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conserve
30 percent of
land and water
by 2030?

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College of Natural Resources

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LETTER FROM THE DEAN

The bustle of a new academic year is always invigorating, and this fall has been especially so as we transition back to life on campus. I want to thank all those who performed essential functions on campus through the last year and a half—from facilities management to research operations. Whether on site or remote, everyone in the College rose to the challenge in support of our mission.

We're all experiencing a "new normal" in this phase of the pandemic. As we also face drought, record high temperatures, and yet another season of widespread wildfires, our efforts to create a sustainable future are more important than ever.

Here we share two projects working toward that reality. First is the California Heartbeat Initiative, which is pioneering the use of drone flight data to provide information on how climate change is affecting California's natural ecosystems. Next up is 30x30, the ambitious goal to preserve 30 percent of the world's lands and waters by 2030. Our College has been conducting influential research in the fields of conservation and biodiversity for years, and now many of our faculty are involved in this initiative at the state, federal, and global levels.

The year 2030 is also significant to me in my role as dean, as we embark on a strategic planning effort to chart a path for Rausser College for the decade ahead. We'll assess our research and curriculum priorities, our operations and finances, and our progress toward our diversity, equity, and inclusion goals.

Those just joining our community will play an especially important role shaping our future. Especially notable this fall are faculty recruited as part of two campus-wide cluster hires—one in climate equity and environmental justice and the other in Native American studies. We look forward to introducing you to their work.

I welcome your feedback at dackerly@berkeley.edu.

David D. Ackerly

BREAKTHROUGHS

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ONLINE

After reading the story on page 12, learn more at our virtual panel event with Rausser College researchers working on the 30x30 initiative on November 10th. Register at nature.berkeley.edu/30x30.

Stuart Dunn (frog); Impossible Foods (meatball); Todd Dawson (drone)

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Breathing safe at home

Smoke from catastrophic wildfires now frequently pours hazardous air pollution across the western U.S. While many people reduce their exposure by staying inside, keeping windows closed, and running air filtration systems, data remains limited on the effectiveness of these efforts.

In a study published in the *Proceedings of the National Academy of Sciences* in August, a team of Berkeley researchers used crowdsourced data from thousands of indoor and outdoor air sensors to determine how well residents in the San Francisco and Los Angeles metropolitan areas could protect indoor air from hazardous outdoor pollution. Co-authors include Rausser College's professor **Allen Goldstein**, postdoctoral researcher **Deep Sengupta**, and graduate student **Yutong Liang**, who is lead author.

The team found that, by taking steps like shutting windows and using filtration systems, people were able to cut the infiltration of PM_{2.5} particulate matter to their homes by half on wildfire days. However, indoor exposure depends heavily on the nature of the building itself. By assessing building characteristics like relative age, the type of building, and the neighborhood's socioeconomic status, the researchers showed that newer homes and homes with central air conditioning are significantly better at keeping wildfire smoke out.



The authors also emphasized environmental justice and equity issues surrounding indoor exposure. Because sensors are expensive, they note, households that contribute data to the network tend to be affluent, with an average price of homes about 20 percent higher than median surrounding property values. They aim to develop ways to sample indoor air quality from a more diverse array of homes in future research.

— Adapted from an article by Kara Manke

Olympians Among Us

The UC Berkeley community is always proud to cheer on Cal athletes at the Olympics. This year, seven current or former students of Rausser College traveled to Tokyo to compete in the summer games. Two high-ranking athletes were **Bryce Mefford**, a senior environmental economics and policy major who took fourth in the men's 200-meter backstroke, and **Camryn Rogers**, a senior society and environment major who placed fifth in women's hammer throw.



Beetles' Antibiotic Excrement

The horned passalus beetle, commonly known as the bessbug, may seem gross. In addition to eating its own feces, or frass, the shiny black beetle lines its living spaces and larval chambers with its excrement. Now, new research suggests that the beetle's frass habits are actually a clever strategy for protecting its own health, and they could help inform human medicine too.

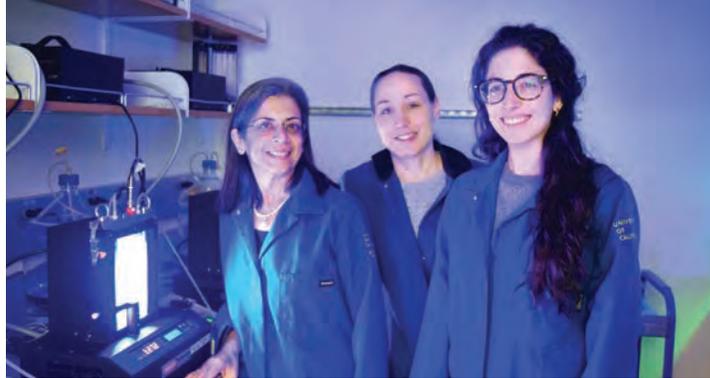
Researchers, including postdoctoral scholar **Rita de Cassia Pessotti** and assistant professor of plant and microbial biology **Matthew Traxler**, discovered that bessbug frass is teeming with antibiotic and antifungal chemicals, similar to the ones that humans use to ward off bacterial and fungal infections. These compounds are made by beneficial bacteria called *actinomyces* that live in the beetle's frass, appearing to be passed from beetle to beetle, and from colony to colony, through coprophagy—the technical term for eating feces.

With the discovery, bessbug beetles join a handful of other insects that benefit from symbiotic relationships with *actinomyces*. Understanding the relationship between the bessbug beetles, *actinomyces*, and antimicrobials could help scientists develop new antibiotic drugs and assist doctors developing strategies for combating antibiotic-resistant infections.

“When scientists discover a new antibiotic, it often only takes a few years before the pathogen starts to develop antibiotic resistance, but these microbes have been using the same molecules for millions of years,” said Traxler. “Learning more about their strategies could inform key breakthroughs for human health.” — *Adapted from an article by Kara Manke*



Rita de Cassia Pessotti (Beetle); Lindsey Pleiffer (Merchant)



Sabeeha Merchant (left) and members of her lab with a bioreactor, which they use to culture algal cells.

Why I Do Science

BY SABEEHA MERCHANT

Everyone can benefit from the scientific method. The importance of thinking critically and evaluating data has become especially evident during the pandemic as each of us evaluates risks and faces questions around masking, vaccination, and travel.

My own introduction to science—and my path to a scientific career—began when I was twelve, and I had to choose a science or arts focus in school. I had an aptitude for both, and my mother chose science for me. She didn't hold stereotypes of what women should study or whether they should have a career.

I've now been studying the biology of trace metals in plants for over 30 years. Small amounts of metals like copper, iron, zinc, and manganese are needed for the health of organisms, from bacteria to plants and animals. I research plants because they only use water, carbon dioxide, light, and a few mineral nutrients, so it's straightforward to prepare growth conditions where we can control the supply of minerals. I also study *Chlamydomonas reinhardtii*, an alga in the green plant lineage. Twenty years ago, we started to use genomic approaches for this work; now, my research group is well known in the area of green algal genomics. It's exciting that there are still so many discoveries to be made—the field is ripe for young scientists.

I'm so thankful for the community of researchers I interact with regularly at conferences and through research collaborations and the review process. Our individual scientific discoveries are each important, but more lasting is the education of students and postdoctoral scholars. Their discoveries are a direct outcome of my efforts, and they will further educate other students. Helping to grow this family of scientists is my proudest achievement.

Sabeeha Merchant is a professor of plant biology and of biochemistry, biophysics, and structural biology, and a senior scientist at Lawrence Berkeley National Laboratory. In 2007, she led a team that sequenced the *Chlamydomonas* genome.

Changing the Environmental Narrative

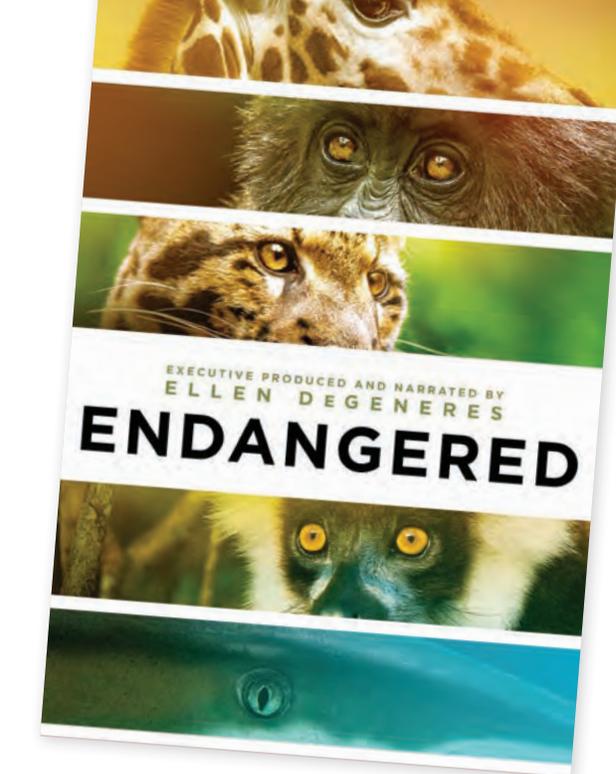


Erica Bree Rosenblum is featured in the BBC film “Endangered,” which premiered on Discovery+ earlier this year.

From tropical forests to high-tech labs, Environmental Science, Policy and Management (ESPM) associate professor **Erica Bree Rosenblum** has spent decades researching amphibian biodiversity and the modern extinction crisis. More recently, Rosenblum has also turned her attention to storytelling—specifically, how to craft constructive narratives about conservation.

