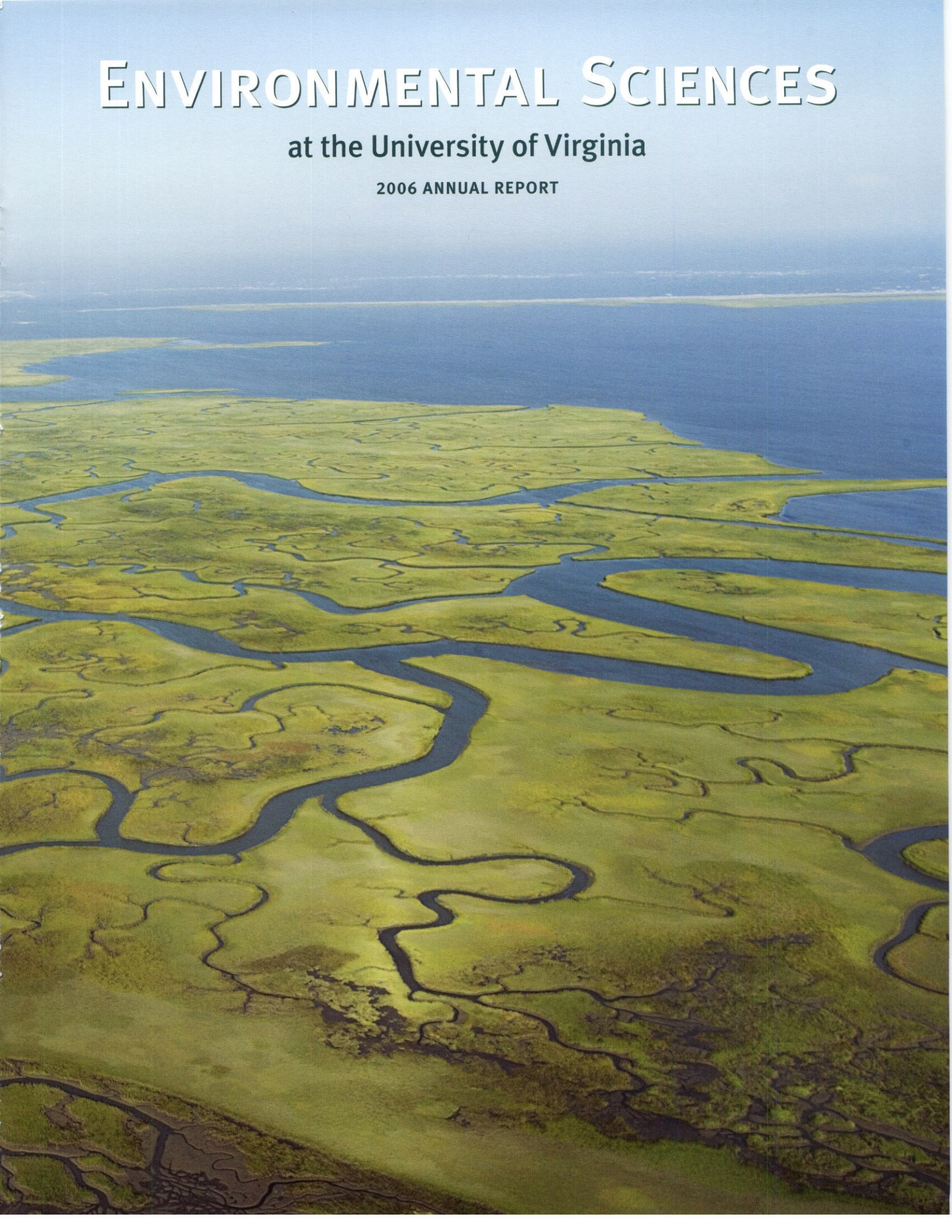
Environmental Sciences

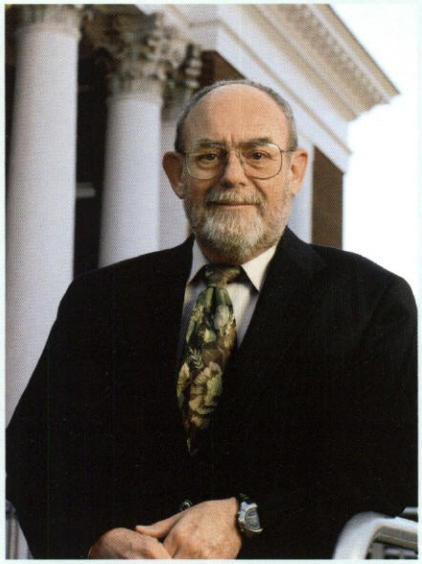
at the University of Virginia

2006 ANNUAL REPORT



Letter from the Chair

The long-anticipated report of the International Panel on Climate Change only underscores what many of us in this department have known for some time. The nations of the world are facing a series of very difficult decisions as we enter a period of climate change that is unprecedented in human history.



This department has the potential to play a significant role in ensuring that these decisions are made on the basis of scientific fact—for a number of reasons. There are few departments of environmental sciences that can match the array of talent that we've assembled—and retained. Jack Cosby, Jim Galloway, George Hornberger, and Hank Shugart have spent most if not all of their careers at U.Va., and all of them are designated as highly cited researchers by the Institute of Scientific Information. Highly cited researchers—the 250 most frequently cited in their field—comprise less than one-half of one percent of all publishing researchers. Bill Ruddiman, recently retired but still actively publishing, is also a most highly cited scientist.

For a medium-sized science department, we have received major University and statewide recognition. In 2005, José Fuentes was named the Cavaliers' Distinguished Teaching Professor, an award given to the University's most distinguished teacher, and in 2006, Governor Timothy Kaine honored him as one of Virginia's 15 top faculty members for his distinguished record of teaching, research, and public service. In 2006, the University selected Hank Shugart as one of the two inaugural winners of its Distinguished Scientist Award, and in 2007, Governor Kaine named George Hornberger one of Virginia's five Outstanding Scientists and Industrialists of the year.

In addition, we've dramatically upgraded the quality of our facilities in the last five years to match the excellence of our faculty. In 2002, we completed a $40 million project—encompassing both an addition to and the renovation of Clark Hall—that dramatically increased the quality of office, laboratory, and computational space. In 2006, we opened the first set of buildings at the Anheuser-Busch Coastal Research Center, the new headquarters for the Virginia Coast Reserve LTER, and celebrated the fifth renewal of our Long-Term Ecological Research grant from the National Science Foundation, giving that program funding through 2112.

