

MARINE NOTES

SPOTLIGHT ON RESEARCH

A QUESTION OF SURVIVAL

Helping Oysters Overcome Disease

BY MERRILL LEFFLER AND JACK GREER

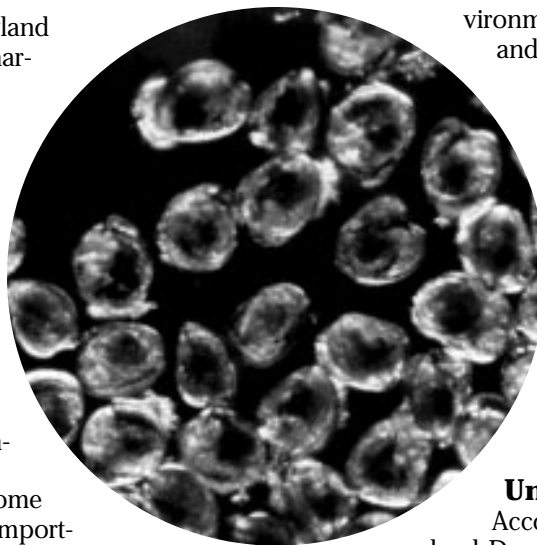
For more than a half century Maryland and Virginia have regulated the harvest of oysters in an attempt to slow a long decline. Now, with the continuing devastation of two oyster diseases — MSX and Dermo — some question remains whether even tight restrictions can save the Chesapeake's oyster populations.

Oysters under Siege

"Diseases," says Victor Kennedy of the University of Maryland's Center for Environmental and Estuarine Studies (UMCEES), "are a natural component of biological systems." Those such as Dermo — and MSX, which some researchers believe was accidentally imported into the Chesapeake — might have been present for many years. That they are so virulent now may be the result of the Bay's changing ecology. These changes could be related to pollution, to runoff, and to the overharvesting of oysters themselves — and consequent changes in habitat and bottom-dwelling communities, most notably the destruction of large reefs.

Some scientists argue that in addition to the destruction of reefs and other habitat changes, the years of intense harvesting in the Chesapeake may have also removed substantial numbers of oysters, and their potential progeny, with a natural resistance to parasitic disease. If left undisturbed — though for how long is uncertain — oysters with a natural resistance could begin, through natural selection, to survive and repopulate themselves.

Whatever the reasons, these two diseases are now firmly entrenched, though their virulence depends on en-



vironmental factors, particularly temperature and salinity.

In the face of social and economic pressures resulting from the demise of the oyster fishery in the Chesapeake and with the recognition that oysters play a critical role in the ecology of estuaries, the U.S. Congress appropriated funds in 1989 for the Oyster Disease Research Program, which is supporting scientists and resource managers to develop new ways of combating disease (see the sidebar, "Legislating to Fight Disease").

Understanding the Enemy

According to Chris Dungan, of the Maryland Department of Natural Resources Cooperative Shellfish Laboratory, the devastation of MSX and Dermo will "wax and wane" year by year, in a game of climatic roulette. The amount of rainfall affects salinity and both diseases are worse at higher salinities. In 1996, for example, Maryland's oysters got a break, according to Dungan, when record precipitation led to lower salinities in many parts of the Chesapeake. In 1996, he reports, the state's annual survey showed MSX restricted primarily to Tangier Sound, the more saline part of Maryland's Bay.

Dermo also slacked off slightly, according to Dungan. "We found a few places well north of the Bay Bridge that had Dermo last year that didn't have it this year." Otherwise, says Dungan, "Dermo is still everywhere."

"Dermo was actually discovered in the Chesapeake Bay first," Dungan says, but he points out that once MSX arrived its staggering virulence tended to attract all the attention. Now even when MSX lets up during periods of

Photo above shows free-swimming larval oysters.

Please turn page

Oysters, continued

lower salinity, Dermo tends to keep on killing.

According to Eugene Bureson at the Virginia Institute of Marine Science (VIMS), the fresh water flows of 1996 helped hold down disease in Virginia as well, at least in the rivers. "We saw no MSX in the James River or the Rappahannock," he said, "and only a little in the York." MSX could still be found in the mainstem Bay and in Tangier and Pocomoke Sounds, though mortalities were down. And while still present in their samples, the severity of Dermo disease was also lessened by the rains. "We haven't seen levels this low in eight years," says Bureson, but he points out that Dermo is still widely distributed and found "just about every place we look for it."

