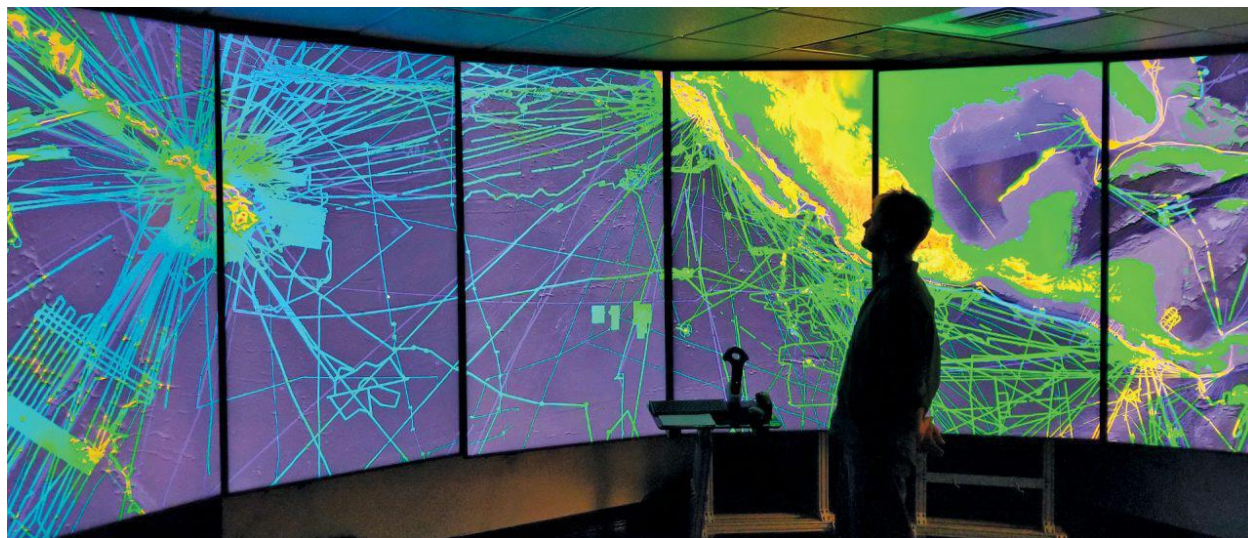


Report of the External Review for the Cooperative Institute for Ocean Exploration (OEI)



OCEAN EXPLORATION COOPERATIVE INSTITUTE



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SUMMARY

An external review of the exploration activities, technology development and innovations, research, education, and outreach programs of the Ocean Exploration Cooperative Institute (OECI), based at the University of Rhode Island – Graduate School of Oceanography (URI GSO), was conducted on April 3 and 4, 2023. This external review was conducted in person and virtually. The OECI is a collaboration between partner institutions (University of Rhode Island, Ocean Exploration Trust, Woods Hole Oceanographic Institution, University of New Hampshire, and University of Southern Mississippi) and NOAA Office of Ocean Exploration and Research (OER) to advance ocean exploration through research, technology innovation, and education. The OECI is a new Cooperative Institute (CI) in its fourth year with the current Cooperative Agreement award covering the period July 1, 2019, through June 30, 2024.

Guidance for conducting the review was provided by the Cooperative Institutes Administration Office (CIAO) within the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Atmospheric Research (OAR). The review was conducted under the auspices of the NOAA Science Advisory Board, which ensures the review team meets the requirements of a subcommittee under the Federal Advisory Committee Act. It should be noted that the guidelines for the CIAO were in the process of being revised with the updated version released in June 2023. This review was subject to the previous version and not the revised version. Despite this change that was in progress, the review committee did consider one revision – Diversity, Equity, and Inclusion – in its review to help provide recommendations to the OECI and NOAA OER for consideration in the next 5-year funding cycle.

A list of review panel members is provided in Appendix I. The agenda for the review meeting is provided in Appendix II.

Summary of Findings and Recommendations

The Review Panel rates OECI as overall **'satisfactory'**. Given the wide scope for the CI and the role of OECI for aiding OER to accomplish its mission, the Review Panel divided observations and findings into the following categories that were independently rated. The Review Panel felt it was important and necessary to consider categories based on the themes identified by OECI and the objectives for the CI identified by NOAA OER. The Review Panel would also like to comment that it was agreed among the members that the OECI was rated 'outstanding' in many areas, but there were key areas for consideration of improvements within the OECI itself, re-shifting of activities (to broaden exploration targets and metrics), and realignment of how NOAA OER leverages the strengths that the OECI could provide to better advance and accelerate meeting OER's Strategic Plan.

The numbers of cruises, technology developments, and research that the OECI has conducted in the last four years is commendable, especially given the external environment challenges (COVID) and internal and NOAA OER leadership changes during the first funding cycle. It is also notable how capable the OECI is able to flex and meet challenging priorities and shifting

planning landscapes. The composition of the OEI is also strong; in fact, this is one of the strongest assets of the OEI in that it includes many world renown institutions and covers an expanse of the U.S. Northeast and Gulf of Mexico in addition to the exploration work being conducted in the U.S. Pacific and Remote Islands Exclusive Economic Zone. The OEI partners also bring extensive research and technology networks, being able to leverage international institutions and private sector partners.

Overall, the Review Panel felt strongly that the OEI as a Cooperative Institute is an asset for NOAA OER and that the OEI should be funded for a second cycle; however, the Review Panel also felt strongly that the OEI could mature in certain categories as it continues in the last year of this award and the next 5-year cycle to be the highest performing and to further increase value and utility to NOAA OER. The Review Panel also identified important gaps that limit the OEI's ability to reach potential as a leader in the ocean exploration and scientific communities. This report is intended to provide constructive and actionable feedback in the form of recommendations for the OEI to begin addressing in Year 5 of the first cycle (2023 – 2024), as many of the recommendations require more than a year to complete and some recommendations require actions by NOAA OER in how the agency interfaces with and utilizes the CI to advance its mission.

The Review Panel's report is organized in three sections:

- Summary table of the Review Panel's observations and findings,
- Justification for continuation of funding for a second 5-year cycle, and
- Recommendations for NOAA OER and the OEI in Year 5 and beyond.

Section 1

Summary table of the Review Panel’s observations and findings

CATEGORY		RATING	KEY FINDINGS
OECI STRUCTURE	Funding	Satisfactory	The majority of funding is Task II with NOAA-initiated collaborative projects with NOAA OER heavily managing the OECI’s agenda. There are less Task III funds allocated to the OECI, limiting the CI’s flexibility in self-selecting projects that advance NOAA OER’s mission. Less Task III funds requires the OECI to rely on leveraging member networks to build new partnerships and source additional funds to expand upon novel research applications. The range of activities across the OECI requires additional Task I funds as OECI management has to maintain an extreme pace in reporting with 50+ active projects, fieldwork campaigns, and student support.
	Governance & Function	Satisfactory	The OECI governance model is dense and does not govern by intent. The model limits broad representation for the selection of proposals and stalls inclusion across the full membership of the OECI. The current governance model, paired with the NOAA OER integration, appears to create inefficient proposal ideation and decision-making processes. The ability for the OECI to take more risks in exploration research and technology is constrained by one-year planning cycle imposed by NOAA OER. There appears to be a lack of young career connection in the organization, specifically in governance model (Working Groups, program leadership).
	Reporting Metrics	Outstanding	The OECI is participating in conferences. These numbers exceed expectations for the length of the program and other constraints, such as COVID. The value of the work is recognized by the academic community with many invited talks and lectures. The OECI is producing strong numbers annually for peer reviewed publications with highest (12) in 2022.
	Support for Students & Staff	Unsatisfactory	The discussion focused on the individual nature of the education and outreach programs happening at partner institutions and it was clear that attempts to cross-pollinate younger staff and students across institutions was unsuccessful. At-large it is unclear if there is confidence across the student population in interacting with leaders in the OECI and NOAA OER. The Review Panel, in conversations and heard during questioning, thought it was clear that many students at the OECI partner institutions did not know about the OECI or were fully integrated into the OECI program., 4his was highlighted as a major gap especially with the emphasis of the OECI serving the Blue Economy as a leader in workforce and economic development for the ocean exploration community.

