UNIVERSITY OF DELAWARE SEA GRANT

REPORTER

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Delaware Sea Grant

SEA QUEST

1999 Annual Report

Marine Research and Education for Delaware

http://www.ocean.udel.edu/seagrant

UNIVERSITY OF DELAWARE SEA GRANT
REPORTER

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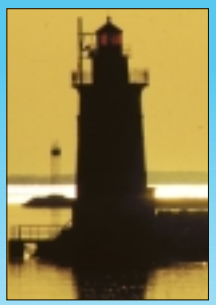
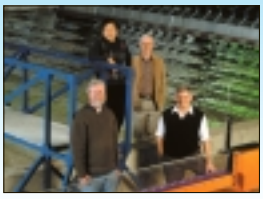

Robert Cohen


Robert Cohen


Robert Cohen

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. Richard W. Tarpley, Executive Director.

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Floyd Dean

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

Delaware's marine resources benefit millions of people in some way, on some level.

Our sandy beaches attracted more than 5 million tourists last year. Not only do these beaches provide vacationers with respite and contribute to Delaware's economic health, but they are also essential to the welfare of the horseshoe crab. And the horseshoe crab's health is critical to our own.


Robert Cohen

▲ *Graduate students in marine studies gain valuable hands-on experience working with their advisers on Sea Grant research projects.*

This crab's eggs provide food for thousands of shorebirds migrating northward each spring to Arctic nesting grounds. The horseshoe crab also yields a component that's used to test every intravenous medication for bacteria. So if you or someone you love has ever been hospitalized, it's likely that the horseshoe crab played a role in your recovery.

Each year, more than 70 million tons of cargo are transported up the Delaware Bay and River to the nation's fifth largest port complex for distribution to consumers throughout the region. The

MESSAGE FROM THE DIRECTOR

estuary also supplies a myriad of other vital needs, from nursery grounds for major fisheries such as blue crabs and sea trout, to drinking water.

Delaware's Inland Bays — Rehoboth, Indian River, and Little Assawoman bays — shelter striped bass, diamondback terrapins, black ducks, and many other sea life. The bays are a favorite with anglers and birdwatchers and also rank as the state's top boating destination.

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 marine research, educate the nation's future marine scientists, and advance public understanding of the ocean and coast.

During the past year, with the aid of our Sea Grant Advisory Council and external scientific panels, we underwent an intensive strategic planning process and determined the following research priorities that our program should address in the next five years:

Robert Cohen

▲ *Youngsters check out the deep-sea exhibit at Coast Day. Held the first Sunday in October at the Lewes campus, Coast Day educates thousands about marine science.*

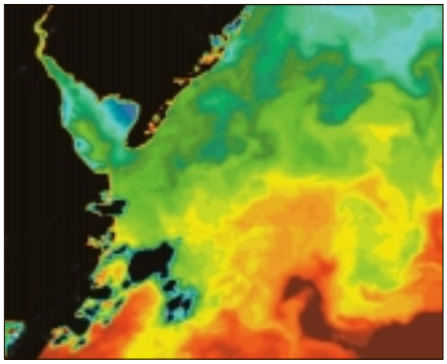
- *Coastal Ocean Studies.* Improve the scientific basis for assessing and managing the response of estuaries, coastal waters, and watersheds to human impacts.
- *Environmental Technology.* Develop cost-effective technologies for monitoring the health of coastal ecosystems.
- *Coastal Engineering.* Develop predictive models of shoreline change and improve coastal erosion mitigation strategies.
- *Marine Biotechnology.* Explore, develop, and use the unique, adaptive capabilities of marine organisms.
- *Fisheries.* Achieve sustainable fisheries and aquaculture.

In the following pages, you'll learn more about the research projects we've funded under each of these priorities, as well as our efforts in public education on behalf of the coast.

Our Marine Advisory Service and Marine Communications staff play a key role in building the bridges between our labs and the public. Whether developing a report, designing a Web page, or coordinating our award-winning Coast Day festival, our outreach staff are dedicated to providing you with accurate, useful information.

As new and continuing challenges face the Delaware coast, our program's role will be to continue to provide the objective, research-based information critical to sound environmental decision-making. It's our commitment to you, and to the environment.

Recently, we expanded our Web site to share a variety of educational resources with you, from research summaries and press releases to publications, audio clips of our popular "SeaTalk" radio series, and information on seafood, aquaculture, tourism, and other topics.



▲ *New technologies are advancing environmental monitoring. This satellite image from October 25, 1998, shows the cooling down of Delaware Bay (upper left) in autumn.*

I encourage you to visit us at *www.ocean.udel.edu/seagrant* or contact us at (302) 831-8083 to learn more about the educational resources we offer. We look forward to hearing from you!

Carolyn A. Thoroughgood

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

The goal of this Delaware Sea Grant research priority is to improve the scientific basis for assessing and managing the response of estuaries, coastal waters, and watersheds to human impacts. Thus, this research requires establishing linkages among land-use practices, shipping activities, ecosystem production, and water quality.

Our Coastal Ocean Studies currently focus on the Delaware River and Bay, and Delaware's Inland Bays. They range from assessing dissolved oxygen concentrations in the Delaware River and Bay, to determining how the tides affect nutrient inputs in the Inland Bays.

Are Groundwater Seeps Piping Excess Nutrients into the Sea?

Historically, the chief concern associated with the hydrological connection between groundwater — the water that flows beneath the Earth's surface — and the ocean has been saltwater intrusion into coastal drinking-water supplies.

However, several studies now suggest that groundwater discharges, or "seeps," may play a significant role in transporting contaminants, particularly excess nutrients, from the land to the sea.

Oceanographers Bill Ullman and Doug Miller from the University of Delaware College of Marine Studies are using infrared images taken by aircraft and ground surveys to map where these freshwater seeps enter Delaware Bay. Their study area is the Delaware coast from Cape Henlopen to the St. Jones River.

Once the seeps have been identified, the scientists will use several chemical techniques to determine the differences in distributions of nitrogen — the predominant nutrient contaminant in Delaware groundwater — in the seep zones compared to adjacent, non-seep areas.

They also will analyze bottom-dwelling organisms to assess differences in their abundance between the two areas. Ullman notes that some freshwater worm species often occupy the seeps, which are like islands of fresh water in the salty bay.

"Our ultimate goal is to determine the effect of groundwater seeps on the bay's biological productivity and how their nutrient inputs can be controlled," says Ullman.

"If the bulk of the groundwater enters the bay in a few areas, like water from a pipe, treatment technologies could be applied to these seeps to help reduce the amount of nutrient input," he adds.

Oxygen Study Important to the Delaware and Other Urbanized Estuaries

In the 1940s, the Delaware River and Bay was so polluted from sewage and industrial effluents, there was no oxygen in the water in the upper estuary. At times, a 20-mile section of the estuary, from Philadelphia south, was devoid of oxygen and reeked the hydrogen-sulfide odor of rotten eggs.

In the last 25 years, however, the estuary has made a dramatic comeback thanks to reductions in municipal and industrial inputs.

"The Delaware Estuary has shown improvements in water quality unequaled by almost any other estuary in the world," says Jonathan Sharp, an oceanographer at the University of Delaware.


