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WOODS HOLE Currents

Digging into HURRICANES

CONTENTS

WOODS HOLE Currents

2 We Never Promised You a Rose Garden
Seafloor Eruption Paves Over Historic Vent Site

4 Getting the Dirt on Hurricanes
Jeff Donnelly Digs Into Historic Storms

8 Science Under Siege
Pirates and Politics Encroach on Ocean Research

12 Losing a Mate, Finding Themselves
Knorr *Crew Receives 2001 Penzance Award*

WHOI Waypoints, Pages 15 to 20

- USNS *Mary Sears* Visits Namesake's Woods Hole Home
- WHOI Celebrates Pioneering Woman Oceanographer
- The Albatross About His Neck Was Hung
- The Rest of Them Wore Medals
- Two Elected to Academy
- Scientists Share Ocean Discoveries with the Public
- "Planet Ocean"
- Carolyn Bunker Appointed Chief Financial Officer
- An Ocean of Ideas for Planned Giving
- New Look for Quissett Campus

COVER: Hurricane Erin menaces the North Atlantic Coast in September 2001. Inset photos show the damage wrought in Woods Hole and nearby Silver Beach during the Great New England Hurricane of 1938, as well as scientists digging up the sediments that record such storms. PHOTO CREDITS: Jacques Descloitres, MODIS/Terra satellite, NASA/GSFC; WHOI Archives; and Jeffrey Donnelly.

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THE WOODS HOLE OCEANOGRAPHIC INSTITUTION is a private, independent, not-for-profit corporation dedicated to research and higher education at the frontiers of ocean science. WHOI's primary mission is to develop and communicate a basic understanding of how the oceans function and how they interact with the earth as a whole. The Institution strives to be a world leader in advancing knowledge about the oceans and explaining their critical role in the global environment.

Capitalists visit Wall Street. Lawyers go to the Supreme Court. Marine biologists go to the "Rose Garden." Or at least they used to.

Discovered in 1979 not far from the Galápagos Islands, the Rose Garden (inset photo) was an ocean scientist's paradise, a hydrothermal vent site lush with life. Tubeworms covered the seafloor, their blood-red tips peeking out of slim, 6-foot white tubes. Like flower petals atop tall stems, they swayed in the shimmering breeze of warm vent fluids.

The surprising discovery of rich communities of life on the sunless seafloor fundamentally rearranged ideas about the origin and evolution of life on Earth. It also offered entirely new perspectives on the search for life on other planets.

Scientists eagerly revisited the site in 1985, 1988, and 1990. They were intrigued to find that mussels and clams had started to overrun the tubeworms. In May 2002, they set out on *Atlantis* to find out how Rose Garden had changed in a dozen years. But they did not find Rose Garden, nor any trace of previous *Alvin* visits such as seafloor markers and dive weights. Instead they found fields of fresh lava.

"We think a seafloor eruption of lava since 1990 may have overrun and paved over Rose Garden—like Pompeii after Mount Vesuvius erupted," said Tim Shank, the expedition's co-chief scientist and a WHOI biologist. "It is a bittersweet reminder of just how dynamic the seafloor is."

Not far from the original Rose Garden site—atop the new lava flow—Shank and colleagues discovered a new community of adolescent clams, mussels, and tubeworms, (large photo) some as small as an inch tall. They named the new site "Rosebud."

"The new 'Rosebud' community could be very young—less than a year old," Shank said. "This is an exciting opportunity to watch the development of a new community almost from its very beginnings."

The 2002 Galápagos Expedition was funded by the Ocean Exploration Program of the National Oceanic and Atmospheric Administration, by the National Science Foundation, by Woods Hole Oceanographic Institution, and by WHOI's Deep Ocean Exploration Institute. For more information, visit www.divediscover.whoi.edu.

Photo by Tim Shank, Inset Photo by Fred Grassle

We Never Promised You

A Rose Garden

Getting the Dirt on HURRICANES

By Michael Carlowicz

21 September 1938 *– With little warning from forecasters, the Great New England Hurricane raced toward land at 60 miles per hour (the fastest forward speed of any hurricane in regional history), cutting a path of destruction across Long Island and deep into New England. Sustained winds exceeded 121 mph, and a gust of 186 mph was recorded in Milton, Massachusetts, both records for New England. The storm surge reached 20 feet in Narragansett Bay, and wave heights reached 50 feet off Gloucester. By the time it blew away, New England's last "intense" hurricane—defined as category 3 or higher on the Saffir-Simpson scale (see page 7)—took the lives of more than 700 people and destroyed more than 8,900 homes and buildings. Property damage was estimated at $400 million in Depression-era dollars.*

Most hurricane researchers look at the atmosphere to study their subjects. Some look in the history archives. Jeff Donnelly looks in the mud.

In Succotash Marsh, Rhode Island, on Whale Beach in New Jersey, in Long Beach, New York, Donnelly unearths the history of intense hurricanes in the Northeast. By digging up sediments from back bays and coastal marshes, he can reveal the past and perhaps the future of hurricanes.

As a graduate student at Yale and Brown in the 1990s, Donnelly took sediment cores from salt marshes, searching for evidence of past sea-level changes. He sank metal tubes into marshes and pulled up twenty-foot cylinders of mud—much like using suction and a well-placed fingertip to keep a milkshake suspended in a straw. Layered within the cores were sediments containing pollen grains, plant fragments, and sand layers that helped spell out what had happened in the ancient coastal environment.

"As a kid, I was always into dirt," says Donnelly, an Assistant Scientist in WHOI's Geology and Geophysics Department. "But I didn't just want to get dirty. I wanted to figure out the riddles that the Earth could provide the answers to. Earth has a wonderful story to tell if you know how to read its pages."

Donnelly grew up in southeastern Massachusetts with a rock collection and a love for science and history. "When I was trying to decide what kind of scientist I was going to be, I decided that I wanted my work to be useful and relevant to people," he notes. "In my view, the coastal zone is ground zero for many of the environmental challenges society is facing."

His interest in dirt and history became an asset when Donnelly's advisor at Brown, geologist Tom Webb, got involved with a hurricane research project in 1996. Colleagues working on the Risk Prediction Initiative (RPI), based out of the Bermuda Biological Station for Research, asked Webb if he could find evidence of hurricanes in the records of vegetation changes he was collecting from New England lakes. Webb didn't see such a signal as

The surge of water during an intense hurricane carries sand from the beach into the marshes behind a barrier island.

he identified and counted pollen grains preserved in the mud of the lakes, but he had a graduate student who was willing to look for one near the coast. Donnelly was suddenly a hurricane researcher.

