Making Sustainable Energy Technologies Come Alive

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Cover: Professor Craig Arnold’s fall freshman seminar, Science and Technology for a Sustainable Future. Photo: Denise Applewhite

This page: (top left) University energy plant manager Edward Borer, right, speaks to students while visiting Craig Arnold’s freshman seminar. Photo credit Denise Applewhite. Please see the story on page 4. Top right: An aerial photo of the Blue Plains Advanced Wastewater Treatment Plant. Story on page 12.
Welcome to the winter 2011 issue of PEI News. Inside we share exciting stories that reflect the innovative and transformative work being done by our enterprising group of faculty, staff, students and alumni.

We kick off this issue with an article about PEI Associated Faculty Craig Arnold’s Freshman Seminar, *Science and Technology for a Sustainable Future*. An outgrowth of the Grand Challenges program, this fall course provided freshmen with an in-depth understanding of issues and opportunities surrounding energy generation and usage.

Next, we feature PEI environmental historian Emmanuel Kreike. He discusses his new book *Deforestation and Reforestation in Namibia: The Global Consequences of Local Contradictions*, which is an account and a critique of the way scientists and historians have been describing and modeling environmental change.

Our ONE PHOTO focuses on some of the unique architectural features of PEI’s home base, Guyot Hall. Learn from Professor Henry Horn about what the stone ornaments tell about the research conducted inside.

George Hawkins ’83, an environmental attorney who teaches one of the ENV Program’s most popular spring courses, *Environmental Law and Moot Court* describes the cutting-edge environmental work he is spearheading as General Manager of the District of Columbia Water and Sewer Authority.

We interview Stephanie Tatham ’04, a dynamic Environmental Studies (ENV) Program alumna who, as an environmental lawyer in Colorado, continues to be greatly inspired by the ENV courses she took.

We round out our selection of stories with an update from PEI’s research centers and Grand Challenges cooperatives. We also provide highlights from PEI’s largest class day celebration to date and our recently published Grand Challenges Progress Report.

PEI is looking forward to a very full and ambitious 2011. We are introducing several new environmental courses through the Environmental Studies Program (ENV); awarding new Grand Challenges seed grants with great potential to generate important research discoveries; and offering another round of unique internship opportunities to undergraduates that will once again take over 100 Princeton students around the globe this summer.

To follow these exciting developments, please go to our website [http://www.princeton.edu/pei/](http://www.princeton.edu/pei/) or follow us on our Facebook page.
Almost anywhere he looks, Princeton professor Craig Arnold sees energy. “Plants convert light to sugar—this is chemical energy,” Arnold told students in his freshman seminar Science and Technology for a Sustainable Future. “Cars take chemical energy and convert it to linear motion. We convert electrical energy into visible light by using a light bulb.”

For Arnold, an associate professor of mechanical and aerospace engineering and an associated faculty member of the Princeton Environmental Institute, the intricacies of energy are central to his research. In his freshman seminar, Arnold conveys his fascination with the subject to “get students to think, ‘I can make a difference.’”

Students reported the seminar helps inform their strong interest in sustainability topics. Designated as the Donald P. Wilson ’33 and Edna M. Wilson Freshman Seminar, the course is an outgrowth of Princeton’s Grand Challenges Program, an interdisciplinary effort to address global environmental problems.

“I was the president of an environmental organization in high school, so I have always been interested in energy issues,” said freshman Emily Eitches. “This class is so relevant and topical. Already I understand things so much more than I did before, such as how energy works, the societal and bureaucratic parts of energy production and how many people are involved in the process of creating energy.”

In an early class, Arnold told students about the life of the 19th-century English physicist and chemist Michael Faraday, whose experiments and discoveries led to the use of electricity in technology and whose experience provides a model for the challenges facing today’s technology innovators.

In the 1820s, the battery had recently been invented and people were just starting to understand electricity. Scientists thought of it like water flowing through a pipe, but did not appreciate that invisible forces occurring around the wires could be important, Arnold explained.

Faraday, he said, recognized an effect whereby changes in a magnetic field produced an electrical current. This concept is the basis for the modern-day electrical generator.

“By doing so he invented a new kind of physics” and demonstrated a new method that is at the heart of many of today’s discussions about electricity, Arnold said. “These discoveries changed the world.”

To demonstrate Faraday’s law of induction—if the magnetic field is altered, an electric current will travel through wire—Arnold led the class through a lab in which the students used Legos, wire, magnets and voltage meters to construct small electric generators using Faraday’s ideas.

The lesson on Faraday was not just about the discovery itself, but also what happened to
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Faraday’s work. About 50 years elapsed before people were able to turn Faraday’s discoveries into efficient and practical devices, Arnold said.

“Does this still happen today? It does, and this is a real problem. It is known as the ‘valley of death,’” said Arnold, who also is an inventor. “If we invent the next great energy-producing widget in our lab, unless there’s money, the political will and a technological need, it won’t leave the lab and reach the public.”

Faraday’s life story is key for another reason, Arnold said. “Faraday had a fourth-grade education and did not know calculus from trigonometry, but he had an instinct and he wasn’t afraid to ask the questions. ‘What if I do this or that, or flip this around?’ Arnold said. “Today scientists still must be fearless and ask, ‘How does this work? How can I make it better? How can we avoid getting stuck in a rut and come at the problem from another place?’”

Field trips were part of the seminar as well.

While visiting the University’s energy plant, which employs a technology known as cogeneration, the students learned how technologies evolve into more sustainable applications.

On the tour Edward Borer, the energy plant manager, explained how the plant is powered by a large combustion engine. “We generate Princeton’s electricity with big engines to turn the generator — just like your Lego ones, only they are bigger, less flimsy and more precise,” Borer said.

