

The background image shows two men standing in an outdoor industrial setting. The man on the left is wearing a white short-sleeved button-down shirt, blue jeans, and glasses. The man on the right is wearing a grey short-sleeved button-down shirt, blue jeans, and has a goatee. They are standing next to a large green pump and some grey electrical equipment. In the background, there is a field of tall, dry grass.

CA&ES Outlook

GRAPPLING WITH GROUNDWATER

California taps into a deep well of knowledge

CA&ES Outlook

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▲ COVER STORY

Groundwater is essential to California's water supply. CA&ES faculty shed light on this resource and are developing innovative strategies for sustainable management. **4**



◀ ALUMNI SPOTLIGHT

Animal science educator establishes an award for undergraduates. **19**



◀ MAKING A DIFFERENCE

Donation from Carlos Alvarez gives brewing program a big boost. **20**

▼ ALSO IN THIS ISSUE

Dean's Message **3**


College Celebration **13**

Around the College **14**

Students and Studies **16**

Giving Opportunities **22**

COVER PHOTO: UC Davis Cooperative Extension Specialist Thomas Harter (left) and Professor Graham Fogg are two of the state's leading experts on California groundwater. Their work provides water policymakers and managers with crucial information about groundwater. *Photo by John Stumbos.*



Toby O'Geen (right), a UC Cooperative Extension specialist in the Department of Land, Air and Water Resources, demonstrates a new interactive map for Dean Helene Dillard. The Soil Agricultural Groundwater Banking Index provides information on how likely land could accommodate deep water percolation to help replenish groundwater supplies.

JOHN STUMBOS/UC DAVIS

DELIVERING NEW TOOLS FOR CALIFORNIA

FOUR YEARS OF DROUGHT HAVE HIT CALIFORNIA hard. According to researchers affiliated with the Center for Watershed Sciences, the impact to all economic sectors will be \$2.74 billion in 2015. The direct cost to agriculture is estimated to be \$1.84 billion. More than 10,000 seasonal jobs related to farm production evaporated in 2015.

Surface water shortages of nearly 8.7 million acre-feet have been offset mostly by groundwater pumping of about six million acre-feet. But the heavy reliance on groundwater to meet our diverse needs comes with consequences such as increased energy costs to pump deeper and to drill more wells. Heavy pumping in groundwater basins in overdraft has led to land subsidence, water quality problems, and additional stress on groundwater-dependent ecosystems.

Our faculty are helping the public understand the issues involved and find better ways to manage groundwater. One group of UC Davis scientists is looking into groundwater banking to replenish reserves in times of heavy runoff. They identified about 3.6 million acres of farmland with good potential for utilizing this strategy on land that could accommodate deep percolation with little risk to crops and groundwater quality. This could be a vital tool to revitalize aquifers in areas of the state with historically low groundwater tables.

We are at an important milestone in the history of California water. While government officials work out the details of a regulatory framework to guide sustainable groundwater management policies for the future, we in the academic community are working in tandem with our partners in agriculture, the environmental community, and in our cities and towns to find solutions. We are leading the way in the development of new knowledge and better tools to manage our indispensable groundwater resources.

California is not alone in this challenge. One-third of the world's biggest groundwater basins — places like the Indus Basin aquifer of northwestern India and Pakistan — are in distress. We may be short of water in California right now, but we have talented teams of scientists who are leading the research that will determine how we can work with nature to meet our needs while protecting the environment.

Our feature story highlights some of our exciting work on groundwater. I hope you enjoy learning more about it.