Webb and Donnelly were funded by RPI to help prove that you could find hurricanes in the coastal geologic record. The fieldwork began at Succotash Marsh (near Kingston, RI) because it sits behind a barrier beach that protects it from constant changes along the surf line. Sifting through the sediments, Donnelly found layers of sand mixed between peat. That sand, he surmised, must have been washed into the marsh by great storms. Essentially, a hurricane or Nor'easter would have had to wash sand from the shoreline all the way into the back bay. And it would have to be a pretty potent storm to move sand that far, over dunes and other coastal formations.

Jeff Donnelly

Donnelly used his geologic dating tools—pollen grains, industrial metal residues, carbon 14—to estimate when those sandy sediments were laid down. He then compared his records with aerial photos of the "overwash" fans spread by known historical hurricanes. The sand layers were reliable evidence of the biggest storms. Taking samples from several other sites along the New England coast, he found he had a record of major hurricane activity stretching back 600 to 1,000 years, well beyond the meteorological data. Such a long record would allow scientists to estimate the long-term return rates of intense, landfalling hurricanes.

"I was surprised to see that the concept worked," Donnelly recalls. "We really could constrain the dates of hurricanes pretty well." The research was modeled after a study by Kam-biu Liu of Louisiana State University, who had found evidence of ancient Gulf Coast hurricanes in coastal lake deposits in Alabama and Florida.

***3 September 1821** — Perhaps the most destructive hurricane in the history of New York City raised a ten-foot surge of water in just one hour onto the Battery in lower Manhattan—the highest surge ever recorded in New York Harbor. The storm had moved from North Carolina to New York in just ten hours, and hurricane winds were experienced as far west as Philadelphia. Though reliable meteorological records are scarce, eyewitness accounts and historic reconstructions suggest the storm made landfall near*

Marie Walcott

Near Hick's Beach, NY, Jeff Donnelly (right) and colleagues balance a metal tube used to extract sediment cores from the marsh. Such sediments (photo at left) allow Donnelly to chronicle the landfall of historic hurricanes, such as the 1635, 1938, and 1954 storms that struck New England.

Jayne Doucette

Jamaica Bay as a category 3 hurricane. It was the only time in recorded history that New York took a direct hit from an intense hurricane.

After Miami and New Orleans, New York City is considered the most troubling target for a major hurricane disaster. Recent research using theoretical models suggests that a modern category 4 hurricane would drown John F. Kennedy International Airport under 20 feet of water and would flood the Holland and Brooklyn-Battery tunnels and the subways.

That is frightening news to the insurance industry, which has liability for more hurricane-endangered property in New York than in any state besides Florida. After getting hammered by Hurricane Andrew in 1992, insurers decided that they needed to know more about the long-term return rates of major hurricanes. The storm database at the National Oceanic and Atmospheric Administration only goes back to the mid 1800s, so no one really knows whether the 1821 and 1938 hurricanes are hundred-year events or thousand-year events at those locations.

"We need to know how frequent these major hurricanes may be for societal reasons," says Chris Landsea, an atmospheric scientist in NOAA's Hurricane Research Division. "For instance, when you develop building codes, you need to decide whether you have to prepare for 100 mph winds every 100 years or every 10 years."

"But until we get a few big ones, I am not sure the public and policy makers are going to take notice," Landsea adds. "It is probably going to take a few $10 billion hurricanes to get their attention."

While the science policy makers may have other research priorities and interests, insurers have a vested economic interest. So for the past decade, Donnelly and other researchers looking at hurricane history have secured funding from insurance underwriters, by way of the Risk Prediction Initiative.

"At an RPI meeting in Bermuda geologists were giving the long-term perspective on hurricanes over thousands of years," Webb recalls. "Then Jeff got up and gave a picture of the past 700 years. The insurance folks stood up and said 'That's what we need to know. That's much closer to our time frame.'"

Jeff Donnelly

A cross-section of a marsh at Barn Island, CT, shows the layers of sand laid down by Hurricane Carol in 1954 (at 10 centimeters) and the 1938 Hurricane (at 14 centimeters).

***25 August 1635** – Barely a decade after the European settlement of New England, the Great Colonial Hurricane cuts straight across Buzzards Bay and Cape Cod Bay and pounds southeastern Massachusetts with a storm surge over 20 feet. The leaders of the two English colonies—John Winthrop of Massachusetts Bay and William Bradford of Plymouth—made the first historical record of an intense hurricane striking New England, a storm that nearly wiped out early settlements. Given the size of the storm surge and the tales of extensive destruction of forests, modern researchers believe the hurricane was at least as powerful as the 1938 storm.*

Though hurricanes in New England don't have the notoriety that they do in the Florida Keys, the Carolina Coast, or the Gulf States, the region has taken its share of hurricane hits. Intense hurricanes—category 3 or higher—are relatively rare in New England because the cooler sea surface temperatures and prevailing winds weaken the storms or bend them eastward.

But when intense hurricanes do strike New England, the wind speed on the eastern side of the storm is often accentuated by the fast forward motion of the whole system, creating a greater storm surge. Because Long Island and New England jut out into the western Atlantic, they are a mark for fast-moving tropical storms tracking north. Donnelly's research suggests that a fast-moving category 3 hurricane hits about every ninety to one hundred years.

Donnelly would like to know more about this history and whether there are larger patterns at work in the cycle of hurricanes. He is slowly working up and down the East Coast, "trying to get samples from Virginia to Cape Cod in every suitable marsh" and combining his hurricane research with his interest in long-term climate change. One of the scenarios of current global warming projections is that hurricanes might become more frequent and more intense. Donnelly is trying to figure out if that is historically accurate. So far his data suggests little change in hurricane frequency over the past 700 years, a period

when the global climate has cooled with a "Little Ice Age" and warmed in the Industrial Age. "But intense hurricanes are so infrequent here that it is hard to get a statistically valid sample size to compare with climate," he observes.

In the Gulf of Mexico, where Liu has been working in back-barrier freshwater lakes, the geological evidence for hurricanes extends further back into history, though it is somewhat less precise in the storm-by-storm details. "Our records go back about 5,000 years, and we definitely see a long-term cycle," he notes. From about 5,000 to 3,400 years ago, hurricane patterns in the Gulf Coast were relatively mild. From 3,400 to 1,000 years ago, the region endured a "hyperactive" period. The past 1,000 years have been relatively placid.

