MARYLAND

Research, Education, Outreach

MARINE NOTES

or three days the metal jaws of a 🕇 grab sampler took discrete bites out of the bottom of the Patapsco River where it forms Baltimore Harbor. Day after day, as if working a huge oyster bar, the crew on deck pulled the sampler aboard, taking on their harvest of mud. By the time they finished, they had taken more than 160 samples at 81 locations, 160 snapshots of sediments in Baltimore Harbor and the nearby waters. The purpose — to help the Maryland Department of Environment determine the extent of contaminants in harbor sediments

Those three days, five years ago now, were part of a long and complicated detective story. The story is not only about what has been released into these waters for many decades, but also about chemical compounds that are still coming into the Patapsco River and nearby tributaries from countless diffuse sources, such as runoff from urban and industrial sites. And more — by studying the behavior of sediments, researchers have begun to piece together a detailed chronicle of how contaminants move, a story where the major actors include not only Baltimore Harbor and the Patapsco River, but also the Susquehanna River, an immense fresh water source that dominates currents throughout the upper Bay.

Helping to unravel this tale of contaminants is a team of researchers, including Joel Baker and Larry Sanford, of the University of Maryland Center for Environmental Science. Their work has been funded by the Maryland Department of the Environment for the last several years and is continuing. Baker is an expert in chemical contaminants. Sanford's expertise is in the area of physical oceanography — tracking waves and currents that move sediments through the water. With funding from the



SPOTLIGHT ON RESEARCH Taking on Toxics in Baltimore Harbor

BY MERRILL LEFFLER AND JACK GREER

Researchers are working together on a long-term study of the harbor that is assembling data and developing predictive models to help show where contaminants come from, where they go and how they interact with living organisms.

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Contaminants include not only heavy metals, PCBs and PAHs, but also substances not usually considered pollutants such as nutrients and sediments

Maryland Department of the Environment (MDE), the scientists are working together, and in collaboration with others, on a long-term project. Called the Comprehensive Harbor Assessment and Regional Modeling (CHARM) Study, it is assembling data and developing predictive models to help show where contaminants come from, where they go, and how they interact with the Bay's living organisms.

A Sense of Urgency

MDE — and the researchers who are helping the state's resource agencies — find themselves facing a difficult deadline. If the state cannot show that the Bay and its tributaries have met strict federal standards by the year 2011, not only are federal funds from the U.S. Environmental Protection Agency (EPA) in jeopardy, but the EPA can actually step in and take over management of these waters. Improvements in tributaries such as the harbor could help in meeting the 2011 goals.

Driving this deadline is the Clean Water Act, a law that has been instrumental in helping reduce pollution from a number of sources, most notably so-called point sources, such as large industries. Also in the Clean Water Act, but not focused on until relatively recently, is a requirement to monitor Total Maximum Daily Loads (TMDLs), the maximum amount of various pollutants that can enter a stream, creek or river per day before causing environmental harm.

Those pollutants include heavy metals like mercury, lead and cadmium; organic compounds classed as



While Baltimore's Inner Harbor has become an economic engine for the region, the sedi ments beneath its waters remain toxic — not only with the residue of past industrial ac tivities, but also nutrient and sediment runoff from city streets and parks.

PCBs (polychlorinated biphenyls) and PAHs (polycyclic aromatic hydrocarbons). They also include substances not necessarily considered pollutants, such as nutrients and sediments, which can impair the health of streams, rivers and estuaries.

Maryland has listed Baltimore Harbor and the Patapsco River as "impaired," because of excess contaminants, sediments or nutrients, or a concoction of all three.

The question MDE must answer for each body of water is how much of each contaminant can be released in a day without detrimental impacts — this number is the TMDL for that chemical for that system. Next, MDE must identify sources of the contaminant, then allocate percentages of that specified limit among the different sources. This includes not only industries and waste treatment plants but diffuse sources of runoff including farms, suburban and urban areas and atmospheric deposition.

Larry Sanford notes that the limits set by TMDLs don't really focus on who's responsible for local contamination — that's the state's job — but rather on the sum of all pollutants entering a water body. And that sum should not cause impairment. This means that regulatory agencies like the Maryland Department of the Environment (MDE) must understand the whole mix of contaminants and sediments and nutrients in a given tributary to determine what sources are causing damaging effects.

"We have to start out trying to understand the process," says Sanford, "and predictive models help you to do that." What Baker, Sanford and their colleagues are after in Baltimore Harbor is a view of the whole. "If the model works right, it can help a manager allocate different sources to achieve an acceptable measure of water quality," says Sanford.

