

# MARINE NOTES

SPOTLIGHT ON AQUACULTURE

## Down on the Fish Farm

BY JACK GREER



Skip Brown

***A new report calls on the federal government to encourage environmentally friendly methods for growing fish.***

Tony Mazzaccaro had a better year this year than last. After losing more than 20,000 prime market-size hybrid striped bass in the summer of '96, he lost only about 10,000 fish in 1997 — about half a pond's worth — and got the rest to market.

Without intending it, Mazzaccaro's aquaculture ponds have become a biological, sociological and economic laboratory, one that is being watched closely by conservationists, resource managers and the seafood industry.

"These ponds are like a petri dish for the river," quips Mazzaccaro, who owns and operates HyRock Farm near Princess Anne, Maryland. The river is the Manokin, which provides abundant water for his operations; like other Bay tributaries, the Manokin is populated with numerous species of dinoflagellates, algae that include *Pfiesteria* and other single-celled organisms capable of producing harmful toxins. Mazzaccaro is on full alert against dinoflagellates that come in with the river water.

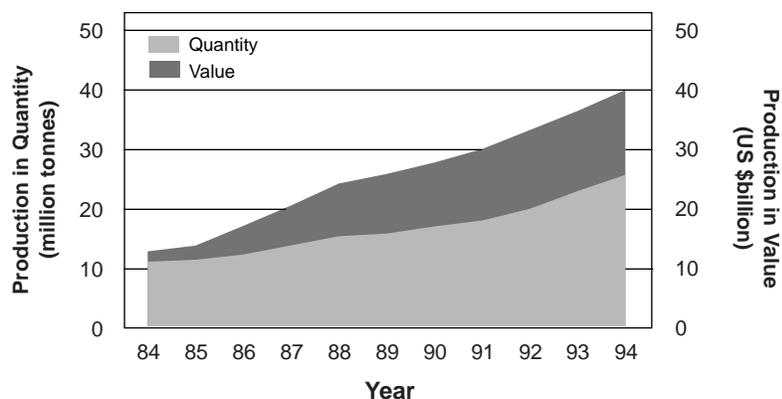
"It's gotten so I hate summer," he says, with a sweeping exaggeration. From June to October, Mazzaccaro checks his ponds for dissolved oxygen three times a day, seven days a week. "I go out at 5:30 am, 6:00 pm and midnight, every day," he says.

While on guard against potentially deadly invasions from the Manokin, Mazzaccaro must at the same time be careful that nutrient effluent released to the river from fish waste does not degrade the river's water quality. Those nutrients can lead to algal blooms that cause problems both in the ponds and in the river. Fortunately, the HyRock ponds drain into a wetland, which helps to filter out nutrients. Also helpful is the fact that Mazzaccaro drains his ponds once the fish have all gone to market, which means the middle of winter, when biological activity is low in the Bay.

The ecological give-and-take between aquaculture operations and the environment is no small concern in Mazzaccaro's ponds and in aquaculture operations nationally. With an overabundance of nutrients in our coastal waters, environmental organizations caution that the nation's expanding aquaculture operations can become sources of unwanted nutrients if not handled properly. In a recent report on aquaculture entitled "Murky Waters," the Environmental Defense Fund (EDF) argues that fish farming, especially in open-water systems such as netpens, can have direct impacts on the quality of coastal waters. At the same time, EDF concludes that aquaculture does not need to be a polluting industry, and calls upon the federal government to encourage environmentally friendly methods for growing fish.

*Please turn page*

## Global Trends in Aquaculture Production



Between 1984 and 1994, aquaculture production worldwide increased 250 percent and economic value showed a nearly 400 percent increase (see graph above). While U.S. aquaculture production continues to expand, the U.S. accounted for less than seven percent of world aquaculture production in 1994 (see graph on page 3).

Source: United Nations Food and Agriculture Organization and the Environmental Defense Fund.

