



Smithsonian Environmental  
Research Center

Spring 2007

S | E | R | C

*Mangroves  
in the Margin*

*Only time and careful science  
will reveal the human impacts  
on the wetlands of the tropics.*

Sun Bleached Water

Gulf Invaders

Soil: Carbon Sink or Source?



SERC welcomes Tom Lindley as a valuable addition to our advisory board. Mr. Lindley is a partner in the law firm Perkins Coie in Portland, Oregon where he practices environmental law and natural resources law.

Mr. Lindley has been listed in Best Lawyers in America since 2001.

### Science Committee Tours SERC

Members of the Smithsonian National Board Science Committee visited SERC this spring for a tour of the labs and many of the field sites. Those who attended included:

Chair of the committee, Peggy Burnet, Claudia and Bill Allen, Barbara Barrett, Bob Donnelly, Paul Hertelendy.

This visit represented their first to SERC and provided them with an opportunity to see first-hand the breadth and depth of research activities here.

“We were fascinated with every aspect of our tour; we were intrigued by the ballast reporting program and grateful for the key role that SERC provides to the nation. We appreciated the opportunity to learn more about the research you do. Thank you for your gracious hospitality.”

*–Peggy Burnet, Chair, Smithsonian National Board Science Committee*

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### Tom Lindley, Esq., Partner, Perkins Coie LLP, Portland, OR.



## A Whole New Audience

Public programs will begin offering Spanish language canoe tours this summer with the addition of volunteer canoe guide Mara Jonas.

Jonas, who spends her weekdays working at the Smithsonian Office of Public Affairs in Washington, has been training to guide visitors through the creeks and marshes around SERC providing information on the natural features, habitats, and wildlife in the area. Her first public excursion in Spanish will be on June 9th.

# Eye on Education . . .

## *North Pole Adventure for Visiting Students*

Mark Haddon and Pat Neale gave a special International Polar Year presentation for school groups at SERC in which Neale discussed his polar research and Haddon guided the group through a live two-way linkup with scientists at the North Pole from Woods Hole Oceanographic Institution.

In recognition of the International Polar Year, Neale and SERC Marine Invasions Researcher Gregory Ruiz also participated in the pan-institutional polar science symposium, Smithsonian at the Poles: Contributions to International Polar Year Science", which celebrated Smithsonian and NSF-sponsored research.



Pat Neale speaks to a group of students about polar science before they connect live with researchers from the North Pole.

## *National Science Teachers meeting*

Bert Drake and Mark Haddon joined other Smithsonian educators and scientists attending the National Science Teachers Association Conference in St. Louis, MO, this spring. Drake gave a 90-minute presentation to 40 middle and high school teachers on "Global Climate Change in Our Lifetime." SERC also assisted in talking to teachers and passing out materials at the Smithsonian's NSRC exhibit tables. Over 10,000 teachers attended the conference.

## *Fair Science*

Mario Sengco hosted visitors from Thomas Jefferson High School, Virginia, in conjunction with their science fair projects, and conducted a demonstration for students from Baltimore City College.

**More than 850 students attended SERC education programs in April.**

## *NEXGEN*

### *Fostering the future of environmental science*

Summer interns have begun to arrive. This year SERC will host 30 students from 24 universities. It's a diverse group representing 16 states and six foreign countries including the U.K., Singapore, Ghana, Japan, Austria and the West Indies.

In addition to working on SERC research projects, interns will be offered mini courses on science ethics, alternative careers in science, applying to graduate schools, giving a scientific presentation and writing a scientific paper.

Our interns are funded this year with support from the NSF Research Experiences for Undergraduates program (11 interns), the Smithsonian Women's Committee (six interns), Warren Wilson College in North Carolina (one intern) and research grants in various SERC labs.



**A**gainst the azure backdrop of the Caribbean sky, Dr. Candy Feller perches in the canopy of a mangrove tree nearly 20 feet off the ground unaffected by the sweltering heat and oppressive smell of sulfur wafting from the swamp. Painstakingly, she plucks select leaves and insects from the highest branches, inspects them one by one and then tucks them carefully away for later.

