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Springtime in the South Atlantic
The springtime phytoplankton communities shown in this image were spotted between the Falkland Islands to the west and South Georgia Island to the east by the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument aboard NASA-NOAA’s Suomi NPP satellite on November 16, 2015. Photo courtesy: NASA/Ocean Biology Processing Group, NASA Goddard Space Flight Center

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Duke Environment
forging a sustainable future
EARLY STRUGGLES & INTERDISCIPLINARY ENVIRONMENT BONDED STUDENTS AND FACULTY TO CREATE A FOUNDATION FOR GREAT THINGS

BY KATI MOORE MEM’16

Rikki Grober-Dunsmore is a resident of California and is the director for The California MPAs Program @ The California Marine Sanctuary Foundation.

“I really value and feel fortunate that I had the experience that I had at Duke. I think we were there at the right time and right place.”
KATHARINE HETTS

Katharine is a resident of Oregon but is currently in California as the acting Fire Staff Officer for the Forest Service on the Stanislaus National Forest in Sonora, Calif.

“The friendships I made there are some of the best and most long-lasting I’ve had. We had an incredible, awesome tight-knit group of people in the class.”
BY 1989, environmental concerns had grabbed worldwide attention. The global population surpassed 5 billion, and the United Nations had just formed the Intergovernmental Panel on Climate Change. Environmental disasters such as Chernobyl and the Exxon Valdez oil spill dominated the headlines over the previous decade. The time was right for Duke to reposition itself as a leader in addressing these challenges.

That fall, Provost Phillip Griffiths charged a faculty committee to determine Duke’s role as an environmental leader using the School of Forestry and Environmental Studies as a starting point. After months of deliberation, the committee recommended that Duke create a new school of environmental science and policy on the base of the School of Forestry. They called for a school that focused on “educational and research programs in terrestrial ecosystems, marine ecosystems, the earth sciences and human-environmental interactions.”

Two Duke units, the School of Forestry and the Duke University Marine Lab on Pivers Island in Beaufort, N.C., both established in 1938, would be the heart of the new school: an ambitious experiment using an interdisciplinary approach to address environmental challenges.

“Both the Marine Laboratory and the School of Forestry were, compared to many units, relatively interdisciplinary,” says Norman L. Christensen, chair of the 1989 committee and, at that time, professor of botany. “But the school of the environment had to become really interdisciplinary. That had to be the central focus, not for its own sake, but because that was what solving environmental problems demanded.”

After a nationwide search, Christensen became the first dean of the new School of the Environment, which was officially established in 1991 (and renamed the Nicholas School after a gift from Peter and Ginny Nicholas in 1995). “I was very invested. The opportunity to start up this enterprise was just so exciting,” Christensen says.

The school’s leaders continued to work to cross boundaries between different fields of study. In 1997, the Geology Department joined the school as the Division of Earth and Ocean Sciences.

Even before this, however, “there was a recognition that it was important to have strong linkages to that unit,” says Randy Kramer, professor of environmental economics and deputy director of the Duke Global Health Institute, who was a member of the original school faculty.

One of the factors that eventually helped glue together the three units forming the school was the creation of master’s concentrations overseen by faculty in each division. For instance, faculty from the Marine Lab developed the Coastal Environmental Management concentration, and faculty from Earth and Ocean Sciences created the Energy and Environment concentration.

WHAT IT WAS LIKE
By 1992, the school’s new home base, the Levine Science Research Center, was under construction. But in the meantime its Duke campus offices, classrooms and labs occupied the two lower levels of the BioSciences building on Science Drive.

Built in 1962, the BioSciences basement and sub-basement may not have seemed the most auspicious starting place for the incipient school. But its tile walls and linoleum floors (like “the largest men’s lavatory I’d ever seen,” says Christensen) housed a small, but tight-knit, group of scholars and researchers.

There were less than 50 students in the new program, and only 12 faculty members.

Activities that bonded them extended beyond the classroom and field trips to include student-organized and spontaneous social gatherings. Katie Hetts MEM/MF ’94 recalls Friday afternoons at the loading docks behind the building where students gathered with a keg and a fire in a barrel to ward off the winter cold. “We’d stand out there in our overalls and boots, and waylay the faculty as they came out of the building.”

Hetts helped lead the school’s chapter of the Society of American Foresters (SAF), which hosted a Field Day event every year—a tradition that still continues yearly at Couch Farm in Duke Forest. From the beginning the event kicked off with a night spent roasting a whole hog that would then feed participants who joined in cross-cut saw and caber toss competitions the next day.

Rikki Grober-Dunsmore MEM ’92 remembers renting beach houses on the Outer Banks with other students for the weekend, and cheering on the men’s basketball team as Duke won both the 1991 and 1992 NCAA National Championship.

The faculty had their own social gatherings, meeting for potluck dinners and Christmas parties. The school would provide a main dish such as a turkey or ham and everyone would bring a dish to share—forestry professor Bill Stambaugh’s wife always brought fruit tarts, says Lynn Maguire, professor of the practice of environmental decision analysis.

The school’s sense of community was forged not only by celebrations and social events, but also by loss. In 1992, the graduating class lost three of its members within months of graduation. Kerrie Kuzmier and Pavlik Nikitine were in a plane crash on their way to Costa Rica to work on sustainable development and ecotourism. That same year, their colleague Steve Lee lost his fight with leukemia.

“It was heart wrenching, and it also brought us together,” says Grober-Dunsmore. Students, faculty, and staff banded together in support of each other to create an endowment fund in memory of the three graduates. The Kuzmier-Lee-Nikitine fund still provides scholarships to Nicholas School students, and members of the ’92 graduating class continue to meet to select recipients and remember the colleagues they lost.

The other classes of the early 90’s stay in touch as well, both socially and professionally. They are all part of an extensive network of Nicholas School alumni.
Judith is a resident of California and is the procurement strategy program manager at the Energy Division of the California Public Utilities Commission.

“I really enjoyed my time there, and it was a very friendly and down to earth place.”
"There’s this incredible professional network that I’m in touch with, but also know I can access because of the camaraderie of graduates from the school,” says Karen Young MEM’93. “There’s this amazing network that will always be there for you as an alum.”

This network extends even to recent graduates. Karen Kirchof, assistant dean of the Career and Professional Development Center, maintains relationships with the ‘92 and ‘93 graduates and facilitates connections between alumni and current students, helping secure jobs and internships for tomorrow’s environmental leaders.

Many of today’s environmental leaders are products of the Nicholas School’s early years. “I never cease to be impressed with the number of former students I run into at the EPA (Environmental Protection Agency), the Forest Service, the Wilderness Society, the Nature Conservancy,” says Christensen. You’ll find those early Nicholas School graduates doing great things in a wide range of environmental fields, from corporate sustainability and environmental regulation to wildlife conservation and fire management. (Read how Jane Bacchieri MEM’94 and Henry Stevens MEM’92 have developed green infrastructure as part of watershed management in Portland, Oregon, Page 28.)

**A STRONG FOUNDATION**

Although her focus has shifted to land conservation, Young’s years studying ecotoxicology and environmental chemistry at the Nicholas School laid a strong foundation for her career. Coordinator at Mt. Agamenticus to the Sea Conservation Initiative in Maine, she works with 10 partner organizations across the state.

Her career has taken a path from environmental monitoring, risk assessment, and permitting to conservation work using broader management and policy tools. “The toxicology and other scientific knowledge and skills I gained at Duke have been a really important foundation for all my work through my career.”

Judith Iklé MEM ‘92 also studied ecotoxicology and environmental chemistry, though her career has taken a different path. She is the procurement strategy program manager at the Energy Division of the California Public Utilities Commission. Over the past 25 years—including five during which she worked in Washington, D.C., for the U.S. Environmental Protection Agency—she has worked on the nexus of the environment, energy sector and economic regulatory policy; the implementation of a landmark climate law; and programs supporting a 33 percent Renewable Portfolio Standard, electric reliability integrating distributed resources, and electrification of transportation. “Duke provided me with a valuable education, and I have been working in the climate change policy and energy sector ever since, using the policy and analysis skills.”

During Katie Hetts’ time at Duke, she earned degrees in both forestry and forest ecology—the first student to pursue the Master of Environmental Management/Master of Forestry dual degree. She is now a fire management specialist with the U.S. Forest Service in Oregon. During her career she has studied forest diversity in Nepal, been a fuels specialist and fire analyst, and even fought forest fires via helicopters. Last spring she returned to the Nicholas School to teach a session on fire ecology and fire
DAN RITTSCHOF

Professor of Marine Science and Conservation, he joined the Marine Lab as a research associate in 1982.

