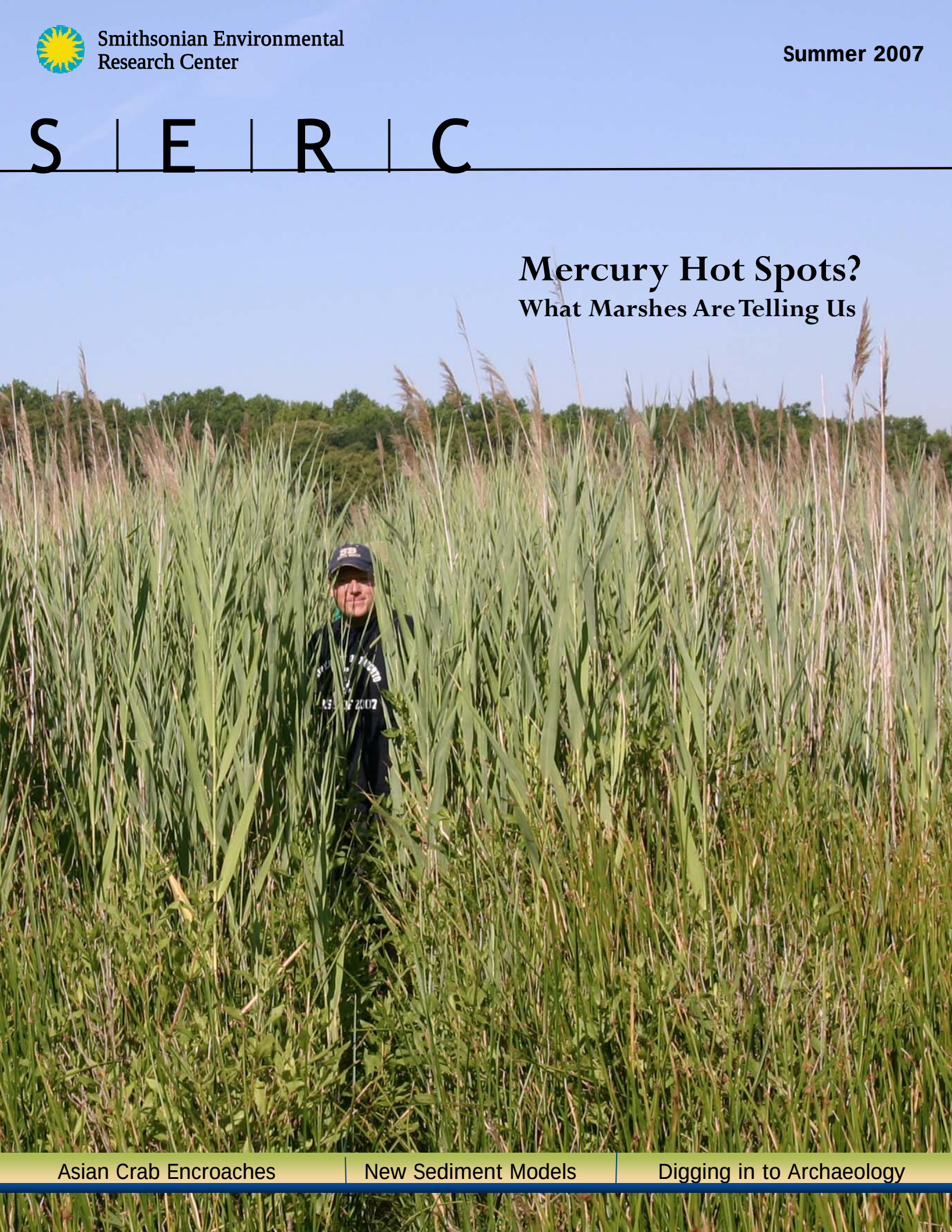
Smithsonian Environmental Research Center

Summer 2007

S | E | R | C

Mercury Hot Spots?
What Marshes Are Telling Us



Asian Crab Encroaches | New Sediment Models | Digging in to Archaeology

CHANGING OF THE GUARD

Midgett Parker speaks at the opening of SERC as a Chesapeake Gateway in 2006.

