

EARTH MATTERS

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SUPPORTING DIVERSE COMMUNITIES IN THE WARMING NORTH ATLANTIC

Optimizing conservation with guidance
from invasive species

Heat and health: Climate models help predict
future outcomes

Undergraduate entrepreneurs plan to revolutionize
food supply in Kenya



BROWN
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LETTER FROM THE DIRECTOR

The precipitous decline of Arctic ice on land and sea has attracted widespread attention. As of this writing, the Arctic is witnessing a summer ice extent approaching the third lowest value ever observed. In Greenland, surface melting is proceeding rapidly and is on track to reach the second-most extensive melt on record, particularly in the southwest. The records set during the warm year of 2012 have yet to be broken, but the ice has not recovered; it remains thin and vulnerable.

The dwindling ice cover is a serious threat to Arctic ecosystems and peoples, and to the globe at large. But it has also spurred a “race to the North,” introducing novel opportunities for the shipping industry, minerals companies, tourism, fishing, and military mobility.

According to a study by the U.S. Geological Survey, the Arctic likely harbors 13% of the world’s undiscovered oil and 30% of its natural gas resources—valuable commodities if we can afford to extract them. The Northern Sea Route cuts shipping distances by 40% compared to the Suez Canal, saving time and reducing carbon emissions. Arctic cod are beginning to retreat northward, opening the marginal ice zone to desirable Sub-Arctic species such as Pacific salmon. Meanwhile, Arctic vacationers are steadily growing in number, seeking everything from sport fishing to cultural education, and the balance is shifting toward smaller private craft. Russia,

Canada, Norway and Denmark have all initiated claims to enlarge their exclusive economic zones in the far north.

The Arctic may seem a remote place: a vast, distant, sparsely populated region, capable of absorbing the environmental damage we inflict through global and local industrial developments. But by rapidly expanding human activities in the Arctic, we risk creating a ‘sacrifice area’ rife with geopolitical confrontation, toxic pollution, rapid warming and greenhouse gas emissions. Yet avoiding these risks by forgoing development would likewise deprive Arctic communities of valuable opportunities for economic growth and employment.

The danger, Kaplan (1958) warns, is the propensity to mistake success for good. In such a scheme, “vulgar pragmatism does not ground values in existence, but takes as valuable whatever is existent,” and “competitive success is taken to be at once the sign and the very substance of worth.”

Kaplan’s words are both instructive and timely. The rapidly changing Arctic challenges us to take our next steps mindfully if we are to discover and pursue goals that are enduring and inclusively good.

Amanda Lynch, Director

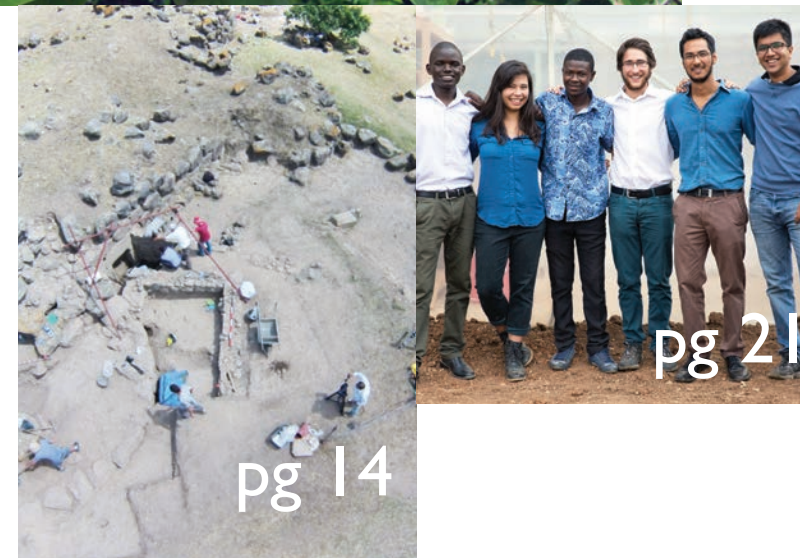
KAPLAN, A. 1958. *American ethics and public policy*, Westport, Connecticut, Greenwood Press.



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- food & water
- health & well-being
- natural systems
- equity & governance

BOOSTING ARCTIC RESILIENCE: EFFECTIVE POLICY DESIGN IN THE WARMING NORTH ATLANTIC

In 1986, a massive storm whipped through the small Arctic town of Barrow, Alaska, swallowing the face of an ancient cliff and revealing an archaeological surprise: a human foot, encased in a traditional mukluk, protruding from the reshaped bluff.



An adult polar bear and her cubs roam the shrinking ice in Barrow, Alaska. Photo: Amanda Lynch

The limb's owner had been buried face-down, indicating that he had once been a revered elder. Community members nicknamed their fallen ancestor 'Uncle Foot' and promptly prepared to rebury his body. But they were not swift enough; shortly thereafter, a second storm tore through the region, eroding even more of the land and sweeping Uncle Foot out to sea.

Sixteen years later, locals relayed this story to Amanda Lynch, a climate modeler who was conducting research



Uncle Foot's mukluk was revealed by a severe Arctic storm. Shortly thereafter, another squall swept his body out to sea. Photo: Paul Hess

in the region. As she tells it, their lingering feelings of mourning were palpable.

"The loss of Uncle Foot was really important to the community in that they hadn't been able to save him," she explains. "And the reason they weren't able to was because of the storm."

Thanks to climate change, such Arctic hurricanes have become especially unpredictable in recent years. "The elders used to know when [the storms] were coming, but they didn't know anymore," she continues. "And they didn't want to lose another elder like that."

THE THEORY

Amanda Lynch, Professor of Earth, Environmental and Planetary Sciences and Director of IBES, launched her illustrious career, almost accidentally, as a highly technical and sought-out arctic climate modeler. But her focus shifted when she realized that her computations weren't accomplishing much on the ground.

She recalls one particular conversation with an Inupiat man in Alaska. "We were talking about climate change

and how the ice was going to melt and all of this kind of stuff, and he said, 'How is all this science you're doing... going to help me? I live here.' And that really brought me up short," she says. "I thought, I'm writing all of these papers, but what am I doing that's really making a difference in people's lives?"

That encounter spurred Lynch to begin collaborating with fellow professor Ron Brunner, a political scientist at the University of Colorado Boulder who studies policy science and theory. Together they developed a new model of *adaptive governance* for climate change adaptation, a policy framework that empowers vulnerable communities to develop flexible and realistic strategies that will remain effective in the face of an unpredictable climatic future.

"My work in adaptive governance is all about trying to make policy that's modest and redundant and resilient," she explains. "And if it's going to fail, it fails gracefully and has resources left over for another try. It's about making policy adaptive and iterative over time. And that kind of policy in a situation of high uncertainty is, I think, the right way to go."

THE WORK

Today, Lynch works primarily in the north Atlantic region, which includes places like Greenland, Iceland, and northern Norway. Her research is guided specifically by the needs and concerns of local stakeholders, mostly in relation to one overarching question: *What does the retreating ice mean to each of the groups confronting it?*

This single question begets multiple answers.

