U.S. IOOS ENTERPRISE

STRATEGIC PLAN 2022–2025

LAST UPDATED AUGUST 8, 2022

ioos.noaa.gov

IOOS
Integrated Ocean Observing System

Acknowledgements

The Integrated Ocean Observing System (IOOS) is our eyes on the ocean, coasts, and Great Lakes. We are an integrated network of people and technology gathering observing data and developing tracking and predictive tools to benefit the economy, the environment, and public safety at home, across the Nation, and around the globe.

We gratefully acknowledge the following partners in the IOOS Enterprise:

Federal Partners

Regional Associations

Letter from the Director

Much has changed in the world since the U.S. Integrated Ocean Observing System (IOOS®) was founded in 2009. Our Nation is increasingly feeling the impacts of the changing climate on our oceans, coasts, and Great Lakes including sea level rise, ocean acidification, marine heatwaves, and more intense hurricanes. Authoritative data, information, and services are needed more each day as our coastal communities respond to these chronic challenges and prepare for a more resilient future. As coastal communities become increasingly vulnerable to the impacts of climate change, IOOS strives to provide better services and information across all our Nation's communities.

The 2022-2025 IOOS Enterprise Strategic Plan prioritizes efforts in ocean, coastal, and Great Lakes data, equity, and services and will position IOOS and our Nation for success in the 21st century. We continue to focus on our five long-standing goals: 1) Sustain long-term, high-quality observations of ocean, coastal, and Great Lakes environments to address local, regional, and national needs; 2) Deliver standardized, reliable, and accessible data; 3) Support model predictions that address a wide range of user requirements; 4) Provide integrated, user-driven products and tools; and 5) Increase the reach and effectiveness of IOOS through partnerships, stakeholder engagement, and investment in Enterprise excellence.

In 2023, IOOS is working to execute our priorities and mandates for preserving, strengthening, and growing our coastal and ocean investments and resources highlighted in the Infrastructure, Investment, and Jobs Act; the America the Beautiful Initiative; and Executive Orders that ensure Federal agencies prioritize diversity, equity, inclusion, and accessibility, and support IOOS' efforts to respond to and plan for a worsening climate crisis.

In all our work, IOOS endeavors to ensure that our authoritative ocean, coastal, and Great Lakes data, information, and services are available and accessible by all communities, including those that are historically underserved. Integrating equity in all that we do positions IOOS to: build resilience and tackle the impacts of a changing climate on our coasts, oceans, and Great Lakes; produce better and more actionable data; deliver more effective services; improve our stewardship of our Nation's waters and economy; and build a more inclusive workforce. For all these reasons and so many more, IOOS is an essential partner for our strong Nation to keep thriving.

Meeting the goals and objectives outlined in this plan will advance NOAA's priorities around growing the New Blue Economy and providing equitable service delivery. The New Blue Economy is a data and information-based economy that supports our Nation's coastal and ocean needs by improving access to authoritative information, predictions, tools, and services. The contribution of the oceans and Great Lakes to our overall economy is significant. In 2020, knowledge-based ocean activities generated $8 billion in revenue and 325,000 jobs, and

both and are expected to continue growing. Economic growth and resilience rely upon IOOS' authoritative data, information, and service. When we combine climate-smart innovation and social inclusion within the New Blue Economy, we collectively create more resilient coasts and communities where we can preserve coastal livelihoods and ensure the environmental sustainability of our Nation's coastal, oceans, and Great Lakes' waters.

I want to thank everyone from the IOOS Enterprise for contributing to this plan, especially the U.S. IOOS Office staff, Regional Associations, IOOS Association, U.S. IOOS Advisory Committee, and the Interagency Ocean Observation Committee. From transitioning new research into operations to supporting safe cargo transits in our booming ports to expanding and improving access to open data and supporting development of new observation systems worldwide, we are proud of the important work IOOS does and look forward to what we will accomplish together in the future.