"The good news is that we are living in a quiet period," Liu says. "The bad news is that if we think we have seen too many catastrophic hurricanes coming our way, we haven't seen anything yet."

This winter, Donnelly will take core samples from the mangrove wetlands and coastal ponds of Puerto Rico "because there should be a much more extensive record there." Landfalling hurricanes are much more common in the Caribbean, so he hopes to find a clearer signal of how often hurricanes reach their most frightening potential.

WHOI Archives Photos

Hurricane Carol of 1954 brought a storm surge and 100 mile per hour winds into Woods Hole, submerging the railroad station and depositing buoys and boats on the shore in Little Harbor. Three hurricanes—Carol, Edna, and Hazel—made landfall in New England that year.

Since 1938, development has exploded along the North Atlantic Coast. A Northeast-bound intense hurricane would threaten billions of dollars worth of property, along with one-seventh of the US population. If a modern version of the Great New England Hurricane were to strike the exact same spots as in 1938, it would result in at least $18 billion dollars of property damage.

"Most people have short memories," says Donnelly. In fact, it is estimated that three-quarters of the population of the northeastern US has never experienced a hurricane. Donnelly's research provides evidence to be heeded. "The geologic record shows that these great events do occur," he says. "We need to make people aware that it can happen again. We've got to have better evacuation plans and we need to equip people to react to a big storm."

Hurricane Classification

The Saffir-Simpson Hurricane Scale is a 1 to 5 rating based on a hurricane's intensity, principally wind speed.

Category One: Winds 74 to 95 mph. Storm surge generally four to five feet above normal.

Category Two: Winds 96 to 110 mph. Storm surge generally six to eight feet above normal.

Category Three: Winds 111 to 130 mph. Storm surge generally nine to twelve feet above normal. Terrain lower than five feet above sea level may be flooded inland eight miles or more.

Category Four: Winds 131 to 155 mph. Storm surge generally thirteen to eighteen feet above normal. Low-lying escape routes may be cut by rising water three to five hours before arrival of the hurricane center. Major damage to lower floors of structures near the shore. Terrain lower than ten feet above sea level may be flooded as far inland as six miles.

Category Five: Winds greater than 155 mph. Storm surge generally greater than eighteen feet above normal. Massive evacuation of residential areas on low ground within five to ten miles of the shoreline may be required.

Science Under Siege

With gunshots buzzing past Ewing, *the captain ordered: Go to your cabins and lock your doors.*

By Michael Carlowicz

The usual morning pleasantries aboard R/V *Maurice Ewing* were swept away by talk of a suspicious boat that had been lingering nearby. Chief Scientist Amy Bower and colleagues watched as the small craft sped closer, its passengers gesturing and shouting. When gunshots buzzed past *Ewing*, the captain gave the order: Go to your cabins and lock your doors.

The ship was 18 nautical miles off the coast of Somalia, on an oceanographic expedition called "REDSOX," the Red Sea Outflow Experiment. Before *Ewing* ever left port, Bower and the science team had gone through security training and hypothetical discussions about conducting research in a dangerous part of the world. But as a shipmate looked through a porthole and described a rocket-propelled grenade skipping across the water toward the ship, Bower realized that no amount of training could have prepared her for being under real fire.

"I was nervous for my safety, wondering if a grenade was going to fly through my ceiling," Bower said. "I was also thinking about how devastated I'd be if someone got hurt on this cruise. How was this going to end?"

Ewing steamed away from the coast of Somalia and the attackers at 14 knots. An hour later, the captain gave the all-clear sign. The grenades and gunshots on August 31, 2001, did not damage *Ewing*, but they did shake up its crew and their research.

Bower conferred with the captain, *Ewing's* operators at the Lamont-Doherty Earth Observatory, and Na-

Jim Carnahan

In 2001, 335 incidents of piracy—including 16 hijackings—were reported to the International Maritime Bureau's Piracy Reporting Centre. At least 21 crewmembers were killed and 210 were held as hostages. This map depicts the locations of those attacks, with red stars marking the areas of highest frequency.

tional Science Foundation (NSF) officials. The expedition could continue, but the ship was ordered to remain 30 to 50 miles from the coasts of Somalia and Yemen.

"It never crossed my mind to quit," says Bower, a physical oceanographer at Woods Hole Oceanographic Institution. The science team revised its plans. The oceanic region they wanted to investigate was compromised and their morale suffered, but the expedition carried on.

"Ship time is very expensive," Bower says, "and we knew that this would probably be the last cruise in this area for many years."

X Marks the Hazardous Spots

For oceanographic research, the *Ewing* incident was a cannon shot across the bow.

"Prior to the attempted attack on the R/V *Ewing* and prior to September 11, 2001, many of us had a limited and unduly rosy notion of the extent or viciousness of piracy in the modern world, and none of us imagined the kind of suicidal terrorism directed at US entities," says Bob Knox, chair of the University-National Oceanographic Laboratory System (UNOLS), the organization that coordinates the US oceanographic research fleet.

UNOLS, NSF, and other agencies are adjusting their research plans for a tumultuous new era. More than 1,100 incidents of piracy have been reported worldwide since 1999, and more than 100 sailors have been killed, according to the London-based International Maritime Bureau (IMB). Incidents run the gamut from petty theft by disorganized rogues to coordinated hijackings of cargoes and entire ships.

The majority of those attacks have occurred off the coasts of Southeast Asia, the east and west coasts of Africa, and South America. In these waters, commercial traffic is thick, law enforcement is lax, and land is never far, making it easier to work in small, cheap, and fast boats. The tools have changed—swords have been traded for AK-47s, and swashbuckling has given way to grenade launching. But the fundamental premise—boarding a ship with the intent to commit theft or garner a ransom—has not really changed.

Just months before the August 2001 REDSOX cruise, terrorists had bombed USS *Cole* in the port of Aden; just weeks before, a band of pirates captured a fishing vessel off the Somali coast and held the crew for ransom. And on the same day that *Ewing* was attacked, a cargo ship in the Gulf of Aden was accosted by four boats full of modern-day buccaneers. As recently as April 2002, the US Navy oiler *Walter S. Diehl* fired its 50-caliber machine guns against a half-dozen powerboats that approached as the ship passed through the Straits of Hormuz in the Persian Gulf.

In a report from IMB's Piracy Reporting Centre, officials noted, "the chief weapons of these modern pirates are speed and surprise." Ships that decrease their speed while navigating narrow channels or rest at anchor near a port are especially vulnerable. That can make a scientific research vessel—whether setting a mooring, drilling the seafloor, or operating a submersible—an easy target, if not a profitable one.