## *Waste from aquaculture ponds can be treated in constructed wetlands or used to grow desirable plants.*

vests and aquaculture — rose to 109.6 million metric tons in 1994, then 112.3 in 1995. That increase, the FAO reports, is mainly a result of continued rapid growth in aquaculture production, which now accounts for some 27 percent of seafood consumption worldwide.

Since 1984, production more than doubled, reaching a record 20.9 million tonnes of fish and shellfish in 1995. Farmed seafood was tabulated at more than \$36.2 billion (in U.S. dollars) and represented 18.5% of the total world seafood supply.

The largest player in this aquaculture increase is not the United States, but China. China, together with India, Japan, the Republic of Korea and the Philippines, account for 80 percent of the world's volume of cultured seafood, according to the FAO report. And the largest species by volume is neither rockfish nor shrimp nor catfish, but carp. "In 1994," reports the FAO, "carp accounted for almost half of the total volume of cultured aquatic products (aquatic plants excluded)."

Though the U.S. does not loom large on the world aquaculture stage, aquaculture plays an increasingly important role here. Based on FAO statistics, nearly all of the catfish and rainbow trout, about half the shrimp and about one-third of the salmon consumed in the U.S. is raised by fish farmers.

A key question in all of this production is whether aquaculture can be both environmentally friendly and economically sustainable.

### The Challenge

The biggest environmental problem that aquaculture poses in the long run is waste. There are two

## Farm, continued

According to Jim McVey, the federal government has already been moving in precisely that direction. The coordinator of aquaculture efforts at the National Sea Grant Program, McVey has helped shape a new initiative in the Department of Commerce that will focus on environmentally sustainable aquaculture, with an initial emphasis on offshore aquaculture, recirculating systems and marine fish enhancement.

The EDF is also calling for further federal oversight of aquaculture, for example, over water netpens as well as regulation of potential pollutants that include chemicals, nutrients and the accidental release of non-native species into local waters. In addition, EDF argues for a program that certifies farm-raised fish grown in "environmentally friendly" systems.

In the midst of concerns about environmental protection and new methodologies, another concern looms large, according to Reginald Harrell, Maryland Sea Grant Extension Aquaculture Specialist. Harrell, who runs an aquaculture research and outreach program at the University of

Maryland's Center for Environmental Science (UMCES) Horn Point Laboratory, worries about the bottom line of aquaculture enterprises such as those undertaken with considerable financial commitment by fish farmers like Tony Mazzaccaro.

While Harrell applauds new efforts to develop environmentally friendly aquaculture, he says that "these ideas may get you on the cover of *Mother Earth* magazine, but you won't see them in *Forbes*. It all comes down to the economics. Otherwise, why are you doing it?" Like any farmer, fish farmers must, after all is said and done, register a profit. And unlike land farmers, fish farmers have no subsidies to fall back on. If their operations lose money, they're sunk.

### The Big Picture

The fledgling efforts to promote aquaculture in the Chesapeake Bay region are being played out against the gigantic backdrop of world fisheries markets. According to the United Nations Food and Agriculture Organization (FAO), in recent years, worldwide fish supplies have expanded rapidly. From 20 million metric tons in the 1950s, world fisheries production — including both wild har-

kinds to worry about, says McVey: the waste products in fish excreta (in particular nitrogen and phosphorus) and fish remains after processing. Striped bass provide an example of the latter: about 55 percent of a striped bass after fillet is waste that has to be disposed of. If this waste could be turned into a byproduct, such as fishmeal, it could help solve the problem of disposal. At the same, better use of these fish byproducts could reduce the intense pressure on species such as menhaden which are harvested for processing into fishmeal or fish oil.

