The $7-million increase in research funding (up 7 percent over 2003) was driven mainly by growth in funding from the National Science Foundation and the National Oceanic and Atmospheric Administration. Navy funding is down as the Navy increases its emphasis on applied research.

By 2004 we recovered the endowment principle lost in the market downturn since 2001, while distributing more than $13 million per year since then to support our science. Our endowment ended 2004 at $291 million, with a 12% annual average rate of return, outperforming our benchmark.

1Endowment comprises cash and securities to provide income for maintenance of the organization. Market value is as of December 31.

2Total operating revenue is total funding of the Institution’s research and education programs, including a component of endowment income appropriated for operations during the financial year ending December 31. See Financial Statements, Note 2, page 49.

3Total operating expense is cost incurred in support of research, education, and operations during the financial year ending December 31. See Financial Statements, Note 2, page 49.

WHOI personnel in 2004 totaled 1,092.
Woods Hole Oceanographic Institution is a private, nonprofit marine research and engineering, and higher education organization. Its mission is to understand the oceans and their interaction with the Earth as a whole, and to communicate a basic understanding of the ocean's role in the changing global environment. Established in 1930 on a recommendation from the National Academy of Sciences, the Institution is organized into five scientific departments, interdisciplinary research institutes and a marine policy center, and conducts a joint graduate education program with the Massachusetts Institute of Technology.

Front Cover: In June, MIT/WHOI Joint Program students and staff hiked Mount Kilauea on the Big Island of Hawaii to study the island’s origin and active volcanism. They are standing near an opening in a lava tube, about eight miles from the eruption source. Leading the field trip was Postdoctoral Scholar Adam Soule (sixth from left, hat backwards). Escorting the students were seismologist Jeff McGuire (far left), geophysicist Hans Schouten (right, with gloves) and physical oceanographer Jack Whitehead (right, with backpack). The trip to Hawaii, part of the geodynamics seminar, was jointly sponsored by the Deep Ocean Exploration Institute and the Academic Programs Office.

Back Cover: Glen Gawarkiewicz, right, and Al Plueddemann deploy a REMUS autonomous underwater vehicle in January off the dive platform of R/V Tioga. The vehicle was used for a hydrographic survey in shallow water off the east coast of Cape Cod.

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Contents

2 Letter from the President and Director
4 Letter from the Executive Vice President and Director of Research
6 Marine Facilities and Operations
11 Science highlights
20 Applied Ocean Physics and Engineering
22 Biology
24 Geology and Geophysics
26 Marine Chemistry and Geochemistry
28 Physical Oceanography
30 Academic Programs
31 Ocean Institutes
35 Marine Policy Center
36 WHOI Sea Grant
37 Cooperative Institute for Climate and Ocean Research
38 Institution outreach
39 WHOI in the news
40 Public policy and science policy
41 Promotions and appointments
42 Trustees and Corporation Members
44 Report from the Vice President for Finance and Administration
45 Financial statements
60 WHOI history timeline
In 2004 we made significant strides in affirming the leadership position of our Institution and in preparing for difficult times for federally funded basic research. We took major steps to enhance our science and education, both ashore and at sea.

On the Quissett Campus, we broke ground (photo at right) for much-needed new laboratory space, adding 80,000 square feet to relieve crowding of our scientists and to accommodate newer technologies. The project is on time and on budget, with occupancy scheduled for late 2005. We also provided 10,000 square feet of space in the village for our Deep Submergence Group.

We signed a $21.6-million cooperative agreement with the National Science Foundation (NSF) to build a replacement for the venerable and industrious submersible, Alvin, which was 40 years old in 2004. The replacement sub, which will be the deepest diving and most technically advanced in the world, is scheduled for launch in 2008. We also began the design phase for a hybrid remotely operated vehicle, an innovative mix of free-swimming and tethered vehicle designs, which will operate to the deepest ocean depths of 36,000 feet—deeper than Mt. Everest is high.

Tioga, our new coastal research vessel, completed its first eight months of operations, logging 75 trips in support of WHOI science and our at-sea education for undergraduate summer student fellows, and for media outreach (photos below and on page 7).

A joint grant from NSF and the National Institute of Environmental Health and Sciences funded a new $6.5-million Woods Hole Center for Oceans and Human Health based at WHOI and operated jointly with Marine Biological Laboratory and MIT. The center will coordinate research at the intersection of oceanographic, biological and environmental health sciences.

An external review committee for our graduate education efforts reported that “the MIT/WHOI Joint Program remains a (if not the) top educational program covering all the marine sciences and engineering”—a ringing endorsement of the quality of our faculty, staff, and students. In addition, WHOI rated in the top ten U.S. institutions for postdoctoral researchers nationwide in a reader survey conducted by the magazine The Scientist.

A changing attitude toward science

While I’m proud of our accomplishments, we face new challenges that come from a changing attitude toward science in the United States.

In 2004, a modest increase in NSF ocean sciences funding did not keep pace with demand for important research. A rising percentage of highly rated proposals is being turned down, which has a demoralizing effect on our scientists.

As we anticipate declining research support from federal agencies, my focus remains on controlling nonscience expenses while building sources of revenue. Here, there is some good news. With the support and efforts of our Board, our fund raising passed $115 million toward our campaign goal of $200 million. The campaign enters its public phase in 2005.

Thanks to the talent of our trustee investment committee and a rebound in Wall Street, by 2004 we recovered the endowment principle lost in the market downturn since 2001, while distributing more than $13 million per year since then to support our science. Our endowment ended 2004 at $291 million, with a 12% annual average rate of return, outperforming our benchmark. On the expense side of the balance sheet, our discipline in controlling administrative costs contributed to positive financial results. We are also addressing increasing health care and retirement benefits costs.

A priority for 2005 will be to promote recognition of the importance of our science. Gone are the days of my youth when science, while perhaps not widely understood, was at least widely valued. We can no longer as-

Tioga crew, WHOI personnel and members of the Smith family along with others who supported the new coastal research vessel, gathered at its launch in March at Gladding-Hearn Shipbuilding in Somerset, MA.
sume the importance of our work is self-evident to the public and those in government. Peer-reviewed journal articles are no longer enough. The public must hear if we are to win its support for science. Congress must hear. The White House must hear. I believe that if the science community does not advocate for science, no one else will.

Advocating for science

Our Ocean Institutes, with their mission to communicate the importance of our work, are pioneering an approach that will make our research and its benefit to society broadly understood and appreciated. This step is essential to win further federal support for research.

The continuing success of our researchers requires that they write ever more proposals, eroding the time spent on science. Today, the average WHOI researcher writes four to six proposals a year and some write as many as a dozen. Those that are funded, are often at a level below what they need to achieve their scientific objectives.

In this environment, private funding increasingly enables science that likely would not have happened otherwise. Today about 20% of the Oceanographic’s science is underwritten by private sources and we are working hard to increase that figure. Private funding is needed to maintain our ability to do high-risk, high-reward science that catalyzes our scientific leadership and pays dividends to society in the long run.

There is some good news in the research arena, despite difficulties with the NSF budget. The crossroads we stand at today, on the threshold of the 75th anniversary of our Institution, presents opportunities we have not encountered in decades. The recommendations of the U.S. Commission on Ocean Policy promise to reinvent our country’s policy and funding framework for ocean science. Congress has renewed consideration of the U.S. Commission on Ocean Policy recommendations, with hearings likely to stretch until July 2005.

What would implementation of the Commission recommendations mean for WHOI?

We are uniquely prepared to take advantage of a renewed emphasis on oceanography.

First, we have an unmatched scale of sea-going expertise—ships, tethered and autonomous vehicles, buoys and observatories, and we are building a new human-occupied submersible.

Second, we have a unique partnership of science and engineering. We don’t just buy new technology off the shelf and adapt it. We invent it, design it, build it, test it, and deploy it.

Third, we have excellent academic programs that cultivate the inventive minds we will need in the future.

A renewed emphasis on ocean science would mean reinvigorated demands placed on ocean scientists and engineers. Not only are we qualified to meet these demands, the Ocean Institutes have proved their ability to incubate new ideas, and multiply small private investments into major federal support.

For 75 years, researchers at Woods Hole Oceanographic Institution have proved their adaptability. During World War II, we did mainly defense-related work. During the height of the Cold War, our scientific and technical innovation kept our Navy a step ahead of the Soviet navy.

Today, we are in another time of change and I am confident that the world-class creativity and enterprise we nurture in our extraordinary village will lead us productively into new waters.
Shrinking federal investments in basic research will make the coming years challenging for Woods Hole Oceanographic Institution. Despite this outlook, the Institution’s research and engineering achievements continue. We are prepared for rough waters in the short term, and are preparing for a new way of funding basic research in the long term.

Achievements

By the end of 2004, we had approximately $120 million in hand for funding of 865 research projects. Continuing the trend over the last few years, our Biology Department and Applied Ocean Physics and Engineering Department show most rapid growth in personnel and in the number and size of sponsored research projects. Our scientists made significant advances in earthquake research, involving the application of mathematical models to the extensive databases for earthquakes on the East Pacific Rise, leading to a better understanding of early release of stress that may ultimately provide some predictive capability. Jeff McGuire, graduate student Margaret Boettcher, and colleagues have led this effort. Jian Lin, with Uri ten Brink of the U.S. Geological Survey, reported their work on assessing the potential for tsunami-generating earthquakes in the Caribbean in December.

The sensitivity of the polar seas to global changes in climate has led to a large, and growing, research effort to understand the complex relations that control marine life, as well as the processes that control the balance between fresh and salty water—which in turn influences earth’s climate. We have more than 40 funded projects scheduled for the Arctic and Antarctic, involving more than 30 investigators from a wide range of disciplines, including biologists Carin Ashjian, Peter Wiebe, Scott Gallager; physical oceanographers Andrey Proshutinsky, Bob Proshutinsky, Bob Pickart, Fiamma Straneo, Al Plueddemann, and John Toole, geologist Rob Reeves-Sohn, and engineering scientist Hanu Singh. Some of the polar areas of interest to these scientists are highlighted in the map (left). We expect to play a significant role in International Polar Year, a coordinated effort starting in 2007 to focus on leading polar science questions.

The prospect of making observations from autonomous platforms has been a dream for oceanographers for decades. This dream is finally becoming realized. An autonomous transect of the Gulf Stream south of New England was accomplished this year by Breck Owens and Scripps collaborators, using the Spray glider (page 29). In addition, Dave Fratantoni participated with the Naval Oceanographic Office in a field program in the Philippine Sea with five Slocum gliders to test the concept of using a mobile array of gliders as synthetic moorings, using the measurements to initialize and then validate numerical models. Christopher von Alt and colleagues in the Oceanographic Systems Laboratory delivered to the Navy a second autonomous underwater vehicle rated for depths to 6,000 meters. The vehicle successfully conducted more than 5,000 nautical miles of deep ocean surveys for the Naval Oceanographic Office.

Also started in 2004 was the work of Dennis McGillicuddy’s group and colleagues in many institutions on biological-physical interactions in the Sargasso Sea to better understand the effect on biological productivity of ocean eddies, which are hundreds of kilometers across. The eddies, sometimes referred to as the “internal weather of the sea,” are highly energetic and ubiquitous features of ocean circulation. They perturb the chemical and biological environment that can dramatically impact biogeochemical cycling in the ocean.

Following a recommendation made in 2004 by the “Access to the Sea” task force, an internal fund has been established to foster the development of state-of-the-art sea-going technologies and support high-risk or innovative sea-going research. The first projects are due for selection in 2005.
Near-term prospects

Much of our existing funding is for ongoing projects, which have been funded in the past few years for three to five years. In addition, there are significant new projects. Some of these include the Clivar Mode Water Dynamics experiment (CLIMODE), a large, multi-institutional observational program to understand the formation and maintenance of large bodies of water adjacent to strong currents (such as the Sargasso Sea, along the south side of the Gulf Stream) and their role in climate. Andrey Proshutinsky is leading a group of investigators working in the Beaufort Gyre, off the Alaska north coast, to understand its role in the balance of fresh and salty water, and its influence on global heat distribution.

As part of an international effort called VERTIGO (VERtical Transport In the Global Ocean), WHOI scientists and technicians Ken Buesseler, Jim Valdes, Tom Trull, Karen Casciotti, Ben Van Mooy, and Steve Manganini are studying processes that control the sinking of particles from the ocean surface to depths of 1,000 meters. This work will enhance modeling of the global carbon budget and understanding of the role of carbon in the global climate.

Biology is thriving because its funding base is highly diverse, and because it has become an international scientific focus driven by extraordinary developments in genomics, proteomics, and in the oceans in particular because of the observational capabilities developed in the past 10 years. The Woods Hole Center for Oceans and Human Health, one of four in the country, exemplifies the application of modern understanding in biology to addressing issues of immediate human interest.

The longer view

Despite the decrease in National Science Foundation (NSF) funds overall for 2005, the Foundation will still spend more than $300 million in basic research in ocean science per year. Our scientists and engineers are very competitive (figure at left) and we anticipate that we will continue to participate substantially in the major oceanographic initiatives in the coming decade. We also expect to continue to receive substantial funding for individual investigators and major facilities, such as the accelerator mass spectrometer, ships, and submersibles. We continue to attract highly qualified candidates for new scientific and technical positions.

In addition, advances in instrumentation and technology make possible measurements and understanding that was previously beyond our reach. This advancement is moving faster than the required increase in funding. To fully harness these emerging capabilities, we will require a more diverse funding base. Roughly eighty percent of the federal funding we need will still come from traditional sources, such as NSF, the Office of Naval Research, the National Oceanic and Atmospheric Administration, and the National Institutes of Health. The remainder will need to come from new sources.

Escalating competition for federal research funds is contributing to growing risk aversion in basic science funding. As a result, private funding—which underwrites 20% of WHOI science today—will become increasingly important to demonstrate success and smooth the way for subsequent federal support. This is already happening within our Ocean Institutes and other internal programs.

In the larger picture, not only is funding for basic research continuing to decline at most federal agencies, the character of the funding is changing. There is more focus on applied problems. Unlike the funding for basic research, this money comes with more strings attached, more rigid timelines, and firmer expectations of results. To participate in this world, our scientists’ way of working will need to change to accommodate the different requirements of the funding agencies. Some of our scientists and engineers have been successful at navigating in this world. We are exploring ways, within the Institution’s culture, to create an environment that enables more scientists and engineers to take advantage of these opportunities.
The past year marked a major milestone in deep submergence operations at WHOI. Alvin, the nation’s only deep-diving, human-occupied research submersible, completed its 4000th dive during its 40th year of operation. As the sub approaches retirement, the National Science Foundation announced in August that it would fund the construction of a new, deeper diving submersible. The replacement vehicle, expected to be complete by 2008, will allow researchers access to more than 99% of the seafloor.

As shown in the maps on pages 8 to 10, Atlantis spent 2004 in the eastern Pacific working primarily on the East Pacific Rise and Juan de Fuca Ridge. Knorr operated in the North Atlantic conducting a wide variety of research from Panama to Baffin Bay and the Norwegian Sea. Oceanus worked in the western North Atlantic and Mediterranean Sea.

In June, after nearly 14 years at the helm of marine operations at WHOI, Rear Admiral Richard F. Pittenger retired. His legacy includes major upgrades to the research vessels Knorr and Oceanus; the 1996 replacement of Atlantis II by the modern vessel Atlantis; and the 2004 acquisition of a new 60-foot coastal vessel, Tioga.

As the incoming Vice President for Marine Facilities and Operations, I am developing and managing a strategic plan for the integration of the Institution’s research fleet with its various undersea vehicles and ocean observatories. In 2005 I look forward to working with others at WHOI to implement recommendations made in 2004 by the Access to the Sea Task Force in areas such as fleet replacement, development of new vehicle platforms and sensors, establishment of seafloor observatories, and improvement of scientific data management at WHOI, both at sea and on shore.

—Robert Detrick
Vice President for Marine Facilities and Operations
Four years ago, WHOI Vice President for Marine Operations Dick Pittenger and Senior Scientist Rocky Geyer crossed paths while walking through Woods Hole village and talked about bringing a new vessel to WHOI for coastal research. Through their dedication, as well as generous outside donations, on April 16 WHOI welcomed the 60-foot, $1.6 million coastal research vessel Tioga.

During its first nine months of operation 456 people traveled on Tioga, including scientists and students who tagged whales, collected water samples, deployed prototype instruments for testing, and gathered data about coastal larvae, sediment, currents, water temperatures, and depth.

Clockwise from top: WHOI employees, donors, and shipyard workers gathered March 29 for the launch; WHOI President and Director Bob Gagosian, donor Hope Smith, and Dick Pittenger pose at the launch at Gladding-Hearn Shipbuilding in Somerset, Massachusetts; Rocky Geyer (on vessel) talks with well-wishers at the April welcome ceremony; Tioga, capable of cruising 20 knots, speeds into Woods Hole; the WHOI flag is raised on the vessel for the first time. Center photo: Hope Smith cracks a ceremonial champagne bottle across the bow.
R/V *Atlantis* and DSV *Alvin* at the Juan de Fuca Ridge.

**R/V Atlantis**
- Capacity: 59 people at sea for 60 days
- Launched: 1996
- Days at sea in 2004: 225
- Cruises: 12
- Investigators served: 311
- Nautical miles: 20,338

**DSV Alvin**
- Alvin dives: 114

**Cruise tracks: R/V Atlantis and DSV Alvin**

- **Costa Rica, offshore Nicoya Peninsula**
  - Feb. 27–Mar. 7: Deployed and recovered pressure, fluid, and chemical monitoring instruments. 8 Alvin dives

- **East Pacific Rise**
  - Mar. 15–Apr. 1: Measured heat fluctuations at hydrothermal vents. 11 Alvin dives
  - Apr. 6–Apr. 30: Made seafloor maps. Gathered data on salinity, temperature, and water depth. 16 Alvin dives
  - Nov. 5–Nov. 26: Tested chemistry instruments in hydrothermal fluids. Collected sulfide, sediment, and fluid samples. 13 Alvin dives
  - Nov. 30–Dec. 20: Collected water and sulfide samples as well as vent organisms, including tubeworms, mussels, and clams. 12 Alvin dives

- **Gulf of Alaska Seamounts**
  - Jul. 30–Aug. 23: Surveyed five seamounts. Analyzed and collected deep water corals from various sites. 19 Alvin dives
  - Aug. 28–Sep. 4: Collected animals living at hydrothermal vents. Surveyed invertebrates colonizing seafloor. 4 Alvin dives

- **Endeavour Segment, Juan de Fuca Ridge**
  - May 23–Jun. 7: Recovered and deployed instruments, including several prototypes. Cleared vent field of research instrument debris from previous expeditions. 14 Alvin dives

- **Gorda Ridge and Axial Volcanoes**
  - May 12–May 18: Deployed prototype moored seafloor observatory.
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- **Gulf of Alaska Seamounts**
  - Jul. 30–Aug. 23: Surveyed five seamounts. Analyzed and collected deep water corals from various sites. 19 Alvin dives

- **Nootka Fault, Juan de Fuca Ridge**
  - May 12–May 18: Deployed prototype moored seafloor observatory.

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- **Strait of Juan de Fuca and Neah Bay**
  - Sep. 8–Sep. 28: Researched how a harmful algae produces toxins, and studied how algae move to the coast, threatening shellfish. Gathered data on salinity, temperature, and water depth.

- **Gulf of Alaska Seamounts**
  - Jul. 30–Aug. 23: Surveyed five seamounts. Analyzed and collected deep water corals from various sites. 19 Alvin dives

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**Cruise tracks: R/V Knorr**

**R/V Knorr** is fitted with a coring device at a Florida dock.

**Grand Banks** Jul. 16–Aug. 15: Conducted coring and seismic surveys. Made seafloor maps.


**Panama Basin** Feb. 14–Mar. 5: Collected sediment cores as part of a long-term study into the connection between salinity of the area and global climate.

**Knorr**
- Capacity: 58 people at sea for 60 days
- Days at sea in 2004: 242
- Cruises: 9
- Investigators served: 174
- Nautical miles: 43,529

**Davis Strait and Baffin Bay** Sep. 22–Oct. 4: Deployed instruments, including subsurface moorings. Conducted bathymetric survey.

**Norwegian Basin** May 8–May 18: Collected sediment cores. Gathered data on salinity, temperature, and water depth.

**Storegga Slide, Norwegian Sea** Aug. 29–Sep. 11: Conducted seismic, sediment, and geochemical research.

**Mid-Atlantic Ridge (7 locations)** Mar. 16–Apr. 10: Deployed and recovered moorings and other ocean instruments monitoring earthquake activity along the Mid-Atlantic Ridge.


**Kane Fracture Zone, Mid-Atlantic Ridge** Nov. 14–Dec. 17: Used ROV Jason and other vehicles for rock dredging and seafloor mapping.
Cruise tracks: R/V Oceanus

“Station W” in North Atlantic  Apr. 27–May 6: Deployed and recovered ocean research instruments, including moorings.

Hudson River (near Staten Island and New Jersey shelf) Jun. 2–6: Conducted biology, chemistry, and physics experiments to map amounts of dissolved organic matter living in the region.

Gulf of Maine  Apr. 16–23: Collected water samples and sediments for research on carbon cycling.


Sargasso Sea  Feb. 15–Mar. 1: Measured response of ocean biogeochemistry to passing weather fronts.

Sargasso Sea  Mar. 19–Apr. 10: Collected surface water samples to measure trace metals, nutrients, and phytoplankton.


