MARYLAND

Research, Education, Outreach *July-August 1997*

MARINE NOTES

SPOTLIGHT ON RESEARCH

In Harm's Way? The Threat of Toxic Algae

BY JACK GREER

Flying a small plane some 500 feet above the Chesapeake Bay, researcher Larry Harding can easily observe changes in color — from green, to brown to mahogany and even red. But Harding, a scientist at the University of Maryland Center for Environmental Science (UMCES), and his colleagues do not depend on the eye. They have on board highly sophisticated computerized "ocean color" instruments, that, when properly interpreted, can "read" chlorophyll levels and signal the location and density of phytoplankton blooms throughout the Bay.

In spring, much of that phytoplankton is comprised of diatoms — these minute plants use silica to form skeletons that, under the microscope, look like delicate geodesic domes or Roman amphitheaters. By mid-summer diatoms have largely given way to other forms of phytoplankton, including blue-green algae and dinoflagellates.

While diatoms float through Bay waters, dinoflagellates are generally more active. Using their flagella — slender whip-like tails — they propel themselves about, acting very much like animals, though half contain chloroplasts and perform photosynthesis like other algae. Actually neither plant nor animal but "protists," these tiny organisms cause blooms that we call "red tides."

JoAnn Burkholder

Red tides are not necessarily toxic, although at times even harmless species of algae can cause extensive fish kills by depleting the water of oxygen.

Dinoflagellates, along with diatoms and many other single-celled organisms, form part of the Chesapeake's normal cohort of microscopic life. In other parts of the world, however, dinoflagellates have for years attracted attention because a few — less than two percent of the known species — can contain very powerful biotoxins.

When Tides Turn Red

For many years people living in South Florida have seen dinoflagellate blooms come and go. They call them red tides because the dinoflagellates in question — such as *Gymnodinium breve* — have a reddish color due to photosynthetic pigments and appear to turn water the color of blood.

Red tides are not necessarily toxic, although at times even harmless species can cause fish kills by depleting the water of oxygen. Toxic forms have more dramatic effects — extensive fish kills in some cases, or even impacts on human health. Blooms of *Gymnodinium breve*, for example, can cause eye and throat irritation of shore-dwellers, when surf and wind combine to atomize the toxin and waft a noxious mist inland. Such was the case in coastal North Carolina in 1987, when an er-

Please turn page

Toxic Algae, continued

rant spiral off the Gulf Stream sent a bloom of toxic dinoflagellates toward Atlantic beaches.

But at least since 1991, North Carolina — and now Maryland — have been preoccupied with another dinoflagellate, not a typical red tide organism, but one with a remarkable ability to use its toxin to stun fish and feed on them. This dinoflagellate, *Pfiesteria piscicida*, is the only dinoflagellate known to use a toxin in precisely this way.

"Usually dinoflagellates produce toxins internally, what we call endotoxins," says Sea Grant Extension specialist Dan Terlizzi. "These can be released when the cells die and break up," he says, "but *Pfiesteria* employs an exotoxin, meaning that it emits the toxin as part of a direct attack on its prey."

Although *Pfiesteria* shares characteristics with many other dinoflagellates, it does not cause visible "red tides," and its attack strategy and multiple life stages tend to set it apart. According to research by JoAnn Burkholder and others at North Carolina State University, *Pfiesteria* assumes more than twenty different forms during its lifetime, including a difficult-to-detect cyst stage; an amoeboid stage; and a toxic vegetative stage, in which, propelled by its flagella, it can kill fish.

In North Carolina, *Pfiesteria* was implicated in the fish kill of some one million menhaden, and caused the closing of ten miles of river to fishing and swimming. Estimates are that fish kills with possible links to *Pfiesteria* have claimed a billion fish in that state so far.

Since last fall, when fish began showing lesions in the Pocomoke, dinoflagellates, especially* Pfiesteria, *came under suspicion.

Drawing on both Biblical language and the image of red tides, writer Rodney Barker has written a book about *Pfiesteria* entitled, *And the Waters Turned to Blood*. Early press about the book cast *Pfiesteria* as something of a plague, as "deadly as the Ebola virus" — exaggerated claims that caused widespread concern and seemed to have misled some into thinking that *Pfiesteria* is an infectious disease organism, like a bacterium or a virus.