One problem with combustion engine technology, he noted, is that during this process heat is created and in most plants it is wasted. Princeton has overcome this problem by harvesting this heat for other purposes.

“This is the notion behind a cogeneration plant,” Borer said. “Instead of the heat getting away through the chimney we use it on campus for a number of things, such as heating water and buildings. This ultimately saves the University a significant amount of electricity and money.”

For their final projects, students presented tabletop demonstrations of sustainable energy technologies at the Liberty Science Center in Jersey City, N.J. The project provided an opportunity for the freshmen to be creative and gain insights into a subject about which they are passionate, Arnold said.

Freshman Max Rubin said, “The number one threat to the future of mankind is environmental deterioration. Now that I am a student at Princeton, I thought instead of waiting for someone else to find a solution, I should jump into the fray and try to solve it myself.

“I took this class because I want to understand more about sustainable energy solutions such as nuclear fusion, algae, solar and wind,” Rubin said. “We probably won’t be able to solve our environmental problems unless we use less energy. For this to happen, cultural and political change must occur before scientists can implement the technology needed to reduce our energy usage.”

Craig Arnold, an associate professor of mechanical and aerospace engineering, taught the freshman seminar Science and Technology for a Sustainable Future, in which students learned about opportunities and challenges related to the development of sustainable energy technologies. The course included a trip to Princeton’s energy plant. On the tour, Edward Borer explained the environmental and financial benefits of Princeton’s use of a technology known as cogeneration. Students work on a laboratory exercise using Legos, wire, magnets and voltage meters to construct small electric generators. Photos: Denise Applewhite
Your book “Deforestation and Reforestation in Namibia: The Global Consequences of Local Contradictions” was published in January 2010. What is the central message you hope to convey? The book is both an account and a critique of the way scientists and historians have been describing and modeling environmental change, and how these descriptions and models may not help our understanding of environmental problems or improve our ability to solve them.

How do the descriptions and models fail to accurately describe what you have seen happening to the environment in Namibia? Environmental change cannot be explained in a linear way; change does not occur as a single, continuing process of undisturbed nature being transformed, much to its detriment, into human culture. My extensive research in the Ovambo floodplain in north-central Namibia reveals that chronicling, evaluating and judging the impact of human life on Earth is multilinear and extremely complicated. And to ascertain how much degradation humans have imposed through land use is highly subjective, requiring a much broader view than most models provide. It is important to come up with a pluralistic model of environmental change, one that allows us to focus on multiple and contradictory processes taking place simultaneously. Humans are responsible for the situation we are in, but we are interacting with processes beyond our control and understanding.

How do historians and scientists differ in the ways they describe environmental change? Historians who deal with the environment sometimes use models and ideas from the sciences, agriculture, ecology and forestry as shortcuts. Scientists sometimes accept historical data too much at face value. When we talk and think about environmental change, we want to explain it as a perceived outcome. We look for a point of
It is important to come up with a pluralistic model of environmental change, one that allows us to focus on multiple and contradictory processes taking place simultaneously.”

— Emmanuel Kreike

departure in the past—and that point is seen as “pristine nature.” We also tend to be fixated on the outcomes of our behavior, such as pollution and deforestation, but the models we use do not fully explain and investigate the intricacies of the process of change.

You have a Ph.D. in history from Yale University and recently received a second doctorate in tropical forestry/environmental sciences from Wageningen Agricultural University in the Netherlands. Did this have an impact on the book? I credit many of the new insights I had during the research for this book to my second doctorate. I wanted to complete the second doctorate to facilitate my ability to work in a truly transdisciplinary way, to better speak to and to understand scientific language and models. Historians and scientists use different languages. This second doctorate enables me to gain a better understanding of what is going on in both disciplines and stimulate more dialogue.

You have chronicled the way environmental change has been described for more than a half century. How have historians told this story? The perception of environmental change definitely evolved in the 20th century. I have identified three paradigms to explain this phenomenon. In the 1950s, people viewed nature almost as a commodity—it existed to serve humanity in its quest to develop. Humanity’s use and exploitation of the world’s natural resources was humanity’s right and duty, and any environmental decline that resulted was seen as an acceptable price we paid for progress. This set of beliefs I refer to as the modernization paradigm.

During the 1960s, the story of our relationship to the environment was reinterpreted and became the story of human abuse and violation of nature. People began to describe and view environmental change as a series of negative outcomes, such as environmental decline and pollution. They became concerned with nature’s condition, and the green movement took off. I call this the declinist paradigm.

In the 1990s, the story changed again when many people reacted to the Western bias of the traditional green movement and began arguing that some indigenous societies, such as the American Indians, had a different relationship with the environment, a secret way of improving it that was inherently sustainable. The environmental literature began to change. Historians began to focus less on degradation and assert there could be improvement if we took the recipe from these societies to reverse environmental decline. I refer to this as the inclinist paradigm.

Which of the three paradigms do you think is the most useful for understanding human impact on the environment? There are problems with all of these paradigms, the most glaring of which is they are all based on the same perspective—they all took “pristine nature” as the starting point and “culture” as the outcome. They portrayed humankind’s relationship to nature as an irreversible and linear journey from nature to culture, from wild to domesticated, on a straight, simple path.
How does your research show that environmental change does not follow this path? This is what I highlight in the book—it’s not black and white, it’s not nature to culture.

For example, I studied the settlement history of 30 Namibian villages in detail. The pioneers who founded the villages had cut down trees and deforested the area in order to build their homes when they first settled the area. But after they built their homes, they planted many fruit trees and thus reforested the area. Over time new arrivals continued the cycle: first causing deforestation as they constructed new homes and fields, and next facilitating reforestation with fruit trees.

