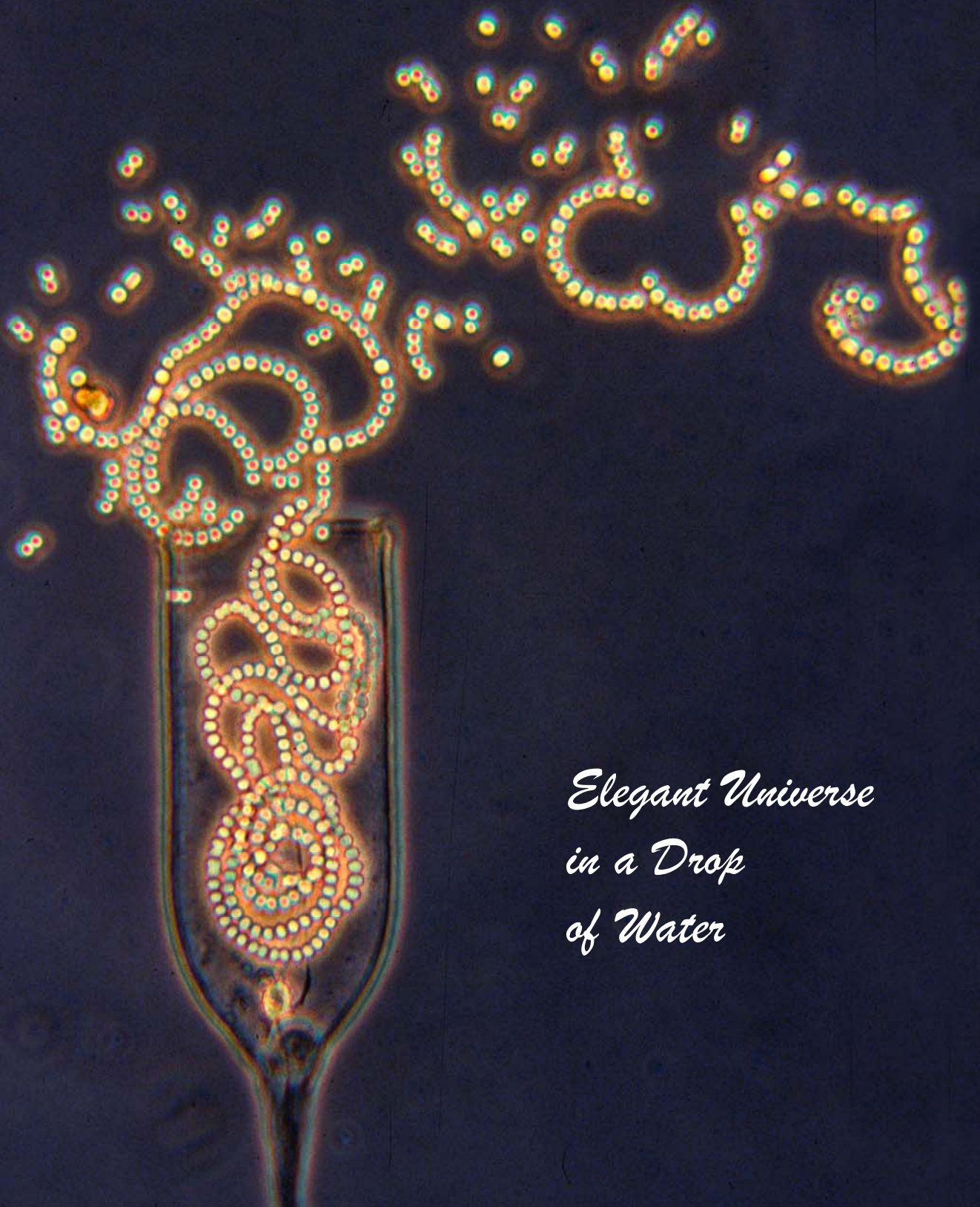




Smithsonian Environmental
Research Center

Winter 2006 / 2007

S | E | R | C



*Elegant Universe
in a Drop
of Water*

Forest Mapping

Oyster Interactions

Beyond Global Warming

Smithsonian Environmental Research Center Advisory Board

New to the Board:

Marjorie Murtagh Cooke is a Naval Architect and Marine Engineer who recently retired from federal service and serves as a consultant for a private accident investigation organization, Robson Forensics, Inc. Ms. Murtagh Cooke received her Bachelor of Engineering degree and her U.S. Coast Guard marine engineering license in 1974 from the State University of New York Maritime College, located at Fort Schuyler, New York. She worked for the Department of the Navy's Military Sealift Command and held a civilian position with the United States Coast Guard's Office of Marine Safety, Security and Environmental Protection at Coast Guard Headquarters.