"For the fishing communities in northern Norway and in Iceland, it's about the health of the cod and the cod fisheries, and the shrimp fisheries, and how they're trading off," explains Lynch. "For the Saami [in Norway], who are primarily reindeer people, what they're looking for is, how is this going to impact the terrestrial climate and the fodder for the reindeer? And the shipping companies and the oil rigs are worried about how quickly the ice is really going to retreat, and how dangerous it's going to be."

Lynch tackles these distinct perspectives one by one, interviewing representatives from each demographic

to determine what their major concerns are in relation to climate change—and what, if any, plans they have in place to cope with these issues. She and her colleagues then identify alternatives that might help stakeholders accomplish their goals more effectively or efficiently.

These conversations also inform the research questions that Lynch targets when running climate simulations. In this way, her modeling skills often come in handy; however, these days, she tends to respect the models more for their explanatory value than for their predictive power. “What I use them for is to understand mechanism,” she says. “Because if we have insight into how the system works, then we can have some sense of where it’s headed—without necessarily being tied to the false precision of one projection over another, which have such profound uncertainties.”



Amanda Lynch flies over western Iceland to survey the changing terrain.

Ultimately, armed with an empirical understanding of local climatic processes, Lynch can apply various “adaptive” policies to her model in order to determine which is likely to be most comprehensive and resilient under future conditions.

As a former climate model designer and programmer, her approach is both exacting and systematic. “If there’s anything that I could help quantitative scientists understand, it is that qualitative rigor is a thing,” she says. “It’s a real thing, and there are ways you can measure it.”

THE IMPACT

This type of work, so fundamentally based in the service of others’ goals and interests, is highly rewarding.

But it does present certain ethical challenges. And although Lynch may not agree with the goals of certain stakeholders—native communities hunting whales for meat, for instance, or minerals companies seeking to excavate formerly ice-covered plains—she is a strict adherent to the principle of the *common good*.

As she explains, the common good is inherently case-specific and must be determined anew in each situation and for each population.

“You can’t assume, walking in, that you know what the common good is,” says Lynch. “And that’s why I am very clear about, for example, being an honest broker in Greenland and never saying to them, ‘I don’t think you should mine toxic metals,’ because it’s not for me to say that’s not in their common interest. It’s for them to decide that.”

Lynch’s commitment to autonomy and empowerment positioned her well to take on the role of inaugural Director of IBES. As both its leader and one of its core faculty fellows, she believes that the Institute is uniquely equipped to promote the ideals of equity and human dignity.

“IBES is the expression of our commitment to the common good, collectively,” she says. “I might be a little bit more explicit and theoretical about how and why I do that [kind of work], but you can see it in all of the faculty; we’re all committed to the common good. And that’s really what it’s about. That’s what we’re building it for.”

This commitment is likely to become even more imperative in the decades ahead. As climate change advances upon communities with the smallest voices, the fewest resources, and the least power, the consequences of our warming world will hit such vulnerable groups worst and first. And in Lynch’s view, there can be no global benefit while a significant group of people remains in a state of suffering.

“That’s why I never talk about win-win,” she says. “Everybody might lose a little, but nobody loses everything. And everybody gets to live with dignity and hope.” ■

INTRODUCING: BATHSHEBA DEMUTH



Bathsheba Demuth, a former Brown undergraduate, returns to campus this Fall—this time, as an IBES fellow and Assistant Professor of History. Demuth, an environmental historian, has long been interested in how human interests in the natural world interact with nature itself, specifically in a half-Alaskan, half-Russian region of the western arctic known as the Bering Strait. This region, already fractured

along communist, capitalist, and indigenous cultural lines, is also subject to a rugged and unforgiving climate that offers little to facilitate either industry or agriculture.

Demuth’s research examines the way that both capitalism and communism have evolved against such a harsh backdrop. “It’s a chance to see how two different and generally opposed ideas about how to organize social, economic, and cultural life changed—or didn’t—under the pressures of the Arctic environment,” she says.

Her efforts have yielded some surprising conclusions. “What I found is that Arctic conditions often altered how ideology was performed in ways that made the two systems, so contrary to each other in theory, sometimes look basically identical in practice,” she explains. “It turns out that capitalism and communism

don’t exist, in reality, as fixed, unitary systems. They change across space, based on the ecologies they are trying to use and change.”

Demuth’s work is intimately connected to climate change and its consequences, which are already disproportionately affecting Arctic communities. “My research tries to trace how we as a species, and as members of the U.S. and Soviet national cultures, came to this point,” she says, “while also setting down a record of what life was like in this place that is changing so radically.”

She looks forward to continuing this work at Brown and with IBES. “Having the chance to work with people from a range of disciplines is really a dream job,” she says. “Teaching and researching with a group of colleagues with diverse expertise, but interested in cross-discipline questions, is thrilling.”

faculty spotlight

Interested in energy efficiency? **KURT TEICHERT** can tell you exactly how to optimize your space. Now a Senior Lecturer in Environmental Studies, Teichert has always been interested in reducing energy use in buildings. In his course, Sustainable Design



in the Built Environment, he brings together students from a variety of disciplines and encourages them to collaborate and examine sustainability issues and opportunities in new and innovative ways.

“Particularly when it comes to electrical use in the built environment, there are so many investments that can be made that just have a great return,” he says. “That really resonates well for students.”

Teichert explains that his priorities at Brown are teaching and advising, above all else. As a senior lecturer and advisor, he enjoys helping students find and take advantage of the many opportunities for engaged learning that the University offers.

“Fieldwork and field observations that they can make are a bus ride away, if not a bicycle ride away,” he says. “And the type of educational experience is right here for them too. Being at a liberal learning college with this very open curriculum—where they have to take responsibility for their program, both

within their concentration and outside of it—I can’t imagine they’d get that anywhere else.”

For Teichert, integrating sustainability into analyses and decisions is an ideal challenge for students because it requires critical and inventive thinking. “These are such interesting and pressing issues and there are so many interdisciplinary and transdisciplinary approaches that need to be taken,” he says. “Even if students finish Brown and their work isn’t necessarily directly related to the architectural and engineering fields, I think they benefit that way of thinking and problem solving. This field just offers so many opportunities.”

HOW TO SAVE A SPECIES: GUIDING CONSERVATION IN THE FACE OF A CHANGING CLIMATE

One hundred years from now, our planet is likely to be a very different place. Earth's climate is already changing, threatening vulnerable ecosystems the world over.

Many scientists consider a major global extinction event to be all but inevitable within the next century. Indeed, the scientific consensus forecasts a literal decimation of the world's lifeforms: 1 in 10 species are likely to have vanished from the planet by 2100.

So what are conservation-minded scientists to do?

Dov Sax, an associate professor in the department of Ecology and Evolutionary Biology, has dedicated his career to informing conservation policy by identifying and filling knowledge gaps in the field. Now, he and his team are trying to determine which plant species are most endangered by warming conditions in the United States.

This is not a straightforward question. "One of the big problems we have is in understanding which species are going to be at risk from climate change," he explains.

PICKING THE PLAYERS

Species, even those that live near to each other today, are not created equal. Some may be able to tolerate wide variations in climate and will therefore be able to

flourish in place; others will not be so fortunate. And it is not always easy to determine which is which.

