CA&ES

# Outlook

# SIZING UP NATURE

## How we are helping conserve biodiversity in California

COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES • UC DAVIS • SPRING/SUMMER 2012

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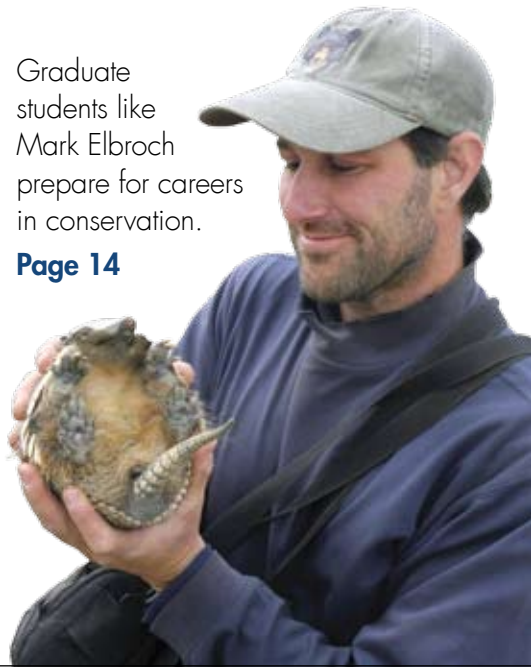
THIS ISSUE

**Cover story:** Conservation biologist Brian Todd holds a Mojave desert tortoise, one of hundreds of species in California threatened or endangered by habitat loss and human activity. UC Davis scientists are helping protect the state's rich heritage of biodiversity, which includes an estimated 433 bird species, 197 mammals, 135 reptiles and amphibians, 67 freshwater fishes, 28,000 insects, and 5,047 native plant species, many of which are found only here. **Page 4**



ON THE COVER: Ted Grosholz, the Alexander and Elizabeth Swantz Endowed Specialist in Cooperative Extension, examines the effects of an invasive *Spartina* cordgrass on native *Spartina* (pictured) and other organisms in San Francisco Bay.

Cover photo by John Stumbos/UC Davis



Graduate students like Mark Elbroch prepare for careers in conservation.

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OUTLOOK SPEAKER SERIES

## SAVE THE DATE

Join us Thursday, May 10, 2012, to hear faculty experts featured in this issue of *CA&ES Outlook* speak on the challenges of conserving California's rich array of biodiversity. The event will be held from 4–6 p.m. at the UC Davis Conference Center. Visit http://outlookspeaker.ucdavis.edu for more information.

MEIJA NAFUS/UC DAVIS

# AT THE CROSSROADS OF CONSERVATION

**CALIFORNIA IS A RICH TAPESTRY OF** terrestrial and aquatic ecosystems containing more biological diversity than any other state in the nation. We are also a state with 38 million people. Meeting human needs while protecting our natural heritage is a big job.

At UC Davis, we contribute to this effort by focusing the lens of research on our natural resources, educating students about conservation issues, and providing science-based information for sound policies that preserve and enhance biodiversity. In this issue of *CA&ES Outlook* we examine some of this work.

One of the most troubled species in California is the delta smelt, an endangered fish that lives only in the waters of the Sacramento-San Joaquin Delta. The Delta also is the hub of California's complex water system. Understanding the biology of this protected species is crucial. For more than 20 years our scientists have been studying the delta smelt. Fisheries professor emeritus Joe Cech pioneered laboratory techniques in our unique research facilities. Nann Fangue, a newer faculty member in the Department of Wildlife, Fish and Conservation Biology, continues research on the biology of this fish.

## Meeting human needs while protecting our natural heritage is a big job.

Conservation biologist Brian Todd studies habitat requirements of the Mojave desert tortoise, protected under the Endangered Species Act. The tortoise's desert habitat is threatened by roads and human encroachment, and potentially by new solar power installations. Todd's research may help protect this iconic desert species while allowing for important renewable energy generation.

Protecting plants that grow on rare serpentine soils is important to conserving the diversity of California flora. Environmental science and policy professor Susan Harrison is an expert on serpentine landscapes, which harbor a significant number of endemic plant species. Given the limited distribution and unique characteristics of serpentine plants, Harrison is studying their vulnerability to climate change.

Invasive species pose an enormous threat to California's natural environment. Yellow starthistle infests millions of acres, crowding out native grasses, depleting soil moisture, and hindering native oaks. UC Davis Cooperative Extension specialist Joe DiTomaso works with resource agencies to control this and other damaging weeds.

MARK SCHWARTZ/UC DAVIS

During a tour of the university's Quail Ridge Reserve in Napa County, Dean Neal Van Alfen and UC Davis Chancellor Linda Katehi are shown a California newt by professor Marilyn Ramenofsky of the College of Biological Sciences.

Zebra mussels and quagga mussels are invasive freshwater organisms that pose significant threats to waterways—natural and man-made. Ted Grosholz, environmental sciences professor and Cooperative Extension specialist, studies the biology of a number of invasive organisms in marine and estuarine systems and works with water management groups to limit damage caused by mussels.

In this issue, we also report on other faculty research, alumni past and present who are making a difference in the world, and an innovative certificate program giving our graduate students new skills to deal with real-world conservation challenges. We hope you enjoy learning about how your university is meeting some of the important challenges of our day.

NEAL VAN ALFEN, DEAN
COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Our scientists are working hard to restore California's landscape and to prevent further decay

# Protecting paradise

**Story by Ann Filmer, John Stumbos and Robin DeRieux**

California's deserts, mountains, rivers, wetlands, woodlands, and coastal areas provide habitat for an amazing assortment of biological diversity—more than any other state in the nation. Amidst this species richness, however, are numerous challenges to preserving California's biological diversity.

Population pressures have created conflicts with plants and animals, as the number of people living in California has doubled to 38 million since 1965. Habitat degradation, human encroachment, invasive species, competition for natural resources, and other threats have taken their toll. Resource agencies have designated more than 2,500 species with special status such as rare, threatened, or endangered. Efforts to prevent these species from trending further toward the brink involve a wide range of strategies—from conservation planning to habitat preservation and restoration. UC Davis, ranked first nationally in environmental research, plays a significant role in conservation efforts through its scientific research, education, and outreach. As the examples in the following pages illustrate, our scientists can be found gathering field data, conducting laboratory experiments, and engaging public and private stakeholders to help protect the state's great wealth of biodiversity for the future.

JOHN STUMBOS/UC DAVIS

UC Davis scientists conduct field research to track the health of California's native flora and fauna. The experiment pictured here is documenting how an invasive species of *Spartina*, a salt marsh cordgrass, facilitates the invasion of other non-native species such as the ribbed mussel *Geukensia*.