Furthermore, during this time period, other factors shaped the villages’ forest vegetation. One was a reemergence of dangerous animals due to colonial conservation practices, illustrating the unintended consequences of environmental measures. It led to further deforestation, as villagers cut down trees to build fences to protect themselves from predator and elephant populations that had made a comeback and threatened their livestock, crops and fruit trees.

Despite the contradictory vegetation trends, overall, the effect was that the very same sites that were subject to the most intense deforestation—villages’ farms and fields—were reforested with fruit trees. This phenomenon is borne out by an analysis of a time series of aerial photographs dating from 1943 and 1972 and satellite images from 2005.

The landscape of north-central Namibia is now a park-like setting, consisting of farms, fields and fruit trees. It looks like the Princeton campus in some ways. Homes are surrounded by old trees with big, wide crowns. Descriptions of the landscape 100 years ago are almost identical to what you see today. Comparing the states of the environment today and of 100 years ago thus suggests continuity and sustainability over time. But, the apparent continuity is misleading, because radical political, social and economic changes occurred in those 100 years, such as genocidal warfare, devastating epidemics, horrible famines and massive population displacements, causing very dramatic environmental changes including both deforestation and reforestation.

Did the reforestation with fruit trees ultimately improve the environment and the lives of the villagers? In terms of environmental resources available to the human population, the reforestation with fruit trees is an improvement over the previous bush vegetation. Tree fruits contribute to health and food security. Fruits ripen early in the rainy season before the field crops become available. The fruit trees also provide environmental services: They buffer temperature fluctuations under their crowns and provide shade. Villagers use the leaves to feed livestock (and they do this without killing the trees). But, at the same time, the selection of fruit trees over other trees species results in a decrease in biodiversity. This story is not captured fully by a homogenous “nature to culture” paradigm, and it shows that to understand environmental change we need to understand the intricacies and contradictions involved.

“We need to abandon the idea that environmental change is apriori bad or good.”
— Emmanuel Kreike
How do we judge whether over time an environment is degraded, improved or sustainable?

It is difficult to assess if changes like these are unambiguously positive or negative. We need to abandon the idea that environmental change is apriori bad or good. The scenario I just mentioned suggests that maybe environmental change can’t be understood as a singular process. My book therefore argues that it is critical to look at environmental change through multiple lenses allowing for the occurrence of plural processes of change, and study carefully what has happened in the time between the point of departure and the outcome in order to understand the dynamics rather than jumping to hasty conclusions.

Are there other ways the nature vs. culture paradigm causes confusion? Paradoxically we celebrate or mourn modern industrial society as the cause and effect of humans’ victory over nature. Modern industrial society thus is seen as the end of nature and the highest state of culture. Yet modern industrial society is at the same time critically dependent on “natural” resources such as hydrocarbons. Modern human society is not independent of nature; at best (and at worst) it’s a hybrid of nature and culture.

Even many animals are not really unambiguously part of nature or culture. Several of North America’s iconic “wild” animals, for example, are neither wild nor domesticated. Turkey, deer, buffalo, pigeon and geese all passed through genetic bottlenecks as humans subjected the species to dramatic selective pressures by (nearly) exterminating them, breeding them back or managing their populations. Many plants don’t fit into the two categories of wild or domesticated, either. An example is the bioengineering of crops. These crops are not merely human-created technology, but a hybrid of nature and technology.

Now that this book has been published, what’s next? I am finalizing a second book that proposes a new vocabulary that will shed more light on the issues and hopefully create a deeper understanding of environmental change. The vocabulary we use to analyze and describe the environment has given us many insights, but now we are stuck. I’m not rejecting the achievements of the language that we have been using—it has brought us here—but we are in a rut and we have to get out of it to move forward.

History teaches us that every society in the past has believed it understood all, and could find solutions, but no past civilization was ever fully right. And I think that despite the enormous scientific and technological advances of the last decades, we still do not have all the answers today. Nor have we asked all the right questions. Since the origin of the human species, we have been looking for one miracle cure. Environmental change is not about one evil, so it isn’t going to be about one cure. As long as we keep using the vocabulary derived from the nature vs. culture dichotomy, we won’t be able to escape its conceptual limitations and bring our understanding of environmental change to a new level, which is critical in order to face new and old environmental challenges.

Kreike has conducted extensive fieldwork in Namibia for his research on environmental change. The photos below and on pages 6 and 7 depict a typical landscape in north-central Namibia, where the floodplains are lush during the country’s rainy season from December to April and dry during the rest of the year. Photos by Emmanuel Kreike
STONE CREATURES
“The theme of preserving biodiversity is literally carved in stone on the exterior of Guyot Hall. The menagerie of ornaments are mostly extant creatures on the biology side and extinct on the geology side. Some may be from the studio of Gutzon Borglum, of Mount Rushmore fame. The bighorn ram from the North East portal and the ammonites from the South West portal share the developmental feature of a logarithmic spiral, generated by a constant geometry of growth at the big end. A large part of the work of PEI consists of searching for such mathematical regularities in environmental relationships of geology, ecology, technology, and society. One hope is to discover features that stabilize dynamics, and that can be exploited in sustainable ways to keep the living, including us, from joining the extinct.”
— Henry Horn, Professor of Ecology and Evolutionary Biology
ou see it, and you know you are in DC,” explains George Hawkins ’83, General Manager of the District of Columbia Water and Sewer Authority (DC Water) and a Princeton Environmental Institute (PEI) visiting faculty member since 1999. “Driving north from Maryland into DC, people know they’ve arrived when they see our logo—a 7-foot solar-powered water drop that lights up our plant.”

