BREAKTHROUGHS

UC BERKELEY COLLEGE OF NATURAL RESOURCES

SPRING 2011

SEEDS OF PROMISE?

ENRICHED

INSIDE

LETTER FROM THE DEAN

I'm sure all of you heard or read about the proposed budget cuts to the University of California. At this time, UC Berkeley's share of the system-wide $500 million reduction in funds proposed by Gov. Jerry Brown looks like it will be about $100 million. That's a lot of money.

While cuts are never good news, I'm pleased to report that because CNR got out in front of Berkeley's administrative restructuring, we will get through the 2010-2011 academic year with no layoffs and only modest administrative changes. In other words, yes, times are tough, but for this year our good work goes forward without dire or dramatic news.

Fortunately, the federal research funding we depend on survived Washington's combative, brinksmanship-heavy budget season this year, despite ferocious opposition to funding work in some areas like climate change. Controversy over research funding is nothing new to the scientific arena—globally, nationally, or right here at CNR.

In this issue of *Breakthroughs*, we focus on GMO discoveries in CNR's plant and microbial biology labs that are potential game-changers for large-scale societal issues like disease treatment and food production. Yet lack of political and/or financial support keeps these innovations either unfunded or stuck somewhere in the implementation pipeline. GMO opponents would say that that's a good thing. We examine this complex space between the cautionary principle of doing no harm versus the cost of stifling the emergence of potentially life-nurturing innovations *(page 10)*.

Funding and resource-allocation decisions have always been a part of academic life, and how we respond to them says a lot about our values as a community. The Environmental Leadership Pathway program assists science-oriented community college students from the most underserved populations in the Bay Area to successfully make the transition to a four-year university, and many of their graduates land at CNR. Why have applications to the program tripled and faculty support surged in just three years? Typical of CNR's small-college environment, it came down to listening to our students *(page 14)*.

The long view for the College also includes good news. This year we are moving forward on a campaign to renovate Hilgard Hall, the first priority identified in the strategic facilities plan CNR adopted last year. Having already earned LEED Gold certification for our Morgan Hall renovation (Briefs, page 6), we are setting our standards high. Cutting-edge education and research to sustain the planet merit a cutting-edge —and sustainable—setting. I welcome your comments at gilless@berkeley.edu.

J. Keith Gilless

PHOTO CREDIT: *Shutterstock*

COLLEGE OF
Natural Resources
UNIVERSITY OF CALIFORNIA, BERKELEY

BREAKTHROUGHS

SPRING 2011

ONLINE **Class Notes**

Go to **www.cnr.berkeley.edu/breakthroughs/break_classnotes.php.**

Calling All Peace Corps Veterans

Cal is the all-time top producer of Peace Corps volunteers, so it's only fitting we help the renowned agency celebrate its 50th anniversary this year. Share your Peace Corps story by August 1 at **nature.berkeley.edu/site/peacenotes_submit.php.**

A special online section will be published in conjunction with fall 2011 *Breakthroughs*.

Ant genome reveals secrets to success, clues to defeat

Anyone who has spent time around Berkeley has likely had to deal with legions of marching ants invading their kitchens.

Now a research team has unlocked the genetic code of the Argentine ant, providing clues as to why this species has been such a successful invader—and why they can often be found swarming minuscule or even invisible food sources.

Scientists have found that these South American pests have a huge number of sensory receptors for taste and smell. "They are covered with sensors," says **Neil Tsutsui**, an associate professor in the Department of Environmental Science, Policy, and Management, and lead author on the study, which was published in the *Proceedings of the National Academy of Sciences* in January 2011.

Argentine ants have 367 genes for sensory receptors for odor and 116 for taste, the study found. By comparison, the honeybee has 174 genes for odor—less than half as many as the ant—and 10 for taste.

But this is about more than household pests. "The Argentine ant is a species of particular concern because of its enormous ecological impact," said Tsutsui. "When the Argentine ants invade, they devastate the native insect communities while promoting the population growth of agricultural pests."

The genome map will help researchers understand and manipulate genes to interfere with mating, break up the super-colony running the length of California, develop repellants, or simply attract ants to a trap.

How does understanding these sensory markers help? For example, Tsutsui said that identifying the biological chemicals that ants use to tell friend from foe might make it possible to spray a nest with naturally occurring chemicals that trick the ants into thinking that they've been invaded. "Triggering their aggressive behavior would let the ants kill each other off and thus eliminate the need for pesticides," Tsutsui said.

The ground-dwelling species also appears to have the capacity to adapt to the variety of poisons they encounter in their foraging: they have a high number of genes that help detoxify harmful substances. Tsutsui says knowing where these genes are could help researchers learn whether the ants are developing a resistance to pesticides.

Researchers caution that there's no quick fix. They say the next step on the path to real-world applications is to study these genes in the lab and the field to confirm the genomic findings.

—adapted from an article by Sarah Yang

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Learning Backward

How mold can teach us about climate change

To the untrained ear, "reverse ecology" sounds like something out of a time-bending science fiction movie. But in **John Taylor's** genomic research lab, it's a powerful new tool in evolutionary genetics research, one that could be used to help monitor the effects of climate change and habitat destruction.

In a study published in the *Proceedings of the National Academy of Sciences* in January 2011, Taylor and his team used 48 different strains of wild *Neurospora crassa* from three far-flung regions to show that it's possible to determine an organism's adaptive traits by looking first at its genome and then checking for variations across a population.

They found a gene that is known to indicate cold tolerance, and then showed that members of the population that contained unique variants lived in regions with lower minimum temperatures—up to 9 degrees Celsius on average—and were able to grow better at cold temperatures than were strains found in more tropical climates.

"The normal route for adaptation studies is to first look at obvious differences—such as hair or skin color—between two closely related organisms," said Taylor, a professor of plant and microbial biology (PMB). "Then we look at the environment in which the organism lives to see if it might explain those differences, and finally, we examine the genes to see if there is evidence of natural selection."

For example, the researchers referred to a 2003 University of Arizona study noting that rock pocket mice with tan-colored fur are often found among light-colored rocks, while those with black fur were found on dark lava flows. Those researchers identified the genetic basis of this adaptive trait by targeting genes for further study that were known to be involved in pigmentation, and showed that gene variants were, indeed, associated with the different habitats.

"For our study, we reversed the order, beginning with genes that showed evidence of selection, and then looking at the environmental factors that might influence those genes," said Taylor, who emphasized that the research was a collaboration that included fellow Berkeley professors **Louise Glass** and **Rachel Brem**, plus a host of graduate students.

The study argued that this "reverse-adaptation" approach is especially useful when studying microbes. "Microbes are inconspicuous by nature and, unlike mice, which can have different colored coats, different strains and species look pretty much the same," said study lead author **Christopher Ellison**, a PMB graduate student.

As if to demonstrate this point, the research team discovered that what had been considered a single group of interrelated strains of microbes was instead two distinct populations. "Given that the two populations are structurally indistinguishable, and that they mate with each other, we never could have guessed that they were genetically distinct without having sequenced them," Taylor said.