Carl Gouldman
Director, U.S. IOOS

This document has been reviewed and approved for release by the office of the Assistant Administrator for the National Ocean Service of the National Oceanic and Atmospheric Administration within the U.S. Department of Commerce.

Foreword

It's been over 10 years since the passage of the Integrated Coastal and Ocean Observation System (ICOOS) Act, which established the U.S. Integrated Ocean Observing System (IOOS®) and formalized the commitment to build a national, integrated, and centralized ocean observing system that prioritizes regional needs. IOOS has accomplished a lot during this time and has become a premier source of authoritative ocean, coastal, and Great Lakes data, information, and services that meet the safety, economic, and stewardship needs of our Nation. Congress reaffirmed IOOS' approach and fundamental priority to our Nation's investments with the bipartisan reauthorization of the ICOOS Act through the Coordinated Ocean Observations and Research Act (COORA) in 2020.

The IOOS Enterprise is a globally linked, nationally coordinated Federal and non-Federal network of observations, data management, analysis, services, and communications that systematically and efficiently delivers information on past, present, and future states of the U.S. coastal ocean. The Enterprise consists of a national network of 11 Regional Associations, the IOOS Association, the U.S. IOOS Advisory Committee, the Global Ocean Observing System (GOOS), as well as the 17 interagency federal partners in the Interagency Ocean Observation Committee (IOOC). The IOOC works to improve the efficiency of Federal agency contributions to IOOS.

The IOOS Enterprise is inclusive and represents the full scale of global-to-local partners contributing to, or benefiting from, this ocean observing system. Any entity contributing toward solutions or the implementation of IOOS is welcomed to be part of the Enterprise. It is the synthesis of these local, national, and global elements working together toward shared goals and objectives that makes IOOS the robust, agile system that it is today and why this document encompasses the full Enterprise.

The past two years have arguably been among the most challenging in modern history. Widening disparities in community resilience are increasingly linked to societal upheavals and disasters. Thus, a wide-ranging and cross-cutting commitment to diversity, equity, and inclusion is necessary to accomplish the IOOS mission. Diversity drives innovation and IOOS is committed to building a culture where differences are valued and acknowledged through both top-down and grassroots approaches.

IOOS Societal Benefits

IOOS meets the Nation's ocean, coastal, and Great Lakes needs by integrating information and providing key services across seven areas of societal benefit:

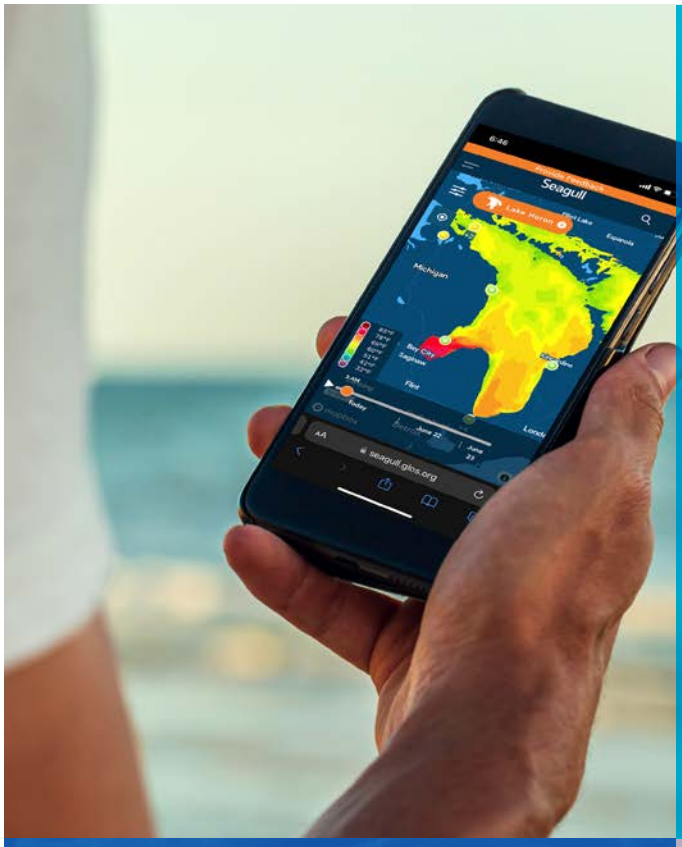
- Improving ocean, coastal, and Great Lakes predictions across weather and climate timescales and their effects on coastal communities and the Nation;
- Improving the safety and efficiency of maritime commerce;
- Mitigating the effects of natural hazards;
- Improving public safety and national and homeland security;
- Reducing public health risks;
- Protecting and restoring healthy coastal ecosystems; and
- Enabling the sustained and sustainable use of ocean and coastal resources.