Clearly, toxic dinoflagellates may have human health effects. In some areas outside the Bay — in the Pacific Northwest and Alaska, for example, and in Maine — dinoflagellates have caused diseases in humans such as paralytic shellfish poisoning. In tropical areas, ciguatera toxin from dinoflagellates accumulates in the flesh of fish and shellfish and can cause food poisoning. In North Carolina, researchers working with *Pfiesteria* in the laboratory reported neurological and other health problems, and watermen in Maryland's Pocomoke River area have reported fatigue, respiratory problems, weight loss and other ailments after working in waters where they caught fish with lesions.

Whether the ailments reported in the Pocomoke are related to *Pfiesteria*, *Pfiesteria*-like organisms, or to some other cause remains uncertain, but clearly something unusual is going on in that quiet Eastern Shore river.

Trouble on the Pocomoke

On August 6, waterman Eddie Johnson, along with Sheila Tanata, a fisheries biology student at the University of Maryland Eastern Shore, began to see large numbers of dead fish in the Pocomoke River. Soon estimates began to come in of thousands of dead menhaden, croaker, and other species, many — about a third, according to some reports — with lesions.

Once again *Pfiesteria* and its relatives became prime suspects.

Dinoflagellates, Protists and *Pfiesteria*

JoAnn Burkholder

To botanists, dinoflagellates are microscopic plants, algae that are also referred to as phytoplankton; to zoologists, they are protozoans, one of the simplest, most primitive animals. The difference in classification arises because half of the known species of dinoflagellates are photosynthetic — like plants they manufacture their own food. The other half are heterotrophic, meaning they must feed on other organisms for nourishment as animals do. Dinoflagellates are now classified in the kingdom Protista, which includes simple single-celled organisms that cannot be classified as either plants or animals.

Many of the photosynthetic species, says JoAnn Burkholder, can switch between plant-like and animal-like modes of nutrition. "*Pfiesteria*," she says, "is actually a little animal . . . thousands of these little creatures would fit on the head of a pin." So far, of the 24 stages have been identified, at least four stages have been shown to be toxic. However, for much of the year, says Burkholder, "its various forms are usually harmless members of the food chain that survive by eating bacteria, algae and small organisms."

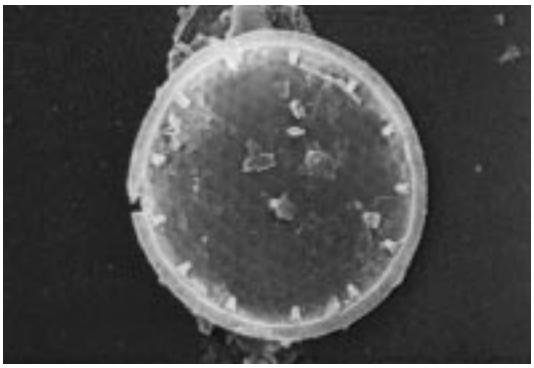
Since last fall, when fish began showing lesions in the Pocomoke, dinoflagellates, especially *Pfiesteria*, had come under suspicion. But there are many other reasons why fish suffer from lesions, and so state agencies have struggled to understand exactly what is happening in this low-lying tributary that runs along the Maryland-Virginia line.

With uncertainty and concern mounting as the summer progressed, Governor Parris Glendening called, just days before the fish kill, for an interagency team to meet near the Pocomoke to share information about fish lesions and their possible cause.

Donald Boesch, President of UMCES, was appointed to head a technical advisory committee that included experts in algae and dinoflagellates, water quality and fish diseases. JoAnn Burkholder, an authority on *Pfiesteria* from North Carolina State University and a member of the committee, attended the Pocomoke summit, along with representatives from the Maryland Department of Natural Resources, the Maryland Department of the Environment, the Maryland Department of Health and Mental Hygiene, the Maryland Department of Agriculture, The Academy of Natural Sciences, and the University System of Maryland. Other scientists from Maryland, Virginia, Delaware, and Florida joined the group.

According to Boesch, determining the nature of the problem will require careful monitoring coupled with experimental studies. Only by sampling over time, he says, will we be able to determine whether this is a "short-term" or a "long-term" problem.

The state is taking a close look at a number of possible causes of lesions and fish kills, including harmful chemicals, infections by bacteria and fungi, and other harmful microorganisms, including *Pfiesteria piscicida*. There is some thought that changes in runoff and water chemistry (including salinity) could play a role, especially since 1996 was one of the wettest years on record, followed by a very dry summer.



