dukenvironment

NICHOLAS SCHOOL OF THE ENVIRONMENT FALL 2009

THE DREDGING OF THE HUDSON RIVER

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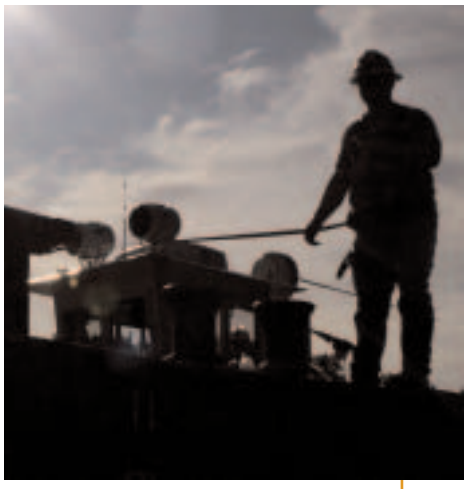

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Due to recent budget cuts and our ongoing commitment to preserve our environment and forge a sustainable future- we have streamlined and shortened the print version of the magazine. Some of your favorite sections like class notes are revised monthly and will be in the online version. Come see the new and updated online magazine at

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Editor Scottee Cantrell

Art Director Amy Chapman Braun

Senior Writer Tim Lucas

Contributing Writers
Monte Basgall, Laura Ertel, Erica Rowell, Donna Sell and Robyn Walker

Photography
Jared Lazarus, Jon Gardiner, Megan Morr and Les Todd, Duke Photography; Judy Rolfe; Kristina Loggia; Ed Hyman; Ari Friedlaender; Robyn Walker; Noah Yavit and Heidi Hausman

Student Assistant Robyn Walker MEM'10

Web Editors Stephanie Thirolle and Brian Johnson

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E-mail Scottee Cantrell at
dukenvironment@nicholas.duke.edu

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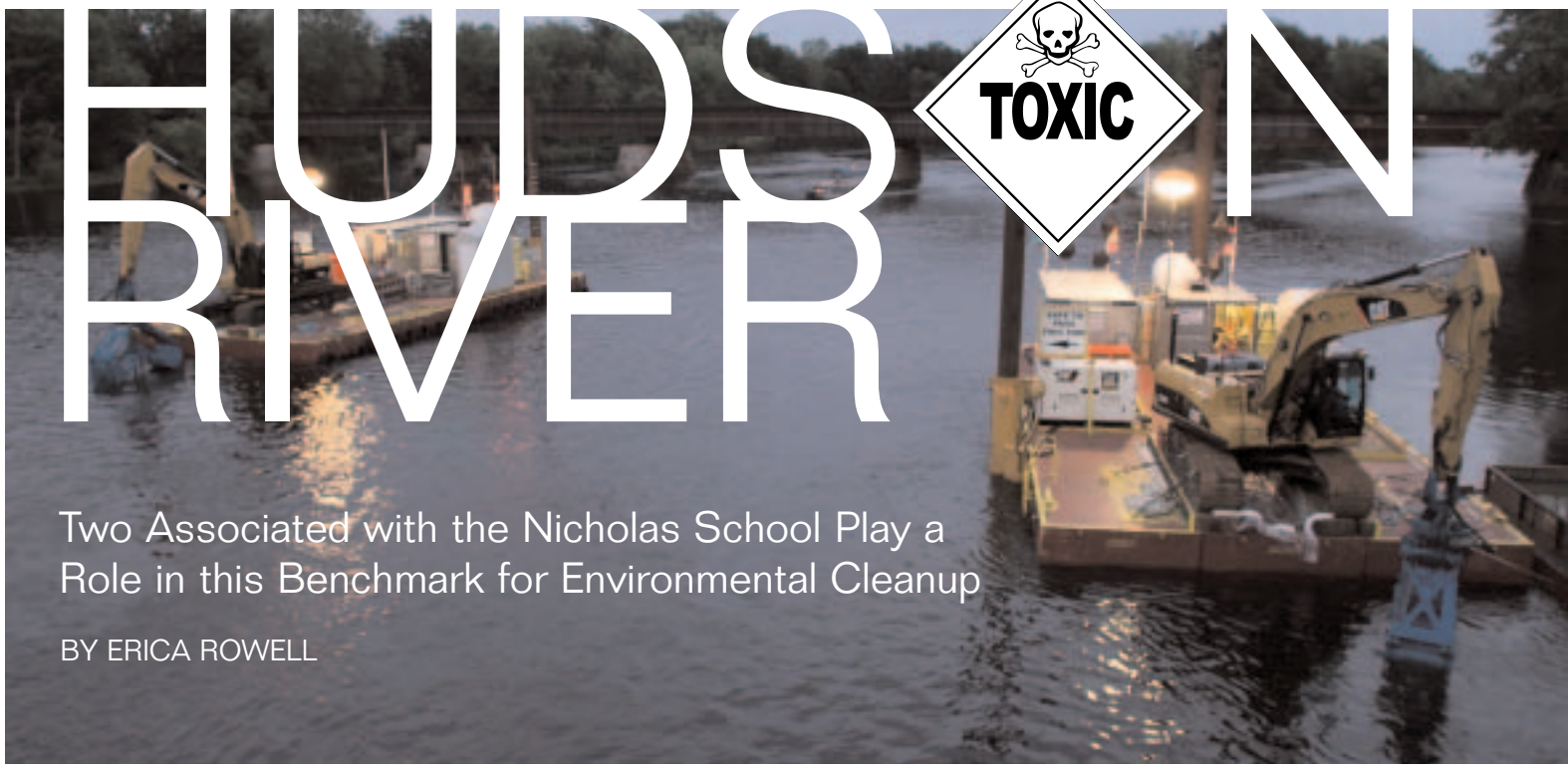
THE DREDGING OF THE HUDSON RIVER



Two Associated with the Nicholas School Play a Role in this Benchmark for Environmental Cleanup

BY ERICA ROWELL

The Hudson River's impact on American history is nothing short of stunning. For millennia, the Hudson has showered riches on the region: bountiful food, scenic vistas, and an important transportation route, to name a few. Today, a new chapter awaits the river. The mighty Hudson is poised to become the nation's biggest environmental cleanup story—or else a lesson in how not to clean a toxic waste site.

The removal of PCBs from the Hudson has been a long time coming. For decades, General Electric dumped contaminants into the river, fought long and hard against a cleanup, all the while denying health problems relating to the polychlorinated biphenyls, the collective name for the group of 209 synthetic compounds better known as PCBs. But then in 2002, 18 years after nearly two-thirds of the Hudson was designated a Superfund site, GE did an about-face and stopped balking.

On May 15, 2009, the dredging of the Hudson River began.

"It's the most challenging project I've ever worked on," says **David Rosoff MS'90** (geology), the Hudson River on-scene field coordinator for the Environmental Protection Agency and one of two alums associated with the Nicholas School who are working on the project. "It's a challenge to work with the best people in this industry. … Technically, the challenges are immense—controlling re-suspension; dealing with quality-of-life issues; working six days a week, 24 hours a day, very close to residents; dealing with noise, lights, and odor complaints; the extensive amount of data

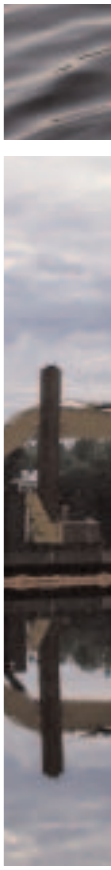
OBJECTIVES OF THE PROJECT

- **Reduce the cancer risks** and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish.
- **Reduce the risks to ecological receptors** by reducing the concentration of PCBs in fish.
- **Reduce PCB levels** in sediments in order to reduce PCB concentrations in river (surface) water that are above surface water applicable or relevant and appropriate requirements.
- **Reduce the inventory (mass) of PCBs** in sediments that are or may be bioavailable.
- **Minimize** the long-term downstream **transport of PCBs** in the river.

(from EPA's 2002 Record of Decision)

THE DREDGING PROCESS:
Following the PCBs from the River to Their New Residence

State-of-the-art dredgers remove sediment from predetermined areas of the riverbed and load it onto hopper barges. When full, the scows are sent via the Hudson River/Champlain Canal to the dewatering/processing facility in Fort Edward, a 120-acre site constructed for the project. The barges are off-loaded into a size-separation process. Coarser material goes to a staging area near the rail yard. The finer silt, where most of the PCBs lie, is slurried with water and pumped to a dewatering building. There, filter presses squeeze out the water and press the material into filter cake. The water is cleaned at an on-site water treatment plant and eventually returned to the river. The filter cake is delivered to a storage area, where it is eventually loaded along with the coarse materials onto trains bound for a Texas landfill where the material will reside in a tightly controlled situation.



that we have to look at every day."

The cleanup covers the upper 40 miles of the roughly 200-mile Superfund site that runs from Hudson Falls, N.Y., all the way to New York City. The pressure on Rosoff and his EPA team seems as intense as the project's scope is vast.

Says Rosoff, "This is going to be a benchmark for environmental dredging."

A Contaminant Runs Through It

The Hudson flows from its primary source high in the Adirondacks, Lake Tear of the Clouds on New York's tallest peak, Mount Marcy, to the tip of Manhattan. Between Albany and the Battery, the river is a tidal estuary, something the Lenape must have sensed—Muhheakantuck, their name for the river, means "river that flows two ways."

Throughout, the Hudson teems with life, from the phytoplankton at the base of the marine food web to underwater plants that host invertebrates, and on up the chain. More than 200 fish species swim it—from important anadromous types like sturgeon, shad and striped bass to mollusks, crabs, and shrimp. Archeological findings indicate Hudson fish have fed humans for millennia. Today bald eagles, peregrine falcons and snowy egrets call its environs home and hunting ground.

A nexus of recreation, culture, and commerce, the Hudson journeys through landscapes that inspired the Hudson River School, passes by West Point—George Washington's "key of America"—and streams past the estates' of artists (Washington Irving), inventors (Samuel Morse), U.S. presidents (FDR and Martin Van Buren) and other American titans (Frederick Vanderbilt and John D. Rockefeller). Dotting the riverbanks are industrial sites past and present—from foundries, paper mills and power companies to plants of corporate powerhouses like International Paper, General Motors and GE.

For much of the last century GE operated two capacitor-producing plants in Hudson Falls and Fort Edward, using its own blend of PCB oil—trademarked Pyranol—as an electrical insulator. In the eyes of electrical equipment manufacturers, PCBs were a "miracle" chemical because of their stability and inflammability—the very characteristics that make PCBs environmentally dangerous.

From the 1940s through 1977 GE's two plants discharged about 1.3 million pounds of PCB-contaminated waste into the river.

"That was just the standard back then," says Rosoff. "If you have waste, you put it in a river."

Part of the trouble with this waste stream is that it lingers and likely causes cancer.

In 1966, a report in the British journal *New Scientist* gave rise to new concerns over PCBs, concerns that date back to the thirties, shortly after Monsanto began producing them. In studying DDT, Swedish chemist Soren Jensen happened upon the startling fact that PCBs are everywhere: "in his own, his wife's and his baby daughter's hair. As the baby is only five months old, her father concludes that she got her dose of PCB with her mother's milk." ("Report of a New Chemical Hazard," *New Scientist* 32 (1966), p. 612.) A flurry of reports followed.

As early as 1971, *The New York Times* cited "possible health hazards" associated with PCBs along with warnings by Nobel scientists that

PCBs could damage ecosystems "irreversibly" on a global scale. Around the same time, PCBs started showing up in Hudson River fish, and the first actions were taken to protect human health.

"Most people aren't in contact with PCBs in the riverbed," explains Rosoff. "However, the fish are, and the fish are consumed by people. As a result of heavily contaminated fish..,, the Department of Health in New York State issued a ban of all consumption of fish in the upper 40 miles of the Hudson."

That was back in 1976; the ban is still in effect. The destruction of the fisheries, so vital to the region's economy, was one of the first victims of the widespread PCB release. Says Rosoff, "The hopes of this project are to return the Hudson to a usable resource and to eliminate the potential risk people have from consuming fish from the river."

By 1977 the federal government's concerns over the health risks PCBs posed reached a tipping point: the Toxic Substances Control Act essentially prohibited the U.S. manufacture and sale of PCBs.

But long after GE stopped using PCBs, the chemicals are still Around—and still leaking from the Hudson Falls plant into the river. (GE is conducting a separate cleanup under New York State's supervision to remove contamination from the plant site and plug the source.) The problem has spread downriver: each year about 300-500 pounds of PCBs cross over the Troy Dam into the lower river.

