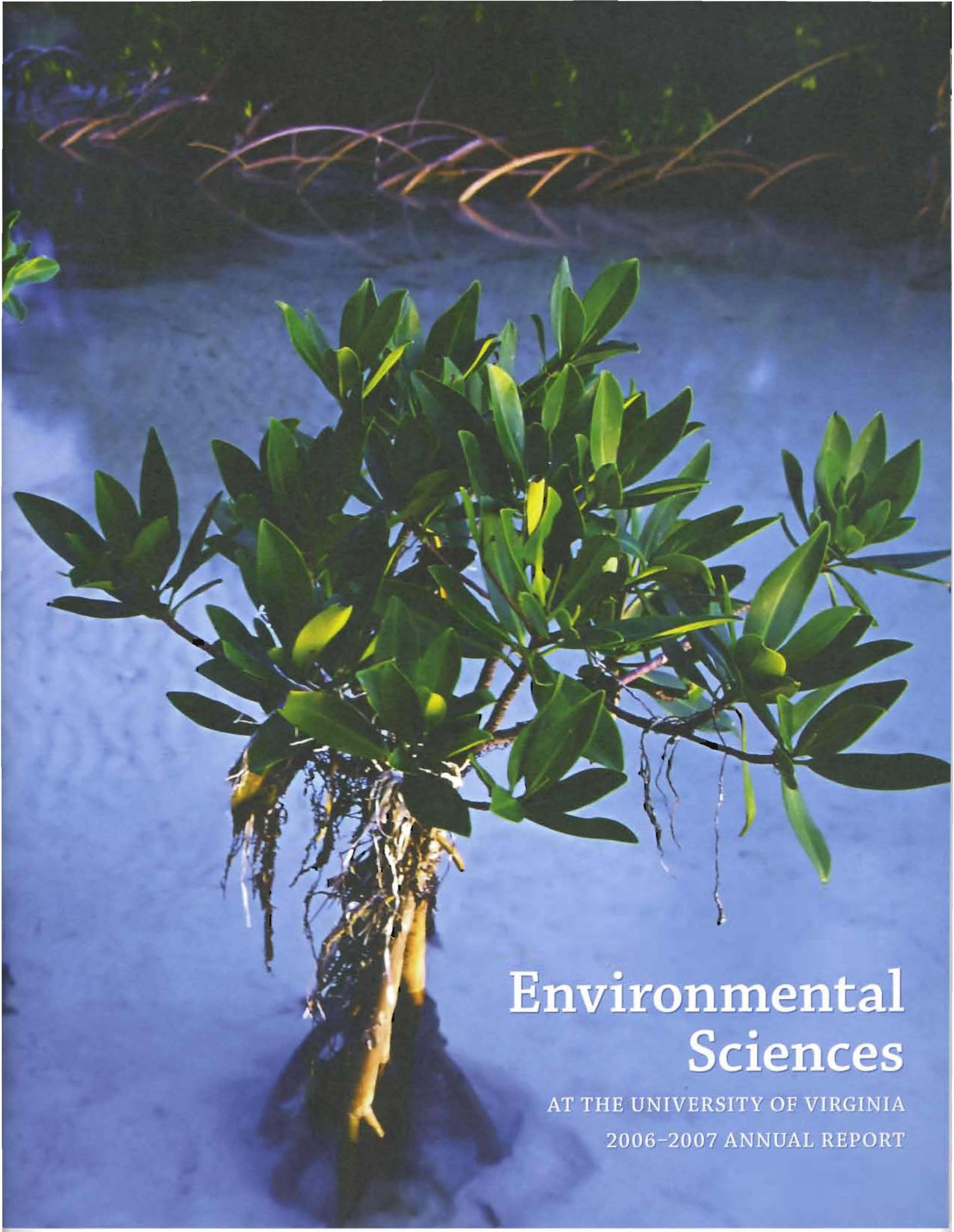
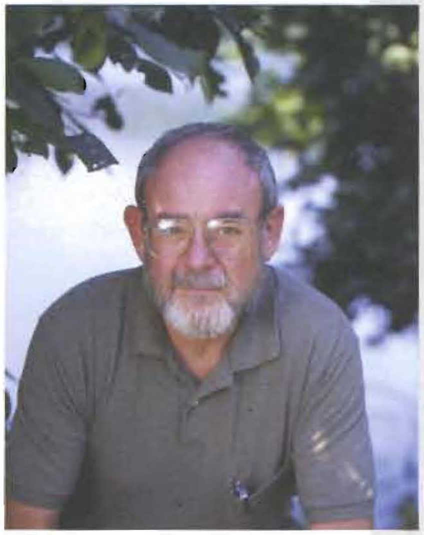


Environmental Sciences

AT THE UNIVERSITY OF VIRGINIA

2006–2007 ANNUAL REPORT

Letter from the Chair



The challenge of global environmental change requires the ability to collaborate and to work at the regional scale. The faculty in this department possess these characteristics in abundance.

We stand at a decisive moment in our history. The processes of life have always influenced the earth's environment, but for the most part these changes have been gradual. It is now clear that the activities of man over the last century have set in motion a series of dramatic environmental changes that we are only now beginning to understand. We are finding, to our dismay, that the scope and pace of this change is much greater than we had imagined just a few years ago. Many scientists now believe that the Arctic sea ice could be gone by 2030, rather than by the end of the century has had been supposed.

The implications of warming in the Northern Hemisphere are both complex and ominous. To name just two—the changes in the earth's reflectivity as white ice is replaced by dark ocean water will itself lead to additional heating—as will the release of carbon dioxide as peat, formerly frozen in northern tundra, starts to warm and decompose.

Because of its complexity, the ability to address global environmental change necessitates an interdisciplinary approach, with collaborations across the environmental sciences and with researchers from other disciplines. And because of its extent, the challenge of global environmental change requires the ability to work at the regional scale, where these issues can be addressed most effectively. The faculty in this department possess these characteristics in abundance.

Collaboration is the defining characteristic of this department, which was the first in the nation to incorporate atmospheric science, ecology, geology, and hydrology in a single organization. And our long-standing efforts in southern Africa, involving partnerships with faculty members from the School of Nursing, the School of Medicine, and the School of Engineering and Applied Science is now seen as a model for the University. As you will read in this report, we will be building from this pattern in forging new relationships in Panama.

Our faculty members, who collectively have conducted research in 90 different countries, have gained a regional perspective. The work currently under way at the Virginia Coast Reserve, for instance, is distinguished by its broad temporal and spatial analysis of coastal barrier ecosystems, and the alliance that Jim Galloway leads to manage the flow of nitrogen, to take another example, acts on the regional level.