Dinoflagellates and diatoms, like the one pictured above, produce seasonal blooms in the Chesapeake Bay every year, most of them harmless.

The advisory committee discussed the importance of runoff, and though they determined that there is "no demonstrable cause and effect linkage," nonpoint inputs — such as nutrients and pesticides — should, they said, be a primary focus of study.

Prognosis for the Bay

Is the appearance of *Pfiesteria* the first sign that the Bay's luck has run out?

"Every year in Chesapeake Bay and its rivers, diatoms and dinoflagellates produce seasonal blooms," says Harold Marshall of Old Dominion University, "and in most cases they are harmless." But, he adds, "there is some evidence that concentrations of potential toxin producers now living in the Bay are increasing." Marshall, who has tracked phytoplankton in the Bay for the past three decades, says that this increase may be due to human impacts such as increased nutrients, or it may be due to changing environmental factors. Or both.

These changes, says Marshall, "may also enhance the development of newly observed and dangerous species," which, he says, have "the potential for expanding their distribution within the estuary."

For the past twelve years, Marshall has cooperated with others in the northern Bay, including Kevin Sellner and Richard Lacouture of the Academy of Natural Sciences Estuarine Research Center, to track phytoplankton blooms — their evaluation report is due out this fall.

"There is some evidence that concentrations of potential toxin producers now living in the Bay are increasing."

Marshall has identified nine dinoflagellates, as well as three diatoms, which are toxin producers in other parts of the world. Add another two dinoflagellates and one diatom from previous reports, and that adds up to fifteen known species that could produce toxic blooms in the Bay.

What is puzzling — and fortunate — is that so far none have apparently done so.

Says Marshall, "The enigma regarding many phytoplankton species is that not all of the potential toxin producers will produce toxins, or blooms in their respective habitats."

Why not? "Maybe," he says, "these species have not been exposed to the specific environmental conditions that would initiate their toxin production." Or, he suggests, perhaps these dinoflagellate populations found in the Bay represent non- or less virulent strains of toxin producing species.

Whatever the reason, in the Chesapeake Bay we have been extremely lucky. Despite the Bay's battle against nutrients and contaminants — made more difficult by continuing growth and development in the watershed — large dinoflagellate blooms in the estuary have remained non-toxic.

Marshall cites an example. During mid-summer to early fall in 1992, a bloom of the dinoflagellate *Cochlodinium heterolobatum* Silva spread from the mouth of the York River into the lower Chesapeake Bay and out the Bay's mouth. Nearshore currents carried the bloom toward North Carolina. At one point, Marshall reports, the bloom spread over 83 square miles of the central and western Chesapeake Bay.

Continued on page 4

Toxic Algae, continued

Previously, he says, blooms of this species were generally localized in the York River. Since 1992, this dinoflagellate has apparently expanded its range, and has become an annual bloom producer in several rivers of the Chesapeake, according to Marshall.

This same species has caused fish kills in culturing grounds in Japan and reduced calcium uptake and elevated oyster larvae mortality in lab studies in New York. Karen Steidinger, an expert on dinoflagellate blooms with the Florida Department of Environmental Protection, lists this species as a toxin producer, though it has not caused large fish kills in the Bay.

Other examples abound. Kevin Sellner and Mark Luckenbach, a scientist at the Virginia Institute of Marine Science, have noted that *Prorocentrum minimum*, a common Bay dinoflagellate, induces high mortalities in juvenile oysters in lab studies. Fortunately there has been no observation of any impact in the Bay.

Further, according to Gail Mackiernan, who was studying dinoflagellates at the time in Virginia, in 1967 a dense bloom of *Gonyaulax monilata* covered much of the southern Bay from just north of Mobjack Bay nearly to the mouth of the Bay. That dinoflagellate is a known toxin producer and is responsible for fish kills in both Florida and Texas. "The bloom persisted for more than a month," says Mackiernan, Assistant Director for Research at Maryland Sea Grant, "but in the Bay it had no apparent effect on fish."

As researchers continue to track composition trends of phytoplankton in the Bay, they will be keeping a close eye on dinoflagellates, including and especially *Pfiesteria*.

Harmful Algal Blooms on the Move

BY MERRILL LEFFLER

If toxic algae, or harmful algal blooms, as they are now referred to, are rare to the Chesapeake Bay, that is not the case for coastal regions nationwide and throughout the world.

