

FY 2025 OEAB Program Review of NOAA Ocean Exploration: Findings and Recommendations

*A Review of NOAA Ocean Exploration's achievements,
challenges, and strategic directions as evaluated by the
Ocean Exploration Advisory Board (OEAB)*

Review Panel Members:

Dr. Vicki Ferrini, Chair, Columbia University, Lamont-Doherty Earth Observatory

Dr. Peter Girguis, Harvard University

Dr. Kevin Hand, NASA Jet Propulsion Laboratory

Dr. Mark Moline, University of Delaware

Dr. Frank Muller-Karger, University of South Florida

Dr. Ellen Prager, Earth2Ocean Inc.

Mr. Justin Manley, Just Innovation Inc.

Mr. Ramsay Taum, Pacific Islands Leadership Institute, Hawaii Pacific University

Mr. Eric King, Schmidt Ocean Institute

Mr. David Millar, Fugro USA Inc.

Dr. Carla Smart, Johns Hopkins Applied Physics Laboratory

Dr. Veronique Le Roux, Woods Hole Oceanographic Institution

Overview

Achievements in Quality, Relevance, and Performance: NOAA Ocean Exploration (OE) has made significant progress advancing national exploration goals while enhancing the quality, relevance, and efficacy of activities and outcomes. Over the past five years, OE has specifically strengthened coordination among partners, fostered technological innovation, and increased public engagement. The Cooperative Institute (OEI) and Explorer Model have proven effective at enhancing collaboration with other organizations and partners, as well as standardizing protocols and advancing technology testing. With respect to community engagement, OE has increasingly worked jointly with local and Indigenous groups and aligned campaigns such as the current "Beyond the Blue" with regional and national strategic priorities. NOAA OE's adaptive public outreach strategy demonstrates the flexibility and expanded engagement necessary to sustain public interest, reach broader audiences, and ensure that ocean exploration remains relevant to the nation. Overall, the Board commends NOAA OE's achievements, and recommends that it further aligns exploration with the nation's global maritime challenges and public engagement needs detailed below.

Upcoming Challenges: NOAA OE must continue to highlight its unique role, enhance public engagement, increase partnerships with industry and academia, and remain agile in adapting to technological innovations and evolving national maritime priorities. The program must also find ways to adapt and sustain its efforts while regularly facing uncertainty in its budget and agency priorities. The transition from the NOAA ship *Okeanos Explorer* to *NOAA Ship Discoverer* will require careful planning to ensure that the ship is purpose-built for exploration. Balancing exploration that addresses global maritime challenges with National Ocean Mapping, Exploration, and Characterization (NOME) goals is vital, especially under funding constraints. OE should ensure that the data it acquires supports national priorities, including characterizing the ocean environment, advancing scientific understanding, addressing environmental changes, and benefiting society. Leveraging advanced technologies, such as Artificial Intelligence (AI) and Machine Learning (ML), and implementing interoperable data strategies will be pivotal for enhancing data analysis, accessibility and utility.

Strengths to Leverage: NOAA OE's leadership in national and global ocean exploration can be strengthened through strategic partnerships, particularly under NOME, and by prioritizing innovation informed by private sector collaboration. Frameworks such as the OEI, Explorer Model, and interagency coordination, along with potential private sector partnerships, offer scalable approaches to achieving national goals while addressing emerging maritime priorities. NOAA OE is uniquely positioned to advance national prosperity, health, and security through a cohesive and collaborative ocean exploration program that engages multiple partners. It is also

positioned to play a critical role in science diplomacy, strengthening U.S. leadership while safeguarding national interests in international efforts such as the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement and other High Seas initiatives. Emphasizing the societal benefits of ocean exploration—including ecosystem health, sustainable resource management, and the growth of the Blue Economy—can further amplify NOAA OE’s public relevance.

Opportunities for Growth: NOAA OE is positioned to grow its leadership in ocean exploration while contributing to global scientific advancements. Strengthening collaborations across private, academic, and government sectors will significantly extend NOAA OE's reach and influence, while actively pursuing public-private partnerships will further enhance its visibility, scope, and impact. By cultivating a more inclusive exploration community, NOAA OE can draw on a wider range of perspectives and expertise, driving innovation and ensuring the program reflects the full potential of America's talent pool. Ensuring transparency in OEI participation and actively broadening the pool of funded Principal Investigators (PIs) will reinforce NOAA OE's leadership and enhance its ability to address national priorities. This approach strengthens the integrity and impact of NOAA OE's mission while advancing the nation's competitive edge in ocean exploration. In cooperation with other parts of NOAA, OE can help to further identify and document changing ocean conditions, including but not limited to deep-sea biodiversity, ocean heat content and chemistry. Promoting standardized data practices aligned with national and international initiatives, such as essential ocean variable frameworks, will further solidify NOAA OE as a global leader and key contributor to enhancing ocean knowledge. To expand its reach and maintain alignment with national ocean exploration goals, sustained partnerships, broader data applications, and robust tracking of educational and outreach impacts are essential.