Gulf of the Lion, Mediterranean Sea  Sep. 25–Oct. 15: Deployed ocean research instruments and collected water and sediment samples.

Aegean Sea  Oct. 27–Nov. 19: Conducted ocean physics research on waves and mixing. Recovered moorings.

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Aegean Sea  Oct. 27–Nov. 19: Conducted ocean physics research on waves and mixing. Recovered moorings.
WHOI researchers scouted the perfect spot to deploy instruments in the Beaufort Sea in the western Arctic Ocean. In August 2004, John Kemp (far right) and Rick Krishfield (who took this photo) found their spot: a stable, four-meter-thick piece of ice to install an Ice-Tethered Profiler (ITP). Developed at WHOI by John Toole, the ITP is secured to a drifting ice flow. It dangles an instrumented cable into the ocean to measure water temperature and salinity—through all seasons and over several years—transmitting data back via satellite. (It was also an ideal spot for polar bears—hence Seaman Andrew Kaiser of the Canadian Coast Guard Icebreaker *Louis S. St. Laurent* and his shotgun.)

Using a variety of instruments to measure ocean, ice, and atmosphere in the Beaufort Sea, WHOI researchers seek to elucidate the sea’s critical role in global climate. Vast amounts of fresh water collect in the sea: from the Pacific Ocean through the Bering Strait; from precipitation and melting snow and ice; and from great Siberian and Canadian rivers draining into it. This huge freshwater reservoir is trapped by a wind-driven, cyclonic current called the Beaufort Gyre. WHOI physical oceanographer Andrey Proshutinsky has theorized that when the winds occasionally shift, the gyre weakens, allowing large volumes of fresh water to leak into the North Atlantic. This flywheel may have large impacts on ocean circulation and climate, and it may be sensitive to global warming. Nobody knows for sure, because the Beaufort Sea is among the Earth’s most hostile and inaccessible regions, and data is scarce. But pioneering, annual expeditions to the Beaufort Sea from 2003 to 2008 will begin to reveal its secrets.

The Beaufort Gyre Freshwater Experiment is funded by the National Science Foundation and the WHOI Ocean and Climate Change Institute. The Cecil H. and Ida M. Green Technology Innovation Award at WHOI funded initial development of the ITP.
Emma Teuten may be a vegetarian, but that didn’t deter her from seeking intriguing chemical clues in whale blubber to an important marine pollution issue. Teuten and fellow chemist Chris Reddy discovered that two suspected man-made pollutants found in marine mammals actually came from natural sources.

Methoxylated polybrominated diphenyl ethers (MeO-BDEs), a component of flame retardants, have been found accumulating in animal tissues around the world. Some researchers suspect that these compounds may affect animal and human health, and some compounds have been banned. Bromine compounds have been found in fish and humans near industrialized areas, but they have also shown up in the flesh of sea sponges, dolphins, and other creatures far removed from human activity.

Teuten, a postdoctoral fellow in the Department of Marine Chemistry and Geochemistry (MCG), dulled a dozen knives and burned up two blenders in order to isolate just 1 gram of brominated compound from 20 kilograms (22 pounds) of blubber from a beached whale that had died. “There was no road map for this,” said Teuten. “This just hasn’t been done before.”

Teuten and Reddy examined her sample for carbon-14, a natural radioactive isotope of carbon that is incorporated into all living things, but is not found in industrial petrochemicals. They found that BDEs in the whale tissue contained carbon-14, meaning the chemicals were derived from a natural (though still unidentified) source. Gordon Gribble, an environmental chemist at Dartmouth College, called the technique “very exciting... a great tool for distinguishing natural compounds from man-made ones.”

This research was supported by the National Science Foundation and The Camille and Henry Dreyfus Foundation, Inc.
In near-freezing waters thousands of meters below the ocean surface, communities of brightly colored corals bloom on the seafloor, living quiet, long lives far from sunlight and waves. Like their tropical, shallow-water cousins, these deep-sea corals harbor a rich diversity of underwater life, including abundant commercially valuable fish.

Scientists only recently discovered these ancient ecosystems. So have fishermen, who have begun to target seamounts—extinct submarine volcanoes whose rocky slopes and nutrient-rich currents provide the rare combination of foundation and food that deep-sea corals need to grow.

Like old-growth forests, deep-sea coral communities may persist for hundreds of years and, scientists fear, may be slow to recover from disruption. Once damaged, they may disappear, along with the rich ecosystems they have sustained over long reaches of time.

“Conservation concerns have added urgency to our research,” said Lauren Mullineaux, senior scientist in the Biology Department. “Closures of many shallow-water fisheries have forced people to fish deeper, so there is increasing pressure on these habitats. We’ve seen trawl tracks on them.”

In 2003 Mullineaux (below, left) and WHOI biologist Susan Mills (below, right) dived in the submersible Alvin and in 2004 used the remotely operated vehicle Hercules. (Alvin’s claw extends to sample a coral, at right.) They took part in an expedition to the New England Seamount Chain off the U.S. Eastern Seaboard to study where and how long the corals live, to catalog the richly diverse animal communities that live with them, and to find out how they reproduce. In particular, they seek to learn how coral larvae disperse through the oceans to settle and reseed coral communities, or to create new colonies. The answer is essential for understanding if deep-sea coral habitats can endure and recover from the threats they now face.

The research was supported by the NOAA Office of Ocean Exploration and the WHOI Ocean Life Institute.
At first glance, it looks like an art project: a spinning Plexiglas box filled with paint. To Claudia Cenedese, the box contains the ocean—but on a miniature scale.

A plastic mound in the center of the box represents a seamount—an extinct submarine volcano—that would span 1,500 kilometers (9,000 miles) in the real ocean. Colored food dyes are injected into the water from different locations on the “seamount” (blue from the bottom, red from the middle, and green from the top). The table rotates as the Earth does. A camera above, rotating in synchrony with the table, photographs the swirling field of small vortices that spin off the seamount. One large, single vortex (green), however, forms above the seamount.

The same basic physical laws that govern geophysical fluid dynamics in the box apply in the real ocean. In this experiment, Cenedese (in blue, above and at right), an associate scientist in the Physical Oceanography Department, and Rachel Bueno de Mesquita, a visiting undergraduate from the University of Rome, explore how seamounts sticking up from the seafloor modify ocean circulation and create organized, rather than random, patterns of vorticity. Such experiments reveal subtle complexities of ocean circulation. They also help explain, for example, how larvae of animals living on seamounts might spin out to colonize new seafloor regions (as indicated by blue or purple dyes), or alternatively, spin endlessly around the seamount and become trapped in one region (as indicated by the green dye).

Theoreticians create mathematical equations with all the interacting variables that go into complex geophysical fluid dynamics. Observationalists go to sea to observe actual ocean dynamics, but can observe only a tiny portion of a wide-scale process. Somewhere in between is Cenedese, an experimentalist, who devises laboratory studies to observe and measure actual fluid dynamics on a small scale.
The Samoan island of Ta’u is a tropical paradise, but Rhea Workman knows it was created by an undersea volcano that is still active. Ta’u’s central volcano was formerly dome-shaped, but one of its sides collapsed in landslides that cast debris all the way onto the seafloor. The landslides left a steep escarpment, which is primed for further catastrophic landslides—and possibly tsunamis—especially if it is disturbed by movements inside the volcano.

Within a volcano’s underlying magma chamber, magma or gas continually surges or subsides, inflating, deflating, and deforming the volcano’s surface. These deformations are usually tiny, but they can be measured to evaluate what’s going on inside the volcano and predict whether it might erupt.

Workman, a graduate student in the WHOI Geology and Geophysics Department, wanted to assess Ta’u’s volcano and landslide hazard potential by measuring the volcano’s subtle motions with Global Positioning Satellite receivers, which can measure ground-motion changes within 1 centimeter. She organized an expedition, conscripting GPS equipment and fellow MIT/WHOI Joint Program students. In 2002, they installed GPS benchmarks (left, red dots on the map) throughout the island and took GPS measurements. In 2004, Workman returned to re-measure the benchmarks, also taking time to explain her research at local schools (above).

Since her return, Workman scrambled to complete and defend her Ph.D. dissertation on March 16. Dr. Workman will now analyze and compare her GPS measurements to see if she can detect telltale ground motion on Ta’u.

This research was supported by a grant from the Robert H. Cole Endowed Ocean Ventures Fund.
The North Atlantic right whale never rebounded from centuries of whaling, and fewer than 350 remain. With the species edging toward extinction, the WHOI Ocean Life Institute mustered scientists from several institutions and with a diverse range of expertise to launch the collaborative Right Whale Research and Conservation Initiative in 2004. The ambitious research plan aims to quickly advance understanding of the critical factors hindering the species’ recovery and to accelerate more effective conservation efforts.

Under one Initiative-sponsored study, for example, WHOI biologist Mark Baumgartner works between Nantucket and Georges Bank to learn essential details about why the whales’ main food (microscopic zooplankton called copepods) aggregate where they do, and how the whales dive and forage. Such fundamental knowledge will provide new insights to devise management strategies that protect critical feeding grounds and help reduce accidental whale deaths caused by ship collisions and fishing gear entanglements.

At left, WHOI biologist Michael Moore steers toward a whale, with Baumgartner poised to use a 9-meter (27-foot) pole to attach a temporary tagging device that records whale movements. Meanwhile, the scientists use instruments to measure salinity, temperature, and other ocean properties and to assess the abundance and location of copepods in the area. The scientists used WHOI’s new coastal research vessel Tioga (background above), which was delivered in 2004.

“Tioga gives us the capability to rapidly respond to right whale sightings,” Baumgartner said. “We can leave the dock early in the morning, zoom out to where the whales are (virtually anywhere in the western Gulf of Maine off the Massachusetts coast), work a full day with the whales, and be back at the dock by evening.”

The vessel and part of the research were funded by donors of WHOI.
Like deep-sea treasure hunters, the oceanographers and engineers began their search with a rough map and a few clues. They sought neither silver nor gold, but hydrothermal vents in the Lau Basin, a previously unexplored area in the southwest Pacific Ocean.

“We knew there were vents, but we had to figure out exactly where,” said Dana Yoerger, one of six WHOI researchers who worked from the research vessel Kilo Moana in September 2004. “Our clues appeared in the form of smoke,” he said of the buoyant plumes of warm, chemical-rich fluids that rise from deep-sea vents and spread a few hundred meters above the seafloor.

The vents offer a potential treasure trove of information about how Earth works, and how deep-sea vent organisms have adapted to thrive in these sunless places, under extreme pressure and intense heat. The processes that shape the Lau Basin are undergoing study through a series of cruises that are part of the Ridge 2000 Program.

High-resolution seafloor and plume maps made by a University of Hawaii group were used to guide surveys by WHOI’s Autonomous Benthic Explorer (ABE). ABE, a free-swimming robot used to locate the vents, flew 10 to 300 meters (33 to 990 feet) above the seafloor on a series of missions at six sites. The robot searched for telltale changes in water temperature and chemistry that signaled the presence of a vent.

In the image shown, at the ABE vent site, the vent spires were about 10 meters (33 feet) tall and located along fissures that crack the volcanic seafloor, allowing hydrothermal fluids to exit. ABE enabled researchers to make detailed bathymetry maps of the site and also collected digital images to document organisms living at the vents.

The cruise was funded by the National Science Foundation Ridge 2000 Program; four WHOI scientists were supported by the Deep Ocean Exploration Institute.

Teamwork for discovering vents on the seafloor

Like many expeditions involving WHOI scientists and engineers, the cruises to the Lau Basin require a multidisciplinary team. Participants on the September 2004 cruise included engineers Dana Yoerger (1), Rod Catanach (2), Al Bradley (3) and Joint Program engineering student Mike Jakuba (4), as well as geologist Dan Fornari (5) and biologist Tim Shank (6). Geochemists Meg Tivey (7) (who will be the Chief Scientist) and Jeff Seewald (8) will participate on the April 2005 return to Lau Basin, which will involve deep-sea exploration with the remotely operated vehicle Jason.
WHOI engineers call them pickup trucks, though these underwater vehicles are a bit sleeker than the typical terrestrial model from Detroit. And these multi-purpose workhorses drive themselves.

Chris von Alt (below right) and colleagues from the WHOI Oceanographic Systems Laboratory have been rolling out new models of Remote Environmental Monitoring Units, or REMUS, since the mid-1990s. New customers for these autonomous underwater vehicles (AUVs) arrive each year with requests for custom-built chassis and features—from Navy personnel who used REMUS to hunt for mines in Iraqi harbors, to urban engineers who use them to examine underground aqueducts for leaks. REMUS can be launched and recovered from small boats (or even torpedo tubes) and equipped with a variety of instruments and sensors to tackle assorted missions.

The newest vehicle is the REMUS 600, designed for dives as deep as 600 meters (1,980 feet) and for long-duration missions, REMUS 600 has enough battery power to range from nearshore areas to the continental shelf break and back. REMUS 600 is equipped with Global Positioning System receivers, and Iridium satellite and WiFi transmitters to allow scientists to track it even on a several-hundred-mile survey.

Senior Engineer Tom Austin (large photo) launched a REMUS 600 from the WHOI dock for a test drive in 2004. This one had a synthetic aperture sonar (white portion of the tube) mounted in its midsection for detailed mapping of the ocean bottom. Engineers such as Fred Jaffre (above right) can swap instruments and preprogrammed flight plans in and out of the AUVs.

Development of the REMUS 600 vehicle was supported by the Office of Naval Research.
Hey traveled in small “dormitory” boats from Tulcea, Romania, where the roads end, to their base station near the Black Sea coast. They cruised along canals and tributaries to find ancient beach sediments and used sonar to map the seafloor near the mouth of the Danube River. On two expeditions funded by the WHOI Coastal Ocean Institute, WHOI geologists Liviu Giosan and Jeff Donnelly teamed with colleagues from Bucharest University to reconstruct the evolution and dynamics of one of the world’s most environmentally and economically important river deltas.

“The Danube delta is like the Everglades,” said Giosan. More than 300 bird species and 45 freshwater fish species live in its labyrinth of marshes, dunes, and channels. At the mouth of the 2,840-kilometer (1,776-mile) river, the delta forms the largest wetland in Europe and has been dredged and altered to create canals and shipping channels.

Giosan and Donnelly are trying to understand how river flow, sediment load, sea level change, and coastal currents combine to form a delta. A first challenge from the new research comes to the traditional view, which holds that rivers carry all the sediment deposited at their mouths. But the research team’s sediment cores, seafloor maps, and theoretical models suggest that the river actually serves as a natural barrier, partly blocking the natural flow of waves and sand along the coast.

Besides the fundamental implications on river delta geology, the results are expected to be important for the management of shipping lanes and coastal water supplies, and for protection of coastal habitat.

This research was supported by the WHOI Coastal Ocean Institute and a WHOI Interdisciplinary and Independent Study Award.
The Applied Ocean Physics and Engineering Department (AOPE) is famous for building instruments, sensors, and vehicles at the forefront of oceanographic research and discovery. The department is also increasingly recognized for scientific advances in ocean physics and interdisciplinary ocean sciences. Our scientific and engineering activities focus on five areas: ocean acoustics, environmental fluid dynamics, submersible vehicles, observing systems and sensors, and engineering services.

Early in 2004, we held a retreat to examine our priorities and directions for the next decade. The retreat reaffirmed the value of the synergy between scientists and engineers within the department and the institution. This synergy will be particularly important in the growing enterprise of oceanographic observatories, which is likely to be a major element of our engineering and research effort in the next decade.

An emerging research area in the Department is computational fluid dynamics, in which ever-faster computers are used to model and predict the complex flows that occur in the ocean at a wide range of scales. Houshuo Jiang is modeling the flow around minute crustaceans called copepods at scales of micrometers. He recently revealed a subtle interaction between “feeding currents” produced by the organisms to gather prey and their upward propulsion, which optimizes their feeding efficiency.

New Assistant Scientist Tom Hsu is modeling the complex interactions of waves and sediment in the surf zone. His models are revealing how changing wave conditions can shape shorelines on time scales from days to years. New Assistant Scientist Ruoying He is modeling currents in the coastal ocean, at scales of 1 to 100 kilometers (1/2 to 60 miles). His recent work in the Gulf of Maine and the Gulf of Mexico is being applied to the prediction of the transport of toxic “red tide” organisms.

Ruoying’s collaborator in red-tide studies, Dennis McGillicuddy, is modeling biological-physical interactions at a variety of scales, extending to basin-scale circulation models. These large-scale modeling studies focus on the role of eddies—some as wide as 150 kilometers (90 miles)—in the vertical redistribution of nutrients, which he has found to be a key link in the productivity of the open ocean. Dennis is now leading a major field study to test his numerical predictions, using two ships to measure the influence of eddies in the North Atlantic during the summers of 2004 and 2005.

Jim Ledwell is collaborating with Dennis in the eddy study, using a tracer to quantify the vertical mixing within the eddies with unprecedented precision. Jim is also working with Research Specialist Gene Terray to measure horizontal mixing in the coastal ocean with airborne light detection and ranging (LIDAR).

—W. Rockwell Geyer, Department Chair

From left, Griff Outlaw, Bob Brown, Rocky Geyer, and Barrie Walden, inspect the mock-up of the 7-ft personnel sphere for the Alvin replacement submersible. With funding from the National Science Foundation, WHOI staff began design work this year on a replacement for the 40-year-old Alvin. The new submersible, due in 2008, will dive deeper, be more maneuverable, and provide better visibility for the pilot and two observers.
Awards & Recognition

**Tom Hurst** received the Excellence Award for highest ranking senior electrical engineering major (transfer student) from the Electrical and Computer Engineering Department, University of Massachusetts, Dartmouth.

Swashzone Process Student Fellows **Catie Lichten** and **Kristie Loncich** both received Sigma Xi gold ribbons for excellence in research they did under the direction of Britt Raubenheimer in 2004.

**Jim Lynch** and **Sandy Williams** have been elected Fellows of the Institute of Electrical and Electronics Engineering. Jim was also named recipient of the Robert W. Morse Chair for Excellence in Oceanography.

**Dennis McGillicuddy** received an American Geophysical Union Editors’ Citation for Excellence in Refereeing 2003 (Journal of Geophysical Research—Oceans).

**Peter Schultz** received the inaugural Ryan C. Schrawder award, established in memory of the late Ryan Schrawder of the Physical Oceanography Department. The award recognizes "an employee who has, after a short period of time, proven himself/herself to be a valuable asset to scientific projects both at sea and ashore in the lab, exhibited the ability to learn quickly, and applied acquired knowledge towards the success of scientific missions."

Clockwise from top left: Jim Edson attaches a tube for an ozone sensor on the Air-Sea Interaction Tower off Martha’s Vineyard; Dennis McGillicuddy deploys a drifter in the Gulf of Maine to study coastal circulation and its impact on transport of toxic plankton blooms; Andy Billings prepares the autonomous benthic explorer (ABE) for deployment; Dick Nowak prepares a temperature control incubator for experiments by postdoc Beatriz Mouriño to determine the ability of the surface layers of the ocean to work as a sink or source for carbon dioxide; Bob Brown, left, and Tito Collasius are at work on Sentry, the next-generation autonomous underwater vehicle.
The Biology Department continued to expand into new research, even while preparations are underway for expansion into two new buildings on the Quissett Campus. Studies continued on whales, microbes, and a variety of organisms between. In pursuit of questions about organisms and their function in the seas, biologists employ a wide range of methods, from traditional sampling to isotope chemistry, molecular genetics to mathematical modeling. This year, we spotlight research into the lives of whole animals, focusing on research of two associate scientists who were awarded tenure in 2004. Both study the persistence and distribution of populations of marine animals, but in very different settings.

Carin Ashjian continued her work on planktonic ecosystems in polar seas, with a cruise to the Beaufort and Chukchi seas in summer, 2004. There she studied population dynamics and distribution of copepods, including rates of reproduction and population exchange between the two seas, as part of the Shelf-Basin Interaction project (www.whoi.edu/science/B/people/cashjian/index.html). She monitors copepods to help estimate how climate change may influence not only their abundance and dispersal, but also the structure of the entire Arctic Ocean ecosystem.

Simon Thorrold studies distribution of larval fish, particularly tropical reef fish. He has developed techniques of measuring small amounts of naturally occurring isotopes in fish ear bones that allow him to trace an adult back to its place of origin. Knowing how far fish travel from their spawning place allows him to estimate rates of dispersal, the degree of connection between isolated populations of a species, and the likelihood of success of marine protected areas in re-establishing populations in depleted areas (www.whoi.edu/science/B/thorroldlab/).

Among the hundreds of projects, other work in the department included: a finding that bone lesions in adult sperm whales are linked to chronic decompression damage; discovery by mathematical modeling that marine protected areas enhance fish catches; and research on the biochemistry and ecology of deep sea organisms including corals on sea mounts and bacteria in deep sediments.

In April, the Woods Hole Center for Oceans and Human Health was established as a partnership between WHOI, the Marine Biological Laboratory, and the Massachusetts Institute of Technology, administered through WHOI with novel joint funding by the National Institute of Environmental Health Sciences (a component of the National Institutes of Health), and the National Science Foundation. One of four such centers nationwide, the Woods Hole Center encompasses research on harmful marine species (e.g., algae that create “red tide” blooms) and human pathogens in coastal waters as influenced by physical and environmental factors as well as population dynamics and genetics, and also studies of possible pharmacologically useful marine biochemicals. The Center also funds small feasibility grants at the member institutions, which allow scientists to do initial research on a topic and determine whether to pursue it.

