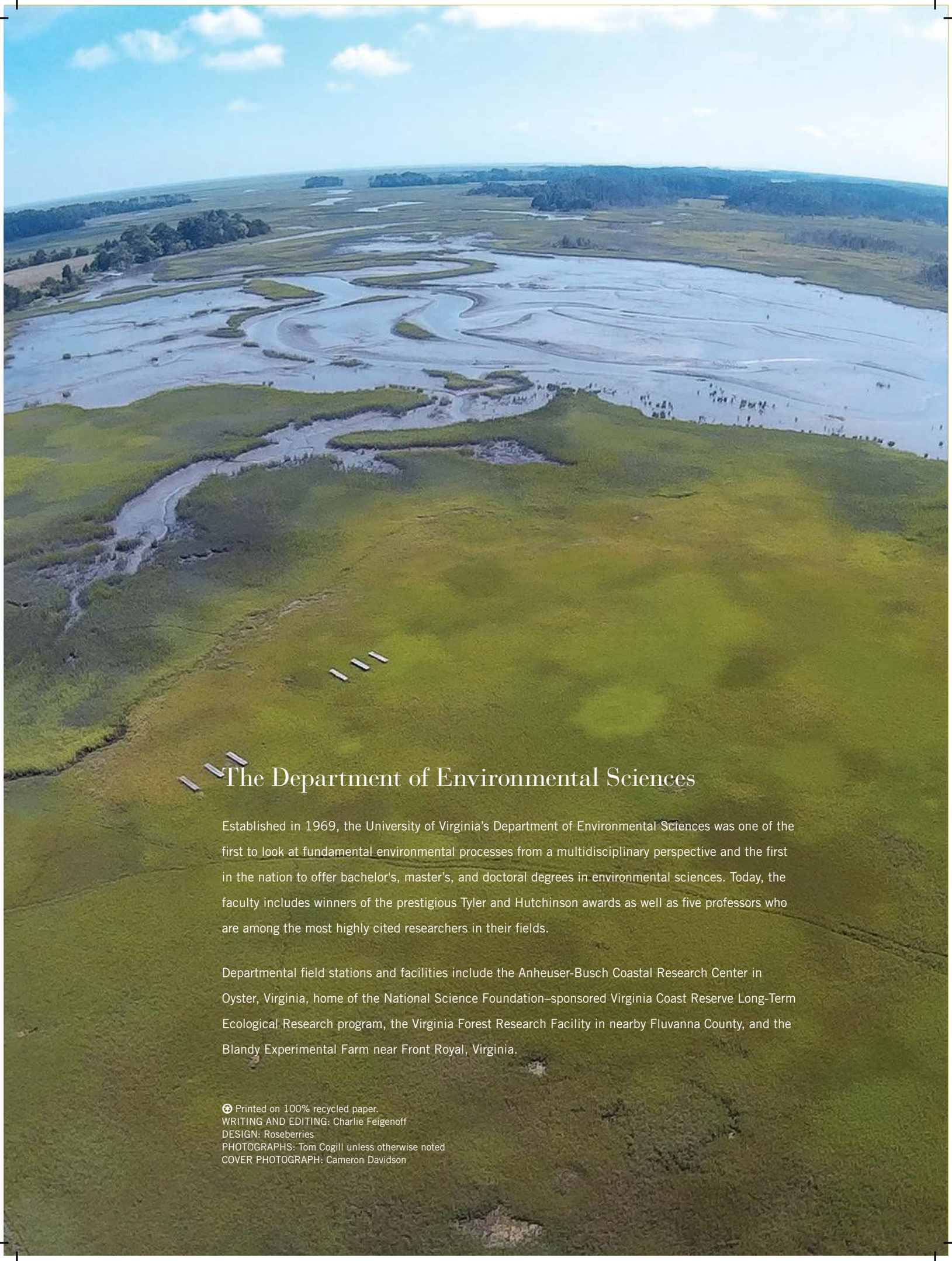
Environmental Sciences

AT THE UNIVERSITY OF VIRGINIA

2017–18 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 bachelor's, 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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JOHN PORTER

From the Chair

If there is an underlying message to the National Climate Assessment, released just after Thanksgiving, it is that a changing climate could have devastating effects, not just on the environment but on the health and economic well-being of our citizens. These findings come a month after the United Nations' Intergovernmental Panel on Climate Change issued its most alarming report to date about the consequences of our current rate of greenhouse gas emissions.

Both reports note, however, that we will be able to avoid the worst consequences of climate change if we take action now. As a department of environmental sciences, we can play a crucial role in avoiding a climate catastrophe by providing people with the insights they need to make more informed decisions about our environmental future while shedding light on the processes that are taking us there.

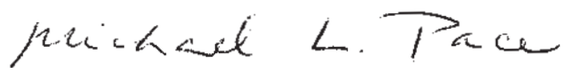
As you will read in this report, our faculty are pursuing this agenda from a number of perspectives. They have developed a series of tools that individuals, government agencies, universities, and cities can use to better understand the consequences of their choices and make more constructive decisions about the environment.

The department is also the linchpin of the University's Environmental Resilience Institute, directed by Professor Karen McGlathery. The institute is mobilizing expertise across Grounds to help society meet such complex challenges as building resilience to climate change, achieving water and energy security, and gauging the impact of the environment on health.

To be effective, interventions require a sophisticated knowledge of the complex biogeochemical interactions that shape the environment. Teasing out these interactions is painstaking and demanding work, requiring creativity and perseverance. Our faculty is deeply immersed in this effort, in areas as diverse as coral reefs and the Antarctic ice sheets.

We are particularly proud of the research we conduct on coastal systems as part of the Virginia Coast Reserve Long-Term Ecological Research program. This year, the site secured its seventh round of funding from the National Science Foundation, a vote of confidence in the quality of the research we produce there.

Finally, through efforts like the Conservation Scholars Program and Professor Deborah Lawrence's Write Climate project, we are engaging students whose lives will be, in many respects, defined by climate change and other environmental challenges.



Michael L. Pace, Chair

The Environment and Health

The link between the environment and health is one that we take for granted but is often more complex than we realize.

Understanding the Nuances of Weather and Disease

THE IMPACT OF the seasons on health is well established. In addition to the flu and allergy seasons, studies have shown that there are seasonal fluctuations in diabetes, mental health disorders, migraines, and even acute gout. In mid-latitude cities, there are more deaths and hospitalizations during the winter than summer, driven primarily by increases in respiratory and, to a lesser extent, cardiovascular disease.

"We hypothesized that rapid weather changes would produce spikes a few days later in deaths and admissions for respiratory illnesses."

Research conducted by climatologist **Bob Davis** suggests, however, that the relationship between the seasons and health is more nuanced than commonly thought. "People assume that there is a correlation between temperature and seasonal health patterns," Davis says, "but there are other seasonal factors besides temperature."

