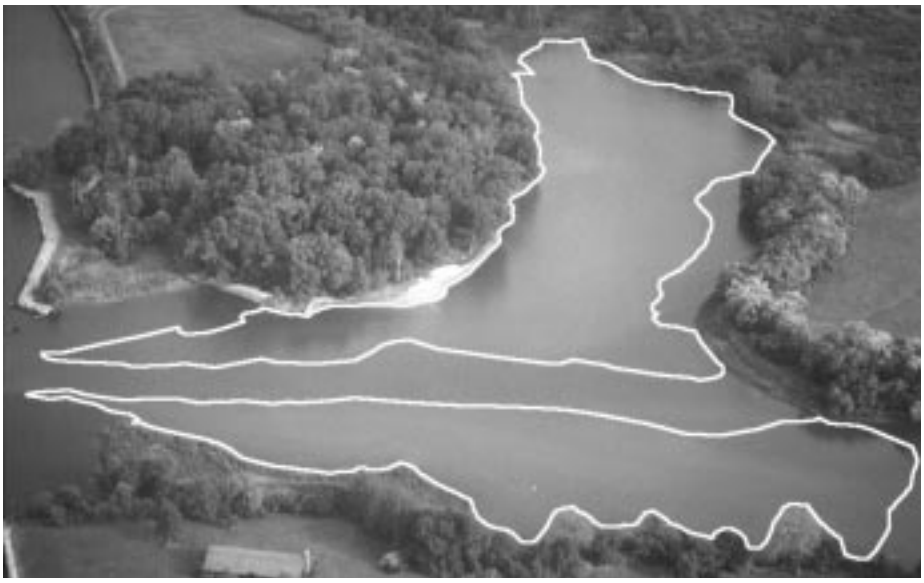
MARYLAND
MARINE NOTES

SPOTLIGHT ON RESEARCH

Uncommon Blooms: The Nitrogen Factor

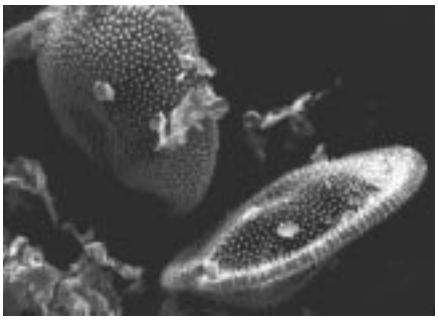
BY MERRILL LEFFLER



Jason Adolf

For almost three weeks this May, the surface of the Choptank River was running visibly red, for about 10 miles from Cambridge downstream to its mouth. "It was the largest bloom in anyone's memory," says Pat Glibert, a professor at the University of Maryland Center for Environmental Science (UMCES) Horn Point Laboratory. And even more surprising, it consisted of a single species of dinoflagellate, *Prorocentrum minimum*.

"*Prorocentrum* typically blooms at this time of year," says Glibert, "but it's usually isolated in coves here and there. We just haven't seen anything of this magnitude in the river." In the mainstem of the Bay, on the other hand, blooms covering as much as 30 miles have been observed over the years.



Maria A. Faust

An aerial photograph of the Choptank River (top) shows this May's large bloom of Prorocentrum minimum *(pictured in the lower photograph). Bloom areas are outlined in white.*

Nor was the Choptank the only host: the same dinoflagellate showed up in the Tred Avon and Miles rivers, and, there is some evidence says Glibert, in the Pocomoke.

The bloom seems to have gotten underway when the sun finally emerged after several days of rain that probably introduced heavy loads of nutrients from the land, according to Glibert.

But nitrogen and phosphorus loading, warming temperatures and sunlight — prime conditions for algae in general — don't account for *Prorocentrum* in particular, nor can it explain why there wasn't another species or a mixed group.

Large outbreaks of *Prorocentrum* are of some concern: while there are no reports of it being toxic to shellfish or humans in the Chesapeake Bay system, there have been such reports in other coastal waters. To ensure that it is not toxic, Glibert is having water samples from the Choptank evaluated.

