

OCEAN OBSERVATORIES INITIATIVE (OOI)

\$48,500,000
+\$4,500,000 / 10.2%

Ocean Observatories Initiative Funding

(Dollars in Millions)

FY 2020	FY 2021	FY 2022	Change over	
			FY 2021 Estimate	
Actual	Estimate	Request	Amount	Percent
\$43.97	\$44.00	\$48.50	\$4.50	10.2%

Brief Description

OOI is a networked observatory that includes deployed ocean instrumentation delivering long-term, time-series ocean data sets for multidisciplinary oceanographic research. All data and metadata are openly available to the public at the OOI website.¹ OOI consists of a system of five arrays of instrumented platforms located at critical locations in the ocean, a fleet of autonomous underwater vehicles, and a cyberinfrastructure to deliver the data. The five arrays include:

- Two Global Arrays:
 - Station Papa Array in the Gulf of Alaska
 - Irminger Sea Array off Greenland.
- One Regional Cabled Array in the ocean basin off the coast of Oregon and Washington.
- Two Coastal Arrays:
 - Endurance Array with one mooring line off the Washington coast and one off the Oregon coast.
 - Pioneer Array deployed 55 nautical miles south of Martha's Vineyard, MA.

Data from the OOI instruments are processed, stored, displayed, and served by the OOI Cyberinfrastructure.²

Scientific Purpose

OOI provides the oceanographic research and education communities with continuous, interactive access to the ocean through an integrated network of observatories. Deployed in critical parts of the global and U.S. coastal ocean, OOI's instrumentation captures climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur. Data streams from the air-sea interface through the water column to the seafloor are available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability and ocean circulation, coastal ocean dynamics, ecosystem response, and the interplay of tectonically driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

Status of the Facility

OOI began full operations in FY 2016 with seven arrays. In 2019-2020 the two Global Arrays in the Southern Hemisphere, in the Argentine Basin and at 55 South, were descope following recommendations from the National Academies of Science, Engineering and Medicine's *Sea Change* report. In 2021 OOI is operating the remaining five arrays and a fleet of gliders as described above. A maintenance cruise is conducted annually at each Global Array and the Regional Cabled Array and bi-annually at each Coastal

¹ www.oceanobservatories.org

² www.oceanobservatories.org/data-portal/

Array to install refurbished and re-calibrated instruments and deploy replacement gliders. A subsample of the data collected on the instruments at the Global and Coastal Arrays is transmitted ashore in near-real time via satellite communications and all data are stored on board the in-water instruments until retrieved during the maintenance cruises. The subsampling interval has a complex dependence on the parameter being measured as well as on the available bandwidth and battery lifetime. All data collected by the Regional Cabled Array are transmitted ashore in real-time via the underwater cable. The OOI cyberinfrastructure supports data handling, processing, and serving through the OOI Data Portal.

The OOI Facility Board (OOIFB, described below under External Governance) conducted a survey of users during FY 2019 and provided NSF with a report that was shared with Woods Hole Oceanographic Institution (WHOI), the managing organization, and the broader OOI team, comprising staff at each of the participating organizations. Report recommendations were used to inform the redesign of the OOI data portal user interface and the OOI website. The OOI team continues strong efforts to engage the community of scientific users, including a booth and a virtual Town Hall at the Fall 2020 Virtual American Geophysical Union meeting.

NSF is currently collaborating with the science community to identify and assess possible options for relocating the Pioneer Array (PA). The PA was originally planned to be relocated every five years to a new region of scientific interest. It has now been in place since 2016 and the stakeholders are working together through a series of Innovation Labs to identify future location options. Initial experience with OOI shows that the complexity and logistical issues involved with moving an array make it likely that the typical interval before relocating an array will be longer than 5 years. The PA would be deployed in its new location and configuration in 2024.