With the new cheap and fast methods of censusing microbes, bacteria, or fungi, Taylor said soil and air can be sequenced every few years to see if the populations of microbes are changing. Additionally, researchers said the relative ease of studying a microbe like *Neurospora crassa* in the lab may make it an appealing tool to monitor the impact of environmental stress.

"If temperature is a key adaptive factor in populations of fungi and microbes in general, this could have important implications in the study of climate change," said Ellison. "Adaptation is a crucial part of evolution, so microbes could be used to monitor global temperature change."

—adapted from an article by Sarah Yang

A wild Neurospora colony releases spores on a heat-killed plant.

PHOTO CREDIT: John Taylor

New Wildlife Survey Tool

Pooches sniff poop for good, not evil

Alice Whitelaw, co-founder of Working Dogs for Conservation, at work with Camas, a dog trained to sniff out the scat of target species. *Right:* Maggie, a Labrador retriever mix also in the study, at the Hopland Research and Extension Center in Mendocino County.

Dog owners may find it disconcerting that their four-legged friends have a flair for sniffing out the excrement of other animals. But now, biologists have trained dogs to detect the scat of other critters for the greater good: to conduct more accurate surveys of wildlife.

"Wildlife detection dogs have been mostly used in airports to detect contraband, including endangered species and wildlife products, but in recent years, interest has grown in using the dogs to help scientists track biological targets in natural settings," said **Sarah Reed**, lead author of a paper documenting the dogs' performance that is published in the January 2011 issue of the *Journal of Wildlife Management.* "Working with dogs can greatly improve our ability to detect rare species and help us to understand how these species are responding to large-scale environmental changes, such as habitat loss and fragmentation."

Reed, now a postdoctoral fellow at Colorado State University, conducted the research while she was a graduate student in CNR's Department of Environmental Science, Policy, and Management. She worked with study coauthor Aimee Hurt, cofounder and associate director of Working Dogs for Conservation, a Montana-based nonprofit organization that promotes the training and use of dogs as a noninvasive tool for wildlife studies and management.

"Once the ability to extract and analyze DNA improved, researchers recognized the value of scat as a way to non-invasively monitor the location and population size of key species," said Hurt. "With scat, you can confirm the ID of species and even individual animals, as well as analyze hormone levels and diet. It's a very valuable data deposit. So then it became a matter of finding ways to better track the scat, and dogs naturally came to mind."

The researchers searched animal shelters and rescue organizations in Northern California for candidate dogs to train. "The dogs that do really well in this type of work are high energy, which also makes them hard to live with as pets," said Hurt. "Those are often the types of dogs that end up in shelters. They are not kennel dogs. They need a job."

—adapted from an article by Sarah Yang

PHOTO CREDITS:
Left: Photo courtesy of Alice Whitelaw/Working Dogs for Conservation
Right: Nancy Haggerty/Marin Humane Society

Tree Blight?

There's an App for That

California's majestic oak trees have been felled by the hundreds of thousands by a disease first reported in 1995 and dubbed "sudden oak death." To get a broader perspective on the disease, UC Berkeley scientists have developed a new smartphone app for hikers and other nature lovers to report trees that have succumbed to sudden oak death.

While out in a park or forest, iPhone users can use the free OakMapper mobile application to report sightings of trees killed by Phytophthora ramorum, the plant pathogen that causes sudden oak death. On site, they can note the symptoms they see, such as seeping, bark discoloration, crown discoloration, dead leaves, shoot die-back, fungus, beetle frass, and beetle bore holes.

The OakMapper app, created by scientists in CNR's Geospatial Innovation Facility (GIF), uses the phone's built-in GPS to identify the participant's location when the data is submitted. Users can also plot their location on a digital map.

UC Berkeley Cooperative Extension specialist and GIF director **Maggi Kelly** began collecting data from community members through the OakMapper website in 2001. The geographer said crowd sourcing is ideal for collecting data for her research.

"Many of the challenging natural resource problems that we face today—like invasive species, fire, climate change—are large in spatial scale and impact diverse public groups," said Kelly. Addressing these challenges often requires coordinated monitoring, efficient data collection, and increased communication and cooperation between scientists and citizens.

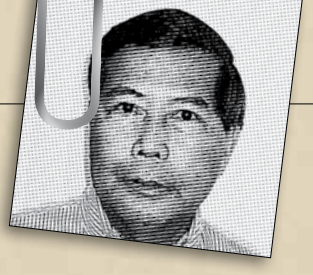
OakMapper serves all of these needs, she said.

"OakMapper is a coordinated monitoring effort," Kelly said. "It is also a citizen science project, collecting information about oak mortality from the general public, and it is an outreach tool, showing people where the disease is and providing them with information about it."

In addition to contributing to the database, people using the OakMapper app can view a map that shows known and suspected locations of sudden oak death in their vicinity as well as around the state.

To learn more about OakMapper visit oakmapper.org.

—Pamela Kan-Rice



SUBJECT:

Why I Do Science

ENTRY BY: **Ben O. de Lumen**

ENTRY #: **005**

Ever since I was in grade school, the idea that science is used to benefit humanity has always motivated me.

As I look back on my science career, I realize that research has presented me with many unexpected pathways. One has to be ready to take advantage of these opportunities—this is what makes doing science exciting. Having worked in industry, where one is assigned a project, I really appreciate the privilege here at Berkeley of being able to take one's research in unexpected and challenging directions.

About ten years ago, our research took a totally unexpected path. While working on a project to improve the nutritional quality of plant proteins, my team serendipitously discovered the cancer-preventive properties of a soy peptide (a small protein). We named it lunasin, from the Tagalog word lunas, for cure. Our lab has made significant progress in characterizing lunasin from various seeds and studying how it works.

Our next step is to move the project to clinical trials, possibly beginning with skin and cervical cancer prevention. Lunasin science is sufficiently robust that it is protected by patents owned by UC Berkeley, and has led to the founding of a biotech company. Participating in the translation of lunasin science from the laboratory bench into clinical trials is especially rewarding.

Science has always been a team effort, and I gratefully acknowledge the participation and contributions of colleagues from all over the world, as well as postdoctoral fellows, graduate, and undergraduate students.

Benito O. de Lumen is a professor of nutritional sciences and toxicology. He was recently named a 2010 Fellow of the American Association for the Advancement of Science (AAAS) for his contributions to natural-products biochemistry, with special regard to the discovery of lunasin, a cancer preventative derived from seeds of common crop plants.

NEW MORGAN HALL

A Green Champion

The Morgan Hall renovation team held their project to the highest standards of sustainable building practices, and they were rewarded with one of the highest honors currently available in that field: LEED Gold. CNR's top-level certification was a first for the Berkeley campus—already a green leader.

But the project team went further, and was rewarded for its efforts. At the California Higher Education Sustainability Conference in June 2010, the project was also recognized for educating students about green building practices and working with them to develop an educational program for the building occupants—completely integrating the build into Berkeley's mission of teaching and public service.

LEED—Leadership in Energy and Environmental Design—is an internationally recognized green building certification system.

"This lab renovation demonstrates to the campus community that green laboratory design is achievable without sacrifice to scope, timeline, or budget," said Dean J. Keith Gilless. "The added accolades for student involvement remind us that every campus initiative is a teaching opportunity," Gilless said.

