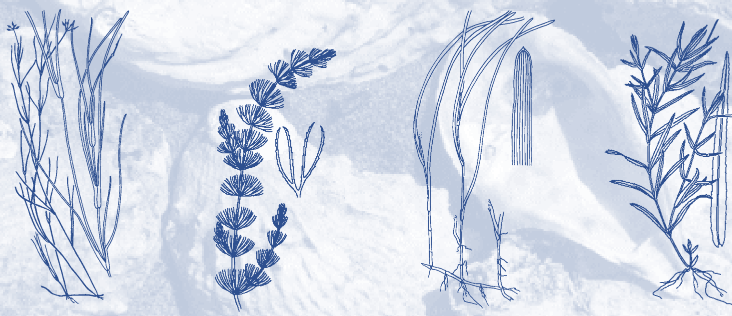
MARYLAND
MARINE NOTES

SPOTLIGHT ON RESEARCH

Oyster Reefs: Key to Restoring Bay Grasses?

BY MERRILL LEFFLER



Illustrations by Karen Teramura; photo by Sandy Rodgers

In a 1988 scientific paper, Roger Newell, a researcher at the University of Maryland Center for Environmental Science (UMCES), dramatized the importance of oysters to Chesapeake Bay. He made the then-astonishing argument that a century before, oyster stocks could have filtered the entire Bay in less than six days. In 1988, the Bay's considerably depleted oyster population, said Newell, would have taken more than 300 days to do the same. Today's further diminished stocks would likely take even longer.

Though Newell's calculations are based on a number of simplifying assumptions, his argument seized the attention of many in the Chesapeake region and has been instrumental in changing the way we think about oysters in the Bay. His paper has been cited in countless articles on the ecological value of oyster restoration; it has been used by journalists, nonprofit organizations and educators and has led to major changes in Bay oyster policy.

In Maryland, for example, where oysters are still largely managed for

> ***The ecological role of oysters is now recognized as an important thrust of resource management***

the commercial fishery, their ecological role is now recognized as an important thrust of resource management and replenishment activities. Today, for example, there are 19 oyster sanctuaries for "ecological purposes and not for harvest," says Chris Judy of the Maryland Department of Natural Resources.

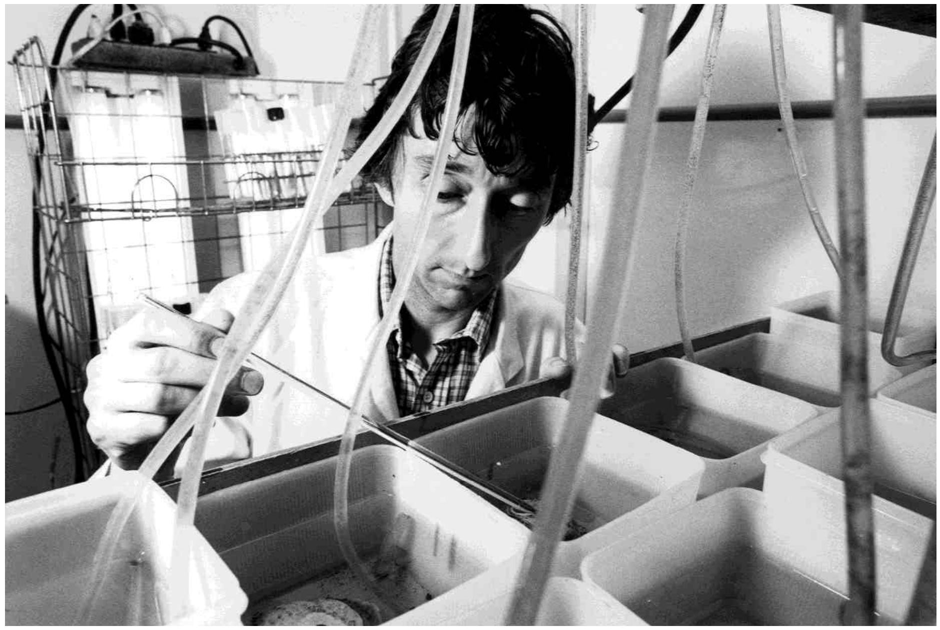
In its Chesapeake 2000 agreement, which covers goals for the next decade, the Chesapeake Bay Program — the multi-state and federal Bay restoration effort — has called for a minimum tenfold increase of oysters by 2010. Can this be done? And if so, what will it actually mean for sustainable oyster populations for the fishery, let alone for the ecosystem?

