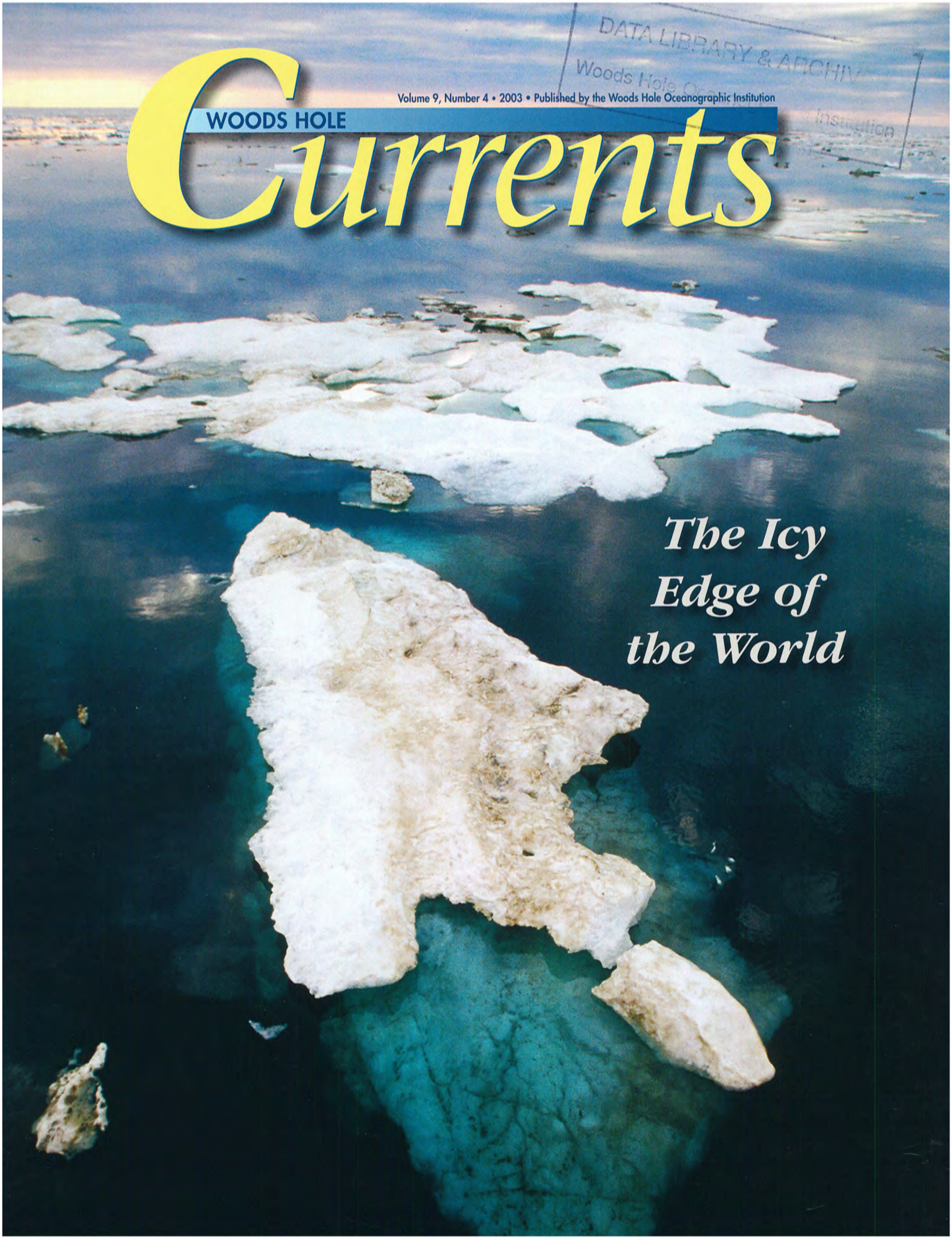

WOODS HOLE
Currents
Volume 9, Number 4 • 2003 • Published by the Woods Hole Oceanographic Institution
The Icy Edge of the World

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WOODS HOLE
Currents

COVER: Ice at the poles helps keep Earth's climate in balance, but it is no help to the scientists trying to monitor deep Arctic Ocean currents. Icebergs such as this one in the Chukchi Sea provide candy for the eye and trouble for scientific gear. Photo by Christopher Linder.

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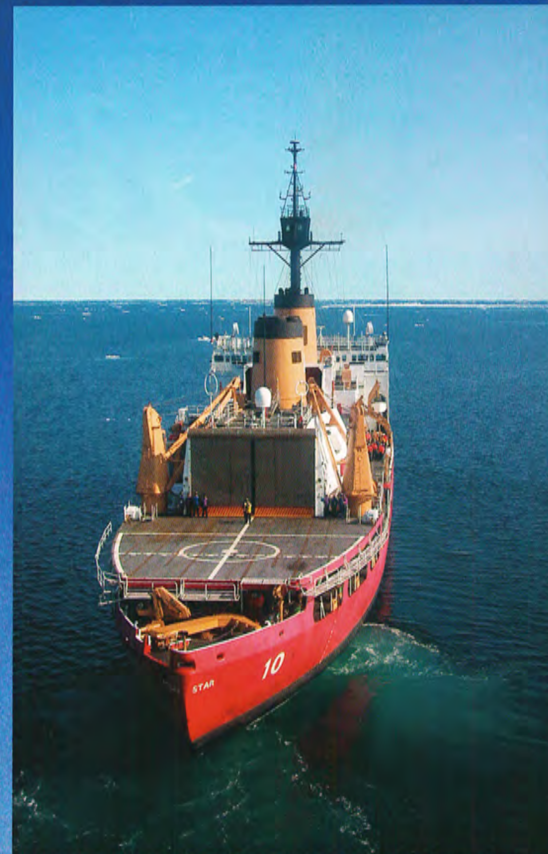
THE WOODS HOLE OCEANOGRAPHIC INSTITUTION is a private, independent, not-for-profit corporation dedicated to research and higher education at the frontiers of ocean science. WHOI's primary mission is to develop and communicate a basic understanding of how the oceans function and how they interact with 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.

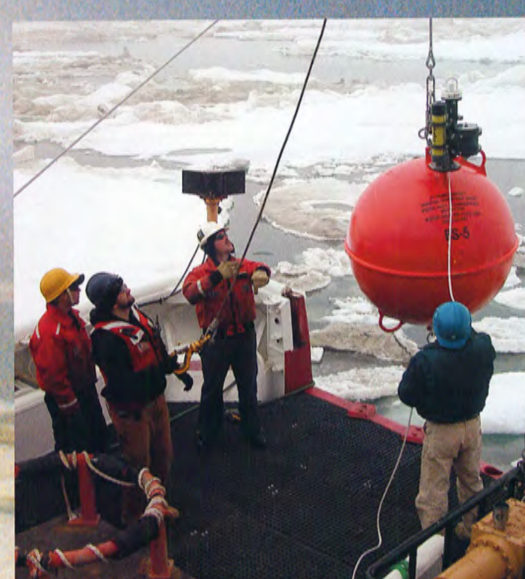


Crew from USCGC *Polar Star* welcome open patches of sea, where they use less energy than driving through thick ice (far right). (right) Melt pools are formed when sunlight melts enough snow and ice to form small ponds in the midst of floes. (lower right) Whether seas are clear or ice-covered, the moorings must go into the water.