In short, the Department of Environmental Sciences has built one of the foremost programs of its kind in the nation. With further funding from the department's supporters, we plan to build on these strengths ever further, giving policy makers the tools and the information to address the environmental challenges that are upon us.

Jay Zieman, *Chair*

A New Era Begins at the

The new Anheuser-Busch Coastal Research Center in Oyster, Virginia, with its laboratory, residence buildings, and research vessels, is the foremost facility of its kind on the East Coast.

Introducing the Anheuser-Busch Coastal Research Center

For twenty years, the University of Virginia has set the research and educational agenda at one of the oldest sites in the Long-Term Ecological Research (LTER) Network, the 35,000-acre Virginia Coast Reserve (VCR). Collaborating with the Nature Conservancy, which owns and manages the property, U.Va. scientists successfully secured LTER status for the reserve from the National Science Foundation in 1987 and began a series of pioneering research projects that have uncovered many of the fundamental relationships that shape this irreplaceable landscape—the barrier islands, lagoons, tidal marshes, and watersheds of Virginia's Eastern Shore.

Department faculty have conducted a wide-ranging research program despite limited facilities. Researchers operated out of a Victorian-era farmhouse that served as a research station. If they needed to go out in the lagoon or to the barrier islands, they had to drive to Red Bank, a half hour away, where the department kept its boats at a rented dock.

While this system was adequate during the formative years of the program, it was not very efficient. Researchers spent hours moving instruments and samples from the dock to the rented house—and because laboratory facilities were limited there, they often had to stabilize the samples before driving back to Charlottesville to analyze them.

In August 2006, we rectified this situation, setting the stage for an even more extensive research program. The department officially moved into the $2.5 million Anheuser-Busch Coastal Research Center (ABCRC), a new state-of-the-art research station located on 42 acres in the town of Oyster, about 15 miles north of the Chesapeake Bay Bridge-Tunnel. The ABCRC includes more than 9,400 square feet of dry and wet lab space, a 5,800-square-foot residence building that can accommodate 30 people, and a dock for its fleet of six shallow-water research vessels.

The ABCRC is networked to the University and to other research sites, and scientists are able to access real-time data remotely from monitoring equipment located at field sites throughout the reserve. The facility also has a conference room for scientific meetings and for community outreach projects, including a planned lecture series.

"This opening of the ABCRC represents a true milestone in the history of the Virginia Coast Reserve," says Jay Zieman, the department's chair. "These new facilities will not only enable us to conduct our research more efficiently, they will make our LTER one of the preeminent sites for barrier island research on the East Coast."

The department is now gathering support for phase two of the project, which will include an additional

Virginia Coast Reserve

Associate Chair Dave Smith (starting from left), University President John T. Casteen III, Chair Jay Zieman, and Keith Roots from the Dean's Office in the College of Arts & Sciences gathered for the dedication ceremony.

laboratory and a second residence building as well as a commons building. "People love being down there," observes Karen McGlathery, the VCR LTER principal investigator. "Our new facilities will bring researchers together in ways that were very difficult before. Now they'll be able to live and work together in a comfortable environment that's conducive to collaboration and exchanging ideas. It's an equally great place for a senior scientist or a graduate student just starting out."

Center Dedication Highlights Broad Support

The range of speakers at the August dedication ceremony for the Anheuser-Busch Coastal Research Center highlights the partnerships required to sustain first-class university research. Speakers from U.Va. included President John T. Casteen III, Department Chair Jay Zieman, and VCR LTER Principal Investigator Karen McGlathery. They were joined by officials from The Nature Conservancy, the National Science Foundation, and other federal and state agencies, as well as U.Va. alumnus John L. Nau III, owner of Silver Eagle Distributors, an Anheuser-Busch distributorship in Texas. Nau played an instrumental role in gaining a $1.25 million gift from the Anheuser-Busch Companies to help build the new center. The project also received

A Dynamic Natural Laboratory

The Virginia Coast Reserve is one of the few remaining pristine areas on the Atlantic seaboard and Gulf Coast available for the study of the barrier island ecosystem. Found on every continent except Antarctica, these systems are irreplaceable—as a source of livelihood, as a refuge for wildlife, as a buffer for storms, and as a filter for nutrients in the groundwater. We are only beginning to learn how this complex and dynamic system works or how it is affected by forces of global change.

The 35,000-acre Virginia Coast Reserve is an assemblage of 14 barrier islands, shallow lagoons with extensive mudflats, tidal marshes, and mainland watersheds extending 70 miles along the seaward margin of the Delmarva Peninsula. Created as a preserve by The Nature Conservancy in 1970, this barrier island and lagoon system has been designated a United Nations International Man and Biosphere Reserve. It supported one of the most prosperous farming- and fishing-based communities in the country at the turn of the last century. Now all but one of the islands of the Virginia Coast Reserve are uninhabited.

One reason that they have been abandoned is the dramatic rate of shoreline change—as much as 40 feet in a single year—as the islands migrate toward land in response to the rising sea level. While this makes human habitation difficult, it makes the reserve the ideal place to study natural processes. Events that might take decades elsewhere can be observed over the span of just a few years.

Hog Island is one of 14 barrier islands in the Virginia Coast Reserve Long-Term Ecological Research site.

substantial support from University benefactor Paul Tudor Jones.

Also in attendance were local leaders from the town of Oyster and Northampton County. They included Andrew Barbour and Richard Tankard, both Northampton County supervisors, and Kendall Berry, headmaster of the Broadwater Academy. The department made it a priority to design the center's buildings to fit into the vernacular architecture of the area and consulted with members of the surrounding community throughout the design and building process. Our goal is to ensure that the research and education conducted at the center benefit the area.

LTER staff have worked closely with Northampton High School faculty members including Tom Bonniwell to develop hands-on science programs for their students.

Scientists at the LTER look at coastal barrier ecosystems from a broad temporal and spatial perspective.

Strengthening Science Programs at Local Schools

The Virginia Coast Reserve is not only a site for scientific research, but also a resource for the citizens of neighboring Northampton and Accomack counties. Department faculty, looking for a way to join forces with Northampton educators, successfully applied for a grant from the National Science Foundation's Schoolyard LTER program in 1998. We also secured funding to work with the Accomack County School District through an NSF Biocomplexity Grant.

