

MARINE NOTES

SPOTLIGHT ON SCIENCE AND MANAGEMENT

Blue Crabs: The Biology of Abundance

BY MERRILL LEFFLER



Skip Brown

How threatened is the blue crab fishery in the Chesapeake Bay? Could crabs plummet like the Bay's once bountiful oyster fishery? Or the striped bass fishery before its rescue?

In 1995 reports based on an annual Baywide monitoring of blue crabs spurred anxiety over a possible decline. Some newspapers reported a decline of adult crabs as high as 62 percent, compared with the previous five years, a number that was quickly corrected and revised downward to 34 percent. Scientists and resource managers alike scrambled to understand not only the short-term but the

long-term trend of Chesapeake crab stocks.

The cause for public unease appears to rise not only from scientific reports, but from an underlying intuition that we may be too fond of the blue crab. With consumer demand growing for hard and soft shell crabs, and with seafood processors competing for the picked crab market, many Marylanders and Virginians worry that a vast array of pots, trotlines, dredges and dipnets are taking too many blue crabs out of the Bay.

For Bay researchers and resource managers, the question became this:

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Last year annual Baywide monitoring of blue crabs showed a 34-percent drop in abundance compared with the average of five previous years.

Although Chesapeake watermen harvest nearly 100 million pounds of blue crabs a year, the number of crabs available for catching fluctuates. According to CBSAC scientists, crab stocks peaked during the 1980s, then declined in the 1990s. While the 1995 winter dredge survey showed a 34-percent decline of adult crabs, preliminary results from the 1996 survey appear to show a rebound.



Skip Brown

Based on the 1995 survey, the subcommittee started from the position that there was a stock collapse. But after an analysis of long-term monitoring and other data, they “simply were not picking up the problem.”

Blue Crabs, continued

Was the 34-percent drop the first sign of a crisis, or was it merely a low point on the chart of booms and busts that characterize most fishery harvests — more the result of natural processes, such as storms, winds, rains, and temperature shifts, all of which affect the number of young crabs that inhabit the Bay each year? Or did it indicate some other problem as well — such as the loss of underwater grass beds, a key habitat for crabs?

“We had been identifying a number of developing problems,” says W. Pete Jensen of Maryland’s Department of Natural Resources. An increase in fishing effort, for example. That was one reason, says Jensen, for limiting entry into the commercial fishery in 1994 and for putting limits on fishing hours and numbers of crab pots.

In January 1995, at the annual East Coast Fisherman’s Expo in Ocean City, Anne Lange of the NOAA Chesapeake Bay Office presented a graph suggesting a decline. As this and other data emerged, Jensen grew especially concerned about “a declining trend in mature female crabs.” These were signs, says Jensen, that meant Maryland had to act: “We have a very valuable fishery, and we are just not going to wait for a crisis to occur.”

Maryland did act, by imposing in the fall of 1995 a temporary set of emergency crabbing restrictions. Ad-

ditional, though less stringent, regulations have been proposed for 1996 (see sidebar, “The Summer of 1996”).

The actions by fisheries managers in Maryland and Virginia, says Bill Goldsborough of the Chesapeake Bay Foundation, represent a historical shift from crisis management to conservation. “However,” he says, “it means that if we’re going to act to avoid a crisis, we’re acting with less definitive information. If we want more perfect information, we’ll have to wait for a collapse. So it’s a matter of being sensitive to warning signs — even if they’re not definitive.”

Taking Stock of Blue Crabs

To get a better handle on the status of blue crab stocks, the Chesapeake Bay Stock Assessment Committee (CBSAC) Technical Subcommittee brought together available data from blue crab research and monitoring efforts in order to do an analytical stock assessment. According to fisheries scientist Louis Rugolo of the Maryland DNR, who chairs that subcommittee, stock assessment is a mathematical tool that can give managers a quantitative idea of whether the fishery is being harvested above or below its highest sustainable rate. As Rugolo points out, the mathematics are only as good as the quality of data that are available, including basic assumptions about crab biology.

