UNIVERSITY OF DELAWARE SEA GRANT

REPORTER

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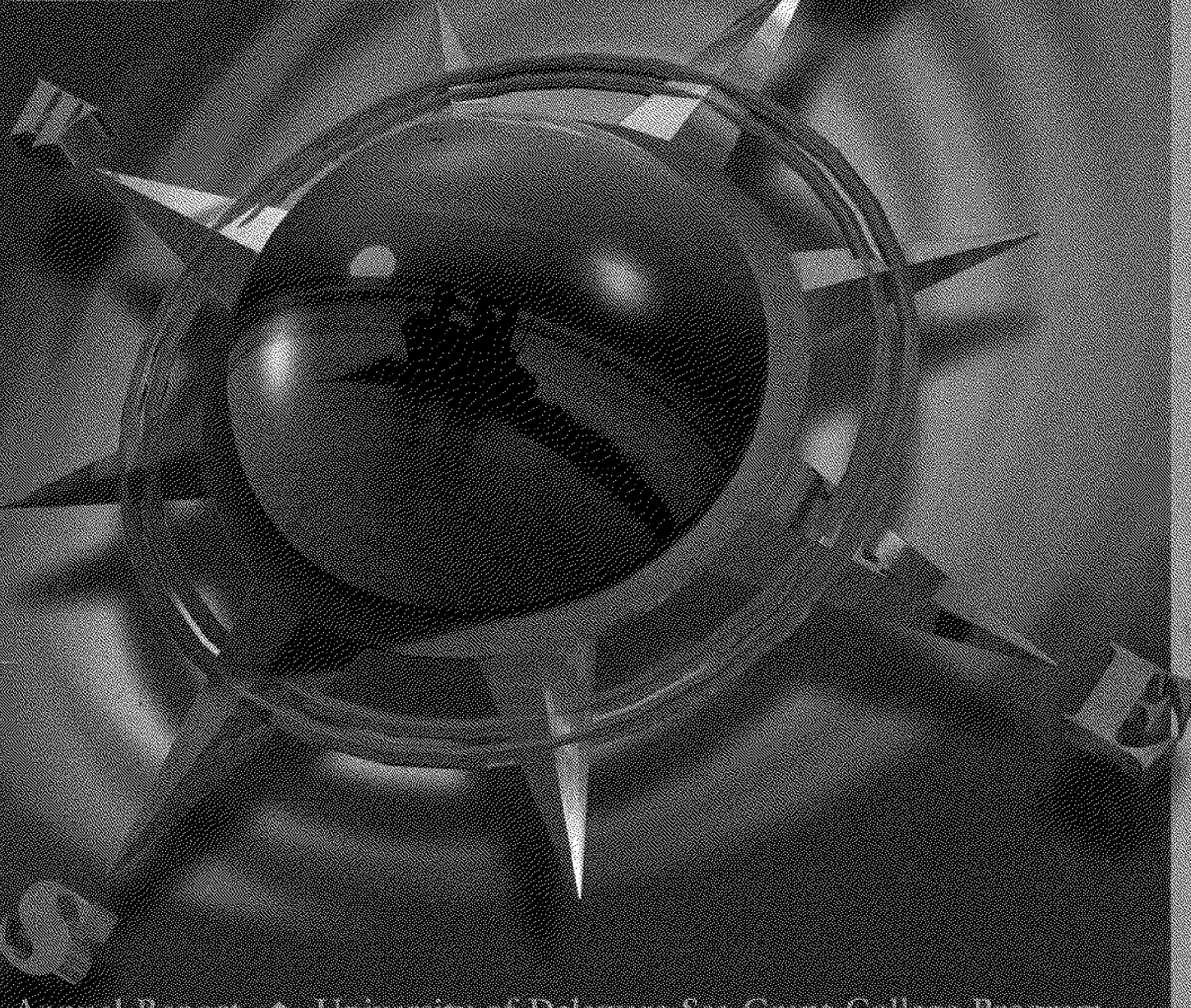
Launching Partnerships for Delaware's Coast



Annual Report ◆ University of Delaware Sea Grant College Program

UNIVERSITY OF DELAWARE SEA GRANT

REPORTER

UNIVERSITY OF DELAWARE SEA GRANT REPORTER is published twice a year by the University of Delaware Sea Grant College Program to inform the public of marine research, issues, and events that affect Delaware.

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Sea Grant
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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 our ocean, coastal, and Great Lakes regions. The program is financially supported by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, the State of Delaware, and the University. Dr. Carolyn A. Thoroughgood, *Director*. Mr. Richard W. Tarpley, *Executive Director*.

For assistance with a marine problem or opportunity, contact the appropriate Sea Grant Marine Advisory Service specialist in Lewes at (302) 645-4346.

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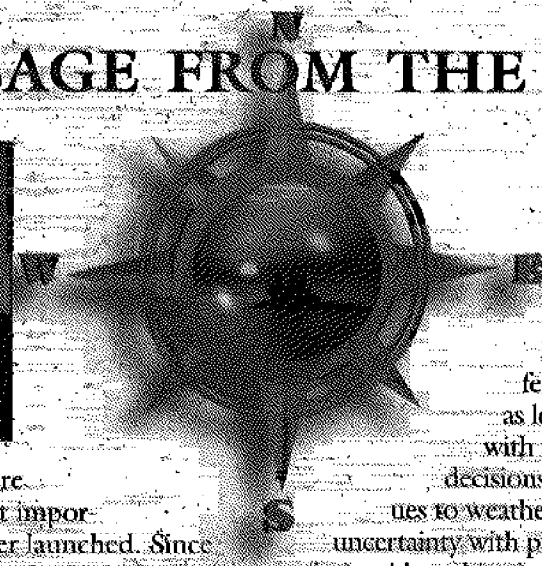
MESSAGE FROM THE DEAN



Partnerships are some of the most important "vessels" ever launched. Since it was founded by the U.S. Congress in 1966, the National Sea Grant College Program has strived to build partnerships among federal and state government, academia, industry, and the public to accelerate marine research, promote environmental education, solve coastal problems, and address new opportunities for the benefit of our treasured seas and shores and all of us who depend on them.

During the past year, as you'll learn in the following pages, the University of Delaware Sea Grant College Program has been working to advance research in marine biotechnology, coastal engineering, environmental studies, seafood science, and marine policy in association with a broad range of partners, from coastal resource managers to local communities.

Additionally, the Sea Grant Marine Advisory Service and Marine Communications staffs have formed partnerships with thousands of citizens, providing useful information through both traditional and innovative new tools, from private consultations, workshops, and publications, to radio announcements and home pages on the World Wide Web.