Thanks to the Schoolyard LTER program, hundreds of Northampton students have had the opportunity to gain a new appreciation of their surroundings, while developing a firsthand understanding of science. Our approach has been collaborative. "We opened the dialogue with Northampton faculty by describing what we do and asking them how we could be of assistance," notes Dave Smith, the department's associate chair.

Thanks to the LTER connection, the Northampton School District has been able to upgrade its Internet connection, purchase additional textbooks and computers equipped with GIS software, and buy GPS equipment and pond-sampling kits for outdoor laboratories. LTER staff members also worked closely with high school faculty to develop a new environmental science class and to incorporate environmental sciences into the general science curriculum. We encouraged students to participate in our long-term sampling programs and have supported student-interns who have reported the results of their data collection at our VCR LTER all-scientist meetings.

With the Accomack schools, we organize yearly field trips for high school students and science teachers that include sampling at the reserve and a trip to the geochemistry laboratory in Charlottesville to process and analyze their samples.

Our next step is to expand on these partnerships. With funding from the National Science Foundation and the Henry L. and Grace Doherty Charitable Foundation, we will equip teachers in the North Hampton and Accomack school districts to present site-specific science modules. Our goal is to help them meet individual Virginia Standards of Learning while giving students a meaningful understanding of watershed dynamics. This funding will help them enable us to hire a science education coordinator charged with creating a systematic program for educational outreach at the VCR LTER.

Research at the reserve has focused on how interactions among the land, sea, and groundwater influence ecosystem states.

Big-Picture Research

The goal of the Virginia Coast Reserve LTER program is to develop a predictive understanding of how slow, progressive changes in climate, sea level, and land use and short-term disturbances like hurricanes influence the dynamics and biotic structure of coastal barrier systems. Since 1986, research at the reserve has focused on the major components of this landscape—the barrier islands, lagoons, and tidal marshes—and how the relative positions of the land, sea, and groundwater and their interactions influence ecosystem states.

The knowledge gained from this work has given us the ability to look at coastal barrier ecosystems from a much broader temporal and spatial perspective—and has set the agenda for the fifth renewal of our LTER grant, which will provide annual funding of $820,000 for six years. Among the issues that LTER researchers will be focusing on:

- **Drivers of State Change.** Although the long-term drivers of environmental change—climate, rising sea level, and land use—are common across the VCR landscape, their relative importance for the different landscape units varies. We continue to study progressive change within the landscape units, while identifying the threshold responses that might produce an abrupt transformation in ecosystem state.

  We are addressing such questions as whether marshes can keep pace with increases in sea level, whether changing land use will affect water quality in lagoons and affect the return of seagrass, and whether spatial variations in species and community distribution patterns on the islands can be used to predict areas vulnerable to change.

- **Biotic Feedbacks.** The activity of living organisms can modify an ecosystem's response to external drivers, by either promoting a stable state or facilitating change. We are investigating the way biotic feedbacks from marsh grass and seagrass affect turbidity and erosion rates in marshes and lagoons and the role of birds in the expansion of vegetation on the islands.

- **Fluxes of Materials and Organisms.** Developing an understanding of the patterns and dynamics of ecosystem change requires us to determine the ways organisms and materials move across the landscape. Our research currently focuses on a number of key fluxes. They include the movement of groundwater nutrients from mainland watersheds to coastal lagoons, sediment transfer between lagoons and intertidal marshes, water exchange between lagoons and the coastal ocean, and seed transfer by birds among the barrier islands.

- **Landscape Synthesis.** We are taking a number of complementary approaches—including landscape modeling and network modeling—to synthesize the data gained through long-term monitoring and shorter-term process studies. Our goal is to identify the causes and consequences of state change on the landscape so that we will be able to predict how coastal systems respond to drivers of global change. This will enable us to provide policy makers with a solid scientific foundation for decisions related to planning, management, and restoration of this dynamic environment.

Restoring the Seagrass

The year 1933 was the second most active Atlantic hurricane season on record. In August, a massive hurricane swept along the Delmarva Peninsula, wiping out a seagrass population already weakened by disease. The character of the lagoon changed immediately. Without seagrass lining the bottom of the lagoon, wave-induced sediment resuspension during storms blocked out light and hampered seagrass recolonization.

Relatively low nutrient levels in the lagoon and the work of graduate student Sarah Lawson, who mapped the lagoon for turbidity and light availability, have given us hope that we might be able to restore the seagrass to Hog Island Bay. This fall, working with the Virginia Institute of Marine Sciences, we spread 1.5 million seeds on areas in the bay reserved for seagrass restoration by the Virginia Marine Resources Commission. We will look at the effect of different seed densities as well as changing nutrient conditions and the presence of invasive algae and also tubeworms on the success of the restoration, and we will establish a chronosequence so that we can trace our progress over time.

Strengthening Our

Students pitched in to prepare our new on-site laboratory at the Pace-Steger estate.

Building Capacity for Piedmont Forest Research

When the first Europeans settlers arrived at Jamestown four hundred years ago, the Piedmont of Virginia was thickly wooded. As the Europeans spread, they cleared vast tracts of land for cultivation, and their descendants devoted themselves to agriculture for several centuries. In the early twentieth century, these Virginians began leaving the farm, and the countryside changed once again. Today, the landscape is dominated by a relatively young, vigorously growing, mixed deciduous forest.

This shift is not trivial. The new forest covers millions of acres, in Virginia and down through the Carolinas. As a result, understanding the intricate mechanisms of gas and energy exchange between the Piedmont forest and the atmosphere is a critical step in developing a fully realized conception of climate change.

In 1999, faculty members José Fuentes and Bill Keene realized that the 480-acre Pace-Steger estate, which had recently been donated to the University, would provide an ideal site for this research. They led a group of graduate students in erecting a 120-foot-tall tower on the property, which is located less than twenty miles east of Charlottesville in Fluvanna County. This eddy flux tower stands at twice the height of the surrounding tree canopy and is used to investigate exchanges of energy and chemicals (such as carbon dioxide, ozone, and water vapor) between the atmosphere and the forest.