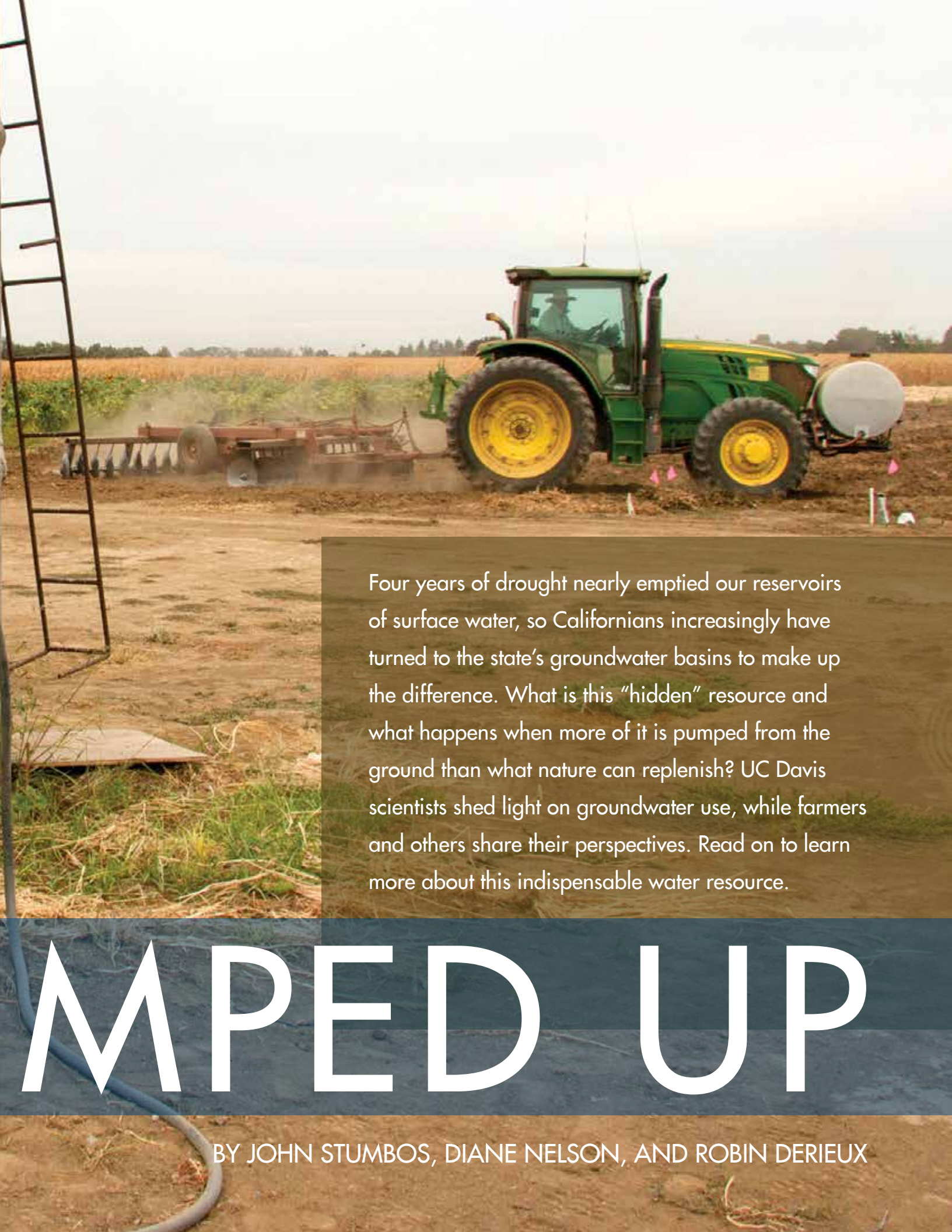
HELENE R. DILLARD, DEAN
COLLEGE OF AGRICULTURAL AND
ENVIRONMENTAL SCIENCES



Professor Graham Fogg (left) and Cooperative Extension Specialist Thomas Harter, both of the Department of Land, Air and Water Resources, have been studying California's groundwater for decades. Photo taken at a well on the UC Davis campus.

JOHN STUMBOS/UC DAVIS

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Four years of drought nearly emptied our reservoirs of surface water, so Californians increasingly have turned to the state's groundwater basins to make up the difference. What is this "hidden" resource and what happens when more of it is pumped from the ground than what nature can replenish? UC Davis scientists shed light on groundwater use, while farmers and others share their perspectives. Read on to learn more about this indispensable water resource.

IMPED UP

BY JOHN STUMBOS, DIANE NELSON, AND ROBIN DERIEUX

GROUNDWATER: BANK ON IT

Groundwater is a natural resource we can't see, which makes it hard to understand. It is shared by many, which makes it difficult to regulate. Although California is rich in groundwater, aquifers are not bottomless savings accounts.

UC Davis hydrogeology professor Graham Fogg favors a banking analogy to explain the importance of better groundwater management in California.

UNDERSTANDING GROUNDWATER

Checking and savings

Imagine every single penny we own is in two bank accounts: one checking, one savings. Surface water is checking. Groundwater is savings.

We keep track of the checking account balance and its deposits and withdrawals, but we have little idea of the balance and transactions in our savings account.

The two accounts are linked. When the checking account (surface water) balance runs low, unknown amounts of money are transferred from the savings account (groundwater) to the checking account. We're not sure how much is transferred from savings because we don't monitor those withdrawals. Nor do we adequately track when and where they occur.

How secure would our finances be? Not very!

"That's how we've been managing surface water and groundwater in California," said Professor Fogg of the Department of Land, Air and Water Resources. "Not only do we need to replenish that groundwater savings account, but also we need to manage both accounts in a smarter, more efficient fashion."

Better Accounting

In the past, groundwater systems in California were flush enough to cover for little oversight. No more. With drought, climate change, and population pressures, we have entered a new era of water scarcity.



"I'm optimistic," said groundwater expert Fogg. "If we can get a better handle on the whole interconnected surface-subsurface system, including the flows between groundwater and surface water, then we'll be able to make changes to live within our means. When there is transparency, the state of the resource and the consequences of not managing it become obvious. Without that transparency, the incentives are simply too weak to spur action." — RD

Visit GROUNDWATER.UCDAVIS.EDU to find in-depth information about our groundwater research, education, and outreach programs.

95%
of all freshwater
on earth is groundwater,
excluding the glaciers
and icepacks.



Approximately 40 percent of the state's baseline water needs are supplied by groundwater in a year of average rainfall. During drought, that may increase to 60 percent or more.

TIFFANY KOCIS/UC DAVIS

WHAT IS GROUNDWATER?

Groundwater is water that fills the pore spaces between the sand, clay, fractured rock, and other subsurface geologic materials that lie beneath our feet. Think of it as the water held between the spaces in a jar full of marbles. Groundwater not only saturates much of the subsurface, but also flows from areas of recharge to areas of discharge, such as springs, wetlands, and rivers.



IS GROUNDWATER ACCESSIBLE EVERYWHERE?

No. Underground sediments and rocks vary. It's difficult to pump groundwater from layers of clay or silt with tiny soil particles. Aquifers are underground areas with coarse sediments or fractured rocks that make it easier to extract groundwater.

HOW MANY WELLS TAP THE GROUNDWATER OF THE CENTRAL VALLEY?

Hundreds of thousands of small domestic wells.

Tens of thousands of agricultural irrigation wells.

Several thousand public water supply wells.



Challenges arise when groundwater gets drawn down

As the drought of the past four years deepened, Californians have been forced to dig deeper into the state's groundwater basins. New wells and deeper wells have pressured this "hidden" resource as never before. While everyone hopes for an end to the drought and replenished reservoirs, the problems facing California's groundwater resources are a persistent challenge.

GROUNDWATER OVERDRAFT

"We're seeing groundwater levels much lower in many wells in California than they've ever been," said Thomas Harter, a UC Davis groundwater specialist. "That has



Cooperative Extension Specialist Sam Sandoval Solis (right) speaks with grower John Eiskamp about water use. Sandoval and his research group interviewed growers and conducted a statistical analysis to document potential water savings in the Pajaro Valley.

consequences: seawater intrusion, pumping costs and the costs of drilling new wells, land subsidence, water quality degradation, surface water depletion, and stress on groundwater-dependent ecosystems."

Average annual statewide groundwater use is 16.5 million acre-feet. According to a report by the Center for Watershed Sciences, an additional six million acre-feet per year have been withdrawn from California aquifers in recent years to offset surface water shortages. The state has identified 21 groundwater basins and sub-basins that have been significantly overdrafted by excessive pumping. Overdraft is especially evident in the Tulare Lake Basin of the southern San Joaquin Valley.

SEAWATER INTRUSION

The Pajaro Valley in Monterey County is an agricultural region that is heavily dependent on groundwater. Pumping water from the ground at a rate faster than it is being replenished has allowed seawater from the Pacific Ocean to enter the aquifer, posing a water quality threat for agriculture and human consumption.