Earlier this year, Rosenblum partnered with the BBC to help bring on-the-ground conservation stories to life. Her work on amphibian conservation is one of the seven segments featured in the film “Endangered,” which streams on Discovery+ and is narrated by Ellen DeGeneres.

The film is only the latest in her ongoing commitment to redefining humans’ relationship with the natural world. From her research into how global environmental change impacts biodiversity, she developed the popular undergraduate course, Global Change Biology, in part to counteract the defeatist nar-



ratives she found to be prevalent among environmental science undergraduates.

Following the popularity of the class, Rosenblum created a new textbook of the same name (Oxford University Press, 2021). Its innovative curriculum empowers students to personally relate to environmental issues, and it encourages educators to foster constructive, critical thinking about global change.

“The story we tell matters,” said Rosenblum. “We can contribute to a sense of hopelessness and helplessness, or we can empower students, conservationists, and the public to be truly curious about our place in the world and create a more inspired vision for the future.”

Rausser College Reads BY JACOB SHEA

Getting to the Heart of Science Communication: A Guide to Effective Engagement

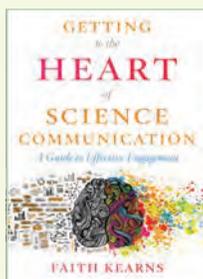
Island Press, May 2021
By Faith Kearns

At a community event in northern California years ago, scientist and author **Faith Kearns**, PhD '03 ESPM, gave a presentation on wildfire and firesafe housing. When an audience member whose house had been destroyed in a fire grew

distraught, Kearns began to reevaluate her approach to communication involving wildfire or other traumatic or polarizing scientific subjects.

Her new book, *Getting to the Heart of Science*

Communication, outlines how human relationships are central to successful practice-based science. It uses personal anecdotes, interviews,



and Kearns’s own field experience to explain the evolution of science communication and demonstrate how emotional, high-stakes issues—for example, wildfire, climate change, or COVID-19—can shape communication. The book provides useful tools that help readers listen, handle conflict, and understand trauma, loss, and healing. It also includes a conver-

sation about diversity, equity, and inclusion in science, as well as advice for researchers on how to manage their own emotional needs.

Climate Stewardship: Taking Collective Action to Protect California

University of California Press, September 2021
By Adina Merenlender with Brendan Buhler

As climate disruption intensifies globally,

Working for the White House



PATRICK GONZALEZ APPOINTED TO OFFICE OF SCIENCE AND TECHNOLOGY POLICY

In August, the White House Office of Science and Technology Policy (OSTP) appointed **Patrick Gonzalez** as assistant director for climate and biodiversity. OSTP advises the president, vice president, and the executive office on the science needed to develop and implement national policies.

An associate adjunct professor in ESPM, Gonzalez previously served as principal climate change scientist of the U.S. National Park Service (see “The New Conservation,” page 12). “I aim to advance science-based action on human-caused climate change to protect nature and people,” said Gonzalez,

who earned his PhD in the Energy and Resources Group (ERG).

Gonzalez credits **John P. Holdren**—ERG founder and his dissertation chair—as a role model for connecting science to policy. (Holdren served as the science advisor to President Obama.) “John emphasized to us that scientists can move beyond their research area and produce greater change through policy, which can positively affect people across the country and around the world,” said Gonzalez.

Gonzalez is a forest ecologist who has conducted field research in Africa, Latin America, and the U.S. He is a lead author on four reports of the Intergovernmental Panel on Climate Change, including both the forthcoming 2022 assessment and two of the previous reports for which the organization shared the 2007 Nobel Peace Prize.

Newsmakers

“I haven’t been this excited about a discovery since CRISPR.”



Jill Banfield, Professor, ESPM

Banfield caught the attention of the scientific community when she tweeted in July about her lab’s discovery of mysterious, extra-long DNA elements that are unlike anything ever found. The group named the elements BORGs—after *Star Trek*’s assimilation-prone Borg aliens—because they “assimilate” genes from microorganisms in their environment. In a preprint paper, Banfield and co-authors noted that BORGs may play a role in methane metabolism by microbes and could eventually have “important and unanticipated climate implications.” Outlets including *Nature*, *Science*, and *Vice* covered the finding.

“This is front-page news, and we’d better get it right.”



Marc Hellerstein, Professor, Nutritional Sciences and Toxicology

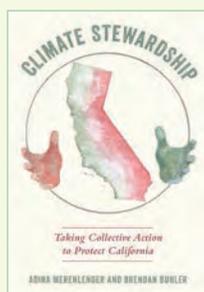
In a May film produced by Los Angeles Times Studios and the *Los Angeles Times*, researchers discussed COVID-19 vaccines, emergent variants, and the importance of scientific accuracy in the media. Hellerstein explained how vaccinations prevent infections, prospects for long-term immunity, and reasons for hope moving forward.

“It’s death by 5,000 cuts.”



Arthur Middleton, Assistant Professor, ESPM

In August, Middleton and graduate student **Wenjing Xu** were featured in *National Geographic*, offering expertise on how fences constrain the movement of wildlife and break up habitat. The researchers underscored the importance of studying the complex ecological impacts of fences and how to mitigate them, especially because fences are ubiquitous: No matter where a person stands in the Western United States, said Xu, they are on average less than two miles from a fence.



Californians have been finding unique solutions across diverse communities and landscapes. In *Climate Stewardship: Taking Collective Action to Protect California*, ESPM Cooperative Extension Specialist **Adina Merenlender** and co-author Brendan Buhler tell the stories of everyday people and how their actions enhance the resilience of both communities and ecosystems across the state. *Climate Stewardship* shares examples of community-based

climate actions and explains the science associated with them. Spanning ten distinct California bioregions, the book explores topics including wildfires, drier deserts, shrinking forests, San Francisco Bay wetlands, large-scale farming, sprawling urban development in Los Angeles, and oceanic temperature rise. It highlights stories about ecologically regenerative solutions in agriculture, energy, and land- and water-use across natural, working, and urban landscapes. The book also serves as the text for the UC California Naturalist’s new Climate Stewards certification program.

Adam Sings in the Timber (Gonzalez)

Research in Climate Equity and Environmental Justice

BY JACOB SHEA

As climate change transforms the physical world—and increasingly, our society—its impacts disproportionately affect marginalized and vulnerable groups due to historical, systemic inequities.

New faculty members—many recruited through the campus-wide Climate Equity and Environmental Justice cluster initiative that Rausser College led—will strengthen UC Berkeley research in the areas of climate mitigation, adaptation, and sustainable development. The Roundtable on Climate and Environmental Justice—an intellectual community composed of both new and existing faculty working in environmental justice and climate equity—will meet regularly to collaborate, share research, and develop joint initiatives.



Youjin Chung

ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT ENERGY AND RESOURCES GROUP

Chung's research draws on ethnographic, historical, and participatory visual methods to examine the relationship between gender, intersectionality, development, and agrarian-environmental change in Tanzania and sub-Saharan Africa.



Danielle Zoe Rivera

LANDSCAPE ARCHITECTURE AND ENVIRONMENTAL PLANNING

Rivera's research examines movements for environmental and climate justice in low-income Mexican American and Puerto Rican communities. Her current work uses community-based research methods to study the impacts of climate-induced disasters on low-income communities.



Meg Mills-Novoa

ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT ENERGY AND RESOURCES GROUP

Mills-Novoa researches the enduring impact of climate change adaptation projects on the landscapes and livelihoods of communities in the Andes mountains.



Daniel Aldana Cohen

SOCIOLOGY

Cohen researches the politics of climate change, investigating how climate change, housing, political economy, social movements, and inequalities of race and class intersect in the U.S. and Brazil.



Zoé Hamstead

CITY AND REGIONAL PLANNING

Hamstead researches climate planning and environmental justice. Through a mixed-method, multidisciplinary “critical heat studies” agenda, she studies how climate change-exacerbated heat is produced in urban physical and institutional spaces, and how urban designers can address heat as a critical environmental and racial burden.



Maya Carrasquillo

CIVIL AND ENVIRONMENTAL ENGINEERING

Carrasquillo’s research applies an interdisciplinary, community-based approach to develop decision-making tools for equitable stormwater management in predominantly African American communities, with a broader focus on equity and justice in engineering and critical infrastructure development.



Ajay Pillarisetti

SCHOOL OF PUBLIC HEALTH

Pillarisetti, PhD ’16 Public Health, researches how household energy use impacts human health, the environment, and the climate. In particular, he investigates pollution exposure, and how low-cost sensor technologies can enhance monitoring, evaluation, and control of environmental pollutants.



Christopher Schell

ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT

Schell’s research incorporates urban ecology, animal behavior, physiology, and socio-ecological and -evolutionary dynamics to investigate how cities shape human-wildlife interactions.