"If you show me any two critters and tell me where they live, I can't necessarily tell you which is going to survive in place and which is going to need to shift and track changes in climate," says Sax. "And if you don't know that, it's pretty hard to prioritize conservation decisions."

One way to learn more about the conditions that a given species is able to tolerate is to look at whether or not it is able to grow on its own, in the wild, in a location different from its expected habitat. These outliers are known as *non-native species*, and they can tell scientists a lot of information about the potential of different species to withstand changes in their ambient environment.

"One of the hallmarks of my science career has been trying to understand what insights we can get from non-native species," says Sax. "We normally think of them as a problem—and they often are a problem, but not always. They often have a lot of insights for us. They're sort of like unplanned experiments."



Osage orange (*Maclura pomifera*), whose native range is the south-central region of the U.S., is spotted growing in California. Photo: Gretel Clarke

Sax explains that, for most species, the geographic boundary between a liveable habitat and an intolerable one is not rigid. Instead, species' ranges tend to fall on a gradient; that is, some plants tolerate a wide variety of conditions exceptionally well, and thrive far beyond their expected climatic limitations. Others may grow, but are unable to reproduce outside of their native range. Still others may fail to grow at all.

These subtle differences in survival potential are important to understand because they enable conservation scientists to optimize their interventions.

"Imagine you have a long-lived organism like a tree that maybe takes 100 years before it can reproduce," suggests Sax. "Imagine there is some place you could move it now where it couldn't reproduce yet, but it could grow. You could move it now, establish a population, have it

grow up, let climate change catch up to that population, and have it poised to be able to reproduce in the future."

These types of interventions are part of a strategy known as managed relocation, in which scientists actively move members of a species whose native range is threatened by climate change. Sax hopes to inform the conversation surrounding managed location by determining which plant species are at risk—and furthermore, which of those are likely to be savable.

EXPECTING THE UNEXPECTED

It's a lofty goal; and sometimes, predicting where a plant is likely to flourish is all but impossible. For instance, while studying plants native to Europe, Sax and his team stumbled upon an interesting dichotomy. Plants that had large geographic ranges in Europe generally thrived in areas of the U.S. that were climatically similar;

however, plants with much smaller distributions had completely unpredictable growth patterns once they hit U.S. soil.

“The assumption had been in the past that if something is only in the foothills of the Alps, it’s a climate specialist. It’s there because that’s the climate space that’s perfect for it,” explains Sax. “And what that work showed was that that’s actually not true at all. We don’t know why those species are limited just to the foothills of the Alps, but it’s not climate.”

So what is going on in plants with these mysteriously small, niche ranges?

One possibility is that the distribution of these species is, in ecology parlance, dispersal-limited. In other words, when a plant can’t move its seeds around, it will have a very difficult time spreading—even to regions where it might otherwise flourish.

This is the case for some of today’s limited-range plants, which originally evolved to coexist with so-called megafauna, giant animals of prehistory that helped to disperse their hefty seeds. But animals that exist today are much smaller and lack the strength to do the same, which puts limits on these plants’ ability to spread.



Trumpet creeper (*Campsis radicans*), whose native range is the Southeastern U.S., is spotted growing in New England. Photo: Gretel Clarke

The fact that plants with especially small ranges tend not to correspond with the ambient climate is what Sax calls a ‘rule of thumb’. He conducts much of his research in the service of seeking out similar patterns, with the hope that understanding these rules will better inform conservation efforts moving forward.

FORECASTING THE FUTURE

In order to determine which species are likely to be the most threatened in the coming decades, scientists must do their best to understand exactly how the climate is going to change. However, climate modeling is an inexact science. No one knows precisely how the world will warm in the future, or how it will warm in a given spot.

In an effort to account for these uncertainties, Sax and his team are applying their data to multiple climate models, under multiple conditions. Some species may pass the test for all models, under all circumstances. These species are likely to be safe in their current range. Others may fail all tests, and are likely to be unsafe in their current range. Many others will pass some tests and fail others, leading to a certain amount of uncertainty.

“It’s not so much that there’s an answer,” explains Sax, “as much as, ‘this is what the range of approaches suggests for this particular species, or that particular species.’”

For his part, Sax is motivated to do this work because he believes that the world’s diverse ecosystems have immense intrinsic value. “There are a lot of reasons to not want to lose a major fraction of the species on the planet,” he says.

“This research that I’m doing is pretty basic and fundamental to try and understand how big of a crisis we’re really in,” Sax continues, “and in trying to decide how to prioritize what we do with the limited amount of funds that we have to try to spend on conservation goals.”

This kind of prioritization is an inherently interdisciplinary endeavor. As such, Sax sees a larger, collaborative role for his colleagues in IBES down the road.

“This particular project is a project for ecologists and biologists,” he says. “But, this project is filling a knowledge gap so that I can come back to this larger set of conservation questions. And for that, I will need the sociologists and the political scientists and economists and the like.”

The ultimate goal is realistic, workable solutions. “How do we develop approaches that we can scale up?” he asks. “This is one part of that puzzle.” ■

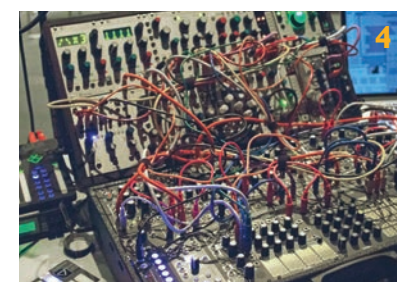
Earth, Itself 2016: ATMOSPHERES



1. Wendy Woodson performs her original theatrical work, *Drift*. Photo: Corey Marsh



2. Neil Safier, Director of the John Carter Brown Library, opens the Friday sessions. Photo: Alexandra Cerda



3. Presenter Cymene Howe. Photo: Alexandra Cerda



4. Sound artist Garth Paine wires up for his performance. Photo: Corey Marsh

5. Sound program attendees take in a unique audio experience. Photo: Corey Marsh



Join us for next year’s *Earth, Itself* event in **April-May 2017** **WHAT FIRE DOES** will feature an extended series of thematic seminars, clustered interdisciplinary presentations, and sparks of artistic inspiration in conjunction with **Providence WaterFire.**



Convened by Lenore Manderson

ATWATER AND NELSON TARGET BROWN, IBES AS INTEGRATIVE INNOVATORS

Institute supporters John Atwater and Diana Nelson are accustomed to seeking cutting-edge, collaborative solutions in the boardroom. In recent years, the couple has extended their efforts to fostering new partnerships—this time, in environmental research and education.

John C. Atwater has always been an entrepreneur at heart. After graduating from Brown in 1983, he completed a brief term on Wall Street before moving across the country to earn his M.B.A. at Stanford University. At the age of 29, he founded Prime Group, a real estate and finance venture based in San Francisco that now owns and manages over \$8 billion in real estate assets nationwide and is one of the largest providers of commercial real estate debt in the country.

Atwater, a product of Brown's self-directed curriculum, knows that his undergraduate education played a large role in grooming him for such an enterprise; but he also credits the University with igniting in him a brand new sense of perspective. Having spent his first eighteen years



in the upper Midwest, Atwater found Providence and the academic community new and exciting, but also profoundly inspiring.