This year, Fuentes and graduate student Tom O'Halloran took the next step. With funds from Department Chair Jay Zieman and logistical support from Associate Chair Dave Smith, Fuentes and O'Halloran oversaw the construction of an insulated laboratory to house the electronic equipment, gas analyzers, aerosol probes, data loggers, and computers that complement the instrumentation on the 40-meter tower. Thanks to these efforts, researchers can now conduct long-term continuous observations, and they can do so in comparative comfort regardless of the season.

Constructing the laboratory required a fair amount of grit and ingenuity. The dirt access road needed repairs and gravel before the shed and large equipment could be brought in piece by piece. O'Halloran and undergraduate Meredith Cleveland spent the summer obtaining permits and inspections, consulting with engineers, coordinating construction and electrical work, and installing the heating and air conditioning. They were motivated by the desire to begin their Double 'Hoo Award–funded research at the site.

Getting power to the lab also proved a challenge. "The power company wanted to follow its normal practice and cut a swath through the forest for power lines," Fuentes says. "From our point of view, this would have been less than ideal, to say the least." The solution was to bury the power cable in a trench that followed the existing access road, minimizing damage to the forest.

All this effort has produced a facility designed to help researchers gain insight into fluxes that drive environmental processes in the Piedmont. Fuentes points out that researchers from universities in Colorado, Georgia, Texas, New York, Italy, and Germany have expressed interest in working in Pace-Steger's unique environment. Their presence, in turn, opens new doors for University faculty and students.

Equally important, the laboratory increases the research station's usefulness for undergraduate teaching. A number of the labs associated with the department's core courses are conducted there. "With its close proximity to the University, the Pace-Steger estate provides an ideal setting for undergraduates to conduct basic

Laboratory Facilities

research and learn how to make discoveries," says Fuentes. "After all, that's what science is really about."

According to Fuentes, the next step is to deploy additional instrumentation that would enable researchers to take on ambitious long-term projects like monitoring ambient air pollution, analyzing the available energy in the environment, and assessing the carbon assimilation capabilities of the ecosystem. "Having established a first-class facility, we hope to attract funding from state and federal sources," Fuentes says.

The Shenandoah Watershed Study Modernizes Lab

When Jim Galloway, George Hornberger, and their former colleague Roger Pielke created the Shenandoah Watershed Study (SWAS), they had an ambitious agenda: to investigate how atmospheric sulfur- and nitrogen-based compounds affect the acidity of Virginia's mountain watersheds and impact the health of organisms living in their water and soil. Their first order of business was to create a high-end analytical laboratory. Working with a limited budget, they bought some of the new equipment they needed and salvaged the rest.

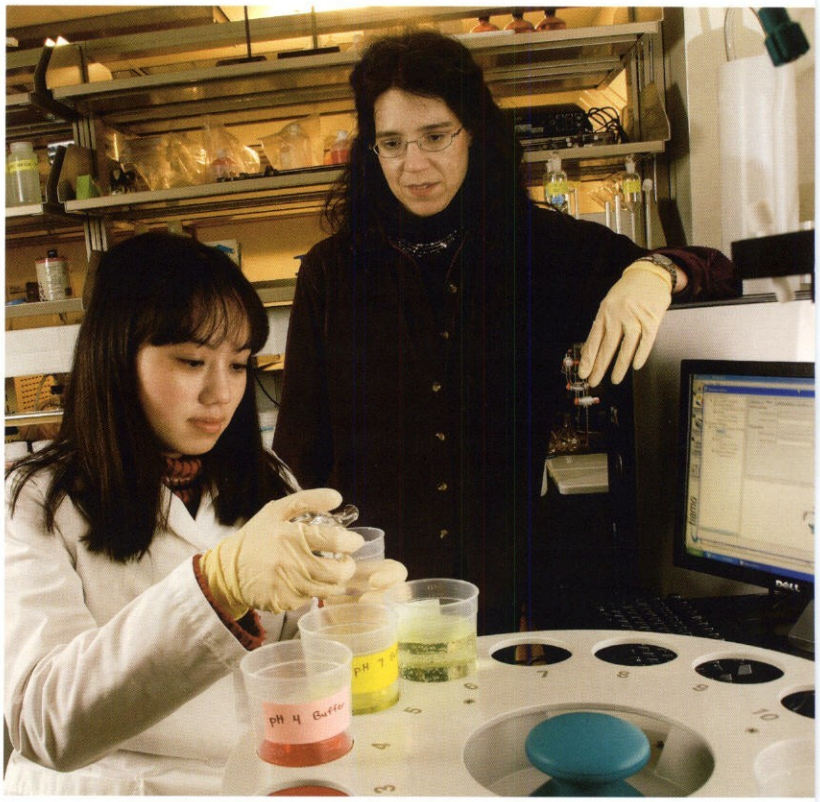
That was in 1979. During the 28 years that followed, SWAS technical staff kept this equipment in running order, though it took an increasingly large portion of their time. Maintaining this aging equipment was not simply a diversion from research. It also meant that SWAS could not respond fully to new scientific challenges.

On its 25th anniversary, SWAS hosted a symposium for a variety of stakeholders—nonprofits, government agencies, and private corporations. SWAS researchers summarized their achievements over the past quarter century and laid out their vision for increasing SWAS's coverage to West Virginia and coordinating more closely with researchers in Maryland and North Carolina. One of the stakeholders at the meeting was Dominion, one of the nation's largest energy companies, based in Richmond, Virginia.

Pamela Faggert (SEAS '79), vice president for the environment at Dominion, put Galloway in touch with the Dominion Foundation, and, armed with a commitment from the University to match private giving on a dollar for dollar basis, SWAS wrote a proposal for $100,000 to the foundation, which it approved.

Galloway and SWAS codirector Jack Crosby are delighted and grateful. The equipment purchased—a state-of-the-art ion chromatograph, a dissolved organic matter analyzer, an autotitrator, and a mercury analyzer—allows SWAS to be more efficient and productive and to expand its area of study. "This equipment will provide the analytical foundation needed to address current science questions," Galloway says, "and the flexibility to formulate new questions that will allow us to assess more precisely the health of Virginia's mountain streams."

Suzanne Maben, the SWAS laboratory manager, and Christine Okano prepare stream water samples for analysis with the newly purchased Metrohm Titrando Titration System.