Ms. Murtagh Cooke served as the Chief, Marine Division, and as an investigator-in-charge at the National Transportation Safety Board's Headquarters in Washington, DC. In May 1997, she assumed the duties as the Director, Office of Marine Safety for the NTSB.

She also served as the Safety Board's representative at the International Maritime Organization's World Maritime University in Malmo, Sweden. From 1986 to 1994, she was the U.S. representative for The International Maritime Organization. IMO is a United Nations' agency headquartered in London, England. She was elected Vice-Chairman of the Subcommittee in 1988 and served in that capacity until 1992 when she was elected as the Chairman of the IMO Subcommittee on Fire Protection.

In 1992, Ms. Murtagh Cooke received the U.S. Department of Transportation's Silver Medal for "her initiative and leadership at IMO in negotiating unprecedented fire safety requirements to upgrade passenger ships worldwide."

William R. Sweeney, Jr., Chairperson

Vice President, Global Government Affairs, Electronic Data Systems, Washington, DC.

Barbara Bedford, Ph.D., Senior Research Associate, Department of Natural Resources at Cornell University, Ithaca, NY.

Frank Chaney, CEO, Chaney Enterprises, Lothian, MD.

Marjorie Murtagh Cooke, Naval Architect and Marine Engineer, Washington, DC.

Diane Ebert-May, Ph.D., Professor, Department of Plant Biology, and Director, Assessment in Science Education, Michigan State University, East Lansing, MI.

Marlin Fitzwater, Writer and lecturer, former White House Press Secretary 1983-1992, Deale, MD.

Scott Nixon, Ph.D., Professor of Oceanography, University of Rhode Island, Kingston, RI.

Jeanne M. Grasso, Esq., Partner, Blank Rome LLP, Washington, DC.

Midgett S. Parker, Jr., Esq., Attorney and Partner, Linowes and Blocher, LLP, Annapolis, MD.

Brenda Robinson, President, Environmental Solutions, Inc., Richmond, VA.

Charles G. Rose, former North Carolina Congressman, Westminster, VA.

Robert B. Whitlatch, Ph.D., Professor, Department of Marine Sciences, University of Connecticut, Groton, CT.

\$1.49 Million Grant: Assessing Risks of Marine Invasions

SERC has recently received funding to support the National Ballast Information Clearinghouse (NBIC) for the next five years. The commercial shipping industry provides a sort of global mass transit system for marine organisms as it connects distant continents throughout the world. NBIC, a joint program between SERC and the U.S. Coast Guard, is studying the patterns of ship movement throughout the world and quantifying the volume of managed and unmanaged ballast water arriving to U.S. ports, information that is critical to assessing the risk from invasive marine species in coastal waters.

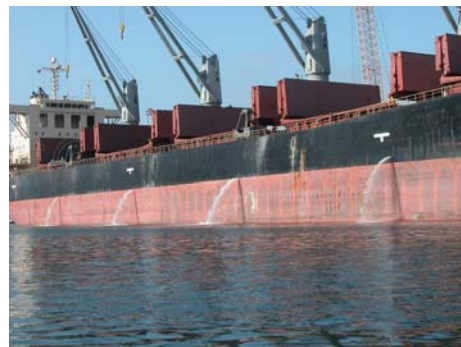


Photo: Christopher Brown

Cover photo: Sporocytes of a parasitic dinoflagellate, *Duboscquella aspida*, disperse from its host, the tintinnid ciliate *Favella panamensis*. This is just one of the many elegant species interactions Protistan Ecologist Wayne Coats studies (story page 4).

Eye on Education . . .

Taking the Show On the Rhode

Mark Haddon, Director of Education, is gearing up for a pilot season of video conferences in which city high school students will connect directly with educators and scientists as they explore the Rhode River and Chesapeake Bay on educational research cruises.

Using NOAA research vessels, SERC's video conferencing expertise, and funding from NOAA's B-Wet program, the new video conferences will be free to Washington, DC high schools as an extension of the classroom-based hands-on oceanic and atmospheric Emerging Scientist Project.

