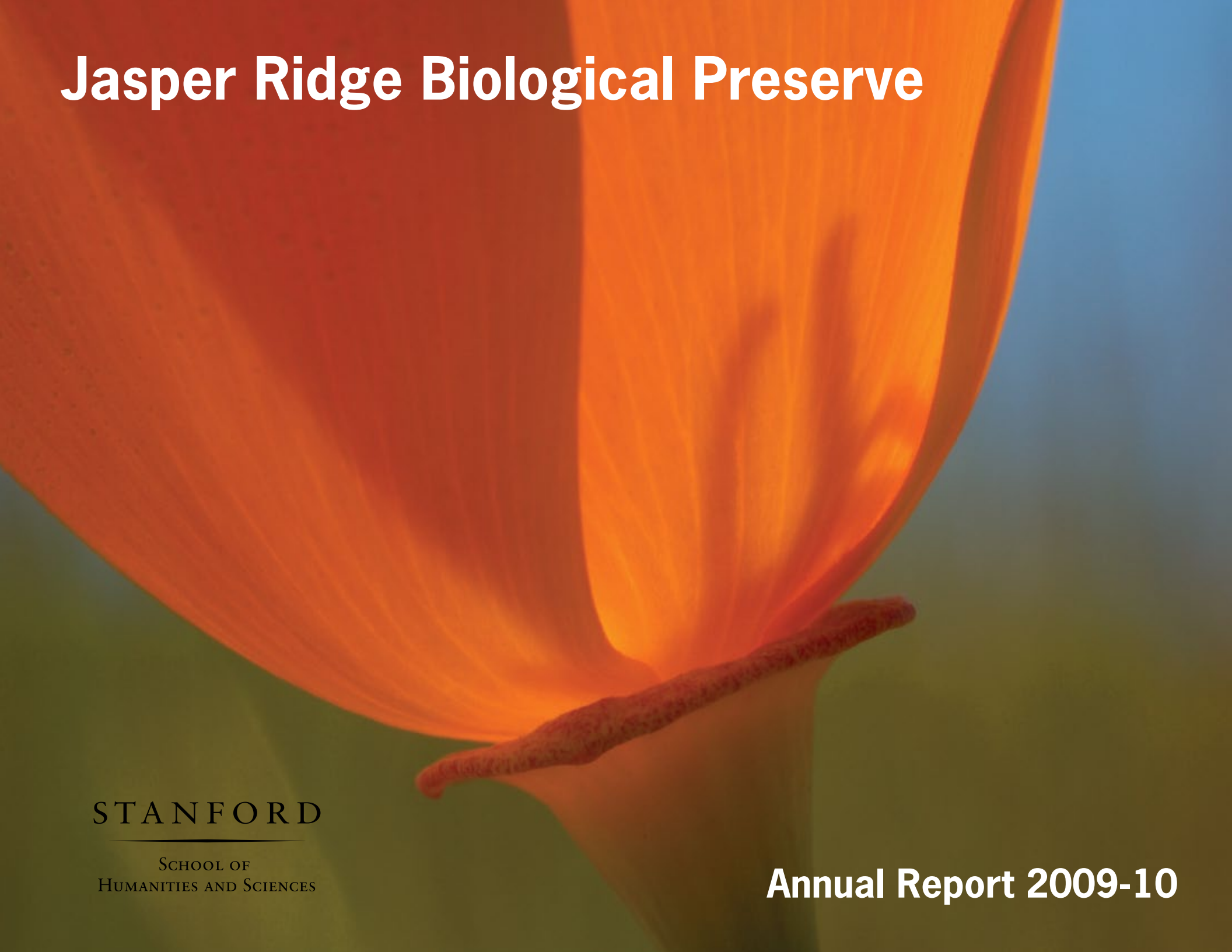
Jasper Ridge Biological Preserve



STANFORD

School of Humanities and Sciences

Annual Report 2009-10

Contents

From the Faculty Director

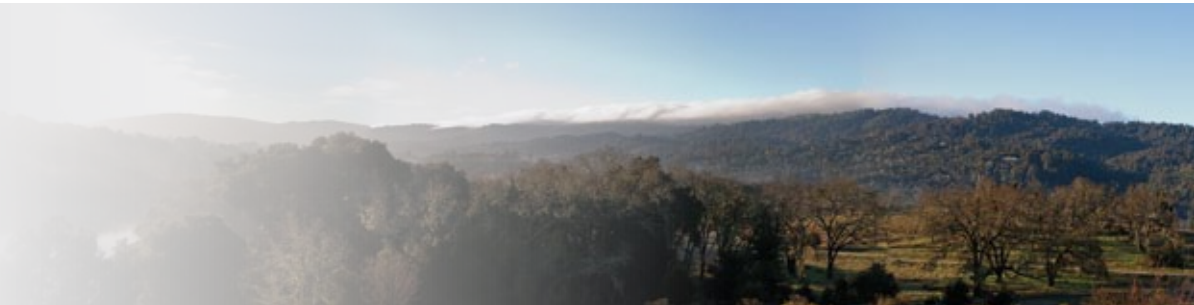
Chris Field

Jasper Ridge is an amazing asset — not only for Stanford, but also for the local community and the scientific world. Combining aspects of laboratory, classroom, nature preserve, park, and spiritual retreat, Jasper Ridge serves a wide range of user groups and supports a myriad of activities. As faculty director, I have tried to balance maintaining the preserve's established strengths with encouraging new endeavors that build on these. In particular, I have focused on a series of goals that grew out of the strategic planning efforts initiated by Philippe Cohen in 2003, and completed by an outstanding committee in 2004. The strategic plan, available on the Jasper Ridge website, emphasized opportunities in three areas. These are:

- improving the integration among the preserve's activities in research, teaching, and conservation;
- strengthening the relationship between Stanford's teaching and lands management objectives;
- enhancing programs that build on links between the preserve and other lands.

Over the past six years, we have seen exciting progress in all three areas. I want to highlight a few new programs that build directly from the vision in the strategic plan.

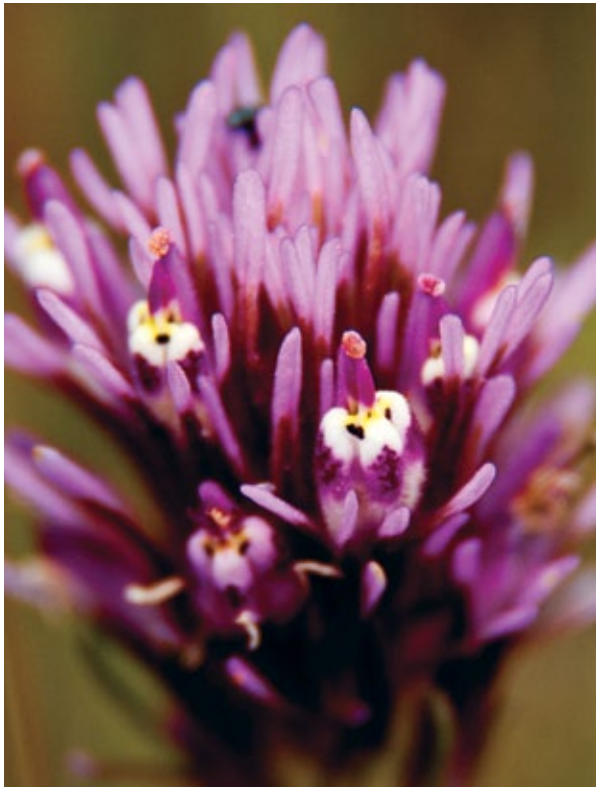
Front Cover: California poppy *(Eschscholzia californica)* in the serpentine grassland, taken facing south from Road F, between Trail 3 and Trail 9. **Left:** A spiderweb after a dewy night. Each spherical dewdrop contains a view of Searsville Lake. Look closely – the image has been reversed, to fit in the space here. Photos: Dan Quinn