Midgett Parker has taken over the reins as Chair of the SERC Advisory Board. Parker is the recipient of the 2007 Bridge Builder Award from the Black Chamber of Commerce of Anne Arundel County and a partner in the law firm Linowes and Blocher LLP. He recently stepped down from his position as Chair of board of Trustees to the Chesapeake Bay Trust.

"Midgett Parker is exceptionally well qualified to lead SERC's Advisory Board in a period of rapid advancement for our world-class research, innovative public programs, and expanding outreach," said SERC director Anson Hines.

Parker is recognized for providing valuable legal counsel to businesses, churches and developers in land acquisition, land use regulations, financing, construction contracts and dispute resolution in the construction process.

Commenting on the appointment, Parker said, "As the new Chairman of the Board, I look forward to helping increase public awareness of the significant research, education and outreach of the Smithsonian Environmental Research Center. It is such an important time for all of us to understand climate change and our impacts on the earth, and to learn to be responsible stewards of the environment. SERC is laying the foundation for that knowledge. I'm excited to reach out to the public and let them know that we're here."

Parker replaces William R. Sweeney, Jr., who has stepped down after serving 8 years as member including 5 years as Chair of the Board. For his exceptional service and his notable contributions to SERC during his tenure, Sweeney was awarded the Isaac Hull Medal commemorating Captain Isaac Hull and the victorious action of the USS Constitution with the HMS Guerriere in the War of 1812. Sweeney is the third recipient of this prestigious award.

LEADING WETLAND ECOLOGY

Microbial ecologist Patrick Megonigal was recently inducted as President of the Society of Wetland Scientists, an international organization of about 4,000 scientists which publishes the quarterly journal Wetlands.

Megonigal also recently hosted the 10th Symposium on Wetland Biogeochemistry, an international event organized by leading wetland scientists at two year intervals. The meeting attracted about 180 participants from 13 countries. Megonigal organized the event and Chaired the symposium. Five SERC scientists presented papers (Jason Keller, Adam Langley, Samantha Chapman, Kathy Boomer, and Carl Mitchell). In addition, Pat Neale, Tom Jordan and Fritz Riedel served as Session Chairs. Several other papers at the meeting included Pat Megonigal, Cindy Gilmour and Candy Feller as authors. During the meeting, SERC hosted a workshop for the Scientific and Technical Advisory Committee of the EPA Chesapeake Bay Program.

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CORRECTION: Mara Jonas is the guide for our new Spanish language canoe tours, not Tara Cashman as indicated in the Spring 07 Issue..

Cover photo: Carl Mitchell traverses tall stands of phragmites on the way to his study site. Photo: Kimbra Cutlip (story page 4).

Eye on Education . .

Rising STARs

On May 16th, students, teachers, SERC researchers and educators, and representatives from NOAA attended the Student Training in Aquatic Research (STAR) Symposium marking the culmination of a three to four-month long research program for 12 high school students. During the symposium, students presented the results of their work which involved developing and implementing environmental research projects related to the Chesapeake Bay and its watershed. Working with SERC scientists, students engaged in all aspects of environmental research: from writing a proposal and planning the fieldwork, to field sampling, data analysis, and reporting results through presentation at the symposium. This was the fourth year of the STAR program at SERC.

Athman Adiseshan explains the results of his research to protistan ecologist Wayne Coats during the poster session of the STAR Symposium.

Wade In

West/Rhode Riverkeeper Bob Gallagher "measures" water quality during the second annual SERC Wade-in held in conjunction with SERC's Open House.

Open House

SERC Open House was a great success this year. Local officials spoke and participated in our second annual wade-in, more than 30 boats participated in our first annual canoe and kayak race and fun paddle which included families with children as well as serious kayakers. The outreach effort as well as the wonderful weather coalesced to bring in about 1,000 participants.

SERC's annual Open House is funded by the Chaney Foundation.

NexGen

Fostering the future of environmental science

Candy Feller helped organize a University of Georgia field course in Marine Ecology at the Institute of Marine Studies on Calabash Cay, Turneffe Atoll, Belize. Her students Sea McKeon and Jonathan Pahlas were teaching assistants.

