MARYLAND

MARINE NOTES

SPOTLIGHT ON SCIENCE

Restoring Bay Grasses to the Chesapeake

A Long Way Back

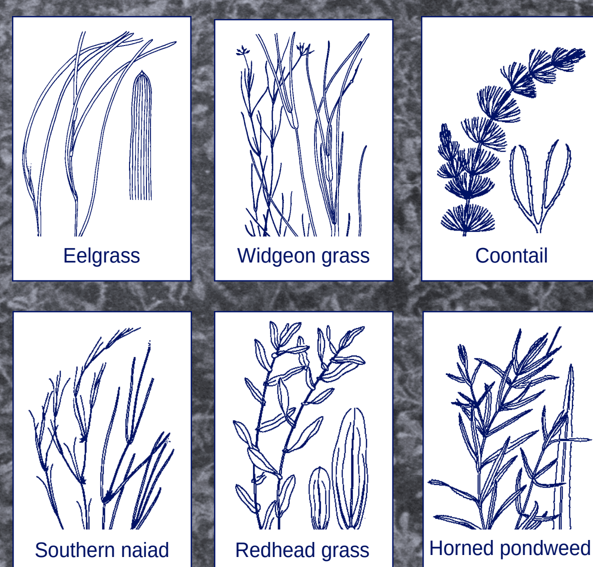
BY MERRILL LEFFLER

When Peter Bergstrom of the U.S. Fish and Wildlife Service recently visited the Severn River near Annapolis to check on the condition of what had been a large area of underwater grass, he was surprised at what he found. “There was almost nothing there,” he says, “a few patches the size of a patio table.”

Since 1994, the grasses had been making a remarkable comeback. Mostly widgeon grass, along with redhead grass, sago pondweed and wild celery, their return was attributed by many to improved water quality conditions brought about in part by the Critical Areas law, which restricted clearance of trees near shorelines and presumably reduced runoff of sediment and nutrient pollution. Moreover, the Severn, unlike such rivers as the Choptank and Patuxent, does not have sewage plants discharging nutrient wastes, treated though they may be, into its waters. “We were patting ourselves on the back,” Bergstrom says. Until this year, that is. What happened to the grasses? “It may have been some combination of drought and rain,” he says. But precisely what “combination” remains open to speculation.

Further down the Bay, in the higher salinity waters of Tangier Sound, the story is reversed. Between 1993 and 1998, underwater vegetation, largely eelgrass, had continued to decline until reaching a low of some 6,600 acres, down from 18,000 acres in years prior to 1993. This past year, however, grass acreage expanded dramatically: the 1999 aerial survey, conducted by researchers at the Virginia Institute of Marine Science (VIMS) since the 1980s, showed more than a 60 percent gain to some 10,600 acres. Though factors having to do with freshwater runoff might account for the turnaround, scientists and resource managers didn’t predict it.

The situations in the Severn River and Tangier Sound provide two examples of the challenges that bay grass restoration efforts in the Chesapeake have faced over the last 20 years. Vast meadows of underwater grasses, some 600,000 acres, once flourished throughout the Chesapeake system. Water stargrass, wild celery, southern naiad, redhead grass, coontail, waterweed and muskgrass, eelgrass, widgeon grass, sago and horned pondweed and a score of others. This lush vegetation provided important habitat and food for fish, other aquatic organisms and waterfowl. At the same time, it helped promote water clarity by absorbing nutrients, trapping sediments, slowing currents which can scour the bottom and resuspend sediments, and by producing oxygen. Except for scattered grass beds in various parts of the Bay — for instance, the Susquehanna Flats, areas of Eastern Bay and Mobjack Bay — much of that diversity is now gone.