Amy Bower

Maps of the REDSOX I and II cruises to the Red Sea (upper left) and the Gulf of Aden depict the ship tracks and how they were altered after the piracy incident during REDSOX II. Close to 30 percent of the science program of the second cruise was lost in the wake of the attack.

Dangerous Ground

Jian Lin knows something about being an easy target. In February 1999, the WHOI geologist was aboard JOIDES *Resolution* during a cruise of the Ocean Drilling Program (ODP). The ship had to sail through the treacherous Sunda and Karimata Straits near Java, the site of hundreds of pirate attacks in the past decade.

"*Resolution* doesn't have the power to outrun most pirate vessels," Lin notes, and the 469-foot ship is immobile while drilling. "Our captain refused to enter the South China Sea unless we got an escort." Thanks to the intercessions of Chinese-speaking scientists on the cruise, the Chinese navy loosely escorted *Resolution* to its appropriately named drilling site, the Dangerous Ground (so named on Admiralty charts because it is poorly charted territory with many reefs and shallows).

The captain also "held a meeting with the entire scientific team, and we conducted a few drills on what to do if pirates boarded the ship," Lin says. The ship's crew was instructed in how to aim searchlights and keep the ship well lit, how to improve night watches (when most attacks occur), how to repel boarders with fire hoses, and how to use radios and hand signals. But the ultimate guidance for scientists and sailors alike was to give armed attackers what they wanted.

The cruise was further complicated by the politics of the South China Sea. The governments of the People's Republic of China, Vietnam, the Philippines, and Taiwan all assert territorial rights to the areas around the Dangerous Ground, so planning the mission required approval from all four. But that did not necessarily release all political tension. While transiting to a drill site in daylight, *Resolution* witnessed a several-hour standoff between Chinese and Vietnamese navy ships keeping an eye on the science cruise.

Pirates and Politics

WHOI physical oceanographer Glen Gawarkiewicz had similar experiences during a collaborative research cruise in 2001 in the South China Sea. He worked with colleagues from National Taiwan University to study ocean currents and temperature fields at the edge of the continental shelf near China.

"The threat of piracy affected our planning," Gawarkiewicz notes. During a previous cruise in the program, his Taiwanese colleagues had been harassed and boarded by rogue fishermen. "Ships are nearly immobile when a CTD is down in the water, and the casts go on for hours, so we are really vulnerable at those times. We were wondering if our equipment would be stolen. After all, a $4,000 laptop is compelling when you make $100 a month."

Political events also caused the entire research cruise to be conducted under "high alert." A few months before the cruise, Chen Shui-bian of the Taiwan Independence Party was elected president, escalating tensions between China and Taiwan. And just days before the cruise, a US reconnaissance plane collided with a Chinese fighter jet, sending the jet into the sea and forcing the US craft to make an emergency landing in China.

"We were on a foreign ship, and we were not going to be the decision

Courtesy of ODP

Ocean research vessels such as JOIDES *Resolution* could be easy targets for pirates because seafloor drilling and other work with tethered equipment and submarines require that a ship remain stationary for long periods of time.

makers," says Gawarkiewicz of those tense days. "People on the ship were aware of the risks, but we didn't talk about it because we didn't want to think about it. It's already hard enough to work at sea. People just tried to keep a mentally tough mindset."

Damn the Torpedoes

Before the *Ewing* incident, there was not a lot of precedent for how to handle a pirate attack. Now, ship operators and funding agencies are working on guidelines and strategies to protect the fleet and to keep the research going.

"There are several things we can do," notes Joe Coburn, WHOI's ship operations manager. "We train the crews in how to recognize and respond to threats. We can adjust the ship schedules so as not to be predictable, or to travel in daylight." New UNOLS guidance also recommends much tighter control of access to the ship while in port.

In the case of the REDSOX program—which was actually a two-part series of cruises, in March and August 2001—WHOI chose to hire former US Navy Seals as security consultants for the first leg on R/V *Knorr*. The consultants trained the crew and the science team before leaving port, then sailed with them and kept round-the-clock watches for suspicious activity.

How the threat of piracy affects funding and approval of future research programs remains to be seen. A recent newsletter from NSF's Division of Ocean Sciences stated: "Before submitting a proposal, principal investigators should carefully consider regions of potential danger when proposing a cruise strategy...NSF will not support cruises in areas where war risk insurance is unavailable, or is available at excessive premiums." If a research proposal is approved for its scientific merit, ship operators will be asked to indicate willingness to undertake the cruise, and NSF will conduct reviews of security and its costs.

"The UNOLS fleet is not about to retreat to US coastal waters entirely," says Knox, Associate Director of the Scripps Institution of Oceanography. "But we will have to learn how to temper plans and schedules in light of available information about terrorist and piracy threats. There may well be certain places and times where UNOLS ships should not go, even though good scientific reasons would lead there. The continued engagement of seagoing scientists will be needed to strike balances."

David Fochella

Tethered science instruments can leave a research ship immobile and vulnerable when unidentified boats approach. After the August 31 attack, the REDSOX II crew (above) was able to salvage their equipment and their mission. But even their return from the cruise was troubled. The science team disembarked from the ship on September 12, 2001, and were prevented from returning home for more than a week due to the terrorist attacks in America.

At WHOI, the response is a mix of steely determination and practical concern. No one wants to be shut out of major regions of the ocean, but no one wants to risk the safety of ships and their crews. Coburn says that "we won't say no to a cruise" because of piracy. Though she was fired upon the last time she went to sea, Bower insists, "We can't let this change globe-trotting oceanography. I'd hate to see an overreaction to piracy." Lin suggests one of the best preventive measures might be to expand international collaboration. Common interests and good communication can be an aid when politics intersect with science.

"In the end, we are all pretty hard-core about pursuing the science," Gawarkiewicz says. "I haven't heard anyone say, 'It's too dangerous, I won't go there.'" But before they go in the future, they will probably learn a bit more about Blackbeard's successors, global politics, and the art of self-defense.

Losing a Mate, Finding Themselves

Knorr *Crew Presented 2001 Penzance Award*

By Laurence Lippsett

The crew of R/V *Knorr* was accustomed to sailing through rough, uncharted waters. In oceans, however, not in the depths of their souls.

They knew how to keep the sea at bay, but they had no experience at keeping a gravely ill shipmate alive.

In December of 2000, *Knorr*'s scientists and crew had been investigating a previously unexplored section of the global mid-ocean ridge. They were working in one of the most remote parts of the planet, the Southern Ocean between Africa and Antarctica, nearly equidistant from both shores.