“The Nicholas School is a really good idea. The professional master’s program has made a difference. And I’m proud to be in the Nicholas School.”

LYNN MAGUIRE

Professor of the Practice of Environmental Decision Analysis, she joined the faculty in 1982.

“Both the interdisciplinarity and the collegiality of people in pursuing that interdisciplinarity is a really special quality of the Nicholas School.”
behavior to students in a fire management class taught by Dan Richter.

For Grober-Dunsmore, the grounding she received in resource ecology—and the interdisciplinary interactions with fellow students—proved instrumental in shaping her career in marine conservation and policy.

"Somehow we all gelled. Our student projects really valued and appreciated the diverse perspectives and angles that we all came to the table with. And I think that was phenomenally strong," says Grober-Dunsmore, program director at the California Marine Sanctuary Foundation.

INTERDISCIPLINARY BY NATURE
The interdisciplinary nature of classes at the school was also a major plus for Young. "One of the awesome things about being at the school was the ability to learn about so many different aspects of environmental management and science," she says. "It was nice to be exposed to such a broad range of different ways to work in the environment."

The Nicholas School’s approach to environmental problem-solving has made impacts in the careers of not only its professional graduates but its faculty as well.

Maguire, for example, began primarily by teaching decision analysis and population ecology. Over time the interdisciplinary emphasis of the school allowed her to branch out and expand her focus to include participatory management, conflict resolution and community-based environmental management, topics on which she is now widely cited.

Richard Di Giulio, professor of environmental toxicology, who studies how pollution affects aquatic ecosystems, came straight to the Nicholas School after receiving his PhD at Virginia Tech. He found that having colleagues who studied water quality and aquatic ecology from different perspectives helped him broaden his research focus.

“There is no doubt that being close to social scientists and policy experts has benefited me, by helping me think more broadly about how my research can relate to other issues,” he says. “I think having this vibrant Marine Lab also is a huge bonus to the school.”

One of the biggest changes over the years has been the increased focus on social science at the school, Di Giulio and others say.

“There’s definitely been a growth in the social sciences over time,” says Kramer. “When I came here, there were three social scientists. Now we have quite a few more than that. That’s certainly made me more interdisciplinary in my outlook and the way I organize research projects. It’s also made me fond of teaching students with a diverse set of backgrounds.”

Faculty demographics have broadened as well. When Maguire first came to the school in 1982, she was the only female faculty member on the Durham campus, “and I continued to be the only female faculty member for maybe 12 or 15 years,” she says. Now the school’s core faculty includes more than 20 women, though this number is still less than a third of the total core faculty. Still, Maguire says, “It is very refreshing to have so many female colleagues now.”

In 2006, the Nicholas School hired the first female director of the marine lab, Cindy Van Dover.

BUILDING BRIDGES
Even as gains were made in increasing the school’s size, interdisciplinary, and diversity, bringing all the parts together into a cohesive unit wasn’t without challenges.

“Whatever people may say, nobody really likes change all that much, but it’s understandable,” says Christensen. “You’re used to thinking about things a certain way, and having to reframe or rethink it is really challenging.”

Both the Forestry School and Marine Lab had been fixtures at Duke since 1938, but existed on fairly separate planes for the 53 years leading up to the creation of the Nicholas School.

Bridging the physical and cultural gap between these units was particularly difficult, says Dan Rittschof, professor of marine science and conservation who joined the Marine Lab as a research associate in 1982. “The existing faculty had to change its perspective from basically being a field station and a service institution to a functional, multidisciplinary unit of the school.”

The completion of Interstate 40 between Raleigh and the coast in 1990 helped bridge the physical divide between the two units. But more important were the people who got others to work together across boundaries.

The late Ken Knoerr, who was professor emeritus of environmental meteorology and hydrology, was particularly instrumental in building bridges between the Forestry School and Marine Lab, and later, the Earth and Ocean Sciences Division.

“Each of the three units had its own culture, but he was willing to cross boundaries,” says Rittschof.

Knoerr joined the Duke faculty in 1961 as assistant professor of forest climatology, and later served as director of graduate studies for Environmental Sciences and Policy from 1995 to 2007.

Christensen as well as the three subsequent deans have also made great efforts to increase the collaboration between disciplines at the Nicholas School. Even seemingly small acts like Dean Alan Townsend’s Weekly Update, which is emailed to all students, faculty and staff, help build community, Christensen says. “These kinds of things are not things you do and then on you go—they’re really high maintenance items that people have to attend to constantly.”

Ultimately, it’s about building relationships, both between and within divisions. “Trust is key,” says Rittschof. “Trust is really hard cross-culturally, but once it’s there the whole world opens up. That’s where I see the school. I see the school on the edge of being able to do some really dramatic things. And I think it’s probably worth the last quarter of a century of struggling.”

Kati Moore MEM’16 is a Duke Environment blogger and writes regularly for the Nicholas School’s communications team.
Karen is a resident of Maine and is the coordinator for The Mt. Agamenticus to the Sea Conservation Initiative.

“There’s this amazing network that will always be there for you as an alum.”
DUKE KUNSHAN to Offer New Professional Degree in Environmental Policy

Duke Kunshan University will offer a new international master’s degree in environmental policy (IMEP) beginning in the fall of 2017.

The four-semester, 16-course program is designed to meet the growing global need for leaders who are versed in both Chinese and international environmental issues and policies. Student recruitment began this spring.

It was approved by Duke University’s Board of Trustees and Academic Council in fall 2015 and will be offered at Duke Kunshan as a Duke University degree issued jointly by the Nicholas School and the Sanford School of Public Policy.

“Rapid economic development has transformed the landscape across China and much of Asia. This has brought new opportunities, but also new challenges linked to increased air and water pollution, water scarcity, resource depletion and toxic waste disposal,” says environmental economist Junjie Zhang, who will direct the IMEP program.

The impacts of these challenges are compounded by concerns about climate change and food security, and extend far beyond Asia’s shores, Zhang says. There is now unprecedented demand for policy analysts and environmental and business managers who understand the issues, can recognize global and local opportunities for addressing them, and help governments, businesses and nongovernmental organizations forge solutions.

Duke faculty members Erika Weinthal of the Nicholas School, Billy Pizer of the Sanford School and the Nicholas Institute for Environmental Policy Solutions, and Jim Zhang of the Nicholas School and Duke Global Health Institute spearheaded the program’s creation.

Students in the new program will gain the knowledge, tools and training they need to devise solutions through intensive instruction by researchers from both China and the United States. Core classes will span multiple disciplines, including economics, political science, sociology, history, law, statistics and environmental science.

In addition to the full-time IMEP faculty members based at Duke Kunshan, a rotating roster of Duke faculty members will visit the campus each semester to teach, conduct research and advise students. Some classes may be taught jointly at both Duke and Duke Kunshan via teleconferencing and other technologies.

Extensive networking opportunities and professional internships will augment classroom instruction, and students will gain firsthand experience conducting policy research at a new environmental research center slated to open at Duke Kunshan this year.

IMEP students at Duke Kunshan can spend one semester studying at Duke, and master’s students in public policy and environmental management at Duke can spend a semester in China.

Long-Term GLOBAL WARMING Requires External Drivers

By revealing in new detail how Earth cools itself back down after a period of natural warming, a study by scientists at Duke University and NASA’s Jet Propulsion Laboratory reinforces that global temperature does not rise or fall chaotically in the long run but, instead, should remain stable unless pushed by outside forces.

The new evidence may finally help put the chill on skeptics’ belief that long-term global warming occurs in an unpredictable manner, independently of external drivers such as human impacts.

“This underscores that large, sustained changes in global temperature like those observed over the last century require drivers such as increased greenhouse gas concentrations,” says lead author Patrick Brown, a PhD student at the Nicholas School. Natural climate cycles alone are insufficient to explain such changes, he says.

Brown and his colleagues published their peer-reviewed research in the Journal of Climate in February.

Using global climate models and NASA satellite observations of Earth’s energy budget from the last 15 years, the study finds that a warming Earth is able to restore its temperature equilibrium through complex and seemingly paradoxical changes in the atmosphere and the way radiative energy—or heat—is transported through it.

Scientists have long attributed this stabilization to a phenomenon known as the Planck Response, a large-scale increase in infrared energy that Earth emits as it warms. Acting as a safety valve of sorts, this creates a negative radiative feedback that allows more of the accumulating heat to be released.
through the top of atmosphere into space.