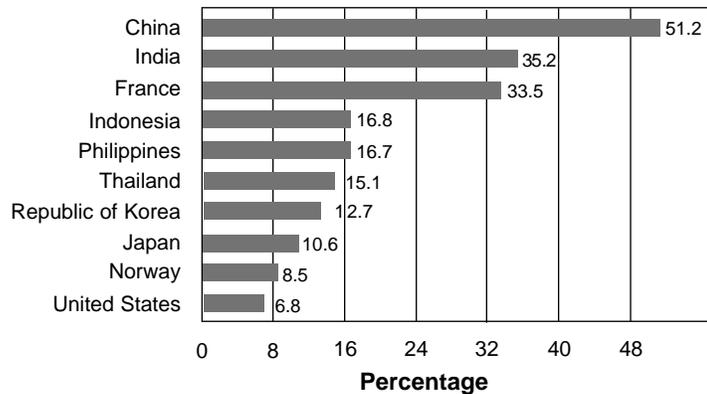
There are innovative examples of how science has been put to use in designing sustainable technologies that can relieve such problems as heavy fishing pressure on menhaden. The EDF report points to the Inslee Farm, Inc. of Oklahoma which grows chives in greenhouses using effluent from ponds for raising tilapia, catfish and grass carp. According to EDF, “the farm produces 80 pounds of chives weekly, which are shipped fresh to a wholesaler in Houston.”

Waste from aquaculture ponds can also be treated in constructed wetlands, or used to grow desirable plants. “I have always thought it would be good for the Chesapeake Bay to grow plants used for shoreline stabilization,” says Harrell. They would use nutrients coming from aquaculture ponds, and provide plants needed for Bay restoration work.

While such integrated systems are attractive, says Harrell, hydroponics require a great deal of work, and additional time and money. In some cases, he says, additional nutrients could be required for particular plants, forcing the farmer to add nutrients at the same time he is trying to remove them. Also, plants must be removed, he points out, or else the nutrients will simply be recycled back into the system.

Removing nutrients in this way has worked well for the Japanese, says McVey, who divide their efforts into “fed” and “extractive” aquaculture. “Fed” aquaculture refers to the raising of species that require additional nutrition in the form of fish

### Contribution of Finfish and Shellfish Culture to National Fishery Production in 1994



food, while “extractive” refers to the culture of species, such as plants, that take up nutrients.

“Unfortunately, we can’t grow very much nori or kelp in the Bay area,” says Harrell, adding that this is a shame, since the approach is truly “extractive,” and provides products, such as agar, which are in great demand. “Once you grow something, you have to be able to market it,” he says. Otherwise, the grower is losing money.

#### Last Best Hope

If striped bass culture can provide a livelihood for small farmers in the mid-Atlantic region, while taking pressure off the wild stock, then aquaculture will have gone a long way toward fulfilling its original promise.

“We did not intend our report to be anti-aquaculture,” says EDF’s Rebecca Goldberg. The report concludes: “Aquaculture need not be a polluting industry. A wide variety of technologies and practices now are available to make aquaculture facilities environmentally friendly...”

Like McVey, Goldberg and her colleagues put considerable faith in the ability of science to solve current technological problems. They call for source reduction of pollutants, and where that is not possible the recycling and reusing of wastes. The least

preferred option, says EDF, is disposal of waste in the environment.

McVey and Goldberg agree on other approaches as well, including the use of feeds designed to protect the environment. These include feeds with low fishmeal content, which lessen aquaculture’s pressure on wild fisheries, and feeds with nutritional and other characteristics that help aquaculturists minimize food waste.

And finally the EDF report calls for research that can help improve the function of aquaculture and reduce its potentially negative impact on the environment. In the long run, scientific research and technologies are key to the future of aquaculture — if aquaculture is to continue its expansion, we must find new and better ways of protecting against the impacts it is likely to bring.

The potential benefits of such expansion are many: the ready availability of more farmed seafood, greater economic development, reduced pressure on wild fisheries as well as means for enhancing stocks that have already been subjected to the impacts of human activities.