An Enthusiastic Faculty

Shugart Wins U.Va.'s First Distinguished Scientist Award

When the University inaugurated its Distinguished Scientist Award, Herman H. "Hank" Shugart was the logical choice to be named as one of award's two winners. Shugart, who holds a joint appointment in the Department of Biology, certainly has the necessary credentials. The W. W. Corcoran Professor of Environmental Sciences, he has published over 330 papers, 14 books, and 75 book chapters, including more than 130 papers in peer-reviewed journals. The Institute of Scientific Information named Shugart a highly cited researcher in ecology/environmental science, which places him in the top one-half of one percent of all publishing scientists. Shugart, a committed educator, has also guided more than 50 master's and doctoral candidates to the completion of their degree programs.

For his achievements, Shugart has been named a fellow of both the World Innovation Foundation and the American Association for the Advancement of Science. He was also the first American ecologist to be named a foreign member of the Russian Academy of Sciences.

But Shugart is not the kind of person to rest on his laurels or dwell on the past. Currently, Shugart is engaged in a number of multidisciplinary international research projects. He is the chief scientist for the Northern Eurasian Earth Science Partnership Initiative, a vast research endeavor involving the collaborative efforts of 353 scientists and 186 different institutions. In support of this effort, Shugart just received an award of almost $1 million from NASA to conduct satellite remote sensing to evaluate the effects of climate change on the habitat of the endangered Amur tiger, found in the Russian Far East and China. He will be conducting this research with graduate student Nancy Sherman. Shugart's lab is also contributing to the Global Mammal Assessment, a collaborative project that brings together researchers from U.Va. and Conservation International to create the first comprehensive appraisal of the status of mammals worldwide.

When Mountains and Air Meet

Stephan De Wekker, a new addition to our faculty, has always been interested in atmospheric sciences, particularly in the interactions that occur when soil, water, and the atmosphere meet. To satisfy this multidisciplinary interest, De Wekker went to an agricultural university in his native Netherlands and pursued research opportunities and graduate studies in Germany, Switzerland, Canada, and the United States. His postdoctoral work includes stints at the Pacific Northwest National Laboratory in Richland, Washington, and the National Center for Atmospheric Research (NCAR) in Boulder, Colorado.

De Wekker's specialty is how mountains affect the atmospheric boundary layer, and his work combines field studies, data analysis, and numerical modeling techniques. While at NCAR, he studied the way mountains can trigger the formation of atmospheric waves, which in turn produce circular currents of air at the surface. When violent enough, these rotors can be dangerous to aircraft. Last year, he participated in NCAR's T-REX (the Terrain-Induced Rotor Experiment) in the Owens Valley of California. Scientists deployed instruments, on the ground and in the air, that tracked the movement of aerosols, which reveals atmospheric circulation.

De Wekker is also interested in how mountains affect the transport of carbon dioxide. "Mountain forests take up a high percentage of the world's carbon dioxide," he notes, "though how they do it and how much carbon dioxide is involved is not well known." While at NCAR, he participated in the Airborne Carbon in the Mountains Experiment, the first attempt to measure carbon exchange in mountainous terrain using airborne techniques.

Having estimated carbon fluxes at the mesoscale using aircraft data, De Wekker is now tackling the complementary problem of estimating fluxes using ground-based measurements at mountaintops. In collaboration with the National Oceanic and Atmospheric Agency, De Wekker will be establishing a suite of highly precise instruments on the department's tower in Shenandoah National Park during the summer of 2007. He's also encouraged by the possibility of collaborating with his colleagues. "There is a lot of interaction that takes place at U.Va.," he says. "The faculty here welcome opportunities to do work together."

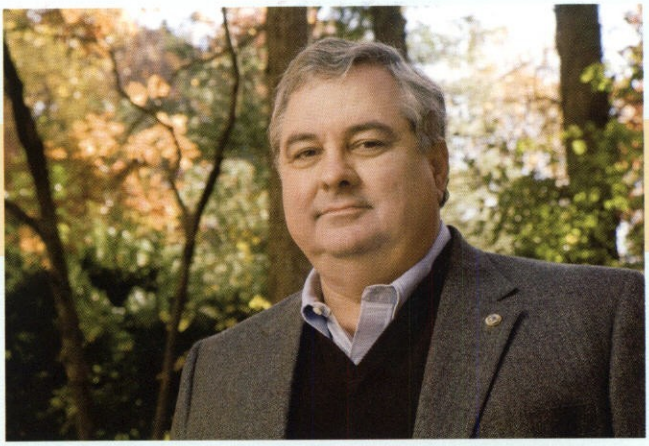
A Biological View of Plants and Atmosphere

Manuel Lerdau trained as a plant biologist at Stanford University, but his career took a turn in a new direction when he discovered that researchers had gained the ability to measure the connection between the activities of plants and the composition of the atmosphere. "This fundamental connection still amazes and fascinates me," he says. "Finding out how it works is the common thread that runs through my work." He took a post-doctoral fellowship at NASA Ames Research Center studying analytical chemistry so that he could better understand the atmospheric as well as the terrestrial sides of the equation.

While teaching at the State University of New York at Stony Brook, Lerdau's interest in combining ecology and evolution with atmospheric science brought him into contact with members of the department at U.Va., where interdisciplinary work is the rule. He brings this interdisciplinary focus to his post as newly appointed director of Blandy Experimental Farm, the University's 700-acre research facility in the northern Shenandoah Valley, and professor of environmental sciences. "My goals for Blandy include the creation of a research and education center there that would give scientists from different disciplines the opportunity to meet, study, and exchange ideas."

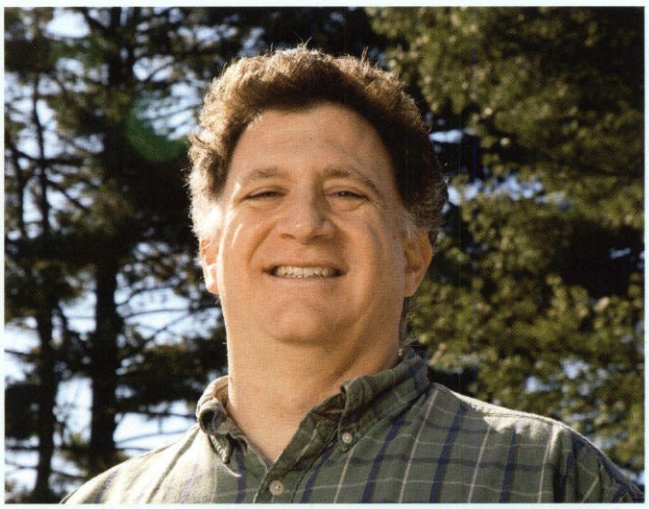
Lerdau's foundation in biology gives him a unique perspective on atmospheric science. The fates of chemicals such as ozone, nitric oxide, and methane in the atmosphere are difficult to predict because they are affected by the presence of isoprene, a highly reactive compound produced in very large quantities by some plants that provides some resistance to air pollution. Lerdau's strategy is to learn more about isoprene's impact on the atmosphere by better understanding its function in plants. He has been investigating such questions as why some plants produce isoprene while others don't, as well as what conditions stimulate plants to produce this volatile chemical.