At this point, global environmental change cannot be reversed—certainly not in our lifetime—but its effects can be mitigated—and long-term strategies for sustainability deployed on the basis of hard scientific fact. The Department of Environmental Sciences stands ready to make its contribution.

JAY ZIEMAN, *Chair*

Humans' Long Relationship with Climate

The current debate on climate change focuses on the dramatic rise in greenhouse gases since the Industrial Revolution. In his recent book, *Plows, Plagues, and Petroleum*, Bill Ruddiman looks at evidence that suggests that humans first made their influence felt in significant ways on climate 5,000 years ago.

Plows, Plagues, and Petroleum

People in Western cultures tend to hold an idealized view of the past. They envision a time when primitive man lived in Edenic harmony with the natural world—and they contrast this pristine vision with the sprawl, pollution, and environmental degradation we see today. But as Professor Emeritus Bill Ruddiman stresses in *Plows, Plagues, and Petroleum*, this pristine natural world is a myth. "Our preindustrial ancestors," he argues, "had a large environmental and climatic impact on this planet." In *Plows, Plagues, and Petroleum*, he lays out his case.

Evidence from ice cores has established the fact that regular fluctuations in the earth's orbit have created the cycles that characterize climate history. During warm periods, the additional heat produces a more powerful tropical summer monsoon, which in turn nurtures large wetlands. These wetlands produce large amounts of methane, a powerful greenhouse gas that amplifies the effects of these climate cycles, pushing temperatures even higher.

The peak of the last 22,000-year cycle occurred 11,000 years ago. After that, methane levels began to decline as the climate cooled, that is,

Bill Ruddiman has found evidence to suggest that the domestication of rice 5,000 years ago—and the creation of artificial, methane-producing rice paddies—marked the first step in human beings' taking control of climate.

Professor Emeritus
Bill Ruddiman

GINGER RUDDIMAN

until 5,000 years ago, when they reversed direction. Ruddiman noticed a similar, equally mysterious increase in carbon dioxide around the same time. Since the earth's orbit had not changed and solar radiation levels continued to fall, the solution, Ruddiman believed, must be found elsewhere.

He found an answer in the activities of man. The first great civilizations appeared 5,000 years ago, and well-organized agricultural societies began to transform the landscape. The large-scale irrigation that accompanied the domestication of rice in effect produced enormous artificial wetlands and led to an increase in methane. The widespread clearing of forests raised carbon dioxide levels. Ruddiman has assembled evidence that the effects of these emissions have been substantial. "Our releases of carbon dioxide and methane during the last several thousand years," he says, "may have stopped a small-scale glaciation that would have naturally developed in far northeastern Canada." Ruddiman also makes a case that brief dips in atmospheric carbon dioxide correspond to periods of pandemic, when the land was depopulated and forests returned.

Ruddiman concludes that long before the Industrial Revolution, man began to exert a small but growing influence on the earth's climate. "Greenhouse-gas concentrations in the atmosphere remained within their natural range of variation, but the levels were approaching the top of their range," he says. With the Industrial Revolution, man took control of the climate. The pace of deforestation increased dramatically, and fossil fuels were consumed at ever-increasing rates. At current rates of consumption, greenhouse-gas concentrations will soon rise to levels unprecedented in the last several million years, leading to corresponding increases in temperature.

Ruddiman has no crystal ball, and he does not know how human beings will deal with climate change over the coming centuries. But whatever the immediate outcome, his long perspective suggests that rather than relinquish control to nature, humans will try to engineer the climate we desire.

Bill Ruddiman on Being a Scientist

Q. What motivated you to look into this topic?

A. I was struck by what appeared to me to be an anomaly—atmospheric methane levels increasing over the last 5,000 years rather than decreasing as expected. And I remained unconvinced by the explanations that attributed this surprising trend to natural causes. So I decided to take a fresh look and see if I could come up with a new hypothesis. And having done that, I published to see what other people think of my ideas. That's what scientists do.

Q. What was the most challenging aspect of your research?

A. For me, the challenge was to follow it into fields in which I was not an expert, like the interpretation of ice-core data or the rise of civilizations. On the other hand, explanations for environmental change are by their very nature interdisciplinary.

Q. How has your hypothesis been received?

A. Not everyone agrees with me, but it is receiving serious consideration. During the last academic year, I gave 21 invited talks, and it's been mentioned in a number of papers by other scientists. One of the difficulties is that I am making a series of logical inferences based on something that didn't happen.

Q. Why write a book?

A. I wanted to reach several audiences, students and members of the general public as well as other scientists. I am especially interested in giving nonscientists an idea of how science works and conveying science as a human endeavor.

Q. How does the book fit into the debate on climate change?

A. People today are naturally worried about the future, about how the climate will change. By trying to present a more complete picture of our interactions with climate, I hope to provide a better basis for their predictions.

Carbon Sequestration in Mangrove Swamps

Mangrove swamps are a critical part of the ecology as well as the economy in subtropical and tropical regions of the world. They absorb energy of wind and water, protecting the coast from the battering of storm surges. And they help sustain a nutrient-rich environment that's essential for fisheries. Pioneering work being done by members of the department reveals that they also play a crucial role in carbon sequestration.

Mangrove Swamps—Rebuilding after Wilma

In 2003, Professor José D. Fuentes, Department Chair Jay Zieman, and a team of graduate students braved temperature and humidity in the high 90s and hordes of hungry mosquitoes to erect a 30-meter flux tower in a mangrove swamp on the southwest tip of Florida. They equipped the tower with instruments capable of producing a remarkably detailed record of carbon dioxide and water vapor exchange—and in the process transformed our understanding of this ecosystem. "When we integrated all the carbon dioxide that the ecosystem absorbs from the environment, we found that it amounts to seven tons of carbon dioxide per hectare a year," Fuentes says. This figure far exceeds the amount of carbon sequestered in the Piedmont surrounding Charlottesville or even the rain forests in the Amazon basin.

A number of factors contribute to the mangrove's exceptional effectiveness as a carbon sink. For one thing, mangroves grow year-round, steadily absorbing carbon regardless of the month. At the same time, when they do shed their leaves, the leaves are trapped in the anaerobic sediment in which they grow.

When Hurricane Wilma roared through the area in October 2005, it destroyed 30 percent of the mangrove trees and damaged the tower instruments beyond repair. A year later, Fuentes and Zieman had rebuilt the tower, eager to understand the impacts of hurricane disturbances on mangrove carbon assimilation. One effect of the hurricane is that the albedo—the reflectivity at the surface—decreased by half. Now, evaporation, not transpiration from mangrove leaves, is the major source of water vapor.