Back in 1984 when the river became a Superfund site, remediation wasn't seen as an option.

"The technology in the 1980s didn't exist to dredge the river without unacceptable levels of resuspension and redeposition," explains Rosoff. That was then.

Anatomy of Today's High-Tech Dredging Project

Fast-forward to 2002. With cutting-edge dredge tools available. EPA determined the PCBs must go. And so began design work followed by construction, and a raft of sediment sampling to locate the worst areas of contamination.

In the spring of 2009—the quadricentennial of Henry Hudson's sail up the river that took his name—GE started "pinpoint" dredging , using the Global Positioning System (GPS) satellite navigation network and a bucket-load of other high tech, much of it custom-built for the project.

"This is the most state-of-the-art, advanced equipment out there," explains Rosoff.

Plugging some 50,000 data points into a Geographical Information System (GIS), General Electric created detailed maps of the dredge targets.

"Those maps [are] .... on the dredge barges … hooked into a GPS system which is used to position the bucket to do cuts," says Rosoff.

Sensors on each moving part of the bucket and excavator tell operators exactly where in space they are and how deep they must dig. Another mechanism prevents dipping beyond the pre-determined scoop specs. Thus the pinpoint accuracy of PCB hotspots..

"Overall, the remedy is a mass reduction remedy," says Rosoff. "We're trying to remove a large volume of the PCBs … as opposed to trying to remove all the PCBs from the river, which is impossible."

SIDE PROJECT: Floodplains Work

The PCBs are not confined to the riverbed into which they were dumped. They have grossly contaminated the two GE plants where they were used, have even spread beyond the Hudson's banks onto some residential properties.

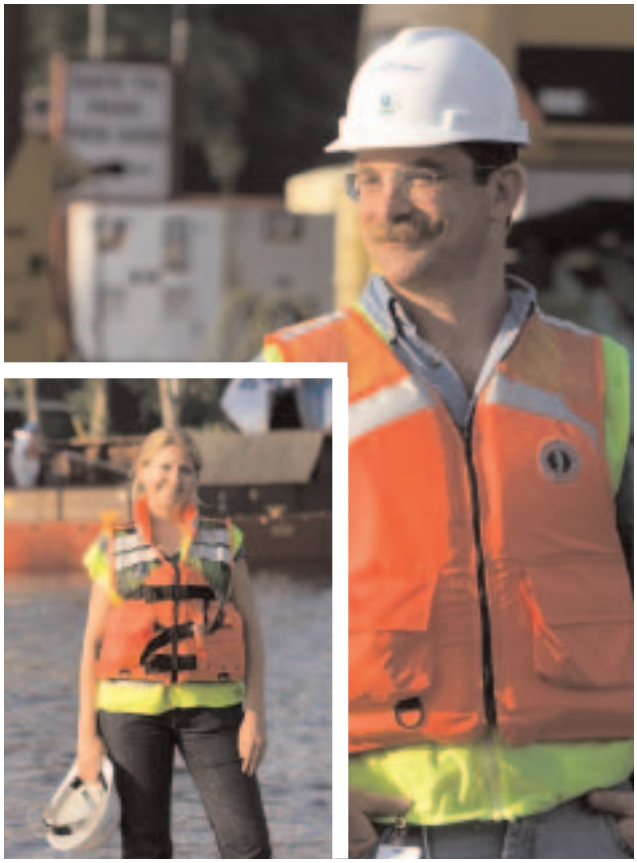
"We have the dredging corridor where we're doing physical in-river work," explains **Melanie Chapman MEM'06**, who works on the floodplains with **David Rosoff MS'90**. "And then we have … the floodplains work."

Though the process for the two is very similar, the floodplains work is in its nascent stages.

"We go in and sample the sediment in people's yards, agriculture fields and in backwater areas," says Chapman, "and try to figure out if people are using this area of their yard, and what they're using it for. [Looking] at that and the results of the sample, we … do kind of a risk assessment."

From that, they determine which places require immediate action, which can wait for further assessment, and which are relatively clean.

"We're getting a much better idea on both sides of the river of where the hot spots are, where the sediments have settled," explains Chapman. "We want to make sure people are safe today even though we'll still be dredging for a few years."



This project's initial phase, to last through the fall, entails bank-to-bank dredging of the contamination site's upper six miles. A peer-review process will follow, after which GE and EPA will make any necessary adjustments. Phase II, expected to last about six years, will tackle the remaining 35 miles.

Rosoff reports that the progress is going well, but not "without bumps in the road."

Three months in, 115,000 cubic yards of sediment had been removed but without meeting cleanup targets. That meant new cutlines had to be drawn, followed by residual dredging. (If PCB levels are still too high after two residual rounds , GE can opt to cap the contaminants.) Such learning as they go makes this foray a critical part of the project.

"I wouldn't call Phase I a test case," says Rosoff, "but it's certainly going to be evaluated heavily for the much longer and more voluminous Phase II."

Keeping the Community Safe and Informed

Whether one is a long-time resident of the area or someone just passing through, it's impossible not to notice something going on. While various tug, personnel, and monitoring boats run the river, dredgers work it, all day and night, except for Sundays. Lights illuminate the nighttime work. Monitors in bright-orange casing sit in the river and pepper its shores, measuring light and noise levels and air and water quality, and standing as visual reminders of the kind of quality-of-life standards at the project's core.

"The project has a lot of parameters to keep the public safe and minimize disturbance to their daily lives," says **Melanie Chapman MEM'06**, an environmental scientist with Ecology & Environment (E&E), one of the consultants working with EPA. "There are a lot of things going on … not only in the river but in people's backyards as we do floodplains work. (See sidebar.) There are also new people in the area. There's vehicular traffic."

As a check on GE's own monitoring and reporting, Chapman's team inspects the cleanup site and investigates potential disturbance issues: "Is the project too loud? Is there light shining on someone's house in the middle of the night? Is there an odor preventing people from being outside and enjoying their yards?"

While navigation and odor issues must be relayed by the public, noise and light have specific numerical standards not to be exceeded.

Most important are the air and water quality standards. If those are not met, action is swift.

In late July elevated levels of PCBs were detected in the air and water near one of the dredging sites. EPA responded immediately, cutting back on dredging and putting up windscreens to catch the off-gassing of excavated sediment. Longer-term adjustments are also in the works.

"We're pushing GE harder to put more engineering controls in place to prevent these air conditions," says Rosoff, who notes that past projects have not had such extensive monitoring or public involvement.

Daily updates and information on PCB levels are available through an EPA Web site (www.hudsondredging data. com). Informational flyers are handed to boaters at the locks. Community meetings are held regularly so that residents can learn directly

THE PROJECT BY THE NUMBERS

40 MILES: area to be dredged
200 MILES: rough area of PCB-contaminated site
$750 MILLION: EPA's estimated costs
$650 MILLION: amount GE claims to have spent already
$1 BILLION+: projected costs if Phase II goes as planned

MINIMIZING RE-SUSPENSION

One of the project's biggest hurdles is the resuspension of PCBs—the disruption and distribution of contaminants into new areas.

The following measures are being taken to limit resuspension rates:

- **Extensive monitoring -** There are strict performance standards for water and air quality. If these are exceeded, immediate steps are taken. In addition, a number of quality-of-life parameters are in place.
- **Environmental clamshell dredge bucket -** Though the buckets are specially designed to clamp shut, riverbed debris such as branches and rocks are often scooped up, preventing the buckets from sealing completely.
- **Silt curtains -** Protection walls are put up around all dredging areas, which in project parlance are called Certification Units.
- **Sheet piling -** This stronger buffer against PCBs distribution is an alternative to silt curtains. Phase I has a test site using sheet piling to determine its effectiveness.
- **Sorbent booms and carbon-impregnated containment materials -** These contain and collect PCB sheens.

about the project's many moving pieces.

Getting the community onboard with the project had been a tall hurdle. GE had spent years and millions spreading a PR campaign against any kind of cleanup and downplaying the hazards of PCBs. But when the tide turned and scientific information about PCBs was widely publicized, the community largely came around.

Of course, it doesn't hurt that the influx of Regional workers might have jump-started the local economy.

Rosoff lacks hard numbers, but says, "We've spoken to several business owners who have related to us an increase in patronage."

Still, at times, the imposition to the sleepy hamlet is palpable. At a community meeting in mid-July, residents aired a number of grievances. Chief among them were noise and air quality complaints.

"We're dredging in some of the worst places in the river and the dredged sediment is off-gassing," says Rosoff.

"For air emissions," he continues, "the standards we use are for chronic exposure over a six-year time frame, so one day of an exceedance is not an issue from a health standpoint."

It's when there's a trend, he says, that big adjustments must be made.

With short-term controls in place, EPA and GE are working on longer-term fixes. And they are keeping lines of communication open.

"We're talking to the entire community and entire world about what happens when you remove this type of gross contamination," says Rosoff.

If people recognize the disturbance aspect of the project, many also recognize the importance of cleaning up the PCBs.

Rosoff underlines the need to succeed.

"The local community … and future projects all over the country are depending on our success," says Rosoff, "So there is a heavy burden, not knowing whether or not the project is going to work the way it's been planned because we've never done anything at this scale."

He sees the restoration as a chance to return the historic river to its former magnificence, where its fish are plentiful and safe to eat.

"Perhaps down the road," says Rosoff, "Fort Edward and the upper Hudson River won't be known for PCBs but instead for the place of serenity and beauty that it is."

Erica Rowell is managing editor of Dean Chameides' blog, TheGreenGrok.com. She is based in New York City.

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Breathtaking and wounded

Despite the Rough, Natural Inhospitableness of Antarctica, Human Industry has had an **Unprecedented Impact on its Environment**

by Ari S. Friedlaender

Assistant Research Professor **Ari Friedlaender** *recently came back from the first of two voyages south to Antarctica as part of MISHAP: the Multi-scale and Interdisciplinary Study of Humpbacks and Prey. His science party was made up of seven researchers and students from Duke's Nicholas School, and another eight from other institutions around the country. This was the first scientific trip sponsored by the National Science Foundation's Office of Polar Programs specifically designed to study whales. What the team found was, quite literally, fantastic. Read on.*

I made my first trip to Antarctica 11 years ago. I was young and eager, naïve and impressionable, over-excited and under-clothed, and in no way prepared for what I was about to experience. I was hooked before passing through the furious 50s (a particularly treacherous stretch of the Southern Ocean) and since then have done whatever I could to make this place part of my life.

Antarctica does not provide a lot of breathing room. It does not yield, is not forgiving, and does not give away secrets from its cold clutches easily. Mostly it takes your breath away.

Consider the early explorers who challenged the limits of human endurance, both physical and emotional, to measure and conquer this land and surrounding ocean. The names are both famous and linked with disaster. Amundsen calculated and conquered. Mawson gained insight and survived. Scott miscalculated and paid. Shackleton endured. Cushman-Murphy narrated.

Yet despite the rough edges and natural inhospitality of Antarctica, human industry has had an unprecedented impact on its environment. During the 20th century, commercial whaling ventures killed more than 2 million baleen whales (blue, fin, sei, humpback, minke) as quickly and as thoughtlessly as possible. And over the past 50 years, aided by human-induced climate changes, the Antarctic Peninsula has been warming at as fast a rate as anywhere on the planet.

The effects of these two extraordinary perturbations cannot be underestimated.

There is no baseline for how this ecosystem functioned before these changes. Rather, we are measuring and documenting things amidst the changes, making comparisons to 'normal' nearly impossible.

Take South Georgia Island for example. For the first quarter of the 20th century shore-based whaling stations here processed hundreds of thousands of baleen whales. Today, finding more than a handful of whales in the surrounding waters is unheard of.

In contrast, there are seabird and penguins by the millions, fur and elephant seals by the tens of thousands. All of these animals are fed by a conveyor belt that transports krill from the Antarctic Peninsula and deposits them around the island. But in some years, there are fewer krill and the reproductive success of the penguins and seals drops precipitously.

What is happening upstream to cause these changes? Where do the whales fit into all of this?

In the time since large-scale commercial whaling, the common belief has held that other predators took advantage of the krill left by the once numerous whales.

Perhaps then, there are more seals and penguins now than before the system was thrown into flux? Given time, however, whale populations are beginning to show signs of recovery. Whales are not tied to land to give birth and are thus free to range far and wide to feed. And given their large size, they likely require prey in larger and more dense quantities than smaller animals. The makings of an ecological conundrum are in the works.