Cesunica Ivey

CIVIL AND ENVIRONMENTAL ENGINEERING

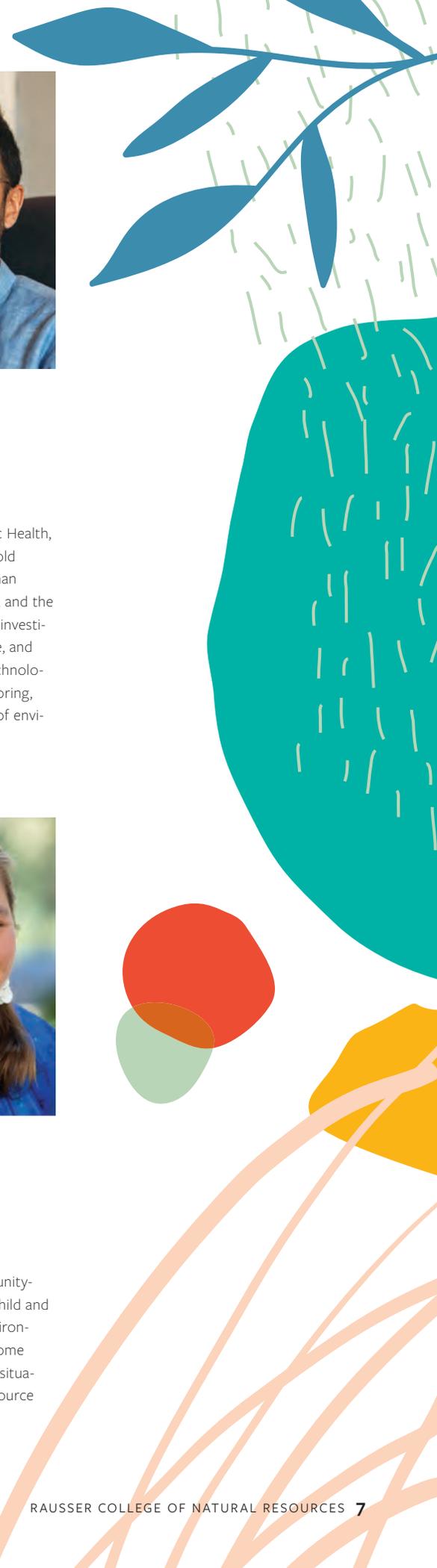
Ivey focuses on community-scale exposure to air pollution in the U.S., as it relates to atmospheric modeling, data assimilation, exposure monitoring, and environmental justice applications, among other subjects.

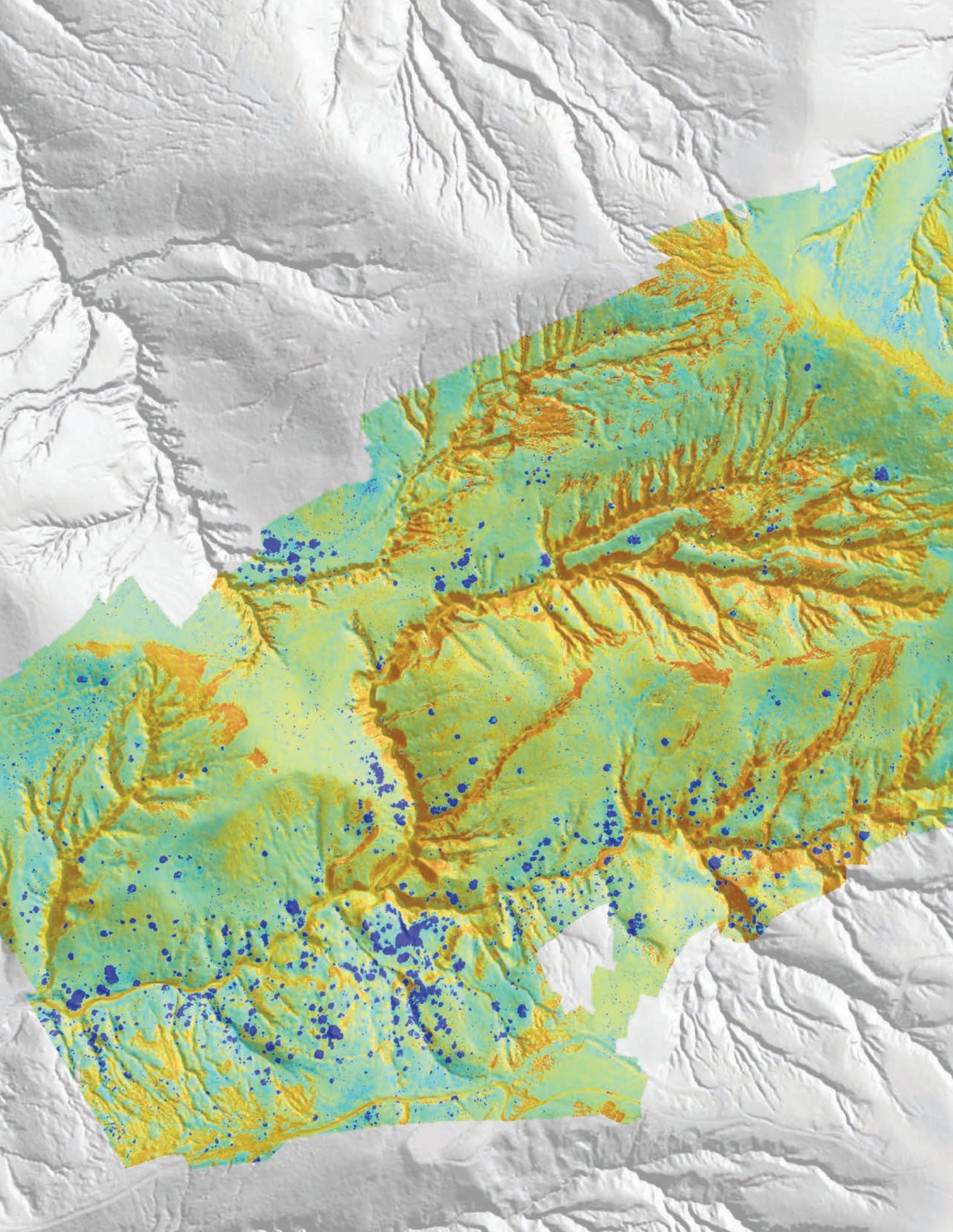


Laura Kwong

SCHOOL OF PUBLIC HEALTH

Kwong conducts community-engaged research into child and maternal health and environmental issues in low-income countries, humanitarian situations, and other low-resource settings.







Taking the pulse of California ecosystems

The California Heartbeat Initiative uses new technologies to track environmental change on a landscape scale

BY KATHLEEN WONG

The climate crisis is changing California in ways unimaginable just a few decades ago. Droughts are growing longer and drier, wildfires are exploding to frightening sizes, and heat waves are setting temperature records on land and at sea. The magnitude of today's disasters has scientists scrambling to measure the pace and scale of these shifts.

Biologist **Todd Dawson** believes that remote sensing is critical for monitoring the health of natural ecosystems going forward. "We can't do this just with boots on the ground," he says. "There's not enough of us, and we can't do it fast enough."

Dawson and colleagues across the University of California are tackling this challenge with a pilot project called the California Heartbeat Initiative (CHI). Utilizing technologies such as drones and miniature climate stations in novel ways, they are tracking environmental change on a landscape scale.

A NEW TOOLKIT

Just as physicians gauge wellness by measuring temperature and blood pressure, CHI measures characteristics such as chlorophyll content, soil moisture, and microclimate to spot plants under stress—key indicators of waning ecosystem

Using drones, California Heartbeat Initiative researchers can track water stress in vegetation across an entire landscape. Data from multispectral cameras are reassembled into a map showing well-hydrated plants (green) versus water-stressed plants (orange) in California's Channel Islands.

health or environmental change. But instead of assessing vital signs one plant at a time, drones generate data across hundreds of acres of forests and meadows per flight.

"We're equipping ecologists with a new toolkit and demonstrating how well it can be used to detect change in natural environments," says **Becca Fenwick**, CHI project coordinator and lead drone pilot.

Over time, regular CHI-style assessments can pinpoint forests at high fire risk, landscapes on the threshold of major shifts, and ecosystems in need of a human helping hand. "If we see signals of change, we understand that the way the ecosystem is knit together is fraying, and we can look for solutions to protect biodiversity or manage the land in a new way," says Dawson, a professor in the Departments of Environmental Science, Policy, and Management (ESPM) and Integrative Biology.

Funding for CHI comes from the Gordon and Betty Moore Foundation, and collaborators leading the project include ESPM professor and Cooperative Extension specialist **Maggi Kelly**, Rausser College Dean **David Ackerly**, and **Peggy Fiedler**, MS '80, PhD '85, Forest Ecology and Botany, former executive director of the UC Natural Reserve System.

The CHI toolkit is being put through its paces across the UC Natural Reserve System (NRS), a network of 41 reserves in California used for research and teaching. NRS lands represent nearly every major ecosystem in the state, enabling CHI scientists to study a wide range of climate and vegetation types, from succulents in hot deserts to redwoods in coastal forests.

CHI's versatile toolkit has proven particularly adept at tracking water availability across ecosystems. Water-starved plants are vulnerable to both disease and fire, making landscape water an important signal of ecosystem health in a drying region.

To spot thirsty plants, CHI researchers have mounted multispectral cameras, typically used by satellites, atop drones. They simultaneously capture images in six different light ranges, helping scientists quantify how green and active, or brown and water-stressed, one plant is versus another.

While each pixel in a satellite image covers roughly the area of a baseball diamond, a pixel from a drone camera covers just a few centimeters—a 30x boost in resolution. Drones also enable the scientists to obtain far more comprehensive surveys, since they can fly over places that are inaccessible on foot, like rugged ravines and stands of poison oak.