Detailed feedback

NOAA OE would benefit from clarifying its **unique role** as an exploration leader and enabler, particularly in light of NOMECE, where it has a significant opportunity to enhance the OE's relevance and recognition, especially through work within the U.S. Exclusive Economic Zone (EEZ). By scaling infrastructure and partnerships, like the OEI, and building collaborations with entities such as NSF and UNOLS, NOAA OE can broaden its resources for large-scale mapping efforts. Emphasizing the Explorer Model and integrating advanced technology, such as uncrewed systems and AI/ML, OE can significantly expand its capacity to meet NOMECE's 2030/2040 mapping and exploration goals while reinforcing its unique role in producing accessible, high-quality ocean exploration data to support science, policy, and public use. Strengthening initiatives such as the Explorer-in-Training program, creating more captivating digital

content, and accelerating mapping efforts within the U.S. EEZ will advance NOAA OE's mission and recognition.

While there is a strong foundation in contract and partnership processes, OE could **improve connections** with the private sector and foster more collaboration across private, academic, and government technology sectors to better achieve its goals. Currently, outreach is narrowly focused, primarily on the science community, educators, and private groups directly servicing tech needs. OE could adopt a more strategic approach to partnerships with government (including NOAA), private, and academic institutions for broader impact. Utilizing the National Oceanographic Partnership Program (NOPP) could help leverage additional funding and partnerships. There are also missed opportunities for partnership and outreach in public engagement, such as large media outlets (e.g., Discovery, NatGeo), innovators in the private sector, and public broadcasting. OE might also benefit from attending professional industry society meetings, private sector, and archaeological conferences to broaden its reach.

NOAA OE faces key challenges that call for a strategic focus on quality and **societal impact** over purely technological innovation and exploration metrics. While excelling in validating mature technologies for reliable use, NOAA OE can further enhance public engagement by highlighting the societal and environmental benefits of ocean exploration. Enhanced strategic planning for high-risk, high-reward innovations, especially in partnership with the private sector, would further strengthen technology development.

The Board noted that assessing the achievement of goals is challenging due to the current reliance on scientific publication counts as primary **metrics of impact**. Expanding the evaluation framework to include additional metrics would provide a more comprehensive view of OE's contributions and value. Examples include impacts on management practices, discoveries with biochemical or technological applications, adoption of technologies in broader industries, social and economic benefits, workforce development, contributions to the Blue Economy, partnerships with the private sector, and leveraged funding. These measures would highlight OE's broader impact and underscore its national relevance beyond scientific publications. Improved tracking of educational impacts from programs like Explorer-in-Training, along with enhanced domestic EEZ mapping efforts, will support NOAA OE's mission and reinforce its leadership in ocean exploration. Additionally, broadening metrics to measure program impacts, including contributions to the Blue Economy and societal benefits, will better highlight NOAA OE's multifaceted contributions.

While data quality control is often highlighted as a challenge, the underlying issue may be the lack of cohesive frameworks for **data standardization and integration**, which should take priority in strategic discussions. The upcoming release of Exploration

Variables 2.0 offers an opportunity to ensure alignment with established frameworks such as Essential Ocean, Climate, and Biodiversity Variables (EOVs, ECVs, and EBVs). To address this, the program should strengthen its emphasis on data standards for grantees and contractors, including Darwin Core (DwC) for taxonomy, Minimum Information about any (x) Sequence (MiXS) for omics, and specific standards for video and acoustic data. Controlled vocabularies like CMECS and WoRMS should also be integrated to enhance interoperability. OE should also prioritize middleware innovation to bridge data platforms and lead efforts in national and international coordination of data standards and observation integration. Partnerships with initiatives like DOOS and Challenger 150 could further advance data standardization, integration, and synthesis, while positioning the program for international leadership and engagement. With the growing need for U.S. leadership in high seas exploration under the Biodiversity Beyond National Jurisdiction (BBNJ) agreement, NOAA OE is well-positioned to lead this important effort.