The new Duke-NASA research, however, shows it’s not as simple as that. “Our analysis confirmed that the Planck Response plays a dominant role in restoring global temperature stability, but to our surprise we found that it tends to be overwhelmed locally by heat-trapping positive energy feedbacks related to changes in clouds, water vapor and snow and ice,” Brown says. “This initially suggested that the climate system might be able to create large, sustained changes in temperature all by itself.”

A more detailed investigation of the satellite observations and climate models helped the researchers finally reconcile what was happening globally versus locally. “While global temperature tends to be stable due to the Planck Response, there are other important, previously less appreciated, mechanisms at work, too,” says Wenhong Li, assistant professor of climate at Duke. These mechanisms include the net release of energy over anomalously cool regions during an unforced warming event and the transport of energy from the tropical Pacific to continental and polar regions where the Planck Response overwhelms positive, heat-trapping local energy feedbacks.

“This emphasizes the importance of large-scale energy transport and atmospheric circulation changes in restoring Earth’s global temperature equilibrium after a natural, unforced warming event,” Li says.

Jonathan H. Jiang and Hui Su of NASA’s Jet Propulsion Laboratory, managed by the California Institute of Technology, co-authored the new study.
Increasing Drought Now THREATENS Nearly ALL U.S. FORESTS

Forests nationwide are feeling the heat from increasing drought and climate change, according to a new Duke-led study by scientists from 14 research institutions.

“Over the last two decades, warming temperatures and variable precipitation have increased the severity of forest droughts across much of the continental United States,” says James S. Clark, Nicholas Professor of Environmental Science.

“While the effects have been most pronounced in the West, our analysis shows virtually all U.S. forests are now experiencing change and are vulnerable to future declines,” he says. “Given the high degree of uncertainty in our understanding of how forest species and stands adapt to rapid change, it’s going to be difficult to anticipate the type of forests that will be here in 20 to 40 years.”

Drought-induced diebacks, bark beetle infestations and wildfires are already occurring on large scales in the West and models predict droughts will become more severe, frequent and prolonged across much of the United States.

There is also mounting evidence that climate is changing faster than tree populations can respond. Many tree populations, especially in Eastern forests, may not be able to expand rapidly enough into new, more favorable habitats through seed dispersal or other natural means.

“Prolonged drought affects wildfire risks, species distribution, forest biodiversity and productivity, and virtually all goods and services provided by forests, so there is a pressing need to know what is happening now, what might happen in the future and how we can manage for these changes,” Clark says.

The new paper addresses this need by providing a comprehensive overview of current and projected future drought impacts on forests nationwide, how they vary by region, and which management practices could help partially mitigate problems.

“We have a pretty good handle on predicting the impacts of climate change and drought on individual trees,” Clark explains. “But there’s still uncertainty about what might happen at the species-wide or stand-wide levels. These are the scales where we need reliable predictions so forest managers can take steps now to help reduce large-scale problems.”

Clark and his colleagues published their paper in February in the journal Global Change Biology. Funding came from the National Science Foundation.

Reducing U.S. climate emissions enough to avoid a 2°C Celsius increase in global warming could prevent hundreds of thousands of pollution-related premature deaths nationwide by 2030 and generate health benefits of about $250 billion annually, according to a new analysis led by Drew T. Shindell, professor of climate sciences.

“Many people view climate change as a future problem, but our analysis shows that reducing emissions that cause warming—many of which also contribute to air pollution—would benefit public health here and now,” says Shindell.

Most recent climate negotiations have focused on reducing current levels of emissions enough to avoid triggering a 2°C Celsius rise in atmospheric warming—a threshold at which the increased risk of prolonged droughts and heat waves, accelerated sea-level rise and other damaging climate impacts could outpace our ability to adapt. Much of these negotiations have centered on reducing emissions of longer-lived greenhouse gases such as carbon dioxide.

Shindell’s team’s analysis demonstrates the benefits that come from concurrent reductions in emissions of other climate pollutants that are also major causes of air pollution.

“We created a ‘clean transportation’ scenario in which surface transport emissions are reduced by 75 percent, and a ‘clean energy’ scenario in which emissions are reduced by 63 percent relative to reference case increases,” Shindell says. “These scenarios exceed current U.S. emissions reductions targets but are technically feasible and in accordance with the reductions we pledged to achieve at the COP21 climate conference in Paris last December and in our climate accord with China last year.”

The models showed that by 2030, cleaner energy policies could prevent as many as 175,000 premature deaths, and another 22,000 or so deaths each year following that.

Cleaner transportation policies could prevent around 120,000 premature deaths by 2030, and another 14,000 or so deaths each year thereafter.

The nationwide health benefits associated with preventing these deaths would total around $250 billion a year in the near term, likely exceeding what it costs to implement the new policies. When the global health and climate impacts of the reduced emissions are factored in, the value of the accrued long-term benefits could become 5-to-10 times larger than the costs.

Shindell and a team of colleagues from Duke and NASA’s Goddard Institute for Space Studies published their analysis this spring in the journal Nature Climate Change.
In Quest of the Steady State

By William H. Schlesinger

Biogeochemist Bill Schlesinger, former dean of the Nicholas School, probably was born a Citizen Scientist and lives by the creed that it is important to inform the public about the environment in any way and form you can—small or large. He has been a prolific op-ed writer for many years and in the past year has been persuaded to join the “new media” age and put his words into a blog, which he calls Citizen Scientist. Since the Nicholas School is celebrating its 25th year as a school of the environment, Duke Environment magazine asked Bill to take a look at what environmental issues those first graduates of the school might have faced and what we face now. He explains in his essay that what once may have seemed simple has gotten far more complex as the population has grown.

Americans began to take environmental issues seriously in 1969 when the Cuyahoga River in my hometown of Cleveland caught on fire.

On grade-school field trips to the Cuyahoga, I remember seeing pipes carrying brightly colored effluents entering the river. The water pollution of the Cuyahoga typified the problem of “point-source” pollution that was rampant throughout the nation.

Corporations, municipalities, even individuals regarded our air and water as the logical dumping ground for myriad wastes of a modern industrial society—“the solution to pollution was dilution.”

With point-source pollution, blame was easily cast, appropriate remedial actions were obvious, and the regimen for cure, perhaps painful to initiate, was effective.

Some sources of pollution were local while others, such as the sulfur dioxide emitted from coal-fired power plants, cast acidic deposition over a vast downwind region. In college I measured a pH of 3.4 in the rainfall on Mt. Moosilauke in New Hampshire.

The Clean Air Act, the Clean Water Act, and the Endangered Species Act appeared with bipartisan support shortly after Earth Day in 1970. While toxic legacies of point-source pollution persist, such as the PCBs that GE dumped into the Hudson River, we have much reason to rejoice from the early successes of the environmental movement. Few pollutants now spill unregulated into the natural environment, urban children have lower levels of lead in their blood, and whitefish have returned to Lake Erie.

Still, the age-adjusted breast cancer rate among women born after 1940 vastly exceeds that of earlier generations—a poignant reminder of what’s in today’s environment and that there is not always better living through chemistry.

Twenty years after Earth Day, the first students entering the Nicholas School faced even more complex challenges than we did in the early 1970s. If for no other reason, it is because there were simply more of us in 1991—a gradual change that has impacted us in myriad new ways with each passing year.

Today’s environmental problems stem from a rising global population of humans, now close to seven billion, each with a desire for a higher standard of living. Last year, the world’s population increased by 75 million, equivalent to adding a new Raleigh-Durham metropolitan area every two weeks.

While the growth rate of population has slowed since the 1960s, global population has doubled since...
the first Earth Day, and it continues to grow exponentially. Meanwhile, our planet, save for the receipt of a few meteors, doesn’t grow at all.

There are ample field and laboratory studies that show the collapse of populations growing exponentially in a finite environment. Why should Homo sapiens be different?

Nighttime satellite photographs show that humans now occupy nearly all of the Earth’s land surface that is not too dry or too cold for our physiology. The rising human numbers leave less of nature in its natural state, fewer species to share the planet with us, and changes in the basic chemistry of Earth’s atmosphere and oceans that form the evolutionary environment for all life now on Earth.

The old challenges of abating point-source pollution now seem simple compared to how we must address the global impact of humans on the chemistry, climate and biodiversity of our planet.