Professor Ted Grosholz (right) and graduate student Elizabeth Wells hold specimens of invasive European green crabs. His research in California estuaries documented dramatic changes in native clams and crabs from predation by the invasive green crabs.

# Invasive species alter ecosytems

Many of California's introduced species—plants, animals, insects, aquatic organisms—cause little harm, but some have marked impacts on ecological systems, agricultural production, and human well-being.

Preventing non-native species from becoming invaders is important, as is early control. Once a species becomes invasive, it is difficult and expensive to control, so early detection is critical.

## AQUATIC SYSTEMS

Invasive aquatic and riparian species can have broad ecological impacts, affecting populations of fish, shorebirds, and marsh plants, and altering functions of lakes, watersheds, floodplains, and coastal ecosystems.


Zebra Mussels

AMY BENSON/ U.S. GEOLOGICAL SURVEY

Estuarine ecologist Ted Grosholz, a professor and Cooperative Extension specialist (Department of Environmental Science and Policy), is an expert on invasive species, including the European green crab and the hybrid cordgrass *Spartina*. His research addresses the ecological impacts of these organisms on native oysters and shellfisheries, marshlands, and riparian habitats.

Grosholz's education outreach is addressing two invasive, freshwater Eurasian mussels—zebra mussels and quagga mussels—that could have a profound impact on California's lakes and water distribution systems.

The two quarter-sized mussels showed up in California six years ago. They attach themselves to water conveyance systems—pumps, pipes, dams, aqueducts, fish hatcheries—and proliferate. According to Grosholz, "our drinking water and agricultural irrigation systems could be shut

JOHN STUMBOS/UC DAVIS

down quickly by these organisms."

Southern California water districts are coping with the mussels, which are now in watersheds, and in Colorado River reservoirs and canals. There is tremendous concern about their potential spread into Lake Tahoe, and they have recently shut down a reservoir near San Jose.

Zebra and quagga mussels pose a serious ecological threat in California. In the Great Lakes they have removed phytoplankton—a food source for juvenile fishes—thereby impacting the food web. They have also concentrated the environmental contaminant botulism, resulting in massive deaths of ducks and shorebirds.

Aquatic invasive species are moved long distances by ships—in ballast water, hulls, and attached to ships' surfaces. Within California they can be moved by recreational and fishing boats, and trailers.

"Once aquatic species are introduced, the cat is out of the bag—they spread easily, and they're very difficult to control," notes Grosholz. Since the state doesn't have the resources to adequately enforce mussel control, areas such as Clear Lake and Fallen Leaf Lake are establishing local mandatory vehicle and boat inspection programs.

Grosholz works closely with resource agencies and other organizations to develop programs aimed at identifying and reducing the spread of invasive aquatic organisms. "It's important to increase awareness of these species because they're such a problem," says Grosholz. "Their impact on ecosystems is big, and early control is very important."

## INVASIVE WEEDS

Of the 1,500 non-native plants in California, about 200 species are invasive in natural areas, and 40 of those are highly invasive and disrupt ecosystems. These invasive weeds can transform environments and change ecosystem functions, impacting other plants, insects, and wildlife within the system.

Joe DiTomaso, a Cooperative Extension specialist (Department of Plant Sciences), researches the ecology and control of invasive plants, many of which don't respond to their new California environment as they do in their native areas. He works with resource agencies, landowners, and the nursery industry on education to prevent and manage yellow starthistle, perennial pepperweed, medusahead, salt cedar, and other invasive plants.

Yellow starthistle is California's most invasive plant, occupying a whopping 10–14 million acres. Starthistle moves into grasslands, outcompeting the grasses because of its ability to draw on deep soil moisture.

Starthistle also inhibits native oak seedlings from establishing in grassland areas. "Starthistle uses so much of the water in the soil profile that it creates a local drought, even in times of normal rainfall," says DiTomaso, a national expert on yellow starthistle. "In areas infested with yellow starthistle, you no longer see a lot of native live oak seedlings."

California's most invasive weed also creates economic problems because cattle and sheep don't want to forage amid spiny starthistle plants. Livestock will graze on young starthistle, but not once the plants get spiny. The weed has a tremendous impact on grazing and rangeland, as it does on recreational and hiking areas.

GUY KYSER/UC DAVIS

Joe DiTomaso treads carefully through spiny, chest-high yellow starthistle plants.

Preventing establishment of non-native plants is paramount. The collective work of researchers, government resource agencies, and the public is necessary to build an effective prevention program. "We need to understand what plants are likely to be introduced, the problems they will cause, and their pathways of spread," says DiTomaso. "If you understand all of this, you can build an invasive-weed prevention program.

"We need to establish a strong Early Detection Rapid Response program, such as the Centers for Disease Control has. Investing money *now* will save a lot more money in the long run. We're making progress, but it's slow." — AF

Joan Lindberg, manager of the Fish Conservation and Culture Laboratory, checks a fish tank at an operation rearing the endangered delta smelt for research purposes. **See sidebar**

# Research sheds light on imperiled fish

UC Davis scientists are conducting research on some of the state's most imperiled fish species, including the poster child for an ecosystem in trouble—delta smelt.

This little-finger sized fish lives only within the reaches of the Sacramento-San Joaquin Delta. Its population has dropped precipitously from relatively abundant a few decades ago to the brink of extinction today, placing it on both state and federal endangered species lists.

One of the first to conduct laboratory research on delta smelt in the 1990s was fisheries professor Joe Cech (now emeritus), who learned quickly how sensitive the tiny fish are. Cech found delta smelt would die with exposure to air, so he, students, and colleagues, developed innovative methods for capturing and retrieving the fish from the wild. Instead of a dip net to lift the smelt from the water, for instance, they used plastic bags on net frames, like little tea cups, to transfer the fish to bags of oxygenated water.

"We learned to treat them very carefully," Cech said.

Back at the laboratory, Cech and associates examined biological factors such as temperature tolerance, salinity tolerance, and swimming performance. Another project examined the delta smelt's vulnerabilities to screens used to protect fish from getting sucked into water diversions. Working with university and resource-agency engineers, Cech's team videotaped smelt under different water flows in an innovative circular flume dubbed a "fish treadmill."

Much of this work occurs in the laboratories and fish tanks of the college's Center for Aquatic Biology and Aquaculture (CABA).

"It's important to have reliable facilities with good infrastructure, cold water, and experienced, knowledgeable staff to do this kind of research," said CABA director Lisa Thompson, a UC Cooperative Extension specialist. "I liken it to being an intensive care unit for fish. If the water temperature changes too much or if you lose water flow from the pumps, those fish could be dying

JOHN STUMBOS/UC DAVIS

within minutes."