Understanding River Flow

Years ago, it was assumed that contaminants discharged into Baltimore Harbor and the Patapsco River were largely diluted, first in the river and then in the Bay, as currents carried contaminants down toward the Virginia capes and finally out into the Atlantic ocean. By the time those contaminants flowed that far, the reasoning went, they were presumed to be of little harm, either to fish or to human health.

In the early 1980s, however, it became clear that the Patapsco was different. Physical oceanographers Bill Boicourt of UMCES and Peter Olson of Johns Hopkins University — both were then at the Chesapeake Bay Institute — confirmed the earlier hypothesis of pioneering oceanographer Don Pritchard that water flow in the Patapsco River differs significantly from most other rivers in the Chesapeake. Most rivers in the Chesapeake can be characterized as having a twolayered circulation pattern, where buoyant freshwater from the river runs on the surface down river to the Bay, while dense saline water below pushes upriver. The Patapsco, however, more often demonstrates a threelayered circulation pattern, where fresh surface water flowing from the powerful Susquehanna River — as well as the saline water below coming up from the Bay — push up the Patapsco. The relatively weak outflow of the Patapsco is mixed into these strong inflows and emerges as a layer of intermediate salinity at mid-depth. In other words, the flow of the Patapsco River itself exerts little influence on the circulation of its estuary.

Sediment particles suspended in the Patapsco River waters (and other internal fresh water sources such as storm sewer outfalls) are similarly mixed with sediment particles that come in with fresh water from the Susquehanna and sediments that have been resuspended from the bottom. Riding on this whirl of suspended sediments are potentially toxic compounds, many of which have strong chemical affinities for particles.

These sediment-bound contaminants settle to the bottom, but are periodically lifted back up by currents, storms, dredging or passing ships. This up-and-down recycling finally ends when the old sediment particles are buried by newer sediment particles, many of them supplied by the inflow from the Bay. Burial happens sooner in the relatively calm recesses of the Inner Harbor, at Bear Creek, for example, but sedimentation rates in the Patapsco estuary are rapid in general. Rather than helping to carry contaminated sediments down the Bay, the force of the Susquehanna River actually causes more rapid burial and greater retention of contaminated sediments originating within the harbor.

"The Susquehanna River flow is a net source of sediment to Baltimore Understanding the dynamics of contaminants is the first step in trying to control their ecological impact.

Harbor," says Baker. There is more sediment coming into the Patapsco from this source than from the surrounding landscape. "The work we've done supports that," says Baker, who adds, "the magnitude of the Susquehanna's contribution of sediment just hasn't been appreciated."

These physical patterns help to explain why Baltimore Harbor retains contaminants in its waters. "Though there is some leakage of contaminants out of the harbor into the Bay," says Baker, "much of the material that is released there just doesn't move." Even clean sediment particles coming into the Patapsco mix with waste discharges and absorb chemical contaminants. Little of what is loaded into northern Chesapeake Bay makes it south. If it did, Baker says, we would see contaminants south of Kent Island. He points to PCBs as an illustration. Samples taken from sediments in the Baltimore Harbor area showed concentrations ranging from 10 to 20 nanograms per liter of PCBs, while sediment samples taken near Kent Island showed levels at only 1 to 2 nanograms per liter. Not many PCBs made it out of Baltimore Harhor

Measuring Contaminants

Though MDE had been sampling sediments for contaminants for some years in Baltimore Harbor, until the CHARM Study that Baker and Sanford directed, there was no comprehensive map of the distribution and concentrations of toxic compounds. In part, the reason was cost, which accounts for the paucity of contaminant data throughout the Bay system, especially when compared with data on nutrients.

Unlike the nutrients nitrogen and phosphorus, which include only a handful of chemical forms, "contaminants" is a general term covering a complex of many compounds, among them the various forms of heavy metals, as well as PCBs and PAHs — generic names for scores of related compounds. The costs for measuring a suite of contaminants can run between \$1,500-2,000 per sample, compared with \$20-30 for nutrients. Analyzing the large numbers of discrete samples, necessary to construct an image of contaminant distribution, can add up to a hefty sum. In fact, the Chesapeake Bay Program's monitoring effort does not include regular measurements of metals or organic contaminants.

