## Sea Grant College Program

# Financial Report

*July 1, 1999 – June 30, 2000*

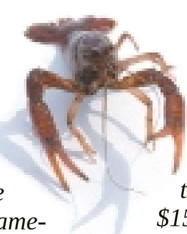
| Program Area | State Funds | Federal & Other Matching |
|---|---|---|
| Coastal Ocean Studies | $ 61,637 | $ 211,998 |
| Environmental Technology | 15,839 | 88,337 |
| Coastal Engineering | 50,040 | 83,172 |
| Marine Biotechnology | 34,718 | 78,010 |
| Fisheries | 64,127 | 283,186 |
| Marine Outreach | 208,346 | 762,644 |
| Graduate Education | 0 | 503,679 |
| Program Management | 37,993 | 219,600 |
| **Totals** | **$472,700** | **$2,230,626** |
| **Grand Total** | | **$2,703,326** |

In addition to this funding, Delaware investigators successfully competed for several special grants from the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. Funds for these projects are managed by the University of Delaware Sea Grant College Program and serve as an important mechanism for the development of comprehensive and integrated research efforts:

- *UD marine biologist Patrick Gaffney received $63,000 to evaluate Chesapeake Bay oyster stock enhancements with molecular markers. This is in addition to his current award ($83,000) from the Sea Grant Oyster Disease Research Program.*

- *As part of a regional Mid-Atlantic Sea Grant outreach project, UD Sea Grant investigators James Falk and Tracey Bryant received $15,639 to conduct a survey of public perceptions and attitudes about* Pfiesteria piscicida *and to develop radio public service announcements about the microorganism.*

- *Under the NOAA Sea Grant Technology Program, UD investigators Biliana Cicin-Sain and Robert Knecht are developing a policy framework for governing marine aquaculture in U.S. federal waters. This 18-month effort is funded at $103,608.*



- *At Delaware State University, aquaculture scientists Bernard Petrosky and Williams Daniels are completing the third year of a $150,000 award to develop aquaculture methods in the Mid-Atlantic for crawfish and bait fish.*

2000 Sea Grant University of Delaware

## Advisory Council

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*Chairman*

| | |
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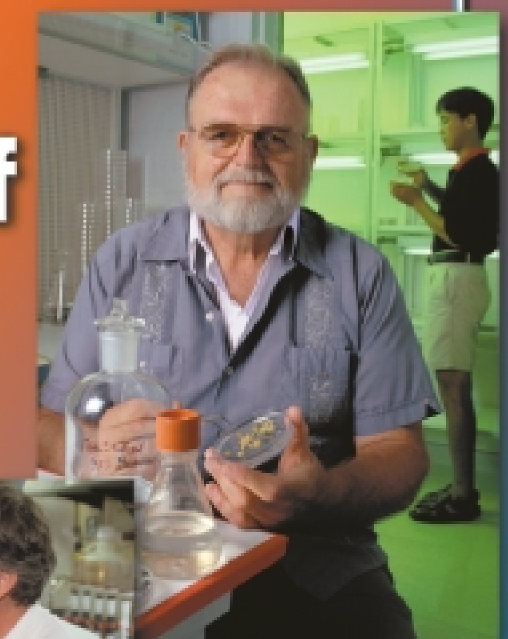
University of Delaware Sea Grant

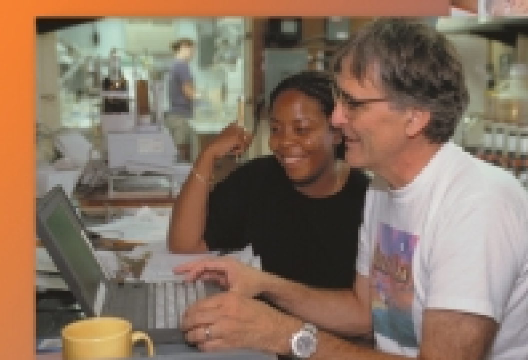

# REPORTER


Volume 19, No. 1 — *Special Issue 2000*


www.ocean.udel.edu

# Exploring an Ocean of Wonder





2000 Annual Report

UNIVERSITY OF DELAWARE SEA GRANT
REPORTER

CONTENTS



Sea Grant
University of Delaware

The University of Delaware Sea Grant College Program is a member of a national network of universities committed to research, education, and technology transfer designed to meet the changing needs of U.S. coastal regions. The program is financially supported by the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce; the State of Delaware; and the University. Dr. Carolyn A. Thoroughgood, Director. David McCarren, Executive Director.

UNIVERSITY OF DELAWARE SEA GRANT REPORTER is published twice a year to inform the public of marine research, issues, and events that affect Delaware. Tracey Bryant, Editor; David Barczak, Art Director; Pam Donnelly, Production Manager. For more information, please contact University of Delaware Marine Communications, Newark, DE 19716-3530. Phone: (302) 831-8083. E-mail: MarineCom@udel.edu. Web: www.ocean.udel.edu/seagrant.



# Message from the director

Floyd Dean

**Dr. Carolyn A. Thoroughgood**
Director, *University of Delaware Sea Grant College Program*

It covers more than 70% of the Earth's surface and harbors more than half of all the species living on the planet. It makes our weather and provides us with food, jobs, transportation, and recreation. It awes us with its tremendous power and lulls us with its music. The ocean is indeed a world of wonder.

With a resource as vast as the ocean to explore, marine scientists may well be the pioneers of the 21st century. Using tools ranging from highly equipped research ships and submarines to satellites in space, today's ocean pioneers are making steady progress in unraveling the mysteries of the complex resource we all depend on.

Here in Delaware, where nearly our entire state lies in the Coastal Plain, knowing more about the ocean around us is critically important. We count on healthy bays, beaches, and wetlands. We expect plentiful fisheries, from succulent blue crabs to keeper-size striped bass. We want to benefit from the economy our marine resources drive, but we also know we need to protect these resources if we want them to sustain future generations.

At the University of Delaware Sea Grant College Program, our mission is to promote the wise use, conservation, and management of Delaware's marine resources. Our goals are to conduct high-quality research, educate the nation's future marine scientists, and increase public awareness and understanding of the ocean and coast.

During the past year, we continued to make progress in research areas of importance and promise to Delaware and the nation, from coastal ocean studies to environmental technology, coastal engineering, marine biotechnology, and fisheries.

In addition to these efforts, our outreach team — the Marine Advisory Service and Marine Communications staffs — shared information with thousands of people on topics such as *Pfiesteria*, boating safety, aquaculture, seafood, hurricane preparedness, open-space conservation, nutrient management, horseshoe crabs, and many other marine life and phenomena.

And the methods we are using to extend this information to the public are as diverse as the topics themselves, including Web pages, seminars, publications, radio announcements, videos, press releases, and our award-winning Coast Day festival.

In fact, this past January, we invited Delaware students and the public to tag along on the first deep-sea expedition of the new millennium. As our scientists set out on an 11-day mission to hydrothermal vent sites over a mile deep in the Sea of Cortés off Mexico, students read daily logs, viewed video clips of each day's findings, and met members of the crew from computers in their classrooms and homes. Several classes also took part in a historic conference call with our scientists as they worked aboard the submarine *Alvin* on the seafloor.

So far, the interactive Web site we developed for the project has engaged more than 60,000 people from around the world in the excitement of discovery, opening a porthole to the ocean's greatest depths.

It's been said that "the larger the island of knowledge, the longer the shoreline of wonder." At Delaware Sea Grant, we're working to expand knowledge and appreciation of the ocean. It's a resource we really can't live without.

Carolyn A. Thoroughgood

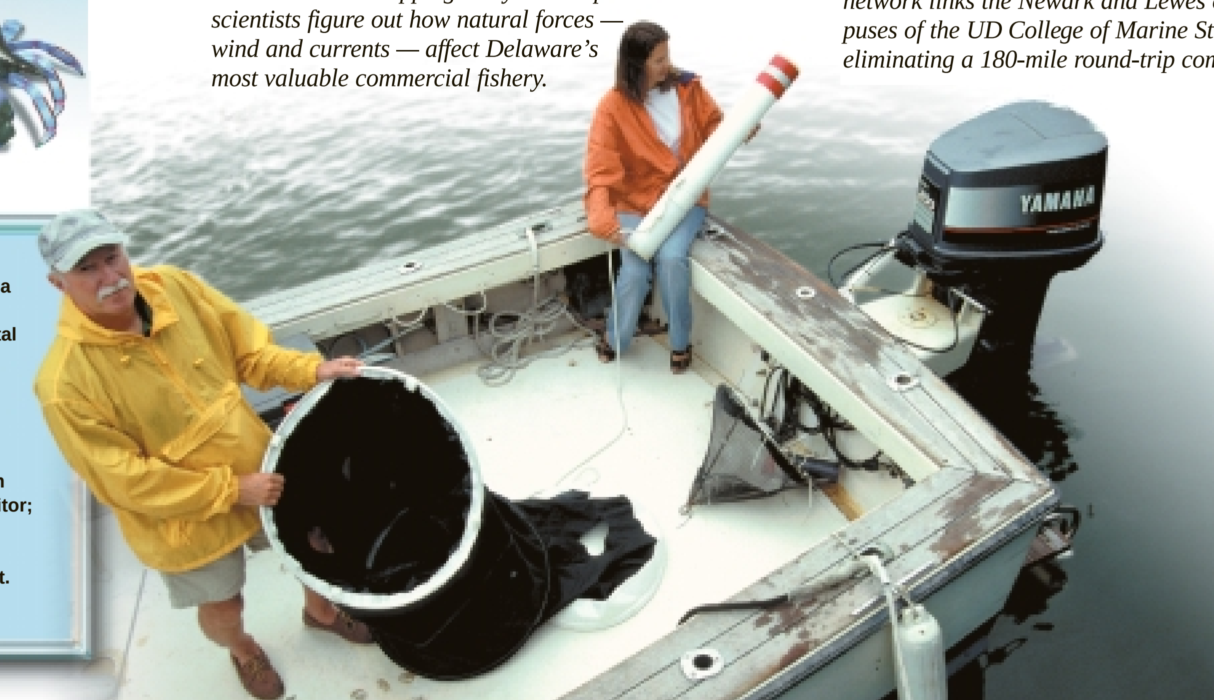
**Dr. Carolyn A. Thoroughgood**
*Director, Sea Grant College Program*
*Dean, Graduate College of Marine Studies*