In fact, Bureson says, "if I had to pick one of the diseases as the worst, I guess I would have to pick Dermo." This may seem surprising, since MSX has decimated the oyster industry in Virginia, but, as Dungan also notes, even though Dermo does not kill as quickly or as completely as MSX, it is more persistent. "When salinities drop below 10 parts per thousand, MSX will disappear for a while," says Bureson — at least until salinities rise again. But Dermo, he says, will "hang on" even in low salinities, and as soon as conditions become more favorable the disease will spread.

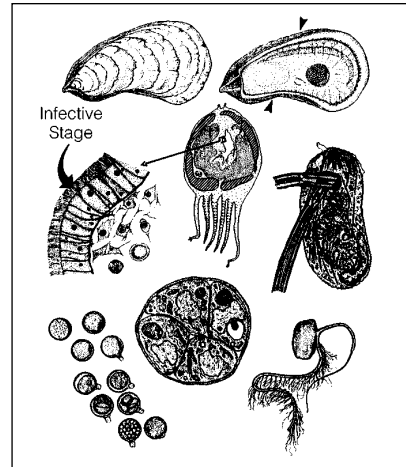
A major front in the search to understand the diseases is in trying to discover the fundamentals of the parasites' behavior, says Chris Dungan, the conditions that favor growth, survival, and virulence. "We need to know our enemy," he says.

Scientists in the mid-Atlantic were first able to culture Dermo several years ago (see *Marine Notes*, Volume 11, Number 4), an advance which has allowed scientists to undertake studies on the oyster's immune system that would otherwise not have been possible. In the last year, researchers at VIMS have developed new molecular tools to discover the life cycle of MSX. According to Dungan, Eugene Bureson not only has a new diag-

Formidable Foes

MSX first appeared in Chesapeake Bay in 1958, after it ravaged oyster beds in Delaware Bay the year before. Though this single-celled organism has been identified as a protozoan, *Haplosporidium nelsoni*, its life cycle and means of infecting oysters remains as mysterious now as it did then. Unlike Dermo, MSX cannot be transmitted from oyster to oyster — new molecular tools, however, are now making it possible to hunt for carriers of microscopic MSX cells, in zooplankton, in fish and in bottom-dwelling organisms.

Dermo — also a protozoan, *Perkinsus marinus* — was first observed in Gulf Coast oysters in the 1940s, and in the lower Chesapeake in the early 50s. With the widespread movement of oysters to different areas throughout the Chesapeake, Dermo itself has inadvertently been spread as well to most harvesting areas. While recent studies have shown a higher virulence of *Perkinsus* in the mid-Atlantic than in Gulf waters, genetic research has revealed differences between *Perkinsus* in two mid-Atlantic locations — Delaware and Mobjack bays. Knowing areas where *Perkinsus* strains are more virulent could help state and private aquaculturists better manage around disease.



Stages of Dermo seen in *Crassostrea virginica*. From *THE EASTERN OYSTER: CRASSOSTREA VIRGINICA*, edited by V.S. Kennedy, R.I.E. Newell and A.F. Eble

If I had to pick which disease was worse, I would pick Dermo.

nistic tool and an "excellent team," he is also driven to solve the disease problem.

"He has a thing for MSX," says Dungan. "I am really excited about their work."

Such excitement is understandable. Though MSX has ravaged Bay oyster bars for four decades, neither scientists, resource managers nor watermen can say how the parasite moves around or how it infects the oyster. Bureson hopes to change that, using tools never before available. "We have already found positive samples" says Bureson, meaning that genetic material from MSX is present

in the sediment and water column. "Whether these are free spores or developmental stages [of MSX] we don't yet know," he says. Bureson's team is just now proceeding with its analysis.

Developing Oysters that Can Resist Disease

In addition to the development of new techniques for culturing Dermo, and new probes for detecting both Dermo and MSX, the disease research program has focused on developing a hardier oyster. If successful, the program could speed up what natural selection might otherwise do.

These studies, says Rutgers University scientist Standish Allen, include:

- Breeding disease resistant oysters through traditional genetic techniques.
- Evaluating the Chesapeake's native species, the eastern oyster (*Crassostrea virginica*) in other regions where Dermo is prevalent (such as

Gulf Coast waters) and where oysters may have already developed improved resistance to disease.