Duane Perry

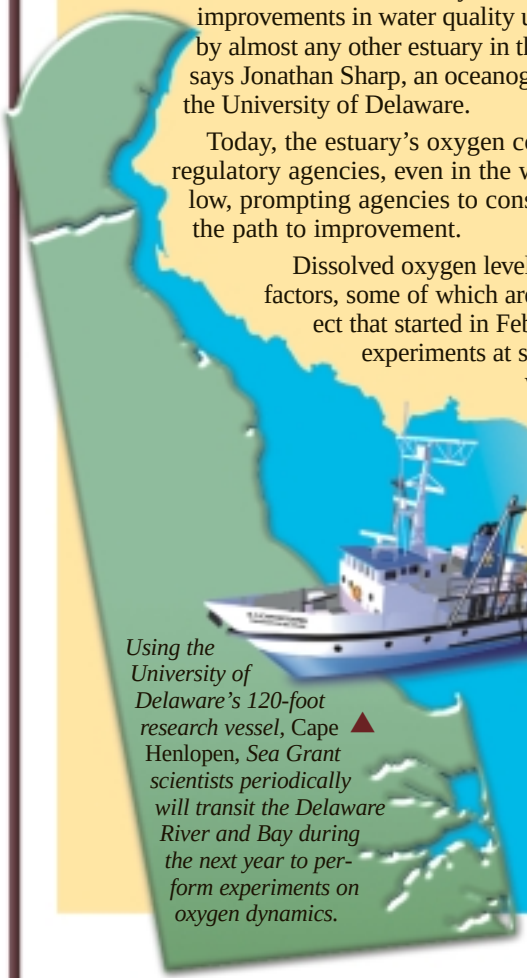
▲ *Aboard the* Cape Henlopen, *oceanographer Jon Sharp and Forsyth Kineon, Delaware Estuary Program coordinator at the Delaware River Basin Commission, review water-sampling locations in Delaware Bay.*

Today, the estuary's oxygen concentrations exceed the minimum level set by regulatory agencies, even in the warmest summer conditions. But the minimum is low, prompting agencies to consider revising their guidelines to keep the estuary on the path to improvement.

Dissolved oxygen levels in the estuary can vary significantly due to a host of factors, some of which are not well understood. In a three-year Sea Grant project that started in February, Sharp and his research group have begun field experiments at specific locations in the estuary. They're analyzing water chemistry and comparing differences to determine what role carbon, nitrogen, and phosphorus play in the system's oxygen dynamics.

The group's results should help resource managers as they evaluate water-quality guidelines, and aid major municipalities, such as the city of Philadelphia, with wasteload allocations. The project's results also should be translatable to other urbanized estuaries.

"A number of estuaries are in similar condition as the Delaware, such as the Hudson, Potomac, and others," Sharp notes. "There are many inputs reaching these systems through human activities. We're working to sort out their effects."



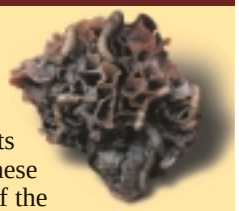
▲ *Using the University of Delaware's 120-foot research vessel,* Cape Henlopen, *Sea Grant scientists periodically will transit the Delaware River and Bay during the next year to perform experiments on oxygen dynamics.*

Robert Cohen

▲ *Bill Ullman (left) and Doug Miller use a mini-piezometer to sample groundwater on the Delaware shore near the Cape Henlopen fishing pier.*

◀ *This infrared image verifies the location of a groundwater seep, flowing into Delaware Bay, not far from where the above photo was taken.*

How Do Sediments Impact Bottom Life?



▲ *Tube-building worms form reef material like this in the Delaware Bay. These reefs, often called the "coral beds," are a favorite of fish and anglers.*

Dredging and beach nourishment projects are a necessity along the coast. However, these projects can have a down side: disruption of the unique community of marine organisms that occupy the *benthos*, or sea bottom, including worms, oysters, and other creatures.

"While seldom seen, these organisms play an important role in the ecosystem," says University of Delaware oceanographer Doug Miller (in photo, left). "They provide food for fish, crabs, and birds. Some of these animals also serve as 'conveyor belt' species, turning over the bottom sediment and mixing it in the process."

During the next two years, Miller will be working to determine what rates and frequencies of sediment deposition are detrimental to the bay's major benthic species. He then will examine how the results can be incorporated into the design of dredge spoil disposal and beach nourishment projects to minimize harmful impacts on benthic life.

Studies Address Dredging the Delaware

Robert Cohen

Two University of Delaware marine scientists recently received Sea Grant funds to conduct preliminary studies relating to the environmental impact of deepening the Delaware Bay shipping channel from its present depth of 40 feet to 45 feet.

Both are "white paper" studies, based solely on surveys of existing literature on two topics: sediment geochemistry and bottom-dwelling organisms.

Oceanographer Tom Church and postdoctoral fellow Najid Hussain have reviewed over 40 scientific reports on heavy metals, radionuclides, pesticides, and other hazardous materials that could be released and remobilized from river-bottom sediments.

Oceanographer Doug Miller has surveyed more than 60 published reports on the effects of disposing dredged material, or "spoil," on the worms, oysters, and other organisms that comprise the bay's benthic community.

Both studies voice several concerns about the potential environmental impacts of the proposed dredging project.

Technical reports on the two studies are now in production. For information, contact the University of Delaware Marine Communications Office at (302) 831-8083, or *MarineCom@udel.edu*.

Sludge-Busting Plant Takes Root at Local Facilities

In the annals of marsh research, it's a tale reminiscent of *The Strange Case of Dr. Jekyll and Mr. Hyde.*

The common reed, *Phragmites australis*, overtakes hundreds of acres of wetlands in the United States each year, crowding out more desirable plants that wildlife depend on for food and habitat.

Once transplanted in sewage treatment facilities, however, *Phragmites* is proving to be a real benefit. The extensive root system that makes the plant a nemesis of the marsh helps *Phragmites* rapidly dry and break down treated waste, reducing sludge removal costs and landfill fees.

So far, the *Phragmites* installed through Sea Grant research at the Bridgeville Wastewater Treatment Plant has saved the town $2,000 per year for the past three years.

Recently, at the University of Delaware's Halophyte Biotechnology Center, botanist Jack Gallagher and his team used tissue-culture techniques to develop a sterile variety of *Phragmites* to allay concerns that the wild plant, used in open-air sludge beds, could revert to its old habit and seed and degrade marshes.

These techniques entail "planting" seeds on a growth medium of hormones, sugar, and minerals, where the seed produces a tumor-like *callus*. When the hormones are changed, the callus forms many embryonic plants, often with different genetic traits.

The scientists have regenerated 1,000 *Phragmites* plants from tissue cultures and are now evaluating them in lab and field tests in search of plants with superior traits for sludge drying and decomposition, such as compact shoots, large leaves, and strong, fast-spreading roots.

If the scientists succeed, the idea of using *Phragmites* for sludge busting may take root in other towns.

Robert Cohen

University of Delaware botanist Jack Gallagher examines Phragmites *grown in the Halophyte Biotechnology Center at the Lewes campus. He and his research team are using tissue-culture techniques to develop plants with superior traits for sludge busting, such as strong roots.*

Water-Use Plan to Aid Bays

Robert Cohen

▲ *Marine Advisory Service director Jim Falk (right) reviews boating regulations with Steve Beaston, owner of Beaston's Marina in South Bethany.*

From bird-watching to boating, Delaware's Inland Bays, in Sussex County, support a diversity of activities. With the county's population projected to increase by 35%, to more than 180,000 people by the year 2020, demands on the bays are destined to grow.

During the past year, Jim Falk, director of the University of Delaware Sea Grant Marine Advisory Service, has been working with resource managers and local residents to develop a water-use plan for the bays. The plan's goal is to outline acceptable uses of the bays to ensure that user conflicts and environmental impacts are minimized.

"Our plan focuses on the multitude of activities occurring on the bays and the adjacent shoreline," Falk says. "We recommend strategies and actions to help decrease the negative effects these activities have on the environment. Additional enforcement is one action we considered. More often, additional education is needed to make users better aware of the things they can do to protect the health of the Inland Bays."

The Center for the Inland Bays has appointed an implementation team to carry out the plan's action items. For information about the plan, call Falk at (302) 645-4235.

Brown Tide Found in Little Assawoman Bay

Last summer, oceanographer David Hutchins went searching for brown-tide organisms in the Inland Bays and found them.

Brown tide *(Aureococcus anophagefferens)* is a microscopic plant that can "bloom," or reproduce, so rapidly that surface waters take on its color. While harmless to human health, brown-tide blooms have devastated shellfish beds by forming a thick mat of vegetation impenetrable by sunlight. Brown-tide blooms in New York, New Jersey, and other states have cost the fisheries and tourism industries millions in losses.