CATEGORY		RATING	KEY FINDINGS
PARTNERSHIPS	Partnerships (Across OECI)	Outstanding	The Ocean Exploration Trust (OET) partnership is one of the strongest assets and a force multiplier to the OECI (in mapping and outreach), but also can be a limiting factor (with number of sea days, accessibility to EEZ locations, involvement in cruise planning) for researchers at the other OECI institutions. Additional access to ships requires the OECI institutions to leverage existing grants and/or partner with other ship-based organizations to expand time-at-sea.
	Partnerships (New Partners or Institutions)	Satisfactory	The OECI-funded members have individually increased partnerships across federal agencies (e.g., NOAA, Bureau of Ocean Energy Management (BOEM)). There is not a systematic or standard approach across the OECI, but this is ad-hoc or driven by individual proposals for OECI members that require additional funds for research versus receiving more funds from NOAA OER. This creates a disparate strategy and at times it is difficult to discern if the partnerships are strategic in meeting NOAA OER's objectives and the OECI's mission or are simply partnerships of convenience or resulting from grants received outside of the OECI funds.
MISSION	Exploration	Satisfactory	The OECI's mission, specific to 'explore ... the nation's ocean territory' lacks identity and the motivating factors for why exploration is important. This also impacts the ability of the OECI to drive a strong leadership and research agenda with NOAA OER. The OECI does exhibit nimbleness to pivot locations as many of technology and/or research applications are basin agnostic. Yet, exploration is still quite limited to other OET priorities in a given year. The quality of mapping is superior; the quantity of mapping is subject to OET schedules unless OECI institutions have secured ship time through other outside grants. By design, ideation within the OECI appears driven by the OET agenda and not by the OECI governance or NOAA OER priorities.
	Research	Satisfactory	The scientific rigor and execution delivered by OECI is exceptional. However, the general research categories seem ad-hoc as a result of the broad science plan that overly focuses on the NOAA OER Strategic Plan, which lacks itself clear direction, and other NOAA priorities and strategic plans that are topical in nature. There is no cohesion and identity for what the OECI brings that it believes is key to characterizing the nation's ocean territory. While the OECI expressed a focus on full water column exploration, the research efforts seemed skewed toward seafloor exploration with less focus towards water column characterization. The only water column mapping effort is utilizing the WHOI Mesobot vehicle and sensor development designed specifically for this vehicle, to which there is only one available.

CATEGORY		RATING	KEY FINDINGS
MISSION (Cont.)	TECHNOLOGY	Vehicles	Satisfactory - Outstanding The OEI multi-vehicle operation success rate is commendable. The platform integration and interoperability across specific vehicle types used by the OEI is outstanding. Surveys are now routine, reliable and productive with limited at-sea time available. This technology is not agnostic - the utility of some of the vehicles is limited to the specific set of vehicles owned by the academic partner institutions and it is not yet clear how these would be reproduced at scale for NOAA.
		Sensors	Unsatisfactory - Satisfactory The OEI has made incremental improvements in sensors. The sensors developed are vehicle-specific and not adaptable to multiple platforms and it is not clear how sensors could be reproduced at scale for NOAA vehicles. The integration of OEI in the global sensor community is lagging, due to COVID limitations. The funding allocation from NOAA OER does not provide types of funds to accelerate sensor development to stay on par with the private sector or other private academic institutions that are outpacing the OEI.
		Development & Testing	Satisfactory - Outstanding Funding levels provided by NOAA OER are not reliable for the OEI and in turn, may be preventing the OEI from providing proposals that take more risks. The technology developed is focused on addressing a problem (for example, mid-water exploration) and less so on reproducibility by others. Some of the development and testing requires the OEI institution engineers to ensure reliability, which is not sustainable in the broader oceanographic community. However, the development and testing achieved (such as demonstrations of the connectivity from the surface to midwater and tandem operations of vehicles) during the challenging external environments of the last few years has been remarkable.
		Operations-to-Science	Satisfactory The partner institutions have historically excelled at reaching difficult parts of the ocean and are known for developing technology to do this. Yet, this is done in an applied manner by engineers and technicians and less so the OEI scientists, who should also push the boundaries on the research for exploration of the oceans. Accessibility to vessels and platforms provide ample opportunities to measure, to test, and to collect samples and for taking more risks in each. Scientists should comparatively push the boundaries for exploration as is done by the OEI engineers.
		Technology Transfer & Intellectual Property	Unsatisfactory Professionalism of thought is missing with intellectual property management and technology transfer management. There is no clear vision of what will be achieved with the technology development in the next 5 years, if the OEI were to continue. It should be noted that such a vision requires more than one (1) year to complete. Partners leverage their institutions, but there is not a cohesive strategy or approach to managing IP from sensors or novel exploration approaches or exit strategies for the technology such that some of the technology can be utilized broadly across the entire oceanographic community. This is further convoluted by the arrangement of the public and private partners within the OEI.

CATEGORY		RATING	KEY FINDINGS
OUTREACH	Outreach (Workforce)	Satisfactory	The opportunity for the OECI to serve as a talent pipeline is currently underutilized by the OECI and NOAA OER and should be a key focus area in the next 5-year cycle. NOAA OER does not seem to fully increase awareness of the OECI as a talent pipeline for the agency.
	Outreach (Programs)	Outstanding	The programs are well-structured and successful, mainly because the programs focus on different constituencies and do not overlap. The programs focus to the strengths of individual partner institutions. There is a lack of transference with programs across institutions. This is in part due to the strengths of institutions themselves, location and demographics of the partner institutions, and the accessibility to other educational institutions – items that may not be easily transferable. With the successes gained across institutions, the OECI should focus on publishing the models of the programs and adding new partners that can help to amplify or adapt these models across other institutions, entities, and sectors. NOAA OER could be a conduit to bring these models into NOAA and help to distribute the models through other NOAA outreach programs.
ENGAGEMENT & EDUCATION	Engagement (Communities)	Satisfactory	The OECI partner institutions fully utilize resources to target underrepresented groups (HBCUs, Community Colleges, Technical Colleges) in their vicinity. The OECI is not fully utilizing its abilities to be leading practitioners of culturally relevant partnerships with native and Indigenous communities where the exploration is occurring or accessible to the institutions. Engagement with these communities is limited to leadership of the communities and less so to parts of the community that be part of the workforce, enable future activities, or can learn from the science and mapping efforts, e.g., K-12 schools or local universities.
	Engagement (Ocean Exploration & Scientific Communities)	Unsatisfactory – Satisfactory	The OECI conducts outreach and solicits feedback through engagements with the ocean exploration and scientific communities. While these outreach efforts provide opportunities for partner institution staff or broader communities to share or recommend project ideas, it is not clear how of if the OECI acts on those and this creates perception of not being trustworthy or collaborative in the ocean exploration and scientific communities. Satisfactorily the OECI does engage with NOAA OER programs (Deep Sea Dialogues, Okeanos Explorer) and participates with the broad communities by disseminating outcomes and findings of exploration activities and research in standard community-wide venues, e.g., major scientific conferences.
	Education	Outstanding	The education content generated and distributed by the OECI and the partner institutions at multiple levels is strong. There are unique gems (OECI Storytelling, among others) that are flagships of the OECI. The live streaming ocean exploration and ship-to-shore engagement numbers are outstanding and a notably unique conduit for NOAA to engage with broader communities beyond ocean exploration and research communities. NOAA OER would be at a significant loss without these OECI education contributions.

CATEGORY		RATING	KEY FINDINGS
DATA	Data Accessibility	Satisfactory	Data accessibility for exploration data is trending positively and a recognized area of constant effort and improvement by the OECl. Outstanding: The initiatives with the University of Southern Mississippi to develop common user interfaces are a unique strength of the OECl and should be continued as NOAA OER standard practice. Unsatisfactory: The OECl is lagging in being a leader in data accessibility for the ocean exploration and research communities. Accessibility to video data and cruise data is not provided quickly to requestors and the process for requesting can be long, even for researchers collaborating with the OECl.
	Data Management	Unsatisfactory	For generating public data on behalf of government, the OECl is not effectively and quickly annotating video data and other institutions are surpassing the OECl. This directly impacts the data accessibility. There is a misalignment with the OECl and NOAA OER priorities and funding allocated to data management noted by an apparent decrease in funding from Year 3 to Year 4 for data management. and It is also unclear how the OECl and NOAA OER intend to manage data legacy beyond the OECl funding.
NOAA PARTNERSHIP	Utilization of NOAA Enterprise	Satisfactory	There were many instances in the discussion of technology, partnerships, and education/outreach where the OECl is missing valuable connections into other areas of NOAA, e.g., workforce, data & observations, that NOAA OER can help to facilitate. At times, NOAA OER acknowledged such connections, but it was not entirely clear if NOAA OER intends to facilitate such connections, which could expand the utility of the data, the incorporation of research to meeting NOAA priorities, the technology developed, and/or workforce pipeline generated by the OECl.
	Relationship with NOAA OER	Outstanding	The relationship between the OECl and NOAA OER is distinctive. The main reason is the NOAA OER dedicated CI manager that is fully integrated into the CI. In most respects, this is a positive and should continue. It should be recognized that this can also create concern and hesitation within the CI and potentially can limit the true extent of the OECl members to appropriately challenge NOAA OER's views and implementation of the office's Strategic Plan. The OECl should have reasonable freedom and flexibility as a research program to interpret – through science and technology development – NOAA OER's mission goals and Strategic Plan, as is common for all other Cooperative Institutes. The Review Panel also recognizes that changes in NOAA OER in the last 5 years have created lack of stability, shifting priorities, changing relationships, and realigned focus areas (for where to map in the U.S. EEZ) – these were taken under consideration by the Review Panel.
	Diversity, Equity, & Inclusion	N/A	Out of scope for this review. This will be a required topic in the next scientific review of the OECl. The Review Panel and the OECl did discuss this category at a high-level to understand how the CI is considering and implementing DEI programs to inform the Review Panel's recommendation for future funding. While out of scope, the Review Panel commends the OECl's efforts to consider DEI in its activities and how the OECl can advance DEI initiatives in the ocean exploration community.