Successfully meeting this potential and minimizing its effect on the environment will take not only the commitment and support of our public agencies, but the efforts of scientists and industry working together. ✓

# Aquaculture and Restoration

BY MERRILL LEFFLER

Not only is aquaculture bringing more farmed seafood to the table each year, it is also bringing assistance to resource and habitat restoration programs. In the Chesapeake Bay, for instance, hundreds of thousands of striped bass were released annually by public and private agencies — this was part of the successful program to restore the species throughout the East Coast. Populations of striped bass appear to be back to historical levels and agencies only have a limited need to release them now. Research and management agencies are currently looking at how aquaculture can help restore other species, among them, severely diminished shad populations and the nearly extinct sturgeon that used to roam the bottom waters of Chesapeake rivers.

But the greatest restoration challenge for aquaculture in the Chesapeake is its once-renowned oyster populations, which are at historical lows. The heavy loss of oysters to two parasitic diseases — Dermo (caused by *Perkinsus marinus*) and MSX (caused by *Haplosporidium nelsoni*) — has combined with a century of steady harvesting pressure and an increase in landborne pollution, especially sedimentation, to decimate the species.

Not only has the oyster industry suffered — watermen, suppliers, seafood processors and distributors — but so apparently has Bay water quality which depends, at least in part, on robust oyster populations and the communities that form around them. Only in recent years have we begun to appreciate how oysters and their habitats contribute to improving water quality by filtering algae, which remove some of the excess nutrients that are plaguing the Bay.

Despite their decline, oysters are resilient animals — this past summer, for example, the Chesapeake had a record spat set, new young oysters that settled on shells and other substrates throughout the Bay. Because of Dermo and



MSX, however, most of these oysters are not likely to survive to harvestable size in the three years it generally takes oysters spawned in the wild. The poor prospect for survival is one reason restoration plans have been looking to the controlled spawning of oysters in hatcheries: hatchery operators can spawn oysters earlier than under natural conditions and give young oysters a big headstart in growing to maturity. Moreover, as specially-selected stocks are developed that are more resistant to disease, hatcheries can be used to get these oysters to growers for restoration purposes (see *Maryland Marine Notes*, January-February 1997). Such efforts are making it possible to better manage around disease by giving resource managers and commercial operations more flexibility.

For more than 20 years, Maryland Sea Grant Specialist and researcher Don Meritt of the University of Maryland Center for Environmental Science has been operating the hatchery at Horn Point Laboratory (HPL) and working with watermen to set their own oysters and plant them on privately-leased beds. With Dermo now entrenched on oyster beds throughout the Bay, Meritt has teamed with other researchers, including those at the Maryland Department of Natural Resources (DNR) and in the Maryland Oyster Recovery Partnership — a co-venture of watermen, aquaculturists and environmentalists — to spawn disease-free oysters in the hatchery and grow them to maturity in lower-salinity areas. While optimum growth in oysters favors higher salinities, disease

pressure is generally less intense at lower salinities and the hope is that oysters can survive to maturity there.

The Partnership grew out of a unique consensus agreement in Maryland, says its executive director Robert Pfeiffer, among watermen, aquaculturists, resource managers, legislators, scientists and environmentalists — its long-range goal is restoration of oyster populations. The agreement divided the Bay system into three zones, A, B and C. In the upriver and low salinity waters of Zone A, certified disease-free spat can be planted; furthermore oyster harvesting is not allowed in these areas.

Is it possible to bring these oysters to harvest before disease kills them? Further, asks Meritt, can we bring them to harvest under different climatic conditions, particularly when salinities are higher because of drought-like weather and disease intensity is therefore greater? So far the prospects are promising, says Pfeiffer, though we need several more seasons of differing weather conditions to have a clearer idea.

In 1997, Meritt produced more than 20 million oyster spat at HPL — still only enough to plant some 20 to 30 acres of bottom ground. While DNR is also growing and planting disease-free seed, sustainable restoration could be lifetimes away. Consider that Maryland has some 270,000 acres of designated public oyster grounds (though most no longer produce harvestable oysters), says Meritt — our efforts are a measure of the task ahead of us.