Critical private support for the project was led by **Li-Chiang Chu**, a graduate of the College (MA, Nutrition, 1967) in honor of her graduate mentor, Professor Emerita **Mary Ann Williams**, in recognition of Williams' passion for teaching, mentoring, and research.

—adapted from an article by Kathryn Moriarty Baldwin

ELP Alum Wins Goldman Prize

The 2011 Goldman Environmental Prize was awarded in April to **Prigi Arisandi** *(left, teaching locals how to monitor water quality)* for his community-based work restoring and monitoring Indonesia's polluted Surabaya River, a source of drinking water to millions of people. Arisandi and his wife Daru Rini, who works closely with him in their conservation organization, are both graduates of CNR's Beahrs Environmental Leadership Program (ELP).

Arisandi, who won for the "Islands" region, is the second ELP graduate in three years to win the prestigious prize, the world's largest annual grassroots environmental prize.

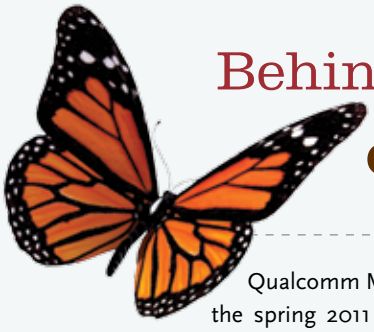
PhD Programs Earn National Kudos

The College of Natural Resources' doctoral programs recently received top marks from some of the nation's most noteworthy evaluators.

Agricultural and Resource Economics was ranked No. 1 in the United States by the 2010 National Research Council (NRC) study, the most comprehensive assessment of research universities in the country. Plant and Microbial Biology was ranked in NRC's top three. Environmental Science, Policy, and Management (ESPM) and Nutritional Sciences and Toxicology were both in the top ten.

The NRC evaluated programs on the basis of 20 characteristics, including the number and significance of research publications, financial support, graduate student qualifications and outcomes, and diversity. Because of the structure of the study, CNR's work in some other core fields (e.g., entomology and forestry) was not evaluated. Evaluated programs were ranked within a range, such as between first and sixth—an acknowledgment of the uncertainties surrounding any attempt to rank programs by quality.

Adding to the kudos, the annual *U.S. News and World Report* rankings placed ESPM programs in the areas of Ecology and Evolutionary Biology at number one in the nation.



Behind the Scenes of PMB 190

Qualcomm MEMS Technologies (QMT) sponsored the spring 2011 PMB 190 class. *Breakthroughs* asked Qualcomm MEM Technologies director Cheryl Goodman about the company's educational mission.

Why is QMT sponsoring this class?

QMT has made a serious commitment to advance the field of biomimicry because of the possibility to innovate new technologies. One of our efforts is to focus on education. It is our belief that for the field of study to reach its full potential it must be present from the classroom to the lab. The opportunity to support the UC Berkeley College of Natural Resources is a great start to help bring biomimicry to the forefront.

What are some examples of biomimicry in QMT's work?

QMT has developed the industry's first biomimicry-inspired micro electro mechanical systems (MEMS) display for mobile devices—a technological innovation that results in low power consumption and superb viewing quality in a wide range of environmental conditions, including bright sunlight. The principle that makes a butterfly's wings reflect light and "shimmer" is the same used in Qualcomm's mirasol displays. The display works by reflecting light so that specific wavelengths interfere with each other to create color.

We also have a fabrication facility in the Longtan Science Park of Taiwan, and when we first broke ground for this plant we sponsored the building of a butterfly observatory for the local elementary school district. With an observatory right there on their school grounds, these kids not only have an up-close example of biomimicry, but they have a place where the true practice of biomimicry can begin.

What do you think the next generation of students discovering this concept can bring to the world?

We live in an amazing world and Mother Nature's answers to scientific challenges are all around us. This new generation of students has an unparalleled opportunity to apply what they find in the natural world and innovate more efficient and effective technologies. The first step is to develop curriculum around the principles of biomimicry and then integrate it into our classrooms. As more students learn about biomimicry and the related opportunities, new waves of innovation will help drive this new field of study into the future. We hope this class of Berkeley students will help lead that charter.

Qualcomm MEMS Technologies (QMT) is a wholly owned subsidiary of Qualcomm.

PHOTO CREDIT: Shutterstock

Five Key Lessons

FROM PMB 190

In Spring 2011, CNR offered the new University-wide seminar, "Biomimicry: How Would Nature Do That?" sponsored by Qualcomm. Tom McKeag, founder and president of BioDreamMachine, served as lecturer, and was assisted by faculty members Lewis Feldman (Plant and Microbial Biology) and Robert Full (Integrative Biology). Feldman said the class "aimed to take a problem-solver's approach to viewing the treasure trove of ideas that exist in nature, and to analyze the opportunities and constraints that exist in the practice of bio-inspired design."

Breakthroughs asked Feldman and McKeag to share Five Key Lessons they hope will stay with the students—and with you. According to McKeag, "Technologies that incorporate these approaches will have a decided advantage in a resource-limited world."

1. **Be self-sufficient:** Provided with light, water, CO_2, and a few basic minerals, plants are totally self-sufficient.Fungi come in three body plans. These include single cells, as in the yeasts; the filaments of the mushrooms and molds; and the flagellated cells of water molds, which resemble animal sperm.

2. **Be responsive:** Plants, rooted as they are in their environments, have developed many ways of sensing and measuring changes in their surroundings and conditions, and responding adaptively.

3. **Surf for free:** Organisms take advantage of existing thermodynamic pathways in order to optimize their metabolic success. Soaring birds, drifting larvae, even prairie dogs ride the waves.

4. **Be energy-smart:** When solving problems, nature tends to use information and structure more often than large amounts of (expensive) energy.

5. **Solve for contradictions:** Some of the cleverest designs in nature and technology resolve contradictions—for example, the high strength and low weight exhibited in bird bones. A fast path to innovation is to head straight for a problem's central conflicts and try to solve them first.

Photo Above: Sterculia paniflora, of Singapore, uses bright color and high contrast to attract animals that will eat and later disperse its seeds. PHOTO CREDIT: Lewis Feldman

ON THE GROUND IN:

SOUTH E

Here are just a few CNR projects happening on the ground in Southeast Asia.

Small Farmers and the Spread of Bird Flu

In Southeast Asian developing countries, small and backyard farmers keep over 90 percent of poultry flocks and play a critical role in the control of avian flu. Over the past five years, **David Roland-Holst**, adjunct professor of agriculture and resource economics, has conducted studies in Thailand, Laos, Vietnam, and Cambodia that aim to improve the efficiency of policies for reducing disease risk, and also protect the livelihoods of small livestock producers. The research led to innovative strategies like health certification, micro-contracting, and text-message-based trading, which improve the product and market access for these smallholders.

Post-War Development in Burma

Kevin Woods, a graduate student in environmental science, policy, and management (ESPM), is studying the development of what he calls "ceasefire capitalism" in the wake of military operations targeting ethnic territories in northern Burma (Myanmar). He is looking at the ways that military government officials and Chinese businessmen make new alliances to create post-war, state-controlled landscapes.