Bob Bowden

▲ *David Hutchins, an oceanographer at the University of Delaware, discovered brown tide in Little Assawoman Bay last summer.*

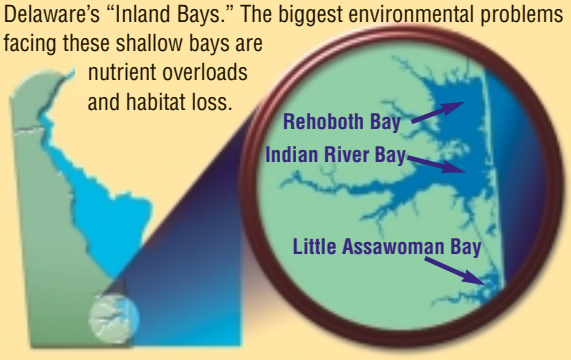
Hutchins' research, funded by Delaware Sea Grant and the Center for the Inland Bays, was conducted in conjunction with regular water sampling performed by the Department of Natural Resources and Environmental Control.

Surface water was collected from 13 sites. Eleven samples, from Indian River and Rehoboth bays, were negative. But both samples from Little Assawoman Bay indicated the organism's presence.

"Although Delaware has not had a brown-tide bloom, the organism definitely is here," Hutchins says. "We're now working to give managers some idea of the potential for a harmful bloom and the conditions under which it would be likely to occur."

Delaware's Inland Bays

Rehoboth, Indian River, and Little Assawoman bays comprise Delaware's "Inland Bays." The biggest environmental problems facing these shallow bays are nutrient overloads and habitat loss.



How Do Tides Affect the Flow of Nutrients in the Inland Bays?

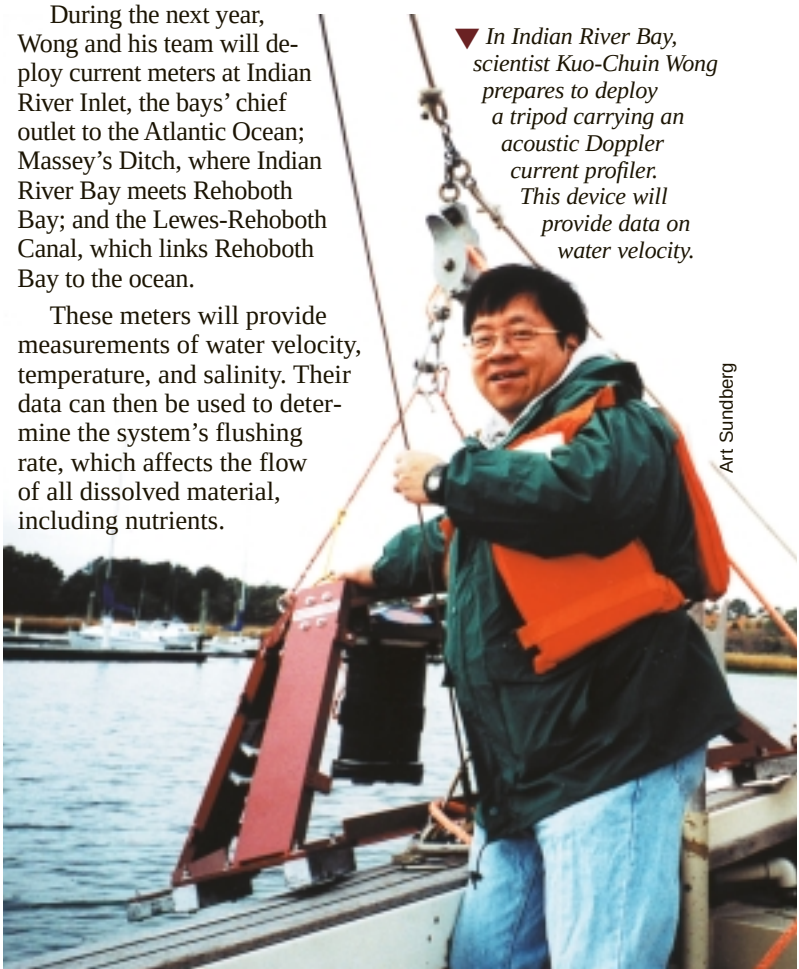
Delaware's Inland Bays — Rehoboth, Indian River, and Little Assawoman Bays — have been deemed a "National Estuary" by the Environmental Protection Agency, advancing efforts to remedy the bays' most serious problems, including excess nutrients from land runoff and sewage discharge.

One question that scientists and resource managers cannot yet answer is how long these nutrients stay in the bays before they are flushed out to the Atlantic Ocean.

In a new Sea Grant project, oceanographer Kuo-Chuin Wong of the University of Delaware College of Marine Studies is taking the first step in addressing this question. He's working to determine what role the bays' physical processes — the twice-daily tides — play in transporting dissolved material in and out of the system. Wong is using a simple dissolved material as his tracer: salt.

During the next year, Wong and his team will deploy current meters at Indian River Inlet, the bays' chief outlet to the Atlantic Ocean; Massey's Ditch, where Indian River Bay meets Rehoboth Bay; and the Lewes-Rehoboth Canal, which links Rehoboth Bay to the ocean.

These meters will provide measurements of water velocity, temperature, and salinity. Their data can then be used to determine the system's flushing rate, which affects the flow of all dissolved material, including nutrients.



Art Sundberg

▼ *In Indian River Bay, scientist Kuo-Chuin Wong prepares to deploy a tripod carrying an acoustic Doppler current profiler. This device will provide data on water velocity.*

Coastal managers need to be able to easily observe resources as large as the Delaware Bay and track key health indicators, from pollutants in the water, to the productivity of wetlands that provide nursery areas for fish.

The goal of this Delaware Sea Grant research priority is to develop cost-effective technologies for monitoring coastal ecosystems using satellites, acoustic sensors, and other tools.

Taking the Coast's Pulse from Space

From their vantage point in space, satellites are the "eyes" that help us with tasks from weather forecasting to military surveillance.

During the past three years, in a special research initiative called the Coastal Ecosystem Health Project, a team of University of Delaware scientists and an advisory group of resource managers from throughout the state have been working together to improve the use of satellites and related technologies in monitoring the health of the coast.

Resource managers must grapple with a host of water-quality issues and impacts, sorting out the factors that increase and ameliorate water pollution problems.

For example, an increase in impervious surface from development in a watershed helps accelerate the rate of stormwater runoff, while an increase in vegetation zones around streams and wetlands may buffer excess nutrient inputs to coastal waters.

Assessing these factors is difficult, but improvements in the processing of satellite images may soon make the task much easier.

Recently, Sea Grant scientists completed a detailed land use/land cover classification of a 1993 Landsat Thematic Mapper satellite image of Delaware (see figure).

This classification breaks out major land-cover sectors, from developed areas to mudflats. To aid Delaware resource managers, the image is being segregated into the 39 sub-basins used for water-quality reporting in the state.

As additional satellite images undergo classification, managers may be able to assess watershed changes, right at their fingertips.

Robert Cohen

▲ *Oliver Weatherbee, a doctoral student at the University of Delaware College of Marine Studies, is developing satellite image-processing techniques to help resource managers assess land-use changes over time.*

▲ *This satellite image of Delaware, enhanced by new processing techniques, reveals the land use/land cover in the state in 1993. Land-use changes can signal changes in coastal water quality.*

Land Use/Land Cover Categories

- Developed (Impervious)
- Disturbed/Transitional
- Bare (Non-Agriculture)
- Herbaceous (Non-Agriculture)
- Agriculture
- Forested
- Emergent Wetland Group 1
- Emergent Wetland Group 2
- Emergent Wetland Group 3
- Unconsolidated Shore
- Mudflat/Exposed Bottom

Research Offers Students Ocean of Opportunity

A key mission of the University of Delaware Sea Grant College Program is to educate graduate students in marine studies, providing them with the hands-on experience critical to the development of keen analytical and problem-solving skills.

For example, a dozen students participated in Sea Grant's Coastal Ecosystem Health Project (article, left), advancing research in areas ranging from satellite oceanography to marine policy.

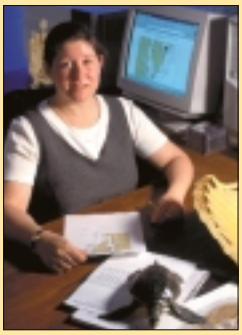
Additionally, several policy students on the project participated in internships and fellowships with the Delaware Nature Society and the Department of Natural Resources and Environmental Control, examining riverfront development, exotic species, and other issues.