Reports come in each year of thousands of floating dead fish from the Gulf of Maine, from the coast of Florida and from the Gulf of Mexico killed by toxic algae. Of 4,400 marine phytoplankton species, only 50 to 60 are toxin producers — a mere 1.3 percent, though the impact of these few species can be significant. The toxin producers can injure or damage fish, or they can be taken up by shellfish and then passed along to human consumers, potentially causing paralytic or diarrhetic shellfish poisoning.

The scientific consensus is that outbreaks of harmful algal blooms are escalating in frequency and extent. Just how much of that escalation is due to natural environmental change such as rising sea level, for example, and how much results from human activities, remains uncertain. Increasing nutrient runoff in most populated nearshore areas and the shifting of organisms from one ecosystem to another in the millions of gallons of ballast water ferried around the world by cargo ships could be important factors.

What is certain is that the effects of these blooms are significant. The economic impact of fish kills and closed beaches has been estimated at tens of millions of dollars over the last two decades. In addition, researchers worry about the ecological changes that can occur as concentrated neurotoxins work their way up the food chain. These economic and biological concerns have spurred legislators to establish a new federal program that will support long-term research aimed at unraveling the processes that foster such blooms.

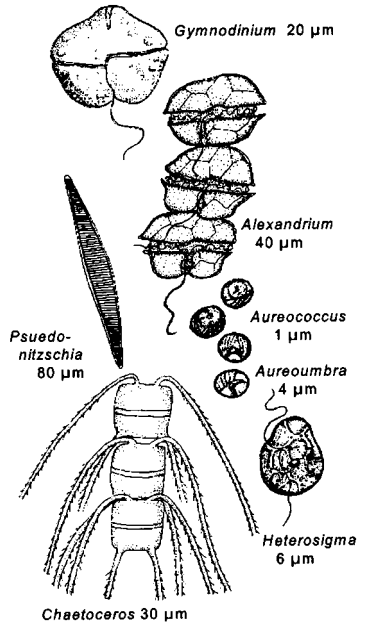
Economic and biological concerns have spurred legislators to establish a new federal program that will support long-term research aimed at unraveling the processes that foster such blooms.

That program — the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) — is a multi-agency undertaking and includes the National Science Foundation, the Environmental Protection Agency, the Office of Naval Research and the National Oceanic and Atmospheric Administration's Coastal Ocean Program, which is taking the lead in this effort.

The goal, says Kevin Sellner, is to develop a much better understanding of how biological and physical processes interact to promote algal blooms. Sellner, a scientist at the Academy of Natural Sciences Estuarine Research Center in St. Leonard, Maryland, is on a two-year assignment at NOAA's Coastal Ocean Program, where he is heading up ECOHAB. In the long run, he says, we need to better predict their occurrence if there is to be any chance of taking actions that can reduce their impact.

The extent of concern over harmful algal blooms can be gauged from a web site overseen by the National Office for Marine Biotoxins and Harmful Algal Blooms (http://www.redtide.whoi.edu/hab/) that has links to regional research programs and

Some Culprits



The organisms above are some of those responsible for harmful algal blooms in U.S. coastal waters. The drawings and the information below are from *Harmful Algal Blooms in Coastal Waters* produced by the NOAA Coastal Ocean Program.

- *Gymnodinium breve*, a dinoflagellate, produces neurotoxic shellfish poisoning along the coasts of the Gulf of Mexico and, rarely, the southeast Atlantic coast.
- Various species of the dinoflagellate genus *Alexandrium* are responsible for paralytic shellfish poisoning in New England, northern California, the Pacific Northwest and Alaska.
- *Aureococcus anaphagefferens*, a small golden brown algae, is responsible for brown tide blooms in southern New England, particularly Long Island, and in New York and Texas. *Aureoumbra lagunensis*, a similar species, causes blooms in Texas bays and lagoons.
- Blooms of various species of the diatom genus *Pseudo-nitzschia* produce domoic acid that causes amnesic shellfish poisoning on the northwest, east and Gulf coasts.
- The raphidophyte flagellate *Heterosigma akashiwo* and a few species of the diatom genus *Chaetoceros* cause catastrophic losses of cultured and wild fish, particularly in the Pacific Northwest.

