

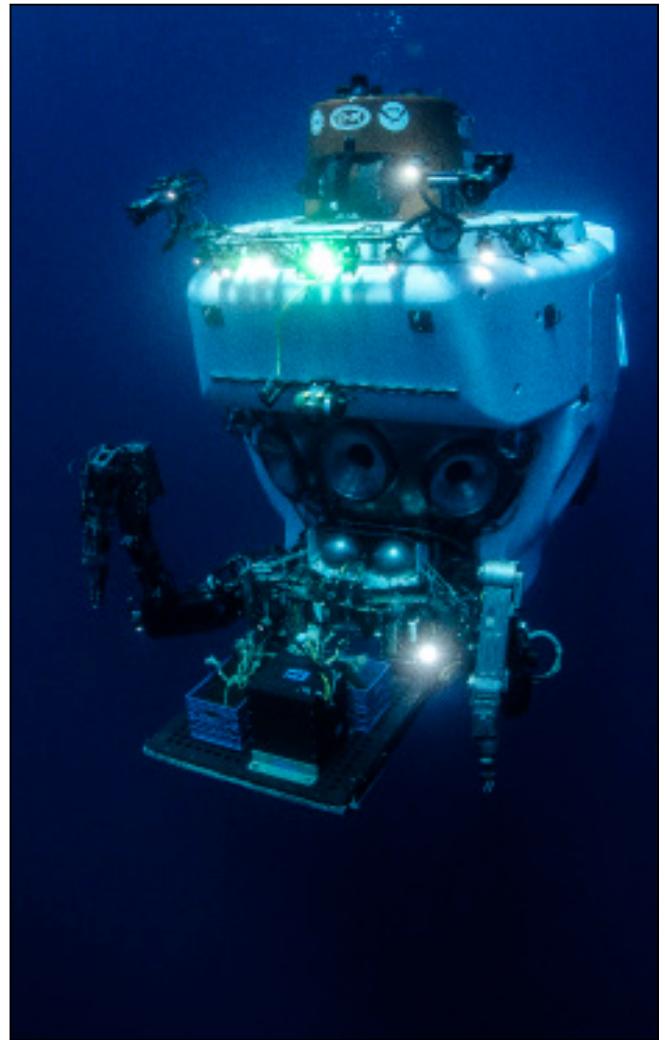
NATIONAL DEEP SUBMERGENCE FACILITY

The National Deep Submergence Facility, operated by Woods Hole Oceanographic Institution (WHOI), supports advanced scientific discovery and ocean exploration with a suite of advanced underwater assets, including the human-occupied submersible *Alvin*, remotely operated vehicle *Jason*, and autonomous underwater vehicle *Sentry*. Their capabilities are enhanced by a growing number of cooperative vehicles and technologies that extend the reach, flexibility, and cost-effectiveness of deep-sea research. A highly skilled team of engineers provides support for both shore-based and at-sea operations across the Academic Research Fleet.

ALVIN

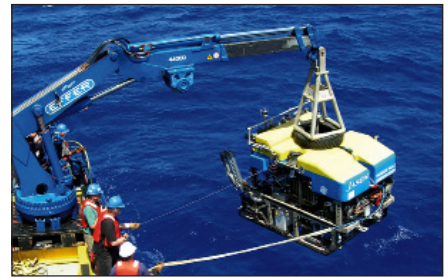
The Navy-owned, WHOI-operated deep-submergence vehicle *Alvin* is the nation's deepest-diving human-occupied submersible and the longest-serving, most frequently-utilized research sub in history. Over its 60-plus years of operation, *Alvin* has undergone multiple upgrades and overhauls, with the most recent completing an extensive process extending its dive range to 6500 meters (over four miles) and providing access to 98% of the global seafloor.