Robert Cohen

◀ *As part of Sea Grant's Coastal Ecosystem Health Project, marine biologist Kent Price (right) and graduate student Brian Glazer prepare to deploy a seaweed collector in the Inland Bays. They are working to determine the impact of nutrients on the bays' submerged aquatic vegetation.*

Tracking Turtles in Delaware Bay

Robert Cohen



▲ *Scientist Pam Plotkin is assessing the Delaware Bay's importance as habitat for sea turtles.*

Sea turtles visit the Delaware Bay each summer to feed on blue crabs, horseshoe crabs, and other favorite foods.

Two years ago, University of Delaware scientist Pam Plotkin conducted three aerial surveys of Delaware Bay and found the density of sea turtles to be comparable to or greater than numbers reported for the southeastern U.S. coast, where sea turtles are most abundant.

This summer, Plotkin will be conducting more extensive aerial surveys to gather more complete data on turtle densities and the bay's importance as turtle habitat.

"Many sea turtle species have declined dramatically," she says. "If our data confirm that the Delaware Bay provides habitat critical to sea turtles, we hope to begin building regional cooperation to protect them and help their populations recover."

Lighting the Way to New Technologies

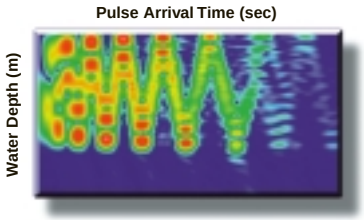
Lighthouses have guided mariners for centuries. Now these beacons may light the way to new technologies for monitoring the health of coastal waters.

With permission from the U.S. Coast Guard, a team of scientists from the University of Delaware, including Mohsen Badiey, Kuo-Chuin Wong, and Alexander Cheng, recently began exploring the use of Fourteen Foot Light, in Delaware Bay, as a platform for gathering environmental data.

In recent underwater communications fieldwork supported by the U.S. Office of Naval Research, the scientists demonstrated the feasibility of attaching cable from computers stationed in the lighthouse to acoustic sensors positioned in the bay.

This summer, the team will return to the lighthouse to deploy sensors for a three-month test period when acoustics, weather, tide, and current data on the bay will be continuously transmitted from sea to shore.

"The beauty of this approach is that it makes use of existing infrastructure — lighthouses — which makes it extremely economical," Badiey says. "It could save thousands of dollars currently spent for more expensive shipboard monitoring."



▲ *This model shows the intensity of a pulse of sound made underwater in Delaware Bay. Sea Grant researchers are refining the use of acoustics in monitoring salinity, temperature, and other parameters.*

Badiey notes that since the scientists control the sensors by remote control in their labs, they have the capability of monitoring the environment at will, even during big storms, an impossibility with traditional techniques.

"The biggest benefit of using the lighthouses," he adds, "is that we will be able to provide the long-term, real-time measurements needed to formulate sound strategies for protecting coastal waters."

▼ *Oceanographer Mohsen Badiey (below right) and his crew leave Fourteen Foot Light, in Delaware Bay, after checking the status of current meters and weather and acoustic sensors attached to the lighthouse by cable.*

Duane Perry

Tributary Teams Work

Robert Cohen

▲ *Marine Advisory Service specialist Joe Farrell (left) and Ed Lewandoski, of the Center for the Inland Bays, review GIS maps of the bays for water-quality information.*

Organizing the Inland Bays' Tributary Action Teams has been a real team effort.

During the past year, Joe Farrell, Sea Grant Marine Advisory Service specialist, worked with Bill McGowan, from University of Delaware Cooperative Extension, and Ed Lewandoski, education coordinator for the Center for the Inland Bays, to build the teams for Rehoboth, Indian River, and Little Assawoman bays.

"The Inland Bays Tributary Action Teams are charged with building agreement among stakeholder groups in the estuary, from property owners to industry operators, on a plan of action for reducing habitat loss and nutrient enrichment in the bays," says Farrell.

"Our goals are to improve the bays' water quality using sound science as a basis for decisions and to use creativity in solving nutrient and habitat problems," he notes.

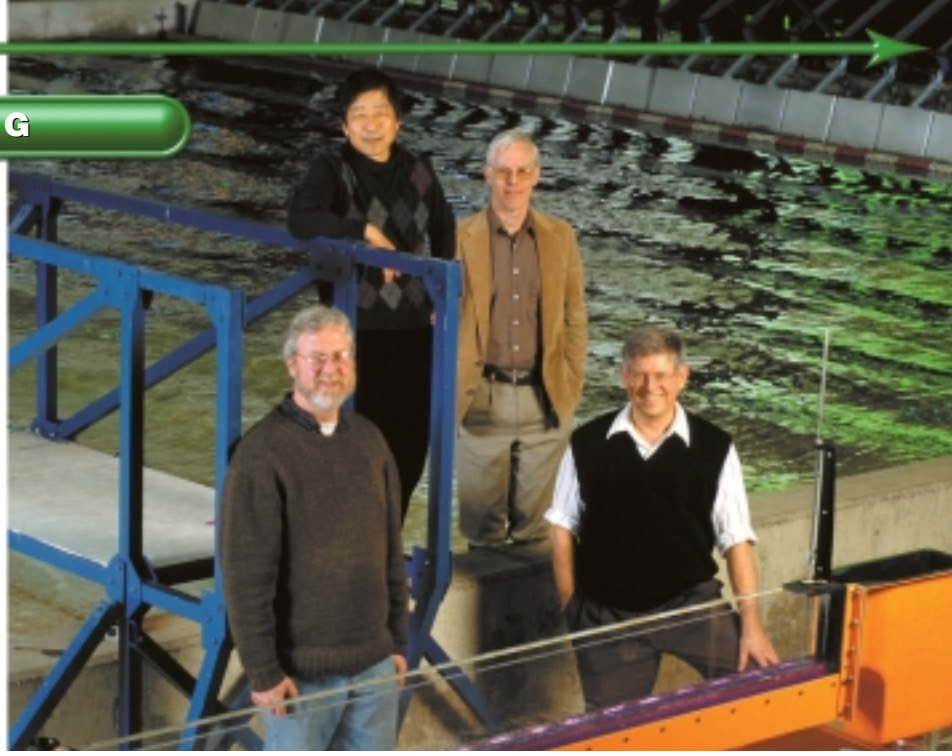
Currently, the Tributary Action Teams are working to develop a nutrient pollution control strategy that conforms to the Total Maximum Daily Load limits for nitrogen and phosphorus set by the state.

The teams meet once a month. For information, contact Farrell at (302) 645-4250.

Delaware's beaches and dunes play important roles in protecting coastal communities from storms, in supporting marine life from piping plovers to horseshoe crabs, and in fueling a healthy tourism economy.

The goals of this Sea Grant research priority are to develop predictive models of shoreline change and assess and improve strategies for countering coastal erosion.

Robert Cohen



▲ *Delaware Sea Grant's coastal engineering team includes, from left, Jim Kirby, Nobuhisa Kobayashi, Robert Dalrymple, and Ib Svendsen. Based at the University of Delaware's Center for Applied Coastal Research in Newark, the scientists use a variety of wave basins and flumes to research the complexities of waves and currents near the shore.*

Coastal Engineers Make Waves for Science

For most of us, the sight and sound of ocean waves rolling in to shore evoke a feeling of great peacefulness.

For coastal engineers, the scene inspires a nagging desire to better understand the physics of waves and currents, so that we can figure out better ways to protect the beaches we love.

"Even a beach that appears to be stable is constantly changing, with periods of erosion balanced over time by periods of sand deposition," says Robert Dalrymple, director of the University of Delaware's Center for Applied Coastal Research.

Dalrymple and his colleagues, Jim Kirby, Nobuhisa Kobayashi, and Ib Svendsen, are developing and refining a series of computer models to advance the science of coastal protection. The models are aimed at improving our capability of predicting future shoreline changes during short-term events such as northeasters, and in the long term, during decades of sea-level rise.

