Spring 2022

BREAKTHROUGHS

Berkeley Rausser
College of Natural Resources

The

STUDENT ISSUE

Berkeley Rausser
College of Natural Resources

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LETTER FROM THE DEAN

For me, one of the best parts of being a faculty member at UC Berkeley is working with students. In the classroom and the lab, their ideas and enthusiasm have inspired me throughout my career.

At Rausser College, we're proud to offer outstanding instruction, hands-on research and discovery experiences, and high-quality mentoring and advising—all with the goal of preparing our students to pursue their dreams and make a positive impact in the world. And, as I'm often reminded, our students are also doing big things even before they graduate.

This issue of *Breakthroughs* shines a light on several of our College's amazing undergraduate and graduate students. They are from various backgrounds and are pursuing a range of academic paths, but they all embody our mission of "seeing the bigger picture and making a better world" in their own way.

They are scientists, artists, musicians, authors, athletes, mentors, and changemakers. They are conducting groundbreaking gene-editing research and essential work on environmental justice issues, advancing equity and inclusion, leading student organizations, and working to encourage UC Berkeley to be the best university it can be. They are the reason we are here at all, and even as we strive to give them an exceptional education, we acknowledge that they are teaching us every step of the way.

I hope you'll enjoy reading about the many and varied accomplishments of those featured here and consider making a gift to support all Rausser College students.

As always, I welcome your feedback at dackerly@berkeley.edu.

David Ackerly

David D. Ackerly

On the cover: Seniors Isaac Aguilar and Denice Li, both advisors in Rausser College's Undergraduate Peer Advising (PAL) Program.

COVER PHOTOGRAPHY BY ADAM SINGS IN THE TIMBER

BREAKTHROUGHS

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Deciphering Microbial Mysteries

Students help reshape our understanding of the bacterial world. Page 8

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New mapping project illustrates the impact of sea level rise. Page 12

ONLINE
Learn about graduate student **Mickey Boakye**'s research on leaf structure and plant adaptation through our photo essay at nature.berkeley.edu/leaf-photos.

Reaching the next generation

Adam Sings In The Timber (Williams)

Tyus D. Williams credits the many hours he spent watching VHS tapes of wildlife experts Jeff Corwin and Steve Irwin with influencing his decision to pursue ecological research.

With heroes like those, it's no surprise that his first book—*Big Cats (A Day in the Life): What Do Lions, Tigers, and Panthers Get up to All Day?* (Neon Squid, April 2022)—is geared toward children. Part of the larger A Day in the Life series, the book gives readers a glimpse into the lives of several big cat species over a 24-hour period. Representatives from Neon Squid—an imprint of Macmillan Publishers—asked Williams to contribute to the series after hearing him discuss tigers on a science podcast.

"I stand by the precedent that if you can't explain your research to an elementary school-aged child, then you probably don't understand the depth of your research as well as you think you do," said Williams, who wrote the book while working as a field ecologist in Nevada.

Big cats compose just a slice of his overall research. As a graduate student in the Department of Environmental Science, Policy, and Management (ESPM) working with assistant professor **Christopher J. Schell**, Williams focuses on how anthropogenic influences affect the interaction and competition between carnivores: a group of species that ranges from bears and wolves to skunks, seals, and weasels.

Writing the book also aligns with his larger efforts of making a direct investment in community outreach. As a science communicator, Williams regularly speaks on podcasts, gives interviews and presentations, and uses social media to break down his research for a broader audience.

"If you had told my childhood self—a young, racially ambiguous Black kid—that he would be cultivating and inspiring the next generation of scientists and researchers, he would have never been able to conceive a future like that," Williams said.

— *Mathew Burciaga*

Five key lessons

ESPM 136

Sustainable Industries

BY ANJIKA PAI

Every industry—from apparel to food to transportation—has the potential to change for the better. In the past decade, consumers, nonprofits, and governments have motivated companies to commit to people and the planet, not just profit. **Dara O'Rourke**, associate professor in ESPM and former senior principal sustainability scientist at Amazon, prepares students to be leaders in the field of corporate responsibility through his course, Sustainable Industries.

1 THINK IN SYSTEMS AND FOCUS ON "HOTSPOTS"

From resource extraction through disposal, every product accumulates negative impacts. Existing companies should improve the product life cycles that cause the most environmental or social damage—the hotspots—to make the biggest impact. For example, Starbucks' plant-based alternative menu reduces its use of dairy, which is responsible for the largest portion of its carbon footprint.

A new charge on cars

Starting in 2025, San Francisco will begin charging drivers a fee to enter the downtown area during peak hours. This road-pricing strategy—often referred to as cordon pricing—has been used in London, Stockholm, Milan, and other cities to alleviate road congestion and offset the negative environmental and health impacts of vehicle traffic.

But research by **Matt Tarduno**, an Agriculture and Resource Economics PhD candidate, suggests that these strategies are often too simplistic. The price set by cities sometimes leads drivers to detour around the cordon zone, simply moving congestion elsewhere. And drivers are usually charged the same amount regardless of their vehicle's fuel efficiency, trip duration, or anticipated route.

Published as a Haas Energy Institute working paper, Tarduno's research uses data from the Bay Area's FasTrak system to understand how drivers respond to toll prices and model how cordon zones would impact congestion and pollution.

"Road-pricing models can help address congestion, accelerate the retirement of "heavy polluters" by tying price to fuel efficiency, and push both transit systems and individual drivers toward greener technologies," said Tarduno. "This research builds on the benefits of traditional road-pricing models while explicitly accounting for the imperfect nature of proposed road-pricing systems."

Tarduno found that cordon pricing performs better when cities set both off-peak and peak prices, rather than only charging prices during peak hours. In San Francisco, he said, this policy improvement would generate hundreds of millions of dollars each year in avoided traffic slowdowns and air pollution-related health costs. San Francisco drivers also stand to benefit under Tarduno's peak-pricing proposal: It is two-thirds lower than the city's current proposed rate. Even though it was modeled using Bay Area data, Tarduno said, his proposed approach can also be deployed by cities across the globe. — *Mathew Burciaga*

2 DESIGN FOR SUSTAINABILITY

After the design phase, 80 percent of a product's impact has already been locked in. Companies from Apple to Allbirds have worked to minimize the environmental footprint of a product by designing for circularity, zero waste, and zero carbon.

3 SUSTAINABLE INNOVATIONS REQUIRE AGILITY AND SCALE

While startups are well-positioned to develop progressive innovations, industry incumbents are better suited to scale up sustainable initiatives. Electric vehicles will reach widespread adoption through both startups, like Tesla, and established auto companies, like Ford.

4 BELIEVE IN PEOPLE POWER

Consumers, communities, and activists can all play a role in the transition to a green economy. Changes in consumption habits, product or company boycotts, and political organizing can push companies and governments to advance more sustainable options.

5 BUILD IN EQUITY

In any industry, sustainable transitions should benefit those most impacted by environmental crises. As companies create social responsibility policies, they must account for input from local communities and support job growth to foster "just transitions" towards more sustainable industries.

Extracurricular Endeavors

A GLIMPSE AT HOW SOME RAUSSER COLLEGE STUDENTS SPEND TIME BEYOND THEIR STUDIES

Whether in the Bay Area, traveling around California, or conducting research overseas, **Isaac Aguilar** always tries to make time for a hike. The fourth-year molecular environmental biology and ecosystem management & forestry double major most recently completed a 16-hour through-hike to the top of Ixtaccíhuatl, a dormant volcanic mountain in Mexico. At 17,160 feet in elevation, Ixtaccíhuatl is the third-highest peak in the country and the eighth-highest in North America.