"I have a deep interest in how organisms work," he explains. "I'm interested in how ecology and evolution influence physiology and how physiology translates upward to affect the atmosphere."



Hank Shugart received the University's first Distinguished Scientist Award.

Stephan De Wekker joined the faculty this year. An atmospheric scientist, he specializes in the impact of mountains on the boundary layer.



Manuel Lerdau is the newly appointed director of the Blandy Experimental Farm, the University's 700-acre research facility in the northern Shenandoah Valley.

Leadership in Education that

Bob Swap leads a January-term course that prepares University students for research in developing countries.

Ethics Course Prepares Students for International Research

In recent years, a growing number of University students have gone abroad, not merely to study, but to conduct research. Research Associate Professor Bob Swap has played a major role in encouraging them, providing advice on fund-raising and proposal-writing as well as introductions to researchers and institutions in South Africa and neighboring countries. Swap realized that students would be more effective abroad and require less support from international colleagues if they had a better understanding of the ethical and social issues that international research raises. "I wanted to help them explore the ethical obligations of contemporary researchers and students who visit developing countries, especially in light of the legacy of colonialism," he says.

Collaborating with Michael Smith, the Sorenson Professor of Political and Social Thought, Swap introduced Ethics, Protocols, and Practices in International Research as a January-term course in 2006. In the space of 10 densely packed days, the students confronted such issues as the responsibilities of students and scholars to establish research partnerships and conduct research in ways that bring sustained benefits to the environment and to the people at their project site.

One of the highlights of the course was presentations by faculty members and researchers from the University of Venda for Science and Technology, the University of Botswana, the University of Johannesburg, the University of the Witwatersrand, and the Gobabeb Research and Training Centre in Namibia. Experts from the U.Va. schools of medicine and nursing and the College as well as from the World Bank also participated. Another highlight of the course from the students' perspective was talks given by U.Va. students, both undergraduate and graduate, who themselves had just undertaken international research efforts. As a final project, groups of students collaborated on the development of a proposal for a research program or policy initiative that included measures of how they would build partnerships with their counterparts overseas.

Getting Engineering Students to South Africa

During their first year, two engineering students, Kathleen McDowell and Peter Stapor, attended a meeting of the University chapter of Engineering Students Without Borders. While the service learning project they signed up for was canceled, the two were determined to go overseas. They soon found their way to Research Associate Professor Bob Swap and the University's SAVANA summer study abroad program.

Although initially skeptical, Swap was impressed by their determination. He critiqued their grant proposals and suggested sources of funding. Their goal was to help improve access to water in the community of Bushbuckridge in the Limpopo Province of South Africa, where two of their fellow engineering students had done work the previous summer.

"We wrote a lot of grant proposals," Stapor recalls. "It was like a class in itself." Although they did receive a few rejections, McDowell and Stapor clearly learned their lessons well. They raised most of the $21,000 to cover their costs from University of Virginia Engineering Foundation and from the Center for Global Health, the Office of the Vice President for Research and Graduate Studies,

Impacts the Entire University

the Rodman Scholars Foundation, the International Studies Office, Engineering Students Without Borders, the University Giving Tree, and several private donors.

Swap also connected the pair with Wayne Twine, former manager of the Wits Rural Facility, part of the University of the Witwatersrand, who in turn put them in touch with a community outreach worker with contacts with local school administrators. After meeting with the school officials, McDowell and Stapor decided to use their funds to install rainwater harvesting systems at a number of local schools. They hired a local contractor and oversaw the installation of 10 5,000-liter tanks on 10 school blocks and the repair of a 10,000-liter tank at another. They returned the next summer to check on the status of their rainwater collection systems and to help a new team of engineering students carry on their work. But that's not Stapor's last trip. "I definitely plan to return to the region many times over in the future," he says.

Students Take J-Term in Belize

As the environmental challenges society faces become increasingly global in nature, an international experience has become increasingly important for science students. More than ever before, scientists need to bring a global perspective to their work and be prepared to collaborate with researchers from other countries. Unfortunately, because they must take a large number of prerequisites, science majors have a more difficult time than other students finding room in their schedules to spend time abroad.

Dave Smith realized that the January term would provide the ideal occasion to provide students with an overseas field experience. Smith and his colleague Fred

Kathleen McDowell and Peter Stapor on a water tank that was installed at Shobiyane High School in the rural village of Acornhoek, South Africa.

Thanks to our January-term course in Belize, University students have the opportunity to conduct field work.

Tom Smith and Vivian Thomson codirect the Environmental Thought and Practice major.

Diehl, a professor in the Department of Biology, have long collaborated on Biology 350, an intensive three-week, four-credit, study abroad course in marine biology and coral reef ecology. Together, they planned a January-term course, Tropical Ecosystems and Conservation in Belize.

"Belize has a wide range of easily accessible tropical ecosystems," Smith notes. The course began on Tobacco Caye, a five-acre island in the midst of the largest barrier reef in the Northern Hemisphere. The class moved on to study terrestrial ecosystems at Monkey Bay Wildlife Sanctuary and the Tropical Education Center, outside of Belize City. Students also learned about freshwater ecosystems at the Tropical Education Center as well as during their stay at Crooked Tree Wildlife Sanctuary.

"This was a hands-on class," Smith notes. "Students snorkeled, explored caves, and visited Mayan ruins. They ended the course with an independent research project, which gave them the opportunity to discover what field-work is all about."

The experience has borne fruit. A number of the participants in the course have applied to spend their summer with faculty members doing research.

The Environment in the Everyday World

As Tom Smith thinks of it, the Environmental Thought and Practice major that he codirects with Assistant Professor Vivian Thomson serves as a bridge from Environmental Sciences to the rest of the University. "The major gives students and faculty the opportunity to look at environmental issues in their social and political context," he says.