IOOS is a growing network of regional coastal observing activities coordinated at the national scale. The IOOS Strategic Plan outlines five goals that address IOOS' core and emerging capabilities of observation, data management and cyberinfrastructure (DMAC), modeling and analysis, user-driven products and tools, and Enterprise excellence. IOOS evaluates stakeholder needs to prioritize mature and emerging observing systems and DMAC capabilities. IOOS will continue to infuse emerging technology into operations, resulting in a more efficient, cost-effective, and advanced ocean, coastal, and Great Lakes observing system while facilitating the creation of useful products and services from its data. This Strategic Plan articulates the vision and goals for achieving a more coordinated, efficient, and advanced Enterprise that supports both coastal and economic resilience by meeting our Nation's safety, economic, and stewardship needs.

This Strategic Plan is the first step towards achieving a more coordinated, efficient, and advanced Enterprise. The U.S IOOS Office is drafting an agile implementation approach to improve planning and execution efforts. This approach includes an annual review and refresh of the Strategic Plan and will outline the office's priorities, performance-based indicators, and metrics of success that will be used to forward the goals and objectives outlined in the IOOS Enterprise Strategic Plan. Through implementation, IOOS will continue to be the premier source of authoritative, high-quality ocean, coastal, and Great Lakes information to meet the safety, economic, and stewardship needs of the Nation.

"Fishermen, scientists, business owners, and more use tools built on IOOS data every day, relying on it to guide smart decision making."

— Lisa Auermuller,
Assistant Manager, Jacques Cousteau National Estuarine Research Reserve



Vision

Improve lives and livelihoods with ocean, coastal, and Great Lakes information.

Mission

To produce, integrate, and communicate reliable, high-quality ocean, coastal, and Great Lakes information that meets the safety, economic, and stewardship needs of the Nation.

Guiding Principles

Productive public-private partnerships

Integrated, high-quality, and reliable data

Easy and open exchange of information

Nimble, responsive services support diverse and evolving priorities and end-user needs

Leveraged resources and innovation produce efficient, sustainable observing systems

Coordinated networks of people, technology, and information

Stakeholder-driven, science-based, and policy neutral

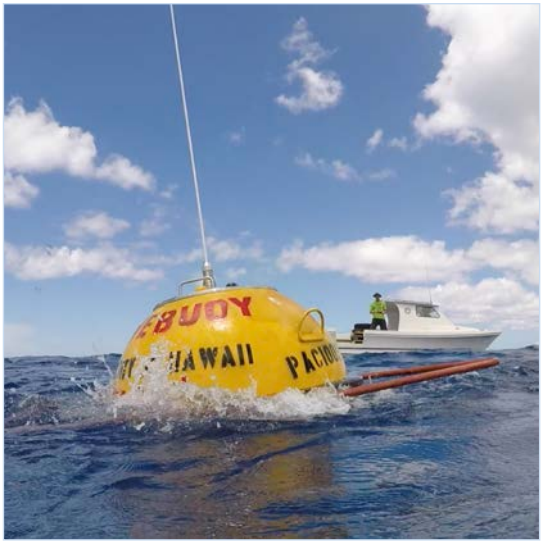
Goals and Objectives

Goal 1. Sustain long-term, high-quality observations of ocean, coastal, and Great Lakes environments to address local, regional, and national needs.

