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Outlook

COOL *and* COLLECTED

UC Davis researchers are a step ahead of climate change

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THIS ISSUE

COVER STORY:

Climate change and UC Davis

Our scientists address the challenges **4**

Saving native species **8**

Livestock researcher leads UN committee **11**

Cracking the case on walnut behavior **12**

Oceanographer John Largier (right) chaired a scientific advisory group that prepared a report on how climate change might affect two valuable marine sanctuaries off the Northern California coast.

See story, page 7

JENNIFER SAUTER/UC DAVIS

ALUMNI SPOTLIGHT

Leading the beef industry's largest sustainability project **15**

ALSO IN THIS ISSUE:

DEAN'S MESSAGE	3
STUDENTS & STUDIES	14
MAKING A DIFFERENCE	16-17
NEW FACULTY	18-19

COVER: UC Davis watershed scientists (from left) Ryan Peek, Joshua Viers, and Sarah Yarnell study the Sierra Nevada to generate new information for water users and natural resource managers. Story on page 6.

PHOTO BY JOHN STUMBOS/UC DAVIS

FEATURED AES FACULTY

The Agricultural Experiment Station funds research that helps solve specific problems of importance to the people of California. UC Davis faculty featured in this issue of *CA&ES Outlook* magazine who conduct research with AES funding include:

Cort Anastasio
Arnold Bloom
Patrick Brown
Ted DeJong
Mary Delany
Graham Fogg
William Horwath
Bryan Jenkins
Douglas Kelt
Mark Schwartz
Daniel Sperling

SAFEGUARDING OUR FUTURE

We're taking on the challenges presented by climate change

CLIMATE CHANGE IS ONE OF THE MOST-discussed issues of our day. The consensus among scientists is that increasing amounts of atmospheric gases generated by a suite of human activities are impacting our world through the "greenhouse effect."

Scientists in our college are conducting research on what changes may be in store for California, and how to reduce greenhouse gases and their impact on the environment while improving our vibrant agricultural and food systems. Mitigation of greenhouse gas emissions and adaptation to a changing environment will be no small task, yet they are vital to California's future. Our faculty also bring science to bear on policy development in response to climate change. This issue of *CA&ES Outlook* highlights examples of our work in these important arenas.

Climate models predict that a warming planet will lead to a shrinking snowpack in California. The Sierra Nevada is a significant source of the state's water supply, so a better understanding of our water resources is crucial and is the work of a research team led by ecologist Josh Viers.

Sea levels are predicted to continue rising this century, affecting coastal areas globally. Professor John Largier, an oceanographer based at the Bodega Marine Laboratory, is studying regional impacts of climate change such as shifts in coastal upwelling.

Climate change will affect California's rich biodiversity. Some species may need special management or even relocation to survive, and increased risk of catastrophic wildfires is a big concern. Professor Mark Schwartz is analyzing threats to native species and helping resource managers develop proactive strategies.

Climate change will impact our agricultural and food systems, which we are actively addressing with our industry partners. Professor Will Horwath and soil-science colleagues have identified farming practices that improve fertilizer use efficiency and reduce emissions of the greenhouse gas nitrous oxide. Research by doctoral student Katherine Pope shows how climate change is altering the behavior of walnut trees in California.

In the public policy area, Professor Dan Sperling helped develop a low-carbon fuel standard for California and is now helping design a national low-carbon fuel standard. Professor Frank Mitloehner is chair of a U.N. committee to assess environmental impacts of the livestock industry, and Professor Bryan Jenkins, director of the UC Davis Energy Institute, contributes to energy sustainability through work on renewable energy generation. And a new doctoral training program, led by Professor Graham Fogg, is preparing the next generation of science and policy leaders to take on climate change challenges.

JOHN STUMBOS/UC DAVIS

Atmospheric science professor Cort Anastasio discusses climate change with Dean Mary Delany. An expert in snow chemistry who has conducted research on the Greenland ice sheet, he has given many presentations and led classroom discussions about what scientists know about climate change.

Read on to learn more about how the College of Agricultural and Environmental Sciences at UC Davis will continue to produce sound science and strong leadership to help California adapt and thrive in a warmer world.

MARY DELANY, INTERIM DEAN
COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Note: Mary Delany, a professor and avian geneticist in the Department of Animal Science, is interim dean of the College of Agricultural and Environmental Sciences. Delany previously served as an associate dean in the college and as chair of the animal science department. She holds the John and Joan Fiddyment Endowed Chair in Agriculture.

Change in the air

Earth's climate depends on the balance of energy entering and leaving our atmosphere. One component of our climate system is the "greenhouse effect," where atmospheric gases trap energy emitted from the earth. This effect causes our planet to be about 60 degrees Fahrenheit warmer than it would be otherwise.

"There's been a natural greenhouse effect for billions of years and it is beneficial," says Cort Anastasio, an atmospheric science professor in the UC Davis Department of Land, Air and Water Resources. "The problem is that now humans are emitting enormous quantities of greenhouse gases into the atmosphere, trapping more and more of the energy that would otherwise escape from the earth."

Scientists know from Antarctic and Arctic ice cores that over the past 800,000 years atmospheric concentrations of three major greenhouse gases—carbon dioxide, methane, and nitrous oxide—have remained relatively constant, rising and falling with prehistoric temperature changes. However, concentrations of these and other greenhouse gases have jumped dramatically since the industrial revolution, especially in the last 50 years.

Human activity is responsible for most of this increase. As shown in the figure on page 6, the main human sources of greenhouse gases in California include transportation, electricity generation, and industry, with smaller contributions from agriculture and forestry, residential emissions, and other sources.

