UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary of Commerce
for Oceans and Atmosphere
Washington, D.C. 20230

April 04, 2022

Mr. Scott Rayder
Chair, IOOS Advisory Committee
Alabama Water Institute, University of Alabama
205 Hackberry Lane
Tuscaloosa, Alabama 35401

Dear Mr. Rayder:

In June 2021, the U.S. Integrated Ocean Observing System (IOOS) Advisory Committee submitted a report on their recommendations to the National Oceanographic and Atmospheric Administration (NOAA) and the Interagency Ocean Observation Committee (IOOC). This report aligns well with NOAA's priorities and vision for the future. NOAA supports strong and resilient coastal economies, sustainable management of protected areas and natural resources, and innovation to support science and stewardship—and recognizes the critical role of the U.S. IOOS Enterprise in those endeavors.

The U.S. IOOS Office has already begun to implement several recommendations included in the Committee's report, and NOAA intends to continue making progress on many more as well. Please see the attached NOAA response to the report. NOAA is keenly interested in furthering a discussion about new innovative partnerships through the IOOS Enterprise that will spur economic growth, help our nation address climate change and coastal inundation, and ensure equitable NOAA services to all Americans.

Sincerely,

Dr. Richard W. Spinrad
Under Secretary of Commerce
for Oceans and Atmosphere
and NOAA Administrator

THE ADMINISTRATOR

cc:
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NOAA Response to:

June 2021 Recommendations to NOAA and the IOOC by the U.S. Integrated Ocean Observing System Advisory Committee

A Report to the
U.S. Integrated Ocean Observing System Advisory Committee
May 2022

Submitted by:
Richard W. Spinrad, Ph.D.
Under Secretary of Commerce for Oceans and Atmosphere
and National Oceanic and Atmospheric Association Administrator
May 2022

Introduction

In June 2021, the U.S. Integrated Ocean Observing System (IOOS) Advisory Committee submitted a report on their recommendations to the National Oceanographic and Atmospheric Administration (NOAA) and the Interagency Ocean Observation Committee (IOOC). Their recommendations were organized over three priority areas based on a survey of IOOS Enterprise members and stakeholders that identified enterprise strengths, weaknesses, opportunities, and challenges: 1) Vision and Strategy for the Future, 2) Creating and Sustaining Strategic Partnerships, and 3) Requirements Management and Infrastructure Investments for Success and Growth. This report aligns well with NOAA's priorities and vision for the future. NOAA supports strong and resilient coastal economies, sustainable management of protected areas and natural resources, and innovation to support science and stewardship—and recognizes the critical role of the U.S. IOOS Enterprise in those endeavors.

This document describes NOAA's response to the 21 recommendations put forth by the U.S. IOOS Advisory Committee. Each recommendation is organized under each relevant priority area. The "NOAA Response" section under each recommendation includes a concurrence statement (concur, concur with the intent, or does not concur) and a brief description of NOAA's rationale for its position. The "What we have done" section outlines activities that have already been taken to meet this recommendation. The "What we will do" section outlines activities and projects that address the call to action within each recommendation. Some activities identified in the "What we will do" section reflect current continuing projects while others describe new initiatives yet to be started.

The U.S. IOOS Office has already begun to implement several recommendations included in the Committee's report, and NOAA intends to continue making progress on many more as well. NOAA is keenly interested in furthering a discussion about new innovative partnerships through the IOOS Enterprise that will spur economic growth, help our nation address climate change and coastal inundation, and level the playing field to ensure equitable NOAA services to all Americans.

Response to Recommendations

1. Priority Area: Vision and Strategy for the Future

1.1 Ensure sustained observations to respond to changing ocean and climate conditions

1.1.1 Recommendation*:* Maintain and increase IOOS observing infrastructure and measurements and ensure they capture the coastal climate signal and its impact through sustained observations and models.

> ***NOAA Response***: NOAA concurs with this recommendation. As the nation increasingly feels the impacts of climate change to our nation's coasts and oceans, (including sea level rise, ocean acidification, and more intense hurricanes), authoritative ocean, coastal, and Great Lakes information is needed to address and prepare for current and future challenges.
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> ***What we have done:***
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> NOAA is constantly working to improve its observing capabilities. Increased resources in recent years have been critical for maintaining and growing IOOS observing infrastructure. "Fill the Gaps" funding from Congress in FY17–21 invested $11.6M in glider observations, $9.6M in high-frequency radar (HFR) observations, and $8.1M in streamlined access to observations. Between 2017 and 2020, annual glider missions funded with Fill the Gaps funding increased from ~50 to over 100 missions, and ~15 gliders were procured across the 11 RAs for missions related to harmful algal blooms (HABs), fisheries, hurricane intensity forecast improvements, ecosystem monitoring, and water quality. Funds also supported the IOOS National Glider Data Assembly Center, which has become the operational conduit for getting nonfederal glider data into NOAA for operational assimilation by the NOAA Real-time Ocean Forecast System (RTOFS). "Fill the Gaps" funding also contributed to the addition of 30 new HFRs, funded major repairs to a further 31 HFRs, and supported operations and maintenance of 63+ HFR stations. These enable predictive services such as the West Coast Operational Forecast System model that provides water levels, currents, water temperature, and salinity nowcast and forecast guidance. In addition, the FY22 President's Budget for IOOS Regional Observations was $69.5M (a 49% increase over the FY21 enacted funding level of $40.5M), and for NOAA IOOS (the national line that is in the "Navigation, Observations, and Positioning" Program, Project, and Activity) was $11.3M (a 67% increase over the FY21 enacted funding level of $6.78M). Even though the FY22 enacted

funds did not match the President's budget level, this represents a historic budget request for IOOS, and important growth potential for the program.

