Science and Technology Policy (OSTP) and the Chair of the Council on Environmental Quality (CEQ) and is directed to engage and collaborate with the ocean community on ocean-related matters, facilitate coordination and integration of federal activities in ocean and coastal waters to inform ocean policy, identify priority ocean science and technology needs, and to leverage resources and expertise to maximize the effectiveness of federal investments in ocean research. For more information about the work of the OPC, please see https://www.noaa.gov/interagency-ocean-policy.

About the Office of Science and Technology Policy

The Office of Science & Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976 to provide the President and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy, national security, homeland security, health, foreign relations, the environment, and the technological recovery and use of resources, among other topics. OSTP leads interagency science and technology policy coordination efforts, assists the Office of Management and Budget with an annual review and analysis of federal research and development in budgets, and serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the federal government. More information is available at http://www.whitehouse.gov/ostp.

About the Ocean Science and Technology Subcommittee

The purpose of the Subcommittee on Ocean Science and Technology (SOST) is to advise and assist on national issues of ocean science and technology. The SOST contributes to the goals for federal ocean science and technology, including developing coordinated interagency strategies and fostering national ocean science and technology priorities. The SOST reports to both the National Science and Technology Council (NSTC) Committee on Environment and the Ocean Policy Committee.

About the National Oceanographic Partnership Program

The National Oceanographic Partnership Program (NOPP) was established by Congress in 1997 and reauthorized in 2021 to promote the national goals of advancing economic development, protecting quality of life, strengthening science education and communication, and assuring national security by improving knowledge of the ocean. These goals are achieved through partnerships among federal agencies, academia, industry, and nongovernmental organizations that advance interagency initiatives and federal science and technology priorities and cut across agency missions and multiple disciplines. Through NOPP, public and private sectors across the ocean science community coordinate to support larger, comprehensive projects, promote sharing of resources, and foster community-wide innovative advances in ocean science, data, technology development, resources, education, and communication.

About this Document

Under the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 (Public Law 116–283, §1055(b)(2)(A)), the OPC is required to report to Congress annually on NOPP activities. This report details activities in fiscal year 2023.

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Introduction

The National Oceanographic Partnership Program (NOPP) under the Ocean Policy Committee is the nation's flagship program to facilitate ocean research partnerships across government and other sectors. NOPP was established by Congress in fiscal year (FY) 1997 to promote the goals of ensuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication by improving knowledge of the ocean. These goals are accomplished through partnerships among federal agencies, academia, industry, and nongovernmental organizations. The program is an effective forum for advancing national goals through the development of interagency initiatives and projects that span agency missions, research sectors, and scientific and technological disciplines. The Biden-Harris Administration has advanced America's leadership in ocean health and resilience, environmental justice, and policies that strengthen research opportunities NOPP advances. Such ocean knowledge informs and augments marine stewardship by bringing agencies together to drive forward research and education missions.
NOPP focuses on two strategic goals:

- Facilitate and promote interagency ocean research partnerships
- Catalyze and support scientific and technological research on critical and emerging issues

In FY 2023, NOPP agencies funded 18 new projects, 17 focusing on assessing the potential of marine carbon dioxide removal (mCDR) as a climate mitigation solution. One project investigates soundscapes and environmental changes in the Gulf of Maine. These 18 projects bring the total number of active awards to 62 and the total number of awards funded since the inception of NOPP to 289. The combined agency funding dedicated to new FY 2023 projects totaled $18.23 million. The Inflation Reduction Act (IRA) provided $14.36 million of the $18.23 million to fund 10 of the FY 2023 mCDR projects as part of the Investing in Coastal Communities and Climate Resilience provision under National Oceanic and Atmospheric Administration's (NOAA) U.S. Integrated Ocean Observing System Office IRA priorities. This investment supports climate mitigation through research as part of President Biden's Investing in America agenda. An additional $13.77 million was provided in FY 2023 for ongoing multi-year NOPP projects, bringing the total FY 2023 investment in all NOPP-solicited activities, both new and continuing, to $32 million. NOPP partner agencies also provided continued oversight of 44 ongoing projects funded in FY 2022 and earlier.

NOPP Interagency and External Interactions

Interagency and external partnerships are a central tool of NOPP. Agency participation in NOPP includes sponsoring research through partnership funding opportunities and prize competitions.
Within the U.S. government, collaboration is accomplished largely through an Interagency Working Group (IWG) that aims to develop, plan, and oversee NOPP ocean research and technology projects and to address topics of mutual and emerging interest. The IWG NOPP meets monthly to advance projects that benefit from the collaboration of more than one agency, require government-private-academic partnerships, and work toward fulfilling the missions of multiple agencies.
Mechanisms for external input include the Ocean Research Advisory Panel (ORAP), which was recently reconstituted as a Federal Advisory Committee Act Panel to advise the OPC.

Fiscal Year 2023 NOPP Activities

Annual Solicitation and New Partnership Projects

Each year, NOPP partner agencies identify ocean research and technology topics of mutual interest that would benefit from cross-agency and cross-sector partnerships leading to an agency-issued formal Broad Agency Announcement (BAA), Request for Proposal (RFP), or Federal Funding Opportunity. Proposals are received, usually in the fall, and funded projects are then selected through a formal merit review process developed with the guidance and approval of the participating federal agencies. Details of the procedure for developing these funding opportunities are described in Appendix 1.
The IWG NOPP developed topics and language for an FY 2023 BAA, published on November 22, 2022. The solicitation was intended to provide up to $23 million over five years and was focused on one topic: *mCDR: Research and Development for Assessing Large-Scale Carbon Removal and Local-Scale Ocean Acidification Mitigation.* NOPP received 52 proposals. Of these proposals, 50 proposals totaling just shy of $86 million passed the minimum standard scientific review threshold. 17 proposals totaling $24.4 million were selected for funding in FY 2023.

In FY 2023, 18 new NOPP projects were funded (17 selected from the FY 2023 BAA, totaling $24.3 million):

1. *Carbon capture and ocean acidification mitigation potential by seaweed farms in tropical and subtropical coastal environments*
2. *Assessing chemical and biological implications of alkalinity enhancement using carbonate salts obtained from captured carbon dioxide to mitigate negative effects of ocean acidification and enable mCDR*
3. *Electrolysis-driven weathering of basic minerals for long-term ocean buffering and carbon dioxide reduction*
4. *Multiscale observing system simulation experiments for iron fertilization in the Southern Ocean, Equatorial Pacific, and Northeast Pacific*
5. *An opportunity to study ocean alkalinity enhancement, carbon dioxide removal, and ecosystem impacts through coastal liming*
6. *Tidal wetlands as a low pH environment for accelerated and scalable olivine dissolution*
7. *Assessing the laboratory and field responses of diatoms and coccolithophores to ocean alkalinity enhancement*
8. *Determining the influence of ocean alkalinity enhancement on foraminifera calcification, distribution, and calcium carbonate production*
9. *Assessing the effects and risks of ocean alkalinity enhancement on the physiology, functionality, calcification, and mineralogy of corals and crustose coralline algae in the Pacific*
10. *Assessing carbon dioxide removal and ecosystem response for an ocean alkalinity enhancement field trial*
11. *Assessing efficacy of electrochemical ocean alkalinity enhancement at an existing outfall using tracer release experiments and oceanographic models*
12. *Quantifying the efficacy of wastewater alkalinity enhancement on mCDR and acidification mitigation in a large estuary*
13. *Biotic calcification impacts on mCDR additionality*
14. *Developing a coupled benthic-pelagic biogeochemical model to evaluate the effectiveness of mCDR interventions*

15. *Engaging U.S. commercial fishing community to develop recommendations for fishery-sensitive mCDR governance, collaborative research and monitoring, and outreach to fishing communities*
16. *Coupling desalination with novel mCDR membranes*
17. *Data requirements for quantifying natural variability and the background ocean carbon sink in mCDR models*
18. *A Gulf of Maine ambient sound network*

Abstracts for all 18 projects can be found in Appendix 2. Information on the 17 mCDR NOPP projects can also be found at https://oceanacidification.noaa.gov/fy23-nopp-mcdr-awards/.

Prior Year Project Continuations

NOPP partner agencies also continue to oversee 44 additional ongoing NOPP projects. FY 2023 funding totaling $13.77 million was provided to support the ongoing multiyear NOPP projects. The partnering agencies for these efforts include but are not limited to NOAA, Office of Naval Research (ONR), Naval Research Laboratory (NRL), Bureau of Ocean Energy Management (BOEM), Federal Highway Administration (FHWA), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), Environmental Protection Agency (EPA), and National Science Foundation (NSF). Further information for these additional projects, along with the new FY 2023 projects, can be found in Appendix 2.