A new sophistication in integrating teaching, research, and conservation is apparent in several activities. Two new research programs are explicitly focused on linking research and conservation. Both emphasize applying our knowledge of Jasper Ridge grasslands to strategies for native plant restoration, with one study emphasizing grasslands on serpentine and one on non-serpentine soil (see pages 10-11). Both studies are carrying out well-designed experiments that utilize, test, and further develop the knowledge necessary to restore native species. These studies are approaching restoration through an experimental framework for two main reasons. The first is that restoration can be a stringent proving ground for testing our understanding of ecological principles and mechanisms. The second concerns the reality that we live in a world where ecosystems are increasingly modified or even dominated by human actions. In a world of mostly inadvertent impacts, there is likely to be great value in the knowledge to undertake purposeful interventions that enhance or restore key species or ecosystem functions. I hope the new projects at Jasper Ridge help launch the field of "intervention ecology" based on concepts and tools to add management to understanding.

Another investment in improving the integration among teaching, research, and conservation comes from a complete rethinking of the Jasper Ridge component of Biology 44Y, part of the core laboratory sequence for Biology majors. The new Jasper Ridge activities, spearheaded by professor Tad Fukami, are designed to emphasize access to cutting-edge topics, plus low impact for long-term sustainability, in a framework that allows students to participate in developing datasets with long-term research value. With the new laboratory, many generations of students in Biology 44Y effectively become collaborators, researching questions that are not only instructive but are also innovative and powerful, especially when evaluated as a long-term integrated dataset.

New investments in technology are helping us better integrate teaching, research, and conservation and improve the links between Jasper Ridge and other lands. Last year's annual report described a facilities grant we received in August 2009 from the National Science Foundation. Much of the focus of that grant is on technologies that provide data from large areas with minimal environmental impacts. Implementation of the systems funded by the grant is well under way. One key system is the wireless network described by Trevor Hébert on page 20. Across a broad swath of Jasper Ridge, there is now wireless internet access, which enables students and researchers to receive data or control equipment wherever they are. Our near-term goal is that the wireless mesh will encourage new research on the wildland-suburban interface; our longterm goal is to encourage students to envision research far beyond what we've already imagined.



Other progress in integrating the preserve with other lands builds on the breadth of disciplines and perspectives in the university. I am increasingly convinced that the significance and vitality of JRBP depends on engagement by a broad array of disciplines from across the university. The Jasper Ridge advisory committee, another product of the strategic plan, includes faculty and graduate students from several Schools at Stanford and meets quarterly to consider topics ranging from management of Searsville Lake to accommodating research by non-Stanford investigators. During the past year, the advisory committee has been considering some fascinating, multidisciplinary issues regarding puma (mountain lion) presence in the region. One area of focus is whether there are unique opportunities for Jasper Ridge to contribute to research and communication on puma ecology in order to foster a better understanding and awareness of their presence. To fully explore this we have partnered with a multidisciplinary team of students and postdoctoral scholars convened by the Woods Institute for the Environment. That team will make recommendations to the advisory committee in the months ahead.

It is great to see progress in implementing the vision in the strategic plan, but it is also exciting to think about the opportunities that still lie ahead. I am eager to see further progress on all three of the major recommendations. One priority for me is continuing to upgrade Jasper Ridge educational experiences, so that all students get a real feel for the nature of ecological research questions and the process of ecological research. Another is developing ways to further minimize the impact of visitors and researchers, so that the Jasper Ridge experience is available for many future generations. Finally, I am very interested in finding ways to take full advantage of the enthusiasm, creativity, and skills of the amazing Jasper Ridge volunteer docents.

Jasper Ridge Advisory Committee

A committee of Stanford faculty and graduate students that provides high-level guidance on strategy and policy.