Section 2

Justification for continuation of funding for a second 5-year cycle

The Review Panel feels strongly that NOAA should fund the OEI for a second 5-year cycle. The Review Panel identified areas for improvement that will further enhance and strengthen the OEI's performance and overall value as a high-performance research and technology program for NOAA OER. The OEI has performed effectively and efficiently given many immense challenges out of the consortium's control, notably COVID-19 pandemic and changes in NOAA OER leadership. The Review Panel recognized these challenges and appreciated the NOAA OER and the OEI's honesty and transparency in managing and adapting to these challenges. The COVID-19 pandemic created extraordinary situations for all large global and national fieldwork programs and limited travel and accessibility to vessels.

The interconnection of NOAA OER and the OEI is unique, and the structure does not exist for any other NOAA Cooperative Institutes. At times this can be challenging for both organizations as to the intent of what a CI should do and the autonomy a CI should have from the agency in how the CI identifies and executes research. The unique relationship and the functioning of that relationship is a key difference that this review considers. The Review Panel attempted to identify areas where the OEI focuses on trying to assume and interpret what NOAA OER wants and how such a dynamic may be affecting performance within the OEI. In this regard, the Review Panel provided recommendations for NOAA OER to consider in how it manages the OEI. Adding to the challenges is the turnover that has happened with NOAA OER leadership. This has resulted in shifting priorities and slowdowns in the overall strategic and project approval processes. Internally the OEI also transferred leadership to a new Executive Director. Also because of these challenges, this has resulted in the underspent funds in the first four years. Despite the challenges, the OEI was able to outstandingly respond, adapt and continue to execute mapping and research. The new OEI leadership and staff are transitioning out of response mode due to the pandemic and are beginning to hit a more solid stride in productivity across all pillars of the Cooperative Institute. Because of the OEI's resiliency and capabilities to continue as a high-performance program, the Review Panel encourages NOAA OER to continue funding for another cycle and to consider what should be appropriate levels of autonomy given to the OEI.

The OEI is performing outstandingly in key categories: partnerships, programs (outreach), education, and performance (reporting metrics). Notably the OEI is leading the exploration community in public outreach and exposure to ocean mapping. Because of this, not continuing this level of outreach will create a significant gap for NOAA OER. More so, NOAA OER has not considered a contingency plan to maintain the high degree and level of outreach if the OEI was not continued. The OEI education programs should be held in similar regard to the success in outreach. Again, not continuing these efforts will create a significant gap in NOAA OER that will be difficult to address given structural and funding limitations within NOAA.

The averaging of all topic areas resulted in the overall rating of 'satisfactory'. Seven areas were rated as 'outstanding' or include subparts that were recognized as 'outstanding'. The OEI is clearly demonstrating connection from surface-to-seafloor for mapping, building, and integrating vehicles to operate in tandem for exploration, excelling at data interoperability across vehicles and platforms, outreach and education, and adoption of research and technology to NOAA missions. However, when considering all elements that the OEI is undertaking, the Review Panel ranked most as 'satisfactory' (ten areas, with an additional two that were very close to borderline satisfactory/outstanding). The justification is that many of these elements were close to receiving an 'outstanding' rating. The reasonings varied, but often were resulting from the dynamics of the relationship between NOAA OER and the OEI or were areas where the OEI should step up and own strategy and prioritization of research or technology without relying solely on NOAA OER to provide clear strategic guidance. A few correctable gaps were identified, including how to transfer the research and technology to reach the entire ocean exploration and scientific communities and transfer the technologies developed from academic and industry to NOAA (see *Recommendation E*). Correcting or enhancing these items would, in turn, position the OEI as a national and global leader in ocean exploration, from operations to technology, at the level that the OEI is leading in outreach and education across the community. The missing items, and the criticality of addressing these items in Year 5 and the next cycle of funding, is detailed in Section 3.

There were five areas that the Review Panel rated 'unsatisfactory' (with one area receiving a unsatisfactory to satisfactory): support for students and staff, sensors, technology transfer (and intellectual property), engagement with ocean exploration and scientific communities, and data management. Again, the Review Panel's findings in these specific categories were critical items that the Review Panel felt strongly that were limiting the OEI from reaching full potential and were limiting the full utility that NOAA OER is receiving based on the amount of funding NOAA OER is providing. However, per the recommendations in Section 3, the Review Panel felt that all these items could be improved in Year 5 or within the next 5 years (in some cases, such as technology transfer, it will take more than one year to fully realize the potential) to justify continuation for the next five-year cycle.

When the Review Panel considered all elements of the OEI program, the overall rating given was 'satisfactory'. Again, the Review Panel believes that areas receiving a 'satisfactory' rating have minor corrections or improvements that if completed would result in an 'outstanding' rating. More so, the items receiving 'unsatisfactory' can be corrected and were not considered reasons to not fund the CI for a second cycle. The Review Panel felt that 'unsatisfactory' areas were preventing the OEI from demonstrating the highest level of performance for NOAA OER. If the OEI and NOAA OER implement the improvements identified in areas rated 'unsatisfactory' and 'satisfactory', the Review Panel has no hesitations in believing the OEI

would likely have resulted in an 'outstanding' review, meaning that NOAA OER should undoubtedly fund another five-years. However, the Review Panel strongly believes that NOAA OER should critically consider how the agency is leveraging the CI to advance NOAA missions and priorities in ocean exploration. The shared responsibility between NOAA OER and the OEI is important to get right, and the next five years of funding provides the opportunity to do exactly that and rebalance the relationship between the CI and NOAA OER. Further the Review Panel strongly felt that NOAA OER needs to provide more strategic direction that the OEI could interpret and advance, with NOAA providing flexibility and support for the OEI to take more risks than is currently being supported. The Review Panel felt that in some capacities, NOAA OER is limiting the potential of OEI to push boundaries and excel as a national and global ocean exploration leader. Given the unique interconnection and involvement of NOAA OER in the OEI planning and project selection and execution, the Review Panel felt NOAA OER should strongly reflect on whether this is appropriate or there should be wider degree of separation in the next five-year cycle. Part of this internal agency reflection should consider if NOAA OER is effectively utilizing the CI to advance NOAA mission and priorities to the fullest, including pushing boundaries (and taking more risks) to advancing ocean exploration efforts. The utility of a CI is that it does provide NOAA with opportunities to take such risks and to more rapidly advance initiatives that are otherwise limited by agency, or other government, processes. The Review Panel feels this reflection with more strategic direction from NOAA OER to the OEI will enable the OEI to reach full potential and accelerate as a more visible leader in the ocean exploration community. More so, the OEI brings important elements (and executes those to high degree), to which OEI is leading in the ocean exploration community, notably outreach and education, that would be significant loss to NOAA if not continued.

Section 3

Recommendations for NOAA OER and the OEI in Year 5 and beyond

The findings above informed the Review Panel's deliberations and final recommendations. Many of the Review Panel's recommendations centered on ten (10) themes that the Panel felt would raise the OEI from 'Satisfactory' to 'Outstanding' if addressed. There were a set of individual recommendations that did not fit into these categories and those were included in the section titled 'Other Recommendations.' It should also be reemphasized that these recommendations apply to both the OEI and NOAA OER and recommend that both jointly consider how to address the recommendations given the close unity of the two. Further, given the unique and close link between the OEI and NOAA OER, the Review Panel also offered specific recommendations to only NOAA OER. These recommendations are meant to enable NOAA OER to provide independent space or clearer direction for enabling the OEI to reach its full potential.

The recommendations, in no particular order, offered are:

- A. Redefine OECl's mission to be a cooperative vision, that includes NOAA OER vision and input, and provides OECl with a unique identity that is measurable
- B. Streamline of the OECl governance process
- C. Create opportunities in the OECl program and governance process for contributions from early career scientists
- D. Strengthen guidance and mentoring for graduate students and young career staff
- E. Establish technology transfer plan and a unified intellectual property management plan that utilizes the strengths of the partner institutions
- F. Work with NOAA OER to promote projects that take more exploration and technology risks – "Safe-to-Fail" Approach (requiring NOAA OER to fund beyond a 1-year cycle)
- G. Strengthen connectivity and broader activities in the water column characterization efforts (requiring NOAA OER to determine if water column is an exploration priority)
- H. Separate engagement and education with a renewed focus towards innovating community engagement methods and distributing educational models generated by the OECl
- I. Strengthen data management plans to provide longevity beyond the NOAA CI-funding cycles
- J. Initiate planning and execution of a Diversity, Equity, and Inclusion Strategic Plan that stems off of NOAA's DEI Strategic Plan and builds off the strengths brought by the partner institutions

Recommendations

A. Redefine OECl's mission to a cooperative vision, that includes NOAA OER input, but is unique to the OECl and provides the OECl with a unique identity that is measurable

OECl's vision and mission focuses primarily on alignment with the OER strategic mission and themes in countless NOAA Strategies. The challenges with this are the ownership of the mission is not unique to OECl and the value that OECl can provide to the ocean exploration community and beyond to communities impacted by the oceans. The Review Panel is not challenging the alignment of the OECl to NOAA OER or the NOAA Strategic Plans but suggests that OECl build brand identity that includes a cohesive problem statement supported by integrated exploration and research and development programs centered on an exploration challenge(s). The Review Panel suggests that NOAA OER consider a clear mandate of ocean exploration. Such a mandate would allow the OECl to improve performance more as the OECl it would be able to develop clear mandates and strategic direction for the institute.