Bay oysters, after all, are still plagued by MSX and Dermo, parasitic diseases that have been devastating oysters and limiting many attempts at oyster restoration. While research efforts show much promise in developing disease-tolerant strains, getting these oysters into the Chesapeake in large enough numbers over the next decade will require a considerable investment.

It will also take more — a clear idea, says Newell, of what the goals of oyster restoration are. Just planting oyster reefs to meet the tenfold goal may not be enough. To make use of the oyster's filtering capacity, we need to develop a strategic plan, he says, one that identifies those areas in the Bay where oysters and reef habitats can provide the most benefit by filtering algae from the water. "So many shellfish feeding on algae," says Newell, "can help improve water clarity," and if we choose our locations wisely, he adds, "those oysters could also help in restoring submerged bay grasses."

It is the Bay's dark, murky waters — a combination of dense phytoplankton growth and suspended particles, the result of nutrients, shore erosion and the scouring of bottom sediments by waves and currents — that prevent light at the surface from reaching the bottom waters that grasses inhabit. Submerged aquatic vegetation (SAV) throughout the Bay system is limited by light — it is the major reason that grasses now cover less than 15 percent of the bottom than they did 50 years ago.

By integrating plans for oyster reef restoration with nutrient reduction efforts on land, it may be possible to use oysters for bringing SAV back. Placed in the "right areas," reefs could not only offer grass beds protection from pounding waves, but would help clear nearby waters, enabling sufficient light to reach the grasses.



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Meticulously tracking the oyter's filtering capacity, Roger Newell analyzes how oysters located in well-oxygenated waters can affect the Chesapeake's water quality.

Oysters and Algae

Others besides Newell had recognized the great potential of oysters for clearing algae from the Chesapeake and what their loss has meant for water quality. Max Chambers, a commercial aquaculturist on the Eastern shore, argued that "the Bay is polluted because the oysters are gone." In a paper written in 1988, he called for "bolstering the [oyster] filter feeders in the Bay for the purpose of 'from the bottom-up clean-up'" and went on to quote a retired biologist from the UMCES Chesapeake Biological Lab, Klaus Drobeck who, in 1970, told him, "If for no other reason, we need to breed and reproduce oysters just to keep the Bay clean. Are we to think an oyster's only value is for food?"

Not having what scientists refer to as "fishery-independent data," Newell's calculations of the filtering capacity of pre-exploited oyster stocks had to be based on some educated guesses. Drawing on harvest records from the 1880s and the present, he projected how many oysters were in the Bay then and now. Assuming average filtration rates for all oysters, he then calculated the volume of water oyster populations in the 1880s and in the 1980s would filter.

Newell's assumptions have been subject to criticism because they did not take into account important factors that could have significantly altered his conclusions. For example, oysters of course release feces, pellets of nutrient-rich excreta that could be chemically recycled back into the water for uptake by algae; they also produce pseudofeces, pellets of undigested particles that include sediment. What is the fate of these biodeposits? Do they remain inert in the sediments? Do microbial processes recycle them into the water for uptake by algae so that, in effect, there is no ecological gain? Over the past five years, Newell and his colleagues at the UMCES Horn Point Lab have been working to answer these questions.

With support from Maryland Sea Grant, Newell, along with researcher Jeff Cornwell, has conducted laboratory studies to examine how the recycling of nutrients in oyster biodeposits would affect the production of algae and, therefore, water quality. The answer, says Newell, depends on whether oxygen is present (oxic conditions) or absent (anoxic conditions) in the bottom environment where oysters dwell.

As it is, the Chesapeake's natural circulation patterns tend to leave bottom waters in many regions vulnerable to declining concentrations of dissolved oxygen, especially during the warm spring and summer months. Research has shown that low oxygen conditions are further exacerbated by bacterial decomposition of the dense algal growth that results from large volumes of nutrients running into the Bay. A century ago, perhaps, oyster stocks in the tributaries and along the flanks of the Bay might have consumed a vast majority of this algae; today, with so few oysters, much of this production remains uneaten. Ungrazed algae eventually die and sink into bottom waters beneath the salt layer (pycnocline); there they are metabolized by bacteria and other microbes, a process which further depletes oxygen.