Davis is trying to understand these seasonal health patterns, with particular emphasis on exceptions to the rule. "These deviations can give you a deeper glimpse into the relationships that determine how weather and climate affect health," he says.

Collaborating with **Kyle Enfield, MD**, an associate professor in the Division of Pulmonary and Critical Care Medicine at UVA, Davis sought to determine if there is a connection between upticks in respiratory disease and the short-term fluctuations in weather conditions that occur during fall and spring. They chose respiratory conditions because the lungs are uniquely exposed to these fluctuations. Humans have evolved a number of protective responses—including sweating, vasoconstriction, and vasodilation—to protect skin surfaces, which we supplement by changes in clothing. There is nothing comparable for the lungs.

"When cold dry air is directly inhaled into the lungs, the body must raise that air's temperature and moisture content, a process that puts a strain on the respiratory system," Davis says. "We hypothesized that rapid weather changes would produce spikes in deaths and admissions for respiratory illnesses within a few days."

That is exactly what they found. Using 600,000 total admissions recorded by the UVA Medical Center between 1997 and 2015 and weather data from the Charlottesville-Albemarle County Airport from the same period, they identified fall and autumn peaks in respiratory admissions following shortly after abrupt weather changes. The impact in the fall is particularly pronounced, reflecting the overall trend to lower temperatures.

Davis and Enfield recently received a 10-year data set covering hospital admissions for the western half of Virginia. "This will enable us to move beyond results for cities like Charlottesville and look at a much broader area that includes places with smaller populations," he says.

Davis is looking at other weather patterns for additional clues about weather's impact on health. Along with Wendy Novicoff, a professor of public health sciences, Davis has investigated the correlation between heat waves and emergency department admissions. They have discovered that the consequences of prolonged hot weather go beyond acute issues like heat stroke; extended heat also exacerbates symptoms of people with a broad range of existing conditions.

The Special Case of Karst Groundwater and Health

MORE THAN HALF the population of the United States relies on groundwater for their drinking water—and each one of these individuals depends on the environment to ensure it is safe to drink. As water percolates slowly through layers of soil and rock, physical, chemical, and biological processes remove or degrade various pollutants. The soil acts as an enormous filter, trapping debris and larger bacteria. The reactive surfaces of soil particles capture contaminants, and bacteria and soil micro-organisms break them down.

As Professor **Janet Herman** notes, these systems are now under tremendous stress. Vast amounts of nitrates from fertilizers as well as toxic chemicals and organic compounds from manufacturing processes are being flushed into the subsurface at record rates. Nowhere is this situation more dangerous than in regions that rest on highly soluble bedrock such as limestone. Even rain that is weakly acidic can eat away at existing fractures and bedding planes, forming complex networks of underground conduits and caves. This system is called karst.

"In karst environments, groundwater moves so quickly through the subsurface that there is little opportunity for contaminants to be removed," Herman says. "Furthermore, these systems are so complex that it is difficult to track their movement. As a result, individuals far from a point of contamination can unwittingly drink polluted water, with serious consequences for their health."

"In karst environments, groundwater moves so quickly through the subsurface that there is little opportunity for contaminants to be removed."

The magnitude of this problem is difficult to overestimate. In the United States, 20 percent of the land surface is karst, including large portions of Missouri, Iowa, Indiana, Texas, and Georgia, and virtually the entire state of Florida. Forty percent of our drinking water comes from karst aquifers.

The health issues arising from drinking contaminated water in karst regions have been well documented. For instance, in Puerto Rico, where pharmaceutical companies manufacture birth control drugs for the U.S. market, researchers have linked endocrine disruptors in the karst water supply to preterm births. In the karst country of Minnesota, downpours flushing waste from farms and septic tanks regularly lead to outbreaks of diarrheal disease.

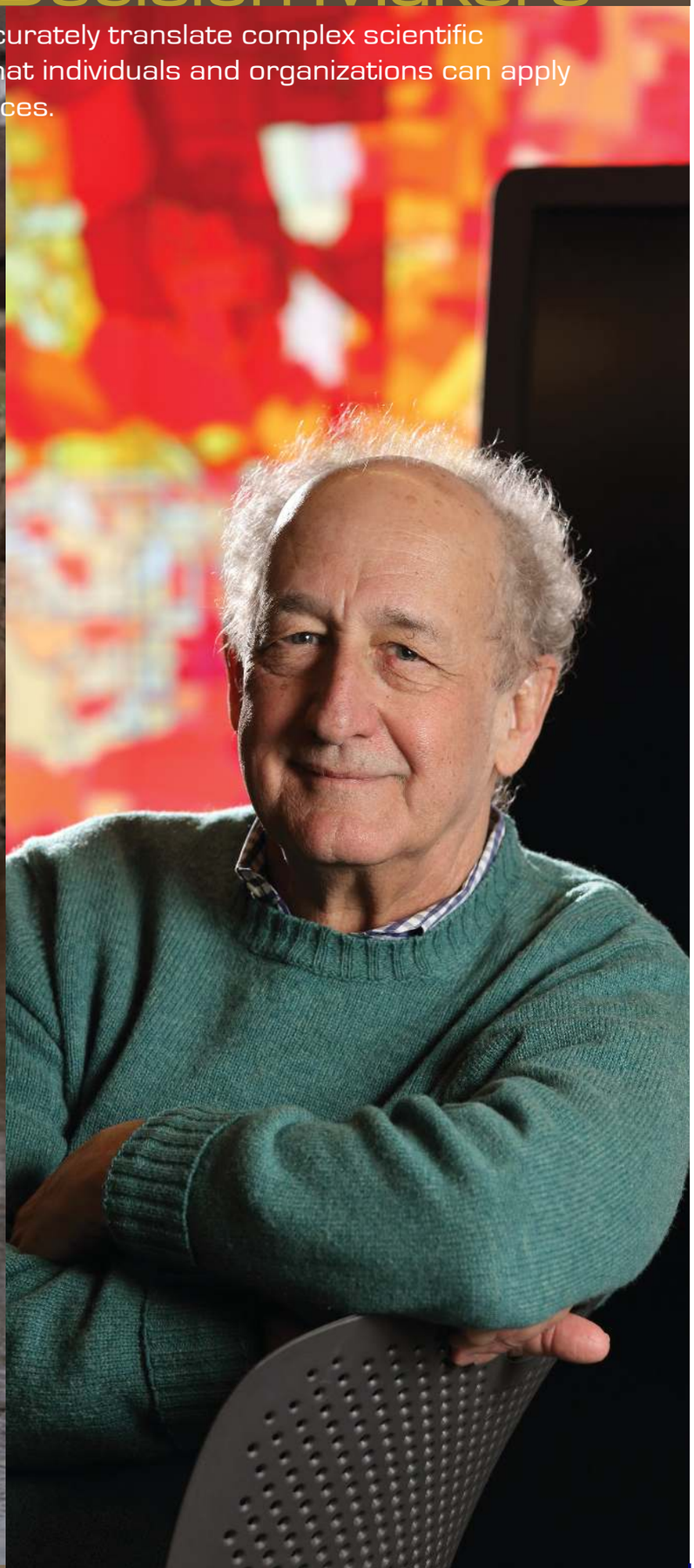
As president of the Karst Waters Institute, Herman helped secure funding from the National Science Foundation and the National Institute of Environmental Health Sciences to convene a meeting to focus on the impact of contaminated karst aquifers on public health. It brought together 70 scientists, physicians, public health officials, and regulators from eight countries.

