



Challenges and Opportunities for Ocean Data to Advance Conservation and Management

Executive Summary

Ocean data collection and access are in the midst of a revolution with new technologies, new applications and renewed national commitments to understand and manage our ocean. We have an unprecedented ability to collect and analyze information about our environment and human uses of marine natural resources and to create significant opportunities for improvement in science and decision-making.

Government agencies currently have limits to their abilities to efficiently process and incorporate ocean data from new sources, including new technologies, into the decision-making process. In some cases, the data management infrastructure has not kept pace with the nearly exponential increase in data that the public and private sectors are now collecting. This problem is compounded by the reality that data-sharing programs are not always designed to benefit all stakeholders or the public equally, information is not accessible due to technical barriers, or longstanding cultural practices of withholding data to protect intellectual property, particularly in academia and industry.

Ocean data providers and stewards are beginning to address issues of data accessibility and discovery through frameworks such as FAIR (Findable, Accessible, Interoperable and Reusable) principles, which aim to facilitate the open and free exchange of data in the ocean observation community. However, even with the adoption of communities of practice, end users as well as Indigenous and coastal communities are not engaged to the extent they could be, and the federal government must continue to improve access and, in turn, allow for data sharing with and among these groups.

Other challenges must also be resolved if the ocean data revolution is to be impactful. Two examples of these challenges include chronic shortages of funding for the timely and efficient processing of data for ocean management and protecting the privacy and confidentiality of data providers while maximizing the use of new data streams from innovative technologies and from ocean industries (e.g., fossil fuel extraction, offshore wind).

Fortunately, solutions to these challenges are on the horizon, and the federal government is positioned to usher in a new era of improved data transparency, access and use to advance conservation, grow the blue economy, and support the sustainable management of ocean resources. The federal agency tasked to lead this ocean data revolution in the United States (U.S.) is the National Oceanic and Atmospheric Administration (NOAA). NOAA's mission is "to understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources."¹ The agency finalized a series of strategies in July 2020 to maximize the value of its data collection, processing and management assets, including Data, Cloud Computing, Artificial Intelligence (AI), 'Omics, Citizen Science and Unmanned Systems.

Beyond NOAA's commendable work and formidable capacity and expertise, the agency, along with its sister agencies at the Department of Interior (DOI), will need assistance from Congress and the White House in the form of sustained funding and political support to transform the ocean data ecosystem in service of marine conservation, the \$373 billion blue economy, and sustainable and equitable use of marine resources.

The National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone (U.S. EEZ) (the National Strategy) is one example of an unprecedented opportunity to improve knowledge about ocean seafloor and water column ecosystems, guiding the appropriate types, locations and intensities of ocean use compatible with ecosystem health and function. The data to be collected, much less the enormity of new data to be processed, analyzed and applied to manage decisions, will require significant and sustained resources from Congress. Also, new partnerships among the federal government, private industry, academia and non-governmental organizations (NGOs) are needed to leverage survey assets and avoid duplication of effort. The National Strategy represents a microcosm of the challenges confronting ocean data custodians and end users and the opportunities for realizing the full potential of ocean data in service of sustainable and equitable management of ocean resources.

This paper reflects a comprehensive literature review, discussions from a February 2020 Ocean Data Roundtable hosted by the Center for Open Data Enterprise (CODE) in partnership with Ocean Conservancy, Esri, NOAA, Amazon Web Services, and Microsoft, and interviews with ocean data experts. Table 1 illustrates the technological, institutional, financial and cultural challenges faced by the ocean data community, from data providers to data stewards to end users, and some of the solutions available to alleviate them. The examples in Table 1 display a high-level summary of a more complete set of challenges and actionable solutions described in greater detail in the report.

i NOAA Mission and Vision. Science, Service and Stewardship [Internet]. Available from: noaa.gov/our-mission-and-vision