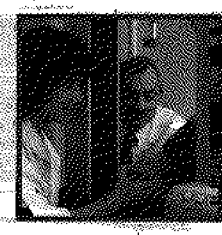
As with all federally funded science programs, the National Sea Grant College Program recently has been under the federal microscope, as legislators grapple with tough budgetary decisions. Sea Grant continues to weather this period of uncertainty with praise for the benefits it provides: objective, high-quality, cost-effective research, education, and public service in support of the wise use, conservation, and management of the nation's marine and coastal resources.

Delaware's coastal treasures are many, with more than 260 miles of saltwater shoreline along Delaware Bay, the Inland Bays, and the Atlantic Ocean, thousands of acres of marshes, and rich wildlife resources. Our seas and shores provide us with livelihoods, commerce, and recreation, and a quality of life that we cherish. Yet the challenges that face this environment — from a growing coastal population to global warming — are serious and complex.

Charting the right course for tomorrow's coast will require partnerships among people from all walks of life — citizens to legislators, resource managers to scientists. Here at Delaware Sea Grant, we know that strong partnerships can lead to success. We welcome you aboard as we embark on tomorrow's voyage.

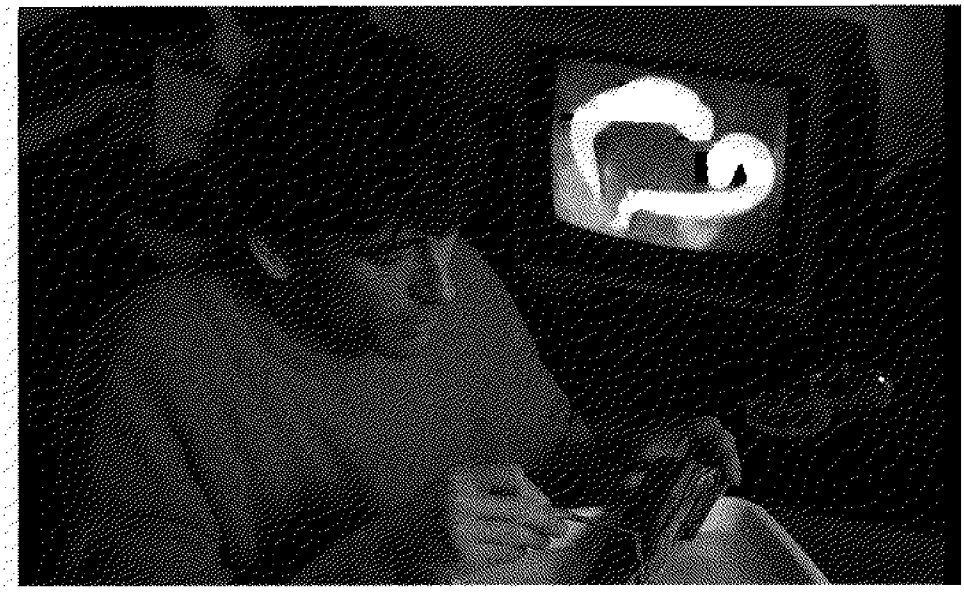
Carolyn A. Thoroughgood

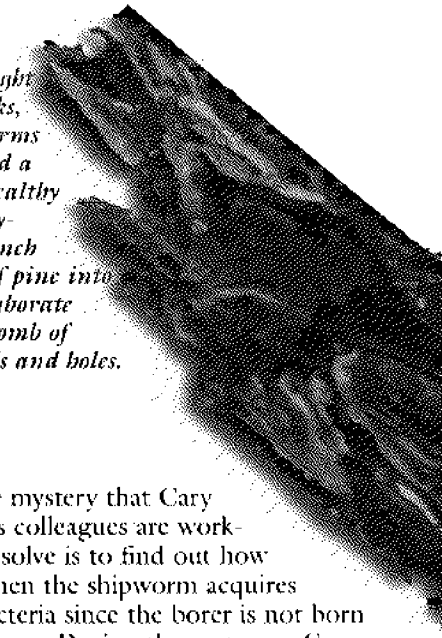
Dr. Carolyn A. Thoroughgood
Director, Sea Grant College Program
Dean, Graduate College of Marine Studies



Solving the Case of the Clam Who Loved Wood

Scientists Probe for Answer to Age-Old Problem





In eight weeks, shipworms reduced a once-healthy four-by-eight-inch piece of pine into this elaborate honeycomb of tunnels and holes.

Craig Cary (above) gently extracts the shipworm *Teredo navalis* from a tunnel it has bored in a four-by-eight-inch piece of pine. The honeycomb of tunnels and holes eaten through the wood in only eight weeks testifies to the destructive potential of this voracious creature.

Actually, the shipworm isn't a worm at all, but a clam. Instead of two shells encasing its body, this clam possesses two small shells at the top of its head, each equipped with two sets of ridges. Using these ridges, the shipworm bores its way into wood, growing as it goes. Species like *Teredo navalis*, common to the East Coast (and magnified on the monitor behind Cary in the photo above), may grow up to 3 feet long and a half inch in diameter.

For centuries, shipworms have feasted their way through wooden vessels, piers, and other structures in salt water, resulting in billions of dollars in damages. Within the past few years, ironically due to improvements in water quality, the creatures have re-invaded New York harbor, prompting the city to spend more than $100 million to brace and wrap plastic around thousands of pilings supporting its most vital piers. Locally, the Delaware River and Bay Authority has been working to replace wooden pilings ravaged by shipworms at the Cape May-Lewes Ferry terminals with pilings made of composite materials.

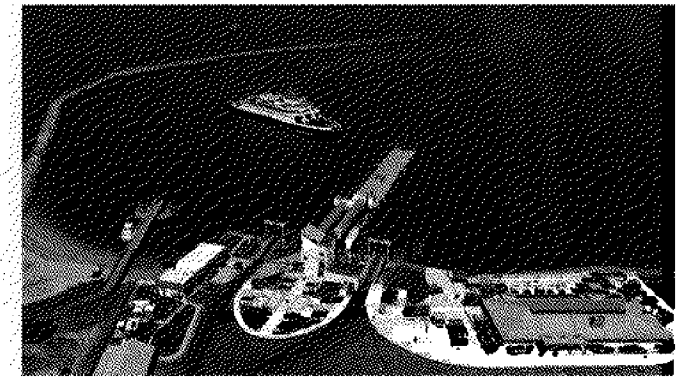
Chemical warfare has also been waged against the wood borers, which do not attack timbers impregnated with creosote or copper compounds. The downfall is that these biocides must be used in high concentrations to be effective, raising concern about their impact on non-target marine life.