Such an assessment had not been done for the blue crab, says Bess Gillelan, chief of the National Ocean-

ic and Atmospheric Administration’s Chesapeake Bay Office in Annapolis and chair of CBSAC, because long-term Baywide monitoring information wasn’t available. “We realized the limitations of that data on blue crab in the ‘80s,” she says, “and that was a major reason for beginning the annual winter dredge survey.”

The Baywide dredge survey is a comprehensive monitoring effort covering crab stocks in Maryland and Virginia (see “Blue Crabs in Winter,” *Marine Notes*, Vol. 12, no. 1).

Rugolo’s technical subcommittee gathered statistics from commercial harvests and from state monitoring efforts, in addition to laboratory and field studies reported in the scientific literature (see Sidebar, “Counting Crabs”). The committee included representatives from Maryland and Virginia and the NOAA Chesapeake Bay Office, as well as from outside the Bay region: Vic Crecco of the Connecticut Department of Environmental Protection and two scientists from the National Marine Fisheries Service — Mark Terceiro from the Northeast Fisheries Science Center at Woods Hole and Douglas Vaughn of the Southeast Fisheries Science Center at Beaufort, North Carolina.

“When our subcommittee met last July in Beaufort,” says Rugolo, “we were starting from the position that there was a stock collapse. After the announcement of the blue crab’s 34-percent decline, we believed that we

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Counting Crabs

In 1968, when the Baltimore Gas and Electric (BG&E) Company began construction of the Calvert Cliffs Nuclear Power Plant, George Abbe began setting crab pots offshore in the Chesapeake Bay. Abbe, a scientist at the Benedict Estuarine Research Center, also set pots up-Bay at Kenwood Beach and three miles down-Bay at Rocky Point. Working with support from BG&E, he wanted to determine if the discharge of heated water from the nuclear plant would affect crab populations.

Though support from BG&E has slowed, he is still baiting pots in the same locations, tracking the year-to-year fluctuations of crabs per pot (called catch per unit effort), taking weight and size measurements, and distinguishing between the numbers of males and females. His data set — one of the most comprehensive and long-term measures of crab stocks that researchers in the Chesapeake Bay have — has the added advantage of consistency: he has set pots in the same locations and has only varied the number of days fished during the year.

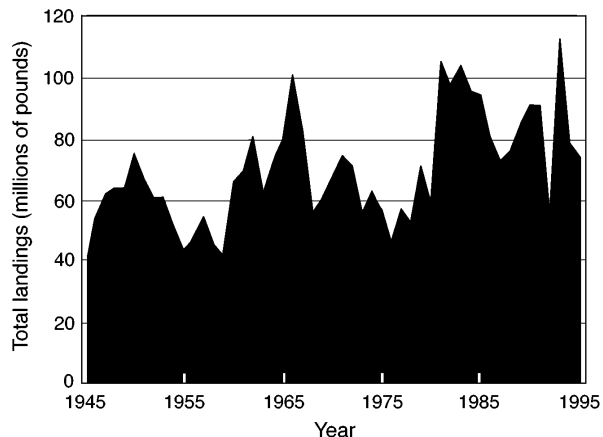
Twenty-eight years of setting pots and more than 113,000 crabs later, here are some of his findings:

- From 1968 to 1982, the annual percentage of males in pots decreased significantly; since 1983, annual percentages have fluctuated but there have been no further decreases.
- Mean width and weight of males have decreased significantly.
- Percentage of legal males (5 inches across) decreased from 56% in 1968 to 19% in 1995.
- Catches of female crabs have remained relatively steady, declining only slightly in the in the last few years.

Between 1968 and 1980, Abbe's counts averaged 3.6 legal-size crabs per pot, very close to the 3.7 average between 1986 and 1995. However, between 1981 and 1985, the average shot up to 8.1 crabs per pot, a number that was especially high because of the 1981 average of 13.

How representative are Abbe's findings for the rest of the Chesapeake Bay? He and Cluney Stagg of the Maryland DNR calculated a number of comparisons with other data — for instance, the annual record of commercial landings in Maryland and Virginia, as well as the statistics that Maryland gets on the harvesting efforts of commercial crabbers. The researchers also compared Abbe's data with the winter dredge survey sponsored by the Chesapeake Bay Stock Assessment Committee. In general, says Stagg, the records from survey data, from commercial catch statistics and from Abbe's records all seem to track.