From this, the OECl can generate clear problem statements. Ideally problem statement(s) can be divided into pure exploration target(s) and research target(s) that are less directly tied to the broader NOAA OER mission. In doing so, this eliminates any potential perception that the OECl is merely an extension of NOAA OER and not

a tool that brings innovation into NOAA OER. For example, the OET has clear and defined problem statements that are unique to the organization and used to drive their science priorities that make OET distinct in the ocean exploration community. Similar deliberate statements should be true of the OEI. Such a problem statement(s) should be a motivating factor for OEI members and staff. As it is currently structured, OEI's accomplishments to broaden NOAA Strategic Plans that lack actions in themselves and portrays OEI as 'checking boxes' through only metrics rather than showcasing itself as a unique tool for NOAA to push the boundaries of ocean exploration from mapping, to research and development, to engagement and outreach. The Review Panel recommends that NOAA OER provide the OEI the space to develop a cooperative vision with strong problem statements and challenges that are linked, but not duplicative or implementation plans, to NOAA OER.

B. Streamline the OEI governance process

The OEI has undergone change since its inception and has overcome significant challenges as a result of COVID, which stifled the ability to get out to sea, the levels and types of engagement with communities, and interfaces with the ocean exploration and research communities (conferences, workshops, etc.). The OEI's ability to respond, adapt and maintain a prominent level of productivity amidst the challenges is commendable. One item that has not adapted and has limited the ability of the OEI to be nimble and increase risk-taking is the governance structure. The current structure and process flow for the OEI's governance model seems to slow innovation and the ability of the OEI to respond to the evolving needs of ocean exploration and technology (vehicle and sensor) communities. The Review Panel recommends that the OEI streamline the governance model by integrating the Science & Technology Working Group and Council of Fellows that currently serves as a single group master project level that reviews and recommends proposals to NOAA. The Review Panel also recommends that NOAA OER reconsider the distribution of NOAA involvement in Working Groups to avoid duplication of effort and streamline the advisory and communication roles to the OEI. The Executive Committee should include the Chairs from the Working Groups and only the NOAA OER Director. This eliminates duplication of effort and any perceptions of too much NOAA influence and interface, which also has unintended consequences towards stifling risk-taking that the OEI should be considering in proposals to NOAA OER (see *Recommendation E*).

Proposal development and selection should be revisited to meet the cohesive problem statement(s) recommended previously (*Recommendation A*). Problem statements should be different for exploration and research tied to exploration. Exploration initiatives should have goals that push the boundaries and position the OEI and NOAA OER as international leaders. The Review Panel recognizes that the OEI has had research projects declined because the proposals were too heavy on research and did not include enough exploration. The Review Panel believes that

clearer and innovative problem statements will help to minimize the occurrences of declined proposals and also allow the OEI to better tell their stories and accomplishments in a more comprehensive manner.

The Review Panel recognizes that not all of what the OEI structures in mission and vision is entirely independent to the OEI and that some level of connectivity and influence is required by NOAA OER. The Review Panel actually feels this is one of the negatives for the OEI - too closely engrained with NOAA OER compared to other NOAA Cooperative Institutes and their respective NOAA programs and offices. In turn, the OEI's mission and objectives feel more like implementation plans for NOAA OER's Strategy than what is more traditional for a Cooperative Institute. The Review Panel challenges both the OEI and NOAA OER to independently assess the linkages between the two and jointly determine if there should be intentional distance to provide the OEI more autonomy to push the boundaries of exploration to lead in the ocean community and what will best benefit NOAA OER serving the nation.

C. Create opportunities in the OEI program and governance process for contributions from early career scientists

One model missing for the OEI is the integration and involvement of graduate students and early career scientists. In fact, the Review Panel felt that the OEI was too encumbered to the original leadership and had not truly integrated all levels of minds available to the OEI for proposal development. In its strong promotion of education and outreach, there is a link missing to promoting ideas of graduate students and early research scientists in a unique way that

1. Supports the future generations of ocean explorers, and
2. Brings new perspectives that can push the boundaries in technology innovation and research that can increase value served to NOAA OER.

The Review Panel suggests that OEI create a new Working Group of graduate students and early career scientists that are given opportunities to develop, shepherd and present proposals for consideration and adoption by NOAA OER. The Chair of this new Working Group should also sit on the Executive Committee.

D. Strengthen guidance and mentoring for graduate students and young career staff within the OEI and across the OEI partner institutions

The OEI provides NOAA with a workforce pipeline of future ocean explorers, data scientists, researchers, engineers, and more. It was not evident in the review how the partner institutions, their staff funded by the OEI, or the students funded have performance evaluated. Performance evaluation is an important part of career development. The Review Panel recognizes that this can be an overly burdensome process for the OEI Director but believes necessary to maintain a strong program

and in providing necessary growth and support opportunities for graduate students and young career staff.

The Review Panel recommends that NOAA OER work with the OECl to focus on fully utilizing the potential workforce pipeline that OECl can provide to NOAA. It is clear and apparent that there will be a workforce gap in the near future for NOAA and with the forthcoming funds from legislation passed under the Biden Administration, workforce demands will only increase. NOAA OER should recognize that the OECl provides unique opportunity to help close the gap and should work closely with the OECl in the next 5-years to find ways to leverage OECl's full potential to provide workforce to the agency. The Review Panel recommends that OECl strengthen guidance and mentoring for graduate students and postdoctoral researchers. Given the unique connection between NOAA OER and the OECl, that is unlike other Cl's, the Review Panel invites NOAA CIAO and OER jointly to determine if there are mechanisms that permit a stronger and more formal role for NOAA staff to contribute to the performance evaluation of graduate students and postdoctoral researchers. Doing so provides the future workforce with increased knowledge and pathways into the agency.

One of the significant strengths of the OECl is the (institutional and industry) partnerships. The Review Panel recommends that the OECl and NOAA OER create systematic approaches for postdoctoral researchers in developing skills needed for obtaining future employment in the private sector, in addition to opportunities for pursuit of academic positions.

While University of Rhode Island is a graduate school, other institutions in OECl are not. The OECl is attempting to develop cross-institutional opportunities in the form of internships, but the Review Panel recommends that the OECl explore other opportunities for graduate students and postdoctoral researchers to mentor younger graduate students and undergraduates across the institutions. This provides more exposure overall to students of different possibilities, helps students to build a professional network early, and encourages cross-disciplinary collaboration among students. Exemplifying this type of institutional collaboration may more broadly expose students to other research areas that are not related to their dissertations.

NOAA OER should work with the OECl to best position students for opportunities within NOAA, ranging from internships, contractors, and/or full-time employment. NOAA OER can serve as a valuable extension resource for students and early career staff interested in supporting the NOAA mission. The Review Panel believes NOAA OER can provide funds for incentive-based programs that can be granted to students and early career staff in the OECl. In turn, such programs would help to increase the OECl exposure within the agency and would help to identify where there might be increases in cross-collaborative research, education, and outreach opportunities between OER and other parts of NOAA leveraging the value and strengths brought by the OECl students and early career staff.

The Review Panel recognizes the OECI's efforts to optimize outreach across the partner institutions, particularly in the time of COVID and limitations with in-person opportunities. However, the Research Panel felt that this type of engagement (undergraduate-to-graduate) was only limited to the direct and immediate partnership between University of Southern Mississippi and Tuskegee University, a HBCU institution. The Review Panel did also note that the OECI has initiated direct outreach with the New England Institute of Technology and the Community College of Rhode Island (multiple campuses) through the 'Bridge-to-Ocean Exploration' project. With the proximity of the other partner institutions to a wide undergraduate institutions (especially non-science institutions), and other types of institutions, the Review Panel recommends that the OECI consider how to broaden and expand upon the efforts brought from these two examples to other adjacent institutions in partners' proximity, as many of the partner institutions broadly have arrangements with different types and levels of institutions that could extend the reach of the OECI.

The Review Panel also felt that institutional opportunities could be explored with different institutions, schools, and other education centers in local communities where ocean exploration activities were occurring. Overall, it felt that the OECI and the partner institutions are underutilizing such opportunities to connect more broadly in partner and collaborators' institutions' networks to increase outreach and education opportunities.

The graduate and undergraduate students are the future workforce and the best advocates for OECI. With the increase in travel post-COVID, the Review Panel encourages the OECI to make travel funds available for students to participate in conferences, science meetings, and other related venues to display their research and build professional networks, which in turn can serve as an additional recruiting tool for the OECI partner institutions.