Going with the Floes

Exploring the Fringes of the Arctic Ocean

During four weeks aboard the US Coast Guard Cutter *Polar Star* in the summer of 2002, scientists and sailors battled Arctic Ocean ice to observe one of the world's least-studied bodies of water. As they deployed moorings and cast instruments into the cold, deep water, Research Associate Chris Linder (Physical Oceanography Department) documented the scientific efforts and the raw beauty of this alien land. "Viewed through my lens," he says, "the landscape seemed harsh and unforgiving, and at other times delicate and fragile. These photographs and accompanying text are my attempt to convey the awe I felt while working 'in the ice.'"



I stared out over the sea of ice from my perch in the bow of Polar Star, *the world's most powerful non-nuclear icebreaker. The sun had just dipped into a fog bank and tinted the surrounding floes with brush-strokes of peach and magenta. Before us lay huge blocks of ice tumbled together like an upended box of Legos.*

When we first passed from the steel-gray waters of the Bering Sea into the frozen reaches of the Chukchi Sea, I felt a quickening of my pulse and a twitch in my shutter finger. The ice is hypnotic; you cannot resist the urge to stare at it. The wind and waves carve odd shapes, and the palette of colors ranges from

deep aquamarine to stark white to muddy brown.

As the ship battered the floes, it shuddered violently. The bow smashed into the larger chunks, fracturing the ocean's cap. The cracking ice rumbled like distant thunder. We knifed through the slabs and thrust them aside, leaving a thin gap that would soon narrow, freeze, and close behind us.

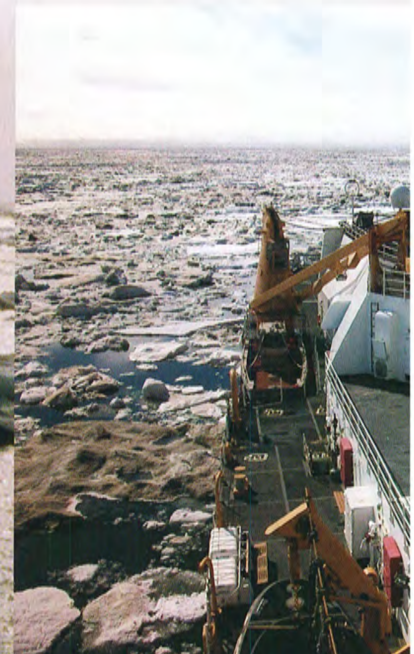
This is the Arctic Ocean—a deep, frigid sea covered by a blanket of shifting ice. It's another world, a place that for centuries lured explorers seeking fame and scientists seeking knowledge. Like Nansen and Sverdrup, Franklin and Amundsen, we are here seeking answers, though the questions have changed.

Putting scientific equipment into Arctic waters—such as the conductivity-temperature-depth (CTD) rosette (far left, middle) and an acoustic Doppler current profiler (above) requires an intricate balance of motion and timing. A dozen scientists and crew members work together (mid-page) to lower a mooring over the stern. Bryan Klostermeyer (silhouette, far left) readies an expendable CTD probe, used for rapid surveys in inclement weather. John Kemp and Dan Torres (center inset) wait for the signal to launch the top buoy of a mooring with a beacon and GPS locator. All the while, a group of walruses huddle on an ice floe and shun the hard work.

The Arctic has been described as a "canary in a coal mine" from which we will likely receive the first warning signal of the next great climate change. Understanding this isolated, delicately balanced ocean at the top of the world is critical to understanding climate all the way down to the tropics.

The Arctic Ocean is a deep basin rimmed by continental shelves and shallower waters. Through a new multi-year, interdisciplinary research project called "Western Arctic Shelf-Basin Ineractions," WHOI scientists (led by physical oceanographer Bob Pickart), plan to observe how waters originating in the Pacific Ocean are transferred from the Bering Sea, across the Chukchi and Beaufort shelves, to the deep basin of the Arctic Ocean. The project is funded by the National Science Foundation and the Office of Naval Research.

Of paramount interest is the formation and maintenance of the cold "halocline," the layer of salty water that resides 150 to 200 meters (500 to 650 feet) below the surface. This halocline acts as a barrier between ice at the surface and the reservoir of warmer water in the depths. If this shield weakens, there is more than



The crew is constantly challenged to defend their equipment (above left), using makeshift "ice poles" to push floes away from science gear like this mooring flotation. Sarah Zimmermann and co-chief scientist Bob Pickart (mid-left) inspect the Niskin bottles on the ship's conductivity-temperature-depth (CTD) rosette, while others test *enough heat stored in the deep water to melt the ice from below.*

One of the objectives of our cruise in the summer of 2002 was to deploy a "picket fence" of profiling instruments, a closely spaced array of eight moorings that extends 40 kilometers (25 miles) along the edge of the Beaufort Sea. The array of instruments will measure the complex ocean circulation processes between the Pacific and Arctic Oceans as they have never been measured before.

In the autumn of 2003, the science team will return to retrieve a year's worth of data, and then reset the moorings for another year of measurements. Never before has such a continuous, high-resolution series of data been collected in the Western Arctic Ocean. This "picket fence" approach is new in a region where scientists have typically been limited to one or two "fence posts." We hope that these measurements can improve theories and predictions of changes in the Arctic Ocean...and help scientists listen for that proverbial canary of the climate. To learn more, visit www.whoi.edu/arcticedge.

an acoustic release (far right) and attach a moored profiler (mid right) to the lines of a sub-surface mooring. (top middle) The 400-foot icebreaker *Polar Star* houses 164 crew and science team members, as well as two helicopters, a barber shop, a movie theater, a gym, and a hospital to keep everyone physically and mentally fit.

Oil Spill Lingers in Falmouth Marsh

By Mike Carlowicz

MIT/WHOI Joint Program student Helen White gathers a sample of marsh sediments from West Falmouth, MA, where residues of a 1969 oil spill can be found just below the surface. WHOI Assistant Scientist Chris Reddy (right) and colleagues used an advanced chemical analysis technique known as "two-dimensional gas chromatography" to delineate exactly how the oil has decomposed over the years. They found that not much has changed at all.

It has been 30 years since the barge *Florida* ran aground in Buzzards Bay, spilling 175,000 gallons of diesel fuel into Wild Harbor and fouling the beaches of West Falmouth, Massachusetts. But three inches below the seabed, it's as if the spill happened yesterday.

In a study published in November in the journal *Environmental Science and Technology,* WHOI Assistant Scientist Chris Reddy (Marine Chemistry and Geochemistry–MC&G) and colleagues observed that residues of the oil from that spill are still present in marsh sediments. The findings add to a growing body of evidence suggesting that oil can persist in the marine environment for a long time, even though surface sediments may appear healthy.

"We found that the oil had not weathered significantly, and most of the compounds typically found in oil were still present after 30 years," Reddy says. "We don't know whether this is the exception or the rule, but due to physical and chemical conditions, we believe that the oil at this location will persist indefinitely."