Strip away the sapiens and the rising numbers of humans show singular Darwinian motivation to pursue resources to make life comfortable. For the past couple of centuries, we have capitalized on the use of fossil fuels to supplant human labor, heat and light our dwellings, grow our food, and move us about in pursuit of the good life.

Population growth rates decline with increasing per capita energy use, but the rate of decline is too slow to circumvent greater overall energy use by the human population. The correlation between the growth of carbon dioxide in Earth’s atmosphere and our rising population shows an astounding $r = 0.9986$. And one recent study reports a new trend of increasing fertility in families at the highest levels of economic wellbeing.

Sixty-five percent of the rise in CO₂ concentration in the atmosphere is attributed to increasing global economic activity. Increasingly, we seem willing to sacrifice areas that are dear to us, such as barrier islands on the mid-Atlantic, in the pursuit of the last drop of petroleum that we can extract from the Earth’s crust.

Bigger is better, when it comes to pick-up trucks, suburban houses, and McDonald’s hamburgers. Apparently, these are the measures of our evolutionary fitness in the modern world.

In the face of rising human population, most of our food production is dependent upon external subsidies of fossil fuels, especially petroleum, for which there is no obvious alternative at a reasonable price to feed us all. Without exogenous nitrogen fertilizer made with fossil fuels, it is doubtful that the present global human population could feed itself adequately.

Meanwhile, freshwaters, especially groundwater, are widely depleted and contaminated with nitrogen from fertilizer runoff. There is nothing sustainable about feeding a population with exponential growth in a finite environment.

Humans already are pushing the biophysical limits of the Earth, changing its climate, ocean circulation, stratospheric chemistry, and net primary productivity—all of which sustain life on our only planetary home.

In the geologic record, we see major extinction events that have accompanied similar changes in these planetary properties in the past. The predicted changes in climate alone are destined to impact the food supply for our increasing population. Given recent events, it seems doubtful that we will withstand lower per capita resource availability on a crowded planet without famine, war and epidemics.

I suspect that the human species will survive, but at what quality of life?

Even so, economists applaud rising human population and tell us that economic growth of about 4 percent per year is best for human well-being. The Wall Street Journal’s front page carries a story “Population’s Flagging Growth Undermines Global Economy.” Don’t worry, we are told, we will grow the size of the resource pie. Demand in the face of shortage yields rising prices which bring new supplies to market.

Economists say that if critical resources fall short, we will simply substitute other goods. The threat of lost jobs and lower profits trumps nearly all efforts to protect the environment from excessive exploitation. But mention family-planning policies to political leaders, and they scamper to escape the room.

So, the biggest challenge facing those concerned about the environment, and thus the challenge before students at the Nicholas School, will be to change the thought process of the public to the notion that a steady-state economy is the best alternative for the future.

The job will not be easy. Sustainability will not be achieved with rising human population and increasing resource use. The challenge asks for a change in human nature, so that we can live up to the species epithet of sapiens and behave, not like the squirrels at my birdfeeder, but in a manner that is truly best for the biosphere with all its inhabitants.

William L. Schlesinger is James B. Duke Professor Emeritus of Biogeochemistry and former dean of the Nicholas School.
The week Duke’s newly formed School of the Environment opened, I was nearly 5,000 miles away, quite possibly covered in mud. It’s not as bad as it sounds: the mud would have been Hawaiian, and I’d wash it off around sunset each day by jumping in the ocean.

More of the mud—or more properly, soil—would have been in a jumble of Ziploc bags scattered about the bed of a dented white pickup truck. Eventually, I’d measure how much carbon was in that soil, among other attributes, and the three-dimensional tapestry of field days would become flattened into a series of spreadsheets. It was all aimed at unraveling just one piece of a problem at once momentous and yet describable in two words: climate change.

The first I remember those words entering my personal radar was during the summer of 1988, just weeks before I began graduate school. My plans for a trip in the Yellowstone backcountry were scrapped by historic fires. The East Coast was unrelentingly hot. At some point, I read a short article in the New York Times entitled Global Warming Has Begun, a piece that summarized the warnings several scientists had delivered to a Congressional panel. Little did I know that one of those scientists, George Woodwell, would soon join the board of a new environment school in Durham, N.C.

I started my PhD that fall, working on a topic that had nothing to do with climate change. But I couldn’t shake both the intellectual excitement and the societal urgency of what I was hearing. Within months, I’d switched labs and dug my first soil pit, proud to be a small part of what I thought was the initial groundswell of a widespread response to a truly global challenge. Two years later, the Nic School opened its doors, I was washing mud off in the sea, and that optimism remained. The problem was defined, the need for action clear, and the first climate summit in Rio was but months away.

So am I jaded now?

Well ... a little, but mostly not. The pessimistic take is that when it comes to meaningful climate action, we've essentially wasted the last generation. In many respects, that's true, and it means our job today is harder than it might have been back then.

But as I've written here before, climate change is a wicked problem, and solutions to those don't come easy. I didn't really understand that in 1991, but now that I do, I see a lot of progress over the last 25 years. Today, we understand and approach climate change through the kind of interdisciplinary lens it demands—one that embraces the workings of both people and the natural world. We have a much better grasp on both the risks and the potential solutions. We've put the topic on nearly everyone's radar. And led by examples such as the Nic School's, we've transformed many of our educational institutions in ways that can better train students to put solutions into play—in private and public sectors alike.

Put another way, I think we've set the table. I wish we'd done it faster, and yes, we now better serve the meal and wolf it down. The last few months are but our latest alarm bell, with an Arctic winter that nearly wasn't, eastern seaboard tornadoes in February, corals bleaching and sea ice melting as never before.

But I also don't think the next 25 years will see the same gridlock. Too many forces are now pushing us onto a different path. To be sure, some of those forces are frightening, but some are unquestionably hopeful. Six months ago in this column, I wrote that the Paris Conference of the Parties would be more of the same: a disappointment. It wasn't.

Even more importantly, real options exist to help meet the Paris targets. Accelerate the widespread adoption of current wind, water and solar technology, and let that in turn spur even more rapid technological innovation. Focus policies—domestic and beyond—on some of the other climate mitigation levers we can pull fastest, for the greatest effect: preserving forested lands, transforming agricultural practices, reducing non-CO2 agents of warming. Achievable solutions, ones that will not wreck economies and toss us back to the Stone Age, are before us. We just have to start putting them into play.

Will we? In truth, none of us knows the answer. I've watched maddening setbacks play out again and again. I've watched the warning signs of climate change mount, and as they have, I've watched our own country's politics descend into a dangerous theater of the absurd. My glasses aren't as rosy as when they were splattered with Hawaiian mud, and I know we might screw this up.

But most days, I think we'll get there. Most days, if you asked me how a Nic School 50th anniversary retrospective will start, my answer might be: In the first 25 years, we laid the groundwork for change. In the next 25, we saw it come to pass.
DAN RICHTER and PETER HAFF believe we’re living in a new age, one that is unlike any that has come before it. And for better or worse, they say, it’s of our own making. “There is compelling evidence that human activity has become the driving force shaping our planet,” says Richter, professor of soils and ecology. It’s time that we recognized this change, Richter and Haff say, by formally acknowledging that a new geologic epoch, the Anthropocene, or Age of Humans, has dawned. This January, Richter and 23 other scientists published a widely cited paper in Science that presented comprehensive evidence that human actions have left measurable signals in Earth’s geological strata and that these signals—which occur on a global scale—are different from those of the relatively stable Holocene epoch, the previous 11,700-year period that allowed human civilization to develop.
The great global carbon, nitrogen and phosphorus cycles have been substantially modified, the analysis shows. Plastics and other manufactured materials with long lifetimes are showing up in sediments worldwide. The rates of erosion and sea-level rise are accelerating. Concentrations of greenhouse gases are rising in our air and oceans, exacerbating human perturbation of the climate system. Against this rapidly changing landscape, invasive species are thriving, and speeding the rates at which others go extinct.

Essentially, humans are playing a role once reserved for geological forces such as wind, water, fire or ice.

At the same time, our machines are becoming more biological, says Haff, professor emeritus of geology and civil and environmental engineering.

We’re creating technologies that can think and communicate with one another, and react in real time to the world around them. Wireless connectivity has allowed these technologies to form new kinds of hybrid ecosystems that turn our farms and factories and homes and cities into responsive environments. The lines between biology, geology and technology are blurring.

In 2014, Haff published a pioneering paper in The Anthropocene Review that introduced a new concept, the technosphere, to describe this emergent Earth system.