Along this idea, the Review Panel also encourages the OECI to establish a fund for graduate and undergraduate students to conduct community outreach and education. This can take many forms but should be flexible and open to the creativity of the younger workforce of the OECI to bring new and novel ideas for engaging with communities. Again, programs like this help to highlight the work of the OECI, promote the importance of ocean exploration, and bring visibility to opportunities in NOAA. To support these types of novel approaches, the Review Panel also recommends that NOAA OER increase support for Task I (Administration/Outreach) to allow for new and novel approaches to education and community engagement.

Lastly, the Review Panel recommends that the OECI optimize outreach investments by considering new approaches to encourage more underrepresented minority students to apply to OECI institutions and/or support the OECI program. With the levels of funding available, the OECI could provide incentives for these students to participate in the OECI above and beyond the current programs, furthering the workforce development pipeline.

E. Establish a technology transfer plan and a unified intellectual property management plan that utilizes the strengths of the partner institutions

The OEI believes that the technology developed by the OEI should be widely available and usable by the ocean exploration and scientific communities, including the federal government. In regard to commercialization of technology, the OEI itself does not have a strong motivation for the partner institutions to focus on commercialization and instead relies on the OEI's commercial partners for this. Given the interesting integration of the academic members and private sector members within the OEI, the Review Panel is concerned that the collaborative nature of technology development affected the private sector such that these are not true mutually beneficial relationships for the OEI academic members. The Review Panel felt this topic is of utmost importance with the amount of time and effort the OEI focuses on its role in the Blue Economy – time and funds spent for training engineers, technicians, scientists and students and economic development in the respective U.S. states of the partner institutions.

The Review Panel expressed concern that the OEI funding is supplementing commercial research and development. When asked, the OEI did explain that in exchange, commercial companies do provide academic discounts to the institutional members of the OEI. However, the Review Panel did note that this is institution-by-institution and not equal across all members of the OEI, current or future, and this is a limiting factor to widespread technology use for scaling exploration efforts.

While the Review Panel generally agreed with the OEI that there are mutually beneficial relationships between the companies and Universities involved, there is still exposure with technology development that requires management. The often mixing of unique (academic) vehicles with commercial technology or commercial vehicles with academic technology still requires robust technology transfer protocols and a more thorough IP model than currently exists in the OEI.

The Review Panel believes that the OEI can be a leader in this space and provide a leading model for how to develop public-private technology relationships to accelerate national ocean priorities and provide templates for technology transfer and unified IP plan for other large, integrated programs to use. Included in this is training younger staff and researchers on how to do this. To execute, the Review Panel feels strongly that the OEI team needs to initiate more official conversations with the technology transfer offices within and across the partner institutions and with commercial partners to be respondent to the requirements of funding from government for technology to be publicly accessible. At a minimum, this requires mutual non-disclosure agreements for institutions under the OEI. The OEI needs to leverage the academic institutions' resources to establish a Technology Transfer Working Group that establishes a plan to meet the timeline of the end of the OEI and exit strategies for all technologies – vehicles or sensors – created from the OEI and its partners. Doing so protects the researchers and the OEI and provides a clear engineering path for technology developed so uptake can occur by the broader

ocean exploration community and commercialization can take place. This Technology Transfer Working Group should be cross-institutional to ensure seamless OEI emerging innovation. More so, doing this provides NOAA OER (and taxpayers) certainty and protection in the event that in the future NOAA would like to optimize a fleet of certain vehicles or sensors to support its mission.

While the Review Panel feels that the working relationships across the OEI partnerships institutes is outstanding, the Review Panel feels that partnerships with commercial entities leveraged by the OEI were a bit ad-hoc and mostly driven at the principal investigator networking level than by the cooperative institution itself. One remedy to this is to consider a technology transfer vision to broaden participation by institutions and companies outside of the OEI that could bring in new technologies that in turn benefit the OEI and NOAA OER. With the tremendous university resources available, the OEI management should be able to utilize the best of university processes to develop such a vision that can further the breadth of partnerships and ultimate value to NOAA OER.

The Review Panel expresses concerns with the appearance that commercial partners have stronger influence over projects proposed to and accepted by NOAA OER. The Review Panel believes that this influence could skew the direction of research conducted by the OEI and its partners. Further, many of the commercial partners working with the OEI receive other funds from NOAA, can leverage the OEI to receive preferential research and development opportunities and use each to grow their commercial viability to sell back to the U.S. government. The Review Panel feels that solutions need to be in place for commercial technology developed as part of OEI research projects, and that such technology is not subject to IP restrictions for future U.S. government use.

As part of the risk-taking that the Review Panels feels is necessary for both the OEI and NOAA OER, the Review Panel recommends that the OEI should be a tool to grow smaller, U.S. based companies that broaden the exploration industry and challenge the quid pro quo – meeting the challenges that NOAA has in accelerating and expanding ocean exploration. In the next 5-year cycle, the Review Panel also recommends that NOAA OER allow the OEI to expand beyond partnerships with already established technology and exploration platform vendors.

F. Work with NOAA OER to promote projects that take more exploration and technology risks – “Safe-to-Fail” Approach (requiring NOAA OER to fund beyond 1-year cycle)

Ocean exploration and pushing innovation requires taking calculated risks. The risks required to advance the field necessitate funding expectations beyond a year. The Review Panel felt that the OEI is, in some places, lagging behind the broader global ocean technology and exploration community, particularly in sensor development and integration and in new platform development. While the partner institutions are

some of the best in the world, these institutions have remained focused on a smaller suite of ocean exploration platforms with limited use, primarily amongst OEI member institutions. The technology developed by the OEI partners is difficult to transfer outside of the OEI to the ocean exploration and research communities without considerable support from the engineers and technicians from the OEI institutions or their commercial partners. The Review Panel recognizes this was the original structure of the partnership, however the field of ocean exploration and sensor development agnostic to vehicles is far exceeding the pace of the OEI.

The OEI should be NOAA OER's tool for keeping up with the rapidly evolving innovation environment. The Review Panel recommends that NOAA OER foster an environment of risk-tasking, allowing for the partner institutions to push the boundaries in the technologies and platforms. This can be accomplished by increasing support for Task III funding, by creating new avenues for rating risk levels in proposals, fostering and rewarding new platform and sensor development, partnering externally with the broader sensor and platform technology and innovation community, and providing funding for younger career scientists and technologists to propose novel ideas for funding, independent of the standard mission and tasks that the OEI is accomplishing. The Review Panel believes that NOAA OER is underutilizing this potential that can be provided by the OEI and its partner institutions and in doing so, will not be able to fully advance and accomplish NOAA OER's Strategic Plan if the agency does not encourage and accept such risks.

The power of the OEI to advance ocean exploration is with the people in the program. From its inception, the OEI has been primarily driven by the Executive Committee and the Council of Fellows, both of which have undergone significant change in the first four years. However, the Review Panel feels that the OEI is not fully utilizing younger staff – faculty, researchers, students, and engineers – at the partner institutions. In addition to program realignment, the Review Panel encourages NOAA OER to realign and increase support for Task III funds. Specifically, the increase in Task III funds would serve as a funding vehicle to encourage collaboration between younger OEI members and partners to bring forth new ideas, innovations, and technology proposals that would be considered for funding. Doing this effectively also requires the OEI to realign the governance (*See Recommendations C and D*).

Combined with *Recommendation E*, NOAA OER and the OEI should also create avenues to partner outside of the OEI, specific to technology development and testing, and work together with outside partners on the uptake of technology that has been developed by the wider community. The portfolio of vehicles and the interconnectivity of those vehicles, offers multiple platforms for testing of outside technology, in combination with the testing of technology development within the OEI. The Review Panel notes that this is simpler to ask than implement but highlight that this specific recommendation has to be led by NOAA OER. The agency should

provide the necessary supporting funding and time needed to the OECI to implement effectively and to become a leader in the community.

G. Strengthen connectivity and broader activities in the water column characterization efforts (requiring NOAA OER to determine if water column is an exploration priority)

Both the OECI and NOAA OER are highly efficient in field operations. Part of the reason for this success is the OECI's focus and prioritization of mapping and visualization techniques in the deeper ocean environments. As part of the OECI's effort to increase the utility of ocean exploration information and in response to the 2017 San Diego National Ocean Exploration Forum (NOEF), the OECI added research and mapping of the water column. The OECI combined new exploration targets and sensor development for water column characterizations. Yet, NOAA OER does not have water column characterization clearly identified as an exploration priority. NOAA OER should not rely on the OECI to be the leader in all things related to ocean exploration and should carefully consider how important and critical this topic is and whether the OECI is best suited to conduct this work.

Granted, the Review Panel supports this initiative and agrees with past reports and the OECI that the ability to fully characterize the overlying water column is important and is critical to exploration of the nation's EEZ. Primarily, the Review Panel recommends that NOAA OER needs to determine whether this is a key priority for the program. Doing so will inform the level of commitment that the OECI should strategically dedicate to this.