“Brown, for me, was a sort of intellectual and societal awakening,” he says. “Minnesota during those years was very, very homogenous. Diversity was, ‘Are you German or Swedish?’ And then I got to Brown, and the world was so much bigger and richer than I ever imagined.”

Atwater has maintained a thoroughly global perspective ever since. Together with his wife Diana Nelson, he has channeled that view into international travel, nonprofit work, and a keen interest in current events. A consequence of his sustained attention, he explains, is a strong conviction that climate change is altering life on the planet

in indisputable and extraordinary ways.

“The environment is really one of the biggest issues of our time,” he says.

Atwater cites a variety of emerging crises whose origins can be traced to global climate change, from the ongoing civil war in Syria and changing trade routes in the Arctic to farming challenges in South America and recurrent coastal flooding in Bangladesh. When considering these issues, he is careful to balance the environmental consequences of climate change with the social ones.

“Somebody has to be thinking about the second and the third and the fourth level impacts of climate-based decisions on actual people’s

lives,” Atwater says, citing a domestic example to illustrate his point. “If you’re a miner in Appalachia and you suddenly aren’t allowed to mine coal, you can’t feed your kids. Environmental leaders can’t just say, ‘Don’t worry about that, because you’re saving the Earth.’ That’s not how things work.”

Faculty and students at IBES agree; indeed, the Institute’s primary mission is to craft a sustainable future not only for the world’s natural ecosystems, but also for at-risk human populations. Atwater believes that Brown’s academic community is uniquely qualified to take up such a lofty charge.

“You have to have a more integrated approach to figure out the most equitable solutions,” he says. “And at Brown, students and researchers are encouraged to integrate all different aspects of these issues so they can understand the bigger picture.”

Atwater and Nelson are confident that their investment in Brown’s environmental programs will enable its scholars to do just that. To this end, the couple has endowed a new Chairship in Physical Hydrology, a role as joint professor in IBES and the department of Earth, Environmental and Planetary Sciences (DEEPS). The position will be taken up by Laurence C. Smith, a widely acclaimed climate scientist and author of climate change treatise *The World in 2050*.

“I’m interested in empowering real experts to spend full time focusing on these challenges,” says Atwater. “My belief is if you get the best people working across disciplines,

that you gain a lot of knowledge. And once you get a lot of knowledge and communicate that knowledge, that the answers start to become a bit clearer.”

“My hope,” he concludes, “is that we won’t have to wait for another colossal disaster to trigger people into action.” ■

“The dual pressures of human development and climate change make water resources a leading environmental challenge of our century. Through creation of the new Physical Hydrology Chair, it is clear that both John Atwater and Brown University recognize this critical issue. I am excited and humbled by this once-in-a-lifetime opportunity to join the world class faculty and students at Brown and the extraordinarily talented and accomplished group of scholars at IBES and DEEPS.”

— *Incoming Atwater Chair of Physical Hydrology Laurence C. Smith*

Last year we featured the story of Peter and Pamela Voss, whose dedication to environmental research and education helps bright young scholars conduct new and innovative research each year. We spotlighted a handful of these undergraduates and early-career scientists in the last issue. **Where are they now?**

2015-2016 VOSS ENVIRONMENTAL FELLOWS

ALEXANDRA SWANSON '16 is now working as a policy research assistant for the Providence City Council. She will join the Peace Corps in February as an environmental volunteer.

PAUL WOJTAL '16 is currently living in Portland, Oregon.

FORMER VOSS POSTDOCS

SARAH IVORY has been awarded an NSF grant to continue examining the long-term impacts of climatic processes on vegetation. She will bring her project to the Ohio State University in December 2016.

ERIC ROY is now Assistant Professor of Environmental Sciences at the University of Vermont’s Rubenstein School of Environment and Natural Resources.

REBECCA RYALS is now Assistant Professor of Agricultural Ecosystem Ecology at the University of Hawaii at Manoa.

JOHN ZINDA is now Assistant Professor of Development Sociology at Cornell University.

FORECASTING HEALTH IN A WARMING WORLD

Epidemiologist uses climate models to predict health outcomes

Intense heat has long been recognized as an insidious threat to public health. Indeed, as the mercury rises, so too do emergency department visits, hospital admissions, and even deaths. And as the world continues to warm, such measures of so-called morbidity and mortality are likely to become more prevalent.

Kate Weinberger, a Voss Postdoctoral Fellow and epidemiologist, wants to quantify this increase. Here in Rhode Island, Weinberger is working with the state's Department of Health to evaluate the relationship between heat and poor health outcomes. She then uses climate models to project what these numbers might look like in the not-too-distant future.

"How many more heat-related deaths could we see in 2050 or 2090, if temperatures increase by x degrees?" Weinberger asks. "And what does that mean for local health departments and policymakers?"

Other IBES affiliates, including Weinberger's mentor, Associate

Professor of Epidemiology Gregory Wellenius, and graduate affiliate Samantha Kingsley, have long been exploring similar questions surrounding the public health implications of climate change; however, their research has focused

mainly on temperatures only observed in New England between April and October.

But as Weinberger explains, the future forecast may be more complex than that. She is now building on the group's former work by probing



the effects of a full spectrum of temperatures.

"Cold temperatures are also related to illness and death," she says, noting that as the world warms, colder temperatures will necessarily occur less frequently. "So as you look to the future," she asks, "will the increases in heat-related illness and death be at least partially offset by decreases in cold-related illness and death?"

The answer appears to be 'no... or, at least, 'not enough'. Weinberger and her group have found that, despite predicting relatively fewer cold-related emergency department visits in the future, the rapid and dramatic warming forecasted for benchmark

years like 2050 and 2090 is likely to overwhelm any modest gains in health outcomes afforded by fewer cold days.

In the face of such predictions, how can leaders ensure the best possible health for their citizens?

Communication protocols like heat warnings and advisories play an enormous role in maintaining safe conditions for today's city residents; these policies will only become more vital in the coming decades. Weinberger herself hopes to extend her research into determining the effectiveness of current policies, as well as identifying the factors that improve or worsen their efficacy. In the long term, she hopes that

her research will enable cities to optimize their weather response plans and, ultimately, to foster better public health.

At a place like the Institute, Weinberger feels confident about expanding her project in this direction. "What's incredible about IBES is the freedom to pursue truly interdisciplinary research projects, and the access to intellectual resources to support those projects" she says.

"What interests me is, how can I ask questions that are scientifically interesting and valuable but that can also inform a policy conversation?" she adds. "That's the goal for me." ■

student spotlight

Despite the state's modern-day progressive leanings, sociology PhD candidate **MICHAEL MURPHY** knows that the history of racial



oppression in Rhode Island is far from benign. Throughout the 17th and 18th centuries, European settlers to the region ousted tens of thousands of Native peoples from their ancestral territory and enslaved thousands more Africans on unfamiliar lands.

Murphy believes that these actions, disgraceful and profoundly unjust in their own right, also had a subtler consequence:

they fundamentally altered the relationships between people of color and the environment. Moreover, he explains, these relationships are still complex and often remain bounded today—but by a notion of race that has evolved alongside the ambient culture.