The water-drop logo and the new tagline “Water is Life” symbolize DC Water’s recognition that water is a critical environmental resource and that the public needs to understand what it takes to deliver clean water to the tap every minute of every day, and then cleanse it once we have used it. DC Water and other utilities and companies in the field need to emphasize their environmental mission to steward water responsibly. George Hawkins explains, “DC Water’s goal is similar to PEI’s: how can we use our skills and knowledge to have the most impact on an environmental cause we care about? DC Water represents an enormous public investment; without it the city of Washington, D.C.—or any city—does not function. Access to a clean, constant water supply supports every single job, every single life, as does removing contaminants and then recycling that water back into the environment after people use it. We provide a fundamental, extraordinary service to human civilization.”

DC Water purchases water that is removed from the Potomac River at Great Falls and treated by a federal agency before delivering it to the entire city. After use it is recaptured by DC Water’s sewer system and taken to the Blue Plains Advanced Wastewater Treatment Plant, the largest advanced wastewater treatment (or water recycling) plant in the world. There, all the waste humans have added, including soap from showering, food and oils from cooking, fertilizer from plants, and solid waste, etc., is removed. The water is then returned to the Potomac. Providing this service involves solving many challenging environmental problems and developing new, cutting-edge technologies.

As General Manager, Hawkins fully enjoys this challenge. “DC Water delivers life-giving water and removes dangerous pollutants through
PEI Visiting Professor George Hawkins ’83 Promotes Sustainability as Head of The District of Columbia Water and Sewer Authority  By Carol H. Peters

a vast, complicated, and aging infrastructure system—almost entirely hidden from the people we serve. Yet DC Water and most utilities are considered polluters by the public, and are not well known for their customer service or technical innovation. I thought the best way to help change and improve this industry is to join DC Water and lead a transformation from the inside. I’ve loved every job I’ve had, but this has been the most rewarding, exciting, and fascinating work of my career—even if also a huge challenge on a daily basis. When you run a utility, you are always connecting theory and research to what works.

DC Water operates its own research department. We have our own labs. We routinely hire outside experts. And we have a wonderful staff, all of whom are connected to and committed to actual, concrete improvements to the environment. Someone has to translate grand environmental policy goals into the deliverables we seek. DC Water does this.”

Hawkins graduated from Princeton in 1983 and Harvard Law School in 1987, and began his career as an environmental lawyer for the Boston firm of Ropes & Gray. He then became a federal enforcement lawyer for the U.S. Environmental Protection Agency in Boston, and ever since has held a variety of positions in the environmental field. Prior to DC Water, Hawkins served as: Director of the District Department of the Environment in Washington, D.C., where he regulated all environmental issues for the city, including DC Water; Executive Director of New Jersey Future in Trenton, planning smart growth strategies for New Jersey; and Executive Director of the Stony Brook-Millstone Watershed Association in Pennington, NJ, advocating for land development and management practices that protect vital water resources, including a historic battle over a proposal to extend sewer service from the Trenton Sewer Authority into the countryside.

Hawkins also devotes time helping to develop the next generation of environmental leaders by teaching PEI’s Environmental Studies course ENV 310: Environmental Law and Moot Court. He has many goals for the course, one of which is to demonstrate to undergraduates how employing policy and theoretical knowledge to a
practical outcome, like working for a utility, is a great environmental career. “I encourage all my students to consider a ‘boots on the ground’ job where you use knowledge, experience and ideas to directly improve the environment. We have plenty of theory and ideas, but precious few who dig in and drive fundamental, practical change in the field,” he explained.

While he admits his career path, including working for a utility, is probably not a typical one for Princeton graduates, he explains, “One of my goals for the class is to make my students aware that there is a whole world out there for lawyers. The analytical skills that are taught in law school, combined with the ability to persuade, are golden attributes in the working world. You can use these skills, along with legal knowledge, to support and fundamentally change the environment and the human condition by working for a non-profit, government agency or a utility.”

To translate this conviction into real change, Hawkins is spearheading many innovative environmental initiatives. DC water recently identified $4 billion of long-term capital projects, in concert with more than $400 million in annual operating expenditures. He has led the remarkable effort to raise the necessary support and funds from the public to make the projects a reality, and he has presented these ideas to Congress to obtain support. “All our efforts to serve our customers are founded on the reality that we need support for the inevitable rate increases,” George notes. For example, the average residential customer were charged an additional $8.00 a month beginning October 1, 2010. A few of these long-term projects include:

- Eliminating dead zones in the Anacostia and Potomac Rivers and the Chesapeake Bay by removing nitrogen from wastewater. DC Water created a nitrogen-removal technology (it has applied for a patent), and is now refining it to meet even more stringent nitrogen reduction goals by 2015.

- Implementing new technology to turn biosolids into energy by building digesters, generating enough renewable energy to power 26,000 homes—although all will be used by DC Water itself. The proposed CAMBI digester will be the first installation of its kind in the United States and the largest in the world.

- Using biosolids as a resource by extracting phosphorous, nitrogen, and ammonia—which are used in products people already buy—from the waste collected and selling it. This will

“Princeton is educating the next generation of leaders. Teaching a class at Princeton allows me to work with very gifted students and help them, and me, see the world differently.”
— George Hawkins ’83
ensure that everything DC Water produces is used wisely.

- Building a tunnel to capture sewer overflow during torrential rainstorms, so the combination of stormwater and untreated wastewater does not end up in the Potomac, Anacostia or Rock Creek. The tunnel will catch and hold the excess water until the storm abates and DC Water can pump it out of the tunnel and back to pipes so it can be sent for treatment.

- Looking into the possibility of capturing rain right off residential roofs, in rain-capture planters, or in rain gardens, or using porous pavement so rainwater sinks into the ground directly where it hits. These changes will also help offset storm runoff, and simultaneously create non-exportable green jobs.