To find safer alternatives for preventing shipworm boring, Cary, a marine molecular biologist at the University of Delaware Graduate College of Marine Studies, and associate Jeff Morrell, a forestry scientist from Oregon State University, are focusing their research on a unique relationship between the shipworm and a special guest.

"Unlike most clams, shipworms can digest wood thanks to specialized bacteria that live in a unique gland in their bodies," Cary explains. "The shipworm and the bacteria have a symbiotic relationship. While the shipworm provides the bacteria with a home, the bacteria provide the shipworm with the enzymes it needs to digest cellulose, the primary component of wood, as well as a form of nitrogen essential for the shipworm's survival on wood."

The mystery that Cary and his colleagues are working to solve is to find out how and when the shipworm acquires the bacteria since the borer is not born with them. During the past year, Cary, postdoctoral assistant Ami Wilbur, and graduate student Alison Sipe have set up a state-of-the-art shipworm culture facility and have begun constructing the molecular probes necessary for detecting the bacteria in the worms, as well as in wood, which may serve as the bacteria's initial host. Meanwhile, forestry scientist Morrell is examining woods that may have antibacterial properties, which could indirectly prevent attack by wood borers and thus offer important clues for preventing shipworm predation on susceptible woods.

As this project progresses over the next two years, the scientists hope to increase our understanding of the unique relationship between the shipworm and the bacteria that enable it to digest wood, providing insight into new ways of combating the "termite of the sea."



The salty water of Delaware Bay is a prime habitat for shipworms, which have attacked the piers at the Cape May-Lewes Ferry terminals. The Lewes, Delaware, terminal is shown here.

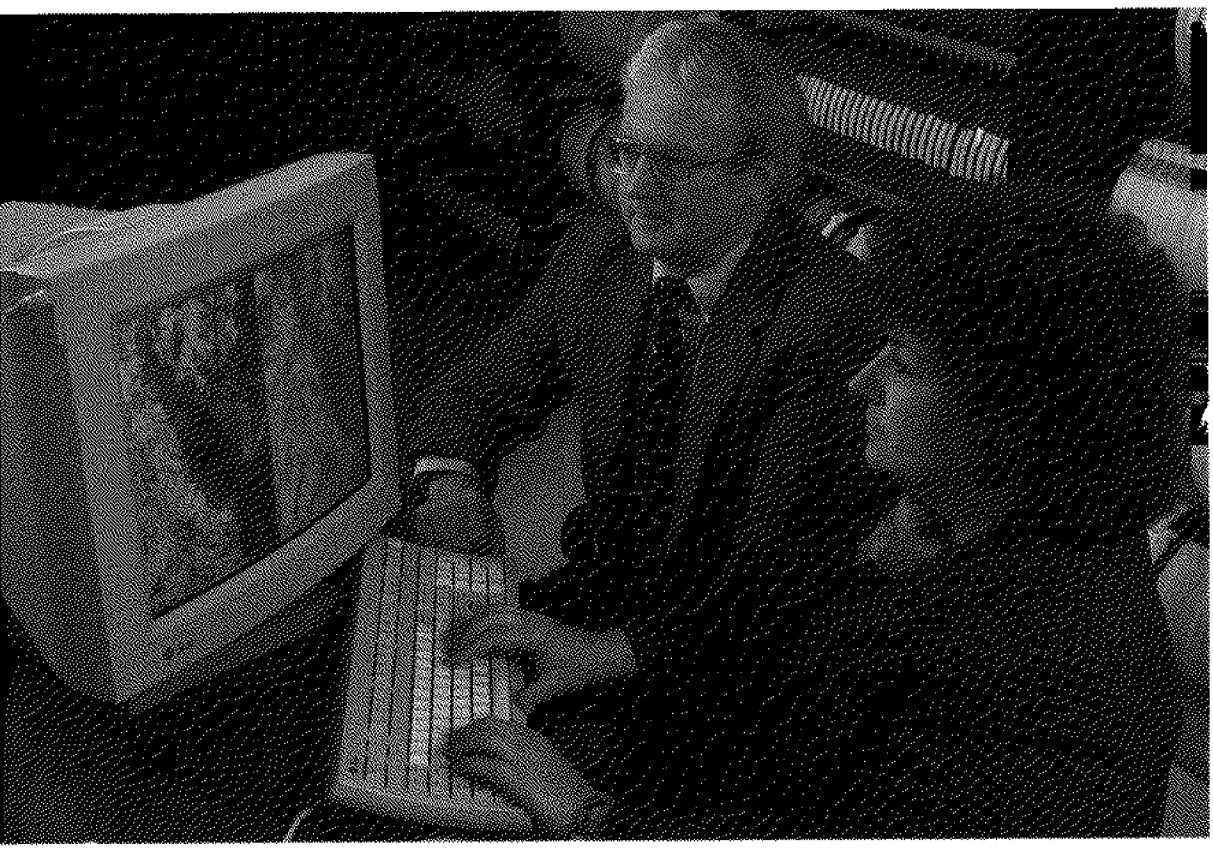
Putting Emerging New Technologies at Resource Managers' Fingertips

Last July, through a competitive proposal process, the University of Delaware Sea Grant College Program received a special enhancement award from the National Sea Grant College Program to develop emerging technologies that coastal managers can use to assess and improve the health of the Delaware Estuary, Delaware's Inland Bays, and Delaware's National Estuarine Research Reserves.

Led by Robert Knecht, professor of marine policy, and Vic Klemas, professor of applied ocean science, the project's interdisciplinary team includes experts in satellite remote sensing, ocean acoustics, oceanography, marine policy, education, and communications from the University of Delaware Graduate College of Marine Studies, with critical input from a Managers' Advisory Committee comprising representatives from the Center for the Inland Bays, the Department of Natural Resources and Environmental Control, the Delaware Estuary Program, and other coastal resource management programs in Delaware.

The landmark initiative is organized into three components. The first research group is integrating land cover data gathered by satellites with other environmental indicators to create a computerized Geographic Information System (GIS) for assessing wetlands health. With its rich layers of data, the GIS should help managers more easily assess changes in land use affecting wetlands, from encroachment by urban development, to invasion of the nuisance plant *Phragmites australis*.

A second research group seeks to develop a remote sensing observing system incorporating data on water temperature and salinity, suspended sediments, primary production, surface and nearshore waves, tidal flow and freshwater discharge, and other parameters derived from satellite images, space shuttle photography, acoustics profilers, and other sources. These techniques and their vast data base would significantly enhance resource managers' capabilities to view an entire ecosystem — from the Inland Bays to the Delaware Bay— and monitor its changes.