What Goes In . . .

May come out more toxic.

The wetlands of the world are often referred to as kidneys of the earth, filtering nutrients, sediment and toxins from water as it makes its way into our streams, rivers and oceans.

And like the kidneys in our bodies, wetlands are not merely passive filters. They also process, alter and manufacture chemicals that flow into our waterways—some of them not so desirable. Methylmercury is a particularly insidious natural product of bogs and marshes that is often over looked in wetlands management. However, mercury pollution from such things mining and the combustion of fossil fuels is accelerating methylmercury production in the marshes.

Carl Mitchell, a post doctoral fellow in the microbial ecology lab recently took a couple of visitors on a tour of his field site to explain what scientists know about the role of marshes in methylmercury production and about his investigations into just how much methylmercury is produced in the marshes at SERC.

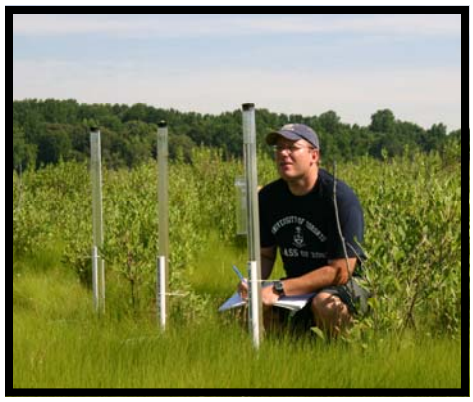
As he donned a pair of rubber boots, Mitchell cautioned us to walk carefully along the eight-inch planks forming the boardwalk to his site at the headwaters of the Rhode River. Then he disappeared into a thicket of 12-foot tall reeds and we followed his voice into the unknown. The tide was running particularly high, and we felt our way along the boardwalk with our feet as water slapped nearly up to our knees. "In some areas you will sink to your waist in peat if you fall," he called over his shoulder with the authority of someone who knows this first-hand.

One of the most toxic trace metals, inorganic mercury, the slippery quick silver with which we're most familiar, is prevalent almost everywhere. Traces of it occur in sediments and soils laid down over millions of years by volcanic eruptions. More recently, industrialization has rapidly increased the amount of mercury in the environment and new deposition is still occurring.

Inorganic mercury becomes more toxic and accumulates in wildlife and humans when it's converted into organic methylmercury. This is where wetlands come in. They are loaded with naturally occurring microbes that gobble up inorganic mercury and convert it to the organic form. Recently deposited mercury is much more available to those microbes than older mercury, which is tightly bound to the sediments. So, in the marshes, human activity is fueling the engine of methylmercury production.

During previous work Mitchell found that the edges of freshwater bogs produce more methylmercury than the center, perhaps because the interior is drier, and

methylmercury-producing microbes are more productive in flooded areas where less oxygen is available. "This presents a 'double whammy,'" he says, "in that the fringe is also where there is more water flow. Therefore, more of what is produced is delivered to downstream ecosystems, like lakes and bays." There, methylmercury begins its journey up the aquatic food web.



Carl Mitchell shows where the creek flows into the Rhode River (above). Measuring evaporation (below) is an important part of understanding water flow through the marsh.

His new studies introduce the effects of tides. According to Mitchell the ebb and flow of the tides may stimulate more methylmercury production as water pumps in and out the creeks and rivulets. He likens it to a bellows fanning a fire.

After nearly 15 minutes of slogging through the marsh, we arrived at a wooden hut built over a muddy brown stream. Mitchell knelt down and opened his laptop, which had thus far avoided a dunk in the marsh. He asked me to remove a small cap from a grey PVC pipe sticking up through the platform beside me.

Inside, I found a port and connected his laptop so he could retrieve data on the flow of water in and out of the creek. Next, Mitchell handed a pair of blue latex gloves to another guest named David. "You've got the dirty hands" he said to David. "I've got the clean hands." He gave David a zip lock bag containing another zip lock bag with a bottle inside it. Mitchell snapped another pair of gloves on his own hands and instructed David in the process by which they would retrieve a pure, uncontaminated sample of water.

