Critical Infrastructure for Ocean Research and Societal Needs in 2030

U.S. ocean research depends on a broad range of ocean infrastructure assets—the national inventory of ships and other platforms, sensors and samplers, computational and data systems, supporting facilities, and trained personnel. In order to ensure that essential infrastructure is available for both fundamental research and issues of social importance in 2030, a coordinated national plan for making future strategic investments is necessary. A growing suite of infrastructure will be needed to address urgent societal issues in coming years, such as climate change, offshore energy production, tsunami detection, and sustainable fisheries. This report identifies major ocean science questions anticipated to be significant in 2030, defines the categories of infrastructure needed to support such research over the next two decades, identifies criteria that could help prioritize infrastructure development or replacement, and suggests ways to maximize investments in ocean infrastructure.

The United States has jurisdiction over 3.4 million square miles of ocean—an expanse greater than the land area of all 50 states combined. This vast marine area offers many environmental resources and economic opportunities, but also presents threats, such as damaging tsunamis and hurricanes, industrial accidents, and outbreaks of waterborne pathogens. The 2010 Gulf of Mexico Deepwater Horizon oil spill and 2011 Japanese earthquake and tsunami are vivid reminders that our understanding of the ocean system is still incomplete.

The nation’s portfolio of ocean infrastructure changes over time in response to scientific needs, investments, and to advances in
technology. However, because of lengthy lead times for planning, designing, funding and building major infrastructure assets, and because of the long service life of many of these assets (often 25–30 years or more), federal agencies with ocean responsibilities need to anticipate the directions that ocean research could take in coming decades. Some critical pieces of ocean infrastructure, for example heavy icebreakers and ocean color satellites, are degrading and will be in need of replacement in coming years. To assist in planning for the nation’s future ocean infrastructure needs, the National Science and Technology Council’s Subcommittee on Ocean Science and Technology requested that the National Research Council convene a committee of experts to provide advice on the types of U.S. ocean infrastructure that will facilitate research in 2030.

Building the Ocean Infrastructure Inventory

A comprehensive range of ocean research infrastructure will be needed to meet growing demands for scientific information to enable the safe, efficient, and environmentally sustainable use of the ocean. Institutional barriers have inhibited collaborative efforts among federal agencies to plan for the operation and maintenance of high-cost critical infrastructure assets such as ships, satellites, and global observing systems.

Establishing and maintaining a coordinated national strategic plan for shared ocean infrastructure investment and maintenance is essential to build the comprehensive range of ocean infrastructure that will be needed in coming years. Such a plan would focus on trends in scientific needs and advances in technology, while taking into account factors such as costs, efficient use, and the capacity to cope with unforeseen events.

Overarching Infrastructure Needs

The committee identified overarching infrastructure needs based on trends in ocean infrastructure use over the last two or more decades and on the major research questions anticipated for 2030. It focused on common or shared infrastructure, rather than equipment generally found in the inventory of an individual scientist. The committee expects that research vessels will continue to be an essential element of ocean...
The committee concluded that the following actions would help ensure that the U.S. has the capacity in 2030 to undertake and benefit from knowledge and innovations possible with oceanographic research:

- Implement a comprehensive, long-term research fleet plan to retain access to the sea
- Recover U.S. capability to access full and partially ice-covered seas
- Expand abilities for autonomous monitoring at a wide range of spatial and temporal scales with greater sensor and platform capabilities
- Enable sustained, continuous timeseries measurements
- Maintain continuity of satellite remote sensing and communication capabilities for oceanographic data and sustain plans for new satellite platforms, sensors, and communication systems
- Support continued innovation in ocean infrastructure development. Of particular note is the need to develop in situ sensors, especially biogeochemical sensors
- Engage allied disciplines and diverse fields to leverage technological developments outside oceanography
- Increase the number and capabilities of broadly accessible computing and modeling facilities with exascale or petascale capability that are dedicated to future oceanographic needs
- Establish broadly accessible virtual (distributed) data centers that have seamless integration of federally, state, and locally held databases, accompanying metadata compliant with proven standards, and intuitive archiving and synthesizing tools
- Examine and adopt proven data management practices from allied disciplines
- Facilitate broad community access to infrastructure assets, including mobile and fixed platforms and costly analytical equipment
- Expand interdisciplinary education and promote a technically-skilled workforce

Setting Priorities and Maximizing Investments

Prioritizing investments in ocean infrastructure involves choosing optimal combinations of assets.
within budget restraints. The committee devised criteria that could help agencies prioritize investments, taking account of issues such as whether the infrastructure can help address more than one research question, the quality of the data collected using the infrastructure, and future technology trends. The committee concluded that the development, maintenance, and replacement of ocean research infrastructure should be prioritized in such a way to maximize the benefits from the infrastructure. This type of economic optimization includes consideration of factors such as:

1. usefulness of the infrastructure for addressing important science questions
2. affordability, efficiency, and longevity of the infrastructure
3. ability to contribute to other missions or applications

Federal agencies can maximize the value of ocean infrastructure by following a number of best practices, including efficiently managing resources, providing broad access to data and facilities, fostering collaboration at many levels, and enabling the transition from research to broader use. Conducting formal reviews of ocean infrastructure assets approximately every 5–10 years would help ensure the infrastructure remains useful across the full range of ocean science research needs.

The 2010 Deepwater Horizon oil spill demonstrated the diverse range of infrastructure needed to provide a timely, integrated response to a disaster. The color map and vectors represent a Naval Oceanographic Office ocean model simulation, and graphics and tracks represent in situ assets such as drifters, underwater gliders, and remotely operated vehicles.