They concluded that promoting a more robust exchange of data between public health officials and karst experts would be the first step in accurately assessing the health impact of contaminated karst water. "If we are to make any progress, physicians need to collect information about each patient's environmental circumstances, much as they do health habits and family history," Herman says. "At the same time, public health officials need to be able to turn to karst scientists for insight about contaminant flow. It will take an interdisciplinary effort to come to grips with this problem."

Facing page, top: Janet Herman; bottom, left to right: Kyle Enfield and Bob Davis

Closing the Gap Between Scientists and Decision-Makers

We are working to create tools that accurately translate complex scientific relationships into easy-to-use formats that individuals and organizations can apply to make sustainable environmental choices.



Tools That Help Communities Manage Storm Water

IT CAN BE a challenge. Stand on a street corner in a major city, and see if you can spot a patch of ground amid all the brick, concrete, and asphalt. Urban areas, almost by definition, are characterized by hard surfaces. When it rains, urban impermeability almost inevitably damages the environment. Funneled into storm drains that magnify its impact, storm water pulses through streams, scouring their channels, destroying the aquatic habitat, and overflowing their banks. At the same time, storm water carries a host of pollutants that further degrade these waterways. And it is not just the city centers that are impermeable; in the suburbs water is routed through curbs and pipes directly into streams, wetlands, and ponds.

"The challenge is redeveloping urban ecosystems to regenerate functions lost when we paved the landscape and pulled out the trees."

As the nation becomes both more urbanized and suburbanized, these issues become more critical. Over the last three decades, ecohydrologists like **Larry Band**, the Ernest H. Ern Professor of Environmental Sciences, have been able to better understand storm water movement in watersheds with a high proportion of impervious surfaces and develop mitigation strategies. In doing so, they often apply insights gained from watersheds that have been spared from much of the pressures of population growth.

"The challenge is redeveloping urban ecosystems to regenerate functions lost when we paved the landscape and pulled out the trees," Band says. "We are taking new ecosystem and hydrologic science from high-quality naturalized systems and translating these principles for the urban environment."

The result has been a complex of approaches that fall under the general category of green infrastructure. Green infrastructure initiatives, depending on the site, might include a series of small-scale interventions—planting trees that add to the canopy cover, creating rain gardens that encourage biofiltration, evaporation, and transpiration, and installing rainwater harvesting systems that collect and store water from roofs for later use.

Band, who has been actively involved in assessing, designing, and analyzing green infrastructure techniques, is taking this work a step further. He and his colleagues are creating powerful, fine-grained software programs that allow storm water engineers to understand the effectiveness of a system of green infrastructure techniques in a neighborhood or small watershed. These programs can also be used to encourage community members to take an active role in minimizing the consequences of storm water runoff.

"With the programs we are developing, people will eventually be able to go online, see their street, redesign it, and view the actual benefits of their choices," Band says. "We can also show them how their actions affect other community-wide sustainability goals such as sequestering carbon and reducing urban heat islands."

Creating software that incorporates complex ecohydrological interactions at a meaningful spatial resolution and represents them in a form that can be grasped by a nonscientist is a significant challenge, but one Band sees as critical to address. "We need to translate our knowledge into tools that individuals and communities can use to make better, more informed decisions about the environment," he says.

Replicating the Nitrogen Footprint at Different Scales

WHEN YOU'RE DIABETIC, excess sugar in your bloodstream circulates through your body, damaging organs in a variety of pernicious ways. Excess reactive nitrogen in the environment works in much the same way.

Injected into the environment deliberately in the form of fertilizer and inadvertently in the process of burning fossil fuels, reactive nitrogen increases ozone levels in the lower atmosphere, causing respiratory diseases and reducing crop yields. It is returned to the land in the form of precipitation that acidifies soils, lakes, and streams. There it joins the reactive nitrogen from agricultural runoff and sewage as it makes its way to the coastal oceans, provoking algae blooms that damage fisheries. As a final insult, oceanic nitrogen is converted to nitrous oxide, a long-lasting greenhouse gas and destroyer of ozone in the upper atmosphere.

Jim Galloway, the Sidman P. Poole Professor of Environmental Sciences, has devoted himself not simply to describing the nitrogen cascade, but also tracing the ways that flows of reactive nitrogen are intertwined with the global economy. For this work, he won the Tyler Prize for Environmental Achievement in 2008. "I decided at the time that I would use my prize money to build a nitrogen footprint calculator," he said. "This would enable people to better understand the amount of reactive nitrogen lost to the environment through their decisions about food, energy, and other resources and to run scenarios so they could develop a plan to reduce it."

"Each country participates in the global nitrogen economy in its own way. Each national footprint is designed to reflect those unique relationships."

Since that time, working with colleagues and students, Galloway has developed nitrogen footprint tools for individuals and institutions. He introduced the first nitrogen footprint for individual consumers in the United States in 2010—and he has followed up with versions for 10 additional countries. "Each country participates in the global nitrogen economy in its own way," Galloway says. "Each national footprint is designed to reflect those unique relationships." Galloway and his colleagues are currently working on individual footprints for Brazil, Portugal, Ukraine, and Denmark.

Allison Leach, a former student of Galloway's, now a postdoctoral student at the University of New Hampshire, was instrumental in developing a nitrogen footprint for academic institutions. She developed a prototype for her senior thesis and tested it at UVA. It worked so well that the Board of Visitors agreed in 2013 to decrease UVA's nitrogen footprint 25 percent by 2025, relative to base year 2010. Now, over 450 universities are using it in conjunction with the carbon footprint tool developed at the University of New Hampshire to calculate their combined nitrogen/carbon footprint.

Thanks to the work of another graduate, Elizabeth Dukes, Galloway is preparing to launch a nitrogen footprint tool for communities. For her senior thesis, Dukes developed a model for Baltimore based on data from the 536 census blocks in the city. "We have already had interest in our community tool from as far away as China," Galloway says. "This is exciting because the impact of the tool rises with increases in scale."

Facing page, left: Larry Band; right: Jim Galloway in front of images made by Eliazbeth Dukes

Assessing the Vulnerability of the Permafrost

PERMAFROST IS ONE of the largest repositories of carbon in the world. Approaching a mile deep in some places and covering a quarter of the Northern Hemisphere, permafrost contains the frozen remains of plants and animals that have accumulated over hundreds of thousands of years. Researchers estimate that this organic matter contains 1,500 billon metric tons of carbon, almost double the amount of carbon currently in the atmosphere.