- *Alvin* has completed more than 5,300 dives over more than 60 years and gone through regular upgrades to extend its dive range and improve its capabilities.
- The Alvin Group and their equipment meet the highest safety and reliability standards as a result of decades of operational and engineering expertise and U.S. Naval Sea Systems (NAVSEA) oversight.
- The sub's most famous efforts include locating a lost hydrogen bomb in the Mediterranean Sea in 1966, exploring the first known hydrothermal vent sites in the 1970s, and surveying the wreck of RMS *Titanic* in 1986 with the prototype remotely operated vehicle *Jason Jr.*
- Recent expeditions by *Alvin* have revealed unique seafloor features off the U.S. East and West Coast, such as extensive deep-water coral habitats off the Mid-Atlantic and methane seeps near the Aleutian Islands. These provide insight into previously unknown submerged resources within the half of U.S. territory that is underwater.



JASON

The remotely operated vehicle *Jason* is capable of diving to 6500 meters depth and controlled from a ship via a 10 kilometer reinforced fiber optic tether that also returns data and video to the surface in real time. *Jason* is equipped with sonars, imaging systems, lighting, and a flexible payload of sampling systems, including two multi-function manipulator arms to collect samples of rock, sediment, or marine life. Since its debut in 2002, *Jason* has served as a model for generations of work-class remotely operated vehicles that followed and that are in use today by commercial and defense operators worldwide.



- Recent modifications to the vehicle and support systems give it flexibility to operate in heavy-lift, single-body, and long-duration modes.
- In 2009, *Jason* captured video of two separate seafloor volcanic eruptions, the first time such a phenomenon had been witnessed and enabling the vehicle to collect precisely aged lava samples.
- Expeditions by *Jason* to service the Ocean Observatories Initiative Cabled Array are helping refine estimates of risks posed by geohazards to the U.S. Northwest Coast.
- *Jason* and its support equipment are modular, facilitating multi-modal transport and contributing to its high utilization rate of up to 200 days per year.

SENTRY

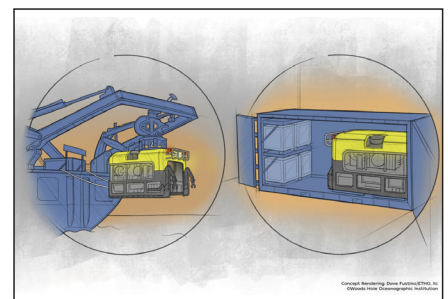
The autonomous underwater vehicle *Sentry* is a programmable underwater robot capable of mapping and exploring the ocean and seafloor to 6000 meters depth. *Sentry* carries a flexible suite of sensors for both mid-water and seabed surveys to produce high-resolution bathymetric, sidescan, sub-bottom, and magnetic maps of the seafloor and is capable of taking digital bottom photographs in a variety of deep-sea terrains to identify locations of interest for more detailed study.



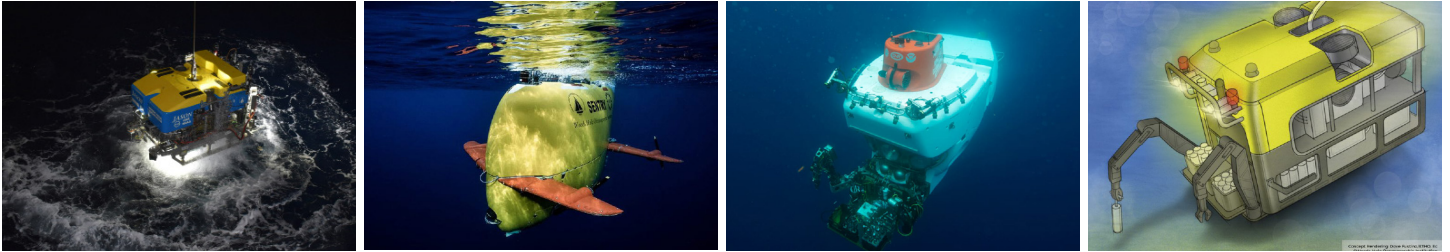
- *Sentry* is often used as an advance scout for *Jason* or *Alvin* to maximize dive efficiency and a new Wave Glider autonomous surface vehicle paired with *Sentry* now permits simultaneous two-vehicle operations.
- In 2024, high-resolution seafloor mapping by *Sentry* enabled BOEM and USGS to begin assessing critical mineral resources in part of the U.S. EEZ southeast of American Samoa.
- In 2016, *Sentry* aided in the National Transportation Safety Bureau's investigation of the sinking of the cargo vessel *El Faro* by mapping the wreck and locating the ship's voyage data recorder.
- In 2010, *Sentry* was equipped with a compact mass spectrometer to autonomously map the plume of hydrocarbons flowing from the Deepwater Horizon well into the mid-water of the ocean.