Socionatural Histories of Trees and Tropical Territories

Henry Vaux Distinguished Chair of Forest Policy **Nancy Peluso** is working on a book about how ethnic and national identities and relevant territorial associations are produced through both violence and the law. She's taking a feminist perspective on the socionatural histories of three key trees that are important in the West Borneo landscape: durian, an indigenous fruit tree; rubber, an imported cash crop; and Meranti, the trade name for several species of tropical "light hardwoods" that dominate the dipterocarps forests of this region. Each tree has its own political-economic history and cultural politics, and when their respective trajectories are compared, a nuanced and complex view of the "rainforest" landscape emerges. Peluso, an ESPM professor, argues that political and ethnic violence have been a key part of the history of each tree and, in turn, of local people's social histories and identities.

Agrarian Reforms in West Java

The history of forestry in West Java's forest lands is quite different from that of the Central and East Java teak forests because of the province's different colonial history and close proximity to Jakarta, Indonesia's capital city. ESPM doctoral candidate **Noer Fauzi Rachman**, supported by a Mellon Dissertation writing fellowship, is finishing his dissertation this year on agrarian reforms in the region's forests. His work explores the claims and practices of growing peasant movements in West Java and the counter-claims and counter-reforms being made by the State Forestry Corporation.

PHOTO CREDIT: Shutterstock

AST ASIA

Managing the Impact of Chinese Hydropower

Entomology professor **Vince Resh** has been conducting research with teams from Laos, Thailand, Vietnam, and Cambodia since 2000 to evaluate the ecological health of the Lower Mekong River. Their objective is to prepare management strategies and monitoring programs in response to the potential disruption of fish production, which an estimated 75 million people in the region depend upon, from the "Cascade of Hydropower" being built in the Yunnan province of China. This project includes construction of a 100-story dam, the largest in the world. Resh has also been working in Java with Indonesian alumni from the Beahrs Environmental Leadership Program to develop water-quality monitoring programs that can be done at the village level. *(See "ELP Alum Wins Goldman Prize," page 6.)*

The Politics of Mapping in Laos

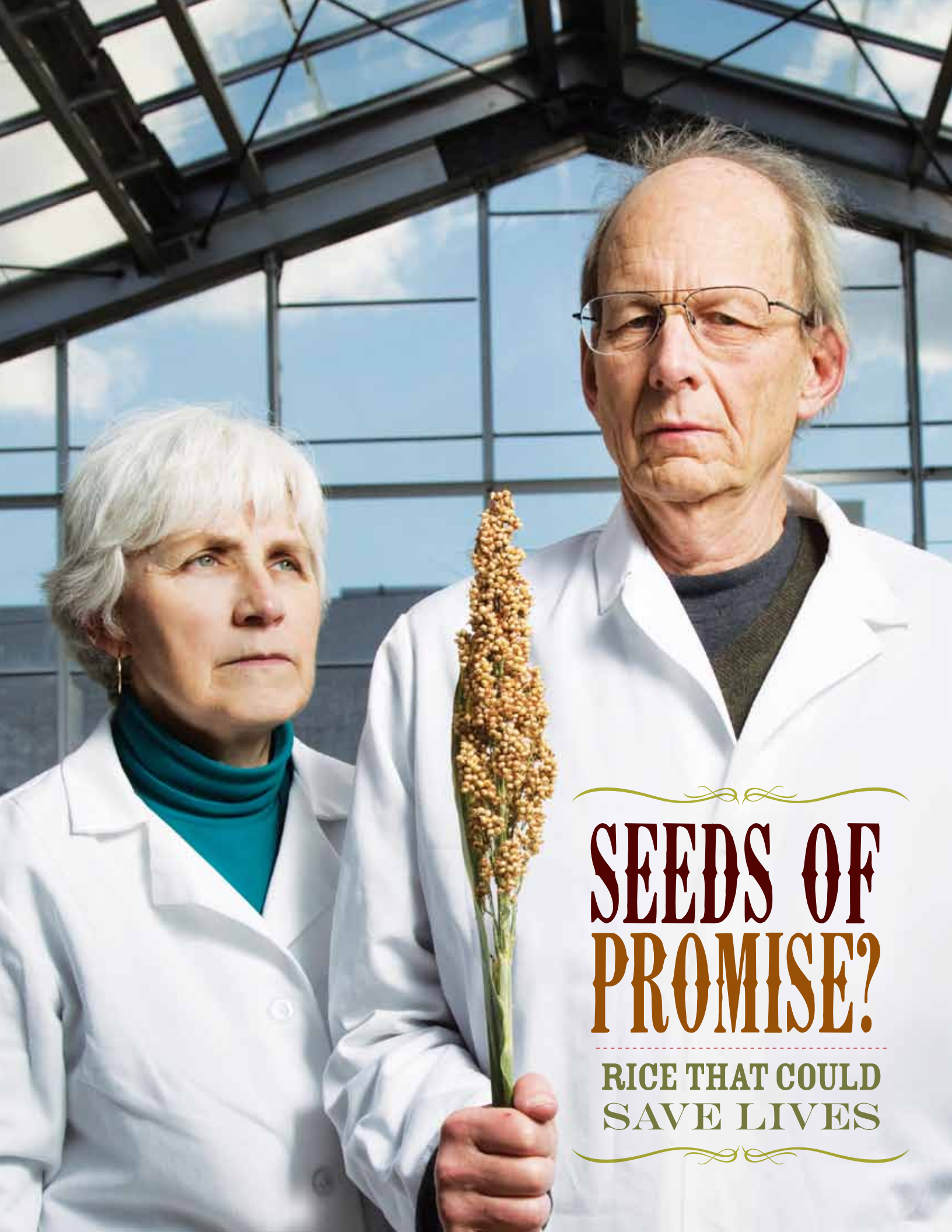
Peluso graduate student **Mike Dwyer's** dissertation is on the politics of mapping and land allocation in post-conflict Laos. Judgments are tied up with tensions between county and centralized governance and the rush of investors seeking concessions to grow rubber—again, largely for the China market.

Chinese Mining Influences in Vietnam

ESPM doctoral candidate **Jason Morris-Jung** is writing his dissertation on the social milieu in Vietnam in regard to Chinese investment and management of a controversial bauxite mine. Bauxite is the main ore of aluminum. Because the mining concession is held by Chinese capital and the tailings from the mines are being dumped not far from a major Vietnamese river used for drinking water supplies, Morris-Jung is finding that the mood in Vietnam, especially among intellectuals and activists, is conflicted.

Forest-Society Relations in Indonesia

ESPM's **Peluso** is also planning a restudy of the villages of Java and of the State Forestry Corporation that were the subjects of her 1992 book, *Rich Forests, Poor People: Resource Control and Resistance in Java*. A short reconnaissance visit in 2010 demonstrated that the ecology of the teak forests, the policies around growing teak, and the relative availability of a labor force had all changed since the fall of President Suharto in 1998 and the Asian economic crisis of the late 1990s. Peluso will be looking at the changing forest-society relations and what difference the forest makes in the forest villagers' current livelihood strategies.



SEEDS OF PROMISE?