In supporting the work of Baker, Sanford and others on the UMCES research team, MDE made a commitment to understanding the dynamics of contaminants as the first step in trying to control their ecological impact. The scientists have taken their samples throughout the harbor and Patapsco River: in the Northwest Branch, which includes Baltimore's Inner Harbor; in highly urbanized areas along Curtis Bay, Curtis Creek and Middle Branch; along heavily industrialized Sparrow's Point; and on Bear Creek, which is largely residential upstream.

Over the following months, samples were subjected to a battery of tests in order to determine composition and concentrations. Using these data, scientists were able to create a map of the locations and concentrations of each contaminant they found. "The spatial variability is enormous," says Baker, meaning that values of any one contaminant range widely, even when sites are near each other. Still, he adds, the data reveal striking insights into the condition of sediments, as well as general water quality in the region. A substantial number of sites, for example, contained concentrations of metals and organic contaminants that were well above the "no effects" level. Though not a direct measure of biological impact, this observation suggests a strong likelihood of impaired habitat.

Mapping Contaminants

R esearchers from UMCES analyzed sediment samples from locations throughout Baltimore Harbor and used the data to create a map of contaminant locations and concentrations. These data are serving as a baseline for the development of models that aim at predicting the movement of toxic compounds in harbor waters. If successful, the models will help the Maryland Department of Environment better allocate a total maximum daily load (TMDL) of a given pollutant for each potential source, whether direct or diffuse. Below is a summary of major chemical hotspots. The study also found all over the harbor low levels of Chlordane, a powerful biocide once used to control termites and other pests. Though no longer manufactured, it is so opersistent in soils that it continues to enter the system in runoff and is the cause of a fish advisory recommending against consumption of catifsh and eels caught in the harbor.

- PCBs and PAHs appeared in extremely high concentrations in the Inner Harbor, which may reflect the influence of stormwater runoff carried to the harbor from Jones Falls. PAHs were high on the southern shore of Sparrows Point, on Bear Creek, probably due to heavy industry located there. PCB concentrations were high in Bear Creek and Curtis Creek, compared with most sites along the Patapsco River.
- Zinc and chromium were high in Bear Creek, potentially related to the Sparrows Point industrial complex, while concentrations were high at several sites in Northwest Branch, which may be due to stormwater runoff.
- Nickel exhibited high values at 70 percent of the sites sampled.
- Mercury was highest at the entrance to the Inner Harbor, likely due to stormwater runoff; high concentrations also occurred in Curtis Creek, Bear Creek and Back River.
- Copper was highest in Northwest Branch and Curtis Creek.



Until this study, there was no comprehensive map of the distribution and concentrations of toxic compounds.

The mapping provides a baseline of data — it doesn't reflect how long contaminants have been in these sediments or how they move around. This is the role of predictive models. "Many people have the misconception that all toxic problems are from activities that occurred 40 to 60 years ago," Baker says. "We have been measuring concentrations of the same suite of chemicals at Gwynns Falls and Jones Falls to get an estimate of [current] loading to the Inner Harbor." While there is not enough data yet to draw conclusions, Baker believes that contaminants in such stormwater flow will emerge as a large part of the problem. Computer modeling that relates these loadings to their spatial distribution in the sediments will allow scientists to make predictions about how far a given contaminant will travel.

Inching Towards Prediction

Modeling contaminant movement depends on understanding the dynamics of suspended sediments as well as the behavior of different chemical contaminants. Organic compounds and metals have different affinities for binding to particles. "[Contaminants] with low affinities may travel around, but there is a widely varying behavior," says Sanford. The model must take into account these different binding affinities.

"The typical sediment particle that enters the harbor," says Sanford, "experiences multiple cycles of resuspension and deposition, before it's permanently removed from circulation by sedimentation." As with the sediment particles, so too with the sediment-bound chemicals. "There is, as we've seen, a huge pool of contaminants in the sediments already," says Sanford. "These are the legacy



These samples of mud from Baltimore Harbor will be brought back to the laboratory for slow and painstaking analysis. The hope is that ongoing studies will one day provide the means by which managers can clean up some of the Bay's most polluted waters.

of the past — we need to know how much they impact Baltimore Harbor without any new input."

Addressing such issues are important for evaluating realistic management options. For example, if sediments in a creek feeding the Patapsco River are high in PCBs but indicate little evidence of new inputs, there may be value in considering such remediation options as removing the impaired sediments by dredging or capping them with clean sediments. On the other hand, if the model indicates that the sediment-bound PCBs are from continuing runoff sources, then land-based management efforts may need to be stepped up.