"To sociologists, race is still patterning human relationships all the time. It has just changed form," says Murphy. "The form it has changed into [today] is one that is less obvious to a lot of people—but, it is very obvious to the people who deal with the consequences."

He cites an example from his work with the Brown Superfund Research Project, an initiative that studies the remediation of polluted neighborhoods in Rhode Island. These neighborhoods often disproportionately comprise low-income inhabitants, particularly people of color, who have been living amidst contaminated soil and drinking water for decades. As Murphy explains, 300 years' worth of racial progress has not equipped these individuals with the resources to move.

Murphy is careful to note that, despite the forms of race-based oppression that persist into the modern era, many people of color do cultivate rich relationships with the natural world. He recalls a research project undertaken with fellow IBES graduate affiliate Apollonya Porcelli and sociology graduate Karida Brown. "In that project, we looked at the ways that the environment and nature form an integral part of this community of African Americans living in Appalachia—their worldview, their sense of identity, their sense of belonging," he says. "And so I want to be careful not to sound too negative or to present too totalizing of an image, because there are lots of ways that environment and nature play a huge role in the identity of African Americans and other groups."

In his dissertation, Murphy hopes to examine the variety of ways—both positive and negative—that race has patterned human relationships to the environment over the last three centuries. "Ultimately the goal is to change how we think about race and the environment," he says, "and if you weren't thinking about race and the environment, to get you thinking about it."

STONES OF SARDINIA: EXPLORING THE HISTORY OF AN ANCIENT COLONIAL HOTSPOT

One fine day in the 9th century BCE, bands of traders and colonists from the Middle East set sail across the Mediterranean Sea, headed for the island of Sardinia. There, they found an indigenous society living among giant stone towers called *nuraghi*, occupying modest dwellings built into the rocky monuments and herding cattle for sustenance.

Over time, the settlers influenced many fundamental areas of “Nuragic” life, giving rise to new ways of building homes, farming land, and cooking food—permanently altering the Sardinian culture and countryside in subtle ways, and preserving it in others.

Thousands of years later, archaeologist Peter van Dommelen and his team are retracing these foreign encounters in an effort to better understand the changes wrought by colonialism in Sardinia, on both local peoples and their land.

COLONIALISM AND CULTURE

Van Dommelen, a native of the Netherlands, has been conducting research in Sardinia for over 25 years. His fascination with the region stems from its pivotal role in what he calls the “formative moments of the ancient world”: the arrival of Phoenicians from the Levant, the establishment of Carthage, the Punic Wars, and the subsequent sprawl of the Roman Empire.

But his efforts are also based in a desire to shed light on the ordinary people of classical antiquity; that is, those who were not crafting famous works of art

or pioneering influential architecture—who, instead, whiled away their days engaging in relatively quiet yet vital tasks like animal husbandry, cooking, or producing goods and services. For van Dommelen, unearthing the past represents a way to give voice to these so-called “people without history.”

Colonial encounters, like the ones that occurred in Sardinia beginning around 900 BCE, only serve to enrich this study. Indeed, archaeology reveals much about the ways in which foreign influences altered the lives of everyday people on the island.

“You see the culture changing,” explains van Dommelen. “People start eating in different ways. They change their pottery, their utensils, everything—their way of life, their way of burying their dead.”

At excavation sites in Sardinia, van Dommelen and his team have uncovered proof of colonial influences in the form of Phoenician kitchen wares, Greek pottery, and large, Middle Eastern-style bread ovens; however, the researchers have also unearthed large numbers of discarded cattle bones alongside their other finds,



Aerial view of *nuraghe* Su Nuraxi (Barumini), which is one of the best preserved and most comprehensively excavated monuments. It has been listed as a UNESCO World Heritage monument. Photo: Peter van Dommelen

revealing evidence of a food source that was preferred in the local, Nuragic diet. Indeed, despite the changes so often wrought by colonial settlers, van Dommelen explains that some local traditions usually persist. He and his team are fascinated by the way that colonial influences mix with native practices to create an entirely new culture.

“What we’re basically looking at is a community that, by the 5th or 4th century BCE or so, is still eating cattle as their ancestors had done,” explains van Dommelen, “but because of all their new connections, they are eating their beef on a Middle Eastern flatbread, and enjoying it from plates that are Phoenician-style.”

“In a way it’s comparable to what you see in our society, in cities, where you can go from pizza to Indian to Greek on one street, and find them including native ingredients like corn and turkey,” he says.

CONNECTED TO THE LAND

It isn’t just people that change in the face of foreign influence; the earth beneath their feet changes as well. The Institute has sponsored an interdisciplinary branch of van Dommelen’s project in which the team is examining the way that land use, geology, and soil composition changed along with the ambient culture in Sardinia.

“It’s clear that agricultural techniques are changing,” he says. “After colonization there are simply more farms out in the countryside, so it’s actually a greater intensity of land use and of agricultural production.”

Van Dommelen is no stranger to the ways that humans have altered their lived environments over the millennia. From silty marshland forged due to damming of a large river around 500 BCE to ancient ice cores that show evidence of pollution during the times of the Romans,

archaeology clearly reveals the historical human influence on both local and global ecosystems.

“That’s where the intersection with IBES is,” he explains. “People in the past engaged with physical landscapes and have left traces, built farms, and were working lands—they were transforming their environment.”

HERITAGE MATTERS

In the Sardinian village of San Vero Milis, van Dommelen’s team works closely with farmers who are responsible for tending the same fields as their ancestors did, gathering information about the way they use the land today and describing the relics that have been uncovered in the area.

“It was very interesting, the survey that we did with the IBES funds, talking with peasants and farmers around the area,” he says. “They were very interested to hear what could be down there in something that they now think of as their best land. That’s very rewarding.”

Thanks in part to an enormous stone nuraghe just outside of town, locals have a keen interest in their own heritage and history. In this way, van Dommelen’s research has become somewhat of a community endeavor.

In fact, the village itself has facilitated many of the logistics necessary to the project at large: securing the excavation permit, hiring a staff archaeologist,

maintaining a local museum and accompanying research infrastructure, and providing a safe space for van Dommelen and his team to store their tools and equipment. In the summertime, local amateurs, University students, and high school students even get their hands dirty by helping with the excavation.

In honor of the locals’ hard work and participation, van Dommelen, his Sardinian counterpart Alfonso Stiglitz, and the rest of the team present their findings each year at the end of the field season, at an event that typically attracts 100 or more community members. Today’s Sardinians are eager to learn more about their forbears’ traditions, livelihoods, and unique cultural relationship to the nearby giant stone nuraghe.

“The thing that they repeat all the time is that they’re so grateful that someone is really looking at their monument,” van Dommelen says. “That’s how they regard it: ‘It’s our monument, it’s our ancestors and past.’ And we’re coming up with all these details about the past and it’s basically bringing it back to life.”

“That’s where I think archaeology is important,” he continues, “because it helps people to create a relationship to their living environment. And the living environment is not just the environment that’s created by the city or the state; it’s also the past that you relate to.”