COVID-19 has impacted the OOI team by limiting the access of team members to the laboratories to conduct required equipment refurbishment activities. In addition, planned at-sea marine infrastructure recovery and deployment activities have been limited due to requirements for personnel testing and isolation before embarking on the ships. The number of OOI team members embarked on the ships for the maintenance cruises was reduced to meet the requirements to mitigate the potential spread of COVID-19. Despite the limitations, the OOI team has been able to conduct maintenance cruises for all the arrays and thereby significantly mitigated the potential for loss of valuable in-water infrastructure. There were some instances where reduced battery power required adjustments to the instrument sampling rates, resulting in reduced data flow.

Meeting Intellectual Community Needs

In close collaboration with and in response to the needs expressed by the science community, the overarching scientific themes of the OOI span six multi-disciplinary domains, with each theme incorporating a multitude of research questions.

- *Ocean-Atmosphere Exchange*. Quantifying the air-sea exchange of energy and mass, especially during high winds, is critical to providing estimates of energy and gas exchange between the surface and deep ocean, and improving the predictive capability of storm forecasting and climate-change models.
- *Climate Variability, Ocean Circulation, and Ecosystems*. As both a reservoir and distributor of heat and carbon dioxide, the ocean modifies climate, and is also affected by it. Understanding how climate variability will affect ocean circulation, weather patterns, the ocean's biochemical environment, and marine ecosystems is a compelling driver for multidisciplinary observations.
- *Turbulent Mixing and Biophysical Interactions*. Mixing occurs over a broad range of scales and plays a major role in transferring energy, materials, and organisms throughout the global ocean. Mixing has a profound influence on primary productivity, plankton community structure, biogeochemical processes (e.g., carbon sequestration) in the surface and the deep ocean, and the transport of material to the deep ocean.

Major Facilities

- *Coastal Ocean Dynamics and Ecosystems.* Understanding the spatial and temporal complexity of the coastal ocean is a long-standing challenge. Quantifying the interactions between atmospheric and terrestrial forcing, and coupled physical, chemical, and biological processes is critical to elucidating the role of coastal margins in the global carbon cycle and developing strategies for managing coastal resources.
- *Fluid-Rock Interactions and the Subseafloor Biosphere.* The oceanic crust contains the largest aquifer on Earth. Thermal circulation and reactivity of seawater-derived fluids modifies the mineralogy of oceanic crust and sediments, leads to the formation of hydrothermal vents that support unique micro- and macro-biological communities can form economically-important mineral deposits, and concentrates methane to form massive methane gas and methane hydrate reservoirs. The role that transient events (e.g., earthquakes, volcanic eruptions, and slope failures) play in these fluid-rock interactions and in the dynamics of benthic and sub-seafloor microbial communities remain largely unknown.
- *Plate-Scale, Ocean Geodynamics.* Lithospheric movements and interactions at plate boundaries at or beneath the seafloor are responsible for short-term events such as earthquakes, tsunamis, and volcanic eruptions. These tectonically active regions are also host to the densest hydrothermal and biological activity in the ocean basins. The degree to which active plate boundaries influence the ocean from a physical, chemical, and biological perspective are largely unexplored.

The science community is continuing its use of the OOI data through downloads of both raw data and derived products. Feedback from users in the science community has been very positive. In October 2020, OOI launched a new data discovery tool, Data Explorer, designed based on input from the science community, that allows users to explore, use, and visualize OOI data in new ways that will help advance understanding of the ocean, its processes, and how it is changing. After the new website went online, the number of users and number of new users of the site doubled, and the number of page views and number of unique page views tripled. Users of the new website also visited more pages and stayed longer on the site. The stakeholders list, which now numbers more than 2,600, has continued to grow.



