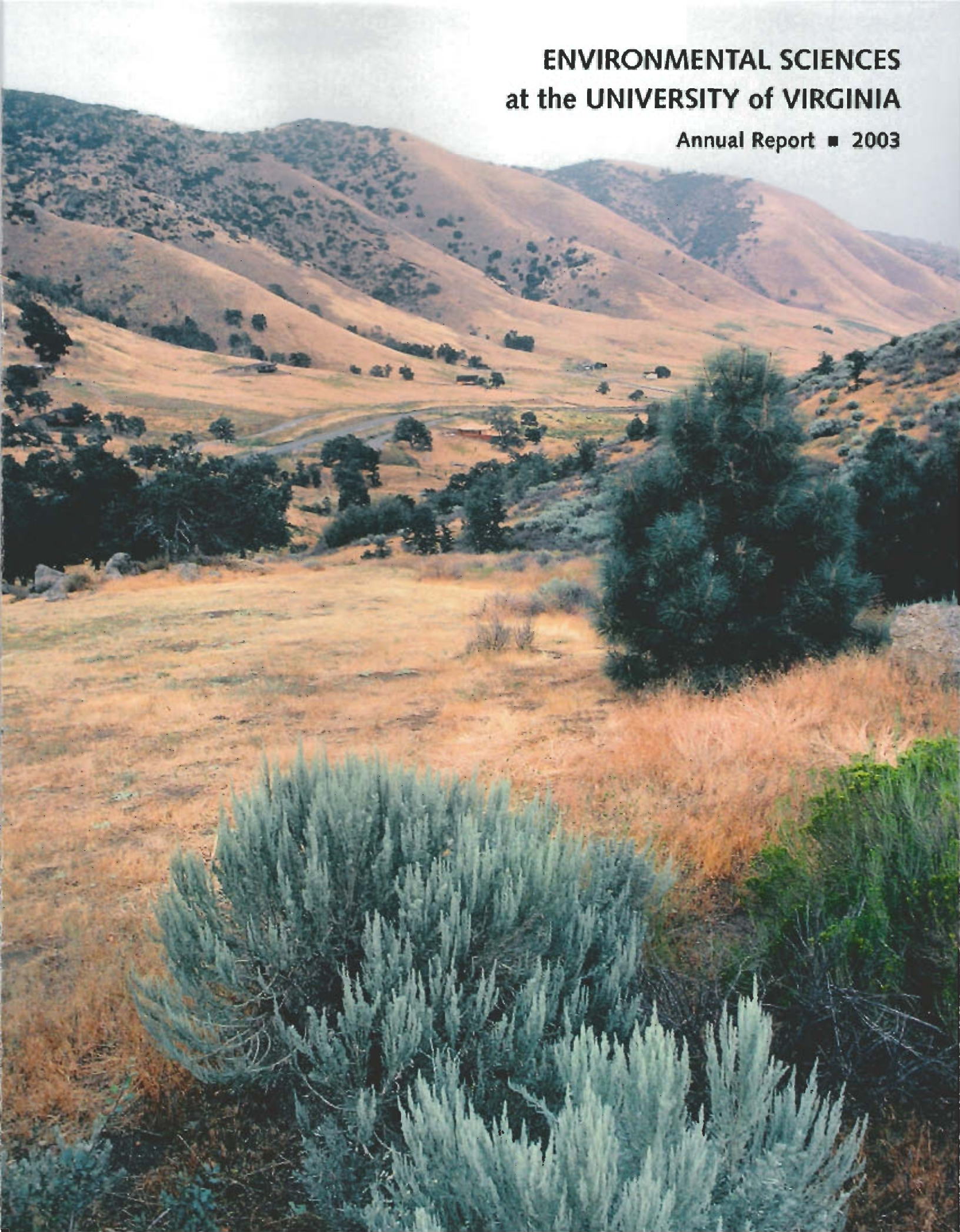
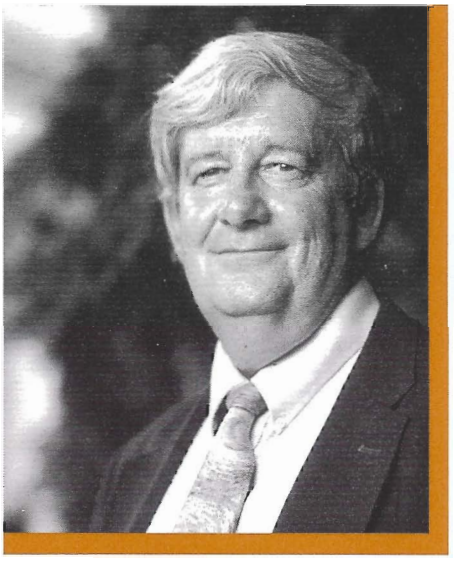


ENVIRONMENTAL SCIENCES at the UNIVERSITY of VIRGINIA

Annual Report ■ 2003

Interdisciplinary work has defined the Department of Environmental Sciences from its very inception. Established in 1969, the department was explicitly founded to advance our understanding of the environment through interdisciplinary scientific research and education. As such, it was the first in the nation to offer degrees through the Ph.D. level in a group of disciplines collectively known as the environmental sciences.



The decision to focus on a group of sciences, rather than a specific discipline, was a momentous one that has distinguished this department. It has shaped the careers of our faculty, just as it has enlarged the intellectual range of their experiences and those of our students. It has meant we have been free to ask very ambitious questions about the environment and, if we chose, to engage in research projects of a scale and complexity that matched the issues we were attempting to understand.

Quite naturally, our focus on interdisciplinary work led us to value collegiality. Over the last 30 years, teams of faculty members have assembled and reassembled in a variety of configurations. At the same time, our interdisciplinary approach has given this department an appreciation for individual initiative and the willingness to nurture these initiatives, knowing that we all can benefit.

The flexibility we have gained pursuing interdisciplinary research has spilled over into our approach to the curriculum. Not only do we expose our undergraduate and graduate students to interdisciplinary perspectives in the classroom and the field, we work hard to develop educational opportunities that match their interests and aspirations, including the new specialization in environmental and biological conservation and the master's in public health.

Over time, our interdisciplinary approach has proven to be remarkably resilient. It is a major factor in the success of the department during these tough economic times. Our external research funding has remained relativity constant, despite retirements of senior faculty and decline in our faculty numbers.

Perhaps the best way to understand the ultimate value of our interdisciplinary approach to the world around us is to learn about it yourself. Accordingly, this report focuses on collaborations within the department, within the University, and with other institutions—and in doing so, it reveals the characteristics that make our department distinctive.

Bruce Hayden
Chair

Collaborations and Interdisciplinary Work within the Department

A Collective Endeavor

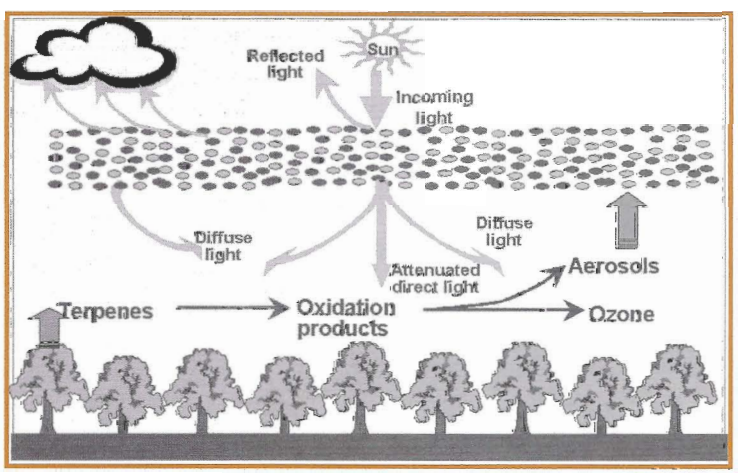
One of the greatest resources for members of our faculty is their colleagues within the department. The presence of colleagues with complementary expertise not only creates new opportunities for research, but exposes our faculty to perspectives that can enlarge their view of their own disciplines.

