Woods Hole Oceanographic Institution

VESSELS AND VEHICLES

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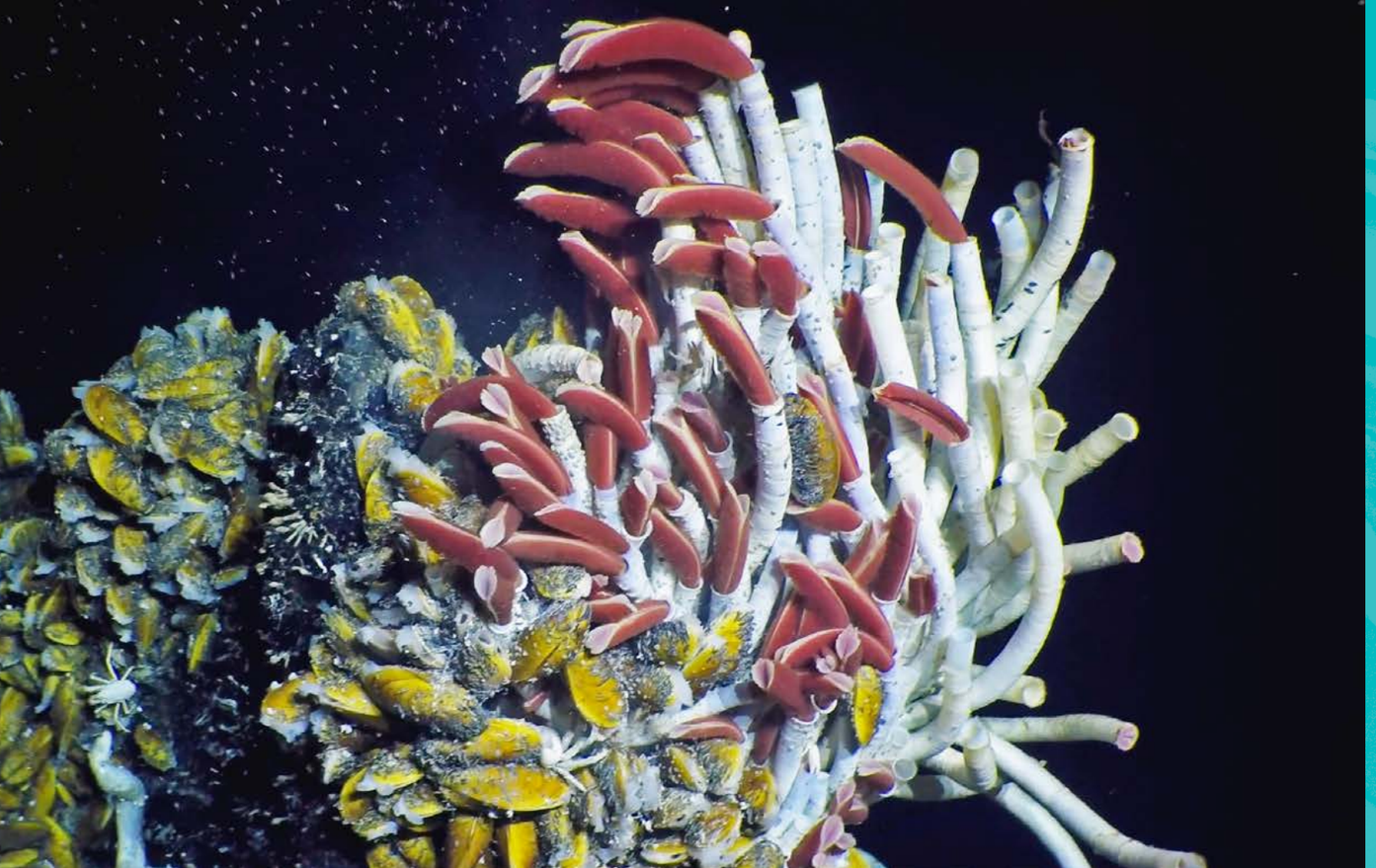


UNLOCKING THE SECRETS OF THE DEEP

The Earth and its ocean do not give up their secrets easily. But learning as much as we can about our planet is critical to ensuring a sustainable future for all.

To better understand our planetary life support system and how it affects everyone, everywhere, scientists need to transport themselves and their instruments far from shore and deep beneath the ocean surface. And to do that, they need research vessels and underwater vehicles capable of going to great distances and depths in exploring every corner of the global ocean.

Over much of the past century, Woods Hole Oceanographic Institution (WHOI) scientists and engineers have built a reputation of excellence by designing and operating some of the most advanced ships and vehicles available and in partnering with researchers around the world to learn about the global ocean that connects us all. Together, they have brought back hard-won insights that have helped foster revolutionary advances in knowledge about our ocean planet.

R/V Atlantis

The research vessel (R/V) *Atlantis* is owned by the U.S. Navy and operated by WHOI for use by the entire ocean science community. It is one of the most sophisticated research vessels afloat, and it is specifically outfitted to support operation of the human-occupied submersible *Alvin*.