Back in the lab, he will analyze his samples and compare the amount of mercury methylation in the marsh with the amount of methylmercury flowing into the Rhode River. He also compares this information with the overall flow of water in and out of the marsh.

A hydrologist by training, Mitchell wants to know how the water flow impacts production of methylmercury and its delivery into the Bay. "We're trying to identify the likely places or conditions under which new deposits of inorganic mercury may be more readily methylated," he explains.

Ultimately, Mitchell's work could lead to the ability to predict methylmercury hot spots, and help guide the process of restoring or constructing wetlands without inadvertently creating a new source of methylmercury.

Constructed wetlands are most often focused on removing nutrients and other pollutants from upland water sources, but some of the methods used in the process may actually increase methylmercury coming out of the system. "It's the classic man vs. nature scenario where you try to have control over one thing and something else comes along and bites you in the [backside]," Mitchell says.

That's why Mitchell is trying to get a better handle on the processes governing mercury methylation and movement. If marshes are in fact hot spots of methylmercury production as Mitchell and his colleagues in the Microbial Ecology Lab suspect, and if they can identify what governs the process, they may be able to figure out how fast the marshes would respond to reductions in mercury pollution. They also may help managers learn to construct wetlands without increasing methylmercury in the water.

Photos: Kimbra Cutlip

Field Notes:

Crab Invasion: Predictable Pattern

Recently caught in the Chesapeake Bay, chinese mitten crabs are so named for the distinctive "mittens" on their claws.

SERC researchers have been on the leading edge of an invasion that is playing itself out as if by script. In June 2005, a local waterman delivered a Chinese Mitten crab to SERC for identification. It was the first specimen of this non-native species ever captured in the Chesapeake Bay.

According to ecologist Greg Ruiz, the conditions were ripe for the arrival of the Chinese Mitten Crab in Chesapeake Bay waters just as they had been in San Francisco Bay when they first appeared there in 1992. Not only was the habitat suitable, but the presence of a delivery mechanism for juvenile crabs and larvae seemed irrefutable. Ships entering Baltimore Harbor are not required to treat their ballast water to remove or destroy organisms that may have hitched a ride from the last port of call. Untreated ballast water provides a veritable transoceanic shuttle service for larvae and small organisms.

Since the first report, the development of the Mitten Crab story has followed the pattern scientists have observed time and again. When the public was put on the lookout, Mitten Crab specimens began steadily creeping in. One crab was delivered to us by a watermen who had captured it in 2005 and kept it in his freezer. Between May and early June of this year six additional male crabs were confirmed. True to the pattern, the findings expanded the region of original capture to include Delaware Bay and New York's Hudson River.

The crabs are a concern because they can cause considerable damage, eroding embankments with their burrows, fowling fishing gear and clogging water intake equipment for power plants. In California, as in Europe, economic loses have been significant.

The subsequent capture of two female crabs in June and July, both of which had mated and carried eggs, may herald the next phase in the progression of species invasions. "We have not yet found larvae or juvenile crabs, the latter occurring in freshwater tributaries," Ruiz says, indicating that "we do not know whether the Mitten Crabs have established a self-sustaining population in the Mid-Atlantic region."

Ruiz's caution is warranted, as mitten crabs found in the Detroit River and Lake Erie 30 and 40 years ago seem not to have become established. However, the pattern looks suspiciously familiar. The conditions are more appropriate along the Mid-Atlantic coast, and according to Ruiz, "the door remains wide open."

A New Perspective

According to ecologist Dr. Kathy Boomer, it's time for a change to the status quo. Boomer has been examining the tools scientists and managers use to predict how much sediment runs into the Chesapeake Bay, and by her account, they're way off the mark. Sediment running off the land reduces light, suffocates underwater organisms and is a significant source of phosphorous, a nutrient that essentially fertilizes the water causing algal blooms and many other problems in the Bay.

"Cities and Counties are under increasing pressure to meet total maximum daily loads set by State and Federal agencies, and to try to attribute various sources of sediment," she says. "So we looked at validating the tools most widely in use now to predict sediment delivery."