The Infrastructure Investment and Jobs Act (IIJA) is bringing critical resources to enhance and improve ocean, coastal, and Great Lakes observing infrastructure. IIJA provides a singular opportunity. These investments allow NOAA to increase support for key programs, activities, and partnerships that expand delivery of strong science, service, and stewardship to address improved and enhanced coastal, ocean, and Great Lakes observing systems.

What we will do:

NOAA will continue to pursue sufficient resources for observing infrastructure as part of annual budget requests, and will continue to leverage partner investments to maintain and expand the system. The IOOS Office will also work with NOAA ocean observing programs under the Weather Water Climate Board to continue executing the IIJA funding over the next five years.

1.1.2 Recommendation*:* Advance linkages between regional near-shore and global ocean models and enhance integration with NOAA's Unified Forecast System (UFS).

NOAA Response: NOAA concurs with this recommendation. Integrating models and forecasts across varying spatial and regional scales is important for creating uniformity, increasing data accessibility, and improving model and forecast accuracy.

What we have done:

In FY21, NOAA established the NOAA Modeling Board to unify production of world-leading, fully coupled, Earth System models for research, operations, and applications. In FY22, NOAA established a new Working Group under the NOAA Modeling Board called "Expanding Operational Ocean Forecasting and Prediction" which will be responsible for achieving a clear framework for cross-NOAA and external modeling community coordination and integration with respect to the operational ocean observation value chain and to define needs/requirements and a path for research to operational models. NOAA also hosted a Coastal Community Modeling Workshop to engage the extramural and internal NOAA coastal modeling community.

Additionally, the National Ocean Service (NOS) has established cross-NOAA teams under the UFS to generate consensus guidelines (i.e., metrics, criteria, and competing numerical oceanographic models) for model evaluation of each application theme. NOS is also coordinating with the NOAA Climate, Ecosystems, and Fisheries Initiative to use UFS global models with operational coastal models on the U.S. west coast.

Within the IOOS Office, five three-year projects were funded in FY21, with varying scope, through the Coastal and Ocean Modeling Testbed program with a focus on transitioning models from research to operations. These projects include improving data assimilation, coupling of 3D ocean models to the National Water Model, and improvements to the NOS Global Extratropical Surge and Tide Operational Forecast System model.

NOAA is taking action by implementing changes to marine Joint Effort for Data assimilation Integration (JEDI) infrastructure within the UFS. This includes funded projects to advance atmosphere/ocean coupled modeling and ocean data assimilation in UFS and JEDI frameworks in support of UFS-based Hurricane Analysis Forecast System and UFS-based coastal applications.

What we will do:

NOAA will use the Expanding Operational Ocean Forecasting and Prediction Working Group under the NOAA Modeling Board to address this recommendation. Additionally, the Coastal Application Teams (inclusive of other agencies and academia) plans to define the components of the operational coastal prediction systems to be integrated into the UFS.

1.1.3 Recommendation: Continue to undertake economic valuation processes of observing systems to better quantify benefits and enhance messaging for sustained observations.

NOAA Response: NOAA concurs with this recommendation. Beyond their contributions to scientific research, sustained operational ocean observations, measurements, and forecasts support a wide range of societal and economic benefits related to safety, operational efficiency, regulation, and management of activities on, in, and under the ocean. Quantifying the value of the socioeconomic benefits of observing systems is critical for conveying the importance of these systems in a broader context.

What we have done:

NOAA and IOOS are involved in a number of projects seeking to determine the economic value and benefits derived from ocean observing activities and systems. The IOOS Office has released two Ocean Enterprise Studies: a baseline study in 2015, and a 2015–2020 update released in December 2021. These studies include survey results and trend information to better understand how the U.S. Ocean Enterprise business cluster of providers of ocean observing technology and intermediaries creating value added information services have responded to opportunities to support a growing and changing Blue Economy.

Within NOAA Oceanic and Atmospheric Research (OAR), the Global Ocean Monitoring and Observing Program and the Ocean Acidification Program co-funded a

valuation study by Hauke Kite-Powell, which was completed this past winter. This report will be made public once the results have been reviewed by the NOAA sponsor programs.

Additionally, in June 2021 NOAA's Office of Performance, Risk & Social Science (PRSSO) worked with the U.S. Bureau for Economic Analysis to release the first official Marine Economy Satellite Account statistics from 2014–2019. In 2021, PRSSO also initiated a study of the potential benefits to society of NOAA's next generation geostationary satellite program (GeoXO). More than 150 discrete benefits have been identified, with applications ranging from electric power production, aviation, hurricane response, wildfires, human exposure to poor air quality, HABs, and agriculture. GeoXO will also provide new types of observations, which are likely to lead to discoveries and new applications. The GeoXO working group completed a report detailing these findings as part of the mission planning efforts and studies for producing monetized benefits estimates are underway.