Without a clear NOAA OER mandate, the Review Panel feels that the OECI has not fully embraced a comprehensive plan with clear metrics to how it intends to characterize the water columns in the areas which the OECI partners and NOAA OER are prioritizing for mapping. The efforts feel ad hoc and more as efforts of opportunity versus a cohesive research and technology implementation plan that helps to push the norms for exploration. The Review Panel suggests that NOAA OER provide clear guidance to the OECI so that partner institutions are able to develop a risk-based plan for how the OECI can push the boundaries and the science for exploring and characterizing the water column, albeit a combination of models for sensor integration on multiple platforms (within and external to the OECI), sensor development itself, and/or novel research applications that push the field while meeting key needs and challenges outlined by NOAA and the exploration community at-large. Again, the OECI should serve as NOAA OER's risk entity for characterizing the water column, as explained in *Recommendation F*.

If NOAA OER determines this to be a priority, the Review Panel invites the OECI to be clear about how the OECI will be unique to other programs and institutions focused on water column characterization. The OECI should not be a derivative of that, but a leader in this exploration effort. If NOAA OER determines this to not be an

exploration priority, the OEI can recalibrate resources towards other priorities and focus more on the institute's strengths.

H. Separate engagement and education with a renewed focus towards innovating community engagement methods and distributing educational models generated by the OEI

The Review Panel appreciates and commends the OEI's initiatives in education and outreach. The Review Panel felt that OEI should focus new engagement efforts to the communities in which the OEI is exploring or conducting research. The Review Panel defines these efforts as meeting the people where they are as opposed to bringing the communities to the OEI. While Ocean Exploration Trust does do this with respect to the communities in which the ship is conducting exploration, the partner institutes are not as fully integrated into these communities. This limits the institutes and NOAA in its abilities to create workforce opportunities and future pipelines of ocean explorers. One way to improve is with the assistance of NOAA OER to help the OEI build and leverage partnerships with other NOAA programs, such as Integrated Ocean Observing System, Sanctuaries, SeaGrant, and others to not solely rely on the activities of Ocean Exploration Trust.

The Review Panel recommends the OEI consider how it can generate more exposure across the partner institutions and companies, not solely relying on Ocean Exploration Trust. The Review Panel suggests that OEI can have more presence at international and national meetings and conventions, including the U.N. Ocean Decade among others to promote advancements and innovation in ocean exploration. Recognizing COVID created such challenges, the Review Panel felt that the OEI has not fully utilized all the tools available, primarily its people, to create such exposure.

The Review Panel also encourages the OEI to consider how to take the current engagement models and expand those models to regional and under-represented communities beyond the areas to which the Ocean Exploration Trust vessel is operating. NOAA OER could provide the OEI tools and exposure within other NOAA programs and offices that could provide accessibility to such communities. This should be a key task that the Education and Engagement Working Group undertake in the next 5-year cycle.

J. Strengthen data management plans to provide longevity beyond the NOAA CI-funding cycles

The amount of and types of data generated by the OEI is outstanding. Accessibility of exploration data, through data services generated by the OEI (Rolling Deck to Repository, NOAA NCEI, Marine Geoscience Data System, etc.) and the engagement thru data streams (YouTube videos, OET live streams, and other projects) is one of the strongest attributes that OEI provides. However, the Review Panel was concerned with length of time for data to be annotated, distributed (through government portals), and made available to collaborators and the ocean exploration

and research communities. Members of the communities, along with some of the Review Panel, have direct experiences with how slow data is made available, even if researchers are collaborators with the OEI. The Review Panel recognizes the challenges with managing the amount and types of data generated by the OEI and recommends that NOAA OER provide more deliberate direction and resources towards improving data management and accessibility.

The Review Panel commends NOAA OER and the OEI for maintaining nearly equal allocations towards data and education/engagement programming. Given that the OEI is in Year 4 of the first cycle, the Review Panel also recommends that the OEI and NOAA OER more closely engage with NOAA NCEI and IOOS offices, where relevant, to establish plan for maintaining data integrity and utility beyond the OEI's funding so that the communities at-large can continue to access all forms of data after the OEI ends.

K. Initiate planning and execution of a Diversity, Equity, and Inclusion Strategic Plan that stems off of NOAA's DEI Strategic Plan and builds off the strengths brought by the partner institutions

Review of DE&I efforts was not a requirement per the current NOAA Cooperative Institute Handbook and therefore not assessed by the Review Panel. However, the CI Handbook was undergoing review and updates, which were published while this report was being generated. The Review Panel encourages the OEI to strongly focus on developing a robust DE&I Strategic Plan, including clear steps to be taken, goals to be met, and metrics to which those goals will be measured that can be implemented starting the first year of the second 5-year funding cycle. The OEI should bring the strengths of the partner institutions to this effort and in this Strategic Plan provide a model that NOAA OER can leverage across its program. The above-mentioned community engagement recommendation could also feed into this Strategic Plan.

L. Other Recommendations

Student Engagement & Awareness: The Review Panel encountered a few instances where students at the OEI partner institutions were unaware of the OEI and opportunities that could be pursued, e.g., advanced degrees, access to sea and samples for research ideation and collaboration, or employment opportunities. The Review Panel recommends that the OEI leadership and related Working Groups consider opportunities for cross-institute student engagement, of those whose advisors are involved with the OEI and those who are not, and the building of an alumni network that would strengthen the entire cohort of all the students in these institutions. This could branch beyond students to early research and teaching staff and faculty (see *Recommendation C and D*).

Technology (Strategy): The Review Panel recommends that both NOAA OER and the OEI create clear vision for what should be achieved with technology development in the next 5 years. Success of this requires NOAA OER setting clear

directive, with objectives that NOAA, on what the agency wants to achieve and in turn, providing the OEI with the resources and funding to clearly execute the vision. Ideally this effort would inform the efforts made by the OEI under *Recommendations E and F*.

Technology (Vehicles): The Review Panel recommends that over the next few years that NOAA OER and the OEI consider ways to make vehicle fleet of the OEI more agnostic to increase the usefulness across the ocean exploration and research communities. This will be particularly important if NOAA OER sets water column characterization as a priority.

Research Ideation: It was unclear how the OEI responds and actions feedback solicited through the aspects of the OEI's Scientific Management Plan. Members of the Review Panel noted that there is a community history of the OEI soliciting, but not being responsive, to feedback. The Review Panel recommends that the OEI consider strong actions in being responsive to the feedback solicited from researchers within the OEI community, partner institutions, and the ocean exploration and scientific communities. Not being responsive to partners and the larger communities can limit ideation for the OEI and create an environment of mistrust versus collaboration. Given the role of NOAA OER, it could also be that NOAA OER assume more of a leadership role in the solicitation of research ideas or technology concepts that the OEI could mature and/or execute.

Publications: NOAA OER should consider a review publication at the end of the 5-year funding cycle that captures the breadth and expanse of research, technology, mapping, education, and outreach accomplishments achieved by the OEI. The program review should be presented within NOAA and to the broader scientific community at national and international scientific conferences and exploration venues.

Workforce Opportunities: NOAA OER, and broader NOAA, should recognize that OEI is an opportunity for expansion into the Blue Economy and exploration workforces. The OEI should be viewed as a capacity-building resource for the agency. The Review Panel feel that this benefit is underexploited and that if not given considerable attention in the next 5-year cycle, will be a significant failure on NOAA's part to recruit and hire talent to replace forthcoming retirement gaps. The Review Panel strongly encourages NOAA to institute the necessary formal processes to solidify the talent pipeline into the agency, especially in the near time as NOAA will have significant FTE and contractor resource demands with the implementation of recent Biden Administration fundings through the Inflation Reduction Act and the Bipartisan Infrastructure Law.

Program Management: Given the size of the OEI and the large number of ongoing projects (50+), it may not be possible for the Director to be directly aware of the progress unless such progress is raised up and through the governance model. With the heavy governance model and the timing associated with proposals, reviews, and

engagement with NOAA OER, there seems to be little time for performance oversight to happen. The Review Panel recommends that a formal review structure (with multiple program members) is in place to monitor graduate student progress. The Review Panel also believes that NOAA OER could contribute to this effort, helping to provide NOAA staff that could participate and provide objective evaluations of the programs, research, and technology innovation. If done right and well, this can help generate more outreach for the OEI, as well as provide influx of information more broadly that can help to inform future (risk taking) in research, innovation, and technology.

Outreach: The OEI should increase its presence as a cooperative institution (versus individual member institutions) at international and industry conferences. This will not only extend the reach of the work conducted by the OEI, but also enable the OEI and NOAA OER to remain on the forefront of the exceedingly fast pace of technology (vehicle and sensor) development happening. This could strongly benefit NOAA OER in pushing the boundaries and taking risks in ocean exploration.

Summary of the Ocean Exploration Cooperative Institute (OEI)

The OEI mission is to explore, map, and characterize the nation's vast ocean territory, to develop and implement new technologies, and to engage future generations of ocean scientists, engineers, and stakeholders.