Photograph by Skip Brown; Illustrations by Karen Teramura

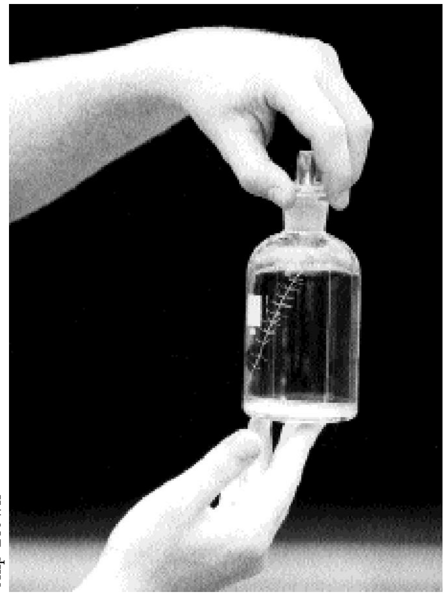
Grasses, continued

While restoration of submerged aquatic vegetation (SAV) has been a key goal of the Chesapeake Bay Program, its success has depended on stopping the immense volume of nutrient and sediment runoff throughout the Bay and its network of feeder streams, creeks and rivers.

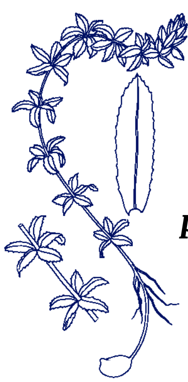
Nutrients stimulate the growth of algae, or phytoplankton, in spring and summer — with warming water temperatures and longer hours of sunlight, algal growth can become so extensive that thick blooms blanket vast stretches of water. This dense algae, combined with sediments in runoff and erosion, as well as resuspended sediments churned from the bottom, block the transmission of light, vital to the growth of SAV.

While submerged grasses are self-sustaining in some areas, overall their recovery seems to have reached a plateau over this last decade, ranging between 60,000 and 75,000 acres a year; this is about a tenth of the former acreage and still far short of the Bay Program's first tier goal of restoring 114,000 acres by 2002 to nearshore areas that currently have only sparse or no vegetation. Longer-range goals call for eventual restoration to the 600,000 acres that once covered bottom grounds and in some areas helped make Bay water nearly transparent to depths as much as 10 to 12 feet.

Ironically, baywide recovery of SAV seems stalled in a catch-22: healthy, sustainable bay grass communities require good water quality conditions, especially light; meanwhile, good water quality conditions require healthy, sustainable bay grass communities. This means that bringing SAV back on a baywide scale is even more difficult than it would be if water quality were not so poor and vegetation not so spotty. As Michael Kemp of the University of Maryland Center for Environmental Science (UMCES) Horn Point Laboratory and Chris Madden of South Florida Water Management District have written, water quality requirements to restore underwater grasses baywide have probably become "more stringent than before their initial declines."



Skip Brown



Hydrilla verticillata

Water quality requirements to restore grasses baywide have probably become more stringent than before their initial declines.

Setting Water Quality Goals

To develop realistic strategies for curtailing runoff for SAV restoration, resource management agencies need specific water quality goals that they can aim for. In 1992, the Chesapeake Bay Program released *Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets*, a report that took the first steps in detailing conditions that would promote SAV growth.

The technical synthesis, as it was called, aimed at determining minimum water quality conditions necessary for survival and propagation of underwater grasses in the Chesapeake. With these conditions as the goal, state and federal agencies could then develop management policies — particularly in targeting limits on runoff.

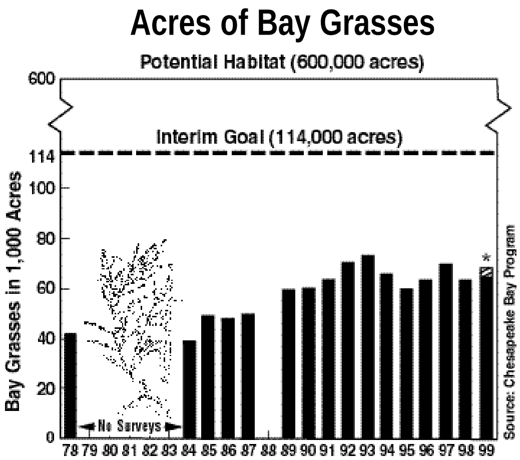
The synthesis drew on 15 years of research data such as extensive monitoring of grass beds and water quality conditions in the Bay system where SAV was flourishing. Grasses in lower salinity areas of the Potomac, for example, saw a resurgence during the 1980s — while not extensive, their recovery was strong, and accompanied by an increase in plant diversity as well. In part, this recovery resulted from the inadvertent introduction of *Hydrilla verticillata*, a fast-growing, non-indigenous species often considered a nuisance and referred to by some as aquatic kudzu. "*Hydrilla* started modifying shallow water environments," says Bob Orth of VIMS, "and that made it possible for other species to survive."