"THERE IS COMPELLING EVIDENCE THAT HUMAN ACTIVITY HAS BECOME THE DRIVING FORCE SHAPING OUR PLANET," RICHTER

The technosphere, he explained in the paper, is a quasi-autonomous system that is every bit as real and relevant to global change as the biosphere. It encompasses not just nature but also humans and all their inventions and institutions—everything from cars and computers to satellites and cyberspace. It has its own definable behaviors and internal dynamics, which humans currently drive but don’t really control. And it is evolving at a speed that leaves biological evolution in its dust.

Through their scholarship on these issues, as well as their leadership on the international Anthropocene Working Group, Richter and Haff are helping spearhead the push for a new paradigm in how we view and ultimately manage human impacts on the Earth.

"WHAT WE’RE PROPOSING REQUIRES A FUNDAMENTAL SHIFT IN HOW WE VIEW THE EARTH SYSTEM AND HUMANS’ ROLE IN IT." HAFF

DukeEnvironment recently sat down with them to discuss their work, its implications for environmental science and policy, and how, or if, humans can forge a future that is both sustainable and worthwhile in the face of the rapidly evolving technological and natural changes we’ve helped set into motion.
Based on the unique signals you’re finding in the geologic record, when did the Anthropocene start?

**RICHTER:** “The most widely agreed upon date is likely the mid-20th century, when unique biogeochemical signals from nuclear bomb fallout, plastics and other manufactured materials first began appearing in sediments, ice and ocean water worldwide.

“But you could argue that the earliest signals of human-driven functional change in the Earth system date back hundreds to even thousands of years to the Stone Age, when humans first began using small tools to drive the mass extinctions of other species during the Late Pleistocene. The bones of those extinct species are found in the fossil record.”

Given that the Holocene Epoch is only 11,700 years old, isn’t it a little premature to be recognizing the start of a new geologic era?

**RICHTER:** “That’s the subject of vigorous scientific debate. From my perspective and that of many colleagues, the biogeochemical signals we’re finding and the functional changes we’re observing are large, persistent and distinct enough to indicate we’re in a new geologic age. So, no, it’s not premature.”

But not all scientists agree, right?

**HAFF:** “As scientists, we all agree that something new is happening in the Earth system. Large forces are afoot. The question is whether they are distinct enough from the forces that shaped Earth in the past to leave a unique, global and lasting geologic signature. The answer is yes.”

So what’s the next step in the scientific consensus-building process?

**RICHTER:** “We need to keep searching the geologic and anthropological record for additional evidence. I think we’ve only begun to scratch the surface of what’s out there. We need to expand the scope of our work to the humanities and social sciences, where there is an incredible level of interest in this. We also need to expand the scope of our research geographically, through improved use and funding of resources like the global Critical Zone Observatory network.

“Ultimately, to gain formal recognition of the Anthropocene we’ll have to convince the members of the International Stratigraphy Commission, who can be a tough and skeptical bunch. They’re expected to meet and vote on the issue sometime this year or next, and we’re hoping our research helps persuade them.”

Do you mean that skeptics think the proposed recognition of the Anthropocene—and even its name itself—is more about symbolism than science?

**HAFF:** “It’s partly that, yes, but also it’s that what we’re proposing requires a fundamental shift in how we view the Earth system and humans’ role in it.”

“The world’s technological systems and the human population are all linked together into a combined system that I call the technosphere. It’s a hybrid Earth system.

“With the advent of this rapidly evolving global system, the lines where biology and geology end and technology starts are becoming less defined. The Earth no longer just makes mountains and valleys. It also makes hospitals and highways.

“So what does that mean for humans? It raises difficult questions that extend beyond the traditional scope of the geosciences. They require a paradigm shift in our understanding of how the Earth system operates, the degrees of freedom humans have to operate within it, and how much control we exert over the system itself.”
This could be interpreted as presenting a fairly pessimistic outlook about our future. Is there reason for hope we can turn things around in time?

**Richter:** “Absolutely. It all comes back to degrees of freedom at the personal or local scale, correlated to the scale of the system you’re dealing with. What I love about Peter’s work is that it emphasizes that the greatest resource we have—and the best opportunity for positive change—starts at these personal or local scales, not at the system-wide level.”

**Haff:** “To me, a more important question than climate change is the role of people in an increasingly technological world.

“Humans are being marginalized by technology. Just as Earth’s natural critical zones are being squeezed by highways and buildings and other infrastructure, so too are the small, unscripted places in the technosphere being squeezed. These are the places where free-flowing human interactions and emotions can thrive, independent of the larger system’s control. It’s where much of human purpose, ethics and intentionality lives.”

And these spaces are at risk?

**Haff:** “They’re being squeezed, yes. The technosphere operates like any large dynamic system. To preserve itself, it requires that most of its parts, at least some of the time, have to support its operation. This can be called the rule of performance. It also aims for efficiency. If its parts, including humans, are not performing efficiently they become obsolete and eventually discarded as new technologies appear.

“But there is also a reciprocal rule that governs the way the technosphere operates. This is the rule of provision. It requires that the system provide its parts with an environment in which they can do their jobs, so they can contribute to the system’s operation and continued preservation. It’s a two-way street, like supply and demand. But humans have to perform.”

**Haff:** “That’s a decidedly human perspective! The technosphere is autonomous and doesn’t care what happens to us. But I don’t think it will squeeze us out, either, as long as we fulfill a uniquely useful function and support its operation. As long as we perform better than technology, we have some job security.

“IT might seem that conceptualizing the technosphere from this physical perspective rules out the importance of human initiative, self-direction and purpose. But it doesn’t. It just provides an explanation of the physical conditions under which these qualities can express themselves.

“That’s what I like about the idea of the Anthropocene. It encompasses the unity of people, technology and geology. It’s an idea that helps bring some clarity to what’s happening in the world now.”

In light of all of this, how do we move forward to forge a sustainable and worthwhile future?

**Haff:** “As individuals, as a school and as a society, we have to approach this challenge with humility. A focus only on human self-interest is not really in our own best interest because it discounts the needs of the technosphere, and any solution that fails to address its needs as well as our own is likely to fail.”

**Richter:** “The trick is to find a way to bring about worldwide changes that align the goals of the individual with the goals of the larger collective, and with the needs of the biosphere and technosphere. That’s a tall order, but it’s not insurmountable.

“The greatest opportunity for solutions starts by changing our actions at the personal or local scale, where we have the greatest degrees of freedom. It all builds from there.

“A first step would be to recognize that human activity has become the driving force shaping our planet. Recognizing the Anthropocene would force us to take a broader, more interdisciplinary focus in our study of the Earth system. It brings in the humanities and social sciences, and underscores the different way in which we are now affecting Earth’s biogeochemical processes. It’s a new age, a new system, a new planet. That’s an important message to the stratigraphers who study the Earth’s dynamic rock record, and also to us all.”

Tim Lucas is senior writer for *Duke Environment* magazine and is the Nicholas School’s director of marketing communications.
NICHOLAS SCHOOL FACULTY AND STUDENTS

SPEARHEAD THINK TANK ON OCEAN ENERGY

BY NATHAN MILLER MEM’17
A s interest in offshore drilling grows worldwide, a diverse group of Duke students, scientists and policy experts have come together to identify the impacts increased energy exploration and drilling might have on coastal ecosystems, and to propose possible solutions.

Led by Nicholas School Professor Doug Nowacek, the group is addressing the issues as part of a Bass Connections interdisciplinary research project called, “The History and Future of Ocean Energy.”

In addition to Nowacek, leading the group are Nicholas School faculty members Lori Bennear and Jay Golden, and John Virdin and Jonas Monast from the Nicholas Institute for Environmental Policy Solutions.

“Jay Golden and I had been discussing the idea of bringing a group of students and faculty to research ocean energy and policy for several years. The Bass Connections program gave us a great platform for doing that,” says Nowacek, Repass-Rodgers University Associate Professor of Conservation Technology. “Bass Connection initiatives are nothing new at Duke, but there had never been one that specifically focused on ocean energy.”

The timing for the initiative couldn’t be better, he adds.

With government and industry expressing growing interest in energy exploration off the U.S. East Coast and in the Arctic, agencies such as the Bureau of Ocean Energy Management (BOEM) have been scrambling to develop national policies for regulating the proposed offshore energy activities.

“We’re looking to generate products—papers, presentations and the like—that consider ocean science as well as the socioeconomic impacts of potential policies agencies like BOEM may enact,” Nowacek says. “We ultimately hope that whatever results we produce will help federal agencies formulate the best possible policy for a specific region or topic.”