What we will do:

The IOOS Office plans to repeat the Ocean Enterprise Study listed above every 5 years, to track trends over time. The Center for the Blue Economy at the Middlebury Institute of International Studies at Monterey, in partnership with the IOOS Association, is close to releasing a prototype economic valuation study of ocean observing systems within the IOOS Regions. The IOOS Office is also working with the Center for the Blue Economy on a "Benefits of Ocean Observing Catalog" to provide a GIS-based central repository of case studies, papers, and reports describing the societal and economic benefits derived from ocean observations, with input by various stakeholders from around the world.

1.2 Capitalize on technological innovation to enable Smart Coastal Oceans and Great Lakes

1.2.1 Recommendation*:* Ensure use of 11 federally certified regional data centers to implement advanced data tools and further data aggregation.

NOAA Response: NOAA concurs with this recommendation. The 11 IOOS Regional Associations (RAs) are essential to the U.S. IOOS Enterprise for providing increased observations, distinctive knowledge, and critical technological abilities, and applying these to develop products that meet regional and local needs.

What we have done:

In 2020, all 11 RAs recompeted for five-year cooperative agreement awards. Additionally, all IOOS RAs are certified or getting re-certified in data management, and

within the five-year certification period have undergone or are subject to undergoing a review/audit. The IOOS Office hosts an annual Data Management and Cyberinfrastructure (DMAC) meeting that brings together RA and community members to communicate and discuss advancements and innovations in the coastal oceans and Great Lakes; the next meeting is scheduled for June 2022. The IOOS Office also maintains https://IOOS.us/, which hosts community-based, open-source platforms for co-development of standard protocols (e.g., NOAA's Environmental Research Division's Data Access Program).

Recent NOAA funding opportunities have also helped advance this recommendation. A Notice of Federal Opportunity regarding Topic Area 2 (Advancing the National DMAC System Architecture) of the FY21 Implementation of the U.S. Integrated Ocean Observing System funding announcement resulted in funding for two projects: (1) Passive Acoustic Monitoring Access Network: Advancing Data Management and Cyberinfrastructure Solutions for a Big Data Problem (awarded to the University of Colorado), and (2) Reaching for the Cloud: Architecting a Cloud-Native Service-Based Ecosystem for DMAC (awarded to RPS).

Congress has recognized the need to enhance regional ocean and Great Lakes data sharing, and from FY19–21, Congress appropriated a total of $5.5M for regional ocean partnerships (ROPs)[1], or their equivalent, to enhance their capacity for sharing and integration of Federal and non-Federal data to support regional coastal, ocean and Great Lakes management priorities. In the Explanatory Statement for NOAA's FY20 and FY21 appropriation to support "Regional Data Portals", Congress directed the IOOS Office and the Office for Coastal Management to coordinate implementation of these funds given that the RAs have strong regional relationships and capacity for data sharing and could serve this role effectively in regions without an established regional ocean partnership. In the five regions where established ROPs do not exist (Great Lakes, Caribbean, Southeast, Pacific, and Alaska), IOOS RAs have been serving as the equivalent to enhance sharing and integration of federal and non-federal data.

What we will do:

The IOOS Office will continue to track and audit certifications for the RAs. In addition, the IOOS Office will continue to convene targeted data management workshops to continue to work with the community to innovate and improve data sharing tools. For example, the U.S. IOOS Office is organizing a DMAC code sprint in April 2022 that will bring together RA and external programmers to use innovative tools and code to tackle urgent coastal ocean and Great Lakes issues.

[1] Regional ocean partnerships (ROPs) are regional organizations voluntarily convened by governors working in collaboration with other governments (including tribal, federal, and local) and stakeholders to address ocean and coastal issues of common concern in that region. There are four regional ocean partnerships: the Gulf of Mexico Alliance, the Northeast Regional Ocean Council, the Mid-Atlantic Regional Council on the Ocean, and the West Coast Ocean Alliance.

1.2.2 Recommendation*:* Identify ways that NOAA can use technological innovations to address the needs of coastal and oceanographic communities and stakeholders, including for outreach and education purposes.

NOAA Response: NOAA concurs with this recommendation. Technology advancements provide opportunities to more effectively engage with communities and stakeholders, and to better address their needs.

What we have done:

NOAA is actively engaged in spurring technological innovation to meet community and stakeholder needs. The IOOS Office's Ocean Technology Transition (OTT) Program sponsors the transition of marine observing technologies to an operational mode, and currently supports eight projects at an annual expenditure of $2.75M covering topics such as HABs, hypoxia, ocean acidification, animal borne sensors, and physical ocean observations. The IOOS Office also hosts seven HAB Pilot Projects and a three-year testbed pilot project, where researchers will deploy a small suite of autonomous instruments to test their suitability in the turbid waters of the Gulf of Mexico, and build both the instrument and personnel capacity to operate, maintain and interpret the data from the systems. The Pilot Projects deploy a variety of technologies (e.g., qPCR assays, Imaging FlowCytobots, Environmental Sample Processors, machine learning, HABscope) to better observe and predict HABs.