Professor Nann Fangue, a physiologist specializing in fish ecology, is continuing the thread of laboratory research begun by Cech. In addition to physiological measurements, she and a team of graduate students and research colleagues, use molecular approaches to address how changes in temperature, salinity, and turbidity affect delta smelt at different life stages.

"We manipulate environmental conditions such as temperature to simulate real-world challenges facing these fish in the estuary," she said. "We then assess behavioral and physiological responses with tools such as water-tunnel testing of swimming and molecular testing to measure changes in bodily function. This will tell us something about how well these animals are likely to fare in a changing estuary."

JOHN STUMBOS/UC DAVIS

Professor Nann Fangue (left), who specializes in fish ecology, conducts research on delta smelt in facilities of the Center for Aquatic Biology and Aquaculture, managed by Paul Lutes.

Fangue and environmental engineering colleagues are also studying the "bioenergetics"—food requirements—of delta smelt. "You need to know how they feed, how much they eat, what their rate of digestion is, and how changing environmental factors might affect these processes," she said.

By understanding optimal conditions for delta smelt in a laboratory setting, scientists can then model conditions delta smelt need to swim, grow, and reproduce in the wild. "Once we have a better sense of what they need, we can ask whether we have those habitats available in nature, and if not, we must develop conservation strategies to enable the persistence of these special fish," Fangue said. — JS

## RAISING DELTA SMELT FOR RESEARCH

Laboratory research on live delta smelt wouldn't be possible today were it not for the determination of Joan Lindberg, a UC Davis researcher who manages the Fish Conservation and Culture Laboratory (FCCL) near the Delta town of Byron.

CALIFORNIA DEPARTMENT OF WATER RESOURCES

In 1992 delta smelt were proposed for listing as a threatened species, and Lindberg, who earned her doctorate at UC Davis working on sturgeon aquaculture, thought a supply of the smelt for research would be useful because so little was known about the fish.

"I figured we could probably raise them," she said. "I didn't know what I was getting myself into."

She and a colleague set out in a boat on winter nights in search of delta smelt. They eventually found a few dozen near Cache Slough—not many, but enough to learn that captive delta smelt could be spawned, hatch, and grow. But, for the first few years, the fish never matured to adulthood.

"We got better and better survival to older and older life stages," she said. "So we figured the next year, we'll get it."

And they did. The FCCL now turns out thousands of reared delta smelt each year for use by researchers at UC Davis and the state and federal agencies seeking knowledge that could help stave off the fish's demise.

In 2007 the lab embarked on a new effort to preserve the genetic diversity of delta smelt—a "refugial" captive population with managed breeding. UC Davis geneticists Bernie May and Kathleen Fisch designed the breeding strategy, while Lindberg and FCCL staff keep track of fish groups and cross the fish when ready.

The refugial population is entering its fifth successful year. "I think it's one safeguard for delta smelt," she says. "But I don't think it's a silver bullet. The problem is there's still something wrong with the Delta." — JS

# Conserving native flora

Plants that survive in serpentine soil are rare by nature. They grow in small patches where seismic forces have shoved serpentine rock to the earth's surface in outcroppings that weather to a harsh soil—poor in nutrients and rich in toxic elements.

Professor Susan Harrison stands on a serpentine slope, home to rare plants that are adapted to harsh soil conditions.

Serpentinite is a hard rock to call home, but more than 200 rare serpentine plant species grow in California that are found nowhere else in the world. The state's serpentine outcrops are clustered in the Coast Ranges, the Sierra Nevada foothills, and the Klamath Mountains. Typically, they support sparsely vegetated communities with plants that are quite distinct from surrounding vegetation on nonserpentine soils.

"I visualize them as little jewels scattered around the landscape," said Susan Harrison, a UC Davis professor of environmental science and policy. "One serpentine outcrop can have a very different set of species from another, partly because of the spatial separation."

In California, more than 10 percent of the endemic plant species—those unique to a particular region—grow only on serpentine, even though serpentine soil makes up less than 2 percent of the state's surface area. Serpentine landscapes are less likely to have been affected by invasive species since most exotic species are unable to tolerate the hardship. "People look at serpentine areas and think of them as useless brush," said Harrison. "But these serpentine communities contribute a lot to the biodiversity of California."

With funding primarily from the National Science Foundation, Harrison and colleagues are conducting field research on serpentine species, including long-term sampling studies and analysis of stress tolerance adaptations. One area of investigation is the vulnerability of serpentine plants to climate change. Their loss would dramatically diminish plant diversity in California.

"Since they're stuck on small islands of special soils—with little potential to migrate—we wonder if serpentine endemics will be the early victims of climate change," said Harrison. "On the other hand, maybe their stress tolerant traits will make them the hardy survivors." — RD

# Tortoise territory

An ancient species, the Mojave desert tortoise has evolved over eons to endure extreme temperatures and sparse rainfall. The harsh landscape inhabited by the tortoise is also well suited to the generation of solar energy. Solar installations in the Mojave Desert that reduce California's carbon emissions may be good for the globe—but not so good for the tortoise, which is protected by the Endangered Species Act.

"Renewable energy is frustrating for conservation biologists," said Professor Brian Todd of the UC Davis Department of Fish, Wildlife and Conservation Biology. "We recognize it as one of the most effective ways to combat greenhouse gas emissions and global climate change, yet at the local level, we know it may have a considerable impact on habitats and species."

On the edge of the Mojave National Preserve—a protected area administered by the National Park

The population of the Mojave desert tortoise has declined due to the impact of human activities on its habitat.

BRIAN TODD/UC DAVIS

Service—herpetologist Todd and collaborators Tracey Tuberville and Kurt Buhlmann of the University of Georgia are conducting various studies to help restore the population of the Mojave desert tortoise. Listed as a threatened species by the federal government in 1990, it has declined due to various factors that include habitat loss, roadway mortality, and an increase in predation by ravens and coyotes.

At the Ivanpah Desert Tortoise Research Facility, a seven-acre facility built by Chevron Environmental Management Co. and scheduled for donation to the National Park Service, Todd and fellow researchers have begun a 15-year study that will protect vulnerable tortoise hatchlings in captive, semi-natural conditions until the tortoises grow large enough to have a greater chance of survival upon release into the wild. Nearby, the world's largest solar thermal power plant began construction in 2010. Tortoises displaced by construction are slated for relocation to other areas. Some hatchlings from displaced females will be incorporated into Todd's recovery work with juvenile tortoises.