Dalrymple is modeling how the descending eddies in breaking waves act as small tornadoes to lift sediment, while Nobuhisa Kobayashi is working to predict the impact of wave run-up on beaches.

Jim Kirby is studying how waves at tidal inlets are affected by changes in depth and by the presence of currents. The model he develops should be useful in the design and analysis of navigable inlets.

Ib Svendsen is testing a model called SHORECIRC, which was developed in previous Sea Grant research, to further study the hydrodynamics of rip currents, including those induced by coastal structures such as submerged breakwaters.

At "Modelers Week" in Egmond, the Netherlands, this past November, Kevin Haas, one of Svendsen's graduate students, took part in a workshop where he and colleagues from England, France, the Netherlands, and Spain were challenged to simulate the hydrodynamics at a site on the Dutch coast.

Robert Cohen

▲ *Doctoral student Kevin Haas recently represented the University of Delaware at Modelers Week in the Netherlands, where Delaware's wave model best predicted the behavior of the waves and currents at a site on the Dutch coast.*

Each participant was provided with data from the same field experiment and then used his model to simulate it. At the end of the five-day event, the University of Delaware's SHORECIRC model came out on top, giving the best agreement with respect to the data.

"We were proud of the way our model performed," Haas says. "But we're working to make it even better."

Robert Cohen

▲ *In lab research, coastal engineer Robert Dalrymple tracks a rip current.*

Engineer Wins International Award

Robert Dalrymple, director of the University of Delaware's Center for Applied Coastal Research, has received the 1999 International Coastal Engineering Award from the American Society of Civil Engineers.

The award was made to Dalrymple in recognition of his "outstanding and continuing achievements and contributions to the advancement of coastal engineering through research, teaching, and professional leadership."

Dalrymple, his colleagues, and students conduct research funded by Sea Grant and other agencies aimed at improving coastal shoreline prediction and protection.

He has produced over 175 research publications, from books to technical reports; and advised 30 students, many of whom have gone on to leadership positions in universities and coastal institutions. He also has developed educational resources on the Internet for the coastal engineering profession and the public at *www.coastal.udel.edu.*

Giving the Ocean a Voice

Robert Cohen

▲ *Marine policy experts Biliana Cicin-Sain and Robert Knecht (right) are working to keep decision makers apprised of major coastal issues through newsletters and forums.*

The ocean took center stage last June when the Clinton administration hosted the National Ocean Conference in Monterey, California. The historic event, to set the direction of national ocean policy in the 21st century, featured key speeches by President Clinton, Vice President Gore, and First Lady Hillary Rodham Clinton. In attendance were a number of Cabinet officers, members of Congress, and 500 leaders in government, business, and the academic community.

Among them were University of Delaware marine policy professors Biliana Cicin-Sain and Robert Knecht. The policy scientists recently completed a Sea Grant report on U.S. coastal tourism and recreation for the National Oceanic and Atmospheric Administration. The report highlighted the status of coastal tourism, its economic benefits, and growing challenges related to beach restoration and other sustainable development issues.

Currently, with Sea Grant support, the scientists are producing *Ocean & Coastal Policy Network News,* a newsletter designed to provide a forum for the exchange of news and viewpoints on U.S. national ocean policy. For information, contact the University of Delaware Center for the Study of Marine Policy at (302) 831-8086.

Should We Save the Beach or Say Goodbye?

As the shoreline is swallowed up by storms and sea-level rise, coastal states often respond by renourishing beaches with sand to keep them in place.

"Most analysts argue that nourishment costs under such a policy will increase over time, which raises the issue of whether retreating from the coastline may be a more sensible policy," says George Parsons, an environmental economist at the University of Delaware.

Parsons is working on a Sea Grant project with coastal engineer Robert Dalrymple (see previous page) to estimate the long-term economic costs of beach retreat versus nourishment for the Delaware coastline.

Robert Cohen

▲ *George Parsons is working to determine the economic costs of replenishing the beach with sand versus letting nature take its course in certain areas.*

"Delaware has a policy of beach nourishment but has given consideration to retreat as a possible long-run strategy," Parsons notes.

"Nourishment and retreat both involve economic costs. The issue is which policy is the least costly for a given coastal community."

Although the scientists' focus is the Delaware coast, Parsons says their method will be transferable to other regions.

Counting Horseshoe Crabs and Their Benefits

The horseshoe crab's eggs sustain hundreds of thousands of migrating shorebirds that stop along Delaware Bay each spring. While few may know it, the crab also has saved countless human lives.

"The horseshoe crab's blood contains a unique clotting agent that the pharmaceutical industry uses to test intravenous drugs for bacteria," says Bill Hall, marine education specialist for the Sea Grant Marine Advisory Service. "No IV drug reaches your pharmacy and no prosthesis reaches your hospital without its horseshoe crab test. So if you or someone you love has ever been hospitalized, you owe a lot to the horseshoe crab."

Hall helps organize a regional census of the Delaware Bay's spawning horseshoe crab population. The census is conducted on selected bay beaches by volunteers from Delaware and New Jersey. This year, the census is being expanded to additional beaches along both sides of the bay with support from the Atlantic States Marine Fisheries Commission.

"Delaware Bay is the world's population center for horseshoe crabs, but recently, we've noted a significant downturn in the animal's population," Hall says.

"Scientists believe the decline is due to overfishing of the crab for eel and conch bait and to the loss of the sandy beaches it needs for spawning.

"The census is designed to help resource managers and scientists gain a better understanding of the horseshoe crab's status and what we can do to guard our 'golden goose,'" he notes.

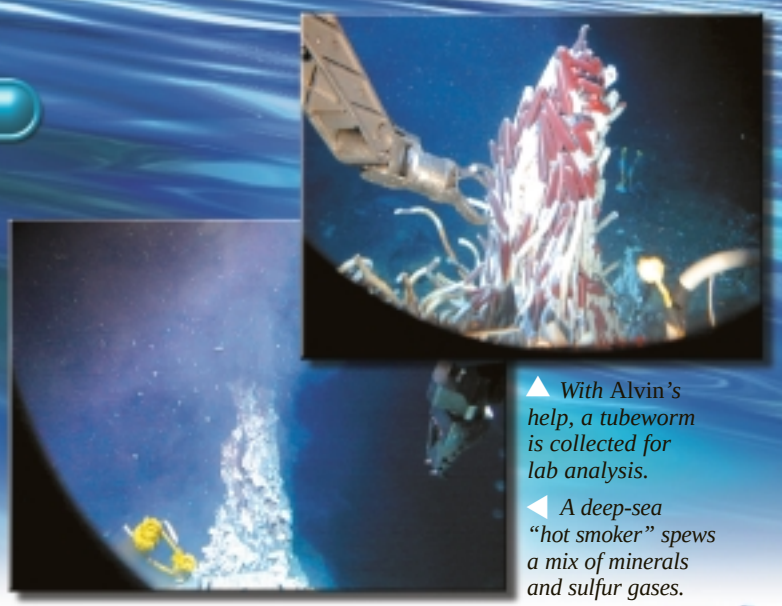
Robert Cohen

▲ *Marine Advisory Service specialist Bill Hall helps coordinate a regional census of the Delaware Bay's spawning horseshoe crab population.*

Bob Bowden

This Delaware Sea Grant research priority focuses on exploring the unique capabilities of marine organisms to adapt to demanding environments. This knowledge, applied to human settings, can result in a host of useful products in fields ranging from medicine to industry.

Our current projects share a common goal of understanding the role and function of marine bacteria in two very different ecosystems — the deep sea and the Delaware Bay.



▲ *With* Alvin*'s help, a tubeworm is collected for lab analysis.*

◀ *A deep-sea "hot smoker" spews a mix of minerals and sulfur gases.*

Exploring New Depths in Search of Useful Marine Microbes

From lipstick-like tubeworms to giant clams, a bizarre community of organisms inhabits hydrothermal vent sites over a mile deep on the Pacific Ocean floor.

▲ *Onboard the deep-sea sub* Alvin, *University of Delaware scientist Craig Cary weathers the 90-minute trip to the bottom of the Pacific Ocean off Costa Rica.*

Hydrothermal vents occur at fractures in the ocean floor where the Earth's crustal plates move apart. Here, super-heated seawater spews, carrying with it a mix of toxic minerals and gases.