Those positive conditions, according to the synthesis, relied on minimum water quality requirements for (1) inorganic nitrogen, (2) inorganic phosphorus, (3) water column light attenuation coefficient (a gauge of water clarity), (4) chlorophyll (an index of algal biomass) and (5) total suspended solids. In other words, the technical synthesis set the standards that sediment and nutrient reduction efforts would need to meet.

"This synthesis was a great step forward," says Richard Batiuk of the U.S. Environmental Protection Agency. "It gave management agencies scientifically defensible numbers to aim for," he says, "numbers that we wouldn't have had otherwise — it is the only reason these standards were adopted by the Chesapeake Bay Program." It was also an example, he adds, of how the relationship between management and science can really pay off.

Still, there were a number of factors that the synthesis did not account for — while it highlighted the requirements for salinity zones, it did not take into account differences among grasses adapted to low salinity waters and those that grow in higher salinities. It is not possible to generalize about such requirements for all grass species and all habitats, says Bob Orth. "You're dealing with different species and each is adapted to different needs of light, salinity and

Where Have All the Grasses Gone?



*Note: Total acreage mapped in 1999 was 64,689. More than 3,000 acres of bay grass beds mapped in 1998 were not fully mapped in 1999 due to extreme weather events. To account for those areas, the hatched area of the bar includes the estimated additional acreage, for a total of 68,125.

The Chesapeake's underwater grasses reached their low point in the early and middle 1970s after Tropical Storm Agnes deluged the Bay in 1972, sending torrents of sediment down its rivers and main stem. With the immense volumes of fresh water and sediments came heavy concentrations of nitrogen compounds, in some cases two to three times normal levels. A report by the Chesapeake Research Consortium in 1974 inventoried the impact and concluded that next to oysters and soft clams, "the ecological group most depressed was submerged aquatic plants." Moreover, this storm of the century arrived at the worst possible time, says Bob Orth of VIMS, in June, at the height of the grasses' growing season.

But Agnes only magnified declines that had already begun more than a decade before in many areas, particularly the upper Bay, says Mike Naylor of the Maryland Department of Natural Resources and chair of the Chesapeake Bay Program's SAV Workgroup. "In the 60s and 70s, there were massive changes in farming practices," he says, "with heavy use of chemical fertilizers and pesticides." At the same time, he adds, "waste treatment flows doubled and tripled." In the Patuxent River, for instance, where vast grass beds had begun to die off in the 1960s, researchers began tracking immense amounts of nutrients coming in from runoff and from groundwater seepage, along with poorly treated wastes in sewage discharges, as major causes. Research in recent years has been detailing unexpectedly high amounts of nitrogen from airborne deposits, as much as 25 percent or more of the nitrogen entering estuarine waters like the Bay.

There are indications of grasses returning to some areas of the Chesapeake since the late 1970s, particularly in the upper Bay and western shore. How much of that return is due to natural recovery and how much to better controls on runoff and nutrient discharges remains an open question. A unique database may begin providing some answers over the next few years.

For two decades, VIMS has been using aerial photography, taking more than 2,000 photographs annually, to track the comings and goings of grassbeds, from the Conowingo Dam on the Susquehanna River to the mouth of the Bay. Each year, a cadre of researchers and citizen volunteers tromps through some 2,300 miles of shorelines to identify and ground truth species of grasses. With these data now in geographical information systems, VIMS has a rich lode of information that may help scientists and managers clarify just what effect restoration efforts are actually having.

nutrients. Think about all the varieties of grass growing on your lawn," he says. "Some want more shade, others more sun; some require more fertilizer, others less." In other words, Orth says, "there are species-specific differences." And these are important differences, he adds, that we need to consider in developing plans for SAV restoration.

There were also limitations to the water quality measures themselves. For instance, they were unable to predict the recovery of vegetation, what Nancy Rybicki of the U.S. Geological Survey (USGS) calls, "the variation in SAV coverage." How many of the five requirements had to be met? Why did some areas consistently have grass but fail the water quality requirements? Studies in the Potomac River by Rybicki and colleagues at USGS showed that "water quality constituents alone are not sufficient to describe SAV coverage." In analyzing data in the Potomac River between 1983 and 1996, they have since found that coverage of SAV for the previous year is an important factor in explaining the extent of coverage in any given year.