Do whales directly compete with the penguins and seals? Is there enough food for all of the predators? Where will the whales go to feed?

By coming to land frequently, seals and penguins provide scientists with great opportunities to be weighed, measured, or outfitted with devices to track their movements and behaviors at sea. We know generally where they go, how deep they dive, what size krill they favor, and what they require. We know next to nothing about the behaviors and needs of whales in this system.

Our mission is to study how humpback whales feed and begin to understand their relationship to Antarctic krill.

- **Doug Nowacek** was our Chief Scientist, in charge of organizing and facilitating all of our work. His ability to juggle and find a path forward and conduct cutting-edge science in a difficult environment is reminiscent of a great symphony conductor.
- Our first task generally is to survey an area visually and determine the number of whales in the region. **Dave Johnston** and **Andy Read** coordinated our visual surveys to locate and measure their distribution and abundance. It turned into an extraordinary effort to manage our team and comprehensively collect one of the most fascinating and valuable data sets on the density of whales our community has known.
- **Reny Tyson** and **Lindsey Peavey** were champion observers, working tirelessly with honed vision.
- We then use echosounders to measure how much prey is available to them at a broad scale. **Elliott Hazen** used his savvy and technological expertise to shine a light in the darkness and illuminate the patches and layers of krill upon which the whales feed.
- To collect data on individual whales, we place suction-cup tags with sensors to continuously measure underwater movement and behavioral patterns for about 24 hours on the whale's back. By linking their movements with real-time acoustic measurements of their prey, we can assess whale behavior in relation to the distribution, abundance, and behavior of their prey, Antarctic krill. My role was to get the tags on the whales and analyze these data once they were full of information and retrieved.
- With new analytical technology we can visualize in unique ways the underwater path of the whales and determine when, where, and how humpback whales feed, and how these behaviors relate to the density, patch size, and other characteristics of their prey. Colleagues from the University of New Hampshire are building new and creative ways for us to do this. Likewise, **Pat Halpin** used his wizard-like skills to integrate our many data streams and project them in ways that will allow us to comprehensively analyze the relationships between predators and prey.

Our home for the past two months was the 220-ft long *R/V Laurence M. Gould.* During the day, we fanned out in a small armada of inflatable boats to tag and follow the whales, and map the prey around them.

With the visual survey team poised outside around the ship's bridge, we zig and zag, push and churn through ice floes and bergy bits. Our office is beyond compare.

We spent our time probing and surveying three of the large bays and fiords on the western side of the Antarctic Peninsula. These natural harbors are buffeted by a formidable coastal mountain range. Glaciers and ice sheets fill in the open spaces between jagged peaks and end abruptly at the water's edge as sheer cliffs reaching 100 feet or more.

The skin of the water was sprinkled with fields of sea ice floes that are blown about by the winds. Sometimes it was an impenetrable single mass, and on other days the ice was spread thin enough for us to pass through without incident.

Pictures and words can't fully capture being in Antarctica. There are sensations

that surge through your body with the combination of sight and sound and cold that continually bombards you.

Personally, this voyage south was special for many reasons. This was my first opportunity to work with so many close friends and colleagues from Duke with whom I have grown and from whom I have been mentored.

On my first trip south I remember a dear friend telling me that one of his greatest thrills was watching someone see their first iceberg in Antarctica. I remember mine as if it were yesterday and how overwhelmed I felt by its size and beauty. This trip gave me the opportunity to have the same experience several times over.

Antarctica often seems like a distant fantasy-land that is too foreign and different to comprehend. In so many ways it is beyond human approach, yet its vulnerability is painfully obvious and clear. Between commercial whaling and human-augmented climate warming, the Antarctic Peninsula is under an assault it cannot repel.

This place and the animals here are more than important to me. Our team has the desire and ability to do something special, and make a difference here. Understanding the foraging behavior of the whales is the first of many steps toward determining how different krill predators satisfy their needs, and how each of them impacts or is impacted by changes in krill and the environment around them.

I struggle to rationalize how the history of humans in the Antarctic can be so inspiring and yet so nauseating. We are racing against an ambiguous clock to learn as much as we can about this ecosystem and the relationships between predators and prey so that we can better understand the impacts of a warming climate.

Those who came before us are glorified by their writings, but to me the wounds of a short-sighted and gluttonous industry remain open.

statistically SPEAKING

Because we're rarely far from a well-stocked supermarket or convenient drive-thru, many Americans aren't aware of the worrisome trend toward monoculture in our agricultural ecosystems. But the loss of diversity in the plants we eat should give us all food for thought.

OUR FOOD SUPPLY BY THE NUMBERS:

Approximate number of plants that are edible:
30,000

Of those, how many have people consumed throughout history:
10,000

Of those, how many make up the basis of our diets today:
150

Of those, how many provide 80 percent of the world's food:
12

Of those, how many provide 60 percent of the world's food:
4*

Percent of genetic diversity lost in agricultural crops over the last century:
75 percent

**(Note: You get extra credit if you guessed which four crops these are: Wheat, rice, maize and potatoes.)*

Statistics courtesy of: Dean Bill Chameides' blog, The Green Grok, thegreengrok.com

Mr. Robert Redford

Received the Duke LEAF Award • April 2008

new online *video & photos*

nicholas.duke.edu/leaf

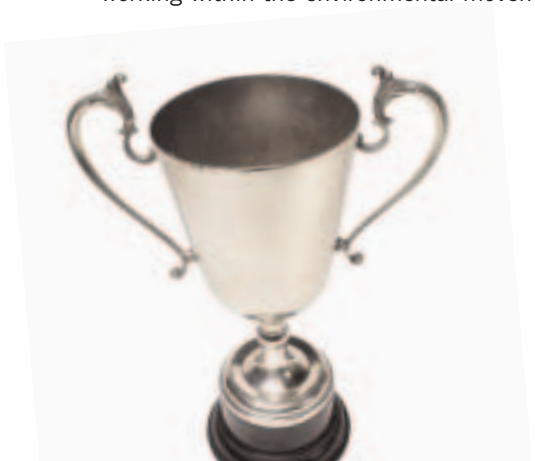
Special Awards

Virlis L. Fischer Award—Goes to the graduating professional degree student with the highest academic achievement. Given by Bernice Fisher in memory of her husband.

Drew McConville of Tolland, Conn.
MEM, Environmental Economics and Policy;
Activities at Duke: Climate Change Policy Partnership (research assistant), Farmhand, intramural dodge ball, and activities related to Doris Duke Fellows (co-organized workshops and an MEM volunteer day, for example);
Awards/Honors: Doris Duke Conservation Fellow, University Scholar, Presidential Management Fellow;
Post-graduation destination: Washington, D.C.;
Future goals: "To live a balanced life and work for clean air, clean water, and open spaces."

Sara LaBoskey Award—Given in recognition of personal integrity and academic excellence.

Carina Barnett-Loro of Durham, N.C.
Environmental Sciences and Policy, BA, Latin American Studies
Activities at Duke: Environmental Alliance, Project WILD (Wilderness Initiatives for Leadership at Duke), LEAPS (Learning through Experience, Action, Partnership, and Service), Students for Sustainable Living, Duke Community Garden;
Awards/Honors: Benjamin N. Duke Scholar, Student Environmental Leadership Award, Betsy Alden Service-Learning Award, Graduation with Distinction*;
Post-graduation destination: Green Corps Fellowship for Environmental Organizing;
Future goals: "Potentially environmental law, but certainly working within the environmental movement in some capacity!"



Naomi Schwartz of Morristown, N.J.
Environmental Science and Policy, BA
Activities at Duke: Peace or Pieces Coalition (group dedicated to creating dialogue between Jewish, Israeli, Arab, and Muslim Students). On Tap student tap dance group. Durham Noise Network Radio show (audio documentary/talk show on WXDU);
Awards/Honors: Graduation with Distinction*, Magna Cum Laude, Fulbright scholarship;
Post-graduation destination: "I'm heading to Cambodia on a Fulbright Scholarship to study community resilience to environmental change around the Tonle Sap, a seasonally flooded lake that provides up to 70 percent of Cambodia's protein";
Future goals: "I would like to pursue a PhD in either environmental science or policy and hopefully have a career in research and teaching."

Thomas V. Laska Memorial Award—Given by the Earth and Ocean Sciences faculty to the most outstanding senior major.

Nicholas Lowman of Kernersville, N.C.
Earth and Ocean Sciences, BS, and Mathematics
Activities at Duke: Army ROTC, Club Baseball, Intramural Athletics, Gothic Bookshop student employee (named Student Manager), Peer Tutor in Calculus, Math Department grader;
Awards/Honors: Magna Cum Laude, Dean's List, Distinguished Military Graduate, ranked 33rd in the country of all Army ROTC cadets (about 4,500), Army Airborne School and Air Assault School graduate, named top cadet Army ROTC Program three consecutive years;
Post-graduation destination: "Serving a 4-year commitment on Active Duty as 2nd Lieutenant with U.S. Army, Military Intelligence Branch. After basic officer training in September, my permanent duty station will be in Italy;"
Future goals: Graduate school in the earth/atmospheric sciences

**Graduation with Distinction—Accords special recognition for academic excellence to students who successfully complete a significant independent research project on the environment or earth sciences.*

Public Trust Doctrine Could **Aid** Management of **U.S. Oceans**

Since Congress lifted a moratorium on offshore drilling last year, federal lawmakers have grappled with the issue of how best to regulate U.S. ocean waters to allow oil, wave and wind energy development, while sustainably managing critical fisheries and marine animal habitats.

A new policy paper, published in *Science* last spring by a team of Duke University experts, argues that establishing a public trust doctrine for federal waters could be an effective and ethical solution to this and similar conflicts.

"The public trust doctrine could provide a practical legal framework for restructuring the way we regulate and manage our oceans. It would support ocean-based commerce while protecting marine species and habitats," says lead author **Mary Turnipseed**, a PhD student at the Nicholas School.

The public trust doctrine is "a simple but powerful legal concept," Turnipseed says, that obliges governments to manage certain natural resources in the best interests of their citizens, without sacrificing the needs of future generations.

The doctrine already is well established in the United States at the state level, where natural resource agencies are legally bound to seek legal action against private parties who are infringing on the public trust.

Extending the public trust doctrine to U.S. ocean waters would help federal agencies better manage conflicting demands such as conservation, offshore energy development, fisheries and shipping in the 3.6 million nautical square miles of water included in the nation's territorial sea and Exclusive Economic Zone (EEZ), Turnipseed says. Currently, more than 20 different federal agencies, operating under dozens of laws, regulate species and activities in these waters, without any mandated, systematic effort to coordinate their actions for the public good.

"In the Gulf of Maine, as an example, a wide range of different activities—including shipping lanes, ferry routes, U.S. Navy operations, fisheries and proposed wind farms—overlap critical habitat of the endangered right whale," she says. "Most of these are regulated by separate agencies, with only piecemeal coordination. A public trust doctrine would identify these agencies as trustees of the U.S. ocean public trust, unifying them for the first time under a common mandate to manage the gulf's resources sustainably."

Stephen Roady, senior lecturing fellow at Duke's School of Law and an environmental lawyer at Earthjustice, **Larry B. Crowder**, Stephen Toth Professor of Marine Biology at the Nicholas School and director of Duke's Center for Marine Conservation, and **Raphael Sagarin**, former associate director for coastal and ocean policy at Duke's Nicholas Institute for Environmental Policy Solutions, also contributed to the paper.

Wyatt Hartman Receives Dean's Award for Outstanding Graduate Student Paper

Dean Bill Chameides presented the second annual Dean's Award for Outstanding Graduate Student Manuscript to **Wyatt H. Hartman** at the Nicholas School's recognition ceremony in May.

Hartman, a PhD student, was honored for a landmark study of wetland soil bacterial populations he wrote with his advisor, Curtis J. Richardson, professor of resource ecology and director of the Duke University Wetland Center.

Their study was published in *The Proceedings of the National Academy of Sciences* in October 2008. It reported the novel finding that restoring degraded wetlands—especially those that had been converted into farm fields—actually decreases their soil bacterial diversity.

"It sounds counter-intuitive, but our study shows that in restored wetlands, decreased soil bacterial diversity represents a return to biological health," Hartman says. That's the opposite of the response seen in terrestrial ecosystems, where restoration improves conditions from a more barren, degraded state, he notes.