They had found "a huge, deep rift valley stretching straight for 280 miles with almost nothing but mantle rocks rising up out of the earth," said WHOI Senior Scientist Henry Dick, chief scientist for the cruise. On most mid-ocean ridges, molten rock from Earth's mantle erupts to create an overlying crustal layer. Here, "the mantle was spreading directly onto the seafloor," Dick said. "It was like nothing I had ever seen before."

But rippling through the scientific excitement was an ominous undercurrent. It might have been completely forgotten had events turned out differently. Joe Mayes, *Knorr*'s oiler, was suffering from headaches.

'Thousands of Miles from Anywhere'

"At sea, everyone has a job that affects everyone else, from the captain all the way down," said George Silva, *Knorr*'s captain on this voyage. "There's no place to run or hide. There's not much room for whiners or complainers. You just have to buck up."

"You don't easily pull the plug on an expensive science expedition," Silva said. "If your mother gets sick, and we're thousands of miles from anywhere, you have to accept that you won't be able to do much about it."

Cyndy Chandler

Joe Mayes, shown aboard R/V *Knorr*, was a ten-year veteran of WHOI cruises.

Mayes knew the score. He was a 10-year Navy veteran and had worked on Woods Hole research ships since 1991. He consulted Janet Costello, the ship's medic, about his headaches.

Costello, a registered nurse, had a lot of experience in hospital emergency rooms. But she also loved the sea. For years, she had been chief nurse for a luxury cruise line, and she had sailed on WHOI expeditions in the early 1990s, including several with Mayes. WHOI had hired her as an extra measure of safety for this series of *Knorr* cruises.

"It's Institution policy," said Joe Coburn, WHOI's Ship Operations Manager. "Whenever we send a ship that far for that length of time in remote places, we put a medic on."

'You Can't Call 911'

Costello closely monitored Mayes's condition. She was in close contact with Medical Advisory Services, which links ships with shore-based physicians via satellite telephone. Then on New Year's Day 2001, the unexpected happened. Mayes suddenly lost consciousness and stopped breathing. Costello inserted a breathing tube and attached an airbag, called an "Ambubag," that is squeezed between two hands to force oxygen into lungs.

"We all know that anything can happen out there, and you can't call 911," Silva said. "You steel yourself. You try to be ready. But this was nothing we could plan for."

The crew searched for other military ships in the area that might have more extensive medical facilities. "But we were very much on our own," Silva said. "So we turned around and made tracks."

Knorr was 1,200 miles from the nearest coast. It headed north toward Capetown, South Africa, where a medical team would be dispatched to evacuate Mayes as soon as the ship came within the 200-mile range of a helicopter.

Coburn coordinated efforts on the

home front. He helped expedite an emergency passport for Mayes's fiancée, Sunny Bigby, and arranged to fly her from Oregon to Capetown. But he couldn't do much more to help the situation on *Knorr*.

"A ship is on its own," Coburn said. "You can't pull the strings to exercise precise control over a ship far away. You have good people who are trained, and you back them up. But they're on the front line."

A Real Test of Fortitude

In *Knorr*'s sickbay, Mayes's temperature had dropped and Costello worked to keep him warm. She had dealt with numerous medical emergencies in her career, but usually in controlled settings.

On *Knorr*, "I had no lab tests," she said. "I didn't have any fancy equipment." In fact, she had brought her own cardiac monitor. She had persuaded a medical salesman to donate it and she shipped it herself to Capetown. "I remember thinking, 'I hope I never have to use this.'"

But there it was, indicating that Mayes's heart was still pumping—even though he could not breathe for himself. Costello was aided by C.R. Johnson, *Knorr*'s electrician, who had emergency medical training. But the two could not continue squeezing oxygen into Mayes's lungs for long by themselves.

"I put up a sign-up list for volunteers to help work the Ambubag," Silva said. "The list was filled within seconds. Some people didn't know Joe at all. Others knew him well and had been in many ports with him.

"I swear it was the love and caring of the crew that kept him going."

—Medic Janet Costello

They did their normal jobs, and then they volunteered to breathe for Joe."

Every four hours, three people took turns, on 15-minute shifts, squeezing the Ambubag. The volunteers ranged in seagoing experience from Amy Simoneau, a Shipboard Scientific Services Technician on her first *Knorr* cruise, to Stephen Walsh, who began working at WHOI in 1985 and has been *Knorr*'s chief engineer since 1995. "It was tough going," Walsh said. "Everyone watched the heart monitor, hoping nothing would happen to Joe, especially on their watch."

Meanwhile *Knorr* bounded through the waves, going as fast as prudently possible, in foggy, icy waters.

"It was a gloomy, gloomy ship," Silva said. "The crew was dismal. It was the longest four days of my life. Looking at Joe in the wee hours of the night, with the bad weather and the ship bouncing, standing watch with fog and snow and ice all around, it was a real test of fortitude."

'We Were All Together in This'

Over four days, Costello and Johnson spelled each other and never left Mayes's bedside.

"I'd lie down once in a while to close my eyes," Costello said. "I had never been stretched so far in my life. I had to rely on all my accumulated knowledge and experience.

"At one point, the breathing tube got clogged and I had to intubate again—on a rolling ship, in a small space. My eyes filled up. I prayed a lot. But I couldn't fall apart. We were all together in this."

When the limited supply of oxygen ran out, the crew continued pumping, using regular air. But Antarctic air is very dry, which causes problems in the lungs. "I said, 'I need more humidity,'" Costello recalled. "The engineers jumped up, and I heard all this clanging. They built a humidifier out of a galley mop pan and a fan."

"Nobody was freaking out. Everyone did what needed to be done," Costello continued. "I've worked in neurosurgical and intensive care units, and even in one of those, I wouldn't have thought we could keep Joe alive. I have no explanation for how he remained alive. I swear it was the love and caring of the crew that kept him going."

The map displays the location of *Knorr*—nearly 1,000 miles from the coasts of South Africa and Antarctica—when Joe Mayes lost consciousness. It took four days to get within range for a helicopter evacuation.

79,680 Breaths

On January 5, *Knorr* was finally within range. A helicopter rendezvoused with the ship 200 miles off

the coast. Paramedics descended by wire onto the deck and bundled Mayes into a gurney that was hoisted up to the helicopter. The helicopter's winch broke immediately after Mayes's ascent, stranding two paramedics on *Knorr*. But Mayes was headed to a hospital.