Forest Haze and Climate

Before colonial times, hickory and chestnut forests dominated in eastern North America. The forests back then released trace amounts of reactive hydrocarbons. At the turn of the eighteenth century, forests disappeared as settlers cleared the land to support agriculture and other activities. In the last 70 years, the region has become reforested with oaks, sweet gums, and conifers. The emerging forest species emit more hydrocarbons into the atmosphere than the indigenous trees.

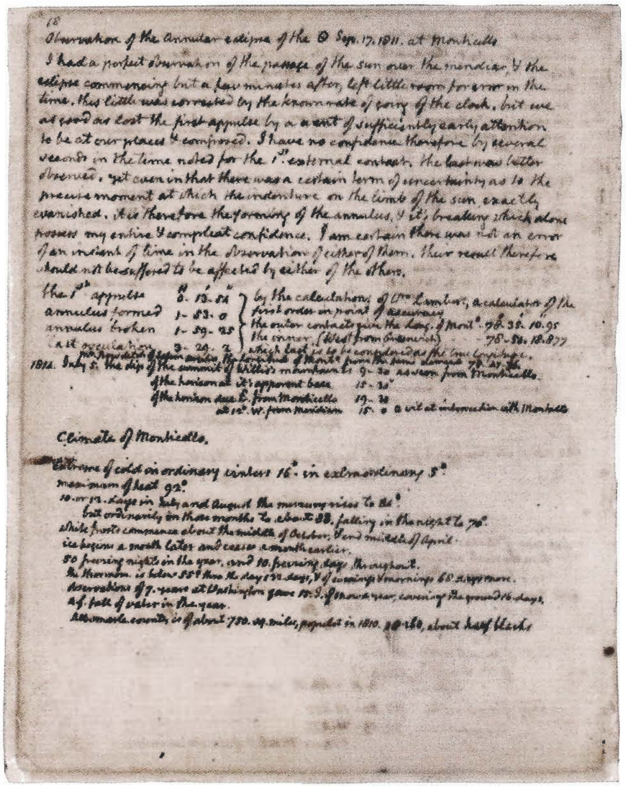
Associate Professor José D. Fuentes is working together with Assistant Professors Greg Okin, Michael E. Mann, and Paolo D'Odorico to understand the influence of this increased emission of biogenic hydrocarbons on the climate in eastern North America. They are investigating the ways in which hydrocarbons can lead to the production of fine aerosols in the lower atmosphere, where aerosols effectively scatter and absorb incoming sunlight. This reduced sunlight could produce a net cooling effect, which at the present time is not properly understood and therefore not included in climate models.

Aerosols can also influence processes such as cloud formation as aerosols derived from hydrocarbons become effective cloud condensation nuclei. It is then possible that due to changes in forest composition, cloud formation may have been influenced as well. Under cloudier conditions, enhanced levels of diffuse light can be observed. Forests can sequester more carbon dioxide because diffuse light reaches more deeply into forest canopies, allowing more foliage to consume carbon dioxide. This creates a feedback mechanism that results in reduced thermal radiative forcing as greenhouse gases such as carbon dioxide are removed. These regional processes are outlined in the figure shown below.



A faculty team is studying the interaction between radiative forcing and aerosols formed from biogenic compounds and its effect on climate as a forest matures.

As part of this team project, Okin is tracking the spatial distribution of hydrocarbon-emitting tree species throughout North America using satellite images. Fuentes is developing and applying models to quantify rates of hydrocarbon produced from forested landscapes, assessing the subsequent production of aerosols, and estimating the light scattered and absorbed by particles. Mann is investigating the influence of reduced surface insolation caused by aerosols on climate. D'Odorico is studying the ways in which the hydrologic cycle is being slowed by the decrease of available energy at the Earth's surface.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Observation of the annular eclipse of the ☉ Sep. 17. 1811. at Monticello

I had a perfect observation of the passage of the sun over the meridian, & the eclipse commencing but a few minutes after, left little room for error in the time. this little was corrected by the known rate of going of the clock. but we as good as lost the first appulse by a want of sufficiently early attention to be at our places & composed. I have no confidence therefore by several seconds in the time noted for the 1st. external contact. the last was better observed, yet even in that there was a certain term of uncertainty as to the precise moment at which the indenture on the limb of the sun exactly evanished. it is therefore the forming of the annulus, & it's breaking which alone possess my entire & compleat confidence. I am certain there was not an error of an instant of time in the observation of either of them. their result therefore should not be suffered to be affected by either of the others.

the 1st appulse 0. 13. 54 | annulus formed 1. 53. 0 | annulus broken 1. 59. 25 | last osculation 3. 29. 2 — by the calculations of Mr. Lambert, a calculator of the first order in point of accuracy [illegible] the outer contacts give the long. of Montto. 78. 35. 10.95; the inner, (West from Greenwich) 78. 50. 18.877 [illegible]

1812. July 5. the dip [illegible]

Climate of Monticello.

Extreme of cold in ordinary winters 16°. in extraordinary 5°.
maximum of heat 92°.
10. or 12. days in July and August the mercury rises to 86°.
but ordinarily in those months to about 88. falling in the night to 70°.
white frosts commence about the middle of October, & end middle of April.
ice begins a month later and ceases a month earlier.
80 freezing nights in the year, and 10. freezing days throughout.
[illegible]
[illegible]
[illegible] fall of water in the year.
Albemarle county is of about 750. sq. miles, populat. in 1810. [illegible], about half blacks

A page from Thomas Jefferson's weather diaries contains a discussion of the climate of Monticello. Library of Congress, Manuscript Division.

A Sunny Day in 1792

Two of Virginia's most overqualified weathermen were James Madison and Thomas Jefferson. Between 1784 and 1802, Madison and his father, James Madison, Sr., recorded 16,227 weather observations from their home, Montpelier, in Orange County. Jefferson's weather diaries are even more expansive, spanning the first half century of the republic. He began them in July 1776 and continued recording observations until his death in 1826. Many of these observations were recorded at Monticello, in Charlottesville.

Assistant Professor Mike Mann and graduate student Ian German Mesner are using these diaries to reconstruct weather patterns in Virginia during the 1780s and 1790s and, in particular, to focus on 1792, a year when both men were in Virginia and actively maintaining their diaries. This year was unusually dry and correlates with an unusually strong El Niño.

Aside from the fame of their authors, the diaries are exceptional research tools because they follow similar formats. Jefferson enlisted Madison in his project of recording the weather and suggested the type of data to be collected as well as the time of observation. As a result, Mann and his students not only can determine the frequency of different weather events, but can even trace the progression of fronts as they move across the Piedmont.