The DOE's Water Power Technologies Office and the Integrated Ocean Observing System (IOOS®) program at NOAA, continue to support the U.S. Ocean Observing Prize. FY 2023 activities under this competition continue support for the DEVELOP Competition focused on the theme of hurricane monitoring.

FY 2024 Plans and Partnership Priorities

In FY 2024, the IWG NOPP will continue to identify, facilitate, and foster collaboration on priority interagency ocean research projects through engagement with representatives from federal ocean agencies and other appropriate avenues.

The NOPP Office will assist the NSTC Marine Carbon Dioxide Removal Fast-Track Action Committee (MCDR–FTAC) host a series of listening sessions to inform the public on the development of a federal government research plan regarding mCDR research in the United States. They will also continue supporting follow on events that are in development coming out of the August 2023 Ocean Life Forum, including the Ocean Biodiversity Town Hall event taking place in partnership with the Smithsonian Institution, NOAA, and IOOS Foundation at the Ocean Sciences Meeting in February 2024 in New Orleans, LA.

The IWG NOPP continues to examine and discuss ocean science and technology areas needing further advancement to meet agency missions.

National Oceanographic Partnership Program Office

The NOPP Office, contracted to Integrated Systems Solutions, Inc., facilitates communication across ocean science sectors to expand the scope of public/private partnerships; plans and facilitates fora

and workshops; provides administrative support to IWG NOPP; supports the NOPP peer review grant process; facilitates the annual NOPP Excellence in Partnership (EiP) Award; supports drafting the NOPP annual report to Congress; and coordinates NOPP outreach and education activities including the www.nopp.org website.

NOPP Partnership Forums

NOPP Partnership Forums are a newly established component of NOPP focused on facilitating partnerships in ocean science, research, and education that address pressing ocean science topics and priorities. Partnership forums, convened individually or in conjunction with scientific conferences, are in-person meetings between federal agencies, academia, and the private sector, including industries, nongovernmental organizations, and philanthropic organizations. Information on NOPP Partnership Forums can be found here.

In FY 2023, the NOPP Office held its first ever partnership forum, the 2023 NOPP Ocean Life Forum from August 9-10, 2023, in Edgewater, MD. The forum was held in collaboration with NOAA IOOS and Smithsonian Institution National Museum of Natural History partners. The forum gathered nearly 60 experts from across federal government, Tribal, academic, and nonprofit organizations to identify priority needs and opportunities for coordinating and expanding marine biodiversity information to inform management, development, conservation, and response to climate change.

The NOPP Office also hosted a second forum in partnership with NOAA Ocean Exploration and the National Ocean Mapping, Exploration, and Characterization (NOMEC) Council at the OCEANS '23 conference on September 26, 2023 in Biloxi, MS. The forum consisted of panelists from government agencies and the private sector, and it engaged the marine technology community on topics surrounding the NOMEC Strategy and partnering across sectors.

NOPP Excellence in Partnering Award

Each year the NOPP EiP Award is presented to a research team that best demonstrates the partnership objectives of the NOPP. The 2023 NOPP EiP Award was awarded to the Atlantic Deepwater Ecosystem Observatory Network (ADEON) project team. This project was conceived by Dr. Kyle Becker of ONR, Dr. Rebecca Green of BOEM, and Dr. Jason Gedamke of NOAA. It was led by Dr. Jennifer Miksis-Olds of the University of New Hampshire (UNH). Team members consisted of 10 institutional partners including Applied Ocean Sciences, BOEM, Florida Atlantic University, JASCO Applied Sciences, Ocean Acoustical Services and Instrumentation Systems (OASIS), Inc., NOAA, ONR, Stony Brook University, Netherlands Organization for Applied Scientific Research, and UNH with additional partnerships that evolved during the lifecycle of the project. Support for the NOPP project was provided by BOEM, ONR, and NOAA.

The ADEON program acquired long-term measurements of the natural and human factors that describe the ecology and soundscape of the Mid-South-Atlantic Outer Continental Shelf. Acoustic information was combined with contextual data from space-based remote sensing, hydrographic sensors, and mobile platforms to fully comprehend how human, biological, and natural abiotic components create the soundscape and influence regional ecosystem dynamics.

Summary of NOPP Investments

FY 2023 funding for new and ongoing projects under NOPP totaled $32 million. From FY 1997 through FY 2023, the total expenditures on NOPP are $551 million. Figure 1 shows a sand chart of recent NOPP funding by agency and year. The same data are presented as a table in Appendix 3. Appendix 4 provides a list of the 62 active NOPP projects. All historical projects supported by NOPP can be found at www.nopp.org.

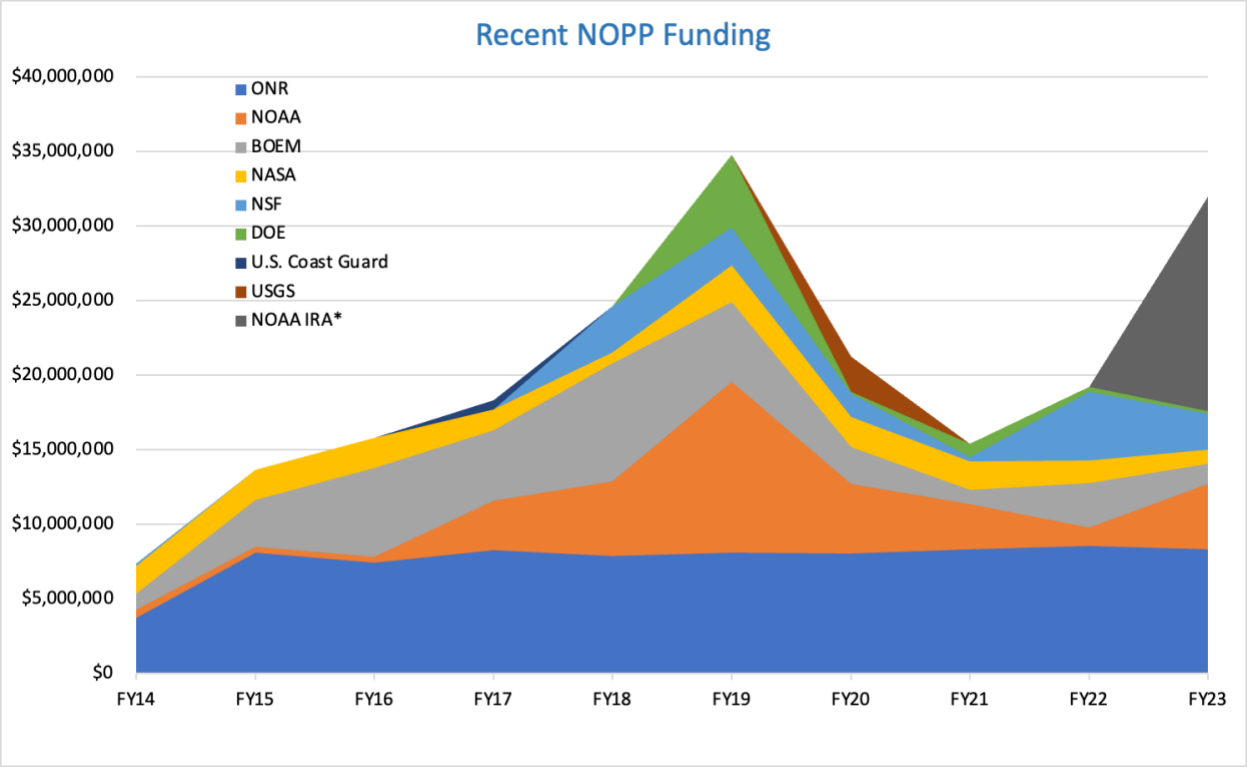

Figure 1. Reported agency contributions to NOPP projects from FY 2014 to FY 2023. * The IRA provided $14.36 million of one-time funding for 10 NOAA NOPP projects in FY 2023.

Conclusion

In FY 2023, NOPP launched 18 new projects and supported the U.S. Ocean Observing Prize competition while continuing successful projects from previous years. NOPP also held its first ever partnership fora, a newly established component of NOPP. NOPP's FY 2022 BAA announcing the possible award of $23 million over five years is one of the largest award amounts in recent years, and the IRA provided $14.36 million to fund ten of the FY 2023 projects as part of the Investing in Coastal Communities and Climate Resilience provision under NOAA's U.S. Integrated Ocean Observing System Office IRA priorities. Going forward, NOPP will draw upon its 25 years of experience and lessons learned to serve as an efficient mechanism for implementing productive ocean partnerships among federal agencies, industry, academia, and other sectors; supporting IWGs focused on key ocean research and facilities issues; and supporting federal ocean science priorities.