Haddon said the next step may be to enhance the interactive experience for students by bringing teachers and/or small groups of students on the research vessels to participate in experiments during the video conference with their classrooms.



Education Director Mark Haddon brings schools students on a virtual research cruise on the Rhode River.

New S.T.A.R.S.



SERC welcomes Josh Falk as the new coordinator of the STAR Program. Falk previously ran an education center on Smith Island for the Chesapeake Bay Foundation and worked for the Chesapeake Connections program at Arlington Echo. Falk

said his favorite place to be is out on the Bay and that he "enjoys connecting students to that amazing resource in most of our own backyards."



Mapping It Out

Since the expansion of our public programming last March, 3,000 people have participated in SERC's classroom programs and onsite talks, and learned of our work at events such as Smithsonian Teachers' Night. Programs like the mapping program shown at left encourage participants from the general public to explore science with Smithsonian educators.

NEXGEN

Fostering the future of environmental science

The opportunity to contribute to an active research project while working under the guidance of internationally respected scientists is one of the major draws of a SERC internship. One indication of the strength of our interns and the value of their experience is reflected in their presence in professional scientific journals and conferences.

In 2006, interns were named as co-authors on seven scientific papers.

Yossi Shirazi, a summer intern in the Marine and Estuarine Ecology Lab, presented a poster on his project at the Atlantic Estuarine Research Society Fall 2006 Meeting in October. His poster was titled "Utilization of microzooplankton by adult ctenophores:

Effects on fecundity and growth."

In November, **Evan Malczyk**, who interned in the Microbial Ecology Lab presented the poster "Effects of iron addition on methylmercury production in Everglades soils," at the Society of Environmental Toxicology & Chemistry's Annual Meeting, in Montreal, Canada.

*L*ast summer, astronomers redefined one of the most basic structures in their field of study, the planet.

With Pluto now demoted to a new category, that of dwarf planet, it has become very publicly evident how fluid the science of classifying our world can be.

So it is in the complex world of single-celled organisms, where nomenclature continually shifts in an elusive attempt to describe the order of the universe in a drop of water. What distinguishes and defines these tiny beings—protists as they are collectively called—is not merely a question for academics, for they are among the most abundant forms of life on earth. Some of the most infamous of the protists include the parasitic sporozoan that causes malaria, the insidious amoeba responsible for dysentery, and, perhaps more germane to the developed world, the many species of dinoflagellate responsible for harmful algal blooms such as toxic red tide.

What goes on between these elusive single cells in their enigmatic world ripples up through the fabric of their universe into the very tangible reality of ours. Understanding how is critical to the hope that we may some day exert control in the areas of human health and economics where the protists reign.

For Wayne Coats, SERC's Principal Investigator in the Protist Ecology Lab, that hope is translated from the study of what drives and controls the populations of various species of microalgae in the Chesapeake Bay.

It's well known that nutrients flowing into the water from the land after a heavy rain can cause a bloom of algae. But what determines the species that blooms at any given time remains a mystery. What causes blooms to recede is equally unclear. However, Coats has demonstrated that parasites may play an important role.

Indeed, he has shown that they hold great potential for helping us manage harmful algal blooms. To be useful, a parasite would need to infect only the species of algae that we want to manage without having other impacts on the environment. It would need to be harnessed, cultured in the lab in great quantities, and kept live at the ready should a bloom begin to form. These are exactly the pieces of the puzzle that Coats has been laying on the table.

A few years ago, he began investigating the role that microalgae of the genus *Amoebophrya*, played in the waters of the Chesapeake Bay. A nasty parasitic algae that enters its single-celled host and destroys it from within, *Amoebophrya* has been known to infect at least 30 species of microalgae around the world. It had been linked in the field to declines in red tides, and clearly played an influential role in the environment. But, with so many species susceptible to infection by *Amoebophrya*, it was dismissed as a potential tool for controlling harmful blooms.

Coats, however, was determined to understand the details of the relationship between *Amoebophrya* and its hosts. After careful lab and field studies, he discovered that *Amoebophrya* was not comprised of a single species, but rather a species complex with a number of variants, all very specific as to their target hosts. His work re-invigorated scientific interest in the use of parasites to control blooms.