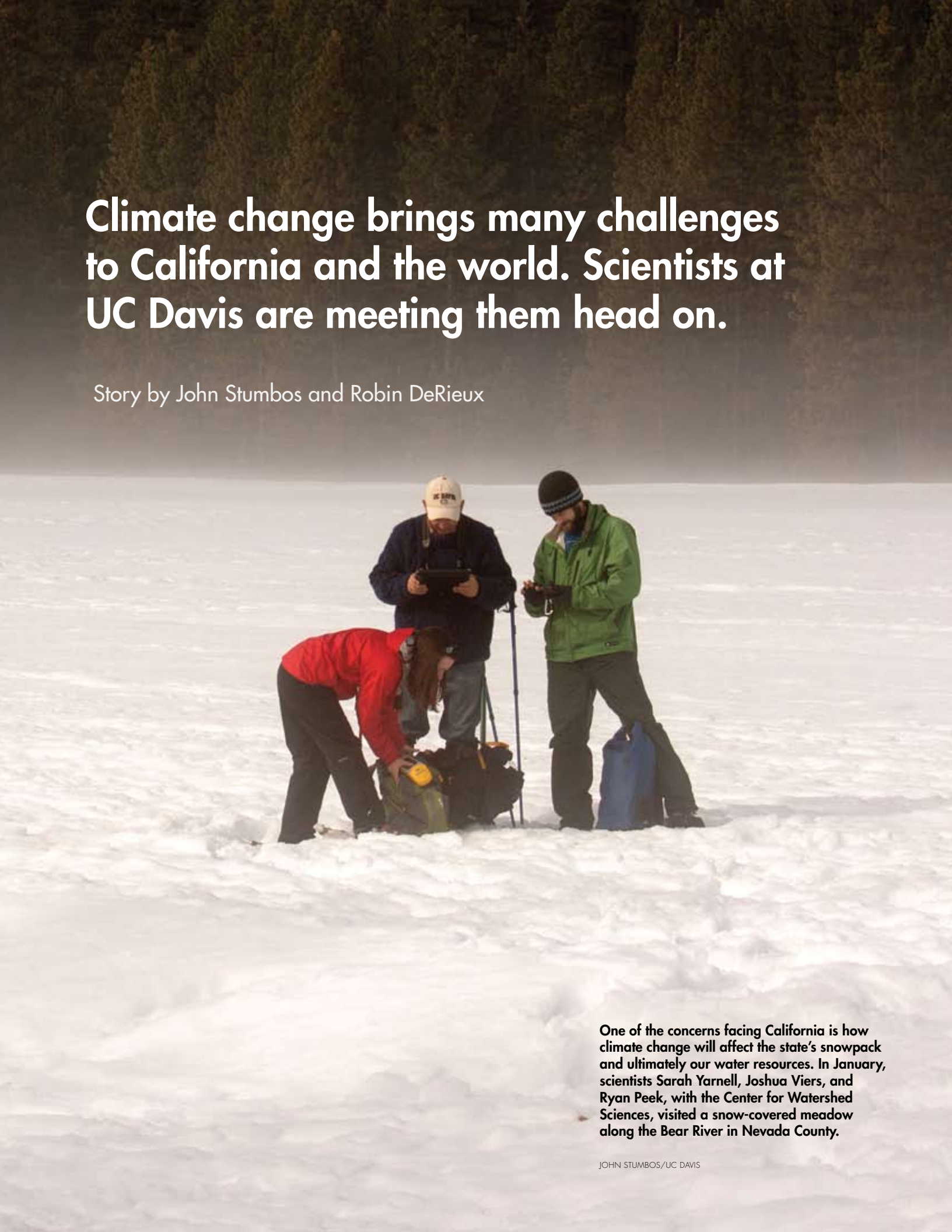
Globally, the picture is somewhat different, with a much smaller percentage from transportation and larger percentages from deforestation and agriculture. These emissions increase levels of greenhouse gases, leading to more energy trapped in the atmosphere and the earth and intensifying the greenhouse effect. One result is a rise in the earth's temperature—approximately 1.5 degrees Fahrenheit in the last 100 years. Climate scientists estimate that by the end of this century, average global temperatures could rise another three to seven degrees or more.

This warming of our planet will have major consequences for natural systems and for humans, including more extreme weather, the loss of plant and animal species, sea level rise, and coastal flooding. While a specific weather event may or may not be linked to a warming of the earth, the recent pattern of more extreme weather—droughts, frequent and intense wildfires, and more powerful storms—is consistent with what scientists expect from climate change.

A changing climate poses tremendous challenges for California's biodiversity, water resources, and agricultural systems. UC Davis scientists are working hard to improve our understanding of climate change and its impacts, to reduce emissions of greenhouse gases, and to lay the groundwork for how we'll adapt to these changes in California and beyond.

Climate change brings many challenges to California and the world. Scientists at UC Davis are meeting them head on.

Story by John Stumbos and Robin DeRieux



One of the concerns facing California is how climate change will affect the state's snowpack and ultimately our water resources. In January, scientists Sarah Yarnell, Joshua Viers, and Ryan Peek, with the Center for Watershed Sciences, visited a snow-covered meadow along the Bear River in Nevada County.

JOHN STUMBOS/UC DAVIS

ANNA FRYJOFF-HUNG/UC DAVIS

In July 2012, undergraduate Robin Shin delineates a stream in Sequoia National Forest. UC Davis scientists are mapping meadows in 10 national forests.

The water resources of the Sierra Nevada

The Sierra Nevada, one of the most important sources of California's water, is the focus of an interdisciplinary team of scientists led by Joshua Viers, a research ecologist in the Department of Environmental Science and Policy.

Viers is also an associate director of the UC Davis Center for Watershed Sciences, where the Sierra Nevada Strategies Group meets to chart out field studies, modeling efforts, and database development for the benefit of California water users and natural resource managers. Their work covers far-ranging topics such as rate of spring snowmelt, status of mountain meadows, and water availability for hydroelectric generation—all central to better water resource management under hydroclimatic change.

"The natural flow regime is a big part of our research," Viers says. "We characterize the flow of water through time and space—magnitude, timing, frequency, duration, and rate of change. Those elements give us a way to look at the physical and biological processes in river systems, and we can use those as the basis for guiding future management actions."

To meet future domestic, agricultural, and environmental needs, water resource managers may be dealing with a great deal of uncertainty and more very wet years and very dry years. "Our models project that the northern Sierra Nevada will see some of the greatest change, whereas the high elevations of the southern Sierra Nevada may be more resilient," he said. "There are very few policies in place to address how individual watersheds may need to adapt to changing hydroclimatic conditions."

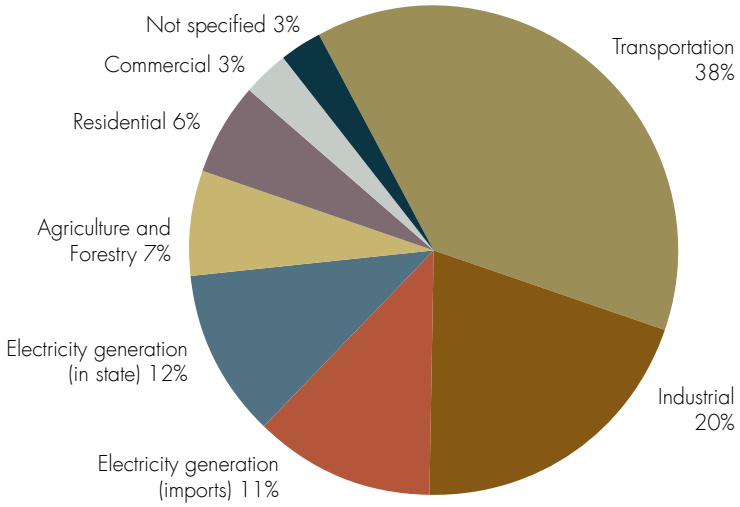
More than 17,000 mountain meadows greater than one acre in size are scattered throughout the Sierra Nevada high country, sustaining biological communities and helping provide clean water. Diminished snowpacks in the future could alter plant communities in mountain meadows, affect dependent wildlife species, and change hydrologic function, so a better understanding of current conditions is needed. Field research teams from the group have begun inventorying and mapping meadows in 10 different national forests.

