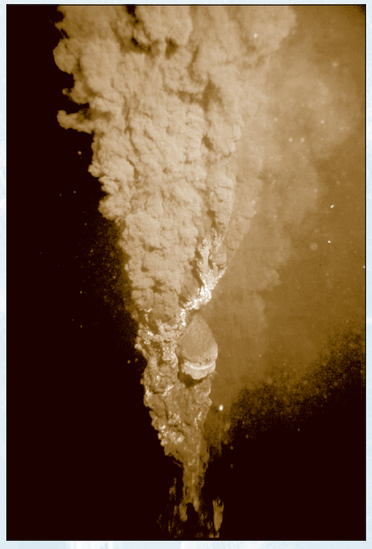
Today the US National Deep Submergence Facility operated by WHOI includes the submersible Alvin, *pictured, along with robotic and towed vehicles.*



One of the 20th century's most important scientific discoveries was hydrothermal vents on the seafloor. These phenomena are the object of intensive WHOI investigations.

WHOI scientists range the world ocean from their laboratories based in the village of Woods Hole, pictured here in a rare moment with three ships in port, and on the nearby Quissett Campus.

grams Office administers a variety of additional academic activities.

Today, the WHOI community numbers nearly 1,000, including over 300 scientific and technical staff, about 130 Joint Program students, 60 ships' crew and officers, and a variety of scientific, services, and administrative support staff. The Institution operates three large research vessels, *Atlantis* (275 feet), *Knorr* (279 feet), and *Oceanus* (177 feet), as well as *Tioga* (60 feet), the submersible *Alvin*, remotely operated and autonomous vehicles, and several small boats.

Institution scientists work in the marine components of engineering and all scientific fields. The following projects are among hundreds of investigations underway in the five scientific departments.

• Biologists probe the reasons for the collapse of Georges Bank and other fisheries and the causes and spread of "red tides," examine marine viruses, and analyze whale sounds.

• Physical oceanographers study water movement, from the rapid flow of the Pacific Kuroshio Current to the slower subsurface spread of Mediterranean water across the Atlantic and the six-year trip of Labrador Sea climate signatures south to Bermuda.

• Chemists study the unique natures of marine compounds and employ sophisticated instruments to follow substances as they travel through the ocean's depth and breadth.

• Geologists and geophysicists tap knowledge of the earth bound in seafloor rock and sediment as well as the deeper, molten layers of our planet, and they bring innovative techniques to the quest for new sources of minerals and petroleum.

• Members of the Applied Ocean Physics and Engineering Department study interactions of ocean and atmosphere, sediment transport, and other physical phenomena, and they develop instruments for a wide variety of disciplines and projects.

At the Marine Policy Center, scholars study the economics, conservation, and wise management of coastal and marine resources. They undertake projects in such areas as marine transit technology and safety, conservation of biological diversity, land-based marine pollution, and fisheries management.

Cross-disciplinary work is nurtured in four Ocean Institutes initiated in 2000 and a cooperative institute with the National Oceanic and Atmospheric Administration.

One of the most exciting recent oceanographic stories began 25 years ago with the first detailed look at hydrothermal vents on the deep ocean floor by scientists towing a WHOI camera sled from *Knorr* and diving in *Alvin*. WHOI scientists and their colleagues from many other institutions are slowly writing a still-emerging story of hydrothermal systems that contribute significantly to the temperature and chemical balances of the world ocean. The vents also support thriving communities of animals that depend not on a photosynthetic (sunlight driven) system but rather on a chemosynthetic (chemically driven) system in which bacteria absorb chemicals from vent water and then serve as food for other animals. Ultimate practical applications of this new knowledge may be expected to range from the pharmaceutical industry to mineral exploration.

This is oceanography at its best, using a pool of intellectual talents and innovative tools to bring knowledge from uncharted waters to enlighten and better humankind's use and preservation of the oceans.

You can learn more about WHOI by visiting our Exhibit Center, subscribing to our publications, and becoming an Associate through a contribution to support research.

For general information about Woods Hole Oceanographic Institution, please call or write:

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Cover photos, top to bottom: Henry Bigelow, the Bigelow Laboratory, the research vessel Atlantis, *and the WHOI pier in 1962.*

2004

Woods Hole Oceanographic Institution

A Brief History

At its founding in 1930 the Woods Hole Oceanographic Institution joined an already thriving scientific community in the village of Woods Hole, Massachusetts.

Spencer Fullerton Baird, the first US Commissioner of Fish and Fisheries, began to work in Woods Hole in 1871, and the first US marine station was built for the Commission in the village in 1885.