—John Stegeman, Department Chair
Awards & Recognition

The Scientist magazine ranked the WHOI Biology Department as the second most cited organization in the U.S. in the field of pharmacology and toxicology.

Don Anderson was listed in ISIHighlyCited.com, in recognition of the high number of citations of his scientific papers.

Darlene Ketten was keynote speaker and featured scientist at the Australian Ministry of the Environment in Sydney, Australia.

Larry Madin and John Stegeman addressed the United Nations Law of the Sea conference respectively on, seamounts and deep coral beds and developing marine genetic resources.

Michael Moore received the Cape Cod Stranding Network Outstanding Service Award.

Lauren Mullineaux received the first WHOI Arnold B. Arons Award for Excellence in Teaching, Advising and Mentoring.

Mike Neubert was elected Chairman, Theoretical Ecology Section, Ecological Society of America.

John Stegeman was appointed Chair of the Institute of Medicine Committee on Health Effects of Agent Orange in Vietnam Veterans. He also gave a keynote address at the European Society for Comparative Physiology and Biochemistry, Alessandria, Italy.

Simon Thorrold was keynote speaker at the Third International Symposium on Fish Otolith Research and Application, Townsville, Australia.

Tim Shank received the Ocean Explorers Award from NOAA in recognizing of his research and outreach efforts regarding the evolution of deep-sea communities and species on the Galápagos Rift, seamounts, and polar ridge.

Clockwise from top: Joint Program student Regina Campbell-Malone steadies a right whale jaw bone during a 3-D laser scan (This bone, recovered from a whale hit by a ship off Virginia, will be used to study the material properties of whale bones and develop speed restriction recommendations for ships.); Joint Program student Kristen Whalen studies a sea slug that feeds on a chemically-defended sea fan, which then uses the sea fan’s noxious compounds for its own defense; Chad Klinesteker (U.S. Coast Guard), Bob Campbell (University of Rhode Island), and Phil Alatalo deploy a net to capture copepods during Carin Ashjian’s cruise to study the Arctic food web.
The Geology and Geophysics Department focuses on understanding how our Earth works by investigating the dynamics of convection in the mantle, the geologic structure and tectonics of the ocean basins, interactions of continental and oceanic geologic processes, the history of ocean circulation patterns and climate change, and the interactions between geological and biological systems.

In 2004, the G&G Department comprised 97 staff and 28 postdoctoral and Joint Program students who were involved in 268 research projects. Bob Detrick stepped down as Chair in 2004 and was succeeded by Susan Humphris. During Bob’s term, G&G began building a coastal processes group by hiring three assistant scientists, while simultaneously strengthening and diversifying the geophysics, geochemistry, and paleoceanography groups. In 2004, two new assistant scientists were appointed. Sarah Das is a glaciologist with an interest in the factors that cause surface melting on ice sheets, and in understanding the dynamics of ice sheets. Mark Behn, a 2002 graduate of the Joint Program, is a geophysicist who integrates field observations with numerical modeling to understand a broad range of magmatic and tectonic processes.

G&G staff and students traveled far and wide in 2004 collecting data and samples. Some conducted fieldwork on land, collecting volcanic gases from Nicaragua and Sicily; studying the volcanology of Tá’u Island, Samoa; conducting geophysical surveys across South Africa; and investigating the geology and tectonics of the western Sichuan basin, east of the Tibetan plateau. Others worked near shore at the interface between land and sea, along the east coast of the U.S. and in the Danube and Indus river deltas. Still others led or participated in research cruises to the East Pacific Rise, the Mid-Atlantic Ridge, the western north Atlantic, the Gulf of Mexico, the Panama Basin, and the Lau back-arc spreading center west of Tonga (see page 17).

This year, the capabilities of the WHOI Seafloor Sampling Laboratory (above) were greatly enhanced when Liviu Giosan, Jeff Donnelly, and Rindy Ostermann received funding for the acquisition of a core scanner. The first of its kind in the U.S., this instrument allows rapid, nondestructive, ultra-high resolution measurements of the chemical composition and density structure of sediment cores and other geologic materials. One of the major uses of this instrument will be in detecting chemical changes in sediment cores at an annual to millennial resolution that can be linked to environmental and climatic changes.

Science highlights of 2004 included significant advances in earthquake research made by two groups. Jeff McGuire and graduate student Margaret Boettcher, together with a colleague from the University of Southern California, applied a mathematical model to a database of earthquakes on the East Pacific Rise and demonstrated that the largest earthquakes are preceded by abundant foreshocks, thus indicating a significant amount of predictability. This work, published in Nature, represents an important breakthrough in earthquake predictability studies. In addition, Jian Lin, Debbie Smith, and graduate student Trish Gregg investigated a several year record of earthquakes along the Siqueiros Transform Fault in the eastern Pacific and showed that an earthquake in one area can transfer stress and trigger an earthquake nearby. Both studies emphasized the need for a better understanding of these oceanic faults, and suggest that at least some earthquakes might be predictable.

—Susan Humphris, Department Chair
Awards & Recognition

Susumu Honjo received the 2003 Medal of the Imperial Order of the Rising Sun for his research on the transfer of carbon dioxide from the atmosphere to the ocean’s interior and for his efforts to strengthen Japan’s role in the international ocean science research community.

Lloyd Keigwin was recipient of the 2004 Edna McConnell Clark Chair for Excellence in Oceanography.

Dan McCorkle was awarded the position of J. Seward Johnson Chair/Educational Coordinator.

Clockwise from top left: Research Assistant Jess Tierney runs the new X-ray fluorescence spectrometry core scanner, which allows detailed imaging and elemental analysis of sediment cores; Assistant Scientist Sarah Das works on the Greenland Ice Sheet with an ice core used to determine changes in ice sheet conditions over the past few centuries; a new addition to McLean Laboratory expands the sample preparation lab for radiocarbon-dating at the National Ocean Sciences Accelerator Mass Spectrometry Facility. The addition also houses a newly designed gas-accepting accelerator, the first of its kind.
Scientists in the Marine Chemistry and Geochemistry (MCG) Department were extremely active in 2004 analyzing the chemical composition of the ocean and its constituent sediments, rocks, and biota. While laboratory studies, modeling, and remote sensing of the ocean all are important to many of our staff, what stands out in 2004 was the wide range and number of field programs.

Jeff Seewald, Katrina Edwards, and Wolfgang Bach conducted research cruises to undersea hot spots in the Pacific, where chemical and microbiological transformations at high temperature and pressure take place in and around underwater volcanic systems. Such sites are accessible several miles below the surface only by remote samplers and submersibles that take measurements and collect samples for analyses.

At the ocean surface, MCG scientists studied processes in waters off Bermuda. Ed Sholkovitz measured chemical input to the surface ocean on a novel buoy-mounted aerosol sampler, catching dust as it falls on the waters off Bermuda. Bill Jenkins made monthly measurements of dissolved gases in the ocean, to understand ocean productivity and the physical processes that mix water to depth.

Bill Jenkins and Ken Buesseler also joined an interdisciplinary team of scientists from three WHOI departments to look at ocean eddies off Bermuda, which alter the local physical conditions and induce plankton blooms that change chemical conditions as they move through the ocean.

Bermuda and the wider Sargasso Sea also attracted the attention of Jim Moffett and his group for studies of very rare metal compounds required for phytoplankton growth. In a related study in the Pacific, Jim and other U.S. scientists made detailed comparisons of the analytical methods they use to measure minute traces of iron in seawater.

Notable in 2004 was the launch of VERTIGO, an international and interdisciplinary study of ocean particles in the “twilight zone,” depths below about 100 meters, where sinking particles are either consumed by bacteria and zooplankton, or settle to the bottom. It is a region of interest to many on our staff (Ken Buesseler, Dave Glover, Karen Casciotti, Benjamin Van Mooy, and Tim Eglinton).

Scientists in MCG also worked close to home. Bill Martin studied marine sediments and their fluids in local waters, Matt Charette studied how ground water flows from the Cape into Waquoit Bay, and Nelson Frew investigated the chemical exchange of gases across the ocean surface. Bernhard Peucker-Ehrenbrink and Chris Reddy examined riverine systems in the Hudson River and Gulf of Maine, respectively, while a bit further from home, Dan Repeta studied coastal systems of Chesapeake Bay and Jean Whelan worked on Saanich Inlet, Washington.

Our scientists recover samples that require chemical analyses with cutting-edge analytical facilities at WHOI, including mass spectrometers (above), gas chromatographs, spectrophotometers, low-level radiation detectors, and other instruments, to tease out the chemical composition.

What does all this traveling and chemical analysis mean for the advancement of ocean sciences? Without direct measurements of chemical distributions and transformations in the oceans, we’d be studying the oceans with our eyes closed. MCG scientists work diligently in the field and lab, make models of ocean processes, and open our eyes with chemical analyses that help us better see how this ocean planet works.

—Ken Buesseler, Department Chair
Awards & Recognition

**Larry Ball** received the Al Vine Senior Technical Staff award in recognition of his outstanding technical accomplishments and management of the Inductively Coupled Plasma-Mass Spectrometer facility.

**Scott Doney** was selected as a 2004 Aldo Leopold Leadership Fellow, for excellence in modeling of ocean biogeochemistry. This award recognizes interdisciplinary environmental research and encourages scientists to communicate their results to policy makers, the media, and the public.

**Jim Moffett** received the Mary Sears Chair for Excellence in Oceanography, in recognition of his research in understanding chemical transformation of trace metals in natural waters.

**Chris Reddy** was awarded a WHOI Coastal Ocean Institute Fellowship, in recognition of his research on the sources, transport, and fate of organic contaminants in the ocean.

**Meg Tivey** was named the RIDGE 2000 Distinguished Lecturer for 2003–04, an honor that involved traveling the U.S. giving lectures on seafloor hydrothermal systems. Meg also received the J. Seward Johnson Chair as MCG education coordinator.

MIT/WHOI Joint Program students **Desiree Plata, James Saenz, Kristen Smith, and Jacob Waldbauer** received National Science Foundation Graduate Research Fellowships. Waldbauer was also awarded a National Defense Science and Engineering Graduate Fellowship. These fellowships encourage U.S. students to pursue careers in science and engineering.

Clockwise from top left: Nelson Frew, Leah Houghton, and Nick Witzell (AOPE) launch the Slick Chemical Identification and Measurement System from Tioga for air-sea interface studies; Chris Reddy, left, and Liz Kujawinski sectioning a multicore from the Columbia River margin; from left, Steve Manganini, Devin Ruddick, Jim Valdes, and Ken Bueseler celebrate success upon recovering the seventh and final instrument array for a study of how materials move from the surface to the deep ocean, hitchhiking on sinking particles; Carl Johnson works in the nuclear magnetic resonance facility.
Research in the Physical Oceanography Department centers on the description and understanding of the evolving state of the ocean and its interaction with the atmosphere and Earth. While we have traditionally identified ourselves with making observations at sea, our scientists also make important contributions to numerical modeling, theory, laboratory experimentation, and instrument development.

The last year, once again, has been a busy one at sea. Bob Pickart completed the field phases of two programs, his study of deep convection in the Irminger Sea off the east coast of Greenland and his investigation of the stability of the inflowing Pacific water current along the south coast of the Beaufort Sea. Nearby, Andrey Proshutinsky expanded his array of moored profilers and current meters in the Beaufort Gyre. Across the Pacific, off Japan, Nelson Hogg and Steve Jayne began their study of the Kuroshio Extension Current by installing an array of moored profilers stretching 500 kilometers (300 miles) across the current. Also in 2004, John Toole and colleagues here and in the U.K. began a multi-year Station W program to investigate interannual variations of the poleward flowing Gulf Stream and equatorward flow beneath. A related effort undertaken by Terry Joyce was a hydrographic section from Cape Cod to Bermuda. In addition, Fiamma Straneo installed a mooring in the Hudson Strait to measure freshwater efflux. Surface moorings that measure air-sea fluxes were replaced in the Atlantic (Al Plueddemann) and the Pacific (Bob Weller), and a third air-sea flux site was established off Hawaii. The intent of this program is to provide accurate fluxes in order to ground truth those obtained indirectly, particularly by satellites.

This year we also put some new technology to its first scientific use. The maiden “flight” of an undersea autonomous glider, Spray, was carried out in November from south of Cape Cod to Bermuda under the direction of Breck Owens and colleagues at Scripps Institution of Oceanography. During its seasaw flight, it collected temperature and salinity data from the surface to a depth of 1,000 meters (3,300 feet), thus duplicating what could be done from a ship but more quickly and at lower cost. A new mooring system, called Ultramoor, was installed at Bob Pickart’s Irminger Sea site. It has been developed by Dan Frye, Nelson Hogg, and others and has the goals of lasting five years and sending data back to shore through the periodic release of data-containing capsules, which send their recorded data back to the lab via satellite. The first capsule was released and the data recovered on schedule Thanksgiving Day.

Continuing our expanding interest in the Arctic, Peter Winsor joined the staff as assistant scientist early in the year. Peter’s interests focus on Arctic oceanography and he has talents in seagoing observation, data interpretation, and numerical modeling.

Before his appointment to the scientific staff Peter had been a postdoctoral scholar working with Dave Chapman. It is with great sorrow that I report that Dave lost his fight with cancer during the summer. Funds are being solicited for a memorial and to endow a lecture series on coastal oceanography. In a tragic motorcycle accident, the department also lost a talented young seagoing technician, Ryan Schrawder. A fund has also been established in his name to make an annual award to a similarly skilled employee at the institution’s annual employee recognition ceremony.

—Nelson Hogg, Department Chair
Awards & Recognition

Ken Brink was named Chief Scientist for Ocean Research Interactive Observatory Networks (ORION) in Washington DC, splitting his time between Woods Hole and Washington.

Nan Galbraith won the Linda Morse-Porteous Award, established to recognize a female technician for her leadership, dedication to and quality of work, abilities as a role model and/or mentor for junior women, and involvement in the WHOI community.

Karl Helfrich was reappointed to a second term as the J. Seward Johnson Chair/Educational Coordinator for the Physical Oceanography Department.

John M. Toole was elected an American Geophysical Union Fellow.

Bruce Warren received the Ewing Medal from the American Geophysical Union for "contributions to the understanding of the general circulation of the ocean, including water mass formation by sea-air interaction, deep and surface boundary currents and interior flow, planetary waves, and the impact of global integral momentum constraints on ocean circulation."

Clockwise from top left: the high-resolution profiler, which measures a variety of physical properties over a wide range of scales, is prepared for sea trials off Long Island, New York; Bob Pickart recovers a sampling device in a remarkably ice-free Beaufort Sea in September; Jim Ryder deploys Fiamma Straneo’s mooring to measure the freshwater flow through Hudson Strait, an important component of climate studies; a mooring is launched during Nelson Hogg’s and Steve Jayne’s study of the Kuroshio Extension Current off Japan; Breck Owens, aboard the Bermuda Biological Station’s R/V Henry Stommel, shuts the Spray glider down after its first successful crossing of the Gulf Stream.
Close interactivity between research and higher education and the exposure of students and postdocs to theoretical, experimental, and observational ocean sciences and engineering are at the heart of WHOI’s Academic Programs. External assessments provide us with one indication of the success of our efforts.

A nationwide survey of postdoctoral programs conducted by The Scientist magazine ranked the WHOI postdoctoral program among the top ten nationwide. The contents of the review have provided insights into where our program is on track and the few aspects in need of improvement.

An External Review Committee for the MIT-WHOI Joint Program in Oceanography and Applied Ocean Sciences and Engineering visited both MIT and WHOI in June. As with the previous two external reviews in 1989 and 1998, the comments on the overall quality of the program were laudatory: “The MIT/WHOI Joint Program remains a (if not the) top educational program covering all the marine sciences and engineering.” The report also suggested several areas for continuing innovation and improvement.

Thirty-one new students enrolled in the Joint Program, and the total fall 2004 enrollment was 139. The program awarded 15 Ph.Ds and 4 S.M degrees. The Joint Program Alumni/ae Association continues to be supportive of the Joint Program by offering advice to current students, providing evaluation of the Joint Program graduate education efforts, and contributing financial support for student research and career activities.

We were saddened by the loss of first-year graduate student Celeste Fowler (left), to metastatic melanoma. To honor her memory and love of photography, a Celeste Fowler Memorial Art Show was planned for January of 2005 and will become an annual event showcasing the diverse artistic talents of our graduate students.

The Summer Student Fellow and Minority Fellows Programs for undergraduates enjoyed another successful summer with 32 students from 27 universities and colleges involved in the summer-long research experience. This was the inaugural summer of an at-sea practicum for fellows in the use of coastal ocean sampling and measurement instruments aboard the new coastal research vessel Tioga (above).

In collaboration with partners in the Woods Hole scientific organizations, we led an effort to draft an memorandum of understanding signed in July by the presidents/directors of these organizations to undertake a collaborative diversity initiative that offers pathways of increased opportunity in sciences and engineering.

Our partnership with New England Aquarium and the University of Massachusetts in the NSF funded New England Center for Ocean Science Education Excellence (COSEE) continued for the second year in K-12 formal and informal education activities along with the twice-yearly teacher workshops that are highly acclaimed by participating teachers.

I will step aside during 2005 after fifteen years as dean. I have been honored to be associated with WHOI’s Academic Programs and the superb group of students, postdocs, faculty, and staff involved in these activities.

—John W. Farrington
Vice President for Academic Affairs and Dean
The Coastal Ocean Institute and Rinehart Coastal Research Center promote scientific inquiry into the phenomena that shape our coastal waters and ecosystems, encouraging innovative, interdisciplinary research and high-risk technology development. We also strive to translate the results of this basic research for citizens and policymakers, while providing a solid information base for resource managers.

In July, Don Anderson became the director of COI and RCRC, succeeding Ken Brink. Don is a biologist who conducts research on toxic and harmful blooms of algae, commonly called “red tides.”

In addition to six research projects initiated in 2004 (see map below), we undertook a wide range of activities to promote and communicate coastal research. In April, our Short Course and Workshop on Coastal Change drew 70 individuals, including federal and state agency representatives, students, and researchers. In September, the Moving Shoreline Forum generated lively debate with trustees and guests, and culminated in a science plan for an initiative on this topic. Bruce Peterson, of the Marine Biological Laboratory, gave a seminar on carbon and nutrient flux in the coastal oceans, and Richard Jahnke, of the Skidaway Institute of Oceanography, gave a seminar on continental margin processes in marine biogeochemical cycles.

We provided support for three postdocs this year. Rubao Ji is studying processes that control phytoplankton blooms on Georges Bank. Kevin Kroeger is studying nitrogen in groundwater at the interface of land and sea to better understand groundwater input to coastal pollution. Tom Hsu is modeling sediment transport in nearshore waters. We initiated support for two new COI Fellows, Jeff Donnelly, a geologist (jointly sponsored with the Ocean and Climate Change Institute), and Chris Reddy, an organic chemist. Jeff specializes in climate change recorded in sediments, and Chris studies the source, transport, and fate of organic compounds in seawater.

We continue to support John Trowbridge, who is taking a leadership role in guiding work at the Martha’s Vineyard Coastal Observatory, and Heidi Sosik (jointly with the Ocean Life Institute), who works on phytoplankton ecology and biooptics.

—Don Anderson, Institute Director

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**2004 COI Research Project Locations**

**Influence of Tidal Pumping on Denitrification in Waquoit Bay Sediments**

*Waquoit Bay, MA:* Joint Program student Emilie Slaby and advisors Dan McCorkle (G&G) and Harry Hemond (MIT) are studying how the mixing of fresh and salty water in nearshore sediments influences the removal of nitrogen from groundwater, a large and often underestimated component of nutrient flux to the coastal ocean.

**Developing a Coastal Groundwater Observatory**

*Waquoit Bay, MA:* Matt Charette (MCG) and Ann Mulligan (MPC) are establishing an observatory to improve understanding of how tidal and seasonal changes in subsurface flow and chemistry control the flux of land-derived nutrients into estuaries.

**Reconstructing Hurricane History**

*Cayman Islands:* COI rapid-response funding allowed Jeff Donnelly (G&G) to study inundation of coastal ponds and wetlands with sand overwash when Hurricane Ivan struck the Cayman Islands, part of a larger effort to reconstruct the hurricane history from bands of sand found in cores dating back several millennia.

**Airborne LIDAR Mapping of Dispersion and Mixing in the Coastal Ocean**

*East Florida Shelf:* Jim Ledwell and Gene Terray (AOPE) are testing airborne light detection and ranging (LIDAR) to more accurately measure dispersion and mixing in the coastal ocean.

**Heat as a Proxy Tracer for Gases in Air-Sea Exchange**

*Heidelberg, Germany:* Nelson Frew (MCG) is determining whether measurements of heat emitted from the oceans can improve estimates of the exchange of oxygen and carbon dioxide at the air-sea interface.

**The Economics of U.S. Shoreline Change**

*Cape Cod & Florida Panhandle:* Porter Hoagland, Di Jin, Hauke Kite-Powell (MPC), and Rob Evans (GG) are developing annual estimates of the economic consequences of shoreline change regionally and nationally, a final step in the establishment of programs in shoreline change.

**Dissolved Organic Carbon (DOC) Cycling in the Coastal Ocean**

*Plum Island, MA:* Dan Repeta and Ben Van Mooy (MCG) are studying the little-known fate of DOC that rivers carry to the sea.
The Deep Ocean Exploration Institute (DOEI) promotes interdisciplinary investigations of planetary processes occurring in the deep ocean and within Earth's interior. These processes help to regulate the chemistry of its ocean, determine the nature of magmatic activity observed on our planet's surface, and impact microbiological, chemical, and geological processes that shape the planet and affect its inhabitants.