"It is already thawing in some places, and if thawing increases, it will produce a feedback loop that could accelerate climate change."

"The fate of the permafrost is an ultimate question for arctic scientists," Professor **Howie Epstein** says. "It is already thawing in some places, and if thawing increases, it will produce a feedback loop that could accelerate climate change."

Because the dynamics of permafrost thawing are extremely complex, it is difficult to assess how vulnerable it is. A research project that Epstein is currently undertaking with funding from the NSF's Arctic System Science Program illustrates this challenge.

Ice-wedge polygons are one of the most common ground patterns in the Arctic, ranging in size from 30 to 150 feet across. From the air, a landscape with these polygons can resemble an enormous dried mud puddle. Ice-wedge polygons form when, during the summer, water fills cracks in the permafrost. When it freezes, the water expands and opens the cracks further, which can accommodate even more water during the next summer.

"If these wedges melt, they can turn into ponds, ultimately connecting and forming drainage channels," Epstein says. "As a result, you have water and nutrients leaving the system—and what has once been almost entirely a terrestrial system has gained an aquatic component."

The question that Epstein is trying to determine is whether the new surface water will lead to additional permafrost degradation. The complicating factor is the aquatic sedges and mosses that thrive in these ponds. "If the added insulation provided by aquatic vegetation keeps pace with warming caused by climate change, we might end up with a self-regulating system, at least temporarily," Epstein says.

Epstein encounters a number of these countervailing effects as part of his annual review of tundra conditions, which he writes as part of NOAA's annual Arctic Report Card. Not surprisingly, as temperatures warm, the tundra is greening, though there are variations from year to year, and some areas are even showing the reverse trend.

Trying to tease out the causes and implications of these conflicting trends can be daunting. As in the case of ice-wedge polygons, the additional vegetation produced by a warming Arctic provides a measure of insulation for the permafrost. At the same time, the warming can also lead to outbreaks of insects, which could produce die-offs of tundra vegetation. "Making accurate predictions about the future of the permafrost," Epstein says, "will require us to understand all the modifications caused by climate change as well as their interrelationships."

DONALD A. WALKER

CLIMATE
THE FATE

Recreating the History of the West Antarctic Ice Sheet

THE STAKES ARE high. Thwaites Glacier, a Florida-sized segment of the West Antarctic ice shelf, is already melting. Losing 50 billion tons of ice each year, its melt is already the largest single component of sea-level rise from Antarctica. Its collapse could raise sea levels rapidly by as much as three feet, dislocating tens of millions of people worldwide and destabilizing the rest of the West Antarctic ice sheet. If the entire ice sheet melts, global sea levels would rise an additional 13 feet. That's why the *Washington Post* called Thwaites "the world's most dangerous glacier."

"If we are to understand the future of the glacier, which is so closely tied to our future, we must gain a much better understanding of the complex mechanisms that drive its growth and retreat."

One reason the West Antarctic ice sheet is so vulnerable to catastrophic collapse is that the continental shelf in this part of Antarctica slopes downward as it approaches land. In essence, the ice sheet bridges the underwater chasm between land and a point out to sea where it is grounded on the higher seafloor. As water warms, it will melt the ice margin and cause thinning that could lead to its rapid retreat toward the shore.

"If we are to understand the future of the glacier, which is so closely tied to our future," says Assistant Professor **Lauren Simkins**, "we must gain a much better understanding of the complex mechanisms that drive its growth and retreat."

Simkins is part of the recently announced International Thwaites Glacier Collaboration (ITGC), a five-year, $25 million research partnership between the U.K. Natural Environment Research Council and the U.S. National Science Foundation. It is the largest joint project that the two nations have undertaken in more than 70 years, involving 100 scientists from both countries as well as South Korea, Germany, Sweden, New Zealand, and Finland.

Simkins is a member of the ITGC's Thwaites Offshore Research (THOR) project. "One of the major challenges we face is that satellite observations only go back a few decades at best," Simkins says. "That is not nearly long enough for us to develop models that account for what we are seeing today and to forecast what will happen to Thwaites in the future."

Simkins and her colleagues plan to extend the record back tens of thousands of years into the past by analyzing sediment cores taken from below the ice shelf and seaward from its current edge. They will gather a variety of historical insights from the cores, including the location of the grounding line, ocean temperatures, and the vigor of the ocean's circulation. Simkins will use clues from the cores to reconstruct the glacier's meltwater discharge history and correlate it to sea-level change.

"The geologic record is critical because it is the only way we can extend our knowledge beyond the modern instrumental record," Simkins says. "Fortunately, it is well suited to provide a wide range of information about processes that influence ice sheet dynamics."

Facing page, top: Howie Epstein; bottom: Lauren Simkins

ANNA RUTH HALBERSTADT

DONALD A. WALKER

CHANGE: OF THE POLAR REGIONS

BECAUSE THEY SEQUESTER HUGE AMOUNTS OF CARBON AND WATER, THE CONSEQUENCES OF CLIMATE CHANGE IN THE POLAR REGIONS HAVE OUTSIZED GLOBAL SIGNIFICANCE.

ANNA RUTH HALBERSTADT

DAVID SMITH

THE NEXT GENERATION TO CONFRONT CLIMATE CHANGE

The 21st century will be defined by climate changing at a rate that no human society has experienced. We are preparing students to meet this challenge.

DEBORAH LAWRENCE

Preparing Students for Careers in Conservation

CONSERVATIONISTS ARE AN endangered species. At the precise moment that the natural world is experiencing unprecedented stress from population pressure and climate change, the number of conservationists available to ensure the persistence of healthy biodiversity and habitat is falling far short of the need.

To address this deficiency, the National Fish and Wildlife Foundation (NFWF) in 2011 approached the University of Virginia and six other organizations to assist in developing the next generation of conservation stewards. This year, UVA students undertook a survey of almost 170 students who have participated in the Conservation Scholars Internship program, a key element of the NFWF initiative, to determine if the internship was contributing to NFWF goals.

"The results clearly affirmed the effectiveness of the program," says Professor **Dave Smith**, the program director for UVA. "Students reported that the internship helped them build their skill sets and impacted their choice of career."

A nonprofit organization created by Congress in 1984, NFWF directs public conservation funding to protect and restore America's native wildlife species and habitats and matches these public monies with private funds. It is among the nation's largest conservation organizations. Since 1984 it has supported more than 16,500 projects and generated a conservation impact of more than $4.8 billion.

"The results clearly affirmed the effectiveness of the program. Students reported that the internship helped them build their skill sets and impacted their choice of career."

The Conservation Scholars Program gives undergraduates the opportunity to spend time with conservation professionals and learn firsthand about the environmental, institutional, economic, and social factors associated with conservation practice. In addition, the department has used NFWF funding to develop an advanced course for undergraduates enrolled in the Environmental and Biological Conservation Specialization and to offer a series of fellowships to graduate students.