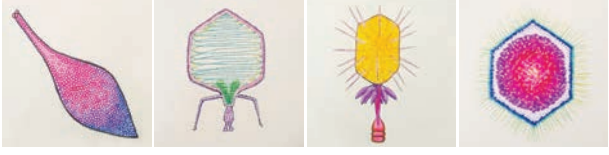
Shelby O'Neil is a National Geographic Young Explorer and the founder of both the No Straw November challenge and Jr Ocean Guardians, an organization committed to increasing ocean literacy and advocating for ocean conservation. She has collaborated with companies in the aviation, health care, and beverage industries to reduce single-use plastic pollution; so far these efforts have resulted in the reduction of over 40 million single-use plastic straws annually. Her work with California legislators also led to the 2018 designation of November as "No Straw November" in California. A third-year society and environment major, O'Neil appeared in Sesame Street's "N is for Nature" episode at the Monterey Bay Aquarium in 2020.

Victor Reyes is working to increase food safety and reduce waste in the food service industry. A graduate student in the Energy and Resources Group (ERG), Reyes co-founded Recotrak, a startup that monitors the temperature of cooked food and the length of time it has been left out. That data, according to Reyes, will help caterers determine if their excess food can be recovered and safely donated.

Stella Singer plays keyboard and synthesizer in Chalk Talk, an all-female band based in San Diego. Formed in 2019 by Singer and three high school classmates, Chalk Talk is a way for her—a classically trained pianist—to express new musical ideas and concepts. When not in class, the first-year Conservation and Resource Studies major spends her time recording and sharing snippets of music with her bandmates. Listen to their debut album, "Just a Girl Band," on Spotify and Bandcamp, and be on the lookout for their follow-up.

Hal Gordon has mastered the art of the hot dog. When the Agricultural and Resource Economics PhD candidate isn't researching solutions for pressing environmental issues, he can be found slinging sausages at Oakland A's home games. Known as "Hal the Hot Dog Guy," Gordon is something of a ballpark celebrity. His bright red vest and colorful antics—he hands out collectible baseball cards of him working at the Coliseum and often pranks unsuspecting fans with trick ketchup bottles—have won the hearts of A's fans.

Plant and microbial biology PhD candidate **Zoe Netter** is amazed by the beauty and complexity of the microscopic world. Outside of her time spent researching the interactions between bacteria and their viral predators (known as bacteriophages), Netter draws colorful works of art inspired by her current research and old scientific textbooks. She shares her self-described "microbial fan art" on Instagram and has even produced illustrations for scientific journal articles.



Images courtesy of featured students

Poem

Persistence and the Path Home

Even with the legacies of my family holding me up,
Imposter syndrome still comes knocking
When it does,
I open up and let it in, tell it that
in order for the caterpillar to become what it is meant to be,
it first has to dissolve in a pile of goo
Tell it that my curiosity and grit
Are as natural to me as breathing
These days
I think a lot about the people I come from
The ones who walked a trail made of their tears
And the ones who crossed oceans
Because water is cleansing and destructive
I don't know what it means when my colonized taste buds
don't like traditional foods
I hope the ancestors will understand when I add a
spoonful of sugar
just to help the taste of grief go down
Is the colonial project complete
when they've claimed the last frontier of our very senses?
One thing I know for sure
Is that the meaning of the land is sacred
that our obligations to it
are what have kept us consistently cultivating
new generations of beautiful beings
Know that we speak a language that does not yet exist
For how to persist in this ever changing world
And when that legacy feels too heavy
I set it down for a moment
Look through my family tree, and
Remember my mother telling me,
that she wouldn't have the courage to do what I'm doing,
but it's her who paved the path
Remember my dad
Who taught me a sense of direction so strong
that I always know where I'm headed, no matter what road
I'm on
Deep roots keep me grounded
Knowing that every path
Leads home.

McKalee Steen is a graduate student in ESPM who studies the ecological impacts of Indigenous land stewardship in cases of direct purchases of land within traditional Indigenous territories in California and the Pacific Northwest. An enrolled member of the Cherokee Nation, she grew up on a farm in Oklahoma and has a passion for scientific and creative storytelling.

Small trees, big benefits

Clearing California's forests of dense overgrowth is critical for curbing catastrophic wildfire. But forest restoration—whether through prescribed burning or thinning—is complicated: Treatments are costly, and cutting down or burning vegetation releases stored carbon dioxide, accelerating the impacts of climate change.

An analysis led by ERG PhD candidate **Bodie Cabiyo** shows how incentivizing industries that convert wood residues into useful products—including biofuels and construction-quality engineered timber—could fund forest-thinning treatments that reduce wildfire risks while preventing the release of extra carbon.

Larger trees can be harvested and sold as lumber, but smaller wood residues produced by forest thinning are often burned or left to decay.

The analysis, published in the *Proceedings of the National Academy of Sciences* in December last year, notes that small trees and wood residues can be mixed with adhesives and compressed into large sheets strong enough for construction. Woody residues can also be converted in biofuel plants to create electricity or liquid fuels, and if these plants are outfitted with carbon capture technology, carbon dioxide can be diverted from the atmosphere during the process.

Cabiyo and his collaborators, including senior author **Daniel Sanchez**, assistant professor of Cooperative Extension in the Department of Environmental Science, Policy, and Management (ESPM), also propose a model scenario in which the state incentivizes the use of engineered wood in the construction of multi-unit affordable housing.

"If California starts thinning at a large scale, we're going to be producing a lot more lumber and wood residues," Cabiyo said. "Using that new material for building affordable housing could produce massive carbon benefits, largely because those buildings otherwise would be built with steel and cement, which have significant carbon emissions associated with them."

— Adapted from an article by Kara Manke

In their own words

On the ground at COP26

BY KATE ALTEMUS CULLEN

Deep in the maze of bustling event pavilions, we gathered as a dozen young climate scholar-activists to discuss the key questions: What will realizing intergenerational climate justice look like? What is it understood to mean across a global multiplicity of lived experience and perspectives? How must we, as wings of the generation tasked with delivering a climate-safe future before we reach age sixty, effectuate that vision? It was informal and impromptu, but also one of the most essential and sustaining dialogues that I had the opportunity to take part in at the 2021 United Nations Climate Change Conference in Glasgow last fall.

The two previous UN Climate Change Conferences that I participated in were hectic and weighty, but COP26 was something beyond. The Glasgow summit was the pandemic COP, a year-delayed, vaccinated and masked. The weight of collectively living through—of surviving—nearly two years of a global pandemic was material, and the atmosphere was tense with the injustice of the differing tolls the pandemic has taken across the world. It was also, I would argue, the COP where the clearest cognitive dissonance emerged between two truthful narratives: the official narrative that incremental progress and consensus building are something to celebrate, and the more critical narrative that our current system of global climate governance—abounding with unfulfilled promises—is struggling to deliver an urgent and just global transformation.

Attending with the University of California delegation, my primary purpose in Glasgow was to serve as a research partner to the Water Pavilion, the first explicitly water-focused venue at a COP. I coordinated a team of fifty student rapporteurs who joined from across the world via the livestream to document the 120 events and dialogues that occurred during the two-week conference.