Background: Sustained observations of ocean, coastal, and Great Lakes systems are critical for the Nation's economy and security. U.S. IOOS, with its regional and Federal partners, supports an integrated system that combines in situ (e.g., moorings, gliders, shore stations) and remotely-sensed platforms (e.g., high frequency radars (HFR), satellites, drones, etc) to observe the range of physical, biogeochemical, and biological parameters necessary to meet an array of user needs. The national network of Regional Associations provides tailored products and information, and supports the Federal government's ability to do the same, at the scale needed to solve issues that manifest at the regional and local levels. This goal also supports the U.S. commitment to the United Nations Decade of Ocean Science for Sustainable Development by generating data, information, and knowledge for a comprehensive understanding of the ocean.

Moorings, shore stations, wave buoys, HFR, underwater gliders, and satellites all provide vital weather and sea state data to support safe navigation, recreation, efficient commerce, and the Blue Economy. Biological and ecological observing activities support a prepared and productive nation empowered to predict and manage harmful algal blooms (HABs), hypoxia, ocean acidification, and temperature anomalies, and to understand marine biodiversity and animal movement. IOOS fosters the development and adoption of effective and reliable

new technologies that address user needs in a cost-effective and reliable manner through the Regional Associations and the Ocean Technology Transition program. U.S. IOOS facilitates collaboration and leveraging of resources among its many public and private partners to promote efficiencies, cost savings, and increased return on investment.



Goal 1 Driver. Dedicated resources and efforts are required to sustain, operate, and maintain ocean and coastal operations over long timeframes. To sustain efforts, IOOS must balance the maintenance and operation of the mature observing system while expanding the system to tackle emerging societal issues.

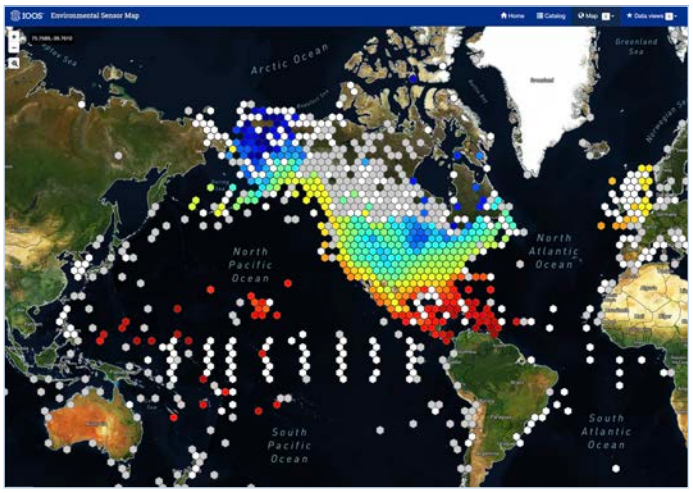
Objective 1.1 Leverage investment to improve system efficiencies, identify synergies, and provide common platforms to execute various missions.

Objective 1.2 Sustain and operate a national network of regional observing systems composed of multidisciplinary observations from a variety of technologies.

Objective 1.3 Improve coverage of observing systems and modernize aging infrastructure to fill critical gaps in regional and national observing networks to address high-priority needs.

Objective 1.4 Incorporate sustainable and innovative technologies to address existing and emerging needs and transition proven technologies to operational use or other applications.

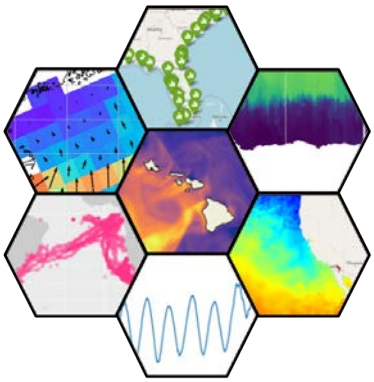
Goal 2. Deliver standardized, reliable, and accessible data.