Vic Klemas, director of the Center for Remote Sensing at the University of Delaware Graduate College of Marine Studies, and Biliana Cicin-Sain, co-director of the college's Center for the Study of Marine Policy, compare two satellite images of the Delaware Bay. The scientists are involved in an interdisciplinary research and education project designed to provide resource managers with useful, new remote sensing techniques for monitoring and improving the health of coastal ecosystems such as the Delaware Bay, Delaware's Inland Bays, and other vital waterways.

"Until now, managers have not had access to the up-to-date observing and monitoring technologies that could provide the kind of timely, relevant information that would increase their capabilities to manage on a whole ecosystem level rather than on a resource-by-resource basis," says Knecht. "Our project proposes to do exactly that by closing the gap between the capabilities of science and technology, on the one hand, and the needs of resource managers on the other."

The goal of the third research group is to engage coastal resource managers as full partners in the effort, by communicating closely with them to learn more about their information needs. This collaboration will not only ensure the usefulness of the tools the project team develops but also advance new regional partnerships toward integrated coastal management.

In forging a new alliance among scientists, policy experts, and coastal managers, this Sea Grant project may become a model for other regions to follow as our nation strives to improve management of its coastal ecosystems.

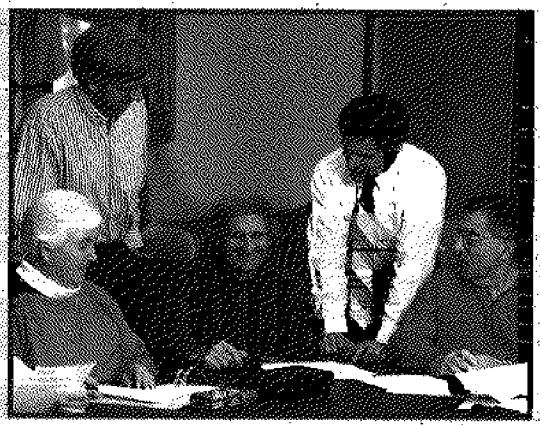
Responding to Community Needs:

Volunteers Conduct South Bethany Canal Study

South Bethany TOWN HALL

In 1991, the University of Delaware Sea Grant College Program established the Inland Bays Citizen Monitoring Program to enlist area volunteers in collecting badly needed water-quality data on Rehoboth, Indian River, and Little Assawoman bays. Today, the monitoring program is still going strong, with more than 25 volunteers donating their time every week to help build a long-term portrait of the bays' health.

During the past summer, the monitoring program undertook a special project at the request of the town of South Bethany. Local officials were concerned about water quality in the town's man-made canal system, which links to Little Assawoman Bay.



Marine Advisory Service specialist Joe Farrell (standing left), provides an update on the water quality of South Bethany's canals at a recent meeting of South Bethany Town Council and the Department of Natural Resources and Environmental Control. Representing the state was Gerard Esposito (also standing), director, Division of Water Resources. Seated, from left, are town secretary Dee Burbage, Mayor Herbert Schaefer, and councilman Sal Aiello.

Working with town councilman Sal Aiello, Joe Farrell, Marine Advisory Service specialist and manager of the monitoring program, and assistants Reneé Karrh and Maryellen Timmons trained 16 of the town's residents in water-testing and data-recording techniques. From June 30 to September 1, the volunteers measured water clarity and depth, air and water temperature, salinity, pH, and dissolved oxygen concentration at assigned sites on the town's canals. This information now forms a valuable data base against which future monitoring efforts to assess stormwater impact may be compared.

"Our study was truly a collaborative effort that was done for very little money," says Joe Farrell. "Instead, we relied on a strong commitment from the town council and volunteers from South Bethany and a lot of goodwill and support from our partners — DNREC's Office of Shellfish and Recreational Waters, the College of Marine Studies, South Coastal Water Treatment Facility, and the state Public Health Lab. We collected a lot of valuable information that can be used to support the town's stormwater management decisions," he notes, "and we welcome the opportunity to help other communities address their water-quality concerns."

For more information about the Inland Bays Citizen Monitoring Program, please contact Joe Farrell, University of Delaware Sea Grant Marine Advisory Service, at (302) 645-4250.

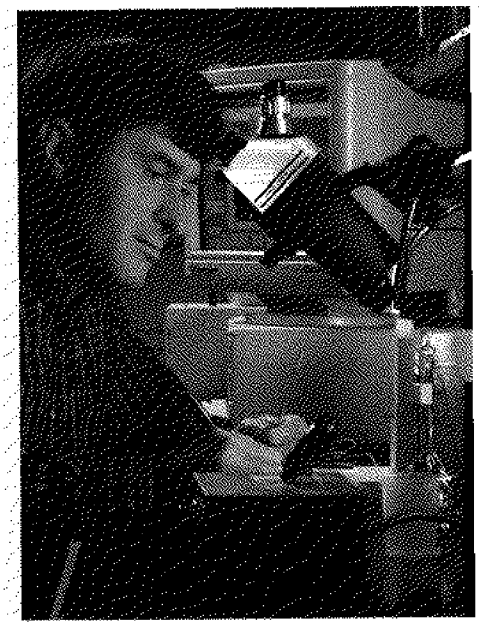
Changing the Flow of Ideas about Bay Circulation

Oceanographer Kuo Wong (on the deck in the photo below) and his research crew have completed the final check of their computer system and are now ready to motor the 26-foot *Captain Thomas White* into Delaware Bay for a sampling experiment that will run continuously over the next eight hours. As the research vessel travels back and forth from Bowers Beach, Delaware, to Norbury's Landing, New Jersey, Wong and his crew will constantly take near-surface salinity and temperature measurements, as well as acoustic doppler profiler readings to capture data on the currents flowing through the bay.

"Traditionally, people think that the only change in estuarine circulation occurs in the longitudinal direction, in the deep channel," says Wong. "But recent surveys have shown that there is a lateral variation in circulation along the bay that appears to be closely linked to across-channel variations in depths. What that means is that the transport of salt, nutrients, pollutants, and other materials along the shore is a lot different than what occurs in the deep channel."

Besides increasing our fundamental knowledge of how water circulates in the Delaware Estuary, Wong's research will provide valuable information on nutrient transport and its effect on the aquatic food supply, new data for forecasting the position of oil spills and other pollution events, and the "ground-truthing" necessary to validate satellite remote sensing efforts.

New Sensor Advancing Coastal Diagnostics



George Luther examines the unique microelectrode he has developed to provide rapid assessments of seawater and sediment chemistry.