UVA participants, who represent the largest cohort of Conservation Scholars, found that the internship was particularly valuable in confirming their career goals. Eighty-two percent of the former interns said that they applied to the program to gain specific work experience in conservation, and 82 percent are currently working in the field. "The program had a major impact on me," reported a UVA graduate whose internship with The Nature Conservancy focused on water rights in the West. The student is now a water resource specialist with the State of Montana.

Others appreciated the opportunity to make a real difference. "The highlights for me were working and networking with the people at NFWF, gaining an understanding of the pros and cons of working in the conservation field, and having real impacts on the work going on within the organization," said another UVA graduate.

"We are grateful to NFWF for its support," Smith says. "The program has been transformative for many of our students and has strengthened our country's capacity to find ways to conserve the natural world."

Conveying the Significance of Climate Change

IT CAN BE frustrating being an environmental scientist. As the consequences of global warming become clearer with each successive environmental assessment and the impact of inaction becomes more and more dire, the public remains strangely indifferent.

Recent research published by the Global Carbon Project forecast that worldwide carbon emissions are expected to increase by 2.7 percent in 2018. This does not bode well for the future. "For scientists, the difference between 2 and 3 degrees Celsius in warming over the next century is catastrophic," says Professor **Deborah Lawrence**, "but for most people it seems insignificant. Our efforts to convey the seriousness of the situation have been an utter failure."

Part of the solution, she says, is focusing on the impact of the data, rather than the data itself, and talking about climate change in terms of relatable consequences like heat stroke or flooding. Another approach is education.

As an expert on the link between tropical deforestation and climate change, Lawrence collaborated with a group of fellow scientists in advance of the latest Intergovernmental Panel on Climate Change report to release a statement explaining why forests matter. And at least once every other month, she explains climate change to community groups or classrooms of school children. "I see all these efforts as a way to share my concern that we are at a real tipping point," she says.

"For scientists, the difference between 2 and 3 degrees Celsius in warming over the next century is catastrophic, but for most people it seems insignificant. Our efforts to convey the seriousness of the situation have been an utter failure."

But her most successful and fulfilling effort to date is the Write Climate project she and her students launched this year as part of her one-credit course, Words on Paper: History of Climate Science, Policy, and Art.

The idea for the installation evolved over time. Lawrence was inspired by the example of artist Morgan O'Hara, who took a copy of the U.S. Constitution to the Rose Reading Room at the main branch of the New York Public Library on Inauguration Day 2017 and began copying it out by hand. She was soon joined by a group of friends and strangers. O'Hara noted that "hand copying a document can produce an intimate connection to the text and its meaning."

Lawrence tried the same approach with the Paris Climate Accord, but she concluded that fewer, well-chosen words could attract greater participation. Her students set up tables on Grounds and asked passersby to jot down their thoughts about climate change, the steps they now take to integrate sustainability in their lives, or excerpts from texts on climate science and policy. The students collected responses from 1,200 people, and then used the paper to create a variety of art objects related to climate, including representations of the Earth, windmills, and waves. The project was sponsored by the Jefferson Trust.

"Perhaps the best thing about the project was that we were able to reach out to people who really never think about climate change," Lawrence said. "We were able to grab people's attention in a new way."

DAVID SMITH

DEBORAH LAWRENCE

Facing page, top: The National Fish and Wildlife Foundation funds the Conservation Scholars Program at UVA.
Facing page, bottom: Thousands of students visited the Write Climate art exhibition, designed to heighten awareness of climate change.

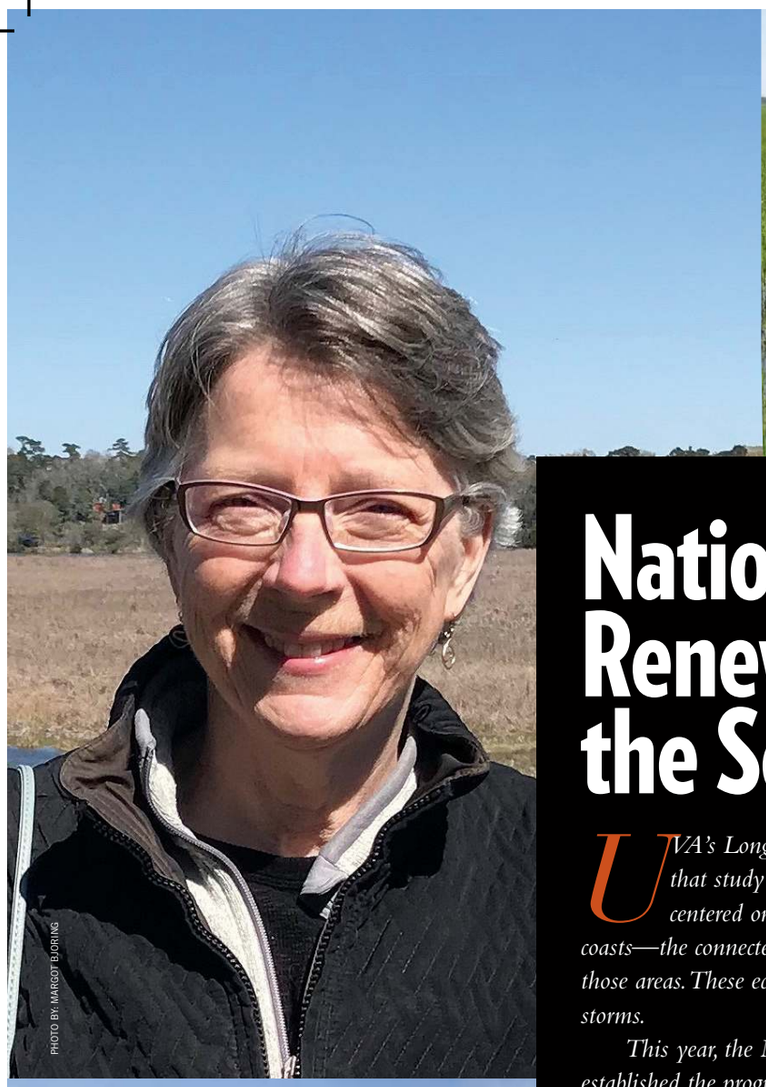


PHOTO BY: MARGOT BJORING

DAVID LEE

National Science Foundation Renews VCR LTER for the Seventh Time

UVA's Long-Term Ecological Research Project is part of a nationwide network of NSF-funded sites that study long-term environmental change across a broad range of ecosystem types. UVA's project, centered on the Nature Conservancy's 133,000-acre Virginia Coast Reserve, focuses on shallow coasts—the connected system of barrier islands, marshes, and bays, and the diverse life forms that inhabit those areas. These ecosystems are the first line of defense for coastal communities against sea-level rise and storms.