With colleagues, I'm now in the throes of coding and analyzing this rich textual data set of notes and transcripts to elucidate the ways in which the agenda-setting of water policy is shifting to incorporate climate policy. This work offers a key starting point for my dissertation research, which aims to understand and characterize the processes in which water scarcity—deepened by climate change—compounds inequality and poverty, and to envision solutions and governance structures that catalyze adaptation in a just and community-driven way.

The value of attending a COP, and generally of convening a global summit focused specifically on the climate crisis, is to engage in these impromptu, difficult dialogues that map the vast range in worldviews, urgent needs, and understandings of the synergies and tradeoffs that we're navigating in our (in)actions. In Glasgow, I saw anew the ways in which climate justice is imperative for water justice, which in turn is imperative for climate justice. Engaged in this research and collective thinking at COP, I felt the most alive—the most myself as a water and climate scholar-activist. I'm incredibly grateful to have found a home here in the interdisciplinary Energy and Resources Group that provides me with the tools and community of care to engage in this critical research and contribute to global action on the climate crisis.

Kate Altemus Cullen is a doctoral student in the Energy and Resources Group and a National Science Foundation Innovations at the Nexus of Food, Energy and Water Systems Fellow. Her work examines the role of climate change in exacerbating water stress in the Andes mountains and community-driven and just adaptation solutions. Cullen currently leads a joint UC Berkeley and University of Oxford research group exploring the meaning of equity and justice in net zero pathways. Previously, she served on the secretariat team for the UN Race to Zero consultations, and was a glacier tour guide in Antarctica, a U.S. Fulbright Scholar in Chile, and an outreach assistant for the Union of Concerned Scientists.

Courtesy of Kate Cullen

Rausser Students by the Numbers

2,575
total undergrad students
(as of Fall 2021)

365
total grad students
(as of Fall 2021)

Fall 2021: Largest ever incoming class

637
First-year students

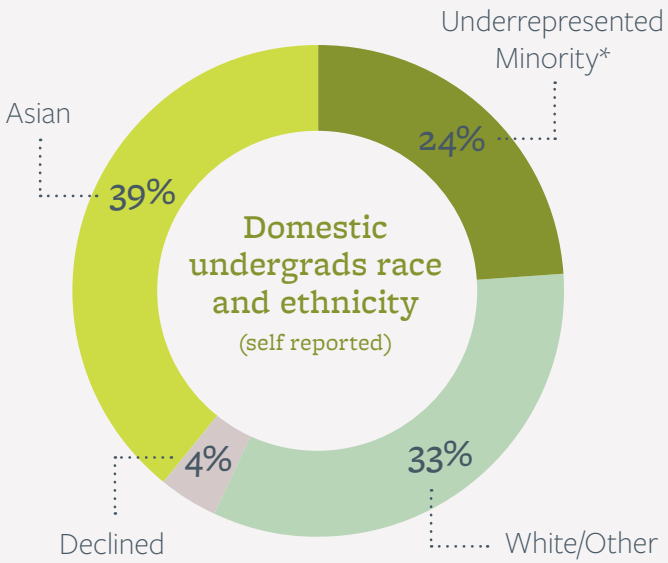
131
Junior transfers

41
graduate students were supported by the competitive National Science Foundation Graduate Research Fellowship in 2020-21

9
undergrad majors

9
undergrad minors

10
grad programs



*African American, Chicano/Latino, Native American/Alaska Native, Pacific Islander

32%
of undergraduate students received Pell grants in 2020-21

Berkeley's high percentage of Pell recipients among its large undergraduate student body translates into many more low-income students having access to a world class education.

1 in 10
undergrads is an international student

Over 50%
of Rausser undergraduates conduct research during their time at Cal

1 in 3
undergrads complete a senior thesis or honors thesis

Deciphering Microbial Mysteries

Rausser College students are helping reshape our understanding of the bacterial world

BY ZAC UNGER | PORTRAITS BY ADAM SINGS IN THE TIMBER

Some scientific breakthroughs happen with researchers crowded around a high-tech machine in a lab. Some discoveries are made deep in the rainforest, on the ocean floor, or high on a snowy mountaintop. For **Basem Al-Shayeb**, the moment that changed the course of his career happened in a wetland just a mile from his professor's house in Northern California.

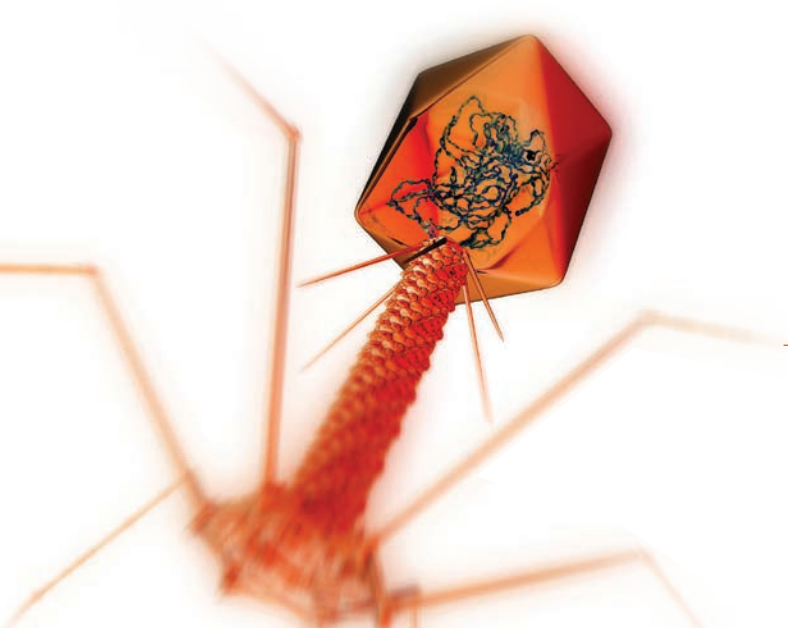
"We were just passing through on a hike, and Jill said 'why don't we take some samples from here,'" Al-Shayeb recalls of that day with his advisor, **Jill Banfield**, a professor in the Departments of Environmental Science, Policy, and Management, and Earth and Planetary Sciences.

Banfield is a pioneer in metagenomics, a relatively recent field of study that involves reconstructing the genomes of organisms found in natural environments. She and her team often search for samples in unusual places ranging from a hypersaline lake in Australia, to a geyser in Utah, to the gastrointestinal tracts of newborns in an intensive care unit. But on that day in 2017, the only high-tech sampling equipment on hand was a garden spade, which Al-Shayeb plunged deep into the good, clean, West Coast mud.

After scouring a large database of DNA generated from the samples taken that day, along with others the team collected from nearly 30 different Earth environments, Al-Shayeb and his colleagues found hundreds of unusually large, bacteria-killing viruses known as megaphages. The research is just one of many important projects that Al-Shayeb has been involved with during his time as a graduate student at UC Berkeley. Working in the labs of both Banfield and **Jennifer Doudna**—who shared the 2020 Nobel Prize in Chemistry for her work developing CRISPR, the revolutionary gene-editing tool—Al Shayeb is at the leading edge of one of science's most exciting frontiers.