Important inroads are being made in the effort to bring back the oyster in the Chesapeake Bay, but it will take more than aquaculture to restore what has taken a century to nearly destroy. It will take major efforts to maintain reductions of pollution from the land along with progress in ongoing research to develop oysters that are resistant to disease. But we have made a start, says Meritt. “They may be small steps, but at least they are steps.”

# UMBI President to Head National Science Foundation

President Clinton nominated Rita R. Colwell, president of the University of Maryland Biotechnology Institute, as director of the National Science Foundation in February.

The President first announced his intent to nominate Colwell during a luncheon at the American Association for the Advancement of Science (AAAS) Annual Meeting and Science Innovation Exposition in Philadelphia. At the same time, he said he intended to nominate Neal Lane, current NSF Director, as assistant to the President for science and technology and as director of the White House Office of Science and Technology Policy.

Colwell, a past president of AAAS, is also a professor of microbiology at the University of Maryland, College Park. She is active in national and international research and teaching in the areas of marine biotechnology and the molecular genetics of marine and estuarine bacteria, and on the microbiology of the Chesapeake Bay. She is the author or co-author of 16 books and more than 450 scientific publications. She has been a member of the National Science Board and also past president of the American Society for Microbiology and the International Union of Microbiological Societies. Her degrees include a B.S. in bacteriology and an M.S. in genetics from Purdue University and a Ph.D. in marine microbiology from the University of Washington.

Founding director of the University of Maryland Biotechnology Institute (UMBI) in 1985, Colwell became its president in 1991. With a mission of fostering research, training and education, and economic development,



UMBI has grown, under Colwell's leadership, to include four research centers: the Center for Advanced Research in Biotechnology (Shady Grove), the Center for Agricultural Biotechnology (College Park), the Center for Marine Biotechnology (Baltimore) and the Medical Biotechnology Center (Baltimore). The latter

center also includes the Institute for Human Virology.

The National Science Foundation initiates and supports fundamental, long-term, merit-selected research in all the scientific and engineering disciplines. An independent federal agency, it funds research in all 50 states through grants to more than 2,000 universities and institutions. Colwell's appointment as NSF director does not become final until confirmation by the U.S. Senate.

## Fowler Receives Bay Award

The Chesapeake Bay Trust presented the first Ellen Frites Wagner Award to Senator Bernie Fowler in January at the Second Annual Governor's Tributary Teams Conference at the University of Maryland in College Park.

Chesapeake Bay Trust Board member and former Governor Harry Hughes presented the Award to Fowler at a luncheon ceremony. "Bernie's love and leadership for the Chesapeake has influenced thousands of people and activities," noted Hughes. "He exemplifies the mission

of the Chesapeake Bay Trust — promoting public awareness and involvement in the restoration and protection of the Chesapeake Bay."

A lifelong resident of Calvert County, Fowler has led efforts to restore the Bay as a waterman, County Commissioner, and State Senator. He has chaired the Patuxent River Commission and led development of Patuxent River policy, and has served on the Chesapeake Bay Commission, Chesapeake Bay Program, the Oyster Recovery Program, and the Hughes Commission.

But Fowler is perhaps best known for the Annual Bernie Fowler Wade In and Sneaker Index, a June ritual in which he wades into the Patuxent River off Broome's Island to see how deep his sneakers will still be visible. This popular gauge of Bay health has caught public attention nationwide and has focused that attention on Marylanders' shared responsibility in taking care of the Chesapeake.

Named in honor of the Hughes administration staffer who came up with the idea for the Chesapeake Bay Trust, the Ellen Frites Wagner Award is a bronze statue of a blue heron, the Chesapeake Bay Trust (CBT) logo. CBT Chairman Senator Art Dorman reiterated Hughes's praise of Fowler. "I have had the pleasure of working with Bernie in the Senate on many Bay issues — he is the perfect recipient of this first Award."