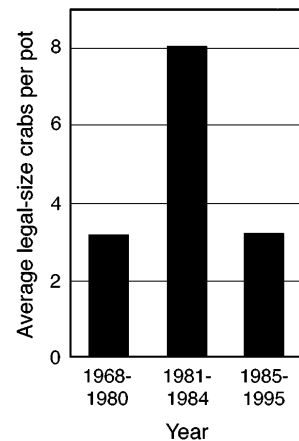
Chesapeake Bay Blue Crab Landings



For the last ten years, Abbe's pots have turned up crab numbers similar to those between 1968 and 1980 — but sizes of males are smaller. "If you look at the percentage of legal crabs that we caught over time, the average size of all males, and the average size of legal males, you see downward trends. To me," he adds, "that says we've put so much effort into the fishery that we're pulling out males as soon as they hit the minimum legal size. We're getting males primarily between five and six inches and males over six inches have declined precipitously."

Whether the decline in large males is representative Baywide and what that might imply for the blue crab fishery remains unknown. If the largest male crabs continue to be harvested, could this have an effect on the reproductive capacity of future stocks? So far, there is no consensus for predicting a future decline — surveys of the incoming numbers of young crabs (recruitment) have been steady or rising for the last five years. Meanwhile, Abbe's results are being incorporated into the CBSAC stock assessment effort, and for now at least, Abbe plans to keep catching crabs, and to keep counting them. ■

Blue Crabs Caught by George Abbe



Just as Chesapeake crab harvests rise and fall, so too does crab abundance and catch per unit effort. Researcher George Abbe is now catching fewer large crabs, a possible signal that while harvest pressure is up, stocks of larger males may be falling.

Blue Crabs, continued

were going to find a stock problem.”

As the subcommittee members went through the data and finished a preliminary analysis, they were “stunned and flabbergasted,” says Rugolo. “We simply were not picking up the problem.”

How Long Does a Blue Crab Live?

“The first order of business in doing an assessment is literally to define the characteristics of the species,” says Rugolo. For the blue crab, like other species, this means identifying its life history, how soon it matures, how fast it grows, how long it lives — these are examples of biological reference points that can then help scientists calculate levels of catch or exploitation that will leave enough crabs to sustain stocks at a desired level.

The blue crab’s natural longevity is an important factor here and one still disputed by scientists. So far, no reliable method exists for calculating the age of blue crabs, a process made difficult by molting, where the crab leaves its shell — and evidence of its age — behind.

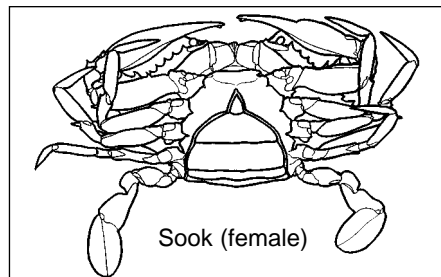
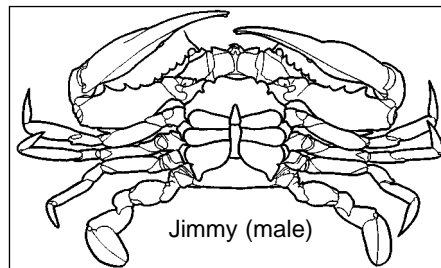
The question of aging is crucial. According to John McConaugha of Old Dominion University, if the crab reaches maturity quickly, only living to age three, as many scientists have believed, then one could argue that fishermen may as well harvest them, since market-sized crabs will have already reproduced and will die anyway. If, on the other hand, crabs can live to age six or seven or eight, then fisheries managers may want to establish regulations based on longer lives. For instance, females are thought to mate only once, though they can spawn more than once — a second or third spawning could depend on how much sperm she is still carrying from the original mating.

If larger (and, therefore, older) male crabs carry and deliver more sperm, one management consideration may focus on protecting large males. Jacques van Montfrans of the Virginia Institute of Marine Science argues that protecting females is also important since larger females pro-

duce more eggs. An important management issue, then, would be to protect the largest spawners, not just the egg-carrying females, known as sponge crabs. “Fishing on them [the large males and females],” he says, “could potentially have a great impact on the crab population.”