An insect and plant ecologist, Feller, will spend many hours a day for two to three weeks at a stretch engaged in this tedious ritual at her field site in Belize. She will repeat the process, as she has for many years, in mangrove forests in Panama, Brazil, Australia, New Zealand and Florida. Her goal is to understand the impact of changes in available nutrients on the structure and function of mangrove ecosystems. “All kinds of things such as growth, decomposition, nutrient cycling and herbivory respond in different ways to different nutrient inputs,” she says. “These differences can have major effects on the function of the mangrove.”

Once considered unpleasant and expendable coastal hinterlands, mangroves are now recognized as necessary to the health of both the terrestrial and aquatic worlds they straddle. As buffers, they trap sediment, pollutants and nutrients running off the land. As breakwaters, they protect the shore from erosion and storm damage. They also serve as nursery grounds for marine

organisms, such as reef and ocean fish and shore birds.

Like the salt marshes of the temperate zone, mangrove trees are supremely adapted to living in the extreme environment where land and sea intertwine. Inundated with salty ocean tides, desiccated under the sun, intermittently drenched in fresh rainwater and battered by storms, mangroves dominate the marine wetlands of the tropics.

To survive their harsh environment, they have developed a variety of adaptive characteristics. Prop roots emerge from the trunks of some species cascading downward through the air in a tangled thicket. On island fringes, the roots hang suspended in the water and provide a sturdy brace against the tireless sea breeze and relentless waves. In other species, specialized roots shoot skyward out of the sodden ground, their pores opening to an extensive system of airways that transports oxygen to the belowground root system. They also possess a variety of elegant mechanisms to help them survive their briny environment, such as extracting fresh water from the sea or excluding salt water from their tissues.

But despite their adaptive nature and hardy resilience, mangroves are losing ground to the demands of the modern world. In 2006, the United Nations Environmental Program reported that more than a third of the world’s mangroves are now gone. Cleared to make way for housing developments, resorts, and aquaculture, they are disappearing faster than tropical rainforests.

In Belize, though regulations are in place to restrict clearing, enforcement is rare, and pressure to capitalize on the demand from the developed world is, in most cases, irresistible. On the islands adjacent to Feller’s study site, large tracts of mangroves are being cleared for luxury homes, resorts and shrimp farms.

The consequences of similar actions around the world have proven disastrous. Tropical shorelines depleted of their mangrove buffers regularly suffer more damage from big storms. Furthermore, like big sponges, mangroves absorb human waste and sediment washing off the land. They are the first line of defense for coral reefs against the assaults of land side development. What those assaults do to the mangroves, however, is largely unknown.

Feller hopes to help change that. For 15 years, she has been carefully fertilizing patches of mangrove trees and

monitoring the effects on plant growth and herbivory. At Twin Cays in Belize and at comparative sites in Florida, Feller has found that what she uses for fertilizer and which trees she fertilizes can have very different impacts on the ecosystem.

Her studies have shown that nitrogen, such as that introduced by fertilizer and waste, spurs the growth of mangroves along inland shorelines. The addition of phosphorous (often introduced in sediment when land is cleared) increases growth of trees in the interior of offshore mangrove islands.

Such changes in plant growth and nutrient availability can affect the behavior of animals that feed on the mangroves. As food sources change we may see shifts in populations of herbivorous animals and their predators. Increases in herbivores could result in lower yields in plant material. Because herbivores control the amount and distribution of forest biomass, over time, these sorts of interactions can influence the structure and function of the mangrove ecosystem.

Predicting how such changes will unfold is nearly impossible at the moment because so much remains to be learned. Sitting among the gnarled thicket of her experimental mangrove trees, Feller has collected dozens of insects previously unknown to science (including one she describes as “a gorgeous long-horned beetle” that was named after her). In a recent study investigating the impact of nutrient inputs to herbivory at Twin Cays, Feller determined that the two dominant herbivores are previously undescribed psyllids. A type of sap-sucking plant lice, the psyllids varied their eating patterns and their location on the island depending on the nutrient added. While they don’t leave holes in the plants or eat the leaves, the psyllids do stunt and deform them, resulting in a loss of yield to the plant. “It’s subtle, often overlooked as a significant form of herbivory,” Feller says. “Quantifying it is the tricky part.”