“We don’t live in a vacuum,” he adds. “We go somewhere, but also we come from somewhere. There are plenty



Animal bones from the domestic trash deposit at *nuraghe S'Urachi*, showing (from left to right, and top to bottom) cattle, red deer, pig, sheep/goat, dog, chicken, fish, horse. Photo: Peter van Dommelen



View of fieldwork at S'Urachi in July 2015. This image shows a view of area D, eastern sector. Photo: Peter van Dommelen

of single-narrative, nationalist, or otherwise-motivated pasts that are being promoted, but archaeology actually reveals that the past is never simple.”

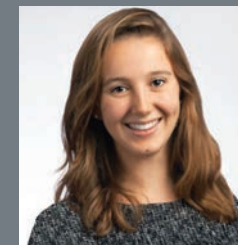
Indeed, after centuries of outsiders reshaping the local culture and heritage, Sardinia has become a melting pot of many different influences: from its indigenous Bronze Age roots and subsequent Middle Eastern influences to the Roman Empire and the modern Italian state. The historical marriage of cultures on this small island is not linear or straightforward, but van Dommelen takes this fact in stride.

“Archaeology—seeing those direct remains—is often very messy, and it confronts you directly with the messiness,” he says. “Well, life isn’t straightforward and neat; it tends to be messy. And that’s what I think you see in the past as well.” ■

Van Dommelen is Director of the Joukowsky Institute for Archaeology and the Ancient World. He is the Joukowsky Family Professor in Archaeology, a Professor of Anthropology and Italian Studies, and an IBES fellow.

student spotlight

Last Spring, **SOPHIE PURDOM '16** became the first undergraduate appointed to the IBES Advisory Council; however, this is far from Purdom’s first advisory role. Over the last four years, she has served on the University’s Environmental Change Task Force, headed



the Departmental Undergraduate Group for Environmental Studies and Science concentrators, engaged in policy negotiations at the UN climate talks in Warsaw and Lima, and more.

Purdom is especially passionate about tackling environmental issues from an economic perspective. After quickly rising through the ranks to become co-president of the student-run Socially Responsible Investment Fund (SRIF), Purdom became convinced that the University could apply similar principles to the management of its endowment. With support from President

Christina Paxson and members of the University’s Corporation, Purdom’s idea became the brand new Brown University Sustainable Investment Fund.

“The Fund is ground-breaking on both an environmental and an accessibility front,” she explains. “First, it has a special investment focus on outstanding environmental, social and governance companies. Second, it has no minimum—meaning that anyone can give any-sized gift to the endowment.”

Purdom also designed a brand new undergraduate course: The Theory and Practice of Sustainable Investing. She spent her final semester at Brown teaching the course alongside Cary Krosinsky, an Adjunct Lecturer in International and Public Affairs whose expertise in sustainable investing is internationally renowned.

The course, which includes guest lectures by high-profile luminaries as well as opportunities to research and pitch real-world equities, was in high demand.

“We thought that maybe 30 students might be interested in such an intense, focused, niche

seminar,” says Purdom. “We were wrong on that estimate; over 100 students showed up to the first class, and we already have a waiting list for future years.”

She is looking forward to bringing her unique point of view to the Institute’s roundtable. “I’ve touched many different sides of the student perspective throughout my time at Brown and with IBES,” she says. “I’m well-positioned to bring this perspective to the Advisory Council, and am honored to be working with the other brilliant and passionate council members.”

Purdom explains that she is proud of the Institute’s engaged, hands-on focus when it comes to tackling complex sustainability challenges. “It’s fine and well to discuss issues and problematize all day,” she says, “but IBES differentiates itself by taking research and learning outside the lab and the classroom, and putting solutions into practice. I think that’s essential.”

To learn more about the Sustainable Investment Fund, please contact Mary_Conway@brown.edu

GETTING THE LEAD OUT

Early lead exposure affects cognitive health throughout the lifespan.

Until the late 1990s, lead-based paint was a ubiquitous feature of Rhode Island's lowest-income rental properties. After the state passed legislation requiring landlords to remove the paint, public health experts predicted that the high blood levels of lead found in resident children would begin to decline. But according to Anna Aizer, Associate Professor of Economics, children's lead levels were in decline even before the law went into effect. The culprit? Yet another environmental source of the same chemical: leaded gasoline, which had been phased out of circulation incrementally over the preceding 20 years.

Such declines are good news for younger generations; however, for those born before environmental sources of lead were addressed, the health effects are very real indeed. Like many heavy metals, lead is highly neurotoxic—especially in children. High lead levels in childhood have been linked to a variety of cognitive health problems throughout the lifespan. Moreover, the burden of lead often falls on the most disadvantaged children, perpetuating their social and economic limitations.



In the 1990s, Rhode Island passed legislation requiring landlords of low-income housing to remove all lead paint from their properties. Photo: Kailani Acosta

Aizer sees these types of environmental health questions as fundamentally economic issues. “Economists spend a lot of time trying to understand the determinants of what we refer to as human capital,” she explains. “Human capital is everything that makes you productive, and those can be both cognitive and non-cognitive skills. And to the extent to which the environment influences people's development of human capital—that makes it an economic problem.”

Aizer is currently working on two projects: one that explores the effect of childhood lead exposure on test scores, and another that seeks to determine whether such exposure predicts future disciplinary infractions and crime. There is a wide base of literature around these two topics; but Aizer's work is especially strong, due in part to Rhode Island's uniquely comprehensive lead screening campaign.



Lead, a common component of water pipes, paint, and, formerly, gasoline, is highly neurotoxic to children. Photo: Nicola Buske

“Nationally, maybe 25% of kids ever get screened for lead, and in Rhode Island that number is closer to 80%,” she says. “We are actually getting kind of a universe of kids, so we have a really good picture of the lead burden in Rhode Island—more so than you do in most states.”

Aizer's results confirm the adverse effects of early lead exposure on children's brains, especially for those who are below the curve academically. “For the average kid, it's not mattering a whole lot,” she explains. “But for kids who are at the bottom of the test score distribution, lead levels are very predictive of how well they do.”

She and her team have also found that lead levels are, indeed, predictive of disciplinary infractions in school and juvenile detention later in life.

Aizer is hopeful that her work will help to inform future policy

decisions. “I think [this research] really does support the notion that we should be spending money reducing children's exposure to lead, particularly disadvantaged children,” she says.

In this respect, Rhode Island could serve as an example for other areas. The state has done a particularly good job of addressing the issue of lead paint in rental homes, she explains—and at a cost that is not astronomical to landlords.

In Aizer's view, removing lead from children's environments is a moral imperative; however, it is also an economically smart decision: “I think targeted efforts to reduce exposure to lead among these groups will have long-term gains, and that these remediation programs are likely to be very much cost-effective.” ■

faculty spotlight

Carbon dioxide, a persistent byproduct of fossil fuels burned over the last century and a half, is known to be driving the acceleration of global climate change. But what if CO₂ could be extracted from the skies



and transformed into a form of stored energy? These days, **TAYHAS PALMORE**, an electrochemical engineer and IBES fellow, is trying to do just that.

Her approach is a simple one: make use of the fuel cell, a technology known to convert fuels into clean electricity by way of an electrochemical reaction. At the heart of this technology is the catalyst, whose chemical makeup and structural properties play a key role in the outcome of the reaction. What is most interesting, however, is that when a fuel cell is run in reverse, powered by a renewable form of electricity, CO₂ can be turned back into something useful—for instance, a fuel that can be stored for later use.