NOAA also engages in workshops, conferences, trade shows, etc. to meet this goal. In 2020, OAR and the IOOS Office teamed up to develop and host three regional workshops focused on improving users' access to streamlined ocean, coasts, and Great Lakes observational information. One focus was on Technology Development and Transition, where key areas for IOOS-OAR collaboration were identified including power and persistence of uncrewed vehicle systems, carbon dioxide removal technologies, artificial intelligence and cloud system development, automatic omics' (eDNA) samplers, among others. The IOOS Office is also partnering with the Department of Energy Water Power Technologies Office on the "Powering the Blue Economy: Ocean Observing Prize," which challenges innovators to integrate marine renewable energy with ocean observation platforms, ultimately revolutionizing our ability to collect the data needed to understand, map, and monitor the ocean and to realize the full potential of the Blue Economy. Finally, IOOS sponsors technology conferences and trade shows such as the Marine Technology Society Oceans Conference, Oceanology International, Oceans in Action, BlueTechWeek, etc.

In order to leverage the data and technology advances to serve coastal and oceanographic communities and stakeholders, the NOAA Water Initiative developed a Service Delivery Framework in 2020 with a mission to "continuously build a network of trusted experts who engage internally and externally with partners to inform NOAA's

product and service development to be useful, usable, and used." This involves substantial engagement to: 1) Coordinate and integrate NOAA contributions to understand needs and communicate with product and service developers; 2) Prioritize investments in product lines, e.g., science (observations and data), services (technical assistance, engagement, training), and stewardship (resource management, place-based); 3) Develop new, and refine existing, products and services informed by user needs; and 4) Transmit and translate actionable information for decision-makers across multiple sectors.

What we will do:

To continue working towards achieving this goal, the IOOS Office will continue to fund and promote advancement of new technologies, such as through the FY23 OTT Notice of Federal Funding Opportunity, and through coordination with NOAA's National Centers for Coastal Ocean Science on the HAB Pilot Projects. NOS has also been tasked with delivering a five-year implementation plan for a national HAB Observing Network (NHABON) to Congress by October 1, 2022. This will help inform NOAA's goals and priorities in progressing HABs observation and forecasting tools nationwide.

To guide engagement with coastal and oceanographic communities and stakeholders, the IOOS Office plans to continue to implement NOAA's Service Delivery Framework in partnership with the IOOS RAs. In addition, NOAA is building a plan to accelerate the growth of the New Blue Economy, which includes improving policy and partnership frameworks, technology innovations, and the ocean, coastal, and Great Lakes information services provided by NOAA and other participants in the New Blue Economy to deliver and manage balanced and sustainable use of the ocean and ocean resources.

1.2.3 Recommendation*:* Leverage diverse STEM expertise to enhance future workforce.

NOAA Response: NOAA concurs with this recommendation. A more diverse workforce brings varying experiences and perspectives that allow for teams to approach problems from a broad array of viewpoints, ask different questions, and develop more innovative solutions.

What we have done:

When hiring new employees, the IOOS Office redacts resumes to remove indicators of gender, race, and age in order to minimize unconscious bias that may occur when selecting candidates to interview. The IOOS Office works to engage with students at all levels to enhance the future workforce. At the elementary level, copies of the children's book "The Ocean Is Our Home" by Dina Eparkhina and Karri Lehtonen (published by the European Global Ocean Observing System) were printed for

distribution to six local elementary schools. This book describes the ocean's ecosystem and economic services, and the importance of ocean data and information to maintain and advance those services.

At the undergraduate level, IOOS personnel serve as application reviewers and internship hosts for the Hollings Scholarship Program (provides academic assistance for two years and a ten-week, full-time paid internship at NOAA during the summer that provides hands-on, practical experience in NOAA-related science, research, technology, policy, management, and education activities) and the José E. Serrano Educational Partnership Program with Minority Serving Institutions (EPP/MSI; provides academic assistance for two years and two paid summer internships to outstanding students studying at Minority Serving Institutions). The RAs also host summer undergraduate interns, some through the Hollings and EPP/MSI programs (e.g., SECOORA), and some through their own summer programs (e.g., CARICOOS).

Additionally, the IOOS Office provided funding for an undergraduate and a recent graduate to attend the 2019 DMAC Code Sprint in Ann Arbor, MI, and supported and mentored two undergraduates and one Ph.D. student from around the world, all new or beginning open source programmers, to participate in the 2021 Google Summer of Code, using innovative tools and code to tackle urgent coastal ocean and Great Lakes issues. The IOOS Office also hosts Sea Grant Fellows annually.

The IOOS Office is also working with the RAs to expand its diversity, equity, inclusion, and accessibility (DEIA) efforts to help foster a more diverse and inclusive workforce. In January 2022, a DEIA Fellow was hired through the IOOS Association to help amplify regional work and identify opportunities to improve IOOS' ability to serve and engage underserved communities. IOOS is also actively engaged with NOS DEIA efforts and contributed to NOAA and Department of Commerce strategic plans to expand DEIA efforts within the broader organization.