In addition, Todd and his colleagues are investigating whether fencing along roadways helps limit tortoise road mortality in a study funded by the U.S. Bureau of Land Management. The California Energy Commission has funded a four-year project to explore mitigation options and to identify which plants, landscape features, and other aspects of the desert habitat are most important to survival of the tortoise.

"If we can identify which resources the animals are using, then new energy installations may be guided away from the most sensitive areas," said Todd. "Through knowledge of the landscape, we can limit the impact of development." — RD

# FERTILE GROUND

## Meet the tiny nematodes that play a big role in soil ecology

ROBIN DERIEUX/UC DAVIS

Professor Howard Ferris studies the ecosystem services provided by nematodes and other organisms that make up the soil food web.

**AN ENTIRE ECOSYSTEM EXISTS WITHIN THE** soil beneath our feet. Left undisturbed, soil contains a world of microscopic organisms that include bacteria, fungi, protozoa, and nematodes—tiny roundworms that live in the water films surrounding soil particles.

Ferris calls the beneficial nematodes that feed on plant-parasitic nematodes "the lions and tigers of the soil."

While some nematodes are pests of plants and animals, others are beneficial species that enrich the soil in agricultural systems and help control plant-parasitic nematodes. UC Davis nematology professor Howard Ferris wants growers to know that sustainable agricultural systems need nematodes.

"I'm interested in the role of beneficial nematodes in the soil food web and their importance in providing ecological services for the soil," said Ferris. "Some nematodes feed on bacteria and excrete excess nitrogen in mineral form as ammonia, which plants can take up. The nitrogen becomes available to plants through nematode activity."

Other beneficial nematodes are predators, which feed on plant-parasitic nematodes and help keep their numbers under control. Ferris dubs these "the lions and tigers of the soil."

Nematodes form "functional guilds" with other soil organisms that share similar biology and perform the same ecosystem services. Because nematodes are easier to extract from soil than other organisms, they serve as good biological indicators of how the entire soil food web is performing. — Robin DeRieux

### IN CENTRAL AMERICA, *LOS NEMATODOS*

Last summer, nematology professor Howard Ferris traveled to Nicaragua to extend information on the importance of nematodes in agricultural ecosystems to a group of 18 Central American professionals. Ferris collaborated on a one-week short course with Ignacio Cid del Prado, who completed his doctorate in nematology at UC Davis in 1982 and is now a professor in Mexico.

The two instructors covered the biology and management of nematodes that feed on the roots of coffee and banana plants. They also focused on soil ecology so that participants understood the role of beneficial nematodes. Ferris and Cid del Prado are making plans to offer the course again in summer 2012.

"I think we're making wonderful advances in sustainable agriculture here in Davis," said Ferris. "But I feel there is a need for outreach to agricultural scientists and growers in different parts of the world, where food isn't necessarily being produced in a sustainable manner." — RD

JUAN CASTELLON/UNIVERSIDAD NACIONAL AUTÓNOMA DE NICARAGUA, LEÓN

In Nicaragua, biologists and other professionals learned about managing agricultural systems to reduce pesticide usage in order to preserve beneficial nematodes and similar soil organisms. While some nematodes feed on the roots of coffee and banana plants, others help enrich the soil.

# MADE IN THE SHADE

## Solar project is a cool proposition for California's nursery industry

**HEINER LIETH SEES A GREENER FUTURE FOR** California's $2.85 billion nursery industry with solar energy.

The UC Davis plant scientist has been conducting research in an experimental shade house similar to those used by the industry to protect container plants from weather extremes. Uniquely designed solar collectors atop the shade house allow light to filter through to plants while simultaneously generating electricity.

The project began in 2009 when the solar energy company Solyndra approached Lieth about possible nursery industry applications. "It seemed to me that it was feasible to use their technology as part of a shade house," Lieth said. "We wanted to see how it would affect the plants. It's conceivable that if you change the light environment, you get plants that stretch too much, or if you take away too much light they would not grow as well."

"This has the potential to help solve the global warming problem. If you were to take large expanses of agriculture and put this over it and still grow plants, you would be making enough electricity to displace huge amounts of what's currently used with fossil fuels."

Rather than typical solid flat panels, the Solyndra solar panels are modules of parallel, spaced, photovoltaic tubes. This design projects alternating bands of shadow and light onto the plants below. The zebra-like pattern shifts throughout the day as the sun moves across the sky. Lieth compared this with a conventional cloth-covered shade house that provides uniform shading throughout the day. Each of these cast 35 percent shade. A third testing area with more narrowly spaced solar tubes cast 70 percent shade.

JOHN STUMBOS/UC DAVIS

Plant sciences professor Heiner Lieth has been studying the potential for using specially designed solar panels in nursery shade houses.

Lieth conducted 60 to 70 trials, initially with nursery crops but also with strawberry plants and leafy green vegetables. "We quickly realized that quite a few plants, especially citrus, were doing equally well," he said.

How is it possible to get equivalent plant growth with less light? Lieth suspects it might have to do with a phenomenon visible under the panels: an intense arc of light reflecting off the modules. Or the alternating light and shadow patterns may be generating more plant productivity than expected.

The project has created tremendous interest from scientists, government officials, farmers, and photovoltaic companies. Although Solyndra is no longer in business, Lieth believes the technology will be resurrected by another company because of its potential to allow both crop production and electricity generation from the same land.

"This has the potential to help solve the global warming problem," Lieth says. "If you were to take large expanses of agriculture and put this over it and still grow plants, you would be making enough electricity to displace huge amounts of what's currently used with fossil fuels. The key is to find out which plants will be productive and how to optimize the solar panels for plant and electricity production."
— John Stumbos

# BEYOND THE BLUE HORIZON

Story by John Stumbos

## Graduate program preparing students for conservation work

UC Davis graduate student Kristy Deiner (above right) and Dave Herbst (above left), a research biologist with the Sierra Nevada Aquatic Research Laboratory, take samples of aquatic insects in Sequoia National Park. Deiner's research focuses on the evolutionary impact of introduced fish on alpine lake communities in the Sierra Nevada and in the Alps of Switzerland.

**A PROMISING DEGREE CERTIFICATE PROGRAM IS GIVING** UC Davis graduate students essential skills to tackle challenging careers in conservation management.

Mark Schwartz, an environmental science and policy professor, sees no shortage of people interested in protecting, maintaining, and restoring the earth's ecosystems. "The problem is the way students are trained to be professionals," he said. "Academic institutions are very good at training people to be like us—academics—and that historically has been the emphasis in graduate programs."

Surveys of students entering the Ecology Graduate Group (EGG) found that most of them were interested in jobs with resource agencies and nongovernmental conservation organizations.

