Environmental Sciences

AT THE UNIVERSITY OF VIRGINIA

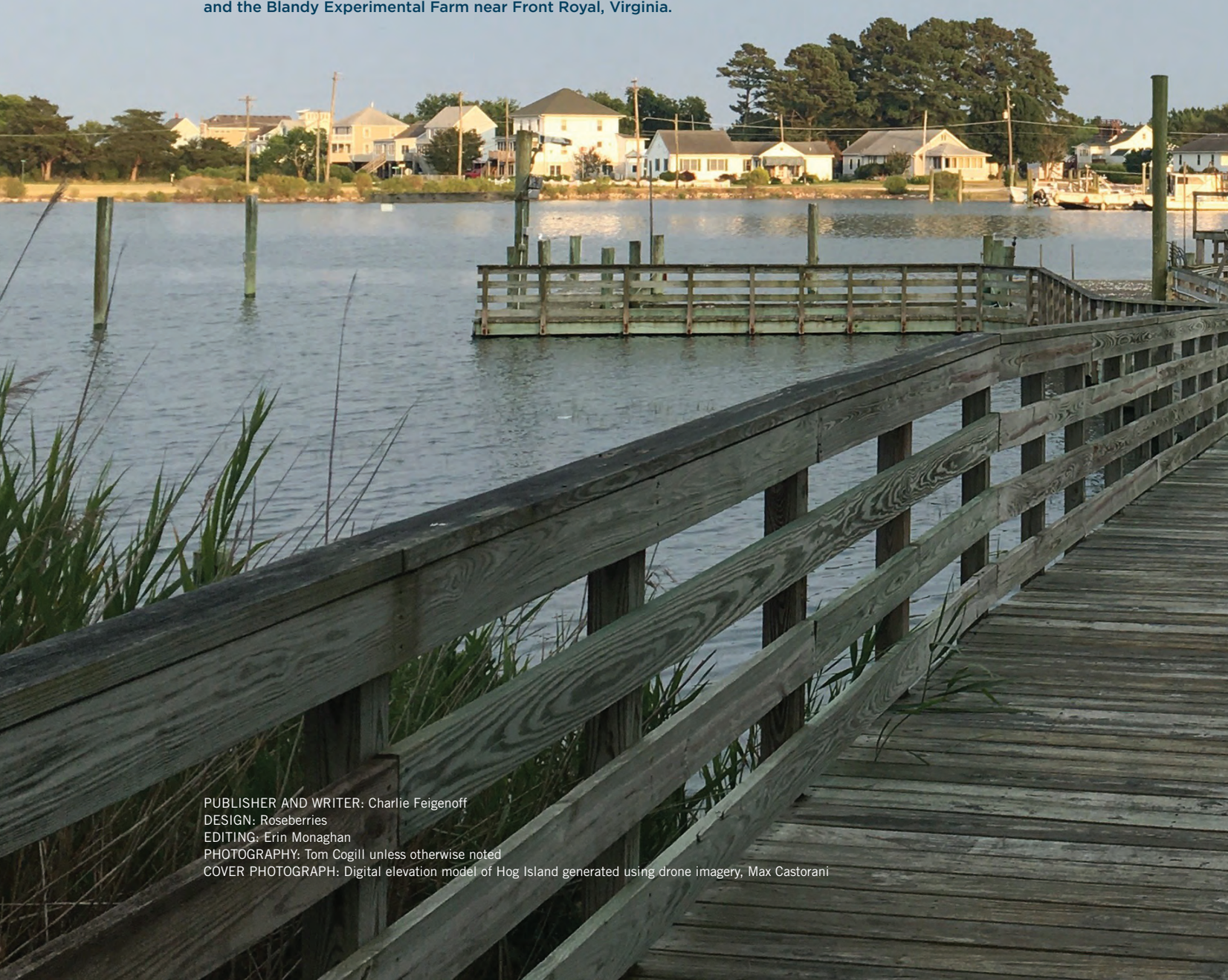
MAXIMIZING OUR IMPACT

2018–19 Annual Report

The Department of Environmental Sciences

Established in 1969, the University of Virginia's Department of Environmental Sciences was one of the first to look at fundamental environmental processes from a multidisciplinary perspective and the first in the nation to offer undergraduate, master's, and doctoral degrees in environmental sciences. Today, the faculty includes winners of the prestigious Tyler and Hutchinson awards as well as five professors who are among the most highly cited researchers in their fields.

Departmental field stations and facilities include the Anheuser-Busch Coastal Research Center in Oyster, Virginia, home of the National Science Foundation–sponsored Virginia Coast Reserve Long-Term Ecological Research program, the Virginia Forest Research Facility in nearby Fluvanna County, and the Blandy Experimental Farm near Front Royal, Virginia.



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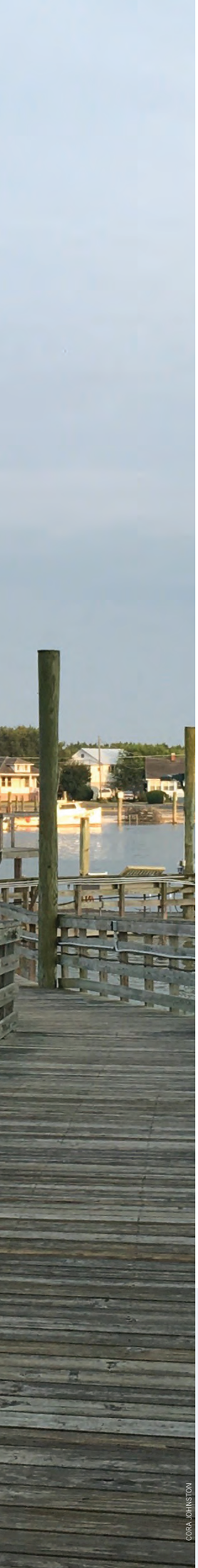
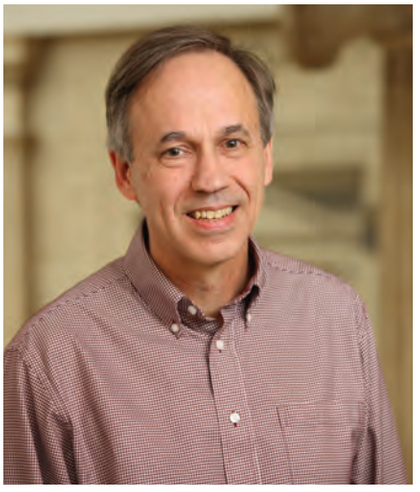


CORA JOHNSTON

FROM THE CHAIR



In the past, the work of environmental scientists was driven primarily by intellectual curiosity, by a desire to understand the natural systems that shape life on our planet. Today, we are also motivated by a desire to use that knowledge to limit the potentially disastrous consequences of climate change. It is not an exaggeration to say that environmental scientists—collaborating with government agencies, policy makers, community leaders, and experts from scores of other disciplines—will play a decisive role in determining how well our civilization withstands the tremendous forces that we have unleashed.

This department has dedicated itself to this effort. Over the last five years, we have added six new assistant professors and hired two chaired professors who rank among the most eminent in their fields. We have recruited an exceptional group of graduate students and are equipping them to play active roles, as researchers and professionals, in the response to climate change. And we have attracted scores of undergraduate majors, heightening their awareness of fragile ecosystems and preparing them to address the defining challenge of their generation.

In addition, faculty members are pushing our field stations to their limits, mounting ambitious research programs that shed light on the intersection of natural processes and climate change. And they are playing an active role in forging the kind of interdisciplinary coalitions, across the University and with colleagues at other institutions, needed to slow climate change and to increase resiliency.

As I hand my duties as chair to Howie Epstein, I can say that the members of this department, individually and collectively, feel deeply about the role of research and education in strengthening society's ability to confront the climate crisis.