The major is a direct outgrowth of the Environmental Literacy Program that the department started in 1998 to develop ties to researchers across Grounds working in areas related to the environment. "When we started to put together a Web site listing all the courses around the University that had an environmental component, we were amazed," says Smith. "There's expertise on the environment in every school of the University."

To complete the major, all students take a series of core courses on environmental policy and decision making as well as an introductory course in one of the environmental sciences. They then take electives from a selection of courses offered by a variety of departments, including anthropology, planning, economics, and mechanical engineering. "There is a lot of enthusiasm on Grounds for the program," Smith observes. "Departments are very helpful in opening their courses to our students."

Students also take part in the Sara Shallenberger Brown Seminar in Environmental Literature, which was founded as part of the Brown Residential College program on environmental scholars and writers. Since the Environmental Thought and Practice program joined forces with the college, such highly regarded authors as Barry Lopez, Charles Burgess, Joseph Cronon, Leo Marx, William McKibben, Merrill Gilfillan, Holmes Rolston III, David Gessner, and Verlyn Klinkenborg have come to U.Va.

These experiences serve as a bridge for students. Students with a background in architecture or liberal arts gain an appreciation of the rigor that informs the scientific view of the natural world. Students versed in the sciences have the complementary experience. "It's really eye-opening for them to see science as it plays out in society," Smith says, "and to discover what is required to make a real-world decision that involves the environment."

Awards, Appointments, & Achievements

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 **Rachel K. Gittman**, the Wilbur A. Nelson Award in geology was given to **Melissa A. Rodriguez**, the Michael Garstang Atmospheric Sciences Award went to **David B. Knight**, and the Hydrology Award was presented to **Jacquie Wan Ching Hui**.

Selected as Distinguished Majors were **Rachel K. Gittman, Amy E. Grady, Katherine C. Hamel, Jacquie Wan Ching Hui, David B. Knight, Melissa A. Rodriguez**, and **Maria Takahashi**.

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 **Nicholas C. Radko.**

Amy E. Grady 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." She also 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 **David B. Knight**. He also won the Chair's Award, which is presented to an individual who has performed extraordinary services for the department.

Temple R. Lee was honored for making the outstanding undergraduate student presentation at this year's Environmental Sciences Research Symposium. **Jacquie Wan Ching Hui** had the most impressive poster by an undergraduate student.

Amanda N. Brown 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.

Jenna N. Lucas won a coveted Harrison Undergraduate Research Award. Forty Harrison Awards of up to $3,000 each are distributed by the Faculty Senate to the most promising undergraduate research projects at the University.

Graduate Students

Alexia M. Kelley was selected for a Graduate School Dissertation Year Fellowship for 2006–7.

Established by Dr. F. Gordon Tice in 1992, the Maury Environmental Sciences Prize is the premier department award. This year's winner was **John F. Lamoreux**.

Dane A. Barr was honored for producing the best poster by a master's student at this year's Environmental Sciences Research Symposium, while **Chuanhui Gu** created the best poster in the doctoral student category. **Gina M. Casciano** was singled out for producing the best graduate presentation by a master's student, and **Luke W. Cole** gave the best presentation by a doctoral student.

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

David L. Richardson 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, **Gina M. Casciano** earned the Graduate Award in Ecology, **Marcia S. DeLonge** won the Graduate Award in Hydrology, **James C. Kathilankal** won the Graduate Award in Atmospheric Sciences, and **Lixin Wang** won the Arthur A. Pegau Award in Geology. **Sujith Ravi** received the Robert Ellison Award for Interdisciplinary Studies.

This year, **Jenica M. Allen, Marcia S. DeLonge, Ryan E. Emanuel, Thomas L. O'Halloran**, and **Lixin Wang** 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. **Kendra K. Dowell, Eric E. Elton, James C. Kathilankal, Daniel J. Muth, Sujith Ravi, Parameswar Sahu**, and **Karen L. Vandecar** 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 **Wai-Yin Stephen Chan**.

Lixin Wang 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.

Staff

Cindy Allen, Jann Goetzmann, and **Henry White** received Accomplished Service in Arts & Sciences Awards for winter 2006. **Lelia Gibson, Jann Goetzmann, Henry White**, and **Charlotta Wriston** won spring 2006 awards.

Shelley Vance was presented the Graduate Student Association Award.

Faculty

Linda Blum served as conference chair for the highly successful 2005 biennial meeting of the Estuarine Research Federation in Virginia Beach and was appointed vice-chair of the National Research Council Committee on Independent Scientific Review of the Everglades Restoration Project.

Jack Cosby was 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.* He also received the John R. Mather 2005 Paper of the Year Award from the Climate Specialty Group of the Association of American Geographers.

Paolo D'Odorico served as associate editor for *Water Resources Research.* He convened special sessions at the European Geophysical Union General Assembly in Vienna and at the American Geophysical Union meeting in San Francisco.

Robert Dolan was a member of the editorial board of *Journal of Coastal Research.* He served the University as a member of the Jefferson Scholars National Selection Committee.

Howard Epstein sat on the Committee of Visitors charged with evaluating the National Science Foundation's Office of Polar Programs. He was a College of Arts & Sciences Advising Fellow and spoke at Reunions 2006.

José D. Fuentes was one of just 15 faculty members statewide to receive an Outstanding Faculty Award from the State Council of Higher Education for Virginia. This is the top honor for faculty at Virginia's public and private colleges and universities. He was also presented with the Hispanic Educator Award by the Virginia Hispanic Chamber of Commerce and held a Cavaliers' Distinguished Teaching Professorship. Fuentes edited *Journal of Geophysical Research—Atmospheres* and represented the Department of Environmental Sciences and the University of Virginia at the University Corporation for Atmospheric Research in 2006.

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. He was a member of the Environmental Protection Agency Science Advisory Board and the Board of Trustees of the Bermuda Biological Station for Research. He also chaired the International Nitrogen Initiative.

Janet S. Herman served as associate editor of *Water Resources Research,* which is published by the American Geophysical Union, and chaired the Hydrogeology Division of the Geological Society of America. Locally, she was the top individual fund-raiser for the Charlottesville Women's Four Miler, which supports the U.Va. Breast Care Center.