Clearly, the age used in stock assessment models can significantly influence a model’s projections. While long-time Bay scientists like Eugene Cronin and Willard Van Engel have taught for years that crabs live three, at most four, years, there have been recent indications that they may live five or six or even eight years. Though one tagging study from the 1940s showed that blue crabs lived to at least five years, that study took place farther south, in Albemarle Sound, North Carolina.

Are such results applicable to the Chesapeake Bay as well? According to some researchers, new information is causing scientists to rethink several basic assumptions about blue crab biology — not only the natural life span of a crab, but multiple spawnings by females, and possible molting



Jimmies or sooks — which are more important for maintaining blue crab stocks? Some believe that protecting egg-bearing females is more important, but others argue that size may be as important as sex, and that we should protect older, larger crabs. This is complicated by the fact that scientists do not yet have an accurate means for determining the natural life span of the blue crab.

The question of age is crucial. Stock predictions depend on the life span fisheries modelers assume for blue crabs, and that can vary from 4 to 6, or even 8 years.

after reaching sexual maturity, what had traditionally been considered the “terminal” molt.

In 1989 and 1990 McConaugha was funded by CBSAC to conduct a tagging study to try to determine the longevity of female crabs. His group tagged 17,000 female crabs and got about a thousand back, most in the first and second years. When he received calls of tag returns five years later, in 1994 and 1995, he remained skeptical because he never saw the crabs himself. This spring, however, a female crab aged seven or eight years was returned from a source considered reputable.

In the face of changing information Rugolo’s committee assumed a longevity of, at first, six years — a biologically conservative age limit — and then in response to scientific reaction, of four years — a more traditional assumption. In their analyses an assumption of six years led to the conclusion that crab stocks were “close to being [fully] exploited.” When an assumed longevity of four years was used, the model pointed to “no evidence of overfishing.”

Then again, if one assumes that blue crabs can live to seven or eight years, the model may imply that current harvesting could be at the edge — or over the edge — of what blue crabs need to successfully reproduce.

The CBSAC report caused a good deal of controversy: some in the public media focused on the lack of a crisis and downplayed the call for strong conservation measures. Some scientists criticized the assumptions about blue crab age estimates and questioned the stock assessment analysis itself. According to Don Boesch, President of the University of

The Summer of '96: Maryland Blue Crab Regulations

The crabs need a day off as much as we do," says a waterman in Tom Horton's new book about Smith Island, where there is traditionally no fishing on Sunday. As of June 17, new Maryland regulations call for just that, a day to give the crabs a break. Commercial crabbers will have to choose either Sunday or Monday as a no-crabbing day, and they will have to affix a sign (SUN or MON) to let everyone know which day they are taking off.

Recreational crabbers using collapsible traps or trotlines will have to take Wednesday off, to relieve some of the pressure on blue crabs. (Exceptions for both commercial and recreational crabbers will be granted on State and Federal holidays.) The regulations form part of new efforts by Maryland and Virginia to regulate rising fishing pressure on the popular crustacean.

Highlights of Maryland's Regulations

Commercial

- The Maryland crab season runs from April 1 through November 30.
- Commercial crabbers must take off either Sunday or Monday.
- There must be two different-sized cull rings in hard crab pots, one at least 2-3/16 inches and the other at least 2-5/16 inches.
- The minimum mesh size for hard crab pots is increased from 1 inch to 1-1/2 inches.
- Peeler pots can only be baited with live male crabs.
- The importation of late-term sponge crabs, illegal in Virginia, into Maryland is prohibited.

Recreational

- The recreational crab season runs from April 1 through November 30.
- Recreational crabbers using collapsible traps and trotlines must take off Wednesdays.
- No license is required for recreational crabbing, but sport crabbers can catch only one bushel of crabs a day per person, or two bushels per boat.
- It is illegal to possess an egg-bearing (sponge) crab in Maryland.
- Recreational crabbers cannot set or fish a trotline or collapsible trap within 100 feet of a commercial trotline.
- Recreational crabbers cannot sell crabs without a commercial license.