"In order to make them effective at conservation management jobs, we need to train students in environmental decision making and how people engage stakeholders in making decisions about resources," Schwartz said.

With a grant from the David and Lucile Packard Foundation, Schwartz and fellow EGG faculty launched the Conservation Management Program in 2008. The program is guided by four core principles:

- A strong foundation in ecology, including skills in statistics, experimental design, and quantitative ecology
- Training in the social sciences of human ecology and environmental policy

## INSIGHT INTO CONSERVATION PLANS

Kristy Deiner, a doctoral candidate in ecology pursuing the conservation management certificate, is focused on how social, biological, and economic factors influence the development of strategic conservation plans.

"The Conservation Management Program expanded my knowledge beyond that of the natural sciences because of the cross-training in social and political aspects related to conservation," she says. "This new perspective has allowed me to evaluate and confidently expand my career goals beyond conservation biology research."

Deiner evaluated how local governments developed conservation plans under California's Natural Community Conservation Planning (NCCP) Act. This gave her the opportunity to survey politicians and analyze social networks. Working with people who implement conservation policy at the state level gave her additional insight into the political process.

"The skills I learned during my internship with the NCCP program have led me to think about ways I can incorporate them into my own research on the effect of introduced trout on alpine lake biological communities," she said.

- Development of practical skills for decision making, planning, and communication
- Skill integration and application toward real conservation problems

"Our objective is to provide rigorous training in aspects of conservation management outside the routine of a strictly research-based doctorate in the sciences," Schwartz says.

Students from any UC Davis graduate group are eligible to participate. One course in the program is a class on ecosystem management that examines the policy process, the role of leadership and advocacy, and stakeholder engagement in resource management.

Another examines different decision-making frameworks used by conservation organizations such as The Nature Conservancy and the Wildlife Conservation Society. Students must also participate in a group project with fellow students.

Alumnus Matt Muir, now with the U.S. Fish and Wildlife Service, found the networking opportunities in the program to be quite valuable. "I met several key people who either later hired me or who I remain in professional contact with—people who I likely never would have crossed paths with during my dissertation," he said. "The program definitely defined the next stage of my career and launched me into all the jobs I've had since graduation."

Upon completion of the coursework and group project, students are eligible for the degree certificate

## TRACKING A CAREER IN WILDLIFE CONSERVATION

Mark Elbroch, a doctoral candidate in ecology pursuing the conservation management certificate, is interested in increasing the involvement of local communities in conservation work and in mitigating conflicts between humans and large carnivores like mountain lions.

The opportunity to become involved in a program that emphasized applied conservation work was a strong draw for Elbroch. It provides both the academic structure to learn skills useful to conservation careers, and the opportunity to join with others who feel that "conservation is a worthy ambition in and of itself."

Elbroch's team worked with the organization CyberTracker Conservation to analyze data collected by an indigenous animal tracker in South Africa. Their recently published analysis formed a case study illustrating the benefits of including local experts in conservation projects.

Elbroch values the Conservation Management Program's emphasis on social skills to communicate with broad audiences and leadership required to see conservation projects succeed. "For those of us who believe that conservation projects are a greater priority than theoretical science, we are no longer left to learn to swim on our own," he said.

Mark Elbroch is pictured with an anesthetized 10-month-old male puma. His dissertation research focuses on the influence of pumas on endangered huemul deer in Chilean Patagonia and is providing some of the first evidence that pumas play positive roles in natural systems.

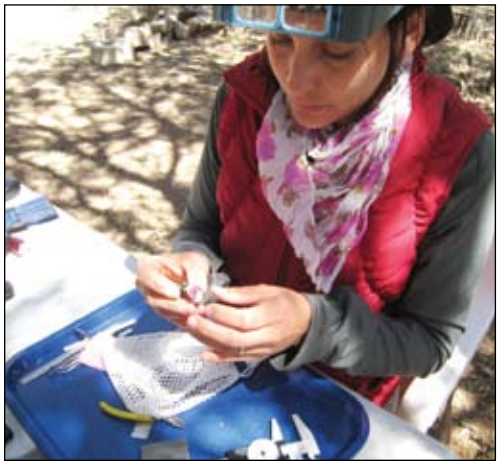
## VETERINARIAN RETOOLS FOR CONSERVATION WORK

Loreto Godoy, a doctoral candidate in ecology pursuing the conservation management certificate, is a veterinarian from Chile who wants to reorient her career toward wildlife conservation.

She said the Conservation Management Program is giving her the broad overview she needs to understand all the components involved in the conservation process, especially related to management and policy.

Godoy and fellow students Casey Peters, Levi Sousa, and Yu Zhan are conducting research on how volunteers involved with the Land Trust Alliance can best be used for monitoring and data collection. The students are developing a survey linking specific attributes of organizations and their volunteer monitoring programs to the success of their projects.

"Our goal is to use this survey to create a portfolio of best practices that can be used to maximize the benefits and minimize the costs of volunteer-based monitoring," she says.



Loreto Godoy's dissertation research involves the population structure and health status of Anna's Hummingbird in California. Skills she learned in the program have come in handy working with volunteers at bird-banding stations.

Professor Mark Schwartz developed the Conservation Management Program for graduate students.

as an addendum to their graduate degree. Although the program was developed with doctoral students in mind, master's students also are eligible. To date, 35 students have completed or are nearing completion of the program.

The certificate program builds on the university's outstanding reputation in conservation biology. A study reported in the journal *Conservation Biology* in 2007 noted that UC Davis was the top-rated university among 315 evaluated for scholarly productivity in the field.

"We have a lot of people interested in the application of ecological knowledge to conservation," Schwartz says. "It is easier for us to succeed when our campus is a global leader in the environment and our ethic is one that encourages students to engage in solving problems."

## AN ADVOCATE OF CITIZEN SCIENCE

Tavis Forrester, a doctoral candidate in ecology pursuing the conservation management certificate, believes that "citizen scientists" have an important role in conservation work.

"Graduate education needs to prepare people for the large needs of conservation and our society, and this program is a good step in that direction," he said. Forrester believes effective conservation work requires the ability to communicate science, to make personal connections with people to build networks and coalitions, and to use planning to prioritize goals and allocate limited resources.

**Forrester**

Along with education professor Heidi Ballard, he teamed with fellow graduate students Susana Cardenas and Erin Hardie on a project that utilized volunteers—citizen scientists—to monitor blue oaks across different grazing schemes on private ranches and Audubon California land. They trained volunteers, established plots, and gathered monitoring data.

"I am very glad I was part of the conservation training program not only because of what I learned," Forrester said, "but also because it created a culture where the focus on applied conservation was accepted and encouraged."