Whether or not this bloom serves as a warning signal for potential outbreaks of harmful algal blooms in the Bay is open to question, but "one of the situations we face in the United States," says Donald Anderson, "is that we have more toxic algae, more toxic outbreaks, more areas affected, more economic costs, and more impacts on resources."

A scientist at the Woods Hole Oceanographic Institution, Anderson has been studying harmful algal blooms for years. Everything is growing better because of nutrient pollution running into our coastal waters,

Please turn page

Blooms, continued

he says. "It is like fertilizing your lawn, but just as you get more grass, you also get more dandelions and more crab grass."

But why more harmful algal blooms? Glibert, together with other scientists — Sybil Seitzinger at Rutgers and Deborah Bronk at the University of Georgia — has strong suspicions that explanations are to be found in the kind of nitrogen present in the water.

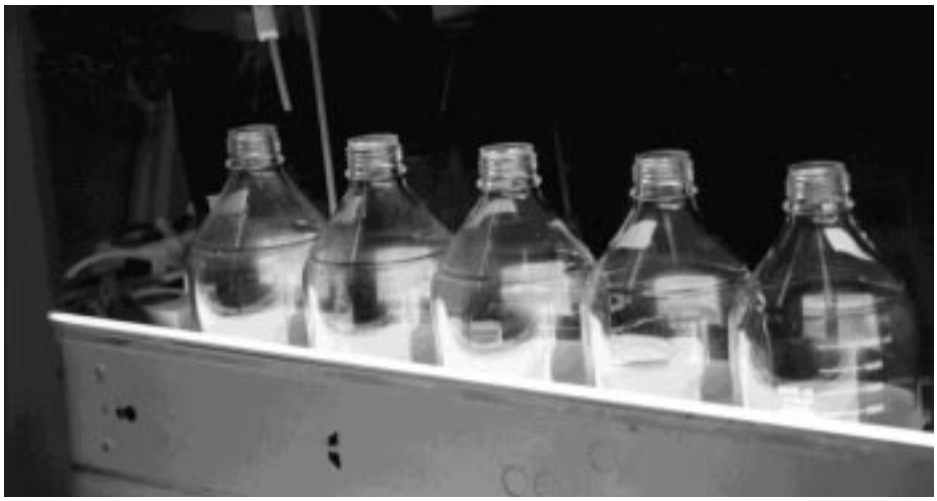
By way of analogy, Glibert says, "when you use fertilizers in your garden, you use different formulations of phosphorus, nitrogen and other compounds, depending on whether you're growing grass, tomatoes or roses. While we have a good understanding of how these combinations affect gardens," she adds, "we have very limited knowledge about what we're selecting for in coastal waters like the Chesapeake. That's because there are different forms of nitrogen entering the Bay, and we don't understand their dynamic relationships with algal species."

Nitrogen in the Bay

The issue is not an academic one — in the long run, understanding how different forms of nitrogen are related to the growth of particular algal species could be critical if we are to successfully restore the Bay's degraded water quality and sustain the production of fish and shellfish.

Nutrient control, after all, has been the keystone goal of the Chesapeake Bay Program since 1987 — a 40-percent reduction is the mantra. According to Bay researchers and their increasingly sophisticated computer modeling, a 40-percent reduction from 1985 levels is the minimum necessary to keep oxygen levels in large stretches of the Bay from bottoming out at or near zero, to bring back underwater grasses, and to revive benthic habitats in the deeper waters.

While there has been measurable success in reducing the loading of total nitrogen and phosphorus compounds to the Bay over this last decade, from point sources such as waste treatment plants especially, there has been less success in stemming flow from diffuse sources such as agricultural and urban runoff. Glibert and her colleagues Seitzinger and Bronk have been speculating that the form of nitrogen in that runoff could have important consequences: different compounds of nitrogen — along with other available nutrients, temperature, salinity, light, oxygen concentrations and compounds such as metals — can determine which species of algae will grow.



Jason Adolf

In this experimental set-up, water samples taken from the Choptank River contain Prorocentrum minimum *in cell concentrations of 100,000 per milliliter, compared to normal Bay concentrations of 100 cells per milliliter.*

Everything is growing better because of nutrient pollution running into our coastal waters.