- Transferring genes for disease resistance from other *Crassostrea* species, such as the Pacific oyster (*Crassostrea gigas*) into the Bay's eastern oyster.
- Hybridizing the eastern oyster with strains of the same species that are more disease resistant, and also with the Pacific oyster.

"Perhaps closest to making a difference in the relatively near term," says Allen, "is a program where we have taken MSX-resistant oysters as a foundation stock to breed oysters for resistance to Dermo as well."

Hal Haskin began those foundation stocks shortly after MSX invaded Delaware Bay in 1956, virtually eliminating the oyster industry there. Scientists at what is now Rutgers' Haskin Shellfish Research Laboratory continued that breeding program and have reared oysters in the Rutgers hatchery

that would tolerate MSX. Those stocks have been used for research, and for aquaculture. When Dermo invaded Delaware Bay in 1990, however, these specially bred stocks were vulnerable — those that have survived are now being used as the basis for creating a second generation, says Allen.

Allen is working with Kennedy Paynter of the UMCP Department of Zoology and Don Meritt of UMCEES and Mark Luckenbach and Eugene

Continued on page 6

Legislating to Fight Disease

The Oyster Disease Research Program



While researchers in the Bay region have been at work for years trying to map the outbreaks of oyster disease, to understand its cause and to discover why the Eastern oyster (*Crassostrea virginica*) remains unable to defend itself, they lacked stable funding for such a sizeable undertaking. In 1989, however, the U.S. Congress enacted legislation to fund a focused initiative, the Oyster Disease Research Program.

This extensive program of ongoing research coupled with outreach and management efforts aims to better serve the restoration of healthy populations of oysters in the nation's coastal waters. The Program began in 1990 with oversight by the NOAA National Marine Fisheries Service and its Chesapeake Bay Office, and is now administered by the National Sea Grant College Program.

Through competitive proposals each year, the Oyster Disease Research Program is supporting efforts to develop:

- optimal strategies for managing around disease
- molecular tools to better monitor the onset and presence of disease
- better understanding of the processes of parasitic infection
- improved understanding of the oyster's immune system
- hatchery techniques for producing disease-resistant strains

As one researcher says, it is a program that spans approaches from the "molecule to the mudflat."

"In the first six years," says Bill Rickards, director of the Virginia Sea Grant Program, "we have made enormous progress in our understanding of the dynamics of disease and in capabilities that are now ready for field trials."

These capabilities include molecular probes that can rapidly determine whether or not an oyster has Dermo or MSX — conventional tests require laborious laboratory confirmation that can take days, says Rickards. This ability to diagnose quickly whether oysters have Dermo or MSX could better enable aquaculturists to take remedial actions such as moving oysters to lower salinity waters where disease may be less of a threat.

Several years ago, Rickards points out, scientists at Rutgers University, the University of Maryland's Center of Marine Biotechnology (COMB), and the Virginia Institute of Marine Science (VIMS) determined how to culture Dermo, allowing them to grow significant quantities in the laboratory. This has had enormous benefits for scientists, says, COMB researcher Gerardo Vasta, who, with his colleagues, helped to lead the effort in Maryland.

Research that Rickards is especially excited about for its near-term potential are the studies for developing oysters that are more resistant to disease. Oysters that survive to maturity will not only lead to larger commercial harvests but will help begin restoration of depleted oyster reefs, thereby returning some of the oyster's important ecological function to the estuary. While he is sanguine about the prospects, Rickards is also realistic. "It has taken more than a century to decimate the nation's greatest oyster resource," he says. "We are not going to restore it very quickly, no matter how successful our research proves to be."

Without that research, restoration of the Bay's oyster populations would no doubt be even further off.

For more information on the Oyster Disease Research Program, visit the web: <http://www.mdsg.umd.edu/NSGO/research/oysterdisease/RFP.html>

A Book Review

Yesterday's Oysters Today

BY DON WEBSTER

The Oyster, by William K. Brooks. Introduction by Kennedy T. Paynter, Jr. The Johns Hopkins University Press. \$14.95.