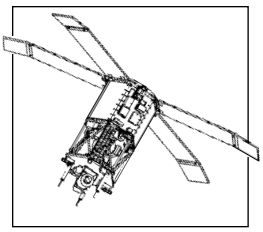
regularly updates reports of toxic red tides in coastal areas. The office's Director, Donald M. Anderson of the Woods Hole Oceanographic Institution, is one of the country's leading authorities on algal blooms. Together with Sylvia Galloway and Jeanne Joseph, he authored *Marine Biotoxins and Harmful Algae*, a national plan that set out the priorities for understanding the causes and behavior of harmful blooms.

This document concludes that the United States research, monitoring and regulatory infrastructure is not adequately prepared to meet this threat. The panel recommends a more proactive approach on the part of agencies. (Fish kill responses, for example, are often too late to identify causative organisms, and often the appropriate tests are not conducted.) The plan recommends development of expertise and tools (including molecular probes) to facilitate sampling for toxic species and the presence of biotoxins, and the use of computer technologies to communicate the information quickly to users and the research community.

Most recently, Donald Boesch, President of the University of Maryland Center for Environmental Science, chaired a scientific committee that, as a complement to the research plan, examined the management options for controlling harmful blooms. Those options are limited, given the extent of our understanding of how physical and biological processes interact to regulate the extent of such blooms. The committee's report, *Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control and Mitigation*,* acknowledges that while there is a compelling link between increasing algal blooms and overenrichment of coastal waters, it has not been unequivocally identified as the cause of any harmful algal blooms considered in its assessment. Still, says the report, the goal of reducing excess nutrients "could well yield positive results in terms of reductions in some harmful algal blooms."

** To order a copy, contact the NOAA Coastal Ocean Office by phone, (301) 713-3338, or fax, (301) 713-4044*

SeaWiFS Launch Successful



Friday afternoon, August 1, just after 4:20 pm EDT, the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), a new ocean color sensor, was successfully launched on a Pegasus XL rocket. The long-awaited launch of SeaWiFS will give global ocean color data for recovering information on phytoplankton abundance and primary productivity for the first time in over a decade. The launch, shown on closed circuit television at Goddard Space Flight Center, went off without a hitch. When the Pegasus XL dropped from beneath an L-1011 at 38,000 feet, it fired — all three stages — and SeaWiFS is now in low earth orbit at approximately 300 km.

In the next few weeks, it will be carefully raised to its operational orbit of 705 km. Tests of the instrument will then commence and, if everything goes well, within 6 to 8 weeks data will be processed. Larry Harding and other scientists have been flying aircraft instruments over the Chesapeake Bay for some years — the Ocean Data Acquisition System (ODAS) since 1989 and the SeaWiFS Aircraft Simulator (SAS II, now SAS III) since 1995. They hope to continue flying these instruments for several years, "under" SeaWiFS, to compare radiances measured in "low orbit" (500 ft.) to those from SeaWiFS and to use these data to follow phytoplankton dynamics in the Bay. It's an exciting time for the oceanographic community, says Harding.

For more information about SeaWiFS, visit the home page that Gene Feldman of Goddard is keeping current. The address on the web is: http://seawifs.gsfc.nasa.gov/SEAWIFS.html. Bay data are also bookmarked there and updates will be available over the next month.

Mackiernan Retires

Gail Mackiernan, Assistant Director for Research at the Maryland Sea Grant College, will retire in September. Since 1986, she has directed a research program that supports an array of projects in fisheries and aquaculture, ecosystem processes, new technologies, and policy-related issues. She has also managed Maryland Sea Grant's participation in large regional and national research initiatives, among them, oyster disease, dissolved oxygen dynamics, toxics and marine biotechnology.

In addition to directing research, Mackiernan has overseen Sea Grant's Traineeship program, which supports graduate student research on Sea Grant-funded projects, and for nine years has served as principal investigator for the Research Experiences for Undergraduates (REU) fellowship program. The REU program, supported by the National Science Foundation, gives 12 undergraduate students each summer an opportunity to work with a mentor-scientist on a specific research project. Maryland Sea Grant is the only Sea Grant College in the nation which serves as an REU site.

"After all these years, it will seem strange not to be talking with scientists nearly every day," says Mackiernan. "That, and my friends at Sea Grant and at the research institutions, will be what I'll miss the most." She and her husband Barry, who is taking an early retirement due to a merger at his bank, are both serious bird watchers and in October, they will inaugurate "this next phase of our life" with a three-week trip to Bolivia. She looks forward to resuming more regularly other things that she has been doing far longer than science — showing dogs, fly fishing, and painting.