mROV

With NSF support and based on broad science community support, NDSF is currently developing a new class of medium-size remotely operated vehicles (mROVs) to expand ocean research, exploration, and restoration more broadly to the Academic Research Fleet. The vehicles will have a compact, modular design and 4000 meter depth capability to bridge the gap between large, work-class ROVs and allow deployment from smaller ships such as the upcoming Regional Class Coastal Vessels. The mROVs will also help advance deep-sea science by leveraging a public-private partnership with WHOI, NSF, NOAA, and industry partners.



NDSF AS A NATIONAL RESEARCH ASSET



NDSF operates ROV *Jason*, AUV *Sentry*, HOV *Alvin*, and is currently designing and building a 4000 m medium-sized ROV.

INTRODUCTION

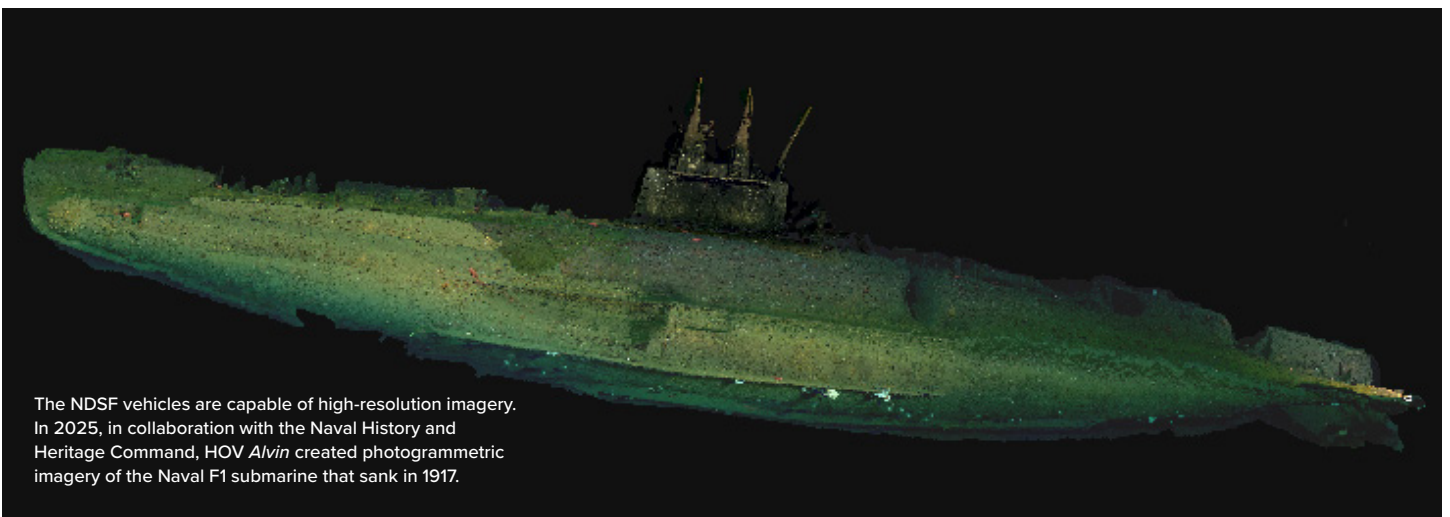
The National Deep Submergence Facility (NDSF) is a unique national asset that gives NSF, ONR and NOAA a safe, persistent, and scalable way to “touch” the deep ocean and seabed for oceanographic research and exploration that ranges from basic ocean sensing and exploration to hypothesis driven research. Its combination of vehicles, people, and infrastructure directly advances stated NSF needs for undersea domain awareness and seabed science.