Though hardly the largest or worst oil spill on record, the West Falmouth spill is arguably one of the best studied. Three generations of WHOI scientists have sampled and analyzed the site, and the work is considered a baseline for studies of the long-term fate of petroleum products in marine sediments. In the early 1970s, WHOI geochemist Max Blumer made one of the first-ever uses of gas chromatography and mass spectrometry to study the degradation of spilled oil. Scientist Emeritus John Teal (Biology) and Senior Scientist and Vice President of Academic Programs John Farrington also did extensive work at the site in the 1970s and again in 1989 (after the Exxon *Valdez* spill in Alaska).

Reddy renewed the study in August 2000 with WHOI Associate Scientist Tim Eglinton (MC&G), Research Associate Li Xu (Geology and Geophysics), MIT/WHOI Joint Program student Helen White (MC&G), former guest student Aubrey Hounshell, and colleagues from the US Coast Guard Academy. With funding from the National Science Foundation and the Robert T. Alexander Trust, they brought a new angle to the West Falmouth studies, applying a novel technique known as "comprehensive two-dimensional gas chromatography" to precisely delineate how the petroleum had decomposed and into what compounds.

The team collected a 36-centimeter (14-inch) sediment core from the West Falmouth site, finding no evidence of petroleum residues in the top 6 centimeters (2 inches) of mostly new sediment, or in the bottom 8 centimeters (3 inches). But the central section of the core—from 6 to 22 centimeters (2 to 11 inches)—contained petroleum hydrocarbons in concentrations very close to those observed shortly after the spill.

The paper by Reddy and colleagues was published just days before the Bahamanian tanker *Prestige* sank off the coast of Spain on November 19, 2002. That ship was carrying more than 20 million gallons of fuel oil, a third of which has already leaked into Atlantic waters. Researchers expect oil to seep out of *Prestige* for at least 40 years.

"When it comes to oil spills, it's a lot like buying a home: location, location, location," says Reddy. "Location can dictate how fast weathering can occur and the potential effects. I would wager that a lot of the oil that spilled from *Prestige* would biodegrade rather quickly due to the high-energy environment of the open ocean. However, some portion of the spilled oil has already impacted the coastline, where its persistence and impact may be more severe."

"One of the reasons why oil persists at the West Falmouth site is that the oil impacted a very sleepy, low energy salt marsh," Reddy notes. "The long-term biological effect is unknown since animals burrowing into these sediments can be exposed to high levels of some of these compounds."

WHOI Releases *Jason* Version 2.0

A new stage of seafloor exploration began last fall as the WHOI Deep Submergence Laboratory and the National Deep Submergence Facility unveiled a new remotely operated vehicle (ROV). Designed and built by WHOI scientists, engineers, and technicians, the second-generation *Jason* is an imaging and sampling platform that gives oceanographers a virtual presence in the deep ocean. The National Science Foundation, the W.M. Keck Foundation, and WHOI funded the project.

The new *Jason* has two hydraulic manipulator arms that can reach twice as far and lift five times as much as the single arm on the original ROV *Jason*. State-of-the-art SeaNet wireless connections and fiber-optic cables allow data to be shared and visualized remotely and in near-real time. And a more robust design allows the new vehicle to dive to 6,500 meters (21,385 feet) while carrying more equipment, gathering more samples, and supplying more power to the instruments. It can do all of this at twice the speed of the original vehicle (which could dive 6,000 meters, or 19,000 feet).

"We have been able to put into practice a lot of the things we have learned from ten years of operating the first vehicle," says *Jason* project manager Andrew Bowen. "We basically kept the best of that ROV, then took advantage of developments in technology in the past few years to design a much more capable system."

In September 2002, the new *Jason* and its operators executed their first science mission, deploying and retrieving several experiments to study the microbes living within oceanic crust and the environmental conditions that support them. The ROV has been used on two more cruises since then and has a full schedule for 2003 and beyond.

For nearly a decade, the original *Jason* offered scientists a new way to visit and sample the deep seafloor. In more than 30 cruises, *Jason* helped prove the value and utility of ROVs, allowing scientists to explore the deep without leaving the deck of a ship—or in some cases, the comfort of their shore-based laboratories.

Look for a feature story about both generations of *Jason* in the next issue of *Currents*.

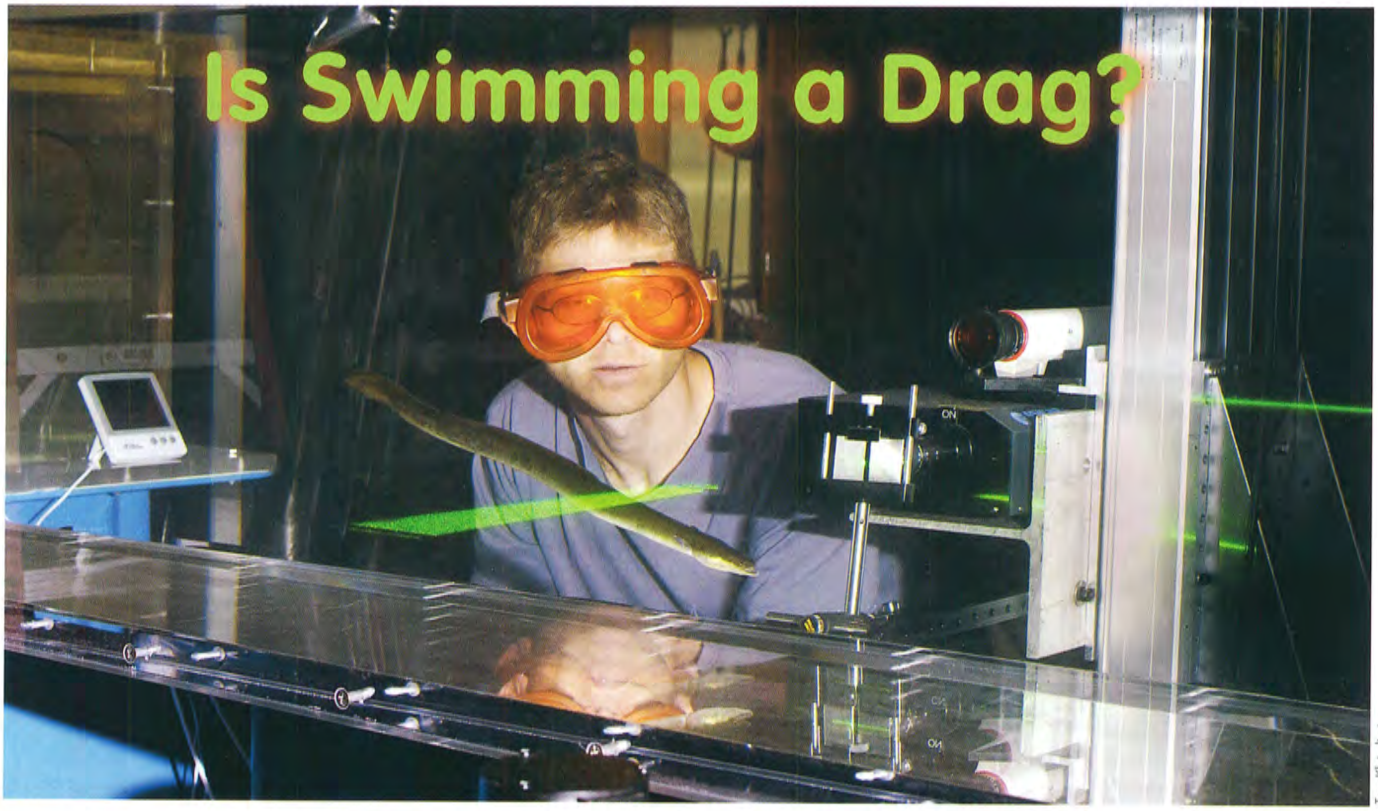
Dan Fornari

Matt Heintz (left) and Andy Bowen of the WHOI Deep Submergence Laboratory inspect the new *Jason*'s thrusters during sea trials of the vehicle off the Oregon coast in July 2002. The new ROV can survey the seafloor at 1.5 knots, nearly twice the cruising speed of the original vehicle.