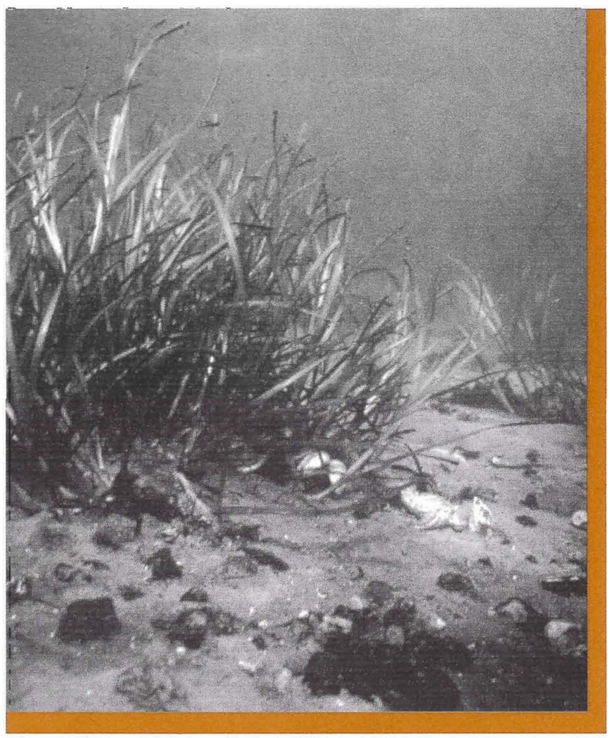
This research also plays a role in a large-scale study on changes in forest composition and climate change being undertaken by José Fuentes and others in the department. If we can understand the difference between today's climate and that of Jefferson's and Madison's time, we have a basis for investigating the influence of land use on climate.

The Return of the Eelgrass

At the turn of the last century, the bottom of Hog Island Bay at the Virginia Coast Reserve LTER was an eelgrass meadow. The eelgrass, weakened by a wasting disease, was devastated by a huge hurricane in August 1933. Until recently, the floor of the bay was devoid of vegetation.

Now there are signs that the eelgrass is about to stage a resurgence. If it is successful, it will create a major ecosystem state change in the lagoon, improving water clarity and leading to the reintroduction of benthic flora and fauna. Associate Professor Karen McGlathery has positioned herself to understand the conditions that will affect its return and its ecosystem-wide effects if successful. In addressing these issues, McGlathery, an aquatic ecologist, is collaborating with experts in such fields as land use, nitrogen loading, and sedimentation.

As a case in point, McGlathery and Professor Pat Wiberg are coadvising graduate student Sarah Lawson, who is trying to understand the role of turbidity in eelgrass recolonization. Lawson has developed a model incorporating such factors as sheer stress on the sediment surface and data on current and winds to determine how sediments enter the water column. This information will help McGlathery understand the light conditions at the bottom, which will play an important role in eelgrass regeneration.



Karen McGlathery and Pat Wiberg are collaborating to study the effects of turbidity on eelgrass recolonization in Hog Island Bay.

Atmospheric Science and Elephant Evolution

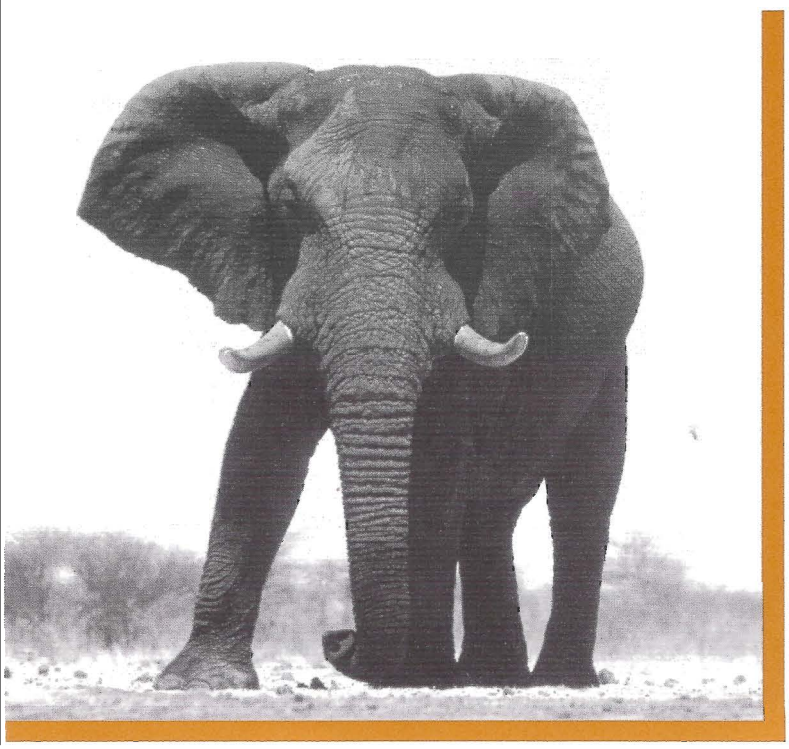
Advances in sonar research had the indirect effect of increasing our awareness of how large marine mammals capitalize on thermal stratification in the oceans to communicate over long distances. Research Professor Mike Garstang has applied his expertise as an atmospheric scientist to show that elephants and other terrestrial mammals communicate over distances by taking advantage of similar stratification in another fluid medium—the air.

Garstang hypothesized that to be successful, elephants would have to choose their moments carefully. That is because they rely on a fluid that is less stable than water, which means the conditions favoring long-distance communication are not always available. In the dry African savanna where Garstang found his subjects, hot air rising from the solar-heated surface creates turbulence that dissipates sound. It is only at night—and particularly at sunset and sunrise—that a lens of cold air near the ground forms a temperature inversion that tends to duct or trap sound. This cold, dense layer is decoupled from winds in the atmosphere, creating an ideal environment in which to detect sound.

Elephants produce loud, low-frequency sounds, which in themselves have great carrying power. As Garstang has documented in the course of fieldwork at Etosha National Park in Namibia, they call most often when atmospheric conditions are ideal for getting the most from their efforts. The difference is dramatic. At midday, the area over which a call can be heard is less than 30 square kilometers; just after sunset, the range expands to more than 300 square kilometers, thanks to the thermal stratification during this period.

As Garstang points out, this adaptation to atmospheric conditions is critical to the survival of the species. Females are in estrus just four days every four years, and it is to the species' advantage to reach the healthiest male in their vicinity. In the matriarchal society of the elephant, the prime males, who also go through a sexual cycle, called musth, may be many kilometers away from the female.

Mike Garstang's study of elephant communication places him at the intersection of atmospheric sciences, physiology, and evolution.



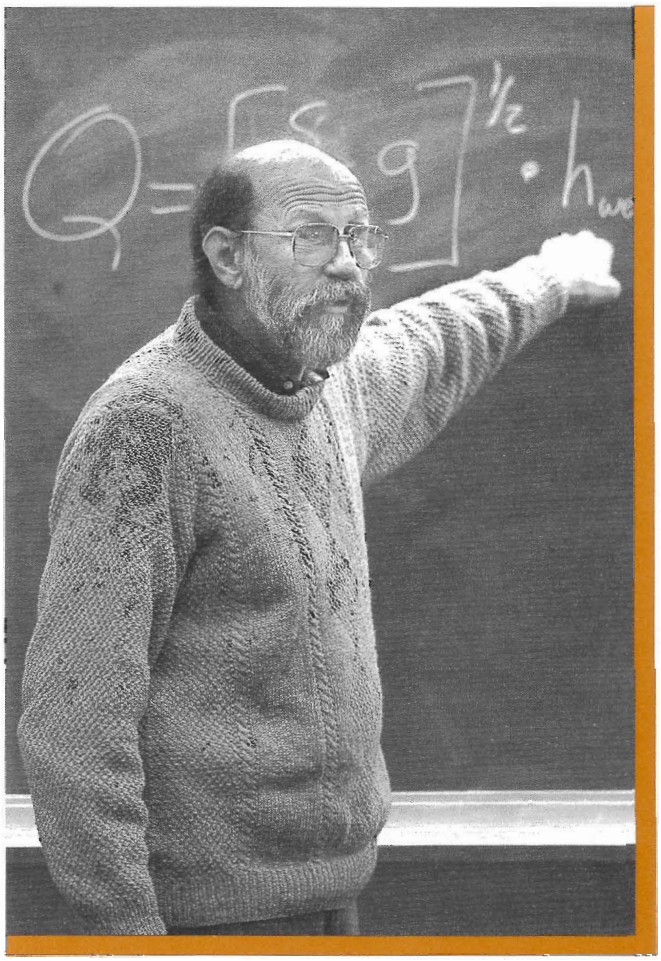
The Nonhydrological Perspective on Hydrology