Chris Field (chair), *Biology and Carnegie Institution*

Eric Abelson, *graduate student, Biology*

Nicole Ardoin, *School of Education*

Rodolfo Dirzo, *Biology*

Paul Ehrlich, *Biology*

David Freyberg, *Civil and Environmental Engineering*

Tadashi Fukami, *Biology*

Elizabeth Hadly, *Biology*

David Kennedy, *History*

Katharine Maher, *Geological and Environmental Sciences*

Alexander Nees, *graduate student, Biology*

Stephen Palumbi, *Biology*

Philippe Cohen, *ex-officio, Jasper Ridge*

Nona Chiariello, *ex-officio, Jasper Ridge*

Jasper Ridge Coordinating Committee

Is composed of individuals from Stanford and non-Stanford organizations representing the broad range of groups the preserve interacts with. Provides advice and guidance to the Administrative Director on significant management challenges facing the preserve.

Philippe S. Cohen (chair), *Jasper Ridge*

Julie Andersen, *Midpeninsula Regional Open Space District*

Lisa Bankosh, *Midpeninsula Regional Open Space District*

Leonie Batkin, *Stanford Real Estate Operations*

Angela Berhnheisel, *California Department of Forestry and Fire Protection*

Rick DeBenedetti, *Woodside Trail Club*

Denise Enea, *Woodside Fire Protection District*

Jerry Hearn, *Acterra*

Don Intersimone, *Office of the Dean, School of Humanities and Sciences, Stanford University*

Leslie Lambert, *Town of Portola Valley Planning Department*

David Lenox, *University Architect/ Campus Planning and Design*

Jean McCown, *Stanford University Government/Community Relations*

Elizabeth Meehan, *Jasper Ridge docent*

Trish Mulvey, *Palo Alto Community Volunteer*

Ellen Natesan, *San Francisco Water Department*

Chindi Peavey, *San Mateo County Mosquito and Vector Control District*

Diane Renshaw, *Jasper Ridge docent*

Jeanne Sedgwick, *neighbor and Jasper Ridge docent*

David Smernoff, *Acterra*

Susan Witebsky, *SLAC National Accelerator Laboratory*

Tom Zigterman, *Stanford University Facilities Operations*

JRBP Staff

Chris Field, PhD	Faculty director
Philippe Cohen, PhD	Administrative director
Nona Chiariello, PhD	Staff scientist
Cindy Wilber	Education coordinator
Trevor Hébert	GIS and data manager
Carolyn Taylor	Administrative assistant
Cary Tronson	Operations manager
Brooke Fabricant	Resident ranger
Steven Gomez	Temporary maintenance assistant

Managing Biological Field Stations

Philippe S. Cohen

Jasper Ridge is a biological field station: that means we're part of a big secret

When I first arrived at Jasper Ridge, I was stunned by the reservoir of knowledge within the community of docents, staff, and researchers. Their familiarity with the intimate details of the preserve was both intimidating and exhilarating. However, I was struck by how unaware the preserve community was of the larger community of biological field stations. Understanding how the preserve fits into the extended family of field stations can enhance and deepen our appreciation for this remarkable place and community.

This lack of awareness of other field stations is not surprising, as the contributions of field stations are a well-kept secret – and yet, these contributions are profoundly important and play an essential role in supporting science education and outreach.

This unfamiliarity is similar to our collective ignorance about the infrastructure that makes our everyday lives possible. For example, I am always surprised by how few people know where their water comes from or where their waste goes. At the same time, infrastructure is often best when it can be taken for granted. One of the true benefits and luxuries of life in a developed nation is not constantly worrying about water and waste.

This "taken-for-grantedness" can be thought of as the freedom it provides to focus on other priorities. For instance, a good theater production means the efforts of the stagehands and the backdrops are so seamlessly integrated that we don't really notice them, and our attention is focused on the performances and content of the play. In many ways, biological field stations are like good theater productions — they are places where infrastructure, support, and conditions make possible the performances of the stars: researchers and students.