Appendix 1. Development and Process for NOPP Solicitations

Being a funded NOPP project requires multi-sector partnerships among academia, industry (including nongovernmental organizations), and government (including federal, Tribal, state, and local entities). Research topics funded through NOPP are initiated via interactions among agency program officers and managers, most often at IWG NOPP meetings. Partner agencies then discuss the research topic with other agencies through NOPP. At this point, a follow-up meeting is conducted where interagency partnerships are formed and tentative levels of support are pledged on an as-available basis. The research goals, partner resources, solicitation mechanisms, and language are then proposed, and the lead agency and agency project coordinator are identified.

Once the solicitation is approved by the lead agency and its partners, NOPP then reviews the funding announcement language, which is then presented as either a BAA, RFP, or federal funding opportunity by the lead agency on behalf of NOPP.

Once a funding opportunity is announced, submitted proposals undergo a review process which fulfills the review standards of all agencies sponsoring that topic. For instance, when NSF is a co-sponsor, this may be some combination of mail and panel peer review. Proposals are reviewed based on:

- Relevance of the proposed research to NOPP objectives and federal science and technology priorities,
- Overall scientific and technical merits of the proposal,
- Level of support of critical research objectives or operational goals,
- Quality of proposed partnerships,
- The offeror's capabilities, related experience, and access to facilities that are critical to the proposal objectives,
- The long-term commitment of the partners to the proposed objectives,
- The qualifications and experience of the proposed principal investigator and key personnel, and
- Rationale of proposed cost.

At the conclusion of the review process, agency program officers or managers recommend funding. After NOPP discussions and receipt of appropriations, the awarded research projects are announced.

Appendix 2. New NOPP-Awarded Activities in Fiscal Year 2023

NOPP BAA: mCDR: Research and Development for Assessing Large Scale Carbon Removal and Local Scale Ocean Acidification Mitigation (17 projects, $24.3 million total funding over four years)

Project Website: https://oceanacidification.noaa.gov/fy23-nopp-mcdr-awards/

Carbon capture and ocean acidification mitigation potential by seaweed farms in tropical and subtropical coastal environments

PI: Andreas Andersson, Scripps Institution of Oceanography

Partners: Scripps Institute of Oceanography University of California San Diego, Okinawa Institute of Science and Technology, Marine Biological Laboratory, Sunburst Sensors, NOAA Pacific Marine Environmental Laboratory (NOAA PMEL)

This project will explore the carbon capture capacity and ocean acidification mitigation in three operational seaweed farms in Florida and Okinawa, Japan. At the two smaller study sites, co-culturing of seaweed with shellfish and corals offers opportunities to assess the additive co-benefits of these combined activities, which could strengthen ecosystem resilience. The study sites in Japan are larger than any seaweed farms in the United States, and studies here will help identify the risks and benefits of seaweed farming at scale. Researchers will use a state-of-the-art monitoring program with ocean sensors as well as reference-quality measurements. Drifting ocean sensors will measure water flow across the seaweed farms, which affects the productivity and the amount of carbon absorbed. Numerical modeling will elucidate the capacity of seaweed to absorb carbon under a range of different conditions. By comparing these estimates based on seawater chemistry and physics to the amount of seaweed harvested and exported each year, we can identify carbon capture efficiency to different aspects of the seaweed cultivation.

Assessing chemical and biological implications of alkalinity enhancement using carbonate salts obtained from captured CO2 to mitigate negative effects of ocean acidification and enable mCDR

PI: Andrew Dickson, Scripps Institution of Oceanography

Partners: Scripps Institute of Oceanography University of California San Diego, Pacific Rim Design and Development, Oregon State University, NOAA PMEL

Researchers will develop and test a pilot-scale system that captures carbon dioxide from the air and converts it into a mixture of salts that can be used for mCDR (sodium carbonate, sodium bicarbonate). To understand the chemical constraints of this method, the project examines the precipitation of different minerals in seawater and the best rate of adding the critical components. Marine species may differ in their response to the changes caused by ocean alkalinity enhancement. Part of this project synthesizes published data to assess how different species with varying calcification behaviors may respond to changes in seawater. Researchers will then evaluate the potential effects of ocean alkalinity enhancement on different habitats along the U.S. west coast that incorporate both experimental data and field data. Lastly, the project emphasizes maintaining quality control and chemical validation throughout the research to ensure accurate and reliable results.

Electrolysis-driven weathering of basic minerals for long-term ocean buffering and CO2 reduction

PI: Burke Hales, Oregon State University

Partners: Oregon State University, NOAA PMEL

Environmental risks could result from releasing too much alkalinity into ocean waters, as well as releasing harmful byproducts. In order for this method to successfully remove carbon from the atmosphere, it will also need to be powered almost exclusively by renewable energy. To address these risks, the team will develop an alkalinization system for seawater that is simple to control, limits the simultaneous release of harmful byproducts like chlorine, and operates on wave energy. Researchers will design components and procedures that minimize the generation and release of these byproducts while carefully controlling the alkalinity of the effluent. To address sustainably powering the system, the team will test how much power the alkalinization system requires and build a wave-energy power system that can support its operation. Once the technical specifications are established, the team will use circulation and ecosystem models to simulate the addition of alkalinity across a variety of seawater conditions representing real-life Oregon coastal waters where this type of system may be deployed. Modeling will identify the best local conditions for alkalinity enhancement and identify local ecosystem sensitivities to alkalinization actions. Subsequent laboratory experiments will help identify ways to limit impacts of alkalinity enhancement on sensitive life stages of commercially and culturally sensitive species, including California mussels, Olympia oysters, Dungeness crab, and eelgrass.

Multiscale observing system simulation experiments for iron fertilization in the Southern Ocean, Equatorial Pacific, and Northeast Pacific

PI: Dennis McGillicuddy, Woods Hole Oceanographic Institute

Partners: Woods Hole Oceanographic Institution, National Center for Atmospheric Research, NOAA Geophysical Fluid Dynamics Laboratory, NSF

This project studies the effectiveness of iron enrichment for carbon capture at different scales and the long-term effects of regional iron fertilization. Researchers will use Observing System Simulation Experiments run by ocean biogeochemical models to assess the potential impacts of new observing systems, instrumentation, or data assimilation, prior to implementation. The Observing System Simulation Experiments will target field trials in three regions: the Southern Ocean, the Equatorial Pacific, and the Subarctic Pacific. High resolution models will examine the extent of carbon sequestration and potential effects on local and remote ecosystems on a small scale. Global biogeochemical models will explore the long-term effects of regional iron fertilization, including carbon sequestration and monitoring of ecosystem perturbations.

An opportunity to study Ocean Alkalinity Enhancement, CDR, and ecosystem impacts through coastal liming

PI: Jaime Palter, University of Rhode Island

Partners: NOAA, Environmental Protection Agency (EPA), University of Rhode Island, University of Connecticut, University of Hawai'i at Manoa, Weekapaug Golf Course

Dr. Jaime Palter of the University of Rhode Island says “a golf course’s routine lawn care includes the spreading of large quantities of limestone—nearly 20 tons for nine holes. With that fact in mind, we

realized that using a golf course's lime deployment as our release experiment could provide an ideal, permit-free opportunity to study the effect of coastal alkalinity enhancement." This project takes advantage of a routine lawn care technique of golf course liming. The team will monitor the carbon chemistry of a small coastal lagoon before and after the application of the limestone on a nearby golf course. The team will measure dissolved inorganic carbon, or the total amount of inorganic carbon in the water, using sensors continuously measuring water properties and in weekly field sampling. They will also measure total alkalinity, the water's buffering capacity that may increase with liming and enhance the lagoon's ability to take in carbon dioxide. These essential observations help track the sources and sinks of carbon in a system. More specifically, they will allow the team to calculate the balance of dissolved inorganic carbon and total alkalinity in the lagoon to understand if the lagoon can further absorb carbon after the liming process. The research will also study the impact on the ecosystem and mitigation of local ocean acidification on clams. Finally, the project employs modeling simulations to understand the fate of alkalinity and dissolved inorganic carbon as it leaves the coastal zone, estimate the carbon dioxide removal achieved through observed lime application, and explore the scalability of terrestrial liming along the U.S. east coast.