A dominant nitrogen compound that comes off the land in fertilizer and stormwater runoff and in treated sewage discharges is nitrate, an inorganic form (inorganic because it lacks a carbon molecule). Nitrate is a natural product of microbial processes, part of the complex nitrogen cycle that first oxidizes ammonia to nitrite and then from nitrite to nitrate. Nitrate is also manufactured chemically for use in fertilizers. We know that algae readily take up nitrate, says Glibert. "We can measure it easily and we have a good deal of understanding about the dynamics."

Though researchers have been studying the uptake of dissolved organic nitrogen by algae for some years, that understanding is still limited, in part because it is more complicated to measure, says Glibert.

Organic nitrogen compounds — they include urea, amino acids and other complex molecules — can make up a large percentage of the total nitrogen arriving in coastal waters. Urea, for instance, is frequently used in lawn fertilizers, golf courses, and as a de-icer on roads and airport runways; there are also indicators that farmers are replacing nitrates with urea as fertilizer for some crops because of its slow release properties.

Seitzinger estimates that stormwater runoff may be composed of 30 to 60 percent organic nitrogen. For sewage treatment plants, the numbers range from 15 to 60 percent. In confined animal areas, organic nitrogen could comprise 60 to 90 percent of total nitrogen, and rain falling from the sky may have 30 to 70 percent of nitrogen in an organic form.

Algae and Nitrogen

Unlike their uptake of inorganic nitrate, many algae do not take up organic nitrogen directly — it first has to be recycled into inorganic forms by bacteria and other microbes. But

according to Glibert, there are algae that do take up organic nitrogen compounds directly. In some instances, these algae may even compete with bacteria for the same compounds. If, for example, inorganic nitrogen such as nitrate is all used up in a particular part of the Bay, then those algal species that are better at taking up organic nitrogen (such as urea) directly could outcompete algal species that cannot, species that have to wait for microbial cycling to supply nitrogen in inorganic forms.

In a study of a golden-brown alga (the chrysophyte *Aureococcus anophagefferens* which has caused massive brown discolorations in coastal waters in the northeastern U.S.), Glibert found that it had a higher affinity for organic nitrogen than inorganic nitrogen. This algal species was able to absorb organic nitrogen through biochemical processes on the surface of its cell, which implies that it could outcompete algal species which lack that capability, as well as bacteria.

It is such reasoning that has led Glibert, Seitzinger and Bronk to hypothesize that an increase in the ratio of dissolved organic to inorganic nitrogen is favoring algal species that are particularly adept at using organic forms.

While organic nitrogen in the form of urea can run off the land directly, it — like inorganic nitrogen — is also the product of microbial recycling. How much urea, for instance, is coming off the land and how much is being recycled? That is an important question, says Robert Magnien of the Maryland Department of Natural Resources. Before answering it, he says, we have to find out how much organic nitrogen is in the ecosystem, what percentage Bay algae use, and how this form of nitrogen influences the development of different kinds of algal species.

"Once you measure the dissolved organic nitrogen, can you ask where it comes from? That's a complex question," Magnien says, "a tough one." If organic forms such as urea are found to be important in controlling the dynamics of algal or bacterial communities, then identifying specific sources becomes very important. "If there's some direct runoff stimulating harmful algae, that might point us to a more refined management approach than just trying to reduce total nitrogen. We might be more concerned," Magnien says, "with a particular fraction of the nutrients."

First, says Magnien, we have to find out if the different forms of nitrogen make a difference, and then we have to track them.

New techniques that Glibert has had a hand in developing have made it possible to better measure the uptake of organic nitrogen. In experiments over the last couple of years, she and Bronk have found that uptake of organic nitrogen by algae was as great as and, she says, "on occasion greater than" uptake of inorganic forms (of nitrate and ammonium). One implication is that increases of organic nitrogen, relative to inorganic, correlate with the outbreak of some algal bloom species that are identified as harmful.

Different compounds of nitrogen can determine which species of algae will grow.