The fog seemed to lift then, along with the crew's burden. "We could let out our breath," said Simoneau, "and we were really hopeful."

At the Capetown hospital, medical personnel "were all absolutely amazed by the efforts of the crew," Coburn said. "It was recognized as absolutely unprecedented to keep someone alive manually for all that time—not just on a ship, but in any environment."

"They did their normal jobs, and then they volunteered to breathe for Joe."

—Captain George Silva

"By my estimation, the crew pumped approximately 79,680 breaths into Joe," Silva said. "When he left the ship, he was alive. He had a heartbeat."

But when *Knorr* arrived in port hours later, the crew learned that the 46-year-old Mayes had died at the hospital. Bigby, his fiancée, was at his bedside. The cause of death was a brain aneurysm.

Coburn made arrangements through the US Embassy to transport Mayes's body home. Professional grief counselors—arranged by Karen Rauss, WHOI's ombudsperson, to meet the ship in port—talked with emotionally spent crew members.

"We gave it our all," Silva said. "We knew we'd done everything we possibly could. And that helped the healing process."

"It was a life-affirming experience for me," said Costello. "You will rarely find the camaraderie in any working environment that you do on a ship. Shipmates take care of each other. I've never seen anything like that crew, and I know I never will again. They were very courageous—the finest group of human beings I've ever been associated with."

Henry Dick

This bathymetric map reveals the topography around Joseph Mayes Seamount, located at 11°20' E and 52° 50' S. The name honors both Mayes and all research vessel crews, especially the one that worked to save him.

Epilogue

Knorr's crew was presented with the 2001 WHOI Penzance Award, given "for sustained exceptional performance, for outstanding representation of the WHOI spirit, and for major contributions to the personal and professional lives of our staff."

In nominating the crew, Chief Scientist Henry Dick wrote: "I will carry away with me a deep and enduring sense of the commitment and caring of the men and women of this ship....In my twenty-five years as a marine scientist, I had never experienced anything as moving as the effort these men and women made. It was truly in the best spirit of the Institution and an inspiration for mariners anywhere."

Before Mayes fell ill, the crew had discovered a new mountain on the seafloor. "Normally, naming of these features honors a scientist or some other individual who stands out in the public record," said Dick. "However, I think it appropriate that one of these major features should be named in honor of the many individuals who make these discoveries possible."

It has been named Joseph Mayes Seamount, "in honor of both Joe and the many sailors who have contributed so much to oceanography."

I had never experienced anything as moving as the effort these men and women made. It was truly in the best spirit of the Institution and an inspiration for mariners anywhere."

— Chief Scientist Henry Dick

Remembering Mary Sears

Tom Kleindinst

Viewed from the National Marine Fisheries Service pier, USNS Mary Sears lights up the village of Woods Hole at dusk.

USNS *Mary Sears* Visits Namesake's Woods Hole Home

The US Navy's newest oceanographic survey vessel, USNS *Mary Sears,* called in Woods Hole from July 24 to 26. The ship tied up within sight of the Bigelow Laboratory office where Mary Sears worked for many years. WHOI staff and other affiliates toured the ship, and President and Director Bob Gagosian and Captain Philip Renaud, Naval Oceanographic Office Commander, exchanged gifts to commemorate the visit.

Mary Sears is a multi-mission vessel capable of surveying coastal and deep ocean waters. The Pathfinder class ship is 329 feet long, draws 19 feet, and accommodates 27 scientists and 25 civilian officers and crew. The Military Sealift Command operates *Mary Sears* for the Oceanographer of the Navy.

WHOI Celebrates Pioneering Woman Oceanographer with Award

Mary Wilcox Silver recalls the moment when she knew she had been accepted into the mostly male fraternity of oceanographers. She was serving as chief scientist for a cruise in the Vertical Transport and Exchange (VERTEX) program in 1981. Years before she had been the first woman to ever lead a cruise on a Scripps Institution of Oceanography vessel. "But here I was, fifteen years later, sitting on the deck with [WHOI scientist] John Farrington, talking about God knows what, and I had this incredible feeling," said Silver. Given the opportunity to lead a "big oceanography" cruise with so many prominent researchers, "I felt like I had finally joined the oceanographic community."

A professor of ocean sciences at the University of California in Santa Cruz, Silver was honored this spring with the first Woman Pioneer in Oceanography Award named for Mary Sears. Her

Tom Kleindinst

Mary Wilcox Silver gave a lecture and science seminar during her visit in March.

Woman Pioneer predecessors were Mary Sears herself (one of WHOI's first scientists), Betty Bunce (WHOI), Ruth Turner (Harvard University), and Marie Tharp (Lamont-Doherty Earth Observatory). The award recognizes women who exhibit long-term achievement and impact through both scientific excellence and mentoring.

Silver's most notable scientific achievement is her work with "marine snow." In the late 1970s, she showed that many planktonic organisms thought to be "free-living" actually reside on particles in dense and unique microbial communities visible to the unaided eye. Silver's research led to a greater understanding of plankton ecology and the role "marine snow" plays in geochemical cycles. In more recent years, Silver has become a leader in studying the role of harmful algal toxins in the marine food web.

But Silver is more than just a great researcher. Nomination letters cited her unfaltering dedication to her students and peers, especially young women in the field. One nominator noted that she had "led the way for people with strong family commitments to go to sea, showing that scientists could combine challenging, field-based careers with family life."

"The Albatross About His Neck Was Hung"*

Jayne Doucette

Mike McCartney acquired a new traveling companion during a recent meeting in Hawaii.

"For describing the Atlantic circulation with bewildering simplicity," Senior Scientist Michael McCartney was named the latest winner of the prized and playful Albatross Award. The stuffed albatross—complete with wood-and-wire cage, a golden egg, and scrapbooks full of four decades of droll oceanographic humor—was presented to McCartney in February 2002 in Honolulu during the AGU Ocean Sciences Meeting.

According to custom, the bird was presented at a remote science meeting in order to test the logistical skills of its new keeper. McCartney's odyssey through the airport—which included purchasing airfare for the bird—lasted hours, invoked puzzled and disapproving stares, and shut down an entire baggage screening line. The highlight of the voyage was a visit to a restaurant, where McCartney was informed, "You can't bring live animals in here!" When he pointed out that the albatross was hardly living, the waitress told him, "You can't bring dead animals in here!"

"From its first hatching, as the name implies, the award was intended to confer a mixed blessing on the recipient, partly out of the Founding Fathers' sense of fun, and partly out of the feeling that the recipient should be smart enough to cope," said Robert Dickson, previous recipient of the award and a physical oceanographer from the UK's Centre for Environment, Fisheries, and Aquaculture Science. The Albatross is given periodically to "someone with an Albatross-like ability to make conceptual leaps on the scale of an ocean."