But just as actors and directors often ask stagehands to come out and take a bow at the end of performances to acknowledge their essential role, it is good to periodically reflect upon the importance of field stations as well as the unique contributions of Jasper Ridge as evidenced by the contents of this annual report. So, over the years, I have tried to find ways to increase awareness of that broader context. One of the most enjoyable strategies I have employed is taking members of the JR community on an annual field trip to other field stations. In 17 years, we have gone to 18 different field stations from Colorado to Costa Rica. These trips are specifically designed to broaden our understanding of the similarities and differences across the spectrum of the over 300 field stations in North America.

Left: Dawn vista from Jasper Ridge, looking toward the Stanford "Dish". **Right:** In September 2009, the annual docent field station field trip was held at the University of California's Valentine Eastern Sierra Reserve. Dan Dawson, director, describes some of the important research taking place there.

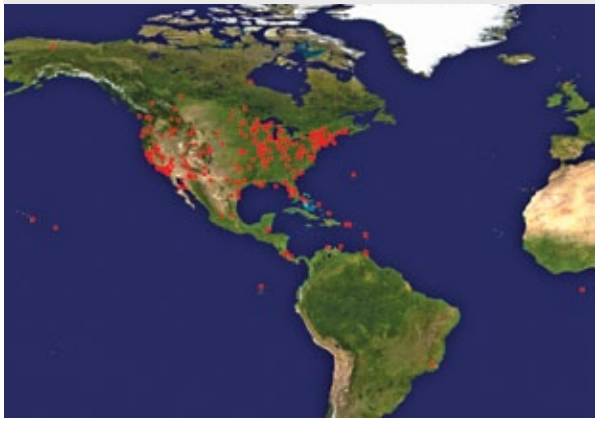
Important contributions by biological field stations

So what are some of the significant contributions made by field stations, and how have they impacted our lives in important and unexpected ways? The examples are numerous, but I will list just a few to give a flavor to their range and significance.

- One of the turning points of World War II was the development of sonar and radar by the Allied Forces, which was instrumental in turning the tide in that war. Few people realize that neither of those important technological advances would have occurred for at least several years (if not decades) had it not been for Donald Griffin's work on bats and his discovery of echolocation while at Edmund Niles Huyck Preserve and Biological Research Station in New York.
- Rachel Carson is often credited with giving birth to the modern environmental movement thanks to her seminal work "Silent Spring." What is not appreciated was that Pennsylvania's Hawk Mountain Sanctuary's commitment to monitoring migrating raptors beginning in the 1930s provided the data Rachel Carson used to establish the ecological impacts of DDT and other organochlorine pesticides.
- The identification of acid rain as a serious environmental problem was made possible from years of monitoring stream and lake water chemistry by researchers at Hubbard Brook Experimental Forest in New Hampshire. Researchers at the field station not only identified acid rain as a serious environmental problem, but helped link it to emissions from coal-fired power plants and industrial activities. This, in turn, helped lay the groundwork for national emission-control efforts.
- Researchers at the University of New Mexico's Sevilleta Field Station have been instrumental in unraveling the ecology of disease vectors such as West Nile and Hantavirus.
- How about a new generation of hearing aids being developed thanks to the work of a graduate student at Brackenridge Field Station at the University of Texas? His discovery of how a parasitic fly is able to home in on a chirping cricket was essential to the design of new directional microphones using nanofabrication techniques for new hearing aids.
- Years of research on pollination ecology at Colorado's Rocky Mountain Biological Laboratory, resulted in important insights critical to understanding the vulnerability of our food supply due to a lack of pollinators (butterflies, bees, beetles, etc.).
- At Oregon's Andrews Experimental Forest, decades of research on the structure and function of old growth forests and their importance to ecosystem services (such as maintaining water quality, biodiversity, and fisheries) resulted in the Northwest Forest Plan of 1994, which overhauled forest management practices throughout the Pacific Northwest.