Neither Professor Aaron Mills nor Professor Pat Wiberg is a hydrologist. Nonetheless, they are part of the team—along with hydrologists George Hornberger and Paolo D'Odorico—that teaches EVSC 340, Physical Hydrology. This connection is not as eccentric as it might seem at first. Although Mills is a microbial ecologist and Wiberg studies sediment dynamics, they both study fluid transport. Mills has collaborated with professors Hornberger and Janet Herman to track the microbial transformations of groundwater pollutants, while Wiberg's interests include storm-driven transport and the formation of sedimentary strata on the continental shelf.

In other words, their intellectual curiosity has led them to transcend disciplines, to learn much from hydrologists, and to gravitate toward an interdisciplinary context. As Mills explains, he was always interested not just in biology, but in biology in its physical and chemical context. He wants to know how microorganisms function in a specific environment—and the environment in which they most often flourish is water.

Similarly, Wiberg has always seen herself working at the interface between the geosciences and hydrology. She is not just interested in sediments per se, but in how they are transported by water.

At the same time, their disciplinary training outside hydrology enriches the experience of their students. They cover the same material as their hydrologist colleagues, but they naturally illustrate their classes with examples from their experience. For instance, when he discusses transpiration, Mills tends to emphasize the biological component of this process a bit more, explaining how plants move water



Aaron Mills and his colleague Pat Wiberg are part of the interdisciplinary team teaching the department's hydrology course for majors.

from the soil and into the atmosphere. When it's Wiberg's turn to teach, she might focus more on the effect of dams on stream flow and the landscape changes that result.

Wiberg's and Mills's presence in a hydrology class has another, important benefit as well. To the extent that careers in environmental sciences increasingly require our graduates to transcend disciplines, the example they provide by transcending disciplines is a valuable one.

Howie Epstein (kneeling on the right) is collaborating with colleagues at the Blandy Experimental Farm to discover how abandoned fields revert to forests.

Partnerships with Researchers at the Blandy Experimental Farm

Some of the farmland in the Mid-Atlantic States is reverting to forest. In the process, it is absorbing a portion of the carbon dioxide released into the atmosphere when fossil fuels are burned, and thus mitigating, at least temporarily, the effects of this greenhouse gas on global warming. How this process occurs—and its effect on carbon dynamics—is one of Assistant Professor Howie Epstein's research interests. In collaboration with Mike Bowers, T'ai Roulston, and Dave Carr, research faculty at the department's Blandy Experimental Farm, Epstein is studying how disturbed or managed systems revert back to some form of forest after the management or disturbance has been removed.

Working at Blandy gives Epstein the ability to monitor succession simultaneously at several stages in the process. In conjunction with graduate students Ryan Emanuel and Jin Wang, he is gathering data from a group of fields, including those abandoned two, 12, and 17 years ago, as well as from woodlots that are 90 years old. He has erected a tower on the two-year-old field, where he has collected a continuous series of measurements—including water, carbon dioxide, and energy fluxes, rainfall, air and soil temperature, and soil moisture—every half hour since it was last used to grow corn and rye. He correlates these phenomena with the vegetative dynamics of the field.

Epstein's research has already yielded some interesting observations. He has found that the two-year-old field is actually losing carbon because no woody plants have yet colonized it. In essence, decomposition in the soil still outweighs the effects of growth. In addition, he has noticed that the 17-year-old field shows no soil carbon recovery, despite an abundance of woody plants.

Epstein's collaboration with the Blandy team helps shape his conclusions. They bring knowledge of the local animal and insect communities, both of which can play a role in vegetative dynamics in terms of plant reproduction and seed dispersal.

Collaborations Across the University

The Resources of the Nation's Best Public University

Thomas Jefferson invented an educational community he termed "the academical village," a place where students and faculty work closely together. Although the University has grown tremendously since its founding in 1819, the end result has been that the opportunity for collaboration has grown exponentially.

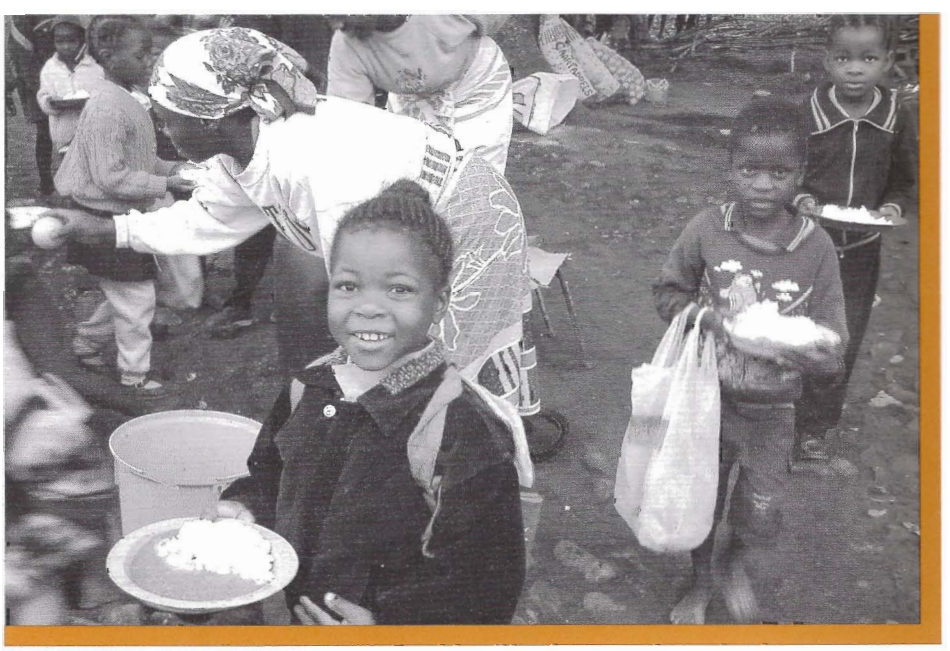
Launching a New Degree Program in Public Health

People are part of the environment. They change it, and they are changed by it, not always for the better. In southern Africa, for instance, recent U.Va. medical school graduate Christine Wilder has found that that asthma rates in South Africa's Limpopo Province seem to be increasing in the same areas where eucalyptus, a heavy pollen producer, was introduced as a source of lumber.

Wilder's research project, funded partly by a scholar's award from U.Va.'s Center for Global Health, is just one indication of faculty and student interest in working at the intersection of public health and the environment. Environmental Sciences Professor Hank Shugart, along with Dick Guerrant, director of the center, advised Wilder on her project. Last fall, Shugart teamed up with Ruth Gaare Bernheim, executive director of the University's Institute for Practical Ethics and an assistant professor of medical education, to offer a course entitled Environmental Health and Ecosystems. Shugart covered such topics as the spread of toxic materials in the environment and the coevolution of diseases and human culture.