The Pajaro Valley Water Management Agency (PVWMA) partnered with Sam Sandoval Solis — a UC Davis professor of hydrology and a Cooperative Extension specialist — for assistance with the agency's agricultural conservation program.

"The key to agricultural water savings is to water a crop to its evapotranspiration value," Sandoval said. "This value indicates optimum water amounts that should be applied."

Sandoval and his research group determined that the Pajaro Valley could save between 4,600 and 5,100 acre-feet of water a year without harming crops. That's about 10 percent of total water use in this aquifer.

Brian Lockwood, PVWMA senior water resources hydrologist, confirmed that Sandoval's estimates were helpful in establishing conservation targets. "We have been implementing our basin management plan to try to limit the amount of groundwater overdraft and seawater intrusion," he said.

WATER QUALITY THREATS

Groundwater overdraft can create new water quality problems or make existing problems worse because contaminants travel with falling water tables into deeper wells. Nitrate contamination stemming from fertilizer use is widespread, especially in many rural communities that, unlike most large cities, are totally dependent on groundwater.

Harter and colleagues found that more than 200,000 people using small, household wells in the Salinas and Tulare basins have been affected. In some counties of the Central Valley more than 40 percent of domestic wells are contaminated with nitrate.

"Providing drinking water solutions for affected

STEVE ORLOFF/UC ANR





UC Davis scientists worked with ranch manager Jim Morris of Bryan-Morris Ranch to flood alfalfa fields along the Scott Valley River to raise the water table and recharge the groundwater.

communities is urgently needed,” he said.

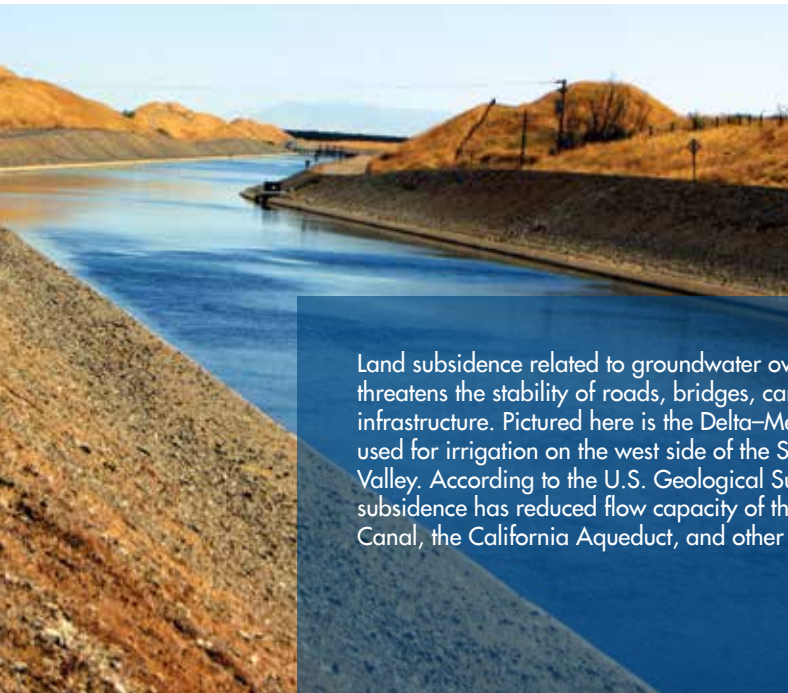
Salinity accumulation is another groundwater issue. Sources of salt include soil, irrigation water, animal agriculture, and municipal and industrial wastes. Salinity affects about 500,000 acres of farmland, mostly in the San Joaquin Valley. But it affects urban areas, too.

LAND SUBSIDENCE

Land subsidence related to groundwater overdraft threatens the stability of roads, bridges, canals, and other infrastructure.

At the Yolo Bypass near Interstate 5, an instrument that measures land subsidence showed the ground sank by almost a foot in 2014. More recently, a study by NASA’s Jet Propulsion Laboratory for the California Department of Water Resources mapped subsidence in

DIANE NELSON/UC DAVIS



Land subsidence related to groundwater overdraft threatens the stability of roads, bridges, canals, and other infrastructure. Pictured here is the Delta–Mendota Canal, used for irrigation on the west side of the San Joaquin Valley. According to the U.S. Geological Survey, land subsidence has reduced flow capacity of the Delta–Mendota Canal, the California Aqueduct, and other canals.

the Central Valley and determined the land is sinking faster than ever before — nearly two inches a month in some locations. Land near Corcoran in the Tulare basin sank 13 inches in just eight months. And a “subsidence bowl” of 14 inches was detected less than a half mile from the California Aqueduct.

“Land subsidence due to groundwater extraction occurs because the clays compact, while sands and gravels do not compact appreciably,” explained hydrogeology professor Graham Fogg.

ECOLOGICAL IMPACT

Lower groundwater levels can drain water from rivers and streams, stressing ecosystems.

The Scott River in Siskiyou County is a tributary to the Klamath River that provides spawning habitat for salmon and steelhead trout. Keeping summer flows in this groundwater-dependent ecosystem are critical, but water flows during this period are below what they’ve been historically. Portions of the river have dried up on occasion.

Harter’s team developed modeling tools to better understand the Scott River system and is working with UC Davis hydrology professor Helen Dahlke, area farmers, and stakeholders to find management practices such as groundwater recharge to help improve the summertime streamflow.

“Recharging areas near the stream in the winter and spring is possible because we have lots of surface water available at that time,” Harter said. “We’re trying to keep the water table up high for as long as possible to improve aquifer support for late summer streamflow, when it’s more important for the fish.” — JS



“Last year we had to lay off 15 percent of our employees, and this year it could be 25 percent.”

Grower Jim Jasper of Newman stands in a neighbor's fallow almond orchard. Jasper had to pull 450 acres of almonds due to lack of water.

When groundwater pumping isn't an option

In many areas of California, growers are pumping groundwater to offset surface water shortages, drilling more wells and pumping deeper into the earth to find fresh water.

But there are a variety of sediments underground, and some materials — such as sand and gravel — are better suited to store or pump water than others. In some areas, growers can't extract fresh water from the subsurface due to salts or sediments with low permeability.

That's the case at Stewart & Jasper Orchards in Newman, on the west side of California's Central Valley, where Jim Jasper and his family have farmed for more than 70 years.