The decrease in active biomass has also reduced the amount of carbon dioxide sequestered by the mangroves, although this effect is temporary. As the mangroves come back, they will require more carbon on a daily basis than they did when they were fully mature. At the same time, much of the biomass destroyed by Wilma is now buried in the anaerobic muck of the mangrove swamp. "Even though there is a short-term downturn, the disturbance caused by Wilma has actually increased the amount of carbon that will be stored in this exceptional ecosystem," says Fuentes.

After rebuilding our 30-meter flux tower, department researchers had the ideal facility to assess the effects of Hurricane Wilma on mangroves' capacity to sequester carbon.

Partnering with Panama for Sustainable Development

With $50,000 in funding from the University, Associate Professor Vivian Thomson, Department Chair Jay Zieman, and other University faculty have embarked on a pilot program with the City of Knowledge, an educational and research institution that has emerged as a significant force for innovation in Panama City. The ultimate goal is to develop strategies for sustainable development that include public health as well as environmental protection.

"Fundamental to this effort is the understanding that it takes a multidisciplinary approach and close cooperation to make sustainable gains in any of these areas," says Vivian Thomson, the initiative's director. The program will involve collaboration by department faculty members with researchers, government agencies, and nonprofits in Panama, as well as with the University's Center for Global Health.

The pilot program responds to growing interest among Panamanians in using opportunities created by the expansion of the Panama Canal to stem environmental degradation and level social inequalities, creating a model of sustainable development that other nations could emulate. Working with Panamanian institutions and stakeholders, Thomson will create an action plan that spells out three to five high-priority goals at the core of this model. She will also be one of the University faculty accompanying Environmental Thought and Practice students to Panama during spring break 2008. "Their goal is to study environmental and health policy issues from a broad interdisciplinary perspective," Thomson says.

Another element of the initiative is assessing the role of economic incentives in preserving and restoring Panama's significant mangrove swamps. Thomson, who has studied the European Economic Community cap-and-trade system, believes that the mangrove's ability to sequester large amounts of carbon may prove to be a valuable economic resource for Panama. U.Va. researchers would conduct research on Panamanian mangroves, using data from the Florida flux tower as a basis for comparison, to analyze this potential.

An integral part of these efforts to foster sustainable development is promoting health. As part of this pilot project, members of the University's Center for Global Health will work with Panamanian researchers to improve the availability of better diagnostic and therapeutic methods to treat malnutrition in children.

"We see this effort as part of the new relationship evolving between Panama and the United States," Thomson says.

Associate Professor Vivian Thomson shown at the Panama Canal, directs the University's Panama Initiative.

"Fundamental to this effort is the understanding that it takes a multidisciplinary approach and close cooperation to make sustainable gains in any of these areas."

Vegetative Feedbacks & Climate

Plants are not passive occupants of the landscape. Rather, each species subtly alters its habitat in ways that increase its chance of survival. In the context of climate change, these modifications can yield powerful feedback loops that may significantly exacerbate the effects of warming temperatures.

Desert Plants and Desert Climate

The Chihuahuan Desert is on the march, heading north through the heart of New Mexico. For the last 150 years, the region's grasslands have steadily succumbed to a tide of shrubs, a phenomenon that is all too prevalent around the world. The latest estimates are that 19 million hectares of native grassland in the southwest United States alone are now dominated by creosote bush.

A number of possible causes have been offered for this encroachment, including overgrazing and global warming, but one thing is certain: desertification has serious economic and social consequences, especially for people trying to eke out their living from the land. As scientists now understand, desertification also has implications for climate change.

"Once this transition occurs," notes Associate Professor Paolo D'Odorico, "there's no going back." D'Odorico, an ecohydrologist, and other researchers have identified a number of positive feedback loops that support the switch to shrublands. Shrubs, by promoting an uneven distribution of nutrients and water across the landscape, adjust the environment to perpetuate their own survival at the expense of grasses. They may also change the local climate, enabling them to extend their range. Researchers have noted that the nighttime temperature over shrublands is from 4 to 6 degrees centigrade higher than over adjacent grasslands, possibly a result of their lower reflectivity. In essence, these shrubs, which are adapted to extremely hot and dry conditions, warm their immediate climate, creating the precise conditions that are favorable for their spread.

Professor José D. Fuentes, Assistant Professor Stephan De Wekker, and Associate Professor Paolo D'Odorico have combined their expertise on a proposal to shed light on the causes of desertification.

D'Odorico has joined forces with colleagues Assistant Professor Stephan De Wekker and Professor José D. Fuentes and faculty at the University of New Mexico on a proposal to understand the dynamics of this process. They plan to do their research at the Sevilleta Long-Term Ecological Research site south of Albuquerque.

"One of the distinctive aspects of our proposal is that we are attempting to develop a detailed and dynamic picture of the conditions that enable shrublands to expand," says De Wekker. We will link changes in vegetation to changes in the layer of air nearest the ground to changes in climate."

D'Odorico's responsibility is to develop a model to predict the effect of temperature changes on grasslands and shrublands, a model that will consider such factors as soil moisture availability, soil nutrients, and soil temperature. De Wekker, a specialist in boundary layer meteorology, will work with Fuentes to assess observational data collected at Sevilleta flux towers and to refine and validate a high-resolution model of the land-atmosphere dynamics. "We want to see how the boundary layer behaves over the two surfaces," he says. "Once the model is validated, we can use it to investigate the feedback process." Unless such vegetative feedbacks are understood and incorporated into climate models, our best predictions are likely to underestimate the impacts of climate change.

Top-of-the-World Climate Change

Some like it hot. Associate Professor Howie Epstein likes it cold. Over the last decade, Epstein has spent a good part of most summers well above the Arctic Circle. Last year, for instance, he spent 30 days in the remote Yamal Peninsula of northern Russia, which juts 435 miles into the icy Kara Sea. Epstein is part of a NASA-funded team using space-based technologies and models to address land-cover/land-use change issues under the auspices of the Northern Eurasia Earth Science Partnership Initiative. The Yamal holds Russia's biggest gas reserves—and the area is scheduled to be developed over the next decade, which jeopardizes the environment and the future of nomadic reindeer herders who live there.

As an ecosystem and plant community ecologist, Epstein has a special interest in climate-plant-soil interactions. He has been particularly active in tracking vegetative change in arctic and subarctic regions. "It's increasingly apparent that the Arctic is undergoing dramatic changes as a result of warming trends," he says, citing sea-ice and glacier melt, permafrost thaw, increased plant productivity, and northward-moving vegetation. These events are all interrelated and in many cases mutually reinforcing, producing additional warming. For instance, Epstein notes that tall shrubs poking out of the snow mean more absorbed radiation, higher surface temperatures, and ultimately more shrubs.