This year, the NSF renewed its support for the VCR LTER for the seventh time since the department established the program in 1986. The $6.72 million grant runs for six years.

"The reserve is a living lab that gives us the rare opportunity to study natural coastal processes under minimal human influence," says Professor Karen McGlathery, who directs the VCR LTER and serves as director of UVA's Environmental Resilience Institute. "This long-term research allows us to develop the basic knowledge of coastal change that decision-makers can use to conserve, protect, and manage these areas for greater resilience."

CORA JOHNSTON

Can the Marshes Keep Pace with Sea-Level Rise?

IF THE TIDAL marshes that buffer Virginia's Eastern Shore are to survive, they must gain elevation at the same rate as the rising seas—and this takes sediment deposition. Professor **Patricia Wiberg** is trying to determine where this sediment might be found.

One of the advantages of the long history of research at this site is that researchers are now in a position to determine how different elements of the system work together. Over the last few NSF funding cycles, Wiberg has studied erosion at the edge of marshes. It is possible that the waves that are eroding the marshes are depositing the released sediment higher up on the marsh.

It is also possible that the tidal flats in the bays between the barrier islands and the marshes could be churned up by storms and the resulting sediments carried to the marshes. In this case, the bays would be gradually becoming deeper over time—unless they were replenished with sediment from the ocean. Recent studies have suggested that this might be the case.

Accordingly, one of the goals Wiberg has set for herself for the new funding cycle is to gain a better understanding of the sediment budget of the system. "This is extraordinarily important," she says. "If we lose the marshes, the whole system will change dramatically."

DAVID LEE

Field Experiences for Students and Teachers

ONLY A SMALL percentage of people who live on the Eastern Shore earn their livelihood from the ocean or spend much time on the coast. As a consequence, school children there have almost no exposure to coastal ecology. At the same time, surveys show that most science teachers do not feel competent conducting classes in the field. "One of the goals of the education and outreach program at the VCR LTER is to get teachers and their students outdoors, where they can gain a firsthand appreciation of the working science," says **Cora Johnston**, site director of the Anheuser-Busch Coastal Research Center, the headquarters of the VCR LTER.

Each summer, the VCR LTER and The Nature Conservancy host two week-long nature camps for students from Accomack and Northampton Counties, one for students from six to eight years old and the other for students between the ages of nine and 13. The VCR LTER provides scholarships for many of these students, and students are encouraged to attend each summer. Johnston is working to establish a counselor program that would serve as a bridge to the VCR LTER's Summer Science Internship program, which pairs two local high school students with VCR graduate students conducting field-based research projects.

"Close observation provides the foundation of both art and science."

The VCR LTER also offers a number of programs for teachers. The Art and Ecology program, now offered four times a year, brings both science and art teachers to the ABCRC. Under the tutelage of scientists and artist Alice McEnerney Cook, they develop skills in drawing or plein aire landscape painting while being introduced to the ecology of the Eastern Shore. "In the course of the program, the teachers realize that close observation provides the foundation of both art and science," Johnston says.

Deploying Technology in Service of Science

REGARDLESS OF ADVANCES in technology, there is a single constant that defines Research Associate Professor **John Porter**'s post as information manager at the VCR LTER program. "My ultimate responsibility is to ensure that researchers at the VCR LTER are more productive," he says.

This can take a variety of forms. Most obviously, Porter spends time evaluating the latest technology and ensuring that the most effective equipment is made available to researchers. For instance, he is leading a LIDAR (light detection and ranging) analysis of the reserve's salt marshes, a critical tool in determining whether marsh elevation is keeping pace with sea-level rise.

The VCR LTER's most valuable resource is its 230 data sets, collections of observations that often extend back 10 years or more. Porter has moved them to the Cloud, where they are easily accessible to researchers who need them. He was the leader of an LTER-wide team that developed a thesaurus of key words that has made searching the entire LTER data repository much more efficient.

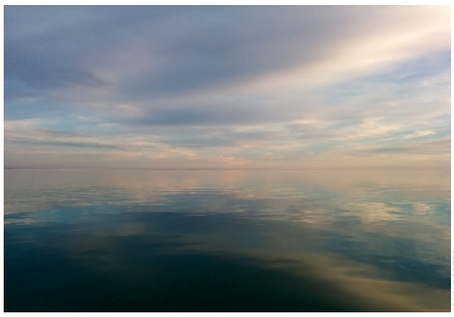
Equally important, Porter shares his own knowledge widely, for instance regularly teaching workshops on geographical information systems, an essential tool for spatial analysis. "It's the best way I know to ensure that when it comes to research at the VCR LTER, I'm not the bottleneck," he says.

ENRIQUE REYES

CORA JOHNSTON

Facing page, clockwise from top left: Sediment researcher Patricia Wiberg; Conducting the annual marsh biomass sampling in at the VCR LTER; Extracting biomass cores from underwater seagrass beds.

Awards, Appointments, and Publications



JOHN PORTER

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 **Dominque H. Ong**, the Mahlon G. Kelly Prize in ecology to **Levi T. Helm** and **Kyle W. Leathers**, the Hydrology Award to **Zachary A. Perkins**, and the Wilbur A. Nelson Award in geosciences to **Michael D. Ratcliffe**.

Katherine K. Knowles was selected to receive the Hart Family Award for Undergraduate Research in Environmental Sciences. It provides funds to assist a full-time environmental sciences major conducting a supervised research project.

Connor W. Smith was this year's recipient of the Richard Scott Mitchell Scholarship, which provides $1,800 to a rising fourth-year student who is focusing on geoscience and has completed Fundamentals of Geology and two other advanced courses in geoscience, preferably including mineralogy or petrology.

Emma M. Lewis 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 **Veronica F. Sullivan**.

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 **Yvonne V. Dinh**, **Gabriella Freckmann**, **Levi T. Helm**, **Kyle W. Leathers**, **Emma M. Lewis**, **Zachary A. Perkins**, **Madeline B. Reinsel**, **Matthew R. Shippee**, and **James L. Thorndike** as distinguished majors.

Elizabeth S. Milo won the Undergraduate Thesis Award.

Six environmental sciences majors were elected to Phi Beta Kappa. They were **Abigail W. Chan**, **Levi T. Helm**, **Heather A. Landes**, **Zachary A. Perkins**, **James L. Thorndike**, and **Hana R. Thurman**.

Shivani Dimri and **Courtney S. Roark** won University of Virginia Harrison Undergraduate Research Awards. Funded by the family of the late David A. Harrison III, the Harrison Awards were first presented in 2000. Each year, approximately 40 awards of up to $3,000 each are granted on a competitive basis to undergraduate students.

Nayoung Lee and **Kathryn A. LeCroy** (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.

GRADUATE STUDENTS

Matthew P. J. Oreska 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. **Alexandra M. Parisien** earned the Graduate Award in Ecology, **Jacob Malcomb** secured the Graduate Award in Hydrology, **Mitchell K. Kelleher** won the Graduate Award in Atmospheric Sciences, and **Laura E. R. Barry** received the Ellison-Edmundson Award in Interdisciplinary Studies.