RICE THAT COULD SAVE LIVES

By Nate Seltenrich

Accounting for more than 1.5 million deaths a year and 17 percent of all childhood mortality, the No. 2 killer of children worldwide is not measles, malaria, AIDS, or any other malady we fear as if by reflex. Instead, it's something we've learned to live with in the United States, where it rarely turns deadly. In the developing world, diarrheal disease is second only to pneumonia in causing deaths among children under five, killing more children every day than malaria, AIDS, and tuberculosis combined.

Peggy Lemaux and **Bob Buchanan** think their technology could help—if only the FDA approved. Using genetic engineering techniques developed through their work in the Department of Plant and Microbial Biology (PMB), the pair devised a method to overexpress individual proteins within the grains of cereal crops such as wheat, barley, and sorghum. When California biotech company Ventria Bioscience caught wind of their innovation in the late 1990s, it immediately saw the potential.

Using Lemaux and Buchanan's platform, Ventria found a way to use rice crops to produce two proteins, lactoferrin and lysozyme, which occur naturally in breast milk and have been shown to provide a range of health benefits for young children. The genetically engineered rice plants (also known as genetically modified organisms, or GMOs) produce a rice grain containing large amounts of the proteins, which are then extracted, purified, and used to formulate a preparation that improves the sort of anti-diarrheal rehydration solutions already consumed by half the world's children.

In a 2007 study involving 140 children in a Peruvian hospital, researchers from Ventria and the University of California, Davis, found that the treatment not only reduced the duration of diarrhea in afflicted children by nearly 30 percent, but also lessened the diarrhea's severity and the number of recurring episodes. In a related study at Johns Hopkins, the preparation dramatically enhanced recovery from diarrhea in adults, a common ailment among hospital patients taking antibiotics. Although not tested, these results seem to indicate that the rice product could alleviate some of the effects of cholera—a worldwide scourge that in recent months has taken thousands of lives in Haiti.

In 2004 Ventria's product received the "Generally Recognized As Safe" label from an international panel of academic experts who specialize in pediatrics, immunology, and allergies. The product was quickly submitted to the FDA for approval as a food supplement, which would enable it to be brought to market. The company expected to receive approval in six months to a year. Instead, all it heard was silence. Concerned that their documentation may have been too broad, Ventria scientists modified the notification to target pediatrics, and resubmitted it in 2007. But three more years passed without a response, and in March of 2010, Ventria withdrew its notification a second time, not knowing where to turn next. "We're sort of stuck in limbo right now," said Scott Deeter, the company's president and CEO. "The potential and the benefits are so enormous. It's hard to give up on it."

Meanwhile, Lemaux and Buchanan feel that a golden opportunity to potentially help save countless lives is being missed. The FDA has not told Ventria why it refused to review its oral rehydration solution, but the Berkeley researchers believe they know why: there is a hesitancy to approve products from genetically modified organisms. "It's simply the GMO issue," said Lemaux, a PMB Cooperative Extension Specialist, who has researched genetic engineering at UC Berkeley since 1991. "That's what the concern is here. They have to be much more cautious than they are with other food supplements."

As Lemaux sees it, the root cause is that the FDA isn't sure how to move forward in this situation. Certain food-safety and environmental groups have launched high-profile campaigns against GMOs, emphasizing potential biological and environmental impacts. As a result, Lemaux argues, regulatory agencies are likely wary of approving such products.

"If you could do this without genetic engineering, there wouldn't be nearly as many concerns," she said. "People want to talk about risks. But there are risks on both sides. In this situation there are risks if you don't do it. The suffering of a lot of people might be spared."

Controversy and innovative science have gone hand-in-hand since the days of the sun circling a flat Earth. More recently, embryonic stem-cell research has kindled ethical quarrels yet to be resolved. Looking forward, robotics and nanotechnology could well be the stem cells and genetic engineering of the future. All hold the potential to both solve and cause problems, and our society appears divided on whether or not to embrace them. As these tensions play out, significant breakthroughs are sometimes lost in the shuffle.

Peggy Lemaux and Bob Buchanan at the Oxford Tract greenhouse.
Photo by James Block

Disagreements over controversial science often boil down to differing perspectives on calculations of risks and rewards. Proponents stress a particular reward, or the cost of inaction. Opponents may concentrate on related risks, or employ the precautionary principle to place burdens of proof on those taking action. One can almost see the scales swaying.

The GMO issue is much broader than biopharming, the term used to describe the production of pharmaceutical agents through crops, such as in Ventria's work with rice plants. Within the United States, hotly contested debates surrounding genetically engineered salmon, alfalfa, corn, and other organisms have also brought an ideological divide to light. The same divisions are evident at the university level, and even within the College of Natural Resources. **Miguel Altieri**, a professor of environmental science, policy, and management (ESPM), is a staunch opponent of the genetic engineering of crops, having written numerous papers criticizing biotechnology. As an alternative to genetically engineered crops, Altieri focuses on developing methods that employ biodiversity and traditional farming practice to sustainably boost food production.

ESPM professor emeritus **Andrew Gutierrez** is another skeptic. He says the scientific testing that goes into many GMOs prior to production is of dubious quality, making it difficult to foresee environmental risks related to cross-contamination and effects on other species. "It's not a system I would trust," he said.

The result is a scenario in which scientists often find themselves pitted on one side or the other of the GMO debate. "There's very little meeting of the minds, which is unfortunate," said Lemaux. But in the end, she adds, this may be no cause for despair: "That's the nice thing about being at a university—you can pursue your own ideas, even if they don't match with what other people are doing."

Buchanan, PMB professor and CNR's Executive Associate Dean of Research and Extension, who has been at UC Berkeley since the early 1960s, puts the disagreement more succinctly: "It's just different philosophies."

While both Lemaux and Buchanan say they're disappointed that the diarrheal treatment has yet to see the light of day, it's not their only source of frustration. Some of their other discoveries have stalled at even earlier stages. In 1997 they used their protein-expression technique to begin creation of a wheat variety that was less allergenic, but they failed to find a partner to further develop it. However, this research led not only to the pair's interactions with Ventria, but also to a further innovation they believe could have a huge impact on worldwide food production. A group of Chinese researchers learned about the pair's work and figured out a way to apply some of the same genetic solutions to a significant problem facing farmers in China and around the world: pre-harvest sprouting in white wheat.

The problem occurs when seeds sprout before the plant is ready for harvest, often triggered by rain and high humidity. As much as 20 percent of China's wheat is lost to pre-harvest sprouting each year. Yet a field test of genetically modified white wheat that resists pre-harvest sprouting was planted in 2007 by researchers from Henan Agricultural University and they are currently growing the fourth generation with no reduced yield, Buchanan said.

> "There are risks on both sides. In this situation there are risks if you don't do it. The suffering of a lot of people might be spared."

Now the Berkeley researchers hope to apply the same approach to wheat that is of value to the United States, where pre-harvest sprouting in white wheat results in millions of dollars of losses every year. Not only would the change result in significant savings, but it would also allow many growers to switch from red wheat to white wheat, which has more nutrients and fiber. A Montana-based wheat-breeding company initially expressed interest, Lemaux said, but it was recently bought by a larger corporation that has not expressed interest in pursuing the approach.