If oxygen levels are already low because of natural conditions, these bacterial processes can be the coup

"If we choose our locations wisely, those oysters could also help in restoring submerged Bay grasses."

Courtesy Evamaria Koch

Examining Bay grasses up close, Evamaria Koch gathers new insight into how these underwater plants interact with their own environ - ment, charting a course for more effective restoration efforts.

de grace, reducing all that remains. When sediments become anoxic, anaerobic microbial processes kick in, releasing ammonia, a form of nitrogen that algae can readily take up to sustain their further growth. If bottom waters are oxygenated, however, aerobic bacterial process occur, releasing nitrate and nitrite rather than ammonia. Such conditions foster denitrification, a microbial process that removes a proportion of nitrogen (20% in mesocosm studies done by Newell and Cornwell) by reducing the nitrate and nitrite into harmless nitrogen gas that algae cannot use. Rising through the water column this gas then escapes into the atmosphere.

According to laboratory studies undertaken by Newell and Cornwell, for oysters to clear algae from the water and not be responsible for recycled nutrients from their excreta, oxygenated sediments are key. "It's location, location, location," says Newell. If we are restoring oysters for ecological purposes, he says, we have to begin by choosing areas in which bottom waters are not starved for oxygen.

Bay Grasses Caught in a Catch-22

While too many nutrients and too much sediment from land runoff continue to be the bane of improving Bay water quality and restoring underwater grasses, turbid waters also result from sediment resuspension by currents and waves as well, says Evamaria Koch, a Horn Point scientist who has been studying the relationships between water flow and submerged vegetation.

A half century ago, when vast underwater fields of eelgrass, widgeon grass, coontail and many other species flourished throughout the Chesapeake, they protected sediments from being resuspended and coastlines from eroding. Leaves swaying in the water attenuated wave energy and slowed water currents, says Koch. Suspended particles settled out from the water. Today's diminished grass beds are often unable to dampen the wave and current energy that can tear up vegetation.

Grass survival is even more tenuous when epiphytic organisms (microscopic plants and animals) colonize grass leaves, further shading them from sunlight. Unless epiphytes are grazed, these combined assaults on grasses leave them weak and unable to obtain the light they need to survive.

Dense epiphytic growth on leaves and high suspended sediments in the water can also have a synergistic effect on reducing light availability to plants. Meredith Guarraci, a former student of Koch's, showed that as the epiphytic layer increases, so does the particle accumulation on the leaf surface. The combination of excessive epiphytes and suspended particles leads to even less light at the leaves than if the problem was only with nutrients.

Scientists believe that for submerged grasses to flourish once more, they must grow densely in a large area so that they can help themselves by creating the light field they need to continue growing. Laura Murray, Michael Kemp and Rick Bartelson, also researchers at the UMCES Horn Point Laboratory, have been conducting field studies that compare a suite of water quality measurements, such as nitrogen and phosphorus compounds, oxygen concentrations and current velocities. They are finding corroboration with computer models, says Bartelson, "which indicate that the degree and spatial extent of water quality changes correlate with the size and density of the seagrass bed."

But herein lies the catch.

In restoring underwater grasses so that they can affect water quality, plants need good enough water clarity to begin with. It is for this reason that stopping landborne nutrients and sediments at the sources on land — before they get into the water — has been the Bay Program's key strategy in trying to bring Bay grasses back. The Chesapeake Bay Agreement of 1987 called for slashing nitrogen and phosphorus by 40 percent (from 1985 levels). According to water quality models, curbing landborne nutrients at these levels will lower algal production sufficiently to have a host of positive feedbacks, especially for submerged vegetation. However, a key problem with this scenario is that slashing nutrients by 40 percent, as well as preventing erosion and runoff, is proving to be extremely difficult. And without the grasses already in place, says Koch, bottom sediments are eroded by tidal currents, waves and of course storms.

Stopping Runoff May Not Be Enough

There are many source reduction programs throughout the watershed that aim at stemming runoff — from vegetated buffer strips, including trees, to sediment traps during new construction to no-till farming to improved waste treatment plants. And more are coming, such as nutrient management plans that all farmers must submit to the state by 2003 and nonpoint management plans mandated by EPA that will set total maximum daily loads (TMDLs) for each river.

Still, despite all these runoff reduction programs, there may still be too many nutrients and sediments to stop at the sources — this is especially likely as development in the Bay watershed continues, and with it the conversion of permeable pasture and forested lands to impermeable built and paved structures.