Background: Ocean, coastal, and Great Lakes data are produced by a complex network of public and private partners. The IOOS Regional Associations prioritize local and regional needs while supporting national observing programs and are certified to meet federal standards for data and management to ingest, store, and host data from buoys and moorings, HFR, underwater gliders, and even animal-equipped oceanographic sensors. IOOS national data management activities include assimilating these data at a national scale, operating data assembly centers for specific data types, and long-term archiving. Collectively, IOOS data are provided at both national and regional scales via standard web services allowing for interactive maps and applications, and individual Regional Association portals. Regardless of the data source, IOOS strives to ensure that all data deliver the information that end-users and stakeholders trust and value by being clearly attributable, meeting FAIR data standards (findable, accessible, interoperable, and reusable), and endeavoring to meet CARE data principles (collective benefit, authority to control, responsibility, and ethics).

Goal 2 Driver: Ocean, coastal, and Great Lakes data come in many formats from a variety of platforms and sensors and are available through a number of web-based sites. IOOS strives to simplify and streamline integrated data access and discovery by providing data sources at regional and national scales.

Objective 2.1 Promote standardization, automation, discovery, and equitable access of data across the ocean enterprise where IOOS connects private and public data providers, data consumers and distributors, academia, industry and the public to create a dynamic ocean data ecosystem that drives innovation, collaboration, and commerce.



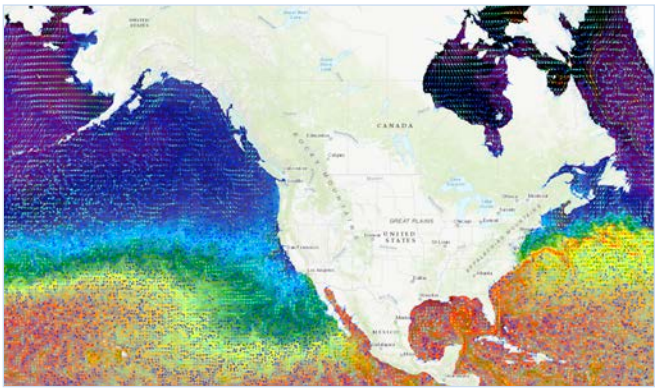
Objective 2.2 Strengthen data stewardship to improve data quality, access, attribution, exchange, delivery, and storage across Federal agencies and regional partners.

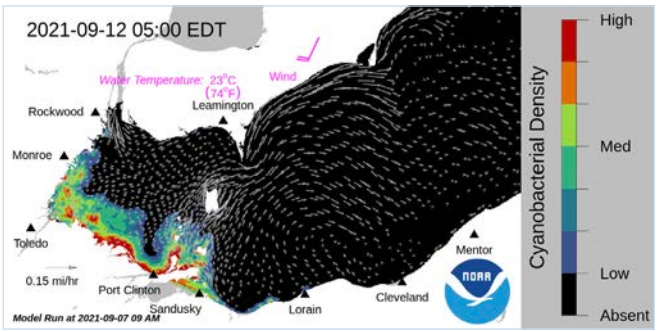
Objective 2.3 Provide data services at the regional level through trusted, certified regional data centers to increase the availability, interoperability, and use of high-quality data.

Objective 2.4 Support the ongoing maintenance and operation of data management systems to sustain long-term data stewardship.

Objective 2.5 Create, maintain, and expand the capacity of functional data assembly centers as go-to data sources through collaboration between IOOS, National Data Buoy Center, National Centers for Environmental Information, and other partners.

Goal 3. Support model predictions that address a wide range of user requirements.





Background: Users desire forecasts and predictions so they can plan and adapt to changes. Models aid our understanding of ocean circulation and properties over various timescales and provide the ability to predict conditions and events. Modeling and analysis are an integral part of IOOS because they allow for the interpolation, interpretation, and prediction of the environment, which are especially valuable when available observations are limited or a synoptic perspective is required. IOOS regional models integrate cross-disciplinary, cross-platform data from diverse partners to improve predictions of ocean, coastal, and Great Lakes phenomena. Many of the IOOS Regional Associations support modeling efforts for maritime commerce and safety, ecological forecasting, and water levels by providing an important link between NOAA, Federal partners, and regional modeling capabilities.