Maryland System's Center for Environmental and Estuarine Studies, "The stock assessment should have had more inclusion of blue crab biologists from the start, more factoring in of the uncertainty involved in stock assessment models, more review and quality control, and more direct communication with managers."

"It is difficult to get consensus," says van Montfrans. "There are things we don't know and things we don't agree on — people tend to think scientists ought to have a unified view."

The stock assessment subcommittee continues to refine its analysis, which will be reviewed by scientists before its release this fall.

For fisheries managers, stock assessment analysis is only one measure of the state of a fishery and only one tool in gauging its health. They have to consider other issues in setting regulations to ensure a sustainable fishery. Bess Gillelan points to the importance of bi-state consistency between Maryland and Virginia, to the need for long-term stability for the industry in the face of fluctuating stocks, and to the overall economics of the fishery — all significant considerations in addition to the question of age and abundance.

Future Management Issues

While a better understanding of blue crab biology and population dynamics is critical to manage the fishery more effectively, there are unquestionably social, cultural and eco-

nomics considerations as well. Doug Lipton, a marine economist with the Maryland Sea Grant Extension Program, points out that whatever decisions managers make will have large economic impacts. And, adds Lipton, we need to consider the potential economic impacts of that decision-making from the outset.

Lipton and economists James Kirkley at the Virginia Institute of Marine Science and Leonard Shabman of the Virginia Polytechnic Institute are beginning to pose the kinds of questions that could influence the future of blue crab management in the Chesapeake Bay. For example, asks Lipton, are there less costly ways of controlling the fishery? Are we achieving our biological goals of sustainability in an efficient manner? For example, declining trends in the effort it takes to catch crabs (the catch per unit effort) could be due to too much fishing gear — if so, every additional pot or trotline results in everyone harvesting fewer crabs.

We need to ask hard questions, Lipton says, questions that in the Chesapeake Bay are likely to be controversial. For instance, some fisheries in other coastal areas have instituted Individual Transferable Quotas (ITQs), a limited entry system in which fishermen are given quotas on how much they can harvest. This system of management eliminates the race to harvest crabs that can lead to what Lipton calls "excessive use of gear" and a waste of resources. With

ITQs, he says, the crabber is free to harvest his or her quota at the lowest possible cost.

For example, says Lipton, every year some 40 million pounds of crabs are being harvested from the Maryland portion Chesapeake Bay, on average. "How many pots do we need to catch that?" he asks, adding that "every pot over that is a waste."

In addition to all these questions are questions about the impact of regulations on Bayside fishing communities, and on those who depend on the blue crab for a livelihood — not to mention the half a million recreational crabbers who spend their free time chasing crabs.

Already a Fisheries Management Plan is being finalized for the Chesapeake blue crab, though important gaps in biological information still remain. In particular, researchers are considering new analytic tools — such as the measurement of lipofuscin, compounds that accumulate over time — to accurately age blue crabs. Meanwhile, resource managers will continue to adjust regulations according to the best information that fisheries science can provide. In the end, there is no doubt that decisions about the blue crab fishery will provide a fascinating history of how scientists, citizens and decision makers interact to manage a much sought-after public resource. ■

(Jack Greer contributed to this article.)

FDA Comes to Columbus Center

The U.S. Food and Drug Administration has announced that it will house its newly created National Seafood Safety Center in the Columbus Center on Baltimore's Inner Harbor. With the Center of Marine Biotechnology already moved in, the Columbus Center is now fully occupied, according to Stan Heuisler, President of Columbus Center Development, Inc.

The agreement, which leases some 20,000 square feet to the FDA for 20 years, should bring at least 24 of the government's top seafood scientists to the marine research center in Baltimore. Senator Barbara Mikulski and other members of the Maryland delegation made the announcement in the Main Hall of the Columbus Center.

Ron Baird New Sea Grant Director

Ocean scientist, educator and businessman Ronald C. Baird has been named director of the National Sea Grant College Program, located in the National Oceanic and Atmospheric Administration, Department of Commerce. Baird assumed his new position on June 3, 1996, after completing his tenure as Vice President of University Relations at Worcester Polytechnic Institute in Massachusetts.