In developing a first-order model to predict sediment transport, Sanford has separated Baltimore Harbor into 24 large regions or "boxes," largely divided among the different feeder tributaries where contaminants were measured. This approach differs from traditional water quality models, which are often divided more finely into hundreds of small compartments, each of which is given a set of water quality parameters. It can take days to run a particular TMDL scenario in such a model. Sanford's box model can get results quickly by trying out different TMDL allocation scenarios. The model has required simplifying generalizations that sacrifice some accuracy for speed, Sanford says; however, it affords managers flexibility they would not have with a finescale model.

Looking Ahead

In its 1996 listing of impaired waters to EPA, the Maryland Department of Environment listed Baltimore Harbor as impaired for toxics — at that time, the agency

could not be more specific. Based on the study by Baker and Sanford, MDE's 1998 revision listed ten chemical contaminants that would require the setting of specific TMDLs, among them, PCBs, chromium, zinc and lead.

Just what are the biological impacts of these contaminated sediments? The answers are complex to begin with, researchers can only determine acute or lethal effects, not long-term sublethal impacts on reproduction or behavior. Even the acute effects are difficult to assess because many of these bottom areas not only have high contaminant loads, they also lack oxygen, a condition brought on by excessive nutrients.

To get a handle on the extent of toxicity in Baltimore Harbor sediments, Beth McGee, now of the U.S. Fish and Wildlife Service, collected sediments from 25 of the 81 sites in the Baker and Sanford study and tested their effects on *Leptocheirus plumulosis*, a small amphipod common to these waters. She found that a number of sites were clearly toxic and lethal. While the hottest were from Bear Creek, she says, other areas exhibiting toxicity included the Inner Harbor and Colgate Creek, with lower levels elsewhere in the harbor system.

Ironically, the biological impact could be greater if nutrient reduction efforts in the harbor lead to improved oxygen levels. Some benthic habitats and organisms such as *Leptocheirus* could flourish; feeding in these sediments, they would pass contaminants up the food chain to invertebrate and fish populations that prey on them. In other words, says Baker, improving habitat conditions could make things worse for the health of fish that feed in harbor waters — at least for a while.

Because of such scenarios, it is critical to distinguish contaminated sediments that are the result of past discharges from those that are on the receiving end of new contaminants. "We need to get a handle on loadings," says McGee, "and do some investigating on whether sediment remediation is appropriate."

For nearly two decades, curtailing nutrient flow to the Chesapeake Bay has understandably held center stage of restoration efforts. Overenrichment of nitrogen and phosphorus has set into play a network of processes that has degraded Bay waters significantly.

In contrast to nutrient overenrichment, which is a problem Baywide, chemical contamination of sediments is largely limited to Baltimore Harbor, the Anacostia River and the Elizabeth River, though there is evidence of localized problems in other parts of the Bay system. For years, it seemed little could be done in these heavily urbanized waters - not only do contaminants come in different species and forms, they behave differently under varying environmental conditions. Furthermore, pollution seemed a given in a heavily industrialized urbanized watershed, the price that had to be paid for commercial activity. That given no longer holds. Not only does the Clean Water Act require action to restore these waters, but there is clearly strong advocacy to do so.

We have come a long way in Baltimore Harbor, says Baker. "We started with knowing little and have some significant progress in the last several years." "But," he adds, "we still have a long way to go." V

MEES Students Receive Knauss Fellowships

Three graduate students in the Marine-Estuarine-Environmental Science (MEES) program at the University of Maryland are recipients of Knauss Marine Policy Fellowships for 2001: John Adornato, Brian Badgley and Wendy Morrison, all finishing Masters degrees. The Fellowship program, begun in 1979 and coordinated by the National Oceanic and Atmospheric Administration's (NOAA) National Sea Grant Office, provides graduate students across the country with an opportunity to spend a year working with policy and science experts in Washington, DC.



▶ John Adornato, III is spending his fellowship year with Senator Daniel K. Akaka, a Democrat from Hawaii. His work will focus on aquaculture, coral reefs, fisheries and other marine-related issues. John received a B.S. degree in biology with a minor in Russian language from Tufts Universi-

ty in 1996. Following his graduation, he worked in Phoenix, Arizona for the USDA, Agricultural Research Services' New Corp Division and their Global Climate Change research group using Free-Air Carbon Dioxide Enrichment research technologies. Since the fall of 1998, he has been a graduate teaching assistant for genetics and general biology in the College of Life Sciences at UMCP and was recently honored with a distinguished teaching assistant award. John also helped conduct wetland plant research in the Chesapeake Bay directed by Dr. Andrew Baldwin, a professor in the Biological Resources Engineering Department. In addition to that work, John designed and undertook his master's research investigating the damage from Hurricane Lili and the initial regeneration of forested wetlands on Hummingbird Cay, Great Exuma, Bahamas. He has successfully defended his Master's Thesis and anticipates graduating from the Marine-Estuarine-Environmental Sciences Program this December.