The Dean's Award is an initiative developed by Chameides to recognize outstanding student scholarship. It is awarded each year to a student enrolled in the Nicholas School PhD programs who has a manuscript accepted or published by a peer-reviewed journal. Manuscripts are judged on disciplinary rigor, originality and likely depth of contribution to the advancement of their field.

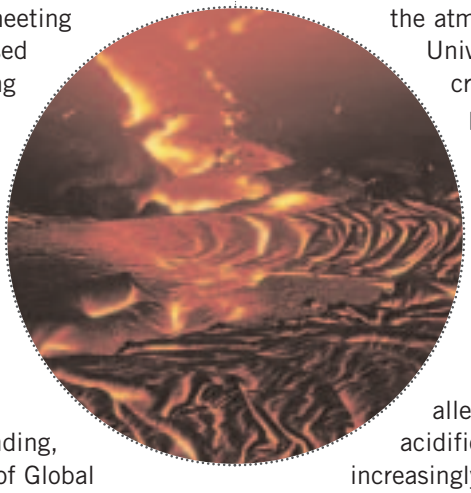
Award recipients receive a $3,000 prize and their name is placed on the plaque hung in Hug Commons.

In his winning paper, Hartman found that one of the simplest and most promising indicators of restoration success was the ratio of Proteobacteria, which have the highest affinity for nutrient-rich environments, to Acidobacteria, which have the highest tolerance for poor conditions.

While more than half of original wetland acreage in the

Assessing the Pros and Cons of Geoengineering to Fight Climate Change

Geoengineering techniques aim to slow global warming through the use of human-made changes to the Earth's land, seas or atmosphere. But new research shows that the use of geoengineering to do environmental good may cause other environmental harm. In a symposium at the Ecological Society of America's annual meeting in Albuquerque, N.M., ecologists discussed the viability of geoengineering, concluding that it is potentially dangerous at the global scale, where the risks outweigh the benefits.



"The bigger the scale of the approach, the riskier it is for the environment," said session organizer **Robert Jackson**, director of Duke University's Center on Global Change. Global alterations of Earth's natural cycles have too many uncertainties to be viable with our current level of understanding, said Jackson, who is Nicholas Professor of Global Environmental Change at the Nicholas School.

One global-scale geoengineering method, termed atmospheric seeding, would cool the climate by releasing light-colored sulfur particles or other aerosols into the atmosphere to reflect the sun's rays back into space. This approach mimics what happens naturally when volcanoes erupt; in 1991, for instance, an eruption of Mount Pinatubo in the Philippines cooled the Earth by 0.9 degrees Fahrenheit.

But Simone Tilmes of the National Center for Atmospheric Research argued that despite its potential to create overall cooling, atmospheric seeding could cause significant changes in localized temperature and precipitation. Her simulations predict that sulfur seeding could destroy atmospheric ozone, leading to increased ultraviolet radiation reaching the Earth's surface.

Another large-scale geoengineering scheme is fertilizing the oceans with iron to increase carbon uptake from the atmosphere. Charles Miller of Oregon State University said that ocean fertilization could create a rise in iron-limited phytoplankton populations, which by dying and sinking would use enough oxygen to create extensive dead zones in the oceans. In addition, he said, the maximum possible rate of ocean iron fertilization could only offset a small fraction of the current rate of carbon burning by humans.

Ocean fertilization also does not alleviate the increasing problem of ocean acidification, caused by carbon dioxide from the increasingly carbon-rich atmosphere dissolving into seawater. In fact, Miller said, ocean fertilization schemes will likely exacerbate this problem.

Despite its apparent hazards at the global scale, Jackson said he thought that research should continue on safer ways to use geoengineering at a smaller scale. But on the planetary scale, most ecologists are skeptical of climate engineering.

"Playing with the Earth's climate is a dangerous game with unclear rules," said Jackson. "We need more direct ways to tackle global warming, including energy efficiency, reduced consumption, and investment in renewable energy sources."

United States has been destroyed or degraded, tens of thousands of hectares have been restored in recent decades as a result of the federal government's "no net loss" policy.

"Re-establishment of microbial communities indicates a restoration of the biological functions of soils. This study across a wide range of wetlands is the first to establish that shifts in soil bacteria populations may be a key marker of restoration success," Richardson says

Rytas Vilgalys, professor of biology at Duke, and **Gregory L. Bruland**, assistant professor of soil and water conservation at the University of Hawaii at Manoa, were co-authors on the paper. The study was funded by a Duke University Wetland Center Case Studies Endowment and a National Science Foundation Graduate Research Fellowship.

40 Nicholas School Faculty and Students

Presented Research at 2009 ESA Meeting

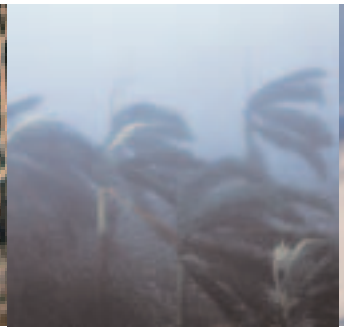
Forty faculty members, research associates and students from the Nicholas School presented findings from new research at the annual meeting of the Ecological Society of America (ESA), the year's most important ecological science conference in August in Albuquerque, N.M.

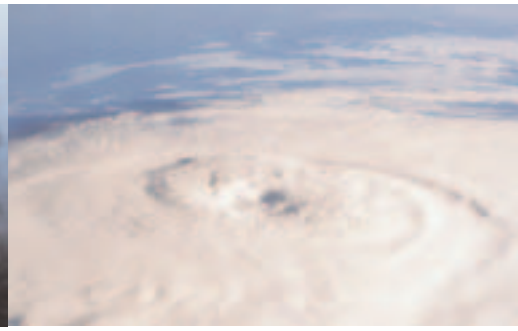
ESA is the world's largest organization of ecologists, with more than 9,000 members.

"Having a major presence at the ESA conference, and in ESA's leadership, is a measure of the Nicholas School's international leadership in forging a sustainable future through strategic, multidisciplinary research, teaching and outreach," says William L. Chameides, dean of the Nicholas School. Faculty, staff or students associated with the school were lead authors or co-authors on 28 presentations.

For the complete list of presentations go to nicholas.duke.edu/??????

Mangroves Save Lives in Storms, Study of 1999 Super Cyclone Finds





A new study of storm-related deaths from a super cyclone that hit the eastern coast of India in 1999 finds that villages shielded from the storm surge by mangrove forests experienced significantly fewer deaths than ones that were less protected.

The study, conducted by researchers at the University of Delhi and Duke University, analyzed deaths in 409 villages in the poor, mostly rural Kendrapada District of the Indian state of Orissa, just north of the cyclone's landfall.

"Our analysis shows a clear inverse relationship between the number of deaths per village and the width of the mangroves located between those villages and the coast," said **Jeffrey R. Vincent**, Clarence F. Korstian Professor of Forest Economics and Management in the Nicholas School.

"Taking other environmental and socioeconomic factors into account, villages with wider mangroves suffered significantly fewer deaths than ones with narrower or no mangroves," Vincent said. "We believe this is the first robust evidence that mangroves can protect coastal villages against certain types of natural disasters."

Vincent conducted the analysis with Saudamini Das of the University of Delhi's Swami Shradanand College. Their findings appeared in a paper in the online early edition of *The Proceedings of the National Academy of Sciences* this past spring.

Mangroves are dense forests of trees and shrubs that grow in brackish, low-lying coastal swamps in the tropics and subtropics. In 1944, mangroves covered nearly 31,000 hectares of land in Kendrapada District and the average village had 5.1 kilometers of mangroves between it and from the coast. Since then, nearly half the area has been cleared, mostly for rice production.

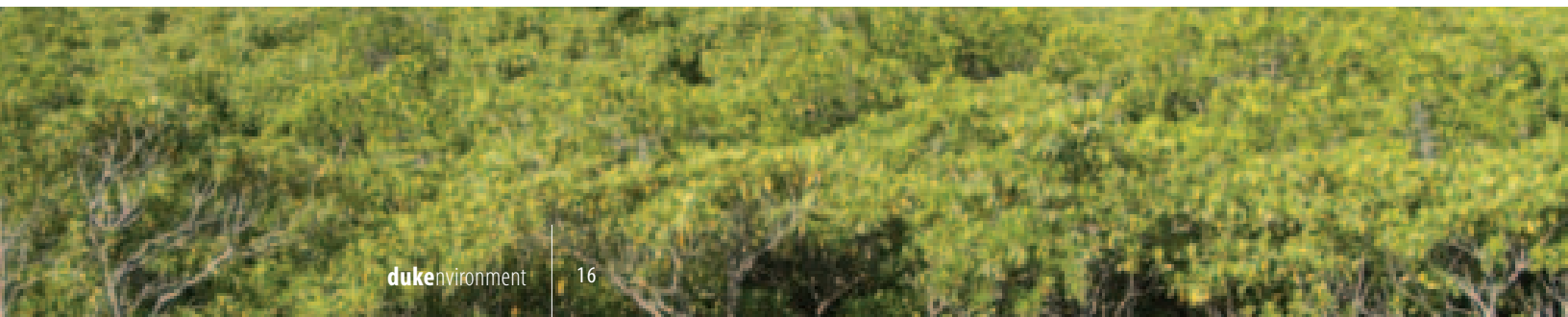
Today, the average width of mangroves between the villages and the coast has shrunk to 1.2 kilometers.

The 1999 storm, which made landfall on Oct. 29, killed nearly 10,000 people, more than 70 percent of whom drowned in its surge.

Using statistical models, Das and Vincent predicted there would have been 1.72 additional deaths per village within 10 kilometers of the coast if the mangrove width had been reduced to zero.

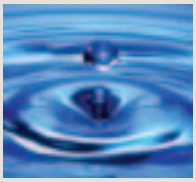
"This is a measure of the life-saving impact of the mangroves that remained in 1999," Vincent said. "It implies that they cut the death toll by about two-thirds."

Das and Vincent's study was supported by the South Asian Network for Development and Environmental Economics (SANDEE), with research facilities provided by the Institute of Economic Growth in Delhi, India.



Nicholas Institute for Environmental Policy Solutions
breaking down barriers to environmental progress





New Policy Brief Reviews Options for Improving U.S. Residential Energy Efficiency

The American Clean Energy and Security Act, recently passed by the U.S. House of Representatives, contains multiple provisions designed to improve residential energy efficiency.

A new policy brief from Duke University's nonpartisan Climate Change Policy Partnership (CCPP) describes these provisions, provides an overview of the numerous barriers they will have to overcome, and presents options for implementing them if they are passed into law.

The brief, at **www.nicholas.duke.edu/ccpp/ publica tions.html**, also presents further policy options federal policymakers could consider to improve residential efficiency.

CCPP is an interdisciplinary partnership of Duke's Nicholas Institute for Environmental Policy Solutions, Nicholas School of the Environment and Center on Global Change.

"There is enormous potential for energy efficiency improvement in the residential sector, but there are significant market, policy and legacy barriers which must be overcome," says CCPP research analyst **David Hoppock**. "The Waxman-Markey bill includes multiple programs and allocates emissions allowance resources to address these barriers. If enacted, the bill would improve residential efficiency, but would not overcome all barriers because some barriers, such as transaction costs, are dispersed and difficult to overcome."

In his brief, Hoppock's examines four key provisions in the American Clean Energy and Security Act (H.R. 2454) designed to overcome these barriers. They are:

- A national building energy code program that sets a goal of improving new building efficiency by 30 percent after the bill is enacted and by 50 percent after 2013.
- A building retrofit program that provides states, local governments and regulated utilities with funds to conduct efficiency retrofits, along with direct incentives to building owners of up to 50 percent of the total retrofit cost.
- An energy performance labeling program for new buildings, designed to provide the residential building market with better information about individual building energy efficiency.
- Lighting and appliance efficiency standards that establish a reward program for retailers and manufacturers who sell and manufacture best-in-class efficient products.