Aquaculture: Nitrogen in a Microcosm

While reports of harmful algal blooms in coastal waters around the world have been increasing, reports are also coming in regularly of fish kills from such blooms in aquaculture ponds. In fact, aquaculture operations — where nutrients, algae and fish are held in high concentrations — serve as microcosms of the natural world for researchers like Sea Grant Extension specialist Dan Terlizzi, who is studying algal dynamics in fish ponds.

Even algal species that do not release toxins can lead to problems if blooms are dense enough, says Terlizzi. He points to *Chaetoceros*, a widely distributed group of diatoms common in the Chesapeake and known for having long spines, adding that it "can injure the gills of fish at high bloom densities."

In 1996, aquaculturist Tony Mazzacarro lost about 20,000 hybrid striped bass in his ponds at HyRock Fish Farm in Somerset County on the Eastern Shore; in 1997, he lost 8,000. The deaths were initially attributed to *Pfiesteria piscicida*, the dinoflagellate that has become a household word in the Chesapeake Bay region after fish kills and reports of human impacts from toxins released by *Pfiesteria*. But according to Terlizzi, other algal species were also found in water samples taken from the HyRock ponds, among them *Gymnodinium estuariale* (recently identified as *Gyrodinium galatheanum*), a dinoflagel-

Continued on page 4

Merrill Leffler

Scientists at the UMCES Horn Point Laboratory are rearing striped bass in ponds that simulate commercial aquaculture operations to study the varying effects of environmental conditions on growth.

Blooms, continued

late which has been implicated in fish kills in other areas, though not previously in the Chesapeake region.

Terlizzi has teamed up with Glibert to monitor the chemical composition of the ponds. One striking finding, Glibert says, is that whenever there was a bloom of harmful dinoflagellate species, the concentration of organic nitrogen compounds was elevated. "Is this cause and effect?" she asks. "Or is it a coincidence? What is leading to what?"

Could high levels of dissolved organics serve as an early warning sign for potential algal blooms? This is precisely what Terlizzi and Glibert are trying to determine.

An early warning could be critical for fish farmers. There are some actions, limited as they may be, that growers like Mazzacarro can take to mitigate the impacts of harmful algae, especially applications of the compound permanganate. (Though copper sulfate is routinely used in freshwater ponds, its use in HyRock's saltwater ponds led to fish deaths.) Permanganate is a strong oxidizer, says Terlizzi, and has been effective in treating dinoflagellate blooms. But as Mazzacarro says, permanganate is expensive and temporary — once dinoflagellates appear in a pond, they could reappear within several weeks of a permanganate treatment.

Good water quality is a major concern to Mazzacarro — it is critical for the production of algae that in the early stages of fish growth supports the food web they need to grow; but too dense a growth can lead to the deterioration of water quality and consequent stress, if not death.

The same can be said of the Chesapeake Bay, a 200-mile-long ecosystem far too large to treat with chemicals. In the Bay, resource managers will need to control inputs of nutrients to hold down unwanted algal blooms. To do this effectively, Glibert and others suggest, they will need to understand more completely the different effects of organic and inorganic nitrogen — and to trace and control their sources accordingly.

Algal Growth: The Role of Metals

Maria A. Faust

All algae are not alike. There are thousands of species — while most are beneficial to the ecosystem, some can have toxic impacts. Particular algal species shift in dominance from one season to another depending on a number of factors. Primary among them are the relative proportions of nitrogen, phosphorus and silica that are available in the water and their interaction with a host of environmental factors, for instance, temperature, salinity and light.

As Pat Glibert has pointed out (see "Uncommon Blooms," page one), the form of available nitrogen can influence which algal species will succeed; also important to success, says James Sanders, are the concentrations of trace metals. Metals like mercury, arsenic, copper, selenium — while natural constituents of estuarine waters — can become contaminants if human activities lead to higher than normal concentrations.

For some years, Sanders and his colleagues at the Academy of Natural Sciences Estuarine Research Center (ANSERC) in St. Leonard, Maryland, have been studying the complex effects of elevated levels of contaminants. While contaminant levels of arsenic, for example, may be toxic to one species of algae, another may be able to tolerate those concentrations and grow well.