We are doing much already. With your support, we will do even more.

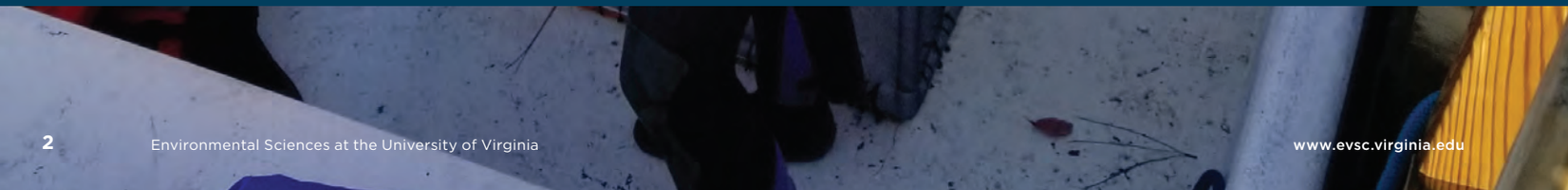
Michael L. Pace

Michael L. Pace, Chair

A WARM WELCOME

Howie Epstein, the new department chair, is a terrestrial ecologist. He recently won a grant from NASA to use Earth-observing satellite data to assess how vegetation diversity is changing in the Arctic tundra.

Anheuser-Busch Coastal Rese



Over the last 14 years, the Anheuser-Busch Coastal Research Center on Virginia's Eastern Shore has established itself as the preeminent place for scientists to study the barrier islands that line our coasts and the bays and wetlands behind them. It has become a center for education and outreach for students and teachers in local communities and throughout Virginia. And it is much in demand as a place where experts can join together to plan the next research campaign and to build coalitions to respond to climate change.

In 2006, the opening of the Anheuser-Busch Coastal Research Center on Virginia's Eastern Shore inaugurated a new era in environmental sciences at UVA. The $2.5 million facility has more than 9,400 square feet of wet and dry lab space, a 5,600-square-foot residence building with accommodations for 28 people, and a dock for shallow-water research vessels.

Equally important, the center has its own personnel who collect routine data, ensure that the wireless sensor network is up and running, maintain the center's boats, and handle scheduling and logistics for visiting researchers and students. It has become home base for scientists conducting research on The Nature Conservancy's Virginia Coast Reserve, a vast area that encompasses a string of 14 undeveloped barrier islands and the lagoons and tidal marshes behind them.

A RESEARCH CENTER AT CAPACITY

- During 2018, the ABCRC hosted faculty and students from **27 different institutions**.
- In July 2019 alone, ABCRC staff ran more than **90 boat trips** for researchers.
- Overnight guests totaled **2,300 person nights** during 2018.
- ABCRC's laboratories logged **339 lab use days** of the 350 days they were open in 2018.
- The VCR-LTER maintains **241 data sets** from the Virginia Coast Reserve. Since 2012, they have been downloaded more than **32,000 times**.

A HOME TO THE VIRGINIA COAST RESERVE LONG-TERM ECOLOGICAL RESEARCH

The bulk of this research is done under the auspices of the Virginia Coast Reserve Long-Term Ecological Research (VCR-LTER) project, part of a National Science Foundation-funded network of 28 sites in the United States, the South Pacific, Antarctica, and Puerto Rico designed to illuminate how representative ecosystems evolve over time. Thanks in part to the level of research that the ABCRC sustains, the NSF has funded the department's proposals to administer the VCR-LTER seven times since its inception more than 30 years ago. Each year, researchers from more than 15 institutions in six states conduct research as part of the VCR-LTER program.

"It is the wildest stretch of coastline along the Atlantic and Gulf coasts and is an iconic system for understanding coastal change," says Professor **Karen McGlathery**, director of the VCR-LTER. "The facilities at the Coastal Research Center are critical to the success of the VCR-LTER program. We can stay on site to do fieldwork, process samples in the lab, and discuss our results over dinner on the deck. This dynamic of faculty, students, and staff sharing the same space leads to cross-disciplinary breakthroughs in our knowledge of coastal processes."

Indeed, the VCR-LTER has compiled an impressive record. To cite just two examples, VCR-LTER scientists have collaborated in the most successful seagrass restoration effort in the world. The seagrass, which serve as the foundation species for a highly productive ecosystem, was wiped out by a combination of disease and hurricane activity in the 1930s. The benefits of restoring these beds, which include carbon sequestration, enhancing biodiversity, and improving water quality, also extend to the regional economy.

In addition, researchers have determined the variables that impact the ability of coastal marshes to keep pace with sea-level rise. These tidal marshes play a vital ecological role in coastal landscapes, acting as a filter for pollutants from the land and a buffer against increasingly damaging coastal storms.

In the course of decades of research, ABCRC staff and VCR-LTER researchers have compiled 241 different data sets, some going back more than 100 years, that represent a wide range of observations. "These data sets—many of which are one of a kind—are an important reason that the ABCRC is in demand as a research site," says **John Porter**, the VCR-LTER's information manager. "Being able to draw on existing data sets makes it possible for researchers to embark on projects that would have been impractical otherwise."

The ABCRC's fleet of four vessels is the mainstay of its education and research programs.

arch Center

A FOCAL POINT FOR COASTAL RESEARCH AND RESILIENCE

A CENTER FOR IDEAS AND ACTION

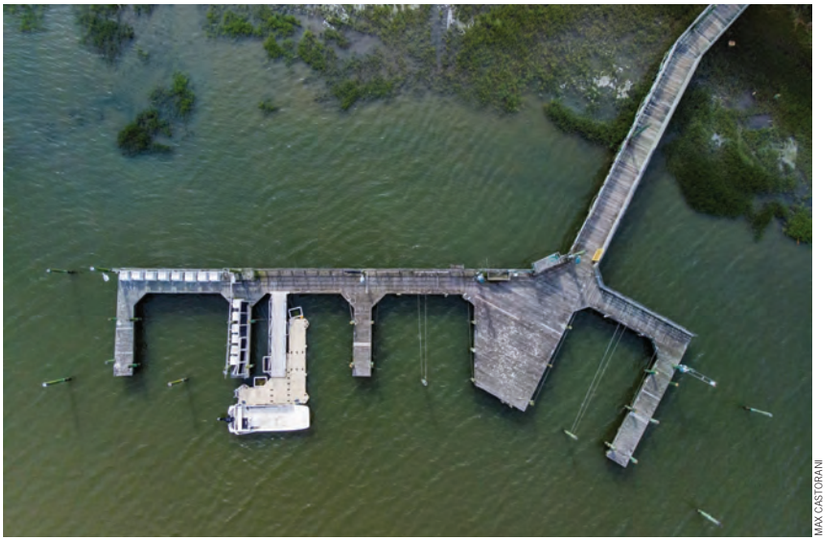
In addition, the VCR-LTER, in conjunction with the ABCRC, hosts a variety of educational initiatives. It accommodates overnight classes from UVA and other universities when space

DAVID LEE

is available, supports six undergraduate interns participating in UVA's Research Experiences for Undergraduates program, and organizes a number of professional development programs for area teachers, including several in partnership with The Nature Conservancy.

The ABCRC is also the site of a number of cross-disciplinary initiatives. Perhaps the most innovative is the Coastal Futures Conservatory, which brings together faculty from the arts and humanities with environmental scientists to find more visceral ways to deepen public understanding of coastal change and to highlight the role of the arts in promoting community resilience.

The value of the ABCRC has only increased in the years since it opened as communities along the East Coast grapple with the consequences of climate change and the acceleration of sea-level rise and as its extraordinary research infrastructure become better known. The demand for its facilities is no longer confined to researchers and coalitions of researchers, but now include government agencies and nonprofits. Unfortunately, the ABCRC has had to turn many of these groups away. In addition, heavy dormitory use by researchers has made it increasingly difficult to schedule all but the smallest overnight classes. "This is a missed opportunity for UVA to assume a leadership role in orchestrating the response to climate change," says ABCRC site director **Cora Johnston**. "In a way, we are victims of our own success. Our aspirations are constrained only by our capacity."