Dan Fornari

Andy Bowen (foreground) checks one of the hydraulic manipulator arms used to deploy science instruments and collect samples.

Is Swimming a Drag?



Tom Kleindinst

Erik Anderson Trains His Camera on a Fishy Subject

By Bonnie J. Scott

A dolphin should not be able to swim. So said Cambridge University zoologist James Gray in the 1930s. The friction caused by water moving over a dolphin's skin, he said, should be like swimming in cold molasses. But dolphins obviously *can* swim, and Erik Anderson wants to find out why.

The paradox springs from a conflict between idealized models and a reality that is difficult to observe and measure. In trying to calculate drag—the force that slows the movement of an object through air or water—Gray could only use formulas and observations based on the flow of water over rigid, static bodies. The physical and mechanical models fell short of the biological reality, and Gray and other scientists were stuck with the implausible conclusion that the force a dolphin or fish needed to overcome drag was greater than the force their muscles could generate.

But the body of a swimming dolphin or fish is hardly rigid or static. So instead of *modeling* the forces of drag, Erik Anderson has combined 21st century lasers, robots, and cameras with old-fashioned attention to microscopic detail to build an experiment that *measures* the forces. "I want to know how a real fish swims," says Anderson, a student in the MIT/WHOI Joint Program. "I want to know their trade secrets."

Gray was stuck with the implausible conclusion that the force a dolphin needed to overcome drag was greater than the force its muscles could generate.

The Accidental Tourist

In the summer of 1997, Anderson had an encounter that would change his scientific life. As a master's degree candidate from St. Francis Xavier University (Nova Scotia), he visited WHOI for a study of the fluid dynamics of squid motion. Anderson and colleagues had traveled to Woods Hole because their subjects were abundant and accessible—the squid *Loligo pealei* migrates through the waters off the WHOI pier every spring—and because the Coastal Research Laboratory had a large flume close to the delicate animal's habitat.

One day while shooting high-speed, high-resolution images of *Loligo* swimming in the flume, Anderson was approached by a man who—without introducing himself—started asking questions about the experiment. "I thought he was a tourist and I was very busy," he recalls, "so I brushed him off with simple answers."

A week later, Anderson attended a scientific presentation by WHOI Associate Scientist Mark Grosenbaugh of the Applied Ocean Physics & Engineering Department. Anderson was curious to meet Grosenbaugh, whose papers he had read. When Grosenbaugh stood up to give his seminar, Anderson did a double take: Grosenbaugh had been his "tourist." "He was not a guy I should have been getting rid of," Anderson says.

Despite the awkward introduction, Anderson began talking with Grosenbaugh and WHOI Associate Scientist Wade McGillis (AOP&E). They are now his thesis advisors. "When they told me about the fish-drag problem, it sounded like a logical step after the squid work," Anderson recalls. "I was especially drawn to the challenge of engineering an experiment."

Within a year, Anderson was admitted to the MIT/WHOI Joint Program and began conducting experiments on a robotic tuna...and hatching plans for one of the most sophisticated studies of fish propulsion ever devised.

"Having to fish as part of my research is hilarious. All my fishing buddies just laugh when they hear I get paid to go fishing."

Swimming Against the Stream

Fish swim against two fluid forces: form drag and friction drag. Anderson compares the physics to riding a bicycle. "When you cycle through air—which is also a 'fluid' medium—you feel pressure on your chest and suction from a wake at your back," Anderson notes. "The pressure and suction are the source of form drag. Friction drag is caused by the air sliding over your skin."

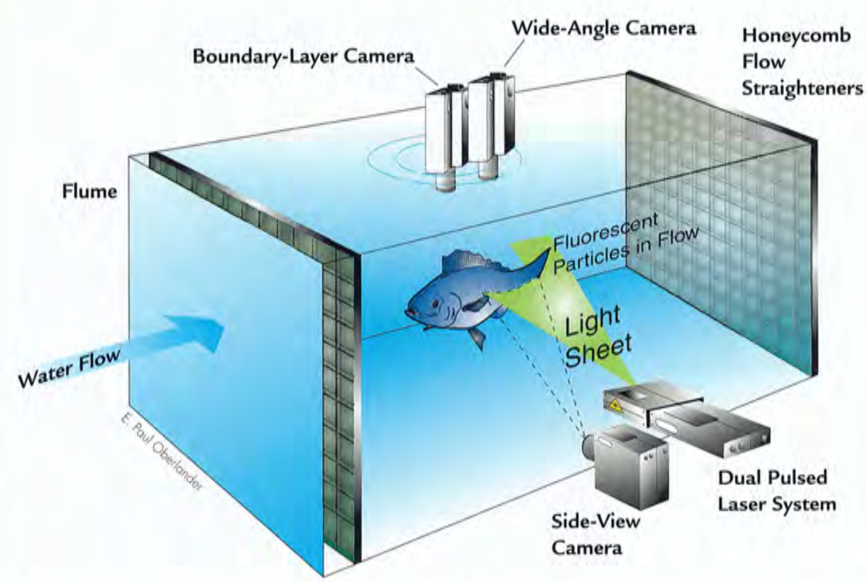
In the 1970s, Japanese researchers who observed fluid flowing over a waving rubber mat found that form drag may be almost negligible on a swimming fish. They demonstrated that as a surface undulates, fast-moving fluid is drawn closer to the surface, creating a smaller wake and reducing suction. The streamlined shape of most fish also results in reduced pressure in the front.

That leaves drag from friction, a force that has been modeled and studied in idealized experiments, but not measured directly on freely swimming fish. Anderson decided to use modern technology to zoom in on the "boundary layer," the critical zone around a fish where the effects of friction have a measurable impact on the flow of water. This layer is usually less than one centimeter thick.