▲ *More than 60,000 people have dived in to the Web site for "Extreme 2000: Voyage to the Deep" — a deep-sea expedition led by UD marine biologist Craig Cary in January. The interactive Web site includes photos and video clips of the scientists' findings at hydrothermal vent sites in the Sea of Cortés off Mexico's west coast.*

Robert Cohen

▲ *David McCarren, Delaware Sea Grant's executive director, convenes a meeting of administrative support staff via the Instructional Television (ITV) system. This electronic network links the Newark and Lewes campuses of the UD College of Marine Studies, eliminating a 180-mile round-trip commute.*





Robert Cohen

▼ *The drifter in scientist Charles Epifanio's hands is attached to a satellite-tracking device held by graduate student Cecily Natunewicz. Once deployed in Delaware Bay, the unit can reveal the exact locations of patches of larval blue crabs. The mapping study will help scientists figure out how natural forces — wind and currents — affect Delaware's most valuable commercial fishery.*

# Coastal Ocean Studies

**The "coastal ocean" constitutes less than 5% of the ocean's total volume, yet this region nearest the shore is where human impact is greatest. A diversity of activities is concentrated in this area, from shipping to mining, boating, and fishing. Ironically, many of the fisheries we rely on are harvested in the coastal ocean, yet this area is also where our most severe pollution problems occur.**

**Sea Grant researchers are working to increase our ability to assess and manage the health of coastal bays and marshes. Current efforts focus on the sea and shores of Delaware's largest marine ecosystems — the Delaware Bay and the Inland Bays.**

Robert Cohen

▲ *Jack Gallagher, a UD botanist, examines marsh-plant tissue cultures grown in the Halophyte Biotechnology Center at the Lewes campus. He and his research team are working to identify and genetically strengthen native marsh plants that can block the invasion of* Phragmites *(left) into Delaware's marshes.*

## Building a Defensive Line to Tackle *Phragmites*

Jack Gallagher is not a football coach, but he's working at beefing up his defensive line. The UD botanist is trying to develop plants capable of blocking the invasive weed *Phragmites australis* in Delaware's marshes.

*Phragmites*, or common reed, overtakes thousands of acres of wetlands in the United States every year, crowding out more beneficial plants that wildlife depend on for food and habitat.

Currently, wetlands managers try to control *Phragmites* by spraying the plants with an herbicide in fall and burning the dead canes in spring — for two consecutive years. Desirable plants may then colonize the sites, but sometimes *Phragmites* re-invades. Then the spray-and-burn cycle begins all over again, further delaying the marsh's restoration as optimal wildlife habitat.

"Much of the reinvasion of marshland cleared of *Phragmites* is by plants that become established on higher ground, either the upland fringe, levees, or high spots in the marsh," Gallagher says. "Thanks to a network of underground stems, *Phragmites* can grow from these more favorable habitats down in to wet sites where it could not initially become established."

Gallagher, colleague Denise Seliskar, and their research team at the UD Halophyte Biotechnology Center are working to identify varieties of marsh plants that, when planted en masse, will form a natural barrier to *Phragmites*.

So far, the team has begun testing several potential "*Phrag* blockers." They include plants such as black needlerush and three-square sedge, which have rigid stems; deep, dense root systems; and other features that would stop *Phragmites* from reaching the "end zone."

In addition to Sea Grant, this project has been funded by Public Service Electric and Gas.

◄ ***Meet the Marsh Invader — Phragmites australis.*** **It has been used for thatching roofs, drying sludge, and making low-grade paper. But in marshes, this plant crowds out grasses important for wildlife food and habitat. The U.S. Fish and Wildlife Service currently ranks *Phragmites* as the number-one invasive species in its northeastern region, which includes Delaware. The plant spreads via underground stems called rhizomes and forms thick stands that may grow to 15 feet tall.**



## Can Seafloor Life Stand More Sand?

While seldom seen, a rich variety of animals make up the *benthos* — the bottom-dwelling animals — in Delaware Bay. Here live worms, oysters, clams, crabs, and many other organisms.

UD oceanographer Doug Miller and his students are working to find out how much and how often sand and mud can be dumped on the bay floor without harming its inhabitants.

Their work should help engineers design projects for disposing dredged sediment, or "spoil," and for replenishing eroded shorelines with minimal impact on bottom life.

During the past year, Miller and graduate student Christine Muir set up field studies to determine the amount of shifting sediment that benthic animals must adapt to from nature. Four beaches now are being monitored, including Slaughter Beach, Primehook Beach, Broadkill Beach, and Cape Henlopen. Both Slaughter Beach and Broadkill Beach are proposed beach nourishment sites for the U.S. Army Corps of Engineers' Delaware River channel deepening project.

"Sediment erosion and deposition vary greatly from month to month, with more erosion typically in the winter and deposition in summer," says Muir. "In some areas, the beach may change by a foot or more of sediment depth a month."

The scientists are now moving to the lab to figure out how much and how often additional sand and mud can be deposited on the bottom dwellers without harming them. The scientists will conduct experiments in aquaria and water tunnels on three of the bay's common benthic species: the sandbuilder worm, the glassy tube worm, and the mud snail. While some people may think these animals could use a good "mud pack" — they're not very attractive — Miller notes that their small size and drab appearance do not minimize their importance.

"They are a critical food source for fisheries, from weakfish to blue crabs," he says.

▲ *Doug Miller collects mud snails on a Delaware tidal flat.*

◄ *The sandbuilder worm's tube homes form the reefs known locally as the "worm rocks" in lower Delaware Bay.*

## Oxygen Study Reveals an Estuary Out of Balance

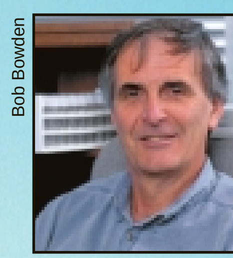
The Delaware River and Bay just isn't behaving like we think it should.

"Like any ecosystem, the estuary has a metabolism," says UD oceanographer Jon Sharp. "But the chemical balance in the river near Philadelphia is unlike that of the lower estuary near the bay mouth. It doesn't fit the standard aquatic model."

According to that model, oxygen should increase and carbon dioxide decrease during the day as microscopic plants use sunlight to make organic matter through the process of photosynthesis. At night, the oxygen in the water should decrease and carbon dioxide increase as the organic matter is decomposed by bacteria.

"What is happening in the lower bay is consistent with our expectations," Sharp notes. "But in the urbanized river, near Philadelphia, we're seeing a very different picture. There, oxygen levels are highly variable. Sometimes they go down during the day, and they are not in mirror image or proportion to carbon dioxide, nitrogen, and phosphorus."

Bob Bowden



*Dr. Jonathan Sharp*

**"What is happening in the lower bay is consistent with our expectations. But in the urbanized river, near Philadelphia, we're seeing a completely different picture."**

To find out what causes this anomalous behavior, Sharp and his team are conducting intensive studies in the estuary.

At sea aboard UD's 120-foot research ship *Cape Henlopen*, the scientists collect large, 300-liter water samples and study them on deck as miniature ecosystems, or *mesocosms*. The samples are incubated for 30 to 50 hours under natural light and temperature conditions and analyzed for changes in their carbon, nitrogen, phosphorus, silicon, and oxygen levels. Chemical tracers are added to monitor the uptake and transfer of carbon and nitrogen by algae.

By comparing changes in the water chemistry of the lower bay, where the system is most biologically active, with the chemistry of the river, which receives high human inputs, Sharp hopes to sort out the factors that control the estuary's unusual metabolism.

"Once we piece together this puzzle," he notes, "we should be able to determine the best strategies for managing the inputs to the river."

## When Toxic *Pfiesteria* Appears, Coastal Tourism May Decline

**When toxic *Pfiesteria* microbes invade coastal waterways, attacking bait fish and leaving telltale sores in their flesh, tourism and seafood sales can suffer, reports Jim Falk, UD Sea Grant Marine Advisory Service director. He recently conducted a survey of 3,500 coastal residents from New York to the Carolinas to find out what they think about *Pfiesteria*.**

Troy Plair

▲ *Jim Falk, Marine Advisory Service director, reports on his* Pfiesteria *survey in a briefing at the National Press Club in Washington, DC.*

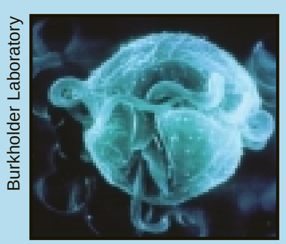
**"According to our results, a *Pfiesteria* outbreak could reduce tourism by more than 40% in an affected area," Falk says. "Approximately 5 million visitors brought $342 million into Delaware's Sussex County in the summer of 1998. If a *Pfiesteria* outbreak were to occur here, the county could see a substantial loss of visitors and their spending power."**

**Seafood sales also may plummet if an outbreak occurs. Nearly two-thirds said they would eat less locally harvested seafood if a *Pfiesteria* outbreak were reported in their waters.**

**"From a human health standpoint, people are very concerned about *Pfiesteria*," Falk says. "Ninety-five percent think *Pfiesteria* can be harmful to them."**

***Pfiesteria's* human health effects are not well understood. Exposure has been linked to memory problems, headaches, and other symptoms. Consequently, the public is advised to avoid waters where fish can be seen floating on the surface and to notify their state natural resource agency if *Pfiesteria* is suspected.**

Burkholder Laboratory



▲ *Toxic stage of the microorganism* Pfiesteria piscicida.