George Luther, professor of oceanography at the University of Delaware Graduate College of Marine Studies, has developed a new sensor — a solid-state gold amalgam microelectrode — that scientists can insert into marine waters and sediments to simultaneously measure dissolved oxygen, iron, manganese, hydrogen sulfide, and iodide. The concentrations of these highly reactive chemicals and metals can serve as indicators of the environmental health of salt marshes, harbors, bays, and other marine habitats.

Microelectrodes are not new to the scientific community. But previously these needle-like sensors could characterize only gaseous compounds, and typically only one gas could be measured per electrode. In addition to its ability to measure a number of chemicals and metals simultaneously, the microelectrode Luther has developed through Sea Grant research can perform its analyses with accuracy to the submillimeter level.

The glass-encased device contains a gold wire plated with mercury. When the probe is inserted into salt-marsh sediments, for example, the chemicals in the sediments react with the mercury, creating a current directly proportional to the chemicals' concentrations. An attached monitor records the readings.

During the past year, Luther and assistants Ph.D. graduate Paul Brendel and master's candidate Steve Theberge put the microelectrode to the test in a series of comparative shipboard studies on the Scotian shelf of Canada and in the Chesapeake Bay. This summer, the research team will continue experiments with colleagues in Canada and Germany to expand the microelectrode's ability to measure chemicals and metals in seawater, in flow conditions. They also hope to test the sensor's use on a remotely operated vehicle, which could further minimize disruption to the environment during sampling while maximizing the quality of the data gathered.

Putting a Nuisance Plant to Good Use in Bridgeville

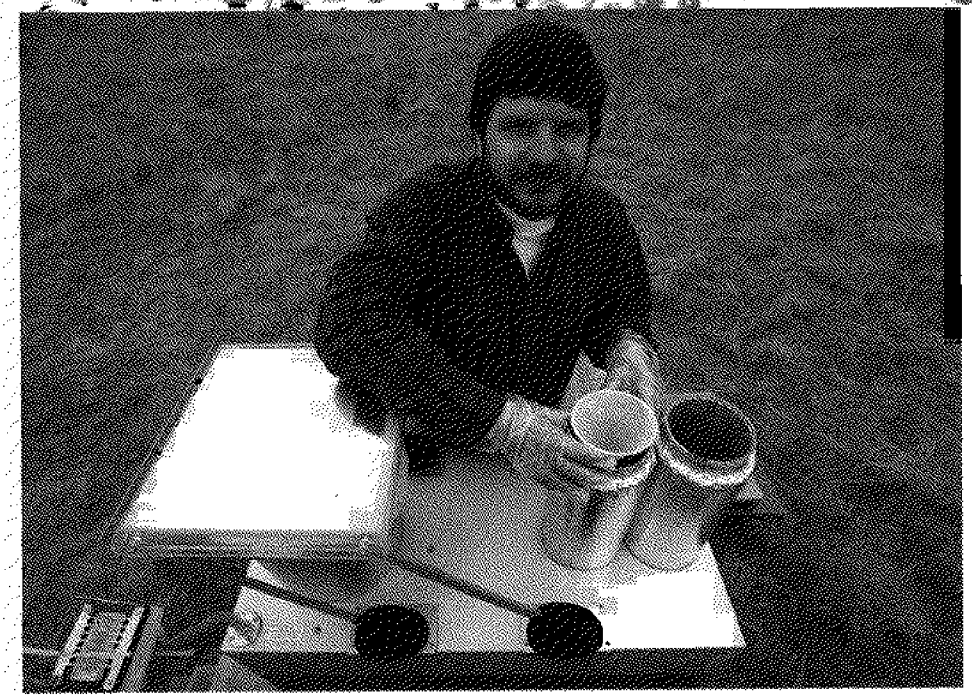
The common reed *(Phragmites australis)* is a tall, plumed marsh plant that most resource managers would run out of town if they could. But last year, Jack Gallagher and Denise Seliskar (right), botanists at the University of Delaware Graduate College of Marine Studies, worked with volunteers from the National Civilian Community Corps to establish a stand of *Phragmites* in Bridgeville, Delaware — at the town's wastewater treatment facility.

Widely regarded as a nuisance in U.S. wetland areas because it out-competes vegetation considered to be more valuable to waterfowl and other wildlife, *Phragmites australis* has proven that it can benefit wastewater treatment operations. Once planted in the sand beds where sewage sludge is released to dry, *Phragmites*, with its extensive root system, enhances the drying and breakdown of organic material, reducing the amount of sludge that eventually must be hauled to local landfills. The wastewater treatment facility thus saves on labor costs for biosolids removal and on landfill fees.

"Currently, at least 75 wastewater treatment facilities in the nation are using *Phragmites* in this manner," says Gallagher, of the college's Halophyte Biotechnology Center, one of only a few institutions in the world focusing on the use of genetic techniques to design better salt-tolerant marsh plants, called halophytes, for use in agriculture and in restoring damaged wetlands. In Sea Grant research, he and Seliskar are using tissue-culture techniques to genetically select salt-marsh plants with high nutritional value and taste. The scientists have developed hay, grain, and vegetable crops that are now being tested in China, Egypt, Israel, Pakistan, Thailand, and the United States. "Eventually, we hope to use these techniques to produce varieties of *Phragmites* that are best suited for sludge treatment," Gallagher notes.

Volunteers from the National Civilian Community Corps helped plant more than 2,000 sprigs of common reed at Bridgeville's wastewater treatment facility in March 1995. The nuisance plant is now redeeming itself as a "sludge buster."

Gauging Mercury's Impact on the Delaware Estuary



Marine chemist Joseph Scudlark retrieves rainwater collected at the University of Delaware Graduate College of Marine Studies in Lewes for transport to the lab for mercury analysis.

Mercury. This poisonous silvery metal is familiar to most of us as a component of thermometers. But it has also been used in a wide variety of other materials and processes, from pesticides to fluorescent lights to gold refining. At one time, mercury was dumped in the ocean and other waterways, where it eventually entered the aquatic food chain, contaminating fish. Although more than 90 nations approved an international ban on ocean dumping of mercury in 1972, as a highly volatile metal, one that easily vaporizes, mercury is still being transported and deposited to land and sea by the atmosphere.

"Of all trace metals, contamination of the marine environment by mercury is of paramount concern," says marine chemist Joseph Scudlark. "This is due to mercury's tendency to accumulate in marine food chains and its reduction by bacteria to more toxic organic forms. Even in very small quantities, mercury exhibits insidious toxic effects and has caused well-documented harm to both marine ecosystems and human consumers of marine products."