MAPPING WITH DRONES

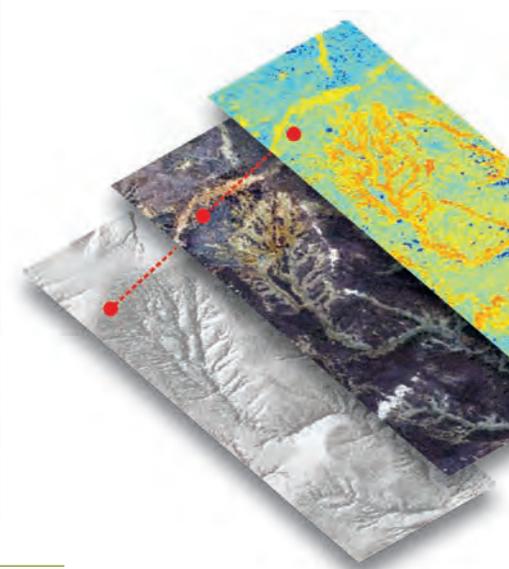
In 2018, the CHI team began using drones to map changes in water availability across seasons at nine NRS reserves featuring distinct ecosystems.

Having a bird's-eye view of 25 tree canopies, rather than looking up at just one, has been a revelation for Dawson. "It's like a new set of eyes," he adds. "We can see one area changing while another remains the same, then go figure out why."

The team also installed miniature weather stations within each flight area. Called ClimaVues, they collect continuous measurements of standard meteorological data, as well as information relevant to plant health, such as leaf wetness and soil moisture. The researchers ground truthed this data with observations gleaned through traditional hand-sampling methods.

The comprehensive data from drones allows the CHI team to create digital surface models of their study areas. Resembling a blanket draped across the landscape, digital surface models enable researchers to deduce the volume and density of vegetation. "We can see changes as they happen—for example, some oak canopies are thinning while others are doing well," Dawson says. When drone maps are melded with ClimaVue data, "we can explain the differences: microclimates, little pockets of resources or water, that we didn't appreciate before."

To date, the CHI team has gathered drone data over some 78 square miles, amassing more than 10 terabytes of data—



Todd Dawson measures water pressure in leaves. The CHI team uses data from hand-sampling techniques in conjunction with data from drones and miniature weather stations.

about the amount of information generated annually by the Hubble Space Telescope. To organize it all, CHI has helped sponsor a geospatial data repository to make processed drone flight images available to anyone.

The meteorological data is served up by a new, open-source data portal called Dendra. Developed by CHI data manager **Collin Bode**, the portal now collates information from climate stations across the NRS, and it will soon be a one-stop resource for meteorological data from entities such as California State Parks, California Department of Fish and Wildlife, and The Nature Conservancy.

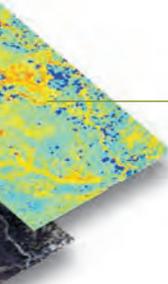
With Dendra, users can easily query the conditions at a reserve across any time period. Dawson contrasts that to the two years he and his colleagues spent calling airports and government offices to locate weather records for a study on fog and redwoods. "If people want to analyze climate trends across the NRS, Dendra is going to be their go-to tool," Dawson says.

FIRE FOLLOWERS

In August 2020, a lightning storm sparked more than 650 wildfires across California. Nine reserves, many of which the CHI team had already mapped, were among the record 2.7 million acres burned.

Amid the devastation, the researchers saw a rare opportunity to observe how landscapes rebound from fire. With additional Moore Foundation funding, they flew drones over the burned reserves a few weeks after the fire, and again six months later. They rounded out the data set with ground surveys of vegetation and arthropods, and collections of soil samples for environmental DNA analysis, to identify returning species. As the scientists are particularly interested in how fire intensity affects ecosystem recovery, CHI postdoctoral fellow **Yinan He** also used remote sensing data from satellites to generate burn severity maps.

One drone flight can supply different types of information about a single site. Here, the research site on Santa Cruz Island can be seen as an elevation map, a visual spectrum image, and a multispectral water status image.



Ocean fog supplied plants on one side of the ridge with abundant moisture, while drier conditions on the other side resulted in the formation of gullies.



CHI data from before and after the fires is revealing how burn intensity affects vegetation survival and recolonization by plants and animals. Such knowledge about the ecological impacts of fire will only become more important as wildfires increase nationwide.

STOPPING A GULLY IN ITS TRACKS

In California's Channel Islands, postdoctoral fellow **Kerri Johnson** has been applying the CHI toolkit to examine how environmental disturbance can destabilize the very integrity of landscapes.

Johnson's laboratory is the NRS' Santa Cruz Island Reserve on California's largest Channel Island. For 150 years, introduced livestock consumed a considerable amount of the native vegetation. This caused much of the island's soil to be lost, and some areas even developed gullies—gashes in the land cut by water. Some of these gullies have stabilized since the grazers were removed in the 1990s, but others continue to erode.

"Gullies are thought of as a canary in the coal mine, an indication of significant change," Johnson says. As a gully expands and steepens, water and soil sheet off ever faster, leaving less for plants. This destructive cycle can eventually produce badlands,

landscapes unable to absorb water or support vegetation.

"I wanted to figure out how to give these landscapes their best fighting chance to once again support vegetation even during droughts and sequester carbon by building up soil again," Johnson says.

Using the CHI tools, she's been able to pinpoint climate as the main factor controlling gully recovery on the island. First, Johnson used lidar data to map the extent of gullies along a section of the island's mountainous spine. Next, she installed six ClimaVue stations in a line across the ridge, and mapped the area with drones to gauge plant hydration.

Meteorological data revealed that the wind blew fog directly onto the north-facing slope, bathing its plants in extra moisture during driest summer months. The drone images confirmed that these plants were relatively well hydrated year-round. Yet plants on the south-facing slope experienced both a fog shadow and received extra sun, and appeared parched in summer.

Johnson's analyses showed that on the wetter slope, thriving shrubs had stabilized gullies, whereas in the drier area, vegetation has been unable to overcome the history of disturbance enough to stanch gully growth. "We found that specific differences in climate across the ridge are enough that, without intervention, one side will stabilize, and the other side will continue to unravel toward a bedrock badland," Johnson says.

These findings will help the National Park Service prioritize sites for future restoration, says Channel Islands National Park botanist **Cameron Williams**, PhD '17 Integrative Biology. "We'll be able to put our effort and money into places where we're pretty sure it's going to work," he says.

Funding for CHI ends this fall, but its achievements will continue to benefit environmental research. In addition to helping establish the Dendra data portal, CHI has inspired others to adopt remote sensing tools in wildland management. For example, California State Parks plans to use drones to monitor natural and archeological areas in places such as wildfire-damaged Big Basin State Park. On a broader scale, CHI's techniques will help California and the world meet the goal of conserving at least 30 percent of lands and waters by 2030 (see page 12).

"Visualization through remote sensing—and calibration by people on the ground like we're doing through CHI—will teach us where we need to intervene to rescue our biodiversity and protect our ecosystems in the face of climate change," Dawson says. 🌱

Becca Fenwick releases a research drone at the Landels Hill Big Creek Reserve in 2020 to capture images of the impacts of the Dolan Fire on the landscape.



Wendy Baxter (Fenwick), Kerri Johnson (fog, gullies)

The New Conservation

The 30x30 initiative employs an inclusive, collaborative approach to preserving biodiversity and mitigating climate change

BY ANN BRODY GUY

ILLUSTRATION BY DANIELE SIMONELLI

In a December 2020 *New York Times* op-ed, Rausser College wildlife biologists **Justin Brashares** and **Arthur Middleton** hailed then-President-elect Biden's "30x30" environmental initiative as "perhaps the most ambitious commitment to conservation by a U.S. president." They also raised tough questions about how, exactly, to accomplish the goal.

Just a week after his January 2021 inauguration, Biden codified the target—conserving 30 percent of the country's land and water by 2030—as part of his sweeping executive order to fight climate change. The *Conserving and Restoring the America the Beautiful* report followed, establishing key principles for the effort consistent with those California established





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a few months earlier—preserving biodiversity, mitigating climate change, building ecological and economic sustainability, and advancing social equity.

There's a long way to go. To date, the U.S. has conserved only 12 percent of land; at 22 percent, marine areas are further along. California has protected 22 percent of land but only 15 percent of its marine area. Many experts at Rausser College of Natural Resources feel that getting to 30 percent is feasible, but, they say, success depends on both acknowledging conservation's history and providing a clear vision for its future. What does "conserved" mean today? Who is doing the conserving, who benefits, and who pays?

Walling off so-called wildlands is an outdated conservation philosophy; modern strategies recognize that biodiversity isn't bound by fences. Instead, the focus is on connecting large-scale landscapes—a mix of public, private, and tribal ownership—to protect vast ecosystems. Removing people from their land to "protect" it is another unacceptable tactic, for both moral and ecological reasons; the current focus is on collaboration and inclusion.

Such complex, interdisciplinary issues have always been at the heart of Rausser College work, including helping to establish a clear role for science in the country's emergent National Parks System over a century ago. Since then, conservation sci-

ence has come a long way, and by guiding the 30x30 initiative, Rausser researchers and alumni are helping to bring this new vision of conservation to life.

KEEPING LANDSCAPES CONNECTED

Reducing planet-warming carbon dioxide in the atmosphere has always been the focus of climate change mitigation, and natural ecosystems play a key role in sequestering and storing carbon. But as scientists have learned more about the enormous role biodiversity plays in keeping ecosystems healthy and resilient, climate change policies have also prioritized preserving that teeming mix of organisms.

"Losing species destabilizes whole ecological communities," says Brashares, who recently moderated the California Natural Resources Agency (CNRA) land conservation panel, one of five advisory groups guiding the state's 30x30 effort. Unhealthy ecosystems can't deliver the critical services on which society relies—pollination, fresh water, and control of ticks, mosquitoes, and other pests, for example. Biologists have long warned that habitat disruptions lead to stressed-out animal populations, conditions that contribute to animal diseases spilling over to humans, as COVID-19 did.