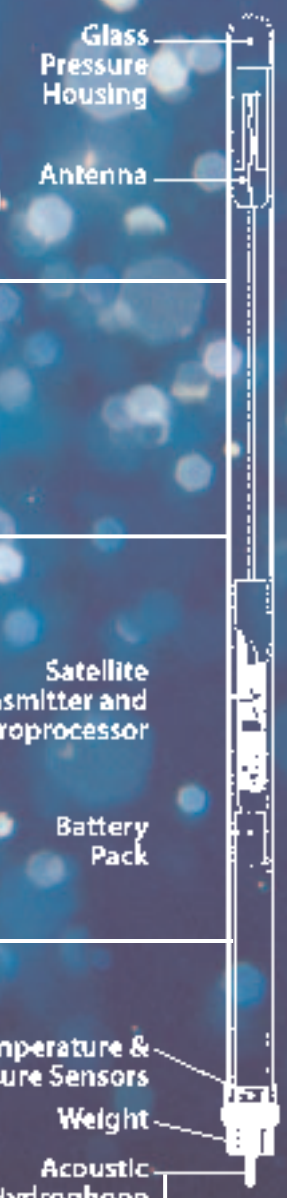
The 30-page brief presents additional energy policy options that federal policymakers could consider. These are:

- Including existing buildings in the energy labeling program;
- Providing incentives to states that encourage or require home energy audits at the time of sale;
- Conducting information campaigns to make consumers aware of the Retrofit for Energy and Environmental Performance (REEP) program and other federal energy efficiency programs;
- Allowing regulated utilities, local governments, and states to issue tax-exempt bonds to finance property tax—and utility bill-financed energy efficiency programs;
- Incorporating energy efficiency into federal foreclosure avoidance and foreclosed home resale programs; and
- Incorporating efficiency into federal low-income housing programs.

Uncharted Interior Ocean Pathways

Using an Armada of Specially Designed Floats, Scientists Get a New Look at the 'Great Ocean Conveyor" with Major Implications for Global Climate Change Research

by Tim Lucas



If you Google the phrase "Great Ocean Conveyor," one of the first images that will likely pop up on your computer screen is a map of the North Atlantic Ocean with color-coded arrows showing a looping, conveyor belt-like path that deep ocean currents follow as they flow north from the equator and south from the polar seas.

It's a model that's been used for more than 20 years to explain how the oceans distribute heat and influence our climate, and—more recently—to shape scientists' hypotheses about the amount and fate of carbon dioxide that oceans sequester from our atmosphere.

In the conveyor belt paradigm, currents warmed by the Gulf Stream move northward and release their heat into the atmosphere, leaving the waters themselves colder and denser. At their northern terminus, the dense, cold waters sink beneath the polar seas and flow back southward along a discrete, well-defined path called the Deep Western Boundary Current that hugs the continental shelf between Canada and the equator. To replace this sinking water, warm surface waters from the tropics are pulled northward again, creating a continuous loop of climate-moderating currents.

It's a nice, neat, tidy system.

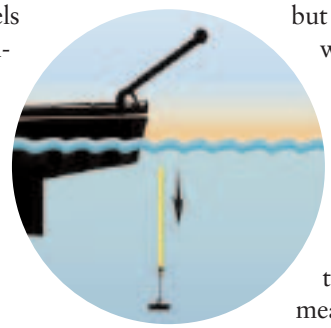
Oceanographers, however, have long known that this paradigm for describing deep ocean circulation is an oversimplification—a useful enough depiction of the general principle, but missing key pieces of the puzzle.

"We've hypothesized, based on studies using indirect evidence like ocean salinities and temperatures, that there are re-circulations, which cause alternative pathways for these deep waters," says Susan Lozier, professor of physical oceanography and chair of the Division of Earth and Ocean Sciences at the Nicholas School.

"If this hypothesis were true," she explains, "it would significantly affect how scientists measure climate signals in the deep ocean. But the hitch was, we lacked the direct evidence to prove it."

Now, a major study led by Lozier and long-time research collaborator Amy Bower, a senior scientist in the Department of Physical Oceanography at Woods Hole Oceanographic Institution (WHOI), has provided that critical evidence.

The study, published in the May 14 issue of the journal *Nature*, used data from computer models and an armada of sophisticated Range and Fixing of Sound (RAFOS) floats, deployed during research cruises in the North Atlantic over the course of three years, to show that most of the southward flow of cold water from the Labrador Sea moved not along the Deep Western Boundary Current, but instead followed previously uncharted "interior pathways" in the deep ocean. Groups of six RAFOS floats were released into the Labrador Sea every three months from 2003 through 2005 and were left in the water to collect data for two years.



Only 8 percent of the floats followed the conveyor belt of the Deep Western Boundary Current, Lozier and Bower's study found. About 75 percent of them escaped that pathway and drifted into the open ocean before reaching the Grand Banks.

"Eight percent is a remarkably low number in light of expectations that the Deep Western Boundary Current is the dominant pathway for Labrador Sea water," Lozier says. "This shows that the concept of the deep flow operating like a conveyor belt doesn't hold anymore. The pathways are more diffuse. They spread out much farther into the eddy-filled deep ocean, so it's going to be more difficult for scientists to measure climate change signals."

Lozier and Bower first conceived of their ambitious project eight years ago, in response to earlier studies, including a widely cited paper Lozier and colleagues published in *Science* in 1997 that strongly suggested unknown interior pathways played an important role in deep circulation of the North Atlantic. A study of floats in the Labrador Sea in the late 1990s by scientists at the Scripps Institute of Oceanography and Woods Hole seemingly confirmed Lozier's hypothesis, but results from this study were not convincing, in part because the submersible floats used to collect the data had to return repeatedly to the surface to report their positions and observations to satellite receivers. This meant the floats' data could have been biased by upper ocean currents during the floats periodic ascents.

"The challenge for Amy and me," Lozier recalls, "was finding a way to collect direct evidence, free of possible bias, that would test our hypothesis and either prove or disprove it."

With funding from the National Science Foundation and technical support from the staff at Woods Hole, Lozier and Bower devised an elaborate plan they hoped would surmount that challenge.

Bower and her colleagues built 76 specially designed RAFOS floats configured to submerge to a depth of 700 to 1,500 meters below the ocean's surface—within the layer of water where a major portion of the cold, south-flowing current of Labrador Sea water flows.

A RAFOS float weighs about 22 pounds (10 kilograms) and can be dropped over the side of a small boat

by one person, although they are most commonly deployed from large oceanographic research vessels. The float's electronics are housed in a thin, six-and-a-half foot (two meter) glass tube that vaguely resembles a giant glass thermometer or overhead fluorescent strip light.

Once deployed, the floats drifted underwater with the currents for two years, recording location information as well as temperature and pressure measurements once a day. After two years, they returned to the surface and transmitted their treasure trove of stored data to scientists back in the lab through the ARGOS satellite-based data retrieval system.

To communicate with the floats and to track their positions while they were still submerged, the researchers deployed anchored low-amplitude sound beacons in the general area of the experiment. The beacons were set to "ping" automatically every day, enabling the scientists to determine the distance between the floats and beacons, based on the time delay between when the ping went off and when it was detected by the RAFOS floats' onboard hydrophones.

The ambitious program would have been prohibitively expensive, Lozier notes, had it not been for a collaboration with Eugene Colbourne of the Northwest Atlantic Fisheries Center in St. Johns, Newfoundland. Colbourne regularly conducts hydrographic surveys around the Grand Banks and agreed to deploy the researchers' floats during his cruises.

Since the RAFOS float paths only could be tracked for two years, Lozier worked with Nicholas School PhD student Stefan Gary and German oceanographer Claus Böning of the Leibniz Institute of Marine Sciences—both listed as co-authors on the *Nature* paper—to run computer models that simulated the launch and dispersal of more than 7,000 "e-floats" from the same starting point.

Subjecting the e-floats to the same underwater dynamics as the real ones, Lozier, Gary and Böning traced their pathways and found that the spread of the e-floats was "very similar" to that of the actual RAFOS float trajectories after two years.

The combined observations from the real and simulated experiments provided clear evidence that southward interior pathways in the deep ocean are more important than previously shown for the transport of Labrador Sea water to the subtropics, says Peter B. Rhines, professor of oceanography and atmospheric sciences at the University of Washington.

"Drs. Bower and Lozier have brought the remarkable technology of neutrally buoyant deep, drifting buoys to bear on a matter of great importance to global climate. The global ocean circulation which ventilates the great depths of the seas is often portrayed as a 'conveyor belt.' While this is a useful analogy, their work establishes conclusively that ocean eddies—swirling water masses, much like the rotating storms of the atmosphere—stir the deep ocean. In doing so, the eddies spread the 'conveyor' over a vast region of the North Atlantic," Rhines says.

Since the southward flow of cold Labrador Sea water is a major component of the waters that flow toward the equator as part of the global overturning circulation, this finding will significantly change how oceanographers observe and monitor the deep ocean

"We will need to make more measurements in the deep ocean interior, not just close to the coast where we previously thought the cold water was confined," Bower says.

The Labrador Sea is an area of special focus for climatologists, she explains, because the effects of climate change are magnified at higher altitudes. Surface waters there absorb heat-trapping carbon dioxide from the atmosphere, and much of that CO_2 is taken to depth within the sinking waters in this region, where it is no longer available to warm Earth's climate.

"We know that a good fraction of the human-caused carbon dioxide released since the Industrial Revolution is stored in the ocean," says Lozier. "The question is, how much is stored at depth? And for how long?

"To answer these questions, we need to learn more about where these deep, cold currents flow, how they act as sinks for heat and carbon dioxide, and their ultimate fate in the ocean," she explains.

Toward this end, Bower and Lozier plan to expand their research in coming years to study the southward flow of cold water originating even farther north in the remote waters of the Greenland Sea.

Additionally, Lozier hopes to make use of a new generation of high-tech underwater submersibles to speed and smooth the data-collection process. In the past five years, she explains, researchers have developed programmable, unmanned battery-operated units that can glide through the deep ocean, collect real-time data at pre-set depths and then surface and transmit the data back to scientists in the lab via satellite, avoiding the long time delays associated with RAFOS floats or the potential data bias of the profiling floats used in the 1990s.

"The idea of being able to program gliders to go where you want, collect what you need, transmit it back to you in real time, and then follow new instructions about where to collect data next—it's an oceanographer's dream," she says.

"I sometimes envy those scientists who can collect a sample in the morning and then go into their lab to do the research that afternoon," she laughs. "Observational oceanography is many things: fascinating, important and rewarding. But no one ever said it was simple."

Tim Lucas is the Nicholas School's national media relations and marketing specialist.

Monte Basgall, senior science writer at Duke News and Communications, and communications officers at Woods Hole Oceanographic Institution contributed to this article.

With the Dean

Can They Stop the Impending Train Wreck? by William L. Chameides

The fall approaches; a new academic year begins and with it a new class of bright and talented students arrived at the Nicholas School. This year's class is especially noteworthy, not only for its stellar qualifications and size—one of the best and largest we have ever seen—but also because this is the first class entering Nicholas since the great economic meltdown of 2008-09.

Despite the sobering events of the past year, this year's group seems as idealistic and energetic as any. They are ready to roll up their sleeves and make the world a better place, and perhaps more so than in previous years, confident that they *will* help make the world a better place. Perhaps having witnessed and survived the meltdown, they feel empowered. Perhaps having witnessed the meltdown, these young men and women see more clearly than before the unsustainable flaws in the system that caused the crash and what needs to be done to make a more sustainable system. Whatever the reason, being awash in the energy and optimism of our new students is a tonic that we in the academic world can look forward to each year, and this year's did not disappoint.

I am especially thankful for the energy and optimism of our students at Nicholas, because I fear that we are leaving them with an impending crisis, a train wreck in the making that could make the great economic meltdown of 2008-09 look like small potatoes.

We already know that as a society we are depleting the resources of our planet. Some 60 percent of the world's ecosystems, that provide us with clean water, timber, fisheries, food, and fiber, have been degraded by human activities. Because of our dependence on fossil fuels we are adding carbon dioxide to the atmosphere at a rate that far outstrips the atmosphere's ability to process it. As a result, atmospheric carbon dioxide concentrations are rising, causing a disruption in climate that is unprecedented in modern times. The critical and very real need for more and more food has necessitated the use of huge amounts of fertilizers, which in turn foul our rivers and streams and cause giant ocean dead zones. Pressures to increase food production also are causing the conversion of enormous swaths of natural habitat to agricultural land at the expense of the genetic treasures of a biodiverse world.

A reasonable response, indeed the only response to the problem of depleting resources, is to adopt a more sustainable approach: use less, conserve more, be more efficient, recycle.

Converting our current unsustainable practices to more sustainable ones would be hard enough under normal circumstances. But these are hardly normal circumstances. Today planet Earth is populated by some 6.8 billion people; a little less than half of these live on less than $2.50 per day according the World Bank. Sometime near the middle of this century, demographers tell us there will be about 9 billion of us—give or take a billion. Demographers also tell us that much of these 9 billion will be urban, with aspirations similar for the high-consumption lifestyles of people now living in the developed economies of the world. Meeting these aspirations would seem to require more not less of the Earth's dwindling resources.