The 274-foot *Atlantis* is equipped with four science labs, a computing facility, precision navigation systems, seafloor and mid-water mapping sonars, and satellite communications systems. It also carries four winches equipped with standard trawl cable and hydrowire, as well as two cranes, and an A-frame rated to 50,000 pounds. The ship was designed to carry a total complement of 22 crew, 10 Alvin Team members, and 24 scientists and to support research expeditions lasting up to 60 days almost anywhere in the global ocean.

R/V Neil Armstrong

R/V *Neil Armstrong* is owned by the U.S. Navy and operated by WHOI for use by the entire ocean science community. Named for the American hero whose "one small step" provided humanity with a new perspective on our planet, this vessel is the first oceanographic research vessel named for a space explorer.

The 238-foot *Neil Armstrong* carries 20 crew and 22 scientists for as many as 40 days and serves as the academic community's primary general-purpose ship to study critical ecosystems and oceanographic features in the North Atlantic. The ship features a specially designed hull that diverts bubbles from the sonar area; high-efficiency, variable-pitch propellers with variable speed motors; and an advanced cooling-water/oil separation system. The ship also includes new systems designed to improve the safety of scientific operations and enable the vessel to effectively operate in higher sea states than existing vessels of its size.

R/V *Tioga*

R/V *Tioga* is an aluminum-hulled coastal research vessel that serves scientists and engineers working in coastal waters of the northeastern U.S. Launched in 2004, this small, fast vessel was designed and outfitted for oceanographic work close to shore and in narrow weather windows common to this part of the ocean.

Tioga can accommodate up to 14 people for day trips. It is equipped with water samplers, a current profiler, and an echo-sounder and can support a wide range of science-supplied sensors and samplers. *Tioga* also has two winches, including one equipped with a standard hydrowire to collect real-time data from underwater instruments, as well as an A-frame on the stern to deploy and recover instruments and moorings.