Three years later, the Marine Biological Laboratory (MBL) welcomed its first summer classes to Woods Hole for studies that followed the legacy of similar classes held on nearby Penikese Island in 1873 and 1874 by Louis Agassiz, founder of Harvard University's Museum of Comparative Zoology. In 1930, MBL owned the most suitable site for the new institution and offered to donate the land—until the trustees discovered their charter did not allow the gift. Instead, they helped the fledgling institution obtain a grant from the Carnegie Foundation to make the purchase.

The original concept for what became the Woods Hole Oceanographic Institution goes back at least to 1924 and the first of a series of conferences between Frank R. Lillie, then the MBL director, and Wickliffe Rose, then president of the Rockefeller Foundation's General Education Board. Their discussions with each other and with other interested individuals ranged over biology in general, then began to focus on oceanography, and eventually resulted in the 1927 appointment of a National Academy of Sciences Committee on Oceanography "to consider the share of the United States of America in a world-wide program of Oceanographic Research."

The committee, chaired by Lillie, recommended that oceanographic activities on the Pacific coast at the Scripps Institution of Oceanography and the University of Washington be strengthened, and that a well-equipped oceanographic institution be established on the East Coast. The committee members, including its secretary, Henry Bryant Bigelow of Harvard University, formed the nucleus of a board of trustees for the new institution. Lillie became president of the board, Bigelow the director, and it is no accident that, after considering many sites, Woods Hole was chosen for virtues that included its established, dedicated, and renowned scientific research community, extensive existing library facilities, ready access both to the deep sea and to the contrasting conditions north and

Henry Bigelow was the founding Director of the Woods Hole Oceanographic Institution.

The Institution's first building, a four-story brick structure, was later named for Henry Bigelow.

Bigelow applied knowledge gained on many research voyages in the Gulf of Maine to design of the first blue-water research vessel, the 142-foot steel-hulled ketch Atlantis.

The 40-foot collecting vessel Asterias, *named for a local starfish, completed the first fleet.*

south of Cape Cod, a small but deep water harbor suitable for berthing oceanographic vessels, and proximity to several universities.

The Rockefeller Foundation provided $1 million for construction, boats, equipment, and upkeep, $1 million for endowment, and $500,000 for 10 years of summertime operating expenses. Bigelow had conducted extensive studies in the Gulf of Maine using boats begged and borrowed from the Fisheries Commission and often not suited for the work being done. He knew firsthand the importance of a seaworthy and reasonably comfortable working platform. "The most essential activities of the institution may be expected to center around the work at sea," he wrote, and the Institution "expects to own and operate a seagoing ship, of moderate size, with convenient living quarters, capable of extended voyages and equipped to carry on investigations at all depths in the various fields of sea science."

A number of existing ships were offered but found unsuitable, and in May 1930 the trustees authorized $175,000 for construction of a new vessel, a 142-foot, 350-gross-ton, steel-hulled ketch spreading 7,500 square feet of canvas. The diesel engine could drive the ship at 8 to 9 knots. The Institution's first annual report said of the ship, "Two laboratories are provided…there are comfortable accommodations in staterooms for six scientists, besides the officers [3], with dormitory space for several students, and ample accommodations for the crew [13]. The main hoisting winch is to be located in the lower hold, but controlled from the deck."

Construction also began on a four-story brick laboratory, which is still in use and called the Bigelow Laboratory. With laboratory and ship under construction, there was nothing to operate in the summer of 1930, so the $50,000 allotment for that season was contributed to an expedition to send the submarine *Nautilus* under the polar ice cap. Though that became impossible when the sub lost a diving rudder, commendable work was done on the expedition, and the first five contribution numbers on a list of WHOI scientific publications now totaling more than 14,000 were assigned to papers written on the work of that expedition.

Atlantis, launched December 31, 1930, was still in the last stages of construction in Copenhagen the following summer, but *Asterias*, a 40-foot launch, had been delivered and served as a collecting vessel for the summer's work. *Asterias* served the Institution until its 50th anniversary, when it was replaced a similar but more modern namesake. In 2004, the larger (60-foot), faster *Tioga* replaced the second *Asterias*.

Atlantis arrived in Woods Hole in August 1931. Throughout the 1930s, while the Institution operated primarily during the summer months, *Atlantis* made short research cruises for the laboratory's eight or ten scientists during the warm season and a long cruise or two in the winter. A typical summer would find the ship exploring newly discovered canyons off Georges Bank, collecting mud cores for bacteriological studies, taking current measurements at anchor stations, dragging for Gulf of Maine shrimp, collecting plankton, taking light intensity readings, and crisscrossing the Gulf Stream with lines of hydrographic stations. During the winter, *Atlantis* made cooperative cruises with Yale University's Bingham Oceanographic Foundation and with joint staff from Harvard University and the University of Havana for a wide variety of work in the Caribbean and Gulf of Mexico.