In addition to its toxic effects on marine life, mercury is poisonous to humans. When ingested in more than trace amounts through the consumption of contaminated fish or absorbed by the skin or mucous membranes, it can cause skin disorders, hemorrhaging, liver and kidney damage, and other problems.

During the past year, Scudlark and fellow chemist Tom Church initiated the first major investigation of mercury in the Delaware region. Since the predominant source of mercury is industrial emissions, which are deposited to the ground in precipitation, the scientists have established rainwater collection sites for mercury analysis in Delaware and in Maryland. They have also begun developing chemical fingerprinting techniques to track the mercury they detect to its industrial source. This year, their sampling efforts will expand beyond rainwater to estuarine and coastal waters and sediments. Their results are being shared with Delaware officials and the toxics subcommittees for the Delaware River Basin Commission and the Chesapeake Bay.

Keeping Up with Current Events

Robert Dalrymple (left) may look like he's creating an abstract work of art, but the red dye he's squirting in the water is actually exposing a potential killer: a rip current.

Dalrymple, director of the University of Delaware Center for Applied Coastal Research, and colleague Ib Svendsen are conducting a series of experiments in the Ocean Engineering Lab to simulate rip currents and quantify their physics. Dangerous to swimmers, these strong currents are formed when there is a break in a nearshore sandbar or the current is diverted by a jetty, groin, or other barrier. Thus, at these locations, water rushes out to sea in a narrow path.

Quantifying the physics of rip currents will help Dalrymple and Svendsen and their associates Jim Kirby and Nobuhisa Kobayashi develop and enhance three-dimensional computer models that can accurately simulate nearshore motions. Not only will these models aid in the design of better coastal protection methods, but they will also eventually help us predict the behavior of the shoreline under various conditions and time scales — crucial information for Delaware and other coastal states where beaches mean big business, and the year-round population of many coastal communities is growing steadily.

In the Hunt for Hardy Oyster Genes

Marine biologist Patrick Gaffney (right) exposes a gel impregnated with oyster DNA to ultraviolet light, instantly revealing the genetic composition of the two different oysters he wants to compare. By using the revolutionary tools of human genetics research, Gaffney is creating DNA markers that will help scientists search among thousands of oyster genes for the handful that may confer resistance to MSX and Dermo, two diseases that have decimated the oyster fishery in the Mid-Atlantic region. If the prized disease-resistant genes can be found, they will dramatically advance breeding programs to revitalize the flagging fishery.

Food scientist Dallas Hoover and seafood technology specialist Doris Hicks load pressure-treated samples of smoked seafood into the Instron Universal Testing Machine for texture analysis.

Aiming for New Heights in Seafood Safety

High in nutrition and heart-healthy benefits, but low in calories, seafood is appearing on the dinner table more and more in America. Yet the safety of seafood products remains a concern among consumers.

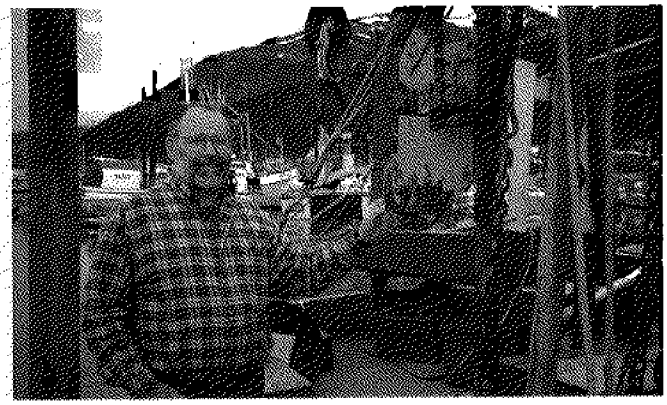
To further safeguard seafood, the U.S. Food and Drug Administrations recently developed a new mandatory seafood inspection program based on the Hazard Analysis Critical Control Point (HACCP) system. Under this system, seafood is monitored at critical points in its journey from sea to consumer to ensure quality and safety.

In complementary research at the University of Delaware, Dallas Hoover, a food scientist in the College of Agricultural Sciences, and Doris Hicks, seafood technology specialist for the Sea Grant Marine Advisory Service, are testing the use of high hydrostatic pressure as a new method for destroying any bacteria that may be present in seafood without affecting its fresh taste, nutrition, and texture.

While high-pressure pasteurization is not a new food processing method, its application to seafood is. In laboratory research last year, Hoover and Hicks demonstrated the successful pressure treatment of crab meat at 3,400 atmospheres (the equivalent of about 50,000 pounds per square inch) for 20 minutes at 25°C with no significant effect on taste. The same treatment extended the shelf life of shucked oysters and inactivated dangerous pathogens they may carry — *Vibrio parahaemolyticus* and *Vibrio vulnificus.*

Earlier this year, the scientists pressure treated shrimp but found the method ineffective in extending the shellfish's shelf life. They are now applying the technique to other processing applications, from inactivating pathogens that can be found in smoked fish products, to dramatically shortening the defrosting time for frozen seafood while maintaining the product's high quality. By literally putting the pressure on seafood, Hoover and Hicks may soon be able to offer both the seafood industry and consumers a new measure of seafood quality and safety.

Getting the Lowdown on ITQ Economics



Fisheries economist Lee Anderson is working to predict the changes in harvesting and processing that will occur during the transition from traditional fisheries management to an Individual Transferable Quota (ITQ) program. ITQs are gaining popularity worldwide as a way to reduce overfishing and overcapitalization.

Since New Zealand first used them on a large scale in 1982, Individual Transferable Quota (ITQ) programs have gained popularity in the United States and throughout the world as a promising method of managing certain fisheries that reduces overfishing and overcapitalization.

The ITQ program focuses on how many fish are caught overall, a total quota, which is divided into individual units that are allocated to holders — fishermen and firms — who are then guaranteed the right to catch that portion of the total quota each year. Because holdings are transferable, meaning that they can be sold, bought, or leased, the holder can set up the optimum harvesting and marketing arrangements to increase his profits.

While the principal components of ITQs and their primary benefits are well known among resource managers and many fishermen, the details of what will likely occur during the transition to a fully functioning ITQ fishery have not been fully explored.

"This transition period to an ITQ fishery is more than the time it takes to formalize initial quota allocations and set up reporting and monitoring programs," says Lee Anderson, a fisheries economist and professor of marine policy at the University of Delaware Graduate College of Marine Studies. "It also includes the short-run period for a market in ITQs to be established and for trades to take place, the medium-run period for harvesters and processors to change their activities, and the longer-run period for them to make capital investments as a result of new opportunities provided by the system."