"Water quality constituents alone are not sufficient to describe SAV coverage."

Nor did the five water quality conditions account for light that actually reaches leaves. In many regions, even if enough light penetrates the Bay's dark waters, grasses may still not "see" that light because of the microscopic plant growth (epiphytes) and sediment grains that can cover their leaves. Epiphytes cling to leaves and compete for nutrients and light — unless grazed by other organisms, they can sheathe leaves and further block available light, preventing photosynthesis. Researchers have long known that epiphytic growth was a key factor in limiting light that leaves actually absorb. Studies have shown that in tidal fresh and low salinity regions, they can diminish light 20 to 60 percent more than what is lost when light passes through water. It is only in the last few years, however, that scientists have been developing the ability to relate epiphytic growth to water quality conditions.

New Synthesis Refines Water Quality Goals

Over the last decade, researchers have been tackling some of the difficult questions that the 1992 synthesis could not then deal with. How much light needs to reach leaves in order for them to grow? In waters where light is not penetrating to the bottom,

Grasses, continued

how much of the dark water is due to suspended solids, how much to nutrients, how much to algae?

To address these questions for the purposes of management, the Chesapeake Bay Program recently completed a second technical synthesis that consolidates much of the research of the last ten years (see SAV Information on the Web). For example, Charles Gallegos of the Smithsonian Environmental Research Center has summarized studies on distinguishing the different optical properties of suspended sediments, algae and nutrients in the water column by how they absorb or reflect light. He has developed a set of diagnostic equations that can provide management with different options for targeting reductions of chlorophyll and suspended solids. While these equations do not account for all factors that affect the availability of light, they offer an overall view of the magnitude of the reductions that are needed and some of the tradeoffs available.

Meanwhile, from other research, including studies supported in part by EPA's Multiscale Experimental Ecosystem Research Center (MEERC) at the University of Maryland Center for Environmental Science (UMCES), Mike Kemp and Rick Bartleson of the UMCES Horn Point Laboratory have developed a mathematical model that predicts epiphytic growth, or how much light reaches a leaf based on measurements of depth of light, total suspended solids, and dissolved inorganic nitrogen and phosphorus.

Studies have shown that in mid- and high-salinity waters, underwater vegetation like eelgrass needs at least 15 percent of surface sunlight to grow. If we see that we are only getting 10 percent sunlight, says Batiuk, we know we may have to reduce runoff. Is the main problem sediment, nutrients, algae? Though not foolproof, we can now provide some answers, Batiuk says. Gallegos' equations can tell us how much we have to reduce total suspended solids or chlorophyll. One strategy may fit the lower James River, for example, while another works for the lower Potomac. In the lower James, for instance, most of the darkness may be coming from suspended sediments — perhaps in runoff — in contrast to chlorophyll (or algae). In the lower Potomac the bigger problem may be algae. "We can use the tools we now have to make a diagnosis," says Batiuk, "and, like a doctor, write a prescription for what we need to do."

It is such work that the technical synthesis has brought together. "We've taken a step we couldn't take in 1992," says Batiuk. If the standards in the new synthesis are adopted, they are likely to serve as a basis for states in the Bay watershed to develop regulations that, river by river, will place maximum discharge and runoff limits. The synthesis report will be printed and distributed after final editorial corrections have been made.

Understanding Grass Habitat


Michael W. Fincham

Researchers Michael Kemp and Laura Murray of the UMCES Horn Point Laboratory are closely tracking several types of grass beds in Broad Creek on Maryland's Eastern Shore, exploring how habitat affects the grasses' growth and retention. Along with several graduate and summer students, the scientists take water quality measurements in different bottom areas; one is dense with vegetation, mostly widgeon grass; another is patchy and sparsely vegetated; the third, about a mile away, is mostly bare sediment. In each place, along a transect that goes from the middle of the grass bed to its edge to the open water, they measure the same parameters — nutrient levels, chlorophyll (a stand-in for algal biomass), suspended solids, water clarity — every four hours, at low, flood, high and ebb tide.