Brashares's research has demonstrated other complex—and often unexpected—connections between climate change, animal populations, and humans. For example, he found that fishery declines led to a rise in child labor in West Africa, and that global wildlife declines have led to social upheavals like war and crime. His lab has studied the effects on wildlife of drought, war, and even cannabis farming.

This enormous, human-inclusive scale at which ecosystems work makes the old model of conservation—setting aside swaths of land—largely obsolete.

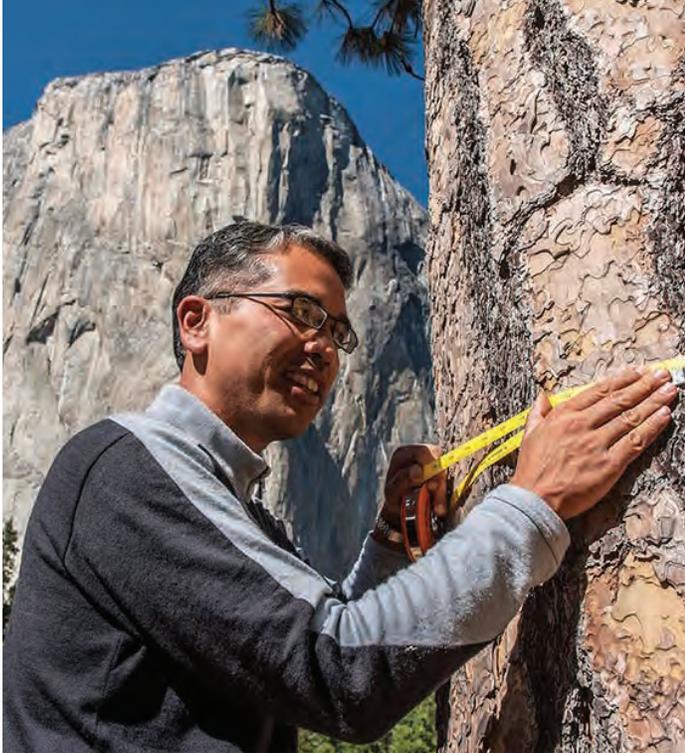
However, existing public lands do offer some low-hanging fruit. Public land covers 28 percent of the U.S., but logging and grazing in National Forests and on Bureau of Land Management land disqualify vast areas from protected status, says associate adjunct professor **Patrick Gonzalez**, PhD '97 Energy and Resources Group. Gonzalez spent a decade as a principal climate change scientist for the National Park Service and recently served as a CNRA working lands panelist.

"That's a great opportunity," he says. "Without buying a single additional parcel of land, the U.S. government can upgrade the conservation status of extensive areas of federal lands and double the protected area of the United States," he says—a process that involves resource-management strategies such as logging limits.

A key 30x30 priority is protecting areas richest in both carbon—to absorb and store climate-warming greenhouse gases—and biodiversity. Gonzalez's research quantifying carbon in for-

Justin Brashares is advising 30x30 efforts at state and federal levels.





Patrick Gonzalez is a lead author of the ecosystems chapter of the Intergovernmental Panel on Climate Change's 2022 report, which will inform global 30x30 policies.

ests can help pinpoint those areas, and his analyses of vegetation shifts are helping to identify refugia, biodiverse areas particularly resilient to climate change. In addition to being on the CNRA climate advisory panel, he is a lead author of the ecosystems chapter of the Intergovernmental Panel on Climate Change's 2022 report, which will inform global 30x30 policies.

While some public lands might be upgraded to protected status, Brashares says, the most biodiverse land is often privately owned, a legacy of European settlers claiming the most productive lands for grazing and agriculture.

"Private lands hold tremendous biodiversity and are a much better return for carbon storage and carbon sequestration per unit area than public lands," he says, explaining that many of our national parks represent land that was unsuitable for farming and generally less biologically productive. That's why conservation easements—legal contracts that compensate large landowners to maintain specific conservation standards over decades-long timeframes—have become a highly effective conservation tool.

While some conservatives call 30x30 a "land grab," others, like many ranchers and hunting associations, are allies.

"Quietly, conservation easements have transformed the ranching world in the U.S.," Brashares says. "Ranch owners are already interested in protect-

Christopher Schell stresses that equity must be at the core of new conservation approaches.

ing their land from housing developments and other habitat conversion, like crop agriculture." From California, Wyoming, and Montana to the Midwest, he says, many are jumping at the chance to get paid for protecting the land and livelihood they've always cared about.

Moreover, such agreements are typically made between landowners and regional or tribal land trusts—nongovernmental stewardship groups. This eliminates the political baggage state or federal transactions carry, Brashares notes. Large landowners often already have relationships with land trusts, so ideally, he says, the government's role will be to use funding to incentivize easements in areas that scientists and other stakeholders deem critical for biodiversity.

EQUITY IS THE BEDROCK

Healthy urban landscapes are another essential part of ecosystem connectivity, says urban ecologist **Christopher Schell**, who joined the Rausser faculty this summer and served on CNRA's equity panel.

In urban environments, particularly in historically disadvantaged communities, ecosystems get disrupted by highways, industrial pollution, and "heat islands"—cemented areas that lack trees and other landscaping, which drives temperatures up and biodiversity down.

Schell's research shows how entrenched racist policies such as housing discrimination and zoning rules are exacerbating the climate crisis. In a recent review published in *Science*, for example, Schell and his colleagues highlighted repeated studies that suggest that highways are a major cause of biodiversity



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loss because they restrict gene flow and dispersal. The “luxury effect”—the wealthier the neighborhood, the more biodiversity is found there—has been well documented, he says, but his review explicitly demonstrates the role systemic racism plays in this relationship.

“That’s why equity has to be the bedrock of conservation,” he says. Limited biodiversity creates localized harms, like increases in pest species, but it also impacts the health of the larger ecosystem, including hindering the movement of wildlife passing through regional landscapes. “We can’t separate ourselves from the systems that we live in,” he says. “Equity in and of itself is an ecological relationship.”

Understanding how racism and racist policies contribute to shaping urban infrastructure can lead to solutions for both wildlife and people, Schell says. For example, tree planting and other landscaping in urban areas can increase bird species, soil health, and microorganism diversity. Schell notes that the solution is not to displace people simply to green the city. This form of green gentrification—when making environmental improvements in the name of “saving the planet” increases property values, driving out lower-income, marginalized residents—is inherently unjust and counterproductive, he says. “If we can figure out how to heal ourselves, we can begin to heal our ecosystems.”

Schell is a biologist, he stresses, not a scholar of urban or African American studies. “But if we ignore these social forces,” he says, “we’re going into the job of solving climate change with only one eye open.”

REINTEGRATING INDIGENOUS PRACTICES

Opening both eyes also means learning from Indigenous practices that have been suppressed and even outlawed over centuries.

“Across the board, conservation has excluded Indigenous people as not having a place in the landscape being conserved,” says **Beth Rose Middleton Manning**, PhD ’08 ESPM, professor of Native American Studies at UC Davis and another member of CNRA’s equity panel. She says not repeating the exclusionary conservation of the past will require building relations with tribes and Native nonprofits and putting Indigenous leaders at the forefront of stewardship activities.

In her book *Upstream: Trust Lands and Power on the Feather River*, Middleton Manning says “the long and ongoing history of cultural and community disruption must inform contemporary conservation measures.”

Recent research and teaching partnerships offer opportunity and “maybe even healing,” she says. She cites co-managed and Indigenous-led stewardship initiatives like North Fork Mono Tribal Chairman Ron Goode’s work, which includes educational partnerships like her collaborative Keepers of the Flame class, to bring back cultural burning, a traditional way Native peoples managed the landscape and optimized ecosystem benefits.



Beth Rose Middleton Manning throws deergrass onto a burning pile as she and students in her “Keepers of the Flame” class at UC Davis take part in a cultural burn.

Such work has raised the water table, reduced woody debris that causes fire danger, and restored fisheries and animal habitat. “It’s inspiring,” she says. “Those ecological gains are intertwined with respecting previously disregarded knowledge and applying it on the landscape.” Cultural burning can take place alongside other strategies such as thinning and prescribed fire, she adds.

Rausser College has numerous similar partnerships. Cooperative Extension specialist **Jennifer Sowerwine**, co-founder of the Karuk-UC Berkeley Collaborative, has collaborated with the Karuk Tribe since 2007 to support their ecological revitalization efforts to reintroduce cultural burns and Indigenous stewardship practices that enhance food security and improve fire resilience. Fire ecologist **Scott Stephens**, with anthropologist **Kent Lightfoot**, is launching a collaborative project with the Amah Mutsun Land Trust.

The Western Klamath Restoration Project is a partnership involving tribes, state and federal agencies, and Rausser faculty, to restore fisheries and improve land stewardship. “It’s a great example of different landowners and land managers working beyond individual property boundaries to protect an economically, culturally, and environmentally critical watershed,” Brashares says. “These are exactly the goals of 30x30.”

“IT’S THE JOURNEY”

Gonzalez points out that community-based conservation isn’t new—the concept has been around since the 1980s or earlier. But operationalizing that approach at the worldwide scale is new. He says inclusivity can contribute to the permanence of the effort, giving more people a stake in its success.

Permanence is an existential challenge. In the U.S. and California, 30x30 is governed by executive orders, rules that can change with administrations. International agreements are nonbinding.