"We'll determine the percentage of meadows with eroded conditions, the extent of degradation, and what the potential restoration benefit is," Viers says.

CALIFORNIA GREENHOUSE GAS EMISSIONS

The California greenhouse gas (GHG) inventory compiles statewide GHG emissions and sinks from 2000 to 2009. It includes estimates for carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

SOURCE: "2009 GHG EMISSIONS BY SECTOR (FROM 2000-2009 EMISSION INVENTORY)," CALIFORNIA AIR RESOURCES BOARD



Forty to 60 percent of California's water is derived from the 15 major watersheds that drain the 400-mile-long mountain range, so the body of research developed by the Sierra Nevada Strategies Group serves a crucial role in informing decision makers.

"The nature of our resources is going to change and water is probably our most critical resource," Viers says. "We need to be prepared and it's important that we become more flexible with respect to our ideas about how to manage that water." — JS

Marine lab keeps watch on the coast

Ocean waters are warming, sea level is rising, seawater is becoming more acidic, and shoreline erosion is intensifying. Ecosystems are responding to these changes as the world's oceans react to increased carbon dioxide and other greenhouse gases in the earth's atmosphere.

"The physical and chemical environment of the ocean is changing with the climate," said Professor John Largier of the UC Davis Bodega Marine Laboratory. "This affects ecosystems that deliver specific services we value—like tidal marshes and coral reefs that protect us from storms and flooding. Often we don't realize the value of these services because they've always been there."

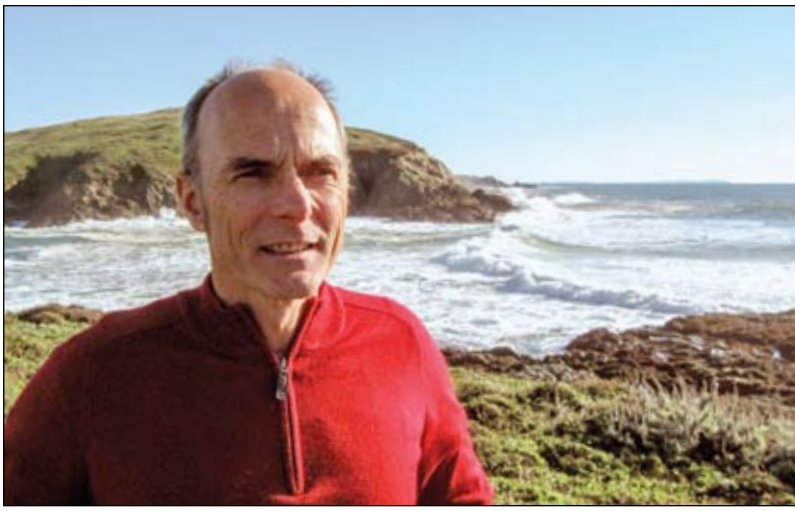
The ocean brings stability to the earth's climate. It heats up and cools down more slowly than the land and the air. With climate change, the ocean absorbs excess heat trapped in the earth's system by the increased concentration of gases in the atmosphere.

As seawater warms, it expands. The increase in the ocean's heat content, charted since the mid-20th century, has contributed to one of the most visible effects of global warming—rising sea level. Thermal expansion, along with melting polar ice caps and glaciers, has led to global sea level rise of more than seven inches over the last century—observed in California at the Golden Gate tide gauge.

"When the ocean begins to warm up, then you know for sure that the earth's climate is changing," said Largier, a faculty member in the Department of Environmental Science and Policy. "Even if we stop putting greenhouse gases into the atmosphere right now, the ocean has warmed up, and it will take centuries for it to cool down. People don't realize that we've already made a long-term commitment to climate change."

"Even if we stop putting greenhouse gases into the atmosphere right now, the ocean has warmed up, and it will take centuries for it to cool down. People don't realize that we've already made a long-term commitment to climate change."

JENNIFER SAUTER/UC DAVIS



Oceanographer John Largier chaired a scientific advisory group that prepared a report in 2010 on how changes in the ocean might affect two valuable marine sanctuaries off the northern California coast. "Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries" is available online at http://sanctuaries.noaa.gov/science/conservation/fb_cbnms_climate.html.

At the Bodega Marine Lab, Largier and other scientists are studying the regional impacts of climate change on the waters off California, which include an increase in coastal upwelling. Driven by winds, upwelling pulls cold water and nutrients from the ocean depths to the surface along the shore and contributes to the "marine layer," the blanket of cool moist air that moderates California temperatures. Largier's research shows a trend toward stronger winds and an increase in upwelling since 1982, leading to cooler waters off central and northern California.

"Worldwide, the ocean's surface water is getting warmer, but in California, the ocean is getting colder near shore," said Largier. "This is intriguing because it shows that climate change is not going to have the same effect everywhere. There will be regional differences." — RD

Protecting California's native treasures

California's remarkable landscape and Mediterranean climate support a wide spectrum of ecosystems that harbor more species of plants and animals than any other state in the nation. As a biodiversity hotspot, the state also hosts the greatest number of endemic species, those that occur nowhere else in the world. California is home to the world's tallest trees—the coastal redwoods. It hosts the oldest living tree, a 4,700-year-old bristlecone pine. It harbors one of the most massive living organisms known—the giant sequoia.

Climate change increases the vulnerability of California's native flora and fauna, much of which is already imperiled due to pollution, population pressures, and invasive species. To conserve the state's biodiversity and the services provided by ecosystems, scientists at UC Davis are helping resource managers develop adaptation strategies to reduce the risks of climate-driven extinction of species.

"By the end of the century, it is almost certain that we are going to have average annual temperatures that exceed what humans have ever experienced since the evolution of man," said Professor Douglas Kelt of the UC Davis Department of Wildlife, Fish and Conservation Biology. "Different species are going to respond at different rates to changes. I think we're going to see wholesale restructuring of ecological assemblages, and all sorts of disharmonies in ecological systems."

To predict the impact of climate change on biodiversity, scientists rely on species distribution modeling—factoring in variables such as soil, elevation, water, temperature, ecosystem, etc.—to project where a species will be distributed based on a future climate scenario. As temperatures rise, species can seek a more hospitable environment through migration or through dispersal, or else face a higher risk of extinction.

"Some of these species will be at risk," said UC Davis Professor Mark Schwartz of the Department of Environmental Science and Policy, a rare plant expert who models distribution shifts in species. "Part of the challenge we have is figuring out which species are most at risk, and what are the indicators of that risk? That's where the future of our research and thinking about climate change vulnerability is headed."