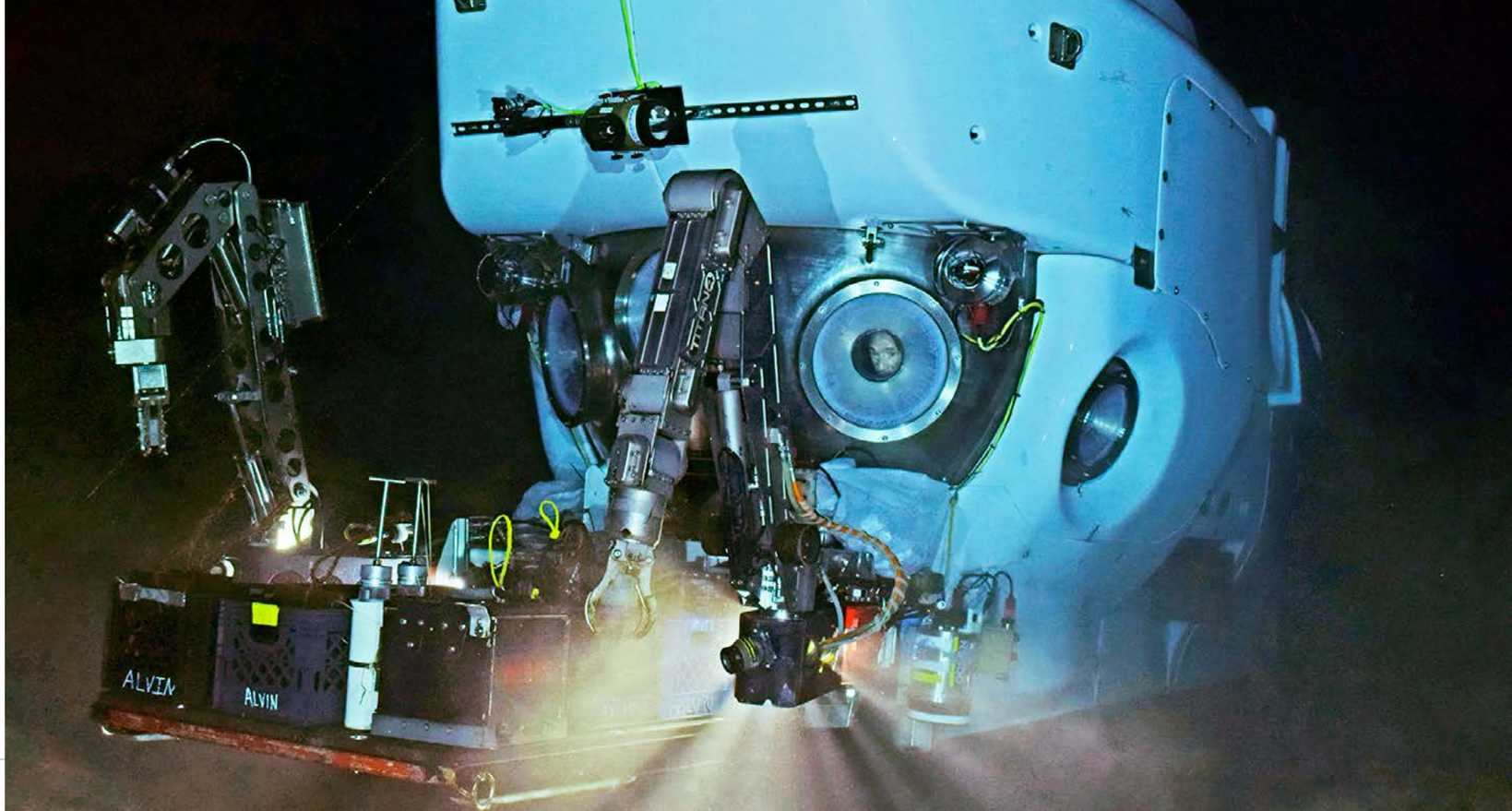
NDSF

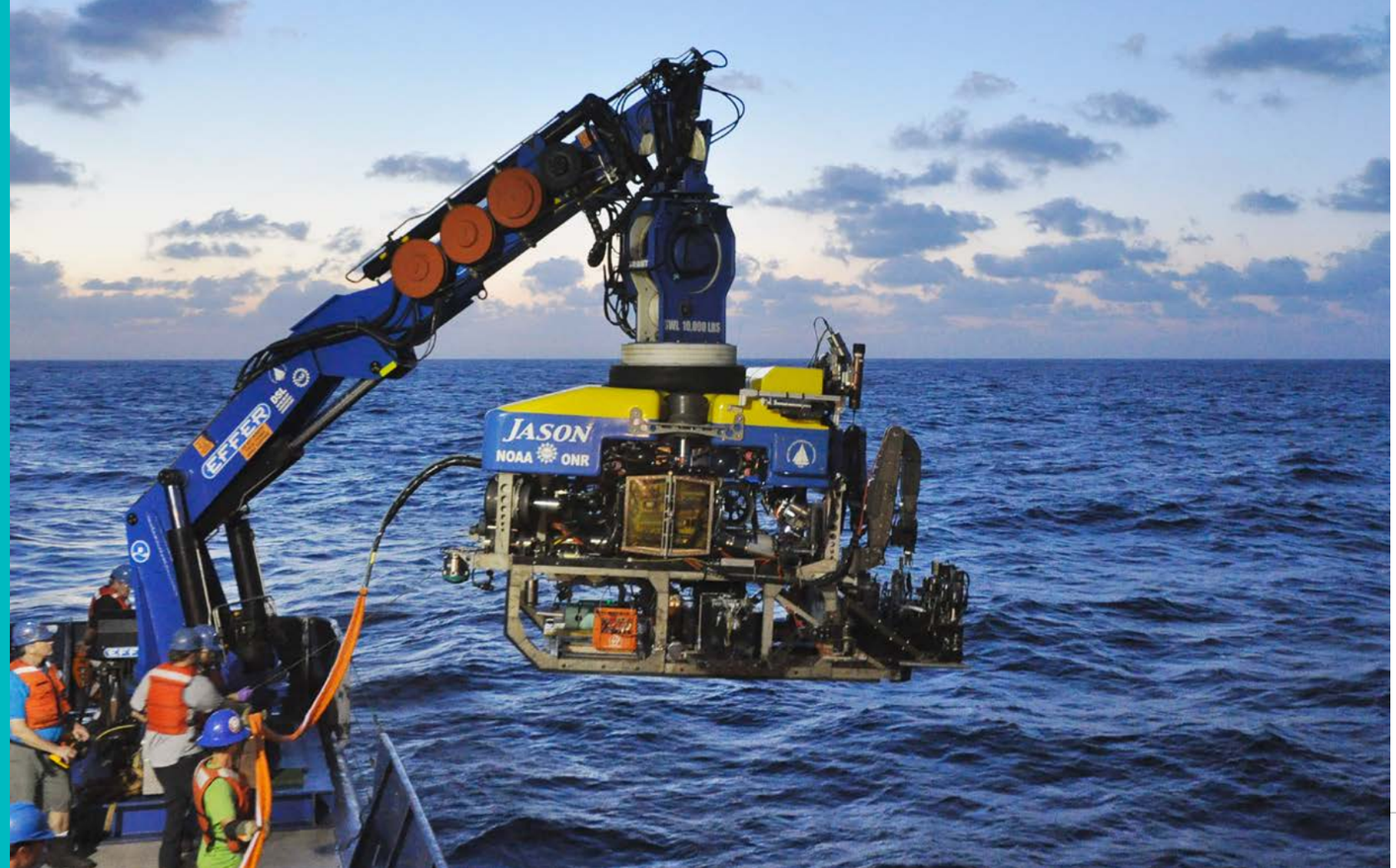
The National Deep Submergence Facility (NDSF) was formed in 1995 and is supported by the National Science Foundation to enable deep-sea research through development of new underwater technology and the maintenance and operation of a fleet of advanced underwater vehicles. Today, the facility includes three primary assets: the human-occupied vehicle (HOV) *Alvin*, remotely operated vehicle (ROV) *Jason*, and the autonomous underwater vehicle (AUV) *Sentry*. The facility also includes a diverse technical staff of 25, many of whom travel with the vehicles to ensure the success of missions around the world.