Specifically, the OEI aims to advance ocean exploration by:

- Researching and developing new ocean-exploration vehicles, sensors, and operations
- Expanding ocean exploration through multi-vehicle operations and the fielding of new technologies and operational approaches
- Reimagining approaches and infrastructure for collecting, analyzing, and delivering ocean-exploration data
- Inspiring and training a new, more diverse generation of ocean explorers

Numerous strategic plans within NOAA have informed the OEI mission and activities, specifically the existing strategic plan for NOAA's Office of Ocean Exploration and Research and the strategic plan for NOAA's Office of Atmospheric Research (OAR). The OEI mission continues to be well aligned with the OER strategic plan that emphasizes exploring the oceans for the benefit of the nation while enhancing partnerships outside of NOAA and educating the next generation of ocean explorers. The OEI also aligns its activities against a series of broader NOAA initiatives and strategic areas, released in 2020, including: NOAA's Cloud Strategy, Data Strategy, 'Omics Strategy, Uncrewed Systems Strategy, and Artificial Intelligence Strategy.

The OEI's science plan has three primary objectives: 1. Operational ocean exploration, 2. Technology development/enhancement, and 3. Education and engagement with a diverse set of future blue economy workers. The OEI's project portfolio is a series of projects across each of these themes. All OEI projects include metrics and outcomes that are tracked in the same format as NOAA's databases, including the NOAA Research and Development Database (NRDD)

and key performance indicators metrics specific to the work conducted by OEI. The subset of these metrics include:

- Operational ocean exploration: Tracked metrics that include days at sea, area mapped, number of deployments, hours of video collected, and samples collected.
- Technology development/enhancement: Tracked 'technology transitions' that classify the advancement of technology for prototype to demonstration to operational asset.
- Education and engagement: Tracking of a) number of graduate students supported, b) number of undergraduate students engaged, c) number of interns, d) views of live exploration streams, e) number of shoreside scientists, f) number of K-12 formal/informal educators, g) ship-to-shore engagements, and h) media impact.
- Data accessibility and technology: Tracked data and physical sample deliveries to long-term archives and repositories and making data publicly available and accessible.

Additionally, the OEI tracks several metrics similar to large research programs, including the number of publications and conference proceedings.

Among the three primary objectives, the OEI has broader scientific themes that include:

- Midwater exploration & eDNA
- Autonomous systems & cooperative robotics
- Machine learning
- Ferromanganese crusts & critical minerals
- Benthic habitat & biodiversity
- Deep sea corals/sponges
- Seafloor mapping

The themes for the OEI's focus areas, and the individual projects within the OEI portfolio, are co-developed with the NOAA OER office and other NOAA partners. The OEI also focuses on building, developing, and deploying novel technologies to meet the evolving technology priorities of NOAA OER. The OEI has a formal process and procedures for cooperative planning with OER to keep the plans evergreen and to select different activities to propose for meeting the OEI mission and OER's goals. These processes and procedures include: 1. Annual Meetings, 2. Proposal draft and review process, 3. OEI Colloquium, 4. OEI Working Groups, and 4. Adaptive Management Meetings. The OEI and NOAA OER leadership, during Annual Meetings, coordinate on OER priorities for the upcoming year and co-develop projects that support NOAA objectives and in turn, influence and drive the OEI objectives. The outcomes of the Annual Meeting inform the annual proposal development for the OEI partners, which is submitted to NOAA OER for review and comment, assuring alignment between the two groups.

The OEI Science Management Plan is a collaborative process in which intellectual opportunities are identified from the partner institutions through their respective engagements with the ocean exploration and oceanographic research communities. The OEI conducts outreach events for these communities to solicit input. The OEI does host opportunities for researchers at partner institutes to share project ideas that could be considered for funding. Finally, the OEI hosts a regular colloquium that provides project updates with invited outside organizations that also generates thought that informs new OEI efforts.

Technology development under the Science Management Plan is limited as there is not a large market for deep sea research technology, partner institutions are not positioned to manufacture at scale, and partners are primarily academic researchers and prefer not to operate private businesses to manufacture technology. For these reasons, the OECI focuses on partnerships with private sector (developing and existing commercial operators) to co-develop technologies that have a realistic path to market, but that meet the objectives of the OECI. Technologies included in the OECI can be referenced at <https://web.uri.edu/oeci/research-and-technology/technology/>.

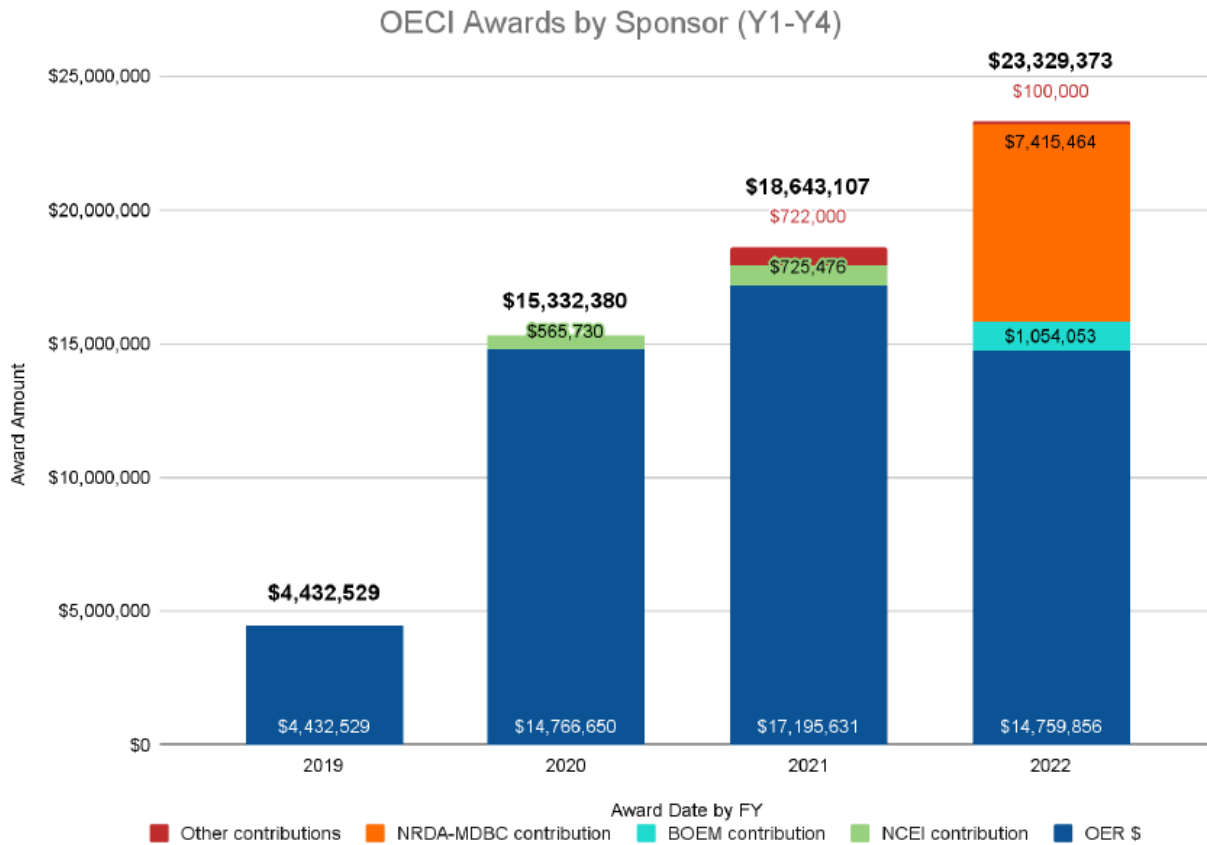
Examples of scientific highlights and accomplishments of the OECI can be referenced in Attachment A, The OECI Executive Summary Year Three Annual Report (July 2021 - June 2022). A listing of projects and publications of the OECI can be referenced at <https://web.uri.edu/oeci/research-and-technology/>.

The OECI has education as a central component of many of the Institute's activities. The OECI works in close collaboration with NOAA OER's Outreach and Education Division. The listing and description of education activities can be referenced at <https://web.uri.edu/oeci/education-and-outreach/>.

The OECI strives to create links between people and the deep oceans through exploration. The OECI recognizes this is difficult given the remoteness of the areas of exploration conducted by the OECI partners and leverages partner strengths to provide value in the social and human dimensions through the OECI research. These include a) Engaging with native and Indigenous communities, b) participation of underrepresented groups, c) socially relevant science, and d) ecosystem services and restoration of deep-sea habitats. The above efforts are integrations of social science in the OECI's exploration, technology and research programs as the Institute does not have an explicit social science agenda as this was not a raised priority of NOAA OER for the OECI to undertake.