Established by the General Assembly of Maryland in 1985, the Chesapeake Bay Trust is a private, non-profit grantmaking foundation. Proceeds from private donations, the Line 63a Maryland Income Tax Checkoff, and the popular "Treasure the Chesapeake" blue heron commemorative license plates have allowed the Trust to fund 3,000 grants to 1,400 different schools, nonprofits, community associations and public agencies — totalling over \$7 million since 1985.

Nomination applications for the 1999 Award will be available in September. For more information about the Ellen Frites Wagner Award or how to apply for a grant, contact the Chesapeake Bay Trust at (410) 974-2941.

## Reauthorization / 30th anniversary



Thanking those who have “dedicated their careers to an understanding of the sea,” U.S. Senators Ted Stevens of Alaska and Judd Gregg of New Hampshire joined a number of dignitaries who gathered recently at the U.S. Capitol to mark the thirtieth anniversary of the National Sea Grant College Program. While the Sea Grant Act was passed in 1966, the first grants were awarded in 1968, and so the actual work of Sea Grant began thirty years ago.

Congressman Frank Palone, Jr. of New Jersey congratulated the assembled scientists and government leaders, noting that he took special pride in the program since he himself had served as a Sea Grant Extension specialist in New Jersey before moving into national politics. “It is Sea Grant’s connection with people,” he said, “that makes it a special program.”

One of Sea Grant’s core missions is to take research and technology from the nation’s universities and marine science laboratories and make it accessible for those who need it, from aquaculturists and seafood processors to school children and interested citizens.

We have come a long way, noted National Sea Grant Director Ronald Baird, but given the challenges that persist we still have a long way to go. This sentiment was echoed by Dean John Knauss, the marine scientist who helped to spark the Sea Grant concept when he discussed the idea with Senator Claiborne Pell of Rhode Island in the early 1960s. Knauss noted that we have many new tools that were unavailable when he began his research, adding that “the ocean is a wonderful place when you have GPS [global positioning satellites].”

## Publications

### New Report on *Pfiesteria*

The Center of Marine Biotechnology and the Maryland Sea Grant College, in cooperation with the USDA Agricultural Research Service, have issued a new report entitled *Molecular Technologies and Pfiesteria Research: A Scientific Synthesis*. This report synthesizes the findings of a diverse group of scientists, health care professionals and science managers who assembled at the Center of Marine Biotechnology in Baltimore, Maryland in October 1997 at a workshop that addressed the emerging problem of *Pfiesteria piscicida* and *Pfiesteria*-like organisms. *Pfiesteria* was found last year in the Pocomoke River and other waters on Maryland’s Eastern Shore where it had caused fish kills and human health problems.

The purpose of the two-day meeting was to develop a consensus of important research strategies for understanding and managing this group of organisms. Within this framework, the program concentrated on four major topics: *Pfiesteria* biology, taxonomy, toxins and human health concerns. The workshop focused in particular on contributions that the application of molecular biology and biotechnology could make to research. The complete report is available online at [http://www.mdsg.umd.edu/fish-health/pfiesteria/biotech\\_rpt/index.html](http://www.mdsg.umd.edu/fish-health/pfiesteria/biotech_rpt/index.html). To receive a printed copy, contact: Communications Office, Maryland Sea Grant College, 0112 Skinner Hall, University of Maryland, College Park, MD 20742.

### NMFS Reports on European and American Fisheries

The National Marine Fisheries Service recently announced publication of a report entitled *The History, Present Condition, and Future of the Molluscan Fisheries of North and Central America and Europe*. The three-volume set covers in detail the species

fished and cultured, nation by nation, and by state and province for the United States and Canada. The illustrated volumes, written by more than 50 noted national and international authorities, were edited by Clyde L. MacKenzie, Jr., Victor G. Burrell, Jr., Aaron Rosenfield and Willis L. Hobart.