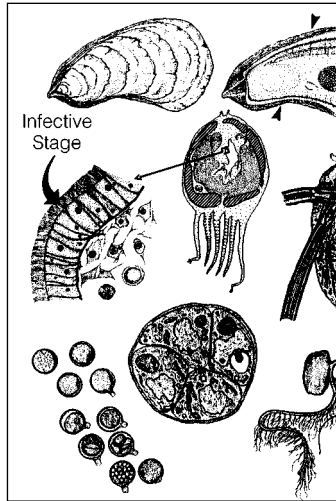
Dr. William K. Brooks has reached from beyond the grave. His book, *The Oyster*, published in 1891 by Johns Hopkins University, has been reissued and stands in stark condemnation of how Marylanders have politicized their oyster industry for over a hundred years.

We have wasted our inheritance by improvidence and mismanagement and blind confidence; but even if our beds had held their own and were to-day as valuable as they were fifty years ago, this would be no just ground for satisfaction, in this age of progress, to a generation which has seen all our other resources developed and improved.

Brooks was writing in a period when the oyster harvest had started to recede from a 10,500,000 bushel annual yield. Harvests had routinely been in these eight digit figures and yet he foresaw the destruction that was occurring through indiscriminate gathering. He also had the unshakable faith of one who knew that, with cultivation methods, harvests could not only be maintained at these high levels, but increased. He was one of Maryland's first Oyster Commissioners and, in that position, argued for the first surveys of the State's oyster bars, a feat which took place early in the 1900s. Unfortunately, most of his other strongly held opinions on how to increase the harvest for the betterment of the citizens were never instituted.

I first read Brooks twenty-two years ago when my wife surprised me with a copy that she found in mint condition in an old book store. I have treasured it since. The impact of the first reading was immense. His warnings, laid down with laser precision, have not diminished to this day.

This edition is enhanced by an introduction by Kennedy T. Paynter, Jr., one of today's bright young oyster scientists. He essentially reinforces Brooks' ar-



guments and updates them with references to contemporary oyster literature. Paynter not only gives a much needed update to the original text but introduces the specter of the oyster diseases popularly known as MSX and Dermo that have led to the current crisis in the industry. An interesting aspect about the diseases, however, is that they have likely been spread by the very programs meant to help the fishery.

If you follow the history of conflict in public policy regarding the Maryland oyster industry, you find that about once in every generation a scientist has come along who has not only come to the same conclusions as

Brooks, but has had about as much success in effecting a long lasting and meaningful change in the industry. Today, however, there has been a new-found interest in the oyster — not just as a commercial entity, but as an important benthic organism and effective biofilter that can be of significant value in helping to cleanse the Bay of excessive phytoplankton.

While the reprint is excellent reading and includes a faithful reproduction of both Brooks' words and figures, its production quality unfortunately cannot come close to the original. The first edition is bound in green with a gilt oyster embossed on the cover. The lithographic illustrations in the original are printed in handsome sepia tone which is not well reproduced in the latest volume. Some of the plates seem to have been reproduced from less-than-perfect originals, as wrinkles and tears seem evident in a few. Perhaps, if this volume sells well, a special collectors' edition should be considered, with binding and plates as high quality as those of the original.

Brooks' popular treatise on oysters contains the basics of how an oyster works, explained in a form easy enough for youngsters to understand. Indeed, in addition to his prowess as a biologist, Brooks was an excellent popular writer, able to explain scientific theory and detail in a very understandable form. In explaining the amazing fecundity of the oyster, for instance, he calculated that, if all descendants from a single female lived and reproduced only once, in the fifth gen-

eration their mass would make up more than eight times the volume of the Earth! And this was in the days before computers. He then goes on to cover the early work in artificial propagation of the animal.

He traces the culture of oysters through manipulation of spawning and catching spat in the water back to the early Romans. Brooks next speaks of the successful culture operations that he had investigated in Europe and various parts of the United States. These are presented as examples of how the Chesapeake Bay could become an oyster gold field, if properly managed.

Our opportunities for rearing oysters are unparalleled in any other part of the world, and in another place I have shown that, in other countries, much less valuable grounds have by cultivation been made to yield oysters at a rate per acre which, on our own great beds, would carry our annual harvest very far beyond the sum of all the oysters which have ever been used by the packers of Maryland and Virginia.

In his chapter on "The Cause of the Decline of our Oyster Industry, and the Protection of our Natural Beds," Brooks notes that the primary obstacles to increases in production are lack of access to planting grounds and theft of privately cultured oysters. These problems remain today two of the most persistent in inhibiting production through non-public means. The history of Maryland's oyster industry is one in which the different segments of the industry blame others for their woes and, as a result, nothing happens to improve matters.