What we will do:

The IOOS Office plans to continue and grow their current outreach efforts. Although copies of "The Ocean is Our Home" have been printed and interested schools have been identified, distribution was stalled due to the COVID-19 pandemic. This project will be resumed and books will be shipped upon return to the office in spring 2022. IOOS is also planning to fund an undergraduate and a recent graduate to attend the 2022 DMAC Code Sprint in Chicago, IL, is planning to support and mentor up to three programmers in the 2022 Google Summer of Code, and plans to host and mentor Sea Grant Fellows annually. Fellowship and internship opportunities in the RAs are also planned to continue, as described above.

2. Priority Area: Creating and Sustaining Strategic Partnerships

2.1 Maintain/Build on existing partnership models

NOAA Response: NOAA concurs with this recommendation. IOOS' success is built on partnership across public and private sectors and is based upon the regional and national cooperation identified in the Integrated Coastal and Ocean Observation System Act of 2009. IOOS continues to foster partnerships that link and leverage different programs' objectives toward larger outcomes which may become greater than the sum of the individual parts.

What we have done:

The IOOS regional coastal observing systems are by definition a network implemented by regional partners. The IOOS enterprise relies upon a complex network of observing, data management, and modeling communities that span government and academia, national and international organizations, and private and public sectors. The IOOC is comprised of 17 federal agencies working toward a national integrated system.

What we will do:

The IOOS Enterprise will continue to grow our partnerships, to leverage emerging technologies and resources. For example, IOOS is considering submitting a proposal to U.S. Climate and Ocean-Variability, Predictability, and Change (CLIVAR) in order to strengthen interagency efforts to address the impacts of climate at the coasts. This would be a new partnership, further integrating the CLIVAR expertise in climate dynamics with IOOS' stakeholder driven service delivery.

2.2 Use partnerships to accelerate innovation and inclusivity

NOAA Response: NOAA concurs with this recommendation. NOAA relies upon a diverse set of partners and viewpoints to ensure data, products, and services are effective and reach a wide range of end-users.

What we have done:

As described in 1.2.2, above, NOAA utilizes existing funding opportunities, such as the OTT program, as an accelerator of innovation and inclusivity. NOAA partners with other agencies to revolutionize new technologies for more efficient and effective ocean observing (e.g. the Department of Energy "Powering the Blue Economy: Ocean Observing Prize"). The IOOS Office has also been cultivating a growing partnership across line offices to increase the impact of ocean observing data and predictions to

support improvements to hurricane intensity forecasting. The initial focus in 2017–2019 was on increasing the sampling locations and number of glider deployments in hurricane prone geographies in partnership with the IOOS RAs and NOAA's Atlantic Oceanographic and Meteorological Lab and the U.S. Navy. In 2020–2021, the Office has joined an even broader group in partnership with the Global Ocean Monitoring and Observing program to design a more integrated field campaign of drifters, floats, UxS surface vehicles, and profiling gliders. This effort has grown in complexity and also in collective impact. There are still many details to be worked through to ensure data are ingested into operational models. This includes analyzing the impacts of those data and improving the design and transition of these efforts into operations.

What we will do:

The IOOS Office will continue to provide funding opportunities through the OTT program and work with other NOAA programs and agencies to leverage their funding announcements through joint opportunities to infuse new technology into the IOOS regional observing systems and/or to leverage NOAA and IOOS expertise to support those programs.

2.3 Leverage non-IOOS data initiatives

2.3.1 Recommendation*:* Analyze NOAA initiatives with established partnership models to ensure alignment with IOOS effort.

NOAA Response: NOAA concurs with this recommendation. It is important for alignment of strategies and priorities across NOAA in order to increase efficiency and maximize outcomes.

What we have done:

The IOOS Office strives to work with partners across NOAA and interagency in order to maintain alignment with ongoing initiatives. The IOOS Office has monitored new and ongoing cross-NOAA initiatives through the Weather Water Climate Board, the NOAA Observing Systems Council, NOAA Oceans and Coasts Councils, the UxS Executive Oversight Board, and other initiatives such as the NOAA Water Initiative, the Coastal Coupling Community of Practice, the NOS Coastal and Ocean Modeling Strategic Plan, the Coastal and Ocean Modeling Testbed, the Climate, Ecosystems, and Fisheries Initiative, and Coastal Inundation at Climate Timescales. IOOS is also engaged in the OAR-led Extreme Events-Ocean Observations Task Team to integrate field campaign efforts for targeted and sustained ocean observing to improve the understanding of air-sea interaction during high wind events, with the goal of improving the accuracy of hurricane intensity forecasts. The IOOS Office also participates in

interagency efforts through the IOOC. IOOS is an active contributor to all the Task Teams, which consist of three or more agencies working together, and the IOOS Office presents an annual report to the IOOC reflecting the last year's accomplishments and the next year's goals and priorities.

What we will do:

The IOOS Office plans to continue involvement in cross-NOAA and interagency groups and initiatives to ensure that IOOS priorities align with NOAA priorities. The IOOS Office was involved in drafting the NOAA Strategic Plan, which is scheduled to be released at the end of summer 2022, and is currently involved in work on NOS and IOOS Strategic Plans. This gives IOOS the opportunity to align Office goals and strategies with larger NOAA and NOS priorities.

2.3.2 Recommendation*:* Expand engagement with private industries and other entities to rapidly establish partnerships to augment aging ocean observing infrastructure.

NOAA Response: NOAA concurs with this recommendation. Stakeholder engagement and partnerships are fundamental to the success of the IOOS Enterprise, and can be leveraged to help address aging infrastructure needs.