WHOI and NDSF’s history crosses a spectrum from designing and developing the first practical, deep diving submersibles, the advent of tethered robotic vehicles and the game-changing advances in autonomous underwater drones. At each step along this 60-year journey, NDSF and WHOI have been defining the vanguard of future systems and advancing their adoption by the U.S. oceanographic research community’s constantly evolving needs. Nimble innovation and a world-renowned ability to act over the horizon on the high seas is an institutional hallmark.

STRATEGIC RELEVANCE TO NATIONAL NEEDS

NDSF provides assured U.S. access to nearly all the global seafloor via the Navy-owned human-occupied vehicle (HOV) *Alvin*, the *Jason* remotely operated vehicle (ROV) system, the autonomous underwater vehicle (AUV) *Sentry*, and the soon to come online medium-scale 4000 meter-rated mROV all hosted at WHOI under a unique cooperative agreement led by NSF. NDSF supports the needs of ONR, NSF, NOAA, other federal agencies and emerging commercial interests. These systems have demonstrated depth capability to 6,500 meters, giving the United States a sovereign capability to operate in both the U.S. EEZ and the high seas in complex settings on a global scale and directly expand the capability and value of the U.S. Academic Research Fleet.

National priorities of undersea domain awareness, seabed operations, autonomous systems, and rapid engineering technology innovation constitute a core investment key to maintaining the country’s undersea advantage. NDSF’s vehicles and engineering teams directly map to these priorities by enabling persistent in-situ sensing, precision mapping, and experimentation with advanced autonomy and communications in the very environments that are defining future theaters of science and security competition.



The NDSF vehicles are capable of high-resolution imagery. In 2025, in collaboration with the Naval History and Heritage Command, HOV *Alvin* created photogrammetric imagery of the Naval F1 submarine that sank in 1917.

ENABLING UNDERSEA DOMAIN AWARENESS AND SEABED SCIENCE OPERATIONS

As a crucial component of the nation's Academic Research Fleet, NDSF routinely produces high-resolution bathymetry, seafloor imagery, sub-bottom data, and water-column measurements that fill these gaps at tactical and campaign scales in regions of direct scientific and strategic interest.

Through missions ranging from mapping methane seeps and deep coral habitats off the U.S. coasts to emergency response such as the Deepwater Horizon incident and loss of the U.S.-flagged vessel *El Faro*, NDSF has shown it can execute high-impact operations that often parallel national needs: rapid localization of wreckage, characterization of complex seabed clutter, and detailed documentation of infrastructure and hazards. When layered within hypothesis-based inquiry and basic exploration, this WHOI operated facility covers present and future needs.

MATURE UNDERSEA CAPABILITY ALIGNED WITH OCEAN SCIENCE AND NAVY TECHNOLOGY PRIORITIES

The NDSF fleet spans key operational and technology modes our nation requires for future undersea science: crewed, tethered, and fully autonomous systems. *Alvin* offers direct human presence at depth with Navy-certified safety oversight by NAVSEA. NDSF's partnership in the engineering and operation of deep submergence tools with the U.S. Navy represents a unique and valuable contribution to the national interests.

ROV *Jason* provides a modular, work-class ROV system with heavy-capability, long endurance, and real-time HD sensing to 6,500 meters. WHOI's development of this technology, enabled by ONR-pioneered advances, now enables Navy intervention ROVs used for salvage, infrastructure work, and special operations. NDSF's contributions to the development of these once nascent technologies continue to set the national and international standard for deep ocean operations.