And this is the train wreck the next generation of environmental managers is going to have to find a way to avert. They are going to have to figure out a way to sustain a population of 9 billion Earthlings while at the same time sustaining planet Earth. Fail to do the later and you can't do the former. But fail to do the former, and I fear that many of the institutions that sustain us a society will fail.

How can this be done? I have some ideas, but I have to confess I don't really know. And I suspect that most of my contemporaries at Duke and elsewhere don't for sure either. What we can do is impart all the wisdom and knowledge and skills that we know on this new class of students and hope and pray that they will be smart enough to avert the train wreck already in motion. Am I optimistic? Given the optimism of our new class of Nicholas Students, it is hard not to be.

William L. Chameides is dean of the Nicholas School and professor of the environment.

Anticipating How **Trees Will 'Duke it Out'** with Global Warming

by Monte Basgall

A corner of the Duke Forest has gone rustic high-tech as researchers assemble an array of aluminum-framed translucent plastic cubicles, devoted to warming up baby trees and the soil they're growing in.

Clear plastic ducts twine through the roofless, boxy walkthroughs, black cables jut into the soil in places, and inelegantly perched propane tanks provide fuel for humming heaters and associated radiators. The floor of each structure is crisscrossed by grids of string.

This encampment is a $2 million U.S. Department of Energy-funded project to assess how today's forest trees will adjust when global warming is predicted to elevate temperatures near the ground between 2 and 8 degrees Celsius over the 21st Century.

"We're taking species that occur at three different geographic latitudes (Georgia, North Carolina, and Massachusetts) and planting them at all three sites," said lead scientist **James Clark**. "When we warm them at Duke Forest it will be interesting to see, for example, whether plants and species from further south will do better than local ones in their new environments."

Sensors will track temperature, soil moisture, air humidity and light levels as each treelet competes to grow within its assigned–and–recorded 10-foot by 16-foot grid.

Crucially, the ducts convey warm air from the heaters and radiators to elevate temperatures around the closely monitored plants by either 3 or 6 degrees Celsius above normal. The jutting cables house 220-volt electrical lines that warm the soil by the same amount.

The study aims at refining forecasting maps of how forests will adjust to changing climates. In the past, these maps have been built by locating the distributions of each of today's species and logging the summer and winter temperatures and precipitation levels where those now thrive. They then predict where the optimal conditions are likely to shift with climate change.

"Maps showing which species will likely make it in a given place are pretty much based on that kind of logic," said Clark, the H.L. Blomquist Professor of the Environment at Duke's Nicholas School.

"The problem is that where a given species will be found on a future map depends not only on climate but also on the other species it's competing with," he added.

"For instance, if you plant a spruce tree in your yard in this part of North Carolina chances are it will do just fine," Clark said. "But it won't reproduce here. That's because it just can't compete with Southern species at these higher temperatures outside its natural range."

As rival trees grow rapidly to shade it out, the struggling baby spruce will be left buried in their shadows and starving for the sunlight it needs to photosynthesize, he explained. Spruce can reproduce naturally only in the wilds of Dixie's highest and coldest elevations—if even there.

In other words, plants not only have to adapt to the climate. They also have to slug it out with their neighbors as temperatures, humidity and precipitation levels change. Nature provides no free lunch. And with global warming, caused in part by growing amounts of human-produced carbon dioxide (CO_2), outcomes should be even more complex.

That's why Clark is overseeing coordinated warming experiments at a Duke Forest plot near Hillsborough, N.C., plus another at Harvard Forest in Massachusetts and a third near the University of Georgia at Athens.

In late May scientists, students and technicians from all three locations and universities began busily pruning unwanted vegetation at Duke Forest and planting seeds of about a dozen different kinds of trees in grid spaces marked with plastic swizzle sticks. In some cases, pre-existing treelets were allowed to continue growing and marked with encircling plastic strips of various colors.

Some seeds were hand-collected in the forest while others came from supply houses. Seeds from Georgia and Massachusetts were planted in Duke Forest, and vice versa.

Increases in surface temperatures brought on by global warming are expected to alter germination, growth and mortality of trees.

Depending on availability, the overall species list might include red, black, white and chestnut oaks; sugar and red maples; loblolly and white pines; and tulip poplar, sweet birch and southern magnolia.

Species like sugar maple, sweet birch and chestnut oak already are near their southern limits in North Carolina, while black oaks, white oaks and tulip poplar are near their northern limits in Massachusetts. The study wants to determine if species near the 'warm' end of their range will decline in abundance during the coming 100 years or whether trees near the 'cool' end of their ranges might extend their range.

The protocols of the three experimental sites are designed to address Nature's inherent messiness and unpredictability.

"Every year there's a different climate, with different temperatures and different patterns of rainfall," Clark said. "And it's difficult to know what's affecting different species in a particular year unless we manipulate conditions."

Consequently, some plants will be warmed more than others, and still others will not be heated at all. Some trees also will receive more water than they would get naturally, while others won't.

"So if, for example, we have plots where we don't warm we can compare those directly to plots we do warm to gauge response to the treatments," Clark explained.

To compare how light levels affect tree growth, some chambers will be situated out in the open and others in dense shade. A third group will be in sun-dappled semi-shade beneath the tallest mature trees.

Meticulous computerized records collected for analysis will include tracking nitrogen use (vital for the photosynthesis process) and measuring movements of carbon and sugars as the young trees prepare for winter and spring.

This is not the first Energy Department-funded global warming study in Duke Forest.

The most famous one—called the Duke Free Air Carbon Dioxide Enrichment (FACE) study—has been studying how plots in growing loblolly pine stands respond to the kind of elevated CO_2 levels expected worldwide by 2050.

Monte Basgall is senior writer in Duke's Office of News and Communications.

Nicholas School Students Make a Splash in the Local Fisheries Market

Walking Fish has sold 400 shares! To find out more about them visit walking-fish.org

Left to right: Chuck Abolt T'11 and Cassie Hoffman MEM'09 help plant crops at Coon Rock

by Robyn Walker, MEM '10

Think of the last bit of seafood you ate. That nice, juicy shrimp lying on your plate, perfectly seasoned and grilled to perfection, brought to you fresh from the oceans of…Thailand?

Americans consume close to 5 billion pounds of seafood each year, 84 percent of which is imported from other countries. Chances are, the last fishy meal you ate traveled a farther distance to get to your table than some people travel in a lifetime.

This is a problem that 10 Nicholas School students are setting out to solve with their fledgling project, Walking Fish: A Community-Supported Fisheries Initiative.

Community-supported fisheries link consumers directly with producers in their area. Customers buy shares in the program and receive weekly or biweekly supplies of fresh, local, seasonal seafood in exchange. The goal is to increase consumption of locally harvested fish, decrease imports, and let consumers know where and how their seafood was caught. Buying direct from local sources brings in more income for local producers and helps promote more sustainable fishing practices.

"The United States is the second largest importer and fourth largest exporter of seafood, and a lot of the seafood that we import isn't necessarily from sustainable or well-managed stocks or fisheries," says **Joshua Stoll**, a second-year student in the Coastal Environmental Management (CEM) program and creator of the Walking Fish project. "Basically we thought that if we can support local seafood, then we can help local economies and build partnerships between rural and urban communities, while promoting sustainable practices and getting some real-life experience."

Stoll got the idea for Walking Fish after talking to **Susan Andreatta**, associate professor of anthropology at the University of North Carolina in Greensboro and project coordinator of Project Greenleaf, an organization devoted to promoting a local agro-food system in North Carolina. Along with community-supported agriculture projects, Andreatta has explored the challenges that small-scale fishermen face in marketing their seafood to local communities, and how community-supported fisheries might help overcome those challenges.

After talking with her, Stoll says all the pieces just seemed to fall together. He brought the idea of a community-supported fisheries project to Duke Fish, the Duke University chapter of the American Fisheries Society, with the goal of trying to move some of the Carteret County catch inland to the Durham area. Other members immediately jumped on board and started trying to figure out how to make it happen.

In March 2009, Walking Fish presented their ideas to Carteret Catch, a marketing group and branding organization in Carteret County that aims to sustain the county's fishing industry through marketing and education.

Carteret County is located along the central North Carolina coast, a three-hour drive east of the Raleigh-Durham metropolitan market. The county is home to many popular beach resorts, small towns and fishing ports, including the village of Beaufort, where the Duke University Marine Lab is located.

"We went in to this meeting with the message that our project was an opportunity where consumers and fishermen alike could benefit. We had access to the market, resources and funding, but no knowledge of the fisheries or community members that need to be

Farm; Kellyn Shoecraft MEM'10 carries seedlings to plant at Coon Rock Farm.

involved, which is where Carteret Catch would come in," says Stoll. "It turns out they're asking the same questions: How do we market our seafood? How do we sustain local communities? There's real overlap between our mission and their mission, and I think this partnership has real potential."

Barry Nash, a Carteret Catch advisory board member and a seafood technology and marketing specialist at the Center for Marine Sciences and Technology in nearby Morehead City, agrees.

"The Walking Fish project is a good match for us, because it provides an opportunity to get a toe in the door in the Triangle area," he says. "Basically we'll be working with them to set up logistics and make sure they have a steady supply of seafood to the participants who buy shares."

With Carteret Catch on board, and armed with funding from both Duke Fish and the Duke University Sustainability Office, the organizers of Walking Fish jumped in with both feet. They began working out the logistics of the project, discussing details, and planning a Web site to promote Walking Fish and provide information about local fisheries. In April, they held a Happy Hour event in Durham to introduce their idea to the public and local restaurant owners, and held focus groups in July to determine what potential consumers and participants might want.

"Everyone in the focus group seemed really excited about Walking Fish," says Duke Fish member and second-year CEM **Jennifer Bruce**. "What it boils down to is that people want to get high quality, fresh local seafood from Walking Fish, but at the same time they're really excited that their purchases will affect the local economy, that their money will mean more to the community than if they just bought a piece of fish in the grocery store."

But the members of Walking Fish say this project is not just about stimulating the local economy.

"There's an increasing demand for sustainable seafood, and if we can show that the consumer wants well-managed and sustainable stocks of fish, then maybe we can influence the fisheries and promote more sustainable processes," says Stoll. "A major component of this effort is economic development, but in the long run this also is about working to ensure that the integrity of our coastal environments are maintained."

However as Bruce points out, the term 'sustainable' is not always easy to define.

"The issue and complexity of the term 'sustainability' poses a challenge because it's so abstract and has so many layers," she says. "It's a big stumbling block. Consumers need to understand that every fish you give them is not going to be the perfect sustainable fish, and what we're trying to do is provide the best product we can while respecting sustainability issues and balancing the needs of the fishermen and the consumers."

And while the focus groups helped determine what the consumers are looking for, the members of Walking Fish are still working on developing partnerships with local fishermen to better understand their needs. To do this, some members have tagged along on local shrimp and trawling boats throughout the summer, forging partnerships and seeing firsthand what the local fishermen do.

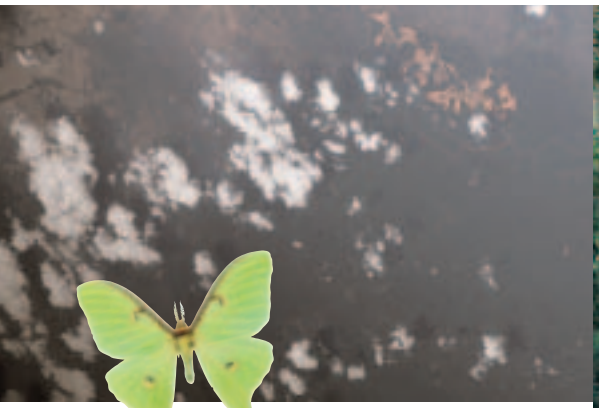
"We want to get a better understanding of what was meant exactly by 'small-scale fisherman' in North Carolina," says Stoll. "The experiences have been really interesting, and different than I imagined. We've learned a lot about what it means to fish, and I think there could be some really good things to come from relationships with these fishermen. It's all about building trust and gaining credibility."