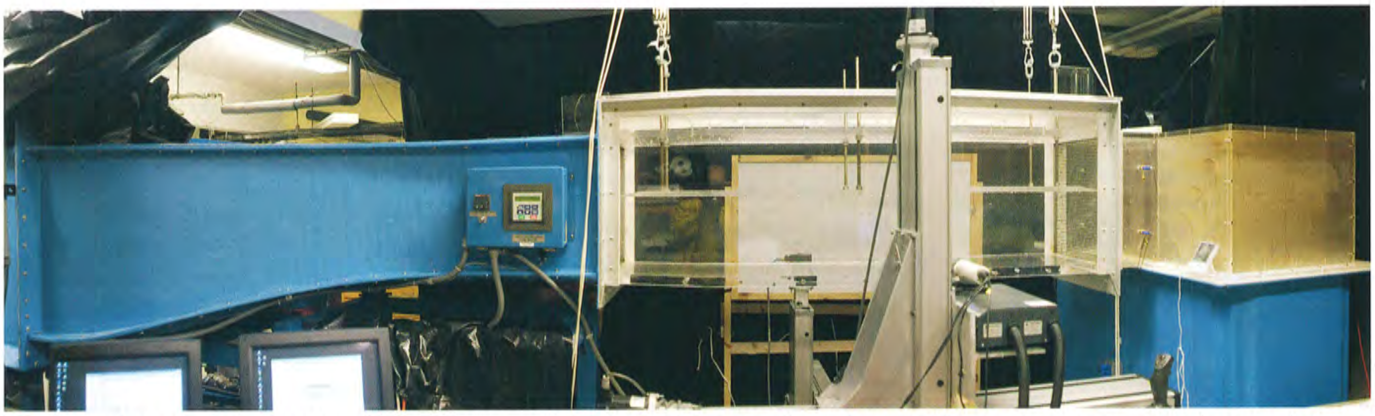
The experiment seems simple enough: photograph the water flowing through the boundary layer and across a fish's skin. From such pictures, Anderson can calculate the friction drag and visualize the shape of the fluid flow, much as engineers study the flow of air over airplane wings and cars. But as Anderson explains, "It was a challenging engineering problem to build a data-taking apparatus that could accurately measure friction drag."

"No one's been able to measure water's speed in the boundary layer of fish before," says George Lauder, who studies the flow around aquatic animals at Harvard University. "It's extremely hard to do, and Anderson's system is the first to be able to accomplish this."

How does Anderson *see* water moving? He puts microscopic, silver-coated beads into the flume as a tracer, then illuminates them with a sheet of light from a laser. To capture an image of water within 12 millimeters (0.47 inches) of a fish's skin, Anderson points a high-resolution digital camera at the sheet of laser light from beneath the flume. Another camera captures the same angle, but with a field of view ten times larger, in order to get a general picture of the flow inside and outside the boundary layer.



In order to measure the drag on swimming fish, Erik Anderson built a camera-laser-robot system that could observe water flowing within millimeters of the fish's skin (Note that the cameras have been placed on top in the graphic to simplify our view.) The photo on the opposite page shows Anderson at work observing an eel with the apparatus.



Dave Gray

During Anderson's experiments in the Coastal Research Laboratory, water flows through this temperature controlled, recirculating water tunnel (blue) and into the plexiglass test section where the cameras and laser are set up. The fish swim against currents up to 1.6 meters per second (3.6 miles per hour).

A third camera snaps a side view, recording the position where the laser impinges on the fish.

The three cameras and laser are synchronized in "dual pulses," taking pairs of freeze-frames two milliseconds apart. Lit by the laser, the beads appear as tiny white dots against the photo's black background. The "image pairs" generated by any of the cameras are nearly identical photos, but close inspection shows that the beads have moved slightly from one exposure to the next. With the help of several sophisticated computer programs that Anderson wrote himself, he can measure the distance the beads travel, effectively measuring how fast the water in the boundary layer traveled in millimeters per millisecond.

Anderson creates a map of water speed and direction along the entire length of a fish. From measurements of how water velocity changes with distance from the fish, he calculates friction drag at the skin. With that data, Anderson can generate a complete picture of the "shape" of the boundary layer and the friction drag along a wriggling fish.

In the first year of his study, Anderson waited days, sometimes weeks, for the fish to swim through his 1-centimeter-square field of view. He surfaced, bleary-eyed, from his experiments with just ten seconds of usable image data. With experience and increased funding from the National Science Foundation, the Office of Naval Research, and WHOI's Ocean Ventures Fund, Anderson's system has evolved from fixed cameras on stands to cameras and the laser gliding on the motorized rails of an 800-pound robot.

Tom Kleindinst

Anderson (right) and Kyle McKenney, a student from MIT's Undergraduate Research Opportunities Program, transfer a bluefish from a holding tank to a water-filled plastic bag in preparation for the fish's appearance on camera.

"Now, I just sit in front of the tank with the joystick, training the laser on the fish," Anderson says. These days, the heavy lifting comes from sifting through the mountains of data. Each camera captures hundreds of gigabytes of images per two-hour experiment.

Data isn't the only thing Anderson catches with his work. An avid angler who spent childhood weekends fishing with his dad, he collects his own experimental "volunteers" (eel, mackerel, dogfish, bluefish, and scup) in Vineyard Sound and Cape Cod Bay. "Having to fish as part of my research is hilarious," Anderson says. "All my fishing buddies just laugh when they hear I get paid to go fishing."

Something Fishy About Drag

Ever since Gray calculated that dolphins shouldn't be able to swim, there has been a controversy in the field of biomechanics: Is drag more intense on a wriggling fish than on a rigid body like a submarine? James Lighthill, another Cambridge scientist and the mathematical genius who helped design the supersonic Concorde jet, predicted in the 1970s that the drag on a real fish would be up to five times greater than on a stiff mock-up.

Of all Anderson's experimental subjects, the bluefish provided the best data. "The bluefish were the best behaved, and they did not seem scared at all," Anderson notes. "I think it's because compared to a little scup or eel, the bluefish has an attitude."

Tom Kleindinst

After observing real swimmers and crunching the data, Anderson saw what Lighthill had predicted. "The friction drag on scup and dogfish was higher than on a rigid body," Anderson says. Essentially, the friction on a swimming fish is higher than that on a coasting fish. "But we also calculated that a scup has two to twenty times the strength needed to overcome this drag." He reported his findings in a 2001 paper in *The Journal of Experimental Biology*, a publication that James Gray edited for 20 years.

Anderson suggests that his most important observation is that the historical concept of "drag reduction" has been improperly defined when it comes to swimming fish. "A true study of swimming fish should compare the drag of one swimming motion compared to another, not a swimming fish to a rigid model," says Anderson. "A rigid eel goes nowhere, so it doesn't make any sense to compare its drag to a swimming eel, unless you are studying swimming versus gliding…or trying to decide whether vehicles should be rigid or fish-like.

"It's possible that while a swimming fish has higher friction drag than a rigid, fish-shaped model, a real fish might tune its motion to have lower drag than another, similarly shaped fish," he adds. "This is the more interesting question: What slight differences in swimming motion and body structure result in enhanced efficiency, stability, or maneuverability?"

Much of the time, the key to minimizing friction drag is to keep water flowing smoothly over the fish's skin and to reduce surface area. "For small and slow fish, the boundary layer is often laminar or smooth," Anderson notes. Some fish appear to have natural drag-reducing strategies, such as slots where they can tuck their fins for a sleeker profile.

But sometimes the opposite is true. "For some large and fast fish, the boundary layer sometimes appears to be turbulent," Anderson says. The rough skin of sharks, for instance, may actually stir up the boundary layer. Such turbulence, although it increases friction drag, can decrease form drag by a greater amount. That's because an eddying boundary layer produces a smaller wake and decreased suction at the tail end. (The same principle is at work in the dimples on a golf ball.) Sharks have a method to counteract friction as well, using tiny riblets along their surfaces to organize the turbulent flow in a way that decreases friction.