Furthermore, airborne deposition can dump a good deal more nitrogen into the Bay system than was originally thought in the 1980s — as much as 30 percent of the total in any given year. Resource management agencies in the Chesapeake have no control over many of these sources — some portion of which originate in power plant exhaust towers in the midwest, others from automobile exhaust from a number of locations — that come down in rain and snow on the east coast. It is for these reasons that the signatories to the Bay Agreement — governors in Pennsylvania, Maryland and Virginia, the mayor of the District of Columbia, the chair of the Chesapeake Bay Commission and the head of EPA — shifted from a commitment to reducing nutrients by 40 percent to reducing *controllable* sources of nutrients by 40 percent.

If restraining runoff was not enough of a problem, the diminished natural capacity of the Bay's wetlands to absorb sediments and nutrients is another. Extensive losses are the consequence of sea-level rise and, again, development.

Disappearing wetlands may be having an immense impact, says Court Stevenson. He points out that marsh vegetation such as tall grasses serve not only to trap sediments in land runoff, they remove nitrogen in groundwater as well. In large-scale experiments supported by EPA's Multiscale Experimental Ecosystem Research Center (MEERC) at UMCES,

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"Oysters and grass beds together could be crucial in doing what source reduction alone cannot do."

Stevenson and his colleagues at the Horn Point Laboratory have been getting surprising measures on just how much nitrogen marsh vegetation removes before it can seep into groundwater and into streams and rivers that feed Bay waters.

If the Bay is to be returned to a semblance of its former integrity, grasses must flourish once more — any hope of successful restoration depends on controlling runoff. But controls may not be sufficient, especially in areas where water clarity is so dismal that grasses cannot even get started. That is where oysters come in, says Roger Newell. "Oysters and grass beds together could be crucial in doing what source reduction alone cannot do." And a study that he, Koch and Raleigh Hood, a computer modeler at the Horn Point Laboratory, are now conducting in Monie Bay, a shallow salt marsh habitat near Salisbury, Maryland, could provide the first tools for predicting how this can be done.

Oysters and Bay Grasses to the Rescue?

Monie Bay is part of the National Oceanic and Atmospheric Administration's National Estuarine Research Reserve System, a program that partners the federal government with states in order to protect estuaries that will also serve as natural field laboratories for programs of research and education.

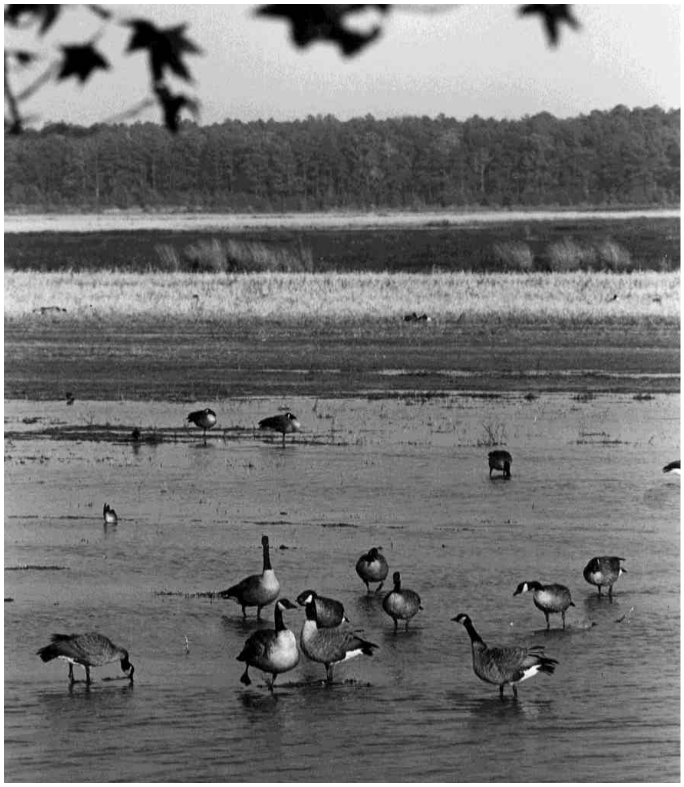
Though underwater grasses were once abundant in Monie Bay, they began disappearing in the late 1960s, according to studies by Robert Orth and Ken Moore at the Virginia Institute of Marine Science; today, they are virtually all gone. Oysters, too, were once abundant but they also fell, first to overharvesting and then to disease. Is there a connection between the loss of grasses and the loss of oysters? Newell and Koch believe that there may be a strong interdependence.