Another one of Hawkins’ goals for the course is providing undergraduates with a taste of a career in environmental law. “I teach undergraduates how to present cases with written analytical firepower and with a practiced, polished, structured verbal presentation. Students take turns as the plaintiff and the defendant on historic, landmark environmental law cases, defending their positions to a jury of peers (their classmates) whether they personally believe in the argument or not. It’s a one semester class, but it’s an important window into this world.

“Princeton is educating the next generation of leaders. Teaching a class at Princeton allows me to work with very gifted students and help them, and me, see the world differently. If they choose a career as business leaders, they can make environmental issues a priority at the places they work. I want students to think about service as a worthy pursuit and I believe it is incumbent upon everyone to build that into their lives.”

It is Hawkins’ belief that DC Water’s service practices and many environmental innovations and initiatives could contribute to the entire nation’s sustainability goals. As he explains, “What we are seeking to do in Washington D.C. could be a template for every community, as the issues we have are not unique problems or opportunities. The opportunities in this field are fundamentally unlimited because DC Water does everything — and it all comes together in this sector.”

BY THE NUMBERS

The District of Columbia Water and Sewer Authority

5800 million annual budget
54 billion ten-year capital projects underway
9,100 public fire hydrants that pump drinking-quality water
36,000 valves
16 stormwater pumping stations
9 sewer pump stations
4 water supply pump stations
5 reservoirs
3 elevated storage tanks
1,350 miles of water main pipes
1,800 miles of sewer main pipes, ranging from 8 inches to 27 foot arch sewers
125,000 building sewer laterals
22 flow-metering stations
75 years is the median age of the pipes
9% of the pipes were put in place before 1900, and .2% were installed before the Civil War (1860)
1,000 employees on staff
600 contractors

DC Water will hire between 600 and 900 more people over the next 4 years

DC Water employees are members of 5 different unions

DC Water’s website: http://www.dcwater.com

Left: DC Water crews repair a broken water main in the shadow of the United States Capitol. Below: The DC Water main headquarters building at night. Photos courtesy of DC Water

http://www.princeton.edu/pei/
Alumna Stephanie Tatham ’04

Environmental Lawyer Inspired by PEI’s Environmental Studies Program

By Carol H. Peters

Stephanie Tatham ’04 graduated from Princeton with a degree in politics and a Certificate in Environmental Studies. Below, she describes the fascinating environmental advocacy work she has pursued since graduating, both as a fellow at the Environmental Law and Policy Center (ELPC) in Chicago, and in her new position as an environmental lawyer in Denver. She also shares her advice to current ENV students “to find ways to apply your environmental interests in the real world, to be open to environmental opportunities outside of the traditional environmental arena, and to seek mentorship from leaders in the environmental field.”

Please describe your new position as an Associate with Kaplan Kirsch and Rockwell.

I am the firm’s third Princetonian, joining Polly Jessen (’87) and Allison Fultz (’84, *86). At Kaplan Kirsch and Rockwell, I work on environmental legal issues ranging from redevelopment of contaminated properties, to environmental impact reviews, to alternative energy development. About half of the firm’s clients are government or public transportation agencies, and it has a strong national transportation practice. For example, Kaplan Kirsch and Rockwell represented Denver’s Regional Transportation District in negotiations to use freight rail tracks to operate new commuter and light rail service, and Denver Union Station’s Project Authority in negotiations with the Federal Railroad Agency in preparation for the station’s redevelopment to accommodate the new transit services.

I am excited by the opportunity to apply the experience I gained in transportation advocacy at the Environmental Defense Fund and the Environmental Law and Policy Center to help transit agencies and freight rail operators address the legal issues that arise in the development and operation of urban rail systems.

Did your participation in the ENV program influence your career choice? If so, why and how?

Absolutely. When I came to Princeton, I knew that I had a strong interest in environmental issues, but it was only once I arrived that I realized how important a role my concern for the Earth’s resources and its inhabitants’ health would come to play in my life. As I examined Princeton’s dauntingly diverse course offerings each year, I was always naturally drawn to environmental courses. The Princeton Environmental Institute’s interdisciplinary Environmental Studies (ENV) Program allowed me to take classes examining the logic and structure of environmental decision-making and its impacts on society in not only my major, the Politics Department, but also in the economics, history, chemistry, geosciences and other departments.

Please describe some of the challenges you faced as an ELPC Fellow, and did the ENV Program help prepare you to address them? If so, how?

Federal regulations or even permits can often run hundreds of pages and are filled with complex technical or economic analyses that are not immediately accessible to the general public. One of the most challenging requirements of this job was developing a thorough understanding of regulations on a variety of subjects, and then translating that understanding into opportunities for public participation and advocacy in the decision-making process.

During my sophomore year, I took ENV’s Environmental Regulation: Law, Economics, and Public Policy course, taught by the late professor David Bradford and then-visiting professor Richard Revesz (’79), now Dean of New York University Law School. This course was my first introduction to cost-benefit analysis, the economic analytical process that grounds federal, and often state-level, decision-making on major environmental, public health, and safety regulations. As Dean Revesz explores in his recent book, Retaking Rationality (Oxford University Press 2008), most important regulation affecting American health or safety
have been required to pass a cost-benefit test since the Reagan Administration. Yet, few environmental advocates are engaged in debates on the details of how cost-benefits tests are and should be conducted. The economic and science courses I took at Princeton, and my subsequent work with Dean Revesz at NYU Law, have enabled me to understand the importance of these analyses. My Princeton experience and ENV courses have also given me the scientific background to really examine, and sometimes challenge, policy prescriptions based on their scientific merits.