That interest drew Mario Sengco to Coats' lab a few years ago when he was a graduate student at the Massachusetts Institute of Technology. Sengco has since earned his Ph.D. and returned to work in Coats' lab. Recently, he has isolated the *Amoebophrya* strain that infects the red-tide algae responsible for paralytic shellfish poisoning in the Gulf of Maine.

With his live cultures, Sengco intends to conduct controlled laboratory experiments to find out exactly how

Photo: Under a blue light, a single cell of the dinoflagellate *Akashiwo sanguinea* can be seen as its chlorophyll glows red while the amoebophrya parasite infecting it fluoresces green.

host specific his strain is, what happens to the host toxins after an Amoebophrya infection and what environmental conditions seem to influence a bloom and a subsequent infection by Amoebophrya.

Isolating specific strains and maintaining live cultures has been a technological challenge, but Sengco's culture is just one of seven different live strains of Amoebophrya housed in Coats' lab. "It's the only place in the world with such a collection," Coats said. His cultures enable him and his colleagues to ask questions that are not feasible in the field. They also provide the framework for creating harmful bloom control tools. "If parasites are ever going to be used to control blooms," Coats said, "the source would have to be a culture."

Though his research is laying the groundwork for a very practical future, Coats is fond of saying that he is driven by a basic curiosity about how things work. Following up on his earlier studies, he set out to understand how parasites manage to infect toxic algal species without themselves falling victim to the toxins.

The bloom-forming micro-algae *Karlodinium veneficum*, (formerly called *Karlodinium micrum*) has a compound in its tissues that essentially pokes holes through cell walls. As water floods in through the new pores, infected cells swell to the point of rupturing. When *Karlodinium veneficum* gets into the gills of certain fish, it's deadly, and has been linked to fish kills in the Chesapeake Bay since the early 1950s. Coats and his colleagues presumed that a successful parasite of *K. veneficum* would either have some means of inactivating the toxin, or would mimic its host's protective mechanisms. They discovered that it was the latter. Amoebophrya utilize the same defense mechanism as the toxic algae, namely their cell membranes contain a certain fatty acid that renders them impenetrable to the hole-punching toxin.

The next question for Coats was how well the parasite succeeded in infecting *K. veneficum* of varying toxicity levels. His work surprised even him, and suggest some solution to the paradox of why the toxic algae comes in a variety of

strengths in the first place.

The species varies from non-toxic to very toxic, and Coats presumed that the Amoebophrya parasite would naturally prefer the non-toxic variety. However, his lab experiments showed a distinct preference for the toxic

K. veneficum. To Coats, this discovery revealed an elegant system of interaction and adaptation.

High toxin levels serve the species very well when grazers are dominating the neighborhood. With few predators willing to risk a meal, toxic *K. veneficum* could be primed for a bloom whenever conditions are ripe. But once their numbers reach some critical mass, conditions become right for an outbreak of any pathogen able to take advantage of high population density. Enter the parasite Amoebophrya.

As we know from human history, outbreaks can be devastating to a population. Here is where the low-toxicity *K. veneficum* shine. Because they are less desirable hosts for Amoebophrya, they avoid the outbreak, and ensure the survival of the community. Varying toxicity, it seems could be *K. veneficum*'s answer to alternating pressures from grazers and parasites.

"There are lots of neat things about this," said Coats. "It helps answer that paradox of why there are toxic and non-toxic strains. There is evolutionary selection for both to persist."

It also points to a potential tool for controlling these types of toxic blooms with no ill effects, by introducing a parasite which only impacts *K. veneficum* and yet does not wipe out the species.

Others, like Sengco, will surely build on this work, searching for practical ways to influence harmful blooms. But in the meantime, Coats continues to lay down the foundation. Understanding the role of parasitic species in mitigating blooms may offer the promise of a potential management tool. But the most important tool Coats and his colleagues are creating is knowledge, the basic knowledge of how organisms in a universe too tiny to see with the naked eye behave and interact to influence the world around us.



Wayne Coats (right) and Mario Sengco inspect a culture in the lab's growth chamber.

Field Notes:

Talking Trees

On the first day of December 2006, two dozen scientists from a variety of Smithsonian offices gathered in the forest at SERC to talk about trees. Their discussions focused on what we know and what we don't know about forests in the temperate zones of the world, and how Smithsonian, with its vast array of researchers and unique outdoor laboratories, could bring many of their questions into better focus.