Monie Bay is surrounded by agricultural land and therefore receives a good deal of runoff. We think that when oysters were abundant, Newell says, their filtering capacity helped clear the water of algae so that grasses got enough light to grow, reproduce and help maintain sufficient clarity of water; however, with the decline and eventual loss of oysters, the waters darkened as a result of algal growth. With shore erosion already high, they believe, algae and suspended sediments together just shut off light from reaching the bottom. Underwater vegetation didn't stand a chance — turbidity was simply too high.

With funding support from the Cooperative Institute for Coastal and Estuarine Environmental Technology, Newell, Koch and Hood are trying to test Newell's original hypothesis with measurements in the field and in the laboratory. They hypothesize that grass beds in Monie Bay declined in part because of the loss of oyster populations and their filtering capacity; they also hypothesize that as grasses declined in extent and density, they were less able to trap sediment, which thereby "permitted" larger amounts of sediment from shore erosion and bottom resuspension in the water column.

Because Monie Bay has no underwater vegetation, Koch is comparing turbidities and particle suspension in an unvegetated area with an adjacent area that has submerged grasses; these comparisons will enable her to measure the positive feedback that grass beds have on water clarity. At the same time, Newell is conducting experiments in the lab that measure how oysters feeding under different environmental conditions affect water clarity. Working with Hood, their goal is to develop a mathematical model that will quantify the actual increase in light penetration based on the biomass of oysters. "The model," says Hood, "will predict increases in light penetration resulting from oyster feeding."

There are numerous examples worldwide of bivalves such as oysters, clams and mussels feeding on algae so voraciously that they significantly improve water clarity. The most notorious recent case is the non-indigenous zebra mussel released in the mid-1980s in ballast water in the Great Lakes. These mussels feed prodigiously on algae and, until recently, without efficient predators grew so extensively that they impacted food webs and cleared large amounts of algae from bodies of water as large as Lake Erie. There is good evidence in the Potomac that the non-indigenous Asiatic clams *Corbicula fluminea* has played a major role in cleaning water so that grasses have come back in certain areas.



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More on the Web

Roger Newell. 1988. Ecological changes in Chesapeake Bay: Are they the result of overharvesting? Originally published by the Chesapeake Research Consortium
www.vims.edu/GreyLit/crc129.pdf

Restoring Bay Grasses to the Chesapeake: A Long Way Back. Maryland Marine Notes, volume 18, Nos. 3-4.
www.mdsg.umd.edu/MarineNotes/May-Aug00/

Restoring Oysters to U.S. Coastal Waters
www.mdsg.umd.edu/oysters/disease/

Maryland Aquafarmer
www.mdsg.umd.edu/Extension/Aquafarmer

Multiscale Experimental Ecosystem Research Center
www.hpl.umces.edu/meerc/

Monie Bay, Chesapeake Bay National Estuarine Research Reserve
www.dnr.state.md.us/bay/cbnerr/monie_bay.html

If the research in Monie Bay proves successful, it will provide resource managers with a predictive technique to link water clarity with oyster biomass and grass density for restoring vegetation. There are other predictive tools under development as well that should identify those areas that stand the best chance for successful restoration. For example, Koch is developing a diagnostic that could determine the maximum wave exposure submerged grasses can tolerate. With such a tool, she says, "it will be possible to map areas of unlikely growth of submerged grasses because of excessive wave exposure." Meanwhile Bartelson, Kemp and Murray are developing models that should help predict just how large and how dense grass beds need to be, given the range of water quality conditions they may be subjected to, in order to contribute to their own sustainability.

Still, models are tools — they are not the real world. What will it take to put them to work so that we can see some demonstrable results?

We have to scale up sufficiently, says Newell. "We can do that," he says, "though it will take a good deal of funding." More importantly, he says, "although scientists are now beginning to understand that oysters were once a keystone species in the Chesapeake, the challenge for Maryland managers and politicians is to implement actions that will actually increase the abundance of oysters for their ecological value." This may mean more tactical planning on just where oyster reefs should be placed. If we are to restore grasses, if we are to improve oxygen conditions in bottom waters, then we may have to think about oysters for harvest and oysters left unharvested solely for the ecological benefits they can help deliver.