Lemaux isn't giving up. She's actively seeking grants and partnerships that may help support implementation of modified white wheat in the U.S.

Upcoming meetings on pre-harvest sprouting in Brazil and Canada, where she will present this work, may help attract some interest—and, ultimately, funding. Still, all the obstacles have taken a toll. "I pick my projects carefully, ones that I think would have some positive impact on agriculture if they were able to get out. The fact that none of them has made it is quite frustrating," she said.

"I wish we could take the wheat work further, because I think there's a lot of promise there," echoed Buchanan. "It could change the way wheat's grown, and the kind of wheat we grow."

Lemaux chalks up some of the challenges with modified wheat in the United States to nervousness about genetically engineering what's known as the "staff of life." But many critics and fellow researchers have expressed practical concerns, perhaps the largest of which is the cross-pollination that can occur when genes from genetically engineered crops mingle with those of non-engineered crops or organic crops.

Santa Clara University professor **Michelle Marvier**, who specializes in risk assessment of genetically modified plants, views gene flow—known as out-crossing—as an inescapable byproduct of genetic engineering. "It's going to happen," she said. "They have no success to date at keeping any genetically modified crop contained. There's a huge list of examples of genetically modified genes getting out of the lab before they're even released."

While Marvier doesn't view out-crossing as an inherently bad thing, she says it can be highly problematic for some modifications. With herbicide tolerance, genes in food crops or grasses could spread to nearby plants and create so-called superweeds that are resistant to certain herbicides. She's also wary of biopharming. While lactoferrin and lysozyme occur naturally in breast milk and are relatively benign, other proteins such as human growth hormone could pose serious problems if they were to make their way into the food system via GMOs, Marvier said.

Both rice and wheat are almost exclusively self-pollinating, dramatically reducing the chances of cross-pollination, Lemaux said. On top of that, most genetically engineered crops are planted a significant distance from non-engineered crops in order to further reduce the odds of gene movement. Lemaux agrees with Marvier that the risk of commingling is never nil; something as simple as a seed spilling off a truck could cause a variety to end up somewhere it's not supposed to be. The debate returns again to the question of risk versus reward: what might happen if we act, and what will happen if we don't?

Tempting as it may be to dwell in the past, Lemaux and Buchanan keep their gazes fixed straight ahead. In recent years they used similar technology in a partnership that sought to increase the nutritional content of sorghum, an important food crop in Africa. The research received funding through both the U.S. Agency for International Development and the Bill and Melinda Gates Foundation's Grand Challenges for Global Health. They've since passed their advances along to another partner in the project, a Johannesburg-based organization, and hope someday to see them implemented. Even in the absence of further funding, Lemaux and Buchanan continue to work on improving the nutritional qualities of sorghum, largely with undergraduate students in their Koshland Hall laboratories.

Motivated by a desire to make a lasting contribution to agriculture, Lemaux and Buchanan—who both grew up on farms; he in Virginia, she in Ohio—maintain hope that someday beneficial GMOs will be widely accepted within the United States and around the world. Buchanan likens the gradual eroding of public opposition to waves wearing away at a rock: "It'll happen," he said. "Slowly, I guess, but it's evolving in that direction. It'll happen."

He may be right, but Marvier stresses that opinions deserve to be nuanced. "There's a million things you can do with the technology, and some of them are going to be really good, some of them are going to be frivolous, and some are going to be harmful," she said. "It's just case by case. You can't lump them all together and say 'I'm for it or against it.'" Lemaux and Buchanan agree. The answers, it seems, are never easy.

This page, left to right: Tamara Miller, Peggy Lemaux, and Kathy Cheung. Opposite page: Bob Buchanan
Photos by James Block

UNCOMMON JOURNEYS

CNR's Environmental Learning Pathway program is lighting the way for underserved students

By Ann Brody Guy

Sporting jeans and a sweatshirt, a backpack, and stylishly cropped hair, **Rathana Yim** looks like a typical California college kid. But his trajectory from high school to UC Berkeley was far from ordinary.

Yim's casual appearance belies his 25 years and a lifelong series of challenges that might derail even the most driven students from reaching their goals. The tenth of eleven children of Cambodian "boat people," refugees from the killing fields of the Khmer Rouge, Yim is the first in his family to go to college. He has child-care responsibilities for his extended family, works to support himself and his nephew, and has been rocked by persistent family struggles with debt, illness, and frequent moves.

Yim is no excuse-maker—he worked and stayed in college, first San Francisco State and then San Francisco City College. But without role models or support, he had no roadmap to guide him from community college to the medical career he envisioned.

Enter **Chris Lever**, director of CNR's Environmental Leadership Pathway program and a CNR alumnus himself, with a Ph.D. in environmental science, policy, and management. The Pathway program, supported by a National Science Foundation (NSF) grant and CNR's Don Dahlsten Outreach Fund, targets students from underserved and low-income populations who demonstrate a strong interest in science. Through classes, research, mentorship, and financial support, Pathway provides an annual cohort of 25 qualifying students with an entrée into a four-year college, a critical first step in helping them reach their goals.

Lever visits classes and posts flyers at community colleges throughout the Bay Area. He uses email lists from science classes and whatever other outreach vehicles he can come up with to find the right kids.

PHOTO CREDIT: Shutterstock

Reaching Out

Yim saw a flyer at City College for a UC Berkeley internship with a grant, and the money got his attention.

"Normally during the summer I worked retail and did landscaping to save up money for school. I didn't have time to enrich my brain," said Yim, now a junior and a toxicology major in the Department of Nutritional Sciences and Toxicology (NST). He showed up for the meeting, and talked to Lever about his family situation and middling grades. He applied and got accepted.

Lever has as many stories as Pathway has students.

"Our students have very complicated lives," said Lever. "They have the will and the intelligence to succeed, but the money they earn usually goes to family expenses before it goes to college expenses, and they often lack the experience, self-image, or confidence that allows them to see themselves as Berkeley students," he said.

Sometimes Pathways simply provides social or cultural reference points. **Yvette Gault**, a 2009 fellow, saw a flyer at Skyline College in San Bruno.

"I didn't have anyone in my family who went to college, so I thought the scope of degrees was more limited, like lawyer, architect, doctor..." Gault said.

After her mother died, she and her four siblings spent stints of several months at a time with family on reservations—the Ute Nation in Utah and the Navaho Nation in Arizona—while their father got back on his feet financially. "When I saw that this program was focused on environmental studies, it just really resonated with me," saying that her Native American background gave her a strong connection to the environment. She's now a junior at CNR, majoring in ecology and the environment.

Refocusing the Program

The program kicks off with a weekend orientation at the Marin Headlands, where the group bonds as a cohort, and where, often for the first time, students find others with comparable life experiences and aspirations.

They proceed through a spring class, a summer research internship that culminates in presenting their work in a symposium, and finally, a teaching-and-learning experience during which they create a science lesson and present it to local public school students.

"It's not that I don't have the intelligence; it's not that I can't do the job. I just thought that those kinds of things were done by other people."