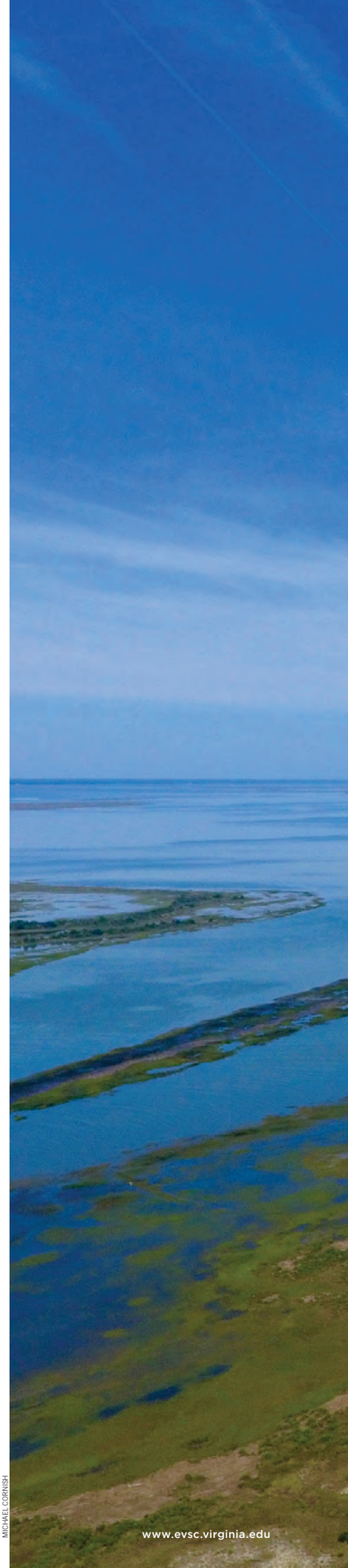
MAX CASTORANI

CONNECTING CLIMATE CHANGE, VEGETATION, AND BARRIER ISLAND TOPOGRAPHY

The research that Assistant Professor **Max Castorani** conducts epitomizes the collaborative ventures that the ABCRC nurtures. Castorani, a coastal marine ecologist, has joined forces with Assistant Professor Julie Zinnert, a vegetation ecologist at Virginia Commonwealth University, and Associate Professor Laura Moore, an expert in coastal geomorphology at the University of North Carolina at Chapel Hill. Together, they are connecting changes in vegetation patterns on Virginia's barrier islands with shifting island topography in the face of climate change and sea-level rise.

"In general, we are seeing trees and grasses replaced by shrubs," he says. "We are trying to determine if coastal storms are promoting this change and whether the transition, in turn, increases an island's vulnerability to erosion."

Castorani is using drones to create three-dimensional maps of the barrier islands, providing precise measurements of its topography as well as the distribution of plant species. The researchers are using this technology to complement measurements taken on the ground by Zinnert and Moore. "This project highlights the value of the ABCRC as an incubator for research," Castorani says. "The idea grew from discussions we had at the VCR-LTER All Scientists Meeting, held each year at the ABCRC."



MICHAEL CORNISH

Virginia Forest Research Facility

A UNIQUE SITE IN A REPRESENTATIVE FOREST

The Virginia Forest Research Facility has the right mix of characteristics to make it an ideal site to study the interaction of atmosphere and vegetation. It is remote, but not too remote, undeveloped but on the grid. As a result, its 40-meter tower is one of the most productive in the country.

The Virginia Forest Research Facility (VFRF) has a number of advantages that distinguish it from similar sites. Most arise from its location, just a 45-minute drive from the University. Researchers can deploy sensitive measuring devices on its 40-meter tower that depend on regular maintenance to function properly. They also can depend on a reliable source of electricity and an Internet connection.

"We have a much broader range of instruments than is typical for towers at more remote sites, and we are able to maintain unbroken records over longer periods of time," says Assistant Professor **Sally Pusede**. "As a result, we have the opportunity to generate the kind of complementary data sets that are particularly useful for analyzing changes in atmospheric composition, where the chemistry is complicated, nonlinear, and variable."

Another advantage is that it has been shaped by human activity. The VFRF is in the midst of a second-growth, mixed-deciduous forest that typifies the Piedmont region along the eastern slope of the Appalachians. At the same time, it is close enough to cities and other population centers so that the atmosphere reflects human activity. This makes the VFRF an ideal setting for analyzing the human impact on biological processes.

Its unique qualities as a research site, in turn, makes the VFRF is an excellent locale for training students. One vision for its future would be to add facilities to better accommodate undergraduate classes, increase its power supply to support even greater instrumentation, and make it more available to a broader community of researchers.

"Atmospheric scientists from a variety of research institutions often come together at a site for an intensive research campaign lasting a month or more," Pusede says. "We would like to create the infrastructure to do that."

Todd Scanlon, Manuel Lerdau, Sally Pusede, and Xi Yang are among the faculty conducting research at the Virginia Forest Research Facility.

NSF GRANT: UNDERSTANDING OZONE-ECOSYSTEMS CONTROLS AND FEEDBACK

Ground-level ozone is a dangerous air pollutant responsible for more than 1 million premature deaths due to respiratory disease and one that, by damaging vegetation, undermines the ability of plants to absorb carbon dioxide, a major driver of climate change. "Ozone has been studied for decades," Pusede says, "but there is still a lot we don't know about the ways in which the biosphere controls ozone loss in the atmosphere. This is important because plants remove the vast majority of ground-level ozone."

Collaborating with Gabriel Isaacman-Van Wertz, an assistant professor of Environmental and Water Resources Engineering at Virginia Tech, Pusede has secured a grant from the National Science Foundation to help understand the complex interactions between ozone and plants, some of which affect ozone concentrations. The project draws on measurements made at the 40-meter tower at the Virginia Forest Research Facility (VFRF).

Plants remove ozone from the atmosphere in a number of ways. They directly take up ozone through openings—the stomata—in their leaves. They also emit reactive volatile organic compounds that react with ozone within the forest canopy. Understanding these processes—and the feedback loops between them—requires a team of researchers with complementary skills. In addition to Pusede, UVA co-principal investigators on the project are Professor **Manuel Lerdau**, Associate Professor **Todd Scanlon**, and Assistant Professor **Xi Yang**.

SALLY PUSEDE: ATMOSPHERIC CHEMIST

To establish the base level of ozone activity, Pusede is measuring the flux—the net exchange rate—of ozone between the atmosphere and the biosphere using a technique called eddy covariance. She will also be tracking the flux of the various oxides of nitrogen, which determine whether the ozone-volatile organic compound reactions consume or produce ozone.

TODD SCANLON: HYDROLOGIST

In photosynthesis, carbon dioxide is taken in through the pores, or stomata, in a leaf, and water vapor is released through these stomata. One way to determine the impact of ozone on the health of a forest is to determine this process at the canopy level. Scanlon has developed techniques to track how much of the carbon dioxide flow into the leaves is consumed by photosynthesis and to distinguish the portion of water vapor in the canopy released from the leaves from that evaporated from the forest floor.

XI YANG: LANDSCAPE ECOLOGIST

Several years ago, Xi Yang was among the group of researchers who discovered that spectrometers aboard satellites were detecting faint fluorescence caused by photons emitted as a by-product of photosynthesis. Yang is using a specially designed detector on the tower to measure solar-induced fluorescence in the forest canopy, providing another way to create a baseline for correlating ozone with photosynthesis and plant health.