Given the magnitude of climate change and its predicted impacts, one strategy under debate among scientists is the possibility of managed relocation—intentionally moving species outside their areas of historical distribution to prevent extinction and

DEB SCHWEIZER/NATIONAL PARK SERVICE

Managing fire in a way that increases ecosystem resiliency is critical to protecting biodiversity under changing climate conditions. Forests in the Sierra Nevada are adapted to periodic low-intensity wildfires. To maintain healthy ecosystem functioning, conservation managers "prescribe" controlled fires that minimize the risk of high-intensity catastrophic wildfires, which are predicted to increase with climate change. Prescribed fires such as this one in Sequoia National Park help sustain populations of giant sequoias, which require fire to germinate the seeds.

to maintain biodiversity. Schwartz recently led a multidisciplinary team of more than 30 experts who examined the ethical, legal, and ecological issues raised by the practice of assisted migration. Because moving species with good intentions can cause unintended harmful consequences, managed relocation remains a controversial adaptation strategy.

One wild card in predicting species vulnerability to climate change in California is the increased risk of catastrophic wildfire. According to Schwartz, the policy of fire suppression in the Sierra Nevada over the last century has led to more intense blazes due to increased forest density and unnaturally heavy accumulations of dead and down fuels on the ground. Fire management adaptation strategies are critical to protecting the state's biodiversity, as higher temperatures, earlier snowmelt, and a longer dry period increase the frequency and extent of wildfires.

Take giant sequoias, as one example. "Sequoias live for 1,500 to 3,000 years, so we have to decide how to protect them for the future," said Schwartz, who is also director of the John Muir Institute of the Environment. "How do we identify high-value resources—such as sequoia groves—and manage appropriate fire regimes in the environment to prevent catastrophic fire? How can we manage a fire regime that increases ecosystem resiliency and eases the impacts of climate change on our natural systems?"

These questions guide the research of an important new study on wildfire vulnerability and adaptation strategies led by Schwartz, in partnership with additional UC Davis faculty and colleagues from the National Park Service, the U.S. Geological Survey, and others. The study is funded by the U.S. Department of the Interior through the Southwest Climate Science Center, a consortium of six research universities that includes UC Davis.

Aside from the threat of wildfires, California's conservation managers face multiple challenges to the survival of species as temperature changes disrupt the timing of seasonal events such as flowering, migration, or raising offspring. According to Kelt, an expert in small mammals who recently completed a study of wildlife diversity in the Sierra Nevada, conservation managers can help protect the state's ecosystems by encouraging varied habitats.

"Systems are adapted to some fluctuation from year to year," said Kelt. "We need to leave enough of a buffer so that we're not pushing natural systems to the edge of their resilience. If we push too far, and then climate change pushes a little more, these systems may not be able to rebound. Proactive management today may pay off in terms of ecological stability in coming years." — RD

UC Davis leaders shape climate policy

TRANSFORMING FUELS

Researchers at the UC Davis Institute of Transportation Studies have joined forces with other leading research institutions to design a national low-carbon fuel standard much like the landmark legislation adopted by California in 2009. A low-carbon fuel standard is a policy that requires oil companies and other fuel providers to lower the carbon intensity of transportation fuels in order to reduce global-warming emissions from cars and trucks. Transforming fuels is part of a larger strategy to move the United States toward a more sustainable transportation system.

TJ USHING/UC DAVIS

Dan Sperling (left), director of the Institute of Transportation Studies, seeks to provide government with the scientific foundation for policy changes in the carbon intensity of transportation fuels.

"Our goal is to provide the scientific foundation—the knowledge—for Congress and the federal government to actually design this policy and put it in place," said Dan Sperling, director of the Institute of Transportation Studies and a UC Davis professor with appointments in both environmental science and policy, and civil engineering.

Sperling was instrumental in the creation of California's low-carbon fuel standard mandate, the first in the nation that requires fuel providers to reduce carbon and other greenhouse gas emissions of transportation fuels by at least 10 percent by 2020. For more information, see http://steps.ucdavis.edu/research/Thread_6/lcfs. — RD

HOMEGROWN ENERGY

Research on biofuels at the UC Davis Energy Institute is helping California meet new state and federal targets to increase the percentage of electricity and fuels generated from renewable resources. Energy Institute director Bryan Jenkins, an expert in biomass thermochemical conversion, has contributed to energy sustainability through research and outreach in renewable energy generation for more than three decades.

One step toward mitigating climate change and decreasing greenhouse gas emissions is to generate more energy from renewable resources and less from fossil fuels. Biomass—organic materials such as agricultural residues, animal manure, food processing residues, forest thinnings, portions of municipal wastes, and purpose-grown crops—can be converted to energy through direct combustion for electrical power generation and many other techniques. Research continues on more advanced systems to provide sustainable fuels, heat, and electricity at increased efficiencies.

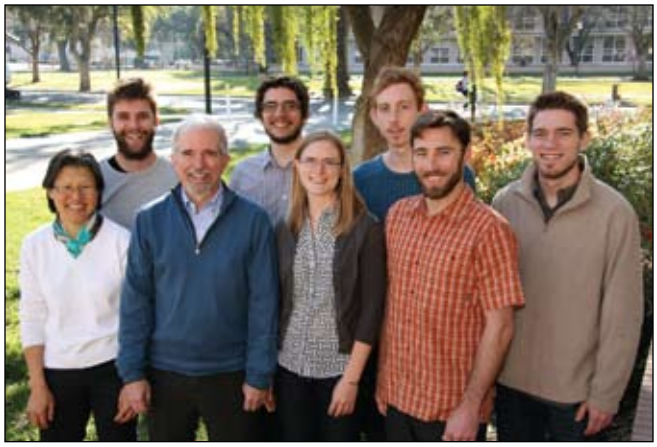
"Research at UC Davis is directed toward ensuring real social, economic, and environmental gains, not only for bioenergy, but also for the transition to a sustainable energy system overall," said Jenkins, a distinguished professor in the UC Davis Department of Biological and Agricultural Engineering. — RD

NEW DOCTORAL TRAINING PROGRAM

A doctoral level training program begun in 2011 is preparing the next generation of science and policy leaders to take on the challenges associated with climate change, future water availability, and resource management. "Climate Change, Water, and Society" provides training in hydrologic science, atmospheric science, ecology, engineering, geology, resource economics, and political science. The program includes a student-designed conference for science and policy stakeholders, and internships with state and federal agencies.

"To better predict and understand local and global climate change and hydrology, climate and hydrologic sciences must mature into a modern science of hydroclimatology," says the program's director Graham Fogg, a hydrology professor in the Department of Land, Air and Water Resources. "Our program is designed to give students the disciplinary depth and the multidisciplinary breadth to address the effects of climate change on our water resources."

Students will also study how decision makers process scientific information and the influence of social networks. In addition to their doctoral degree, students will earn a graduate certificate in Climate Change, Water, and Society.



JOHN STUMBOS/UC DAVIS

Hydrology professor Graham Fogg (third from left), pictured with students and staff, directs a training program that prepares students to address challenges associated with climate change.

The program, supported by a grant from the National Science Foundation, will include about 10 doctoral students for each of the next four years. Cooperating institutions in the program include the Colorado School of Mines, California State University, Fresno, and the University of Concepción, Chile. — JS

ASSESSING LIVESTOCK'S 'FOOTPRINT'

Animal science professor and air quality specialist Frank Mitloehner is chair of a new committee for the Food and Agriculture Organization (FAO) of the United Nations that will measure and assess the environmental impacts of the livestock industry.