Her research comparing actual observations of sediment delivery rates at several locations and predictions from the most up-to-date models suggests the models aren't very accurate.

The problem, she says, is that the most widely used models all begin with the same tool, the Universal Sediment Loss Equation (USLE). Boomer emphasizes that the USLE was developed to help farmers limit topsoil loss on their fields rather than predict sediment delivery to streams. It gives an average annual erosion rate over a broad area. But not all of the eroded soil makes it into the water, so the estimates don't translate directly into sediment delivery rates.

To account for the discrepancy, different models incorporate a wide variety of adjustments. According to Boomer, the adjustments still don't result in the right analysis because erosion rate is not the best information to start with. "Sediment delivery is largely associated with specific rain events and stream bank erosion," she says. "So, USLE-based models that begin with estimated long-term annual average erosion provide limited information to land managers."

Her work has led to a new tactic. "We're moving away from focusing solely on watershed-level processes and looking more at what happens near streams during specific events that effect erosion and delivery of sediment to the Bay."

Archaeology Dig

Participants in SERC's public programs dig in and learn about local archaeology from county archaeologists as they excavate the grounds of a colonial mansion adjacent to the research center.

Every morning, SERC employees drive to work along a mile of bumpy dirt road bisecting the former Java plantation, a colonial tobacco farm now known as the Contee Farm. On one side of the road lies SERC's campus. On the other side, the remnants of the Contee mansion overlooking the Rhode River. Records indicate that two additional mansions may be buried beneath that same grassy knoll. Perhaps former slave quarters and a graveyard lay hidden nearby as well.

If these remains can be unearthed, they will paint a picture of human land use, and the impacts we've made on this patch of the Chesapeake Bay watershed for the last 320 years. To that end, remains of the colonial mansion and the grounds of the Java Farm are being excavated by archaeologists with the help of volunteers from SERC's public programs. "The site provides an excellent protected example of man's use of the environment," said Al Luckenbach, Anne Arundel County Archaeologist in charge of the excavation.

The education department will use information gained through the project to expand our programs on the history of the land.

STRENGTH IN NUMBERS: SERC was awarded $ 1,297,500 in new grants and contracts last quarter.

SIGHTINGS

Media coverage of the recent discovery of invasive Chinese mitten crabs in the Chesapeake and Delaware Bays has been widespread. Greg Ruiz, the lead scientific expert working on the issue was quoted in stories carried by all the major wire services such as Associated Press, Reuters, UPI, Newhouse, etc. SERC Invasions lab staff has been quoted in more than 200 stories appearing in media outlets from Philadelphia, New York, San Francisco and San Diego to London, Japan and Hong Kong.

Mario Sengco and Patrick Megonigal were featured in two separate BBC world news radio programs focusing on their work.

Patrick Megonigal was interviewed by Channel 9 news for a story on his research showing that soil may prove to be a source of atmospheric carbon, offsetting some portion of the gains in carbon uptake by plants.

The blue crab enhancement project was featured as the main story on Baltimore's Fox 45 nightly news.

Images from the SERC Phytoplankton Guide on the Web have been requested from multiple outlets including: Smithsonian Networks "Stories from the Vault", the Chesapeake Bay Foundation's member magazine, and an upcoming polar sciences publications by the American Academy for the Advancement of Science.

Civil Science

Government leaders, policy makers, and citizen groups look to SERC scientists for consultation and scientific guidance on the issues . . .

Thomas Jordan provided written reviews and advice to the **Chesapeake Bay Program** to reassess the efficiency of nutrient removal by restored wetlands. This advice will be used to modify the Chesapeake Bay Watershed Model, a major tool for management decision making.

Dennis Whigham provided consultation and advice to Richard A. DeVore, Watershed Manager for the **Pennsylvania Department of Environmental Protection**, on new "tools" to help assess ecosystem health.

Charles L. Gallegos provided advice and comment o the **USEPA Chesapeake Bay Program** on the report on statistical analysis of Bay Program light attenuation data.

NEW PUBLICATIONS

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