**Are there particular aspects of the ENV Program that influenced you positively? If so, why?** The ENV Program’s ongoing collaboration with the Community Based Learning Initiative (CBLI) gave me numerous opportunities to work on local environmental issues of importance to surrounding communities. As an example, my thesis on groundwater protection in New Jersey originated in a PEI/CBLI internship after my junior year with the Stony Brook Millstone Watershed Association with then-Executive Director, George Hawkins ’83. The Stony Brook Millstone Watershed Association had been engaged in efforts to conserve groundwater resources around the state, but during my internship the state’s ability to enact protective land use regulations to protect water supplies was called into question by a New Jersey Superior Court decision.

My thesis explored how to write local land use ordinances so as to reduce the risk that these regulations would be struck down in court. As an academic, I enjoyed engaging in this complex legal analysis as well as developing a thorough understanding of threats to New Jersey’s groundwater resources. But the most rewarding aspect of my thesis was knowing that an area nonprofit organization could use my research to further their efforts to protect local water resources. This experience made me appreciate the real world relevance of my academic work, and led me to look for similar collaborative opportunities during law school and in my legal practice.

**Can you offer advice to current ENV students pertaining to the ENV Program or to a career in the field of environmental law?** My advice to students interested in the ENV Program or the field of environmental law is to find ways to apply your environmental interests in the real world, to be open to environmental opportunities outside of the traditional environmental arena and to seek mentorship from leaders in the environmental field. After my sophomore year, I spent the summer as a Project ’55 intern at the Coalition for Peace Action (CFPA) in Princeton. Although one might not immediately identify a peace coalition as an opportunity for environmental advocacy, CFPA’s leadership in advocating for nuclear disarmament was an unexpected bridge into a junior paper examining how the science of risk reduction applied to nuclear regulatory policy and hazardous waste storage.

Working in Princeton gave me the added benefit of being able to work over the summer on my junior paper with my advisor, Frank von Hippel, Director of the Program in Science, Technology, and Environmental Policy (STEP) at Princeton’s Woodrow Wilson School. Professor von Hippel’s scientific expertise meant that he was leading research on issues related to reducing the risk of hazardous-waste storage that were just coming into the mainstream, and were later recognized by the National Academy of Sciences. His insight guided and helped to structure the research that went into my junior paper, which I was able to later use as a writing sample when applying for internships and jobs. As a summer associate at the law firm Arnold and Porter, L.L.P, I found that the issues I addressed in my paper had continued relevance to a firm pro bono project that sought to prevent long-term storage of radioactive waste in Brooklyn, New York.

**Editor’s note:** Stephanie was awarded PEI’s “Environmental Studies Program Thesis Prize” for her thesis “Groundwater Protection in New Jersey: Significance, Current Governance, and the Potential for Further Protection.” Her thesis advisor was George Hawkins ’83, a PEI visiting faculty member who teaches ENV 306: Environmental Law and Moot Court.
Carbon Mitigation Initiative (CMI)
From September 19 to 23, a group of 19 Princeton faculty, graduate students, research staff and affiliates participated in the International Conference on Greenhouse Gas Technologies (GHGT-10) in Amsterdam, The Netherlands. CMI members presented 13 papers and posters related to the fields of carbon capture and sequestration (CCS). Held every other year, GHGT meetings bring together members of academia, government and industry to develop and implement carbon mitigation strategies. Over 1700 participants attended this year’s meeting.

In a continuing research partnership to identify ways to tackle the world’s climate problem, CMI has received a commitment of $11 million from BP as part of an extension of their partnership first announced in October 2008. Lamar McKay, president and chief executive of BP America, visited the Princeton campus on Wednesday, Nov. 17, to celebrate and reaffirm the renewal of the CMI partnership, which will run from 2011 to 2015. While on campus meeting with members of the initiative, McKay presented the inaugural CMI Best Paper Award for Postdoctoral Fellows, recognizing outstanding contributions made by postdoctoral research associates or associate research scholars to CMI’s core areas of research. McKay named Shoibal Chakravarty and Massimo Tavoni as recipients who will share the first award for their paper “Sharing Global CO2 Emission Reductions Among One Billion High Emitters” published in the Proceedings of the National Academy of Sciences in 2009. The paper was chosen from a highly competitive pool of nominations for its high quality and to recognize its original contributions to the discussion of CO2 emissions distribution across the world’s emitting individuals while considering issues of fairness and poverty, McKay said. Future awards now will be made annually through the year 2015 and announced at CMI annual meetings held each spring in Princeton.

The Cooperative Institute for Climate Science (CICS)
In a recent study published in Geophysical Research Letters, a team of scientists from the Geophysical Fluid Dynamics Laboratory (GFDL) and NOAA’s Office of Response and Recovery, including CICS scientist and lead author Alistair Adcroft, created and analyzed computer simulations of dissolved oil plumes, both near the surface and in the deep sea, to help assess the environmental impact of the Deepwater Horizon spill. According to the study, the deep sea plumes of oil and methane from the Gulf of Mexico oil spill will most likely be contained to the Northern Gulf of Mexico because microbial oxidation of the hydrocarbons consumes the plumes before any significant concentrations could reach the loop current and Florida current systems.


Center for BioComplexity
Simon A. Levin Receives Margalef Prize in Ecology
Professor Simon A. Levin was awarded the Margalef Prize in Ecology (Premi Ramon Margalef d’Ecologia) at a ceremony held on October 7, 2010 in the Sant Jordi Hall of the Generalitat of Catalonia (Autonomous Government in the Spanish State), Barcelona, Spain. The President of the Generalitat, José Montilla, presented the award. Dr. Levin received this prize for his fundamental contributions to theoretical ecology (particularly concerning spatial and
temporal heterogeneity), ground-breaking research on integrating different scales in understanding ecological processes, application of basic science to the conservation of biodiversity, and his mentoring of a large number of students who have become highly respected scientists themselves.