Epstein has used a variety of methods to understand these changes. With graduate student Gerald Frost, he is using a series of oblique aerial photographs taken in Alaska over a number of years to assess increases in the prevalence of shrubs. Epstein is also a lead investigator in the National Science Foundation's Greening of the Arctic project, which uses remote sensing and modeling to examine changes in tundra vegetation, sea ice, and surface temperature throughout the entire Arctic. And he has been a participant in the International Tundra Experiment, which conducts field experiments with arctic vegetation.

Because there are relatively few sets of long-term, on-the-ground, observational data of vegetation in arctic and subarctic regions, Epstein has also concentrated on simulation modeling, which he sees as an essential tool for projecting the long-term consequences of warming in the region. Along with graduate student Qin Yu, Epstein is using satellite imagery to examine recent changes and simulation modeling to project future developments. Epstein himself developed ArcVeg, a tundra vegetation model, and he recently published an analysis of several leading arctic vegetation dynamics models for *Computing in Science & Engineering.*

"My goal is to play a part in developing a reliable circumpolar picture of vegetative change," he says.

D.A. WALKER

S. CAPPS

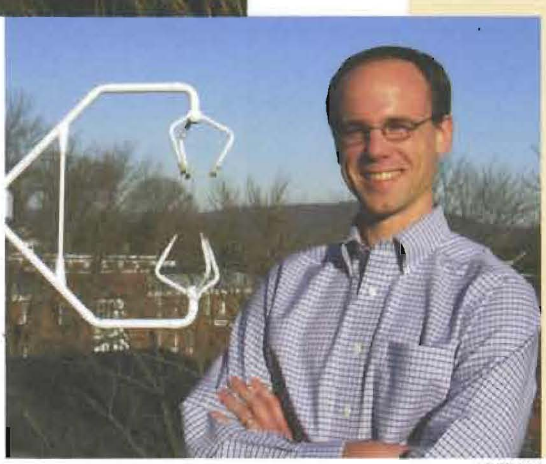
T. JORGENSON

(Top) Associate Professor Howie Epstein's research in the remote Yamal Peninsula of northern Russia brought him in contact with the reindeer-herding Nenet people.

White spruce trees have expanded their range up a montane slope in Lake Clark National Park and Preserve in Alaska. The first photograph was taken in 1928 and the second in 2004.

Nutrients in the Environment

In recent years, scientists have devoted a great deal of effort to understanding the flow of carbon through the environment because carbon dioxide is a greenhouse gas. But when the balance of other elements—among them nitrogen and phosphorus—are disturbed, the effects on the environment as well as on the climate are equally marked.



Assistant Professor Todd Scanlon

MELISSA MAKI

Nitrous Oxide

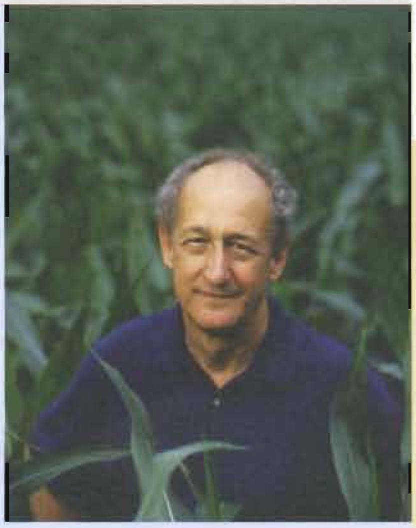
In the dentist's office, nitrous oxide is a good thing. In the atmosphere, it's nothing to laugh about. Unlike other nitrogen oxides, nitrous oxide is a major greenhouse gas, primarily because it persists in the air for decades. On a pound for pound basis, its cumulative effect far exceeds that of carbon dioxide. To make matters worse, nitrous oxide attacks atmospheric ozone in the stratosphere, increasing the amount of ultraviolet light reaching the earth's surface.

Most of the nitrous oxide released into the air is produced naturally by bacteria in soil and ocean waters. When these organisms lack sufficient oxygen to break down organic matter, they turn to oxygen-rich nitrates using a process known as denitrification. Nitrous oxide is a byproduct of this process. The rate of natural denitrification is intensified, however, when fueled by agricultural fertilizers laden with nitrogen.

Assistant Professor Todd Scanlon has set up a research site in a coastal marsh to measure this effect. The marsh, part of the Virginia Coast Reserve Long-Term Ecological Research site, is in an agricultural watershed. Working with a sophisticated suite of instruments including a tunable diode laser, Scanlon is making high-frequency observations of 30 different variables, including concentrations of water vapor, carbon dioxide, and nitrous oxide. "We are generating large quantities of data," he says. "Our goal is to determine if the coastal marshes like these are nitrous oxide hotspots and to account for the pulses in emissions we have observed at other sites."

Scanlon's research is funded by a NSF Faculty Early Career Development (CAREER) grant. The five-year award is one of the most prestigious grants available to junior faculty members in the sciences and engineering.

Nitrogen



Professor
Jim Galloway

A hundred years ago, scientists developed a practical method to convert nonreactive nitrogen, the most common element in the atmosphere, to the reactive form that plants require to grow. A full 40 percent of the population of the world is alive today because of this breakthrough.

Ultimately, however, much of this reactive nitrogen ends up in the environment, with disastrous consequences. Reactive nitrogen is linked to ozone-layer depletion, acidification of soils and surface waters, global warming, surface and groundwater pollution, and biodiversity loss. At the same time, there are areas of the world that still do not have enough reactive nitrogen to sustain life, resulting in hunger and malnutrition.

As Professor Jim Galloway sees it, addressing the issues associated with over- and under-abundance of reactive nitrogen requires an understanding of global nitrogen flows. He was one of the driving forces in 2002 behind the establishment of the International Nitrogen Initiative (initrogen.org), whose goals include increasing the availability of nitrogen in deficient regions while limiting the exposure of humans and ecosystems to the problems of excess nitrogen.

From a scientific point of view, a global perspective makes sense because reactive nitrogen is transported far from its point of entry into the environment by wind and water. But as Galloway's recent research shows, vast quantities of reactive nitrogen also flow from one country to another through international trade in agricultural products.

He cites ham produced in The Netherlands, made from pigs imported from Brazil, raised on grain grown in Europe, with fertilizer manufactured in the Middle East.

During each step of the process, nitrogen is lost to the environment, yet this cost is not passed on to the buyer, though the cumulative costs of damages caused by reactive nitrogen to people and ecosystems easily reach hundreds of billions of dollars annually. "Careful equilibrium modeling of livestock trade that includes additional resource costs," Galloway argues, "could be a useful next step in identifying policies to reduce livestock's impact on the environment."