CONTRIBUTION TO NATIONAL NEEDS ACROSS DOMAINS

NDSF's assets and personnel continuously operate within this space: they survey complex topography for acoustic prediction, locate and characterize objects on the seabed, deploy and recover sensors, and support prototype networks for communication and docking that mirror new architectures currently being developed or envisioned for the future. NDSF is also taking the lead in expanding the footprint of deep submergence by increasing collaborative activities across platforms, including both crewed and uncrewed surface vessels.

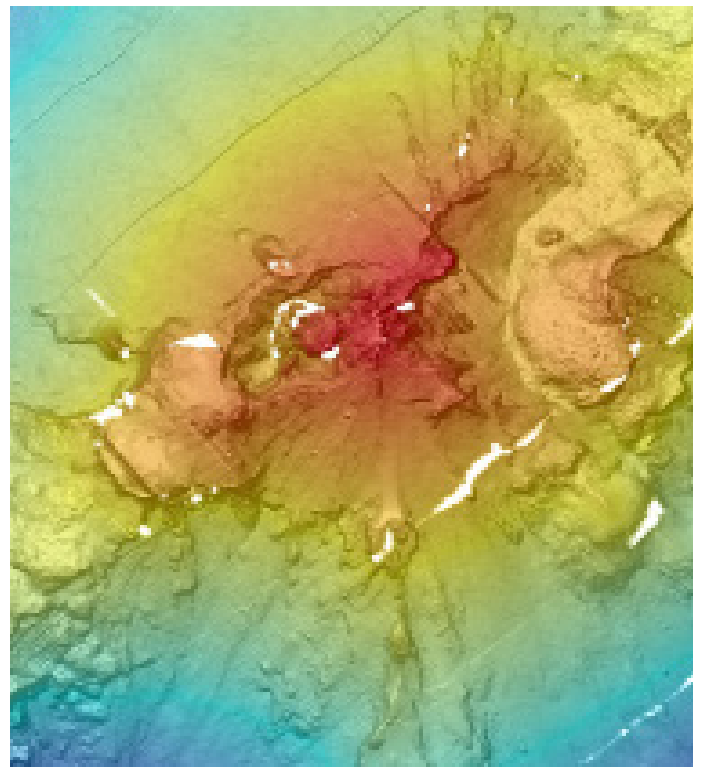
For the U.S. EEZ in particular, NDSF's ability to carry out multi-day, high-endurance surveys to full ocean depth aligns directly with articulated needs for persistent presence, infrastructure surveillance, seabed resource assessment, and under-ice and polar mapping. These capabilities are crucial to avoid gaps in U.S. deep-water access at a time when India, China, and Russia are investing heavily in their own deep submergence capabilities.

UNIQUE INSTITUTIONAL INFRASTRUCTURE AND WORKFORCE

The workforce that operates NDSF—engineers, technicians, and sea-going staff with many decades of combined service to science experience—has a documented track record of delivering reliable systems that routinely operate in unforgiving environments. This human capital, coupled with a culture of mission-driven, non-profit engineering that has supported every major U.S. defense offset strategy from World War II through today's uncrewed and AI-enabled concepts, gives a diverse cross-section of U.S. Federal partners a trusted source that consistently delivers beyond its size when cast against the far larger ocean S&T ecosystem.

LEVERAGING NDSF TO ADVANCE FUTURE OCEAN S&T NEEDS

NDSF is poised to once again play a critical role by improving S&T tradecraft, and deepening partnerships in areas such as autonomous systems, ocean sensing, and resilient undersea capabilities. NDSF has an immediately available platform suite for at-sea experimentation, technology transition, and operator training that can shorten the loop from laboratory innovation to real-world performance in domains of national priority. By incorporating AI, machine learning, advanced autonomy, and edge computing, NDSF will contribute to the creation of a "networked ocean" with greater omnipresence.



AUV *Sentry* has the capability to make high-resolution seafloor maps.