SEEKING TO UNDERSTAND THE UNKNOWN

Little is known about megaphages so far. Banfield had published a paper in 2019 reporting a set of megaphages, and this new research, published in *Nature* in 2020, identified 351 of them in total. Through work in Doudna's lab that was published in *Science* a few months later, Al-Shayeb was able to demonstrate that the megaphages' CRISPR systems could be repurposed for gene editing. Although their genomes are hundreds of thousands of DNA letters long, the CRISPR systems of these megaphages are actually smaller than standard CRISPR tools, allowing them to be easily imported into cells, targeting specific regions of a genome in order to perform edits. Even more exciting is the fact that their CRISPR systems can be utilized in animal, plant, or bacterial cells, giving them massive potential for



Bacteriophages are a type of virus that can infect and kill bacteria without any negative effect on human or animal cells.

Basem Al-Shayeb has uncovered new groups of bacteriophages with huge genomes, including the largest ever documented.

Bacteriophage illustration: PASIEKA / Science Photo Library via Getty Images

Al-Shayeb and Luis Valentin-Alvarado, a fellow student in Professor Jill Banfield's research group.

real-world applications in medicine, agriculture, and even the fight against climate change.

"I always wanted to know more," says Al-Shayeb of his childhood in Egypt. Like a lot of parents of smart kids, his mom wanted him to go into medicine or engineering. "Even as I was taking the GRE, she kept telling me to take the MCAT, saying 'Maybe you can change your mind later and go into medicine,'" he recalls. His mother's worry was understandable, Al-Shayeb says, because they didn't know anybody who had a PhD at the time. "I didn't know that you could have a career in scientific research so it was kind of a risk for me to go more into biology than medicine."

Al-Shayeb didn't come to Berkeley with a specific intent of working with CRISPR. After deepening his passion for research as an undergraduate at the University of Minnesota, he was attracted to Berkeley's interdisciplinary nature. As a graduate student in the Department of Plant and Microbial Biology (PMB), he began his studies on campus by rotating through various labs, eventually finding a place with both Dr. Banfield and Dr. Doudna. "In Jill's lab there's a lot of environmental microbiology and discovery, and in Jennifer's lab we're developing tools for biotechnological applications in cells," he says.

Going back out to the field to follow up on his work with the megaphages, Al-Shayeb and his colleagues made yet another stunning discovery. What they found were exceptionally long strings of extrachromosomal material—up to a million DNA letters long—that seemed to assimilate genetic information from multiple different microbes. With an assist from Banfield's son, they named their new find "Borgs" after the knowledge-devouring Star Trek characters. After further study, they discovered that these Borgs could be incorporated into single-celled organisms called archaea, a group of microorganisms that include some of the greatest producers of methane, a greenhouse gas thirty times more potent than carbon dioxide. Some archaea also break down methane, and Al-Shayeb's work suggested that Borgs could be used to "turbo-boost" archaea's ability to do just that, potentially offering a powerful new weapon in the fight against climate change. "I haven't been this excited about a discovery since CRISPR," tweeted Banfield. The Borg discovery was highlighted by *Nature*, *Science*, and many other news publications.

While gene-editing technology is advancing rapidly, part of what motivates Al-Shayeb is how *little* is still known. Almost eighty percent of the Borg genome consists of proteins that are still completely unknown. The potential for real-world implications is vast, extending beyond methane capture to nitrogen fixation, which is crucial in agriculture and the quest to feed the world's growing population.

ALWAYS ASKING QUESTIONS

Working with Al-Shayeb to understand what he calls "the dark matter on the genome" is PMB graduate student **Luis Valentin-Alvarado**, who also works in Banfield's lab and accompanied them on some of those fateful trips to that unpromising muddy field. Valentin-Alvarado gets excited

Al-Shayeb reaches deep into the mud to collect samples on Jill Banfield's property in 2019.

Banfield and Valentin-Alvarado collect biofilm samples from deeply sourced groundwater in San Jose, California.

Field photos courtesy of Basem Al-Shayeb and Luis Valentin-Alvarado

Valentin-Alvarado uses genomic techniques to investigate the biogeochemical roles of new bacterial families.

thinking about the new avenues he and his colleagues can explore. "There are so many questions to answer," he says. "Can we harness the Borgs and find new ways to improve biotechnology? Can we find new genome editing tools? Can we puzzle out the role of these genomic elements in the evolution of microbial life? Can we look into these enzymes and discover novel chemistry?" His excitement is palpable. "You could do multiple PhDs on this. It's endless!"

Both Al-Shayeb and Valentin-Alvarado exude an enthusiasm that is as infectious as it is wide-ranging. Like Al-Shayeb, Valentin-Alvarado didn't expect to land at the center of one of science's most exciting frontiers. Growing up in Puerto Rico, his first memory of being a scientist was looking at mold on bread and asking his mom what was happening there. "I was always question-driven; my mom would joke and say 'can you please stop asking so many questions,'" he recalls. Also, like Al-Shayeb, nobody in Valentin-Alvarado's family worked in the sciences, and he couldn't even conceive of a career in research. But a high school science project on that moldy bread led him to the Intel Science Fair in San Francisco, and, many years later, to graduate school at Berkeley.

It's a long way from Puerto Rico to Koshland Hall, but Valentin-Alvarado is still asking questions and figuring things out. "It's funny, I came to Berkeley to work on bioinorganic chemistry, but I didn't imagine ending up working on fascinating and collaborative projects involving new lineages of life or mobile genetic elements," he says. "But I'm a scientist, not just a microbiologist or a chemist. I'm driven by questions, and if I have to learn something new, I'll do that if it moves me closer to an answer."

As far back as 2006, Banfield and Doudna frequently shared ideas about CRISPR, and the labs still work closely together today, advancing both the pure science and the practical applicability of their discoveries. Berkeley's focus on collaboration and interdisciplinary work was not only a draw for both students, but also a key component of their effectiveness here. "Being in two labs feeds my innate curiosity and enables me to make discoveries," says Al-Shayeb, "but we're also able to develop technologies that can have a tremendous impact beyond one community."

As if Al-Shayeb isn't busy enough, his far-ranging interests have recently led him to a side project doing early detection of COVID-19 by sampling wastewater. By sequencing the RNA they find in the sewage, he and his collaborators can determine which variants are surging and even identify the presence of previously undetected strains of the virus. Al-Shayeb also participated in a large-scale study of RNA viruses found in genome repositories around the globe, which was published in *Nature* in January.

Both Al-Shayeb and Valentin-Alvarado feel strongly about sharing their knowledge with others and about being the kind of scientific role models that they would have appreciated seeing when they were young. Al Shayeb—who was recently featured on the Forbes 30 Under 30 in Science list—translates scientific articles into Arabic and gives talks to young students, in part to help them imagine a future in research for themselves. Valentin-Alvarado talks to middle and high school students every chance he gets. "I want to tell them that you can do field work, you can get dirty and then come back with this cool data that you publish in high-impact journals," he says.

Whether they find themselves in a muddy field or on the pages of *Nature*, both of these students have cemented their places as researchers on the leading edge of a world-altering field. When Al-Shayeb talks about life after he finishes his PhD, it's clear that his experiences at Berkeley have helped instill a lifelong love of research and academia. "To me it's very rewarding to be able to work on things that I know will help people both here and in the global population, whether it's genetic diseases, or agriculture, or climate change. These are all things that I know can have a big impact everywhere. And to me, that's the dream job."