All agree in throwing the blame on someone else and all believe that some form of the business in which they are not interested is responsible for the present state of things and should be prohibited; but as the oyster navy is a convenient scapegoat, all parties unite in throwing the blame upon the officers of the Fishery Force.

Chapter VI is entitled "A Talk About Oysters" and purports to be a conversation between a farmer visiting an oyster packer in Baltimore. The farmer speaks of the declining oyster populations and the problems of the industry and asks questions from a grower's perspective. The packer answers with the same views that have been given more than a thousand times around the docks of Maryland over the years. He says, in essence, that while we know things can be better and have examples of how they have been, the Bay remains common property for all the state's citizens, though it is only a very few who wish to be allowed to use it.

I think, said the farmer, that I begin to understand the situation. It seems something like this. As the beds belong to the community, private oyster culture has not been permitted, since it would be a monopoly. Yet the common property of the citizens of the State has been given up to one class of citizens in order that they might have profitable employment. They have not managed their trust wisely, and have brought it so near the verge of ruin that it is no longer attractive to Marylanders, and they have called in the cheaper labor of foreigners. To give these foreign laborers employment the people of the State have not only given up their rights, but have also paid taxes for the support of the navy. This state of things cannot last. What do you propose to do about it?

The final chapter in *The Oyster* is called "The Remedy." In it, Brooks gives his ideas about how the oyster harvest from the Bay could be increased, although he is quick to bring humility into his suggestions by noting that there are many divergent interests and viewpoints involved. His proposals, however, remain as potentially effective today as when they were written.

To ourselves and to our posterity we owe it that our resources shall be fully developed, for our oyster-beds are our greatest source of wealth, and upon them, more than upon our commerce, our manufactures, or our farming land, the future wealth and prosperity and population of our State depend.

This is a book that should be in the collection of every person who values the Chesapeake Bay and its natural resources. It is the story of what could have been and what could still be. It is a book that provides facts and figures on how to turn around a failing fishery and make it great once again. It is a book that needs to find its way into the hands of every politician and policy maker in Maryland.

Perhaps William K. Brooks, in his second time around, will be able to change a few hearts and minds about the potential of this great estuary and its oyster industry. But even if that doesn't occur, he will still be seen as a visionary with a hard, practical streak. Not unlike Paynter and some of his contemporaries — let's wish them luck as they try to alter the downward spiral of the Chesapeake oyster fishery.

Don Webster is the Maryland Sea Grant Extension Area Agent for the Eastern Shore.



Oysters, *continued from p. 3*



Researchers Standish Allen and Ximing Guo examine oysters at Rutgers' Haskin Shellfish Research Laboratory.

Burreson at VIMS in a project they call Cooperative Regional Oyster Selective Breeding or "CROSBreed." The team is growing the specially bred Rutgers oysters at three sites — one in the Delaware Bay and two in the Chesapeake (in Maryland's Choptank River and Virginia's Mobjack Bay). In addition to these specially bred oysters, all three sites have been given control stocks from Delaware Bay, and from local oyster beds.

After one year, says Allen, the oysters are doing well. Does that mean that they are more resistant to disease? It is too early to say — this past summer was unique, says Allen. Like Dungan and Burreson, Allen notes that in 1996, "We had a lot of rain." The lower salinities may have held disease in check on the experimental bars, just as on the natural bars.

We need another growing season, says Allen, to see where we go next.

If all the CROSBreed oysters outperform the controls, that could mean these are the ones to use as spawning stock for restoration and aquaculture. On the other hand, if CROSBreed oysters do better in one place and the local strain in another, researchers may need to breed different strains for different locations.

It could take countless growing seasons if the Chesapeake is to once again have sizable oyster populations — but large achievements are the result of many small ones and there is, at least, some optimism that the small ones have begun. ■

Bay Partner Communities

The Chesapeake Bay Program has announced its Chesapeake Bay Partner Communities program — a new awards program to recognize and reward the local governments that are making strong commitment to the protection and restoration of streams, rivers and the Bay. All of the 1,650 local governments in the Bay region are eligible to become a Bay Partner Community. The Chesapeake Bay Program will accept applications from local officials through mid-March.

Coordinated by the Chesapeake Bay Program's Local Government Advisory Committee, the Bay Partner Communities program is based on six themes: development that works; preventing pollution; conserving and preserving living resources (including fish, shellfish and other critters); valuing trees and forests; conserving the countryside/revitalizing communities; and community participation.