Tidal wetlands as a low pH environment for accelerated and scalable olivine dissolution

PI: Kevin Kroeger, United States Geological Survey (USGS)

Partners: USGS Woods Hole Coastal & Marine Science Center, Woods Hole Oceanographic Institution, Vesta Corporation, NOAA National Marine Fisheries Service (NMFS), National Park Service (NPS)

Researchers will test that enhanced weathering, particularly with the rock-forming mineral olivine, leads to a decrease in carbon dioxide released into the atmosphere. Additionally, the study tests that this method increases dissolved inorganic carbon and alkalinity in the porewater and adjacent estuary, and creates a chemical range beneficial for oyster larval recruitment, survival, and growth. The team will conduct experiments at various scales, from the laboratory to field macrocosms, to develop models for olivine dissolution. Laboratory experiments will optimize olivine dissolution rates and assess impacts on various impacts such as the chemistry of soil and coastal seawater and ecosystem health. This small-scale experimentation will inform the design and execution of a field trial where olivine will be applied to a 0.5-hectare salt marsh plot in collaboration with the Herring River Restoration, a salt marsh ecosystem project in the U.S. NPS land. The field trial provides an opportunity for the research and regulatory communities to evaluate environmental safety as well as compare measurement, monitoring, reporting, and verification technologies. Other outcomes of the field trial include understanding the impact of olivine on soil chemistry, microbial communities, vegetation, and invertebrates.

Assessing the laboratory and field responses of diatoms and coccolithophores to ocean alkalinity enhancement

PI: Adam Subhas, Woods Hole Oceanographic Institution

Partners: Woods Hole Oceanographic Institution, Rutgers University

This project aims to address potential impacts of ocean alkalinity enhancement on phytoplankton by conducting laboratory and field experiments. Laboratory experiments will assess the effects of ocean alkalinity enhancement on representative diatom and coccolithophore species. Next, the team will study the response of natural diatom and coccolithophore communities to ocean alkalinity

enhancement during research cruises. They hypothesize that the impact of ocean alkalinity enhancement will depend on the dominant phytoplankton species in the community. Lastly, this study will evaluate the response of a natural microbial community to a dispersing plume of dissolved alkalinity during a field trial. The research team anticipates that the differences in the community response inside and outside the plume will be measurable but insignificant. The project also evaluates the effect of biomass loading during a bloom progression, assessing community composition, mineral production, particle dynamics, and carbon export.

Determining the Influence of Ocean Alkalinity Enhancement on Foraminifera Calcification, Distribution, and CaCO3 Production

PI: Laura Haynes, Vassar College

Partners: Vassar College, NOAA's Ocean Acidification Program (OAP) Atlantic Oceanographic & Meteorological Laboratory (AOML), Oregon State University

To examine the effects of different materials used in ocean alkalinity enhancement on foraminifera, researchers will grow foraminifera in culture experiments and use advanced imaging techniques to examine the impact on calcification (shell building). They will test three materials: calcium carbonate, calcium hydroxide, and olivine. The research team anticipates that adding calcium-bearing minerals will increase foraminiferal calcification, reducing the effectiveness of ocean alkalinity enhancement, whereas adding magnesium-iron silicates will decrease calcification. The team will also investigate how respiration and shell chemistry of foraminifera respond to ocean alkalinity enhancement to understand changes in their physiology. The project will capture young tropical surface foraminifera as well as mid-latitude sediment-dwelling foraminifera to grow in the laboratory under different ocean alkalinity conditions. Results will help estimate global changes in the ocean's calcium carbonate budget and its carbon dioxide absorption capacity under global ocean alkalinity enhancement scenarios.

Assessing the effects and risks of ocean alkalinity enhancement on the physiology, functionality, calcification, and mineralogy of corals and crustose coralline algae in the Pacific

PI: Melissa Meléndez, University of Hawai'i at Manoa

Partners: University of Hawai'i at Manoa, Texas A&M Corpus Christi, NOAA Pacific Islands Fisheries Science Center

The main objectives of the research are to identify how corals and crustose coralline algae respond to immediate alkalinity additions and to determine the effects of chronic and acute exposure to ocean alkalinity enhancement. The study will explore whether biological limitations are primarily attributed to alkalinity or other factors like potential trace metal toxicity from the minerals used in ocean alkalinity enhancement. Laboratory experiments using different alkalinity enhancement agents (quicklime, sodium hydroxide, and olivine) conducted in chambers and mesocosms will establish safe operating conditions and understand the mechanisms of calcification in corals and crustose coralline algae under different ocean alkalinity enhancement scenarios. The team will support inclusivity and equity in the field of mCDR by offering paid internships for underrepresented groups.

Assessing Carbon Dioxide Removal and Ecosystem Response for an Ocean Alkalinity Enhancement Field Trial

PI: David Nicholson, Woods Hole Oceanographic Institution

Partners: Woods Hole Oceanographic Institution, Monterey Bay Aquarium Research Institute, Marine Robotic Vehicle Systems

Researchers will use five ocean gliders to track the alkalinity released by a field trial in the Gulf of Maine. The gliders will track a patch of seawater with elevated alkalinity and 'tagged' with an inert dye and monitor changes in pH (measure of how alkaline or acidic the water is). The gliders can identify these changes from baseline data collected several weeks prior to the start of the trial as well as other measurements and modeled data collected as part of the larger experiment. In order to make these measurements, the team will add specialized sensors to the gliders. This engineering phase will include housing modifications and electrical integration of the pH and dye sensors into the glider body, as well as the development of firmware that controls the glider and the incorporated sensors. Researchers will test integration of these components on short deployments the year before the main alkalinity addition experiment. In addition to these sensors, the glider will also measure temperature, salinity, current speeds and direction, dissolved oxygen, chlorophyll, and ocean sound. The gliders equipped with these sensors will first help identify a suitable location within the bounds of a permitted patch for the alkalinity release. The gliders will then hone in on a particular location or feature. Parts of the fleet will stay close to the original site of release while others will track the outer edges of the patch. During the data analysis phase, reference-quality measurements will be made as part of the parallel alkalinity addition project. These simultaneous measurements allow for the calibration of the glider data, as well as calculation of an overall carbon budget. Data from the glider and from these calculations will also be integrated into a model to characterize how well the gliders were able to monitor the evolution of the patch of added alkalinity over time.

Assessing efficacy of electrochemical ocean alkalinity enhancement at an existing outfall using tracer release experiments and oceanographic models

PI: David Ho, University of Hawai'i at Manoa

Partners: University of Hawai'i at Manoa, [C]worthy Convergent Research LLC, University of California Los Angeles, Ebb Carbon Inc., American University

Through partnership with a local wastewater treatment plant in San Francisco Bay, this project will conduct an experiment that adds alkalinity to ocean water to test its effect on removing carbon dioxide from the atmosphere. Researchers will first use a numerical modeling framework to design the experiment, including the release strategy and a sampling plan that will track effects in the environment. Following the experiment, the team will conduct a retrospective analysis that combines models and observations to estimate the efficacy of the alkalinity release in removing carbon from the atmosphere. Further, they will apply the modeling framework to estimate the efficiency of removal. The technical work will be accompanied by public engagement to introduce local groups and communities like Tribes, nongovernmental organizations, civil society organizations to the project. Engagement will explore how the project aligns with their views and priorities and what associated risks and co-benefits these groups perceive.

Quantifying the Efficacy of Wastewater Alkalinity Enhancement on mCDR and Acidification Mitigation in a Large Estuary

PI: Jeremy Testa, University of Maryland Center for Environmental Science (UMCES)

Partners: UMCES, University of Delaware, Planetary Technologies, Inc.

This project will add alkalinity at a single wastewater treatment plan in the Hampton Roads Sanitation District in Virginia. In the first year, a one-week test will ensure the safety and rigor of the dosing method. The team will closely monitor and control alkalinity dosing rates within the facility and then concurrently monitor the receiving tidal waters for carbon removal and environmental impacts. During the second year, the researchers will perform a 4-week test. This longer test will help identify other natural factors that modify the potential effect of carbon removal, such as the phase of the tide, the amount of algal growth in the water, and weather. During both tests, the team will monitor oyster growth and other environmental parameters like total suspended solids, nutrient concentrations, metals, and carbon chemistry variables. The results of these two tests will inform an ocean model to better understand the benefits and impacts of a scaled-up version of these small field tests.

Biotic calcification impacts on marine carbon dioxide removal additionality

PI: Kelly Kearney, University of Washington Cooperative Institute for Climate, Ocean, & Ecosystem Studies (CICOES)

Partners: University of Washington CICOES, National Center for Atmospheric Research

The team will use simulations from two different model frameworks to identify a range of efficiency reductions that could come from calcification. Simulations will be based on proposed real-world applications of mCDR. Accurate estimation of efficiency and the uncertainty of efficiency will be important to determine the value of carbon removal credits in market settings. In addition to testing this important feedback, researchers will also explore natural processes that mimic this calcification feedback with existing ocean carbon data.

Developing a coupled benthic-pelagic biogeochemical model to evaluate the effectiveness of mCDR interventions

PI: Cristina Schultz, Northeastern University & Jessica Luo, NOAA Geophysical Fluid Dynamics Laboratory (GFDL)

Partners: Northeastern University, NOAA GFDL, University of Maine Walpole, Rutgers University, University of Connecticut, UMCES

This project will develop a model to represent the exchange, transformations, and storage of carbon and nutrients in the sediments. The model will also simulate ecosystem interactions in sediments and assess the efficiency of seaweed aquaculture and benthic ecosystem restoration. Both methods may result in either carbon storage or production under different conditions.