Lever and **Lynn Huntsinger**, a professor of environmental policy, science, and management and Pathway's Principal Investigator, inherited the program from the original PI, professor emerita Sally Fairfax, when it was still very young, and they saw potential to do even more with it. They have succeeded in doubling the applications every year for the past three years, generating enormous faculty support for internship and mentorship roles, and guiding a whopping 84 percent of the program's graduates on to four-year colleges—nearly half of those students to CNR.

How did they build this enormous success? "We listened," said Huntsinger. "It wasn't enough to create a program targeting these kids; to make it a success we had to tailor every aspect of the program to the realities of their lives."

Photo by James Block

Rathana Yim

San Francisco City College → NST

"Attending Berkeley has made me look at things with a more research-oriented perspective. I've always had questions in class, like *'Why do we do this?'* and *'Why do we do that?'* At Berkeley they say *'Go try and find the answer.'*"

Photo by James Block

Yvette Gault
Skyline College → ESPM

"Chuck, and the park system, and the tribe, and biologists, and botanists, and historians… all came together to make the research program work. I was really fascinated by that aspect, how people from different perspectives could come together to form a better understanding of the situation, to develop future plans."

Dollars and Cents

Money was key. Huntsinger alluded to an NSF research report from 2006 showing that successful internships that seek diverse student populations include stipends, and that students who do sponsored research pursue science careers more often.

"One of the key factors that prevents underserved students from succeeding on their own is money. I had a student who was going to be sent to Mexico to babysit for family. So she used her stipend to pay for a nanny." Huntsinger doesn't undersell the difficulties that more mainstream middle- and working-class students face with rising tuition, but she says that the Pathway students are different.

"Their challenges are multi-layered—often generations deep," she said.

Students earn roughly $360 a month during the school year, and $2,000 over the summer, plus a small travel stipend.

For senior **Asma Mohammadi**, a 2007-2008 fellow and a physiology and metabolism major in NST, the money was critical. "I live at home to save money, and I help my parents pay the rent," said Mohammadi, who moved to the U.S. when she was in eighth grade, and was focusing on science at Diablo Valley College when she heard about Pathway through an email.

Unlike some other Pathway fellows, Mohammadi's parents are college educated. They instilled all three of their kids with a love of science and learning.

But before she was born, her parents moved from their home in Afghanistan to New Dehli, India, to escape the then-Soviet war. After years of unemployment, their refugee status allowed them to move to the U.S., where her mother had relatives. They felt lucky, and yet the family never recovered financially from their ordeal.

"I was thinking that I just needed some sort of program to get me on track, and then one day I got this email, and that was it," she said.

Knowing your Audience

Huntsinger and Lever made a major structural change by moving the program from an academic year to a calendar year. This allows them to recruit during the fall semester and have the fellowship culminate in December, just as the students apply to colleges.

They promoted the program to schools within the BART corridor, eliminating transportation problems as an issue.

And they made accommodations. For Mohammadi, this kind of flexibility was critical.

"I couldn't do my research internship the summer I was in the program, so they let me come back and do it the next summer. That was amazing. I never would have been able to finish it otherwise," she said.

Connecting with Mentors

Research is a peak experience for many of the students. Coming from community colleges, most of them had never had exposure to labs, and, despite their science bent, they thought of research as something extremely remote.

"I didn't even know it was possible for me," said Gault, echoing a common sentiment of Pathway fellows. "It's not that I don't have the intelligence; it's not that I can't do the job. I just thought that those kinds of things were done by other people."

Research projects are as diverse as the CNR faculty. The program connects students with a Berkeley faculty member, grad student, or postdoc mentor for the summer. Research from the 2010 cohort included work

on generating salt-tolerant plants, examining the impact of the landscapes surrounding agriculture on farm pests, and learning whether naturally cloning redwoods share resources with each other.

More Than a Lab Coat

Gault worked on an ethnobiology study that looked at how the Central Coast Ohlone tribe used fire as a tool to manage the environment and promote biological diversity. The experience upended her ideas about what research was.

"I wasn't just doing beaker work. I was in the field. I was doing research in the archival library at UC Santa Cruz, making aerial maps of Año Nuevo [Natural Reserve]. I was at the archeological dig at Año Nuevo. I was looking at slabs of redwood, looking at the fire scars to correlate how often Native Americans were using fire as a tool in that area to manage the land," she said.

Gault said she was also surprised to find out who else was doing research. **Chuck Striplen**, her Pathway mentor and a Ph.D. student of Huntsinger's, was also Native American.

"I was just blown away because I thought, here is someone else with a Native American background who is getting their Ph.D. and also doing research on a tribe that he's culturally connected with," she said. Seeing all the things Striplen did—research, family, collaboration, networking—expanded her vision of what was possible for herself.

Paying It Forward

In the last phase of the program, the students themselves step into the role of mentor by going into the public schools to teach a science lesson to kids.

Lever says presenting at the symposium and teaching in the schools help the students take ownership of the knowledge they have and gain the skills and confidence to communicate what they know to others.

"These are the skills that are essential for college success," he said.

In addition to his public school stint, Yim was invited back to Pathway as a mentor, to greet the 2010 cohort. Going in, he didn't think he was that much of an expert, but quickly remembered what it was like to be new.

"It was great being able to pay it forward," Yim said.

Maybe paying it forward is what the Pathway program is all about.

Lever agrees. "That's our mission, taking the educational opportunities at CNR and expanding the number of people—and the kinds of people—who benefit from them."

Help Forge New Pathways

The initial five-year National Science Foundation grant is coming to an end with the 2011 cohort. To support the Environmental Leadership Pathway program, give to the Don Dahlsten Outreach Fund, 114 Giannini Hall, Berkeley, CA 94720, # 3100, or **http://nature.berkeley.edu/site/dahlstenfund.php**

The Dahlsten Fund was established in 2003 to honor Don Dahlsten's commitment to supporting underserved youth.

Photo by James Block

Asma Mohammadi

Diablo Valley College → NST

"I was scared coming to a Berkeley lab from a J.C. But the professor was so supportive, I didn't feel out of place. Because it was summer a lot of people were gone, it was just me and the professor and two postdocs. I just learned so much from them. They'd say, *'Come on, do this procedure with me.'*"

1982 POLITICAL ECONOMY OF NATURAL RESOURCES

ANNE CICERO WEISBERG

If Anne Weisberg has anything to say about it, the most talented and ambitious workers among us will not be climbing the corporate ladder. Instead, they'll be scaling the corporate *lattice*—flexibly ramping up and down over the course of their careers as the circumstances of their lives evolve.

The corporate lattice is the central image that Weisberg and cowriter Cathleen Benko introduce in their paradigm-shifting book about the workplace, *Mass Career Customization*. It's also an accurate description of the way Weisberg's own career has unfolded over the last 25 years. Linear trajectories aren't in her DNA.

In the 1970s Weisberg was an undergraduate at Cornell when the first energy crisis hit, amounting to what many in this country saw as a wake-up call to lessen our dependence on oil. Weisberg's response to the crisis was to drop out of school and work to promote solar energy, eventually moving to New Mexico as a VISTA volunteer.