Encouraged by the success of the class, Shugart and Bernheim along with a team of interested faculty designed a master's degree program in public health. Pending approvals from certifying agencies, the University will offer the master's for the first time in fall 2004.

The master's program will include courses in such traditional areas as epidemiology, health policy and



The University's new Master's in Public Health will have international and environmental dimensions, thanks in part to the department's involvement in South Africa.

A joint project of the Environmental Sciences and Biology departments, the new specialization in environmental and biological conservation will create new options for our majors.

administration, and biostatistics, as well as courses in environmental sciences, a requirement that makes the program unique. Students will also be asked to complete a practicum, which could be undertaken in southern Africa.

At the same time, this new master's program opens new opportunities for the department's best undergraduate majors. Since many of them now come to the University with substantial advanced placement credit, these students could complete the requirements for the master's degree in the year following graduation.

Getting Environmental Sciences into the Classroom

Thanks to a grant from the Virginia Environmental Endowment, Professor Dave Smith, Research Assistant Professor John Porter, and Professor Bruce Hayden are using wireless networking technologies and the Internet to bring visually and intellectually stimulating images from remote barrier islands in the Virginia Coast Reserve LTER into K–12 classrooms. Their goal is not simply to present students with real-time images of nature, but also to give them firsthand exposure to the goals and methods of environmental scientists.

The members of the project have developed a prototype site, successfully installed Webcams aimed at bird colonies and the burrows of fiddler crabs, and compiled databases of archival images. Students from the Curry School of Education are integrating these image sources into a series of Web-based exercises. One of the advantages of the site for teachers in Virginia is that the exercises and supplementary material will conform to the Standards of Learning.

Using live images and archived sequences, students will be able to do things like conduct population counts and assess activity levels. And since each image will be linked to meteorological and tidal data collected at the LTER, students can begin to draw relationships between the phenomena they observe and these measurements. For instance, they will be able to correlate feeding strategies with tidal cycles.

In conceptualizing and implementing this project, Smith, Porter, and Hayden have capitalized on existing relationships. They consulted with colleagues at the High Performance Wide-Area Research and Education Network at the San Diego Super Computing Center, which has a number of Webcam projects under way. And they will turn to the Schoolyard LTER program, which provides access to teachers in the Northampton Public Schools on the Eastern Shore, to test their prototypes.

Introducing a Joint Conservation Specialization with Biology

At U.Va., ecologists can be found in both the departments of Biology and Environmental Sciences. The new specialization in Environmental and Biological Conservation provides an opportunity for faculty to join forces, while giving their students an opportunity to focus on applied skills. As Assistant Professor Howie Epstein notes, the course of study arose from the recognition that many of our undergraduate majors will not go on to become researchers.

Accordingly, the program is designed to expose students to the type of fieldwork they might encounter if they make ecology their career. They have the option of interning with a conservation agency or nonprofit on local policy issues or working on a conservation project at one of the University's four field stations or with our partner institu-

This osprey was one of the first visitors at a Webcam placed on Hog Island as part of a project to create real-time Internet-based exercises on the environment for teachers and students in grades K–12.

tions in southern Africa. In addition, students are required to take a course from either department in biological diversity, one in environmental diversity, and one in such topics as policy, related chemical or physical sciences, statistics, modeling, geospatial analysis, or field methods.

The introduction of this specialization in fall 2003 has set the stage for the development of an M.A. program. The faculty involved in this program envision 24 credits of coursework in conservation in addition to up to two seasons of fieldwork and internships.

Building Partnerships for Southern Africa

SAVANA, the Southern Africa—Virginia Networks and Associations, the new education and research consortium linking U.Va. with four universities in southern Africa, has its roots in a series of initiatives led by members of the Department of Environmental Sciences. Not only has the department intensified its own initiatives in southern Africa over the last year, but it has played a critical role in enlarging and enriching these ties by involving colleagues from other areas of the University.

As Research Assistant Professor Bob Swap points out, department faculty working in the developing world have a special obligation to make sure their science has social relevance—and one of the best ways to boost the relevance of this work is to make University expertise available to our overseas partners.

Among the initiatives that environmental science faculty promoted or participated in this year were the following:

- Swap and Professor Hank Shugart worked with Law Professor John Cannon to facilitate the visit of two U.Va. law students to study water issues in Limpopo Province with faculty at the University of Witswatersrand.
- Swap and Anthropology Professor Hanan Sabea last summer led a combined study abroad course on the People, Culture, and Environment of South Africa.
- The department cohosted six South African health officials who visited U.Va.'s School of Nursing to exchange experiences and expertise in nursing education, training, management, and retention issues. The visit sets the stage for further exchanges between the nursing school and health care agencies in South Africa.
- Associate Professor Tom Smith and Commerce Professor Mark White built their new course, The Business of Saving Nature, around a 12-day trip to South Africa. Fifteen students participated in the course.
- Department faculty located funds to send Girish Ratanpal, a doctoral candidate in computer science, to South Africa to look at telecommunications and networking issues at our partners' sites. Ratanpal also assessed the potential of his organization, Engineering Students Without Borders, to become more involved in southern Africa.
- Swap began work on formulating a proposal with Daniel Pitti of the Institute for Advanced Technology in the Humanities and Will Thomas of the Center for Digital History to create a digital archive of the materials at the Harry Oppenheimer Okavango Research Center at the University of Botswana.

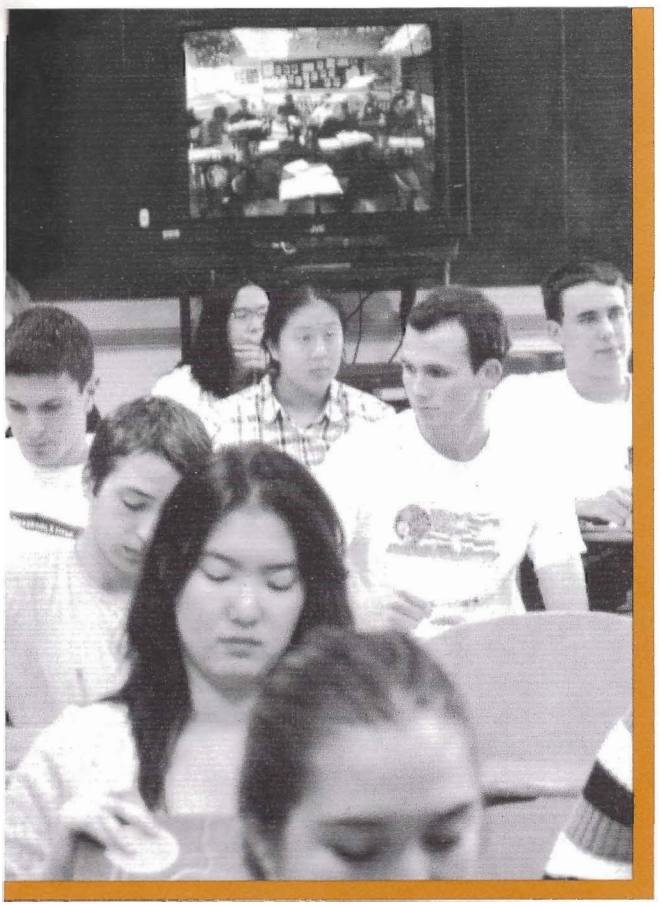
Last fall a group of South African health officials visited the School of Nursing, a direct consequence of departmental initiatives in southern Africa.