Alvin

The human-occupied vehicle (HOV) *Alvin* is a three-person research submersible that carries two scientists and a pilot on dives lasting up to 12 hours to depths of 6,500 meters (21,325 feet). With more than 5,000 dives, *Alvin* is the most successful and productive research submersible in history.

Alvin was commissioned in 1964 as one of the world's first deep-ocean research submersibles and has remained state-of-the-art thanks to an ongoing series of overhauls and upgrades over the course of its lifetime. The most recent upgrade, begun in 2011 and completed in 2021, saw the installation of a new, larger personnel sphere with a more ergonomic interior and improved visibility; new lighting and high-definition imaging systems; and improved sensors, data acquisition and download speeds.





Jason

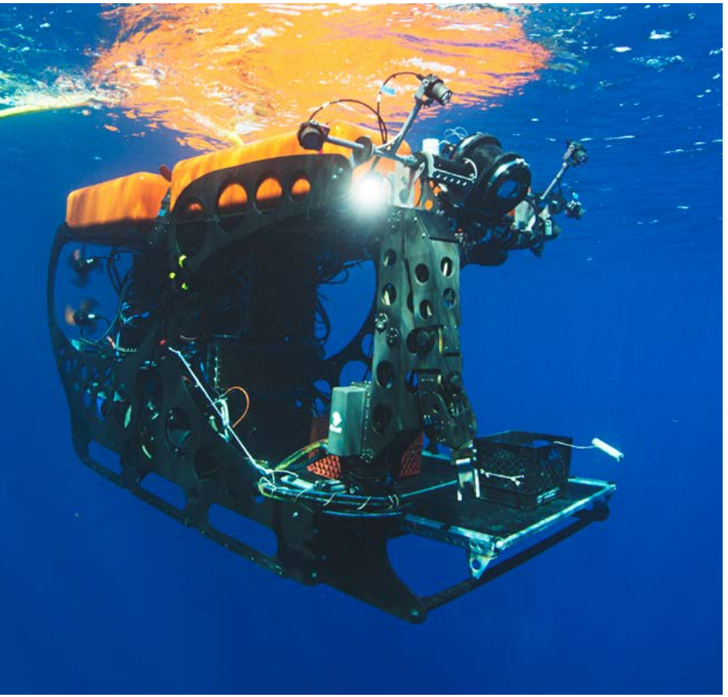
The remotely operated vehicle (ROV) *Jason* is designed for seafloor operations as deep as 6,500 meters (21,325 feet). A 10-kilometer (6-mile), reinforced fiber-optic cable delivers electrical power and control signals from the ship to *Jason*, which then returns data and live, high-definition video from the seafloor.

Jason is equipped with sonars, video and still imaging systems, lighting, and numerous sampling systems, as well as two multi-function manipulator arms. Pilots and scientists work from a control room on the ship to monitor *Jason*'s instruments and video while maneuvering the vehicle. The average *Jason* dive lasts one to two days, though operators have kept the vehicle down for as long as seven days.

Sentry

Sentry is an autonomous underwater vehicle (AUV) capable of exploring the ocean and seafloor down to 6,500 meters (21,325 feet). It carries a sophisticated suite of scientific sensors and also offers scientists the option of attaching their own sensors to study seafloor and mid-ocean processes.

Sentry's design provides a mix of speed, range, and maneuverability underwater, especially on missions in rugged terrain, such as inside submarine volcano calderas. It has excelled at creating high-resolution sonar maps and photo mosaics to support exploration of the mid-ocean ridge, hydrothermal vents, deep-sea coral ecosystems, methane seeps, and the tectonic features that reflect processes controlling the formation and evolution of the seafloor.