Says Chris D'Elia, Director of Maryland Sea Grant, "We say farewell to Gail reluctantly, but with best wishes — we will miss her keen insights, broad appreciation and understanding of science and, most of all, her quick wit."

The Accidental Invasion of America: *Alien Ocean*

Green crabs from the Baltic Sea, zebra Mussels from the Black Sea, seagrasses from Japan, clams from Korea — dozens of alien species are infiltrating hundreds of American harbors, rivers, lakes and estuaries.

And now they are starring in *Alien Ocean*, a new half-hour documentary from Maryland Sea Grant that examines the growing threat posed by invasive species. The National Aquarium in Baltimore hosted a premiere of the video on July 8, which was attended by scientists, policy makers and environmentalists from the Chesapeake Bay region.

Executive Director of the Chesapeake Bay Commission Ann Swanson, writer/producer Michael W. Fincham and Bay pilot Randy Bourgeois at the premiere of Alien Ocean. *Swanson and Bourgeois were featured in the documentary.*

Alien Ocean summarizes the history of recent invasions and illustrates the havoc they are causing across America in the tidewater coves of New England, the Great Lakes of the Midwest and in estuaries like San Francisco Bay and Chesapeake Bay. Storytellers for the video include coastal fishermen who are struggling to eradicate green crab invaders and scientists who are pioneering a new field called "invasion ecology."

According to the fishermen and the scientists, all these aliens are altering the ecology of our coastal and Great Lakes ecosystems. "Invasions are part of the game of ecological roulette that we play with nature, " explains James Carlton, an invasion biologist from Williams College. "And because it is roulette, the outcome is almost always unpredictable — and we are far more often the losers."

In Chesapeake Bay, the lead scientist is Greg Ruiz from the Smithsonian Environmental Research Center. Working with Sea Grant funding, Ruiz has been sending researchers onto cargo ships and military ships to sample ballast water in search of invasive organisms. To date, they have identified over 100 alien species in Chesapeake Bay. Their work led agencies like the Chesapeake Bay Commission to ask Congress for new legislation to protect American coastal waters.

Alien Ocean was written and edited by Michael W. Fincham, produced with Jack Greer and Dan Terlizzi, and photographed by Mac Nelson and Michael W. Fincham. Funding came from NOAA, Maryland Sea Grant and the EPA Chesapeake Bay Program. Copies are now available for $24.95; to order, call Maryland Sea Grant at (301) 405-6376.

End Notes

■ Technology Funds Available

Leonard, Inc., a company that develops, designs, manufactures and distributes yacht sails and related services is working with University researchers to improve the company's capabilities in sail design and manufacture. With the aid of Jewel Barlow, director of the Glenn L. Martin Wind Tunnel, and other researchers they are developing a testing rig and methodology to determine sail performance over a range of wind angles for numerous sail designs. Testing and observation will be done during the course of the 1997-98 Whitbread Round-the-World Race. The company will supply about 30 percent of the competition's participants.

The project with Leonard, Inc. is funded by the Maryland Industrial Partnerships program (MIPS), part of the Engineering Research Center at the University of Maryland, College Park. It is one of numerous projects funded twice yearly by MIPS, which promote interaction between the university and industry. Since 1987 MIPS has supported projects with over 200 companies. The program provides academic expertise to help Maryland companies develop products and improve processes, leading to economic development in the state.

Projects are selected based on technical merit and economic soundness and can qualify for research support for as much as $70,000. The fall application submission deadline is October 15th. For more information, call (301) 405-3891.

■ Job Opening: Assistant Director for Research

The Maryland Sea Grant College is currently seeking applicants for the position of Assistant Director for Research. The individual in this position will lead Maryland Sea Grant's research program. Duties will include developing requests for proposals; conducting peer reviews; recommending proposals for funding; monitoring progress and results of funded projects; preparing technical and administrative reports and proposals; coordinating program development awards; supervising support staff that process proposals, reviews, grants and subcontracts; and supports related educational and outreach functions.

Candidates should have an advanced degree in the marine sciences or a related field, preferably an earned doctorate. Other qualifications should include demonstrated capabilities in management of multidisciplinary academic programs, grants management practices and several years experience in research or research administration. Superior oral and written communications and interpersonal skills are essential.