The development of technology that provides access to the seafloor is also a key component of the Institute's activities. To support these pursuits, in 2004 we funded six new projects within the Institute's ongoing themes of Seafloor Observatory Science and Instrumentation, Fluid Flow in Geologic Systems, and Earth's Deep Biosphere (see map below).

The Institute currently supports three scientists as research fellows. Wolfgang Bach (MCG) studies the relationship between chemical and microbiological processes occurring within oceanic rocks. Greg Hirth (G&G) uses his understanding of rock mechanics to study geological and chemical processes that occur deep below the planet's surface. Stan Hart (G&G) studies the evolution of Earth's interior by using chemical clues from magma erupted from oceanic volcanoes as a window into the mantle. As a fellow, he is spearheading a broad, multidisciplinary study of Vailulu'u, a 4,333-meter (14,300-foot), active submarine volcano in the Pacific Ocean east of Samoa.

In March, the Institute concluded a seminar series for national and international scientists focused on microbes in the deep biosphere. Processes that allow bacteria, protozoa, and other tiny organisms to live in the harsh environment of the seafloor were also the subject of an October workshop, co-sponsored with WHOI's Ocean Life Institute.

In the spring, DOEI supported the presentation of the eighth expedition of Dive and Discover™, an online science learning adventure developed at WHOI. The Website received more than 30,000 visitors during the 17-day cruise from people reading posted stories, viewing photos and videos, and interacting with researchers diving in the submarine Alvin as they explored hydrothermal vents offshore Oregon and Washington.

After four years as director of DOEI, Susan Humphris stepped down in May to become Chair of WHOI's Geology and Geophysics Department. She guided the Institute during its formative years, nurturing innovative and exciting deep-ocean research. I look forward to continuing her legacy.

—Dan Fornari, Institute Director

### 2004 DOEI Research Project Locations

**Monitoring Rumbles from the Seafloor**
North Pacific Ocean: Ralph Stephen (G&G) and John Colosi (AOPE) are using sensors placed on and near the seafloor to record and observe undersea earthquake activity.

**Researching Iron in Hydrothermal Vent Processes**
Manus Basin: Olivier Rouxel (MCG) and Wolfgang Bach (MCG) are analyzing the role that the heavy metal iron plays in hydrothermal vent chemical and microbiological processes.

**Learning How Life Survives in Harsh Places**
Lau Basin: Jeffrey Seewald (MCG) and postdoctoral student Giora Proskurowski (MCG) will be collecting and analyzing gases, fluids, and sulfide deposits from hydrothermal vents in the Lau Basin to understand how organisms use chemicals to survive at deep-sea vents.

**Using Lasers to Map Hydrothermal Plumes in the Deep Sea**
Mid-Atlantic Ridge: Robert Reves-Sohn (G&G) and Albert Bradley (AOPE) are creating a laser mapping system that will improve researchers' ability to find and make images of deep-sea hydrothermal plumes so that new seafloor vents can be discovered.

**Testing a Drill Hole Microbiological Sampler**
Vineyard Sound: Craig Taylor (Bio) is testing a microbiological sampling device to be used in deep ocean drill holes that will allow researchers to collect uncontaminated borehole fluids. This will help in the study of the deep-ocean biosphere in the Earth's crust.

**Developing Better Ways to Collect Living Organisms**
Galápagos Rift: Joan Bernhard (G&G) and Tim Shank (Bio) are developing samplers that better preserve and protect organisms gathered at hydrothermal vents for microbiological and genetic research.

### 2004 DOEI Research Project Locations

Dan Fornari, right, took the helm from first DOEI Director Susan Humphris in 2004.
Pursuing greater understanding of the ocean’s role in climate change, the Ocean and Climate Change Institute (OCCI) launched support for several new research projects, two OCCI fellows, and a postdoctoral scholar. The Institute also provided continued support for two fellows, a postdoctoral scholar, and an MIT/WHOI graduate student.

New research projects include the first culture-based calibration of the deep-sea benthic foraminiferal chemistry used to estimate deep-water temperatures; a study focusing on the influence of ocean surface water temperature on the global air-sea flux of CO₂; the application of control theory to understand how the behavior of the atmosphere can be controlled by sea-surface temperatures; an evaluation of the magnitudes of the buoyancy changes due to changes in heat and freshwater at the surface of the North Atlantic; examination of the sedimentary distribution of protactinium and thorium (uranium radiometric decay products) to measure deep ocean circulation; and the development of DNA extraction techniques to study the historical migration of deep-sea corals from the northwest Atlantic.

OCCI also funded several projects to establish or enhance Atlantic and Arctic Ocean observing systems. They include measurement of the freshwater flux through Hudson Strait; support of equipment and operations to continue data collection at the Beaufort Gyre observing system; development of an observing array off southeast Greenland; modification of an autonomous underwater vehicles for navigation beneath Arctic sea ice; and new measurements to reveal the changes of strength and structure of the Gulf Stream. In addition, OCCI funded the purchase and deployment of a meteorological buoy in the Irminger Sea, and the Institute supported recovery and redeployment of a sediment trap system in the Iceland Sea.

OCCI supported Scott Doney (MCG) in his second year as a fellow and awarded two new fellowships in 2004 to Bernadette Sloyan (PO) and Jeff Donnelly (G&G). Bernadette works to improve our understanding of the Southern Ocean and its effects on the global meridional overturning circulation. Jeff examines natural archives of Holocene and Pleistocene environmental change using an interdisciplinary approach, combining the disciplines of sedimentology and stratigraphy, geomorphology, paleoecology, paleoclimatology, and oceanography. His fellowship is jointly supported with the Coastal Ocean Institute.

A new postdoctoral scholarship was awarded to William Thompson, who studies climate and sea level history. During his time at WHOI he will use radiometric dating of uplifted coral reefs in Barbados to identify rapid changes in sea level that occurred when glaciers melted.

—William Curry, Institute Director
The Ocean Life Institute (OLI) seeks to foster novel and interdisciplinary research on organisms and ecosystems in the oceans, providing a scientific basis for marine conservation. The ocean is the origin and major repository of biological diversity, and life processes in its waters affect everything else on Earth. Working under three broad themes—Discover Life, Sustain Ecosystems, and Develop Tools—OLI stimulates and supports research on subjects ranging from microbes to whales, Antarctic birds to tropical fish, and mangroves to deep-sea corals. Often discovery and explanation depend on new techniques and instruments, and OLI supports development of novel hardware for the ocean and new theoretical methods for data analysis and prediction.

In 2004, OLI supported three Institute Fellows. Cabell Davis is working on ways to merge holographic imaging and DNA recognition with autonomous vehicles to create a new breed of automated plankton survey instruments that can cruise independently and record detailed information on species distributions. Heidi Sosik, supported jointly with the Coastal Ocean Institute, is using remote sensing, in-situ instruments, and physical oceanography to help understand the dynamics of phytoplankton blooms in the coastal ocean (see map below). Mike Neubert develops innovative mathematical models that will help predict the effects of marine reserves on fisheries production. Five new research grants were awarded to WHOI researchers in 2004, adding to those still in progress.

Communication of research results and applications is an important Ocean Institute function. During the year, the Institute hosted the third meeting in the series “Fisheries, Oceanography and Society”, on deep-sea fisheries, co-sponsored with the New England Aquarium. An even deeper subject was the workshop co-sponsored with the Deep Ocean Exploration Institute on the recently discovered communities of microbes living within the Earth’s crust beneath the ocean. An OLI workshop on the demographics of albatross species brought together world experts to analyze the risk of extinction to these increasingly threatened oceanic birds.

OLI has also developed larger research initiatives focused on particular problems in marine ecology or conservation. The Right Whale Research and Conservation Initiative was launched with projects on population genetics and effects of ship collisions. A new initiative on coral reef fishes in the Caribbean will investigate the dispersal and survival of threatened species like groupers. Other research in tropical environments is based at the Liquid Jungle Laboratory in Panama, where OLI has helped develop a modern field station in a pristine tropical environment. It promises to offer many new opportunities for WHOI scientists of all disciplines.

—Laurence Madin, Institute Director
The Marine Policy Center (MPC) conducts social scientific research that integrates economics, policy analysis, and law with the Institution’s basic research in ocean sciences. Areas of recent research include nutrient pollution of coastal waters, the economics of ocean observing systems, offshore wind power, biological conservation, and international fisheries management.

Nutrient pollution is one of the chief causes of environmental problems in coastal ecosystems. Reducing inputs from the sources of excess nutrients—fertilizers, sewage disposal, and fossil fuel burning—generally requires costly and difficult technological and behavioral change. In some cases, it may be equally effective and less costly to mitigate the effects of nutrients after they have entered the water. Researchers at MPC are investigating one simple and inexpensive approach: the use of shellfish aquaculture to reduce nutrients and improve water quality in coastal areas.

Several lines of evidence suggest this approach could work. First, shellfish sequester nutrients such as nitrogen in body tissues, so harvesting them can remove a substantial amount from coastal waters. Second, their tendency to eat large amounts of phytoplankton may reduce the likelihood of algal blooms under conditions of increased nutrient enrichment. Third, the presence of shellfish biodeposits (feces and undigested organic matter) in sediments may increase the rate at which nitrogen is converted to a form that diffuses to the atmosphere. This process, known as denitrification, may be an even more potent tool for nitrogen removal than shellfish harvesting.

Using data from previous studies, MPC Research Specialist Hauke Kite-Powell and colleagues are developing a biogeochemical model of nitrogen flows and nitrogen removal via shellfish cultivation. The model will be verified using data collected at an experimental site in Waquoit Bay, MA. In addition to monitoring sediments for rates of denitrification and monitoring shellfish for rates of survival, growth, and nitrogen uptake, the research team is conducting experiments to assess the effectiveness of on-bottom and off-bottom shellfish cultivation techniques. Their goal is to produce a practical, bio-economic model that can be used to evaluate alternative management scenarios for a range of coastal water bodies.

Kite-Powell also led a project that analyzed the potential economic benefits of improved coastal ocean observing systems around the United States, for which he received the Award for Excellence in Partnering from the National Ocean Partnership Program. In another recently completed project, MPC and Switzer Foundation Fellow Elena McCarthy addressed the growing controversy over the suspected links between human-generated ocean noise and marine mammal strandings and deaths. Her book, *International Regulation of Underwater Sound*, considers how the problem can be addressed in spite of the lack of a regulatory structure and the considerable scientific uncertainty that surrounds it.

MPC researchers are also addressing the much-publicized problems of deep-sea fisheries, where catches have increased steeply over the last two decades. Deep-sea species are especially vulnerable to rapid depletion from over-fishing because of their long lifespans, slow growth rates, and low fecundity. The ecosystems they inhabit suffer collateral damage as well from the bottom-trawling that destroys complex seafloor communities. Although the status of most deep-sea areas remains unknown, many are calling for the conservation of deep-sea biological communities and a moratorium on bottom trawling in international waters.

MPC is contributing legal, regulatory, and economic analysis to the ongoing international debate on deep-sea fisheries. Research Specialist Porter Hoagland and Research Assistant Mary Schumacher prepared a synopsis of the unprotected and largely unregulated status of deep-sea fisheries under relevant international law; it appears in the recently published book *Defying Ocean’s End*. Hoagland has also developed an economic analysis that highlights how the biological characteristics of deep-sea species, the “open access” nature of high seas resources, the threat of impending regulation, and the promise of increased scientific exploration, among other factors, combine to favor more fishing in the near term over more fish in the future. In light of the structural obstacles and weak management record of international fisheries organizations, this analysis suggests that consumer awareness and action may be especially important for deep-sea conservation.

—Andy Solow, Director
The Woods Hole Sea Grant Program is part of NOAA’s national Sea Grant network of 32 programs; collectively, Sea Grant promotes cooperation among government, academia, industry, scientists, and the private sector.

Woods Hole Sea Grant’s annual budget of approximately $1 million supports research projects in environmental technology, estuarine and coastal processes, and fisheries and aquaculture. In addition, Sea Grant funds smaller, “new initiative” grants to encourage Sea Grant research addressing local and regional needs, and many projects have national or even global implications. Projects in 2004 include:

- Lobster and squid population structures, comparing offshore and near-shore populations, and potential fisheries management impacts;
- Environmental contaminants and their effects on marine invertebrates, mammals, and fish;
- Application of fiber-optic technology as a way to detect and count harmful algal cells in the marine environment;
- Atmospheric deposition as a source of nitrogen pollution, measuring vehicle emissions around Cape Cod embayments;
- Development of an autonomous, multi-scale digital imaging system to identify and map distributional patterns of aquatic plankton, micronekton, and nekton;
- Effects of long-term bioaccumulation of oil—from the 1969 grounding of a barge carrying No. 2 fuel oil—on salt marsh biota;
- Groundwater as a transport mechanism for nutrients and contaminants flowing into estuarine systems;
- Metal accumulation in sediments as a result of Boston Harbor sewage discharge;
- Larval dispersal in pelagic fish, using fish otoliths (ear bones) as natural tags to reconstruct temperature histories and seawater chemistry;
- Screening sediments, water, algae, and invertebrates to determine the environmental source of QPX (a parasite affecting hard clams);
- Development of a pattern recognition system to classify benthic habitats and identify flora and fauna.

In addition to research, Woods Hole Sea Grant supports a marine extension program and an outreach/education program. Through those efforts, research is transmitted to a variety of audiences through publications, Web sites, workshops, and lectures. Many Sea Grant outreach programs involve partnerships, such as with the Barnstable County Cooperative Extension Service, to provide technical expertise and demonstration projects on shellfish aquaculture and coastal processes.

A partnership with the Waquoit Bay National Estuarine Research Reserve and the Massachusetts Coastal Zone Management Program provides research-based training to coastal policymakers (www.coastaltraining.org). In the ocean science education field, Woods Hole Sea Grant has partnered with colleagues at New Hampshire Sea Grant to provide marine career information to students (www.marinecareers.net), and with WHOI Academic Programs and the Exhibit Center to provide teacher workshops featuring the latest WHOI research, technology, and instrumentation developments.

Woods Hole Sea Grant is also participating in a WHOI effort to promote effective research-outreach partnerships.

—Judith E. McDowell, Director
The Cooperative Institute for Climate and Ocean Research (CICOR) coordinates and fosters interaction between WHOI and the National Oceanic and Atmospheric Administration (NOAA). CICOR administers NOAA-funded research, builds ties between researchers at WHOI and NOAA, and conducts education and outreach activities. The Institute is one of 13 national cooperative institutes.

CICOR’s research themes focus on climate, marine ecosystems, and coastal research. The center supported 50 projects in 2004, including 16 new projects totaling more than $6 million in funding. Since its inception in 2001, CICOR has supported 61 research projects, bringing the four-year budget to more than $19 million.

One role of the NOAA Cooperative Institutes is to engage the academic and private research communities in working with NOAA to develop plans for research. In 2004, CICOR proposed workshops that would bring NOAA scientists and program managers together with external investigators. The proposal was endorsed, and CICOR has since held the first of a series of workshops on marine ecosystems.

Together with the Northeast Science Center of NOAA’s National Marine Fisheries Service, CICOR organized the Workshop on Planning Coordinated Research on Ecosystems, Climate, and Policy in the Northeast in January 2005. The workshop brought together individuals from more than 30 institutions, representing NOAA staff, fisheries and marine resource managers, and researchers. Participants identified management needs for new research on harmful algal blooms, nutrients and contaminants, biodiversity, and fisheries.

Among CICOR’s diverse research programs, the Ocean Reference Sites (ORS)—long-term surface moorings dedicated to measurement of the exchange of heat, moisture, and momentum between the ocean and atmosphere—progressed under the direction of Robert Weller and Albert Plueddemann of the Physical Oceanography Department. The ORS provide essential data for improving our understanding of atmosphere-ocean coupling and for properly calibrating the estimates and assumptions used in climate modeling. ORS sites in the equatorial Atlantic and Pacific are in their fourth and fifth years, respectively, of continuous operation. A third site, 96 kilometers (60 miles) north of Oahu, Hawaii, was established in August 2004.

CICOR welcomed a new postdoctoral scholar in 2004: Nancy Grumet, a June 2004 graduate of Stanford University. She is working with Konrad Hughen in the Marine Chemistry and Geochemistry Department to understand and reconstruct environmental conditions in the subtropical and tropical oceans through the development of coral chemical records. CICOR also continues to support postdoctoral scholar Nicholas Scott, who is working with John Trowbridge of the Applied Ocean Physics and Engineering Department on statistical analyses of steep waves in open ocean waters. Rob Jennings (right), the CICOR-supported graduate student in the MIT/WHOI Joint Program, is working with Lauren Mullineaux of the Biology Department.

—Robert Weller, Director
The success of our mission depends on public support, through federally funded research projects and private donations. The Institution therefore employs a variety of channels to enhance the public’s awareness and knowledge of the oceans and the critical role of oceanographic research in understanding our planet.

The visiting public’s window into ocean research at the Institution is through the Information Office and Exhibit Center, which together serve more than 30,000 visitors each year and respond to more than 7,500 information requests. Program offerings include informational walking tours, interactive educational exhibits, programs for students and educators, and a “Science Made Public” lecture series, bringing scientists and engineers directly to the public for informal talks about their research. Operation of the Information Office and Exhibit Center relies on the assistance of a dedicated and talented pool of about 30 volunteers.

The Institution has a range of methods for introducing its research and engineering to those who cannot visit Woods Hole. In 2004, nearly 140,000 people viewed the Institution’s traveling museum exhibition, “Extreme Deep,” as it was installed first at ScienceCity in Kansas City, MO, and then at the Maritime Aquarium in Norwalk, CT. At more than 5,000 square feet, the exhibit features a full-size replica of the Alvin personnel sphere, models of vehicles used to explore the ocean, and a life-size, 3-D replica of a seafloor hydrothermal vent community.

During a spring rehab of “Extreme Deep,” pieces of the exhibit were displayed at the exploration pavilion at Wired magazine’s NextFest in San Francisco. Twenty five thousand people attended the exposition, during which Executive Vice President and Director of Research Jim Luyten joined Wired editor Chris Anderson and NASA Space Architect Gary Martin on a panel entitled “The Future, Above and Below.”

A greater still audience, WHOI scientists are bringing the public closer to the extreme environments they work in through the Internet, with five online expeditions in 2004 chronicling life and work at sea (www.whoi.edu/home/marine/expeditions_main.html). The largest of these endeavors is Dive and Discover (www.divediscover.whoi.edu), which, with its daily journals, interactive learning modules, and video and slideshows, attracted more than a half-million visitors in 2004. The expansion of Oceanus magazine (oceanusmag.whoi.edu) onto the Web has helped to deepen the public understanding of ocean science, with annual visits to the site exceeding 120,000. In addition, the Institution’s public Web site saw 3.25 million visits in 2004.

Public outreach at WHOI has also included work directed toward the K-12 audience. While the Institution’s educational focus is on the university level and higher, efforts are made to reach out to teachers and their students through partnerships like the Woods Hole Science and Technology Education Partnership (see Academic Programs section, page 30) and individual efforts. WHOI researchers regularly speak to school groups, visit classrooms, give lab tours, and make presentations at museums and conferences. Our staff has participated as judges, mentors, and advisors in the National Ocean Science Bowl, as well as in local science fairs and WHOI-sponsored workshops for educators.

In addition, WHOI, with the University of Massachusetts and the New England Aquarium, forms the core of the Center for Ocean Sciences Education Excellence—New England (COSEE–NE), a five-year project funded by the National Science Foundation to encourage collaboration among researchers, educators, and the public. COSEE–NE programs (www.necosee.net) in 2004 included workshops to train investigators in giving effective presentations to K-12 students, the creation of a guide for engaging scientists and educators in education and outreach, and a summer education institute fostering researcher-teacher collaboration.

With tightening federal budgets, the importance of cultivating a public educated about the oceans and the value of research and engineering at WHOI has never been greater.

—Stephanie Murphy, Manager of Internal Communications

Left: Jeff Seewald, an associate scientist in the Marine Chemistry and Geochemistry (MCG) department, describes his research and lab equipment to 25 middle and high school science teachers from around New England in November. Jeff spent the day with the group as part of a “Topics in Oceanography” workshop for educators jointly sponsored by Academic Programs, WHOI Information Office, and WHOI Sea Grant. Jeff enlisted help from MCG Senior Scientist Meg Tivey (right), who spoke about the process of collecting and analyzing samples from hydrothermal vents.
Research on hydrothermal vents, undersea earthquakes and resulting tsunamis, weather and changing climate, marine mammals, and the development of new undersea exploration technology attracted worldwide media attention in 2004. Conveying Institution research and engineering activities to the public was also accomplished by providing thousands of images, video footage, and information to textbook publishers, for museum and science center exhibits, Websites, publications and organizations as diverse as the American Museum of Natural History in New York, the U.S. Commission on Ocean Policy, John Wiley & Sons, the National Science Foundation, 20th Century Fox, and the Old Farmers' Almanac. The Media Relations Website had an average of more than 400 visits a day, totaling 163,000 visits for the year.

Among the major media events of the year was an August press briefing at the National Science Foundation to announce plans to replace the Deep Submergence Vehicle Alvin. Stories appeared in hundreds of newspapers, including The Washington Post, The New York Times, The Boston Globe, The Miami Herald, Los Angeles Times, and Chicago Tribune. Associated Press, Reuters, and Scripps Howard News Service distributed the story, which was also featured on ABC News.com, CNN.com and MSNBC.com as well as on National Public Radio and in Science.