“Farmers in this area have tried to dig wells even 2,000 feet deep, and what little water we find is high in salt,” Jasper says. “We depend 100 percent on what little surface water we get.”

California's drought is tightening its grip on agriculture, squeezing about 30 percent more workers and cropland out of production this year than in 2014, according to the UC Davis Center for Watershed Sciences. Surface-water shortages will reach nearly 8.7 million acre-feet in 2015, which will be mostly offset by groundwater pumping.

But as farmers like Jasper know, groundwater pumping has its limits: growers will idle roughly 542,000 acres of fertile land in 2015, on top of 425,000 acres idled in 2014.

“We had to pull 450 acres of almond trees,” Jasper says, walking in a fallow field. “Our neighbors are doing the same thing. When you have to spend up to \$2,500 an acre-foot on water just to keep the trees alive, there's no other way.”

Production is still relatively strong at Stewart & Jasper Orchards, but lack of water is taking its toll.

“I have 175 families that work with me — people who I care about deeply and who contribute tax dollars to our economy,” Jasper says. “Last year we had to lay off 15 percent of our employees, and this year it could be 25 percent.”

Jasper worries what further cutbacks could do to the world's richest food-producing region.

“If we don't find a way to keep agriculture alive, we won't be able to feed our people,” Jasper says. “We'll have to depend on food from other countries with no control over safety, cost, or quality. Agriculture isn't like a light switch. You can't turn it off and on. When it's gone, it's gone.” — DN

Farmland may provide key to replenishing groundwater

California's aquifers are shrinking as more growers pump groundwater to keep crops alive. But that fertile farmland may also provide the means for replenishing groundwater to benefit everyone in the drought-stricken state.

UC Davis researchers are encouraged by early results from tests to see if intentionally flooding farmland in winter can replenish aquifers without harming crops or drinking water.

"On-farm flooding looks very promising," said Professor Helen Dahlke with the Department of Land, Air and Water Resources. "We're pleasantly surprised by how quickly water tables responded to on-farm flooding without damage to crops."

Toby O'Geen, a UC Cooperative Extension specialist with the Department of Land, Air and Water Resources, evaluated all of California's farmland for its potential to bank groundwater. He determined about 3.6 million acres of farmland have good recharge potential because they could likely accommodate deep percolation with little risk of crop damage or groundwater contamination from salt and nitrates in the soil.

O'Geen, Dahlke, and their team are working with alfalfa growers in Siskiyou County and will test flooding on almonds in the Central Valley this winter, looking at plant physiology, infiltration rates, water quality, and costs. They are building on previous

groundwater-banking research in the Kings River Basin where 75 percent of diverted floodwater percolated to aquifers.

"We flooded pistachios, alfalfa hay, and wine grapes," said Don Cameron, manager of Terranova Ranch along the Kings River in Fresno County. "Our wine grapes were under water for five months, which raised a few eyebrows, but they did fine. Diverting floodwater to farms can recharge groundwater and reduce the risk of downstream flooding. It's a good situation all around."

This winter, Dahlke and professors Ken Shackel and Astrid Volder with the Department of Plant Sciences will flood portions of three Central Valley almond orchards and monitor how flooding affects tree physiology, root health, and water quality.

In spring 2015, the team applied 140 acre-feet of water to alfalfa at Bryan-Morris Ranch in Siskiyou County, more than double the irrigation the field normally gets in a year.

"It was amazing to see how well the land absorbed the water and how quickly the water table rose," said Jim Morris, Bryan-Morris Ranch manager. "That's good news for farming and the environment." — DN

UC Davis faculty work out details of a groundwater-recharge project with almond growers in Fresno. From left: George Goshgarian, Sr.; Professor Ken Shackel; George Goshgarian, Jr.; Professor Helen Dahlke; and Professor Astrid Volder.





JOSHUA VIERS/UC MERCED

Researchers found that removing levees on the Cosumnes River can help recharge groundwater. Scientists on the project include, from left, Drew Nichols from UC Davis, Christina Bradley from UC Merced, Carson Jeffres of UC Davis, and Marilyn Fogel of UC Merced.

Planning, research, and fresh ideas will help shape water policy

One of the most positive outcomes of the four-year drought is how it focused attention on the importance of groundwater and the need for better management of this resource in some areas of the state.

With the passage of the Sustainable Groundwater Management Act in late 2014, a framework for managing this precious resource is taking shape. It calls for the formation of local agencies in priority areas to develop plans to manage groundwater and to be held accountable for achieving objectives. Those plans will take at least another five years to implement and decades to have a long-term impact.

Meanwhile, University of California researchers are studying many facets of groundwater. One project along the Cosumnes River in the Central Valley showed that making more room for floodwaters can improve groundwater supplies. “Putting levees back away from rivers rather than just keeping aging ones intact will help replenish groundwater,” said UC Davis hydrogeology professor Graham Fogg.

Fogg is one of the leaders of the UC Water Security and Sustainability Research Initiative, which involves scientists from the Berkeley, Davis, Merced, Santa Cruz, and San Diego campuses. Learn more about this partnership at ucwater.org.

UC Davis agricultural and resource economics professor Katrina Jessoe believes more needs to be done to introduce market-based principles to manage

California’s water resources, especially groundwater banking in wet years and borrowing in dry years.

“It’s not a magic bullet solution to get us out of the drought or to remedy all our groundwater management problems,” she said. “But it’s an important step worth exploring.”

Pricing is another economics tool that Jessoe believes is necessary. “You have to price groundwater so it reflects the true costs of extraction,” she said. “If you take more groundwater, what happens to groundwater quality? You want cost to reflect that.”

Many groundwater quality problems are in small, rural systems that lack resources to address drinking water issues. UC Davis human ecology professor Jonathan London and postdoctoral fellow Carolina Balazs are studying the progress of state efforts to integrate some of these disadvantaged communities into regional water management planning.

Ultimately, sustainable groundwater management is an issue that goes well beyond California. “This is about how we grow 40 percent of our agricultural production in the world,” said groundwater specialist Thomas Harter. “That’s how much comes out of irrigated landscapes globally from places that look very much like California and, more importantly, that feed most of the people in this world. Figuring this out in California is critical.” — JS

THE TRADITION CONTINUES

More than 500 people gathered Friday, October 2, 2015 for the 27th annual College Celebration.