**"The public views *Pfiesteria* as a serious threat," Falk notes. "The majority of our survey respondents strongly support state government's efforts to help understand what causes *Pfiesteria* outbreaks and how to prevent them." For a copy of the final report, call UD Marine Communications at (302) 831-8083.**

# Environmental Technology

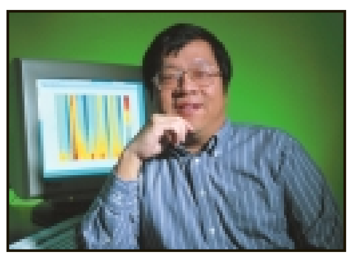
**Monitoring a resource as large as the Delaware Bay requires the "eyes" and "ears" that technology can provide, from satellites in outer space to acoustic sensors positioned underwater.**

**Using these tools, Sea Grant researchers are working to develop accurate, cost-effective approaches for keeping tabs on the coastal resources we depend on and care about, from the Delaware Bay to sea turtle populations.**

## Going with the Flow in the Inland Bays

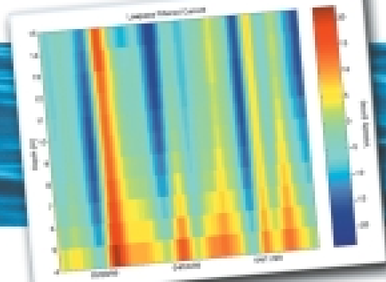
UD oceanographer Kuo-Chuin Wong is literally "going with the flow" in Delaware's Inland Bays. He's figuring out their circulation system.

The bays — Rehoboth, Indian River, and Little Assawoman — suffer from high nutrient inputs from sewage, farming, and other activities. Knowing where these pollutants are carried in the bays and how rapidly they are flushed to sea will help coastal managers plan water-quality improvements.



Robert Cohen

▲ *Kuo-Chuin Wong is pinning down the Inland Bays' complex circulation.*



▲ *This graphic shows the circulation patterns at Indian River Inlet. The top edge represents water nearest the surface; the bottom edge is the inlet floor. In red is water flowing out of the inlet and into the ocean; the dark blue is ocean water flowing into the bays.*

"The first task is to find out what drives the water — including gravity, wind, and tides," he says. "Then we need to figure out how they move pollutants around. For now, we're using the salt in the seawater as a tracer since it's non-reactive biologically," he notes.

This summer, as a follow-up to field work last fall, Wong will deploy current meters in Rehoboth Bay, the Lewes-Rehoboth Canal, Massey's Ditch, and Indian River Inlet. The units measure water velocity, temperature, and salinity. Using the data, he will continue to build a model of the bays' flow.

"In baseball, this is first base," he says. "To truly understand the bays, you need to know how the water is moving."

## Involving the Public in Deciding the Coast's Future

Bob Bowden

▲ *At the request of state legislators, Sea Grant Marine Advisory Service specialist Joe Farrell (standing) recently moderated a public forum on a proposed planned community near Little Assawoman Bay.*

**Joe Farrell is working to bring people together. During the past year, the UD Sea Grant Marine Advisory Service specialist has helped conduct dozens of public meetings on serious issues facing the Delaware coast, from proposed new construction to watershed restoration.**

**A major effort has been a series of public forums called "Saving Our Bays," which Farrell facilitated with colleague Bill McGowan from UD Cooperative Extension. The forums, and their companion publications, have delivered information and helped solicit input from more than 20,000 Sussex Countians on developing a pollution control strategy for the Inland Bays. The project was sponsored by the Center for the Inland Bays.**

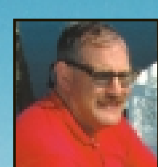
**"We considered a number of possible choices relating to land use and bay use and deliberated their pros and cons," Farrell says. "Through the process, people began to see bits and pieces of choices that will meet their needs and the environment's." This fall, Farrell will lead a similar process for Delaware's Youth Water Congress.**

**Farrell also continues to manage the Inland Bays Citizen Monitoring Program. Now in its tenth year of operation, the program involves more than 30 volunteers, who collect and analyze water samples along the bays. The program is supported by the Delaware Department of Natural Resources and Environmental Control.**

## Scientists Find Islands of Fresh Water in Salty Bay

Thanks to thermal-infrared imagery taken by low-flying aircraft last winter, UD researchers have pinpointed locations along the Delaware coast where warm fresh water is seeping out of the ground and into Delaware Bay.

The scientists are working to determine if these groundwater "seeps" may be piping pollutants such as excess nutrients from the land into the sea.



Robert Cohen

*Dr. Bill Ullman*

During the past year, Bill Ullman and Doug Miller visited seeps from Cape Henlopen to Bowers Beach to determine the origin of the water at each site.

"We found that not all of the seeps discharge fresh water," says Ullman. "In some instances, it's just warm marsh water. Upland groundwaters must be percolating into the marshes lying behind the beach. In those cases, the marshes are intercepting the nutrient pollutants and using them before the water reaches the bay."

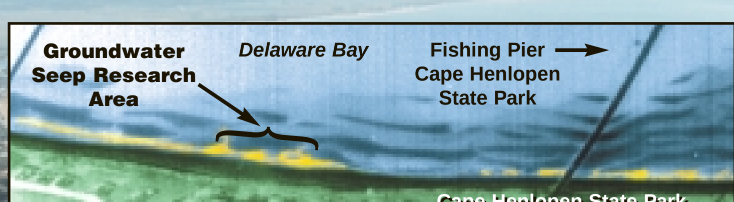
Robert Cohen

*Dr. Doug Miller*

In some areas, however, fresh water travels directly from the ground into the ocean, as is the case in a seepage zone not far from the fishing pier at Cape Henlopen State Park.

The scientists have begun monitoring this site to determine what impact the seep may have on bay-bottom life.

"So far, we've found one unusual inhabitant in this seep, a worm that normally lives in much less salty waters than lower Delaware Bay," Ullman says. Apparently, the organism, the red-gilled mud worm *(Marenzelleria viridis)*, has staked out its own "freshwater island" in the salty bay.





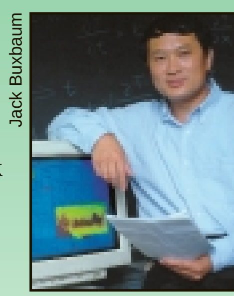
◀ *This infrared image reveals the locations of groundwater seeps (shown in yellow) flowing into the Delaware Bay along Cape Henlopen.*

*The aerial photo below also shows the research area. The T-shaped structure is the fishing pier in Cape Henlopen State Park.* ▼



## How Well Do Satellites See Microscopic Plants?

UD marine scientists have been using satellites to monitor El Niño, predict the path of oil spills, and track the weed *Phragmites* in marshes. Now they are testing how well two new sensors can detect concentrations of microscopic plants in coastal waters.



Jack Buxbaum

*Dr. Xiao-Hai Yan*

The sensors "read" the light reflected by the tiny plants' green pigment, or chlorophyll. The amount of chlorophyll in surface waters is a key indicator of aquatic health.

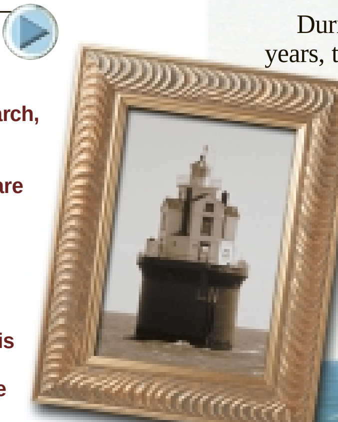
Oceanographer Xiao-Hai Yan and his research team are using Synthetic Aperture Radar (SAR) and the Sea-Viewing Wide-of-Field Sensor (SeaWiFS) to determine how much plant life exists in Delaware and New Jersey waters under different seasons, temperatures, and wind conditions.

While the satellites can easily detect chlorophyll in the open ocean, where the water is clear, the sensors' vision clouds near shore. The problem is the high sediment inputs from land.

Yan and his team are developing new data processing techniques that may help the sensors sort out what is chlorophyll and what is not.

**112-Year-Old Sentinel Still Lights Way for Mariners.**
**Art Sundberg, UD's Assistant Director of Marine Operations, and his wife, Debby, have a special fondness for Delaware Bay lighthouses. According to the couple's research, Fourteen Foot Light was the first "submarine foundation" lighthouse built in the United States. Made of cast iron, the 80-foot lighthouse was first commissioned, or lit, in Delaware Bay in 1888. About 21 feet of the lighthouse is submerged. The lamp is 59 feet above the water line. One of the sentinel's most unique attributes is a cast-iron outhouse.**

**While Fourteen Foot Light is closed to the public, it is well maintained by the U.S. Coast Guard. The interior of the lighthouse was painted in 1997, and the interior woodwork is well preserved. Since 1998, solar energy has powered the lighthouse's beacon and horn. The Sundbergs note that the sentinel's full name is "Fourteen Foot Bank Lighthouse." It earned the name from being constructed on a bank, or shoal, in Delaware Bay.**



## Using Lighthouses to Relay Data from Sea to Shore

Duane Perry

▲ *Aboard the UD research ship* Cape Henlopen, *Mohsen Badiey (left) and Art Sundberg map the location of an acoustic sensor in Delaware Bay. The device is tethered to Fourteen Foot Light (below).*

Through the years, the lighthouses in Delaware Bay have been good and faithful stewards, helping mariners get their bearings.