MANUEL LERDAU: ORGANISMAL ECOLOGIST

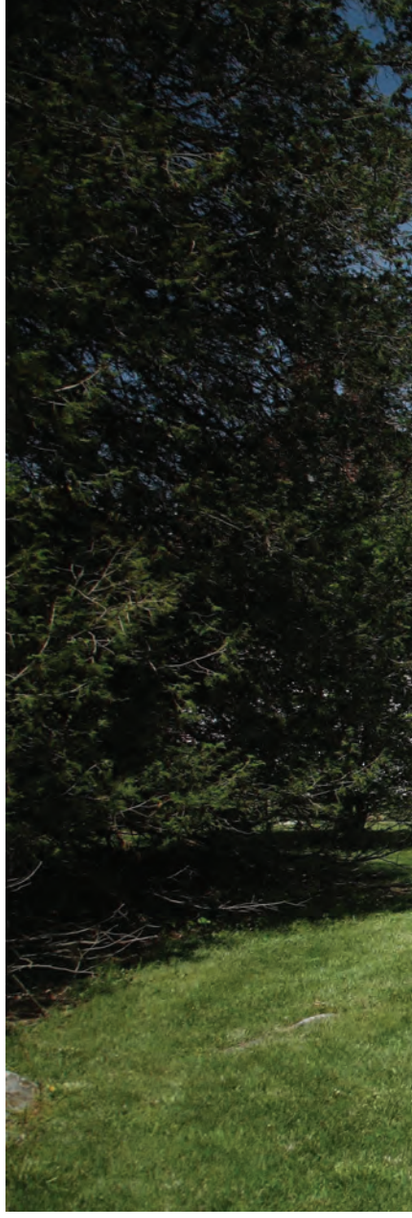
Pusede, Scanlon, and Yang are making measurements on the canopy scale. By contrast, Manuel Lerdau, working with Pusede, is trying to determine what happens within a leaf, multiplied millions of times over, that might account for their findings. The rate at which ozone enters a leaf is determined both by the size of the stomata and by the rate at which ozone is metabolized within the leaf. Lerdau has devised an experimental method to separate these two phenomena, a task made more complex by evidence that ozone itself affects stomatal openness.

HUGH KALERGIS

Thanks to systematic efforts to upgrade its facilities, Blandy Experimental Farm has come into its own as the ideal site to study the mixed ecosystems that characterize so many rural areas in the Mid-Atlantic.

Blandy Experimental Farm

AT THE RURAL INTERFACE



It took the University of Virginia almost 60 years to figure out what to do with Blandy Experimental Farm. In 1926, Graham Blandy, a New York stockbroker and railroad tycoon, left 700 acres of his Clarke County estate along with a substantial endowment to the University to educate boys "in the various branches" of farming.

Farming is the purview of Virginia Tech not UVA, but the University did its best to work within Blandy's bequest. For forty years, the Department of Biology housed its graduate plant genetics program at Blandy, determining relationships among plants from around the world by studying their chromsomes. By the mid-1960s, however, the department had shifted its focus to cell and molecular biology—and the Blandy was effectively mothballed.

Edward Connor, an assistant professor of environmental sciences, led the revival of Blandy in the 1980s. Connor realized that the very factors that made Blandy an anomaly for the University—its agricultural setting—would make it a unique location for environmental research.

"Unlike field stations in pristine environments, Blandy's mix of active and fallow fields and second-growth forest typifies much of the rural landscape in the Mid-Atlantic," says Research Professor **Dave Carr**, Blandy's director. "Connor realized that it is an ideal place to gain a better understanding of the regional effects of land use, particularly related to expected increases in rates of urbanization and resulting changes in biodiversity, biogeochemistry, and infectious and invasive species."

Connor secured the University's commitment to adopt it as an ecological field station under the auspices of the Department of Environmental Sciences and set out to reconceptualize Blandy. As director, Connor hired two full-time scientists, and together they revived the graduate program, secured its first NSF grant to foster research experiences for undergraduates, recruited Blandy's first educational director, and convinced the Commonwealth of Virginia to designate its plant collections as the State Arboretum.

"Blandy's reason for being is its representative ecology."

A VALUED RESOURCE FOR RESEARCH AND EDUCATION

Subsequent directors built on Connor's foundation, and today Blandy Experimental Farm is the site of vibrant research and educational programs that have attracted hundreds of scientists and students from around the country. During the summer research season, there are as many as 30 researchers in residence. "Blandy's reason for being is its representative ecology," Carr says, "but it is successful as a field station because of the facilities and the programs we've put in place that make the most of its location."

Over the last decade, Blandy has seen the construction of a comfortable, well-equipped 4,000-square-foot laboratory with a LEED Silver rating from the U.S. Green Building Council and a multibay, 2,000-square-foot greenhouse to replace one from 1941. At the same time, it has built additional cottages for senior faculty staying for several weeks and renovated a three-bedroom cottage as short-term faculty housing. Graduate students live in a renovated Victorian house on grounds while undergraduates are housed in the Quarters, originally built in the 1820s for enslaved people.

At the same time, Blandy is the scene of numerous outreach programs during the year. It has an extensive pre-K–12 program that features hands-on observation and experimentation for students and a range of professional development programs for teachers. In addition, the Foundation of the State Arboretum of Virginia hosts a variety of walks and presentations while Blandy's book, photo, and sketch clubs hold regular meetings.

"The old adage—if you build it, they will come—has certainly applied to Blandy," Carr observes. "Just eight years after we opened the new lab, it is often at capacity." In coming years, Carr would like to see Blandy add a new wing to the laboratory and create the classroom space needed to bring back undergraduate courses to the field station. "The environment we have at Blandy is increasingly the one we live in," he says. "It's more important than ever to understand it."

Undergraduates conducting research at Blandy Experimental Farm stay in the Quarters, originally built in the 1820s for enslaved people.

UNDERSTANDING HOW PESTICIDES SPREAD

Neonicotinoids are one of the most widely used pesticides in the United States. They are applied to about 95 percent of the corn and canola crops, the majority of cotton, sorghum, and sugar beets, and about half of all soybeans. And while neonicotinoids are less toxic to vertebrates than previous generations of pesticides, they do have serious drawbacks. They have a tendency to leach into the general environment and have been implicated in the decline of pollinators like honeybees.

Associate Professor **T'ai Roulston**, the curator of the State Arboretum of Virginia, has teamed up with colleagues at Virginia Tech to determine the extent and the effect of nicotinoid dispersal from neonicotinoid-treated corn into the environment. They will analyze water at the edge of the cultivated field for traces of pesticide, take tissues from neighboring vegetation to determine how much pesticide they have taken up, and measure its effect on the insects and pollinators that preferentially feed on them.

"We are trying to gain insight at each stage of this process," Roulston says. The U.S. Department of Agriculture is funding the project.

The experiment will be conducted during the 2020 growing season. In the meantime, Roulston and graduate student Emily Spindler are raising milkweed and several other plant species in the Blandy greenhouse to be added to meadows around the test plots. "We want to make sure that the surrounding areas have plants that we know are attractive to insects of interest," he says. "We are growing milkweed, for instance, because monarch butterfly caterpillars feed on it."

Roulston and Spindler are also creating a toxicity reference scale in the greenhouse by separating plants into groups, establishing different neonicotinoid levels in each one, and isolating them from each other. He will release insects and pollinators in each of these confined areas and note whether they survive. "It would have been impossible to conduct an experiment that required this kind of precision in the old greenhouse," he says. "Having the new greenhouse was a game changer for us."

Graduate Students

Our graduate students often follow very different paths to the department—and bring with them unique expectations and aspirations. Even as we train them to be scientists, our task as educators is to recognize their individuality, challenge them to realize their potential, and help them find a career in environmental sciences that is meaningful to them.