The 12 students (five graduate students and seven undergraduates) who joined the project were split into three teams, each assigned to research a different coastal region and assess the state of national policies that govern energy exploration and exploitation there.

One team has been analyzing the capacity for the island nation of Mauritius to transition from fossil fuel-based energy to renewable energies by the mid-century. The other two teams have been investigating how the United States can best manage energy exploration and extraction off the Atlantic coast and in the Arctic, respectively.

For Geoff Cooper, a first-year Master of Environmental Management student concentrating on environmental economics and policy, the project has provided him a conduit to continue researching U.S. affairs in the Arctic.

“It’s nice to be doing work that has direct applications to the real world,” Cooper says, “I like being able to access information from students and faculty whose disciplines are different from mine. Interacting with peers who specialize in engineering or history offers me new insight that allows my research in energy to become that much richer.

“We know there are environmental risks that come with offshore drilling wherever you decide to place the rig, and they’re hard to underestimate. However, it’s also pertinent to consider the fact that more than 90 percent of Alaska’s revenue is based on oil,” says Cooper, who spent several years in Alaska before coming to Duke.

Drilling in the Arctic would be a real lifeline to the state’s economy and the economics of other states such as Louisiana, where many ships are built, and Washington, where there is a staging ground for ships before they sail north, he says.

Through his interactions with students and faculty with expertise in policy and engineering, he’s also gleaned useful insights about how energy development in the Arctic could lead to better high-seas infrastructure.

If industrial ships established a more consistent presence in the Arctic, it could push the Coast Guard to expand what are now minimal resources in the area, which has limited their ability to respond on time to ships in distress, he says.

“Without industry assents or the Coast Guard, the Arctic environment is at a greater risk from oil spills or groundings from foreign-flagged vessels,” he says. “Development in the Arctic is going to happen—it’s just a matter of whether or not the U.S. will be prepared for it.”

Cooper and the other students will work with faculty to submit their research to peer-reviewed journals later this year.

Students in this Bass Connections program not only have access to first-hand research, but they received valuable face time with top BOEM administrators, who came to North Carolina for a special workshop Nowacek led at the Duke Marine Lab this past October.

Nowacek hopes to take the group to D.C. in the spring. “It’d be nice to meet with several key policy makers who have the final say on these issues and gauge their responses to the great work our students are doing.”

Nathan Miller MEM’17 is the Nicholas School’s student communications assistant.
Old Threads,
New Mission:

Nicholas Student’s Business Turns Used Clothes into Curated Fashion

by Nathan Miller MEM’17

photography by Amy Chapman Braun
Thrifting—shopping for used or vintage clothing—is among the biggest style trends today. Whether because of the worldwide recession, the hipster obsession over clothes that evoke nostalgia or irony, or because savvy shoppers genuinely admire the diversity of clothing that thrifting can provide, the resale clothing industry now generates billions of dollars in annual sales.

But for Darius Stanton II, it’s about more than just scoring cool styles and sweet savings. It’s also about promoting sustainable resource use.

“I was thrifting before it was cool,” says Stanton, a Master of Environmental Management student at the Nicholas School. “My love for older clothes and retro styles started when I was a freshman in high school,” he says. “I’d spend a few hours either after school or during the weekend rummaging through the racks at Goodwill and Salvation Army stores just outside of D.C., looking for something unique or unusual.”

To him, a shirt, a jacket, a pair of shoes or any piece of clothing for that matter always maintains its value, regardless of whether or not it remains in style.

It’s this philosophy—along with a passion for environmental stewardship—that inspired him to join forces with high-school friend and fellow thrift-store curator of style Salasi Kallon to start The Rough, a men’s vintage clothing enterprise.

Based in Washington, D.C., The Rough doesn’t just sell vintage apparel. Stanton and Kallon curate the eclectic items they collect from shops all along the East Coast, from Atlanta to New York, combining articles of clothing from faded eras of fashion to create new outfits, each with a style of its own.

“We wanted to create a variety of outfits so that our consumers look unique and feel comfortable in any environment.”

Their website, TheRoughDC.com, reflects the casual yet distinct aesthetic that lies at the heart of Stanton and Kallon’s brand. The site’s pages feature “look books” and videos showcasing relaxed but confident young men hanging out with friends, grabbing a quick bite to eat, and walking around hip neighborhoods. Their clothes reflect styles from more recent decades, including shirts with the intense primary colors of the 80’s or the geometric patterns from the early 90’s. Among the clothes Stanton and Kallon have found are some gems that offer a snapshot into the culture of the times in which the clothes themselves were produced: a Shaquille O’Neal jersey from his tenure with the Orlando Magic, or a Joe Camel bomber jacket (the kind you could get after buying enough cigarette cartons and submitting the proof of purchase to the RJ Reynolds corporation). These particular items, either because of their sentimental value or simply their kitsch, are sure to serve as successful conversation starters for whoever decides to walk out the door in them.

The Rough launched in April 2015. Though still nascent, online business has been steady, and The Rough’s presence has spread throughout the D.C. metropolitan area and along the East Coast. They promoted their clothes last year at the Broccoli City Festival, a day-long fair devoted to sustainable living and environmental causes. Their success from that event led to Stanton and Kallon meeting with the managers of the Nomad Yard Collective, a D.C.-based department store for vintage clothing. The managers were impressed with what the two students had created and offered them their own space within the store to sell their clothes.

Since then, The Rough has

“I’d love a chance to affect sustainable development policies for the country.”
grown a reliable band of male consumers whose ages range from their late teens to fifties.

For Stanton, the Rough is also his opportunity to merge his love for vintage clothing with his work in sustainability.

The idea is relatively simple, he says—if we use articles of clothing longer, or purchase used items instead of new, we aren’t relying as heavily on the raw materials that go into producing new clothes. This helps conserve the planet’s resources and allows consumers to divert their own financial resources into more essential consumption.

Even before he came to Duke, Stanton was heavily involved with initiatives that sought to engage local communities in environmental stewardship. As an undergraduate student at Claflin University in South Carolina, he worked with the Green For All non-profit organization, which collaborates with historically black colleges and universities throughout the country to get communities of color more involved in environmental protection, environmental justice and resource management.

When he came to Durham, Stanton visited local public schools on behalf of Greenpeace to promote “Repower Our Schools,” an effort to integrate renewable energies into the school district.

Now in his final semester of grad school, Stanton is in the midst of wrapping up his master’s project within the Global Environmental Change concentration of the Nicholas School, while concurrently pursuing job prospects in preparation for post-graduate life.

He wants to continue building his career around sustainable development, though he is still deciding on whether he prefers working on the local, national, or international scale.

“Working on sustainable initiatives at the local level is great because you get to regularly engage with community members and witness up close the fruits of your labor,” he says. “But I’ve also interned with the Department of Energy as a graduate student, and I’d love a chance to affect sustainable development policies for the country.”

The Rough is just another extension of his dedication to living sustainably, Stanton explains.

“We tend to get tired of our old clothes,” he says. “Some pieces of clothing do wear out, but there are a lot of articles—pants, jackets, shirts and so on—that are still functional even though they may have fallen out of style.”

By exclusively selling recycled items, Stanton hopes to show that vintage clothing is not only stylish, but also environmentally friendly.

“I’d say we’ve been pretty successful so far, given our time constraints and limited initial capital investment,” he says.

Stanton and Kallon are currently laying the groundwork to expand their brand. They’re generating more video content for their website, and they released a new “look book” of fresh styles this spring. They also have events coming up soon where they’ll travel across the country to promote The Rough directly to pop-up shops.

Despite his busy schedule, Stanton still finds an hour or two in the week to visit thrift stores in the Triangle with the hopes of finding “lifetime pieces” that mesh with The Rough brand.

It’s more than a business, he says, it’s a passion. Regardless of whether or not the vintage clothing trend turns out to be a passing fad for most people, odds are that 10 years from now, you’ll still find Stanton—or a team of stylists he directs—sifting through the racks of Plato’s Closet, breathing new life into old threads.

Nathan Miller MEM’17 is the Nicholas School’s student communications assistant.
How Three Nicholas School Alumni Are Helping Transform Portland’s Stormwater Management Program

By Tawnee Milko, MEM ’12
Photography by Steve DiPaola
Portland, Oregon

is a metropolis enmeshed in water. Bordered on the north by the great Columbia River and bisected by the Willamette River, the city provides water-related utilities to more than 600,000 residents—and protects watersheds through which 13 species of threatened or endangered salmonids migrate annually. Add in the Pacific Northwest’s trademark wet winter climate, and proper stormwater management, usually an invisible city service, could not be more critical.