Now these sentinels may help advance the science of the sea by relaying information on acoustics, weather, wind, tides, and currents to oceanographers on shore.

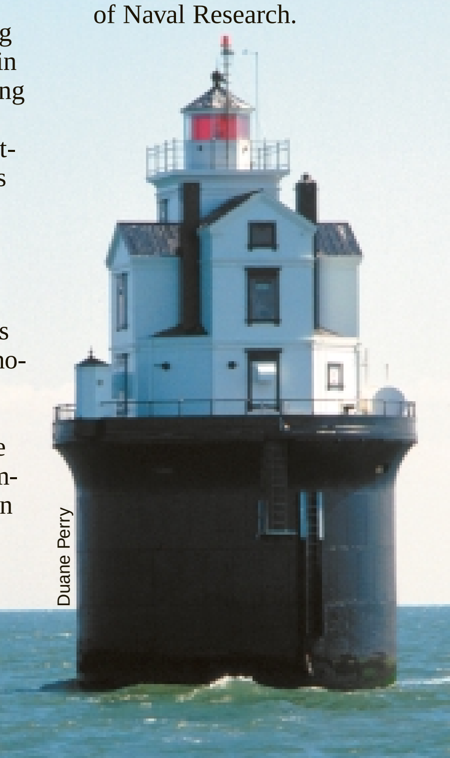
UD marine scientist Mohsen Badiey is working with colleagues Kuo-Chuin Wong and Alexander Cheng to equip Fourteen Foot Light, a 112-year-old lighthouse in Delaware Bay, as a platform for gathering environmental data.

During the past three years, the team deployed acoustic sensors and other oceanographic equipment in the bay. These units were connected to computers stationed in the lighthouse.

This summer, the scientists will test the wireless communications system that will continuously transmit the data received by the lighthouse to the UD College of Marine Studies in Lewes. A "live" camera system also will be installed at the lighthouse, and then a three-month field trial will begin.

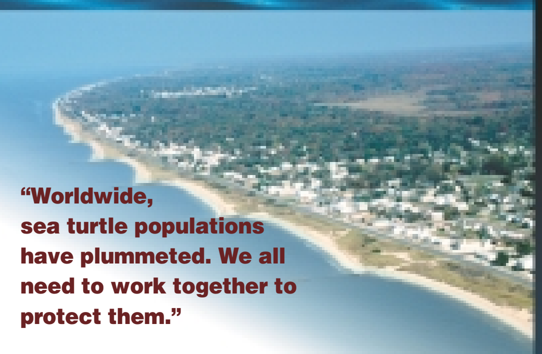
"It's an exciting project with a lot of promise," Badiey says. "If this pilot system works, our next goal would be to connect three more lighthouses to build a long-term, low-cost monitoring network for Delaware Bay."

In addition to Sea Grant, the project has been supported by the U.S. Coast Guard and the U.S. Office of Naval Research.



Duane Perry

# Sea Turtles Count on Delaware Bay



The Delaware Bay provides critical habitat for sea turtles, according to scientist Pamela Plotkin. Last summer and fall, she and her students documented loggerhead and Kemp's ridley turtles during weekly aerial surveys and estimate there are thousands in the bay.

"What we've seen confirms what I saw during a few surveys in 1997," she says. "At that time, I found the density of sea turtles to be comparable to or greater than the U.S. southeast coast, where sea turtles are most abundant."

Robert Cohen

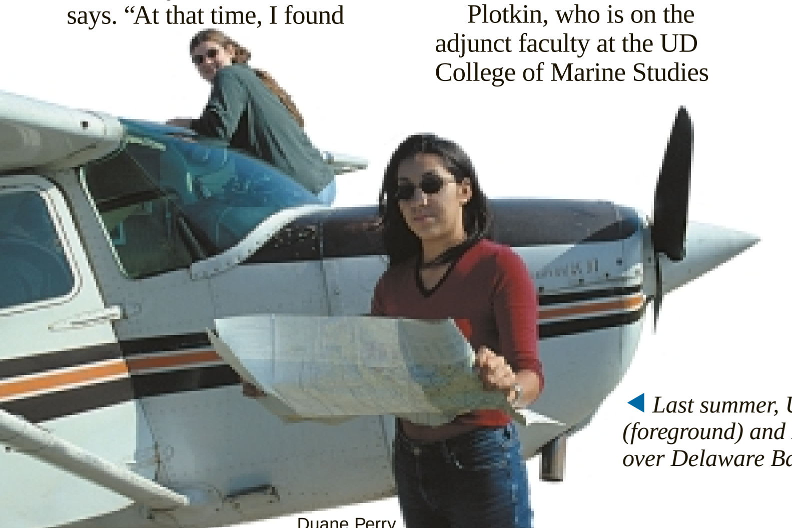
*Dr. Pamela Plotkin*

**"Worldwide, sea turtle populations have plummeted. We all need to work together to protect them."**

Plotkin, who is on the adjunct faculty at the UD College of Marine Studies and a senior scientist at the Center for Marine Conservation in Washington, DC, says the turtles probably are lured to Delaware Bay by their favorite foods — blue crabs and horseshoe crabs.

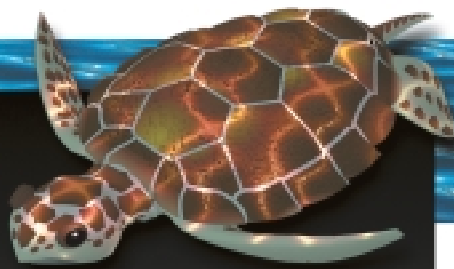
Plotkin now is completing her final report, which will be shared with federal and state agencies.

"I hope these data will be useful to them in regulating activities that adversely impact sea turtles," she says. "Worldwide, sea turtle populations have plummeted. We all need to work together to protect them."



*Last summer, UD students Melissa Brayman (foreground) and Dana Miller made weekly flights over Delaware Bay, scanning for sea turtles.*

Duane Perry



***The Loggerhead Turtle — Common Visitor to Delaware Bay.*** **This turtle visits Delaware Bay in summer and fall. It is the most common turtle in U.S. waters, inhabiting warm, nearshore regions of the Atlantic Ocean. Its major nesting beaches in the United States are in South Carolina, Georgia, and Florida.**

**The loggerhead is named for its large head, which may measure 10 inches wide. Its reddish-brown, heart-shaped shell may reach 3 feet long. This turtle can weigh up to 400 pounds although some tipped the scales at 1,000 pounds years ago.**

**Loggerheads have powerful jaws for crushing shellfish. They eat horseshoe crabs, blue crabs, clams, mussels, and other invertebrates.**

**Like all sea turtles, the loggerhead can see well underwater and is believed to have an acute sense of smell. When active, it must swim to the surface every few minutes to breathe. When resting, it can stay underwater for as long as two hours without breathing.**

**Loggerhead turtles are listed as a threatened species. Their population has been declining for a number of reasons, from turtles drowning in fishing nets, to raccoons preying on their eggs. All sea turtles are protected by law in the United States.**

## Growing a Shellfish Garden in the Inland Bays

Robert Cohen

*John Ewart, aquaculture specialist for the UD Sea Grant Marine Advisory Service, and Keri Maull, an intern for the Center for the Inland Bays, put hard clams in grow-out cages in Indian River Bay.*

John Ewart wants to get more shellfish growing in the Inland Bays. Adding more clams and oysters, which feed by filtering algae out of the water, could help restore the water quality in Rehoboth, Indian River, and Little Assawoman bays. Too many nutrients currently plague the aquatic system.

For the past two years, the aquaculture specialist for the UD Sea Grant Marine Advisory Service has been experimenting with various grow-out systems for shellfish in the Inland Bays. So far, he's had good success — his oysters grew from seed to market size in one year.

This summer, Ewart plans to set up a floating upwelling system, or FLUPSY, to serve as a nursery for the shellfish seed. The FLUPSY consists of a series of mesh-covered silos that house the tiny shellfish. Piped into the silos is a constant supply of algae.

When the clams reach the size of a nickel and the oysters reach the size of a quarter, they are less vulnerable to predation by fish and crabs and are ready for planting.

Ewart hopes to enlist people who live along the bays to help raise the shellfish. In Virginia, he says there are more than 1,000 "shellfish gardeners" who grow oysters for Chesapeake Bay. He believes Delaware could have a similar successful program in the Inland Bays.

"But our bays are more for growing clams," he says.



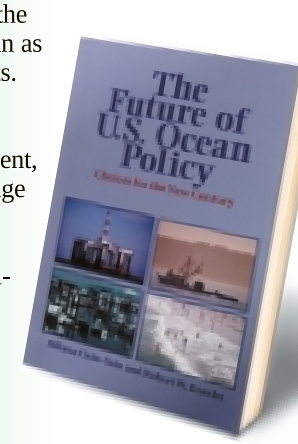
# Coastal Engineering

**Delaware's sandy shores help buffer the mainland from storms and provide habitat for spawning horseshoe crabs to nesting piping plovers. Our beaches also attract an estimated 5 million vacationers each year.**

**Sea Grant researchers are developing computer models to advance the science of shoreline prediction and protection. They also are working to increase public awareness of rip currents, hurricanes, and other coastal hazards.**

## Book Offers Plan for Ocean's Future

*The Future of U.S. Ocean Policy: Choices for the New Century* provides a call for action on the most serious marine issues facing the nation, from restoring America's most depleted fisheries to protecting eroding shorelines. The critically acclaimed book was written by UD professors Biliana Cicin-Sain and Robert Knecht.