"Mike McCartney meets the case admirably," Dickson noted in his citation. "Since the 1970s, Mike has produced a succession of landmark papers to describe...how the important elements of the Atlantic circulation form and move and change. At their mightiest, vast data sets are distilled down to their essence to yield novel, yet essentially simple, full-ocean perspectives...The reason we feel obliged to qualify such simplicity with the term 'bewildering' lies in the level of detail that accompanies it, so that conscientious readers can find themselves wading through drifts of detail they never thought they would ever need to know, and probably wouldn't. And as a result—how shall I put it?—you don't get many of Mike's papers to the pound."

The selection panel—made up of past Albatross winners and known as the American Miscellaneous Society—also considers "signs that the Award and the Awardee are likely to survive one another."

"As regards his ability to look after such a fragile creature in its delicate structure of wood and wire, I need only point out that Mike himself has these several years lived in a succession of equally delicate structures of wood and wire—his sailboats *Wampeter, Plumbelly,* and *Tresarus,*" Dickson added. "His dark blue Morgan convertible means he even drives a delicate structure of wood and wire, so the bird will certainly feel at home if it can be kept above water."

*From Samuel Taylor Coleridge's "Rime of the Ancient Mariner"

Partial List of Past Albatross Awardees

1959 Gordon Lill, John Knauss, and Arthur Maxwell, for conceiving the Award.

1960 John Swallow for innovative measurements of ocean currents both AC and DC.

1963 Victor Vacquier, for displacing the Pacific Ocean by 700 miles.

1966 Henry Stommel, for having abandoned Oceanography's most cherished chairs.

1968 Sumner Pike for the study of the oceans and other liquids after 5:00 PM.

1970 Bill von Arx, for contributions and confusion resulting from the GEK (also for using big words).

1973 Roger Revelle, for coveting the Bird over all other awards.

1976 Sir Edward Bullard, for unintelligible geomagnetism.

1979 J. Tuzo Wilson, for making faults run backward.

1982 Sir George Deacon, for fathering Margaret and the Institute of Oceanographic Sciences.

1987 Paul Scully-Power, for finding a way to observe the ocean without going to sea.

1988 Joe Reid, for his outrageous insistence that ocean circulation models should bear some resemblance to reality.

1991 Michele Fieux, for energetic efforts in international and interocean exchange.

1998 Bob Dickson, for attempting to stem the flow through Denmark Strait with a weir of current meters.

...The Rest of Them Wore Medals

Tom Kleindinst

John Hayes

In August 2002, Senior Scientist John Hayes (Geology and Geophysics) was awarded the V. M. Goldschmidt Medal by the Geochemical Society during the group's annual conference in Davos, Switzerland. In selecting Hayes, the nominating committee wrote: "Through his many efforts combining the development of new analytical techniques, John has redefined the field of biogeochemistry and has taught geochemists to look at organic geochemistry in an entirely new light." In particular, the group cited his development of techniques to extract information about ancient levels of atmospheric carbon dioxide from the isotopic composition of compounds secreted by marine plankton. WHOI senior scientist Stan Hart (Geology and Geophysics) is a past recipient of the medal, which annually recognizes achievements in geochemistry or cosmochemistry.

Hearty congratulations were mingled with sad reflection during the presentation of the first George "Gera" Panteleyev Award at the MIT/WHOI Joint Program commencement in June. Mario Sengco (Biology) was chosen as the first recipient of the award, which honors the graduate who best demonstrates a commitment to improving the graduate experience at WHOI.

The award is named in remembrance of George "Gera" Panteleyev, a Joint Program student who died in 1995 after being swept overboard from a Russian vessel in a tragic accident on the Ob River in Siberia. Panteleyev was revered by classmates for his passionate approach to research and for improving life for fellow Russian citizens and WHOI students.

Tom Kleindinst

Mario Sengco

Classmates cited Sengco for bridging gaps between peers, students, faculty, and the local community by organizing potluck dinners and by encouraging participation in community science programs. He also helped initiate a weekly "tea hour" for students and led local choirs.

Tom Kleindinst

John Hunt

In April, Scientist Emeritus John Hunt (Marine Chemistry and Geochemistry) was awarded the Gold Medal of Honor of Albert Einstein by the Russian Academy of Natural Sciences for "outstanding contributions to the field of geologic sciences." The medal is one of the highest awards of the academy. He was also elected to the Academy as a foreign member. His book, *Petroleum Geochemistry and Geology*, has widely circulated in Russia (including a Russian translation of the work).

Tom Kleindinst

Jack Whitehead (left) and Bob Gagosian

Two Elected to Academy

The American Academy of Arts and Sciences has added two WHOI scientists to its membership. Senior Scientist Jack Whitehead (Physical Oceanography) and WHOI President and Director Robert Gagosian were chosen to join the 2002 class of 177 fellows and 30 foreign members. This year's inductees include National Science Foundation Director Rita R. Colwell, Senator Edward M. Kennedy, violinist Itzhak Perlman, and Academy Award winner Anjelica Huston. They will be formally inducted in October 2002 at the Academy's headquarters in Cambridge, Massachusetts.

The Academy was founded in 1780 by John Adams, James Bowdoin, John Hancock, and other scholar-patriots "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people." The current membership includes more than 150 Nobel laureates and 50 Pulitzer Prize winners. Several WHOI Scientists have been elected in previous years, including John Hayes (Geology and Geophysics), Joseph Pedlosky (Physical Oceanography), Hal Caswell (Biology), and former Institution Director John Steele.

Scientists Share Ocean Discoveries With the Public

From the newsroom to the classroom to congressional briefing rooms, WHOI staff and scientists have been sharing the wonder of scientific discovery with the American public.

• On June 27, Research Associate Anne Cohen (Geology and Geophysics) was invited to testify before the Resources Subcommittee on Oceans, Fisheries Conservation and Wildlife of the U.S. House of Representatives. During a hearing on the impact of climate change, Cohen gave testimony on "Coral Death and Ocean Warming: Unprecedented Increases in the Last Two Decades."

• On July 15 and 16, Deep Ocean Exploration Institute Director Susan Humphris (Geology and Geophysics), and Assistant Scientist Tim Shank (Biology) briefed more than sixty staff members from the Senate and House of Representatives on the need for deep-ocean research and a deep-submergence capability. They also held a meeting with Congressman Wayne Gilchrest (R-Maryland).