"A rigid eel goes nowhere, so it doesn't make any sense to compare its drag to a swimming eel…"

Anderson's research "has implications for the design of more energy efficient underwater vehicles," says Lauder. "His findings might help show whether future vehicles should be flexible like a fish or rigid like a submarine." Along those lines, boat builders have adopted some of nature's ideas by using riblet technology on the hulls of racing boats.

As Anderson finishes his Ph.D. dissertation on fish motion, he is already daydreaming about how to put Gray's dolphin paradox to the test. He'd like to measure the drag on a live dolphin. If he can find the resources and adapt the technology, he will put his camera and laser system into a watertight backpack and snap shots of the dolphin's boundary layer as it swims. That's assuming that a dolphin actually can swim…

WHOI Constructs New Coastal Vessel

By Mike Carlowicz

To satisfy a growing demand for scientific understanding of near-shore waters, WHOI has contracted with Gladding-Hearn Shipbuilding (Somerset, MA) to build a state-of-the-art research vessel. The new boat is intended to improve access to coastal environments from the Hudson River to the Gulf of Maine, from the edge of the continental shelf to the beaches and bays of the northeastern United States. Scheduled for delivery in 2004, it will replace the existing coastal vessel, *Asterias*, which has served the Institution since 1979.

"It is clear that changing research needs and the societally important questions our researchers seek to address will require a much more capable vessel," says Richard Pittenger, Vice President for Marine Operations. "The new boat will provide researchers with a new generation of near-shore vessel with tremendous capabilities for many years to come."

Designed to cruise at twice the speed of *Asterias*, the new coastal vessel should allow scientists to spend more time on station and less time in transit, according to Ernest "Dutch" Wegman, WHOI Port Engineer and project manager for the new boat. The modern hull design and three-point mooring system will allow crews to work farther offshore and closer inshore, and within narrow weather windows, Wegman notes.

"The increased use of autonomous instruments and vehicles, the development of our new Martha's Vineyard Coastal Observatory, and an increased focus on coastal processes are among the many reasons we need a more capable vessel," says physical oceanographer Rocky Geyer, Chair of the Applied Ocean Physics and Engineering Department.

"This new vessel will enhance our seagoing educational experience," Geyer adds. "That experience has been limited somewhat by the realities of long cruises on our larger research vessels. Opportunities for students to conduct research on a variety of coastal processes will now be within a day's reach."

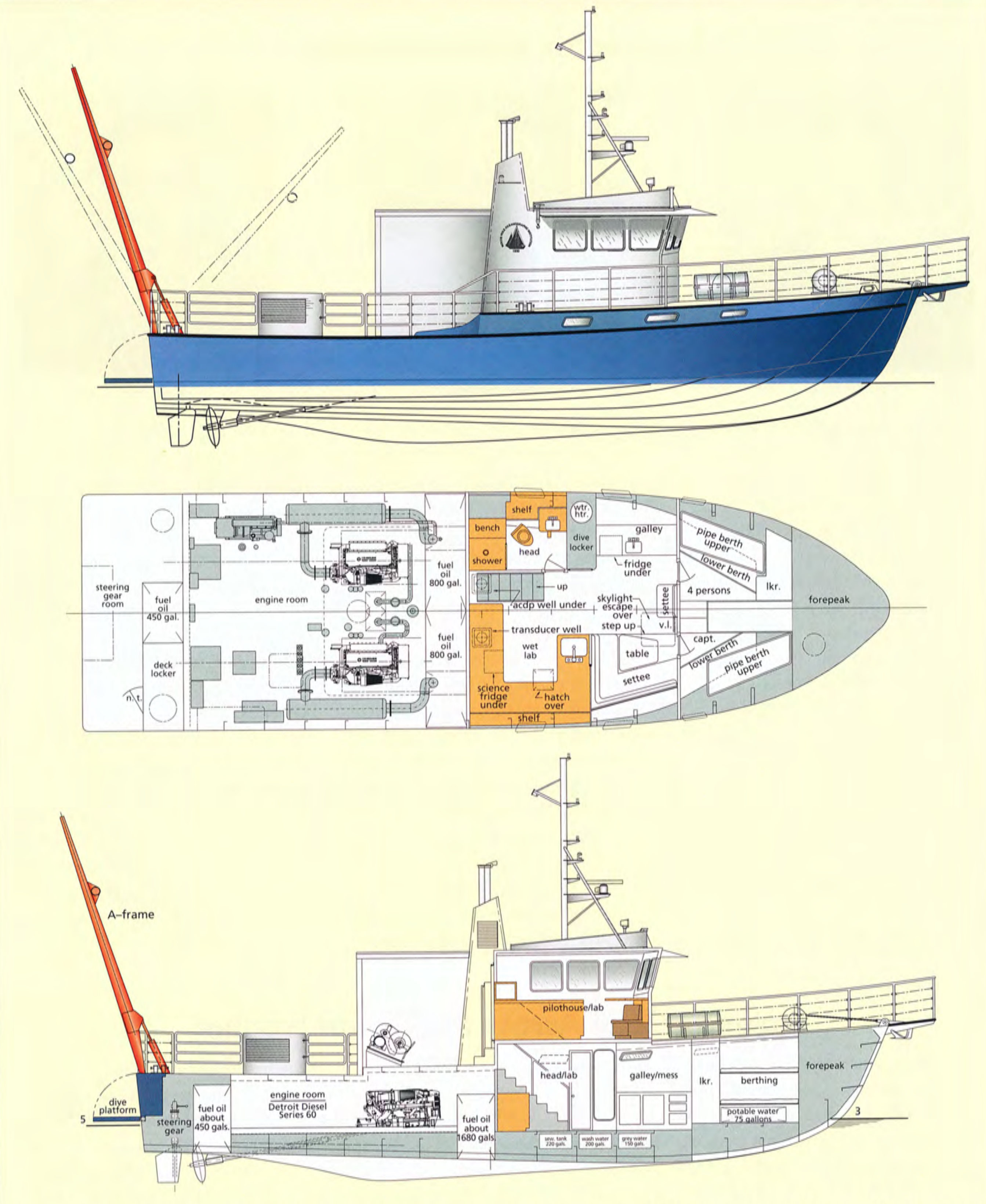
Gladding-Hearn Shipbuilding and Roger Long Marine Architecture collaborated to design and build R/V *Gulf Challenger* for the University of New Hampshire. The new WHOI coastal boat will be modeled after that vessel, though it will be larger.

Wegman says the new boat is being designed to better support scuba and snorkel divers by including a more accessible dive platform, a dive locker and shower, wet suit racks, and tempered (warm) water on deck. The stern A-frame will be capable of lifting 4,500 kilograms (10,000 pounds), and a versatile boom and 4.5- by 6-meter (15- by 20-foot) fantail will enable scientists and engineers to tow and deploy coastal instrument systems and moorings.

Among the standard instruments planned for the vessel are a flow-through water sampling system, a full suite of meteorological measurement systems, an acoustic Doppler current profiler (ADCP), and a conductivity/temperature/density (CTD) rosette with a conducting wire winch.