What we have done:

One way in which the IOOS Office has tackled this recommendation is through the previously mentioned OTT program, which is an ongoing, multi-year effort to transition prototype ocean, coastal, and Great Lakes observing, product development, and data management technologies to sustained operations in a stepped, parallel, and scalable process that includes stakeholder engagement from industry, government, academia, and others invested in the monitoring and assessment of the nation's ocean and coastal regions. OTT focuses on developing and improving technologies for ocean chemical, biological, and physical parameters at multiple spatial and temporal scales to monitor changing conditions in the oceans, coasts, and Great Lakes.

Through efforts to develop and advance the New Blue Economy, NOAA is engaged in dialogue with many private industry partnerships regarding how to share requirements. Additionally, the IOOS Office actively works with IOOS RAs and Ocean Enterprise businesses (e.g., SOFAR, Saildrone, etc.) to tackle aging infrastructure among other things.

The Biden Administration has established ambitious offshore wind energy goals. NOAA has entered into a memorandum of understanding (MOU) with the Bureau of Ocean Energy Management (BOEM) to meet these goals, advancing wind energy responsibly while protecting biodiversity and promoting cooperative ocean use. This MOU provides an unprecedented opportunity to advance offshore wind and

characterization of ocean regions, providing a win-win for addressing climate change and increasing ocean observing capacity to further assess ocean environments.

What we will do:

To further advance this goal, the IOOS Office plans to assist RAs with faster uptake of new technologies by highlighting certification and coordination with other offices (e.g., NOAA Center for Operational Oceanographic Products and Services). Additional plans include continuing to improve research to operation pathways for new technologies, such as through the OTT program. The IOOS Office will leverage the wind energy MOU with BOEM to maximize the benefits of wind energy platforms and minimize the wind energy interference to the IOOS HFR network. The IOOS Office will also leverage wind energy platforms to increase ocean observations in those regions.

2.3.3 Recommendation*:* Pursue leveraged support from other agencies and private sources through the National Ocean Partnership Program (NOPP).

NOAA Response: NOAA concurs with this recommendation. Additional support through alternative pathways is important for advancement of observational research and technology.

What we have done:

The IOOS Office is constantly working to leverage additional support to advance research, technology development, data management, and infrastructure needs. Many IOOS Notices of Funding Opportunities include a clause that allows IOOS to leverage support from other agencies via NOPP. Marine Life Projects through the Marine Biodiversity Observation Network and the Animal Telemetry Network have been routinely funded utilizing NOPP.

What we will do:

The IOOS Office will continue to search and leverage funding opportunities from other agencies and NOPP.

2.3.4 Recommendation*:* Collaborate with NOAA Big Data Project, and other relevant entities, regarding IOOS contributions to ecological forecasting and regional ocean forecasting efforts.

NOAA Response: NOAA concurs with this recommendation. It is important for IOOS to integrate their data into broader NOAA data projects and platforms to inform the most accurate forecasting models and maximize use of data analytics in the cloud. We note that the NOAA Big Data Project (renamed the Open Data Dissemination Program) has

relevance to a broad range of IOOS applications, beyond ecological forecasting and regional ocean forecasting.

What we have done:

IOOS RA hosted datasets are considered NOAA data for purposes of inclusion in the Open Data Dissemination Program. Additionally, the IOOS Office evaluates new datasets for inclusion into the NOAA Open Data Dissemination Program every year. These datasets are subsequently used in ecological forecasting and regional ocean forecasting efforts.

What we will do:

To further this goal, the IOOS Office will continue to evaluate and submit datasets into the NOAA Open Data Dissemination Program. The Office also plans to increase collaborations between the IOOS Cloud Sandbox (a platform for running regional coastal models in the cloud) and the NOAA Open Data Dissemination Program.

2.3.5 Recommendation*:* Expand the participation at all levels of BIPOC and underserved and underrepresented communities, including co-production of knowledge and incorporation of local and traditional Indigenous knowledge.

NOAA Response: NOAA concurs with this recommendation. An absence of participation from BIPOC and underserved and underrepresented communities is an absence of valuable knowledge and expertise that decreases the effectiveness of the IOOS Enterprise.

What we have done:

The new IOOS Association DEIA Fellow has already begun to connect with RAs to help them develop plans to establish and grow DEIA efforts within their regions, including working with indigenous communities to incorporate their knowledge into data portals and hosting workshops with stakeholder communities to facilitate interpretation of data and products and obtain essential feedback. One example of these efforts includes the Columbia River Inter-Tribal Fish Commision taking over the Oregon State University coastal ocean observations and modeling on an operational basis. This effort involves three tribes and includes the accompanying fieldwork. As mentioned above, IOOS is also actively engaged with NOS DEIA efforts and contributed to NOAA and Department of Commerce strategic plans to expand DEIA efforts within the broader organization.

What we will do:

The IOOS Association DEIA Fellow has developed a work plan through 2022 to further the work they have already started. The IOOS Office will continue to remain

engaged and search for additional ways to get involved in NOS- and NOAA-wide DEIA efforts.

3. Priority Area: Requirements Management and Infrastructure Investments for Success and Growth

3.1 Benchmark and ensure active management of requirements, including analysis, traceability, allocation, and guidance, to ensure effective annual and long-term budget formulation.