The turn of the decade brought profound change to oceanography. Columbus Iselin, who succeeded Bigelow as director in 1940, and the WHOI trustees offered the Institution's facilities to the government for war work. During the war, the US Navy realized more and more that many of its operations were intimately dependent on the environment in which ships operate, and oceanographers found themselves consulted more and more frequently on matters of national defense. The summertime staff of 60 expanded to a year-round complement of more than 300, and the annual operating budget skyrocketed to over $1 million.

The first Navy-sponsored program of research at Woods Hole concerned prevention of marine fouling on ships. This was followed closely by an intensive study of the effects of salinity and temperature on the transmission of underwater sound and its application to anti-submarine warfare. Many other research activities with direct application to naval problems followed, the largest of which was the investigation of underwater explosives. Its staff included chemist Paul M. Fye, who later became the Institution's fourth director. The wartime work resulted in the award of the Legion of Merit to the Institution's Director, with the citation "having saved many of our ships" and the acknowledgment that the antifouling studies had "saved ten percent of the Navy's fuel bill."

After the war, there was a period of uncertainty about oceanography's future. For a while it appeared that the Institution might return to the pre-war routine of busy summers and quiet winters. But both the direction of oceanography as a science and its economic situation had changed.

As marine historian Susan Schlee describes it, "Before the war the goal of most oceanographers had been to describe the steady state or average conditions, be it of a current, a trace element in the water, a population of lobsters, or a bed of manganese nodules on the seafloor. But by 1945 the goal had changed to following the dynamic processes that occur in the oceans. Iselin now wanted to know what interplay of forces kept a particular current flowing, for example, and how the forces and the current changed from day to day and even from hour to hour. Such intensive studies could not be undertaken by a summer institution open only three months of each year."

Economic inflation was also a governing factor; costs of running *Atlantis*, for example, had doubled. "The costs of operating our own vessels have become so high," Iselin wrote, "that without Government subsidy we could not hope to undertake offshore observations." So it was that the conjunction of private oceanography and public need that had developed during the war was on the way to becoming the standard for peacetime as well.

Throughout the Cold War, the Navy supported investigations into the nature of the marine environment that spawned greater knowledge of Earth processes. Extensive work in physical oceanography led to better understanding of the Gulf Stream as well as the distribution of properties in the North Atlantic Ocean. Acoustic methods stimulated by war developments allowed geophysicists to extend their knowledge and understanding of the structure of the earth under the ocean basins. Interest in meteorology led to the development of a strong group at Woods Hole making observations on trade wind physics and dynamics.

The 1990s shift of Navy emphasis from the open, deep ocean to coastal areas brought funding opportunities for scientists interested in nearshore processes. The 1996 gift of $5 million dollars from Gratia Houghton Rinehart for the WHOI Coastal Research Center, now named for her, offers a well-appointed home for a variety of interdisciplinary coastal projects ranging from fisheries research to nearshore current studies.

The National Science Foundation (NSF) was created by Congress in 1950 to promote US science and engineering. WHOI's first support from NSF came in 1952 for work on summer plankton blooms in Long Island bays and for eight training fellowships. Over the years, NSF's share of Institution scientific support grew slowly and steadily until it surpassed Navy support. In recent years, the federal share of WHOI's operating budget has been approximately 85 percent, principally from NSF and the Office of Naval Research, and about 15 percent has come from nongovernment sources. Private funding is important to the Institution's freedom and ability to initiate and develop areas of research that are not appropriate for or perhaps not in favor with government funding agencies.

Though students have been involved in research at WHOI since the Institution's founding, the first formal education program was a summer research experience for undergraduates initiated about 1955. Postdoctoral fellowships followed in 1960, and a Joint Program with the Massachusetts Institute of Technology to grant doctoral degrees in oceanography began in 1968. Since then, more than 600 doctoral, master's, and engineering degrees have been granted under the Joint Program and a few more by WHOI alone. The Academic Pro-

Columbus Iselin was the first captain of Atlantis *and the second Director of the Institution.*

Data from bathythermograph, an important early instrument designed at WHOI, helped save US submarines during the war.

The Institution grew substantially during World War II as host to many Navy projects.

The arrival in 1958 of the research vessel Chain, *a converted Navy salvage tug, signaled a move to big-ship oceanography.*