“Stormwater—it’s rain,” says Jane Bacchieri MEM’94, manager of the Watershed Services Group within Portland’s Bureau of Environmental Services. “When it lands, it has to go somewhere. But unless it’s a problem at their house, many people don’t understand the impact stormwater can have on our natural systems, and the broader impacts on human health.”

Thanks to the pioneering efforts of such dedicated personnel as Bacchieri, Naomi Tsurumi MEM’02 and Henry Stevens MEM’92, the City of Portland has become a worldwide leader in sustainable stormwater management. It is a journey that has been long, challenging, and expensive, but also one that has resulted in the development of new, and green, best management practices that today are being employed by municipal governments nationwide.

When a drop of water falls to earth, it typically faces one of three fates: seeping directly through soil into the ground, merging with an open body of water, or collecting on an impervious surface like a roof, road or parking lot. In dense urban areas, where up to 100 percent of surfaces can be impervious, stormwater management systems, usually in the form of pipes, help direct rainfall to sewage treatment plants or to natural waterbodies like streams and rivers.

While metropolitan areas have continued to expand, however, aging pipe infrastructure often has not. During heavy rainfall, stormwater can overload undersized or failing pipes, resulting in significant problems like basement sewer backups, urban flooding, sewage system overflows, pollutant transfer into greenways and waterways, and severe stress on local river ecosystems.

Portland, which contains a 150-year-old combined sewer and stormwater system—in which the same pipe network carries both sewage waste and stormwater—was no exception.

“Until 20 years ago, we had sewage overflowing into the Willamette River almost every time it rained,” says Tsurumi, an environmental specialist in Bacchieri’s Watershed Services Group.
Combined sewer system overflows (CSOs) are subject to Clean Water Act regulations and the permit requirements of the EPA’s National Pollutant Discharge Elimination System (NPDES). It took a major lawsuit citing both to spur Portland to begin a $1.4 billion combined sewer system overhaul in 1991. Completed in 2011, the CSO Control Program was the largest public works project in the state’s history. At federal agencies’ insistence, the program primarily included “grey” technologies, i.e. newer, more, and bigger pipe-and-pump systems, which, Bacchieri explains, the EPA at the time viewed as the most effective solution for combined sewer system overflows.

That didn’t stop the Portland bureau’s staff from including a provision in their earliest NPDES municipal stormwater permit application that required the city to conduct research on more effective ways to manage stormwater. As a result, watershed managers began experimenting with green stormwater management techniques across the city, including engineered landscape systems like rain gardens, bioswales and green street planters (small rain gardens that line roads and parking lots to collect stormwater).

“All these facilities are variations on the same theme,” says Stevens, who focused on water resources and soils during his time at the Nicholas School and has managed stormwater projects for the City of Portland for more than two decades since. “The goal is to create landscape areas where we can divert stormwater that will absorb it directly.”

Portland also has employed strategies like planting trees, acquiring natural areas and disconnecting building downspouts to redirect roof runoff toward more permeable landscapes, such as lawns and gardens. The latter, called the Downspout Disconnection Program, is a seemingly simple but high-impact undertaking involving tens of thousands of Portland households that removes almost a billion gallons of stormwater from sewers per year.

“The CSO Control Program really pushed us forward to test new green systems,” Stevens says. “We had the financial backing and the sense that we had to figure out a way to do this.”

It became evident, he explains, that keeping extra water out of the combined sewer system, which green facilities are good at, was the most cost-effective way to reduce the size and price of new “grey” underground pipe infrastructure.

Green facilities also provide a host of ecosystem services. Among others, filtering stormwater through soil before it flows into watersheds removes most silt and pollutants, improving local water quality, especially for sensitive salmonid species. By reducing stormwater flows, they also protect combined sewers and creeks from damaging water surges, which in turn helps restore some natural hydrologic function to urban water systems.

Still, the grasses, shrubs, trees, channels and ponds that characterize many green systems come with their own cost—regular long-term maintenance—which pipes don’t require.

“We call these natural systems, and in certain ways they are. But if you can imagine a green planter in a street, it’s a super urban setting as far as the heat and the dryness that the systems can be exposed to during summers. They’re not in a natural setting,” Stevens says. “Sometimes it costs less to upsize the local sewer line than it does to find the land and design, construct and maintain green stormwater systems over a period of, say, 50 or 100 years.”

Stevens’ colleague, Tsurumi, has been applying tools she first learned in Professor of the Practice Lynn Maguire’s “Environmental Decision Analysis” class to more adequately capture the full costs and benefits of proposed sustainable facilities. At an asset management planning level, it can be difficult to evaluate project alternatives that contain both grey and green infrastructure solutions. For example, Tsurumi says, it’s far
easier to measure the money the city saves by not sending X gallons of water to treatment plants through pipes, because of associated energy costs, than it is to quantify the myriad ecosystem services—such as water quality, aesthetics, and wildlife habitat—that green systems offer.

In 2008, she piloted the use of multi-attribute utility analysis in the planning process for combined sewer updates to a large drainage basin between Mt. Tabor Park in SE Portland and the Willamette River, a project aptly named “Tabor to the River.” This type of analysis, compared to the purely quantitative evaluation of the cost and volume of piped water, can assign values to project attributes like ecosystem services, so they can be factored into a numeric scoring of decision options.

“The multi-attribute utility analysis allowed us, for the first time, to place our watershed objectives and our pipe objectives on the same table and rank them based on which ones were most important,” says Tsurumi, who has since applied multi-attribute utility analysis to a number of other municipal projects. “That we could quantify how far each potential project got us toward meeting these joint objectives.”

Ultimately, the Tabor to the River planning team decided upon a design which, in addition to repairing or replacing 81,000 linear feet of sewer pipe, included the installation of 500 green streets, 100 private property rain gardens, 3,500 street trees, and natural area restoration to help divert stormwater from the sewer system. Together, the green and grey measures saved the city $63 million in construction costs when compared to an all-grey alternative, with added environmental benefits.

Realizing that such substantial construction would require more than the usual outreach to neighborhood residents, Bacchieri’s Watershed Services Group rolled out a unique educational component to help citizens understand how the highly visible green infrastructure would fit into the bigger picture of what the Portland bureau was doing to keep watersheds clean and stop wastewater from backing up into homes. The initiative included ads in local newspapers, a website, newsletters, responsible stormwater management workshops for property owners, and an “Art of Stormwater” exhibit circulated around Mt. Tabor area coffee shops.

Community engagement is a small but integral piece of the Portland bureau’s operations, says Bacchieri. From Community Watershed Stewardship grants to a reward system that offers discounts to ratepayers who keep stormwater from leaving their property, the city offers funding and incentive programs to encourage citizen stormwater management, and has built partnerships with nonprofits, business owners and local schools.

Bacchieri, formerly natural resources policy advisor to the Oregon Governor’s Office and collaborative systems program manager at Portland State University’s National Policy Consensus Center, is no stranger to partnership building. Before she rose to prominence in Oregon’s water resource management scene, she received a Bradley Fellowship to study marine policy at the Duke Marine Laboratory, where she was able to gain real-world experience working on such public sector multi-disciplinary programs as the Albemarle-Pamlico National Estuary Partnership.

Under her leadership, the Watershed Services Group has implemented standardized monitoring of local waterways and developed a watershed health index. On Earth Day 2015, the Portland bureau released the first Portland Watershed Report Cards, scoring such characteristics as hydrology, water quality, fish and wildlife, and habitat. Many indicators, like effective impervious area, total suspended solids, and the levels of specific pollutants, are related to stormwater management.

“People in Portland care deeply about the environment and about the river, and they try to stay very well informed,”
says Bacchieri. “Beyond measuring our own progress in improving watershed conditions, the Report Cards are another way we can keep the community engaged and together look for opportunities to reduce the effective impervious area in the city, such as by de-paving, reducing surface parking lots, or adding green landscaping.”

City residents also have served as advocates to help push sustainable stormwater projects through a generally supportive City Council. Last November, the Tryon-Stephens Headwaters Neighborhood Street Plan was approved with significant community support, thanks in part to Tsurumi and her colleagues’ painstaking efforts during the project’s planning process to obtain the input of scores of residents in the southwest Portland neighborhood.