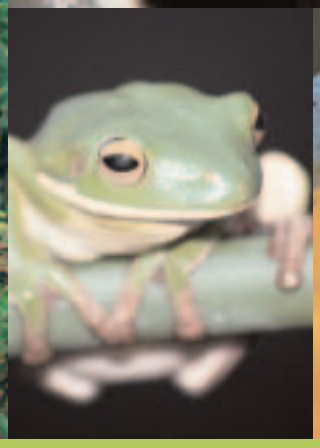
Walking Fish planned to have their pilot program up and running this fall, offering weekly or bi-weekly seafood shares with fresh local seafood delivered for a period of 12 to 14 weeks. The intention is for each share to have a variety of different species in it, which will change as the fishing seasons progress. At first, shares will be marketed mainly to members of the Duke community, but Stoll hopes to expand the project in the future to include the wider Triangle Area and maybe even other counties.

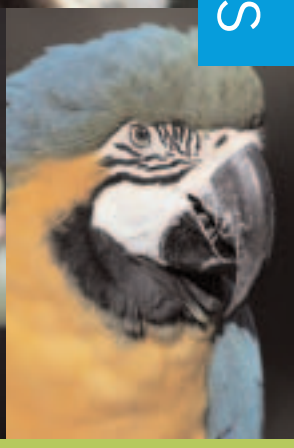
"The idea is that we start here because it's easier to access, but then we could potentially go to other counties and tap into the species that they have too," says Stoll. "Sustainable fishing seems like a big global and national issue, and it's a big local issue right now, so this project is something that people always will be interested in. As long as there are people willing to work for it, then the enthusiasm for it is not going to go away."

For more information on Walking Fish and community sustained fisheries projects, visit www.walking-fish.org.

Robyn Walker MEM'10 is a Nicholas School blogger and was the 2008-09 Nicholas School student communications assistant.







Policy and Geography Shape Tropical Parks' Success in **Stemming Deforestation**, New Paper Finds

Tropical moist forests are home to a majority of the Earth's terrestrial species, yet human activities such as logging, road building and agriculture destroy between one and two million square kilometers of these vital habitats every decade.

But a new paper by a trio of Duke University researchers, published in *The Proceedings of the National Academy of Sciences* this spring, offers cause for cautious optimism—with a major caveat.

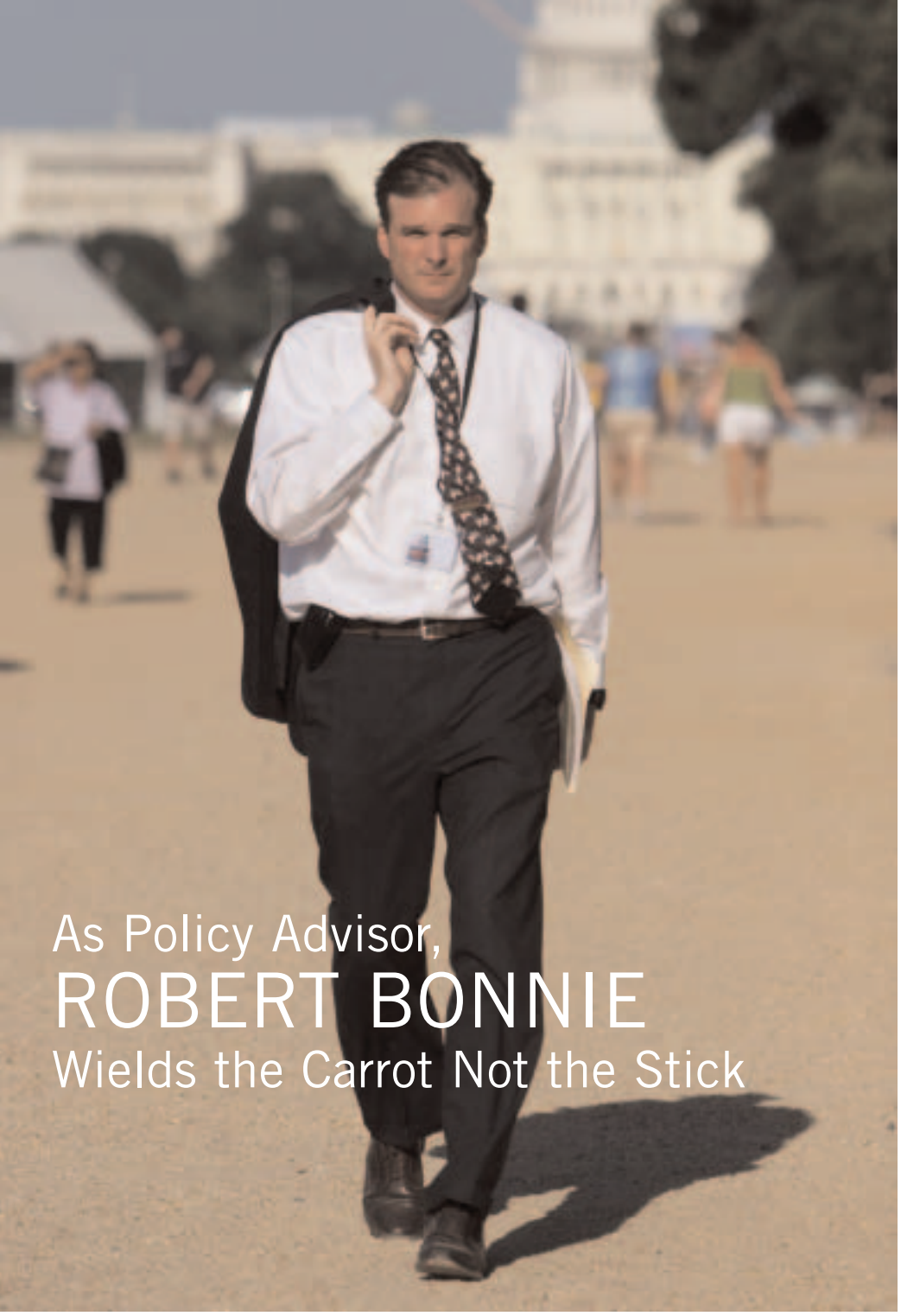
While protected areas seem to be working, there are too few of them and many, especially those in at-risk forests, are small, says lead author **Lucas Joppa**, a PhD student in conservation ecology at the Nicholas School.

Using satellite imagery and data sets from four large tropical regions, Joppa and his co-authors found that the success of national parks and other protected areas to stem deforestation hinges on both their legal designation and their inaccessibility to development. The researchers compiled satellite-derived maps of deforestation inside, or within 30 kilometers of, protected areas across four regions—the Amazon, the Congo, the South American Atlantic coast and West Africa—which once constituted about half of the world's tropical moist forests.

By overlaying the maps of deforestation onto maps showing the boundaries of national parks, state parks, wilderness areas and other protected areas, they were able to compare patterns of deforestation and fragmentation in the four regions.

"What is exciting is that while remote protected areas seem to be protected quite well simply because they are inaccessible, protected areas located in areas of high human pressure also seem to be maintaining their legal boundaries," says **Scott Loarie**, a recent PhD graduate in conservation ecology at the Nicholas School who co-authored the paper.

Joppa and Loarie wrote their paper with their faculty advisor, Stuart Pimm, Doris Duke Professor of Conservation Ecology.



As Policy Advisor, ROBERT BONNIE Wields the Carrot Not the Stick

by Erica Rowell

On April 29, **Robert Bonnie MEM/MF'94** settled into his new office at the U.S. Department of Agriculture (USDA). Of course, the view out the window differed from the sights out his old office window a few blocks away at the Environmental Defense Fund, but the focus of his new position was familiar.

As senior policy advisor to Agriculture Secretary Tom Vilsack, Bonnie would be working on land and water issues and addressing the Obama administration's broader goals, including the big one: passing climate legislation. Tracing Bonnie's path to the government back further, perhaps surprisingly, finds a woodpecker near the journey's start. The endangered red-cockaded woodpecker (*picoides borealis*), to be exact.

For his Duke masters project in 1994, Bonnie teamed up with Michael J. Bean, then head of the Environmental Defense Fund's (EDF) wildlife team. The aim of the project was to protect and restore habitat for the red-cockaded woodpecker; the team's fresh approach was designed to address an inherent flaw in the otherwise robust Endangered Species Act.

Dangling a Carrot When the Hammer Misses the Mark

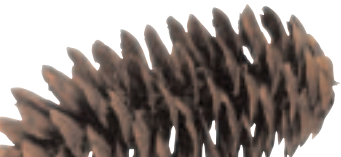
Despite its tour de force as one of the world's most effective wildlife protection laws, the Endangered Species Act (ESA) has some wrinkles.

Consider the landowner worried about the prospect of red-cockaded woodpeckers taking up residence in his forests. What to do? Because the ESA prohibits the killing of a listed species and the harming of its habitat, the landowner might take drastic measures like destroying an old-growth pine stand before it attracts the endangered bird. No harm no foul … except for the loss of habitat critical to the red-cockaded woodpecker.

So not only does the law hamstring what private landowners can do on and with their lands; it also provides no net benefit for the endangered bird and could possibly make things worse through the law of unintended consequences. How to fix?

Enter Bonnie and Bean and their team, which included EDF's Melinda Taylor, as well as participants from the U.S. Army's Fort Bragg military base and North Carolina State University. Thinking the carrot might be just the tool to take the bite out of ESA's stick, the group saw an opportunity to use incentives to restore red-cockaded woodpeckers and create a win-win situation. What if, they reasoned, landowners were rewarded when they managed their lands in ways that would benefit endangered animals?

So Bonnie, Bean, and company developed a program, dubbed Safe Harbor, that would effectively lift regulatory restrictions for landowners who voluntarily agreed to protect and manage habitat for a "baseline" population of endangered woodpeckers; the landowner would also commit to specific habitat



improvements, such as prescribed burning, planting and maintaining longleaf pine, and developing artificial cavities, to further enhance the habitat.

The program slowly took off in North Carolina's Sandhills region before being adopted by the U.S. Fish & Wildlife Service. Today, more than three million acres of land have been enrolled in Safe Harbor Agreements, benefiting a variety of endangered and threatened species. And as for the red-cockaded woodpecker? In just 10 years, reports the Fish & Wildlife Service, thanks in part to the Safe Harbor Program, their numbers have increased nearly 30 percent to about 6,000 groups.

And so began Bonnie's occupation with carrots.

"The work I did at the Nicholas School was all around incentives, both financial and market incentives," says Bonnie, adding, with "a strong emphasis on economics."

Using His Expertise in Incentives as USDA Policy Advisor

Markets and incentives are two key areas of expertise that Bonnie brings to his portfolio of forests, water, climate and offsets.

And despite the recent global financial turmoil, as long as they're structured properly, says Bonnie, markets remain a powerful environmental policy tool.

"Markets can spur innovation and low-cost solutions but they have to be well designed," explains Bonnie. "The legislative process is important to that because, in the case of climate, it is going to provide a broad outline of how the markets will work. But the specific rules and regulations written to implement that legislation are going to be very important."

This is where Bonnie and his USDA team come in—working with others in the administration to create a viable regulatory framework for entities that fall outside a cap on carbon. Landowners are a prime example. The agriculture department can play a role in making markets accessible to landowners, who represent a critical piece of the climate change fix since global lands account for one fifth of global greenhouse gas emissions.

"If you take land off the table, it becomes a lot harder to meet our climate goals," says Bonnie, who goes on to explain the importance of offsets, or different ways emitters can buy pollution reductions that someone else makes.

Offsets fund projects that reduce greenhouse gas emissions. They include activities such as installing methane-capturing systems over animal waste lagoons, planting trees, sequestering soil, and improving forest management practices.

"Domestically," says Bonnie, "if we can bring offsets with environmental integrity into the game, we can meet our climate goals more cheaply and we also can advance land stewardship."

It is here on the subject of offsets that Bonnie points to the lingering debate among environmentalists and others who recognize the need to act on climate change: a tax versus cap-and-trade system.

A carbon tax, says Bonnie, likely wouldn't allow "farmers, ranchers and forest owners access [to] a market that will pay them to protect the climate. A market taps into this potential."

But a cap and trade provides access through offsets.

Critics doubt that all offset projects would be verifiable and enforceable, in part because offsets are entirely voluntary and rely solely on the carrot. There also is the spectra of leakage—the term used to describe a carbon-cutting activity in one place that is canceled out (inadvertently, directly or indirectly) by a related activity somewhere else. (Imagine a tract of forest slated for clearing that is protected as an offset project, but then a nearby forest is cleared. There's no guarantee of any carbon reduction in such leakage scenarios.)

Bonnie counters such opposition by stressing that the bottom line with offsets is integrity: "If there's an offset market, it must do two things at once: 1) lower greenhouse gas emissions (that's the environmental integrity), and 2) must be designed in such a way that landowners can broadly participate.