Held each year at harvest time, College Celebration honors recipients of the Award of Distinction with a ceremony followed by a festive reception of good food, libation, and camaraderie. Mark your calendars for October 14, 2016, when we assemble once more to reflect on the achievements of our college and our impact on California and the world.

PHOTOS BY: TJ USHING/UC DAVIS

1- THE FARMERS MARKET, always a crowd pleaser, offers a sampling of California's agricultural bounty that people take home at the end of the evening.

2- WITH CA&ES DEAN HELENE DILLARD (second from left), 2015 Award of Distinction recipients include (left to right) Jeff Smith (friend of the college), David Ginsburg (staff), Jacqueline Beckley (alumna), Chris van Kessel (faculty), Tom Smith (alumna), Chuck Nichols (alumna), and John Meyer (friend of the college).

3- COLLEGE CELEBRATION is a time to catch up with others and enjoy delicious catered and donated food and drink, as well as campus produced items such as UC Davis olive oil and Russell Ranch dried tomatoes.

4- CHANCELLOR EMERITUS LARRY VANDERHOEF (seated, front), attended the 2015 CA&ES College Celebration. Also shown (left to right) are: Karen Moore, John Meyer, CA&ES Dean Helene Dillard, and Rosalie Vanderhoef. Sadly, Chancellor Vanderhoef died just two weeks later on October 15 at the age of 74.





JOHN STUMBOS/UC DAVIS

Celebration of Advising Excellence – Staff adviser Melissa Whaley and Professor Ed DePeters received the Eleanor and Harry Walker Advising Award at a campus reception. From left to right are Dean Helene Dillard, Associate Dean Sue Ebeler, Eleanore Walker (seated), Melissa Whaley, Ed DePeters, and the Walkers' daughter, Laurie Walker-Whiteland.

LISTEN UP

Ed DePeters and Melissa Whaley selected for Walker Advising Awards

ANIMAL SCIENCE PROFESSOR ED DEPETERS and environmental science and policy staff adviser Melissa Whaley are the 2015 recipients of the Eleanor and Harry Walker Advising Award. The award supports and recognizes excellence in advising in the College of Agricultural and Environmental Sciences.

Whaley is the staff adviser in the environmental policy analysis and planning (EPAP) major, and is co-adviser for the environmental science and management (ESM) major. She is known for being proactive in reaching and retaining students and works hard to increase connections between faculty advisers in her department and current students and alumni. She coordinates an annual career event for ESM majors that provides opportunities for students to meet with alumni and student-selected professionals.

At an awards reception in May, Whaley shared a story about reassuring one student who walked into her office with tears in her eyes. "It's one of the reasons I love advising," she said. "It doesn't matter how smart you are. School is hard."

DePeters is a professor in the Department of Animal Science and serves as the master adviser for the animal science major. Students cite his positive influence on their lives. He developed an annual advising training program for faculty advisers and guides new faculty

in honing their advising skills. He also manages the Animal Science Advising Center.

DePeters said there are three keys to being a successful faculty adviser:

- Have a passion for helping students achieve academic and career goals
- Be a good listener
- Have a coaching philosophy to praise students when they're doing well but also to give them advice when they're not doing well

"It's more of a gentle approach for me," he said. "We want to make a difference in the lives of our students."

The late Harry O. Walker was a professor in the Department of Land, Air and Water Resources for more than 40 years. He was a strong supporter of advising and served as a master adviser for undergraduate students.

"One of my areas of interest is natural resources, and young people with active minds are our most important 'natural resources,'" Walker once said. "We as a community have an opportunity, as well as a responsibility, to maximize the capabilities of these individuals."

— John Stumbos

FACULTY ON BOARD

CA&ES faculty take a whistle-stop tour

TO GIVE NEW FACULTY MEMBERS A SAMPLING OF WHAT our region has to offer, CA&ES and UC Agriculture and Natural Resources organized a two-day bus tour in September before fall classes began. Seasoned faculty members and UCCE county advisors acted as tour guides. Stakeholder visits gave our newest faculty — who are recruited from throughout the world — a view of some of the opportunities for research partnerships here in California.



“I was exposed to the scale of industry that California agriculture allows – previously I had not appreciated a bigger-than-single-farm view of agriculture here. It was also a constructive opportunity to meet and chat with other young or new academics.”

—**Matthew Gilbert**
Assistant Professor,
Department of Plant
Sciences



@Sierra Nevada Brewing Company

“I found it to be particularly useful to meet new specialists and advisors whom I had not had the chance to interact with yet. The local and regional contacts these folks have are essential for my ability to connect with growers, ranchers, agency personnel, and other members of the general public.”

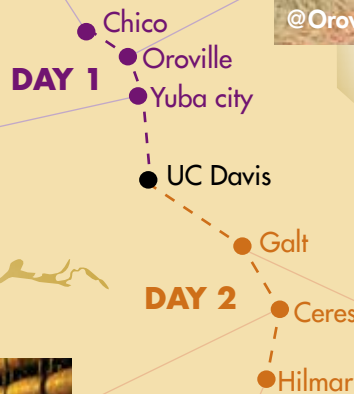
—**Roger Baldwin**
Assistant UC Cooperative Extension specialist,
Department of Wildlife,
Fish and Conservation
Biology



@Oroville Dam



@Charley Matthews Farm



@Cosumnes River Preserve



@Bronco Wine Co.



@Hilmar Cheese Company

“The trip provided me with a deeper understanding of the needs of our community, the research on campus, and the way in which UC Davis is addressing today’s problems. I was fascinated by every single stop and visit. I felt like a kid again, going on a school field trip and taking time from the daily grind to learn something completely new in an engaging, hands-on way.”

—**Leah Hibel**
Assistant Professor, Department of Human Ecology



In a Sacramento Valley creek, Professor Sam Sandoval Solis (holding stadia rod) and CA&ES students collect data as part of a study of California waterways. Left to right, Dennise Alatorre, Sherman Peng, Sandoval, and Belize Lane gather information that will be used to build a web-based map detailing the ecological characteristics of various rivers.

SAM'S STUDENTS

Participating in fieldwork is the high-water mark of summer

ENVIRONMENTAL SCIENCE STUDENTS HAD an opportunity to study water at the source last summer, as they accompanied Professor Sam Sandoval Solis to collect data on California rivers and streams.