Engaging U.S. Commercial Fishing Community to Develop Recommendations for Fishery-Sensitive mCDR Governance, Collaborative Research and Monitoring, and Outreach to Fishing Communities

PI: Fiona Hogan, Responsible Offshore Development Alliance

Partners: Responsible Offshore Development Alliance, NOAA Office of Science and Technology (OST), Shining Sea Fisheries Consulting, LLC

The project will leverage existing networks of fishermen from the Northeast, Alaska, and the West Coast to create mCDR literacy within the community. The project will form a fisherman's marine carbon dioxide learning committee and will produce informational sheets, webinars and articles. Next, the partners will work with this committee, experts within NOAA, and coastal acidification networks to develop three documents to offer guidance on: 1) best practices for siting including recommendations of criteria for project evaluation and permitting, 2) methods to engage commercial fisherman as co-producers of necessary data from observing system and ecosystem impact studies, and 3) ways to engage with the fishman community in culturally appropriate ways.

Coupling Desalination with Novel mCDR Membranes

PI: Katherine Hornbostel, University of Pittsburgh

Partners: University of Pittsburgh, Arizona State University, National Renewable Energy Laboratory, University of California, Irvine

The research team will work with existing desalination membranes to enable them to remove CO2 from seawater while producing fresh drinking water. The team will investigate two different promising chemical groups that can be attached to the surface of desalination membranes to make CO2 bubble out of the seawater when it reaches the membrane. The team will perform a combination of experiments, prototyping, modeling, and technoeconomic assessment to determine which types of membranes and surface groups will result in the most cost-effective system.

Data requirements for quantifying natural variability and the background ocean carbon sink in mCDR models

PI: Galen McKinley, Columbia University

Partners: Columbia University, NOAA PMEL, NSF

"Marine carbon dioxide removal presents exciting new challenges for scientists who have been working for decades to measure the ocean carbon sink that naturally removes 25% of humanity's carbon dioxide emissions from the atmosphere each year" says Dr. Galen McKinley of Columbia University. "In this project, we will apply state-of-the-art methods we've developed for ocean carbon sink studies to the challenge of marine carbon dioxide removal monitoring, reporting and verification." To validate the models that will be required to estimate carbon credits for marine carbon dioxide, the team will determine the natural background carbon uptake, its variability, and the degree of certainty with which it is known in areas where mCDR deployments are likely to occur. The project will also determine the requirements for additional sampling of pCO2, a measure of the carbon dioxide in seawater, needed to quantify the baseline ocean carbon sink in models. This work will develop machine learning approaches for use in mCDR monitoring, reporting and verification. It will also support future observing system development, both of which are critical for future development of observation-based benchmarks for evaluation of proposed mCDR models.

Other NOPP funded opportunities

A Gulf of Maine Ambient Sound Network

PI: Jason Gedamke, NOAA NMFS

Partners: Navy-ONR, NOAA-National Ocean Service (NOS) & NMFS, BOEM

The Gulf of Maine (GoMe) is a semi-enclosed sea with limited exchange of waters with the northwestern Atlantic due to a large series of shoals and banks along its southern and southeastern boundary. The interior GoMe is fed by surface waters from the Nova Scotian shelf and by deeper, nutrient rich slope waters entering through the Northeast channel. Changes to these currents and recent northward shifts of the Gulf Stream have magnified the influence of climate change in the GoMe. It has been found, for example, that sea surface temperatures in the GoMe are increasing faster than 99% of the global ocean, and benthic waters are also rapidly increasing at a rate of 0.2°C/yr. These and other related effects have influenced change in the GoMe ecosystem at multiple trophic levels, including species that are endangered and/or are important considerations for the shifting/growing activities of the blue economy.

One aspect of detecting and monitoring climate change in the GoMe is monitoring its soundscape. Natural sound has been used, for example, to monitor bubble-mediated air-sea gas exchange, rainfall, the habitat usage and behavior of marine organisms (e.g., marine mammals, soniferous fishes), and the sound of healthy reef systems. Federal, state, and academic efforts are currently underway to monitor ambient sound in the GoMe, although these efforts lack the permanency required for long-term change detection. This effort seeks to add connectivity and build community around these efforts, leveraging existing federal agency investments and creating an environment that enhances wider and deeper understanding of the GoMe system and its natural and anthropogenic influences.

Appendix 3. Reported Annual Agency Contributions to NOPP Projects

Agency	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
BOEM	$1,052,620	$3,100,025	$5,968,527	$4,694,001	$7,913,019	$5,391,734	$2,475,464	$990,269	$3,003,277	$1,325,889
BSEE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DOE	$0	$0	$0	$0	$0	$4,900,000	$100,000	$890,000	$350,000	$200,000
NASA	$1,881,041	$2,044,965	$1,978,308	$1,411,618	$776,886	$2,447,638	$2,000,000	$1,861,996	$1,484,595	$999,991
NOAA	$550,000	$438,321	$409,000	$3,347,554	$5,009,402	$11,412,750	$4,700,000	$3,000,000	$1,227,092	$4,369,000
NSF	$149,989	$0	$0	$0	$3,072,498	$2,529,448	$1,575,680	$287,408	$4,612,635	$2,376,422
ONR	$3,750,000	$8,094,000	$7,441,000	$8,278,806	$7,864,000	$8,137,000	$8,034,238	$8,364,000	$8,569,754	$8,356,944
U.S. Coast Guard	$0	$0	$0	$586,250	$0	$0	$0	$0	$0	$0
USGS	$0	$0	$0	$0	$0	$0	$2,400,000	$0	$0	$0
NOAA IRA*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$14,360,000
Total	**$7,383,650**	**$13,677,311**	**$15,796,835**	**$18,318,229**	**$24,635,805**	**$34,818,570**	**$21,285,382**	**$15,393,673**	**$19,247,353**	**$31,988,246**

*The IRA provided $14.36 million of one-time funding for ten NOAA NOPP projects in FY 2023.

Appendix 4. All NOPP Projects Active through Fiscal Year 2023

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
An opportunity to study Ocean Alkalinity Enhancement, CDR, and ecosystem impacts through coastal liming	https://nopp.org/projects/an-opportunity-to-study-ocean-alkalinity-enhancement-cdr-and-ecosystem-impacts-throughcoastal-liming/	NOAA, EPA, University of Rhode Island, University of Connecticut, University of Hawai'i at Manoa, Weekapaug Golf Course	Palter, Jaime	University of Rhode Island	3	2023
Tidal wetlands as a low pH environment for accelerated and scalable olivine dissolution	https://nopp.org/projects/tidal-wetlands-as-a-low-ph-environment-for-accelerated-and-scalable-olivine-dissolution/	USGS Woods Hole Coastal & Marine Science Center, Woods Hole Oceanographic Institution, Vesta Corporation, NOAA NMFS, NPS	Kroeger, Kevin	USGS	4	2023
Assessing Carbon Dioxide Removal and Ecosystem Response for an Ocean Alkalinity Enhancement Field Trial	https://nopp.org/projects/assessing-carbon-dioxide-removal-and-ecosystem-response-for-an-ocean-alkalinity-enhancement-field-trial/	Woods Hole Oceanographic Institution, Monterey Bay Aquarium Research Institute, Marine Robotic Vehicle Systems	Nicholson, David	Woods Hole Oceanographic Institution	3	2023
Assessing efficacy of electrochemical ocean alkalinity enhancement at an existing outfall using tracer release experiments and oceanographic models	https://nopp.org/projects/assessing-efficacy-of-electrochemical-ocean-alkalinity-enhancement-at-an-existing-outfall-using-tracer-release-experiments-and-oceanographic-models/	University of Hawai'i at Manoa, [C]worthy Convergent Research LLC, University of California Los Angeles, Ebb Carbon Inc, American University	Ho, David	University of Hawai'i at Manoa	3	2023