Phosphorus

Most of what we call the natural world is hardly natural—and it is certainly not untouched by the hand of man. This is particularly true of our forests, the majority of which have been harvested for lumber or cleared for agriculture at some time in their history. Associate Professor Deborah Lawrence studies these secondary forests, focusing on the relationship between land use, vegetative patterns, and nutrient dynamics over time. "If you want to understand what's happening to these forests," she says, "you have to follow them through more than one cycle of disturbance and recovery."

Working in the Yucatán, Lawrence found that with each cycle of disturbance there is a steady decline in the pool of phosphorus available in the soil. She has linked this decline to changes in the structure of the canopy, which collects dust and airborne particles containing phosphorus. This phosphorus is conveyed to the soil when it rains. "As forests move through cycle after cycle, the canopy becomes less well developed and less efficient in trapping phosphorus," she says. This shortage of phosphorus can either stunt the growth of vegetation attempting to return or delay the recovery of the forests. Collaborating with Paolo D'Odorico, Lawrence has developed a model of this process that enables her to predict these changes over time.

Her findings have implications for global warming. Secondary forests are commonly viewed as fast growing—and therefore a carbon sink. Lawrence's findings suggest that with each cycle, they lose some of their ability to take up atmospheric carbon.

Associate Professor
Deborah Lawrence

Conservation

Research Professor Mike Erwin monitors the double-crested cormorant colony on Poplar Island.

The environment is changing more rapidly than individual species can adapt. If we are to protect and preserve these species, we must know more about their habitat and we must be able to intercede successfully to preserve it.

Understanding Madagascar's Rain Forests

The truth of the matter is that no one really knows how many different kinds of plants there are in the eastern lowland rain forest of Madagascar, not even Amanda Armstrong. But there is one thing this doctoral candidate can attest to: their diversity is extremely high. "There are estimated to be between 10,000 and 12,000 plant species on Madagascar," she says. "And most of them are endemic."

Madagascar is known for its lemurs and other exotic fauna, but its flora is not as well studied. Working with Professor Hank Shugart, Armstrong is doing her part to rectify this situation. She has spent three field seasons in a pioneering effort to document the composition, diversity, and structure of a forest ecosystem in the 5,500-acre Betampona Strict Nature Reserve on Madagascar's wet eastern coast. Her ultimate goal is to develop a rain forest model specific to Madagascar that can be used to manage species diversity in the reserve under changing conditions.

Time is of the essence. More than 90 percent of the original rain forest has already been lost—and by 2020, observers predict that it will be found only within protected areas.

Armstrong established 100 10-foot-diameter plots in different locations around the reserve. She has catalogued the different species of plants found in each one, noted growth rates of the 235 tree species she found, and assessed the density of the canopy and ground cover, among other characteristics.

Amanda Armstrong uses band dendrometers to measure the growth of tree species in Madagascar.

TATIANA ANDRIAHARIMALALA

This project called upon Armstrong to master a number of very different kinds of skills. In Madagascar, she had to handle all the preparation associated with conducting a successful field campaign lasting as much as 10 weeks in extremely rugged country. In Charlottesville, her challenges were computational rather than logistical. Once she recorded her data, her task was to assess the applicability of two existing rain forest models to Madagascar.

"The Betampona reserve is a very beautiful and unique place," she says. "I feel as though I've just scratched the surface of what there is to know about this complex ecosystem."

PETER MCGOWAN, US FISH AND WILDLIFE SERVICE

Managing the Protection of Mid-Atlantic Shorebirds

Left to their own devices, the shorebirds that nest and feed along the barrier islands and lagoons of the Mid-Atlantic coast would slowly disappear, victims of natural predators, the activities of man, and rising sea levels. Simply setting aside more nesting areas and letting the birds fend for themselves is not enough. Maintaining healthy populations means actively interceding on their behalf, and that requires the efforts of scientists like Research Professor Mike Erwin to understand the forces that threaten their habitat and to test strategies to counter them.

Erwin, who is also on staff at the USGS Patuxent Wildlife Research Center in Laurel, Maryland, approaches this challenge from a variety of perspectives. He led an investigation to determine if *Spartina*-dominated marshes on the Atlantic coast are keeping abreast with the rise of sea level, using sites on Cape Cod, the Jersey shore, and the Virginia Coast Reserve Long-Term Ecological Research site on the Eastern Shore. His results were not encouraging. "In Cape Cod, the marshes are holding their own," he says, "but in New Jersey and Virginia they are losing a few millimeters a year compared to sea level." His data lead him to predict that both New Jersey and Virginia lagoonal marshes may revert to open water in coming decades, depriving many species of shorebirds of nesting and feeding areas.

One response is to create man-made breeding islands. The largest colony of common terns took up residence about 25 years ago on one of the artificial islands created for the Hampton Roads Bridge-Tunnel. Erwin has been studying the restoration of Poplar Island in Chesapeake Bay, a long, narrow, tree-clad island of 1,150 acres that had been reduced to less than five acres by storms, sea-level rise, and the recurrent wakes of nearby boats. Using sediment dredged from the approaches to Baltimore Harbor, the U.S. Army Corps of Engineers will restore Poplar Island, depositing 40 million cubic yards of material over the 20-year life of the project.

A variety of habitats were incorporated in Poplar Island's design to provide nesting and feeding areas for birds with different requirements. The planners made a priority of providing habitat for the American black duck, cattle egret, snowy egret, osprey, common tern, and least tern.

Erwin tracked the repopulation of the island for its first five years. "Much of the wildlife we hoped would appear did," Erwin reports. He and his colleagues documented more than 200 species of birds, seven species of reptiles and amphibians, and 10 species of mammals since 2001. Among those were a few species, including predators like foxes and great horned owls—and opportunistic species like herring and black-backed gulls and double-crested cormorants—that weren't so desirable. It is clear that achieving the habitat goals for the island will require constant monitoring and adaptation. "Ecological restoration is an ongoing process," he says. "You always have your hand on the wheel."

University Recognition

One of the most valuable contributions this department can make is to nurture a generation of citizens who appreciate the environmental difficulties we face and to encourage young researchers to address them. This year members of our department were honored for redefining what it means to be a teacher and a colleague.

Professor Stephen Macko

Professor Janet Herman

For Teaching: A Student of the Earth

Professor Stephen Macko is a successful researcher and teacher precisely because he considers himself a student. Because he is still enthralled by the process of discovery, it seems only natural for him to illustrate his oceanography class with instances drawn from his own experiences, to share with students the gratifications that the process of discovery affords, and, through his example and guidance, to encourage them to pursue discovery on their own. It is these qualities that led his peers at the University to name him a winner of the 2007 All-University Teaching Award.