This approach is promising, in part, because renewable sources of electricity, such as solar or wind, tend to power down once the grid is “full”, even if the sun is still shining or the wind is still blowing. But, given the right catalyst, fuel cells provide a way to turn such renewable energy into stored fuel, allowing solar farms and wind turbines to run 24/7 and ultimately making them more cost-effective.

Palmore herself is motivated by both scientific curiosity and a desire to make an impact in the face of a swiftly warming planet. She hopes to impart both ambitions to her students: “I would love it if they came up with some wild idea that turned into a really exciting discovery,” she says, “because it's their generation and future ones who are most likely to suffer the consequences of global warming, if left unchecked.”

YOUNG SCHOLARS CONFERENCE CELEBRATES DIVERSITY IN SCIENCE



Sometimes it takes a village to navigate a career in academia.

Enter the Brown University Young Scholars Conference. Last May, nearly thirty early career scientists from all over the country

arrived at Brown for three days of sessions dedicated to “thriving in the academy.” The participants, all senior graduate students or postdoctoral researchers, attended programming dedicated to helping them explore their options surrounding mentoring,

networking, management, and achieving tenure. Most participants hailed from institutions outside of Brown, and more than half identified as belonging to historically underrepresented groups.

Institute fellow Meredith Hastings, who headed the conference, explains the event’s targeted efforts. “Research has shown that women and minorities face additional hardships as they navigate scientific careers,” she explains. In light of those challenges, she says, the conference was an overwhelmingly positive experience: “The participants were engaged, eager and full of questions, and they did a fantastic job of taking advantage of the opportunity to get direct feedback.”

The conference, now in its second year, was co-sponsored by IBES and the Brown University Office of Institutional Diversity.

student spotlight

For decades, modern-day descendants of African slaves have been fighting for land rights in Brazil; however, even when they succeed, these individuals and their communities often find themselves caught in further struggles. Here at Brown, graduate student **PAULA DIAS** is studying these



issues from an environmental angle, as side effects of Brazil’s booming oil trade threaten Afro-descendant lands, spurring resident communities called *quilombos* to band together and give voice to their shared demands.

“The environmental interest is something that is just so prominent in Brazil in general, but also in the sector that I study,” says Dias, a PhD candidate in the department of Anthropology and a native of Brazil. “It’s not necessarily something that was driving my question when I first went to the field, but it was something I just couldn’t ignore.”

In recent years, environmental policymakers in Brazil have been working tirelessly to mitigate the damaging side effects of the country’s latest economic boom. Thanks in part to these efforts, oil companies are now required to fund environmental education projects in areas that may be impacted by offshore drilling—including territories claimed by Afro-descendant communities. Dias has centered her research around these projects, which seek to give local community associations a greater voice in decision-making by facilitating their participation in environmental councils, public audiences, and other spaces of participatory environmental governance.

“It makes a huge difference in [Afro-Brazilians’] political activism,” she says. “They’re always on a plane. They are always traveling. And these are people who would never be able to even take a bus to the capital of their state because they wouldn’t have the money.”

The consequences of so-called “oil-sponsored civil society” are mixed. Although Afro-descendant community associations now have greater representation in environmental governance, the oil industry is in a privileged position to frame local communities’ political claims.

Dias is very interested to see how these projects evolve over time. “Now Brazil is in this economic and political crisis,” she says. “There is this huge political scandal in the oil industry. There is this pessimism and political unrest in Brazil. I’m really curious about what will happen to these oil-sponsored projects in the meantime.”

BLACK FLIES, GREEN FEED

Undergraduates’ business revolutionizes Kenyan aquaculture

With its white sandy beaches, crystal blue waters, and gently swaying palm trees, Viraj Sikand ’17.5 describes Msambweni, Kenya as the picture of a tropical oasis.

But there is trouble in paradise.

In recent years, commercial fishing vessels have moved into the region, ravaging the local waters in their quest to harvest small specimens like anchovies and sardines, which are important sources of protein for feed formulation on inland fish farms. These large trawlers commonly displace handmade traps and damage fragile offshore ecosystems, endangering both marine life and the local economy.

Now, Sikand and fellow IBES undergraduate Maya Faulstich-Hon ’17.5 are determined to provide Kenyan fish farms with a better, cheaper, and more environmentally-friendly feeding solution. They want to forget the anchovies altogether; instead, they are launching a business that makes fish food from insects.

The business, named *Kulisha* after the Swahili verb ‘to feed’, revolves around one simple organism: the black soldier fly (*Hermetia illucens*). This insect, in its larval stage, is



The Kulisha team. Left to right: Lunalo Cletus, Maya Faulstich-Hon, Joseph Nderitu, Eric Katz, Viraj Sikand, and Arjun Paurana. Photo: Naiya Raja.

increasingly being heralded for its potential to replace fishmeal in animal feeds; it is nutrient-dense, it is inexpensive, it is environmentally sustainable, and it is easy to harvest. Kulisha will raise black soldier fly larvae on a large scale and then process, package, and sell the resulting feed to local fish farms as a healthy and wholesome source of sustenance.

Sikand originally conceptualized the idea for Kulisha in the summer of 2015. Struck by the concept’s simplicity, he quickly consulted his friend Eric Katz, a business student

at the University of Michigan. Since then, Katz has taken the helm as business advisor, while Sikand, a Kenyan native, has concentrated on site-specific logistics such as negotiating land use and making arrangements with local fish farmers. Faulstich-Hon, who joined the project last Fall, has focused her efforts on multimedia advertising and product development research.

The team also includes fellow undergraduates and Kenyan natives Arjun Paurana (UCLA) and Lunalo Cletus (University of Nairobi), as well as Brown engineering

Black Flies; Green Feed, continued

concentrator Catherine Hebson '17, who joined the team last spring. Hebson is currently working with Sikand and Faulstich-Hon on a series of rapid prototypes for harvesting mechanisms.

The team is sizable, and growing; and as with any venture—especially one that is so global in scope—maintaining cohesion has its obstacles.

“One of the challenges that we face is having a team that is so geographically spread out,” explains Faulstich-Hon. “Communication has clearly been a challenge, but it has been so great that Viraj, Cat, and I are here at Brown.”

The team's dedication to collaboration has paid off. Last spring, both Sikand and Faulstich-Hon were awarded Brown University Social Innovation Fellowships to continue their work during the summer of 2016. The team has also been awarded funding from a variety of other sources, including the Thought For Food Challenge, an annual international event held in Zurich at which Kulisha triumphed over 500 other projects to win the grand prize of \$10,000.

To date, the team has raised more than \$85,000 in total. “This project has been able to develop beyond our expectations,” Sikand marvels.

With support from their various awards, the team began building their infrastructure last summer. Their current site is modest: a small greenhouse on a piece of land just outside of Nairobi, with no electricity and no running water. But despite the inherent challenges, the

students believe that launching their business with so few amenities will ultimately work to their advantage.

“At the end of the day, we want to develop technologies that could be transferrable,” says Sikand. “Potentially selling this pilot in a low-tech scenario where we'll rely on things like charcoal fridges and



solar dehydrating—it's an exciting opportunity for us.”