Many Rausser experts agree that addressing such non-science challenges will be what ultimately defines the initiative’s success, not hitting numerical targets. If the effort aligns peo-

Deep Expertise

Numerous Rausser faculty and alumni serve on scientific panels advising the California Natural Resources Agency on the state's 30x30 initiative. "But these panels are just one small manifestation of our impact," says Energy and Resources Group associate professor **Lara Kueppers**, PhD '03 ESPM, who led the climate advisory panel. "Rausser College has deep expertise and already has contributed extensively to the way many people within government think about 30x30's opportunities and challenges," she said.

In addition to Kueppers, who studies ecological responses to climate change, these Rausser experts are directly engaged with projects supporting the initiative. Countless other faculty and alumni provide indirect support and expertise.

David Ackerly, dean of Rausser College, studies the impacts of climate change on California biodiversity and chairs the California Biodiversity Network's steering committee, a coalition of scientific and research institutions advising the state's 30x30 initiative by reporting on relevant research and research gaps.

Justin Brashares, See "The New Conservation," left.

J. Keith Gilles, emeritus forestry economics professor and former Rausser College dean, was a CNRA climate advisory panelist. Also the chair of the California Board of Forestry and Fire Protection, he recommends shifting from reactive fire suppression to a diverse mix of proactive vegetation-management methods, and encourages sustainable and climate-resilient practices in working forests.

Patrick Gonzalez, PhD '97 Energy and Resources Group, See "The New Conservation," left. Gonzalez recently joined the White House Office of Science and Technology Policy (OSTP) as assistant director for climate and biodiversity (see page 5). The interview for this story was conducted before he took this role, and his comments here do not reflect the views of or his official work for OSTP.

Ted Grantham, PhD '10 ESPM, Cooperative Extension specialist and water and climate adjunct professor, integrates freshwater ecology and hydrology to inform sustainable water management in California. For a new Resources Legacy Fund-supported project, his team will inform 30x30 on research and best practices on conserving rivers, streams, and other landscape-based freshwater ecosystems.

Jonathan B. Jarvis, former executive director of the Rausser-based Institute for Parks, People, and Biodiversity and former director of the National Park Service, is a member of the steering committee of California Biodiversity Network and is co-author of *The Future of Conservation in America: A Chart for Rough Water*.

Adina Merenlender, Cooperative Extension specialist and conservation biology adjunct professor, is a member of the California Biodiversity Network steering committee. Co-author of *Climate Stewardship: Taking Collective Action to Protect California*, she launched the Large Landscape and Stewardship roundtable to work with the network's partners on climate-wise management essential for biodiversity conservation across protected areas and working lands.

Arthur Middleton, wildlife ecology professor, studies the importance of connected landscapes to healthy wildlife populations and ecosystems. He is a science advisor to the Rocky Mountain Elk Foundation, one of 40 hunting and fishing sport organizations that support 30x30's habitat-conservation efforts.

Christopher Schell, See "The New Conservation," left.

ple through panels, funding, and new partnerships with tribes and historically disenfranchised communities, and advances concepts like landscape connectivity, "those would be amazing outcomes," Brashares says. "It's more of the journey than the destination. It's a rallying cry around a new form of conservation and a new commitment to conservation."

Globally, the 30x30 rallying cry is led by a major campaign—fundraising, storytelling, lobbying—by the Washington D.C.-based Wyss Foundation, in partnership with the National Geographic Society (Brashares advises the Society as a member of its Committee on Research and Exploration). So far, the push is working. By October 2020, 27 European countries had committed to the goal, and at the 2021 G7 summit this past May,

member nations pledged support. Conservation organizations and hunting and fishing groups have backed the effort. At the 15th World Congress on Biodiversity in Kunming, China, this October, more than 100 countries are expected to sign on.

Despite the global buy-in and ever-advancing science, the political and social hurdles make many Rausser scientists view 30x30 with the cautious optimism expressed in the Brashares-Middleton op-ed—achievable, but ambitious.

"The reason I say it's ambitious is not an ecological or nature issue—it's a people issue," Schell says. "How do you convince folks that doing something good for others is good for them too? This is a people issue first. We already have the scientific tools to figure out the rest." **BI**

Q&A

Innovation on the Menu

INTERVIEW BY JACOB SHEA

Industrial-scale meat production has widespread environmental impact—from greenhouse gas emissions to water pollution and deforestation. In recent years, the market for plant-based meat alternatives has boomed, with innovative products that boast a lighter environmental footprint and

greater input efficiency per calorie. In this issue's Q&A, *Breakthroughs* spoke with three former students who are changing the meaning of *meat*.

Breakthroughs: How did you get into food innovation?

Deng: I grew up in an agricultural town in China, where I saw environmental problems like drought and disease destroy livelihoods. I initially studied plant pathology, and at Berkeley I researched plant microbiomes. I kept thinking about applications in biotechnology, crop performance, agricultural improvement, and food security.

My co-founder, **Jessica Schwabach**, BA '21 Molecular and Cell Biology: Genetics, and I met in the Alt: Meat Challenge Lab in the College of Engineering. During the course, students from all academic backgrounds formed start-up teams to create technology-backed solutions to address challenges posed by industry partners. Jessica and I were assigned to a team to tackle the dryness problem in most plant-based products. Our team won

Sundial Foods founders Siwen Deng (left) and Jessica Schwabach test cooking a meatless chicken drumstick.

the class and campus-wide competitions and caught the attention of food companies and venture capitalists. **Ricardo San Martin**, research director at UC Berkeley's Alt: Meat Lab, offered us valuable guidance and support, and my dissertation committee members—including plant and microbial biology professors **Devin Coleman-Derr**, **Sarah Hake**, **Frank Harmon**, and **Mary Firestone**—encouraged my pursuit of research in industry and helped me finish my PhD



Siwen Deng
PhD '19 Plant Biology
Co-Founder and Chief Technology Officer at Sundial Foods

In texture and cooking, Sundial Foods' chickenless wings simulate the experience of real chicken. The company has developed a new technology for creating plant-based whole cuts of meat using simple, natural ingredients. Last year, Sundial sold their vegan chicken drumsticks in over 40 grocery stores in Switzerland as a product test run.



early to start our company.

Our participation in accelerator and R&D programs through Nestlé and IndieBio has been crucial as we continue to develop our products, run consumer tests, and scale up. We plan to launch our plant-based chicken wings in California restaurants next year.

Can you describe your role?

I lead the research and development team. Early on that meant trying to find a novel way to structure plant proteins and materials to mimic animal meat. At Sundial, we're doing whole cuts of meat, which is very complex because of the varied consistency and texture—from skin and meat to the bone. Our current focus involves ingredient sourcing, evaluating plant candidates, and developing manufacturing processes.

What's your primary motivation in this work?

We care deeply about using science to help the environment and society. It's exciting to develop a real product that people will eat and enjoy, all while helping to protect the planet and animal welfare. Start-up life can be crazy, but we have a synergistic and passionate team.

Most exciting thing about working in this industry?

It's exciting to join the movement to change the global food system and help benefit the environment. As we are developing innovative products, many of the core questions haven't been answered yet. You may plan for a complex course of experiments to test some ideas, then a single research discovery lets you skip many intermediate steps. Such uncertainty can be scary, but it's also exhilarating.

Biggest industry challenges?

Scaling up. Conventional meat is artificially cheap, not reflecting its true environmental and societal costs. As a start-up, we necessarily create financial deficits by investing in a facility and hiring people, putting a lot in before anything comes out. The promise we make to our investors is that we will compete with animal meat. I'm confident we will succeed, but it presents an initial challenge.

What advances do you anticipate for alternative meats?

Plant-based alternatives have existed for years, but now they actually try to mimic meat. With the next generation of products, you'll see more meat-like texture and flavor, without chemicals or binding agents, using clean-label ingredients and more whole foods. The next big advances, in addition to texture and taste, will be nutritional. We're also curious how cell-based meat—grown from animal cells in a lab—could affect the market for both plant-based and conventional meats. All these developments demonstrate that the meat-eating experience doesn't require eating animals.



Michelle Huang BS '15 Nutritional Science: Dietetics

*Senior Manager, Strategic
Partnerships at Impossible Foods*

Among the first to use science to create a product that closely mimics beef, Impossible Foods introduced its iconic Impossible™ Burger in 2016 in a handful of restaurants in New York and California. Since then, the company has rapidly expanded its operations globally. It now offers Impossible Burger and Impossible Sausage in over 20,000 grocery stores and 30,000 restaurants and fast food chains across North America and Asia.



Breakthroughs: How did you get into food innovation?

Huang: I'm originally from Taiwan, where there is a rich food-centric culture, so I grew up with food at the forefront of everyday life. At Berkeley, I studied dietetics because I wanted to understand the relationship between humans and food on a deeper level—from health to economics and environmental sustainability. Many courses sparked my interest in food systems and innovation—in particular, a science of cooking course in the Department of Nutritional Sciences

and Toxicology (NST) with **Kristen Rasmussen**, where we developed recipes and experimented with cooking methods, a course with Michael Pollan, and another involving field trips to small-scale, aquaponic farms.

After college, I worked as a clinical study coordinator at the UCSF Children's Hospital, where NST adjunct professor **Ron Krauss** led research into the connections between cardiovascular disease and diet. Later, I discovered Impossible Foods. I tried the earliest iterations of the Impossible Burger in 2016 and saw a huge opportunity in the company's mission.

Can you describe your role?

My team works across company departments to build relationships with external partners that will help scale our operations. By working with mission-aligned organizations,

Transforming your plate

Many of our alumni go on to join cutting-edge alternative food companies. Here's a short selection of current and former students reinventing how we eat:

Rachel Li (PhD '18 Plant Biology) and **Nick Harris** (PhD '19 Microbiology) co-founded Berkeley Yeast, which develops yeast strains for beer and wine production. Their yeast can impart desirable flavors and aromas, remove off-flavors, and make the fermentation process more efficient.