To apply, send a detailed letter of application, resume and names, addresses and telephone numbers of at least three professional references by September 19, 1997 to: Susan J. Leet, Director, Search Committee, Maryland Sea Grant College, 0112 Skinner Hall, College Park, Maryland 20742. For more information on the Maryland Sea Grant Program, visit the web: http://www.mdsg.umd.edu/MDSG/index.html. The University System of Maryland is an equal opportunity/affirmative action employer. Women, minorities, veterans, and candidates with disabilities are encouraged to apply.

■ Bringing Back Estuaries

Restore America's Estuaries is an alliance of eleven regional nonprofit organizations working to protect and restore the threatened habitats of estuaries. Tens of thousands of acres of coastal wetlands, shellfish beds, beaches, and sea grasses are degraded or destroyed every year. RAE's mission is to stop estuary habitat loss and to actually increase, through restoration, one million estuarine acres nationwide by 2010.

For more information on the alliance's efforts, contact: Restore America's Estuaries, 1200 New York Avenue, NW, Washington DC 20005, phone: (202) 289-2380, fax: (202) 842-4932, e-mail: restore @estuarine.org or http://www.estuaries.org.

■ Kudos

The 29 Sea Grant colleges in the country's coastal and Great Lakes states produce innovative materials in their extensive outreach and education programs — these include books, magazines, newsletters, fact sheets, radio programs and videos.

To recognize the high quality of these materials at the bi-annual Sea Grant meeting, held this year in Madison, Wisconsin, each program was invited to submit two products for a national competition. Blue Ribbon awards included:

South Carolina Sea Grant for its quarterly newsletter, *Coastal Heritage*

North Carolina Sea Grant for its quarterly magazine, *Coast Watch*

Ohio Sea Grant for "Treasure Trunk," a luggage of print and multimedia materials on zebra mussels that educators throughout the country are using in K-12 classrooms for science and environmental teaching.

Maryland Sea Grant for *The Eastern Oyster*, a comprehensive examination of the biology of *Crassostrea virginica* and *Alien Ocean*, the new 30-minute video on how non-indigenous species transported in the ballast water of international vessels threaten the ecosystems of rivers, lakes and estuaries.

To find out more about what Sea Grant programs can offer to scientists, resource managers, teachers and citizens, visit the National Sea Grant website which has links to regional and state programs: http://www.mdsg.umd.edu/NSGO/index.html.

Calendar

September 10 — Videoconference on Zebra Mussels

National Satellite Videoconference on "Zebra Mussels: Lessons Learned in the Great Lakes Region." This two-hour videoconference will consist of video segments, case study examples, expert panel discussions and opportunities for participants to interact via phone, fax and e-mail. To locate a site where you can attend and participate, call (800) 319-2432 or access a list of registered downlink sites at http://www.aes.purdue.edu/acs/zm/regis.html.

September 11 — Open House

Baltimore, Maryland. Open House for the Certificate Program in Environmental Studies, 6:30-8:30 pm. To RSVP, or for more information, call (410) 516-4842.

October 12-16 — Estuarine Conference

Providence, Rhode Island, Estuarine Research Federation 14th International Conference. The theme of this year's conference will be "The State of Our Estuaries." For more information, contact the Estuarine Research Federation at (410) 586-0997 or visit the ERF website at http://www.cbl.cees.edu/erf/.

Marine Notes on the Web

An electronic version of this issue, as well as back issues, is available on the World Wide Web at: **http://www.mdsg.umd.edu/MDSG/Communications/Marine Notes/index.html**

Maryland Marine Notes

Volume 15, Number 4
July-August 1997

Maryland Marine Notes is published six times a year by the Maryland Sea Grant College for and about the marine research, education and outreach community around the state.

This newsletter is produced and funded by the Maryland Sea Grant College Program, which receives support from the National Oceanic and Atmospheric Administration. Managing Editor, Sandy Rodgers; Contributing Editors, Jack Greer and Merrill Leffler. Send items for the newsletter to:

Maryland Marine Notes
Maryland Sea Grant College
0112 Skinner Hall
University of Maryland
College Park, Maryland 20742
(301) 405-6376, fax (301) 314-9581
e-mail: mdsg@mbimail.umd.edu

For more information about Maryland Sea Grant, visit our web site:
http://www.mdsg.umd.edu/MDSG/

Recycled Paper

PRINTED WITH SOY INK

Maryland Sea Grant College
0112 Skinner Hall
University of Maryland
College Park, Maryland 20742

Forward Postage Guaranteed
Address Correction Requested

Non-Profit Org.
U.S.Postage
PAID
Permit No. 10
College Park, MD