Joining Forces to Telecast Calculus III

By the time they entered their senior year last fall, nine bright Albemarle High School students had simply run out of math courses to take—but they were eager to learn more. With the assistance of Professor Steve Macko and Albemarle High School math chair Carla Hunt, they joined Math Professor John Faulkner's Calculus III class—without leaving school property, disrupting their schedule, or giving up other classes they wanted to take. They telecommuted to Grounds.

Macko built on his experience using teleconferencing to teach classes with faculty at U.Va.'s partner universities

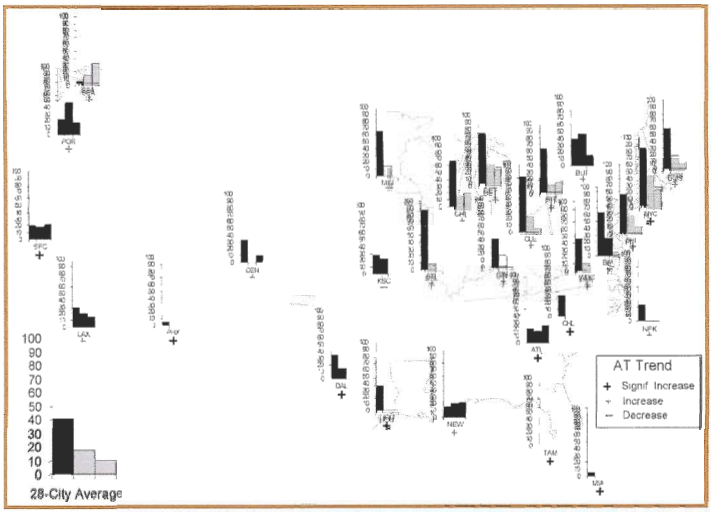
Steve Macko mobilized a coalition of mathematics faculty, public school teachers, IT professionals, telecommunications companies, and textbook publishers to teleconference Calculus III to local high school students.



in Southern Africa, but in this case had to do a lot of the organizing, recruiting, managing—and even the wiring—himself. His efforts were ultimately successful—and popular. The program is currently in its third semester.

Macko mobilized a number of key participants. Sprint and, later, Adelphia, donated high-speed lines to the high school. Eugene Sullivan of the University's Office of Telemedicine agreed to convert the ISDN connection to an IP signal. And Stephen Jennings at publisher Brooks-Cole provided textbooks to Albemarle teachers and students. In addition, Tom Hale, a member of the University's Information Technology and Communication group, helped iron out glitches (and string wire across the ceiling of the classroom, along with Macko and his son, Nikolas), while Hale's colleague Lela Marshall installed a special phone in the class so that audio could still be broadcast even when the video signal failed.

As a result of these efforts, Albemarle High School students now regularly make a virtual appearance on monitors in the back of Faulkner's classroom (which has been shifted from Cabell to Clark Hall to take advantage of its network-ready wiring), and Macko is currently talking to the Albemarle County School Board about expanding the program.



In the process of tracking the relationship between apparent temperature and mortality statistics, Bob Davis demonstrated the potential value of bioclimatology to epidemiologists.

Benefiting from the Medical Perspective

Physicians quite naturally have a nuanced view of mortality and morbidity figures but take a rather simple view of the weather. On the other hand, statistical bioclimatologists understand the complex range of variables that determine the impact of synoptic-scale weather events on such environmental parameters as air quality and visibility but tend to view morbidity and mortality rates as simple variables.

Associate Professor Bob Davis, who studies the effects of weather on human health, is in an ideal position to begin to bridge this gap. He has published a series of papers on the relationship of heat, the primary weather-related cause of death in the United States, to mortality.

The more involved he has become in this research, the more he has understood that his work required a more nuanced approach to mortality and morbidity. Davis notes, for instance, that epidemiologists have developed methods to adjust mortality and morbidity statistics to account for changes in underlying demographics. If you have 50 years of statistics for a particular location, your analysis of this data should ideally take into account changes in the age of the population.

To build his expertise, Davis spent part of his sabbatical this year taking a course on biostatistics taught by a professor in the medical school's Department of Health Evaluation Sciences and has been consulting with Health Evaluation Sciences faculty Wendy Novicoff and Viktor Bovberg on how to reach a medical audience. They have evidently been successful. His upcoming paper, "Changing Heat-Related Mortality in the United States," will be published by *Environmental Health Perspectives*.

Davis's immersion in the world of epidemiologists has highlighted not just the differences in perspectives between environmental and medical researchers. He has found that in their ability to handle large data sets and their statistical methods, they speak the same language—setting the stage for mutually benefiting and mutually satisfying collaborations.

Collaborations with Other Institutions

Extending Our Reach

Issues in environmental sciences are highly complex. They can sweep across disciplinary borders and embrace a variety of temporal and spatial scales. Addressing them requires our faculty to form partnerships with colleagues at other institutions and, in the process, participate in a fluid matrix of institutions around the globe dedicated to demystifying our environment.

With Scientists Worldwide to Create a Nitrogen Strategy

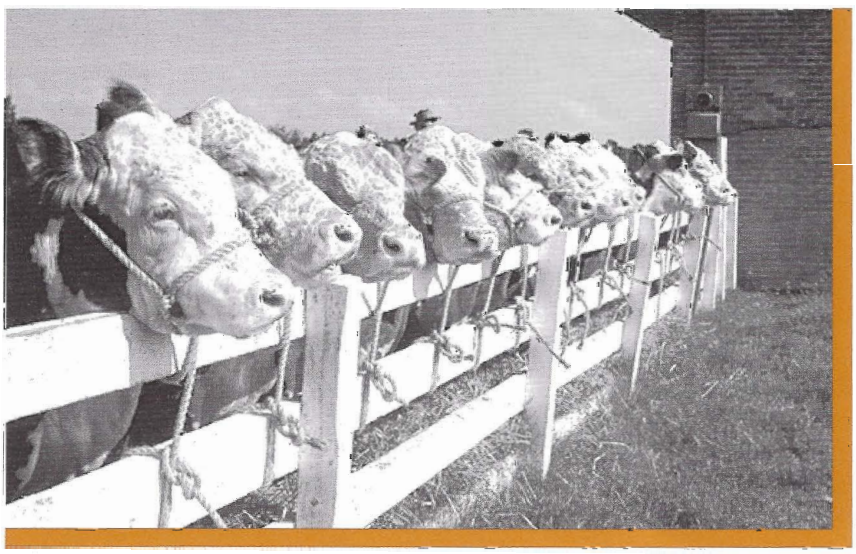
Nitrogen is one of the five major chemical elements that are necessary for life. Although nitrogen is the most abundant of these, it exists mostly as molecular nitrogen, a chemical form that is not usable by most organisms. In the prehuman world, a small amount of usable reactive nitrogen was created by lightning and biological nitrogen fixing, but the spread of these substances was held in check by natural denitrification processes.

This is no longer the case. Human beings have dramatically altered the nitrogen balance, breaking into the vast reservoir of molecular nitrogen and releasing reactive forms into the environment. We have done so by cultivating legumes, rice, and other crops that promote nitrogen fixing, by burning fossil fuels, and by transforming nonreactive atmospheric nitrogen to fertilizer to sustain food production.

As Professor Jim Galloway points out, this reactive nitrogen can cascade through a variety of environmental systems, damaging them significantly and exacting a toll on human health. Reactive nitrogen is implicated in the high concentration of ozone in the lower atmosphere, the eutrophication of coastal ecosystems, the acidification of forests, soils, and freshwater streams and lakes, and losses of biodiversity. In the form of nitrous oxide, a greenhouse gas, nitrogen contributes to global warming and stratospheric ozone depletion.