Other stories on a variety of ocean research topics appeared in print and broadcast media in the U.S. and abroad, ranging from The Science Teacher, Mass High Tech, Popular Mechanics in South Africa, Octopus magazine in Russia, NY Teknik in Sweden and National Geographic Magazine to Discovery Channel, The Science Channel, PBS, The Learning Channel, and the BBC.

From left, Margaret Leinen, assistant director of the National Science Foundation (NSF) Directorate for Geosciences, Arden Bement, Jr., director of NSF, and Robert Gagosian, WHOI president and director, watch an animation of the Alvin replacement vehicle during an August media briefing at NSF headquarters in Arlington, VA.

Other highlights for 2004:

• The 20th Century Fox feature film “The Day After Tomorrow,” released in theaters nationwide in May, resulted in dozens of media calls about abrupt climate change before and after the film’s release. Lloyd Keigwin and Ray Schmitt were interviewed for a related one-hour science documentary entitled “Force of Destiny: The Science and Politics of Climate Change,” a special DVD scheduled to be distributed in the U.S. in May 2005.
• The Weather Channel featured Ray Schmitt and the ocean’s role in climate change as part of its “Storm Stories” series in April.
• Wired Magazine’s first NextFest, a festival about technology for the future held in San Francisco in May, was featured in a one-hour television special on the Science Channel. Dave Gallo and the autonomous underwater vehicles (AUVs) REMUS and ABE were featured in the segment on exploration.
• Visiting journalists during the year included the eight 2004 Ocean Science Journalism Fellows, who spent an intense week of study in September as part of the fifth annual program, and ten international Knight Science Journalism Fellows from MIT, who visited in October as part of an annual program begun in 1983.
• Breck Owens and the new glider Spray, the first glider to cross the Gulf Stream, were featured in media stories in November ranging from the Tampa Tribune and San Diego Daily Transcript to Uvonline.com.
• Jian Lin, with Uri ten Brink of the U.S. Geological Survey, was featured in numerous media stories about undersea earthquakes and tsunamis related to the devastating Indian Ocean tsunami; their research findings about similar conditions in the Caribbean and Atlantic Ocean were published just two days before the event.

—Shelley Dawicki, Director of Media Relations

Print media coverage of WHOI science in 2004 reached more than 93 million readers. Millions more were exposed to WHOI science through wire service, broadcast, and Internet news outlets.
Scientists at WHOI contribute to the discussion of public policy and science policy issues at the state, national, and international levels. A selection of their activities in 2004 is given here.

Public Policy

Don Anderson
Testimony on reauthorization of the Harmful Algal Bloom and Hypoxia Research and Control Act, U.S. House of Representatives Subcommittee on Fisheries Conservation, Wildlife and Oceans

Bob Beardsley
Outfall Monitoring Science Advisory Panel, U.S. Environmental Protection Agency and Massachusetts Department of Environmental Protection

Ken Brink
Member, Science Advisory Panel, U.S. Commission on Ocean Policy

Bill Curry
Testimony on Impacts of Climate Change and State’s Actions, U.S. Senate Committee on Commerce, Science and Transportation

Ruth Curry
Briefings on Oceans, Climate Change, and Human Health for members of Congress and Staff, sponsored by U.S. House of Representatives Oceans Caucus and Science and Resources Committees and U.S. Senate Committee on Commerce, Science and Transportation and Health, Education, Labor and Pensions

Briefings on Extreme Weather Events, Climate Instability and Abrupt Climate Change and Their Implications for Human Health for Congressional Staff, sponsored by U.S. House of Representatives Science Committee, Senator Olympia Snowe’s Office, and the Environmental Energy Study Institute

Bob Gagosian
Member, Science Advisory Panel, U.S. Commission on Ocean Policy

Darlene Ketten
Member, Advisory Board, Stellwagen Bank National Marine Sanctuary

Member, Advisory Panels on Acoustic Impacts on Marine Mammals and Sea Turtles for U.S. House of Representatives Committee on Energy and Commerce and U.S. Senate Committee on Commerce, Science and Transportation

Briefing on Acoustic Impacts on Marine Mammals for Assistant Secretary of the Navy Donald Schregardus

Testimony on Marine Mammal Protection Act for U.S. House of Representatives and U.S. Senate Armed Services Committees

Ann Mulligan
Science Advisory Council, Massachusetts Military Reservation

Chris Reddy
Testimony on Oil Spills, Joint Committee on Natural Resources and Agriculture, Massachusetts Legislature

Andy Solow
Member, Science Advisory Panel, U.S. Commission on Ocean Policy

Testimony on the Preliminary Report of the U.S. Commission on Ocean Policy, U.S. House of Representatives Science Committee

Member, Science Advisory Panel, Massachusetts Executive Office of the Environment

Chair, Outfall Monitoring Science Advisory Panel, U.S. Environmental Protection Agency and Massachusetts Department of Environmental Protection

Peter Tyack
Federal Advisory Committee on Acoustic Impacts on Marine Mammals, U.S. Marine Mammal Commission

Briefing on Marine Mammal Protection Act for U.S. House of Representatives Resources Committee Staff

Bob Weller
Testimony on Ocean Observations, U.S. House of Representatives Subcommittee on Fisheries Conservation, Wildlife and Oceans

Science Policy

Don Anderson
Director, U.S. National Office for Marine Biotoxins and Harmful Algal Blooms

Carin Ashjian
Co-Vice Chair, Arctic Icebreaker Coordinating Committee, University-National Oceanographic Laboratories System (UNOLS)

Bob Detrick
Member, Board of Governors, Joint Oceanographic Institutions (JOI)

Chair, Advisory Committee, NSF Geosciences Directorate

Member, Board of Governors, International Ocean Drilling Program (IODP) Management International

Scott Doney
Member, Global Carbon Cycle Panel, National Oceanic and Atmospheric Administration

Katarina Edwards
Member, Biogeosciences Working Group, National Science Foundation

Glen Gawarkiewicz
Member, Steering Committee, NSF Coastal Ocean Processes Program

Rocky Geyer
Member, National Academy of Sciences/National Research Council (NAS/NRC) Ocean Studies Board

Mark Hahn
Member, Expert Review Panel, U.S. Environmental Protection Agency, Framework for Application of Dioxin TEF Methodology in Ecological Risk Assessment

Stan Hart
Member, NAS/NRC Ocean Studies Board

Lloyd Keigwin
Chair, Rapid Climate Change Programme Steering Committee, Natural Environment Research Council, U.K.

Dennis McGillicuddy
Member, Steering Committee, U.S. Global Ocean Ecosystems Dynamics Program (GLOBEC)

Laurent Montési
WHOI Representative, Computational Infrastructure in Geosciences, National Partnership for Advanced Computational Infrastructure

John Stogeman
Chair, Institute of Medicine—National Academy of Sciences Committee on Health Effects of Agent Orange in Vietnam Veterans

Simon Thorrold
Connectivity Working Group, Coral Reef Targeted Research and Capacity Building for Management, World Bank-led Alliance

Meg Tivey
Co-Chair, Ocean Research Interactive Observatories Networks (ORION) Workshop Steering Committee

Bob Weller
Co-Chair, U.S. Climate Variability and Predictability (CLIVAR) Science Steering Committee

ORION Executive Steering Committee

National Research Council Committee on Strategic Guidance to the Atmospheric Sciences Division, National Science Foundation

Peter Wiebe
Chair, UNOLS

U.S. Representative, Oceanography Committee, International Council for Exploration of the Sea

Member, Steering Committee, U.S. GLOBEC

40 * Woods Hole Oceanographic Institution
### Promotions and appointments

**Promotions**
- **John Colosi**  
  Associate Scientist with Tenure
- **Alan Gardner**  
  Engineering Assistant III
- **Laura Goepfert**  
  Information Systems Associate II
- **Sue Grieve**  
  Administrative Associate I
- **Matt Heintz**  
  Research Engineer
- **Thomas Hurst**  
  Engineer II
- **Frederic Jaffre**  
  Engineer II
- **Amy Kukulya**  
  Research Assistant III
- **Gretchen McManamin**  
  Administrative Associate I
- **Marlene Messina**  
  Administrative Associate I
- **Peter Schultz**  
  Research Associate II
- **Alex Shorter**  
  Engineer II
- **Peter Traykovski**  
  Associate Scientist
- **Jonathan Ware**  
  Research Engineer

**Appointments**
- **Linda Cannata**  
  Senior Admin. Assistant II
- **Mary Frederick**  
  Senior Admin. Assistant II
- **George Frisk**  
  Scientist Emeritus
- **Ruoying He**  
  Assistant Scientist
- **Casey Machado**  
  Laboratory Assistant II
- **Kris Newhall**  
  Engineering Assistant II
- **Catherine Offinger**  
  Research Associate III
- **Eben Olson**  
  Engineering Assistant I
- **Cliff Pontbriand**  
  Engineering Assistant II

**Promotions**
- **Molly Allison**  
  Research Assistant III
- **Carin Ashjian**  
  Associate Scientist with Tenure
- **Scott Cramer**  
  Senior Research Assistant I
- **Jen Fitzgerald-Kearney**  
  Research Associate II
- **David Kulis**  
  Senior Research Assistant II
- **Pamela Polloni**  
  Research Assistant III
- **Simon Thorrold**  
  Associate Scientist with Tenure
- **Mary Jane Tucci**  
  Administrative Associate II

**Appointments**
- **Mark Behn**  
  Assistant Scientist
- **Joan Bernhard**  
  Associate Scientist with Tenure
- **Ilya Buynevich**  
  Research Assistant II
- **Sarah Das**  
  Assistant Scientist
- **Susumu Honjo**  
  Scientist Emeritus
- **Pat Lohmann**  
  Scientist Emeritus
- **Luc Mehl**  
  Research Assistant III
- **Beecher Wooding**  
  Oceanographer Emeritus

**Promotions**
- **Anne Cohen**  
  Research Specialist
- **Glenn Gaetani**  
  Associate Scientist
- **Peter Winsor**  
  Engineer II
- **Thomas Hurst**  
  Engineer II
- **Alex Shorter**  
  Engineer II
- **Peter Traykovski**  
  Associate Scientist
- **Jonathan Ware**  
  Research Engineer

**Appointments**
- **Linda Cannata**  
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- **David Kulis**  
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  Administrative Associate II

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- **Susumu Honjo**  
  Scientist Emeritus
- **Pat Lohmann**  
  Scientist Emeritus
- **Luc Mehl**  
  Research Assistant III
- **Beecher Wooding**  
  Oceanographer Emeritus

**Promotions**
- **Claudia Cenedese**  
  Associate Scientist
- **Andrey Proshutinsky**  
  Senior Scientist
- **Kurt Polzin**  
  Associate Scientist with Tenure
- **John Lund**  
  Research Associate II
- **Penny Foster**  
  Administrative Associate I
- **Mary Ann Lucas**  
  Administrative Associate II
- **Hazel Salazar**  
  Administrative Associate I
- **Elizabeth Stokes**  
  Senior Admin. Assistant II

**Appointments**
- **Karen Caciotti**  
  Assistant Scientist
- **Mark Coolen**  
  Assistant Scientist (May 2005)
- **Liz Kujawinski**  
  Assistant Scientist
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Frank V. Snyder
Robert M. Solomon
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H. Guyford Stever
John M. Stewart
David B. Stone
E. Kent Swift Jr.
Maurice Tempelsman
Charles H. Townes
Richard F. Tucker
Marjorie M. von Stade
Emily V. Wade
Elizabeth M. Warner
James D. Watkins
Sidney J. Weinberg Jr.
F. Thomas Westcott
John J. Wise
Alfred M. Zeien

Deceased 2004

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Honorary Trustee and Honorary Member 11/10/04

W. H. Krome George
Honorary Trustee and Honorary Member 9/6/04

William P.E. Graves
Honorary Member 6/12/04

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Honorary Member 5/27/04

Frank L. Nickerson
Honorary Member 9/4/04

Stephen P. Swope
Member 12/8/04

The new Marine Research Facility, left, and Biogeochemistry Building rising on the Quissett Campus in December 2004.
Bigelow became director and committee secretary Henry named chairman of the board, Marine Biological Laboratory, was chair of the Committee on Sciences Committee on recommendation of a National Academy 1930  

Woods Hole Oceanographic Institution history timeline

In 2005, WHOI celebrates 75 years of ocean research, education, and exploration. While the grand story of Institution accomplishments is told in the scientific literature, some highlights of its growth as an institution are summarized in this timeline and treated more fully in the book Down to the Sea for Science, scheduled for publication in late summer 2005.

1930 Based upon the recommendation of a National Academy of Sciences Committee on Oceanography, the Woods Hole Oceanographic Institution was incorporated on January 6, 1930. The chair of the Committee on Oceanography, Frank R. Lillie of the University of Chicago and the Marine Biological Laboratory, was named chairman of the board, and committee secretary Henry Bigelow became director.

By summer 1931, the first WHOI laboratory building was ready for science. It was later named for first director Henry Bigelow.

1931 By June 1931, the 40-foot (12-meter) coastal vessel Asterias had been delivered from New Bedford, MA, in time for the Institution’s first research season. On August 31 that year, the 142-foot (43-meter) ketch-rigged Atlantis, built in Denmark, arrived in Woods Hole, offering U.S. blue-water research opportunities for the first time in many years.

Dean Bumpus tutors navy submersaries in use of the bathythermograph to avoid detection from the surface during World War II.

1940–1945 WHOI’s first federal contract initiated war-related work on July 1, 1940. The mission was to study the organisms that foul ships’ hulls and determine how to eliminate them. Soon the Institution became the National Defense Research Committee’s premier oceanographic research center.

1946 Navy projects continued after the war, and more than 40 WHOI employees were involved in extensive measurements related to atomic bomb testing at Bikini Atoll in the Pacific Ocean. WHOI biologists renewed prewar studies of ocean productivity and began investigations of marine pollution. In late 1947, Atlantis headed to the Mediterranean to map the Aegean seafloor for the U.S. Navy.

The deep-diving submersible Alvin, funded by the U.S. Navy and assigned to WHOI, was dedicated in June 1964.

1950 Wartime inflation rendered ocean science too expensive for private funding. WHOI remained a private corporation, but government funding became essential to progress in ocean science. Coast Guardsman Edward Smith was named director in 1950. He dedicated the Institution’s second large building, a Navy-funded laboratory later named for him, and secured the converted 125-foot (38-meter) cutter Crawford for WHOI. Iselin again served as director in 1956 and 1957.

Knorr splashes into Michigan waters at its launch in August 1968. At delivery, the ship accommodated 24 scientists and 25 crew.

1955 Paul Fye, a wartime member of the explosives research group, returned to WHOI as director. His mission was to lead a rather reluctant staff toward a more formally organized institution. Committees were appointed to consider land acquisition, a building program, research vessel design, and educational policy. Two federal reports promoted new funding for ocean sciences.

1957 Work undertaken for the 1957–58 International Geophysical Year (IGY) tempered continuing funding concerns. WHOI maintained excellence in instrument development—for example, automation of salinity measurements saved time and improved accuracy. Launch of two Russian Sputnik satellites focused U.S. attention on the sciences, including oceanography.

1960 The deep-diving submersible Alvin, funded by the U.S. Navy and assigned to WHOI, was dedicated in June 1964.

1962 WHOI was moving ahead on all fronts. The first computer went to sea to process gravity measurements in 1961. The following year, Atlantis II was delivered, ground was broken for a new building to house biological and chemical laboratories along with a computing center, and six science departments were formed. Atlantis II participated in the search for the sunken submarine USS Thresher.

1965 The deep-diving submersible Alvin, funded by the U.S. Navy and assigned to WHOI, was dedicated in June 1964.

From 1942 to 1945, the staff grew from 92 to more than 300 people working on about 40 war-related projects. These included:  
• development of the bathythermograph, whose temperature/depth measurements helped the U.S. Navy to find enemy submarines and U.S. submarines to avoid detection by the enemy.  
• underwater explosives research and improvements in underwater photography.  
• current and drift predictions for downed aviators on life rafts, and  
• wave and swell predictions for amphibious landings.

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• wave and swell predictions for amphibious landings.

A second WHOI building rose on Water Street in 1954–55 to relieve overcrowded laboratories and house classified work for the U.S. Navy.

Big-lip oceanography came to WHOI in 1958 with the arrival of Chain, a former U.S. Navy deep-sea salvage tug.

WHOI staff prepare Nansen bottles for shipping to Bikini Atoll for oceanographic measurements before and after bomb tests there.

Al Bradshaw, left, and Karl Schleicher operate their salinometer, one of many WHOI advances in instrumentation.

1968 WHOI had grown to about 600 people by this time, and more laboratory space was desperately needed. Acquisition of a large acreage near Woods Hole village brought promise of relief. After years of careful deliberation, an agreement was signed with the Massachusetts Institute of Technology for a joint graduate degree program.


lot to the growth of the Woods Hole Oceanographic Institution.
1970 The National Science Foundation-sponsored International Decade of Ocean Exploration (IDOE) brought a number of "big science" initiatives. WHOI scientists participated in the Geochronological Ocean Sections Study and others among these programs over the next ten years.

Oceania replaced Chien in the WHOI tow in 1975. The 177-foot (54-meter) vessel accommodated 12 scientists and 12 crew.

1971, a WHOI marine policy program was established to work toward wise use of the oceans, and the Institution was chosen as the first host for the University National Oceanographic Laboratories System, designed to promote efficient use of ships and other U.S. marine facilities.

1974 The largest move in the Institution’s history took place in 1974 when some members of each science department relocated, along with the directorate, to the new central laboratory on the Quissett Campus. At its October 1974 dedication, the building was named Clark Laboratory for major WHOI donors Edna McConnell Clark and W. Van Alan Clark. An aquaculture project had moved to the Environmental Systems Laboratory on the new campus the previous year. A new titanium sphere installed in Alvin increased the sub’s depth capability from 6,000 feet (1,818 meters) to 10,000 feet (3,020 meters), and Alvin, its tender Lulu, and Knorr participated in the international French-American Mid-Ocean Undersea Study. This "Project FAMOUS" gave scientists their first opportunity to examine in person the plate tectonic processes at work on mid-ocean ridges.

1975 In 1975, a new record for the buoy group. Deployed for 515 days had marked the first opportunity to examine in 11,000 feet (3,350 meters) for the first time.

1977 After nineteen years as director, Paul Fye stepped down following a period of astonishing growth for WHOI. The number of employees doubled during his tenure, the operating budget increased nearly tenfold from about $2.5 million in 1956 to $24 million in 1977, and new buildings, ships, a submersible, a graduate degree-granting program, and a marine policy program expanded the Institution’s capabilities. John Steele followed Fye as director.

1980 A 50th anniversary celebration included hosting a congress on the history of oceanography, a symposium on the present and future of oceanography, a public open house, and a whisking ‘anything but a boat’ regatta. Wang word processing had changed the process of writing papers the year before, and recovery of a mooring deployed for 515 days had marked a new record for the buoy group.

1989 The World Ocean Circulation Experiments (WOCE) were established at WHOI—one of many administrative or operational offices hosted by the Institution for large oceanographic research programs. Knorr was being lengthened and refitted to meet the global operational requirements of these large programs. Craig Dorman succeeded John Steele as director.

1997 Following visits to the ports of New York City and Alexandria, Virginia, the Institution’s third Atlantis, with Alvin transferred from the retiring Atlantis II, went to work for ocean science. Jason was engaged in a two-month survey of a sunken British bulk ore carrier that would establish the cause of the ship’s demise. A British official said this accomplishment meant “no longer need ships vanish without trace or explanation.”

2004 As festivities for the Institution’s 75th anniversary were being planned, WHOI was coping with a down cycle in federal science funding. A capital campaign to help counter this was well underway with $115 million raised by the end of 2004 toward a $200 million goal. The submersible Alvin marked its fortieth year and four-thousandth dive (with a quarter of these dives made since 1995), and a new deeper-diving Alvin replacement was being designed. A hybrid vehicle that would offer both remotely operated and autonomous operating modes was under construction. The second Asterias, which had replaced the nearly identical vessel of the same name in 1979, retired in 2004 to make way for a larger, faster, larger, coastal vessel, Togo. The Woods Hole Oceanographic Institution maintained its position as a leader in the U.S. and the international marine science community.

1985 Discovery of the sunken Titanic during a Knorr expedition focused an international spotlight on WHOI. The following year, Alvin, working from Atlantis II dove to the wreck. The sub carried the tiny prototype remotely operated vehicle Jason Jr., which signaled a new era of deep-sea exploration as it revealed the interior of Titanic. By 1987, the Deep Submergence Laboratory was operating a full-scale Jason.

1993 The Institution’s most ambitious capital campaign to date, initiated in 1990, went public with a goal of $50 million. At its completion in 1996, it would have raised $54 million. Robert Gagosian, who joined the Institution in 1972 as an assistant scientist and had served as associate director for research since 1987, became director.

2000 In order to encourage interdisciplinary research, respond to societal concerns, and enhance communication of scientific results to the public and policymakers, four ocean institutes were established: the Coastal Ocean Institute (joining the Rinehart Coastal Research Center), the Deep Ocean Exploration Institute, the Ocean and Climate Change Institute, and the Ocean Life Institute.

In 1993, the first addition to Clark Laboratory was occupied, and this extension to it was being framed.

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In 1989, the first addition to Clark Laboratory was occupied, and this extension to it was being framed.
For the fifth consecutive year, government sponsored revenues surpassed both budget and prior year results and the Institution completed 2004 in strong financial condition. This strength is due in large measure to both the Institution’s scientific and engineering achievements and its commitment to administrative efficiency and fiscal discipline.