The committee is comprised of representatives from national governments, livestock industries, nonprofits, and the private sector. Its charge is to establish science-based methods to quantify livestock's carbon footprint, create a database of greenhouse gas emission factors for animal feed, and develop a methodology to measure other environmental pressures, such as water consumption and nutrient loss.

"Transportation choices continue to be the main contribution to climate change and not, as is often depicted, food choices."

"By the end of three years, we'll have a methodology that's globally accepted, that anyone in the world can use to quantify the environmental impact of their livestock," Mitloehner said.

The FAO estimates that meat consumption will increase 73 percent by 2050 and dairy consumption

will increase 58 percent over current levels. Methods of raising livestock differ throughout the world, with American producers being among the world's most efficient. For instance, it takes approximately 20 cows in India to produce as much milk as one dairy cow in the United States.

Mitloehner's UC Davis research has found that livestock account for 3.4 percent of greenhouse gas emissions in the United States. The transportation sector, on the other hand, contributes roughly 26 percent.

"Transportation choices continue to be the main contribution to climate change and not, as is often depicted, food choices," he says. "This new program is an effort to harmonize methodologies to benchmark the environmental impact of livestock." — JS

Warmer winters are shaking up walnuts

JOHN STUMBOS/UC DAVIS

A study of walnuts by graduate student Katherine Pope (above) and colleagues shows how climate change is affecting this important agricultural commodity. The research underscores the need to develop management strategies and new varieties adapted to warming conditions.

Plant sciences graduate student Katherine Pope analyzed 60 years of meticulous records from UC's California Walnut Improvement Program and found some of the first evidence showing how climate change is affecting this important agricultural commodity.

As springs have gotten warmer, many flower and leaf buds have responded by opening earlier. This was the case with California's English walnuts in initial warming decades, but then walnut leaf buds did an about-face and began opening later. The most likely reason: warmer winters are overpowering the effects of warmer springs.

"Most of California's tree crops require a certain amount of cold winter temperatures—called 'winter chilling'— for their leaf and flower buds to open normally," Pope said. "When this requirement is not met, buds open later, are deformed, or don't open at all. That can result in fewer fruits and nuts to harvest, and fewer leaves to turn sunlight into energy. California's walnut varieties have a relatively high chilling requirement."

Since about 1970, temperatures have increased significantly in California. As part of a broader study with plant sciences professors Ted DeJong and Patrick Brown on past and potential future effects of climate change on tree crops, Pope examined the walnut breeding program's records of when flower and leaf buds opened to see if this warming had affected walnuts.

Her analysis showed that male flowering and leaf-out was trending earlier in the 1970s and 1980s. Then, surprisingly, the leaf buds, which need more winter chill than the male flower buds, showed a distinct change about 1994, with subsequent leaf-out coming later, now generally even later than pre-warming years.

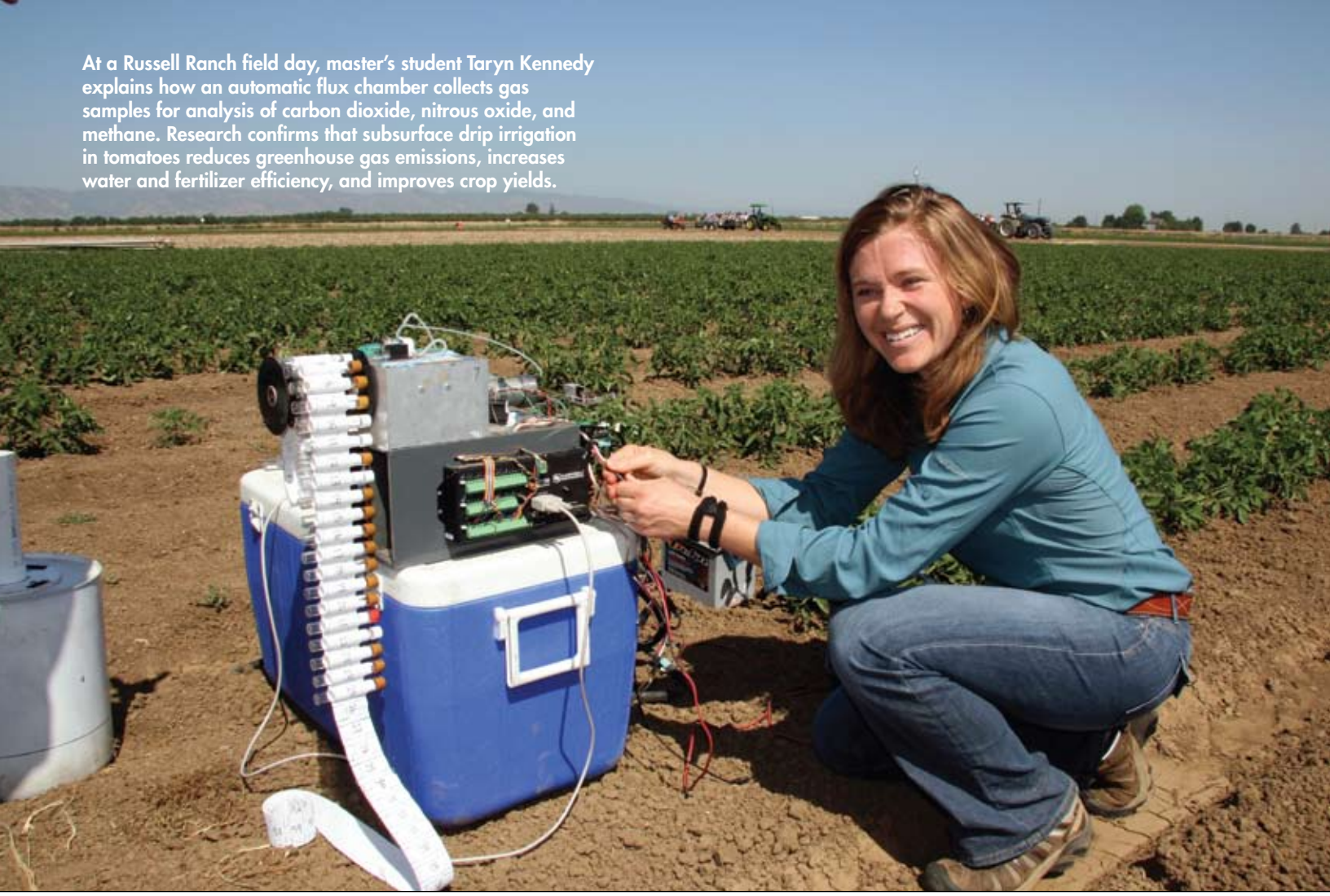
Pope's study is the first to document that a crop species' spring events were getting earlier and have since gotten later. In essence, the male flower buds are showing how most species are behaving now, and the leaf buds are showing the next step, how species may start responding with even more warming.