These unique conditions support the only complex ecosystem known to live on energy from chemicals rather than energy from the sun. No natural light ever reaches these sites. And the pressure on them, created by the weight of the vast ocean above, is tremendous, at 3,500 pounds per square inch.

In a new Sea Grant project at the University of Delaware, molecular biologist Craig Cary (above), and chemist George Luther (right), are combining their expertise to explore the diversity, ecology, and evolutionary history of the tiniest life that thrives at vent sites: bacteria.

"Deep-sea hydrothermal vent bacteria are of great interest to industry because they produce enzymes that are able to withstand both high temperature and pressure," Cary says.

Last year, he and colleagues documented that the vent-dwelling Pompeii worm is the most heat-tolerant creature on Earth, able to withstand temperatures up to 176° F. The worm is covered by a fleece of bacteria that may harbor enzymes useful in food processing, drug manufacturing, and other high-temperature applications.

Cary's molecular techniques now will be aided by a unique microelectrode sensor that George Luther developed in previous Sea Grant research (see below).

The sensor will enable the scientists to detect small variations in concentrations of oxygen, manganese, iodine, iron, and hydrogen sulfide, all of which are thought to determine the distribution of bacteria living in hydrothermal vent communities.

As the scientists track down the ecology and evolution of deep-sea bacteria, they will screen the organisms for enzymes with potential applications in biotechnology.

▲ *In Sea Grant research during the next year, University of Delaware scientists periodically will travel to the Pacific Ocean floor off Costa Rica aboard* Alvin, *the famous sub owned by the Woods Hole Oceanographic Institution. The scientists are studying the microorganisms that inhabit deep-sea hydrothermal vents.*

Sensor Goes the Distance

Robert Cohen

▲ *George Luther constructs a microelectrode in his University of Delaware lab.*

The microelectrode sensor (closeup, bottom right) that George Luther has developed with Sea Grant support is helping to advance marine chemistry research because the device can quickly and simultaneously measure dissolved oxygen, hydrogen sulfide, manganese, and iron. Previous sensors could measure only one element.

Last year, Luther tested the sensor's sea legs at a depth of 40 feet on the bottom of Raritan Bay off the east coast of New Jersey, and the device performed well. The experiment, conducted with colleagues at Rutgers Institute of Marine and Coastal Sciences, is reported in the February issue of *Sea Technology.*

The sensor was mounted, with a submersible electrochemical analyzer and companion microprofiling instruments, on a Remotely Operated Vehicle, or ROV (right). All of the devices were controlled by the scientists from a research vessel anchored above the study site.

Luther now is working with colleague Craig Cary (photo in article, left) to put the microelectrode to work at much greater depths. On a research cruise this past May, the scientists reported the microelectrode's first measurements at hydrothermal vent sites. The sensor was deployed on the sub *Alvin* over a mile deep on the Pacific Ocean floor.

How Do Pollutants Affect Bacteria in the Delaware River and Bay?

For many of us, the word "bacteria" carries a negative connotation. But not all of these one-celled organisms are carriers of disease.

In fact, many of the bacteria that live in the Delaware River and Bay actually play critical roles in maintaining the estuary's health.

"These organisms form the base of the food chain, they mediate a number of important biogeochemical cycles, and they detoxify certain kinds of pollutants," says marine biologist David Kirchman.

In his laboratory at the University of Delaware's College of Marine Studies in Lewes, Kirchman is using DNA fingerprinting techniques to examine the impact of one major class of organic pollutants — polyaromatic hydrocarbons, or PAHs — on bacteria in the Delaware River and Bay.

Originating from oil, tar, wood preservatives, and the incomplete combustion of fossil fuels, PAHs can occur in high concentrations in estuaries heavily impacted by industrial activity.

These compounds persist in the environment because of their complex chemical structure. The many aromatic rings in their chemical makeup cause them to be insoluble in water and difficult to degrade.

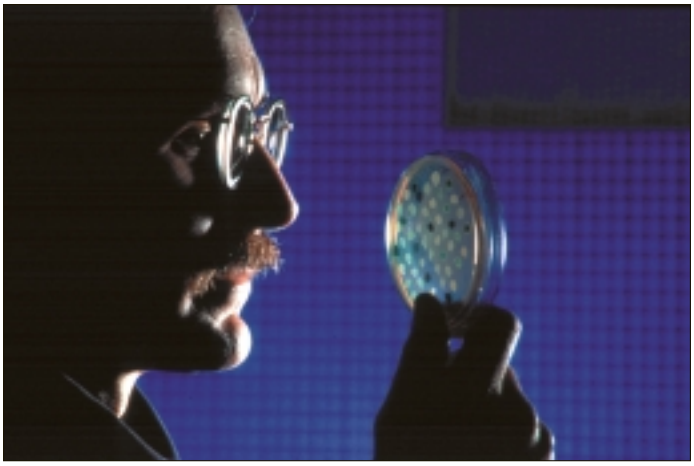
PAHs have been linked to a host of serious effects. Studies have shown that these compounds can bioaccumulate and cause tumors in fish.

"PAHs also are especially harmful to bottom-dwelling organisms like oysters and worms because these compounds adsorb onto particles, which then concentrate in the sediments," Kirchman says.

This summer, Kirchman and his research team will collect water and sediment samples from the Delaware River and Bay and then use molecular methods to find out which bacteria degrade PAHs and which bacteria are inhibited by the compounds. This work relies on DNA fingerprinting techniques because nearly all marine bacteria cannot be cultured.

Throughout the project, Kirchman will collaborate with colleagues at the Naval Research Lab who are working to solve problems caused by organic pollution of estuarine sites, such as the Naval shipyard on the Delaware River at Philadelphia.

"Like others, the Navy would like to know which contaminated sites need active remediation and which can be left untouched, for remediation by naturally occurring processes," Kirchman says. "The processing of pollutants by bacteria may be Nature's way of solving the problem."



Robert Cohen

▲ *David Kirchman is using DNA fingerprinting techniques to examine the impact of organic pollutants on the Delaware Bay's microbial community.*

New Brochure Informs Consumers about Seafood Safety

Seafood safety — what does it mean?

"Think of a safety net designed to protect you, the consumer, from food-borne illness," says Doris Hicks, seafood specialist for the University of Delaware Sea Grant Marine Advisory Service. "Every facet of the seafood industry, from harvester to consumer, plays a role in holding up their edge of the safety net."

While a mandatory seafood inspection program is in place to give consumers the safest seafood possible, Hicks says consumers need to follow through with proper handling techniques, from purchase to preparation.

Robert Cohen

▲ *Seafood specialist Doris Hicks provides copies of Sea Grant's new consumer safety brochure to Chuck Donohue, vice-president of Lewes Fish House.*

During the past year, she spearheaded development of "Seafood Safety: What Consumers Need to Know." This brochure provides guidelines for the proper handling, storage, preparation, and serving of seafood to prevent food-borne illness.

Supported by the National Seafood HACCP Alliance, the brochure was written by Hicks and colleague Don Kramer, Marine Advisory Service director at the University of Alaska Sea Grant College Program. Delaware Sea Grant's Marine Communications Office designed, edited, and oversaw the printing of the brochure.

So far, nearly 35,000 copies of the brochure have been printed and distributed to the Alaska Seafood Marketing Institute, the National Seafood HACCP Alliance, and the Sea Grant programs at California, Connecticut, Maryland, Michigan, Minnesota, Mississippi-Alabama, New Jersey, New York, North Carolina, South Carolina, Texas, Virginia, and Woods Hole.

Hicks is providing copies of the brochure to seafood retail outlets throughout Delaware. For more information, contact her at (302) 645-4297.

FISHERIES

Many commercial fish stocks in U.S. waters are over-exploited and in dire need of rebuilding. The goal of this Delaware Sea Grant research priority is to achieve sustainable fisheries and aquaculture production.

Current projects range from monitoring the effects of chronic reduced oxygen levels on economically vital coastal fisheries, to defining the best methods for culturing crayfish in the region.

