

# **U.S. IOOS ENTERPRISE STRATEGIC PLAN 2022-2025**

**[ioos.noaa.gov](https://ioos.noaa.gov)**

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**Working Document**

# IOOS 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
  1. NASA
  2. NSF
  3. NAVY
  4. NOAA
  5. USGS
  6. USCG
  7. DOE
  8. EPA
  9. USACE
  10. FDA
  11. ARC
  12. CSREES
  13. DOT
  14. DOS
  15. DOI
  16. ONR
  17. MMC
- Regional Associations
  1. NERACOOS
  2. SCCOOS
  3. NANOOS
  4. CENCOOS
  5. PacIOOS
  6. AOOS
  7. CARICOOS
  8. GCOOS
  9. GLOS
  10. SECOORA

## 11. MARICOOS

# Letter from the Director

Much has changed in the world since the U.S. Integrated Ocean Observing System (IOOS) Enterprise was founded in 2009. Our nation is increasingly feeling the impacts of the changing climate at 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 Biden Administration is keenly aware of the threats our Nation's coasts, oceans, Great Lakes, and coastal communities face on a daily basis. In 2023, IOOS is working to execute the Biden Administration's 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; Executive Orders 13985 and 14035 which ensure Federal agencies prioritize diversity, equity, inclusion and accessibility; and Executive Orders 14008 and 13653 which support our efforts to respond to and plan for a worsening climate crisis.

IOOS is also a key leader in forwarding 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 addresses our nation's coastal and ocean needs through improved information, predictions, tools, and service delivery. The contribution of ocean-based and Great Lakes activities to our overall economy is significant and growing. In 2020, knowledge-based activities harnessing the ocean as a resource for economic growth generated over \$8 billion in revenue and are expected to continue growing. Coupling economic growth with climate-smart innovation and social inclusion while preserving coastal livelihoods and ensuring environmental sustainability of our nation's coastal and ocean waters relies on IOOS' authoritative data, information, and services for its effective delivery.

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 better tackle the impacts of a changing climate in 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.

The 2022-2025 IOOS Enterprise Strategic Plan prioritizes investments 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 evergreen 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.

Effective implementation of these goals will maintain IOOS' status as the premier source of the authoritative ocean, coastal, and Great Lakes information that meets the safety, economic, and stewardship needs of the nation. IOOS strives to always implement our mandates more effectively and efficiently. As such, the IOOS Program Office recently adopted a new agile implementation process to improve our planning and execution efforts, which includes an annual review and refresh of the Strategic Plan to ensure that our efforts always address our nation's most critical societal challenges.

From transitioning new research to operations to supporting safe cargo transits in our blooming ports to expanding and improving access to open data and supporting development of new observation systems worldwide, we're proud of the important work IOOS does and are looking forward to what we'll 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.*

[Insert NOAA, IOOS, and DOC logos underneath this statement]

# 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 in the United States 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 the 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 2020 bipartisan reauthorization of the ICOOS Act through the Coordinated Ocean Observations and Research Act (COORA) in 2020.

IOOS 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 IOOS "Enterprise" represents the full scale of global-to-local partners contributing to, or benefiting from, this ocean observing system, and consists of 17 interagency federal partners brought together in the Interagency Ocean Observing Committee (IOOC) as well as a national network of 11 Regional Associations, the IOOS Association, the IOOS Advisory Committee, and connections to the Global Ocean Observing System (GOOS). The IOOS Enterprise is inclusive, and any entity contributing toward solutions or implementation of IOOS is welcomed. It is the synthesis of these local, national, and global elements, working together toward shared goals and objectives, that make 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 American – and global – history. Societal upheavals and disasters are increasingly linked to disparities in community resilience. Accomplishing the IOOS mission is not only possible but enhanced through a cross-cutting commitment to diversity, equity, and inclusion. Diversity drives innovation and the IOOS Enterprise is committed to building a culture where difference is valued and appropriately acknowledged in both a top-down and grassroots approach.

Today, the U.S. IOOS Enterprise is a culmination of coastal observing activities coordinated at the national scale. The IOOS Strategic Plan outlines five goals which 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, and 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 IOOS Enterprise that meets our nation’s safety, economic, and stewardship needs by serving as the premier source of authoritative ocean, coastal, and Great Lakes data, information, and services.

[Call Out Box

**Info Box 1**

**IOOS SOCIETAL BENEFITS**

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

- Improving predictions of climate and weather 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 restore healthy coastal ecosystems; and
- Enabling the sustained use of ocean and coastal resources. ]

## 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

Stakeholder-driven, science-based, and policy neutral

Leveraged resources and innovation produce efficient, sustainable observing systems

Easy and open exchange of information

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

Integrated, high-quality, and reliable data

Coordinated networks of people, technology, and information

Productive public-private partnerships

## 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, as well as supporting 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 for 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.** Ocean and coastal observations are difficult to sustain, operate, and maintain over long timeframes. Public support is often directed to new, emerging marine initiatives and technologies. To sustain the Enterprise, 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** Fill critical gaps in the nation's observing networks to address high priority national and regional needs and improve coverage of regional coastal observing systems.

**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. All IOOS Regional Associations are certified to meet Federal standards for data gathering and management, and ingest, store, and host data from buoys and moorings, HFR, underwater gliders, and even animal-equipped oceanographic sensors, with a priority on local and regional needs while supporting national observing programs. 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 meet FAIR data standards (findable, accessible, interoperable, and reusable) and CARE data principles (Collective

Benefit, Authority to Control, Responsibility, and Ethics) and are clearly attributable and meet quality standards, to deliver the information that end-users and stakeholders trust and value. Improving data access, delivery, and archiving to meet operational needs will continue to increase the functionality and value of IOOS data systems.

**Goal 2 Driver:** Ocean, coastal, and Great Lakes data come from a variety of platforms and sensors, in many formats, 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 access of data.

**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 infrastructure 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 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 with 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:** 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, as they allow for interpolation, interpretation, and prediction of the environment and are highly 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 the 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:** Data from observations alone 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 to link coastal to 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 select IOOS partner models from research to 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 IOOS Program 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 harmful algal blooms. 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 IOOS Program Office's efforts to operate these ocean, coastal, and Great Lakes products and tools, which also forwards the U.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 products requires the integration of variable and complex data with models and 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 of 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 IOOS Program 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. In order 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, IOOS 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 expand 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.

## **Appendix A. Core Variables**

A list of coastal and ocean variables to be measured, integrated, and coordinated across observing systems that allow users to simultaneously exploit multiple datasets was developed early in the formation of IOOS.<sup>1</sup> This list has been expanded over time<sup>2</sup> to include the following 34 core variables that are 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

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<sup>1</sup> Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System from 1999

<sup>2</sup> Updated list includes Biological Integration and Observing (BIO) Task Team recommendations from 2016

- Sound
- Species and abundance of:
  - Coral
  - Fish
  - Invertebrates
  - Marine mammals
  - Microbes
  - Phytoplankton
  - Zooplankton
  - Sea birds
  - Sea turtles
  - Submerged aquatic vegetation