Galloway is leading a global effort to optimize nitrogen's beneficial role in sustainable food production and to minimize nitrogen's negative effects on human health and the environment. As the chair of the International Nitrogen Initiative (INI), he steers a worldwide consortium that is pursuing a multistage strategy combining global and regional initiatives.

With sponsorship from the Scientific Committee on Problems of the Environment and the International Geosphere-Biosphere Program, among other agencies, the INI is moving forward rapidly. In 2004, workshops will be held in Kampala, Uganda, and Woods Hole, Massachusetts, on efficient fertilizer use and denitrification, and the year will end with the Third International Nitrogen Conference in Nanjing, China.



As chair of the International Nitrogen Initiative, Jim Galloway is seeking ways to manage the amounts of reactive nitrogen released into the environment.

Undergraduate Laura Cacho and Deborah Lawrence found the La Selva Biological Research Station in Costa Rica an ideal location for collaborative research.

With Researchers at the La Selva Biological Research Station

Assistant Professor Deborah Lawrence specializes in the effects of land-use change, specifically forest conversion, on nutrient cycling in tropical forests. For someone with her interests, La Selva Biological Research Station in Costa Rica is about as close as you can get to research heaven.

At La Selva, she has the right mix of tropical forest and disturbed lands to work with. Approximately two-thirds of La Selva's 3,900 acres is species-rich old-growth forest, while the remainder of the reserve is abandoned pastures and plantations in various stages of secondary succession or experimental usage.

It is also a great place to meet people and exchange ideas. La Selva is owned by the Organization for Tropical Studies, a nonprofit consortium of 64 universities and research institutions from the United States, Costa Rica, Australia, Canada, Mexico, Peru, and South Africa—and has become one of the most important sites in the world for research on tropical rain forests. As Lawrence says, at La Selva you can routinely lunch with some of the best tropical ecologists and biologists in the world.

Lawrence, an ecosystem ecologist, is collaborating with several of these researchers. She is working with Robin Chazdon, a physiological ecologist at the University of Connecticut, on the Bosques Project at La Selva. Together, they are focusing on the regenerative processes in secondary growth forests and in particular on the effect of biodiversity on nutrient cycling with potential feedbacks on future species composition and forest recovery. U.Va. students Tana Wood, Keya Chatterjee, and Laura Cacho are participating as well.

Lawrence is also collaborating with Deborah Clark of the University of Missouri–Saint Louis on carbon uptake in old-growth tropical forests. Clark, who is in residence at La Selva, is studying the response of carbon stocks to variation in climate and soils. Lawrence is contributing her expertise in nutrient cycling to explore how soil fertility affects carbon uptake, sequestration, and losses. She also adds perspective by comparing processes in secondary and old-growth forests to develop a more accurate overall picture of the factors controlling forest productivity.

With Researchers at the Jornada Basin LTER

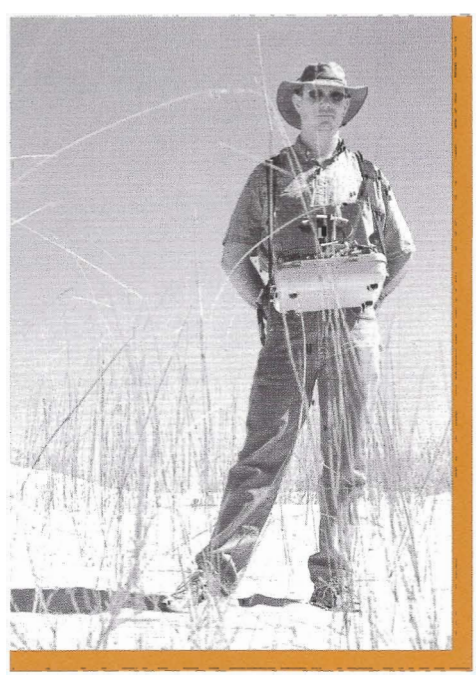
One of the striking features of desertification is the change in the distribution of soil nutrients. In semiarid grasslands, those nutrients are distributed almost evenly, but as the landscape changes, the distribution of soil resources begins to fragment—and as it does the vegetation changes as well. The desert shrubs that replace the lost grasses only accelerate this fragmentation, creating islands of fertility as soil resources are lost from adjacent spaces.

Assistant Professor Greg Okin focuses on the role of wind in this process, and it's what has led him to undertake a number of studies at the Jornada Basin Long-Term Ecological Research Station in southern New Mexico. It's an ideal site for Okin's research because over the last 100 years, large areas of black grama grassland have been replaced by shrubland communities dominated by creosotebush, mesquite, and tarbush.

In collaboration with Howie Epstein, he is examining the effects of vegetative cover on wind erosion. They are measuring the dust coming off plots ranging from grasslands to bare soil as well as its deposition downwind. They hope to learn more about the relationship of erosion and deposition to the spatial arrangements of the plants and nutrients on each plot.

On a slightly larger scale, Okin has examined the long streets of bare soil that frequently characterize mesquite shrublands. These streets are aligned with the prevailing wind, and he has found that they play a significant role in the depletion of soil nutrients as well as account for elevated dust emissions from these environments.

And finally, Okin is interested in the effect of vegetative change in arid and semiarid regions on the global transport of dust and the worldwide redistribution of nutrients. In particular, he is studying the influence of desert dust on the biogeochemistry of phosphorus in terrestrial ecosystems.



Greg Okin focuses on the role of the wind in the redistribution of soil nutrients during desertification.

With Citizens and Government Officials in Virginia

Thanks to a persistent trough in the jet stream over the Northeast, it has been a particularly rainy year in Virginia—and a busy one for Pat Michaels, research professor and state climatologist. Even in an age of information technology and advanced communications, so much depends on the weather. Accordingly, this year Michaels fielded calls from university administrators wanting to know if they should hold graduation outdoors, farmers hoping to find a few dry days to cut hay, and contractors wondering if they were ever going to get their heavy equipment out of the mud and their projects back on schedule.

But even in typical years, Michaels receives some 3,000 requests a year—from lawyers who want to know if weather conditions contributing to an accident are so unusual they could be considered an act of God and from engineers who want to know how deep to set a water pipe or how much snow their roofs might bear.

Michaels also addresses the need for information by posting weather advisories and collecting comprehensive series of weather links at the Virginia State Climatology Office Web site (http://climate.virginia.edu/). Here browsers can check the forecast for their locality or track rainfall from Hurricane Isabel at the National Weather Services Climate Prediction Center.

In addition, he is working to improve the quality of information available to Virginians. He is about to embark on an interdisciplinary project to create a high-resolution moisture monitoring system for Virginia and the Mid-Atlantic region. In cooperation with Virginia's Department of Environmental Quality, he hopes to develop a Web-based program capable of delivering data with a resolution of one square mile, providing a more efficient way for planners and government officials to allocate resources.

When a persistent trough in the jet stream led to an unusually wet year in Virginia, State Climatologist Pat Michaels found his services in high demand.

Jenny Moody's analysis of physical boundary layer characteristics is essential to our understanding of the interaction of sunlight, nitrogen oxides, and volatile organic compounds.