▶ **Brian Badgley** is working with NOAA's National Ocean Service in the National Estuarine Research Reserve System. He will be working closely with management issues for the reserves in North Carolina, Virginia and Maryland. In addition, he will be part of two groups — one examining how to

approach expansion of the reserve system and target new areas for reserves, and one focusing on the implementation of a system-wide training initiative for coastal resource managers. Brian obtained a B.S. in zoology from the University of Georgia, followed by work as a research assistant at the Key Largo Marine Research Lab in Florida and as an instructor at the Jekyll Island Environmental Education Center in Georgia. He is currently writing his thesis. During his graduate career, he researched nutrient dynamics on coral reefs at the Bermuda Biological Station for Research and was a teaching assistant for a Biological Oceanography class and associated lab. In 2000, he was a research assistant at Maryland Sea Grant College, where he helped prepare for the recent external program assessment and aided with other management and administrative issues.



▶ Wendy Morrison is spending her fellowship year with NOAA's National Ocean Service, Center for Coastal Monitoring and Assessment Biogeography Program, where she will work on projects aimed at providing ecosystem-level information on the distributions and ecology of living marine resources, including

projects in central California, and the U.S. Virgin Islands. Wendy received her B.S. degree in marine science and biology from the University of Miami in 1993, which included one year of study at James Cook University in Australia. After graduation, she spent two years as a Peace Corps volunteer working with subsistence fishermen to increase the sustainability of their resources. She spent a year teaching high school science in Miami, Florida before enrolling in the MEES program in 1998. Her work at Maryland, advised by Dr. David Secor, has focused on understanding the biology of American eels with an emphasis on an unfished population in the Hudson River, New York. She plans to graduate this fall.

Over the years, Knauss Fellows have gained experience in the legislative and executive branches of the federal government in locations such as the offices of U.S. Senators and Representatives, on Congressional subcommittees and at agencies such as the National Science Foundation and NOAA. Fellowships run from February 1 to January 31 and pay a stipend of \$32,000.

Knauss fellowships are awarded with the help of Sea Grant programs across the nation. The selection process begins with the submission of applications by candidates recommended for their excellence by Sea Grant Directors. The National Sea Grant office then conducts a rigorous review process and awards fellowships to the top candidates. Maryland was one of the few programs to receive three fellowship awards this year.

The application deadline for the Knauss Fellowship Program is April 1 of the year preceding the fellowship year. To qualify for a fellowship, students must be enrolled by May 1 of the year of application in a graduate or professional degree program in a marine-related field at an accredited institution in the United States. Those interested in applying for 2003 fellowships should check with the Maryland Sea Grant office for guidance and possible volunteer opportunities now. For more information, check the web at www.mdsg.umd.edu/NSGO/Knauss.html, or contact Susan Leet, Maryland Sea Grant College Program, 0112 Skinner Hall, University of Maryland, College Park, Maryland 20742, phone (301) 405-6375, e-mail leet@mdsg.umd.edu.

Maryland Students Are NMFS Fellows

Two marine science students from the University of Maryland have been awarded fellowships from the National Marine Fisheries Service and Sea Grant.

The first fellowship goes to Michael Price, of the University of Maryland, College Park, in the area of marine resource economics. He will be working with Michael Prager, at the NMFS Southeast Fisheries Science Center (SEFSC) in Beaufort, North Carolina and with Harold Pratt at the Northeast Fisheries Science Center in Narragansett, Rhode Island. Price's major professor is Kenneth McConnell of the Agriculture and Resource Economics Department at College Park.

The second fellowship goes to Michael Frisk of the UMCES Chesapeake Biological Laboratory, in the area of population dynamics. He will be working with James Waters, at the SEFSC in Beaufort. His major professor is Thomas Miller, of CBL. The NMFS/Sea Grant fellowships were awarded based on a rigorous national competition.