"For me, teaching is inseparable from discovery," he says. "It is part of the same process."

Given his affinity for sharing knowledge, it is not surprising that Macko has led a number of University efforts to explore the potential of the Internet and videoconferencing technologies to extend a teacher's reach. Several years ago, for instance, he mobilized resources on and off Grounds to create a live, interactive course that brought together environmental sciences faculty and students from two continents in a single virtual classroom.

Although the technology is powerful, Macko doesn't consider it to be the ultimate means for transmitting the thrill of discovery. In his view, that rests with inspired teachers. In 2006, Macko multicast his summer oceanography class to high school teachers in Accomack County on the Eastern Shore of Virginia, enabling them to become certified in earth sciences without leaving their communities. "If you want to disseminate knowledge really effectively," he says, "you teach the teachers."

For Mentoring: Creating a Community of One's Own

Professor Janet Herman's motives in mentoring junior women faculty members are straightforward. "I wanted to create for myself a community of colleagues that included junior women," she says. "It's the environment I wished I had when I came here 26 years ago."

Herman's efforts have made a difference. For more than two decades, she has helped dozens of young women faculty across the disciplines face the challenges of balancing family and work and developing an effective voice in departments dominated by male colleagues. Now the senior woman scientist in the College of Arts & Sciences, Herman was one of two inaugural winners this year of the Excellence in Faculty Mentoring Award.

Her mentoring has taken many guises, from inviting new women faculty to lunch to helping them make more effective presentations for their third-year review. "I've made myself approachable," she says. "I'm considered a safe person to speak to when someone has a question."

In the process, Herman has helped build an informal, but substantial, network among women faculty that has benefited all its members, including Herman herself. She has written successful grant proposals with her women colleagues to fund research and graduate students, and she has been inspired by her junior colleagues to become a better teacher.

Although Herman believes there is still work to be done in removing the obstacles that women faculty confront, one sign of progress at U.Va., she notes, is that her children were invited to her award ceremony.

Awards, Appointments, & Publications

Undergraduate Students

The department recognizes fourth-year students who have done outstanding work in each of the environmental sciences. This year, the Mahlon G. Kelly Prize in ecology went to **Jenna N. Lucas**, the Michael Garstang Atmospheric Sciences Award went to **Meredith J. Cleveland**, and the Hydrology Award was presented to **Jennifer J. Watson**.

Selected as Distinguished Majors were **Leyland W. Del Re, Temple R. Lee, Chad A. Logan, Kathryn A. Mullin, Kendall A. Singleton**, and **Sara T. Wozniak**.

The Bloomer Scholarship provides a $1,500 award to a rising fourth-year undergraduate majoring in the department with a focus on geology. This year's winner was **Thrushara Gunda**.

The Rockfish Valley Project, conducted by the student-run Environmental Sciences Organization, received the Trout Unlimited Award, which was established by the Thomas Jefferson Chapter of Trout Unlimited for "significant contributions to research concerning cold-water fisheries or related ecosystems." Students participating in the project are **Kelly Bowman, Megan Carras, Thrushara Gunda, Martha Kelly, Kirsten Miles, Amanda Schwantes, Laura Teed**, and **Jenny Watson**.

Kathryn A. Mullin won the Departmental Interdisciplinary Award.

This year's Wallace-Poole Prize for the fourth-year student majoring in environmental sciences with the highest grade point average went to **Sara T. Wozniak**.

Temple R. Lee won the Joseph K. Roberts Award. It is given to a student who presents the most meritorious paper on geology at a state, national, or international conference.

Christina L. Woods was this year's recipient of the Richard Scott Mitchell Scholarship, which provides $1,500 to a rising fourth-year student who is focusing on geology and who has taken petrology and mineralogy.

Graduate Students

Ryan E. Emanuel and **Sujith Ravi** were among 14 students who received the Award for Excellence in Scholarship in the Sciences and Engineering from the Office of the Vice President for Research and Graduate Studies. **Ravi** was also selected for a Graduate School of Arts and Sciences Dissertation Year Fellowship for 2007–2008. The fellowship includes an $18,000 stipend as well as payments for research fees and health insurance.

Rishiraj Das received a Fellowship Enhancement Award from the U.Va. Office of the Vice President for Research and Graduate Studies.

Lorelei J. Alvarez and **Lixin Wang** received 2007 Dissertation Acceleration Fellowships from the Graduate School of Arts and Sciences.

Tana Wood and **Benjamin I. Cook** received NOAA postdoctoral fellowships. **Cook** also won the Maury Environmental Sciences Prize. Established by Dr. F. Gordon Tice in 1992, it is the department's premier award.

Marcia S. DeLonge received a NASA Fellowship that funded her stay at the NASA Goddard Space Flight Center during summer 2007.

Katherine L. Tully received the Raven Award, given to members of the University community who are singled out for their scholastic achievement and commitment to University values.

Joseph M. Battistelli was the recipient of a Virginia Space Grant Consortium Fellowship for the 2007–2008 academic year.

Kier Solderberg won a Fulbright Fellowship for research in Namibia.

Michael S. Long received a three-year Global Change Education Program Graduate Research Environmental Fellowship from the Department of Energy's Office of Biological and Environmental Research through the Oak Ridge Institute of Science and Education.

Three graduate students won awards at the Seventh Annual Robert J. Huskey Research Exhibition, open to all students in the Graduate School of Arts and Sciences. Awards are given for the top presentations in four categories. **Stephanie A. Harbeson** placed fourth in the biological and biomedical sciences poster competition, **Ryan E. Emanuel** took first in the physical sciences and mathematics poster competition, and **Katherine L. Tully** was ranked fourth for her oral presentation in physical sciences and mathematics.

Meredith Ferdie received the Thomas Jefferson Conservation Award, which supports basic research related to the conservation of the earth's resources.

Daniel J. Muth won the department's Fred Holmsley Moore Teaching Award. This award is funded by an endowment set up by Fred H. Moore along with matching donations from Mobil Oil Company.

The department offers a series of awards honoring outstanding graduate students in each specialty of environmental sciences. This year, **Katherine L. Tully** earned the Graduate Award in Ecology, **Justin E. Lawrence** won the Graduate Award in Hydrology, and **Wai-Yin Stephan Chan** won the Graduate Award in Atmospheric Sciences. **Helen E. Julier** received the Robert Ellison Award for Interdisciplinary Studies.