The groundbreaking Tryon-Stephens Plan marks the first time that Portland’s bureaus of environmental services and transportation have collaborated on a neighborhood scale, bringing a wider breadth of resources to the table. Given funding limitations that plague even the most enterprising environmental bureaus, the team-up between the two bureaus just made sense, Bacchieri says, since both departments work in the public right-of-way.

“It’s not just one bureau that can do this work,” she says. “To address multiple regulations in a more integrated manner across watersheds, we need to coordinate with other bureaus in the city and with the community. It can be time-consuming, and there can be some bumps along the road, but it’s really exciting when you complete these projects and look at all the people involved and think, Wow, we did this together.”

Indeed, Bacchieri, Stevens and Tsurumi exude enthusiasm when describing their regular collaboration with the ecologists, botanists, hydrologists, economists, engineers, planners, and landscape architects also on City of Portland staff. They credit the Nicholas School’s interdisciplinary master’s degree with providing the background to help them work more easily with experts across disciplines to solve the practical problems surrounding water-related environmental issues.

But they remain mindful of the decades of hard work that has led to Portland’s success—especially when utility managers from around the globe ask them about the adaptability of Portland’s green infrastructure to other major cities, many of which are only just beginning to tackle the sewer and stormwater management challenges that Portland took on a quarter century ago.

“That’s taken us years to get here. And we’re still learning,” Stevens is quick to point out. “Figuring out the local nuances of these systems, taking stormwater management ideas all the way through design and permitting, and building enough trust between bureaus to collaborate on projects can take a long time.”

Bacchieri looks forward to the day when green infrastructure isn’t viewed as a novelty by the public and by many municipal colleagues, but instead is better understood as simply the way the city does business. “I think sometimes it’s still seen as either the add-on or the exception, rather than just another tool in the toolbox,” she explains.

The future of urban stormwater management, agree the three Nicholas alumni, relies not on a blanket prescription for the addition of specific sustainable technology, but on ever-expanding cities becoming open to the idea of experimenting with nature-based systems that fit their own watershed needs, infrastructure, funding and culture.

“At least in terms of stormwater, we’re past the point where we can manage everything in a pipe,” Tsurumi says. “The pipes can only be so big; we only have so much money to go back and put in bigger pipes all the time. We have to come up with more creative solutions, and we have to rely more on partnerships to keep the rivers clean.”

Tawnee Milko MEM’12 has been a Nicholas School student and staff member and led the Dukenvironment blogging team. She is now writing and living in Michigan.
Returning to the Nicholas School as part of the Career & Professional Development Center has provided a unique opportunity to reflect on my own career and what has led me back to Duke. Family legend says that during a family trip to visit my then-freshman uncle, I declared my intention to attend Duke while exploring Duke Gardens at age five. My two-and-a-half-year-old brother declared the same when we entered Cameron Indoor Stadium.

We both ended up graduating from Duke, and this deep connection certainly fueled my desire to come back to where my heart can bleed its truest blue.

But why this job? While I've remained steadfastly loyal to the university over the years, my jobs have varied widely. I've always been passionate about the environment and decided my senior year that being part of the Nicholas School Master of Environmental Management (MEM) program was the best way to learn the skills that would set me on my desired course.

My MEM did indeed set me on that path, leading to work in high school classrooms, canoes in estuaries, offices in corporate technology firms, remote rural villages in southern Africa—while pursuing my doctorate—and most recently, teaching and advising at elite institutions of higher education.

None of these steps were ones I had laid out when I had started thinking about what I wanted to be when I grew up. In fact, to some, my career path might seem like less a path than a random walk of dart throws on a map of career possibilities.

For me, however, they make perfect sense—particularly in retrospect. The jobs I've held have helped me hone skills that allow me to help others be their best. The common theme in all of my career choices is wanting to develop others; this is what has resonated most in all of these roles.

My current Nicholas School job is a wonderful culmination of my passion and decisions to date, decisions that have been facilitated by two very different things: intentionality and happenstance. There are many things we can do to prepare for our “dream jobs”—learn the skills, attend the appropriate conferences, and so on. Doing our homework to learn what these things are and taking the steps necessary to make them happen is essential.

This intentionality in preparation makes us better able to do the jobs we seek. Perhaps more importantly, however, it also makes it possible for us to take advantage of happenstance when unplanned, unexpected opportunities pop up that we could not possibly foresee. So often, the dream job we land is one we didn't know to dream about in the first place.

The notion of happenstance as a major factor in career trajectories has been written about quite a bit (I first became acquainted reading John D. Krumboltz). But beyond the literature, the ideas resonate with me because I have experienced it so much myself and observed it in the careers of many of my friends and colleagues.

It is, in fact, how I ended up in my current job: a conversation predicated on something completely unrelated led to an opportunity I could not have predicted. I had done the work to put the pieces in place—developed the skills and experiences to make this next step possible—but one casual conversation opened up an incredible opportunity and changed my career path in ways I still have yet to fully realize.

So what does this eye toward happenstance mean for the way I coach students?

You can do many things to make sure your career connects with your passion, develop important skills for the types of jobs you want to pursue, and make meaningful connections with people who can help facilitate your career. But in the end, it’s also important to acknowledge that there will be things in your career path you can’t chart, and the best thing to do is always, always, be open to the unexpected.

Deb Wojcik is the new director of Career & Professional Development at the Nicholas School.
LESS THAN A DECADE AGO, a designated home for Duke University’s environmental programs was just a dream. But with the support of alumni, friends, faculty, staff, students and corporate and foundation partners, the Nicholas School of the Environment is now thriving in Environment Hall: the hub of all environmental activities on campus and proof of Duke’s commitment to leadership in forging a sustainable future through education, research and practice.

Environment Hall was recently designated as a LEED Platinum facility by the U.S. Green Building Council.

To recognize the many partners who have made Environment Hall—and the learning and discovery taking place here—possible, the Nicholas School has installed several displays throughout the building.

“Environment Hall would not be complete without acknowledging everyone who had a hand,” says Kevin McCarthy, associate dean for development & alumni relations. “Both the building and the school itself have been built through strong relationships with those who share our desire for a sustainable future and our belief that the Nicholas community can lead in creating that future. As we celebrate our 25th anniversary, this is an ideal time to recognize the relationships that have gotten us this far, and that will lift us as we forge ahead together.”

Just inside the main entrance to Environment Hall, visitors will find a donor wall recognizing all of the contributors to the building campaign, as well as a list of the past year’s donors of $2,500 or more to the Nicholas School Annual Fund, with special recognition for those who give at the Blue Sky and Vanguard leadership levels.

The display also lists the school’s current Board of Visitors and Alumni Council—our most engaged volunteer leaders. A rotating portfolio of photographs, student artwork and other visuals highlights some of the activities made possible by donor support.

Close by, near the entrance to the Wegner Art Gallery, is a new piece of art commissioned to celebrate sustainer-level donors who contributed $250 to $999 to the building campaign through June 2015. The piece incorporates the actual signatures of these donors, to symbolize the personal hand that so many have had in creating this magnificent living and learning laboratory.

Designer Nancy Frame conceived the donor wall and signature panel. “The Nicholas School asked us to design a display system that supports the school’s mission, recognizes the generosity of donors and raises awareness of the importance of philanthropy,” she says.

“We were inspired by the beauty in nature and the important role that the Nicholas School has in educating the next generation of global environmental leaders. The larger background images create context and natural beauty, while the smaller images taken by students demonstrate their passion for and commitment to the natural world.”

Adjacent to these donor recognition displays is the relocated Christensen Reading Room, which has moved from Hug Commons to this bright new space. Named to honor the school’s founding dean, Norm Christensen, the reading room is now home to the original signs for
the School of Forestry and the School of the Environment, linking past, present and future in one of the school’s central spaces.

Just downstairs, in the first-floor Field Auditorium, partner-level donors of $1,000 or more to the building campaign are also recognized on a plaque in this state-of-the-art learning space. In addition, dedication plaques both inside and outside the building recognize larger leadership gifts, often made in honor or memory of family, friends or mentors.

Although the building campaign has officially ended, there are still many opportunities to advance the Nicholas School’s mission through significant naming gifts starting at $100,000, all the way up to $20 million to name and dedicate Environment Hall.

Laura Ertel is a freelance writer in Durham, N.C.

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founding dean

NORM CHRISTENSEN

Professor Emeritus in the Division of Environmental Sciences & Policy. He was the founding dean of the Nicholas School of the Environment in 1991.

“The school of the environment had to become really interdisciplinary. That had to be the central focus, not for its own sake, but because that was what solving environmental problems demanded.”