TOXIC

GOALS OF THE TOXIC TIDES PROJECT

1 Characterize the threats posed by sea-level rise and flooding of hazardous sites to socially disadvantaged populations.

2 Create an online mapping tool that visually depicts toxic facilities at risk of flooding due to sea-level rise and associated socioeconomic conditions.

3 Share findings with advocates and decision-makers in order to protect vulnerable communities through current and emerging climate resilience policies.

TIDES

Nicholas Depsky (left) and Seigi Karasaki stand near the Harbor Channel in Richmond, California, where numerous industrial facilities may be impacted by sea-level rise.

Adam Sings in the Timber

A new project visualizes how sea-level rise may threaten hazardous facilities and the surrounding vulnerable communities along California's coastline

BY KRISTIN BAIRD RATTINI

Over three feet of sea-level rise is expected by the end of the century if little is done to slow climate change. Much of the conversation in the United States around sea-level rise has focused on wealthy areas like Malibu and threats to expensive properties. The Toxic Tides project, launched in 2019, reframes the issue by focusing on far less photogenic—and far more prevalent—stretches of coastline that are home to hazardous sites like industrial facilities, oil and gas wells, landfills, and sewage treatment plants. These sites are often located near poor communities and communities of color that already suffer from environmental injustices.

"Climate change is here," says **Rachel Morello-Frosch**, a professor in the Department of Environmental Science, Policy, and Management and the School of Public Health who co-leads the project. "We have wildfires, tornados, floods. Sea-level rise is a much slower-moving storm." The Toxic Tides project calls attention to that slow-moving storm, offering crucial information about the future as well as the opportunity to do something about it. And, Morello-Frosch points out, the project aims to ensure environmental equity is prioritized in the process. "This key component is often missing in the conversation around sea-level rise, but should be central to climate-action planning at every level," she says.

Knowing she'd need a multidisciplinary team to map the effects of sea-level rise along the entirety of California's coast, Morello-Frosch recruited graduate student researchers with experiences ranging from community engagement to R programming and Geographic Information Systems (GIS). The team has now released a free online tool showing that flooding in coming decades will threaten over 400 hazardous facilities along the state's coast and will disproportionately impact disadvantaged communities living near them.

Two of the students crucial to the success of the program are **Nicholas Depsky** and **Seigi Karasaki**, both PhD students in the Energy and Resources Group (ERG). In addition to technical skills, they've drawn from their experiences outside the academic realm—from the worlds of music, rock climbing, and TEDx—in their approach to not only the data itself but also to whom this crucial information reflects and reaches.

COLLABORATION IS KEY

Collaboration has been encoded in the Toxic Tides project's DNA since the start. Leading the research with Morello-Frosch is **Lara Cushing** (BS '03 Molecular Environmental Biology, MPH '11 Epidemiology, PhD '15 ERG), a three-time Cal alumna who is now an assistant professor of environmental health sciences at UCLA's Fielding School of Public Health. The pair sourced sea-level-rise data from Climate Central, an independent organization of leading scientists and journalists researching and reporting the facts about the changing climate and its impact on the public.

Five community advocacy organizations from throughout California are collaborators on the Toxic Tides project and serve on the project's advisory committee. They've provided guidance and feedback on everything from overall study design and metrics to information dissemination, to ensure the project accounts for the lived experiences of those in vulnerable fence-line communities.

"This was not just checking the box on community engagement," says partner **Amee Raval**, MS '16 Environmental Health Sciences. She is policy & research director at Asian Pacific Environmental Network (APEN), which advocates for environmental, social, and economic justice for Asian immigrant and refugee communities in the Bay

PROJECT FINDINGS

1 At least 440 hazardous facilities in low-lying coastal areas are projected to be at risk of one or more flood events per year by 2100.

2 Industrial facilities account for the greatest number of hazardous sites at risk of sea-level-rise flooding by 2100, followed by oil and gas wells and sewage treatment plants.

3 The majority of at-risk facilities are in five counties: Alameda, Orange, San Mateo, Los Angeles, and Contra Costa.

4 Disadvantaged communities are over five times more likely to live within 1 km of one or more facilities at risk of flooding in 2050 and over six times in 2100.

A Toxic Tides project map showing projected annual flood risk events in the year 2100 at various industrial facilities, landfills, refineries, sewage treatment facilities, and other locations across the Bay Area.

Area. "There is a lot of power when we unite and leverage research and data to support policy advocacy and change."

The research team in Morello-Frosch's Sustainability and Health Equity (S/HE) Lab itself has included members from across multiple UC Berkeley departments. "That's one of the great things that our College cultivates: the importance of collaboration in order to solve challenging problems," Morello-Frosch says. **Jessie Jaeger**, MCP-MPH '20, who has since graduated with master's degrees in city and regional planning and public health, initiated the "cleaning" of facility location and census data. **Yang Ju**, PhD '19, came from the landscape architecture and environmental planning program; he was the primary architect of the Toxic Tides online mapping tool.

Karasaki was highly motivated by the opportunity to work on a community science collaboration in his home state after studying in Japan and conducting research in China as a Fulbright scholar. Depsky wanted to use his technical modeling skills to influence climate-change policy.

"All of the students involved have different training and disciplinary orientations," says Morello-Frosch. "But the thread that ties everyone together is the deep interest in having environmental justice as an underlying motivator of the research questions they pursue."

IMPROVISATION IN THE KEY OF D (FOR DATA)

When Depsky needs to unwind, he picks up his guitar or plays his piano. His true passion is jazz; improvisation comes naturally to him. "I noodle and create ideas of my own that I mess around with," he says.

Depsky's talent for riffing applies equally to spatial analysis—a process of examining geographical data (such as latitude, longitude, and elevation), extracting or creating new insights through computer modeling, and then exploring those insights. "He is always ahead of the ball, trying to think about other ways to do a data mash-up that will help solve a problem," Morello-Frosch says.

For example, the team faced significant difficulties in pinpointing the exact location of coastal hazardous facilities. Their key data source—the U.S. Environmental Protection Agency's Facility Registry Service—proved to be inaccurate for many facilities.

"Location was a crucial component that we needed to get as right as we possibly could to determine if the facility was within a floodplain and at risk of sea-level rise and flooding in future years," Depsky says.

The team incorporated tax parcel records and used Google's Application Programming Interface (API) tools to update the geographical coordinates of sites, significantly improving the location accuracy of the data.

Likewise, census information was not detailed enough to pinpoint where populations lived within larger rural census tracts and block groups. Depsky developed a novel mapping method that utilized Microsoft Building Footprint data and tax parcel data to give the researchers a much more precise picture of where people lived in relation to hazardous sites.

BACK TO THE DRAWING BOARD

Where Depsky unwinds with music, Karasaki heads to the great outdoors for backpacking, hiking, and especially rock climbing. His crowning achievement—so far—came in May 2018, when he and his climbing partner Peter Marsters, MA '15 ERG, reached the nearly 3,000-foot summit of Yosemite's El Capitan via The Nose, a technical climbing route that took them three-and-a-half days to complete.

"It wasn't our first time; we'd tried it before and realized we were moving way too slow or weren't prepared in the ways we thought we were," he says. "There was a lot of going back to the drawing board."