To effectively address marine issues, the authors say we need to consider the ocean as a whole rather than as the sum of its parts. "Many ocean programs were established 30 years ago. One set of regulations was created to manage offshore oil development, a different set of laws was made to manage fisheries, and so on," says Knecht. "It's time now to manage the ocean as the coherent system it is rather than by political and administrative subdivisions."

For information about the book, contact the UD Center for the Study of Marine Policy at (302) 831-8086.

## Shall We Save the Shore, or Let Nature Take Its Course?

Robert Cohen

*Professors George Parsons (middle), and Robert Dalrymple (right) meet with state beach manager Tony Pratt.*

Maintain eroding beaches, or just let nature take its course? The decision may be easy to make now in Delaware, but what about tomorrow?

For a state that currently spends nearly $2 million each year to keep its beaches in place, "it's worthwhile to consider all the options," says George Parsons.

Parsons, a UD economist, is working with coastal engineer Robert Dalrymple to predict the costs of replenishing Delaware's ocean beaches over the next 100 years versus retreating from the coastline.

The Department of Natural Resources and Environmental Control is partially funding the project, with beach manager Tony Pratt serving as an adviser.

Currently, coastal engineers Dalrymple and graduate student Courtney Garriga are collecting beach profile data, from Lewes to Fenwick Island, to estimate how rapidly each beach will erode in the future.

Meanwhile, Parsons and graduate student Jeff Wakefield are collecting housing data from tax records, aerial photos, and other sources. They're putting together an inventory of the structures that could be threatened by beach migration in the next century and estimating the value of the houses that could be lost to the sea. They're also estimating how much it would cost to continue nourishing the beaches with sand.

"Too often economics gets ignored in the policy debate," Parsons says. "We see this as a real opportunity to get economics involved in beach policy-making."

## Modeling How Waves Behave

**Although coastal engineer Jim Kirby grew up on the Chesapeake Bay, he never thought his career would have anything to do with the sea.**

**Fluid mechanics was "always my thing," he says, but mostly as it applied to meteorology. He was interested in air pollution.**

**Then he got a job working in a hydraulics lab where his first job was to design breakwaters in a harbor, and he became hooked on waves.**

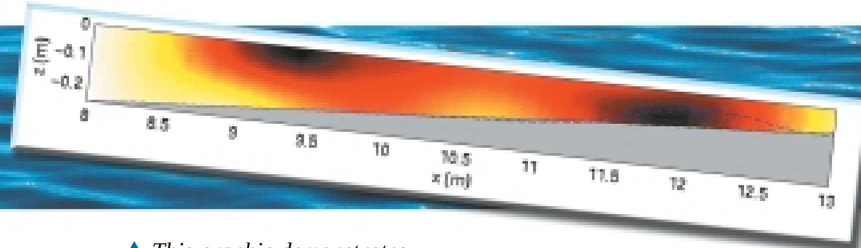
**During the past year, Kirby and graduate student Arun Chawla developed a computer model to estimate when hazardous conditions would be expected to occur in inlets, making them unsafe for navigation.**

**The engineers conducted experiments in a flume in the UD Ocean Engineering Lab to simulate high-energy waves, translated the motions into math and physics equations, and then tested and refined their model.**

**Eventually, Kirby says, the inlet study will be integrated into UD's popular Refraction/Diffraction (REF/DIF) model, which can show how waves behave near harbors, inlets, and islands. Currently, Kirby receives more than a dozen requests for the model each month from engineers from around the world.**

Richard Dunoff

*Professor Jim Kirby (standing) and graduate student Arun Chawla conduct an experiment in the wave flume in UD's Ocean Engineering Lab on the Newark campus.*




▲ *This graphic demonstrates a rip current's velocity over distance from the shoreline. Close to the shoreline (far right) a rip current, shown in deepest red, is fairly uniform in depth. As the current flows out to sea (toward left), its velocity is at the surface rather than the ocean bottom. That's what makes rip currents different from undertows, which have large velocities at the bottom.*

## Getting a Grip on Rip Currents


Robert Cohen

*Dr. Ib Svendsen*

**"If you want to model nature, you must copy nature. If you want to copy nature, you must understand nature."**

One of the first things Ib Svendsen's students learn in his coastal engineering class is his guiding philosophy: "If you want to model nature, you must copy nature. If you want to copy nature, you must understand nature."

For the past few years, the UD coastal engineer and doctoral student Kevin Haas have been working to sort out the complex hydrodynamics of an infamous coastal phenomenon: rip currents.

Dangerous to swimmers, these strong currents are formed when there is a break in an underlying sandbar or the current is diverted by a jetty or other barrier. At these locations, water rushes out to sea in a narrow path.

"We've found that while the rip current stretches over the entire depth as it flows out through the opening in a sandbar, it soon converts into essentially a surface current as it moves seaward. Out there, the current at the bottom usually has an entirely different direction than at the surface and often flows opposite the flow at the surface — directly toward the shore."

Svendsen and Haas are gathering data on rip current channel widths, distances from the shore, and wave height. These measurements will be integrated into UD's SHORECIRC computer model to improve its ability to predict when and where these complex currents will occur and what their effects will be.

Recently, the model was tapped for development into "a community model of nearshore processes" by the National Oceanographic Partnership Program in the National Oceanic and Atmospheric Administration. Led by UD's coastal engineering team, the five-year, $5-million project includes researchers from the Naval Postgraduate School, Naval Research Laboratory, North Carolina State, Oregon State, Scripps Institution of Oceanography, University of Florida, University of Michigan, and Woods Hole Oceanographic Institution.

### Increasing Public Awareness of Coastal Hazards

As the new coastal processes specialist for the UD Sea Grant Marine Advisory Service, Wendy Carey wants to help Delawareans better understand the dynamic natural forces that affect the coast and how to minimize their impacts, from storm flooding to wind damage.

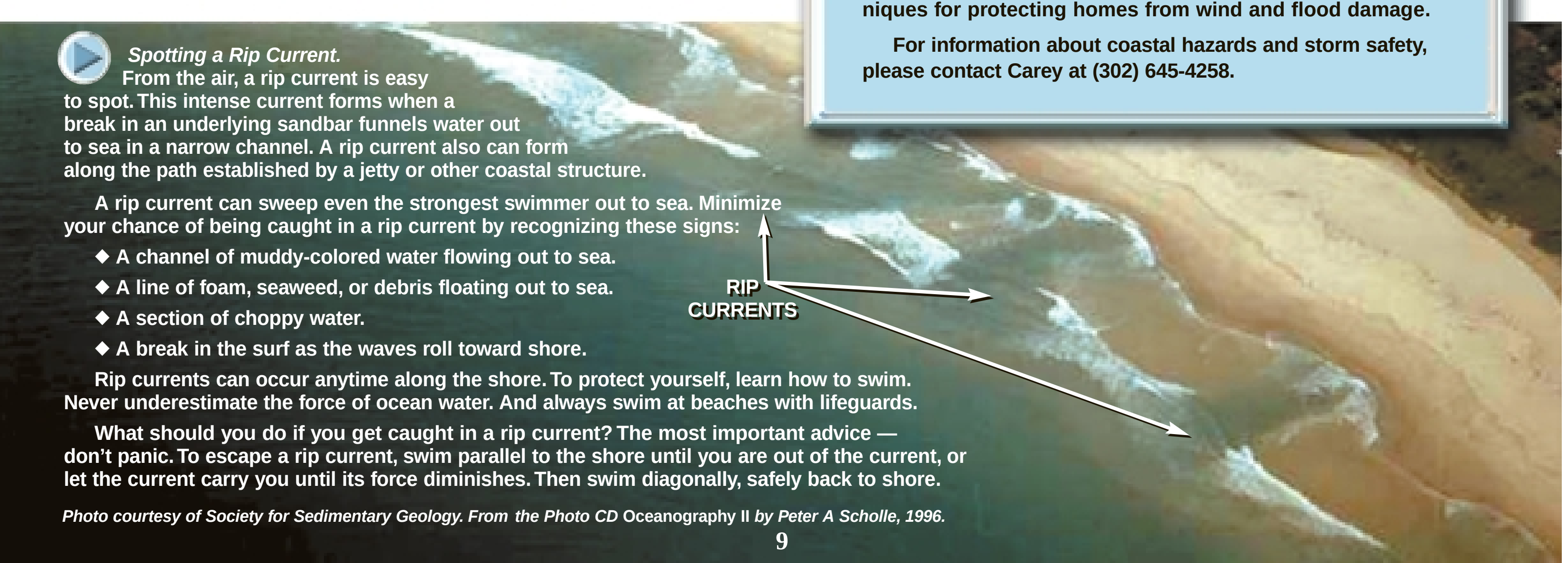

Bob Bowden

▲ *Wendy Carey recently joined the UD Sea Grant Marine Advisory Service as the outreach program's coastal processes specialist. She's shown here taking a beach profile after a recent storm.*

"The rapid growth of the Delaware coast has resulted in a significant increase in the number of people and structures exposed to storm hazards," she says. "Residents, visitors, and property owners will benefit from knowing more about the natural processes that shape the shoreline. An understanding of hazard mitigation and beach management principles is essential for proper planning, construction, and survival at the shore."