The Margalef Prize was created in 2004 by the Generalitat of Catalonia to honor the life and work of Dr. Ramon Margalef (1919-2004), one of the founding fathers of modern ecology and one of the most distinguished Spanish scientists of the twentieth century. The purpose of the prize is to recognize individuals from all over the world who have made major contributions to the field of ecology. Awarded annually and endowed with 100,000 Euros, the Margalef Prize is the most important prize awarded by the Generalitat of Catalonia, and the most important prize, on an international level, exclusively dedicated to ecological and environmental sciences. Past recipients of the Margalef Prize include: Paul R. Ehrlich (2009), Daniel Pauly (2008), Harold A. Mooney (2007), John Lawton (2006), and Paul Dayton (2005).

For a video of the award ceremony, visit (http://www.gencat.cat/premiramonmargalef/eng/index.htm).

**Health Challenge**

From November 4–19, 2010, the Health Challenge hosted Princeton Global Scholar Jeremy Farrar, a world leader in infectious disease research and training. Dr. Farrar’s multi-year appointment began this semester and includes recurring and extended visits to the University, cooperation with faculty on teaching and research, and mentorship of students on campus and abroad.

Farrar brings an in-depth, global perspective to issues facing international public health today. He is the director of the Oxford University Clinical Research Unit (OUCRU) in Ho Chi Minh City, Vietnam. He is the recipient of numerous honors and awards, is a fellow of the Academy of Medical Sciences in the United Kingdom and serves in a number of advisory roles for the World Health Organization.

Farrar studies a wide array of infections. His research ranges from basic work on the ecology and evolution of viruses to applied translational research on vaccines. His work on H5N1 avian influenza was central to defining the clinical presentation and pathogenesis of this disease, while his research on drug resistance in multiple organisms has shed new light on this major evolutionary process. His research has been published broadly over the last five years, particularly in the New England Journal of Medicine.

During this visit Dr. Farrar delivered a public lecture, spoke at the monthly Global Health Colloquium, served as a guest instructor for two courses, and met with faculty and students. He will return to campus in the spring semester, and in the summer of 2011 he will host up to six undergraduates in field research projects addressing multidisciplinary aspects of infectious disease in Vietnam and Nepal.

In the fall semester the Health Grand Challenge hosted and co-sponsored several other events. Highlights included: a public lecture by Chemistry Nobel laureate Peter Agre entitled “Aquaporin Water Channels: From Atomic Structure to Malaria”; Global Health Colloquium seminars by professors Michael Porter (Harvard), Lynn Freedman (Columbia) and Julie Livingston (Rutgers); discussions on HIV transmission and control carried out as part of Princeton’s World AIDS Week; and a career panel and internship information session on pathways to working in global health.
On the faculty front, in the fall Ecology and Evolutionary Biology professor Simon Levin received the Margalef Prize in Ecology and Environmental Sciences from the Generalitat of Catalonia.

Professor Levin is the co-PI on a Health Challenge project investigating the challenge of drug resistance within the broader context of common-property problems in infectious disease.

**Siebel Energy Challenge**

**EVENTS**

**Energy Table**

Schedule of Fall 2010 dinners:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>Oct. 7</td>
<td>Who Killed the Electric Car?</td>
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<td>Oct. 14</td>
<td>Too Cheap to Meter? The Nuclear Fuel Cycle</td>
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<td>Oct. 21</td>
<td>The City Without CO₂: Haider City</td>
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<td>Oct. 28</td>
<td>Stabilization Wedges: How Big is Big?</td>
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<td>Nov. 4</td>
<td>Fall Break</td>
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<td>Nov. 11</td>
<td>Talk about Networking: The Electric Grid</td>
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<td>Nov. 18</td>
<td>Corn Meal, Corn Syrup, Popcorn ... Ethanol!</td>
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<tr>
<td>Nov. 25</td>
<td>Thanksgiving Break</td>
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<tr>
<td>Dec. 2</td>
<td>Printing Energy: Organic Solar Cells</td>
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<td>Dec. 9</td>
<td>Sneak Peek: Siebel Energy Grand Challenge</td>
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<tr>
<td>Dec. 16</td>
<td>Out of the Air: CO₂ Conversion</td>
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<tr>
<td>Dec. 23</td>
<td>Winter Break</td>
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**ARPA-E Program Directors campus visit to discuss new energy technologies.** (http://www.princeton.edu/pei/events/arpa102510/). October 25, 2010.

**Oil, Energy and the Middle East series**

This series was presented by the Institute for the Transregional Study of the Contemporary Middle East, North Africa, and Central Asia, and was cosponsored by the Department of Near Eastern Studies, the Princeton Environmental Institute and the Council for International Teaching and Research.

On October 26, 2010, Professor Giacomo Luciani, Princeton Global Scholar, Director, Gulf Research Center Foundation presented “Commodity Price and Revenue Volatility: Policy Options and the Role of the State.”

**RESEARCH**

Professor of computer science Jaswinder Singh and V. Balaji, Head of the Modeling System Group at the Cooperative Institute for Climate Sciences awarded Energy Challenge funds to pursue research on accessible climate computing for ‘downstream’ science.

**Emily Carter Appointed Founding Director of University’s Andlinger Center for Energy and the Environment**


**COURSES**

Craig Arnold teaches new freshman seminar Science and Technology for a Sustainable Energy Future in fall of 2010 — a course developed with support from the Grand Challenges Program.