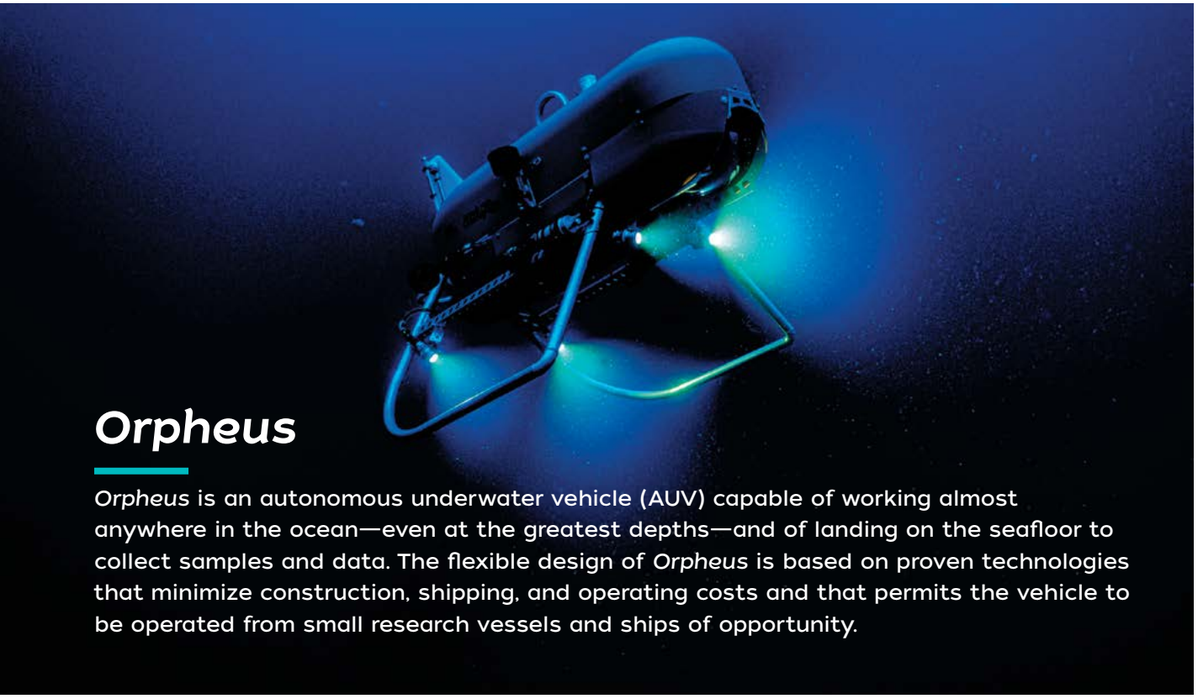


Nereid Hybrid Tether

Nereid Hybrid Tether (NHT) is a hybrid remotely operated vehicle (HROV) that can be configured to operate in any of three modes. First, it can be controlled from the surface via a reinforced cable that carries command-and-control signals, as well as video and environmental data. Second, it can operate at the end of a single-strand fiber-optic tether that maximizes its maneuverability. Finally, it can also be operated wirelessly via either an optical or acoustic underwater modem.

Nereid Under Ice

Nereid Under-Ice (NUI) is a hybrid remotely operated vehicle (HROV), which means it can operate either remotely, connected to the surface via a fiber-optic tether, or autonomously on a pre-programmed mission. It was built to travel long distances laterally from a ship in order to explore beneath ice-covered seas to a depth of 5,000 meters (16,400 feet) while its ship drifts with the sea ice, or to approach dangerous environments where ships cannot go, such as the calving front glaciers or underneath floating ice tongues.