In early experiments, algae in mesocosms (large experimental tanks) immersed in the Patuxent River were dosed with metals and compared with algae in mesocosms that were left alone. In general, says Sanders, while growth and biomass in the dosed and undosed mesocosms did not change, species that were normally dominant were often replaced by algal species that were resistant to the higher loads. And those algal species, he says, tend to be smaller. (Whether coincidental with Glibert's hypothesis that organic nitrogen may favor smaller, potentially harmful, algae is an open question.)

While these studies added to an appreciation of how contaminants may influence the kind of algae that succeed or fail, they did not necessarily simulate the real world of aquatic ecosystems where neither nutrients nor contaminants are constant. To do this, ANSERC scientists took on an ambitious long-term project (supported by NOAA's Coastal Ocean Program) that aims to assess the interactive effects of multiple stressors simultaneously — nutrients and contaminants — and explore the implications of such effects on species further up the food chain.

So far, says ANSERC researcher Gerhardt Riedel, experiments have shown that nutrient loading is the dominant effect on algal growth and species. "Plants need nutrients, and all other things being equal, they will use up all available nutrients." The effects of elevated levels of contaminants are much more subtle, he says. "If you add a toxic element, you inhibit growth of a few species, so that what you do at low concentrations is knock out a few sensitive species. If the species is not dominant, you won't see it at all. If it is important, then you will."

One such dominant species in the Patuxent River is *Rhizosolenia fragilissima*, a large diatom that is sensitive to copper and arsenic. When you add these metals, says Riedel, "you selectively inhibit its growth." But the explanations of just why may depend, once more, on the availability of particular nutrients. The chemical form of arsenic is arsenate, a chemical analogue of phosphate — if phosphate is low, the diatom will take up arsenate which is toxic to it. Toxicity, then, may depend on phosphate concentrations. In general, says Riedel, experimental results so far indicate that the effects of contaminants on algae may vary considerably, depending on the concentrations of metals but especially on the availability of nitrogen and phosphorus.

The bottom line is that the Bay is overenriched with nutrients — if the influence of metal concentrations on the growth of potentially harmful algae is to be minimized, it will depend on major cutbacks of the nitrogen and phosphorus loads that flow into the Chesapeake system.

Knauss Fellowships


Skip Brown

The Knauss Marine Policy Fellowship Program, begun in 1979 and coordinated by NOAA's National Sea Grant Office, provides graduate students across the nation with an opportunity to spend a year working with policy and science experts in Washington. Over the years, fellows have worked in the legislative and executive branches of the federal government in locations such as the offices of U.S. Senators and Representatives, on Congressional subcommittees and at agencies such as the National Science Foundation and NOAA. Fellowships run from February 1 to January 31, and pay a stipend of $30,000. Applications are currently sought for 1999 fellowships.

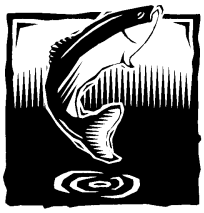
Any student who is enrolled as of September 30, 1998 in a graduate or professional degree program in a marine science and policy field at an accredited institution of higher education may apply through the director of his or her state Sea Grant program. Applicants must send a letter (two-page limit) outlining their education and career goals, a resume, two references (including one from their major professor) and official undergraduate and graduate transcripts by September 1, 1998. To apply, students and residents of the state of Maryland should contact Susan Leet, Maryland Sea Grant College, 0112 Skinner Hall, College Park, Maryland 20742; phone (301) 405-6375; e-mail, leet@umbi.umd. edu.

Hughes Receives Truitt Award

The Truitt Award was presented to former Maryland Governor Harry R. Hughes at a gala event in Annapolis on May 20. Numerous speakers praised Hughes' leadership in forming the state's Chesapeake Bay program, including Louis Goldstein, State Comptroller; Charles "Mac" Mathias, former U.S. Senator; Bernard Fowler, former State Senator; William Eichbaum, former head of the Office of Environmental Programs; John Griffin, Secretary of Natural Resources; Donald Langenberg, Chancellor of the University System of Maryland; and Donald Boesch, President of the University of Maryland Center for Environmental Science (UMCES) and host for the event.