3.1.1 Recommendation*:* The U.S. IOOS Office should adopt a requirements management system that begins with higher-level objectives (e.g. "IOOS observations will lead to a XX% improvement in hurricane intensity forecasts over the next X years").

NOAA Response: NOAA concurs with this recommendation. Tracking requirements is important for determining allocation of resources, and higher-level objectives help steer these resources towards projects that help IOOS meet specific goals.

What we have done:

Based upon recommendations of the IOOS Advisory Committee, the IOOS Office has developed a Community Unfunded Requirements List (CURL) to catalog gaps and needs of the system. This detailed and comprehensive spreadsheet organized by region allows the office to maintain a current and periodically updated information source and tool to help prioritize resource investments and budget requests for the future. The CURL was discussed with the committee at the December 2021 Advisory Committee meeting.

What we will do:

The IOOS Office will maintain and update the CURL and use it as an information resource and tool to identify priority needs, gaps, and budgetary actions. Moving forward, IOOS will strive to create higher level objectives and performance goals organized by mission area or societal benefit.

The IOOS Office is updating its strategic plan and designing a new implementation approach. The intent is to align office priorities with strategic goals and provide a transparent implementation plan to enable partnership with a broad range of entities while maintaining an agile posture in order to take advantage of emerging opportunities and evolving Administration priorities.

3.1.2 Recommendation*:* NOAA Leadership should develop a coherent description of the many ocean observing programs within its Line Offices, including associated budgets in a cross-Line Office roll-up.

NOAA Response: NOAA concurs with the intent of this recommendation. Compiling a list of all the ocean observing programs within NOAA and their associated budgets could enable more cohesive integration of these programs to meet broader goals. However, ocean observing is often integrated with broader research and monitoring programs, making it difficult to compile a complete list of ocean observing programs in NOAA with associated budgets. NOAA concurs with the intent to identify significant ocean observing efforts and ensure that they are being effectively coordinated.

What we have done:

During Ocean Obs '19, the cross-NOAA "Vision Committee" working group, led by the Global Ocean Monitoring and Observing Office, used cross-NOAA interviews to synthesize the vision and role of ocean observing activities at NOAA. These interviews included participants from OAR, NOS, National Weather Service, the National Environmental Satellite, Data, and Information Service, the National Marine Fisheries Service, and the Office of the Chief Data Officer. Although this was not a comprehensive effort to document every ocean observing program within NOAA, it is an effort that can be built upon in the future.

Additionally, the Extreme Events-Ocean Observations Task Team, made up of representatives from OAR, National Weather Service, and NOS, is working to increase ocean observations during hurricane season, in order to further improve hurricane forecasts models, especially hurricane intensity forecasting.

What we will do:

To further address this goal, NOAA will explore adding and establishing an Ocean and Coasts team under the Weather Water Climate Board and renew the emphasis of that body as an Earth System predictions board. In the process of establishing this group, a comprehensive list of ocean observing groups within NOAA will likely need to be compiled. The IOOS Office will explore an ocean observing program budget roll-up with Ocean Service leadership.

3.1.3 Recommendation*:* U.S. IOOS Office should develop an annual investment strategy based on a traceable requirements management process.

NOAA Response: NOAA concurs with this recommendation. An annual planning investment strategy tied to documented requirements would help the IOOS Office to

regularly evaluate the needs and requirements of the IOOS Enterprise, and strategize how best to meet those needs while aligning with office and program goals.

What we have done:

The previously mentioned IOOS' CURL as a valuable tool for understanding requirements that are unmet and under-resourced. In response to stakeholder-driven requirements feedback, the IOOS Office increased the funding amount in their Notice of Funding Opportunity to $6M per region per year for the FY21–25 cooperative agreements. The IOOS Office implements an annual planning process that identifies priorities based on current mandates and initiatives that drive our requirements. The process generates milestones which incorporate input from the CURL, community plans and other traceable requirements. Through the IOOC, IOOS and interagency partners develop community observing plans, such as the Operational Wave Observation Plan, a Surface Current Mapping Plan, a National Strategy for a Sustained Network of Coastal Moorings, and an Animal Telemetry Network Implementation Plan. These plans propose comprehensive system designs that establish a standard level of accuracy, assess existing measurement locations, and propose both new observations and critical gaps locations and upgrades to existing platforms.

What we will do:

The IOOS Office is developing a holistic planning process including a revised strategic plan, community planning documents, multi-year internal program plans, and annual priorities. The IOOS Office will continue development of an agile implementation approach to execute on documented requirement gaps.

3.1.4 Recommendation*:* NOAA Leadership should position IOOS as the oceanographic operational integrator at NOAA.

NOAA Response: NOAA concurs with the intent of this recommendation. Having a single observational entity to manage operational oceanographic data would streamline data integration into models and forecasts. As noted above, oceanographic data is collected across line offices and across NOAA programs. Operational oceanography is implemented across the NOAA line offices, as well. The IOOS Office and the IOOS Regions are critical components in this architecture.