The job of Bonnie and his colleagues is to ensure that the offsets markets are structured in such a way that landowners are only rewarded if they provide real environmental benefits. And so he is working on a solution that even critics can accept.

These days, Bonnie is more apt to be bending the ear of Secretary Vilsack than scouting for red-cockaded woodpeckers. But environmental protection is still the focus. And he's still looking for the right carrots to produce results.

Erica Rowell is managing editor of Dean Chameides' blog, TheGreenGrok.com. She is based in New York City.

International Conservation Leader, Sustainable Energy Advocate Receive Top Nicholas School Alumni Awards

by Laura Ertel

Bill Ulfelder received the 2009 Ralston Distinguished Alumni Award, the highest honor given by the Nicholas School's Alumni Association. It is presented to alumni who have distinguished themselves through contributions made in their own fields of work, in service to the Nicholas School or toward the betterment of humanity.

Ulfelder, who has worked with The Nature Conservancy since graduating from Duke in 1994 with a joint Master of Environment Management and Master of Forestry, is a leader in the conservation movement nationally and internationally. He began his career as a Population and Environmental Fellow working with The Nature Conservancy in Ecuador and Peru before officially joining the Conservancy two years later. In 1997, he was named Peru country director, where he helped negotiate a $10.5 million debt-for-nature swap.

"That deal broke new ground, because it was the first time that The Nature Conservancy, Conservation International and the World Wildlife Fund all worked together on a debt swap deal, where the U.S. government forgave debt in return for the Peruvian government making long-term commitments to its protected areas," he explains.

In 2003, Ulfelder returned to the States to become the Conservancy's Northern Arizona director. Then, recognizing that the next big push would be in conservation of grasslands, and wanting to be in the thick of things, he left the coniferous forests of northern Arizona to become Eastern Colorado director, where he oversaw grasslands conservation of the Western High Plains and led partnership efforts with the private and public sectors, including the US Army, the state and local ranching groups.

"In one deal, by partnering with the Colorado State Land Board, we were able to buy a 25,000-acre ranch, merge it with an existing 25,000-acre ranch owned by the state, and put that still-productive cattle ranch into conservation management of 50,000 acres so it wouldn't lose its biodiversity values. That was a great example of how we can bridge the divide between conservation and ranching, and was reflective of my belief that long-term conservation success is predicated not only on more traditional partnerships among conservation organizations, but also innovative partnerships with unusual bedfellows in industry and other sectors."

Ulfelder, who last year was the Conservancy's Acting Central Caribbean director overseeing work in the Dominican Republic, Cuba, Haiti and Puerto Rico, led the Conservancy in the launch of two of the largest projects in the program's history. One project promotes sustainable tourism in the protected areas of the Dominican Republic and the other will help ensure conservation and environmental protection within the context of the Central American & Dominican Republic Free Trade Agreement with the United States. Ulfelder had no intention of leaving Colorado, but a new opportunity to serve as New York State director was too good to pass up, and this year his

careermatters

Fresh Markets for Environmental Entrepreneurship

by Lucy Roberts Henry MEM '08

Last spring I stopped by Career Services after I gave a talk to a class at the Nicholas School. Assistant Dean Karen Kirchof asked if I'd be interested in a two-week intensive workshop for mid-career professionals that taught the use of markets in conservation? That was my first introduction to PERC (Property and Environment Research Center) in Bozeman, Mont.

The idea that an environmental professional could make a profit while enhancing the protection of natural resources was novel to me, until I recently participated in PERC's Enviropreneur Institute. PERC has been training environmental entrepreneurs for almost a decade now and the real-world lessons learned by these alumni are the centerpiece of the annual two-week, paid, Enviropreneur Institute each summer.

Environmental entrepreneurs from past years have shaped the curriculum and do much of the teaching. Their real-world experience and passion for innovation is contagious. The program combines in-depth sessions on topics such as venture capital and fundraising, collaboration, business plan development and economic analysis.

family headed to the Big Apple.

"Many people don't realize that New York State is incredibly important from an ecological perspective. Long Island has 1,500 miles of coastline, there's the Great Lakes region, and the Adirondacks park is larger than Yosemite, Yellowstone, Glacier and Grand Canyon combined. In addition, New York is linked to the global work of The Nature Conservancy, so it allows me to draw on my international experience in support of our work in 34 countries."

After 15 years on the Conservancy's team, Ulfelder looks forward to seeing what new challenges await. "It has been enormously rewarding to me to have the chance to not just make a difference in the United States but also overseas, and move between those worlds. There are few careers that give you that kind of opportunity. I have a lot of doctor and lawyer friends who say they wish they had my job!"

Ivan Urlaub, who earned joint master's degrees in Forestry and Public Policy at Duke in 2004, received the 2009 Rising Star Alumni Award, which recognizes exceptional achievement by young alumni who have distinguished themselves through contributions in their own fields of work, in service to the Nicholas School or toward the betterment of humanity.

Urlaub, the executive director of the North Carolina Sustainable Energy Association (NCSEA), is a pioneer in the state's sustainable energy advocacy and policy making arena. Over the last three years, he has been instrumental in securing passage of 40 energy bills by the State Legislature. In 2007, he provided critical leadership in the passage of the Renewable Energy and Energy Efficiency Portfolio Standard, the first such standard in the Southeast. Last year, the NCSEA also helped create a survey of green jobs in the United States-only the third such survey ever taken.

"I enjoy being able to see tangible change occur on the ground, as a result of our organization's work and my leadership," Urlaub says. "It feels good to remove regulatory and societal barriers that have prevented people from getting closer to the root causes of problems like global climate change, where they can implement solutions that put our society on a clearer path to a sustainable energy economy."

While at the Nicholas School, Urlaub co-founded the Duke University Greening Initiative (DUGI). Through DUGI, he helped to create a campus sustainability officer position and urged the university to adopt a comprehensive green building policy. He also was involved in the creation of the new MEM program for Energy & Environment.

Urlaub continues to aid the Nicholas School through his commitment to provide internships and to hire graduates. Currently, three MEM graduates work at NCSEA. He has employed 13 MEM interns through the Stanback Program, including four this summer.

"Environmental management is a skill that the Nicholas School helped me craft out of my environmental principles and experience. Receiving the Rising Star Award has inspired me to recharge and recommit to creating a more sustainable energy future. I am touched by the recognition of my friends and colleagues and grateful for the moment of reflection this award has given me."

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

During the training, each fellow develops their entrepreneurial project idea that is further refined through mentoring sessions with the alumni entrepreneurs, PERC staff and invited experts. The fellows come from all sectors, including government, nonprofit, and private. This results in a diverse array of project ideas, from government-run conservation incentive programs to private sector start-up businesses.

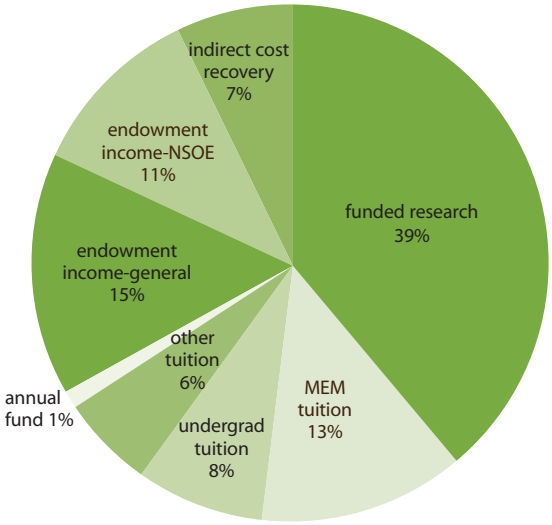
The Enviropreneur Institute offers an opportunity to take a fresh look at solving natural resource challenges and to collaborate with other environmental professionals on devising innovative solutions. The Institute awakened my entrepreneurial ideas and I think it can do the same for you.

In these economic times it is less likely that mid-career professionals are thinking of changing jobs, but now is a very good time to add new skills or experiences to their employment brand, says Kirchof. Mid-career professionals should consider participating in PERC or seek other programs such as NEPA training (offered by the Nicholas School's Duke Environmental Leadership Program), or the Kinship Conservation Environmental Leadership Program.

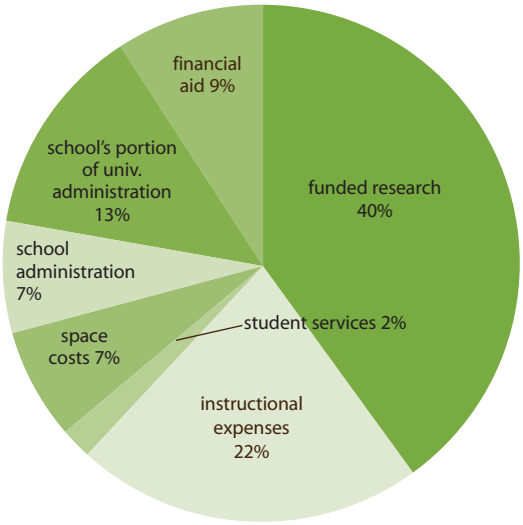
Interested in learning more about PERC? E-mail Lucy Henry at lucy.robertshenry@gmail.com or go to www.perc.org. To learn about other programs, contact Kirchof at kgki@duke.edu or 919-613-8016.

annual report update

sources of funds *figure 1*



uses of funds *figure 2*



July 1, 2008–June 30, 2009

The Nicholas School responded to the challenges of a weak economy during fiscal year 2008-09 by balancing its budget, while continuing to aggressively pursue its mission-critical activities. Expense reductions were made in most administrative functions, enabling strategic investments to continue in direct support of teaching and research allowing us to hire new faculty and recruit a record 2011 class. Contributions to the annual fund and earnings on established endowments were essential components of our revenue stream, allowing us to achieve these goals.

Many people don't realize that tuition supports a little more than one quarter of the Nicholas School's annual budget of about $49 million. The largest source of revenue derives from research grants. Indirect cost recovery on those grants supplies about 7 percent of the total revenue.

Just as research grants bring significant funding on the Nicholas School, they also are an equivalent source of expenditures-to get the work done. Expenses for educational programs account for about one-third of total expenses, dominated by faculty salaries and financial aid for our students.

Each year the budget is affected by changes in our success in obtaining research grants and by changes in tuition revenue derived from student enrollment. Other categories of revenue and expense are more constant and difficult to change in response to changing conditions. Nevertheless, the school is in good financial shape thanks to the contributions of our faculty, our students and our loyal supporters.

external affairs blurb

save the date

Mark your calendar for the following dates and monitor our Web site at **nicholas.duke.edu** for additional events.

november 12

Duke Forest Annual Gathering
5:30-7:30 p.m.
New Hope Improvement Association Center
4012 Whitfield Road
Chapel Hill, NC
Registration not required, but encouraged
Contact: Beverly Burgess
919-613-8013 or beverly.burgess@duke.edu

february 26

Stanback Conservation Internship Interview Day
Bryan Center, Von Canon Rooms, Duke Campus
Contact: Glenda S. Lee
919-613-8079 or gslee@duke.edu

april 10

Spring Banquet and Silent Auction (Tentative)
Nasher Museum of Art
Duke University
Contact: Nancy Kelly
919-613-8090 or nkelly@duke.edu

january 15

Prospective Students Visitation Day
8 a.m.-3 p.m.Bryan Center
Contact: Erika Lovelace
919-613-7459 or
admissions@nicholas.duke.edu

march 26-27

Admitted Students Visitation Weekend
Duke Campus, Levine Science Research Center
Contact: Erika Lovelace
919-613-7459 or
admissions@nicholas.duke.edu

april 16-18

Duke LEAF, Nicholas School Board of Visitors and Alumni Council Meetings
Duke Campus and The Siena Hotel of Chapel Hill
Contact: Celeste Brogdon
919-613-8035 or
celeste.brogdon@duke.edu

february 5

15th Annual Duke/Yale Environmental Recruiting Fair
Gallaudet University
Washington, D.C.
Contact: Thelma Jernigan
919-613-8102 or tejernig@duke.edu

Duke/Yale Environmental Recruiting Fair Reception
Washington, D.C.
Contact: Michelle Meagher
919-613-8003 or
michelle.meagher@duke.edu

april 1-2 (Tentative)

Masters Project Symposium
MEM and MF candidates masters project presentations
Von Canon Rooms, Bryan Center
Contact: Erika Lovelace
919-613-7459 or
admissions@nicholas.duke.edu

fall 2009

a greener magazine

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