This list could go on and on. At Jasper Ridge, we have our own important contributions ranging from ecosystem responses to climate change, to the development of co-evolution theory, the ecology of species invasion, or the definition of species and populations, and many more.

Above: Canopy walkway at La Selva Biological Station in Costa Rica, site of the 2009 OBFS meetings. **Below:** Map showing distribution of OBFS member field stations in the Western Hemisphere.



Field stations are a nexus for science education and outreach

Not only are field stations a linchpin in the nation's field research infrastructure, they play a pivotal role in science education and public outreach. Studies suggest that courses at biological field stations are one of the most effective and important means to recruit future scientists and enhance scientific literacy of the general public. At the undergraduate level, biological field stations have an amazing legacy of offering research opportunities and immersing students in the process of doing science. Studies show that such experiences substantially enhance an interest in, the pursuit of, and a deeper understanding of the scientific process.

Lauren Palumbi with a California Thrasher *(Toxostoma redivivum)* just extracted from a mist net.

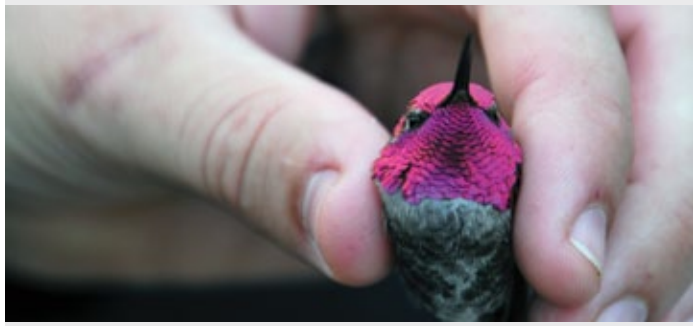
Anybody working or spending time at field stations has witnessed students altering their attitudes, interests, and performance in the natural sciences. Faculty know this firsthand from their own personal histories. Students often talk about how their field experiences far exceed their expectations, determine the course of their careers, and alter their view of life.

By providing both educational experiences and research opportunities, biological field stations routinely create a community of scholars interested in exploring the natural world, understanding our place in it, and generally broadening our view of how rich and amazing it is.

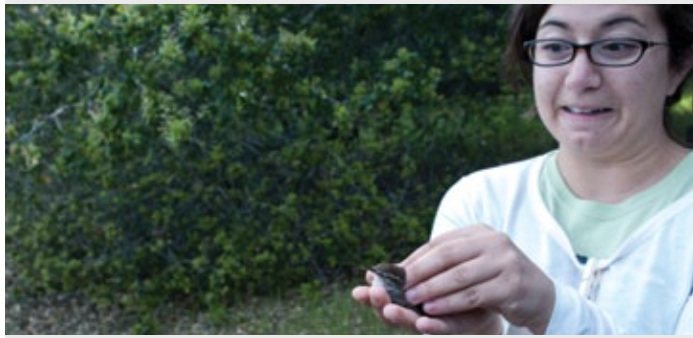
Field stations are places of discovery. I recall the 25th anniversary celebration in 1998 to celebrate the formal designation of Jasper Ridge that included an open house entitled "Discovery Day." That title rings as true today as it did then, when about 3,500 people came to visit and learn about the research at Jasper Ridge. Witnessing the visitors' hunger for knowledge about the natural world and their excitement at having a chance to talk to researchers was quite an inspiration. But what I remember most was how jazzed the researchers, graduate students, and other presenters became as a result of interacting with others expressing a passionate interest in their work.

Being affiliated with a place of beauty (a word we too often shy away from) like Jasper Ridge presents constant opportunities to nurture a passion for discovery about the natural world. This is a unique privilege – one that should not be taken for granted, but rather appreciated and nurtured.