The goal of Anderson's Sea Grant research is to analyze this transition period and develop an economic model to describe the changes in efficiency and distribution in both the harvesting and processing sectors over time in different fisheries. What kinds of structural changes will occur in the two sectors, and when? During the past year, he has identified an extensive range of areas where ITQs can generate increased benefits, from reductions in the size of the fishing fleet, to increased production by focusing on periods where processing yields per individual fish are higher. When his analysis is complete, Anderson's results will aid in the fine-tuning of existing ITQs and the design of new programs, as well as help the commercial fishing industry prepare for an ITQ should one be introduced in their fishery.

Fellowship Offers Ocean of Opportunity

National Sea Grant Fellow Patrick Moran (seated) works with his supervisor, Dean Swanson, Chief, International Organizations and Agreement Division, at the National Marine Fisheries Service in Silver Spring, Maryland.

In February 1996, Patrick Moran, a master's student in marine policy at the University of Delaware Graduate College of Marine Studies, began a year-long appointment as one of 26 National Sea Grant Fellows. Endorsed by the U.S. Congress, this competitive program matches highly qualified graduate students with host agencies in the legislative and executive branches of the federal government, providing them with a unique, year-long educational experience.

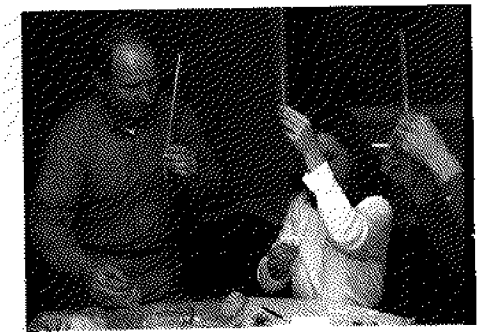
As a foreign affairs specialist at the National Marine Fisheries Service in Silver Spring, Maryland, Moran has been involved in a broad range of activities, from assisting with the appointment of U.S. commissioners, scientific council representatives, and consultative committee members to the Northwest Atlantic Fisheries Organization, which the United States recently joined; to preparation of a report to Congress on U.S. activities relating to Atlantic bluefin tuna and other highly migratory species.

"Just to give you an idea of how I'm doing," Patrick recently e-mailed, "I've been given a direct role in the development of the U.S. position relating to the Northwest Atlantic Fisheries Organization, which is exactly the topic of my thesis research. I've also been included in many meetings and negotiations in the last few months that are not a part of my daily assignments, such as negotiations of the U.S./Russian Intergovernmental Consultative Committee on Fisheries, interagency meetings dealing with the Court of International Trade decision relating to Italian drift nets, interagency meetings relating to the International Whaling Commission, and others. This fellowship is a wonderful opportunity to gain exposure to various issue areas and the workings of Washington," he noted. "I would definitely recommend it to other students. It's an excellent experience!"

Marine Advisory Service: Reaching Out to You

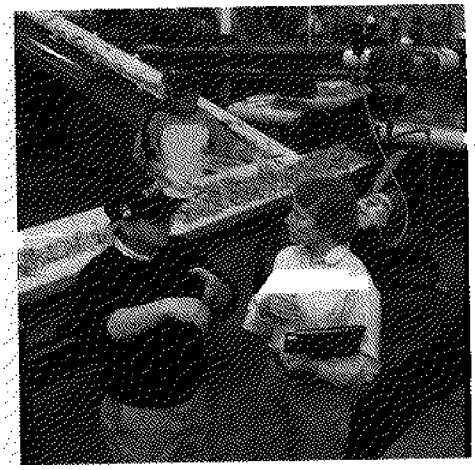
A typical day with the Sea Grant Marine Advisory Service (MAS) might take you to a classroom in Wilmington to teach eighth graders about marine careers to a tidal mud flat along Indian River Bay to check on the status of a clam reseeding project.

Based at the University of Delaware Graduate College of Marine Studies in Lewes, the six-member staff travels the state to deliver timely, objective information to a broad range of audiences, from teachers to business owners.



Bill Hall (left), MAS marine education specialist, demonstrates the Smithsonian's "Sink and Float" curriculum to elementary teachers.

Marine Education. Some people say Bill Hall (above) brings the ocean to the classroom. As MAS marine education specialist, one of his chief goals is to infuse aquatic science into the school curriculum by developing in-service and college-credit courses for several hundred middle school teachers every year. Last year, he helped coordinate "Operation Pathfinder," a U.S. Navy-funded training course in oceanography, which reached teachers from Massachusetts to Alabama. Besides helping to formulate the educational standards for Delaware's new science curriculum, Hall also develops publications on marine life that are popular with readers of all ages.



At Seawatch International in Milford, quality control director Robert Kee discusses the plant's clam processing techniques with MAS seafood technology specialist Doris Hicks.

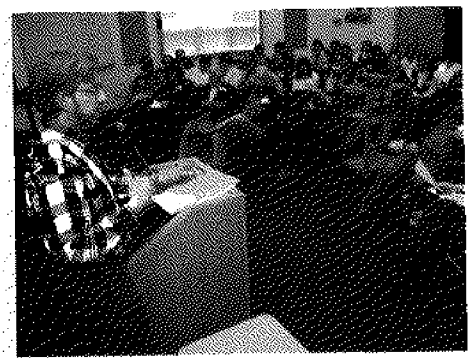
MAS aquaculture specialist John Ewart (right) leads a tour of a fish farming facility in Dover.

Seafood Technology. Doris Hicks (bottom left) has a busy schedule that takes her from pasteurization research in the lab (see page 7), to local schools and retail markets to present food service training programs, to her desk to draft the next installment of her "Seafood Advisor" column for the National Fisheries Institute's *Seafood Source* newsletter. Recently, she began working with University of Delaware Cooperative Extension, Maryland Sea Grant, and members of the seafood and poultry industry on a special project to educate entry-level food processing workers about safe food handling practices.

Aquaculture. John Ewart (above) provides technical assistance to fish farmers through personal consultations and workshops, the Delaware Aquaculture Resource Center at the university's Lewes campus, and the Internet. In recognition of his exemplary service to the public, Ewart was recently honored with the Mid-Atlantic Sea Grant Marine Advisory Service Award by his peers in the region. Current efforts range from a clam seeding project in the Inland Bays to development of a strong aquaculture extension network in the Northeast.