The Truitt Award is named for Reginald V. Truitt, the marine researcher who founded the Chesapeake Biological Laboratory, now part of UMCES, in 1925. For nearly three quarters of a century CBL has undertaken research on the Chesapeake Bay from its vantage point at Solomons Island, at the mouth of the Patuxent River. The Truitt Award was established to recognize leaders who have made a major contribution to the joining of science and policy and to the restoration of the Chesapeake Bay.

Sea Grant Web Site Wins Award



For the third straight year, Wisconsin Sea Grant's JASON site on the World Wide Web has received a Gold Medal in the annual nationwide university communications competition of the Council for the Advancement and Support of Education (CASE).

Sea Grant created the web site for use by fourth- through ninth-grade Madison, Wisconsin area students and their teachers participating in the JASON IX Project. Developed by Robert Ballard of *Titanic* and *Bismarck* shipwreck discovery fame, the JASON Project is an international science education program that uses state-of-the-art technology to enable students to see and talk with scientists doing research in remote sites around the world.

The JASON web site (http://www.edu/madisonjason9/) features profiles of Great Lakes fish, an interactive Freshwater Fish Quiz, guides to student and teacher resources, interviews with scientists, and student art and study projects developed as part of the JASON IX curriculum. During March, the site recorded more than 105,000 visits by people in all fifty states and 25 foreign nations.

More than 3,000 students and nearly 70 teachers from 30 schools in ten Madison-area communities participated in this year's JASON project, "Oceans of Earth and Beyond," which examined coral reefs and deep-sea hydrothermal vents as well as local aquatic environments.

The project culminated March 18-20 with a global live "telepresence" conference — hosted locally by the BioPharmaceutical Technology Center Institute — during which students used the Internet and satellite feeds to watch and talk with Ballard and researchers at the Bermuda Biological Research Station and Monterey Bay Aquarium.

Understanding Blue Crab Biology

In Maryland, the blue crab has become a symbol for the state, as well as the basis for the region's most profitable seafood product. During recent years, controversies have arisen over the status of blue crab stocks and how best to manage them. A clear synthesis of scientific information on the biology of the blue crab would greatly benefit the common baseline of knowledge about this important crustacean. The blue crab is now the most valuable commercial catch in the Chesapeake Bay and a significant commercial and recreational species all along the southeast coast and in the Gulf of Mexico.

Well-known marine biologists Eugene Cronin and Victor Kennedy have assembled scientists who are leaders in their respective fields of blue crab study in Maryland, Virginia and beyond to produce a book which will provide a comprehensive overview of the science surrounding the blue crab, *Callinectes sapidus*. Kennedy was the lead editor on *The Eastern Oyster: Crassostrea virginica*, the most comprehensive compilation of current scientific knowledge about the oyster. The blue crab book will include chapters on systematics, anatomy, molting and growth, ecology of the early benthic phase and juvenile and adult blue crabs and population dynamics. It will be the first treatment of such breadth on any major crab species.

Research support cannot cover the cost of extensive publishing projects such as this one — *The Blue Crab: Callinectes sapidus* represents a considerable expense and the editors are seeking financial support to help underwrite preparation and production of the book, which will be published by Maryland Sea Grant. Tax deductible contributions should be sent to: Blue Crab Book, Maryland Sea Grant, 0112 Skinner Hall, University of Maryland, College Park, Maryland 20742. Make checks payable to The University of Maryland Foundation. For further information, call the Maryland Sea Grant office, at (301) 405-6376.

Reefs in Wrecks

Shipwrecks litter the seafloor off the East Coast, especially in the approaches to New York Harbor. Throughout its history, New York City's port has been one of the busiest shipping channels in the world.

Historian and author Bradley Sheard says storms, collisions, mines and torpedoes have taken countless ships to the bottom. "There's just hundreds and hundreds of shipwrecks down there that represent all eras of history, examples from the Revolutionary War all the way up to the present day."