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

Amelie C. Berger 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.

Katherine M. Coughlin 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."

Laura E. R. Barry won the Michael Garstang Award, which supports graduate student research in interdisciplinary atmospheric sciences.

Lillian R. Aoki received the Jay Zieman Research Publication Award, named after the late Jay Zieman, long-time chair of the department.

This year, **Alice F. Besterman**, **Melissa Hey**, **Kathryn A. LeCroy**, and **Martin P. Volaric** each won the Moore Research Award. Based on merit, this award was initiated to help sponsor the dissertation and thesis work of environmental sciences graduate students.

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

Nevio Babic received the Fred Holmsley Moore Teaching Award, which is 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

Donna H. Fauber won the Department Chair's Award, which recognizes an individual who has performed extraordinary service to the department.

The Environmental Sciences Administrative Office staff was recently awarded Silver Certification as a green workplace at UVA. The Green Workplace Program engages UVA employees in actions that conserve resources, save money, and advance sustainability.

FACULTY

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

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.

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.

Robert Davis was one of eight All-University Teaching Award honorees for 2018. He is a member of 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*. He also serves as a member of the Earth Observatory Science Advisory Team at the National Aeronautics and Space Administration. At the University, Professor De Wekker was a member of the Faculty Senate Nominating Committee.

Scott Doney, the Joe D. and Helen J. Kingston Professor in Environmental Change, was named to Clarivate Analytics' 2017 List of Highly Cited Researchers, a list of 3,300 researchers in 21 fields that recognizes individuals whose papers have supported, influenced, inspired, and challenged other researchers around the globe. He also serves on the Steering Committee of the Decadal Survey of Earth Science and Applications from Space of the National Academy of Sciences.

Howard E. Epstein is a member of the board of directors of the Arctic Research Consortium of the United States. At the University, he is co-director of the College Science Scholars program and served on the College and Graduate School of Arts & Sciences Committee on Graduate Educational Policy and Curriculum as well as its Committee to Imagine the Future of the Graduate School. This year, the department awarded Professor Epstein its Maury-Tice Prize for research excellence.

James N. Galloway, the Sidman P. Poole Professor of Environmental Sciences, and the team developing the Nitrogen Footprint Tool won the 2017 Campus Sustainability Research Award from the Association for the Advancement of Sustainability in Higher Education. He serves as a member of the Environmental Protection Agency's Science Advisory Board as well as the Board of Scientific Counselors to its Office of Research and Development. He is also an associate editor of *Environmental Development*. In addition, Professor Galloway is 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.

Kevin Grise received a prestigious National Science Foundation CAREER Award. 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 a member 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. At the University, Professor Herman serves as the chair of the College and Graduate School of Arts & Sciences Committee on Educational Policy and Curriculum and as a judge at the annual Huskey Graduate Research Exhibition.

Alan D. Howard serves on the Fellows Selection and Awards Committees of the American Geophysical Union and as a panel member of the Headquarters Program Review of the National Aeronautics and Space Administration.

Deborah Lawrence was selected to participate in UVA's Leadership in Academic Matters program. She is also a member of the University Committee on Sustainability and the Department of Politics Environmental Policy Search 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* and was a guest editor of *Ecology Applications* and *Proceedings of the National Academy of Sciences*. At the University, he is a member of the University's Sexual Assault Board and of the Sustainability @UVA initiative.

Stephen A. Macko serves on the Committee on Education of the European Geosciences Union and is editor-in-chief of *Nitrogen*. He is on the editorial board of the *Oxford Research Encyclopedia for 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 was the University's associate vice president for research, sustainability, and the environment through the end of 2017. She serves as the lead principal investigator of the Virginia Coast Reserve Long-Term Ecological Research (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 Steering Committee of the Mid-Atlantic Coastal Resilience Institute, 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 and a member of the Committee on Sustainability.

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 and Sciences and as a member of the University Assessment Advisory Committee, the Institutional Biosafety Committee, and the Institutional Review Entity.

Michael Pace chairs the department. He is president-elect of the Association for the Science of Limnology and Oceanography (ASLO) and chair of its Finance Committee.

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 at *Atmospheric Chemistry and Physics*. She was selected as an Ignite Teaching Fellow by the University's Center for Teaching Excellence.

G. Carleton Ray served as a member of the Council of Trustees of the Bahamas National Trust.

Matthew Reidenbach is a guest associate editor of *Frontiers in Marine Science* and serves on the National Science Foundation's CAREER Award Education Panel. At the University, he is a member of the Jefferson Scholars Foundation Undergraduate Selection Committee.

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

Todd Scanlon is a member of the National Science Foundation's Hydrologic Science Panel. At the University, he is a reviewer for the Harrison Undergraduate Research Awards and the Double Hoo Research Awards.

Pragnyadipta Sen shared the department's Environmental Sciences Organization Award, which is given to members of the department who have been particularly helpful to undergraduate majors.

Herman H. Shugart, the W. W. Corcoran Professor of Environmental Sciences, is a member of the Biomass Mission Assessment Group for the European Space Agency as well as the Intelligence Science and Technology Experts Group at the National Academy of Sciences, Engineering, and Medicine. He is also an associate editor of *Ecosystems* and *Ecological Processes* and a member of the editorial boards of *PeerJ* 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.

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 shared the department's Environmental Sciences Organization Award, which is given to members of the department who have been particularly helpful to undergraduate majors.

Vivian Thomson (retired) won an honorable mention award in the 2018 American Publishers' Association PROSE competition in the Government and Politics category for her book, *Climate of Capitulation: An Insider's Account of State Power in a Coal Nation*.

Patricia Wiberg was elected a fellow of the American Geophysical Union (AGU). She serves on the executive committee of the AGU's Earth & Planetary Surface Processes Focus Group and chairs the Steering Committee of the National Science Foundation's Community Surface Dynamics Modeling System, a modeling community of approximately 1,100 members. She is also 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 proposal review panel for Fonds de Recherche du Québec.

PEER-REVIEWED PAPERS, BOOK CHAPTERS, AND BOOKS

(Summer 2017 through Spring 2018)

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Ade, L.J., L. Hu, H.B. Zi, C.T. Wang, **M. Lerdau**, and S.K. Dong. 2018. Effect of snowpack on the soil bacteria of alpine meadows in the Qinghai-Tibetan Plateau of China. *Catena* 164: 13–22. doi:10.1016/j.catena.2018.01.004.

Ai, J., G. Jia, **H.E. Epstein**, H. Wang, A. Zhang, and Y. Hu. 2018. MODIS-based estimates of global terrestrial ecosystem respiration. *Journal of Geophysical Research: Biogeosciences* 123: 326–52. doi:10.1002/2017JG004107.