The OEI has successfully facilitated advancements in new technologies and data management, reinforcing NOAA OE's national and international role in driving open science and ocean exploration innovation. However, questions remain about the **transparency of OEI's processes**, particularly regarding the inclusivity of participation and the extent of support for institutions beyond the five primary partners, which currently appear to dominate funding allocations. Greater clarity is also needed on how OEI aligns its efforts with national priorities, including strengthening resilience to environmental challenges, managing natural resources and ecosystems, and promoting fairness and opportunities for all Americans in the ocean sector.

There is concern that the pool of awardees from **NOFOs** may not be expanding and diversifying. To avoid any perception of favoritism and to encourage broader participation, OE should take steps to expand the awardee community. Innovation could be enhanced by restructuring the NOFO topic selection process to include broader community input, following models used by NSF and NASA. Regarding general outreach and diversifying participation, current efforts appear concentrated in the Ocean Odyssey grants, which focus on middle/high school and college education but have limited impact on the general public, workforce development, or broader OE programs. While OE presentations highlighted some engagement with Minority Serving Institutions (MSIs) through fellowships and student programs, further evaluation is needed to determine whether OE content and messaging is reaching underserved communities including both students and potential PIs.

Key recommendations:

- **Clarify OE's Unique Role and Identity:** NOAA OE remains uniquely positioned to continue leading the nation in advancing critical ocean exploration activities. To maximize its impact, OE should clearly define its distinct role as a leader and enabler of ocean exploration, distinguishing itself from broader science-driven activities while maintaining integration and contributing meaningfully to ocean science. Enhancing the website to spotlight OE's leadership in providing baseline data specific to ocean exploration variables will help clarify its unique role in the ocean space. Aligning more closely with NOMECE will reinforce OE's national importance and strategic contributions. In coordination with other NOAA offices, OE should play a significant role in understanding and documenting changing ocean conditions as they relate to ocean exploration and societal impact.
- **Fortify OE's role in US Science Diplomacy:** OE has the potential to serve as the flagship program for the United States in leading high seas exploration under the BBNJ framework. By framing these efforts as a cornerstone of U.S. science diplomacy, OE could address key national interests while fostering international collaboration. This approach would deepen OE's position as a global leader in ocean exploration, advancing strategic US priorities and showcasing American innovation and leadership on the world stage.
- **Strengthen Alignment with NOMECE and Community Focus:** Aligning OE's strategies with NOMECE will create a unified, cohesive approach that drives progress on national ocean exploration priorities. This alignment will not only accelerate advancements but also expand and strengthen the cross-sector community engaged in coordinated ocean exploration efforts, fostering collaboration and innovation across government, academia, industry, and other stakeholders.
- **Increase Data Accessibility and Engagement:** Ensure OE data is accessible, usable, engaging for diverse audiences. Developing a data stewardship culture around standards and best practices will ensure interoperability, quality control, and alignment with established frameworks (Essential Ocean, Climate, and Biodiversity Variables (EOVs, ECVs, and EBVs)). NOAA should also continue to take steps to assemble and present data and information in formats and materials that are comprehensible to a wide range of stakeholders beyond the exploration and science communities, including decision and policy makers and the public.

- **Advance Innovation with Broader Strategic Planning:** Broaden OE's FFO and OEI programs to encourage high-risk, high-reward innovations. Use an RFI process to engage the private sector and align with NOMECE's framework to foster dynamic partnerships and technological growth. Opportunities for data buys and platform chartering should be used to scale operations and meet NOMECE's mapping objectives and addressing US BBNJ priorities.
- **Focus on Ocean Exploration in E&O:** Emphasize ocean exploration in educational and outreach (E&O) efforts, distinguishing it from general ocean science and literacy to accelerate and highlight exploration-focused engagement. The use of partnerships, including those within NOAA, will be key in showcasing ocean exploration and its value and relevance.
- **Implement Data-Driven Impact Assessment:** Improve evaluation of educational materials and public engagement by tracking classroom use and setting measurable impact goals.
- **Support Career Pathways through Partnerships and Tracking:** Strengthen career development programs by creating metrics to track intern success, supporting long-term impacts on workforce development in ocean exploration fields.
- **Set Clear Goals and Performance Metrics:** Develop measurable goals and milestones to clarify OE's impact. Balance groundbreaking innovations with practical technology applications and ensure project goals align with OE's mission and strengths.