Recently, Carey helped the City of Lewes procure a $500,000 Project Impact grant from the Federal Emergency Management Agency (FEMA) to advance public awareness and mitigation efforts relating to hurricanes and northeasters. She now chairs Project Impact's Public Education and Awareness Work Group, which is developing programs on topics ranging from disaster preparedness to the design of "storm-safe" homes. With the help of Quality Roofing Supply Company in Lewes, the group is working to build a portable unit that illustrates construction techniques for protecting homes from wind and flood damage.

For information about coastal hazards and storm safety, please contact Carey at (302) 645-4258.




*Spotting a Rip Current.* From the air, a rip current is easy to spot. This intense current forms when a break in an underlying sandbar funnels water out to sea in a narrow channel. A rip current also can form along the path established by a jetty or other coastal structure.

A rip current can sweep even the strongest swimmer out to sea. Minimize your chance of being caught in a rip current by recognizing these signs:

- A channel of muddy-colored water flowing out to sea.
- A line of foam, seaweed, or debris floating out to sea.
- A section of choppy water.
- A break in the surf as the waves roll toward shore.

Rip currents can occur anytime along the shore. To protect yourself, learn how to swim. Never underestimate the force of ocean water. And always swim at beaches with lifeguards.

What should you do if you get caught in a rip current? The most important advice — don't panic. To escape a rip current, swim parallel to the shore until you are out of the current, or let the current carry you until its force diminishes. Then swim diagonally, safely back to shore.

*Photo courtesy of Society for Sedimentary Geology. From the Photo CD Oceanography II by Peter A Scholle, 1996.*

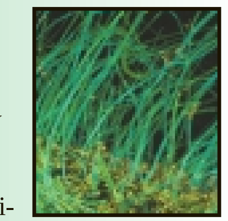


# Marine Biotechnology

**How do marine organisms adapt to super-hot underwater geysers, icy Arctic waters, and other demanding environments? The answers may result in a host of useful products in fields ranging from medicine to food processing.**

**Sea Grant researchers are exploring two very different environments — deep-sea hydrothermal vents and the Delaware Bay — to learn more about the sea's tiniest life and how they might help us.**

## Taking Research to New Extremes


▲ *Magnified view of vent bacteria.*

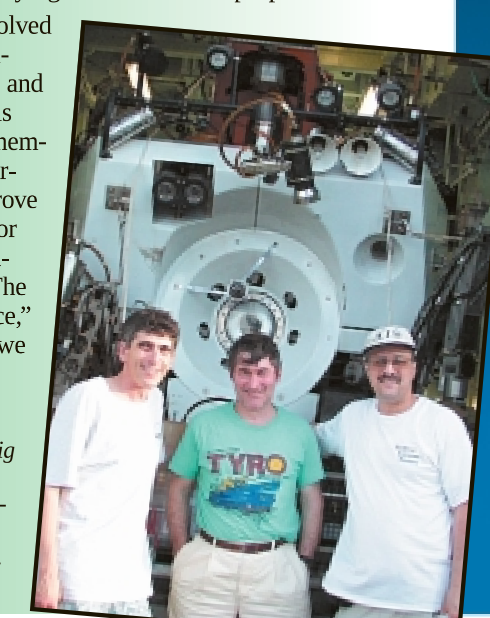
UD marine biologist Craig Cary really knows how to "get down." In January, he led an international team of scientists on Extreme 2000 — the first deep-sea expedition of the millennium — to hydrothermal vent sites in the Sea of Cortés off Mexico.

During the 11-day mission, the scientists used the submarine *Alvin* to explore super-hot vents and their bizarre organisms, from weird 4-foot tubeworms to ancient bacteria. They also made a historic phone call to classrooms in three states as part of the project's education component (see page 14).

The research team used special sensors (see article, right) to learn more about the chemistry and microbiology at the vents. Heat-hardy bacteria were collected from vent chimneys and even off the backs of certain vent worms.

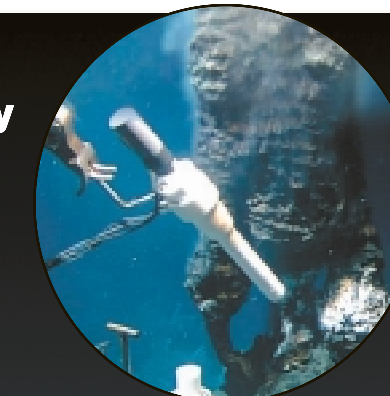
Cary and his group now are culturing the bacteria and analyzing its DNA. The scientists compare the unique sections of the nucleotides, the compounds that make up DNA, to classify the microbes. This process, called genetic fingerprinting, is a useful tool for learning how the microbes are related to one another, as well as for identifying their distinctive properties.

"Vent organisms have evolved the ability to thrive under extreme pressure, temperature, and chemistry," Cary notes. "This ability involves special biochemical adaptations that, if understood, could be used to improve many industrial processes, for example those used in manufacturing pharmaceuticals. The exciting aspect of this science," he adds, "is that every time we explore deep-sea vents, we find something totally new."




▶ *From left, UD scientists Craig Cary and George Luther, and Don Nuzzio, president of Analytical Instruments, Inc., stand in front of the deep-sea sub* Alvin.

## Sensor Sniffs Out Chemistry at Vent Sites



Researchers from the University of Delaware and Analytical Instrument Systems, Inc., have developed an electrochemical analyzer, a kind of underwater "snooper," that can detect the chemicals spewing out of hot vents over a mile deep on the ocean floor.

The analyzer, which is mounted to the submarine *Alvin*, can be parked near a vent to provide readings of the sulfur-rich compounds rocketing out of the Earth's crust. Ironically, these toxic chemicals may serve as fingerprints, leading scientists to the locations of deep-sea organisms that may be beneficial to humankind.

"This is the first time a system like this has been built to operate at such great depths and pressures," says UD chemist George Luther (see photo below).

So far, the analyzer has been tested at a depth of 2,500 meters with pressure over 200 times what it is on the surface. The device has withstood deep-sea temperatures from nearly freezing to 100°C at the vents.

The system consists of two units. The first is a foot-long wand that houses gold/amalgam electrodes, which Luther built and coated in a super-tough plastic. The wand is attached to one of *Alvin's* arms for placement near the vents.

The wand also is connected to a 3-foot-long, 8-inch-diameter tube that houses the system's electronics. This component, built by Don Nuzzio (photo left), of Analytical Instrument Systems, Inc., is mounted to the bottom of the sub. A 2-inch-thick anodized aluminum housing protects the electronics from imploding under the crushing weight of the sea.

The analyzer can detect a number of chemicals simultaneously. Recently, the UD team found that the presence of two compounds — hydrogen sulfide ($H_2S$) and iron monosulfide (FeS) — may be an important indicator of the oldest microscopic vent life. These compounds react to form the mineral pyrite ("fool's gold") and hydrogen gas. The hydrogen provides the energy the microbes need to grow.

Based on this discovery, Luther hopes the "snooper" eventually will aid scientists in sniffing out ancient bacteria and yield information about other vent life.

"Learning more about the chemistry of the vents should help us better understand the biology of the vents, and why deep-sea organisms, such as heat-hardy Pompeii worms, live where they live," he says. "Some of these vent dwellers may possess enzymes useful in processing food and drugs and developing other important applications."

The project is supported by Sea Grant and the National Science Foundation.

## Assessing Pollution's Impact on Delaware River Bacteria

While they are the tiniest organisms on Earth, microbes play many mighty roles.

In aquatic systems, these microscopic plants and animals form the base of the food chain. They impact important geological, biological, and chemical cycles, which among other things, control the amount of oxygen in the water. And they detoxify certain pollutants.

Some pollutants, however, harm microbes. David Kirchman (below), a UD marine biologist, is examining how a major class of pollutants — polyaromatic hydrocarbons, or PAHs — impact microbes in the Delaware River near Philadelphia.

PAHs often are found in highly industrialized estuaries. The pollutants originate from tar, wood preservatives, oil, and other fossil fuels. The complex chemistry of the compounds causes them to be insoluble in water. In estuaries, they can cause tumors in fish and accumulate to lethal levels in bottom-dwelling organisms such as oysters.

Kirchman and graduate student Dawn Ward have been working to find out which microbes are harmed by PAHs, and conversely, which microbes may degrade the complex chemical compounds. The scientists are focusing on one type of microbe — heterotrophic bacteria — which have an animal-like metabolism.

Since nearly all bacteria are impossible to isolate in the lab and grow in pure culture, much of the research relies on molecular methods, which are applied to samples from the river. The DNA fingerprinting techniques help the scientists identify the uncultured bacteria and compare their genetic composition.

During the past year, Kirchman and Ward were able to isolate PAH-degrading bacteria in the samples.

"Although many bacteria can degrade PAHs in the lab, our work is the first to show the impact of PAHs on uncultured marine bacteria in a real environment outside of the lab," he notes.

One of Kirchman's collaborators is the U.S. Naval Research Laboratory, which is working to address pollution of estuarine sites, such as the Naval shipyard at Philadelphia.

"They want to know how rapidly nature, through bacteria, may be able to detoxify PAH pollution," he says. "That would be a lot less expensive than cleanup efforts costing millions of dollars and having additional environmental consequences."

### Putting the Safety in Seafood

Robert Cohen

▲ *Doris Hicks, seafood specialist for the UD Sea Grant Marine Advisory Service, and Chuck Donohue, of Lewes Fish House, examine a shipment of Atlantic salmon.*

**Delaware offers a bounty of fresh seafood. But before you head out to purchase your next bushel of crabs or pound of fillets, let's test your "Seafood Safety IQ."**

**Once you've purchased fresh fish at the market, at what temperature should you keep it refrigerated? And how long can you safely store the fish in the refrigerator before preparing it?**

As seafood specialist for the UD Sea Grant Marine Advisory Service, Doris Hicks works with consumers and the seafood industry to develop educational programs about the proper way to handle, store, and prepare finfish and shellfish.