Financial highlights:
• The Institution’s total assets grew by more than $60 million, or 15%, to $455 million. This increase is attributable to the performance of the Endowment and to construction of new laboratories on both campuses.
• During 2004 the Institution issued $54,850,000 of Massachusetts Health and Educational Facilities Authority (MHEFA) variable rate bonds to construct new laboratories and to repay previous MHEFA loans. The Institution negotiated an interest rate swap agreement that effectively locks in a fixed rate on the bonds of 3.79% for 30 years.
• The Institution’s accrued pension liability increased from $6.9 million in 2003 to $24.7 million in 2004. To allow time to evaluate the retirement plan and control the cost, the plan was amended effective December 31, 2004, by freezing compensation. A task force will propose a new plan that will be in place by the end of 2005.
• The Institution ended the year with a slight decrease in total net assets of $2.5 million due in large part to pension fund accruals.
• The Endowment Fund grew to $291 million in 2004 from $269 million in 2003 with a total return of 12%.
• The Institution ended the year with a total increase in net assets from operating activities of $8.3 million.

Total sponsored research released to operations was $108.5 million in 2004 compared with $100.8 million in 2003, an increase of 8 percent. Government sponsored research, excluding ship and submersible operations, was $67.5 million in 2004 compared with $63.4 million in 2003, a 6 percent increase. The Institution’s labor bases, against which fringe benefits and overhead are recovered, finished the year slightly over budget, while overhead costs were reduced by almost $2.7 million, resulting in a substantial over-recovery of overhead expenses. Our total overhead recovery was $55.2 million compared with $47.7 million in 2003.

Our primary federal sponsor, the National Science Foundation (NSF), did not receive a large increase in its 2004 appropriation. However, the Institution benefited from a 22% funding increase from NSF, which more than offset a decrease in funding from the United States Navy.

Through the generosity of friends of the Institution, gifts, grants, and pledges reached $15.3 million in 2004. Outstanding net pledges at the end of 2004 were $6.9 million.

Investment returns distributed to operations totaled $13.7 million in 2004. Sponsored research received $4.7 million, education received $5.6 million and current operations received $3.4 million. Distributions from investment returns have become an important source of revenue for the Institution and make up 10 percent of total operating revenues.

The Institution spent $56.3 million on compensation during 2004. Included in this amount was $8.9 million for vacation, holidays and sick time. Other fringe benefits cost $10.8 million for a total compensation package of $67.1 million, 52 percent of our total 2004 operating expenses of $128.2 million.

The Institution invested $19.4 million on the construction and renovation of facilities during 2004. In addition, $895,000 was invested in maintaining existing facilities compared with $884,000 in 2003.

During 2004, to relieve overcrowding and create state of the art laboratories, the Institution has made significant progress in developing the Quissett Campus and renovating laboratories in the Village, while maintaining its financial stability. However, we face significant short and long-term economic challenges: reductions in federal funding agency budgets and a shift in focus from basic to applied research will probably require that WHOI change as well.

In the short term we are taking steps to control spiraling health plan and retirement plan costs. We are undertaking a comprehensive assessment of the Institution’s central administrative functions to improve effectiveness and competitiveness and direct resources to high priorities.

To prepare for long-term challenges, we are exploring additional and new funding sources with an emphasis on intellectual property development and applied research. These changes will be challenging, but with the support of the staff, students, trustees and corporation members, the Institution will continue to prosper and grow in reputation.
Financial statements

Statement of Financial Position
December 31, 2004 (with comparative information as of December 31, 2003)

<table>
<thead>
<tr>
<th>Assets</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash, unrestricted</td>
<td>$12,669,547</td>
<td>$18,097,572</td>
</tr>
<tr>
<td>Cash, restricted</td>
<td>382,421</td>
<td>1,507,755</td>
</tr>
<tr>
<td>Reimbursable costs and fees:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Billed (net of allowance for doubtful accounts of $226,658 for 2004 and $234,033 for 2003)</td>
<td>3,335,365</td>
<td>1,728,635</td>
</tr>
<tr>
<td>Unbilled</td>
<td>6,458,930</td>
<td>4,670,629</td>
</tr>
<tr>
<td>Receivable for investments sold (Note 3)</td>
<td>-</td>
<td>22,044,791</td>
</tr>
<tr>
<td>Interest and dividends receivable</td>
<td>276,130</td>
<td>497,941</td>
</tr>
<tr>
<td>Other receivables (Note 12)</td>
<td>2,970,530</td>
<td>8,034,611</td>
</tr>
<tr>
<td>Pledges receivable, net</td>
<td>6,879,190</td>
<td>4,846,696</td>
</tr>
<tr>
<td>Inventory</td>
<td>1,233,746</td>
<td>1,084,124</td>
</tr>
<tr>
<td>Deferred charges and prepaid expenses</td>
<td>1,402,357</td>
<td>775,518</td>
</tr>
<tr>
<td>Deferred fixed rate variance</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Investments, pooled</td>
<td>287,277,109</td>
<td>242,720,582</td>
</tr>
<tr>
<td>Investments, nonpooled</td>
<td>5,237,388</td>
<td>5,326,668</td>
</tr>
<tr>
<td>Deposits with trustees for construction</td>
<td>24,278,081</td>
<td>-</td>
</tr>
<tr>
<td>Deposits with trustees for debt service</td>
<td>3,154,350</td>
<td>-</td>
</tr>
<tr>
<td>Prepaid postretirement benefit cost</td>
<td>639,297</td>
<td>788,826</td>
</tr>
<tr>
<td>Supplemental retirement</td>
<td>6,537,921</td>
<td>6,257,039</td>
</tr>
<tr>
<td>Intangible pension asset</td>
<td>-</td>
<td>5,644,240</td>
</tr>
<tr>
<td>Other assets</td>
<td>17,384,437</td>
<td>11,983,651</td>
</tr>
<tr>
<td>Deferred financing costs</td>
<td>1,268,753</td>
<td>-</td>
</tr>
<tr>
<td>Subtotal</td>
<td>381,385,552</td>
<td>339,206,971</td>
</tr>
<tr>
<td>Property, plant and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land, buildings and improvements</td>
<td>68,493,906</td>
<td>65,789,103</td>
</tr>
<tr>
<td>Vessels and dock facilities</td>
<td>6,442,869</td>
<td>4,365,175</td>
</tr>
<tr>
<td>Laboratory and other equipment</td>
<td>18,132,850</td>
<td>15,880,819</td>
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<tr>
<td>Construction in process</td>
<td>24,195,589</td>
<td>7,523,530</td>
</tr>
<tr>
<td>Accumulated depreciation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net property, plant and equipment</td>
<td>(53,404,419)</td>
<td>(49,070,058)</td>
</tr>
<tr>
<td>Remainder trusts</td>
<td>10,043,233</td>
<td>10,532,306</td>
</tr>
<tr>
<td>Total assets</td>
<td>$455,289,580</td>
<td>$394,227,846</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts payable and other liabilities (Note 12)</td>
<td>$17,845,971</td>
<td>$17,114,484</td>
</tr>
<tr>
<td>Accrued payroll and related liabilities</td>
<td>5,291,214</td>
<td>6,227,950</td>
</tr>
<tr>
<td>Payable for investments purchased</td>
<td>47,251</td>
<td>-</td>
</tr>
<tr>
<td>Deferred fixed rate variance</td>
<td>129,500</td>
<td>-</td>
</tr>
<tr>
<td>Accrued supplemental retirement benefits</td>
<td>6,537,921</td>
<td>6,257,039</td>
</tr>
<tr>
<td>Accrued pension liability</td>
<td>24,697,407</td>
<td>6,946,274</td>
</tr>
<tr>
<td>Deferred revenue and refundable advances</td>
<td>6,739,232</td>
<td>5,316,136</td>
</tr>
<tr>
<td>Bond and loans payable</td>
<td>54,850,000</td>
<td>10,724,206</td>
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<tr>
<td>Total liabilities</td>
<td>116,138,496</td>
<td>52,586,089</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Net Assets</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted</td>
<td>Temporarily restricted</td>
<td>Permanently restricted</td>
</tr>
<tr>
<td>Pension</td>
<td>(23,705,136)</td>
<td>$ -</td>
</tr>
<tr>
<td>Designated</td>
<td>2,148,390</td>
<td>8,243,578</td>
</tr>
<tr>
<td>Pledges and other</td>
<td>2,148,390</td>
<td>8,243,578</td>
</tr>
<tr>
<td>Plant and facilities</td>
<td>29,968,854</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td>-</td>
<td>3,437,863</td>
</tr>
<tr>
<td>Endowment and similar funds</td>
<td>67,894,397</td>
<td>166,942,058</td>
</tr>
<tr>
<td>Total net assets</td>
<td>$86,613,405</td>
<td>$183,317,021</td>
</tr>
<tr>
<td>Total liabilities and net assets</td>
<td>$455,289,580</td>
<td>$394,227,846</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these financial statements.
### Statement of Activities

Year Ended December 31, 2004 (with summarized financial information for the year ended December 31, 2003)

<table>
<thead>
<tr>
<th>Unrestricted</th>
<th>Sponsored Research</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>2004</th>
<th>2003</th>
</tr>
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<tbody>
<tr>
<td>Operating Revenues</td>
<td>$576,649</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fees</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sponsored research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ships and subs operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Released to operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endowment income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gifts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education funds released from restriction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment return designated for current operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions and gifts, net of releases from restrictions of $884,486 and $2,023,298 in 2004 and 2003, respectively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions in kind</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication and publications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total revenues</td>
<td>131,425,633</td>
<td>-</td>
<td>55,716</td>
<td>5,051,897</td>
<td>136,533,246</td>
</tr>
</tbody>
</table>

| Expenses | | | | | |
| Sponsored research | | | | | |
| National Science Foundation | 41,499,749 | | | 41,499,749 | 34,097,378 |
| United States Navy | 14,223,555 | | | 14,223,555 | 18,379,000 |
| Subcontracts | 12,127,174 | | | 12,127,174 | 9,324,911 |
| National Oceanic & Atmospheric Administration | 8,514,822 | | | 8,514,822 | 7,412,224 |
| Department of Energy | 690,864 | | | 690,864 | 878,280 |
| United States Geological Survey | 999,024 | | | 999,024 | 822,196 |
| National Aeronautics & Space Administration | 741,428 | | | 741,428 | 753,186 |
| Ships Operations | 14,809,301 | | | 14,809,301 | 13,001,577 |
| Submersible and ROV operations | 5,293,287 | | | 5,293,287 | 4,556,805 |
| Privately funded grants | 3,126,607 | | | 3,126,607 | 3,742,846 |
| Other | 6,447,780 | | | 6,447,780 | 7,780,861 |

| Total expenses | 131,425,633 | - | 55,716 | 5,051,897 | 136,533,246 | 134,769,356 |
## Statement of Activities (continued)

<table>
<thead>
<tr>
<th></th>
<th>Unrestricted</th>
<th>Sponsorship</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating</td>
<td>Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty expense</td>
<td>2,930,827</td>
<td></td>
<td>2,930,827</td>
<td>2,968,490</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student expense</td>
<td>3,963,605</td>
<td></td>
<td>3,963,605</td>
<td>3,840,130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postdoctoral programs</td>
<td>369,900</td>
<td></td>
<td>369,900</td>
<td>472,037</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>687,280</td>
<td></td>
<td>687,280</td>
<td>647,797</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental expenses</td>
<td>498,164</td>
<td></td>
<td>498,164</td>
<td>535,178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication, publications and development</td>
<td>2,572,930</td>
<td></td>
<td>2,572,930</td>
<td>2,284,343</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundraising expenses</td>
<td>2,507,237</td>
<td></td>
<td>2,507,237</td>
<td>2,201,452</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsponsored programs</td>
<td>5,279,055</td>
<td></td>
<td>5,279,055</td>
<td>3,821,259</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other expenses</td>
<td>920,888</td>
<td></td>
<td>920,888</td>
<td>980,073</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total expenses</strong></td>
<td><strong>128,203,477</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>128,203,477</strong></td>
<td><strong>118,500,023</strong></td>
</tr>
<tr>
<td>Change in net assets from operating activities</td>
<td>3,222,156</td>
<td><strong>-</strong></td>
<td>55,716</td>
<td><strong>-</strong></td>
<td>8,329,769</td>
<td>16,269,333</td>
</tr>
<tr>
<td>Nonoperating income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment return in excess of amounts designated for sponsored research, education and current operations</td>
<td>5,379,780</td>
<td>14,155,380</td>
<td>19,535,160</td>
<td>31,182,420</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net realized/unrealized gains (losses) on interest swap</td>
<td>(4,020,690)</td>
<td></td>
<td>(4,020,690)</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in split interest agreements</td>
<td>(14,038)</td>
<td>(35,851)</td>
<td>(593,686)</td>
<td>(643,575)</td>
<td>1,149,391</td>
<td></td>
</tr>
<tr>
<td>Net periodic pension cost</td>
<td>(9,004,045)</td>
<td></td>
<td>(9,004,045)</td>
<td>(5,819,299)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions and gifts</td>
<td></td>
<td></td>
<td>15,502</td>
<td>15,502</td>
<td>2,163,286</td>
<td></td>
</tr>
<tr>
<td>Net assets released from restriction</td>
<td>1,151,030</td>
<td>(1,151,030)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonoperating expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other nonoperating expenses</td>
<td>(99,976)</td>
<td></td>
<td>(99,976)</td>
<td>(99,972)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redesignation of gifts</td>
<td>(847,746)</td>
<td>(1,249,343)</td>
<td>60,500</td>
<td>(2,036,589)</td>
<td>57,558</td>
<td></td>
</tr>
<tr>
<td>Write-off of fixed assets</td>
<td>(511,023)</td>
<td></td>
<td>(511,023)</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in net assets from nonoperating activities</td>
<td>(7,966,708)</td>
<td></td>
<td>11,734,658</td>
<td>(533,186)</td>
<td>3,234,764</td>
<td>28,633,384</td>
</tr>
<tr>
<td>Change in net assets from operating and nonoperating activities</td>
<td>(4,744,552)</td>
<td></td>
<td>11,790,374</td>
<td>4,518,711</td>
<td>11,564,533</td>
<td>44,902,717</td>
</tr>
<tr>
<td>Change in additional pension minimum liability (Note 8)</td>
<td>(14,055,206)</td>
<td></td>
<td></td>
<td>(14,055,206)</td>
<td>5,975,263</td>
<td></td>
</tr>
<tr>
<td><strong>Total change in net assets</strong></td>
<td>(18,799,758)</td>
<td></td>
<td>11,790,374</td>
<td>4,518,711</td>
<td>(2,490,673)</td>
<td>50,877,980</td>
</tr>
<tr>
<td>Net assets at beginning of year</td>
<td>105,413,163</td>
<td></td>
<td>171,526,647</td>
<td>64,701,947</td>
<td>341,641,757</td>
<td>290,763,777</td>
</tr>
<tr>
<td>Net assets at end of year</td>
<td>$86,613,405</td>
<td></td>
<td>$183,317,021</td>
<td>$69,220,658</td>
<td>$339,151,084</td>
<td>$341,641,757</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these financial statements.
## Statement of Cash Flows

**Year Ended December 31, 2004 (with comparative information for the year ended December 31, 2003)**

### Cash flows from operating activities

<table>
<thead>
<tr>
<th>Description</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total change in net assets</td>
<td>$(2,490,673)</td>
<td>$50,877,980</td>
</tr>
<tr>
<td>Adjustments to reconcile increase (decrease) in net assets to net cash used in operating activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation and amortization</td>
<td>5,180,075</td>
<td>4,585,752</td>
</tr>
<tr>
<td>Change in split interest agreements</td>
<td>643,575</td>
<td>(1,149,391)</td>
</tr>
<tr>
<td>Allowance for uncollectible pledges</td>
<td>93,679</td>
<td>4,708</td>
</tr>
<tr>
<td>Discount on pledges</td>
<td>215,801</td>
<td>(56,202)</td>
</tr>
<tr>
<td>Net realized and unrealized (gain) loss on investments</td>
<td>(27,688,898)</td>
<td>(41,731,926)</td>
</tr>
<tr>
<td>Intangible pension asset</td>
<td>5,644,240</td>
<td>5,854,284</td>
</tr>
<tr>
<td>Additional minimum pension liability</td>
<td>14,055,206</td>
<td>(5,975,263)</td>
</tr>
<tr>
<td>Contributions to be used for long-term investment</td>
<td>(2,553,132)</td>
<td>(4,926,199)</td>
</tr>
<tr>
<td>Gift of property</td>
<td>(5,034,355)</td>
<td>(7,620,000)</td>
</tr>
<tr>
<td>(Increase) decrease in assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted cash</td>
<td>1,125,334</td>
<td>534,400</td>
</tr>
<tr>
<td>Interest and dividends receivable</td>
<td>221,811</td>
<td>34,285</td>
</tr>
<tr>
<td>Reimbursable costs and fees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Billed</td>
<td>(1,606,730)</td>
<td>2,194,443</td>
</tr>
<tr>
<td>Unbilled</td>
<td>(1,788,301)</td>
<td>140,509</td>
</tr>
<tr>
<td>Other receivables</td>
<td>5,064,081</td>
<td>6,890,372</td>
</tr>
<tr>
<td>Pledges receivable</td>
<td>(2,341,974)</td>
<td>(332,147)</td>
</tr>
<tr>
<td>Inventory</td>
<td>(149,622)</td>
<td>405,897</td>
</tr>
<tr>
<td>Deferred charges and prepaid expenses</td>
<td>(626,839)</td>
<td>223,686</td>
</tr>
<tr>
<td>Deferred fixed rate variance</td>
<td>3,197,693</td>
<td>(2,770,823)</td>
</tr>
<tr>
<td>Other assets</td>
<td>(366,431)</td>
<td>(186,464)</td>
</tr>
<tr>
<td>Remainder trusts</td>
<td>(43,044)</td>
<td></td>
</tr>
<tr>
<td>Prepaid pension cost</td>
<td>149,529</td>
<td></td>
</tr>
<tr>
<td>Supplemental retirement</td>
<td>(280,882)</td>
<td>(762,713)</td>
</tr>
<tr>
<td>Increase (decrease) in liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accrued pension liability</td>
<td>3,695,927</td>
<td>308,900</td>
</tr>
<tr>
<td>Accounts payable and other liabilities</td>
<td>(3,903,660)</td>
<td>(7,555,154)</td>
</tr>
<tr>
<td>Accrued payroll and related liabilities</td>
<td>(936,736)</td>
<td>(467,491)</td>
</tr>
<tr>
<td>Deferred revenue and refundable advances</td>
<td>1,423,096</td>
<td>(2,003,202)</td>
</tr>
<tr>
<td>Accrued supplemental retirement benefits</td>
<td>280,882</td>
<td>762,713</td>
</tr>
<tr>
<td>Deferred fixed rate variance</td>
<td>129,500</td>
<td></td>
</tr>
<tr>
<td>Net cash used in operating activities</td>
<td>(8,690,848)</td>
<td>(2,719,046)</td>
</tr>
</tbody>
</table>

### Cash flows from investing activities

<table>
<thead>
<tr>
<th>Description</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital expenditures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additions to property and equipment</td>
<td>(20,007,169)</td>
<td>(9,972,134)</td>
</tr>
<tr>
<td>Short-term investments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase of investments</td>
<td>-</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Endowment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receivable for investments sold</td>
<td>22,044,791</td>
<td>(22,044,791)</td>
</tr>
<tr>
<td>Payable for investments purchased</td>
<td>47,251</td>
<td>(10,193)</td>
</tr>
<tr>
<td>Proceeds from the sale of investments</td>
<td>130,132,661</td>
<td>90,451,740</td>
</tr>
<tr>
<td>Purchase of investments</td>
<td>(146,911,010)</td>
<td>(60,187,013)</td>
</tr>
<tr>
<td>Net cash used in investing activities</td>
<td>(14,695,476)</td>
<td>(762,391)</td>
</tr>
</tbody>
</table>

### Cash flows from financing activities

<table>
<thead>
<tr>
<th>Description</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowings under debt agreement</td>
<td>54,850,000</td>
<td>2,679,044</td>
</tr>
<tr>
<td>Loan payments</td>
<td>(10,724,206)</td>
<td>-</td>
</tr>
<tr>
<td>Deferred financing costs</td>
<td>(1,290,196)</td>
<td>-</td>
</tr>
<tr>
<td>Use of bond proceeds deposited with trustee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction fund</td>
<td>(24,278,081)</td>
<td>-</td>
</tr>
<tr>
<td>Change in debt service funds</td>
<td>(3,154,350)</td>
<td>-</td>
</tr>
<tr>
<td>Contributions to be used for long-term investment</td>
<td>2,553,132</td>
<td>4,926,199</td>
</tr>
<tr>
<td>Net cash provided by financing activities</td>
<td>17,956,299</td>
<td>7,605,243</td>
</tr>
<tr>
<td>Net increase (decrease) in cash and cash equivalents</td>
<td>(5,428,025)</td>
<td>4,123,806</td>
</tr>
<tr>
<td>Cash and cash equivalents, beginning of year</td>
<td>18,097,572</td>
<td>13,973,766</td>
</tr>
<tr>
<td>Cash and cash equivalents, end of year</td>
<td>$12,669,547</td>
<td>$18,097,572</td>
</tr>
</tbody>
</table>

### Supplemental disclosures

<table>
<thead>
<tr>
<th>Description</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash paid for interest</td>
<td>$761,500</td>
<td>$117,284</td>
</tr>
<tr>
<td>Noncash activity - gift of property</td>
<td>5,034,355</td>
<td>7,620,000</td>
</tr>
<tr>
<td>Construction in process additions remaining in accounts payable</td>
<td>4,523,689</td>
<td>-</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these financial statements.
To the Board of Trustees of
Woods Hole Oceanographic Institution

In our opinion, the accompanying statement of financial position and the related statements of activities and cash flows present fairly, in all material respects, the financial position of Woods Hole Oceanographic Institution (the “Institution”) at December 31, 2004, and the changes in its net assets and its cash flows for the year then ended in conformity with accounting principles generally accepted in the United States of America. These financial statements are the responsibility of the Institution’s management. Our responsibility is to express an opinion on these financial statements based on our audit. The prior year summarized comparative information has been derived from the Institution’s 2003 financial statements, and in our report dated March 19, 2004, we expressed an unqualified opinion on those financial statements. We conducted our audit of these statements in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

March 17, 2005

Notes to financial Statements

1. Background
Woods Hole Oceanographic Institution (the “Institution”) is a private, independent not-for-profit research and educational institution located in Woods Hole, Massachusetts. Founded in 1930, the Institution is dedicated to working and learning at the frontier of ocean science and attaining maximum return on intellectual and material investments in oceanographic research.