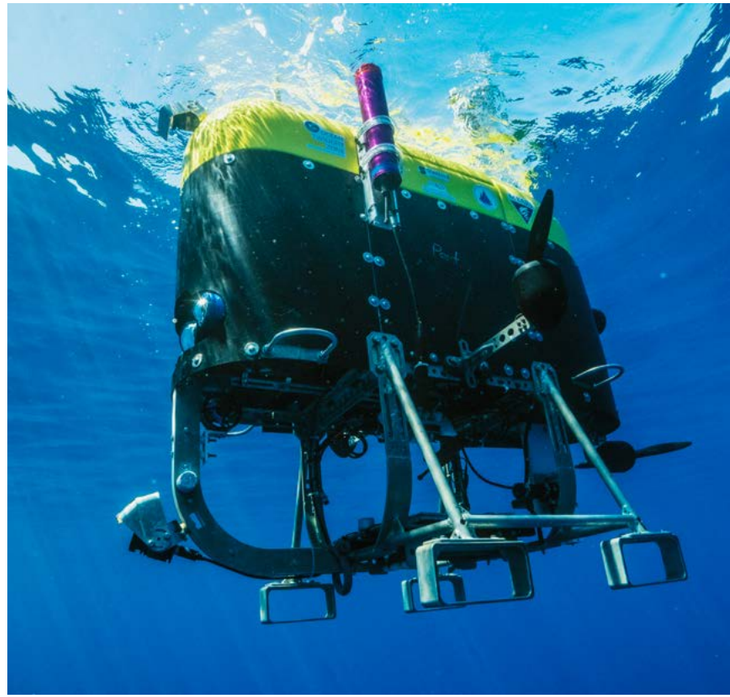


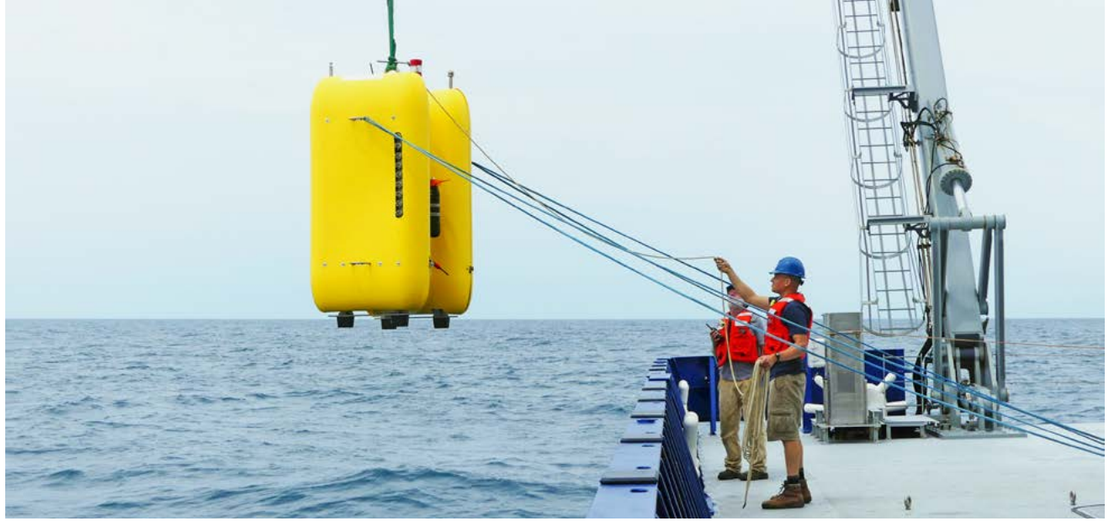
Orpheus

Orpheus is an autonomous underwater vehicle (AUV) capable of working almost anywhere in the ocean—even at the greatest depths—and of landing on the seafloor to collect samples and data. The flexible design of *Orpheus* is based on proven technologies that minimize construction, shipping, and operating costs and that permits the vehicle to be operated from small research vessels and ships of opportunity.

Mesobot

Mesobot is a hybrid remotely operated vehicle (HROV) designed by engineers at WHOI, the Monterey Bay Aquarium Research Institute, Stanford University, and the University of Texas Rio Grande Valley to understand the ocean twilight zone without disturbing its surroundings. The vehicle may be piloted remotely through a fiber-optic cable or released from its tether to follow pre-programmed missions down to 1,000 meters (3,300 feet), where it can help study life in the ocean's little-studied mid-water.





Clio

Clio is an autonomous underwater vehicle built to travel vertically through the water to a maximum depth of 6,000 meters (19,685 feet) and to hover at precise depths while filtering large volumes of water.

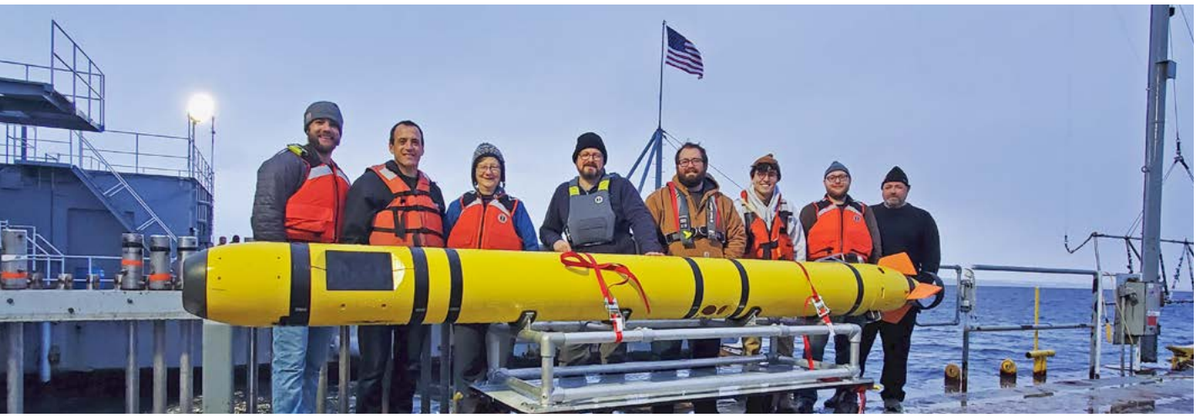
Because *Clio* is untethered, its support ship—almost any ship with a winch and over-the-side crane—is free to conduct other operations while the vehicle is completing its mission.

Jetyak

Jetyak was developed by WHOI scientists, who modified a commercially available gas-powered, jet-drive kayak to do advanced oceanographic research in dangerous and difficult-to-reach places. Scientists can remotely control *JetYak* or program it to run autonomously on a designated course. *Jetyak* has been used to map the seafloor and measure environmental conditions of waters that are too shallow for underwater vehicles or in areas too treacherous for humans, such as the front of calving glaciers. Versions of *Jetyak* also include an A-frame and winch used to lower instruments through the water to collect data or samples.