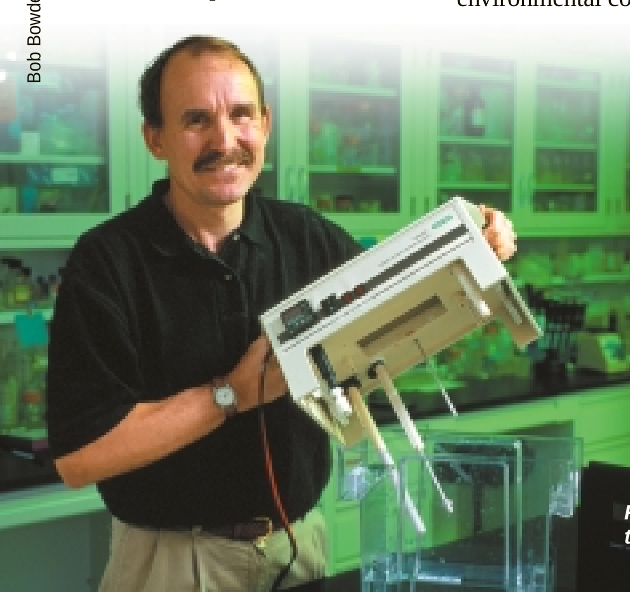
Currently, through a grant from the U.S. Department of Agriculture, she and Bill Daniels, a scientist at Delaware State University, are working to develop a set of training videos on sanitation control procedures for seafood processors. The videos will be made available to the seafood industry on a national level.

Hicks also has been working to boost consumers' knowledge of safe seafood handling practices. In addition to her lectures, Web sites, and publications, she often serves as a resource to reporters seeking information on seafood. During the past year, she was quoted in a variety of media, ranging from the *Washington Post* to the book *Seafood for Dummies*.

Her "Seafood Advisor" column also regularly appears in *Seafood Source,* a newsletter published by the National Fisheries Institute. It is distributed to more than 17,000 readers, including dieticians, food writers, and the seafood industry.

"A mandatory seafood inspection program is in place to provide the safest seafood possible," Hicks says. "Consumers need to follow through with proper handling techniques, from purchase to preparation, to prevent food safety problems."

For more information about seafood safety, contact Hicks at (302) 645-4297.



Bob Bowden

*Welcome to the World of Bacteria.* Look through a microscope and a whole new world suddenly appears. The organism shown here is a member of a large class of bacteria called pseudomonads. It moves about with the help of tail-like flagella.

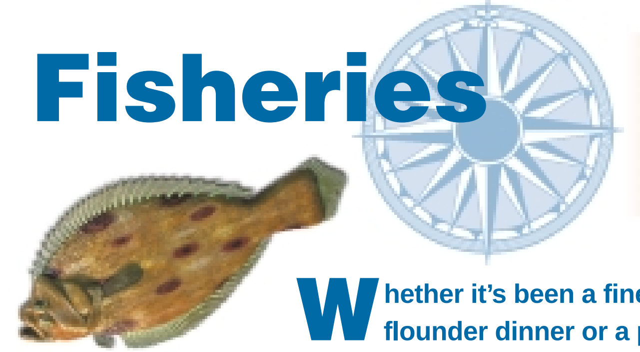
Bacteria are microscopic plants and animals, and they live everywhere. While we often associate them only with disease, bacteria play many good roles. In aquatic systems such as the Delaware River and Bay, bacteria and other microbes form the base of the food chain. They mediate important geological, biological, and chemical cycles. And they detoxify certain pollutants. In short, the life in the estuary couldn't survive, nor could we live, without bacteria.

*Photo courtesy of American Society of Microbiology*

◀ *David Kirchman sets up the gel electrophoresis unit to identify bacteria from the Delaware River near Philadelphia. The DNA fingerprinting device will help him assess the effects of certain organic pollutants on the estuary's bacterial community.*



# Fisheries



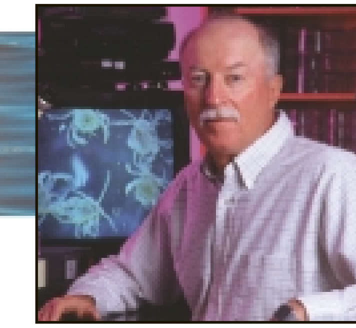
**Whether it's been a fine flounder dinner or a plate of mouthwatering oysters on the half-shell, the sea's bounty has delighted us for ages. Today, however, many commercial fish stocks are in dire need of rebuilding.**

**Sea Grant researchers are working to achieve sustainable fisheries by helping to define essential fish habitat and developing new management tools. Projects focus on flounder, blue crabs, horseshoe crabs, oysters, and others.**

## Following the Floating Crabs

Blue crabs begin life as microscopic, insect-like larvae that float along in the sea at the mercy of winds and currents.

UD marine biologist Charles Epifanio and oceanographer Richard Garvine are combining their expertise to track the tiny crabs' travels in Delaware Bay.



Robert Cohen

*Dr. Charles Epifanio*

**"From an economic standpoint, the blue crab is the most valuable shellfish in the Mid-Atlantic region, so it's critical that we understand the factors that control its population."**

They want to know what role natural forces play in controlling the population of Delaware's most valuable fishery.

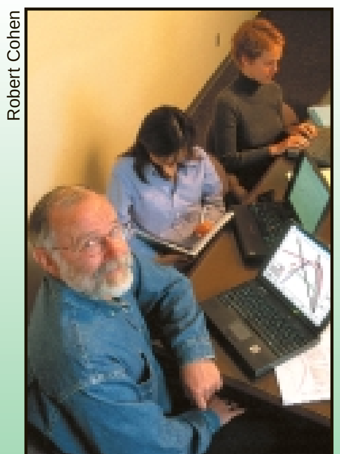
The scientists have found that soon after blue crab larvae are hatched in July and August, they are carried south by the fast-flowing Delaware Coastal Current. Summer winds can then push the larvae back north for re-entry into the bay.

In novel research last summer, the scientists deployed drifters in patches of crab larvae outside the mouth of Delaware Bay. The drifters contained satellite-tracking devices, which revealed the crab's locations over a 12-day period.

"Our study is one of very few that have tracked patches of fish or crabs in the coastal environment," Epifanio notes.

He says the data indicate that as river discharge decreases in late summer, wind effects on larval transport increase. Thus, the supply of larval blue crabs may be maximum in drought years when river flow is at a minimum.

## A Model Tool for Fish Managers



Robert Cohen

▲ *Lee Anderson and graduate students Emiko Maruyama (middle) and Mary Jane Middlekoop are developing simulation models for managing fisheries.*

Lee Anderson wants to help fisheries managers better predict the impact of various regulations on both fish stocks and the fishing industry.

The UD economist and his students are developing computer models, using commercial spreadsheet software, that consider different types of fisheries facing real-world management concerns: from changes in total quotas to limits on numbers of fishing trips.

So far, they have built models to address management issues in the surf clam fishery and in a fishery under joint commercial/recreational exploitation. They are now taking a preliminary look at how marine reserves may serve as a fish management tool.

Recently, graduate student Emiko Maruyama used one of the models to address a request made to the International Whaling Commission. The Japanese government asked that a commercial moratorium on minke whales be lifted in order to increase fishery levels of the whales' chief prey — anchovies and sauries.

The UD model showed that the take of 50 minke whales from the Northwest Pacific stock would not cause significant gains in either prey fishery.

## Researchers Reel in Facts about Flounder Habitat

UD fisheries scientist Tim Targett and Japanese ichthyologist Masuru Tanaka have more in common than a love for sushi. They both study flounder.

▲ *Seated on a tatami mat in his room in Japan, Tim Targett enters data on Japanese flounder.*

Last summer, with support from UD, Sea Grant, and the Japanese government, Targett and student Richard Wong conducted research with Tanaka at Kyoto University's Fisheries Research Station in Maizuru, Japan.

"Japanese flounder are closely related to our summer flounder," Targett says. "They are in the same genus, have similar life cycles, and support important fisheries."

Recently in his Delaware lab, Targett completed research to define the optimal nursery conditions for our summer and southern flounder.

Targett says these flounder have differing habitat needs when they are juveniles (less than 4–5 inches long). For example, young southern flounder can tolerate fresh water, but summer flounder need a higher salinity. Both species need temperatures greater than 20°C (68°F) to grow well.

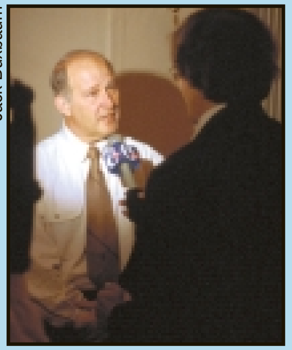
"Knowing the conditions that help young flounder grow best can help resource managers define and protect the nursery habitat needed to sustain these fisheries," he says.

This summer, Targett will return to Japan to help them reel in similar information on their flounder species.

Robert Cohen

*Graduate students Richard Wong (right) and Bill Davidson seine for young flounder in the Delaware Bay near Cape Henlopen.* ▶

## Teaching Students and Public about Ocean Resources


Jack Buxbaum

▲ *Bill Hall, education specialist for the UD Sea Grant Marine Advisory Service, is interviewed about horseshoe crabs by WPVI-TV, Channel 6, in Philadelphia.*

Few people know as much about sea life as Bill Hall, education specialist for the UD Sea Grant Marine Advisory Service. Ask him a question about any number of organisms — from horseshoe crabs to stargazers, moon jellyfish to velvet ants — and rarely is he stumped for an answer.