The hypothesis is that larger, denser grassbeds will be less susceptible to stress than sparse, patchy beds, and will improve water quality and be better able to sustain themselves. In Broad Creek and related studies in other salinity regimes with different grass species, they and Rick Bartleson, also at the UMCES Horn Point Lab, will be quantifying these relationships. Using these measurements, they will be developing more refined simulation models to assess how different spatial patterns of bay grass abundance influence the effects of plants on water quality. This study could be especially useful for widespread transplanting programs by establishing key criteria that will better promote successful recovery of bottom habitats no longer productive as they once were.

SAV Information on the Web

Chesapeake Bay Program, synthesis draft:
www.chesapeakebay.net/temporary/savts2/
SAV overview: www.chesapeakebay.net/baygras.htm

Maryland Department of Natural Resources: www.dnr.state.md.us/bay/sav/index.html

Virginia Institute of Marine Sciences: www.vims.edu/bio/sav/

Alliance for the Chesapeake Bay: www.acb-online.org/savplant.htm

Chesapeake Bay Foundation: www.cbf.org/library/chesapeake_notebook/

U.S. Geological Survey: water.usgs.gov/nrp/proj.bib/sav/wethome.htm

U.S. Fish and Wildlife Service: www.fws.gov/r5cbfo/CBSAV.htm

Restoration May Be Slow

As much of an advance as this second synthesis is, there are still other factors that can affect SAV growth, among them, waves and sediments, animal grazing and disturbance, and propagation patterns, whether by seed or propagules, says Michael Kemp.

Moreover, as Bob Orth has said, this is a system still on the edge. A particular limiting factor, he points out, lies in the loss of plant biodiversity. It is likely, according to Orth, that before the widespread decline in grasses got underway in the 1960s, which was then followed by the devastating impact of Tropical Storm Agnes in 1972, the Bay enjoyed — and relied on — a much greater plant diversity. In years of heavy rains and greater runoff, plants more tolerant of suspended sediments or lower salinity or lower light conditions might outcompete other less-adapted species.

"What makes things different now is that years ago we had many areas that had multiple species so that in a wet year, for example, one species might dominate and in another year, another species would. In the Honga River," says Orth, "the amount of eel and widgeon grass and sago pondweed were all abundant. What we see now is that many areas that had diverse beds no longer do."

Added to the loss of diversity has been the continuing clearance of land for development, which has left many creeks and streams over the last 50 years more vulnerable to runoff surges that can overwhelm the most adaptable species. "There are so many conduits for putting water into the Bay system quickly," says Richard Batiuk. And with that water comes eroding land and a flood of sediments and nutrients.

One thing is certain — in order to ensure healthy ecosystems in the Bay, we need to restore grasses, not only to the initial 114,000 acres by 2002 set as a goal by the Bay Program, but to levels approaching those that existed before the steep declines of the 70s began. The new synthesis will provide a better chart for guiding our efforts — but will it mean that we have turned the corner at last in our striving to restore the Bay? We can't be sure yet, but above all, we have to keep going, says Orth, who has been conducting research on SAVs since the 1970s. "Every little step we take makes a difference. Our job will never be over. We must not give up."

The illustrations of SAV, by Karen Teramura, were published in the U.S. Army Corps of Engineers booklet Identification Guide to Submerged Aquatic Vegetation of the Chesapeake.

From the Director

Since joining Maryland Sea Grant in 1998, I've had the opportunity to fill several different roles within our program. I've learned not only how we function, but also our history as a member of the Chesapeake Bay community. We are a program built upon the efforts of Sea Grant staff, Extension faculty and, without question, our partners throughout Maryland. The interaction of these contributors has led to numerous accomplishments in the state, region and nation. Funding research to answer complex problems, fostering the development of new technologies and communicating the outcomes and role of the scientific process are all hallmarks of Maryland Sea Grant. As I begin my tenure as Director, the time I've spent scaling the learning curve has been invaluable. It has given me an admiration for what Sea Grant is and, perhaps more importantly, a genuine enthusiasm for what we will be in the future.