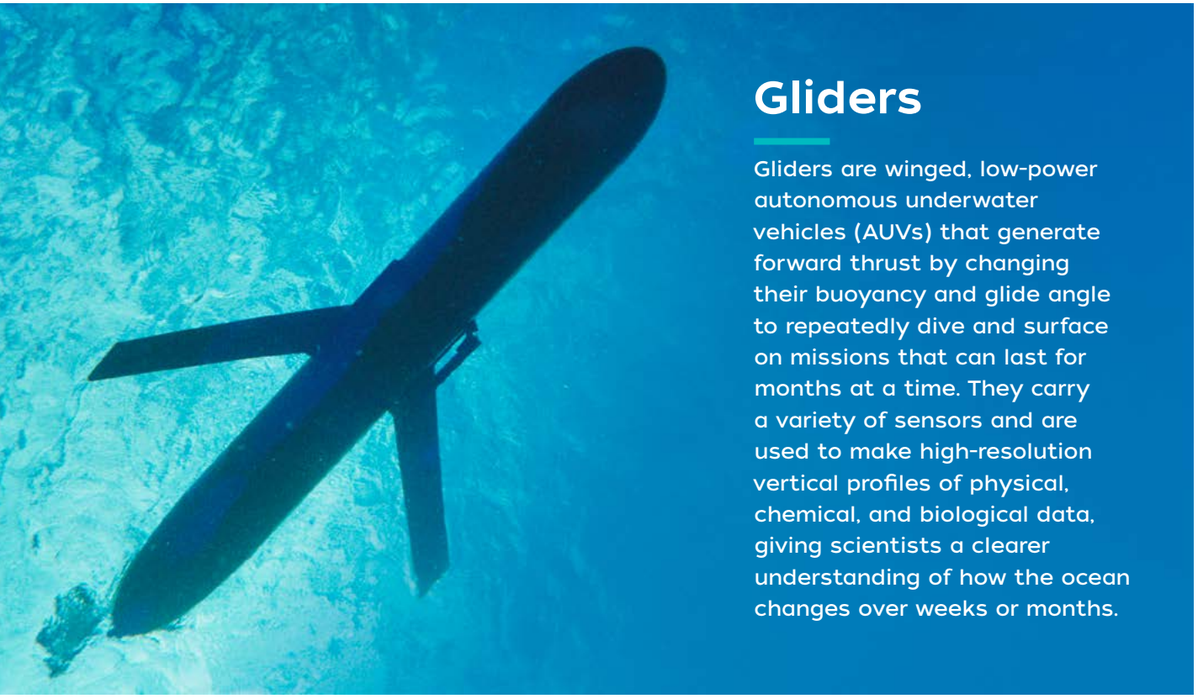
REMUS vehicles

The REMUS (Remote Environmental Units) are a commercially available family of autonomous underwater vehicles (AUVs) developed by WHOI's Oceanographic Systems Lab (OSL) that have become a workhorse of oceanographic research and are used by navies around the world for strategic purposes. Their modular design permits researchers to customize a vehicle to perform specialized seafloor and mid-water surveys from shallow coastal waters down to a depth of 6,000 meters (19,685 feet).



Tethys vehicles

Tethys are a class of long-range autonomous underwater vehicles (LRAUVs) originally designed at the Monterey Bay Aquarium Research Institute to conduct missions covering 1,500 kilometers (930 miles) or more. The vehicles have been modified by engineers in WHOI's Scibotics Lab to perform a wide range of specialized applications, including measuring and mapping oil spills under ice, adaptive sampling of environmental anomalies and rapid deployment to remote locations in emergencies.



Gliders

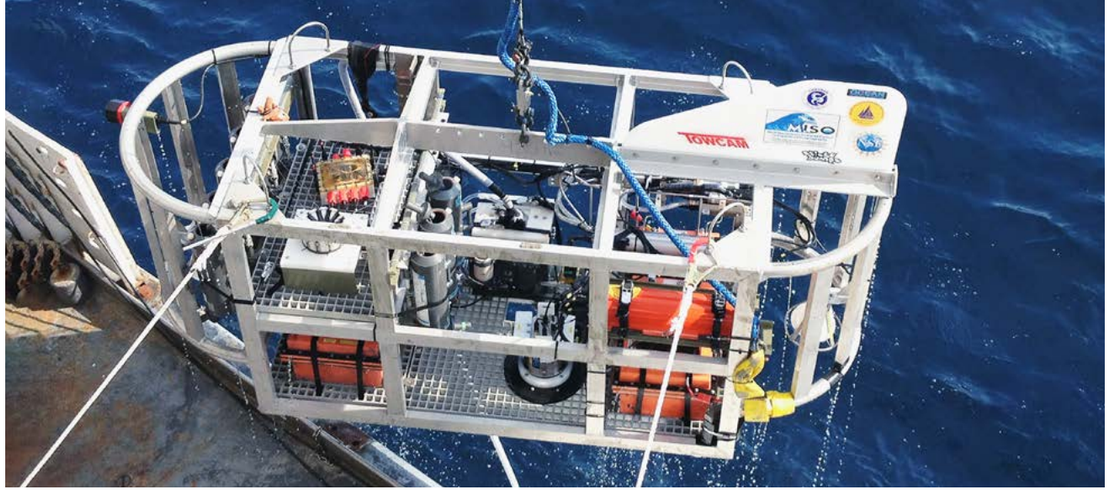
Gliders are winged, low-power autonomous underwater vehicles (AUVs) that generate forward thrust by changing their buoyancy and glide angle to repeatedly dive and surface on missions that can last for months at a time. They carry a variety of sensors and are used to make high-resolution vertical profiles of physical, chemical, and biological data, giving scientists a clearer understanding of how the ocean changes over weeks or months.