# A WILD IDEA

## Student-led project seeks to build awareness of UC Davis wildlife

**"WILD CAMPUS"—A STUDENT-INSPIRED** initiative to educate the UC Davis community about local wildlife and to create new habitat for cavity-nesting birds and other species—is taking flight.

"We aspire to involve as many students and members of the community in wildlife conservation as possible," said Quinn Morgan, a senior in the Department of Wildlife, Fish and Conservation Biology and the group's founder and president. "Our goal is to help craft beautiful regenerative landscapes to benefit wildlife in the central campus, arboretum, Putah Creek Riparian Reserve, and Russell Ranch."

"I have personally witnessed drastic changes in the composition of native populations in and around Davis. This was a primary motivation for starting this group."

The project involves 10 undergraduate student teams—almost 50 students—working closely with more than a dozen faculty mentors and campus staff to build, study, and maintain appropriate wildlife habitats for owls, songbirds, bats, bees, amphibians, and reptiles. Projects are closely supervised to ensure no unintended consequences for existing wildlife or potential adverse human health effects.

In February students held a "Build-a-Wild-Home Day," co-sponsored by the UC Davis Arboretum, with ready-to-assemble kits for installation on campus. Local community members have also been invited to install wild homes on their properties. Students involved in the Wild Campus initiative will be at Picnic Day on April 21 to help raise awareness about the project's activities. And a "Wild Family Day" for all ages is planned for the arboretum Wyatt Deck on May 20.

Morgan, who grew up in Davis, was inspired to create the organization by his own experiences with local wildlife. "Since childhood, I've been a naturalist at heart and to this day I have maintained that passion for wildlife," he says. "I have personally witnessed drastic changes in the composition of native populations in and around Davis. This was a primary motivation for starting this group."

Senior Quinn Morgan is president of Wild Campus, a student group committed to improving wildlife habitat on university grounds and in the Davis community.

The initiative got a boost this year when Wild Campus was awarded a "Go Green" grant from UC Davis Dining Services. The funds have been used to purchase supplies for owl boxes, songbird boxes, native bee "condos," and materials for educational events.

To learn more, check the Wild Campus Facebook page at www.facebook.com/MyWildCampus or email them at WildCampus411@gmail.com.

"There's no stopping Quinn," said Morgan's faculty advisor, wildlife professor John Eadie. "He's clearly tapped into a vein of student interest in participatory science and stewardship of the campus. Hands-on activity is a huge part of the educational experience."
— John Stumbos

# KEEPING CARBON IN THE GROUND

## Alex Moad and UC Davis are partners on climate change

**THE UC DAVIS REPUTATION FOR** interdisciplinary problem solving was what first attracted Alex Moad to campus as a graduate student. Decades later, interdisciplinary collaboration brought the conservationist back to campus to lead an international seminar on climate change.

A forest ecologist, Moad serves as assistant director of the U.S. Forest Service International Programs Office in Washington, D.C. The office works with foreign countries on projects such as conserving forest biodiversity, managing protected areas, and emergency response training. Recently, Moad also has been involved with international climate change efforts to maintain and restore carbon sinks in forests around the world by preventing deforestation and degradation.

"Climate change is *the* defining issue for forest management in the 21st century," said Moad. "UC Davis has been a pioneer in the integration of different disciplines. If there was ever an issue that requires interdisciplinary cooperation, it's climate change."

During the early 1980s, Moad completed a master's degree in forest ecology and development economics at UC Davis—sandwiched between studies at other universities and work abroad. Moad graduated from UC Berkeley, did conservation work in Mexico, and came to UC Davis for graduate studies before moving on to complete a doctorate in biology at Harvard University.

"Working in Mexico, I realized that natural resource management was driven by socioeconomic factors, not just technical issues, so I wanted to learn more about the interface between forest management and development," said Moad. "At the time, there were very few universities that did multidisciplinary degrees. The ecology graduate group at UC Davis was an exception."

Nearly 30 years later, Moad renewed his ties to campus when the U.S. Forest Service began searching for a partner to co-host an international seminar on climate change. After considering various academic institutions, Moad and his colleagues selected UC Davis. The Information Center for the Environment (ICE)—a research lab directed by environmental science and policy professor Jim Quinn—collaborates on the seminar, which will be taught for the third time in May.

The International Seminar on Climate Change and Natural Resources Management is an intensive three-week course that accepts 20–24 participants from around the world, primarily representing developing countries with extensive forest resources. After a week in Washington, D.C., and two weeks in California, participants develop climate change action plans to implement in their home countries. — Robin DeRieux


In Yosemite, Moad discusses the challenges of managing natural resources during an era of climate change.

# NEW TECHNOLOGY TAKES ROOT

## Alumnus Russ Lester is a pioneer in sustainable walnut farming

**RUSS LESTER ('77, BOTANY) IS REINVENTING** what it means to farm sustainably.

He is a native of the Santa Clara Valley, where his family had farmed since the 1880s. With urbanization gobbling up farmland during his formative years, Lester briefly considered career paths other than agriculture when he arrived at UC Davis.

"But I realized that what I really wanted to do was to grow great food for folks, like our family has done for a long, long time," he said.

Lester found his way to the botany department to study plant ecology and was exposed to ideas that would shape his systems approach to farming. He learned about integrated pest management, which emphasizes beneficial insects and reduced chemical use.

"I began to ask whether we needed pesticides at all. Because we lived in the middle of an orchard, I wondered whether they might pose a threat to the health of my family."

After graduation, he and his wife, Kathy, bought a run-down almond orchard near Winters. Today it's a 400-acre certified organic walnut operation, Dixon Ridge Farms.

"I wanted to see what kind of ecological principles could be wedded into agriculture," he recalls. He experimented successfully with reduced insecticide rates to control peach twig borer in almonds and found the practice reduced flare-ups of spider mites and aphids.

"I began to ask whether we needed pesticides at all," he said. "Because we lived in the middle of an orchard, I wondered whether they might pose a threat to the health of my family."

With advice from UC Davis researchers, Lester developed an orchard cover crop mixture to help increase beneficial insects. Perennial plants near the orchard also provide habitat for beneficials.

Another innovation in Lester's orchard is an "upside-down sprinkler system" elevated off the ground several feet. The system is water and energy efficient, enhances frost control, and facilitates mowing weeds beneath trees.

JOHN STUMBOS/UC DAVIS

Russ Lester is a certified organic walnut grower who utilizes innovative technologies that make his operation a model of sustainability.

Lester also tapped an abundant renewable energy source—walnut shells. In 2007 he installed a 50 kilowatt biogas-powered generator that produces nearly $50,000 worth of electricity a year.