This year, **Eric E. Elton, Thomas J. Mozdzer, Daniel J. Muth**, and **Sujith Ravi** won Moore Research Awards. The award is based on merit and was initiated to help sponsor the dissertation and thesis work of environmental sciences graduate students. **Rishiraj Das, Rachel N. Ghent, Robert W. Heckman, Michael S. Long**, and **Virginia A. Seamster** received Exploratory Research Awards. These awards were initiated to support preliminary research leading to a thesis or dissertation proposal.

The Michael Garstang Award supports graduate student research in interdisciplinary atmospheric sciences. This year, the award went to **Matthew P. Tymchak**.

Staff

Cynthia Allen received the Environmental Sciences Organization Award, while **Charlotta Wriston** won the Graduate Student Association Award.

Chair's Awards were presented to **Chonna L. Gammon, Lelia A. Gibson, Jann G. Goetzmann, Henry G. White**, and **Charlotta Wriston**.

Faculty

Tom Biggs helped obtain a grant from the Virginia Division of Mineral Mining (DMM) and the Environmental Protection Agency to fund the Orphaned Lands Assessment class, which was offered in fall 2006. The project serves the Commonwealth by assisting the DMM with mandated inventory of all abandoned mineral mines and quarries around the state and provides students with hands-on field experience conducting level 1 environmental site assessments.

Linda Blum served on a number of committees associated with the Comprehensive Everglades Restoration Plan. She was vice-chair of the National Research Council's Committee on Independent Scientific Review of the Everglades Restoration Progress and the major author of the committee report released in March 2007. She now serves as a member of the National Research Council's Committee on Independent Scientific Review of the Everglades Restoration Progress II.

Jack Cosby was once again designated a highly cited researcher by the Institute of Scientific Information in ecology/environmental science. Highly cited researchers are the 250 most frequently cited in their field and comprise less than one-half of one percent of all publishing researchers.

Robert E. Davis edited *Climate Research: Interactions of Climate with Organisms, Ecosystems, and Human Societies.*

Stephan De Wekker was awarded a University of Virginia Fund for Excellence in Science and Technology (FEST) grant.

Paolo D'Odorico served as associate editor for *Water Resources Research*. He convened special sessions at the European Geophysical Union's General Assembly in Vienna and chaired the Ecohydrology Committee of the American Geophysical Union.

Robert Dolan served the University as a member of the Jefferson Scholars National Selection Committee.

William Emanuel served as program scientist for NASA's Terrestrial Ecology Program.

Michael Erwin was a member of the National Science Panel for San Francisco Bay Restoration and the Advisory Board for the International Shorebird Reserve Network.

José D. Fuentes edited *Journal of Geophysical Research—Atmospheres*. He was elected chair of the Gordon Research Conference on Biogenic Hydrocarbons and was a member of the National Science Foundation's panel on the Integrative Graduate Education and Research Traineeship program. He also served as a member of the International Science Committee for NASA's Global Precipitation Mission.

James N. Galloway was named a highly cited researcher by the Institute of Scientific Information in three separate categories: ecology/environmental science, geosciences, and engineering. The Galloway et al. 2004 *Biogeochemistry* paper is the third-most-cited paper in ecology/environment published in the last two years. Galloway was a member of the Environmental Protection Agency's Science Advisory Board and the Board of Trustees of the Bermuda Biological Station for Research. He also chaired the International Nitrogen Initiative. In addition, he served as associate editor of *The Scientific World: Environmental Chemistry* and is on the international editorial board of *Journal of Environmental Sciences.*

Bruce Hayden served as the principal investigator, senior scientist, and senior adviser for the National Science Foundation's National Ecology Observatory Network.

Janet S. Herman received the Excellence in Faculty Mentoring Award from the University of Virginia. She was one of two faculty members to receive this award in its inaugural year. She served as associate editor of *Water Resources Research*, which is published by the American Geophysical Union.

George M. Hornberger, associate dean for sciences in the College of Arts & Sciences, was named one of five Outstanding Scientists and Industrialists by Virginia governer Timothy Kaine. He served on a number of policy-making committees. He was a presidential appointee to the Nuclear Waste Technical Review Board and was a member of the National Research Council's Committee on Hydrologic Science. He chaired the National Research Council's Board on Earth Sciences and Resources and was president-elect of the Hydrology Section of the American Geophysical Union. Hornberger was named as a highly cited researcher by the Institute of Scientific Information in ecology/environmental science and engineering.

Alan D. Howard chaired the search committee for the new editor of *Journal of Geophysical Research—Earth Surface*. He served as a review panel member of the Deutsche Forschugsgemeinschaft special program on Mars and other terrestrial planets and as a member of the Sediment Protocol Review Panel at the Grand Canyon Monitoring and Research Center.

William Keene was on the board of directors of the Canadian Surface Ocean–Lower Atmosphere Study and served on the advisory group for the U.S. Surface Ocean–Lower Atmosphere Study. Both projects were sponsored by the International Geosphere-Biosphere Programme. In Charlottesville, he was a member of the board of directors of the Thomas Jefferson Emergency Medical Services Council.

Deborah Lawrence codirected the Environmental and Biological Conservation Program. She was a member of the scientific advisory committee of the TROPI-DRY International Research Network and an expert assessor of international standing for the Australian Research Council.

Manuel Lerdau was associate editor of *Journal of Geophysical Research—Biogeosciences* and of *Oecologia*. He is a long-standing member of the editorial review board of *Quarterly Review of Biology* and the scientific committee of the Element Interactions Symposium presented by the Scientific Committee on Problems of the Environment.

Stephen A. Macko received an All-University Teaching Award from the University of Virginia. He was a fellow of the Joint European Association of Geochemistry and the Geochemical Society's Committee on Education and Human Resources. He is also a member of the European Geoscience Union's Committee on Education and the National Science Foundation's Panel on Geobiology. Macko served as associate editor of a number of publications: *Amino Acids, The Scientific World: Isotopes in the Environment,* and *Science of the Total Environment.* In a novel application of telecommunications technology, Macko produced a live, interactive multicast of his summer class on oceanography to teachers at Arcadia High School in the Accomack County schools district.

Karen J. McGlathery served as the lead principal investigator on the Virginia Coast Reserve Long-Term Ecological Research (LTER) site, which was refunded for years 21–26. She sat on the LTER Executive Committee and was associate editor of *Ecosystems*.

Aaron L. Mills was a member of the editorial board of *Microbial Ecology*. He also served on the National Science Foundation's Review Panel for the Hydrological Sciences. In addition, Mills was coordinator for outcomes assessment development in the environmental sciences for the Southern Association of Colleges and Schools and sat on the Advisory Committee of the Appalachian College Association.

Jennie Moody was the University of Virginia's representative to the University Corporation for Atmospheric Research.