Table 1. Examples of ocean data challenges and solutions by issue area

Issue Area	Challenge	Solution
Equity and Transparency	Not all stakeholders, including Indigenous communities and coastal communities, have equal access to ocean data.	Retrofit or design open data and data-sharing programs that improve access to data for all who stand to benefit.
Funding	Data collection, management, sharing and use are expensive, and governments and other stakeholders are often resource-constrained.	<p>Increase congressional funding commensurate with the growing volume and variety of ocean data that will need to be managed and shared via portals or the cloud.</p> <p>Develop new policies ensuring data management is equitably funded by taxpayers and private industry and access to data collected under federal permit is publicly available.</p>
Forming partnerships	Federal government and regional data stewards are not fully leveraging their collective capacity to share or make data publicly available.	The Ocean Policy Committee (OPC) should examine data portals, products and services across federal agencies for improved collaboration and efficiency, namely through shared funding, combining duplicative efforts, and improving interagency, regional, state, Tribal and community collaboration identified in consultation with federal agencies and the broader ocean community.
Data sharing	There is a lack of available incentives and policy frameworks for private industry, academic scientists and other data collectors to share their data. Specifically, academic or industry ocean research data funded or required for regulatory reasons by NOAA are not always posted to publicly accessible platforms.	NOAA should evaluate the effectiveness of its Public Access to Research Results (PARR) plan and strengthen accountability measures for more timely and complete submission of data by researchers or federal permittees/lessees.
Privacy and confidentiality	New technologies enable the efficient collection and transmission of digital data for near real-time management, but federal laws err on the side of restricting such data releases to protect personal or proprietary information.	Balance privacy/confidentiality and open access of data by adapting approaches used in the health care industry to anonymize data while allowing it to be publicly accessed or allowing access under controlled conditions or for specific purposes.
Integrating new data sources	New technologies are not always integrated into existing data collection and processing workflows, limiting their utility for broader public use.	Continue to expand the use of novel and efficient technologies such as Saildrones, electronic reporting and monitoring for collecting ocean and fisheries data while dedicating resources to integrate new and historical datasets so that long-term trends and shifting baselines in ocean conditions can be identified and future conditions predicted.

Issue Area	Challenge	Solution
Data interoperability	Interoperability among different scientific domains and collaboration among data collectors and users are not fully implemented, thereby limiting data use.	The Office of Science and Technology Program (OSTP) should leverage ongoing collaboration with federal agencies on the National Strategy to advance FAIR principles. Coordination with new data providers on appropriate standards for public data systems should be initiated prior to research and monitoring efforts.
Data processing	Data processing can be costly, complicated and time consuming.	The development and use of consistent data standards and improved data interoperability will accelerate the processing of data that can be applied faster to management.
Cloud computing	Increasingly large datasets prevent users from downloading, processing or analyzing data due to lack of end-user computer power.	NOAA's Big Data Program (BDP) should be expanded to house ocean data and potentially fisheries data; the National Strategy could serve as a pilot to add ocean data to the BDP.
Stakeholder technical capacity	Not all ocean data stakeholders have the same level of technical capacity, making it difficult to achieve adoption of broad-based standards or embrace new technologies.	NOAA and regional data stewards should work with data users in remote areas to enable cloud-based data analysis that reduces the burden of accessing and using data.
Domain- and region-specific data gaps	Data domains and regions across the nation have different and sometimes unique data needs, although the following data gaps or needs are common across regions: marine species, commercial fishing vessel location, catch and effort, recreational fishing effort, bycatch and fish discards and bathymetry.	<p>The OPC and federal partners, including NOAA, should create ongoing mechanisms to solicit input on regional data needs as was done in the 2018 Regional Data Platform scoping study conducted by NOAA and DOI's Bureau of Ocean Energy Management (BOEM).</p> <p>OPC should work with the regions to pursue data collection (and needed funding) in deficient, high-priority data categories identified in the scoping study, leveraging existing or new studies (e.g., the National Strategy).</p>