Sustained development of modeling capabilities and the application of models to enhance the design and operation of observing systems is a vital component of a truly integrated system. IOOS' modeling efforts support interoperability and serve to efficiently integrate systems across disciplinary boundaries by aligning with NOAA's Unified Forecast System (UFS), Earth Prediction Innovation Center (EPIC), and National Ocean Service (NOS) Modeling Vision. IOOS is bridging the gap between ocean, atmospheric, and terrestrial systems through model integration involving riverine inputs, currents, storm surge, and coastal inundation.

Goal 3 Driver: On their own, observation data do not go far enough to address stakeholder needs for actionable information. Numerical modeling bridges the divide between data and information by extracting relevant information for end-users, informing modelers on tool accuracy, and allowing resource managers to design optimal observing systems. IOOS supports a vibrant modeling community devoted to innovating models that link coastal and global phenomena.

Objective 3.1 Continually develop and sustain research and community models and model-based products to provide state-of-the-art information needed by regional stakeholders.

Objective 3.2 Transition modeling innovations from the research community into operations through the Coastal and Ocean Modeling Testbed (COMT) and/or Regional Associations as demonstration environments and proving grounds.

Objective 3.3 Assess model skill and advance data assimilation through data delivery, technical advancement, and regionally-led research to improve model accuracy.

Objective 3.4 Advance modeling approaches to inform decisions on the design and implementation of optimal observing systems and maximize the use of regional observations.

Goal 4. Provide integrated, user-driven products and tools.

Background: IOOS supports science and services that are open, accessible, and extensible. IOOS operates and maintains a growing suite of portals and visualization tools to translate data into usable products to promote data analysis and support decision-making. The COORA Act recognized the responsibilities of the U.S. IOOS Office to work with the IOOS Regional Associations to develop products for decision makers with respect to weather, search and rescue, water quality monitoring, and HABs. Regional Associations work with local stakeholders to understand how and why they use information and to create data products that are accessible and easy to use. Regional products support preparedness and response to hurricanes, hypoxia, HABs, red tide, oil and other hazardous marine spills, and other water quality criteria enabling everyday decision making. Wind, wave, current, and water-level forecasts support safe and efficient transportation, navigation, and marine commerce. Identifying and understanding ocean variability, chemistry, and upwelling hot spots allows resource managers and industry to make informed decisions. Biodiversity and animal movement products support ecosystem assessments, management and use, sanctuary condition reports, fish stock assessments, and compliance with protected species laws. The NOAA Service Delivery Framework supports the U.S. IOOS Office's efforts to operate these ocean, coastal, and Great Lakes products and tools, which also forwards the Nation's commitment to the United Nations Decade of Ocean Science to deploy solutions for sustainable ocean development.

Goal 4 Driver: The translation of observations into meaningful information and products requires the integration of variable, complex data and models with a focus on stakeholder requirements.

Users with regionally or topically specific needs often require focused, integrated, user-friendly decision support tools.

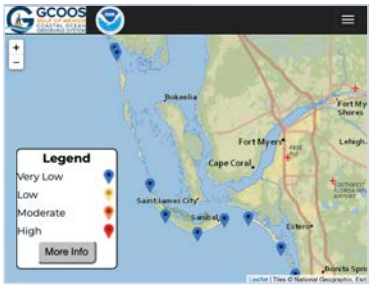
Objective 4.1 Develop regionally relevant, user-driven analysis, decision-support, and visualization products and tools to address historic and emerging stakeholder requirements.