The Institution is a qualified tax-exempt organization under Section 501(c)(3) of the Internal Revenue Code as it is organized and operated for education and scientific purposes.

2. Summary of Significant Accounting Policies

Basis of Presentation
The accompanying financial statements have been prepared on the accrual basis and in accordance with the reporting principles of not-for-profit accounting.

The financial statements include certain prior-year summarized comparative information, but do not include sufficient detail to constitute a presentation in conformity with accounting principles generally accepted in the United States of America. Accordingly, such information should be read in conjunction with the Institution’s audited financial statements for the year ended December 31, 2003, from which the summarized information was derived.

Net assets, revenues, and realized and unrealized gains and losses are classified based on the existence or absence of donor-imposed restrictions and legal restrictions imposed under Massachusetts State law. Accordingly, net assets and changes therein are classified as follows:

Permanently Restricted Net Assets
Permanently restricted net assets are subject to donor-imposed stipulations that they be maintained permanently by the Institution. Generally the donors of these assets permit the Institution to use all or part of the income earned and capital appreciation, if any, on related investments for general or specific purposes.

Temporarily Restricted Net Assets
Temporarily restricted net assets are subject to donor-imposed stipulations that may or will be met by actions of the Institution and/or the passage of time. Unspent gains on permanent endowment are classified as temporarily restricted until the Institution appropriates and spends such sums in accordance with the terms of the underlying endowment funds at which time they will be released to unrestricted revenues.

Unrestricted Net Assets
Unrestricted net assets are not subject to donor-imposed stipulations. Revenues are reported as increases in unrestricted net assets unless use of the related assets is limited by donor-imposed restrictions. Expenses are reported as decreases in unrestricted net assets. Gains and losses on investments and other assets or liabilities are reported as increases or de-
creases in unrestricted net assets unless their use is restricted by explicit donor stipulations or law. Expirations of temporary restrictions on net assets, that is, the donor-imposed stipulated purpose has been accomplished and/or the stipulated time period has elapsed, are reported as reclassifications between the applicable classes of net assets. Amounts received for sponsored research (under exchange transactions) are reflected in unrestricted sponsored research and released to operations when spent for the appropriate purpose, or as deferred revenue if expenditures have yet to be incurred.

Contributions

Contributions, including unconditional promises to give, are recognized as revenues in the period received. Contributions subject to donor-imposed stipulations that are met in the same reporting period are reported as unrestricted support. Promises to give that are scheduled to be received after the balance sheet date are shown as increases in temporarily restricted net assets and are reclassified to unrestricted net assets when the purpose or items’ restrictions are met. Promises to give, subject to donor-imposed stipulations that the corpus be maintained permanently, are recognized as increases in permanently restricted net assets. Conditional promises to give are not recognized until they become unconditional, that is, when the conditions on which they depend are substantially met. Contributions other than cash are generally recorded at market value on the date of the gift (or an estimate of fair value), although certain noncash gifts, for which a readily determinable market value cannot be established, are recorded at a nominal value until such time as the value becomes known. Contributions to be received after one year are discounted at the appropriate rate commensurate with risk. Amortization of such discount is recorded as additional contribution revenue in accordance with restrictions imposed by the donor on the original contribution, as applicable. Amounts receivable for contributions are reflected net of an applicable reserve for collectibility.

The Institution reports contributions in the form of land, buildings, or equipment as unrestricted operating support at fair market value when received. Dividends, interest and net gains on investments of endowment and similar funds are reported as follows:

- as increases in permanently restricted net assets if the terms of the gift require that they be added to the principal of a permanent endowment fund;
- as increases in temporarily restricted net assets if the terms of the gift or relevant state law impose restrictions on the current use of the income or net realized and unrealized gains; and
- as increases in unrestricted net assets in all other cases.

Operations

The statement of activities report the Institution’s operating and nonoperating activities. Operating revenues and expenses consist of those activities attributable to the Institution’s current annual research or educational programs, all gifts received except those received for property, plant and equipment purposes and a component of endowment income appropriated for operations (Note 3). Unrestricted endowment investment income and gains over the amount appropriated under the Institution’s spending plan are reported as nonoperating revenue as investment return in excess of amounts designated for sponsored research, education and current operations. Nonoperating revenue also includes the change in value of split interest agreements, contributions restricted for property, plant and equipment purposes, gains or losses on disposals of fixed assets, net realized/unrealized gains (losses) on interest swaps and the net periodic pension cost (income) on the noncontributory defined benefit pension plan. Additionally, nonoperating activities includes redesignation of donor gifts and depreciation on certain government-funded facilities.

Cash and Cash Equivalents

Cash and cash equivalents consist of cash, money market accounts, certificates of deposit and overnight repurchase agreements with initial maturities of three months or less when purchased which are stated at cost, which approximates market value.

Included in restricted cash at December 31, 2004 and 2003 is $142,991 and $1,268,574, respectively, representing advances received from the United States Navy and other U.S. Government and state agencies. Such amounts are restricted as to use for research programs. Interest earned on unspent funds is remitted to the federal government.

Also included in restricted cash at December 31, 2004 and 2003 is $239,430 and $239,181, respectively, representing cash restricted by the Massachusetts Department of Public Health. Interest earned on unspent funds is reinvested within the restricted cash account.

In addition, cash and cash equivalents include uninvested amounts from each classification of net assets (e.g., endowment).

Investments

Investment securities are carried at market value determined as follows: securities traded on a national securities exchange are valued at the last reported sales price on the last business day of the year; securities traded in the over-the-counter market and listed securities for which no sales prices were reported on that day are valued at closing bid prices. The value of publicly traded securities is based upon quoted market prices and net asset values. Other securities, for which no such quotations or valuations are readily available, are carried at estimated fair value as provided by external investment managers. The Institution believes that these valuations are a reasonable estimate of fair value as of December 31, 2004 and 2003 but are subject to uncertainty and, therefore, may differ from the value that would have been used had a ready market
for the investments existed and such differences could be material.

Purchases and sales of investment securities are recorded on a trade date basis. Realized gains and losses are computed on a specific identification method. Investment income, net of investment expenses, is distributed on the unit method.

**Investment Income Unitization**

The Institution’s investments are pooled in an endowment fund and the investments and allocation of income are tracked on a unitized basis. The Institution distributes to operations for each individual fund an amount of investment income earned by each of the fund’s proportionate share of investments based on a total return policy.

The Board of Trustees has appropriated all of the income and a specified percentage of the net appreciation (depreciation) to operations as prudent considering the Institution’s long and short-term needs, present and anticipated financial requirements, expected total return on its investments, price level trends, and general economic conditions. Under the Institution’s current endowment spending policy, which is within the guidelines specified under state law, between 4 percent and 5.5 percent of the average of the market value of qualifying endowment investments at September 30 of each of the previous three years is appropriated. This amounted to $13,316,806 and $13,509,442 for the years ending December 31, 2004 and 2003, respectively, and is classified in operating revenues (research, education, and operations).

**Deposits with Trustees**

Deposits with trustees consists principally of investments in United States Government obligations and have been deposited with trustees as required under certain loan agreements. At December 31, 2004, the amounts consist of $3,154,350 for debt service and $24,278,081 for construction purposes. Interest income on debt service amounted to $20,766 in 2004 and is reflected in the statement of activities within other income. Interest income on construction funds amounted of $310,933 in 2004 and is reflected in the statement of activities within other income.

**Inventories**

Inventories are stated at the lower of cost or market. Cost is determined using the first-in, first-out method.

**Contracts and Grants**

Revenues earned on contracts and grants for research are recognized as related costs are incurred.

The Institution received approximately 92% and 90% of its operating revenues from government agencies including 57% and 50% of its operating revenues from the National Science Foundation and 14% and 21% from the United States Navy in fiscal years 2004 and 2003, respectively. Although applications for research funding to federal agencies historically have been funded, authorizations are subject to annual Congressional appropriations and payment.

**Deferred Financing Costs**

Costs incurred in connection with the placement of the Massachusetts Health and Educational Facilities Authority, Variable Rate Revenue Bonds, Woods Hole Oceanographic Institution Issue, Series 2004, have been deferred and are being amortized over the term of the obligation on a straight line basis.

**Interest Rate Swap**

The Institution has entered into an interest rate swap agreement on the Massachusetts Health and Educational Facilities Authority, Variable Rate Revenue Bonds, Woods Hole Oceanographic Institution Issue, Series 2004 Bonds in order to convert a portion of the variable rate debt to fixed rate, thereby economically hedging against changes in the cash flow requirements of the Institution’s variable rate debt obligations.

Net payments or receipts (difference between variable and fixed rate) under the swap agreement along with the change in fair value of the swap are recorded in nonoperating activities as net realized/unrealized gains (losses) on interest swap.

**Property, Plant and Equipment**

Property, plant and equipment are stated at cost. Depreciation is provided on a straight-line basis at annual rates of 12 to 39 years on buildings and improvements, 10 to 15 years on vessels and dock facilities and 5 to 10 years on laboratory and other equipment. Depreciation expense on property, plant, and equipment purchased by the Institution in the amounts of $5,058,656 and $4,485,780 in 2004 and 2003, respectively, has been charged to operating activities. Construction commitments totaled $24,339,591 at December 31, 2004.

Depreciation on certain government-funded facilities (the Laboratory for Marine Science and the dock facility) amounting to $99,976 in 2004 and $99,972 in 2003 has been charged to nonoperating expenses as these assets were gifted by the Government.

During fiscal 2004, the Institution capitalized interest of $65,500.

Included in construction in process is $18,799,066 and $4,829,373 at December 31, 2004 and 2003, respectively, relating to campus development.
Use of Estimates

The preparation of the financial statements in accordance with accounting principles generally accepted in the United States of America requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the period. Actual results could differ from those estimates.

3. Investments

The cost and market value of pooled investments held at December 31 are as follows:

<table>
<thead>
<tr>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Market</td>
</tr>
<tr>
<td>US treasury bonds</td>
<td>$27,200,000</td>
</tr>
<tr>
<td>Corporate bonds</td>
<td>17,411,829</td>
</tr>
<tr>
<td>International bonds</td>
<td>9,613,758</td>
</tr>
<tr>
<td>Equity securities and mutual funds</td>
<td>119,723,809</td>
</tr>
<tr>
<td>International equities</td>
<td>50,282,579</td>
</tr>
<tr>
<td>Hedge fund limited partnerships</td>
<td>442,829</td>
</tr>
<tr>
<td>Venture capital and private equity</td>
<td>27,584,494</td>
</tr>
<tr>
<td>Other</td>
<td>46,693</td>
</tr>
<tr>
<td>Total investments</td>
<td>$252,305,991</td>
</tr>
</tbody>
</table>

Amounts held in venture capital and investment partnerships and other investments are invested in securities or other assets for which there is not necessarily a publicly traded market value or which are restricted as to disposition. The return on such investments was $732,688 and ($128,840) for the years ended December 31, 2004 and 2003, respectively, including dividends, distributions and changes in the estimated value of such investments.

During 2003, the Institution terminated certain investment managers. Several of these managers were terminated on December 31, 2003 resulting in a receivable for investments sold of $22,044,791.

The following schedule summarizes the investment return on pooled and nonpooled investments and its classification in the statement of activities:

<table>
<thead>
<tr>
<th>Unrestricted</th>
<th>Temporarily restricted</th>
<th>2004 Total</th>
<th>2003 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dividend and interest income</td>
<td>$4,911,394</td>
<td>$1,902,554</td>
<td>$6,813,948</td>
</tr>
<tr>
<td>Investment management costs</td>
<td>(1,275,801)</td>
<td>(1,275,801)</td>
<td>(1,282,538)</td>
</tr>
<tr>
<td>Net realized gains</td>
<td>4,043,938</td>
<td>13,098,183</td>
<td>17,142,121</td>
</tr>
<tr>
<td>Change in unrealized appreciation</td>
<td>4,764,477</td>
<td>5,782,300</td>
<td>10,546,777</td>
</tr>
<tr>
<td>Total return on investments</td>
<td>$12,444,008</td>
<td>$20,783,037</td>
<td>$33,227,045</td>
</tr>
</tbody>
</table>

Investment return designated for:

- Sponsored research (4,725,103) (4,725,103) (4,696,180)
- Education (3,683,100) (1,902,554) (5,585,654) (5,671,555)
- Current operations (3,381,128) (3,381,128) (3,453,967)

Total distributions to operations (7,864,228) (13,691,885) (13,821,702)

Investment return in excess of amounts designated for sponsored research, education and current operations $5,379,780 $14,155,380 $19,535,160 $31,182,420

Investment return distributed to operations includes $375,079 and $312,260 earned on non-endowment investments for the years ended December 31, 2004 and 2003, respectively.

As a result of market declines, the fair value of certain donor restricted endowments is less than the historical cost value of such funds by $434,022 at December 31, 2004 and $1,014,212 at December 31, 2003. These unrealized losses have been recorded as reductions in unrestricted net assets. Future market gains will be used to restore this deficiency in unrestricted net assets before any net appreciation above the historical cost value of such fund increases temporarily restricted net assets.

Investment securities are exposed to various risks such as interest rate, market and credit risks. Due to the level of risk associated with certain investments, it is at least reasonably possible that changes in the value of investment securities will occur in the near term and that such changes could materially affect the market values and the amounts reported in the statement of financial position.

Endowment income is allocated to each individual fund based on a per unit valuation. The value of an investment unit at December 31 is as follows:

<table>
<thead>
<tr>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit value, beginning of year</td>
<td>$3.9177</td>
</tr>
<tr>
<td>Unit value, end of year</td>
<td>4.1517</td>
</tr>
<tr>
<td>Net change for the year</td>
<td>.2340</td>
</tr>
<tr>
<td>Investment income per unit for the year</td>
<td>.0361</td>
</tr>
<tr>
<td>Total return per unit</td>
<td>$ .2701</td>
</tr>
</tbody>
</table>

4. Pledges Receivable

Pledges that are expected to be collected within one year are recorded at their net realizable value. Pledges that are expected to be collected in future years are recorded at the present value
of estimated future cash flows. The present value of estimated future cash flows has been measured utilizing a discount rate equivalent to U.S. Treasury yields of similar maturity (ranging from 2.36–3.63, depending upon the anticipated pledge fulfillment date).

Pledges receivable consist of the following at December 31:

<table>
<thead>
<tr>
<th>Unconditional promises expected to be collected in:</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than one year</td>
<td>$2,372,251</td>
<td>$1,688,779</td>
</tr>
<tr>
<td>One year to five years</td>
<td>5,087,435</td>
<td>3,428,933</td>
</tr>
<tr>
<td>Reserve for uncollectible pledges receivable</td>
<td>(298,387)</td>
<td>(204,708)</td>
</tr>
<tr>
<td>Unamortized discount</td>
<td>(282,109)</td>
<td>(66,308)</td>
</tr>
<tr>
<td></td>
<td><strong>$6,879,193</strong></td>
<td><strong>$4,846,696</strong></td>
</tr>
</tbody>
</table>

5. Contribution Receivable from Remainder Trusts

The Institution recorded $10,043,233 and $10,532,306 at December 31, 2004 and 2003, respectively, relating to various charitable remainder trusts in its statement of financial position. The receivable and related revenue is measured at the present value of estimated future cash flows to be received and recorded in the appropriate net asset category based on donor stipulation. During the term of these agreements, changes in the value are recognized based on amortization of discounts and changes in actuarial assumptions.

6. Deferred Fixed Rate Variance

The Institution receives funding or reimbursement from federal government agencies for sponsored research under government grants and contracts. Revenue is recognized as related costs are incurred. The Institution has negotiated fixed rates with the federal government for the recovery of certain fringe benefits and indirect costs on these grants and contracts. Such recoveries are subject to carryforward provisions that provide for adjustments to be included in the negotiation of future fixed rates. The deferred fixed rate variance accounts represent the cumulative amount owed to or due from the federal government. The Institution’s rates are negotiated with the Office of Naval Research (ONR), the Institution’s cognizant agency.

The composition of the deferred fixed rate variance is as follows:

<table>
<thead>
<tr>
<th>Deferred Fixed Rate Variance asset, December 31, 2002</th>
<th>$426,870</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003 indirect costs</td>
<td>50,441,014</td>
</tr>
<tr>
<td>2002 adjustment</td>
<td>(7,930)</td>
</tr>
<tr>
<td>Amounts recovered</td>
<td>(47,662,261)</td>
</tr>
<tr>
<td>2003 change in receivable</td>
<td>2,770,823</td>
</tr>
<tr>
<td>Deferred Fixed Rate Variance asset, December 31, 2003</td>
<td><strong>3,197,693</strong></td>
</tr>
<tr>
<td>2004 indirect costs</td>
<td>51,834,850</td>
</tr>
<tr>
<td>2003 adjustment</td>
<td>1,081</td>
</tr>
<tr>
<td>Amounts recovered</td>
<td>(55,163,124)</td>
</tr>
<tr>
<td>2004 change in receivable</td>
<td><strong>(3,327,193)</strong></td>
</tr>
<tr>
<td>Deferred Fixed Rate Variance liability, December 31, 2004</td>
<td><strong>$ (129,500)</strong></td>
</tr>
</tbody>
</table>

As of December 31, 2004, the Institution has received a cumulative recovery in excess of expended amounts of $129,500 which will be reflected as a deduction to future year recoveries. This amount has been reported as liability of the Institution.

7. Bond and Loans Payable

In fiscal 2004, proceeds were received from the offering of the $54,850,000 Massachusetts Health and Educational Facilities Authority (MHEFA) Variable Rate Revenue Bonds, Woods Hole Oceanographic Institution Issue, Series 2004, which were used to repay the MHEFA B Pool loans and are being used for campus construction. The bonds contain certain restrictive covenants including limitations on obtaining additional debt, filings of annual financial statements and limitations on the creation of liens. In addition, the Institution agrees that, subject to any governmental restrictions, its fiduciary obligations and limitations imposed by law, it will maintain unrestricted resources at a market value equal to at least 75% of all outstanding indebtedness. The bonds also require a debt service fund to be established. Included in deposits with trustees on the statement of financial position is the market value of the debt service fund of $3,154,350 at December 31, 2004. The Series 2004 Bonds are collateralized by the Institution’s unrestricted revenues and bond insurance. The interest rate for the Series 2004 Bonds is variable and set weekly, and at December 31, 2004, the rate was 2.28%.

The aggregate maturities due on long-term debt at December 31, 2004 are as follows:

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Principal Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>$1,150,000</td>
</tr>
<tr>
<td>2009</td>
<td>1,200,000</td>
</tr>
<tr>
<td>Thereafter</td>
<td>52,500,000</td>
</tr>
<tr>
<td></td>
<td><strong>$54,850,000</strong></td>
</tr>
</tbody>
</table>

In June 2004, the Institution entered into an interest rate swap agreement, with a term through June 1, 2034. This swap effectively locks in a fixed rate of 3.79% per annum. The agreement has a notional amount of $54,850,000. At December 31, 2004, the market value of the swap agreement amounted to a liability of $3,298,000. The value of the interest rate swap is reflected within accounts payable and other liabilities and nonoperating income/expense in the financial statements. Additionally, the Institution incurred additional interest expense in association with the swap agreement of $722,690 which is reflected as part of the net realized/unrealized gains (losses) on interest swap. For internal financial reporting purposes, the realized/unrealized loss on the interest rate swap is reflected in operating expenses, and interest income and interest expense related to the debt is reflected in operating income and operating expenses, respectively.

The following loans were outstanding in the prior year. These loans were repaid in 2004.

On May 27, 1999, the Institution entered into a $3,000,000 loan agreement with the Massachusetts Health and Educational Facilities Authority (the “Authority”) to finance various
On January 31, 2000, the agreement was amended to increase the maximum loan commitment to $6,000,000. As of December 31, 2003, $5,485,951 had been drawn down on the loan and was outstanding at year-end. The Institution was required to pay interest on the drawdowns at a variable rate established by the Authority, which was 1% at December 31, 2003.