Jeremy Roop (PhD '16 Microbiology) works in science and strategy and **Adia Tajima** (BS '20 Molecular and Environmental Biology) is a research associate.

Romi Takara (BS '23 Nutrition Science) is an intern for Sundial Foods.

Iris Wu (BS '22 Molecular Environmental Biology) partnered with a Brazilian company developing N.Ovo, a plant-based vegan egg.

Marley Pirochta (BS '21 Conservation and Resource Studies) is a marketing coordinator for Unicorn Meat, a company using probiotics to enhance natural flavors and texture in their plant-based products.

Kate Thi (BS '08 Environmental Science) is a senior research associate at Upside Foods, a company that develops cell-cultured meat. **Audrey Taylor** (BS '14 Conservation and Resource Studies) is a senior operations associate.

Impossible can further develop our technology, source better ingredients, and promote sustainable practices across the industry. I get excited about finding partners who are committed to our mission and establishing mutually beneficial relationships.

What's your primary motivation in this work?

I really do believe in the company mission of transforming our global food system. The current animal-based system can't scale to meet growing global demand for nutritious meat. At the same time, we can't rely on consumers to voluntarily choose to eat less meat in the form of beans or tofu. Most people won't compromise on their favorite foods and flavors; we need to find a sustainable way to offer them the meat they love and crave.

This is why Impossible Foods' plant-based meat is a powerful tool. We can mitigate climate change impacts and biodiversity loss by offering consumers a plant-based product as delicious, nutritious, affordable, and craveable as conventional animal meat.

Most exciting thing about working in this industry?

Seeing the direct impact of my work reflected in the scale-up and pace of growth at Impossible Foods. In 2017, our products were sold in a handful of restaurants across the U.S., and now they are in tens of thousands of stores across multiple international markets. Impossible products went from a somewhat niche offering in coastal cities to a mainstream, affordable menu item at chains like Starbucks and Burger King. Also, consumer surveys indicate that many of our sales are at the direct expense of meat from animals—that's a measurable impact on environmental resources.

Biggest industry challenges?

One huge opportunity for growth is in raising consumer awareness about how food production and consumption impacts the environment. Currently, only about 30 percent of American consumers know how strongly their diet choices affect their individual environmental footprint. Building education around this connection is essential to achieving our mission.

It's also important to scale our operations so that we have more products available in more parts of the world, and at an accessible price point—and eventually, even more affordable than meat made from animals.

What advances do you anticipate for alternative meats?

We expect to see huge growth in consumer adoption driven by a number of advancements in plant-based meat, including broader product portfolios as companies offer a wider variety of products at a wider variety of outlets; continuous improvements on taste and nutrition; and lower prices driven by increased demand and associated manufacturing efficiencies.





Kimberlie Le
Co-Founder and CEO of Prime Roots



Since its founding in 2017, Prime Roots has developed numerous plant-based meatless products including bacon, seafood, and ready-to-eat meals like lobster ravioli and sausage paella. Their vegan comfort foods use koji, a Japanese “super-protein” fungi that mimics the flavor and texture of meat.

Breakthroughs: How did you get into food innovation?

Le: I’ve always been fascinated by the taste and preparation of food. My mom is a professional chef, so I learned at home about supply chains and how food comes to tables. My interest in alternative meat specifically began at the UC Berkeley Alt: Meat Lab and classes on agriculture and the environment. As I learned how much soy and corn goes into raising animals, the entire system struck me as incredi-

bly inefficient, so I started trying meat alternatives and began to think about making them better.

At the Alt: Meat Lab, I really plugged into entrepreneurship across campus and began formulating our start-up. We had important support and a network from both professors and industry, and, later, we were accepted for an incubator and accelerator program.

Can you describe your role?

We are a small but growing team, so everyone wears many hats. I spend a lot of time meeting with various teams and attending investor meetings. Recently, I have been meeting with tastemakers and chefs to perfect our products. When we started, I did more product development and food science, but my role shifts as the business grows.

What’s your primary motivation in this work?

Food is inherently cross-functional. It touches everything from human relationships and cultural norms to social issues. Getting people to understand food’s origins can help improve the wellness of both people and the planet.

Both my co-founder Josh and I are meat eaters. Our goal is not to eliminate meat entirely. For the large percentage of the population that eats meat, we want to make it easier to swap one meal per day or week—or even a single component of one meal—to plant-based. Even slight reductions in demand make the entire system more efficient.

Most exciting thing about working in this industry?

It can be hard to change minds, hearts, and stomachs, but we hope people can embrace becoming flexitarian to reduce conventional meat consumption. I think business and entrepreneurship can be an effective path for enacting societal change, if the people in the industry have the right intent.

With koji, we are able to replicate virtually any type of meat, even seafood. We currently don’t see many good seafood alternatives and hope to emerge as a leader in this area!

Biggest industry challenges?

In the U.S., the conventional meat industry has lobbyists and big money. As the little guy, our company going against the grain comes at a monetary cost. Plant-based meat doesn’t have government subsidies, and the factory farming industry has an artificially low price.

What advances do you anticipate for alternative meats?

Today, people call animal meat *conventional meat*, and plant-based is the alternative. I envision a future where plant-based is conventional. Our company is thinking about how to reduce meat consumption globally, not simply how to make a better burger. I believe it will happen eventually, but not without us making strides now.



Called to Serve the Latinx Community

**ROSALÍA MENDOZA,
BS/BA 1997 ENTOMOLOGY AND INTEGRATIVE BIOLOGY**

BY KRISTIN BAIRD RATTINI

When Dr. Rosalía Mendoza was offered a job at the Alameda Alliance for Health this past spring, it was an opportunity she couldn't turn down. As Medical Director of Utilization Management, she's helping the managed Medicaid health plan meet the medical challenges of the most vulnerable within the large, economically and culturally diverse population of Alameda County.

This latest chapter in Mendoza's esteemed medical career continues a common thread that's woven throughout both her paid positions and extensive pro bono work: a heartfelt commitment to serve the marginalized in society, especially among the Latinx community. It's a life calling that Mendoza found at age 14 and further refined throughout her education and career.

LEADERS AND MENTORS

In the agricultural Coachella Valley community where Mendoza grew up in the 1990s, opportunities for bright, science-minded students seemed as scarce as the rain. The summer before starting high school, she attended a Future Leaders of America retreat. A speaker presented the Latinx youth in attendance with a vision of the near future, in which the Latinx population in the state would grow substantially.

“He pointed all around the room and said, ‘I need all of you to be the future leaders of our community. We need lawyers, teachers, politicians, scientists, and doctors,’” she recalls. “I suddenly had this very crystallized purpose. I was being charged to serve my community.”

A shadowing opportunity with a mosquito abatement program in her area sparked her interest in entomology and her awareness of the exceptional entomology program at UC Berkeley. Mendoza saw the degree as a link to either medicine or agricultural science, but she had no contacts in those professions to offer her guidance.

“The mentorship and one-on-one experiences I had as an undergraduate in the smaller, more intimate College of Natural Resources was so important in helping me set my career path,” she says. She appreciated the sincere, personable support of her advisor, **Stephen Welter**, especially as she added a second major in integrative biology. A peer-health-educator internship under **Abby Rincón**, now Chief of Diversity, Equity and Inclusion at the School of Public Health, cemented her focus on public health and community-based health care.

Tomás Aragón—assistant adjunct professor of epidemiology and now state public health officer and director for the California Department of Public Health—counseled her on course selection, guided her Medical College Admission Test (MCAT) preparation, and offered valuable insight during her medical school application and selection process. “He had the understanding of someone who had lived in my shoes, as a Latinx person navigating higher education, public health, and healthcare,” she says.

ATTENTION ON ASSISTANCE

Mendoza went on to earn a Master of Public Health from Harvard and her MD in family medicine from the University of Washington, and then she completed her residency and fellowships at University of California, San Francisco (UCSF), through the Department of Family and Community Medicine. Through it all, she has coupled her medical practice with extensive volunteer medical service to the Latinx community. “I transitioned from primary care to urgent care to have more

flexibility in my schedule so that I could channel my energies into my volunteer activities,” she says.

Since 2007, Mendoza has spent innumerable Saturdays volunteering at Clínica Martín-Baró, a free clinic established by students from San Francisco State University (SFSU) and the UCSF School of Medicine that serves Latinx day laborers in San Francisco’s Mission District. Originally one of the clinic’s co-medical directors, she transitioned in 2010 to a preceptor

position, providing clinical teaching and mentorship as she evaluates patients side by side with both UCSF doctors-in-training and SFSU students who volunteer as translators and patient advocates.

From 2002 to 2010, she administered health screenings to newly arrived immigrants in need of health care at what is now Zuckerberg San Francisco General Hospital’s Newcomers Health Program. She returned to similar work again in 2017, when changes in U.S. immigration policies caused immigrant detainee numbers to surge. Mendoza was among the experienced practitioners who stepped up to help overwhelmed behavioral health specialists provide urgent mental health screenings and diagnoses.

“It was incredibly eye-opening to serve people dealing with complex challenges, not only related to health, but also trauma, legal status, and incarceration,” she says. “Many were under acute stress, with a significant impact on their well-being.”

PIVOTING DURING THE PANDEMIC

In her day job, during her three-year tenure as a physician advisor and medical director of utilization management at Dignity Health St. Mary’s Medical Center and Stanford Health Care, Mendoza dealt with unprecedented stresses and challenges as the COVID-19 pandemic erupted.