Indeed, it requires many laborious hours of counting, measuring, weighing and comparing the leaves and insects from affected and unaffected plants. It’s slow and monotonous, but for Feller, who feels perfectly at home perched high in a tree gathering insects and twigs, it’s a satisfying way to begin assembling the big picture. “I’m trying to figure out basically what happens in the system,” she says, and the system is revealing itself to her one leaf at a time.



Anne Chamberlain

Feller sorts mangrove leaves after a long day of collecting (left).

Scraped from the adjacent island, white sand now marks the site of a new development on a tiny island in Belize where dense mangrove once dominated (right).



Candy Feller

Mangrove roots at low tide (right) and below the water (bottom).



Candy Feller



Jamie Wuif



### Sink or Source?

SERC scientists announced the results of a six-year experiment suggesting that a potential carbon sink may in fact turn out to be a potential carbon source.

Previous studies have shown that as atmospheric carbon dioxide (CO<sub>2</sub>) rises, plants will grow more vigorously and take up much of the excess carbon. Many have suspected that belowground processes in the soil would also serve to store the excess carbon. The new work suggests the opposite, that microbes in the soil may release more carbon in high CO<sub>2</sub> conditions and offset some of the gains in carbon storage caused by increased plant growth.

Karen Carney from the U.S. Agency for International Development was a SERC postdoctoral fellow when she led the study to examine the effects of doubling the atmospheric CO<sub>2</sub> in a scrub oak ecosystem. During the course of their study, the scientists found that the amount of carbon in



the ecosystem as a whole increased. However, they also saw a consistent loss in soil carbon under high CO<sub>2</sub> conditions. The CO<sub>2</sub> loss from soils offset about 52 percent of the additional carbon that had accumulated in the plants above ground and in the roots. “We were surprised to find that these soils were losing soil carbon despite the fact that there was more plant growth,” said Patrick Megonigal, a microbial ecologist at SERC and one of the study’s authors. “We thought that higher plant growth at elevated CO<sub>2</sub> would either add more carbon to soils, or at least leave it the same. We

**Karen Carney's soil samples from an experimental scrub oak site in Florida have shown that increased CO<sub>2</sub> raises release of carbon by soil.**

now need to consider a third possibility—the carbon already in soils will end up back in the atmosphere as a greenhouse gas.”

Working at SERC’s long-term experimental CO<sub>2</sub> site in a Florida scrub oak ecosystem, the researchers compared core samples from test plots that had been exposed to six years of elevated CO<sub>2</sub> and core samples from plots exposed to ambient CO<sub>2</sub>. They also performed laboratory experiments on soils from both elevated and ambient plots to understand microbial composition and activity within each type of soil. Their study reveals that added CO<sub>2</sub> has a so-called “priming effect,” stimulating certain microbes and increasing decomposition which releases CO<sub>2</sub>.

Bruce Hungate, also a former SERC postdoctoral fellow, now a professor at Northern Arizona University; SERC plant physiologist Bert Drake and Patrick Megonigal collaborated on the study which was published in *The Proceedings of the National Academy of Sciences*.

### Sun Bleaching in the Marshes

In the marshy tributaries of the Chesapeake Bay colored dissolved organic material, such as the tannin from fallen leaves is a major reservoir of organic carbon. CDOM, as it’s called, plays a central role in aquatic ecosystems, affecting carbon budgets, nutrient availability and ecosystem productivity. As such an influential component of the system, it’s a major focus of researchers in the Photobiology Lab.

A recent paper by Maria Tzortziou, Patrick Neale and Chris Osburn, published in *Photochemistry and Photobiology*, examines how exposure to sunlight changes the properties of colored dissolved organic

matter (CDOM) in the waters of the Chesapeake Bay.