"Scientists and engineers are pursuing more complex problems and using increasingly sophisticated equipment that they often design, build, and need to test," Wegman says. "Their seagoing needs have changed considerably in the past decade, and it became clear that we needed a new near-shore vessel for a new generation of measurement systems."

The new vessel is expected to cost $1.6 million and will be owned and operated by WHOI. Roger Long Marine Architecture (Cape Elizabeth, Maine) has designed the boat with extensive input from WHOI scientists and ship operators. It is currently under construction at Gladding-Hearn, builders of more than 330 vessels since 1955, including *Gray Lady*, a Hyannis-to-Nantucket fast ferry. The team of Roger Long and Gladding-Hearn recently built similar oceanographic research vessels for the University of New Hampshire (R/V *Gulf Challenger*) and Old Dominion University (R/V *Fay Slover*).



Artist's conception of the profile and layout of WHOI's new coastal research vessel. The new boat will be capable of cruising at 20 knots, taking researchers as far as New York Harbor or the Gulf of Maine within a day. The boat can accommodate as many as ten scientists and crew on short trips and can house several people overnight. *Illustrations by Jayne Doucette.*

Laurels for WHOI Scientists


Dave Gray

Bob Weller


Tom Kleindinst

John Hayes


Tom Kleindinst

Kurt Polzin

In February, the American Meteorological Society presented its Sverdrup Gold Medal to WHOI Senior Scientist **Bob Weller** (Physical Oceanography) during the group's annual meeting in Long Beach, California. Named for Harald Ulrik Sverdrup, a pioneer in the field of oceanography, the medal is awarded to "researchers who make outstanding contributions to the scientific knowledge of interactions between the oceans and the atmosphere." The citation commended Weller for "scientific leadership and sustained excellence in the development and use of innovative measurement techniques in the air-sea boundary layer."

Senior Scientist **John Hayes** (Geology and Geophysics) was awarded the 2003 Geochemistry Division Medal from the American Chemical Society (ACS), in recognition of "outstanding accomplishments in geochemistry." Edel Wasserman, past president of the ACS, presented the medal to Hayes during an award symposium at the ACS National Meeting in March. The honor includes an engraved bronze medallion and a cash prize.

In a news release, ACS noted that Hayes was chosen for "his visionary contributions to an understanding of organic geochemistry, cosmochemistry, isotope geochemistry, and paleoenvironmental analysis. His development of continuous-flow isotope ratio mass spectrometry techniques paved the way for compound-specific isotopic analysis, opened frontiers between isotopic and molecular organic chemistry, bridged the fields of geochemistry and biology, and shed new light on modern and ancient biogeochemical processes."

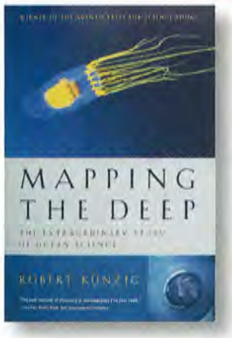
In April, Associate Scientist **Kurt Polzin** (Physical Oceanography) will be awarded the Fridtjof Nansen Medal of the European Geophysical Society (EGS). The medal was established in 1996 by the society's Section on Oceans and Atmosphere in recognition of "distinguished research in oceanography." It commemorates Nansen's achievements as an arctic explorer, oceanographic pioneer, and Nobel Peace Prize winner. During the Joint Assembly of the EGS, the American Geophysical Union, and the European Union of Geoscientists in Nice, France, Polzin will be presented with a handmade bronze medal created by Hungarian sculptor József Kótai.

Blazing a Trail Across the Ocean Frontier

"In 1803, when our country made the Louisiana Purchase, President Jefferson dispatched Lewis and Clark to find out what was out there. The knowledge they brought back opened up the West…Could we fully comprehend our nation without exploring two-thirds of it? Similarly, can we ignore 72 percent of Earth's surface and really understand how our planet works? In comparison to the Lewis and Clark expedition, deep-sea explorers haven't even left Missouri yet…As we launch a new era of oceanographic exploration, I can say with certainty that our discoveries will provide substantial benefits to humankind, and that they will reveal the full wonders of our home planet. That's exciting! What I can't say with any certainty is exactly what we will discover. And that's equally exciting!"

—Susan Humphris, WHOI Senior Scientist and Director of the Deep Ocean Exploration Institute, during a presentation to WHOI Corporation members and guests in September 2002 in New York City

WHOI Announces First Ocean Journalism Awards



A prize-winning science author and a BBC documentary producer are the winners of the first major journalism awards to recognize outstanding achievement in communicating ocean science to the public. Established with private funding in 2002, the WHOI Awards for Excellence in Ocean Science Journalism recognize popular science communications that "enhance public awareness of, interest in, and understanding of the ocean sciences in a clear, accurate, and original way." More than 50 entries were submitted for the first two awards, which include cash prizes and invitations to deliver lectures to the WHOI community.

The award for print journalism will be presented later this year to author Robert Kunzig for *Mapping the Deep: The Extraordinary Story of Ocean Science*, a nonfiction account of the 20th century discoveries that helped shape our modern understanding of the seafloor. Kunzig, former executive editor of *Discover* magazine, is now a contributing editor and freelance writer. His magazine articles have garnered awards from the American Association for the Advancement of Science and the American Geophysical Union. In 2001, *Mapping the Deep* was awarded the Aventis Prize for Science Books published in the United Kingdom.

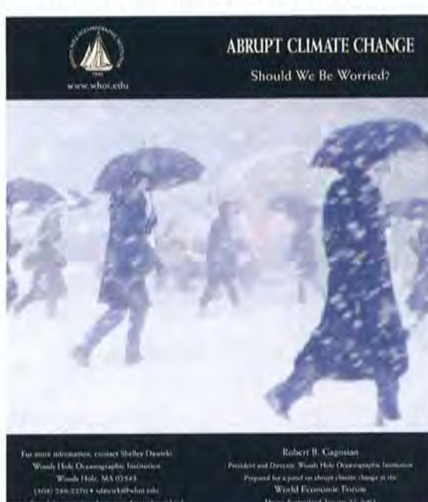
Alastair Fothergill, an executive producer at the BBC Natural History Unit, will receive the broadcast journalism award. Fothergill and colleagues are being recognized for "Ocean World," the first episode of the eight-hour *Blue Planet: Seas of Life* series co-produced by the BBC and The Discovery Channel. Appointed in 1992 at age 32 to be the youngest-ever head of the BBC's Natural History Unit, Fothergill previously won an award from the British Academy of Film and Television Arts for *The Really Wild Show*. He also broke television ground with *Reefwatch*, a live broadcast from under the sea.

Gagosian Facilitates Abrupt Climate Change Discussion

Much of the discussion of climate in recent years has focused on greenhouse gases and gradual warming of Earth on a global scale. But research suggests that global temperature changes can produce unpredictable and counter-intuitive results. The geologic record shows that, in the past, temperatures in some regions have swung by 3 to 6°C (6 to 10°F) in time spans as short as a decade. What would happen to modern economies, agriculture, and public health if, for instance, average temperatures in Europe and the American Northeast suddenly *cooled* by six degrees?