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Assessing the laboratory and field responses of diatoms and coccolithophores to ocean alkalinity enhancement	https://nopp.org/projects/assessing-the-laboratory-and-field-responses-of-diatoms-and-coccolithophores-to-ocean-alkalinity-enhancement/	Woods Hole Oceanographic Institution, Rutgers University	Subhas, Adam	Woods Hole Oceanographic Institution	3	2023
Developing a coupled benthic-pelagic biogeochemical model to evaluate the effectiveness of mCDR interventions	https://nopp.org/projects/developing-a-coupled-benthic-pelagic-biogeochemical-model-to-evaluate-the-effectiveness-of-mcdr-interventions/	Northeastern University, NOAA GFDL, University of Maine Walpole, Rutgers University, University of Connecticut, UMCES	Schultz, Christina; Luo, Jessica	Northeastern University	4	2023
Carbon capture and ocean acidification mitigation potential by seaweed farms in tropical and subtropical coastal environments	https://nopp.org/projects/carbon-capture-and-ocean-acidification-mitigation-potential-by-seaweed-farms-in-tropical-and-subtropical-coastal-environments/	Scripps Institute of Oceanography University of California San Diego, Okinawa Institute of Science and Technology, Marine Biological Laboratory, Sunburst Sensors, NOAA PMEL	Andersson, Andreas	UC San Diego	3	2023
Determining the Influence of Ocean Alkalinity Enhancement on Foraminifera Calcification, Distribution, and CaCO3 Production	https://nopp.org/projects/determining-the-influence-of-ocean-alkalinity-enhancement-on-foraminifera-calcification-distribution-and-caco3-production/	Vassar College, NOAA OAP AOML, Oregon State University	Haynes, Laura	Vassar College	3	2023
Biotic calcification impacts on mCDR additionality	https://nopp.org/projects/biotic-calcification-impacts-on-marine-carbon-dioxide-removal-additionality/	University of Washington CICOES, National Center for Atmospheric Research	Kearney, Kelly	University of Washington (CICOES)	4	2023

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Assessing chemical and biological implications of alkalinity enhancement using carbonate salts obtained from captured CO2 to mitigate negative effects of ocean acidification and enable mCDR	https://nopp.org/projects/assessing-chemical-and-biological-implications-of-alkalinity-enhancement-using-carbonate-salts-obtained-from-captured-co2-to-mitigate-negative-effects-of-ocean-acidification-and-enable-mcdr/	Scripps Institute of Oceanography, University of California San Diego, Pacific Rim Design and Development, Oregon State University, NOAA PMEL	Dickson, Andrew	UC San Diego	3	2023
Quantifying the Efficacy of Wastewater Alkalinity Enhancement on mCDR and Acidification Mitigation in a Large Estuary	https://nopp.org/projects/quantifying-the-efficacy-of-wastewater-alkalinity-enhancement-on-mcdr-and-acidification-mitigation-in-a-large-estuary/	UMCES, University of Delaware, Planetary Technologies, Inc.	Testa, Jeremy	UMCES	3	2023
Multiscale observing system simulation experiments for iron fertilization in the Southern Ocean, Equatorial Pacific, and Northeast Pacific	https://nopp.org/projects/multiscale-observing-system-simulation-experiments-for-iron-fertilization-in-the-southern-ocean-equatorial-pacific-and-northeast-pacific/	WHOI, National Center for Atmospheric Research (NCAR), NOAA Geophysical Fluid Dynamics Laboratory, NSF	McGillicuddy, Dennis	Woods Hole Oceanographic Institution (WHOI)	3	2023
Data requirements for quantifying natural variability and the background ocean carbon sink in mCDR models	https://nopp.org/projects/data-requirements-for-quantifying-natural-variability-and-the-background-ocean-carbon-sink-in-mcdr-models/	Columbia University, NOAA PMEL, NSF	McKinley, Galen	Columbia University	3	2023
Electrolysis-driven weathering of basic minerals for long-term ocean buffering and CO2 reduction	https://nopp.org/projects/electrolysis-driven-weathering-of-basic-minerals-for-long-term-ocean-buffering-and-co2-reduction/	Oregon State University, NOAA PMEL	Hales, Burke	Oregon State University	3	2023

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Assessing the effects and risks of ocean alkalinity enhancement on the physiology, functionality, calcification, and mineralogy of corals and crustose coralline algae in the Pacific	https://nopp.org/projects/assessing-the-effects-and-risks-of-ocean-alkalinity-enhancement-on-the-physiology-functionality-calcification-and-mineralogy-of-corals-and-crustose-coralline-algae-in-the-pacific/	University of Hawai'i, Manoa, Texas A&M Corpus Christi, NOAA Pacific Islands Fisheries Science Center	Meléndez, Melissa	University of Hawai'i, Manoa	4	2023
Engaging U.S. Commercial Fishing Community to Develop Recommendations for Fishery-Sensitive mCDR Governance, Collaborative Research and Monitoring, and Outreach to Fishing Communities	https://nopp.org/projects/engaging-u-s-commercial-fishing-community-to-develop-recommendations-for-fishery-sensitive-mcdr-governance-collaborative-research-and-monitoring-and-outreach-to-fishing-communities/	Responsible Offshore Development Alliance, NOAA Office of Science and Technology (OST), Shining Sea Fisheries Consulting, LLC	Hogan, Fiona	Responsible Offshore Development Alliance	2	2023
Coupling Desalination with Novel mCDR Membranes	https://nopp.org/projects/coupling-desalination-with-novel-mcdr-membranes/	University of Pittsburgh, Arizona State University, National Renewable Energy Laboratory, University of California, Irvine	Hornbostel, Katherine	University of Pittsburgh	2	2023
A Gulf of Maine Ambient Sound Network	https://nopp.org/projects/a-gulf-of-maine-ambient-sound-network/	ONR, NOAA NOS & NMFS, BOEM	Gadamke, Jason	NOAA NMFS Office of Science and Technology	3	2023
Offshore Analysis of Seafloor Instability and Sediments (OASIS Partnership) with Applications to Offshore Safety and Marine Archaeology	https://nopp.org/projects/offshore-analysis-of-seafloor-instability-and-sediments-oasis-partnership-with-applications-to-offshore-safety-and-marine-archaeology/	BOEM, USGS, LSU, The Water Institute of the Gulf, SEARCH	Bentley, Samuel (LSU); Chaytor, Jason (USGS)	Louisiana State University and USGS	5	2022

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Enhancing the Realism of MOM6-SIS2 Simulations with Ocean Tides	https://nopp.org/projects/enhancing-the-realism-of-mom6-sis2-simulations-with-ocean-tides/	NOAA, NASA, Oregon State University, University of Michigan, Florida State University	Zaron, Edward	Oregon State University	3	2022
Electrochemical Acid Sequestration to Ease Ocean Acidification (EASE-OA)	https://nopp.org/projects/electrochemical-acid-sequestration-to-ease-ocean-acidification-ease-oa/	NOAA, DOE, ClimateWorks Foundation, University of Washington, Ebb Carbon Inc.	Carter, Brendan	University of Washington and NOAA PMEL	2	2022
The CeNCOOS MBON: Marine biodiversity information in support of a healthy Blue Economy in the central California Current	https://nopp.org/projects/the-cencoos-mbon-marine-biodiversity-information-in-support-of-a-healthy-blue-economy-in-the-central-california-current/	NOAA, Monterey Bay Aquarium Research Institute, Central & Northern California Ocean Observing System, University of California Santa Cruz, Point Blue Conservation Science	Chavez, Francisco	Monterey Bay Aquarium Research Institute	5	2022
Quantifying marine biodiversity through movements and feeding: Assessing coastal marine ecosystem dynamics near estuary mouths	https://nopp.org/projects/quantifying-marine-biodiversity-through-movements-and-feeding-assessing-coastal-marine-ecosystem-dynamics-near-estuary-mouths/	Office of Naval Research, NOAA, University of New Hampshire, Gulf of Maine Research Institute, Northeastern Regional Association of Coastal Ocean Observing Systems	Furey, Nathan	University of New Hampshire	5	2022
Louisiana Deltaic Estuaries MBON: Sea Level Rise Sentinels	https://nopp.org/projects/louisiana-deltaic-estuaries-mbon-sea-level-rise-sentinels/	LUMCON, LSU, NOAA Fisheries Southeast Regional Office, Texas A&M GCOOS, Imagine Water Works, Jillian Tupitza (eDNA)	Glaspie, Cassie	Louisiana State University	5	2022

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
AMBON (Arctic MBON) - linking biodiversity observations in the Arctic	https://nopp.org/projects/ambon-arctic-mbon-linking-biodiversity-observations-in-the-arctic/	NASA, Office of Naval Research, U.S. Fish and Wildlife Service, Bureau of Ocean Energy Management, University of Alaska Fairbanks, University of Maryland Center for Environmental Sciences, Oregon State University, University of Washington, Alaska Ocean Observing System, Native Village of Kotzebue	Iken, Katrin	University of Alaska Fairbanks	5	2022
The Southeast US Marine Biodiversity Observation Network (MBON): Toward Operational Marine Life Data for Conservation and Sustainability	https://nopp.org/projects/the-southeast-us-marine-biodiversity-observation-network-mbon-toward-operational-marine-life-data-for-conservation-and-sustainability/	NASA, NOAA, University of South Florida, Oregon State University, Texas A&M University, University of Miami, Gulf of Mexico Coastal Ocean Observing System, Southeast Coastal Ocean Observing System, Florida Fish and Wildlife Research Institute, EcoQuants	Muller-Karger, Frank	University of South Florida	5	2022
Diagnosis and validation of the time and spatial variability of remotely generated internal waves in global ocean simulations	https://nopp.org/projects/diagnosis-and-validation-of-the-time-and-spatial-variability-of-remotely-generated-internal-waves-in-global-ocean-simulations/	National Research Laboratory, University of Michigan	Buijsman, Maarten	University of Southern Mississippi	3	2022