The iterative feedback process between the Toxic Tides academic researchers and the community advisory committee guaranteed a lot of trips back to the drawing board for Karasaki and his fellow team members. Over the course of three years, community partners periodically joined the research team's weekly meetings to provide

input. And at annual workshops through Zoom, they gave specific feedback about prototype maps. Karasaki was in his element as he staffed the Zoom breakout rooms in which these discussions unfolded. “It was great to get a mixed coalition of people coming together and really thinking about the platform’s strengths and weaknesses,” Karasaki says.

Community partners suggested hazardous sites not in the EPA database and helped refine how sites were categorized. They also identified which social vulnerability indicators best reflect the lived experiences of the disadvantaged communities surrounding the hazardous sites. As a result, the Toxic Tides map is searchable not only by unemployment rate, education level, and diversity but also by rental rates, voter turnout, and language isolation—households with limited English-language skills.

TRANSLATING SCIENCE FOR THE PUBLIC

Before unveiling the mapping tool through statewide and then regional events at the end of last year, the Toxic Tides team spent a lot of time discussing how to ensure that their tool is accessible to those living in communities affected by sea-level rise, as well as advocates and legislators. “Who this information reaches is as important to me as the research itself,” Karasaki says.

Translating scientific data into everyday language is a challenge that Karasaki knows well. While working on a master’s degree in international environmental studies at the University of Tokyo, Karasaki organized the TEDxTodai conference. “The real challenge is not only for the speakers to pitch an idea in 18 minutes or less, but to pitch it in a way that anyone without any prior scientific background can understand and find relevant to their lives,” he says. “It’s a problem across all disciplines of research. I wish more people would think about how, after their research gets published, it then reaches the public.”

Clarity of the Toxic Tides information was a top priority for Karasaki. “On the data side, I made sure that the data actually represented what we said they did,” he says. “But then I kneaded that data into more intuitive and easily digestible formats—graphs, visualizations, explanations—for people outside the project.”

Toxic Tides has made a significant impression across the state. “It’s a really powerful project,” says Raval. “The findings are compelling. They reinforce and add a sense of urgency to what many of us in the communities already know.”

Looking ahead, the Toxic Tides team is setting its sights beyond the borders of the Golden State. “Our goal is to integrate the work we’ve done in California and scale it up nationally through Climate Central’s Surging Seas interface,” Morello-Frosch says, adding that the team also plans to translate the tool into Spanish. “We want to continue improving this tool, making it more nimble and able to provide even more information and flexibility to look at different kinds of scenarios.”

Depsky and Karasaki are on board as this next chapter unfolds. “Seeing the positive response and the striking results definitely puts wind in the sails,” Depsky says. “It will be exciting to see how this scales up nationally.”

Oxnard resident Lilian Bello stands alongside the Mandalay Generating Station, a gas-fired power plant on the coast in Oxnard, California—one of many facilities that will be affected by sea-level rise in the area. Bello and other local residents have organized for years to remove toxic and polluting facilities from their coast.

Chris Jordan-Bloch/Earthjustice

Adam Sings In The Timber

Bridging Nutrition and Disability Justice

ALENA MORALES, BS '21, NUTRITIONAL SCIENCES AND TOXICOLOGY-DIETETICS

BY MATHEW BURCIAGA

UC Berkeley's storied history with disability rights activism played a big role in bringing Alena Morales to campus. "I really liked Berkeley, not only because it's a good school, but it's the birthplace of the disability rights movement," says Morales, a queer, disabled, woman of color. "I came here to be in that environment and explore my identities."

Throughout her years studying dietetics in the Department of Nutritional Sciences and Toxicology (NST), Morales was a prominent advocate for students with disabilities. She co-led an initiative with **Katie Savin**, PhD '21 Social Welfare, that resulted in the creation of a disability cultural center on campus in 2020.

CHANGING THE CONVERSATION

"Disability justice and dietetics should be more closely intertwined," Morales says. It's a viewpoint she brings to her current work at Kaiser's Oakland Medical Center during her dietetics training program offered through NST. In order to become registered dietitians, all graduates must complete at least 1,000 hours of supervised practice experience through an accredited training program.

Morales will spend a large portion of her 10-month program working in various departments at Kaiser, with additional placements at UC Berkeley, a dialysis center, and the Alameda County Public Health Department. Since starting her rotations in August, Morales has provided clinical nutritional therapy to patients, reviewed nutritional facts for Cal Dining's food service operations, and conducted campus outreach through University Health Services.

"Dietetics is a much more expansive field than people realize" Morales says. "This rotation experience really helps you sample different facets of the career."

During this training program, Morales often connects with patients with disabilities and offers personal insight and advice on navigating systemic barriers to health. "We're having a lot of awesome conversations about race and sexuality as it relates to resources, barriers, and privileges," she says. "I think disability should be part of the conversation too."

Morales credits the dietetics faculty—who are both leading academic researchers in their field and working professionals with dietetic nutritional practices—with supporting her interest in exploring the intersection of dietetics, public policy, and advocacy.

A HOLISTIC APPROACH

An analysis of California's recent expansion of the Supplemental Nutrition Assistance Program (SNAP) that Morales co-authored with Savin and researchers from UC San Francisco and Stanford was published in December. Appearing in *Nutrients*, a peer-reviewed journal on human nutrition, their research found that expanded benefits helped disabled recipients gain access to nutritious food, increased their household budgets, and eased poverty-associated mental distress, among other positive benefits.

That research ties directly into Morales' views on nutrition. As an aspiring dietitian, Morales believes her work should extend beyond a patient's immediate nutritional health and well-being. She hopes to connect communities that are disproportionately affected by food insecurity and other barriers to nutrition—like people with disabilities—to the services and resources that can make a difference in their lives.

"My interest in disability is infused in the clinical setting," says Morales. "Once we address a patient's daily accessibility needs, they might be able to focus more time and energy on improving their health."

Robin D. Lopez puts on a collar depicting the Aztec goddess Coatlicue, a deity considered to be the mother of gods and mortals and a representation of Mother Earth.

‘Hood Ecologist

ROBIN LOPEZ, PHD CANDIDATE, ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT

BY ANDREW FAUGHT

As a native of Richmond, California, it’s not difficult for Robin Lopez to imagine what might have been.

Street gangs, a violent fact of life in the city north of Berkeley, lured many around him out of school and into harm’s way. But two qualities became a lifeline for Lopez: his insatiable sense of wonder and possibility.

“When I was a kid, my mom used to drive me over the Richmond-San Rafael Bridge,” he recalls. “I was curious about how this thing rode over the water. She said, ‘look it up.’ It mystified me. So, when I was really little, I knew I wanted to be a civil engineer, but I had no idea what that was.”

More than two decades later, Lopez is still asking questions and looking for answers—solutions that are of no small consequence, especially in places like Richmond.

SCIENCE AND SURVIVAL

A doctoral candidate in the Department of Environmental Science, Policy, and Management (ESPM), Lopez focuses his dissertation research on water quality in streams and the environmental justice dimensions of river restoration. In particular, he’s considering how restoration efforts mitigate or exacerbate social and economic inequality in cities like his hometown.

“Robin has a deep intellectual curiosity, a positive personality, and a desire to address research questions that are challenging, original, and socially important,” says **Ted Grantham**, Lopez’s graduate adviser and an associate professor of Cooperative Extension in ESPM. “His enthusiasm for science is only matched by his dedication to his community.”

Lopez is the sixth of 12 children, and the only person in his family to attend college. He grew up helping his father run a janitorial business, including cleaning office buildings across the street from the Berkeley campus.