"We have been concerned about how California tree crops might respond to global warming," DeJong said. "This study helps clarify the situation, at least for walnuts, and provides clues for future research."

"The good news is there are management strategies and sprays to deal with moderate warming," Pope says, "and low-chill genes in uncultivated varieties of vulnerable crops like cherries, pistachios and walnuts. But the science behind these strategies and sprays needs to be better understood for them to work reliably, and new varieties need to be developed, which can take decades." — JS

Ag research seeks to cut greenhouse gases

Before climate change became the major issue it is today, UC Davis scientists were studying farming practices that could help reduce global greenhouse gases.



At a Russell Ranch field day, master's student Taryn Kennedy explains how an automatic flux chamber collects gas samples for analysis of carbon dioxide, nitrous oxide, and methane. Research confirms that subsurface drip irrigation in tomatoes reduces greenhouse gas emissions, increases water and fertilizer efficiency, and improves crop yields.

JOHN STUMBOS/UC DAVIS

An early focus was on cover crops that pulled carbon out of the atmosphere and put it back in the ground. Research showed that over the course of 10 years, cover crops increased soil carbon by about three tons per hectare (about 2.5 acres). Reduced tillage is another practice that can increase soil carbon because it enhances soil fauna, such as earthworms, that have a positive impact on carbon cycling.

"We have shown through our experiments and working with growers that it is possible to increase soil carbon," said William Horwath, professor of soil biogeochemistry in the UC Davis Department of Land, Air and Water Resources. "There is potential but there are many obstacles, as well."

In 2003, Horwath and colleagues set up an experiment at the Russell Ranch sustainable agriculture facility to compare conventional furrow irrigation with a newer technique—subsurface drip irrigation—in tomatoes. They discovered they could get the same yield with half the water and dramatically reduce emissions of another important greenhouse gas, nitrous oxide, which is 300 times more powerful than carbon dioxide.

Nitrous oxide emissions are a normal part of the soil but can be exacerbated in intensive agricultural systems where nitrogen fertilizers are used to promote crop productivity. Globally, up to 70 percent of nitrous oxide emissions are attributed to fertilizer use. In California, agriculture contributes a comparatively small amount of total greenhouse gas emissions, but half of that amount is from nitrous oxide.

Building on prior research, Horwath is looking at the factors that go into fertilizer use efficiency, such as fertilizer placement and timing. Also, the California Air Resources Board, the state agency responsible for implementing the California Global Warming Solutions Act (AB 32), has contracted with UC Davis to document nitrous oxide emissions in California's top 10 crops and to identify management practices to reduce emissions.

In the future, researchers will be taking a harder look at organic agriculture systems, which according to Horwath are more resilient to climate aberrations than conventional systems. "We won't be able to feed the world on organic agriculture," he says. "We'll need to rely on some sort of conventional approach, so we need to determine what are the best features or attributes of an organic system that tend not to be so affected by climate." — JS

Everett Rubin (center) an environmental science and management major, works with Anna Smith (left), an environmental toxicology major, during class.

ROBIN DERIEUX/UC DAVIS

DOOM AND GLOOM WITH BLOOM

Course helps students explore the science of global climate change

EARLY IN THE QUARTER, THE 145 UC DAVIS students enrolled in Science and Society 25 complete a spreadsheet assignment that illustrates the global warming trend. After they collect average temperatures over several decades from satellite data on the NASA website and graph the numbers, they can see for themselves that the planet is heating up.

Observing the various indicators of a warming climate is a straightforward exercise for undergraduates taking "Global Climate Change: Convergence of Biological, Geophysical and Social Science." Understanding how, why, and what to do about climate change is a much more difficult endeavor.

"This is a wonderful course for freshmen because they're realizing for the first time that there is no single right answer," said plant sciences professor Arnold Bloom, who has been teaching SAS 25 (which he calls "Doom and Gloom with Bloom") for nearly a decade. "A complex problem such as climate change is going to require a lot of analysis, a lot of information, and will have no simple answers. I don't care what students believe about climate change, either before or after they take the class. What I care is that they can support their beliefs with valid evidence."

Professor Arnold Bloom has developed an online version of SAS 25, soon to be available to University of California students year-round, and has also worked with NASA and the National Science Foundation to create a free online general education curriculum on global climate change, available for faculty to adopt and adapt. (http://www.climatechangecourse.org)

Freshman Everett Rubin became interested in the subject of global climate change in high school, but wanted to know more. "As an environmental science and management major, I wanted to be more of an expert on it," said Rubin. "The class isn't required for my major, but I wanted to know enough to speak convincingly about climate change."

— Robin DeRieux

‘REAL WORLD’ KNOWLEDGE

Alumna takes lead on beef industry’s largest sustainability project

KIMBERLY STACKHOUSE-LAWSON DISCOVERED her calling at a young age, equipped herself with a first-rate UC Davis education, and now leads the nation’s largest sustainability project for the beef industry.

When she was nine years old, the native of Montgomery Creek, Calif., joined 4-H to raise and show her first sheep. By the age of 11, her flock had grown to 40. By her senior year in high school, she and her brother were managing a flock of 300.

On her first trip to UC Davis in grade school, she met sheep facility manager Dana Van Liew, who convinced her that UC Davis was the place to get her college education. “He called me to check up on my scholastic achievements and answer my questions about sheep from that time to the day I was accepted as an undergraduate in the animal science and management degree program,” she said.

SPENCER LAWSON

Kim Stackhouse-Lawson’s research showed greenhouse gases from beef production can be mitigated through improved efficiencies.

“I wanted to understand the science behind these claims, as they varied greatly from U.S. Environmental Protection Agency estimates. I shaped my research program to begin answering questions surrounding the carbon footprint and greenhouse gas mitigation of beef production systems.”

Stackhouse-Lawson earned her bachelor’s degree in 2006 and then began work on a doctorate in animal biology. About the same time, the United Nations Food and Agriculture Organization released a report called “Livestock’s Long Shadow,” which suggested livestock are a greater source of the world’s greenhouse gases than transportation.

“I wanted to understand the science behind these claims, as they varied greatly from U.S. Environmental Protection Agency estimates,” she said. “I shaped my research program to begin answering questions surrounding the carbon footprint and greenhouse gas mitigation of beef production systems.”

Stackhouse-Lawson conducted beef cattle research in large, enclosed corrals and in atmospheric chambers to monitor animal food intake and gaseous emissions. Her work, under the guidance of animal science professor Frank Mitloehner, showed that greenhouse gases from beef production can be mitigated through improved efficiencies.

“Kim learned about the nexus of agricultural productivity and sustainability while being trained here at UC Davis,” Mitloehner said. “She is now moving this knowledge to the ‘real world’ and making a difference in how animal agriculture satisfies societal needs.”

After earning her doctorate in 2011, Stackhouse-Lawson started working for the National Cattlemen’s Beef Association. As director of sustainability research, she leads a project examining the social, economic, and environmental impacts of beef production to provide the beef community with its first sustainability benchmark and a path forward for the industry.