George M. Hornberger, associate dean for sciences in the College of Arts & Sciences, 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 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 served as science advisor for geomorphology at the Grand Canyon Monitoring and Research Center and as a review panel member in the National Atmospheric and Space Administration Mars Fundamental Research Program.

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.

Stephen A. Macko, a fellow of the Joint European Association of Geochemistry and the Geochemical Society, served as associate editor of a number of publications: *Amino Acids, The Scientific World: Isotopes in the Environment, and Science of the Total Environment.* Macko created the first teleducation network between U.Va. and area high schools.

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 boards of *Microbial Ecology and Geobiology*. He also served on the National Science Foundation's Review Panel for the Hydrological Sciences. In addition, he edited the subsurface microbiology volume for the American Society for Microbiology's *Manual of Environmental Microbiology* (third edition).

Jennie Moody was the University of Virginia's representative to the University Corporation for Atmospheric Research in 2005.

John Porter was an instructor at the Organization of Biological Field Stations Information Management Training and participated in the Taiwan Ecological Research Network Information Management Workshop.

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*.

Todd Scanlon was one of just six faculty members selected as a University of Virginia Teaching Fellow for 2006–7. The program aims to help the University's most intellectually sound and successful junior faculty members develop into exceptionally fine teachers.

Herman H. Shugart 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.

David E. Smith won this year's Environmental Sciences Organization Award. He chaired the University-wide search for the U.Va. chief facilities officer and was a member of the U.Va. Executive Leadership Network. He served on the Long-Term Ecological Research Network Education Committee and the Virginia Sea Grant Academic Advisory Panel.

Robert J. Swap was an invited review panel participant at the National Science Foundation Program on Partnerships in International Research and Education held in Arlington, Virginia. He was also an invited organizing committee member for the Alexander von Humboldt International Conference on Biomass Burning. 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 a guest scholar at the Pew Center on Global Climate Change. She was appointed by Governor Warner to the Virginia Air Pollution Control Board.

Robert Washington-Allen sat on the advisory board for a U.S. Department of Agriculture proposal study on remote sensing of invasive species. He was also a participant in the Sustainable Rangelands Roundtable, which was held in Washington, D.C.

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 a member of the American Geophysical Union Information Technology Committee.

2005–2006 Publications

Annual report of published peer-reviewed papers, book chapters, and books for faculty and graduate students for the 2005–2006 academic year (Summer 2005, Fall 2005, Spring 2006)

Acuña Soto, R., D. W. Stahle, **M. D. Therrell**, S. Gomez Chavez, and M. K. Cleaveland. 2005. Drought, epidemic disease, and the fall of classic period cultures in Mesoamerica (AD 750–950). *Medical Hypotheses* 65 (2): 405–409.

Alleaume, S., C. Hély, J. Le Roux, S. Korontzi, **R. J. Swap, H. H. Shugart**, and C. O. Justice. 2005. Using MODIS to evaluate heterogeneity of biomass burning in southern African savannahs: A case study in Etosha. *International Journal of Remote Sensing* 26 (19): 4219-4237.

Armitage, A. R., **T. A. Frankovich**, K. L. Heck Jr., and J. W. Fourqurean. 2005. Experimental nutrient enrichment causes complex changes in seagrass, microalgae, and macroalgae community structure in Florida Bay. *Estuaries* 28 (3): 422–434.

Baldocchi, D. D., T. A. Black, P. S. Curtis, E. Falge, **J. D. Fuentes**, A. Granier, L. Gu, A. Knohl, K. Pilegaard, H. P. Schmid, R. Valentini, K. Wilson, S. Wofsy, L. Xu, and S. Yamamoto. 2005. Predicting the onset of net carbon uptake by deciduous forests with soil temperature and climate data: A synthesis of FLUXNET data. *International Journal of Biometeorology* 49 (6): 377-387.

Barr, J. G., **J. D. Fuentes, T. O'Halloran, D. Barr, J. C. Zieman**, and D. L. Childers. 2006. Carbon assimilation by mangrove forests in the Florida Everglades. *Amalgam* 1:27–37.

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Borum, J., O. Pedersen, T. M. Greve, **T. A. Frankovich, J. C. Zieman**, J. W. Fourqurean, and C. J. Madden. 2005. The potential role of plant oxygen and sulphide dynamics in die-off events of the tropical seagrass, *Thalassia testudinum*. *Journal of Ecology* 93 (1): 148–158.

Brandimarte, L., **P. D'Odorico**, and A. Montanari. 2006. A probabilistic approach to the analysis of contraction scour. *Journal of Hydraulic Research* 44 (5): 493–499.

Calef, M. P., A. D. McGuire, **H. E. Epstein**, T. S. Rupp, and **H. H. Shugart**. 2005. Analysis of vegetation distribution in Interior Alaska and sensitivity to climate change using a logistic regression approach. *Journal of Biogeography* 32 (5): 863–878.

Cane, J. H., R. Minckley, L. Kervin, and **T. H. Roulston**. 2005. Temporally persistent patterns of incidence and abundance in a pollinator guild at annual and decadal scales: The bees of *Larrea tridentata*. *Biological Journal of the Linnean Society* 85 (3): 319–329.

Carr, D. E., J. F. Murphy, and M. D. Eubanks. 2006. Genetic variation and covariation for resistance and tolerance to *Cucumber mosaic virus* in *Mimulus guttatus* (Phrymaceae): A test for costs and constraints. *Heredity* 96:29–38.

Caylor, K. K., and **H. H. Shugart**. 2006. Pattern and process in savanna ecosystems. Pp. 259–282 in *Dryland Ecohydrology*, ed. P. D'Odorico and A. Porporato. Dordrecht, Netherlands: Springer.

Caylor, K. K., **H. H. Shugart**, and I. Rodriguez-Iturbe. 2005. Tree canopy effects on simulated water stress in southern African savannas. *Ecosystems* 8 (1): 17–32.

Chapin, F. S., III, M. Sturm, M. C. Serreze, J. P. McFadden, J. R. Key, A. H. Lloyd, A. D. McGuire, T. S. Rupp, A. H. Lynch, J. P. Schimel, J. Beringer, W. L. Chapman, **H. E. Epstein**, E. S. Euskirchen, L. D. Hinzman, **G. Jia**, C.-L. Ping, K. D. Tape, C. D. C. Thompson, D. A. Walker, and J. M. Welker. 2005. Role of land-surface changes in arctic summer warming. *Science* 310 (5748): 657–660.

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