Maryland Sea Grant's contribution to the protection and wise use of Chesapeake Bay will require approaches that cross traditional boundaries and enfranchise new partners. Across Maryland, from concerned citizens to government agencies, there is a deeply held belief in the importance of restoring Chesapeake Bay and the importance of research in that restoration. Maryland's research communities — in particular, the state's estuarine and coastal scientists — are among the finest in the world. That combination of concern and capability is remarkably potent. I believe strongly that Maryland Sea Grant's greatest strength and greatest challenge is to integrate research, outreach and education in ways that maximize their impact.

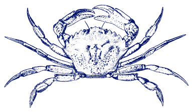
As I look to Maryland Sea Grant's future, three words that characterize our program come to mind — catalyst, source and platform. We should strive to catalyze creative activities in all of our program elements and within the communities we serve. Research investments should be problem driven, and should balance short and long-term outcomes. We must constantly seek new ways to link research to the Sea Grant outreach and education effort and to develop programs with our partners that advance these capabilities within the state and region. Maryland Sea Grant constantly strives to be an unbiased source of information.

We are not advocates for a particular point of view; rather we work to provide useful information in various formats to the public, to environmental managers and to industry around the Bay. One of our most important roles is to infuse science and the scientific process into the ongoing dialogue about Chesapeake Bay so individuals can make better-informed decisions. A key component in this process lies at the level of the Sea Grant Extension Program. The tremendous expertise and the close ties of Sea Grant Extension faculty to constituents around the Bay are essential. Finally, Maryland Sea Grant should be a platform for interaction among numerous stakeholders. We should provide avenues for scientists, managers and others to meet and focus on important and emerging issues. We are in a wonderful position to bring together stakeholders with different expertise and views.

The work ahead of us means making solid choices that maximize our effectiveness and impact. From my vantage, we must build upon our strengths and use that foundation to help us improve. In short, to find better ways to meet the needs of our constituents, partners and most importantly, Chesapeake Bay and coastal Maryland. I hope you will join us as we begin the next stage of Maryland Sea Grant's evolution.

Jonathan Kramer, Director
Maryland Sea Grant

Video on Exotic Species Airs on Maryland TV



Maryland Public Television showed a 30-minute documentary by Maryland Sea Grant on August 19 and 31 on exotic species in U.S. waters. Titled *Alien Ocean*, it is one of three productions by the program that discuss exotic species invasions in marine environments. Those who missed the showing and are interested in the subject may want to order a VHS video copy of one of the documentaries. *Alien Ocean* is available for $24.95. The second production (12 minutes, $7.50), *Exotics in the Chesapeake: Alien Estuary*, discusses exotic species that have been showing up in the Chesapeake Bay. The third (9 minutes, $5.00), *Exotics in the Chesapeake — Alien Rivers: The Threat of Zebra Mussels*, addresses the threat posed to the region's rivers by the zebra mussel and how to help keep it from spreading into the Chesapeake watershed.

Maryland Sea Grant also teamed up with the Chesapeake Bay Program and the Smithsonian Environmental Research Center (SERC) to produce three fact sheets about exotic species. The fact sheets are intended to provide general background on the subject for a broad audience. Titled *Exotic Species in the Chesapeake: An Introduction*, *Exotic Plants in the Chesapeake* and *Exotic Animals in the Chesapeake*, the fact sheets are available for free.

To request printed fact sheets, call (301) 405-6376; to download them from the web, go to www.mdsg.umd.edu/exotics/index.html. To order videos, call (301) 405-6376 or visit the web at www.mdsg.umd.edu/exotics.

Study Finds Increased Atmospheric Nitrogen

The amount of atmospheric nitrogen polluting parts of the North Atlantic Ocean Basin has increased significantly over the past three decades and parallels increasing harmful algal bloom activity, according to a North Carolina Sea Grant study. The report, authored by Hans Pearl, a researcher at the University of North Carolina Institute of Marine Sciences, and UNC graduate student David Whitall, appeared in the June issue of the journal *Ambio*.

The scientists found that atmospheric nitrogen accounted for 46 to 57 percent of the total externally supplied or new nitrogen deposited in the nitrogen-sensitive North Atlantic Ocean Basin. The increase can be attributed to the growing agricultural, urban and industrial emissions of nitrogen oxides, ammonia and possibly organic nitrogen.