According to NOAA Administrator D. James Baker, "Dr. Baird's experience in business and education, as a scientist and college administrator, makes him uniquely qualified to lead Sea Grant." Baker went on to add that Sea Grant — a network of over 300 colleges, universities and research institutions — depends on "a solid working relationship between business, government and the university research community."

Baird was formerly director of research at Geo-Marine, Inc., an engineering consulting firm, and served on the National Sea Grant Review Panel, a 15-member independent citizens advisory committee, from 1990-95.

Knauss Fellowships



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.

This year Tim Battista, a graduate student in the Marine-Estuarine-Environmental Sciences (MEES) Program at the University of Maryland Center for Environmental and Estuarine Studies, is the recipient of the Knauss Marine Policy Fellowship in Maryland. Tim is currently working on marine science and policy at NOAA.

The application deadline for next

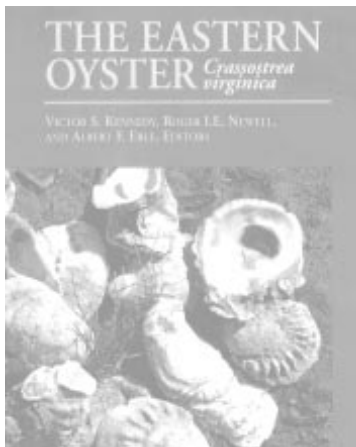
year's fellowship program is September 1, 1996. The applicant must be enrolled in a marine science-related graduate program by September 30 of the year of application.

For more information or an application brochure, contact Susan Leet at the Maryland Sea Grant College (301) 405-6375.

University Faculty on Tributary Teams

When the Chesapeake Bay restoration effort moved upstream to deal with runoff and other land-based problems, the State of Maryland created ten teams to help guide efforts in the ten regions named as watersheds for major Bay tributaries. Along with other Marylanders from all walks of life, a number of University of Maryland System faculty and staff serve on the Tributary Teams. They include: Russell Brinsfield, David Conrad, Paul Gunther, Ted Hass, Don Haynes, Elizabeth Hickey, Pamela King, James Lewis, Ray Morgan, Thomas Miller, Ruth Miller, Dave Nemazie, Robert Ragan, Eileen Setzler-Hamilton, and Carl Weber.

New Book Available



"The Eastern Oyster: *Crassostrea virginica*," edited by Victor S. Kennedy, Roger I.E. Newell, and Albert F. Eble, is currently available from Maryland Sea Grant. The most comprehensive synthesis about *Crassostrea virginica* since "The American Oyster," Paul Galtsoff's landmark 1964 work, "The Eastern Oyster: *Crassostrea virginica*" contains 21 chapters focusing on such topics as anatomy, the shell, larval biology, feeding, reproduction, genetics, predation, diseases and defense mechanisms, aquaculture and management.

The book is hard cover, 772 pages, 8-1/2" x 11" format, with 400 photographs, drawings and diagrams. The cost is \$95.00 U.S. Contact Maryland Sea Grant to find out about discount offers. Mail your order to: Publications Department, Maryland Sea Grant College, 0112 Skinner Hall, University of Maryland, College Park, Maryland 20742.

End Notes

Awards

■ *Ralph Bennett*, a professor active in land use issues at the school of architecture and a member of the firm Bennett Frank McCarthy Architects, received a Gold Seal Award from the National Council of Seniors Housing of the National Association of Home Builders. Bennett's firm received the award for its design of Bartholomew House on the grounds of St. Bartholomew's Catholic Church on River Road in Bethesda. The project, which won the award in the unbuilt category, is scheduled for construction in 1997.

■ *Herman Daly*, senior resident scholar of the School of Public Affairs, won the Dr. A. H. Heineken prize for environmental sciences, which includes a \$160,000 award. Herman was recognized by the Royal Netherlands Academy of Arts and Sciences for his "original contribution to insights into the socio-economic aspects in the decline of the environment." He is one of the first economists to focus on environmental problems and is considered the founder of the new discipline of ecological economics.

Grants

■ Sea Grant Extension Specialist *Dan Terlizzi* has been awarded \$5,000 by the University of Maryland Agricultural Experiment Station for a preliminary study entitled, "Macroalgal Aquaculture for Waste Removal from Netpens in the Chesapeake Bay."