Ground black soldier fly is a dramatically more sustainable product than many other types of fish feed; however, Kulisha's greatest allure is financial. “In Kenya, [aquaculture] has grown something like twelve-fold in the past four years,” explains Sikand. “But the issue is that fish feed is super expensive in that country and so a lot of it is being imported. It comprises 60-80% of your typical farmer's costs.”

“As an environmental science student, I see the huge potential of insect-based protein to solve many of the world's food security

problems and feeding a growing population,” adds Faulstich-Hon. “But at the same time, in Kenya we're not going to be marketing our product as ‘sustainable.’ We're going to be marketing it as a high-quality, low-cost, nutritionally-adequate feed because of this huge market demand for feed.”

In the future, the team hopes to tackle additional issues in Kenya; improving food accessibility, crafting more sustainable waste practices, and harvesting oils from environmentally-friendly sources—such as black soldier fly larvae—are all on the table.

But ultimately, they want to make it clear that feeding the world is not an impossible task.

“I would say our mission is to revolutionize the feed industry in Kenya... slash, the world,” says Faulstich-Hon, with a modest laugh. “We'll start in Kenya.” ■

[Learn more about Kulisha at www.kulishafeed.com](http://www.kulishafeed.com)

FROZEN IN TIME

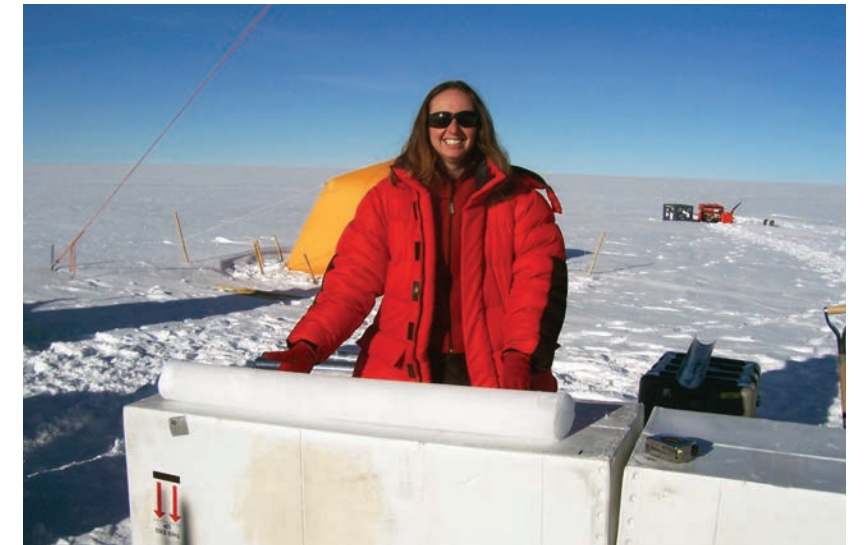
Probing climate history with nitrogen on ice

Meredith Hastings, a biogeochemist in the department of Earth, Environmental and Planetary Sciences, has been studying nitrogen for over a decade. Why? “Sometimes I think it's because nitrogen wasn't carbon,” she laughs.

But as Hastings knows, nitrogen is just as important to scientists' understanding of climate change, both today and in Earth's distant past. Indeed, ancient nitrogen atoms, frozen deep within the ice sheets of Greenland and Antarctica, can reveal much about the interaction between nature, humans, and climate over hundreds—or even hundreds of thousands—of years.

Over the course of her career, Hastings has spent many seasons camping out on high-latitude plains with colleagues, extracting ice cores in order to isolate and analyze the relic atmospheric nitrogen trapped inside.

At an atomic level, this nitrogen generally comes in one of two varieties: N-14, or N-15. These two types of nitrogen are known as different isotopes, because although they exist as the exact same element, there is one crucial difference: N-15 has an extra neutron. This particle mismatch causes the two species to interact with elements of the environment in different ways.



Furthermore, explains Hastings, “the behavior of them relative to each other, of N-14 relative to N-15, seems to be different for human-made sources than biologically made sources.”

For instance, anthropogenic sources of nitrogen (such as coal burning and fossil fuel combustion) and natural sources of nitrogen (such as forest fires and lightning) tend to produce different N-14/N-15 ratios. Such discrepancies illustrate why examining the characteristics of ancient nitrogen signatures can be so telling; when trapped under the polar ice, they become a kind of striated time capsule that indicates what kinds of atmospheric events were occurring at different times.

And in the modern age, the signals of human action are undeniable.

The nitrogen record compiled by Hastings and her team suggests a massive spike in human inputs of nitrogen over the last 200 years, when compared to both the pre-industrial age and the last glacial-interglacial period. This additional nitrogen is primarily sourced from oil burning in the recent past.

Indeed, as you read these words, yet another fine dust of nitrate, carbon, and other atmospheric particulates is settling on the dense snowpack of the Arctic and Antarctic plains; in this way, the history of our time is already being recorded.

The question now becomes: What will biogeochemists of the future find in the next generation's thin slice of ice? ■

ARCTIC ARTS PROJECT



The Institute is proud to announce a striking new addition to its walls: the drama of Arctic terrain, captured in two photographs by award-winning artist Kerry Koepping. The prints, *Vatna Basin Rain* (top) and *Akureyri Retreat* (bottom), are sourced from the Arctic Arts Project—a collaborative photographic exploration of climate change's effects on the region. The Project, which is complementary to the Institute's commitment to interdisciplinary study, aims to bring together artists, scientists, and educators to spark a new conversation about the realities of Arctic change. "In today's world of visual literacy, I believe that it is important to communicate the science of climate change through a medium that all can understand," says Koepping, who directs the Project. "It is how we can make science relevant to the masses." ■



LEADERSHIP

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Deputy Director (Research): Leah VanWey, Sociology
Deputy Director (Education): Dov Sax, Ecology & Evolutionary Biology

INSTITUTE FELLOWS

Lint Barrage, Economics
 Bathsheba Demuth, History
 Scott Frickel, Sociology
 Meredith Hastings, Earth, Environmental & Planetary Sciences
 James Kellner, Ecology & Evolutionary Biology
 Stephen Porder, Ecology & Evolutionary Biology
 J. Timmons Roberts, Sociology

TEACHING FELLOWS

Cornelia Dean, Environmental Studies
 Dawn King, Environmental Studies
 Kurt Teichert, Environmental Studies

ELECTED FELLOWS

Anna Aizer, Economics
 Cici Bauer, Biostatistics
 Kim Boekelheide, Pathology
 Joseph Braun, Epidemiology
 Erika Edwards, Ecology & Evolutionary Biology

Andrew Foster, Economics
 Baylor Fox-Kemper, Earth, Environmental & Planetary Sciences
 Justine Hastings, Economics
 Timothy Herbert, Earth, Environmental & Planetary Sciences
 Yongsong Huang, Earth, Environmental & Planetary Sciences
 Robert Hurt, Engineering
 Nancy J. Jacobs, History
 Agnes Kane, Pathology
 Karl Kelsey, Epidemiology
 Jung-Eun Lee, Earth, Environmental & Planetary Sciences
 Richard Locke, Provost, Political Science
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