One of the most prominent land-use changes since the late 1970s has been the rapidly growing swine and poultry industry in the Mid-Atlantic coastal plain, according to Paerl. This has been accompanied by production of animal wastes and an increase in atmospheric nitrogen from storage and land application. Nitrogen vaporizes as ammonia from hog waste, lagoons and crop sprays. These ammonia emissions travel downwind and are ultimately deposited in nitrogen-sensitive waters. Researchers also found that a significant amount of the new nitrogen is being directly deposited on ocean surfaces, bypassing estuarine processes that filter runoff.

Maryland Sea Grant Review

The Maryland Sea Grant College is preparing for a major program review on October 22-26. This is part of a new system of oversight put in place by the federal agency that funds Sea Grant, the National Oceanic and Atmospheric Administration (NOAA). This process, which will occur every four years, includes a rigorous assessment by a panel of experts drawn from around the nation. Individuals who wish to provide comments to this panel should direct them to the following address: Dr. Linda Kupfer, National Sea Grant Office, NOAA/ Sea Grant, R/ORI, 1315 East-West Highway, SSMC-3, Eleventh Floor, Silver Spring, Maryland 20910, linda.kupfer@noaa.gov.

Maryland Sea Grant Seeks Assistant Director

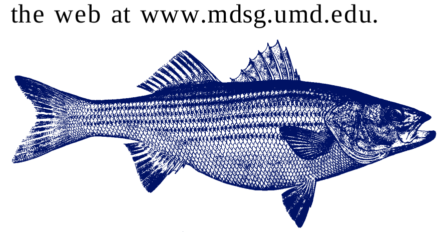
The Maryland Sea Grant College, a joint state-federal program located on the College Park campus of the University of Maryland that funds research, education and outreach related to the Chesapeake Bay, is currently seeking an Assistant Director for Research.

The individual selected for this position will lead the MDSG research program; duties will include developing requests for proposals, conducting peer reviews, monitoring progress and results of funded projects, preparing technical and administrative reports and proposals, coordinating program development awards, maintaining active links with the research and management community and participating in related educational and outreach functions.

Qualifications for the position are an advanced degree in the marine sciences or a related field, preferably an earned doctorate. Experience in management and performance of multi-disciplinary academic programs, a working knowledge of proposal peer review procedures, several years of experience in research, research administration preferred. Superior oral and written communications and interpersonal skills are essential as is a commitment to developing creative science outreach programs.

Applications are due on September 20, 2000. For more information on the position, check the web at www.mid-atlantic.seagrant.org/Jobs/mdsg_adr.html, or contact Susan Leet, Maryland Sea Grant College, 0112 Skinner Hall, College Park, Maryland 20742, leet@mdsg.umd.edu, (301) 405-6375.

For more information on the Maryland Sea Grant program, visit the web at www.mdsg.umd.edu.



End Notes

Contaminants in the Bay

To help explain the complex issue of toxic, or potentially toxic, compounds in the Bay, Maryland Sea Grant has teamed up with the Alliance for the Chesapeake Bay and the Chesapeake Bay Program to produce a fact sheet, *Contaminants and the Chesapeake*. The fact sheet provides a basic primer on toxic chemicals and the recent Toxics Characterization undertaken by the Chesapeake Bay Program. For a free copy of the fact sheet, contact Maryland Sea Grant, at (301) 405-6376 or see the web: www.mdsg.umd.edu/CB/toxics/index.html.

Children's Books

Sierra Press has published a series of three children's books on the natural world of the Atlantic Coast. Aimed at older children, the beautifully designed books are filled with color photographs of birds, marine creatures found along the shore and ponies on Assateague Island.

Assateague: Island of the Wild Ponies tells the story of the famous Assateague ponies and how they live on their island home along the coasts of Maryland and Virginia. *Ribbons of Sand: Exploring Atlantic Beaches* introduces young readers to the rich diversity of life on sandy beaches. *Barrier Islands are for the Birds* explores Atlantic barrier island habitats from beach to bay, while examining the wide and colorful array of birds that depend on the coastal environment. Written by naturalists Larry Points and Andrea Jauck, the books provide not only a survey of species, but thorough descriptions of the environments along the Atlantic coast.