• The Dive and Discover Web site (www.divediscover.whoi.edu) was recently chosen by *Scientific American* for a 2002 SciTech Web Award as one of the Web's five best science and technology sites in the "Earth and Environment" category. It is the second year in which Dive and Discover has been selected for that award.

• In June, filmmakers for The Science Channel spent two weeks at sea aboard *Oceanus* with Ocean Life Institute Director Larry Madin. They shot footage for an upcoming show about mid-water creatures that will air in 2003 as part of a ten-part series called "Science of the Deep."

• An April 18 op-ed piece in *The New York Times* under the byline of Senior Scientist Terry Joyce (Physical Oceanography) provoked calls, letters, and requests for interviews. CBS Evening News interviewed Joyce about how global warming could lead to regional cooling for a segment that aired on April 22. *Discover* sent a writer to interview Joyce, Senior Scientist Lloyd Keigwin, Research Specialist Ruth Curry, and Ocean and Climate Change Institute Director Bill Curry for a September cover story about abrupt climate change.

Joyce Doucette

Karen Tierney and Rick Abrams helped teachers and scientists exchange ideas on education.

• The Information Office, the Education Office, and WHOI Sea Grant hosted a workshop for 28 science educators on April 26 in the Exhibit Center. Teachers were offered science talks on various topics, including coastal pollution and technology for deep ocean exploration. WHOI scientists Ken Brink, Judy Fenwick, Lauren Mullineaux, Debbie Smith, and Simon Thorrold participated. Funding for the workshop was provided by The Ducommun and Gross Family Foundation.

WHOI Corporation Member Rick Abrams and WHOI Sea Grant Board Member Karen Tierney moderated a discussion about ways to enhance interest in and knowledge of ocean science. Abrams is president of Tom Snyder Productions, an educational software publisher in the K-12 market. Tierney is a freelance writer and educator who creates enrichment programs for elementary age children.

"Planet Ocean"

"If you want to control and predict the oceans' role in affecting our lives, you have to understand how they work. We have the technology; we have the science potential. We need the priorities focused and the funding coordinated toward a common goal...I worry that many [ocean research] programs are isolated from each other in their approaches, objectives, and goals...and that they now focus primarily on the narrower objectives of the individual components and facilities and not the broader scientific questions...In order to maximize the results and benefits, it is important that the intellectual content of these programs be global in nature, and there must be synergy and common purpose...One initiative under one umbrella, let's call it the Planet Ocean Initiative, could encompass all these elements."

— WHOI President and Director Robert Gagosian, testifying before the U.S. Commission on Ocean Policy on July 23 in Boston, MA

Carolyn Bunker Appointed Chief Financial Officer

Following a national search that ended in April 2002, WHOI named Carolyn Bunker as its Chief Financial Officer and Vice President for Finance and Administration. "We are extremely fortunate to have someone here with Carolyn's breadth and depth of skills," said WHOI President and Director Robert Gagosian.

Bunker came to the Institution in August 2000 as Executive Assistant to then-Associate Director for Finance and Administration, Paul Clemente. She served for six months as Acting Associate Director following Clemente's departure in November 2001. Bunker brought extensive financial experience to WHOI, including successive positions at the Massachusetts Institute of Technology as Associate Bursar, Bursar, and Director of Student Financial Services. Prior to her service at MIT, she was Manager of General Accounting and then Assistant Comptroller at Boston University. Her experience also includes several positions with accounting firms in the Boston area.

Bunker did her undergraduate work at the University of California, Santa Barbara, in history and sociology, and she pursued graduate studies in art history and education. She later attended Bentley College, where she earned a Certificate of Accountancy with highest honors. She is a Certified Public Accountant.

Tom Kleindinst

An Ocean of Ideas for Planned Giving

He was a visionary who expanded the intellectual and physical horizons of the Woods Hole Oceanographic Institution. As director from 1958 to 1977, Paul M. Fye substantially increased the institution's endowment and doubled its scientific staff. He helped train the next generation of scientists by establishing the Joint Graduate Program in oceanography with the Massachusetts Institute of Technology. He acquired the property for the Quissett Campus and oversaw construction of new research facilities. He modernized the research fleet, promoting "big ship" oceanography and the development of the deep submergence vehicle *Alvin*. Fye's leadership inspires us still.

Now we pursue a new vision for the Institution and the oceanographic community. That vision includes long-term observatories on the ocean floor and human occupied and autonomous submersibles probing unexplored depths. It is a future where great minds gather at WHOI to reach across disciplines and unravel the mysteries of the origin of life, the changing of our climate, and the shaping of our continents. It will be an Ocean Age that rivals the exploration of the Space Age.

Through the **Paul M. Fye Society**, the Institution recognizes individuals who possess the same foresight and generous spirit as Paul Fye. Through charitable bequests, life income gifts, and trusts, Fye Society members help build our endowment and bring our vision of the future closer to reality. We invite you to join these friends by including the Woods Hole Oceanographic Institution in your estate plans. Please direct inquiries regarding the Paul M. Fye Society to: James Rakowski, Fenno House, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, 508-289-2234, jrakowski@whoi.edu.

WOODS HOLE OCEANOGRAPHIC INSTITUTION
FYE SOCIETY

New Look for the Quissett Campus

The Ring Road Starts to Take Shape

This aerial photo, looking north from the villlage of Woods Hole, was taken on July 25th. It shows the south portion of the Quissett Campus ring road in the foreground with Vineyard Sound to the right and Buzzards Bay to the left. Photo by Doug Weisman.

The Institution initiated a master planning process in 2001 to accommodate facility needs both at Quissett and in Woods Hole over the next ten to twenty-five years. Action on that plan began in June 2002 with clearing for a new Quissett Campus ring road, designed to move vehicle traffic and parking areas to the perimeter of the complex and to create a central pedestrian corridor. The goal is to promote an academic campus atmosphere.

The master plan identifies sites for new buildings and calls for preserving and enhancing important natural features of the Quissett Campus. Two buildings to house a biogeochemistry complex, marine mammal researchers, and other laboratories and facilities are in the planning stages. In the village of Woods Hole, plans are being made to renovate the Blake Building to accommodate expanding needs of the Deep Submergence Laboratory.

Ellenzweig Associates of Cambridge, MA, and Stephen Stimson Associates Landscape Architects of Falmouth, MA, are designing and executing the campus plan. Stimson Associates' design received the 2001 Merit Award from the Boston Society of Landscape Architects.

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