Under the leadership of SERC's forest ecologist Geoffrey Parker and Joe Wright of the Smithsonian Tropical Research Institute, the researchers are developing a network of permanent research plots throughout the Smithsonian's forested sites in the region. The intention is to map and track every tree that measures one centimeter or more in diameter living within a combined area of about 150 acres. The survey would be repeated every five years.

Similar projects tracking large forest plots in the tropics were devel-



Volunteers, like Frank Stowell at left, are essential to the Forest Ecology Lab which relies on lots of helping hands to survey the tens of thousands of trees in our forest plots.

Photo: Dawn Miller

oped many years ago to study how rare species persist in the forest. Scientists have since recognized the value of such permanent plots as the forests revealed surprising information. Researchers have found signals of El Niño weather patterns and clues to carbon storage in the tropical forests. Parker said that the new network could be used by scientists interested in everything from land use and forest structure to soil composition and water movement through the landscape. Using a standard method in the new permanent plots also will allow scien-

tists to compare their results with their findings in tropical forests.

Parker, who has just finished his nineteenth year studying one particular forest plot at SERC, said this new network would establish larger plots and include smaller diameter trees than he has been able to map in the past. The permanent plot network would include one large central plot of about 60 acres and a few smaller satellite plots at SERC along with some smaller plots at the Zoo's Conservation and Research Center in Front Royal, VA, and possibly one in the Piedmont region run by the National Museum of Natural History.

Oysters and Jellies

A diminished oyster population in the Chesapeake Bay may be causing a decline in the number of sea nettles, those reviled stinging jellyfish. Welcome news perhaps to summer beachgoers, the recent findings by Denise Breitburg and Richard Fulford may not be such good news to the oysters, or to the fish larvae and other small creatures who depend on sea nettles to eat their predators.

The researchers recently published a study in *Estuaries and Coasts* revealing a strong correlation between declining oyster populations, a reduction in the abundance of sea nettles, and a subsequent increase in sea nettle's



Sea nettle (left) and its favorite prey, comb jelly
Photo: Becca Morris



favorite prey.

Previous assertions blamed sea nettle decline on shifts in climate and freshwater river discharge into the Bay, but Breitburg's study which compared data from a variety of sources suggests it was more likely to have been caused by the decline in oysters. Looking more like tiny sea anem-

ones than the familiar bell-shaped jellyfish, juvenile nettles spend the winter months as young polyps attached to hard surfaces. Oyster reefs provide the perfect nursery ground for those polyps. Without them, fewer young nettles survive to adulthood.

The irony for the oysters is that, without adult sea nettles, fewer young oysters may survive. That's because adult nettles are the dominant predator of another gelatinous bay dweller, the comb jelly or ctenophore which preys on oyster larvae. The new study also

revealed a correlation between a drop in sea nettles and increased ctenophore populations. This work brings the complex interplay between oyster, sea nettle, and ctenophore into better focus, and suggests another complication in the efforts to assist oyster recovery in the Bay.

Beyond an Inconvenient Truth

After 20 years of studying the impact of rising atmospheric carbon dioxide on plants, SERC's plant physiologist Bert Drake is sharing what he's learned with public audiences throughout North America. His talk, "Beyond an Inconvenient Truth: Can we control rising atmospheric CO₂ and climate

"Thank you so much for speaking to my students . . . I really think the students 'got' your message."

--Elaine Hendrickson
Presque Isle Middle School teacher

change?," presents the results of his 20-year study—the longest field experiment of its kind anywhere in the world—introduces the vast body of evidence for global warming, and suggests measures by which plant fuels can help reduce our dependence on fossil-based fuels and reduce global carbon dioxide. Drake's talk has been so well received that he has presented it around the country to audiences

ranging from public lecture series at universities to Audubon Society meetings and school groups from Maine to Colorado, Canada to Florida.

Drake is also spreading his knowledge in the form of new university curricula. He visited McGill University in

Montreal, Canada, to assist with the design and implementation of a course on using green plants to mitigate greenhouse gas emissions.

To see a short video clip of Drake discussing these issues go to: www.serc.si.edu/labs/co2/interview.jsp For more information about his talk or to inquire about him speaking to your group, please call: 443-482-2325.