“By the year 2050 the world will need to produce 70 percent more food for an estimated nine billion people,” she says. “Livestock is an important part of the solution to feeding this growing population. The livestock industries are working hard to reduce greenhouse gas emissions and environmental impact by utilizing resources more efficiently.”

— John Stumbos

JOHN STUMBOS/UC DAVIS

From left, California Grain and Feed Association president John Pereira, CGFA chief executive officer Chris Zanobini, and animal science professor and air quality specialist Frank Mitloehner toured the aging UC Davis feed mill earlier this year.

NEW FEED MILL TAKES SHAPE

Gift from California Grain and Feed Association kick-starts project

A MUCH-NEEDED NEW CAMPUS FEED MILL TO support animal science research is one step closer to becoming a reality thanks to a $150,000 gift from the California Grain and Feed Association (CGFA).

For additional information contact CA&ES development officer Martha Ozonoff at (530) 752-1504, mjozonoff@ucdavis.edu

The current mill, built in 1960, is rusting, in disrepair, and unable to generate the custom feeds needed for the sophisticated research taking place on campus today. "That mill is badly outdated," said CGFA president John Pereira. "UC Davis has a top-rated animal science program that's making a huge difference in our industry, keeping agriculture productive and sustainable. They absolutely need a new feed mill."

The new feed mill will cost $5.3 million—$2 million from already pledged in-kind equipment donations and $3.3 million from new monetary donations. The College of Agricultural and Environmental Sciences also has contributed $100,000 for the new mill.

"All the preliminary work has been done," said Dan Sehnert, animal facilities coordinator for the Department of Animal Science. "With the help of an industry planning committee, we have a site map, an approved Environmental Impact Report, and everything else we need to get started once we have the funds."

The mill does more than generate feed to maintain

campus cattle, swine, goats, sheep, horses, and poultry. Researchers must carefully control and monitor what feed goes in and comes out of the animals for efficiency and environmental studies.

"We integrate additives into feed to reduce the nitrogen that leaves the cow," says animal science professor and air quality specialist Frank Mitloehner. "We work with very small amounts of additives, which need to circulate thoroughly throughout the feed. Much of our research depends on the ability to customize feed."

Mitloehner was recently selected to chair a United Nations Food and Agriculture Organization committee to assess the environmental impacts of the global livestock industry. The effort is important to improve the sustainability of the livestock sector as global consumption of meat, dairy products, and eggs continues to rise.

"I'm thrilled our association has made the first industry gift," said CGFA chief executive officer Chris Zanobini. "I know others will join us, because the work Frank Mitloehner is doing with air quality—along with all the work in the animal science department—is important to our operations. It's vital to our future, not just for our industry but for our state, our nation, and our world."

—Diane Nelson

PLANT A SEED, WATCH IT GROW

Garden club tours arboretum and hears from scholarship recipient

MEMBERS OF THE CIVIC GARDEN CLUB OF San Carlos were honored in early November 2012 for their philanthropic support of UC Davis plant science students with an outdoor luncheon and tour of the UC Davis Arboretum.

"Our club has a long history of providing scholarships for young people interested in learning about horticulture," said Janice Fager, the club's president. "With its premier programs in plant sciences, UC Davis has always been one of the educational institutions we are most eager to support."

About 30 members made the trip from the Bay Area to the arboretum. They gathered in Nature's Gallery Court, adjacent to the Ruth Storer Garden. Nature's Gallery is an arched wall with embedded mosaic tiles depicting the flora and fauna of the arboretum. It was constructed by undergraduate students and community members as a project of the Art/Science Fusion Program.

The College of Agricultural and Environmental Sciences hosted the luncheon to show its appreciation for the club's current and planned support to the university. Campus speakers presented information about the Gardens, Arts and the Environment Project, which connects the arboretum to academic departments, and about the Arboretum All-Stars program of recommended plants for California gardens.

"Philanthropy makes such a huge difference to the campus and to the students we serve," said Mike Tentis, a CA&ES development officer who emceed the event. "Scholarships provide access to higher education. They are a deciding factor when a student selects a university and, indeed, can influence what a student chooses to study while on campus."

JOHN STUMBOS/UC DAVIS

Plant sciences student Stacey Haack told garden club members that the scholarship she received from them helped her define her educational and career interests. "I want to thank you for the financial support and for coming to UC Davis, where I've been able to define my passion for plants, both in agriculture and in the garden," she said.

The Civic Garden Club of San Carlos was organized in 1937 and meets monthly in its "Casa de Flores" clubhouse for educational programs on topics such as hydroponics, bromeliads, orchid cultivation, and container succulents. Garden clubs have existed in the United States for well over 100 years. In addition to educating their members about gardening, horticulture, and floral design, they are frequently involved in civic beautification, youth education, preservation and conservation, and community service projects.

— John Stumbos

THE NEXT GENERATION

New faculty recruits for the 2012–2013 academic year

THE PROCESS OF RENEWAL HAS BEGUN FOR our college, with many new faces among CA&ES faculty and additional recruitments under way. Wide-scale hiring efforts began in 2009 in anticipation of a decade of increased faculty turnover from retirements. In 2011, the provost authorized the release of at least 12 CA&ES faculty positions each year for four years. Joining the CA&ES faculty so far during the 2012–13 academic year are nine assistant professors, one associate professor, and a Cooperative Extension specialist. Additional searches are ongoing.

—Robin DeRieux

Agricultural Sciences

Dario Cantu

Cantu, an assistant professor in the Department of Viticulture and Enology, is a systems biologist. Cantu completed his Ph.D. in plant biology at UC Davis and was a postdoctoral fellow in genomics before joining the CA&ES faculty.

Research interests: using genomics, genetics, and bioinformatics to dissect the molecular networks underlying complex traits in cultivated plants, including grape, tomato, and wheat.

Matthew Gilbert

Gilbert, an assistant professor in the Department of Plant Sciences, is a crop physiologist. Gilbert completed his Ph.D. in botany at Rhodes University in South Africa, and joined the UC Davis faculty after a postdoctoral fellowship at Harvard University.

Research interests: the mechanisms of photosynthetic and stomatal variation, examining how stomata respond to the environment, seeking agronomic outcomes for basic research, breeding crops that use less water.

Michael Miller

Miller, an assistant professor in the Department of Animal Science, specializes in genetics and genomics. Miller completed his Ph.D. in biology at the University of Oregon before joining the UC Davis faculty.

Research interests: animal genetics and genomics, conservation and ecological genetics and genomics, genomics and bioinformatics technology development, salmonid fishes.

Maciej Zwieniecki

Zwieniecki, an associate professor in the Department of Plant Sciences, specializes in whole plant physiology. He has a Ph.D. in forest ecology from Oregon State University, and joined UC Davis from the Harvard University Arnold Arboretum.