Aneece, I.P., **H. Epstein**, and **M. Lerdau**. 2017. Correlating species and spectral diversities using hyperspectral remote sensing in early-successional fields. *Ecology and Evolution* 7: 3475-3488. doi:10.1002/ece3.2876.

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Aoki, L.R., and **K.J. McGlathery**. 2017. Push-pull incubation method reveals the importance of denitrification and dissimilatory nitrate reduction to ammonium in seagrass root zone. *Limnology and Oceanography Methods* 15(9): 766–81. doi:10.1002/lom3.10197.

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Babić, N., Ž. Večenaj, and **S.F.J. De Wekker**. 2017. Spectral gap characteristics in a daytime valley boundary layer. *Quarterly Journal of the Royal Meteorological Society* 143: 2509–2523. doi:10.1002/qj.3103.

Bailey, C.M., M.E. Flansburg, K.E. Lang. and **T.H. Biggs**. 2017. The Geology of Jefferson's Country: A Blue Ridge Traverse Across Albemarle County, Virginia. *Virginia Geological Field Conference Guidebook*, Virginia Department of Mines, Minerals, and Energy, Division of Geology and Mineral Resources, Charlottesville, VA. 52p.

Baker, A.R., M. Kanakidou, K.E. Altieri, N. Daskalakis, G.S. Okin, S. Myriokefalitakis, F. Dentener, M. Uematsu, M.M. Sarin, R.A. Duce, **J.N. Galloway**, **W.C. Keene**, A. Singh, L. Zamora, J.-F. Lamarque, S.-C. Hsu, S.S. Rohekar, and J.M. Prospero. 2017. Observation- and model-based estimates of particulate dry nitrogen deposition to the oceans. *Atmospheric Chemistry and Physics* 17: 8189–8210. doi:10.5194/acp-17-8189-2017.

Balaguru, K., **S.C. Doney**, L. Bianucci, P.J. Rasch, L.R. Leung, J.-H. Yoon, and I.D. Lima. 2018. Linking deep convection and phytoplankton blooms in the northern Labrador Sea in a changing climate. *PLoS ONE* 13(1): e0191509. doi:10.1371/journal.pone.0191509.

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Berg, P., M.L. Delgard, R.N. Glud, M. Huettel, C.E. Reimers, and **M.L. Pace**. 2017. Non-invasive flux measurements at the benthic interface: the aquatic eddy covariance technique. *Limnology and Oceanography*: e-Lectures 7: 1-50. doi:10.1002/loe2.10005.

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Besterman, A.F., and **M.L. Pace**. 2018. Do macroalgal mats impact microphytobenthos on mudflats? Evidence from a meta-analysis, comparative survey, and large-scale manipulation. *Estuaries and Coasts* 41: 2304–2316. doi:10.1007/s12237-018-0418-3.

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Committee on the Decadal Survey for Earth Science and Application from Space (**S.C Doney**, member), National Academies of Sciences, Engineering, and Medicine. 2018. Thriving on our changing planet: A decadal strategy for Earth observation from space. In Press. The National Academies Press: Washington, DC. doi:10.17226/24938.

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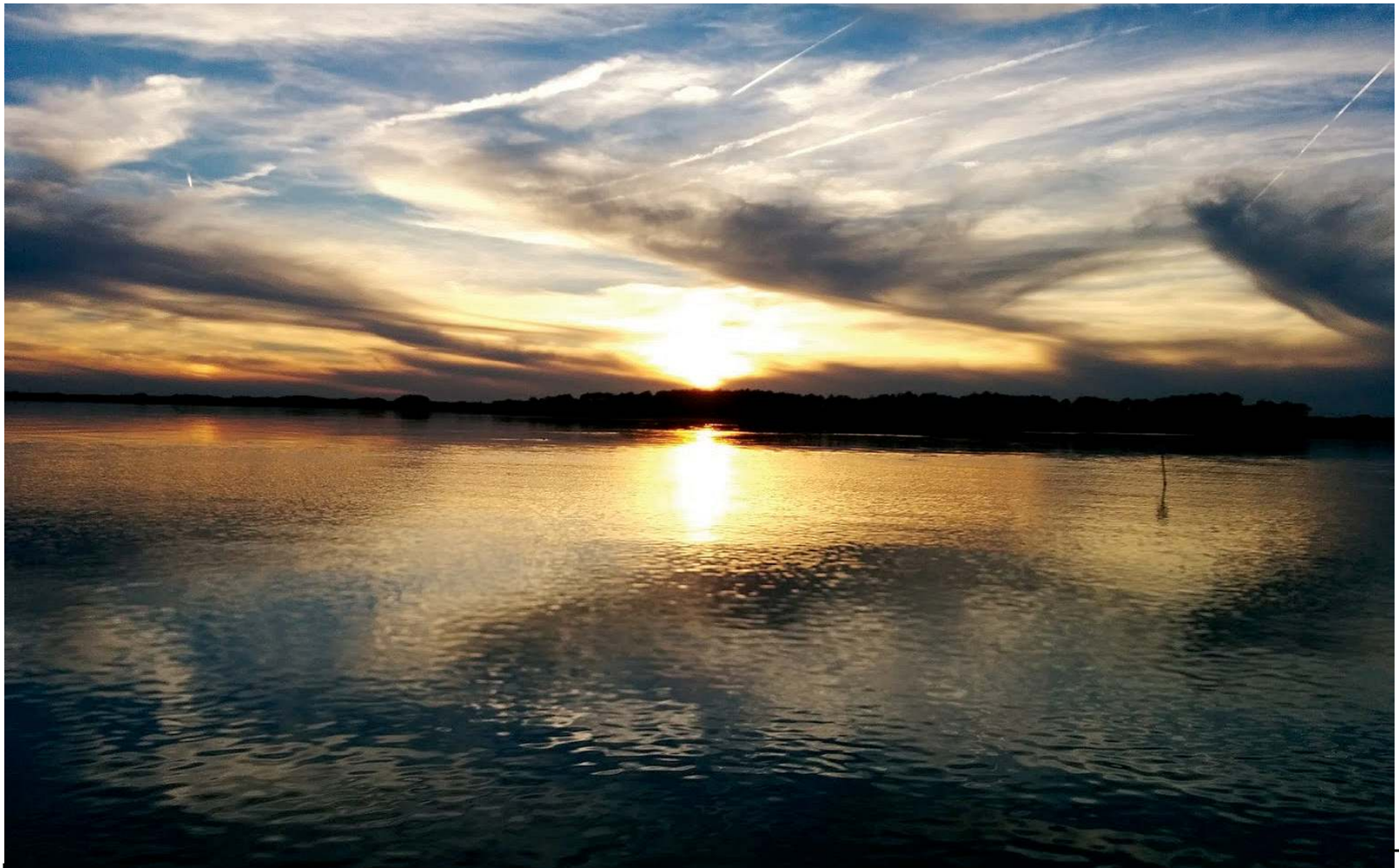

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