With Atmospheric Chemists at the University of Michigan Biological Station

Research Associate Professor Jennie Moody is a proponent of interdisciplinary work. As a meteorologist, Moody often works side by side with atmospheric chemists. In the Program for Research on Oxidants: Photochemistry, Emissions, and Transport (PROPHET), at the University of Michigan Biological Station (UMBS), she has seen how their work has been complementary, helping them together gain a more definitive understanding of the interactions among sunlight, nitrogen oxides, and volatile organic compounds that result in the formation of ozone and other oxidants.

Although the environment of UMBS, on the shores of Douglas Lake, at the upper end of Michigan's Lower Peninsula, is relatively pristine, it is periodically subjected to masses of dirty air being carried north from cities like Chicago and Milwaukee. Moody and her students model this transport, and have developed a chemical climatology for the site.

But to fully appreciate the chemical interactions between the smoggy air and air above the northern forests, you have to understand the physical boundary layer dynamics that bring them in contact. Deploying a wind profiler on loan from the National Center for Atmospheric Research, Moody and her colleagues made boundary layer observations continuously for two summers. Using this radar, which measures the refractive index of the atmosphere and, thus, identifies layers of different densities, Moody and graduate student Mark Lilly can trace the evolution of the boundary layer over the course of a day—as well as the conditions that affect its growth rate. This enables them to predict when dirty air will be drawn to the surface to interact with the atmosphere in the forest's canopy, giving rise to the kinds of chemical reactions their colleagues study.

Indeed, it is the physical setting that unifies the work of the many atmospheric chemists participating in PROPHET. As a result, Moody's work provides the glue that enables the team of researchers to develop a comprehensive overview of the complex processes at work.

Awards, Appointments, & Achievements

Undergraduate Students

Selected for the Distinguished Majors Program in 2003 were **Jennifer L. Andrews** and **Drew B. Gower.**

The department recognizes outstanding fourth-year students in each of the environmental sciences. This year, the Mahlon G. Kelly Prize in ecology went to **Kristin K. Brubaker,** the Wilbur A. Nelson Award in geology was given to **Noah E. Egge,** the Michael Garstang Atmospheric Sciences Award went to **D. Matthew Coleman,** and the Hydrology Award was presented to **Drew B. Gower.**

Drew B. Gower received the Joseph K. Roberts Award for presenting an exceptional undergraduate research paper at a national meeting. He also won the Departmental Interdisciplinary Award.

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 **Debra M. German.**

The honors for producing the best undergraduate poster at this year's Environmental Sciences Research Symposium went to **Evans T. Browne. Eric Losin** gave the best presentation by an undergraduate.

This year's Wallace-Poole Prize for the fourth-year student majoring in environmental sciences with the highest grade point average went to **Jennifer L. Cregar.**

Jessica S. Wenger 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

Nicole M. Kordziel was honored for producing the best poster by a master's student at this year's Environmental Sciences Research Symposium, while **Alexia M. Kelley, Katharina M. Ross, Anthony J. Wimmers,** and **Neil John** tied in the doctoral student category. **Ryan E. Emanuel** and **Thomas L. O'Halloran** were singled out for producing the best graduate presentation by master's students, and **Jeffrey G. Chanat** gave the best presentation by a doctoral student.

The department offers a series of awards honoring outstanding graduate students in each specialty in environmental sciences. This year **Holly S. Galavotti** earned the Graduate Award in Ecology, **Ryan E. Emanuel** won the Graduate Award in Hydrology, **Thomas L. O'Halloran** won the Graduate Award in Atmospheric Sciences, and **William P. Gilhooly III** won the Arthur A. Pagau Award in Geology. **Benjamin Cook** received the Robert Ellison Award for Interdisciplinary Studies.

In recognition of the quality of graduate work being done in the department, the American Meteorological Society (AMS) approved the formation of the Virginia Piedmont AMS Chapter. Interim officers include **Nicole M. Kordziel,** president; **Dan Carre,** vice president; **Lori D. McGuide,** treasurer, and **Thomas L. O'Halloran,** deputy secretary. Associate Professor **José D. Fuentes** serves as secretary.

Janna M. Levin won the department's Fred Holmsley Moore Teaching Award. She also received a graduate student research grant from the Geological Society of America.

Jordan Barr was awarded a NASA Earth Science Fellowship.

Courtenay Strong was awarded a graduate fellowship for work at the National Center for Atmospheric Research.

Thomas O'Halloran was awarded a NASA visiting summer fellowship.

This year, **Jordan G. Barr, Thomas A. Szuba,** and **Suzanne C. Walther** 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. **Thomas L. Kennedy** and **Thomas L. O'Halloran** won Departmental Research Awards, while **Diane K. Barnes, Ryan E. Emanuel, Holly S. Galavotti, Sanghoon Kang, Alexia M. Kelley, Nicola M. McGoff, Sujith Ravi, Laura K. Reynolds, Lydia Ries, Lynette K. Winters,** and **Tana E. Wood** received Exploratory Research Awards.

Joseph A. Krawczel won the Trout Unlimited Award, while the Chair's Award went to **Eric Bricker.**

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

Faculty

William Ruddiman has been elected a Fellow of the American Geophysical Union.

José Fuentes was made an associate editor of the *Journal of Geophysical Research—Atmospheres.*

Michael Bowers accepted a temporary appointment as program officer in the Division of Environmental Biology at the National Science Foundation. He also serves as the foundation's representative to the U.S. National Invasive Species Advisory Committee.

Climate Change Vital Graphics for Africa, a multimedia software program created by **Paul Desanker,** was distributed by the United Nations Environmental Programme to all African environment ministers in November 2002. Desanker was also elected vice-chair of the Expert Group on Adaptation of the United Nations Framework Convention on Climate Change for a term of two years.

Michael Erwin was selected to the National Science Panel for San Francisco Bay Salt Pond Restoration, one of the largest multiagency restorations in the West.

For lifetime contributions to the basic science of hydrology and/or unselfish service promoting cooperation in hydrologic research, **George N. Hornberger** was made the 2002 Langbein Lecturer by the American Geophysical Union.

William R. Emanuel received the 2002 Award for Excellence in a Team Activity from the Oak Ridge National Laboratory.

Scientific American named **Michael Mann** one of its 50 top visionaries in science in technology. He received Outstanding Scientific Paper honors in research from the Office of Oceanic and Atmospheric Research of the National Oceanic and Atmospheric Administration, while an article of his was selected by the Institute for Scientific Information as a top-cited paper. Articles by **Hank Shugart** and **Tom Smith** were also selected as top-cited papers.

Paolo D'Odorico was awarded one of the 2003 University of Virginia Teaching Fellowships.

Ralph Allen is a tour speaker for the American Chemical Society.

Robert E. Davis served a term as chair-elect of the University of Virginia Faculty Senate.

James N. Galloway received a number of awards and honors this year. He was elected a fellow of the American Association for the Advancement of Science. In addition, he was appointed to the Environmental Protection Agency Science Advisory Board and selected to chair the International Nitrogen Initiative, a joint project of the Scientific Committee on Problems of the Environment, and the International Geosphere-Biosphere Program. Galloway also received the Graduate Student Association Award.

Bruce Hayden and **Jay Zieman** were appointed by Governor Warner to Virginia Naturally, the Commonwealth's commission on environmental education.

Patrick J. Michaels was appointed by Governor Warner to the Drought Task Force. Michaels is a visiting scientist at the George C. Marshall Institute in Washington, D.C.

Aaron Mills received a Software Development and Release Award from NASA.

Robert J. Swap received the 2002 NASA Public Service Group Achievement Award for his SAFARI 2000 work. Swap earned the 2002 Fulbright Senior Specialist Award.

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