Copies of the report have been sent to cooperating fisheries agencies, educational organizations and libraries throughout the world. To obtain a copy, contact the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, Pennsylvania 15250-7954, (202) 512-1800 or visit the web, [www.access.gpo.gov/su\\_docs/prf/prf.html](http://www.access.gpo.gov/su_docs/prf/prf.html). The cost per volume is about \$20.00. Alternatively, paper copies (\$44.00) and microfiche (\$19.50) of the volumes are sold by the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (800) 553-NTIS, [www.fed-world.gov/ntis/ntishome.html](http://www.fed-world.gov/ntis/ntishome.html).

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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](mailto:mdsg@mbimail.umd.edu)

For more information about Maryland Sea Grant, visit our web site:

<http://www.mdsg.umd.edu/MDSG>



# End Notes

## Lipton Receives Award

Doug Lipton received this year's Marine Trades Association of Maryland (MTAM) Outstanding Service Award. Lipton is coordinator of the Maryland Sea Grant Extension Program and marine economics specialist in the Department of Agricultural and Resource Economics at UMCP. In presenting the award, Sandy Zimmerman, president of MTAM, cited Lipton's work with the industry that began in 1993 with a study titled "Economic Impact Analysis of Recreational Boating."

He has continued to update that study every year and it is an important source of information for and about the industry. More recently, he completed a study on the effect of boater excise tax on boaters choosing to locate in Maryland. Said Lipton on receiving the award, "Acknowledgement of the industry's appreciation for this work is something unexpected and special, not only for me but for the Maryland Sea Grant Program as a whole."

## Fellowship Opportunities

*Coastal Management Fellowship.* In 1996, NOAA's Coastal Services Center established a Coastal Management Fellowship program to provide professional on-the-job education and training opportunities for post-graduate students in coastal resource management and policy and to provide specific technical assistance to states.

The program matches highly qualified, recently graduated masters, professional degree and doctoral students with state coastal zone management programs around the U.S. for a two-year period. Applications are currently being received for

fellowships beginning October 1, 1998. Fellowships pay \$30,000 per year as a combination of salary and per diem.

In its first year, the program awarded six fellowships nationally, including one to Maryland Sea Grant-nominated candidate Chris Rilling, a Marine-Estuarine-Environmental Sciences (MEES) graduate. Now in his second fellowship year, Rilling works with Connecticut's Tidal Wetland Restoration Program in partnership with Connecticut College.

The deadline for applications is April 6, 1998. For more details about the fellowships, visit the web, <http://www.csc.noaa.gov/>. To apply, contact Susan Leet at the Maryland Sea Grant College office in College Park, by phone, (301) 405-6375, or e-mail, [leet@umbi.umd.edu](mailto:leet@umbi.umd.edu).

## Sebens Studies Corals

Kenneth Sebens, professor in the University of Maryland Department of Zoology and former head of the MEES program, will lead a team of researchers to examine the effects of water flow and prey behavior on the feeding biology of corals. Sebens will do this research aboard the *Aquarius*, the world's only underwater laboratory.

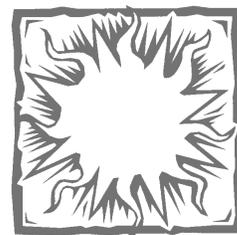
Because researchers can live in the *Aquarius* during their ten-day missions, they can remain on site and do not need to acclimatize themselves to pressure changes associated with dives made from the surface. NOAA re-installed the *Aquarius* on the sea floor at a depth of 63 feet at Conch Reef in the Florida Keys National Marine Sanctuary. For more information call Robert Hansen at (202) 482-4594 or e-mail Ken Sebens at [Sebens@zool.umd.edu](mailto:Sebens@zool.umd.edu).

## Grant Opportunities

*Maryland Industrial Partnerships (MIPS).* Applications are currently being accepted by the MIPS program,

which awards matching grants to Maryland businesses to make use of the resources of the University of Maryland for product or process development designed to meet specific needs. Businesses can qualify for as much as \$70,000 (\$50,000 for start-up firms) in matching grant awards, which may be renewable. The deadline for the next round of applications is May 1, 1998. For more information, contact the MIPS program office at UMCP, (301) 405-3891 or visit the web, <http://www.erc.umd.edu/MIPS/Welcome.html>.