Belize Lane, a graduate student in hydrology, is working with Sandoval on research to characterize various “reaches” of California rivers and their impact on the local ecology. As a former river guide, Lane was inspired to study hydrology by the ecological degradation she observed along waterways. “I was interested in learning about the science behind the problem — and fixing the problem,” she said.

By measuring water depth, channel width, and other landscape features, the research team learns more about the health of the local ecosystem. The data they collect will be compiled in a web-based map that characterizes

natural streamflow and sediments in rivers. This study will enable state water professionals to make more informed decisions about environmental water management.

Sandoval recruited help for the project from the undergraduates enrolled in his water science and management class, ESM 121. His top student, Dennise Alatorre, interned for Sandoval over the summer and organized multiple expeditions to collect information on waterways. She also trained undergraduates and other research recruits to use a handheld GPS and navigation equipment needed to gather data.

A first-generation college student from Bakersfield, Alatorre said, “This work has given me a different perspective on water. Every drop counts.”

— Robin DeRieux

GARRY'S GANG

Greenhouse interns cultivate new skills outside the classroom

STUDENTS WHO ARE INTERESTED IN A greenhouse internship with Garry Pearson need more than just a passion for plants. They need persistence.

Sophomore greenhouse intern Ariana Ramzian said it took several email inquiries before she heard back from Pearson, who serves as the lead greenhouse manager for the College of Agricultural and Environmental Sciences. Her persistence paid off, and Ramzian has been an intern at the west campus greenhouses since spring quarter of her freshman year.

An undeclared sophomore from Bakersfield, Ramzian is interested in a career on the business side of plants. In the greenhouses, she has helped cross-pollinate transgenic tomatoes and participated in research to develop a robotic cultivator for weeds.

"Garry doesn't just give us a task to do — he explains the way plants work, and he shows us around different greenhouses and labs on campus," said Ramzian. "I've gotten to see parts of campus I never would have visited otherwise."

"He explains the way plants work, and he shows us around different greenhouses and labs on campus."

Plant sciences senior Scott Malain became interested in plants as a biology student at his local community college in Redding, California. He transferred to UC Davis and pestered Pearson until he landed a greenhouse internship.

Malain prefers to work with plants indoors, where temperatures and humidity are controlled. Unfortunately, insects and diseases that attack plants also thrive in the climate-controlled confines of greenhouses. So one day per month, Malain inventories 162 greenhouses and related structures on the UC Davis campus. He takes photos, checks for insects and other problems, and reports back to Pearson.

As an intern, Malain gets plenty of experience applying what he's studied in entomology, plant pathology, plant sciences, viticulture, and related sciences. "In the classroom, it's very theoretical," said Malain, who intends to work in plant breeding after graduation. "In the greenhouse, you have to learn to solve problems using a variety of strategies."

— Robin DeRieux

GREGORY URQUIAGA/UC DAVIS



"I give interns the backlot tour of UC Davis," said Pearson, (above left), with Ariana Ramzian.

GREGORY URQUIAGA/UC DAVIS



"Garry is a goldmine of knowledge, and he knows everyone," said Scott Malain, (above right). "Everyone."



Resource manager Kent Nelson has worked on a wide variety of environmental issues in the Central Valley, the Delta, and beyond. He also is involved in the creation of an ecologically sustainable residential community in Costa Rica called Alazan.

SAVING THE SALTON SEA

Alumnus leading efforts to build critical habitat management areas

KENT NELSON (B.S., '83, WILDLIFE AND fisheries biology) has seen his share of environmental issues in a long career in resource management. But nothing has proven more formidable than the challenge he's dealing with now at California's "lost orphan lake."

Nelson manages the Salton Sea Restoration Program for the California Department of Water Resources (DWR). The "Sea" is actually a shallow, saline lake in the Imperial and Coachella valleys that was inadvertently created in the early 1900s when the Colorado River burst through an irrigation project and flooded the Salton Sink for two years. By midcentury, the remaining Salton Sea had become a popular fishing and boating destination. More than 400 species of birds use the area.

The urgency stems from an agreement among Colorado River users that allows water to be transferred to coastal urban areas.

However, deteriorating environmental conditions in the Salton Sea, California's largest lake, now threaten the region's public health, agriculture, recreation, economy, and wildlife unless management actions are taken. "Time is running out," Nelson said. "There

have been many renditions of planning, preferred alternatives, and ideas that have been swirling around and promoted by the federal government, by locals, the Salton Sea Authority, and the state of California, but the pressure's on."

The urgency stems from an agreement among Colorado River users that allows water to be transferred to coastal urban areas, diminishing agricultural irrigation runoff that replenishes the Sea. The agreement requires mitigation water be provided to the Salton Sea through 2017. After 2017 less water will flow into the Sea, which will shrink its size, increase salinity, and threaten tilapia — a fish that is the main food source for migratory piscivorous birds.

The first step toward restoration is moving forward, however, and Nelson is leading the team of consultants and engineers who are developing a pilot project of managed ponds. This winter DWR and the California Department of Fish and Wildlife will partner with the Imperial Irrigation District to construct a 640-acre species conservation habitat project, part of a larger plan to create sustainable habitat for tilapia and the birds that depend on them.

"The state has commitments to the Salton Sea that we need to meet," Nelson said. "Restoration is part of the stakeholder deal that governs Colorado River deliveries to California and water transfers out of the Imperial Valley to coastal communities."

— John Stumbos

PAYING IT FORWARD

Devotion to agriculture leads to gift from animal science educator

LISA NASH HOLMES (B.S., '86, ANIMAL SCIENCE; M.S., '88, animal science) appeared to be a typical city girl surrounded by the beaches and city life of San Diego. But at a young age she discovered agriculture was in her blood.

“My mother started me riding horses at age eight,” she said. “I always loved livestock and horses.”

Holmes entered the UC Davis animal science program in 1982.

“From day one as an animal science major, you’re involved,” she said. “Animal Science I opened up so many things for me. It’s an introductory course, but I learned about the big picture of animal science. It set the tone for me. Everything was hands-on and I just loved going to class every day.”