To be eligible for either bronze, silver or gold status under the new awards program, local officials must complete an application which includes listing specific restoration and conservation actions. In reviewing the applications, Chesapeake Bay Program officials will be looking for communities that have demonstrated their environmental commitment in their programs and budget.

To receive a copy of the Bay Partner Communities application, call (800) 446-LGAC.

SG Fellowships

Graduate students have the chance to obtain up to \$30,000 to work on a project cooperatively with industry, the university and Sea Grant through the Sea Grant Industrial Fellows Program, funded by NOAA's National Sea Grant office. Begun in 1995, the Fellowship Program provides, in cooperation with specific companies, support for highly-qualified graduate students who are pursuing research on topics of interest to a particular in-

dustry or company. The student, a faculty advisor, a Sea Grant program and an industry representative all work together in a partnership on a project from beginning to end. Research facilities and the cost of the activity are shared. Up to seven fellowships are awarded nationally each year with selection made through a national competition.

Those interested in applying must submit proposals to the Sea Grant Program in their state. Proposals may request grants to support up to 50 percent of the total budget, with no more than \$30,000 of federal funds requested in any year. Students can use University faculty as the major source for identifying potential industrial collaborators and suitable research topics as well as the Sea Grant Extension Program, university industrial relations office, and the Sea Grant Review Panel.

To apply, students at any university or college in Maryland should submit a proposal by April 1, 1997 to the Maryland Sea Grant office.

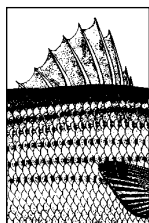
Faculty and Extension personnel are encouraged to recruit and assist qualified students in applying. For more information about the Fellowships and detailed information about putting together a proposal, contact Susan Leet at the Maryland Sea Grant office, by phone (301) 405-6375, or e-mail: leet@umbi.umd.edu.

Sea Grant RFP

Maryland Sea Grant is seeking innovative proposals in marine research for the two-year funding period which begins February 1, 1998. The new Request for Proposals (RFP) will be issued on March 1, 1997, and pre-proposals will be due on April 14, 1997. The RFP encourages projects in a range of areas, from environmental studies to aquaculture and biotechnology. The RFP can also be found on the Maryland Sea Grant web site, at <http://www.mdsg.umd.edu/MDSG>. For additional information, call Gail Mackiernan at (301) 405-6373. To request a copy of the printed RFP booklet, call (301) 405-6371 or e-mail Ellen Lundgren: lundgren@umbi.umd.edu.

End Notes

National Program on Catch and Release



Eleven inshore Atlantic and Gulf species are the target of a new fish tagging program organized by the BOAT/US Clean Water Trust. Anglers are now being recruited to attach tags to healthy amberjack, bluefish, cobia, drum, grouper, mackerel, sea trout, snapper, striped bass, tautog and tarpon that are caught and released.

The BOAT/US Clean Trust is a national nonprofit organization promoting environmentally smart recreational boating and angling practices through public awareness and education.

Under a cooperative agreement between the Trust and National Marine Fisheries Service (NMFS), anglers who tag can play an important role in fisheries conservation and science.

Tagging Starter Kits which include everything needed to tag are available for purchase for \$12.95 at BOAT/US Marine Centers located along the East Coast or by calling 1 (800) 937-2628. Fees for the kit are used to help defray program costs. Additional tags and related supplies are also for sale.

Future plans include tag research and educational initiatives to increase use of catch, tag and release techniques among recreational anglers. For more information about the Fish Tagging Program contact Jenny Pereira at 1 (800) 262-8872.

Maryland Sea Grant offers a 30-minute video (\$10), *Fishing for a Future*, which describes catch-and-release fishing. To order call (301) 405-6376.

Call for Abstracts

Estuarine Research Federation Conference, Rhode Island Convention Center, Providence, Rhode Island, October 12-16, 1997. The theme of this conference will be "The State of Our Estuaries," which will be addressed

through special sessions, oral and poster presentations and workshops. Abstracts are requested on the following topics: the consequence of human development in the coastal zone, the physical and ecological responses of systems to changes in freshwater flow, the recovery of bays and estuaries, the consequence of habitat changes on estuarine systems, the effects of sea-level rise on our estuaries, and photoremediation. For details about submitting an abstract (abstracts are due April 1, 1997), contact the Estuarine Research Federation at (410) 586-0997, fax (410) 586-9226, e-mail: jbarth@cbl.cees.edu.