“We were faced with one of the first cases of COVID-19 in the city of San Francisco,” she says. “We quickly mobilized into a multidisciplinary command center, to address not only issues with our patients and staff safety but also to coordinate with our sister hospitals in the county that were handling cruise ship arrivals and outbreaks at San Quentin prison.”

As she settles into her new role at the Alameda Alliance, Mendoza is still working urgent care shifts and spending some of her Saturdays at Clínica Martín-Baró, which moved to a hybrid care model during the pandemic. The clinic continues to be an invaluable resource for the city’s marginalized residents and remains close to her heart. “Giving back to some of the most vulnerable patients in San Francisco, who can’t easily navigate the formal medical system and city safety net—especially throughout the pandemic—is the most rewarding aspect of volunteering at the clinic,” she says.



Through her work and volunteering with organizations like Clínica Martín-Baró, Dr. Rosalía Mendoza helps vulnerable populations in the Bay Area.



Grace Kase and Harry Tsujimoto in 1993.

True Generosity

HARRY TSUJIMOTO AND GRACE KASE ESTABLISH LASTING LEGACIES THROUGH ENDOWMENT GIFTS

BY JACOB SHEA

Greatly admired by his colleagues, **Harry Tsujimoto** was known for his gentlemanly demeanor and keen mind. Over three decades as the lab manager in former professor **Daniel Arnon's** lab, Tsujimoto trained countless researchers who went on to esteemed scientific careers. As Arnon's right hand, he advanced groundbreaking research in plant mineral nutrition and photosynthesis.

In their philanthropy, Tsujimoto and his wife Grace Kase have given generously to Rausser College of Natural Resources. Through their lifetime and through their estate, the couple has donated nearly \$8 million since 2011 to fund core programs in the department of Plant and Microbial Biology (PMB), establishing a faculty Chancellor's STEM chair, a graduate fellowship, and two lectureship funds. These programs are administered by Tsujimoto's former colleagues in PMB, Professor **Tasios Melis** and Professor Emeritus **Bob Buchanan**.

The couple exemplified the self-made American success story. Tsujimoto was born to Japanese immigrant farmers in Southern California, the youngest of three sons. His family farmed dairy and then vegetables before they were interned for two-and-a-half years during World War II. After they were released, his eldest brother Joshua resettled the family in New York, where both Joshua and Harry obtained bachelor's degrees at Cornell University. Afterwards, Harry came to UC Berkeley for his MS in plant nutrition in the Arnon lab.

Tsujimoto met Kase at a YMCA dance in San Francisco. An ambitious entrepreneur, Kase earned her real estate license at a time when few women—let alone Asian American women—were accepted in the industry. They married and lived frugally, building their business from scratch by buying and renovating apartments. After long days in the lab, Tsujimoto would come home and help Kase with remodeling projects, teaching himself proficiency in carpentry, wiring, plumbing, and tiling.

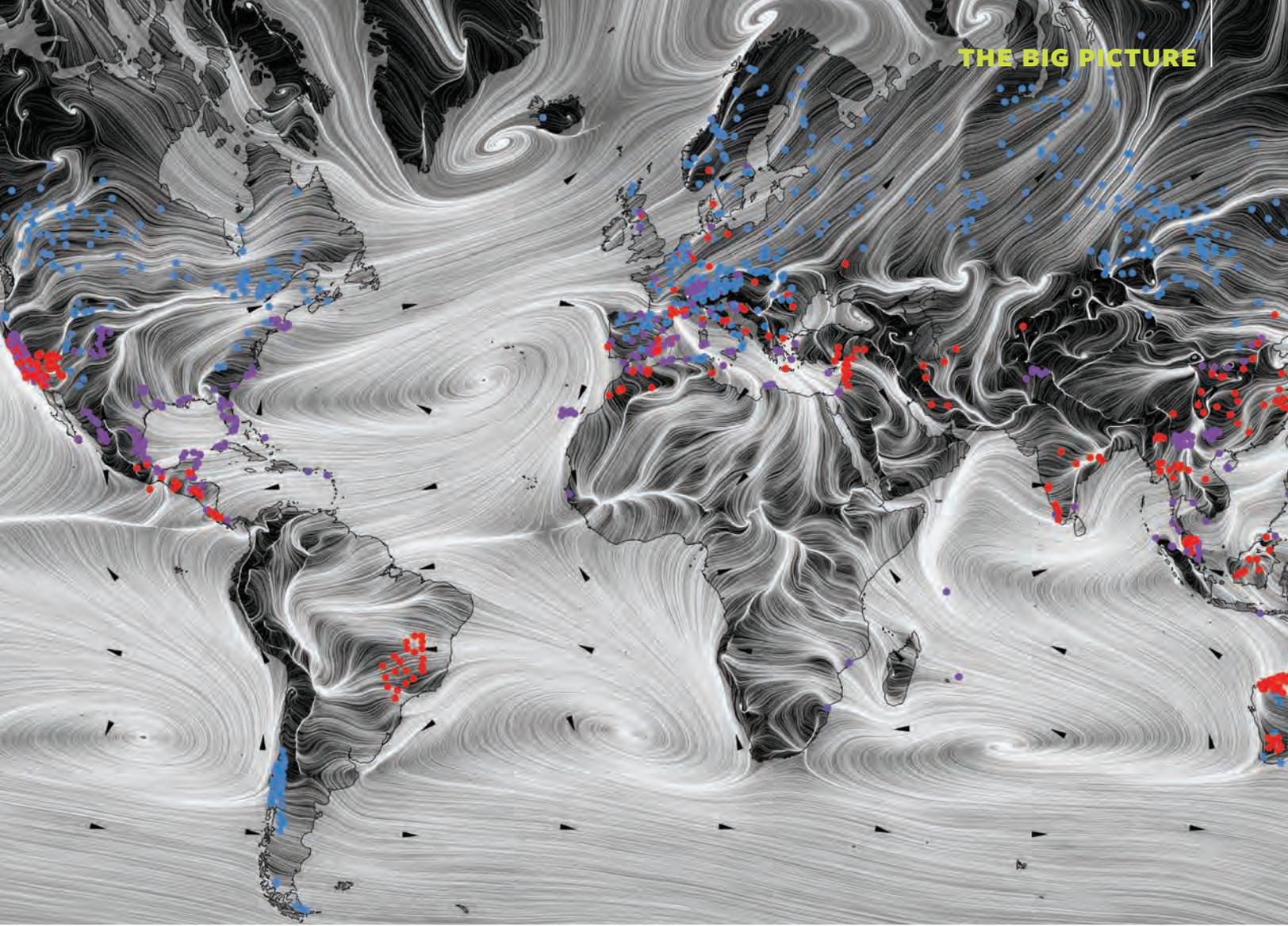
Over the years, Tsujimoto and Kase created a thriving business, allowing them to generously support Berkeley, Cornell, and other institutions. The couple was deeply dedicated to the value of public education and the importance of supporting science. Like numerous staff and faculty who give back to Rausser College, Tsujimoto felt a strong connection to the community and pride in its intellectual achievements.

After Tsujimoto retired, he remained active in planning the two endowed lecture series, which he would often attend, preferring to remain unannounced. Tsujimoto and Kase also gave to Japanese American organizations and veterans groups, and Tsujimoto spent thousands of hours volunteering at a veterans hospital in San Francisco. As animal lovers, they supported service dog organizations and shelters in the Bay Area. Tsujimoto and Kase passed away in 2012 and 2019, respectively.

"Grace and Harry's story exemplifies achieving the American dream in one generation," says their nephew, Mark Tsujimoto. "They understood that making the most of the opportunities in this country requires hard work and the support of others, and they believed that true success is measured in the good one can accomplish for others."

By creating endowed funds, the couple's legacy upholds a critical need for flexible, long-term support of the College. Their latest gift created *The Grace Kase and Harry Tsujimoto Chancellor's STEM Chair*, currently held by Professor Melis. This extraordinary gift also triggered both campus and donor matching funds that enabled Berkeley to create a new faculty position in plant synthetic biology. **Patrick Shih**, PhD '13 Plant Biology, filled the position as an incoming assistant professor in PMB in June.

"It seemed to me that Harry wanted to give back something to the institution that provided him with education and a career," said Melis. "He never wanted to aggrandize himself or be the center of attention—it was true generosity."



Genes with the Wind

IMAGE BY MATTHEW KLING

Forests' ability to adapt to climate change may depend, in part, on the eddies and swirls of global wind currents. New research shows how wind currents shape the genetic diversity of entire forests, offering insight into how well different tree populations might adapt to a changing climate. In a study published in the *Proceedings of the National Academy of Sciences*, Dean **David Ackerly** and integrative biology post-doctoral researcher Matthew Kling compared wind patterns with genetic data from forests around the world. They found significant correlations between wind speed and direction and forests' genetic diversity, and for the first time, demonstrated how wind influences forest genetic composition and diversity at a landscape scale.

In this image, the black arrows and white paths represent global prevailing wind directions, and the colored dots represent the locations of the tree populations where the researchers analyzed genetic data. "As the world warms, many plants and animals will need to move to places with suitable habitat to survive," said Ackerly. "Wind dispersal has a particularly interesting connection to climate change, because wind can either push the genes or organisms toward more suitable habitat, or in the opposite direction." — Kara Manke

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The California Heartbeat Initiative uses drones and miniature climate stations in new ways to take the pulse of California ecosystems. Story on page 8.