The Regional Cabled Array cabled digital still camera, redeployed in 2015 by the Canadian ROV ROPOS, lights up the active hydrothermal vent called El Gordo in the international District Hydrothermal Field, located at the summit of Axial Seamount nearly a mile beneath the ocean surface. *Credit: UW/NSF-OOI/CSSF.*

A summary of several statistics on the usage of OOI for the October-December 2020 period show:

- 9.9 TB of data were provided to 122 distinct users based on over 37.2 million data requests.
- OOI posted 56 times to its Instagram site and had 160 new followers.
- OOI tweeted 98 times with 2,540 likes and gained 50 new followers for a total of 1,522 followers.
- OOI posted to its Facebook account 98 times with 80 new followers and a total of 2,594 followers.

Governance Structure and Partnerships

NSF Governance Structure

The project is managed and overseen by a two-person OOI team in OCE that receives advice and oversight support as required from the Office of Budget, Finance, and Award Management, the Office of the General Counsel, the Office of Legislative and Public Affairs, the Directorate for Computer and Information Science and Engineering, and the NSF Large Facilities Office.

External Governance Structure

A new cooperative agreement for operations and management (O&M) of OOI started 1 October 2018 with Woods Hole Oceanographic Institution (WHOI) as the awardee. The OOI program director at WHOI is responsible for overall operations and maintenance, including data management, of the OOI and serves as the Principal Investigator on the award from NSF. WHOI has subawards with three Implementing Organizations:

- Oregon State University – Endurance Coastal Array and the OOI Cyberinfrastructure Data Systems Center
- University of Washington – Regional Cabled Array
- Rutgers University – Cyberinfrastructure Hardware

OOIFB, established by NSF in FY 2017, comprises ocean science community representatives and is charged with providing independent input and guidance to NSF regarding the management and operation of the OOI. The OOIFB assists in the process of communicating the community science use perspective to NSF and the project teams involved in deploying and operating the OOI. The OOIFB recently completed an update to the OOI Science Plan, available at the OOIFB website (www.ooifb.org). The Data Systems Committee is a subcommittee of the OOIFB helping ensure timely and reliable access to high-quality OOI data.

Funding

Total Obligations for OOI

(Dollars in Millions)

	FY 2020	FY 2021	FY 2022	ESTIMATES ¹				
	Actual	Estimate	Request	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Operations & Maintenance	\$43.97	\$44.00	\$48.50	\$48.50	\$48.50	\$48.50	\$48.50	\$48.50

¹ Outyear estimates are for planning purposes only. The current cooperative agreement ends September 2023.

The budget increase from \$44.00 to \$48.50 is planned to support recapitalization of the primary in-water infrastructure, including the glider fleet which has been in continuous operation since 2016.

Reviews

With the OOI facility in year three of the initial five-year award to WHOI, an OOI Mid-Award Review was conducted in November 2020 and covered all aspects of the OOI Program including: Management, Refurbishment, Deployment and Recovery, Community Engagement, Cyberinfrastructure, Science Products.

In its report, the review panel commented: “The Panel unanimously recommends that the NSF renew the contract [executed as a cooperative agreement] with WHOI to operate the OOI infrastructure. We find that the current project team is maintaining and operating the infrastructure in an effective manner and has successfully managed operational difficulties and budgetary uncertainties. The Program has successfully

Major Facilities

engaged science users to build the Program's platforms and data into proposals for new projects. Observations from OOI are now appearing in the scientific literature at a rate comparable to other large geoscience facilities. The OOI has already supported transformational science and continues to serve as the foundation for future discoveries by the scientific community. It is also in an excellent position to advance engineering and technology needed for ocean exploration using remote observatories."

NSF plans to conduct a tailored Business Systems Review in 2021.

Renewal/Recompetition/Termination

NSF completed the process of recompeting the O&M award through an open, merit-based external peer-review process resulting in a new award to WHOI as the Program Management Office, which started October 1, 2018 and runs through September 30, 2023. Program reviews are held annually, and NSF has begun the mid-award performance review process in accordance with the NSF Standard Operating Guidance for Renew, Re compete, or Divest decisions. Currently there are no plans for divestment of this facility.