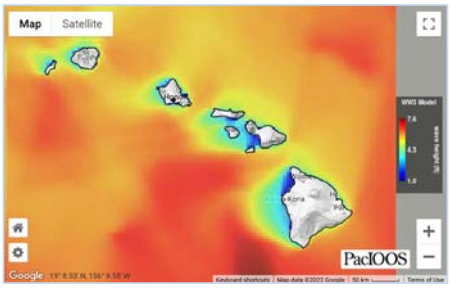
Objective 4.2 Generate and disseminate pan-regional products and tools to respond to environmental issues and seasonal hazards that span larger areas and ecosystems.

Objective 4.3 Create national products that incorporate cross-disciplinary data to provide a single, user-friendly access point to integrated information.

Objective 4.4 Promote IOOS products on international and cross-institutional scales to optimize usage and relevance.

Objective 4.5 Understand the economic value of IOOS data and information to enable communication about the benefits of the observing systems and tools.





Goal 5. Increase the reach and effectiveness of IOOS through partnerships, stakeholder engagement, and investment in Enterprise excellence.

Background: IOOS is a "system of systems" that links local and regional coastal, ocean, and Great Lakes observations to the national and global level through the U.S. IOOS Office, the IOOS Regional Associations, the IOOC, and the GOOS. To ensure partners effectively contribute to IOOS and link to other national and global observation systems, IOOS maintains strong connections to, and understanding of, our partners. IOOS works collaboratively within NOS, across other NOAA line offices, and with the IOOC agencies to coordinate efforts, share information, and address changing observing requirements. To fulfill the need for ocean, coastal, and Great Lakes information, IOOS pursues outreach and education to new audiences, including Federal, state, and local governments, tribal communities, private and nonprofit sectors, and academia to fill gaps, develop information products, address emerging needs, and promote the use of IOOS data.

Goal 5 Driver: IOOS partners are distributed across Federal and state agencies, non-governmental organizations, and private industries around the country. Coordination and communication are essential for success. IOOS relies on balanced and robust partnerships built on trust and a shared mission. We work closely with the national network of Regional Associations to develop and nurture these relationships on a regional and national level. Underserved communities must be engaged in the co-design of observing systems and tailored products to ensure that all have access to information and tools needed to fully prepare for and respond to coastal change. As stakeholder needs evolve over time, partnerships must remain nimble and transparent through effective communications and engagement to remain a cohesive and effective Enterprise.

Objective 5.1 Engage in continuous dialog with stakeholders, including historically underrepresented communities, to gather feedback and refine requirements for IOOS products and services.

Objective 5.2 Increase the operational efficacy of Federal, state, and other partner investments to support regional, national, and global activities and innovative research.

Objective 5.3 Expand and strengthen the network of partnerships with new and existing stakeholders, especially industry and Federal partners, to innovate ocean observations and information products.

Objective 5.4 Empower communities of practice to expand observing capabilities and expertise.

Objective 5.5 Foster the next generation of science, technology, engineering, and math specialists through targeted education, training, and research opportunities.

Objective 5.6 Elevate outreach and engage new audiences to convey the societal and economic value of sustained ocean, coastal, and Great Lakes observing systems.

"Delivering the growing demands for New Blue Economy products and services requires partnership across the triple helix of government, academia, and industry. It is specialized businesses that provide the technological means to observe and measure the ocean and who act as Intermediaries, leveraging NOAA's public data and delivering much of the customized ocean information needed to support the rapidly changing and growing needs of the Blue Economy."

— 2015–2020 Ocean Enterprise Study

Appendix A. Core Variables

A list of coastal and ocean variables to be measured, integrated, and coordinated across observing systems was developed early in the formation of IOOS[1] to allow users to simultaneously exploit multiple datasets. This list has been expanded over time[2] to include the following 34 core variables required to detect and predict changes in the ocean:

IOOS CORE VARIABLES

PHYSICS

Bathymetry
Bottom character
Currents
Heat flux
Ice distribution
Salinity
Sea level
Surface waves
Stream flow
Temperature
Wind speed and direction