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Improving the representation of internal waves in the Navy and NOAA data assimilative forecasting systems	https://nopp.org/projects/improving-the-representation-of-internal-waves-in-the-navy-and-noaa-data-assimilative-forecasting-systems/	NRL, NOAA/NCEP, U. of Southern Mississippi, U. of Michigan, Tendral, LLC.	Chassignet, Eric	Florida State University	3	2022
A global distributed observing program for shear, energy flux, and mixing by internal waves	https://nopp.org/projects/a-global-distributed-observing-program-for-shear-energy-flux-and-mixing-by-internal-waves/	University of Washington, NOAA, NSF, Teledyne Webb Research	Girton, James	Woods Hole Oceanographic Institution	3	2022
The internal wave spectrum and boundary mixing in the sub-tropical south Atlantic	https://nopp.org/projects/the-internal-wave-spectrum-and-boundary-mixing-in-the-sub-tropical-south-atlantic/	University of Delaware, University of Maryland, Georgia Institute of Technology, National Research Laboratory	Polzin, Kurt	Woods Hole Oceanographic Institution	3	2022
A distributed network of internal wave resolving moored arrays for assessing tide-resolving model fields and improving forecasts in the coastal ocean	https://nopp.org/projects/a-distributed-network-of-internal-wave-resolving-moored-arrays-for-assessing-tide-resolving-model-fields-and-improving-forecasts-in-the-coastal-ocean/	Scripps Institution of Oceanography University of California San Diego, Woods Hole Oceanographic Institution, Jet Propulsion Laboratory Pasadena	Waterhouse, Amy	University of California, San Diego, SCRIPPS	3	2022
Wildlife and Offshore Wind (WOW): A Systems Approach to Research and Risk Assessment for Offshore Wind Development from Maine to North Carolina	https://nopp.org/projects/wildlife-and-offshore-wind-wow-a-systems-approach-to-research-and-risk-assessment-for-offshore-wind-development-from-maine-to-north-carolina/	DOE, BOEM, Duke University, Cornell University, Florida State University, Rutgers University, Scientific Innovations, Southall Environmental Associates, SUNY Stony Brook, Syracuse	Nowacek, Douglas P.	Duke University	5*	2022

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
		University, Tetra Tech, University of St. Andrews, Wildlife Conservation Society, Woods Hole Oceanographic Institute, New England Aquarium				
Cost-Effective Environmental Monitoring of Offshore Wind Installations with Automated Marine Robotics	https://nopp.org/projects/cost%e2%80%90effective-environmental-monitoring-of-offshore-wind-installations-with-automated-marine-robotics/	DOE, BOEM, WHOI, Australian Centre for Field Robotics, Marine Advanced Robotics	Camilli, Richard	Woods Hole Oceanographic Institute (WHOI)	3*	2022
Baseline Data Collection on Cetaceans and Seabirds in the Outer Continental Shelf and Slope of Northern California and Oregon to Inform Offshore Wind Energy Development	https://nopp.org/projects/baseline-data-collection-on-cetaceans-and-seabirds-in-the-outer-continental-shelf-and-slope-of-northern-california-and-oregon-to-inform-offshore-wind-energy-development/	DOE, BOEM, Oregon State University, Cascadia Research Collective, ManTech International Corporation	Ballance, Lisa T.	Oregon State University	4*	2022
Surveying commercial fish species and habitat in wind farm areas using a suite of non-lethal survey methods	https://nopp.org/projects/surveying-commercial-fish-species-and-habitat-in-wind-farm-areas-using-a-suite-of-non-lethal-survey-methods/	DOE, BOEM, Coonamessett Farm Foundation, University of Massachusetts Dartmouth, Kitware, Inc., Atlantic Capes Fisheries, Viking Village, Empire Fisheries, Eastern Fisheries, Quinn Fisheries, Nordic Inc, Arnie's Fisheries	Siemann, Liese; O'Hara, Tasha; Davis, Farrell; and Garcia, Luisa	Coonamessett Farm Foundation (CFF)	5*	2022

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Establishing Baseline Data on Bat Activity in The Offshore Environment: Developing Tools and Models to Quantify Risk of Offshore Wind Energy Development	https://nopp.org/projects/establishing-baseline-data-on-bat-activity-in-the-offshore-environment-developing-tools-and-models-to-quantify-risk-of-offshore-wind-energy-development/	DOE, BOEM, EPRI, Bat Conservation International, Stantec, USGS, Woods Hole Group	Newman, Christian	Electrical Power Research Institute (EPRI)	4.25*	2022
COAMPS-TC deterministic, ensemble, and nowcast model support of the ONR NOPP project: Predicting hurricane coastal impacts	https://nopp.org/projects/coamps-tc-deterministic-ensemble-and-nowcast-model-support-of-the-onr-nopp-project-predicting-hurricane-coastal-impacts/	ONR, NRL	Komaromi, William	NRL	4	2021
Coastal Elevation Models and Land Surface Variables for Use in Forecasting Hurricane Impacts	https://nopp.org/projects/coastal-elevation-models-and-land-surface-variables-for-use-in-forecasting-hurricane-impacts/	ONR, USGS, NOAA, University of Colorado Boulder, Marda Science LLC, University of North Carolina Greensboro	Gesch, Dean	USGS	4	2021
Remote Sensing of the U.S. Coastline Impacted by Land-Falling Hurricanes	https://nopp.org/projects/remote-sensing-of-the-u-s-coastline-impacted-by-land-falling-hurricanes/	ONR, National Geospatial Intelligence Agency, University of Miami, Airbus USA, University of Massachusetts Amherst, Capella Space	Romeiser, Roland	University of Miami	4	2021
In-situ measurements of ocean waves from air-deployed Directional Wave Spectra Drifters (DWSD) and Alamo Floats	https://nopp.org/projects/in-situ-measurements-of-ocean-surface-waves-from-air-deployed-directional-wave-spectra-drifters-dwsd-and-air-launched-autonomous-micro-observer-alamo-floats/	ONR, NOAA, University of California San Diego, University of Miami, Woods Hole Oceanographic Institution, U.S. Naval Academy, MRV Systems LLC	Centurioni, Luca	Scripps Institution of Oceanography	4	2021

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Air-deployed wave buoys for hurricane forecast improvements	https://nopp.org/projects/air-deployed-wave-buoys-for-hurricane-forecast-improvements/	ONR, NOAA, University of Washington, Sofar Ocean Technologies, University of Colorado Boulder	Thomson, Jim	University of Washington	4	2021
Real-time and observed measurements of hurricane-induced hydrodynamics and flooding	https://nopp.org/projects/real-time-and-observed-measurements-of-hurricane-induced-hydrodynamics-and-flooding/	ONR, USGS, NOAA, Sofar Ocean Technologies	Brown, Jenna	USGS	4	2021
Forecasting Coastal Impacts from Tropical Cyclones along the U.S. East and Gulf Coasts using the ADCIRC Prediction System	https://nopp.org/projects/forecasting-coastal-impacts-from-tropical-cyclones-along-the-us-east-and-gulf-coasts-using-the-adcirc-prediction-system/	ONR, NOAA, University of Georgia, Renaissance Computing Institute, University of North Carolina Chapel Hill, The Water Institute of the Gulf, Oregon State University, North Carolina State University, Seahorse Coastal Consulting, University of Rhode Island	Luettich, Richard	University of North Carolina Chapel Hill	4	2021
Forecasting Hurricane Impacts on CoastS - FHICS	https://nopp.org/projects/forecasting-hurricane-impacts-on-coasts-fhics/	ONR, USGS, Deltares, University of Central Florida, NRL, IHE Delft Institute for Water Education	Nederhoff, Kees	Deltares USA	4	2021
Coupled Ocean Atmosphere Waves Sediment Transport (COAWST) - Waves, Sediment, Surge and	https://nopp.org/projects/coawst-wsssr-coupled-ocean-atmosphere-waves-sediment-transport-waves-sediment-surge-	ONR, USGS, University of Florida, Fathom Science LLC, Louisiana State University	Olabarrieta Lizaso, Maitane	University of Florida	4	2021