Play the Bay Game



To help children pass the time while learning something on the long car ride to Maryland and

Delaware ocean beaches this summer, ask for a free copy of the "Bay Game" at Chesapeake Bay Bridge toll booths. This fun and educational activity, created by the Maryland Department of Natural Resources, uses a map marked with locations along the journey to teach about Bay ecology and how to protect its resources. This year, there is also a new online "Bay Game for the Millennium" at www.dnr.state.md.us/baygame/ to complement the road game with additional information and interactive activities.

Noteworthy

Honors

Chesapeake Biological Laboratory professor Ed Houde received the Regents Faculty Award for Excellence in Public Service at the Board of Regents meeting in April. He was the first UMCES faculty member to receive one of the prestigious awards. He was chosen for the award, says UMCES President Donald Boesch, "because he has devoted much of his career to advocating for the sound management of fishery resources and is recognized for his contributions not only in Maryland, but throughout the region and the nation."

"A fellow of the American Association for the Advancement of Science, Houde has played a major role in changing the paradigm of fishery management from one that maximizes harvest to the point of species depletion to one that stresses conservation," adds Boesch. This research led legislators to include a commitment to multi-species management in their historic Chesapeake 2000 Agreement.

New Scholarship in Marine Science

The National Oceanic and Atmospheric Administration (NOAA) recently announced the Dr. Nancy Foster Scholarship Program to recognize outstanding scholarship and encourage independent graduate-level research particularly by female and minority students — in oceanography, marine biology and maritime archaeology. Congress authorized the program soon after Foster's death in June 2000 as a means of honoring her life's work and contribution to the nation. The program is administered through NOAA's National Ocean Service and funded annually with one percent of the amount appropriated each fiscal year to carry out the National Marine Sanctuaries Act.

Foster, the former assistant administrator for Ocean Services and Coas-

tal Zone Management at NOAA and Director of the National Ocean Service, was a marine biologist known for her science-based conservation of coastal aquatic life. She was also respected throughout her career as a personal supporter of mentoring, a champion of diversity and an advocate of fair and equal treatment of all people in the workplace.

Åpplications are currently being solicited for the Foster Scholarships that carry a \$16,800 yearly stipend and an annual cost-of-education allowance of up to \$12,000. Masters students may be supported for up to two years and doctoral students for up to four years. For fiscal year 2001, approximately five scholarships will be awarded. The original deadline of April 22, 2001 has been extended for at least 30 additional days. For more information and the exact deadline, visit the web at www.fosterscholars. noaa.gov/

Bald Eagles Thriving



Bald eagle populations have reached a twenty-three year high in the Chesapeake Bay watershed, according to data released in March by the Chesapeake Bay Pro-

gram. For the first time since the 1940s an active nest with a fledgling has been recorded in the District of Columbia. Results from the annual Baywide bald eagle population count show increased numbers residing throughout the Bay watershed, with 533 active nests fledgling 813 eaglets — nearly a ten percent increase from the previous year.

"Improvements in overall water quality and targeted bald eagle restoration efforts undertaken over the past two decades have brought the species from the edge of extinction to a viable population within the Bay watershed," said Chesapeake Bay Program Living Resources Subcommittee Chairman Frank Dawson.

For more information about the resurgence of the Chesapeake Bay bald eagle, visit the Chesapeake Bay Program online Press Center at www.chesapeakebay.net/press.htm.

End Notes

Oyster Restoration



Volunteers are needed on Saturdays now through October to make shell bags at the University of Maryland's Horn Point oyster hatchery in Cambridge, Maryland. Thousands of shell bags will be needed to produce "spaton-shell" to be used in oyster restoration projects throughout Maryland. The making of shell bags is essential to production of oysters by the hatchery. For more information on volunteering, please contact Heather Tuckfield at the Chesapeake Bay Foundation, by phone, (443) 482-2151, or email, htuckfield@cbf.org

Papers and Posters Invited

A technical forum called "Phragmites australis: A Sheep in Wolf's Clothing" is scheduled for January 6-9, 2002 at Cumberland College, Vineland, New Jersey. Posters and papers are currently sought that address the themes of the forum, which will focus on new research and critical reviews addressing Phragmites' role as a "noxious weed." The forum will allow managers and leading experts on ecology to exchange information. In addition to the forum, a facilitated workshop will allow managers and experts to exchange information that will help focus the national effort in multidisciplinary research to better understand the ecology of Phrag mites and its ecosystem level effects. For more information, visit the web at www.njmsc.org/Phragmites% 20Conference.htm, or contact the New Jersey Marine Sciences Consortium, by phone, (732) 872-1300, or fax, (732) 291-4483.

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