On March 1, 2001, the Institution entered into an $11,000,000 loan agreement with the Authority to finance additional capital projects. As of December 31, 2003, $5,238,255 had been drawn down on the loan and was outstanding at year-end. Drawdowns were expected to occur during an eighteen-month period. During this period, no principal payments were due on the loan, but the Institution was required to pay interest on the drawdowns at a variable rate established by the Authority, which was 1% at December 31, 2003.

The Institution’s variable rate debt approximates fair value. Fair value is based on estimates using current interest rates available for debt with equivalent maturities.

8. Retirement Plans

The Institution maintains a noncontributory defined benefit pension plan covering substantially all employees of the Institution, a restoration plan for certain senior employees and a supplemental benefit plan for certain other employees. Pension benefits are earned based on years of service and compensation received. The Institution’s policy is to fund at least the minimum required by the Employee Retirement Income Security Act of 1974.

The Institution uses a December 31 measurement date for all of its plans.

<table>
<thead>
<tr>
<th>Restoration Plan Pension Benefits</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in benefit obligation</td>
<td>$1,200,690</td>
<td>$790,023</td>
</tr>
<tr>
<td>Benefit obligation at beginning of year</td>
<td>25,699</td>
<td>21,155</td>
</tr>
<tr>
<td>Service cost</td>
<td>86,005</td>
<td>77,640</td>
</tr>
<tr>
<td>Interest cost</td>
<td>(190,939)</td>
<td>-</td>
</tr>
<tr>
<td>Plan amendments</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Actuarial loss</td>
<td>197,601</td>
<td>311,872</td>
</tr>
<tr>
<td>Benefit obligation at end of year</td>
<td>$1,319,056</td>
<td>$1,200,690</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in plan assets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair value of plan assets at beginning of year</td>
<td>$</td>
</tr>
<tr>
<td>Employer contributions</td>
<td>-</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>-</td>
</tr>
<tr>
<td>Fair value of plan assets at end of year</td>
<td>$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funded status</th>
<th>$(1,319,056)</th>
<th>$(1,200,690)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrecognized net actuarial loss</td>
<td>355,726</td>
<td>294,893</td>
</tr>
<tr>
<td>Unrecognized prior service cost</td>
<td>(28,941)</td>
<td>249,648</td>
</tr>
<tr>
<td>Net amount recognized</td>
<td>(992,271)</td>
<td>(656,149)</td>
</tr>
</tbody>
</table>

Amounts recognized in the statement of financial position consist of

<table>
<thead>
<tr>
<th>Accrued benefit liability</th>
<th>$(1,090,718)</th>
<th>$(770,184)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intangible asset</td>
<td>-</td>
<td>114,035</td>
</tr>
<tr>
<td>Cumulative reduction in net assets</td>
<td>98,447</td>
<td>-</td>
</tr>
<tr>
<td>Net amount recognized</td>
<td>$(992,271)</td>
<td>$(656,149)</td>
</tr>
</tbody>
</table>

Cumulative reduction in net assets attributable to change in additional minimum liability recognition

| Information for pension plans with accumulated benefit obligations in excess of plan assets |
|---------------------------------|----------------|----------------|
| Projected benefit obligation   | $1,319,056    | $1,200,690    |
| Accumulated benefit obligation | 1,090,718     | 770,184       |
| Fair value of plan assets      | $              | -             |
Restoration Plan Pension Benefits

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service cost</td>
<td>$25,699</td>
<td>$21,155</td>
</tr>
<tr>
<td>Interest cost</td>
<td>86,005</td>
<td>77,640</td>
</tr>
<tr>
<td>Amortization of prior service cost</td>
<td>87,650</td>
<td>87,650</td>
</tr>
<tr>
<td>Recognized actuarial loss</td>
<td>136,768</td>
<td>157,440</td>
</tr>
<tr>
<td><strong>Net periodic benefit cost</strong></td>
<td><strong>$36,122</strong></td>
<td><strong>$343,885</strong></td>
</tr>
</tbody>
</table>

Weighted-average assumptions used to determine benefit obligations at December 31

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>5.75%</td>
<td>6.25%</td>
</tr>
<tr>
<td>Rate of compensation increase</td>
<td>6.00%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

Weighted-average assumptions used to determine net periodic benefit cost for years ended December 31

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>6.25%</td>
<td>6.75%</td>
</tr>
<tr>
<td>Rate of compensation increase</td>
<td>6.00%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

### Expected Contributions

The Institution does not anticipate contributing to the Restoration Plan in 2005.

### Estimated Future Benefit Payments

The following benefit payments, which reflect expected future service, are expected to be paid as follows:

<table>
<thead>
<tr>
<th>Years</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008 and thereafter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit Payments</td>
<td>$</td>
<td>93,887</td>
<td>1,427,185</td>
<td></td>
</tr>
</tbody>
</table>

Qualified Plan Pension Benefits

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in benefit obligation</td>
<td>$176,914,377</td>
<td>$169,123,168</td>
</tr>
<tr>
<td>Benefit obligation at beginning of year</td>
<td>$7,006,323</td>
<td>6,118,111</td>
</tr>
<tr>
<td>Service cost</td>
<td>11,250,529</td>
<td>11,068,835</td>
</tr>
<tr>
<td>Interest cost</td>
<td>(27,041,213)</td>
<td>-</td>
</tr>
<tr>
<td>Actuarial loss</td>
<td>18,666,776</td>
<td>4,019,659</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(8,869,550)</td>
<td>(13,415,396)</td>
</tr>
<tr>
<td>Benefit obligation at end of year</td>
<td>$177,927,242</td>
<td>$176,914,377</td>
</tr>
</tbody>
</table>

Change in plan assets

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair value of plan assets at beginning of year</td>
<td>$143,751,387</td>
<td>$133,980,735</td>
</tr>
<tr>
<td>Employer contributions</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Actual return on plan assets</td>
<td>15,734,494</td>
<td>23,186,048</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(8,869,550)</td>
<td>(13,415,396)</td>
</tr>
<tr>
<td>Fair value of plan assets at end of year</td>
<td>$150,616,331</td>
<td>$143,751,387</td>
</tr>
</tbody>
</table>

Unrecognized actuarial loss

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>$27,310,911</td>
<td>$33,162,990</td>
<td></td>
</tr>
<tr>
<td>Unrecognized prior service cost</td>
<td>(18,447,001)</td>
<td>9,397,478</td>
</tr>
<tr>
<td><strong>Net amount recognized</strong></td>
<td><strong>$(9,649,930)</strong></td>
<td><strong>$(645,885)</strong></td>
</tr>
</tbody>
</table>

Amounts recognized in the statement of financial position consist of:

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accrued benefit liability</td>
<td>$(23,606,689)</td>
<td>$(6,176,090)</td>
</tr>
<tr>
<td>Cumulative reduction in net assets</td>
<td>13,956,759</td>
<td>-</td>
</tr>
<tr>
<td>Intangible asset</td>
<td>-</td>
<td>5,530,205</td>
</tr>
<tr>
<td><strong>Net amount recognized</strong></td>
<td><strong>$(9,649,930)</strong></td>
<td><strong>$(645,885)</strong></td>
</tr>
</tbody>
</table>

Cumulative (addition) reduction in net assets attributable to change in additional minimum liability recognition

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected benefit obligation</td>
<td>177,927,242</td>
<td>176,914,377</td>
</tr>
<tr>
<td>Accumulated benefit obligation</td>
<td>174,223,020</td>
<td>149,927,477</td>
</tr>
<tr>
<td>Fair value of plan assets</td>
<td>150,616,331</td>
<td>143,751,387</td>
</tr>
</tbody>
</table>

Information for pension plans with accumulated benefit obligations in excess of plan assets

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components of net periodic benefit cost</td>
<td>Service cost</td>
<td>7,006,323</td>
</tr>
<tr>
<td></td>
<td>Interest cost</td>
<td>11,250,529</td>
</tr>
<tr>
<td></td>
<td>Expected return on plan assets</td>
<td>(11,708,592)</td>
</tr>
<tr>
<td></td>
<td>Amortization of prior service cost</td>
<td>1,343,266</td>
</tr>
<tr>
<td></td>
<td>Recognized actuarial loss</td>
<td>1,112,519</td>
</tr>
<tr>
<td><strong>Net periodic benefit cost</strong></td>
<td><strong>$9,004,045</strong></td>
<td><strong>$5,819,299</strong></td>
</tr>
</tbody>
</table>

The Institution has reflected the net periodic benefit cost in nonoperating income. In 2004, the Institution was required to record an additional charge of $13,956,759 to reflect a minimum balance sheet liability equal to the Plan’s unfunded accumulated benefit obligation. In 2003, the additional minimum liability that was established in 2002 was reversed as the minimum balance sheet liability was no longer necessary.
The following target asset allocation is used:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>Target Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. equity</td>
<td>30%</td>
</tr>
<tr>
<td>Global excluding U.S. equity</td>
<td>12%</td>
</tr>
<tr>
<td>Emerging markets equity</td>
<td>3%</td>
</tr>
<tr>
<td>Hedge fund of funds</td>
<td>15%</td>
</tr>
<tr>
<td>Alternative investments</td>
<td>15%</td>
</tr>
<tr>
<td>Real assets</td>
<td>5%</td>
</tr>
<tr>
<td>Bonds</td>
<td>20%</td>
</tr>
</tbody>
</table>

The primary financial objectives of the assets of the Plan are to (1) provide a stream of relatively predictable, stable and constant earnings in support of the Qualified Plan’s annual benefit payment obligations; and (2) preserve and enhance the real (inflation-adjusted) value of assets, over time, with the goal of meeting the anticipated future benefit obligations of the qualified plan.

The long-term investment objectives of the assets of the Plan are to (1) attain the average annual total return assumed in the Plan’s most recent actuarial assumptions (net of investment management fees) over rolling five-year periods; and (2) outperform the custom benchmark.

**Contributions**

The Institution anticipates contributing $1,900,000 to the Qualified Plan in 2005.

**Estimated Future Benefit Payments**

The following benefit payments, which reflect expected future service are expected to be paid as follows:

<table>
<thead>
<tr>
<th>Years</th>
<th>Benefit Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$12,282,106</td>
</tr>
<tr>
<td>2006</td>
<td>14,891,932</td>
</tr>
<tr>
<td>2007</td>
<td>14,810,058</td>
</tr>
<tr>
<td>2008</td>
<td>14,622,043</td>
</tr>
<tr>
<td>2009</td>
<td>15,776,625</td>
</tr>
<tr>
<td>Years 2010 - 2014</td>
<td>79,904,781</td>
</tr>
</tbody>
</table>
### Supplemental Plan Pension Benefits

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit obligation at beginning of year</td>
<td>$3,430,977</td>
<td>$3,282,549</td>
</tr>
<tr>
<td>Service cost</td>
<td>89,087</td>
<td>78,650</td>
</tr>
<tr>
<td>Interest cost</td>
<td>227,880</td>
<td>209,638</td>
</tr>
<tr>
<td>Actuarial loss</td>
<td>393,799</td>
<td>53,532</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(219,460)</td>
<td>(193,392)</td>
</tr>
<tr>
<td><strong>Benefit obligation at end of year</strong></td>
<td><strong>$3,922,283</strong></td>
<td><strong>$3,430,977</strong></td>
</tr>
</tbody>
</table>

### Change in plan assets

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair value of plan assets at beginning of year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Employer contributions</td>
<td>219,460</td>
<td>193,392</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(219,460)</td>
<td>(193,392)</td>
</tr>
<tr>
<td><strong>Fair value of plan assets at end of year</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

### Funded status

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(3,922,283)</td>
<td>$(3,430,977)</td>
<td></td>
</tr>
<tr>
<td>Unrecognized actuarial loss (gain)</td>
<td>331,548</td>
<td>(115,013)</td>
</tr>
<tr>
<td>Unrecognized prior service cost</td>
<td>1,316</td>
<td>1,631</td>
</tr>
<tr>
<td><strong>Net amount recognized</strong></td>
<td><strong>$(3,589,419)</strong></td>
<td><strong>$(3,544,359)</strong></td>
</tr>
</tbody>
</table>

### Accrued benefit liability

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(3,589,419)</td>
<td>$(3,544,359)</td>
<td></td>
</tr>
</tbody>
</table>

### Information for pension plans with accumulated benefit obligations in excess of plan assets

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected benefit obligation</td>
<td>$3,922,283</td>
<td>$3,430,977</td>
</tr>
<tr>
<td>Accumulated benefit obligation</td>
<td>3,402,514</td>
<td>2,854,088</td>
</tr>
<tr>
<td>Fair value of plan assets</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Components of net periodic benefit cost

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service cost</td>
<td>89,087</td>
<td>$78,650</td>
</tr>
<tr>
<td>Interest cost</td>
<td>227,880</td>
<td>209,638</td>
</tr>
<tr>
<td>Expected return on earmarked reserves</td>
<td>(213,372)</td>
<td>(215,441)</td>
</tr>
<tr>
<td>Amortization of prior year service cost</td>
<td>315</td>
<td>315</td>
</tr>
<tr>
<td><strong>Net periodic benefit cost</strong></td>
<td><strong>$103,910</strong></td>
<td><strong>$73,162</strong></td>
</tr>
</tbody>
</table>

### Actual return on earmarked reserves

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>$160,610</td>
<td>$124,929</td>
<td></td>
</tr>
</tbody>
</table>

### Weighted-average assumptions used to determine benefit obligations at December 31

- Discount rate: 5.7% 6.25%
- Rate of compensation increase: 3.50% 3.50%

### Weighted-average assumptions used to determine net periodic benefit cost for years ended December 31

- Discount rate: 6.25% 6.75%
- Expected long-term rate of return on plan assets: 8.50% 8.50%
- Rate of compensation increase: 3.50% 3.50%

The accrued supplemental retirement is matched by a “Rabbi” Trust with $6,537,921 and $6,257,039, respectively, as of December 31, 2004 and 2003. An additional accrual of $2,948,502 and $2,712,680 has been established for the excess of the “Rabbi” Trust assets over the accrued supplemental retirement benefits at December 31, 2004 and 2003, respectively.

### Contributions

The Institution anticipates paying benefit payments to the Supplemental Plan of $299,004 from earmarked reserves in 2005.

### Estimated Future Benefit Payments

The following benefit payments, which reflect expected future service are expected to be paid as follows:

<table>
<thead>
<tr>
<th>Years</th>
<th>Benefit Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$299,004</td>
</tr>
<tr>
<td>2006</td>
<td>275,996</td>
</tr>
<tr>
<td>2007</td>
<td>268,327</td>
</tr>
<tr>
<td>2008</td>
<td>256,312</td>
</tr>
<tr>
<td>2009</td>
<td>229,250</td>
</tr>
<tr>
<td>Years 2010 - 2014</td>
<td>1,097,300</td>
</tr>
</tbody>
</table>
9. Other Postretirement Benefits

In addition to providing retirement plan benefits, the Institution provides certain health care benefits for retired employees and their spouses. Substantially all of the Institution’s employees may become eligible for the benefits if they reach normal retirement age (as defined) or elect early retirement after having met certain time in service criteria.

For measurement purposes, annual rates of increase of 11.5% and 9% in the per capita cost of covered healthcare benefits was assumed for 2004 and 2003 for both pre-65 and post-65 benefits. These were assumed to decrease gradually to 5.0% in 2013 and remain at that level thereafter.

For measurement purposes, annual rates of increase of 11.5% and 9% in the per capita cost of covered healthcare benefits was assumed for 2004 and 2003 for both pre-65 and post-65 benefits. These were assumed to decrease gradually to 5.0% in 2013 and remain at that level thereafter.

The Institution has reflected the net periodic benefit cost in operating expenses, as the amount is reimbursed through federal awards.

On December 8, 2003, Medicare reform legislation was enacted, providing a Medicare prescription drug benefit beginning in 2006 and federal subsidies to employers who provide drug coverage to retirees. The Institution decided not to reflect the future government subsidy in the fiscal 2004 expense. However, in December 2004, the Institution amended the plan to eliminate prescription drug coverage for all post-65 retirees effective January 1, 2006, and to encourage enrollment in Medicare Part D by reimbursing Medicare Part D premiums beginning in 2006. These changes have been reflected in the obligations as of December 31, 2004.

Assumed health care cost trend rates at December 31:

- Health care cost trend rate assumed for next year: 11.0% for both Pre-65 and Post-65
- Rate to which the cost trend rate is assumed to decline: 5.0% for both Pre-65 and Post-65
- Year that the rate reaches the ultimate trend rate: 2014 for Pre-65 and 2013 for Post-65

Assumed health care cost trend rates have a significant effect on the amounts reported for the health care plan. A one-percentage-point change in assumed health care cost trend rates would have the following effects:

<table>
<thead>
<tr>
<th>Year</th>
<th>One-Percentage-Point Increase in Trend</th>
<th>One-Percentage-Point Decrease in Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Effect on total of service cost and interest cost components $803,127 $578,023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Effect on year-end postretirement benefit obligation $3,682,332 $5,633,557</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>Effect on total of service cost and interest cost components $410,645 $446,376</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Effect on year-end postretirement benefit obligation $3,002,534 $4,483,697</td>
<td></td>
</tr>
</tbody>
</table>
Plan Assets
The Institution’s postretirement benefit plan weighted-average asset allocations at December 31, 2004 and 2003, by asset category are as follows:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>2004</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity securities</td>
<td>82%</td>
<td>81%</td>
</tr>
<tr>
<td>Debt securities</td>
<td>18%</td>
<td>19%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The asset allocation follows the broad allocation of 80% equities and 20% fixed income.

To develop the expected long-term rate of return on assets assumption, the Institution considered the current level of expected returns on risk-free investments (primarily government bonds), the historical level of the risk premium associated with the other asset classes in which the portfolio is invested and the expectations for future returns of each asset class. The expected return for each class was then weighted based on the target asset allocation to develop the expected long-term rate of return on assets assumption for the portfolio, net of expenses expected to be paid. This resulted in the selection of the 8.50% assumption.

Contributions
The Institution anticipates contributing $893,000 to its retiree medical plan in 2005.

Estimated Future Benefit Payments
The following benefit payments, which reflect expected future service are expected to be paid as follows:

<table>
<thead>
<tr>
<th>Years</th>
<th>Benefit Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$1,515,281</td>
</tr>
<tr>
<td>2006</td>
<td>1,243,486</td>
</tr>
<tr>
<td>2007</td>
<td>1,260,392</td>
</tr>
<tr>
<td>2008</td>
<td>1,270,574</td>
</tr>
<tr>
<td>2009</td>
<td>1,267,858</td>
</tr>
<tr>
<td>Years 2010 - 2014</td>
<td>6,058,206</td>
</tr>
</tbody>
</table>

10. Commitments and Contingencies
The Defense Contract Audit Agency (DCAA) is responsible for auditing both direct and indirect charges to grants and contracts on behalf of the ONR. The Institution and the ONR have settled the years through 2003. The current indirect cost recovery rates, which are fixed, include the impact of prior year settlements. The DCAA issued an audit report on the completed audit of direct and indirect costs for the year ended December 31, 2003 on September 21, 2004. The audit resulted in no questioned direct or indirect costs.

The Institution through its endowment fund is committed to invest approximately $24,000,000 in certain venture capital and investment partnerships as of December 31, 2004.

The Institution is a defendant in legal proceedings incidental to the nature of its operations. The Institution believes that the outcome of these proceedings will not materially affect its financial position.

11. Related Party Transactions
In fiscal year 2004, the Institution passed through Federal Awards of approximately $1,247,000 to subgrantee organizations in which an individual at the subgrantee organization is also a member of the Institution’s Board of Trustees or Corporation. The Institution also has other transactions such as legal services and other items with organizations where members of the Board of Trustees or Corporation are affiliated with the organizations. Total expenditures for legal and other transactions were approximately $496,000 for the year ended December 31, 2004.

The Institution has loans due from various employees for education advances and computer purchases. The amounts outstanding are approximately $643,000 at December 31, 2004.

12. Clark Laboratory Fire
In October 2002, the Institution experienced a fire in the Clark Laboratory Building which resulted in contamination and damage to several laboratories, clean rooms and equipment. Since then, the Institution has coordinated with its insurance carrier and other interested parties to identify and quantify the damage caused by the fire. At December 31, 2002, the Institution had recorded a receivable due from the insurance company of approximately $13,259,000 to reflect the estimated insurance proceeds to cover the cost of renting temporary clean laboratories, repairing the laboratories, and cleaning and repairing or replacing damaged or destroyed equipment. Additionally, the Institution established an accrual of approximately $14,669,000 to estimate the costs to be paid going forward associated with the fire. Included in the accrual but not covered by insurance was approximately $1,500,000 relating to displaced employees’ salaries, fringe benefits and general and administrative costs as well as $100,000 associated with renting temporary clean laboratories. The total amount not covered by insurance of $1,600,000 was reflected in 2002 as a loss on the fire.

In 2003 and 2004, the Institution has continued to coordinate its fire loss recovery efforts with its insurance carrier and other interested parties. At December 31, 2004 and 2003, respectively, a receivable due from the insurance company of $2,293,000 and $7,435,000 and an accrual of $1,889,000 and $8,877,000 are included in the statement of financial position. During 2003, $4,000,000 was received in cash from the insurance company and approximately $4,150,000 was paid to various outside parties for fire-related damages. During 2004, $1,000,000 was received in cash from the insurance company and approximately $2,718,000 was paid to various outside parties for fire-related damages. The receivable and related accrual have been adjusted during 2004 and 2003 as more information has become available. The estimated amounts continue to be subject to revision. A gain on the fire of $129,000 was recognized in 2004. Any additional resulting gain or loss related to accounting for the fire will be recognized when such amounts can be determined with certainty.