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Structure Response (WSSSR) Forecasting System	and-structure-response-forecasting-system/					
Offshore Wind, Fisheries and Protected Species Science to address the U.S. Climate Crisis	https://nopp.org/projects/offshore-wind-fisheries-and-protected-species-science-to-address-the-u-s-climate-crisis/	NOAA, BOEM, NRL	Lipsky, Andrew (program manager)	NOAA Northeast Fisheries Science Center	3	2021
The Effects of Sea Level Rise (ESLR): surface transportation resilience in collaboration with the Department of Transportation	https://nopp.org/projects/the-effects-of-sea-level-rise-eslr-surface-transportation-resilience-in-collaboration-with-the-department-of-transportation/	NOAA, FHWA, Auburn University, University of South Alabama, University of Wisconsin-Madison, Alabama Department of Transportation, University of New Hampshire, Rockingham (New Hampshire) Planning Commission, JFK Environmental Services LLC, South Coast Engineers Inc.	Bowers, Benjamin: Sias, Jo	Auburn University: University of New Hampshire	2	2021
Ocean Surface Topography Science Team	https://nopp.org/projects/ocean-surface-topography-science-team/	NOAA, NASA, University of Maryland, Global Science & Technology Inc., Rutgers University	Carton, James; Egido, Alejandro; Farrell, Sinead; Wilkin, John	University of Maryland; Global Science & Technology Inc.; Rutgers University	3	2021
U.S. EEZ Mapping and Exploration in the Aleutian Islands	https://nopp.org/projects/u-s-eez-mapping-and-exploration-in-the-aleutian-islands/	NOAA, BOEM, University of New Hampshire, Saildrone Inc., Monterey Bay Aquarium Research Institute	Mayer, Larry	University of New Hampshire	3	2021

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Satellite Hosting Atmospheric and Littoral Ocean Water Sensors (SHALLOWS) Project: Phase A 2 (continuation from 2018 start)	https://nopp.org/projects/satellite-hosting-atmospheric-and-littoral-ocean-water-sensors-shallows-project-phase-a-2/	ONR, NASA, NOAA, U.S. Army Corps of Engineers, University of Cincinnati, Air Force Institute of Technology, University of Alabama	Tolbert, Carol	NASA Glenn Research Center	1**	2021 (from 2018 start)
Bichromatic Littoral Temperature Observer (BLTO) Instrument (continuation from 2018 start)	https://nopp.org/projects/bichromatic-littoral-temperature-observer-blto-instrument/	ONR, Sierra Lobo Inc., University of Cincinnati	Putman, Philip	Sierra Lobo Inc.	2	2021 (from 2018 start)
SOAR Cellular Ocean Altimetry / Scatterometry Technology (COAST), Phase A-2 (continuation from 2018 start)	https://nopp.org/projects/soar-cellular-ocean-altimetry-scatterometry-technology-coast-phase-a-2/	ONR, GeoOptics, University of Colorado	Yunck, Thomas	GeoOptics	1	2021 (from 2018 start)
Escanaba Trough hydrothermal sulfide system - exploring the seafloor and oceanic footprints	https://nopp.org/projects/escanaba-trough-hydrothermal-sulfide-system-exploring-the-seafloor-and-oceanic-footprints/	USGS, NOAA, BOEM, University of Hawai'i at Mānoa, Memorial University, National Oceanography Centre, University of California Davis, University of Washington, University of Bergen	Gartman, Amy	USGS	1.5	2020
A Mixed-Precision Hybrid Saddle-Point 4D-Var System for ROMS with Application to Assimilation of Remotely-Sensed Bio-Optical Properties	https://nopp.org/projects/a-mixed-precision-hybrid-saddle-point-4d-var-system-for-roms-with-application-to-assimilation-of-remotely-sensed-bio-optical-properties/	ONR, NOAA, Rutgers University, University of California Santa Cruz	Wilkin, John	Rutgers, The State University of New Jersey	3	2019

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Lagrangian and Coupled Data Assimilation enhanced by Machine Learning to improve Operational Ocean Prediction	https://nopp.org/projects/lagrangian-and-coupled-data-assimilation-enhanced-by-machine-learning-to-improve-operational-ocean-prediction/	ONR, University of Maryland, University of California San Diego, NRL	Carton, James (formerly Stephen Penny)	University of Maryland	3	2019
The CeNCOOS MBON: Integrating remote sensing, in situ data and models to understand central California ecosystem responses to environmental change	https://marinebon.org/us-mbon/california-central/	NOAA, University of California Santa Cruz, Oregon State University, Monterey Bay Aquarium Research Institute, Point Blue, Humboldt State University, Central and Northern California Ocean Observing System	Chavez, Francisco	Monterey Bay Aquarium Research Institute	3	2019
A sustainable, integrated AMBON in the Chukchi Sea	https://marinebon.org/us-mbon/arctic/	NOAA, University of Alaska Fairbanks	Iken, Katrin	University of Alaska - Fairbanks	3	2019
Small-Sat Lidar Sea Surface Vector Winds and Height Measurements System	https://nopp.org/projects/small-sat-lidar-sea-surface-vector-winds-and-height-measurements-system/	ONR, NASA, University of California Irvine	Boyraz, Ozdal	University of California Irvine	2	2018
Development of Drifting Buoys to Measure Dynamic Ocean Topography and Precipitable Water Vapor	https://nopp.org/projects/development-of-drifting-buoys-to-measure-dynamic-ocean-topography-and-precipitable-water-vapor/	NSF, NOAA, NASA, University of Washington	Morison, James	University of Washington	3**	2018

Title	Project Web Link	Partners	Lead Principal Investigator(s)	Lead Institution(s)	Duration (years)	Start (fiscal year)
Dissolved Methane Sensor	https://nopp.org/projects/dissolved-methane-sensor/	NSF, NOAA, Woods Hole Oceanographic Institution, RingIR Inc., National Academy of Sciences	Michel, Anna	Woods Hole Oceanographic Institution	3**	2018
Development of a Carbon Seaglider for ocean acidification Monitoring and Inorganic Carbon Processes Studies	https://nopp.org/projects/development-of-a-carbon-seaglider-for-ocean-acidification-monitoring-and-inorganic-carbon-processes-studies/	NSF, University of Alaska Fairbanks, Alutiiq Pride Shellfish Hatchery, Kongsberg Underwater Technology	Hauri, Claudine	University of Alaska Fairbanks	3**	2018
Minions: A Low-cost Float for Distributed, Lagrangian Observations of the biological Carbon Pump	https://nopp.org/projects/minions-a-low-cost-float-for-distributed-langrangian-observations-of-the-biological-carbon-pump/	NSF, NASA, University of Rhode Island, Monterey Bay Aquarium Research Institute, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution, Universities Space Research Association	Omand, Melissa	University of Rhode Island	3**	2018

* - These projects were initiated in FY 2022 but were not reported in the FY 2022 Annual Report on NOPP.

** - These projects received no cost extension due to unforeseen COVID circumstances.

Acronyms

ADEON	Atlantic Deepwater Ecosystem Observatory Network
AMBON	Arctic MBON
AOML	Atlantic Oceanographic & Meteorological Laboratory
BAA	Broad Agency Announcement
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
EASE-OA	Electrochemical Acid Sequestration to Ease Ocean Acidification
EPA	Environmental Protection Agency
EiP	Excellence in Partnership
FHWA	Federal Highway Administration
FY	Fiscal Year
GFDL	Geophysical Fluid Dynamics Laboratory
IOOS	Integrated Ocean Observing System
IRA	Inflation Reduction Act
IWG	Interagency Working Group
MBON	Marine Biodiversity Observation Network
mCDR	marine Carbon Dioxide Removal
MCDR–FTAC	Marine Carbon Dioxide Removal Fast-Track Action Committee
NASA	National Aeronautics and Space Administration
NRL	Naval Research Laboratory
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOMEC	National Ocean Mapping, Exploration, and Characterization
NOPP	National Oceanographic Partnership Program
NOS	National Ocean Service
NPS	National Park Service
NSF	National Science Foundation
NSTC	National Science and Technology Council
OAP	Ocean Acidification Program
OASIS	Offshore Analysis of Seafloor Instability and Sediments
OASIS, Inc.	Ocean Acoustical Services and Instrumentation Systems, Inc.
ONR	Office of Naval Research
OPC	Ocean Policy Committee
ORAP	Ocean Research Advisory Panel
OST	Ocean Science and Technology Subcommittee
OSTP	Office of Science and Technology Policy
PI	Principal Investigator
RFP	Request for Proposal
SOST	Subcommittee on Ocean Science and Technology
UMCES	University of Maryland Center for Environmental Science
UNH	University of New Hampshire
USCG	United States Coast Guard
USGS	United States Geological Survey