YI WANG

ZEROING IN ON A CAREER IN MARINE BIOLOGY

Some graduate students arrive at the department with definite career goals and understand the steps necessary to achieve them. Others take a more exploratory approach, trying different fields or, like **Kelcy Kent**, discovering that attaining their aspirations was not as simple as they thought. In these circumstances, they can count on UVA faculty to help guide them through these shifts.

"The department is very supportive of students who rethink their goals," Kent says. "I think some of this flexibility comes from the interdisciplinary nature of the department, but the rest is due to the department's culture. People here are not just helpful. They enjoy being helpful."

Kent should know. She holds a bachelor's in biology and master's in environmental sciences from UVA and is on her way to earning her doctorate here. Her graduate career, however, has been anything but straightforward.

This is not because she has lost the passion for marine biology she brought with her as a first-year student. "I find the beauty and mystery of the oceans as compelling as ever," she says. "It is exciting to me as a scientist that there is so much yet to be explored."

Initially, Kent thought she would earn a master's and then find a job. With the guidance of the late Professor Jay Zieman, she examined mangrove forests along the Gulf Coast to determine if they maintain their genetic diversity as they migrate northward with sea-level rise and increasingly warm winters. The fate of mangroves is important because they provide a variety of ecosystem services, protecting the coastline, supporting fisheries, and serving as a carbon sink. Scientist worried that if only select populations succeeded in adapting, they might become inbred and more susceptible to disease; and if they adapted well enough to firmly expand northward into temperate coastlines, they will be in direct competition with historic salt marsh ecosystems and may drastically alter the coastline and fisheries in years to come. "We found that because of their long-distance seed dispersal mechanisms, new mangrove forests are surprisingly genetically diverse and very robust," she says.

After initially studying mangrove forest genetics, Kelcy Kent has successfully shifted her focus to polar marine biology.

Kent decided to continue on for a doctorate after reading a job listing from the Smithsonian Institution for a researcher who could develop genetic markers to test for diversity in mangroves and other coastal marine environments. "It was the perfect job for me, but it was out of reach," she said. "I had all the credentials except for a doctorate."

Zieman's death, however, meant attaining an academic career studying mangrove genetics at UVA was no longer a viable option. Her new advisor, Professor **Howie Epstein**, provided another path by inviting her to join his research team studying the effects of permafrost thaw in Alaska. "He added an aquatic component to the project just to accommodate my interests, showing how much he wanted to help me do something I deeply care about," Kent says. Epstein paired her with his new arctic marine post-doctoral scientist, Claire Griffin, who is helping her transition from the molecular ecology and microbiology required for her mangrove study to the biogeochemistry needed to study the dynamics of the melting permafrost.

Thanks to this support, Kent now is focusing on a career in polar marine biology. "Climate change is having an outsized effect on polar seas, but because it is so difficult to access and study such areas, there is a lot we don't know, which is most exciting of all," she says.

A FRESH START IN ATMOSPHERIC SCIENCE

As a child, **Daniel Schmidt** was fascinated by the environment, stimulated in part by family trips to Colorado and the Grand Canyon. But when he enrolled in college, his interests shifted to mathematics, and he eventually completed a doctorate at Virginia Tech in mathematical physics. "My work was fascinating, but I realized that it was not what I wanted to be doing long term," Schmidt says. "I decided I wanted to return to my earlier love of earth sciences."

For Schmidt, this meant securing a second doctorate. As he reviewed potential graduate programs, the work of Assistant Professor **Kevin Grise** caught his eye. An atmospheric scientist, Grise combines observational data sets and climate models to explore large-scale atmospheric dynamics and determine the impact on them of climate change. "I had always been intrigued by the circulation of the air on a global scale," Schmidt says. "The complexity of atmospheric systems appealed to me."

With Grise's guidance, Schmidt has been studying the mechanisms that, under the influence of a warming climate, could cause the middle latitudes to become increasingly arid. He focuses on atmospheric circulation patterns known as Hadley cells, which ring the globe north and south of the equator. In these cells, heated air at the equator loses its moisture as it rises, producing the rain that drenches the tropics. This air moves poleward and sinks at around 30° latitude, drying the landscape beneath it and creating many of the world's deserts. Both computer models and observations suggest that as the Earth warms, the leading edge of the Hadley cells should move even closer toward the poles, increasing the likelihood of drought in highly productive agricultural areas.

In the course of his research, Schmidt found that the results were more nuanced. The drying associated with Hadley cell expansion is stronger over oceans and its effect on land is uneven, suggesting to him that he should include regional phenomena in his analysis. During the summer, dry air descending over the oceans creates semipermanent high-pressure zones. In climate change simulations, these high-pressure zones shifted. For instance, the North Atlantic Subtropical High shifted westward to the continent and had a greater influence on summer precipitation than Hadley cells. Schmidt is using the last year of his program to see if he can determine the combination of forces that account for this shift.

In the meantime, Grise is helping him develop professionally, sending him to conferences to share his research and build a network of colleagues at other institutions. Schmidt's goal is to secure a post-doctoral fellowship and eventually an academic appointment that combines research and teaching. "I think I will be able to look back after graduation and say I have had a productive five years," he says. "I've followed an unusual career path, but I'm really glad I came here."

JEREMY SIPANTZI

Motivated by his fascination with global air circulation, Daniel Schmidt decided to pursue an additional doctorate.

The environmental sciences are not subjects that can be mastered in the classroom. It takes hours gathering data, conducting experiments, and modeling results for students to understand the challenges and rewards of scientific investigation. As a result, one of the principal responsibilities of our faculty is to connect undergraduates with opportunities to immerse themselves in meaningful research while helping them understand the broader significance of their work.

Talented Undergraduate

ANNE ELIZABETH HEYSE

Katharine Schlachter is sampling microplastic pollution as part of the decadal analysis being conducted by the Shenandoah Watershed Study.

FINDING A HOME IN ENVIRONMENTAL SCIENCES

When **Katharine Schlachter** arrived at the University, she had a passion for marine ecology and conservation that went back to her childhood. When she was six, her grandmother gave her a subscription to *National Geographic*, and one of the first articles that she remembers seeing was about overfishing and its terrible impact on marine ecosystems. "It really broke my heart," she recalls. "It affected me so much that I gave up eating seafood."

But it was not foreordained that Schlachter would become an environmental sciences major. As a student at Northern Virginia's Wakefield High School, she focused on physics and mathematics—and in fact did so well that she was awarded an Andrew C. Kimball Memorial Scholarship, which are given to the most promising Wakefield graduates planning to attend the University. She came to UVA thinking she would pursue a career in one of those fields but enrolled in an environmental sciences class her first semester to see how she would like it.

She loved it. In short order, she decided to major in environmental sciences with a specialization in environmental and biological conservation and began working in Associate Professor **Todd Scanlon's** laboratory. As a second-year student, she is participating in an exhaustive decadal analysis of more than 400 streams being conducted by the Shenandoah Watershed Study. Scanlon asked her to develop a protocol for sampling microplastic pollution, a new addition to the forty-year-old study. Although she works independently, she is being mentored by Ami Riscassi, the SWAS senior research scientist, and Susie Maben, its senior lab specialist.

Schlachter's rediscovery of her vocation and her immersion in the field illustrates the value of a faculty committed to the personal and professional development of its undergraduates through rigorous, innovative programs and personal attention. As it turned out, her first environmental sciences class was taught by Professor **Jim Galloway**, a recipient of the Tyler Prize, widely considered to be the equivalent of a Nobel Prize. "It was an overview of everything we take from the environment and the effects that this had had on ecosystems," she recalls. "I left every lecture feeling invigorated and excited."

Equally important, she found Galloway warm and approachable. "When I told him I was considering becoming a major, he was super-excited," she says. "He introduced me to ten different professors that he wanted me to talk to." This included Scanlon.