"It takes our walnut shells and gasifies them to produce a combustible gas and heat that we use to dry our walnuts and produce electricity," he said.

Other energy improvements have included solar photovoltaics, motion-sensitive lighting, and retrofitting diesel motors with electric.

Between energy production and efficiency projects, Lester has reduced overall energy usage by 45 percent. His goal is to become 100 percent energy self-sufficient.

"Agriculture can do an incredible amount to produce its own energy," he says. "We have the capability. We just need to spend more time doing research on what that means and how to do it with the 350 crops we raise in California." — John Stumbos


Senior Noelani Velasquez sends greetings from New Zealand. "The 'thank you' was addressed to all those who believed in me, encouraged me, and refused to let me give up on myself when times were hard," she says. "A university education is absolutely not impossible because of people like Lloyd Swift and the range of other donors who put so many young thinkers through this university."

# SWIFT SCHOLARS

## Endowment supports undergraduate wildlife and fisheries students

**NOELANI VELASQUEZ WILL GRADUATE THIS** year with a double major in wildlife, fish and conservation biology and in sociocultural anthropology. It's an achievement she is proud of and one that would please Lloyd Swift, an alumnus who attended the university nearly a century ago.

"Though a university education was a dream of mine since childhood, my mother never had the means of paying for it," she said. "The Lloyd W. Swift scholarship eased the burden."

In the last decade, more than 180 UC Davis students—Swift Scholars—have been helped by the endowment created when Swift donated 325 acres of his family's cattle ranch to support undergraduates interested in wildlife and fish conservation.

"My father would be very pleased that this scholarship has helped so many students," said Swift's daughter, Clara Ailes. "He wanted particularly to support freshmen and sophomores getting started in their educations."

Born in 1904 and raised in the Sierra Nevada foothills, Swift came to UC Davis—then the University Farm—90 years ago. "When I read that four-year students were to be accepted at Davis for the fall of 1922, I borrowed the family car and drove from my home in Latrobe, El Dorado County, to the campus," he recalled in the fall 1998 CA&ES Outlook.

The "bashful country kid" met with Professor Elmer Hughes, who admitted Swift on the spot. Horticulture seemed a likely calling but fruit tree pruning on cold

winter days and exposure to lime sulfur spray changed his mind and his course of study—to range science, a decision that led him to UC Berkeley for a bachelor's in 1927 and a master's in 1930.

Upon graduation Swift joined the U.S. Forest Service and worked in range and wildlife management in California and the Rocky Mountains. In 1942 he moved to the agency's Washington, D.C. office and eventually became the agency's highest-ranking wildlife biologist. Under his leadership, the Forest Service expanded its focus to include habitat improvement for fish, upland game birds, fur-bearing animals, and vanishing species. He retired in 1963 as director of the Division of Wildlife Management yet remained very active as a consulting biologist for many years.

During his time as a university student, Swift made lifelong friendships with students and professors alike—fellow graduate student Emil Mrak, who eventually became chancellor, as well as Provost Stanley Freeborn, and Dean Knowles Ryerson. "The names of some of these people are on campus buildings today," he recalled years ago. "Seeing them reminds me of my good years at UC Davis."

In 1999 Swift gifted the ranch to UC Davis. "It is my desire to recognize the contribution that UC Davis has made to my life and at the same time to encourage undergraduate students to study and pursue careers in wildlife and fish conservation as was my good fortune," he wrote to the college. His generosity established the Lloyd W. Swift Student Support Endowment, one of the largest endowments for CA&ES undergraduates. The endowment grew with a bequest when Swift passed away in 2001.

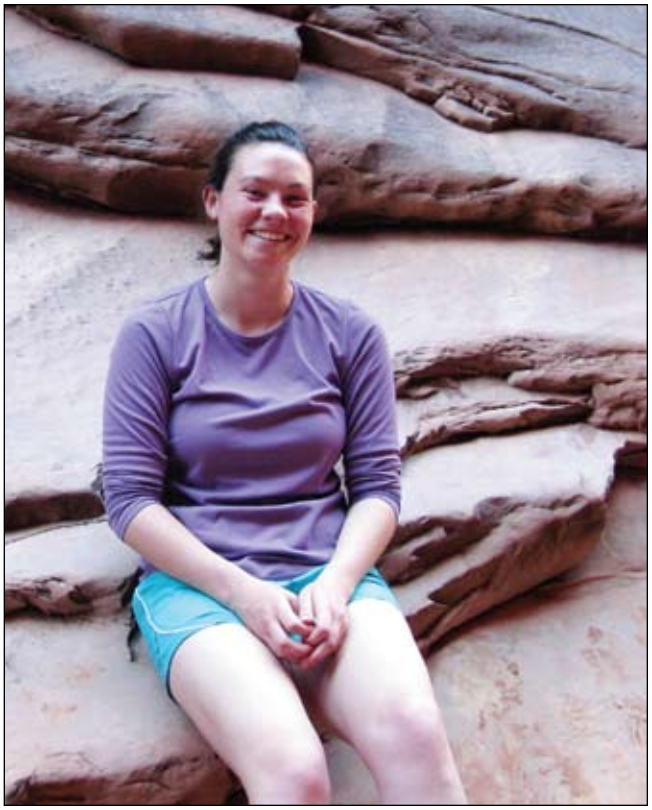
Managed by the Department of Wildlife, Fish and Conservation Biology, the endowment is used in three ways. First, scholarships typically ranging from $2,000 to $3,000 are offered to promising incoming students. "These scholarships provide an important recruitment tool to help convince students who might be undecided about where to pursue their education," said wildlife ecology professor and department chair Douglas Kelt.

**Lloyd Swift**

Freshman Elise Zarri is a Swift Scholar. "Although my parents have been saving for my college fund since I was young, the Swift scholarship has helped out greatly by offsetting the rising cost of tuition that we had not factored into our savings," she said.

A smaller number of scholarships are offered to upper division students. The funds also help cover costs associated with an intensive field course in wildlife ecology (WFC 101). The course gives students the opportunity to learn research techniques, collect data for projects, and write peer-reviewed scientific reports.

"The foresight and generosity of the Lloyd Swift family has allowed our department to provide tangible incentives to incoming students, as well as support for particularly worthy upper division students," Kelt says. "In this manner it has contributed importantly to the future of California's natural resources. It also made possible the development of a capstone course where students learn and apply field methods in a unique immersion setting."



Freshman Elise Zarri takes a break during a family rafting trip in the Grand Canyon last summer. She says "the Swift scholarship has helped out greatly by offsetting the rising cost of tuition that we had not factored into our savings."