John Porter was a member of the User Working Group for the Oak Ridge National Laboratory Distributed Active-Archive Center and trained information managers from Taiwan for the International Long-Term Ecological Research Network.

G. Carleton Ray was an appointed member of the County of Albemarle Natural Heritage Committee. He served on the Scientific Advisory Committee of the Bahamas National Trust for Places of Historic Interest and Natural Beauty and on the editorial board of *Aquatic Conservation.*

T'ai Roulston served on the National Science Foundation's EPE Grants Panel and worked with the U.S. Civilian Research & Development Foundation. He was a member of the Grants Panel for Moldovian Researcher Enrichment Activities in the United States.

Todd Scanlon received a National Science Foundation Faculty Early Career Development (CAREER) Award, the foundation's most prestigious award for young faculty.

Herman H. Shugart was named one of two inaugural winners of the University's Distinguished Scientist Award. He was the chief scientist for the Northern Eurasia Earth Science Partnership Initiative and served on the editorial board of the *Eurasian Journal of Forest Research*. In addition, he was associate editor of *Global Change Biology* and represented the University of Virginia on the Ecology Section of the Board on Natural Resources at the National Association of State Universities and Land-Grant Colleges. Shugart was named as a highly cited researcher by the Institute of Scientific Information in ecology/environmental science. He was also a member of the Board of Directors of the University of Virginia Press.

David E. Smith was a member of the Network Education Committee and the Executive Committee of the Long-Term Ecological Research Network and represented the University on the Virginia Sea Grant Academic Advisory Panel.

Robert J. Swap was international co-coordinator for the Fire-Land-Atmosphere Regional Ecological Study, conducted under the auspices of the International Geosphere-Biosphere Programme's Integrated Land-Ecosystem-Atmosphere Processes Study. He was an invited participant on the Consortia Research Grant Review Panel for the United Kingdom Natural Environmental Research Council Programme APPRAISE and a project director for the American Association for the Advancement of Science, charged with administering an external review of the Inter-American Institute for Global Change Research. Swap, who served as the University's special assistant for international research, represented the University and its environmental sciences programs at a number of meetings with the Department of State, the U.S. Agency for International Development, the World Bank, the World Wildlife Fund, the National Academy of Sciences, and Conservation International.

Vivian Thomson was vice-chair of the Virginia Air Pollution Control Board and named to head the University's initiative in Panama.

Robert Washington-Allen sat on NASA's Research Opportunities in Space and Earth Sciences Proposal Review Panel as well as the National Science Foundation's Geography Review Panel.

Patricia Wiberg served as associate editor of the *Journal of Sedimentary Research* and the *Journal of Geophysical Research—Earth Surface* and as a coeditor of *Continental-Margin Sedimentation: Transport to Sequence.* She was chair of the American Geophysical Union's Information Technology Committee as well as of the Marine Working Group of the National Science Foundation's Community Surface Dynamics Modeling System (CSDMS). She was also a member of the CSDMS Executive Committee. Wiberg was selected to be one of four distinguished lecturers for the National Science Foundation's MARGINS program.

2006–2007 Publications

Annual report of published peer-reviewed papers, book chapters, and books for faculty and graduate students for the 2006–2007 academic year (Summer 2006, Fall 2006, Spring 2007)

Aherne, J., T. Larssen, **B. J. Cosby**, and P. J. Dillon. 2006. Climate variability and forecasting surface water recovery from acidification: Modelling drought-induced sulphate release from wetlands. *Science of the Total Environment* 365 (1–3): 186–199.

Albertson, J. D., C. A. Williams, **T. M. Scanlon**, and N. Montaldo. 2006. Hydrologic controls on water vapor and carbon fluxes in semiarid regions. Pp. 67–84 in *Dryland Ecohydrology*, ed. P. D'Odorico and A. Porporato. Dordrecht, Netherlands: Springer.

Bergquist, D. C., J. T. Eckner, I. A. Urcuyo, E. E. Cordes, S. Hourdez, **S. A. Macko**, and C. R. Fisher. 2007. Using stable isotopes and quantitative community characteristics to determine a local hydrothermal vent food web. *Marine Ecology Progress Series* 330:49–65.

Boyer, E. W., R. W. Howarth, **J. N. Galloway**, F. J. Dentener, P. A. Green, and C. J. Vörösmarty. 2006. Riverine nitrogen export from the continents to the coasts. *Global Biogeochemical Cycles* 20, GB1S91, doi:10.1029/2005GB002537.

Brandimarte, L., **P. D'Odorico**, and A. Montanari. 2006. A probabilistic approach to the analysis of contraction scour. *Journal of Hydraulic Research* 44 (5).

Caylor, K. K., **P. D'Odorico**, and I. Rodriguez-Iturbe. 2006. On the ecohydrology of structurally heterogeneous semi-arid landscapes. *Water Resources Research* 42, W07424, doi:10.1029/2005WR004683.

Connan, J., A. Nissenbaum, K. Imbus, J. Zumberge, and **S. A. Macko**. 2006. Asphalt in iron age excavations from the Philistine Tel Miqne-Ekron city (Israel): Origin and trade routes. *Organic Geochemistry* 37 (12): 1768–1786.

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Deviney, F. A., Jr., K. C. Rice, and **G. M. Hornberger**. 2006. Time series and recurrence interval models to predict the vulnerability of streams to episodic acidification in Shenandoah National Park, Virginia. *Water Resources Research* 42, W09405, doi:10.1029/2005WR004740.

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D'Odorico, P., F. Laio, and L. Ridolfi. 2006. Patterns as indicators of productivity enhancement by facilitation and competition in dryland vegetation. *Journal of Geophysical Research* 111, G03010, doi:10.1029/2006JG000176.

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Emanuel, R. E., P. D'Odorico, and **H. E. Epstein**. 2007. A dynamic soil water threshold for vegetation water stress derived from stomatal conductance models. *Water Resources Research* 43, W03431, doi:10.1029/2005WR004831.

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Fuentes, J. D., D. Wang, D. R. Bowling, M. Potosnak, R. K. Monson, W. S. Goliff, and W. R. Stockwell. 2007. Biogenic hydrocarbon chemistry within and above a mixed deciduous forest. *Journal of Atmospheric Chemistry* 56, doi:10.1007/s10874-006-9048-4.

Funk, J. L., C. P. Giardina, A. Knohl, and **M. T. Lerdau**. 2006. Influence of nutrient availability, stand age, and canopy structure on isoprene flux in a *Eucalyptus saligna* experimental forest. *Journal of Geophysical Research* 111, G02012, doi:10.1029/2005JG000085.

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