Summary of OECI Funding

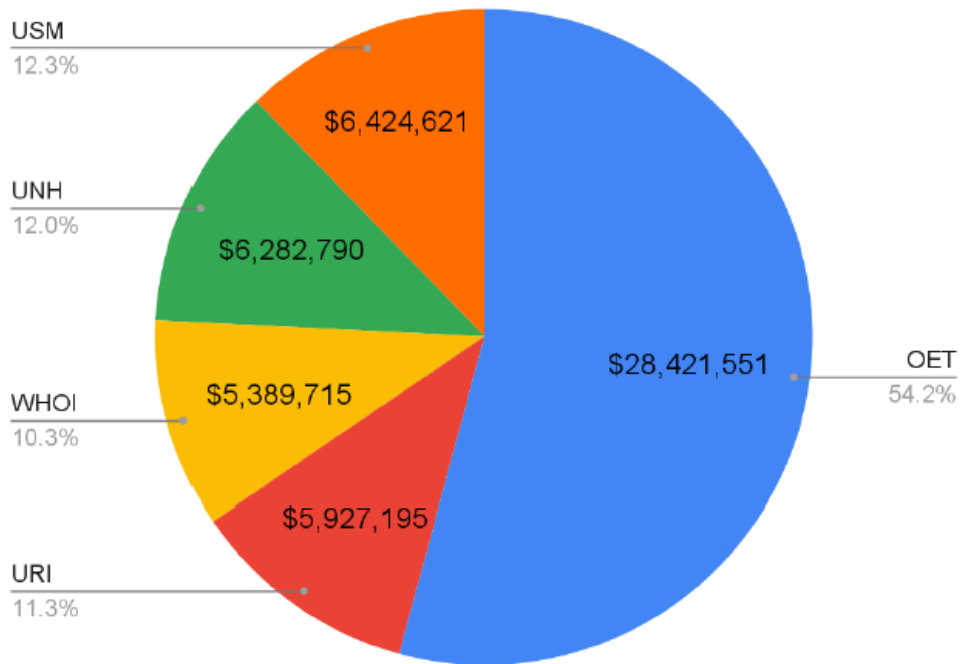
The OECI has received funds totaling \$63.6M for the first four years, with approximately 83% of the funds from NOAA OER (\$53.0M). Additional support comes from the following: NOAA Gulf of Mexico Restoration Program (\$7.4M); NOAA NCEI (\$1.3M), Bureau of Ocean Energy Management (\$1.1M), and NOAA partners (\$0.8M in total). The total support for the OECI falls below the support ceiling established at the start of the award of \$96M (\$19M/year) and the amended support ceiling of \$150M (\$30M/year). Figure 1 (OECI Awards by Sponsor (Y1 - Y4)) provides allocations from each by year.



The cumulative distribution of funds from the primary OEI award amongst the OEI partners is ~54% to Ocean Exploration Trust and ~11% (±1%) to each of the partners (URI, UNH, USM, WHOI). This excludes funds from NRDA (\$7.4M in Year 3), which are in a parallel OEI award as well as funds for the Saildrone Aleutians project (\$1.9M in Years 2 & 3) that passed through UNH to Saildrone Inc. Funds from the NOAA NRDA (\$7.4M in Year 3) are directed to URI (62%), USM (28%), and WHOI (10%). Figure 2 provides the allocations across the OEI partners.

Total OECI Awards by Partner Y1-Y4

(excluding NRDA & Saildrone)



Over the first four years of the award, Task I (dedicated funding to for the administration of OECI) has been supported at 3.6% of the total award funding. The amount of Task I support has varied over the life of the award and is tied to the total amount of each proposal submitted via an agreed upon formula. The remaining funds are dedicated to support of Task II activities.

The OECI tracks spending at partner institutions and on the project level, of which there have been 58. The total awarded and expended amounts by partner institutions are shown in the below table. There have been experienced delays in receiving funds in each year of the OECI and unforeseen circumstances, such as COVID-19 and ship scheduling, which has resulted in project delays and funding expended.

OECI Y1-Y4			
Institute	Budget	Expended	Balance
URI	\$ 5,417,805	\$ 3,480,806	\$ 1,936,999
OET	\$ 28,571,523	\$ 16,907,346	\$ 11,664,177
USM	\$ 7,225,782	\$ 4,191,817	\$ 2,633,387
UNH	\$ 8,158,842	\$ 4,924,088	\$ 3,234,754
WHOI	\$ 5,557,724	\$ 3,814,355	\$ 1,210,438
Total	\$ 54,931,676	\$ 33,318,411	\$ 20,679,756

**This table reflects spending as of December 31, 2022 and does not reflect the current spend down from January 2023 to July 2023.*

Summary of OECI and NOAA OER Interface

The OECI and NOAA OER are closely linked compared to other NOAA Cooperative Institutions. NOAA OER provides a dedicated CI Program Manager that facilitates the collaboration and engagement between the two groups - this is unique to NOAA Cooperative Institutes. NOAA OER helps to manage the OECI interface between other NOAA sponsoring line offices and programs where there is alignment in priorities of NOAA OER and the OECI. NOAA OER has strong influence over the alignment of the OECI's exploration, technology, and research themes and the identification and execution within the identified scientific focus areas previously mentioned. Other ways that NOAA OER integrates into the planning and execution of the OECI activities are described in earlier sections.

APPENDIX I

Review Panel Members

Chair (NOAA SAB)

Dr. Ruth Perry

Head of Regulatory Affairs, Offshore Powers, Americas
Shell Renewables and Energy Solutions, U.S.A.
ruth.perry@shell.com

Panel Members

Dr. Beth Orcutt

Senior Research Scientist
Bigelow Laboratory for Ocean Sciences
borcutt@bigelow.org

Dr. Brendan Roark

Director, Environmental Programs in Geosciences
Texas A&M University
broark@geos.tamu.edu

Dr. Jyotika Virmani

Executive Director
Schmidt Ocean Institute
jyotika@schmidtocean.org

Captain (Ret.) Matthew Borbash

Deputy Hydrographer
U.S. Navy
matthew.borbash2.civ@us.navy.mil

Dr. John Horne (*Ex-officio*)

Director of the Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES)
University of Washington
jhorne@uw.edu

APPENDIX II
OECI Review Agenda

OEI Science Review Panel Agenda

April 3-4 URI Graduate School of Oceanography (GSO) Campus, Narragansett, RI

Panel Room: OEI Fishbowl, 1st floor Ocean Science Exploration Center (Building #1, [map](#))

General Meeting Room: OSEC Classroom 111

Preferred Hotel: [Hampton Inn, South Kingston](#)

Review Panel: (Closed door meetings in yellow)

Dr. Ruth Perry, Marine Scientist and Regulatory Policy specialist, Shell (Chair)

Dr. Beth Orcutt, Senior Research Scientist, Bigelow Marine Lab

Capt. (Ret.) Matt Borbash, Deputy Hydrographer, US Navy

Dr. Brendan Roarke, Director, Environmental Programs in Geosciences, Texas A&M University

Dr. Joytika Virmani, Executive Director, Schmidt Ocean (Virtual, partial attendance)

Dr. John Horn, Director of the Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES) at University of Washington (Virtual, *ex-officio*)

OEI Full-time In-person Attendees:

Dr. Adam Soule (OEI Director)

Jason Fahy (OEI Deputy Director)

Deborah Smith (OEI Data Governance Manager)

Allison Fundis (OET COO)

Dr. Daniel Wagner (OET Chief Scientist)

Dr. Larry Mayer (UNH)

Dr. Leila Hamdan (USM)

Andy Bowen (WHOI)

NOAA Attendees:

Jeremy Weirich (OER Director, TPM)

Dr. Aurora Elmore (OER CI Manager)

Kristen Crossett (OER, Outreach and Education Chief) (Virtual)

Dr. Mashkoor Malik (OER, Science and Technology Chief) (Virtual)

Shannon Louie, Director, Cooperative Institute Administrative Office (Virtual)

Jim Herzog, Specialist, Cooperative Institute Administrative Office (Virtual)

Sandy Byers, Specialist, Cooperative Institute Administrative Office (Virtual)

April 3

7:30am coffee and breakfast for the Review Panel

8:00am Review Panel Executive Session (explanation of priorities and review strategy, including Aurora at 8:00am and Adam at 8:45am)

8:30am coffee and breakfast for all

9:00am URI Welcome - Dr. Paula Bontempi, GSO Dean, URI

9:10am NOAA OAR Deputy Assistant Administrator for Research Dr. Gary Matlock

9:20am Welcome and OER vision from Jeremy Weirich

9:30am Introduction to OEI (Adam Soule)

10:15am coffee and bio break

THEME 1: Operational Exploration

10:30am OET overview of past cruises, Nautilus abilities, achievements, samples collected, data, Pacific partnerships (Allison Fundis)

11:00am Science Lightning Talks

12:30pm-1:30pm Lunch and Review panel closed session on Operational Exploration

THEME 2: New and developing technologies

1:30pm Overview of OEI's technology development and expertise (Adam Soule)

2:00pm Technology Lightning Talks

4:00pm Questions from the panel

4:30pm-5:30pm *Review panel closed session on Education and Outreach*

Dinner 6pm TBD Matunuck or Plum Point

April 4

8:00 am coffee and breakfast for the Review Panel

8:30am Review Panel Executive Session (reflections from day 1)

9:00am coffee and breakfast provided for all

THEME 3: Education and Engagement

9:30am Welcome to day 2, Overview of OEI's Education and Engagement priorities, how they support NOAA (Adam Soule)

10:00am Education and Engagement Lightning Talks

11:15am Questions from the panel

12:00pm-1:00pm *Lunch and Review panel closed session on Operational Exploration*

1:00pm-2:30pm GSO campus tour (ISC, New dock) and mini-poster Session (Dwight Coleman)

2:30pm-4:30pm *Review panel closed session posters and overall and OEI Executive Office debrief and discussion, wrap up*

Travel home or Dinner: Coast Guard House