Holmes thrived as a student and quickly found on-campus employment upon graduation. She worked in the animal science advising center, and then in a laboratory with a mentor, Professor Ed DePeters. For the past 21 years

“I’ve been in their shoes and I know how it is, so I wanted to be able to help them out. ”

she has been the Department of Animal Science teaching coordinator, taking care of the animals, making sure laboratories are properly equipped, and training teaching assistants. She also supervises the advising center.

“We have so many students, labs, and classes, it gets really busy and the things I do are so varied,” she said.

“It makes my job exciting because every day is different.”

Holmes knows that succeeding in college can be a financial struggle for students and their families. “I’ve been in their shoes and I know how it is, so I wanted to be able to help them out,” she said. “I want them to

continue in animal agriculture, and I hope they go on to educate others about animals.”

She planned on donating to the department once she retired, but a conversation with DePeters persuaded her to take action sooner rather than later. In 2013 she established an award for undergraduates — the Lisa Nash Holmes Award in Animal Science — with a match from CA&ES Dean’s Circle funds.

“Now I get to witness firsthand how students are reaping the benefits of my gift,” she said. “It’s rewarding to see how appreciative the students are and to be able to keep up with them on a daily basis.”

— Charleen Floyd

ROBIN DERIEUX/UC DAVIS



As the Animal Science Advising Center supervisor and a staff research associate, Lisa Nash Holmes has a love for animal agriculture that made giving back to UC Davis a no-brainer.

If you are interested in learning more about the many giving opportunities within the college, please contact Mark Foncannon, CA&ES director of development services at mjfoncannon@ucdavis.edu or 530-752-0150.



COURTESY OF GAMBRINUS COMPANY

Gambrinus Company brewmasters meet with company founder Carlos Alvarez at Spoetzl Brewery in Shiner, Texas. From left to right are Tom Fiorenzi, Gambrinus director of brewing operations; Jimmy Mauric, brewmaster at Spoetzl Brewery; Carlos Alvarez; Jeff Edgerton, brewmaster at BridgePort Brewing Company in Portland, Oregon; and Lars Larson, brewmaster at Trumer Brauerei in Berkeley, California.

CHEERS TO CARLOS

Generous gift from craft beer maker to educate future brewers

BREWING EDUCATION AT UC DAVIS HAS COME a long way since Lucky Lager donated a small brewery to campus 56 years ago. In June the brewing science program received a huge boost when Carlos Alvarez, founder and owner of The Gambrinus Company of San Antonio, Texas, gifted \$1 million to help fund new brewing and laboratory equipment.

Gambrinus is a leader in craft brewing with three independent and distinctive breweries: the Trumer Brauerei in Berkeley, California; BridgePort Brewing Company in Portland, Oregon; and the Spoetzl Brewery in Shiner, Texas, which is home of the iconic Shiner Bock beer.

“As an immigrant from Mexico, I have enjoyed the many opportunities I found in this country,” Alvarez said, “and I’m very happy that success in the beer business enables me to help in UC Davis’ efforts to educate future craft brewers.”

Brewing education at UC Davis dates back to 1959 when the Lucky Lager Brewing Company of San Francisco donated a small brewery and launched a teaching program with the Master Brewers Association. As student interest grew, additional companies began supporting the program. In 2011 brewing science moved into the world-class facilities at the Robert

Mondavi Institute for Wine and Food Science.

“This fantastic donation from Carlos Alvarez will allow us to develop our teaching and research capabilities in a way that surpasses anything I could have imagined when I first came to the university in 1999,” said Charlie Bamforth, Anheuser-Busch Endowed Professor of Malting and Brewing Sciences. “I salute Mr. Alvarez’s dedication to education and am thrilled about what we will deliver with his contribution.”

Alvarez is a graduate of the Monterrey Institute of Technology in Monterrey, Mexico, with a degree in biochemical engineering. As export manager for Grupo Modelo, he led the launch of Corona in the United States. In 1986 he founded The Gambrinus Company and became the importer for Corona and the Modelo portfolio for the next 20 years, developing Corona into the No. 1 imported beer and a leading global brand.

Alvarez is deeply committed to education and has contributed to educational institutions across the United States, with a particular focus on scholarship funding. He also has provided generous support to the brewing program at Oregon State University.

— Charleen Floyd and UC Davis News Service

HERBARIUM GIFT

Love of plants blossomed into successful career for botany alumna

WHEN SHE WAS A YOUNG GIRL, SHIRLEY (Cotter) Tucker (Ph.D., '56, botany) spent many a day studying plants along the banks of the Mississippi River. Those experiences led her into a long and distinguished career studying floral morphology, plant systematics, and lichens.

“My earliest memories are of collecting and looking for plants with my parents,” she said. “The spring was really such a lovely time. A lot of things would come into bloom.”

Tucker went on to earn her bachelor’s and master’s degrees in botany at the University of Minnesota. Drawn by renowned plant anatomist Katherine Esau, she headed west to UC Davis to earn her doctorate.

“She was a real role model for a woman student,” Tucker said. “She excelled in her research on the vascular tissue of plants. She helped me a lot.”

Davis is also where Shirley met future husband Ken Tucker, an entomology graduate student. They eventually settled in Baton Rouge, where Ken worked on honey bee genetics for the USDA. Shirley became a Louisiana State University (LSU) botany professor and eventually a Boyd Professor, an honored chair position.

Tucker was one of the first scientists to receive a grant from the National Science Foundation. During her career, she studied many plants, including magnolia, peppers, and legumes. She published extensively and served as president of the Botanical Society of America and the American Society of Plant Taxonomists.

“A strong herbarium is a nucleus to maintain botany as a science. Unfortunately, quite a few herbaria around the country have disappeared, but Davis is one place where you can get a complete education in botany.”

At LSU she also started a course in lichens. “That was a treat because then I could take the classes out, do some collecting, and spread the good word about



ELLEN DEAN/UC DAVIS

Trailblazing botany alumna Shirley (Cotter) Tucker retired to Santa Barbara 20 years ago with husband and fellow alum Ken Tucker after a long and distinguished career studying plants. She showed her support for the UC Davis herbarium with a gift to create a staff position in the Center for Plant Diversity.

lichens,” she said. “Lichens are beautiful and they’re there all the time.”

She also collected lichens throughout the U.S. and abroad, amassing a collection of 50,000 specimens at LSU. After the Tuckers retired to Santa Barbara in 1995, she helped the local botanic garden develop its collection of California lichens. Sadly, Ken passed away in 2014.