During that semester, Schlachter also met with Professor **Dave Smith**, the department's associate chair, to find out more about the major. His advice—that if you love something, you really should pursue it—gave her the confidence to choose environmental sciences. To confirm that marine ecosystems still resonated with her, she enrolled in Smith's Marine Biology/Coral Reef Ecology summer program in the Bahamas. "It was everything I could have imagined," she said. "To my surprise, I found I was even more interested in marine plants than marine animals."

Schlachter's remarkable first year at the University has set the stage for her next step. "I'm not sure how far I want to go, but graduate school is my next step," she says.

Students

SETTING THE STAGE FOR A KOALA REVIVAL

Koalas are one of Australia's most iconic animals, but they are an icon under threat. Once numbering in the millions, the koala population has been decimated by habitat destruction, bushfires, road accidents, and disease. According to the Australian Koala Foundation (AKF), there may be as few as 43,000 koalas left in the wild while their range is just 20 percent of its original size. If koalas are to survive, new habitat must be identified for their reintroduction.

AKF has taken on this challenge, developing what it calls the Koala Habitat Atlas. This is an ambitious but painstaking project, covering almost 4 million acres on the eastern coast of Australia. Because koalas are particular about their habitat requirements, it requires meticulous documentation of hundreds of thousands of trees.

This summer, environmental sciences major **Yulan Lu** traveled to Brisbane to join this effort as an intern. Lu is pursuing a specialization in environmental and biological conservation, and interning with AKF was one of several extracurricular opportunities available to UVA students to deepen their experience in this area. In this case, it was made possible by Professor **Hank Shugart**, an expert on forest ecosystems, who was contacted by the AKF's executive director.

The experience gave Lu insight about the extensive field work needed to create a basis for a successful conservation effort. "We measured 1,900 trees at 46 transect sites during the three weeks I was in Australia," Lu says. "And while it could sometimes be tiring and repetitive, I really loved it." She and her colleagues measured tree diameter, the distance between trees, and whether there were signs that koalas were in the area. She also worked with AFK scientists trying to determine the connections between the slope orientation and the distribution of tree species in an effort to understand how best to restore koala habitat.

PHOTO PROVIDED BY YULAN LU

"We measured 1,900 trees at 46 transect sites during the three weeks I was in Australia."

Back at UVA, Lu is learning that telephone and email can also be important tools for conservation. As part of the Conservation Scholars Internship Program, organized by the National Fish and Wildlife Foundation (NFWF) and seven organizations including UVA, she is trying to determine the status of Bell's vireo in New Mexico and the gopher tortoise in South Carolina and Alabama. These are two species whose future NFWF is particularly concerned about.

Lu's work entails contacting state and local agencies to see if they have been collecting data on these species and analyzing the quality and comprehensiveness of the data that they have. "The goal is to give our NFWF supervisors the information they need to identify gaps in the data and estimate how much effort will be needed to complete its conservation goals," Lu says.

Lu hopes eventually to work with organizations that protect animals and ecosystems. "The kind of experiences I've had so far at UVA has really helped me make progress toward that goal," she says.

Yulan Lu has traveled to Australia, Tanzania, and other parts of the world to pursue her passion for conservation.

Although the environmental sciences are associated with field work, many breakthroughs occur in the lab, where researchers recreate physical processes in a controlled environment and probe samples with cutting-edge technology.

Well-Equipped Laboratories

VIJAY LIMAYE

DETECTING LANDSCAPE CLUES THAT HINT AT OUR FUTURE

When Assistant Professor **Ajay Limaye** surveys a river valley, he sees a landscape shaped over eons by a series of intertwined forces: uplift and erosion, water and sediment. Limaye's goal is to deconstruct this landscape and determine the signatures of these different forces as they act alone and in concert. "A valley is a record of planetary history, one that commonly extends back hundreds of thousands of years," he says. "My work aims to understand the shapes of landscapes today and recognize clues to their evolution."

Limaye conducts these inquiries in a number of contexts, on Mars as well as on Earth, on the seafloor as well as on land. With climate change an increasingly pressing challenge, he is particularly interested in documenting the effects of wet and dry periods—as reflected in the balance of water and sediment in a river—on river valleys as a way of forecasting climate effects in the future. Particularly fertile ground for exploration are river terraces, which are remnants of the river bed that are abandoned as the river erodes down into a valley. "River terraces can form during periods when there is more water relative to sediment, and rivers erode their beds," he says. "These terraces represent one of the few clues we have of how a landscape responded to climate change in the past."

This is challenging work. The landscape record is not only complex but also often obscured by successive events. To isolate specific combinations of processes, researchers like Limaye would normally rely on computational models, but in this case the mathematics needed to replicate these physical processes is still a work in progress. There is no full mathematical description, for instance, for the physics of water interacting with sediment and eroding rock.

One of the factors that led Limaye to join UVA in August 2019 was the support he received from the department to address these challenges by constructing a physical model, which he calls a landscape evolution basin, in his laboratory. "In the basin we can let water and sediment interact without any human intervention," he says. "It allows us to examine natural processes that go beyond the boundaries of our understanding."

The basin will also enable Limaye to dial in specific variables—the ratio of water to sediment supply, for instance, or the rate of sea level change—and track the landscape changes they produce. Limaye can compare the miniature landscapes from the lab to those in nature to find analogies in form and function. Miniaturizing a process that might occur over thousands of square miles has the added benefit of accelerating time. "In the lab, we can build a time machine to observe thousands of years in the evolution of a river valley in just an afternoon," he says.

Ajay Limaye looks to river valleys for clues about how climate change will affect the landscape in the future.

Tracing the Signatures of the Past

The powerful spectrometers that Professor **Stephen Macko** uses place him in the enviable position of being able to make wide-ranging contributions to a variety of fields. By examining meteorites, he has shown that a selection of the amino acids upon which life depends were present at the creation of the solar system. Using core samples from deposits laid down by ancient seas, he has tracked the effects of climate change on ocean chemistry. By analyzing locks of hair from Edgar Allan Poe and George Washington, he has been able to characterize what these seminal figures ate. "The author of *The Tell-Tale Heart* ate more fish than the founder of our country," he says.

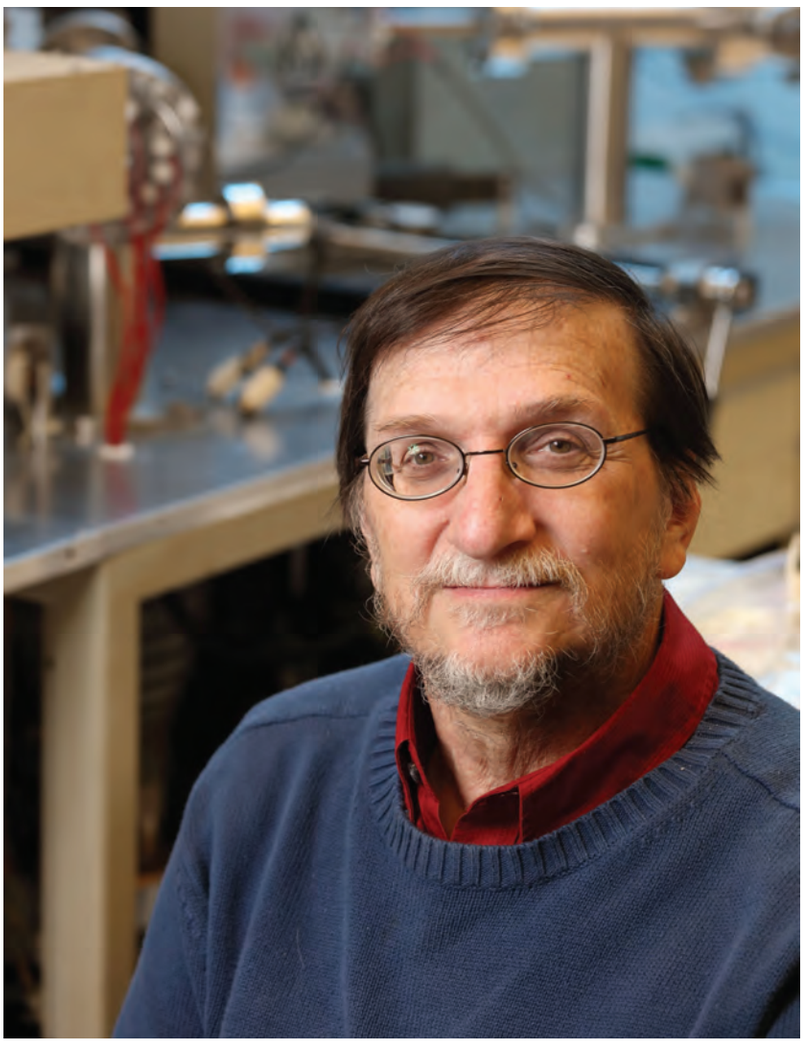
To achieve these interpretations, Macko uses spectrometers to chart the distribution of stable isotopes in a sample. These stable isotopes are relatively rare but naturally occurring variants of such elements as carbon, sulfur, nitrogen, and oxygen that have more than the standard number of neutrons. Because different isotopes are distributed under known conditions, the isotope signature of a material can reveal information about its origins.