Sheard has found and explored many of those wrecks, and he describes them in a new book called *Lost Voyages*. It tells the stories behind many of the sinkings as well as the current state of wrecks such as the *Mohawk* and the *U.S.S. San Diego*. Both sank off Long Island during World War I.

Sheard says these wartime deathtraps now teem with marine life. "The smallest creatures need a place to hide from predators, and so they congregate at any kind of thing like a shipwreck; it's perfect with all kinds of nooks and crannies for them to live in and hide. As soon as they move in, then larger fish that prey on them move in, and suddenly you've got this entire marine ecosystem that revolves around this obstruction on the ocean bottom."

Anemones, starfish and soft corals cover the wrecks, providing oases of life on the otherwise barren sea floor. Sheard says these artificial reefs also attract scuba divers — history buffs and marine biologists alike head for the wreckage. *Lost Voyages: Two Centuries of Shipwrecks in the Approaches to New York*, April 1998, 216 pp., is published by Aqua Quest Publications, ISBN 1881652173; includes 36 line drawings, 215 color photographs of wreckage and artifacts and 111 historical photographs.

This article is one of a series of Earthwatch radio shows produced by Wisconsin Sea Grant.

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

End Notes

Call for Papers

■ **Coastal Zone 99, July 24-30, 1999, San Diego, California.** The eleventh biennial international symposium on coastal and ocean management, Coastal Zone 99 is designed to elicit creative thinking and healthy debate. Currently about 2.5 billion people live within 100 kilometers of the world's coastal margins. Over the next 50 years, that figure will explode to more than 6 billion — more than the entire world population today. Impacts and demands stemming from this population growth will put enormous pressure on coastal and ocean resources.

The conference will focus on the demands and impacts of population growth on coastal and ocean environments and on the kinds of research and strategies needed to deal with them. The search for solutions is the common thread that will embody all presentations and CZ99 will conclude with a declaration of principles and a call for public and private sector actions.

CZ99 invites abstracts on coastal and ocean resources management pertaining to the following themes: the human dimension, the ocean realm, the watershed perspective and the public connection. The conference will include oral and poster presentations, special sessions, roundtables and workshops. Abstracts are due August 1, 1998. For details on abstract preparation and submission guidelines, request a call for papers brochure by writing: CZ Secretariat, Urban Harbors Institute, University of Massachusetts, Boston, 100 Morrissey Boulevard, Boston, MA 02125-3393, or by e-mail CZ99umbsky.cc.umb.edu.

Proposal Request

■ **NOAA/Climate and Global Change.** The NOAA Office of Global Programs has issued a program announcement requesting proposals for its FY 1999 Climate and Global Change Program.

The long-term objective of the Program is to provide reliable predictions of climate change and associated regional implications on time scales ranging from seasons to a century or more. Proposals for projects to be conducted by investigators both inside and outside of NOAA, primarily over a one-, two- or three-year period are encouraged.

Letters of intent must be received at the Office of Global Programs no later than July 16, 1998; full proposals are due September 30, 1998. For details about funding priorities and submission requirements, contact Irma duPree, Office of Global Programs, NOAA, 1100 Wayne Avenue, Suite 1225, Silver Spring, MD 20910-5603, phone (301) 427-2089 ext. 107, fax (301) 427-2073, e-mail (duPree@ogp.noaa.gov) or visit the OGP web site (www.ogp.noaa.gov/C&GC/AO/99ao.html).

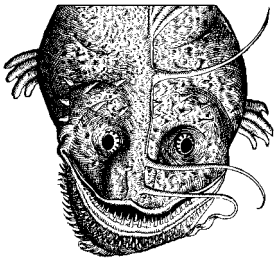
Volunteers Sought

■ **Chesapeake Bay Foundation Oyster Restoration Projects.** The arrival of warmer weather heralds the start of the oyster restoration season. CBF, along with the Oyster Recovery partnership, will be targeting projects in the Choptank, Severn, South, Magothy and Patuxent Rivers. Volunteers will also be needed in southern Maryland at the Piney Point hatchery as well as at the nursery near Chalk Point. Anyone interested in being on the oyster restoration volunteer team should contact Kim Donahue by phone, (410) 268-8816, or e-mail (kdonahue@savethebay.cbf.org) or visit the web (omega.cc.umb.edu/~cz99).