Environmental Finance Innovations

Working with the U.S. EPA, the University of Maryland Environmental Finance Center (EFC) is staging a series of workshops around the country to address creative and effective uses of State Revolving Funds (SRFs). The workshops, offered regionally at sites in Oregon, Texas, South Carolina, Michigan and Massachusetts, is entitled, "Watersheds and the SRF." A number of states around the country are adapting the SRF, originally designed to fund waste treatment plants, to help fund nonpoint pollution projects, including storm water and agricultural runoff abatement. The EFC is part of the UM System's Coastal and Environmental Policy Program, hosted by the Maryland Sea Grant College. For more information, call Elizabeth Hickey at (301) 405-6383 or visit the web: <http://www.mdsg.umd.edu/MDSG/EFC/SRF>

Seminars on Endocrine Disruptors

Endocrine disruptors, compounds that either mimic hormones or act as hormone antagonists, have become the focus of intense interest in Washington during the past year. Publication

of a popular book, *Our Stolen Future*, by Theo Colborn, Dianne Dumanoski and John Peterson Myers first brought the issue to general attention. The book suggests that minute concentrations of synthetic chemicals in the environment are causing abnormalities in the development of humans and wildlife. Dysfunctional reproductive characteristics in wildlife, lowered intelligence in children whose mothers consumed large amounts of contaminated fish and falling male sperm counts are among the symptoms the authors link to endocrine disruptors.

In order to familiarize environmental science and engineering students with endocrinology, the UMCP Water Resources Center is presenting a seminar series on endocrine disruptors. Seminars are open to all, but students in CHEM 729 at UMCP are receiving graduate credit for the seminars. Lectures will take place Mondays from 12-1 pm and can be heard live at the ITV Building, UMCP or by broadcast at IVN sites throughout the state. For more information, call (301) 405-6829. The schedule is as follows:

- February 24 — Basic Endocrinology II, Larry Anderson, Anatomy and Neurobiology, School of Medicine, Baltimore
- March 3 — Great Lakes Experience, Steve Eisenreich, Rutgers Univ.
- March 10 — Global Contaminant Transport, Clifford Rice, Environmental Chemistry Laboratory, USDA, Beltsville, Maryland
- March 17 — Human Toxicology, Steven Safe, Veterinary Physiology and Pharmacology, Texas A&M
- April 7 — Endocrine Risk Assessment, Chris Wilkinson Technology Science Group, Inc., Washington, DC
- April 14 — Future Research Programs, Robert Menzer, USEPA, Washington, DC
- April 21 — Aquatic Toxicology, speaker to be announced



Calendar

March 23-23

Ann Arbor, Michigan. "International Symposium on Biology and Management of Ruffe." Eurasian ruffe, a non-indigenous nuisance fish, may pose serious ecological threats to North America's freshwater fisheries. First discovered in western Lake Superior's St. Louis River in 1986, ruffe are now the most abundant fish found there. As the ruffe population has dramatically increased in the St. Louis River, several species of native fish declined. Ruffe has also spread to Thunder Bay, Ontario, on Lake Superior and to Alpena, Michigan, on Lake Huron. This symposium is designed to enhance the current understanding of the ruffe infestation and its implications to North America, resulting in cost-effective management decisions. The pre-registration deadline is March 7. Registration costs \$100 for participants, \$75 for presenters and \$50 for students. For more information, or to register, contact: Michael Klepinger, Michigan Sea Grant Program, Phone/Fax (517) 353-5508/6496, e-mail: klep@pilot.msu.edu.

April 13-16



Annapolis Marriott Waterfront, Annapolis, Maryland. "Conflict and Cooperation on Trans-Boundary Water Resources," is the title of the fifth meeting of the International Water and Resource Economics Consortium. This conference aims to provide a forum for economists and policymakers to exchange ideas for dealing with conflict over the allocation of water rights and over the responsibilities for protecting trans-boundary water quality. The University of Maryland Department of Agricultural and Resources Economics and the Center for Agricultural and Natural Resource Policy are hosting the conference. Registration costs \$165 for participants and \$35 for students. Registration is limited, so those interested in attending should register immediately. For more information, contact Liesl Koch, phone (301) 405-0057, fax (301) 314-9091, e-mail: lkoch@arec.umd.edu.

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