Such scenarios were the focus of a panel discussion that included WHOI President and Director Bob Gagosian at the World Economic Forum in January in Davos, Switzerland. In a session entitled "Abrupt Climate Change—Should We Be Worried?" Gagosian and colleagues pondered the environmental, social, and economic repercussions of a drastic shift in regional climate. Gagosian was joined in the conversation by Mario Molina, Nobel Prize winner and MIT atmospheric chemist, and Yolanda Kakabadse Navarro, President of The World Conservation Union.

The annual World Economic Forum attracts two thousand political, business, and academic leaders from around the world to broad-based discussions of economic, political, environmental, and societal issues. In addition to the climate change sessions, Gagosian also participated in two other science- and environment-related panels: "Setting the Scene—Update on the Environment" and "Legal Implications of Climate Change." This was the third consecutive year that Gagosian, a forum fellow, was a panelist at the meeting.



The WHOI white paper (left) distributed at the World Economic Forum and many other resources on abrupt climate change are available on the World Wide Web. Printed copies of the white paper are available by contacting Tracey Poirier at 508-289-2990. The Web address is www.whoi.edu/institutes/occi/hottopics/climatechange.html.

New Fellowship Honors Art Maxwell

"As a tribute to my dear friend and longtime mentor," WHOI Corporation Member Jamie Austin has established a graduate student fellowship in honor of Art Maxwell, former Provost and Director of Research at WHOI.

The Arthur E. Maxwell Graduate Student Fellowship will provide annual support (tuition and a stipend) for first-year graduate students in the MIT/WHOI Joint Program in Oceanography/Applied Ocean Science and Engineering. The fellowship is intended to support students pursuing interdisciplinary work. It was initiated with a $100,000 donation from Austin, and a similar fellowship has been established at the University of Texas at Austin, where Maxwell and Austin are members of the faculty.

In 1965, Maxwell left the Office of Naval Research to become Associate Director of WHOI. In 1968, he served as Co-Chief Scientist on the Deep Sea Drilling Project's third expedition, which gathered some of the first direct geologic evidence in support

Courtesy of Emerson Hiller

Art Maxwell (left) and WHOI Director Paul Fye host US Vice President Hubert H. Humphrey on *Atlantis II* during a June 1967 visit for the National Council on Marine Resources and Engineering Development.

Tom Kleindinst

Jamie Austin takes a break from preparations for an October 2002 cruise on R/V *Knorr.*

of the concepts of seafloor spreading and plate tectonics. He was active in the development of scientific ocean drilling through participation in Project Mohole, the Ocean Margin Drilling Program, and the Ocean Drilling Program. He was an early advocate for long-term government support of submersible research using both *Trieste* and *Alvin*.

In later years, Maxwell served as WHOI's Director of Research and as Provost, playing instrumental roles in the development of the MIT/WHOI Joint Program and in bringing the East Coast marine group of the US Geological Survey to the Quissett Campus. Austin notes, "Art Maxwell and [WHOI's fourth Director] Paul Fye epitomized the kind of wise, committed leadership that has helped make the Institution the world's leading center of oceanographic research and graduate training."

In 1982, Maxwell left Woods Hole to become the first Director of the Institute for Geophysics at UT-Austin, where Jamie Austin had taken a position as a Research Scientist. "I helped Art learn about Texas while he continued to teach me about capable leadership," Austin recalls. Maxwell led the Institute until his retirement in 1994. He remains on the faculty as an emeritus professor in the Department of Geological Sciences.

"I wanted to remind people at WHOI that Art played an important role for 17 years in a key period of growth for the Institution," says Austin, President of the MIT/WHOI Joint Program Alumni/ae Association. "He was one of the founding fathers of the business." Austin hopes "to bridge the generations of scientists" with this fellowship and intends that fellows should meet the man who was "one of the formative influences in my life."

Austin is currently a Senior Research Scientist at the UT-Austin Institute for Geophysics. He grew up in New York and on Martha's Vineyard, and still keeps a seasonal home on the island. He was a Joint Program student in Geology & Geophysics from 1973 to 1978 and still frequently uses WHOI ships for his research.

What do you think of *Currents*?

Send your comments, ideas, corrections, and questions to Mike Carlowicz, Editor, at mcarlowicz@whoi.edu or 508-289-3771

A Woods Hole Love Affair

Tom Kleindinst

Dave and Edith Ross want to "give something back" after three decades as a part of the WHOI family.

He was a confident young New Yorker looking to carve a niche in the WHOI Geology and Geophysics Department (G&G). She was a young German chemist coming to Woods Hole for a "break" before medical school. Thirty-seven years later, they wouldn't dream of leaving.

In 1965, David Ross was fresh from graduate school at the Scripps Institution of Oceanography and blessed with a dozen offers for work. "WHOI seemed like the best opportunity for a young oceanographer," he notes. "There were lots of other young scientists and a great chance to jump right into exciting research."

Edith Reppmann had finished her bachelor's degree in chemistry at the Metallfachschule Düsseldorf, worked for a few years in a hospital and an industrial lab, and found herself in need of "a year off." In 1966, she met Egon Degens, Senior Scientist in the WHOI Chemistry Department, while he was visiting Germany. He asked if she wanted a change of pace by working in his lab. "I never had any intention of staying in this country for more than a year," she recalls.

Tom Kleindinst

Dave Ross teaches WHOI Development Officer Jim Rakowski a bit about how to hook the big fish in Vineyard Sound.

Edith and Dave met during a morning break at BJ's, an old coffee shop in the village of Woods Hole. They started spending their lunch hours fishing together on his Boston Whaler. Edith's one year in Woods Hole turned into two. By July 1968, they were married to each other, and in a way, to WHOI.

"Cape Cod is a great place to live, and working at WHOI has always been a pleasure," says Edith, who worked in the chemistry lab of Werner Deuser from 1966 to 1993, finishing her career as a Senior Research Assistant. Her specialty was working with sediment traps and with mass spectrometers, participating in the growth of paleoceanography before the field even had a name. "There is a great work climate, and there is a tremendous relationship between the scientists and technical staff," she says.

"We have incredible talent at WHOI, from scientists to support people to staff assistants," adds Dave, a Scientist Emeritus since 1995. He was a self-proclaimed "jack of all trades" during a career that included stints as Sea Grant Coordinator, Director of the Marine Policy Center, and G&G Department Chair. He authored more than 130 refereed papers and wrote or edited twelve books, including the widely used textbook *Introduction to Oceanography* and *The Fisherman's Ocean*, a popular science book that combines his scientific vocation with his lifelong avocation. "At WHOI, I was fortunate to be able to change my career without giving up my career," he says. "Every Institution scientist is an entrepreneur, and we are only limited by our own imagination."

Blessed by good investments over the years, Dave and Edith Ross now intend to leave part of their estate to WHOI. "Woods Hole has been very good to us, and we believe in this Institution, so why not give something back," says Dave. "We've seen what can be done with even a little bit of money. We've got to keep investing in the future. Small seeds can reap big harvests."

Through charitable bequests, life income gifts, and trusts, members of the Paul M. Fye Society help build the WHOI endowment and promote the development of the next generation of ocean explorers. We invite you to join Dave and Edith Ross and other Fye Society friends by including the Woods Hole Oceanographic Institution in your estate plan.
Please direct inquiries to:

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