To order these books ($7.95 each), visit Sierra Press online, www.nationalparksusa.com/, write Sierra Press, 4988 Gold Leaf Drive, Mariposa, California 95338, or visit author Larry Points's site at www.seacritters.com.

Play the Bay Game

The Maryland Bay Game, an intergovernmental, public/private collaboration, is a creative way to educate children and motorists about the Chesapeake. Designed to be played in the car while traveling from Maryland's Chesapeake Bay Bridge to the state's top summer vacation spot, Ocean City, it requires players to take notice of things they see every day. A connection is made to the Bay to reinforce the message that although the Bay may not be visible from a certain location, land uses and activities within the watershed affect it.

Copies of Maryland Bay Game booklets are distributed at the toll facility at the Bay Bridge, where the activities in the booklet start. For more information, contact Alexis Grant, Special Projects Coordinator, by phone, (410) 260-8016, e-mail grant@dnr.state.md.us, or visit the web at www.dnr.state.md.us.

Websites of Note

■ **Western Atlantic Shorebirds.** An interactive website — formed to promote research, conservation and education about shorebirds that migrate from Tierra del Fuego, at the tip of South America, to the Canadian Arctic — is available for use by the public for the first time this year.

Visitors to the website, developed by the Western Atlantic Shorebird Association (WASA) partnership, can monitor the status of the migration in near-real time by observing the date and location points on the migration maps. You can visit the website at www.hopscotch.ca/shorebirds/index.html.en. For more information, contact Nina Garfield, NOAA's National Estuarine Research Reserve System, phone (301) 713-3141, ext. 171, or Gregory Breese of the Delaware Field Office of the U.S. Fish and Wildlife Service, phone (302) 653-9152, ext. 15.

■ **Contaminant Encyclopedia.** The National Park Service's Environmental Contaminants Encyclopedia summarizes environmental fate and effects information on 118 toxic elements, compounds and products. Entries include the 30 oil and petroleum products most commonly spilled into fresh and marine waters of the U.S., 63 other petroleum-related compounds, metals (mercury, cadmium, selenium), volatile organic compounds (VOCs) and chlorinated organic solvents.

The document will be useful to those who need to obtain information on environmental contaminants quickly. The Encyclopedia is at www.nature.nps.gov/toxic.

■ **Academy 2000 Online.** The EPA's Watershed Academy has developed a distance learning program available online called Academy 2000. The course consists of a set of training modules that provide a basic, broad introduction to the many facets of watershed management using a variety of Internet-based formats.

The time and complexity of each module varies, but most are at the college freshman level of instruction. Completing a series of 15 of these modules earns the Academy 2000 watershed training certificate. Several of these modules are still under construction, but all 15 should be online in the winter of 2000.

The website courses are divided into six themes: Introduction/Overview, Watershed Ecology, Watershed Change, Analysis and Planning, Management Practices and Community/Social Context.

For more information, or to access the Academy 2000 modules, visit www.epa.gov/owow/watershed/wacademy/acad2000.html.

Calendar

July 29, 2000-March 25, 2001— African Americans and the Chesapeake Exhibit

Mariners' Museum, Newport News, Virginia. The museum is featuring a new exhibit titled "Waters of Despair, Waters of Hope: African Americans and the Chesapeake Bay." Drawing on a vast scholarly collection, the museum will feature recordings, rare documents, artifacts, historic photographs, engravings, American literature, ephemera, ship models, postcards, small craft and hands-on interactive displays to weave the story of blacks and the Chesapeake from 1750 to the present.

For more information on the exhibit, which runs from July 29, 2000 to March 25, 2001, check the museum's calendar on the web, www.mariner.org/calendar.html. For information on the museum, visit their main web page, www.mariner.org/, or call the museum at (757) 596-2222.

October 30-November 3 — Wetlands Workshop

Atlantic City, New Jersey. The Third Annual Wetlands Regulatory Workshop will aim to increase dialogue and foster relationships among federal, state and local regulatory agencies, scientists and the regulated community. Held at the Holiday Inn-Boardwalk, the workshop has a range of registration options. For registration information, contact the Wetlands Regulatory Group, 67 Meyer Lane, Stafford, Virginia 22554, phone (540) 286-0072, fax (540) 286-0073, e-mail reillygroup@ msn.com.

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