What we have done:

The NOAA Modeling Board under the Weather Water Climate Board is addressing the need for more integrated oceanography through 1) Coordinating environmental modeling and numerical prediction, forecasts, and projections within NOAA, including research and development, utilization of observations, data

assimilation, relevant data management, post-processing, scientific and societal applications, and high-performance computing that are essential to driving model improvements; 2) Providing strategic advice and guidance on priorities and requirements, understanding stakeholder needs, and defining the continuous process for modeling systems improvement; and 3) Serving as a NOAA point of contact for collaboration and coordination with the broader modeling community. The IOOS Director is currently the champion for the Expanding Operational Ocean Forecasting and Prediction Working Group under the NOAA Modeling Board.

Within NOS, a modeling portfolio manager position was created in 2020 in order to better integrate and coordinate the diverse modeling efforts within NOS. This position facilitates the use of community modeling approaches to improve operational ocean models within NOS and NOAA. These models, in turn, connect to operational forecasts within NOS and NWS. The modeling portfolio manager sits in the IOOS Office, in recognition of the key role the IOOS Office plays in integrating academic and government modeling efforts.

What we will do:

The IOOS Office will continue to leverage the Weather Water Climate Board and the NOS Modeling Portfolio Manager activities to continue to integrate and operationalize oceanographic observing and modeling for the Nation. As NOAA develops a plan to foster development of the New Blue Economy, actions will be identified to improve oceanographic information services to advance this goal.

3.2 Tie requirements management to infrastructure investments

3.2.1 Recommendation*:* IOOS Office should create an unfunded requirements list based on a gap analysis.

NOAA Response: NOAA concurs with this recommendation. In order for the IOOS Enterprise to grow, requirements to meet future goals need to be identified and tracked.

What we have done:

As mentioned previously, IOOS has developed an IOOS CURL to help track unfunded requirements, gaps, and needs of the system, and to help prioritize resources. The CURL was discussed with the committee at the December 2021 Advisory Committee meeting.

What we will do:

In addition to the CURL, the IOOS Office plans to work with the RAs on a repeatable cycle to identify gaps in each region. At a broader level, IOOS will coordinate

with the Weather Water Climate Board and the NOAA Modeling Board to integrate and leverage across initiatives and programs (e.g., Climate, Ecosystems, and Fisheries Initiative) to address requirements gaps.

3.2.2 Recommendation*:* IOOS Enterprise should develop an Observing System Recapitalization Plan to include maintenance, operations, sustainability, and modernization of the observing system.

NOAA Response: NOAA concurs with the intent of this recommendation. Recapitalization is critical to help sustain and advance observational capabilities within the IOOS Enterprise. Recapitalization requirements will be included in planning efforts, rather than developing a separate Observing System Recapitalization Plan.

What we have done:

Recapitalization work within IOOS is tracked and prioritized within the IOOS CURL. In addition, the IIJA allocated resources to IOOS to help meet recapitalization needs. Execution and implementation of these funds are scheduled over the next five years.

What we will do:

To work towards developing an Observing System Recapitalization Plan, IOOS will ensure that all planning documents include recapitalization goals. The IOOS Office will also work with NOAA ocean observing programs under the Weather Water Climate Board to document and communicate the investment plans specifically supported in provision 11 and 17 of the IIJA for "improved and enhanced coastal, ocean, and Great Lakes observing systems." Initial spend plans were established by NOAA for the first 2 of 5 years, with the intent to revisit plans for years 3, 4, and 5 on an annual basis. This represents an opportunity to further address this recommendation.

3.2.3 Recommendation*:* NOAA should set up PAC budget lines for IOOS, for infrastructure refreshes and equipment servicing as part of a larger plan to fully fund present and future known and emerging infrastructure needs.

NOAA Response: NOAA concurs with the intent of this recommendation. The ability to keep existing infrastructure functional is critical for a successful observation network. However, investments in regional infrastructure can be managed through Operations, Research, and Facilities (ORF) funding.

What we have done:

Infrastructure Investment and Jobs Act (IIJA) investments will help with infrastructure refreshes and equipment servicing. $150M is allocated specifically for "improved and enhanced coastal, ocean, and Great Lakes observing systems." This includes $50M of PAC funding, that will be used to recapitalize critical needs in federal observing programs.

What we will do:

NOAA will continue to fund infrastructure recapitalization and equipment servicing through ORF funding, and additional opportunistic funding sources like the IIJA. Also see answer to recommendation 3.2.2.

3.2.4 Recommendation*:* IOOS should, where possible without a federal budget cross-cut, assess requirements in the context of the total federal investments.

NOAA Response: NOAA concurs with intent with this recommendation. Leveraging existing federal ocean observation investments to help IOOS fund its own requirements is an efficient way to grow the IOOS Enterprise while contributing to other federal goals and projects.

What we have done:

To assess requirements in the context of total federal investments in ocean observing, the IOOS Office focuses on leveraging across programs and matrixing requirements through platforms such as the NOAA Climate, Ecosystems, and Fisheries Initiative, connections to the Weather Enterprise, contributions to the Office of National Marine Sanctuaries conditions reports, partnerships with the National Centers for Coastal Ocean Science on HABs, the NOAA Weather Water Climate Board, and the NOAA Modeling Board.

What we will do:

The IOOS Office will continue their current efforts to achieve this goal. Also see recommendation responses for 3.2.2 and 3.2.3.