Fun Books for Kids

■ ***Monsters of the Deep.*** By Stewart Ross (Copper Beech Books, ISBN 0-7613-0548-3). More than a book about sea monsters, *Monsters of the Deep* introduces kids to narwhals, icebergs, whales, piranha, tsunamis and much more. Each page is a collage of colorful drawings, photographs and tidbits of interesting information, such as myths from around the world about sea monsters and sea gods.

The book's approach is to illustrate fictions perpetuated by myths, fables, literature and films and then give children the realities. Though the text only highlights each subject in a paragraph or two, the book will likely encourage curious children to search the library or surf the Internet to discover more about subjects, from human history to ichthyology, literature to natural phenomena.



■ ***Creeps from the Deep.*** By Leighton Taylor (Chronicle Books), ISBN-0-8118-1297-9). The befanged viperfish has a face only an alien could love. The tubular-eyed hatchetfish can look in many directions. These bizarre fish are just two of the creepy deep-sea-dwelling critters highlighted in Taylor's book. With large, clear photographs by underwater master Norbert Wu, this book could spawn a few nightmares in younger children. But it will delight school-aged children with its anecdotes of life at 30,000 feet below the surface. Concise yet comprehensive in scope, the book touches on topics from bioluminescence to submersibles to living in deep-sea pressure. *(These two book reviews excerpted from North Carolina Sea Grant's* Coastwatch *magazine, Spring 1998.)*

Calendar

July 12-15 — Coastal Society Conference

College of William and Mary, Williamsburg, Virginia. "Minding the Coast: It's Everybody's Business" is the title of the Coastal Society's 16th International Conference. The conference will emphasize the myriad interests and issues in the coastal oceans and zones, as well as highlight opportunities to work together on the complex issues facing this environment. Plenary and concurrent sessions will examine how we view and experience the often conflicting needs and uses of coastal oceans and zones. For more information, request a conference brochure from the Conference Services Office by phone, (757) 221-4084; fax, (757) 221-2090; or e-mail (wmcon@mail.wm.edu). Conference information is also available on the web (http://www.vims. edu/TCS16/).

July 11 and 18 — Bay Grass Monitoring

Chesapeake Bay Foundation Bay Grasses Training Session. These sessions are designed to teach volunteers how to identify, map and monitor important submerged aquatic vegetation. The workshops are free and canoes are provided, but attendees should have access to a small boat in order to participate in the Submerged Aquatic Vegetation (SAV) Hunt groundtruthing program. The July 11 session will take place on the Virginia side of the Potomac River and the July 18 session will be in Dundee Creek off the Gunpowder River near Baltimore. Please register a week before the date. To register or for more information, contact Kim Donahue or Heather Tuckfield at (410) 268-8816 (Annapolis), (410) 269-0481 (Baltimore, (301) 261-2350 (DC area), or by e-mail (kdonahue@savethebay.cbf.org).

July 25, August 1, 8 and 15 — Oyster Gardening

Chesapeake Bay Foundation Oyster Gardening Workshops. This program is designed to provide citizens with a way to help restore oysters to the Bay. Participants at the workshops learn about oyster ecology and are trained in oyster culture. Each participant builds a float for growing oysters at their dock and receives 2000 seed oysters. Gardeners grow their oysters for about a year until they are around two inches in length. At that time the oysters are collected and planted on a rebuilt reef in local waters and the gardener starts over with a new batch of seed. For information about the workshops, call Katrina Knudson in Maryland at (410) 268-8816 or Julia Hardee in Virginia at (757) 622-1964 or e-mail (chesapeake@savethebay.cbf.org).

Maryland Marine Notes **(current and back issues since 1995) is also available on the web at http://www.mdsg.umd.edu/MDSG/Communications/MarineNotes**

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