CDOM absorbs sunlight in the visible and UV spectral regions, preventing the sun’s rays from reaching the plants and animals below. That can be a good thing, because it absorbs a lot of the harmful UVB radiation and acts as a natural sunscreen for marine organisms. Under certain conditions, solar radiation can change the chemical composition of CDOM and affect its optical properties, something the scientists call photo-degradation and photo-bleaching.

These chemical alterations can result in the release of important trace gases such as carbon monoxide, carbon dioxide and others. Photo-degradation can also transform CDOM into unstable forms of carbon carbonyl com-

pounds that are readily available for consumption by microbial communities. This in turn affects microbial activity in the water and the cycling of carbon in coastal ecosystems.

The new study shows how CDOM samples from different sources in the Rhode River (marshes, watershed, mouth to the Chesapeake Bay) differ in their susceptibility to photochemical degradation.

According to Tzortziou, this work clears up some previous confusion about CDOM photo-bleaching and describes a new and relatively simple model for predicting the effects of solar exposure on CDOM.

“A model like this is needed for modeling water quality in the Chesapeake Bay and understanding carbon cycling/degradation in coastal waters,” she said.

## Traveling Cities and Other Concerns

Like small reefs, oil platforms form the building blocks of underwater communities of fish and invertebrates. When they are moved, which they often are, the community may move too. But little is really known about these mobile underwater cities because there seems to be no current method in place to track their travels throughout the world. That's one of the issues recently addressed when SERC and Texas A&M University Harte Research Institute organized a

workshop on Marine Invasive Species in the Gulf of Mexico and Caribbean. The meeting gathered scientists and government representatives from the United States and the Caribbean and Gulf countries of Mexico, Trinidad, Jamaica and Venezuela.

Their talks focused on the status of marine invaders in the Gulf and Caribbean and the challenges posed by the unique features of a broad area of incredibly diverse environments and species. They identified the present level of knowledge about many of the ecosystems in the area and about the potential for organisms to move be-

tween and potentially invade different regions within the Gulf and the Caribbean. There is a wide range of potential vectors for invasive species here—from the tropical fish trade to ship hulls and ballast water to the movement of oil drilling platforms.

The workshop served as an opening dialogue to more scientific study and highlighted the need for expanded regional cooperation in science, policy, and management to mediate and prevent the ecological, economic and public health impacts associated with marine invasive species.

**STRENGTH IN NUMBERS:** SERC was awarded **\$1,281,000** in new grants and contracts last quarter.

### SIGHTINGS

Recent work by Karen Carney and Pat Megonigal published in the proceedings of the National Academy of Sciences received the following press hits:

Science Now ran a photograph and article on the work.

The London-based Science and Development Network. The article can be found at <http://www.scidev.net/content/news/eng/carbon-dioxide-released-not-stored-by-soil.cfm>

Pat Megonigal was also interviewed on Radio Islam WCEV 1450AM in Chicago, the nation's first daily call-in talk radio show produced by Muslims for the mainstream audience. The topic of the episode for which Pat was interviewed was global warming.

## Civil Science

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

Bert Drake 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.

Drake also participated in the Board of Directors Meeting and annual meeting of the **Green Crop Network** in Ottawa, Canada.

Greg Ruiz, Catherine deRivera and Brian Steves delivered a draft report to the **Prince William Sound Regional Citizens' Advisory Council**, on the Northward spread of marine invasive species along western North America forecasting the risk of colonization in Alaskan waters using environmental niche modeling.

Patrick Neale attended the **Climate Change Science Program Retreat 2007** (Review of U.S. Interagency climate change program). The retreat was a planning meeting attended by representatives of each of the Federal entities engaged in climate science and technology. Neale represented SI with the role of better informing other agencies of SI work as well as relaying information on program directions and goals to appropriate staff at SI. Interagency offices represented in the Climate Change Science Program: DOE, DOT, EPA, NASA, NIST, NIH, NSF, NOAA, SI, USGS, and USDA.

## NEW PUBLICATIONS

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