## Summer Employment



*Northeast Fisheries Science Center (NEFSC).* The Center has summer positions in a broad range of marine research programs, including fishery science, fishery economics, environmental sciences, aquaculture, and taxonomy of marine organisms. It also employs computer scientists, statisticians, mathematicians and a wide range of other disciplines at laboratories in Woods Hole (MA), Narragansett (RI), Milford (CT), Sandy Hook (NJ) and at the Smithsonian Institution in Washington, DC.

Although specific positions have not been identified, students should apply for opportunities in the research areas described above. Positions run from May through September.

To apply, request an application package from: Mrs. Smith, NEFSC Program Coordinator, 166 Water Street, Woods Hole, Massachusetts 02543, phone (508) 495-2370, fax (508) 495-2258, e-mail ([pie.smith@noaa.gov](mailto:pie.smith@noaa.gov)). The deadline for receiving completed applications is April 10, 1998.



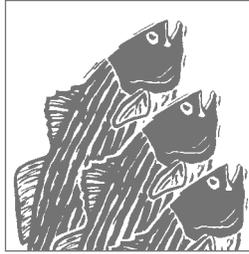
## Calendar

### April 6-8 — Agricultural Runoff

State College, Pennsylvania. The Chesapeake Bay Program's Scientific and Technical Advisory Committee is sponsoring a conference, "Agricultural Phosphorus in the Chesapeake Bay Watershed: Current Status and Trends." The conference will initiate efforts to identify the agricultural sources of phosphorus, the controls on phosphorus export and recommend approaches for targeted, cost-effective, nutrient management plans throughout the Bay region. Registration is free, but limited to 100 participants, so register early. For more information, contact: Katrin O'Connell, Chesapeake Workshops Unlimited, 14 Pennsylvania Avenue, Edgewater, Maryland 21037, e-mail: [katrinoc@erols.com](mailto:katrinoc@erols.com).

### June 6-7 — Striper 2000

College Park, Maryland. "Striper 2000" is a conference that will provide a forum for scientists, producers, extension specialists and agency representatives to



discuss state-of-the-art research in striped bass culture and the potential for increased production. Sponsored by the Maryland Agriculture Experiment Station, the Maryland Sea Grant College and the Striped Bass Growers Association, the conference will take place at the Inn and Conference Center at the University of Maryland, University College.

Registration costs \$125 and includes conference materials, the reception, lunch and dinner. For conference agenda and other information, or to register, visit the web, <http://www.mdsg.umd.edu/stripers2000>, or contact: Fred Wheaton, Biological Resource Engineering, 1439 Animal Science/Agricultural Engineering Building, University of Maryland, College Park, Maryland 20742, phone (301) 405-1198, fax, (301) 314-9023, e-mail, [fw4@umail.umd.edu](mailto:fw4@umail.umd.edu).

discuss state-of-the-art research in striped bass culture and the potential for increased production.

Sponsored by the Maryland

### June 7-12 — Focus on the Chesapeake

Chestertown, Maryland. "The Chesapeake Environment: Our Great Shellfish Bay" is co-sponsored by the Washington College Summer Institute and the University of Maryland Center for Environmental Science (UMCES).

This program offers attendees an opportunity to study the Chesapeake's unique ecosystem aboard the research vessel *Aquarius*, cruise and learn aboard the *Maryland Independence*, search for Native American relics, watch birds and other wildlife, enjoy informative lectures, gourmet meals, skipjack rides, music, dancing, historic tours, painting, kayaking, golf and tennis.

Participants can register for the entire program, or for the sessions that most interest them. Registration is limited, however, so sign up early. For more information or to receive a brochure, contact: Ann Wilmer Hoon, Washington College Summer Institute, 300 Washington Avenue, Chestertown, Maryland 21620, phone (410) 778-7272.

**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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