That would be a new way of thinking about oysters for the Bay, Newell says. There are signs, he adds, of a willingness by many to begin exploring just what such new thinking might mean for the future of Bay oysters — and for the Chesapeake itself, which after all, he says, takes its name from a native American tribe called Chesepiooc, an Algonquin word that means Great Shellfish-Water People.

From the Director

Late last year, Maryland Sea Grant underwent a rigorous evaluation by the National Sea Grant College Program. Part of a new national evaluation effort, this performance assessment aims to insure that all Sea Grant programs are well organized, produce significant, high impact results, reach a variety of important end-users and plan for the future. This was Maryland Sea Grant's first evaluation under this new system and we chose to present our accomplishments in the context of the last ten years. The four-day evaluation — conducted by a team of scientists, managers and administrators drawn from around the country — involved all parts of the program. The assesment team traveled around the Bay, speaking directly with a range of stakeholders, from researchers to educators to representatives of the seafood industry. Their final report is now offical, and I am pleased to say that Maryland Sea Grant received an overall rating of Excellent — the highest possible score.

Of the many lessons I've learned from this look back, two stand out. First, excellence is built by efforts that extend over many years and a commitment to seek new ways to catalyze innovative research, outreach and education. Second, our success lies in the strong partnerships that sustain our program and the many outstanding contributions made by individuals throughout Maryland Sea Grant.

While we have looked back in preparing for this program evaluation, we have been looking forward as well, devising better ways of reaching our important audiences. With this issue of *Maryland Marine Notes*, I am happy to announce that the new, completely revamped Maryland Sea Grant web site (www.mdsg.umd.edu) is now online. Beyond its new face and architecture lie a series of new features that provide a wealth of information about the Chesapeake Bay and Maryland's coastal waters, as well as resources for researchers, teachers and others interested in our program. In the coming months, we'll be adding more pages that provide information on emerging issues, links to important sources of scientific, technical and policy information — and new forums for public comment and debate. I invite you to explore our new site and, most importantly, to comment on what you find there. Your input is essential as we continue to build our capability on the web and throughout our entire program.

Jonathan Kramer, Director
Maryland Sea Grant

Knauss Fellowships Available

Applicants are currently being sought for the Knauss Marine Policy Fellowships for 2002. Begun in 1979, the Fellowship Program is coordinated by the National Sea Grant Office, part of the National Oceanic and Atmospheric Administration. The Program provides graduate students across the nation with an opportunity to spend a year working with policy and science experts in Washington, D.C.

The selection process begins with submission of applications by candidates recommended for excellence by Sea Grant Directors around the country. National Sea Grant conducts a rigorous review and awards fellowships to the top candidates.

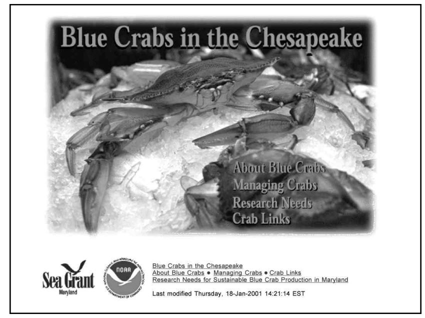
Maryland was one of the few programs with three Fellowship awards for 2001. Recipients are John Adornate III, Brian Badgley and Wendy Morrison, all in the masters program in Marine-Estuarine-Environmental Science at the University of Maryland.

Over the years, Knauss Fellows have worked in the legislative and executive branches of the federal government, 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 $32,000.

The application deadline for next year's Fellowship Program is *April 2, 2001*, a much earlier date than for past years. Those interested in applying should contact Maryland Sea Grant soon for guidance and possible volunteer project opportunities.

To qualify, students must be enrolled in a graduate or professional degree program in a marine-related field at an accredited institution in the United States by May 1, 2001. For more information, visit the web, www.mdsg.umd.edu/Policy/knauss.html. To apply, contact Susan Leet by phone, (301) 405-6375, or e-mail, leet@mdsg.umd.edu.

Maryland Sea Grant Launches New Web Site



In mid-February, Maryland Sea Grant unveiled a redesigned and reorganized web site. Featuring a wide array of information about marine research, education and outreach issues for researchers, educators, students and the public, it has a new look and is more comprehensive and easier to navigate.