Velasquez, a first-generation university student, has made the most of her educational opportunity—active in service clubs, living a "conscious, sustainable lifestyle," and spending a year studying organic agriculture, environmental policy, and society and the environment in New Zealand. "Though I have yet to decide exactly what I want to do after I graduate," she said, "I know that I will continue on the path of social-environmental fusion, most likely in the fields of public awareness, education, social/environmental law, and grassroots initiatives."

Swift's son, Lloyd Swift, Jr., knows his father's legacy is making a difference. "I enjoy the letters we receive from students," he said. "Though their interests often change, the fact that they have some firmly held goals would please my father." — John Stumbos

## Wildlife

# Study aims to put the brakes on roadkill

Researchers with the UC Davis Road Ecology Center (REC) hope to reduce roadkill by capturing, tracking, and monitoring deer on Interstate 280.

Deer are a common sight along the freeway, which runs through heavily wooded areas, rolling hills, and grasslands between San Francisco and San Jose. Working with California Department of Fish and Game, project scientists in December tranquilized and fitted 15 deer with radio tracking collars. An additional 30 deer may be added to the study before its completion in May 2013.

Lead scientist and REC co-director Fraser Shilling says roadkill along the freeway will be monitored and 50 wildlife cameras will be used to photograph wildlife safely crossing the highway using culverts and bridge underpasses. "The goal of the study is to develop strategies to reduce collisions between wildlife and automobiles," Shilling said.

The study is funded by a grant from the federal Transportation Enhancement Program. Every year, about 300,000 collisions occur nationwide between vehicles and wildlife, resulting in 200 human deaths and 26,000 injuries. Deer strikes alone cost more than $8.5 billion annually.

The Road Ecology Center aims to improve transportation systems by better understanding the impact of roads on natural ecosystems and human communities. It is a program of the UC Davis John Muir Institute of the Environment.

A deer uses the Edgewood Park undercrossing beneath Interstate 280, keeping it safe from freeway traffic. The San Francisco Bay Area freeway is the site of a research project by the UC Davis Road Ecology Center.

UC Davis plant scientist Jim Hill (right) who directs the $14 million USDA grant to strengthen Afghanistan's agricultural extension system, works with agriculturists in Jalalabad.

## Food Security

# Giving Afghanistan agriculture a boost

With a $14 million grant from the U.S. Department of Agriculture, UC Davis will lead an effort with other land-grant universities to help Afghanistan strengthen its agricultural extension system and stabilize its agriculture-based economy.

"Thirty years of conflict have left Afghanistan's agriculture far behind much of the world and with little capacity to improve it," said project leader Jim Hill, a UC Davis Cooperative Extension specialist and CA&ES associate dean for international programs. "Our job is to help build the capacity of the extension system to connect with Afghan farmers and provide them with good technical information."

The project seeks to develop a viable agricultural extension system in a country where 80 percent of its workforce is involved in agriculture.

Approximately $5 million of the grant will support UC Davis–based work. The remainder will be awarded to Purdue University, Washington State University, University of Maryland and other land-grant universities. The project seeks to develop a viable agricultural extension system in a country where 80 percent of its workforce is involved in agriculture.

The aim is to improve household food security and increase income through professional training in such areas as postharvest technology for grain and fresh-market produce, conservation agriculture for wheat production, horticulture on the urban fringe, and practical management of livestock and poultry.

## Sustainability

# Conservation practices benefit agriculture

A UC Davis study of several ranches in Mendocino County demonstrates the benefits of managing agricultural landscapes for both production and habitat conservation. Plant ecologists evaluated carbon stocks and woody plant diversity across organic vineyard blocks and in adjoining wildlands belonging to Fetzer/Bonterra Vineyards. Their research was reported in the journal *Carbon Balance and Management*.

"The results of this study clearly indicate that agricultural systems that include a mosaic of both natural vegetation and planted crops can yield significant environmental benefits," said lead author John Williams, a postdoctoral researcher in the Department of Environmental Science and Policy. Williams worked with the laboratory of Louise Jackson, a professor and Cooperative Extension specialist in the Department of Land, Air and Water Resources.

Information about carbon stocks also may help land managers qualify for greenhouse gas mitigation credits. Carbon policy in California is currently more focused on emissions, Williams says. Correcting this shortcoming could create incentives for ecosystem services such as carbon storage and encourage better farm stewardship and habitat conservation.

"All too often, natural ecosystems are rapidly lost in regions where intensive agriculture becomes economically successful," Williams added. "We need land-use policies to include incentives making it economically viable for landowners to develop and manage complex agricultural landscapes."

A study of Mendocino County vineyards demonstrated the value of maintaining a mosaic of natural vegetation and planted crops.

UC Davis and NOAA researchers collect Pacific herring embryos from the San Francisco Bay.

## Ecology

# Bodega Marine Lab study turns up oil spill surprise

A study by the UC Davis Bodega Marine Laboratory (BML) and the National Oceanic and Atmospheric Administration found that an oil spill in the San Francisco Bay in November 2007 had an unexpectedly lethal impact on Pacific herring, a commercially and ecologically important species.

The container ship Cosco Busan spilled 54,000 gallons of bunker oil into the bay after it collided with the San Francisco–Oakland Bay Bridge. The spill contaminated spawning habitats for the largest West Coast population of Pacific herring, one of the last urban fisheries in San Francisco.

Researchers assessed the health and viability of herring embryos from oiled and unoiled locations. Their findings, published in the *Proceedings of the National Academy of Sciences* in January, revealed that components of bunker oil accumulated in naturally spawned herring embryos, then interacted with sunlight during low tides to kill the embryos. Bunker oil is a thick fuel oil distilled from crude oil.

The study points to the extreme vulnerability of fish in early life stages and suggests that even small oil spills can have a large impact on marine life. It also indicates that common chemical analyses of oil spills may be inadequate.

"Our research represents a change in the paradigm for oil spill research and detecting oil spill effects in an urbanized estuary," said study co-author and BML director Gary Cherr, a professor in the Department of Nutrition.

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# THE CAMPAIGN FOR UC DAVIS


## Mark Lundy is helping rice farmers grow more with less.

Lundy, who studies international agricultural development and horticulture and agronomy, has seen firsthand how rural farmers in developing countries depend on rice to feed families, earn a living, and stave off poverty. With the help of the William G. Golden, Jr. and Kathleen H. Golden International Agriculture Fellowship—a $114,000 endowment that has supported 44 students and grown to more than $900,000—Lundy is researching ways to increase rice production while reducing herbicide use.

"Knowing how to improve the productivity of rice," says Lundy, "puts you in position to help farmers in any area of the world."

THE CAMPAIGN FOR UC DAVIS

**caes.ucdavis.edu/giving**