Research interests: plant transport processes, biophysics, evolution of morphological traits, plant responses to abiotic stresses, using molecular tools in addressing questions relating to the biology of trees.

Human Sciences

Siwei Liu

Liu, an assistant professor in the Department of Human Ecology, specializes in human development. Liu completed her Ph.D. in human development and family studies at the Pennsylvania State University before joining the UC Davis faculty.

Research interests: longitudinal data analysis and family research methods. Current research focuses on relationship pairs and physiological data.

Kevin Novan

Novan, an assistant professor in the Department of Agricultural and Resource Economics, specializes in applied econometrics. He joined the UC Davis faculty after completing his Ph.D. in economics at UC San Diego.

Research interests: environmental and natural resource economics, energy economics, applied microeconomics and industrial organization, exploring how policies can mitigate the environmental impacts of the electricity sector.

Martin Smith

Smith, a Cooperative Extension specialist with shared appointments in the Department of Human Ecology and the UC Davis School of Veterinary Medicine, specializes in youth scientific literacy and science education outreach. Smith has been on campus with Vet Med since 1996, but accepted a shared appointment with human ecology in 2012. Smith has an M.S. in biology and an Ed.D. in teacher leadership.

Research and extension interests: the development and dissemination of research-based science curricula, and the design and distribution of effective professional development models for science educators.

Anne Visser

Visser, an assistant professor in the Department of Human Ecology, specializes in public policy and governance. She has a Ph.D. in public and urban policy and joined UC Davis from Hunter College.

Research interests: informal economy, non-standard work arrangements, low-wage labor markets, governance, socioeconomic integration, socioeconomic inequality.

Environmental Sciences

Michele La Merrill

La Merrill, an assistant professor in the Department of Environmental Toxicology, is a developmental toxicologist. La Merrill completed her Ph.D. in toxicology at the University of North Carolina, School of Medicine. She joined UC Davis after a postdoctoral fellowship in environmental pediatrics at Mt. Sinai School of Medicine.

Research interests: developmental and genetic susceptibility to metabolic and endocrine disruption by persistent organic pollutant exposure in animal models and people.

Paul Ullrich

Ullrich, an assistant professor in the Department of Land, Air and Water Resources, specializes in regional climate change modeling. He completed his Ph.D. in atmospheric science at the University of Michigan before joining the UC Davis faculty.

Research interests: regional and global climate change, atmospheric dynamics, computational fluid dynamics, numerical methods for the geophysical sciences, model validation, verification, and uncertainty quantification.

Andrew Whitehead

Whitehead, an assistant professor in the Department of Environmental Toxicology, is a molecular ecotoxicologist. He completed his Ph.D. in pharmacology and toxicology at the UC Davis Bodega Marine Laboratory, and joined CA&ES from Louisiana State University.

Research interests: environmental, ecological, and evolutionary genomics, population genomics, conservation genetics, stress physiology, and ecotoxicology.

CA&ES
Outlook

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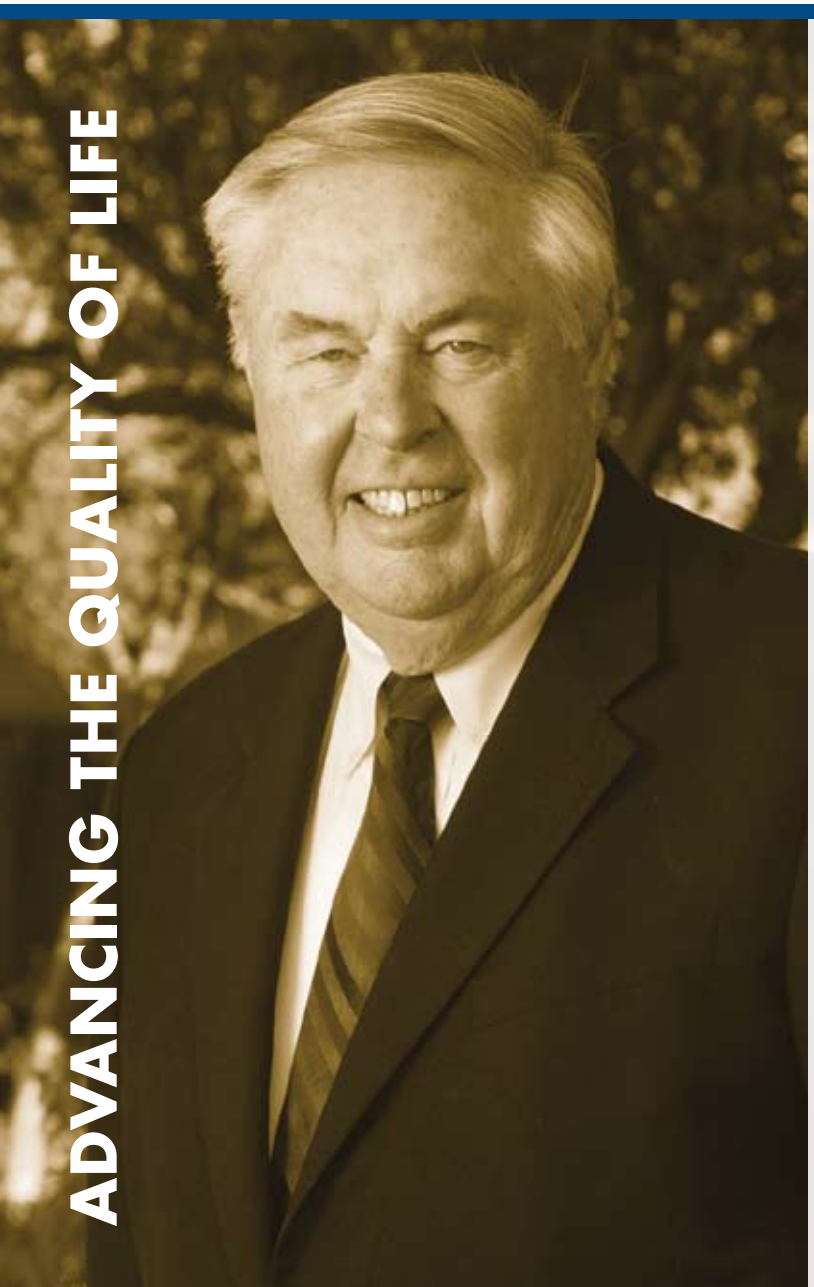

Jerry Lohr is sustaining success through wine and philanthropy.

From an early age, Lohr, the son of a South Dakota farming family, learned the importance of soil quality, the environment, and sustainable farming practices—knowledge that has been instrumental to his success as the Founder of J. Lohr Vineyards & Wines, an enterprise that sells its products across the United States and worldwide.

Lohr has been a key contributor in the design, planning, and fundraising efforts for UC Davis' winery, brewery, and food processing teaching and research complex in the Robert Mondavi Institute for Wine and Food Science.

"We've had a philosophy of sustainability since I started," said Lohr. "I'm a firm believer that success can only be achieved if you take care of your resources—the earth, people and your community."

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