BIOGEOCHEMISTRY

Acidity
Colored dissolved organic matter
Contaminants
Dissolved nutrients
Dissolved oxygen
Ocean color
Optical properties
Pathogens
Partial pressure of carbon dioxide
Total suspended matter

BIOLOGY & ECOSYSTEMS

Biological vital rates
Nekton diet
Sound
Species and abundance of:

- Coral
- Fish
- Invertebrates
- Marine mammals
- Microbes
- Phytoplankton
- Zooplankton
- Sea birds
- Sea turtles
- Submerged aquatic vegetation

Appendix B. References

IOOS' efforts support interoperability and serve to efficiently integrate systems across disciplinary boundaries by aligning with other NOAA and Federal Partner efforts, including:

- NOAA Unified Forecast System (UFS) Strategic Plan 2021–2025
- NOAA Earth Prediction Innovation Center (EPIC) Strategic Plan 2020–2025
- NOAA National Ocean Service (NOS) Modeling Vision
- 2015–2020 Ocean Enterprise Study

Appendix C: Endnotes

1. Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System from 1999
2. Updated list includes Biological Integration and Observing (BIO) Task Team recommendations from 2016

Appendix C: Photo Credits

Front cover and back cover. Blue water background with ripples. Photo credit: Licensed from Shutterstock.

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Page 5. IOOS Great Lakes Seagull app. Photo credit: add credit. Used with permission.

Page 5. SECOORA_marine-operations-header. Photo credit: add credit. Used with permission.

Page 6. CeNCOOS HFR. Photo credit: add credit. Used with permission.

Page 6. IOOS ATN Turtle 3. Photo credit: add credit. Used with permission.

Page 6. NOAA Aquaculture. Photo credit: add credit. Used with permission.

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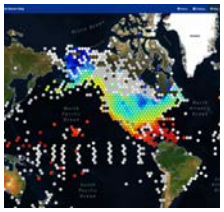
Page 7. GLOS_A-test-installation-of-a-high-frequency-radar-unit-in-the-Straits-of-Mackinac_PC-Nathan-Shaiyan-Michigan-Technological-University.jpeg. Photo credit: add credit. Used with permission.

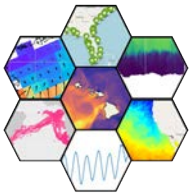
Page 7. NOAA Ocean-glider-off-Puerto-Rico-NOAA.jpeg. Photo credit: add credit. Used with permission.

Page 8. PacIOOS_Wave-Buoy. Photo credit: add credit. Used with permission.

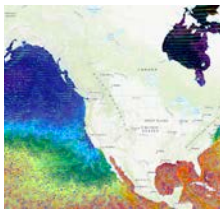
Page 8. IOOS ATN Turtle 2. Photo credit: add credit. Used with permission.



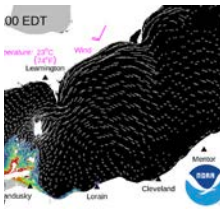
Page 9. IOOS Environmental Sensor Map. Photo credit: add credit. Used with permission.



Page 9. ioos_CodeLab_image_multi_hex. Photo credit: add credit. Used with permission.

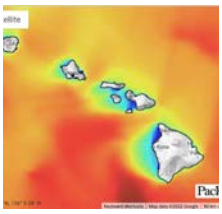


Page 10. EDS Water Temp and Currents. Photo credit: add credit. Used with permission.



Page 10. Forecasted surface bloom in Lake Erie. Photo credit: add credit. Used with permission.

Page 11. GCCOOS HABscope 2022-0621. Photo credit: add credit. Used with permission.



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Page 12. USGS Sallenger+NOAA2. Photo credit: add credit. Used with permission.

Page 12. BOEM Offshore Wind. Photo credit: add credit. Used with permission.

Page 13. HSC-5 conducts a search-and-rescue exercise in Norfolk, Va... _ Flickr. Photo credit: add credit. Used with permission.

Our Eyes on the Ocean, Coasts, and Great Lakes

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Integrated Ocean Observing System

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VER. 1.0.1