Robert Cohen

▲ *Fisheries scientist Tim Targett (left) and graduate student Kevin Stierhoff monitor the effects of chronic reduced oxygen levels on young weakfish.*

Oxygen Study to Net Answers to Fish Habitat Questions

In the rows of aquaria in Tim Targett's lab at the University of Delaware, experiments are under way to determine the effects of reduced oxygen levels on four economically important Atlantic fishes: weakfish, summer flounder, winter flounder, and striped bass.

Oxygen levels fluctuate on a daily and seasonal basis in estuaries as a result of natural biogeochemical cycles. But chronic low-oxygen conditions, known as *hypoxia*, often occur in waterways afflicted by excess nutrients.

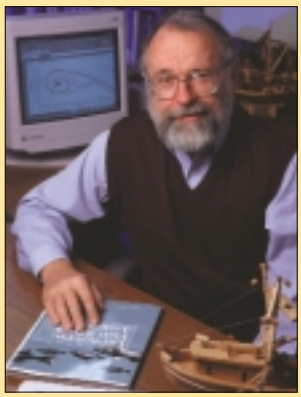
The objective of Targett's Sea Grant research is to assess the impact of hypoxia on young fish that utilize estuaries as nursery grounds. These "juveniles" are less than a year old and average only about 2 to 3 inches long.

"Besides determining the effects of a range of reduced oxygen levels on the fish, we'll also be examining them to see if they adopt certain behaviors to avoid low-oxygen areas," Targett says.

Targett says that by examining the growth and behavioral responses to hypoxia of a variety of species with different "life styles" — from active swimmers to more sedentary flatfish — scientists may be able to predict the susceptibility of different species to hypoxic conditions.

"Resource managers are working to define 'essential fish habitat' — habitat that's critical to fish survival," Targett says. "Our research should reveal the environmental conditions needed for healthy nursery areas."

A Model System for Managing Fish



Robert Cohen

▲ *Lee Anderson is developing economic models that can predict the effects of fisheries regulations on both fish stocks and fishermen.*

Fisheries managers wish they had a crystal ball to help them determine the effectiveness of regulations before they are enacted.

Lee Anderson is working on it. The University of Delaware economist is developing computer models that can predict the effects of any proposed management regulation on fish stocks and the economic conditions of fishermen.

Anderson is building the models using a commercial spreadsheet package. They will be structured to consider various types of fisheries facing real-world management concerns, from changes in total quotas, to limits on numbers of fishing trips.

Robert Cohen

Mapping Blue Crabs Using Space-Age Tools

When blue crab larvae are spawned at the mouth of the Delaware Bay each summer, they are carried southward by a fast-moving conveyor belt called the Delaware Coastal Current. Most of the tiny crabs are shuttled south to other estuaries, but some return to repopulate the Delaware Bay. But how?

University of Delaware marine biologist Chuck Epifanio and oceanographer Richard Garvine are refining a computer model that maps the travels of the larval crabs. The model shows that once carried out to sea, some of the crabs return to the bay with the help of summertime winds.

The model also highlights an area along the northern mouth of Delaware Bay, where patches of blue crab larvae are found. Using satellite-tracked drifters and larval crab collectors, the scientists now are working to determine what role this larval reserve plays in maintaining the bay's most valuable fishery.

◀ *Chuck Epifanio holds a satellite-tracking device that will be attached to the black drifter hanging behind him and deployed in Delaware Bay. The unit will help him map the locations of larval blue crabs and learn how bay circulation patterns affect the valuable fishery.*

Robert Cohen

▲ *Marine biologist Nancy Targett is developing an artificial bait, based on the horseshoe crab's chemistry, to ease fishing pressure on the crab. Currently, the crab is used for eel and conch bait.*

Artificial Bait to Relieve Fishing Pressure On Horseshoe Crabs

Commercial fishermen have known for years that female horseshoe crabs, when used for bait, are practically irresistible to eels and conch.

A common practice has been to collect the female crabs when they come ashore to spawn and then quarter them for bait for eel and conch pots.

Concern about recent declines in the Delaware Bay's horseshoe crab population has spurred research at Delaware Sea Grant to find a way to relieve fishing pressure on the crab, by providing fishermen with an effective substitute for the living creature.

The horseshoe crab provides a host of ecological and human benefits. Its eggs fuel shorebirds that stop along Delaware Bay on their spring migrations. Its blood, removed without harming the animal, contains a compound that is used to test prosthetics and intravenous drugs for bacteria.

Recently, at the University of Delaware College of Marine Studies, marine biologist Nancy Targett and her research team identified the natural chemical attractant in female horseshoe crabs that makes them such a desirable bait for eels and conch.

The active compound has been isolated, characterized with respect to molecular size and stability, and tested on eels. The scientists now are working to incorporate the compound into a variety of artificial bait types.

"Next year, we hope to have baits ready for field testing in collaboration with local fishermen," Targett says. "If we come up with a bait that works, it'll be a win-win situation for everyone, and especially for horseshoe crabs."

Crayfish Research to Benefit Mid-Atlantic Fish Farmers

The eastern white river crayfish, a large species native to the Mid-Atlantic region, might rival the popularity of its crayfish cousins in Louisiana someday.

Robert Cohen

▲ *In their lab at Delaware State University, Bernie Petrosky (left) and Bill Daniels are conducting experiments to determine the best techniques for growing crayfish in the Mid-Atlantic region.*

In Sea Grant research at Delaware State University, scientists Bernie Petrosky and Bill Daniels are working to pinpoint the optimum conditions for growing the native shellfish so that local farmers can produce it in a single growing season.

"Crayfish has long been a favorite in Cajun cuisine," Petrosky says. "It's growing in popularity with consumers in our region and throughout the United States."

Currently, the scientists are conducting experiments to determine the effects of differing temperature and light conditions on crayfish growth and reproduction. The scientists' goal is to define the conditions needed to accelerate the crayfish's egg development during the winter to provide a "jump start" on production and expand the growing season. The scientists also are assessing the feasibility of providing juvenile crayfish alternative feed, such as brewery waste, to potentially reduce production costs.

In related research, the scientists are honing in on the best techniques for growing mummichogs as commercial bait. One study of the fish has been completed; another is scheduled for the upcoming season in Delaware State's aquaculture ponds.

Web Site Aids Aquaculturists

Do any of Delaware's colleges offer courses in aquaculture? How do you grow striped bass? Where can I learn more about ornamental fish for my backyard pond?

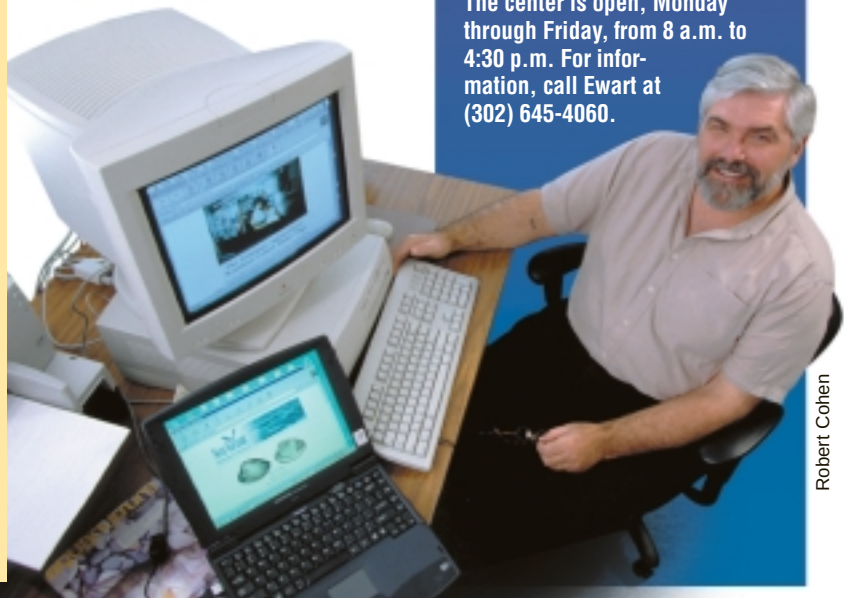
Tap into the Web site of the Delaware Aquaculture Resource Center, at *darc.cms.udel.edu*, and you'll find the answers. The site is a gateway to a vast network of resources relating to marine and freshwater culture.