**Development Challenge**

Daniel Rubenstein, animal behaviorist and professor of ecology and evolutionary biology, is working with hydrologists Kelly Caylor, Michael Celia, and Ignacio Rodriguez-Iturbe from civil and environmental engineering to investigate the interconnectedness of human and wildlife populations and vegetation as factors influencing water availability and land use in the semi-arid grasslands of central Kenya.

**SPRING 2011 COURSES**

Introduction to African Studies
Social Structure in Africa: Responses to Socio-Political and Economic Forces Since Independence
African Development and Globalization
Ecology and Conservation of African Landscape
Natural History of Mammals
Field Ecohydrology
African Development and Globalization

http://www.princeton.edu/pei/
PEI Awarded Five Environmental Studies Prizes and Named 44 Environmental Studies Certificate Recipients on Class Day

By Carol H. Peters

At PEI’s class day in June, 44 students graduating with certificates in Environmental Studies gathered with faculty and family to celebrate. This year’s group of undergraduates represented 16 majors and academic departments, two from the humanities, 11 from both the natural sciences and engineering, and 20 from the social sciences. PEI awarded five prizes to the following students:

Peter W. Stroh ’51 Environmental Thesis Prize
The Peter W. Stroh ’51 Environmental Senior Thesis Prize was established in 2003 as a memorial to Peter W. Stroh ’51, an active member of PEI’s Advisory Council and an enthusiastic supporter of the Environmental Studies Program. The $1,000 prize is awarded annually to the student who is determined to have written the best thesis on an environmental topic. Academic departments are solicited for nominations in the spring with a limit of one student per academic discipline eligible for consideration. All members of the senior class are eligible to be nominated including students participating in the ENV Certificate Program.


Environmental Studies Thesis Prize
The $500 Environmental Studies Senior Thesis Prize is awarded annually to a senior in the Environmental Studies Certificate Program who has written an outstanding thesis in the broad area of environmental studies. Student nominations are made by departmental thesis advisers.


Ruth N. Metzel, Ecology and Evolutionary Biology. Thesis title: From “Finca” to Forest: Forest Cover Change and Land Management in Los Santos, Panama

T.A. Barron Environmental Leadership Prize
The Thomas A. Barron Environmental Leadership Prize recognizes a member of the graduating class who has distinguished himself or herself by showing exceptional dedication to environmental concerns, not only in formal classes and independent academic work, but also by leading and encouraging activities among fellow students and in the community at large. Nominations are limited to one student per academic department. A second letter that addresses the student’s contributions to environmental leadership is also required. A $5,000 prize is awarded.


Becky Colvin ’95 Memorial Award
The Colvin Prize was established in memory of Becky Colvin ’95, an Ecology and Evolutionary Biology (EEB) major who was strongly committed to field ecology and environmental studies. The award provides an annual grant to support undergraduate environmental field research projects for the senior thesis. Juniors in the ENV Program or EEB major are eligible for nomination.

In December, PEI published a progress report on the Grand Challenges Program. To read the report, please go to: http://www.princeton.edu/grandchallenges/

“...The Grand Challenges Program is designed to help solve some of the most important problems that confront humanity by training a generation of leaders committed to these problems, and by recruiting the talents of faculty, postdoctoral fellows, graduate students, and undergraduates to research solutions.”

— Stephen W. Pacala, Frederick D. Petrie Professor in Ecology and Evolutionary Biology, Director, Princeton Environmental Institute

Footnote: With Grand Challenges project funding, our faculty makes significant contributions to solving challenges facing humanity.
In December 2010, PEI published a Progress Report chronicling early success towards implementing the Grand Challenges Program at Princeton. With a bold commitment to providing leadership and solutions for a globally connected world, Princeton’s Grand Challenges Program is an ambitious and broadly inclusive University initiative designed to tackle complex and vexing global environmental problems by fully integrating the research and teaching missions of the University. The program engages faculty from disparate disciplines with postdoctoral fellows and students at all levels of the Princeton University community to examine the scientific, technological, policy, and human dimensions of the world’s most pressing environmental issues.

Since the Program’s inception three years ago, over 75 Princeton faculty from 28 departments have become involved in research and teaching initiatives. More than 30 new interdisciplinary research projects have been funded, including 27 seed projects. Princeton students are benefitting from a suite of new courses, engaging in hands-on laboratory and field experiments, designing and conducting independent field research projects, and participating in an extensive internship program with destinations around the globe.

Grand Challenges research and teaching activities are principally centered around three research cooperatives: the Siebel Energy Challenge, the Sustainable Development Challenge, and the Health Challenge. The Siebel Energy Challenge confronts climate change, the management of fossil-fuel carbon, the expansion of non-fossil energy sources, and other environmental impacts of the energy system. The Sustainable Development Challenge seeks to eliminate poverty in Africa while conserving the continent’s biodiversity and vast store of natural resources. And the Health Challenge focuses on developing methods to prevent and treat HIV/AIDS, tuberculosis, malaria and other infectious diseases around the globe.

The Grand Challenges Program has spearheaded 44 new or significantly modified courses, 220 undergraduate internships in 35 countries, 75 senior thesis research awards, and supported the research of 64 graduate students. The Program fosters a novel approach to developing solutions and seeks to educate Princeton students to become a generation of leaders uniquely prepared for a globally interconnected and resource challenged world. To learn more or to obtain a copy of the Progress Report, please visit the Grand Challenges website at http://www.princeton.edu/grandchallenges/ or call PEI: 609-258-5985.
Professor Emmanuel Kreike taught a course during the fall semester on comparative environmental history that draws on different historical periods and world regions, including Africa, the Americas and Asia. See inside (page 6).

Photo: Denise Applewhite