STRENGTH IN NUMBERS: SERC was awarded **\$2,292,626** in new grants and contracts last quarter.

SIGHTINGS

The Christian Science Monitor quoted Greg Ruiz in a story on the discovery of a Chinese Mitten Crab in the Chesapeake Bay titled "Look What the Cargo Ship Dragged In."

Bo Petersen quoted Greg Ruiz in an article in the Post and Courier, Charleston, South Carolina, titled "Ballast, an open door for invaders; Water from ships raises fears about harmful species."

Mario Sengco was quoted in an article titled "Navigating the Politics of Red Tide" in the local Florida newspaper North Port Sun-Herald.

Civil Science

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

Congressman Wayne Gilchrest (R-MD):

On ecosystem-based fisheries management in Chesapeake Bay.

California Assembly Member John Laird:

On the role of hull fouling and ballast water in marine invasions in California.

U.S. Army Corps of Engineers and University of Maryland Annapolis Synthesis Center:

On reviewing available data and identifying data needs for the Chesapeake Marshlands Management Plan.

NOTE: SERC ecologist **Tom Jordan** has been announced as the new president of the Association of Ecosystem Research Centers, a national network of major research sites across the U.S.

NEW PUBLICATIONS

Kerin, E., Gilmour, C.C., Roden, E., Suzuki, M.T., Mason, R.P., 2006. Mercury Methylation Among the Dissimilatory Iron-Reducing Bacteria. *Applied and Environmental Microbiology*.

Gilmour, C.C., Orem, W., Krabbenhoft, D.P., Mendelssohn, I., Nov-06. Preliminary Assessment of Sulfur Sources, Trends and Effects in the Everglades. South Florida Environmental Report. Appendix 3B-3 West Palm Beach, FL 71 pp.

Gilmour, C.C., Krabbenhoft, D.P., Orem, W., Aiken, G., Roden, E., Nov-06. Status Report on ACME Studies on the Control of Mercury Methylation and Bioaccumulation in the Everglades. South Florida Environmental Report. Appendix 3B-2 West Palm Beach, FL 71 pp.

Tzortziou, M., Subramaniam, A., Herman, J., Gallegos, C.L., Neale, P.J., Harding, L.W., 2006. Remote sensing reflectance and inherent optical properties in the mesohaline Chesapeake Bay. *Estuarine Coastal and Shelf Science*, in press, doi:10.1016/j.ecss.2006.09.018.

Tzortziou, M., Osburn, C.L., Neale, P.J., 2006. Photobleaching of Dissolved Organic Material from a Tidal Marsh-Estuarine System of the Chesapeake Bay. *Photochemistry and Photobiology*, preprint online www.aspjournals.com, DOI: 10.1562/2006-09-28-RA-1048.

Li, J.H., Johnson, D.P., Drake, B.G., 2007. Elevated CO₂ mitigates the adverse effects of drought on daytime net ecosystem CO₂ exchange and photosynthesis in a Florida scrub-oak ecosystem. *Photosynthetica* 45:51-58.

Breitburg, D.L., Fulford, R.S., 2006. Oyster-sea nettle interdependence and altered control within the Chesapeake Bay ecosystem. *Estuaries and Coasts* 29:00:00, 775-783.

Ma, H., Overstreet, R.M., Sniezek, J.H., Solangi, M. and Coats, D.W., 2006. Two new species of symbiotic ciliates from the respiratory tract of cetaceans with establishment of the new genus *Planilamina* n. gen. (Dysteriida, Kyaroikeidae). *Journal of Eukaryotic Microbiology*. 53: 407-419.

Books:

Chesapeake Bay Fisheries Ecosystem Advisory Panel (National Oceanic and Atmospheric Administration Chesapeake Bay Office). (D. Breitburg, Panel Member), 2006. Fisheries ecosystem planning for Chesapeake Bay. American Fisheries Society, Trends in Fisheries Science and Management 3, Bethesda, MD. 450 pages.

Book Chapters:

Breitburg, D.L. and E. Houde, 2006. Habitat, habitat requirements, and habitat management. Pages - Pp. 145-188, Chesapeake Bay Fisheries Ecosystem Advisory Panel (National Oceanic and Atmospheric Administration Chesapeake Bay Office). Fisheries ecosystem planning for Chesapeake Bay. American Fisheries Society, Trends in Fisheries Science and Management 3. Bethesda, MD.

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