During the past year, Hall was asked by the Atlantic States Marine Fisheries Commission to provide expert comment on the horseshoe crab's decline in Delaware Bay and the crab census he helps organize along beaches in Delaware and New Jersey.

Hall also was interviewed about the horseshoe crab by local and national media ranging from the *Delaware State News* and the *Wilmington News Journal* to *U.S. News and World Report,* National Public Radio, and others. Last spring, in response to a request from the U.S. Fish and Wildlife Service, he led Secretary of the Interior Bruce Babbitt on a tour of Delaware's horseshoe crab spawning beaches.

In addition to his work with horseshoe crabs, one of Hall's chief objectives is to help train Delaware teachers in marine science. Last year, in conjunction with the state Department of Education's Smithsonian Project, he hosted workshops on insects, soil and water, and Delaware's Inland Bays. More than 75 teachers attended and are sharing what they've learned with students in kindergarten through sixth grade.

Last year, Hall also helped develop "Extreme 2000: Voyage to the Deep," a multimedia project to engage science students in UD deep-sea research (see page 14). About 800 students learned more about the ocean's greatest depths through a video, printed resource guide, and interactive Web site.

## Marking Oysters for Success

The oyster fishery in the Mid-Atlantic region has suffered from overfishing, habitat degradation, and disease.

Researchers have planted hatchery-produced oyster seed in the Choptank and Tred Avon rivers, two tributaries of the Chesapeake Bay, in the hope that these oysters will survive and reproduce. However, as is true in most stock enhancement efforts, it's difficult to tell whether the introduced stock has any real effect.

UD marine biologist Patrick Gaffney is working on a tool to evaluate oyster stock enhancement efforts. He's discovered a genetic marker that's passed on to the offspring produced by the outplanted oysters.

Gaffney and graduate student Coren Milbury are now using molecular techniques borrowed from the biomedical industry to analyze thousands of young oysters collected from the bay areas that are most likely to contain recruits from the outplanted oysters.

If successful, Gaffney says, the technique could be used in shellfish restoration efforts in Delaware Bay as well as for other fisheries enhancement programs.


Robert Cohen

▲ *Patrick Gaffney is using genetic markers to measure the survival and reproduction of oysters planted in Chesapeake Bay.*

## Scientists Closing in on Artificial Bait Substitute for Horseshoe Crab

UD researchers are closing in on the development of an artificial bait to serve as a substitute for the Delaware Bay's declining horseshoe crab.

Currently, horseshoe crabs, used as bait, support a $2 million conch fishery and a $6 million American eel fishery. In Delaware Bay alone, watermen derive 20–50% of their total fishing income from conch or eel harvests.

For the past four years, UD marine biologist Nancy Targett and graduate student Kirstin Ferrari have been working to track down the compound in horseshoe crabs that makes them so irresistible to eels and conch.

The scientists originally thought the compound was in the tissue of female crabs, but they now know the attractant is concentrated in her eggs. The compound is very heat-stable and freeze-tolerant and can be stored with refrigeration without a loss of activity, the scientists say.

Given the attractant's molecular size and complexity, Targett says it's unlikely that a cost-effective synthetic version of it can be developed. However, she says another source of the chemical cue besides horseshoe crab eggs appears to be available — in hemolymph, a component of the crab's blood.

Horseshoe crabs routinely are bled by the biomedical industry for *Limulus* amoebocyte lysate (LAL), a compound used to test drugs for bacteria. Although the chemical cue is more dilute in hemolymph, Targett says its source is more sustainable than crab eggs.

"As a waste by-product of the LAL industry, hemolymph is available in large quantities year-round," she notes.

She and Ferrari are working to optimize incorporation of the chemical cue from the hemolymph into a cost-effective bait. They also have met with a commercial bait manufacturer.

"We believe we're closing in on a long-term, sustainable solution to the current horseshoe crab dilemma," Targett says.

*Hail to a Medical Hero!*

We owe a lot to the horseshoe crab. A clotting factor in its blood, which can be removed without harming the crab, is used to detect bacteria in human blood, in clinical drugs, and even in prosthetics such as heart valves before implantation. Chitin, a polymer in the crab's shell, is used to make non-allergenic sutures and wound-healing bandages. Human eye research has been advanced by studies of the horseshoe crab's large compound eyes and optical nerve. This research has resulted in several Nobel prizes.


Robert Cohen

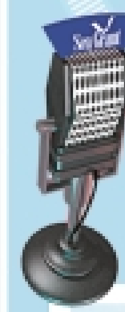
▲ *Nancy Targett (left) and graduate student Kirstin Ferrari are developing an artificial bait to reduce the use of horseshoe crabs as bait for eels and conch.*



# Education & Outreach

**Increasing public awareness, understanding, and appreciation of the ocean and coast is a top priority at Delaware Sea Grant.**

**During the past year, our outreach team — the Marine Communications and Marine Advisory Service staffs — developed a variety of educational projects. Only a few are highlighted here. For additional resources, please visit our Web site at *www.ocean.udel.edu/seagrant* or contact us at (302) 831-8083.**



### Lectures Highlight Latest Sea Research

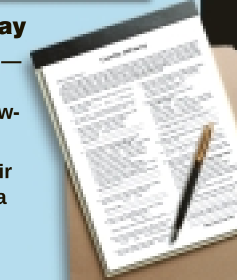
During the past year, UD Sea Grant joined with the College of Marine Studies to host public lectures at the Hotel du Pont in Wilmington and the Hugh R. Sharp Campus in Lewes. More than 1,000 people listened to presentations about the deep sea, horseshoe crabs, and many other topics. The Lewes series is held from April through September. The next Wilmington series will begin in November. For more information, please contact UD Marine Communications at (302) 831-8083.

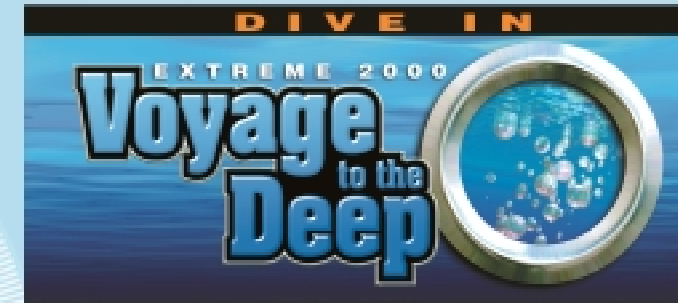
### 12,000 Visitors Turn Out for Coast Day

Coast Day 1999 was one of the largest on record — more than 12,000 visitors turned out for research demonstrations, ship tours, crab races, a seafood chowder challenge, and dozens of other activities.

A survey was mailed to 400 visitors to assess their opinions of the event. Respondents gave Coast Day a high ranking for its educational value. Based on a 10-point scale, the average rating was 8.9. Forty-four percent ranked Coast Day a perfect 10.

Ninety-nine percent of the respondents said they had a better understanding and appreciation of marine resources after visiting Coast Day. And 88% of repeat visitors said that attending Coast Day has changed their views of the marine environment. The number-one response was that they are more careful to minimize their impact on the environment. Two-thirds say they have a better understanding of marine research and how it might affect them. Many are reading more about ocean/marine issues, with 62% more aware of marine conservation laws and regulations. Almost half say they support political candidates who support the environment and environmental issues. Others are more aware of seafood handling. And 16% said they volunteer for environmental/conservation projects.







*Dr. Craig Cary*

### Students, Public Explore the Deep Sea in Virtual Expedition

In January 2000, students and the public took a virtual trip to the ocean's depths as they followed UD marine scientists and an international team of colleagues on the first deep-sea expedition of the millennium. Their mission: to explore hydrothermal vent sites over a mile deep in the Sea of Cortés off Mexico's west coast.

The pilot project — "Extreme 2000: Voyage to the Deep" — was developed by UD Sea Grant outreach staff, working with marine biologist Craig Cary, who was the chief scientist on the expedition. It was supported by the National Science Foundation, Sea Grant, and Public Broadcasting Station WHYY-TV in Wilmington and Philadelphia.

The project included an interactive Web site containing photos and video clips of the scientists' discoveries during the expedition, a half-hour classroom video produced by WHYY-TV, and a full-color resource guide on the deep sea.

About 800 students in 14 classrooms in Delaware, New Jersey, and California participated in the project. One of the highlights was a conference phone call between the classrooms and Dr. Cary as he worked in the submarine *Alvin* during the historic first dive of the millennium. The audio of the call is available on the project's Web site: *www.ocean.udel.edu/deepsea.*


*Students at Talley Middle School in Wilmington talked by phone to Dr. Cary as he worked aboard the submarine* Alvin *on January 13.*

The Web site, which was developed by the UD Marine Communications Office, includes information on the scientific crew, hydrothermal vents and their bizarre creatures, and the high-tech tools that scientists use in deep-sea exploration. The site also includes "News from the Deep," where video clips, photos, dive logs, interviews with the scientists, and daily journals were uploaded daily during the 11-day mission. This information was transmitted from the Sea of Cortés to Delaware with the assistance of the Woods Hole Oceanographic Institution, which operates the submarine *Alvin.*

The Extreme 2000 project also captured attention from the media, including the *New York Times,* CNN Headline News, *Science,* Environmental News Network, *The Lancet, Pittsburgh Tribune-Review,* British Broadcasting Company, *USA Today,* Yahoo.com, and many others.

While the expedition ended in January, the Web site continues to serve as a useful resource on the deep sea. So far, the Web site has logged more than 60,000 visitors and continues to attract new Web travelers every day.

**Dive in to *www.ocean.udel.edu/deepsea***