When she decided to go back to school she chose Berkeley, in part because her sister, Carla Cicero, was there (and still is, as senior curator at the Museum of Vertebrate Zoology), but it also felt like a good fit. "The College of Natural Resources had this degree—Political Economy of Natural Resources—which was exactly what I wanted to study," she says. "I basically wanted to make the world a better place." This imperative to do good was instilled in her from a young age. So, too, was the importance of finding work she loved. Weisberg's mother, a successful architect, stressed the necessity of carving out a satisfying work life.

Weisberg took that to heart. She's long seen herself as a "change agent," and early on she assumed that a career in law—and perhaps a life in politics—was the most logical vehicle for change. So after Cal, she went to Harvard Law School, where she graduated with honors. Three years later she had a law degree, a husband, and a baby on the way.

She spent the next year clerking for a federal judge in Chicago—the perfect law job for a new mother because the hours were nine to five. The following year her husband's career drew them to New York, a city she viewed as less than hospitable to working mothers. She soon found out just *how* inhospitable. She interviewed at all the city's major law firms, and despite her impressive resumé, didn't get a single offer. "It wasn't the resumé," Weisberg says. "It was the fact that I had a ten-month-old at home."

She wound up at a small environmental firm where motherhood wasn't considered a liability. But the closed doors had made their impact and altered the direction of her career. "Even though I'd pursued this path in environmental law, the whole issue of work-life integration really became my passion."

During this time, Weisberg had begun fielding calls from former law school colleagues, women wanting to start families who saw her as a font of information. When a publishing friend suggested she write a book about mothers and work, Weisberg loved the idea. She took a sabbatical from the law firm and wrote *Everything a Working Mother Needs to Know.*

By the time she finished the book, she had three children—and wanted to continue to pursue her passion in the work-life field. She went to work at Catalyst, a nonprofit organization devoted to advancing women at work. Her first assignment was to direct a research study on the career experiences of male and female law graduates.

Among the study's most interesting findings, Weisberg says, was that both men and women in law considered work-life conflict the number one barrier to women's advancement. In the corporate world, women cited other issues: lack of sponsorship and access to informal networks. "But in the law, most major firms have a very rigid career track. It's up or out in eight to ten years." Considering that 28 was the average age of women coming out of law school, the implications seemed clear. "The career path structure was basically forcing them to choose between making a baby or making partner. And most women are going to choose the former."

As Weisberg saw it, this fundamental structural rigidity was what shut women out of the highest levels, not only of law but any number of arenas. "It's a structural issue, and if we're going to make progress, we're going to have to redesign how careers are built." From ladders to lattices.

Today Weisberg is a Talent Director at Deloitte, the professional services giant, where the concept of "mass career customization" was born. In a nutshell, all of Deloitte's 50,000 workers have the option to "dial up" or "dial down"—working more or working less at different phases of their careers, as long as their choices work for them and for the business. Weisman says this flexibility doesn't only benefit working mothers; it benefits fathers, workers with aging parents, as well as boomers who aren't ready to retire but who no longer want to work at the same intensity.

At work in her New York City office, Anne Weisberg uses a slinky to demonstrate the flexibility needed over a lifetime of work.

And it's not only corporations that are interested in a more flexible workplace. After blizzards shut down the government for a week last year—to the tune of $400 million in lost productivity—the Obama administration held a forum on workplace flexibility. Suddenly, enabling people to work from home looked stunningly cost-effective.

Weisberg believes we're on the cusp of a whole new vision of work. "Essentially, we need to think about the workplace and the home front as one ecosystem," she says. "It's all just life."

At press time, Weisberg was beginning a new position as Director of Diversity at Blackrock, a global financial management firm.

Written by: Carol Ghiglieri | Photo by: Bethany Bandera

Striking a Match

NEW GRADUATE FELLOWSHIPS SPARKED BY DONOR GENEROSITY

John Swift and his son Sean at their Bear Creek Ranch in Los Osos, where they grow tropical and traditional fruits and vegetables.

Decades before any fourth grader could define "global warming," John Swift '76, a bright undergraduate majoring in Conservation of Natural Resources, was aware of the threat and starting a career to help save the planet.

Now Swift is an organic farmer with a 600-acre ranch in San Luis Obispo, and he is bringing his dedication to the environment back to Berkeley with a $250,000 gift for graduate students enrolled in a new master's program in sustainable development. The gift was augmented by an innovative matching program offered by the Graduate Division and by the MacArthur Foundation's support for the new Master's of Development Practice.

"It's matched on two sides," says Swift of his graduate fellowship. "That's always a nice thing for a donor."

The Graduate Fellowship Matching Program was launched in 2008 after Graduate Division Dean Andrew Szeri committed to allocating ongoing, annual amounts of $1 million in matching funds. Donors to schools and colleges across the University—from journalism to biological science—seized the opportunity and have created 31 new fellowships to date.

Swift, who is involved in global environmental work with indigenous communities from British Columbia to Papua New Guinea, says he sees a vital need for donors to fill some gaps. "It's important for students' education and the well-being of the good international development work being accomplished," he said.

GRADUATE STUDENTS RECEIVE A BOOST

The new endowed graduate student support funds named below were established during the campaign period as a result of the Named Fund Initiative, the Chancellor's Challenge, and the newest program, the Graduate Fellowship Matching Program. All three of these campus-wide initiatives used matching gifts to encourage giving from faculty, staff, alumni, parents, and friends of UC Berkeley. Undergraduate funds may also be established under the Chancellor's Challenge. We thank all of the generous donors who created these funds.

The Angela C. Little Graduate Student Support Fund

The Arnold Schultz Graduate Student Support Fund in Society and Environment

The David Zilberman Graduate Student Support Fund

The Edna and Yoshinori "Joe" Tanada Endowed Fellowship in Entomology

The Gordon Rausser Scholarship Fund

The Grace Kase Fellowship in Plant Biology

The Jean O. Lanjouw Memorial Endowment

The Lewis and Ann Resh Endowed Graduate Student Support Fund in Freshwater Ecology and Entomology

The Ligon Fund for the Study of Population and Development

The Michael and Mary Hanemann Graduate Student Support Fund

The Michael B. Winton Family Fund for Graduate Student Support

The Michael James Vlamis Graduate Student Support Fund

The Posek Family Endowed Graduate Student Support Fund

The Robert and Patricia Martin Graduate Student Endowment in Wildland Fire Research

The Robert Lane Endowed Graduate Student Support Fund

The Swift International Research Fund

The Vincent and Cheryl Resh Fund for the Essig Museum

The Vincent and Cheryl Resh Fund for the Gump Research Station

They Shall Be Released

On January 26, the California Department of Fish and Game released two orphaned black bear cubs into the wild at Sagehen Creek Field Station, part of the University of California's Natural Reserve System. The site's protected boundaries give the cubs a safe place where they can learn to live on their own.

1. The anesthetized bears were transported to Sagehen from the Lake Tahoe Wildlife Care facility, which kept them away from people and fed them wild foods.

2. Near the den site, biologists lifted the bears from a snowcat one at a time in heavy canvas carrying cloths, then transported them via sled the rest of the way.

3. A biologist placed a cub into the den.

PHOTO CREDIT:
Lobsang Wangdu, *courtesy of the Natural Reserve System*

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