But Macko's excitement about these devices goes beyond what they allow him to accomplish as a scientist. When Macko and a team of researchers from the College of Arts and Sciences and the School of Engineering and Applied Sciences secured a $1 million grant from the National Science Foundation to purchase an exquisitely sensitive X-ray photoelectron spectrometer (XPS), he was particularly enthusiastic about its power as an educational tool. During the first years of the grant, the facility had funding that allowed students and researchers to use the facility without paying a fee.

"Access to an XPS allows you to ask questions that you might not have thought of asking otherwise," Macko says. "Having free access means that there is no barrier between curiosity and the ability to satisfy that curiosity."

Macko's suite of spectrometers—both the XPS and the stable isotope ratio mass spectrometers—is especially important for graduate students, some of whom organize their work around these devices. For instance, his doctoral student, Christina Fantasia-Buscher, is using XPS analysis to determine how ocean acidification generated during climate change affects blue crabs in the Chesapeake Bay. She has found that the carapace, or shell, of young crabs has weakened, a trend that will only accelerate as the century progresses.

Macko maintains that even undergraduate majors who simply take his geochemistry class benefit from exposure to mass spectrometry. "Every student has a fun project," he says. "They learn how to use the instrument, understand the power of the analyses it produces, and then take that knowledge with them as they advance in their careers."



Spectrometers and other devices give Stephen Macko and his students the ability to make critical observations about the physical world.

Awards, Appointments, and Publications

UNDERGRADUATE STUDENTS

The department recognizes fourth-year students who have done outstanding work in specific environmental sciences. This year, the Michael Garstang Atmospheric Sciences Award went to **Jamison A. Orrell**, the Mahlon G. Kelly Prize in ecology to **Anna M. Wright**, and the Wilbur A. Nelson Award in geosciences to **Kathryn R. Robbins**. The department presented its Interdisciplinary Award to **Rachel C. McGill**. It is given to the undergraduate major who has excelled in research across the environmental sciences.

Kathryn R. Robbins was this year's winner of the Joseph K. Roberts Award, given to a student who presents the most meritorious research paper at a national meeting.

Luciana Codella and **Carrie Wentzel** were selected to receive the Hart Family Award for Undergraduate Research in Environmental Sciences. It provides funds to assist full-time environmental sciences majors conducting a supervised research project.

Hana R. Thurman received the Wallace-Poole Prize, awarded each year to the graduating student majoring in environmental sciences who has at least a 3.8 GPA and who is judged the most outstanding student in the class.

The Bloomer Scholarship, which provides $1,800 toward tuition, is given to an outstanding undergraduate environmental sciences major with a focus on geology. This year's winner was **Jonathan W. Lee**.

To be chosen for the College's distinguished majors program, students must achieve an overall GPA of 3.4 or above. This year, the department selected **Jordan E. Chapman**, **Damla Cinoglu**, **Bailey M. Costello**, **Kylor Kerns**, **Katherine K. Knowles**, **Jonathan W. Lee**, **Rachel C. McGill**, **Kathryn R. Robbins**, **Hana R. Thurman**, and **Anna M. Wright** as distinguished majors.

Julia Dessel and Shelby Hooe (a chemistry graduate student) won a Double Hoo Award. This research grant is intended to encourage collaborative interaction between the undergraduate and graduate communities throughout the University.

Courtney Roark, double major in Environmental Sciences and Archaeology, won third place in the poster competition at the UVA Undergraduate Research Symposium. More than 200 students gave oral or poster presentations in all disciplines.

GRADUATE STUDENTS

Alice F. Besterman was the winner of the Maury Environmental Sciences Prize, the department's premier award. Established by Dr. F. Gordon Tice in 1992, the award recognizes and honors outstanding undergraduate or graduate students for their contributions to environmental sciences, their ability to communicate their findings, and their efforts to promote a better understanding of the environment.

The department offers a series of awards honoring exceptional graduate students in environmental sciences specialties. **Emma A. Cronin** earned the Graduate Award in Ecology, **Brenden T. Michaelis** secured the Graduate Award in Hydrology, **Mary Angelique Demetillo** won the Graduate Award in Atmospheric Sciences, **Qingguang Zhu** earned the Arthur A. Pegau Award in Geoscience, and **Jessica A. Flester** received the Ellison-Edmundson Award in Interdisciplinary Studies.

Amber Slatosky received the Thomas Jefferson Conservation Award, which supports basic research related to the conservation of the Earth's resources.

Charles I. Scaife was this year's recipient of the Trout Unlimited Award. Established by the Thomas Jefferson Chapter of Trout Unlimited, this award is presented for "significant contributions to research concerning cold-water fisheries or related ecosystems."

Mary Angelique Demetillo won the Michael Garstang Award, which supports graduate student research in interdisciplinary atmospheric sciences.

Daniel F. Schmidt received the Jay Zieman Research Publication Award, named after the late Jay Zieman, long-time chair of the department.

Stephanie A. Roe was a member of an interdisciplinary UVA team of five students that won the Patagonia Case Competition with their plan for carbon neutrality. One hundred and eight teams from across the nation submitted proposals outlining how the outdoor apparel company Patagonia could become carbon-neutral by 2025.

Three graduate students from the department were among the 15 students from the Graduate School of Arts & Sciences selected to present their research at the 19th Huskey Graduate Research Exhibition. They were **Kathyrn LeCroy**, **Brynn Cook**, and **Daniel F. Schmidt**.

This year, **Amelie C. Berger**, **Cal D. Buelo**, **Alexandra M. Parisien**, and **Stephanie A. Roe** each won a Moore Research Award. Based on merit, this award was initiated to help sponsor the dissertation and thesis work of environmental sciences graduate students.

The Exploratory Research Awards, also based on merit, were initiated to help selected students conduct preliminary research leading towards the development of a thesis or dissertation proposal. The recipients this year were **Clare A. Rodenberg** and **Kinsey N. Tedford**.

Amber Slatosky won the Graduate Student Association Award, which recognizes a member of the department who has been particularly helpful to the graduate student body.

Christina Fantasia-Buscher and **Kelcy C. Kent** shared the Fred Holmsley Moore Teaching Award, bestowed on graduate teaching assistants distinguished by their ability to instill excitement, wonder, and confidence in students. An endowment set up by Fred H. Moore funds this award, along with matching donations from Mobil Oil Company.

STAFF

Cynthia B. Allen won the Department Chair's Award, which recognizes an individual who has performed extraordinary service to the department.