The release of nutrients has been a major impediment to open water aquaculture, especially in areas like the Chesapeake Bay, where restoration efforts aim at reducing nutrients. Terlizzi notes that macroalgae provide waste removal and also produce a product which

is valuable in many areas worldwide. For example, *Ulva*, a typical Bay species, is used elsewhere in the world as a food product.

According to Terlizzi, who is trained as a botanist, the culture of macroalgae could perhaps be used to reduce nutrients in the Bay watershed in other ways, as well. "Here we have a very fertile temperate estuary where we have an overabundance of algal blooms," he says. "Perhaps we could use that same environment to grow more valuable species, and remove nutrients from the estuary at the same time."

Events

■ CEES Open House

The Center for Environmental and Estuarine Studies' (CEES) Horn Point Environmental Laboratory Open House, held on Saturday, May 18, drew some 500 people eager to learn more about the Chesapeake Bay. The open house took place on the banks of the Choptank River near Cambridge, where the Lab is located.

CEES scientists, students, and staff gave presentations and offered special exhibits and tours highlighting recent research efforts in Chesapeake Bay ecology, environmental education, and oceanography. According to CEES spokesperson Alexis Henderson, visitors learned why fish and oyster farms are important to Maryland's future, how scientists measure the Bay's health, how computers are used in environmental research, and how we can all become better caretakers of Maryland's environment.

Maryland's Department of Natural Resources also provided exhibits focused on Bay restoration efforts, including information about the Maryland Tributary Strategy Teams and the Chesapeake Bay National Estuarine Research Reserve.

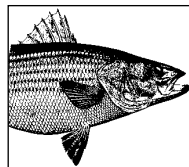
For more information about the open house or other activities underway at CEES, contact Alexis Henderson at (410) 228-9250.

Opportunities

■ Coordinated Education Programs Offered

Three popular education programs in Maryland — Project WET, Project WILD and Project Learning Tree (PLT) — are collaborating with the Maryland Department of Education to develop adaptation, or practice evaluations, to reflect Maryland State performance (MSP-SP) outcomes. By fall, these new tools will be incorporated into the training program. For more information or a brochure listing workshops available this summer contact WET at (410) 974-8474, WILD at (410)-974-3195 or (410) 543-6595, or PLT at (410) 543-1950.

■ Marine Research



Financial Assistance for Chesapeake Bay Stock Assessments
Approximately

\$540,000 in 1996 funds (Federal Fiscal Year) is available through the NOAA/NMFS Chesapeake Bay Office to assist interested state fishery agencies, academic institutions, and other nonprofit organizations in providing information for Chesapeake Bay Stock Assessments through cooperative agreements. About \$70,000 of the base amount is available to initiate new projects in FY 1996, while the balance will be used to fund continuing projects begun in previous years. Applications for funding under this program will be accepted until June 24, 1996. For further information contact: Bess Gillelan at (410) 267-5660.

Conferences, Etc.

ECSA and ERF Symposium September 16-20, 1996

The Estuarine and Coastal Sciences Association and the Estuarine Research Federation will hold its second joint symposium in Middleburg, The Netherlands. The local host organization is the Netherlands Institute of Ecology, in cooperation with the National Institute for Coastal and Marine Management.

The symposium will provide a venue for participants to explore interdisciplinary approaches, with an emphasis on the processes that govern the fate of organic and inorganic matter in estuarine and coastal systems. The meeting will examine improved modeling of chemical, biological and physical factors, essential for improving our understanding of these systems. For more information contact Ken Tenore at (410) 326-7247; fax (410) 326-7302.

International Conference on Shellfish Restoration November 20-23, 1996

Held in Hilton Head, South Carolina, this program will be organized around these general themes: Shellfish Habitat Assessment and Restoration; Shellfish Stock Enhancement; Management and Restoration; Shellfish/Habitat Remediation through Watershed Management and Pollution Abatement.

The conference will feature concurrent sessions structured with an invited plenary presentation, followed by contributed oral presentations in the morning, on-site and off-site workshops in the afternoon, and contributed poster presentations in the early evening. For more information contact: Rick DeVoe, South Carolina Sea Grant, 287 Meeting Street, Charleston, SC 29401.



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