Turning 18 was “surreal,” Lopez recalls. “I was in tears—the fact that I had lived that long.” After surviving his adolescence, he started to look at preserving life on a grander scale.

Froggie Violet Vega

While a student at Contra Costa Community College, he met Berkeley alumna **Mayra Padilla**, PhD '05 Psychology, who serves as dean of institutional effectiveness and equity at the school. Padilla—who transcended her own Richmond upbringing to earn a doctorate in neuroscience—showed him that it was possible to get an advanced degree and use the expertise to improve life in his hometown.

Lopez dropped out numerous times along the way, but ultimately earned a bachelor's degree in civil engineering from San Francisco State University and a master's degree in water resources engineering from San José State University.

Pivoting from civil engineering to an environmental focus, the self-proclaimed "'hood ecologist" has dedicated himself to community-Earth health and welfare. It's a passion he developed during an internship at the Lawrence Berkeley National Lab, which he started while in community college. The experience also was a major factor in his decision to apply to ESPM.

THE POWER OF PERSEVERANCE

A recipient of UC Berkeley's Chancellor's Fellowship, Lopez was awarded a prestigious National Science Foundation fellowship in 2017. Still, he's decidedly modest about his accomplishments. "I will be the first to admit that I'm not the smartest person in the room, and I don't consider myself an intellectual," he says. "But I'm curious, and I'm constantly asking questions."

It's a habit he's passing on to area elementary school children, to whom he routinely talks about science. Lopez reminds them that they, too, can tap their hidden science acumen.

"If they're curious and inquisitive, they're already scientists," Lopez says. "My grandfather is the most intellectual scientist I've ever known, and he doesn't have a degree. But he can tell you everything about geologic features."

"The biggest thing I want them to know is they have an advocate," he adds. "They already know what they haven't accomplished. I remind them if a teacher ever gives them problems, they can hit me up."

Lopez speaks from experience. When he was a high school junior, a teacher encouraged Lopez to drop out of school—and he did, for two months.

"She told me in front of the class that I was a waste of time and that there was no hope for me," he says. "I laugh about it today." Lopez's personal website lists the colleges and universities from which he was rejected admission, a reminder to others—especially young adults who might be following in his path— that perseverance is critical.

And while challenges are part of the deal, so is hope. Lopez lost his best friend to suicide in 2010; he has since volunteered for the American Foundation for Suicide Prevention, once organizing a fundraiser to support mental health research. He also signed up for Be the Match's national bone marrow registry and underwent surgery to donate marrow after it was found he was a match with a man battling Non-Hodgkin's Lymphoma in the Midwest.

Top: During the pandemic, Lopez continued his fieldwork collecting water samples for research on fish migration and survival during changes in climate. Bottom: Lopez with participants in the Oakland Town Camp program, in partnership with Lawrence Berkeley National Laboratory.

These days, Lopez only needs to look to those elementary school children to feel optimistic about Earth's ecologic future. There is something of him in them.

"I'm especially optimistic because of the questions that they're always asking," Lopez says. "That's what makes me think our future is in good hands. I'm just one piece of the puzzle. It's our job to transfer that knowledge to the next generation, and I'm pretty confident the next generation has got this for us."

Froggie Violet Vega (top); Harmony Ortiz (bottom)

Q&A

Scholars and Leaders

INTERVIEW BY KIRSTEN MICKELWAIT PORTRAITS BY ADAM SINGS IN THE TIMBER

Students at Rausser College tend to be passionate about the environment and how it intersects with social justice, equity, and civil rights. Here, we feature two such students with leadership and activist roles who are making a difference in our College, on campus, and beyond.

Varsha Madapoosi

Third-year society and environment and data science double major, sustainable design minor

Beyond her academic coursework, Varsha Madapoosi is engaged across campus in a variety of leadership roles. She's this year's eco-senator for the Associated Students of the University of California (ASUC), a Diversity, Equity, Inclusion, and Justice (DEIJ) fellow at the Office of Sustainability, and a housing staff associate at Cal Zero Waste.

Breakthroughs: What led you to choose your particular areas of study?

Madapoosi: I grew up in St. Louis, Missouri, where I could watch ducklings hatch, pick fruit from neighbors' trees, and watch the sunset every day. I joined the Girl Scouts in elementary school, and, although I was the only brown girl on our camping trips, I enjoyed being outdoors so much that I put up with the stares and invasive questions. After moving to California in high school, I applied my connection with nature to school projects and even implemented a tri-bin waste system for the district's 16 schools. At UC Berkeley, I've learned about environmental justice; it's where I began my journey on advocacy and intersectionality.

I also believe that technology can help us repair many of the environmental issues that my generation is facing. Despite my lack of initial experience with it, I quickly learned to love data science. Now I hope to apply my interest, skills, and coursework in data science to environmental justice issues.

What are you working on as ASUC eco-senator and as DEIJ fellow at the Office of Sustainability and Carbon Solutions?

As eco-senator, I'm working to launch and support environmental justice campaigns, expand environmental education, and strengthen eco-community partnerships. I'm focusing my office's work on wellness and intersectionality to uplift and empower student-driven community action. As DEIJ fellow, I'm implementing DEI into the Campus Sustainability Plan and serving as a liaison between the Office of Sustainability and student and staff groups.

In your view, what's the "Venn diagram" of environmental justice and social justice?

Sustainability has been built under systems such as racism, patriarchy, colonialism, and capitalism. We must actively reimagine the way our world is built in order to have a sustainable earth for everyone. Who is it built for? Whose voices are excluded in that process? In my work with the Students of Color Environmental Collective (SCEC), we've realized that a lot of what justice is isn't taught in the classroom; it's taught through peers' experiences and through conversations about our experiences as people of color in the environmental movement. On this campus specifically, we need to ensure that all student voices are heard. In the spirit of advocacy and intentionality, we must acknowledge and listen to all communities.

Can you explain the term "intersectionality," specifically in the context of environmental justice?

Intersectionality as a term was coined by Kimberlé Crenshaw, a UCLA professor of constitutional law and critical race theory. I think it's very important to acknowledge its roots and the Black woman who created the framework for it. Personally, I view intersectionality as a community-oriented approach—ensuring that economic, political, and social frameworks are woven together to create solutions, while also acknowledging that individuals who make up these larger systems hold multiple identities and belong to multiple communities. Intersecting identities build up a person's self-expression, character, and the way they view the world. So, when crafting environmental solutions, you need the active and intentional participation of even the most marginalized community members.

> **"We must actively reimagine the way our world is built in order to have a sustainable earth for everyone. Who is it built for? Whose voices are excluded in that process?"**
>
> — Varsha Madapoosi

Lucy Andrews

PhD candidate, Environmental Science, Policy, and Management

Lucy Andrews studies water resource management in the lab of **Ted Grantham**, an associate professor of Cooperative Extension in water and climate. In addition to her doctoral work, she's serving as external affairs vice president in the Graduate Assembly and co-chair of the Chancellor's Independent Advisory Board on Police Accountability and Community Safety. A passionate ultramarathon runner, she coaches cross-country running and track at Oakland Technical High School.

Breakthroughs: What water issues are you studying, and what kind of career path do you hope to pursue?