FACULTY

Lawrence Band, the Ernest H. Ern Professor, is an associate editor of *Hydrological Processes* and serves on the Hydrology Section's Fellows Nominations Committee of the American Geophysical Union. At the University, he is a member of the Promotion and Tenure Committee in the College and Graduate School of Arts & Sciences as well as the Dean's Research Advisory Committee.

Linda Blum is a board member of the Chesapeake Bay Sentinel Site Cooperative, sponsored by the National Oceanic and Atmospheric Administration. At the University, Professor Blum serves on the College and Graduate School of Arts & Sciences Committee on Faculty Rules. She is also a faculty panelist at Days on the Lawn.

David Carr is an associate editor of the *American Journal of Botany*. He serves on the Domain Science and Education Coordination Committee of the National Ecological Observatory Network.

Max Castorani received the department's Environmental Sciences Organization Award, which is given to a member of the department who has been particularly helpful to undergraduate majors.

Robert Davis was one of eight All-University Teaching Award honorees for 2018. He chairs the University's Commencement and Convocations Committee.

Stephan De Wekker is an associate editor of the *Journal of Applied Meteorology and Climatology* as well as an associate editor of *Atmosphere*. At the University, Professor De Wekker chairs the College and Graduate School of Arts & Sciences Nominating Committee.

Scott Doney, the Joe D. and Helen J. Kingston Professor in Environmental Change, was named to Clarivate Analytics' 2018 List of Highly Cited Researchers, a list of nearly 6,000 researchers in 21 fields or across several fields that recognizes individuals whose papers have supported, influenced, inspired, and challenged other researchers around the globe. He was named in two areas: geosciences and environmental/ecology. He also serves as secretary of the Atmospheric and Hydrospheric Sciences Section at the American Association for the Advancement of Science and as a member of the Climate Observing System Council at the National Oceanic and Atmospheric Administration. In addition, Professor Doney is a member of the Ocean Carbon Biogeochemistry Scientific Steering Committee of the National Science Foundation. At the University, he is on the Steering Committee of the Environmental Resilience Institute. This year, the department awarded him its Maury-Tice Prize for research excellence.

Howard E. Epstein is a member of the board of directors of the Arctic Research Consortium of the United States. He served as a judge for the American Geophysical Union's Graduate Student Award. At the University, Professor Epstein is co-director of the College Science Scholars program and served on the College and Graduate School of Arts & Sciences Committee to Imagine the Future of the Graduate School. He is a faculty panelist for Days on the Lawn and a faculty fellow of the Echols Scholars Program. He will chair the department starting with the 2019–20 academic year.

James N. Galloway, the Sidman P. Poole Professor of Environmental Sciences, is an associate editor of *Environmental Development*, a trustee of the Marine Biological Laboratory at Woods Hole, Massachusetts, and a member of the Board of Trustees of the Bermuda Institute of Ocean Sciences (formerly the Bermuda

Biological Station for Research). He is a member of the University Committee on Sustainability and was presented the Outstanding Faculty Member Award from the UVA Student Council Sustainability Committee.

Kevin Grise received a prestigious National Science Foundation CAREER Award in August 2018. It is given to junior faculty who exemplify the role of teacher-scholars through research, education, and the integration of education and research within the context of the mission of their organizations. He is co-chair of the Changing Width of the Tropical Belt Working Group, which is sponsored by the United States Climate Variability and Predictability Program.

Kyle Haynes is an associate editor of *Ecography*.

Janet S. Herman is president of the Karst Waters Institute and is a campus representative of the Geological Society of America as well as chair of its Hydrogeology Division's Kohout Early Career Award Committee. At the University, Professor Herman serves as a judge at the annual Huskey Graduate Research Exhibition.

William Keene (retired) was part of a team of UVA researchers who were presented the Project of the Year Award by the Strategic Environmental Research and Development Program at the U.S. Department of Defense.

Deborah Lawrence was named the Sustainability Faculty Teaching Fellow by the University of Virginia. She is a member of the University Committee on Sustainability, the Department of Politics Environmental Policy Search Committee, the Global Studies Curriculum Committee, and the General Education Assessment Committee. She is a trustee of the Virginia Chapter of The Nature Conservancy and the Local Energy Alliance Program.

Manuel Lerdau is an associate editor of *Biology Letters*. At the University, he is a member of the University's Sexual Misconduct Board, the College and Graduate School of Arts & Sciences Faculty Rules Committee, and the Sustainability @UVA initiative. He is steering committee chair for Directors of Diversity and Inclusion.

Stephen A. Macko serves on the Committee on Education of the European Geosciences Union and is editor-in-chief of *Nitrogen,* section editor-in-chief of *Geosciences*, and associate editor of *Minerals*. He is on the editorial board of the *Oxford Research Encyclopedia of Environmental Science*. At the University, he is a member of the Faculty Senate, the Provost's Policy Review Committee, the Provost's Academic Strategy Committee, and the University Libraries Committee.

Karen J. McGlathery is the lead principal investigator of the Virginia Coast Reserve Long-Term Ecological Research (VCR-LTER) program, sits on the national LTER Science Council, and advises the Florida Coastal Everglades LTER and the Moorea Coral Reef LTER. In addition, Professor McGlathery is an associate editor of *Ecosystems*, a member of the Research and Education Advisory Council of Virginia Sea Grant, and a member of the board of the Foundation of the State Arboretum of Virginia. At the University, she is director of the Environmental Resilience Institute, a member of the Committee on Sustainability, and a member of the President's Task Force on the Emmet-Ivy Corridor.

Aaron L. Mills is a member of the Committee on Environmental Microbiology and the Public and Scientific Affairs Board of the American Society for Microbiology. At the University, he serves as secretary of the Faculty of Arts & Sciences and as a member of the University Assessment Advisory Committee, the Institutional Biosafety Committee, and the Institutional Review Entity.

Michael Pace completed his term as chair of the department at the end of the 2018–19 academic year. He is president of the Association for the Science of Limnology and Oceanography (ASLO). This year, he was named a Commonwealth Professor.

John Porter is a member of the national LTER Network Information System Advisory Committee and advisor to the Luquillo LTER.

Sally Pusede is an associate editor of *Atmospheric Chemistry and Physics.*

Matthew Reidenbach is associate editor of *Frontiers in Marine Science*.

T'ai Roulston is an associate editor of *Ecosphere*.

Todd Scanlon is a reviewer for the University's Harrison Undergraduate Research Awards and Double Hoo Research Grants.

Herman H. Shugart, the W. W. Corcoran Professor of Environmental Sciences, is a member of the Biomass Mission Assessment Group of the European Space Agency as well as the Intelligence Science and Technology Experts Group at the National Academies of Science, Engineering, and Medicine. He is also an associate editor of *Ecological Processes* and a member of the editorial boards of *Ecosystems*, *PeerJ*, *The Sejm Review*, and *Forest Ecosystems*. He is a trustee of the 500-Year Forest Foundation. At the University, he participates in Faculty Speakers Day on the Lawn.

Lauren Simkins is on the Books Editorial Committee of the Geological Society of London.

David E. Smith is the UVA representative to the Virginia Sea Grant Policy and Oversight Board. He serves the University as a member of the Executive Leadership Network, the Facilities Management Advisory Board, and the Athletics Advisory Council. This year, he received the Outstanding Faculty Award from the Environmental Sciences Organization.

Patricia Wiberg serves on the executive committee of the AGU's Earth & Planetary Surface Processes Focus Group and is an associate editor of *ESurf*. At the University, she is a member of the Steering Committee of the College and Graduate School of Arts & Sciences as well as the Provost's Promotion and Tenure Committee.

Xi Yang serves on the Foliar Sampling Technical Working Group of the National Science Foundation's National Ecological Observatory Network.

PEER-REVIEWED PAPERS, BOOK CHAPTERS, AND BOOKS

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