The Tuckers have generously supported many institutions, including UC Davis. Shirley recently made a gift for a three-year staff position to assist the herbarium curator in the Center for Plant Diversity. The herbarium, a library of pressed and dried plants, is under the College of Agricultural and Environmental Sciences and the College of Biological Sciences and is located in the Sciences Laboratory Building.

“A strong herbarium is a nucleus to maintain botany as a science,” Tucker said. “Unfortunately, quite a few herbaria around the country have disappeared, but Davis is one place where you can get a complete education in botany.”

— John Stumbos

INVEST WISELY

Endowments expand faculty capabilities and provide student support

ENDOWED CHAIRS AND PROFESSORSHIPS are an essential part of the academic landscape. An endowment provides much-needed financial support for scholarly activities, teaching, and public service, and is an honor for the chair holder. Endowed faculty positions are possible only because of the generosity of donors who believe strongly in the need to support an area of study that will benefit society.

One example of an endowed chair is the Dennis G. Raveling Endowed Waterfowl Chair, established 20 years ago to ensure a permanent funding source to study the habitat needs and population dynamics of waterfowl populations, with an emphasis on agricultural lands in California.

“With continuing urban growth, a changing agricultural landscape, and increasing demands for water, the need for waterfowl research, teaching, and outreach is even greater today than it was 20 years ago,” said wildlife professor John Eadie, who holds the Raveling chair.

The Raveling endowment was established in memory of the late waterfowl researcher and UC Davis professor by individuals, foundations, corporations, and others. The endowment has been

“Endowing a professorship or chair leverages a lot of resources. You get all of his or her students who end up going into the field.”

especially valuable in providing support for research by graduate and undergraduate students. Interest income generated from this endowment in the 2014–15 academic year helped pay for graduate student fees and stipends, undergraduate research assistants, field and laboratory supplies, and travel to field locations, conferences, and meetings.

Research has been focusing on the effects of drought on waterfowl and wetlands. One project evaluated land-use and water-allocation decisions along the Pacific Flyway. Field studies measured changes in body condition of birds during a year when severe drought



JOHN STUMBOS/UC DAVIS

Students (left to right) Melissa Jones, Mitch Hinton, Theresa Wisneskie, Rob Blenk, and Celeste Pelletier examine the plumage of a male wood duck with wildlife professor John Eadie, who initiated a captive rearing and research program for wood ducks.

reduced foraging habitat. Other research is taking place at an experimental wetland at Roosevelt Ranch in the Sacramento Valley.

“Endowing a professorship or chair leverages a lot of resources,” said alumnus Peter Stent, who led the effort to establish the Raveling chair. “You get all of his or her students who end up going into the field. This endowment is supporting applied research to help birds, but just as importantly it’s about the next generation of waterfowl scientists.”

Creating new endowed faculty positions is a high priority for the College of Agricultural and Environmental Sciences. To learn more about the existing endowed chairs and professorships, visit caes.ucdavis.edu/connect/giving/impacts/ended-chairs. To learn more about opportunities for new endowed faculty positions, please contact CA&ES assistant dean Christine Schmidt at cmschmidt@ucdavis.edu or 530-752-6414.

— John Stumbos



Animal Science 142, Companion Animal Care and Management, brings in guest speakers to discuss animal husbandry and management. Left to right, students Navdeep Dhillon, Mayra Preciado, and Jazmin Jordan, with Professor Anita Oberbauer, examine a Mini Lop rabbit used for pet therapy.

THE CAT'S MEOW

Scholarship will help students of companion and captive animals

CA&ES AND THE DEPARTMENT OF ANIMAL Science recently established a scholarship fund specifically for undergraduate students in the companion and captive animals specialty.

That's good news for aspiring veterinarians and scientists who will take care of dogs, cats, and other pets. Undergraduate students in the companion and captive animals specialization make up the majority of animal science majors.

The students in this specialization take courses such as Companion Animal Biology, Companion Animal Care and Management, Comparative Animal Nutrition, and the Ethics of Animal Use, along with

courses in genetics, physiology, reproduction, and growth. Many students also participate in research and internships with animal science faculty, some of whom are associated with the Center for Companion Animal Health at the UC Davis School of Veterinary Medicine.

Your investment in these students will help ensure their success and the future of research and teaching for the health, nutrition, and quality of life for pets. You can make a gift online at give.ucdavis.edu/Go/CompanionAnimalsF15 or contact the CA&ES Development Office at 530-752-1639.

—Mark Foncannon

SERIOUSLY, WE'RE LISTENING

ALL RECENT DONORS TO THE CA&ES Annual Fund were sent a postcard asking them to complete a survey. If that's you, please check the fridge or the "I'll get to it later" pile on your desk, and log on to tell us how you would like to see your gift put to work.

The CA&ES Annual Fund is an unrestricted account designated to support some of the college's highest priorities. The fund is used at the discretion of the college dean. Over the years, it has helped fund student development and outreach programs such as Aggie Ambassadors, startup grants for new faculty, and student travel to national academic conferences. Current funding commitments designated by Dean Helene Dillard include undergraduate and graduate student scholarships.



Dean Dillard has identified some other opportunities for the Annual Fund to support this year, but we'd like to hear what YOU think is important. Please complete the survey at tinyurl.com/ucdsurvey15. Because, seriously, we're listening.

—Mark Foncannon

CA&ES Outlook

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DEAN'S CIRCLE SCHOLAR

NATHAN JAYNE is grateful for CA&ES annual fund support. A senior majoring in biotechnology, he is a two-time recipient of the Dean's Circle Scholarship. The CA&ES annual fund supports three \$5,000 scholarships each year to entering community college transfer students, as well as up to three \$5,000 renewed scholarships to the prior year's recipients.

"As a transfer student, I had a multitude of worries about paying my college expenses," Nathan says. "This scholarship put my fears to rest."

Because of the generosity of our donors, deserving students like Nathan can fulfill their dreams of a college education. After earning his bachelor's degree, Nathan plans to pursue a doctoral degree and eventually find employment as a researcher at a biotechnology company.

"I just want to say thank you to all involved," Nathan adds. "Your continued support means the world to me."

caes.ucdavis.edu/giving