Andrews: I'm fascinated by the management of water resources in a time of scarcity, climate change, and increasing demands for freshwater. I'm focusing on things like dam removal, environmental flows, and stream restoration in California water management. Environmental justice and cross-disciplinary methods are central to my research, as well as involving diverse collaborators in the planning, practice, and application of my science. I use spatial analysis and a variety of computational methods to illustrate trade-offs of various choices related to water use and management. I hope to find a public service or government job where I'm responsible for a blend of applied research, management, and policy support.

How do racial and social justice inform your approach?

I was brought up to believe that no action is neutral—you're either solving a problem or contributing to it. I want to live in a world where everybody is flourishing and able to be whole, and we don't live in that world right now. There's also such a history of colonialism and extraction in traditional "resource management sciences." Even the term itself is colonial, because it speaks of the natural world as a resource to be managed, rather than something with which to relate. As someone who plans to make a living in that field, I want to attend to the harms of my field's past.

What do you do in your role as external affairs vice president in the Graduate Assembly?

I represent the interests of graduate students in political projects both on and off campus, interacting with organizations ranging from the UC Office of the President to state agencies. Recently, our advocacy agenda has included support for state bills that advance the study of reparations for Black Californians and a statewide commission to move toward racial justice and the deconstruction of institutionalized white supremacy. We're also working across the UC system and in Sacramento to create more affordable housing for students, and we're distributing a Graduate Assembly fund that supports Native American students at UC Berkeley.

Does that tie in with your work with the Chancellor's Independent Advisory Board on Accountability and Community Safety?

Yes. A year or two ago the Graduate Assembly supported a political stance of divestment from the campus police department and the reinvestment of resources into forms of safety programs that don't have a history of surveillance and racialized policing. And I'm in full support of that project, because I've observed many of my peers impacted by surveillance and physical harm from our police department that has really impeded their education. In this university-appointed position charged with recommending changes to the policing and safety of my campus, it's incumbent upon me to do so with a deep understanding of what justice and repair would look like in that space.

> **"No action is neutral—you're either solving a problem or contributing to it."**
>
> — Lucy Andrews

What sparked your interest in running, and how does it intersect with your research interests?

I started running on the high school cross-country team as a way to stay out of trouble after school, and I haven't looked back. After competing in college, I found myself running longer distances as a way to explore the places in nature that I was curious about, and then I started racing too. I've probably run six or seven ultras (that's anything longer than a marathon, which is 26.2 miles) and countless shorter trail races. The farthest I've raced is 53 miles, but my 2022 season will end with a 62-mile race in May. For training, I typically run 60 to 75 miles a week, which includes some longer runs and a speed session or two.

Running connects me deeply to landscapes that I love; I've gotten to know a variety of ecosystems and terrains intimately using my own two feet. This makes me want to steward them through my science—that's the core motivation underpinning my dissertation.

Running has also taught me to just keep showing up as I chip away at big goals. I've run almost every day for 15 years, through hard times and joyful times alike. I approach my science the same way—as a marathon, not a sprint—and I embrace the inevitable ebbs and flows that come with long-term projects.

A Passion for Green

DAVID AND SUZANNE WARNER DEEPEN SUPPORT FOR GRADUATE STUDENTS OF SUSTAINABILITY

BY KIRSTEN MICKELWAIT

Growing up on a houseboat on Corte Madera Creek in Marin County—and even rowing a boat to grammar school with his brother—**David Warner**, BS '76 Conservation of Natural Resources, forged an early connection to nature that fundamentally shaped his lifelong commitment to the environment. Rich in salmon, otters, crabs, and oyster beds, the creek habitat gradually became a secondary fill zone for waste dirt from local developments. "Within a period of about eight years, I watched all that wildlife become depleted," he says. "Seeing how fast things were changing directly informed my passion for conservation and sustainability."

With his wife, **Suzanne Warner**, BA '78 Architecture, Warner recently created the Warner Graduate Student Impact Fund, which supports graduate students who are conducting research on sustainability and climate mitigation or adaptation. Such gifts allow Rausser College of Natural Resources to keep graduate funding packages competitive with its peer institutions.

When choosing a college, Warner was drawn to the work of Sim Van der Ryn, the UC Berkeley professor of architecture who would go on to design and build California's first energy-efficient and climate-responsive building as state architect during Governor Jerry Brown's first term. "I really wanted to be part of that creative ecosystem," he remembers, "and the College of Natural Resources was the key to getting in there." At the time, students in the College were working on projects relative to the idea of a building having a "light touch" on the environment. Warner's high school sweetheart, Suzanne Deutsch, came to Cal two years later to study architecture and green building methods.

In 1985, the couple founded Redhorse Constructors, a full-service residential and commercial construction company specializing in sustainable design and green technology—what Warner calls "resilient/regenerative building practices." In addition to high-end private residences and large-scale commercial properties, the company is currently at work on several innovative new projects that include construction of a new factory for MycoWorks, a startup making fabrics from mycelium—the vegetative part of a fungus.

Redhorse is also collaborating with a multi-institutional team—including **Dan Kammen**, a professor in the Energy and Resources Group who was recently appointed the adviser for energy, climate, and innovation for the U.S. Agency for International Development—to create the Oakland EcoBlock, a self-sufficient grid of 30 to 40 adjoining residences that will produce close to zero net energy annually and reduce carbon emissions by 85 percent.

In addition, the Warners co-founded, with actress Connie Nielsen, the Human Needs Project: an NGO that's building physical infrastructure for clean water and sanitation as well as social infrastructure for capacity-building in Kibera, Kenya—the second largest slum in Africa. "Our idea was to bring resources to those who have zero opportunity," Warner says, "to build viable marketplaces and give people the power to uplift and transform their own communities."

Closer to home, David Warner has just completed an eleven-year term on the Rausser College board. "What we did to propel the College's mission is incredibly important to me," he says. "When it comes to enriching and solving the big problems in our world right now, that's just in UC Berkeley's DNA."

That commitment to Rausser's mission is reflected in the new Warner Graduate Student Impact Fund. "We hope to enable graduate students to do their research without having to worry about finances," Warner says. "We believe it's important to have the freedom to explore, to experiment, to investigate, to analyze, and to engage."

Visit nature.berkeley.edu/grad-support to learn more about how you can support our students.

Adam Sings In The Timber

Ecological Art

ART BY JUNIPER HARROWER

The underlying structure of leaves—a veritable maze of branching or looping veins—plays an important role in the functions of plants. How efficiently can they transport water and nutrients? Can they resist damage? How resilient are they to environmental stressors? Environmental Science, Policy, and Management Professor **Benjamin Blonder** hopes to better link leaf venation to ecological function, research that could one day guide the design of things like more efficient roads, drainage systems, and synthetic organs.

Juniper Harrower, BS '06 Genetic & Plant Biology, is an artist-in-residence at Blonder's Macrosystems Ecology Laboratory. Now a first-year master's student in the Department of Art Practice at UC Berkeley, Harrower—who earned a PhD in environmental studies with a focus in eco-art from UC Santa Cruz in 2019—creates art that explores the role that plants play in constructing our identities and how our activities influence and shape their development. Shown here is an art piece Harrower created using sunlight and phytochemistry to print an image of her eyes onto leaves, then partially decaying and dying it. This piece was part of an installation displayed at an exhibit at the UC Botanical Garden in March.

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A pair of Pacific Royal Flycatchers (female with yellow crest, male with red) photographed by PhD candidate Becca Brunner while conducting research in Ecuador's Jama-Coaque Reserve.