Profiling Floats

Profiling floats are easily deployed, relatively low-cost autonomous vehicles that can remain at sea for months or years to measure changes almost anywhere across the breadth and depth of the ocean. The long-running international Argo program maintains a fleet of about 4,000 floats that profile throughout the global ocean. Smaller ALAMO (Air-Launched Autonomous Micro Observer) floats can be deployed ahead of tropical storms to rapidly sample ocean-atmosphere interactions and improve forecasts of storm intensification.

Deep-See

The *Deep-See* is a towed, sensor-filled platform used to observe animals and environmental conditions in the ocean's midwater, or twilight zone. The vehicle is towed behind a research ship from an electro-optical cable that can transmit data between *Deep-See* and scientists on board in real-time. *Deep-See* also carries several specialized camera systems, sonars, and sensors used to measure oxygen, currents, and other seawater properties. It has also been outfitted with a custom-built seawater pumping and filtering system to collect biological samples for genetic analysis.

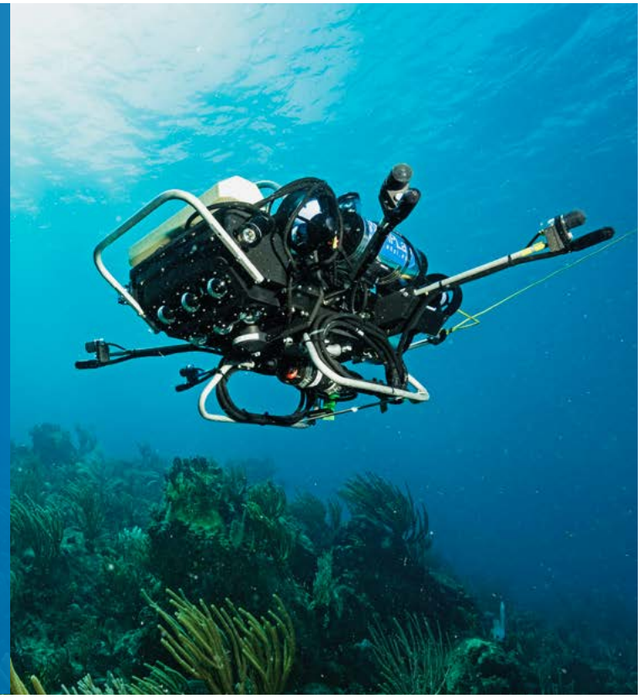


TowCam

TowCam is a digital towed camera system operated by the WHOI-SSSG-MISO Facility that captures high-resolution imagery of the seafloor every 5-10 seconds while also gathering environmental data as it is flown over the seafloor from a research vessel moving at 0.25–0.5 knots. *TowCam* has been used on more than 50 research expeditions in nearly every ocean basin over the past 20 years and has helped discover new hydrothermal vents and map recent volcanic eruptions along the mid-ocean ridge.

CUREE

CUREE (Curious Underwater Robot for Ecosystem Exploration) is an autonomous underwater vehicle (AUV) designed for monitoring complex places such as coral reefs. It relies on two basic observing methods—passive acoustics and vision—to identify and characterize biodiversity hotspots, to visually follow animals and observe their interactions, and to build a detailed picture of ecosystem function and health, much as a trained scientist would over time.



A LEGACY OF EXPLORATION

Atlantis was the first research vessel operated by the Woods Hole Oceanographic Institution and the first U.S. ship designed specifically to support interdisciplinary research in marine biology, geology, chemistry, and physical oceanography. The ketch-rigged, 142-foot ship was built in 1930 and funded by the institution's founding grant from the Rockefeller Foundation. Over more than 30 years, *Atlantis* completed nearly 300 research expeditions and covered 700,000 miles in the service of ocean science.

EXPLORE WITH US

In 1930 WHOI set out on a voyage to explore and understand the ocean for the benefit of society. Today, we continue that journey using the latest technology and advanced robotics to address some of the world's most pressing environmental challenges. Join us in a new age of exploration. For our ocean, our planet, and our future.

LEARN MORE!

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