The site provides "hot links" to sources for aquaculture education and training; on-line publications; and local, regional, and national sources for information and assistance. It's updated continually by John Ewart, aquaculture specialist for the University of Delaware Sea Grant Marine Advisory Service.

"There's an unbelievable amount of useful information available to fish farmers on the Internet," Ewart (below) says. "Our Web site is designed to help Delawareans and other Mid-Atlantic residents find answers to their questions about aquaculture."

Ewart operates the site from the Delaware Aquaculture Resource Center, which is based in Cannon Laboratory at the University's Lewes campus.

If you don't have access to the Internet, Ewart welcomes visitors to drop by the resource center for a tour of the Web site. The center is open, Monday through Friday, from 8 a.m. to 4:30 p.m. For information, call Ewart at (302) 645-4060.



Robert Cohen

EDUCATION AND OUTREACH

Educating Delawareans about the ocean and coast will always be a top priority at Delaware Sea Grant. We're committed to boosting Delaware's "Ocean IQ."

During the past year, our outreach team — the Marine Communications Office and Marine Advisory Service — developed a variety of educational projects, some of which are highlighted here. For more information, visit us at *www.ocean.udel.edu/seagrant* or contact us at (302) 831-8083.

Free Tours Showcase Marine Science ▶

Thanks to a dedicated corps of volunteers called *docents,* hundreds of people each year are learning more about the research conducted at the University of Delaware College of Marine Studies and Delaware Sea Grant. The docents lead free, guided tours of the college's Lewes campus for visitors age 12 and up. For information, call the Sea Grant Marine Advisory Service at (302) 645-4346.

Duane Perry

Robert Cohen

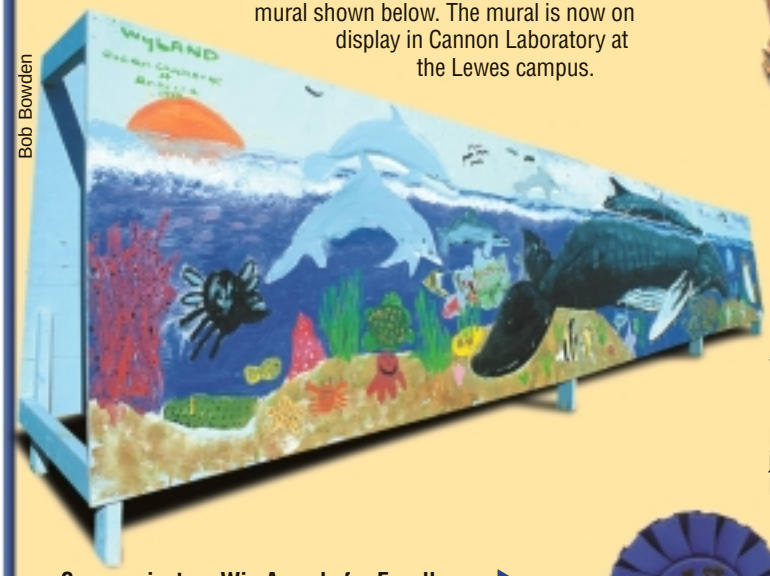
◀ Coast Day Draws Sea of Visitors

Since its debut in 1977, the University of Delaware's Coast Day festival has attracted thousands of visitors to the Lewes campus to learn more about the ocean.

Delaware Sea Grant's outreach staff coordinate Coast Day. Despite a steady drizzle at last year's festival, an estimated 8,000 visitors turned out to take part in activities ranging from the Great Crab Race, to the Seafood Chowder Challenge.

One highlight was a visit by the artist Wyland (above), who has painted life-size marine murals — "Whaling Walls" — on buildings across the United States. Wyland kicked off the Delaware leg of his national Ocean Mural Challenge at Coast Day, inspiring youngsters to join together to paint the 24-foot-long mural shown below. The mural is now on display in Cannon Laboratory at the Lewes campus.

Bob Bowden



▲ Ballard Intrigues Thousands with Tale of Deep-Sea Adventure

Last October, Delaware Sea Grant co-sponsored a special lecture by renowned ocean explorer Robert Ballard at the University of Delaware's Bob Carpenter Center in Newark. Known to millions for his discovery of the wreck of the *Titanic* and other historic vessels, Ballard told a riveting tale of deep-sea research and exploration. The talk drew nearly 3,000 visitors. Many are shown above lining up for the book signing held after the talk.

▲ Brochure Highlights Boater Tips for Protecting Inland Bays

It's coming soon — *Boating in Delaware's Inland Bays: Tips for Protecting the Environment.* Developed with funding from the Center for the Inland Bays, the full-color brochure provides simple tips that boaters can adopt to lessen shore erosion, prevent fuel spills, and protect bay life. For information, contact Marine Communications at (302) 831-8083.

Web Site Offers Ocean of Information ▶

Research briefs, seafood information, publications, press releases . . . these are just a few of the resources now available at Delaware Sea Grant's Web site — *www.ocean.udel.edu/seagrant.*

Special features include a publications catalog with an electronic ordering form, and audio clips of the "SeaTalk" radio series, which is broadcast on 40 AM and FM stations in the Mid-Atlantic region.

Dive into "Scientists in the News" on the site's News & Events page, and you'll find out about University of Delaware ocean scientists who recently made national headlines.

Communicators Win Awards for Excellence ▶

The Marine Communications Office, the public information unit of Delaware Sea Grant and the College of Marine Studies, won a total of 12 awards in local, regional, and national communications competitions during the past year. The winning projects ranged from the staff's Coast Day poster, to the "SeaTalk" radio series.

The awards were made by the Delaware Press Association, International Association of Business Communicators, National Federation of Press Women, and Society for Technical Communication.

The staff includes David Barczak, art director; Tracey Bryant, marine outreach coordinator; Pam Donnelly, production manager; and Claire McCabe, marine outreach specialist.

We'll *SEA* you at

Coast Day!

Sunday, October 3, 1999

http://www.ocean.udel.edu/seagrant

University of Delaware
Sea Grant College Program
Financial Report

July 1, 1998 – June 30, 1999

Program Area	State Funds	Federal & Other Matching
Coastal Ocean Studies	$ 35,198	$ 194,665
Environmental Technology	1,429	48,524
Coastal Engineering	48,942	82,671
Marine Biotechnology	20,652	71,134
Fisheries	42,131	293,606
Marine Outreach	257,306	589,288
Graduate Education	0	451,729
Program Management	13,742	298,553
Totals	**$419,400**	**$2,030,170**
Grand Total		**$2,449,570**

In addition to this funding, University of Delaware Sea Grant 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 Delaware Sea Grant and serve as an important mechanism for the development of comprehensive and integrated research efforts:

- *For a project slated to begin in February 2000, University of Delaware 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 of $83,000 from Sea Grant's Oyster Disease Research Program.*
- *Gaffney also was awarded $31,251 from the National Marine Fisheries Service to study the genetic structure of spring- and summer-spawned bluefish.*
- *Aquaculture scientists Bernard Petrosky and William Daniels, at Delaware State University, began the third year of a three-year award, totaling $150,000, to develop aquaculture methods appropriate to the Mid-Atlantic region for crayfish and bait fish.*
- *Marine Advisory Service specialist Doris Hicks was awarded $16,500 as part of a nationwide program for improving retail seafood quality and safety.*
- *University of Delaware marine biologist Ana Dittel received $23,306 from the Marsh Ecology Research Program to continue investigations of the production of juvenile blue crabs in coastal wetland areas.*
- *Marine scientists David Hutchins and Craig Cary, at the University of Delaware, were awarded $121,000 from NOAA and $10,000 from the Center for the Inland Bays to investigate life-stage-specific molecular tools to predict* Pfiesteria.
- *Hutchins also received $25,000 from the Center for the Inland Bays and $10,000 from Delaware Sea Grant to research the possible development of brown tide, a harmful algal bloom (HAB), in the Inland Bays.*

University of Delaware
Sea Grant College Program
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