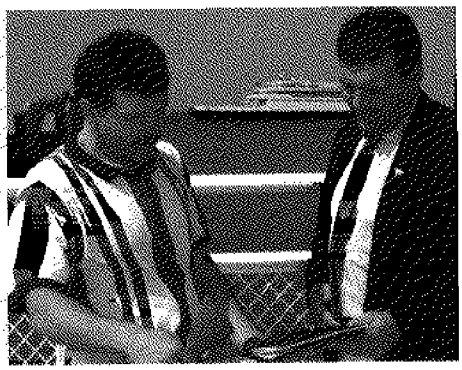
Marine Resource Management. Besides coordinating the Inland Bays Citizen Monitoring Program (page 4), Joe Farrell (below) is playing a lead role in meeting with local resource managers to assess their information needs on behalf of Sea Grant's new coastal ecosystem health project (page 3), which seeks to develop useful monitoring techniques for coastal resource managers. Recently, Farrell organized a forum on the horseshoe crab, which has been declining in local waters. The crab's eggs feed migratory shorebirds along the Atlantic flyway, while its blood contains a component that is used to test prescription drugs for dangerous bacteria.

Marine Recreation. Interest in Delaware's coastal wonders continues to grow among tourists. During the past year, Jim Falk, MAS marine recreation specialist (above right), helped organize the state's second ecotourism conference and co-authored the state's first ecotourism guidebook — *Delaware Eco-Discoveries* — produced by Atlantic Publications Inc. He also recently joined with colleagues from the Sussex County Convention and Tourism Commission and the Delaware Small Business Development Center to form the Southern Delaware Business Alliance to deliver educational programming to coastal businesses. During the next year, the alliance will present workshops on topics ranging from seasonal marketing to special events planning.



Joe Farrell (left), MAS marine resource management specialist, welcomes the 80 attendees to Sea Grant's recent forum to identify research priorities for the declining horseshoe crab.

Marine Biology and Program Management. Kent Price (far right), associate professor of marine biology-biochemistry at the University of Delaware Graduate College of Marine



MAS marine recreation specialist Jim Falk (left) meets with Larry Sharp, marketing director for the Cape May-Lewes Ferry, to discuss regional ecotourism marketing ideas.

Studies, directs the Sea Grant Marine Advisory Service and also conducts research in fisheries and pollution ecology, including a current project to determine the importance of seaweed as a habitat for fish. As chairman of the board of the Center for the Inland Bays, and director of the Inland Bays Scientific and Technical Advisory Committee, Price also is administering a $257,000 set of demonstration projects to promote nutrient pollution reduction, habitat restoration, and public education efforts to improve and protect the bays.

Communications: Opening the Gateway to Knowledge

Whether developing a model of the horseshoe crab to teach children about marine science, briefing a power company representative on the latest zebra mussel research, producing a video about marine careers for young adults, or using electronic mail to share information with an environmental reporter working on a story, the Marine Communications Office provides the vital link between the University of Delaware Sea Grant College Program and the public our program is committed to serving.

The goal of the five-member team is to educate citizens of all ages about marine and coastal resources and promote their wise use and conservation. The staff includes David Barczak, art director; Tracey Bryant, marine outreach coordinator; Elizabeth Chajes, marine outreach specialist; Pamela Donnelly, production manager; and Kimberly Doucette, administrative assistant.

Highlights of the past year include the following:

- The *Sea Grant Reporter* newsletter, which reaches more than 5,600 readers, received publications awards from the Society for Technical Communication and the International Association of Business Communications.
- *Sea Grant's Guide to Coastal Science Experts,* produced by Delaware Sea Grant on behalf of the National Sea Grant network, is helping to inform the media about the wealth of scientific expertise available in the nation's Sea Grant network. During the past year, Delaware Sea Grant scientists and staff have appeared on the Discovery Channel, in *Reader's Digest, Newsday, Business Week, Biotechnology Digest, The Scientist,* and other publications.
- The surf's up at Delaware Sea Grant's home page on the World Wide Web, as visitors continue to check out information about program research and outreach, our Coast Day festival, and Delaware sea facts. The site also includes an on-line version of our latest publications catalog. Visit us at http://www.udel.edu/cms/seagrant.html.

The University of Delaware Sea Grant College Program has long been involved in efforts to improve Rehoboth, Indian River and Little Assawoman bays — Delaware's Inland Bays. Here, Kent Price (right), Sea Grant Marine Advisory Service director and chairman of the board of the Center for the Inland Bays, reviews several publications with Bruce Richards, executive director of the non-profit center.

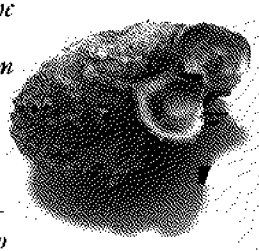
University of Delaware
Sea Grant College Program
Financial Report

July 1, 1995 – June 30, 1996

Program Area	State Funds	Federal & Other Matching
Marine Biotechnology	21,354	169,805
Coastal Processes/Engineering	44,027	160,507
Environmental Studies	46,539	206,472
Seafood Science/Technology	10,561	40,890
Policy Studies	20,368	99,073
Marine Outreach	231,295	599,793
Graduate Education	0	446,860
Program Management	13,356	185,013
Totals	**$387,500**	**$1,908,413**
Grand Total		**$2,295,913**

In addition to this funding, University of Delaware Sea Grant investigators successfully competed for several special grants from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, 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:

- *Marine policy professor Robert Knecht and applied ocean science professor Vic Klemas received a Special Enhancement award totaling $1,055,234 over the next three years to lead a novel interdisciplinary research and education project designed to provide resource managers with innovative new techniques for monitoring and improving vital waterways such as Delaware Bay.*
- *Marine biologist Patrick Gaffney received four awards totaling $165,069 from the Oyster Disease Research Program to conduct genetic research aimed at improving the resistance of Mid-Atlantic oysters to MSX and Dermo diseases.*



- *Botanists Jack Gallagher and Denise Seliskar began the second year of a $225,000 award from the Marine Biotechnology Program for "Transgenic Marine Plants: The Key to Exploiting Saline Land and Water Resources for Industrial and Food Products." Their goal is to transform the salt-marsh plant seashore mallow into a perennial grain plant that can thrive on saline agricultural land and produce protein, oil, and gum, which can be used for food and industrial purposes.*
- *Sea Grant director Carolyn Thoroughgood and Marine Advisory Service education specialist William Hall received $52,600 for "Project Pathfinder: An Introduction to Oceanography and Coastal Processes for Elementary and Middle School Teachers." This in-service course, conducted last summer, provided instruction in oceanography to teachers throughout the region, who are now infusing the science into their curricula, reaching thousands of students.*

University of Delaware
Sea Grant College Program
University of Delaware
Newark, DE 19716-3530

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