The site includes expanded research information, with a searchable database of past and current Maryland Sea Grant research projects, as well as more about the program's research focus, partners and mission. In addition, there is direct access to the site's extensive and popular pages on topics such as interactive education and resources, exotic species, extension and technical information and the program's many print and video offerings. The site now includes pages on policy and management, understanding the ecosystem, history and culture and economics — to name only a few.

Check out the site at www.mdsg.umd.edu and let us know what you think. Your responses will help as we continue to fine tune and update the contents.

Lecture Series to Focus on Land and People

"Journeys Home: People, Nature and Sense of Place" is the title of a series of public lectures scheduled over the next year at the historic Avalon Theatre in Easton. Lectures will delve into the value we place on the natural world and bring new insights to how those values translate into prosperous, vibrant and safe communities. Speakers bring a wide range of perspectives from a variety of disciplines, from the spiritual, to the scientific to the aesthetic. Each presentation will include a lecture followed by a moderated session with the audience.

The series is co-sponsored by the Washington College Center for the Environment and Society, the Adkins Arboretum, the Eastern Shore Land Conservancy, the Maryland Center for Agroecology, Inc. and the Wildfowl Trust of North America. Tickets are $10 for single lectures; special rates available for multiple lectures. To purchase tickets or for more information, call (410) 634-2847. Speakers, dates (all lectures are at 7:30 pm) and topics are listed below.

March 6 — Janisse Ray, Author, "The Country of Longing." Ray will discuss *The Ecology of a Cracker Childhood*, a remarkable first book that juxtaposes growing up as the daughter of a junkyard owner with the ecology of the Georgia longleaf pine ecosystem.

April 18 – Steven Kellert, Professor, Yale University School of Forestry and Environmental Studies, "Values of Nature, Sense of Place and Human Well-Being." Kellert co-authored *The Biophilia Hypothesis* with E.O. Wilson, a book that explores human values in conservation biology and nature.

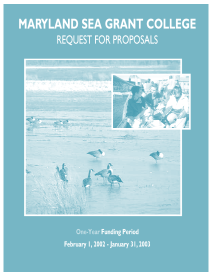
September 19 – John Hanson Mitchell, Author, "Inventing Place." Writer and naturalist Mitchell, a native of Maryland's Eastern Shore, has published several books about a plot of land near his home in Massachusetts melding history, environment and place.

October 17 – Christopher Tilghman, Author, "The Pull of the Land: Place and Imagination." Tilghman is author of *In a Father's Place*, a collection of stories set against natural landscapes and the novel *Mason's Retreat*, about an expatriate Eastern Shore family that, on the eve of World War II, returns to its old estate on the Chesapeake Bay.

November 7 – Northern Neck Chantey Singers, "Songs of Our Life, Songs of Our Sea." Traditional folksingers with the Fishermen's Museum in Reedville, Virginia, the Chantey Singers will perform songs they once sang as fishermen to coordinate raising huge nets of menhaden.

End Notes

Request for Proposals



The Maryland Sea Grant College has issued a Request for Proposals for February 1, 2002-January 31, 2003. Past proposal requests have been for two-year funding cycles. The current, one-time, 12-month proposal cycle will bring Virginia and Maryland Sea Grant programs into phase in order to facilitate research that focuses on regional, Baywide issues and collaborative projects with researchers in both Sea Grant programs.

Proposals with durations of one to three years are solicited. A second RFP will be issued in 2002 for a biennial cycle starting February 1, 2003. Those interested in submitting proposals should read the RFP carefully and direct any questions to the program early in the proposal process.

Sea Grant support is offered on an open, competitive basis and is available to researchers at all academic institutions and research laboratories in Maryland. For more information, visit the web at www. mdsg.umd.edu/Research/RFP/ to read the online RFP and download forms. If you don't have web access, or you'd prefer a paper copy, contact Ellen Lundgren at (301) 40-6371.

Display at BWI

In cooperation with the National Oceanic and Atmospheric Administration (NOAA) and the National Sea Grant Program, Maryland Sea Grant produced an exhibit detailing Sea Grant and NOAA research. The exhibit went on display October 13, 2000 at the entrance to Pier D in Baltimore Washington International airport and will remain there at least through March. It includes photographs, descriptive text, fishing artifacts (a crab pot, oyster nippers and fishing net) and samples of Maryland Sea Grant books and videos.

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