For more information on biological field stations, visit http://obfs.org/



In late March and early April, volunteers set mist nets to capture and mark Anna's Hummingbird *(Calypte anna)* to study how they determine yeast community assemblages in the flowers they visit. Inevitably, other bird species are captured, like Orange-crowned Warbler *(Vermivora celata)* and Bewick's Wren *(Thryomanes bewickii)*, which are released onsite as demonstrated by Leslie Tucci (see p. 13 & 17).



Research and Monitoring

Nona Chiariello

For a natural area of less than two square miles, Jasper Ridge hosts a remarkable intensity and diversity of research. In 2009-10, there were 48 research projects, representing six departments at Stanford and 17 other institutions (appendix 3). The year's research publications include three PhD dissertations and one master's thesis (appendix 4).

Despite the broad scope of Jasper Ridge research, there are several themes that intersect a majority of studies and help characterize the past year. The 2010 growing season was prolonged by spring rains that continued well into May, and a very cool summer followed. The unusual growing season influenced many of the year's findings and likely contributed to the summer's lush and pungent crop of tarweeds, a superabundance of ground squirrels, and more sightings of rattlesnakes than anyone can remember. Research activity also shifted toward summer, with interns and technicians participating in nearly every major study.

A larger point in common across the year's research was the growing evidence of a more integrated mission. Five decades ago, a university publication titled the *Jasper Ridge Biological Experimental Area* defined Jasper Ridge as an outdoor laboratory for conducting experiments, making observations, taking class field trips, and training graduate students. In 1973 the Stanford Trustees reaffirmed those purposes under a new name, the Jasper Ridge Biological Preserve, which they designated "to be used primarily for instruction and research in academic fields..."

The distinction between an outdoor laboratory and a preserve has been debated ever since. For years, resource management followed a hands-off approach that was designed to protect ecological and evolutionary processes rather than resources per se; that approach contrasted with the inherently hands-on nature of research. On a spectrum with laboratory at one end and preserve at the other, JRBP often seemed closer to the laboratory end.

Our 2004 strategic plan began bringing the two ends of that spectrum closer together. The past year continued the momentum toward a more integrated mission that is reshaping JRBP as both laboratory and preserve.

Ant studies

For almost two decades, students and postdoctoral fellows working with professor Deborah Gordon have acquired a massive body of information about the ants of Jasper Ridge and their effects on ecosystems. Recent studies of native and invasive ants are providing insights about the future ant assemblage.

A particular focus of the Gordon lab is the invasion of JRBP by Argentine ants *(Linepithema humile)*, which can displace native ant species or other soil arthropods, and can alter foodwebs, such as those involving plants and aphids or scale insects. Over the past 18 years a preserve-wide survey of the Argentine ant invasion has been conducted twice a year by a succession of graduate students, most recently Katherine Fitzgerald.

This past spring, the Gordon lab teamed up with Jasper Ridge staff to try something new—an intensive one-day ant survey conducted by nine ant researchers and ten volunteers. Nicole Heller, a former lab member and now global change scientist, returned to organize the survey and train volunteers. On a Saturday in May that was perfect for both people and ants, the 19 observers recorded the presence/absence of Argentine ants and thirteen other ant genera at nearly all of the study's 259 observation points. Their success inspired an even larger group of volunteers to join the fall census.

Opposite Page: Noa Pinter-Wollman recording the behavior of native harvester ants *(Messor andrei)* in serpentine grassland. **Below:** One of Noa's study ants carrying a stalk of soft chess *(Bromus hordeaceus)*, a common annual grass.

Galen Coppage and Lis Nelis during a joint survey of Argentine ant activity and plant community composition.

A trademark of the Argentine ant research is that it includes monitoring, natural experiments, and simulations in order to unravel the causes and consequences of the ants' spread. Combining all three approaches in her dissertation, Katherine Fitzgerald recently concluded that Argentine ants may have reached their maximum extent at JRBP (profile, p. 18). Moreover, they are unlikely to become established in the serpentine grassland as long as the ridgetop portion of JRBP remains undeveloped. Katherine's research suggests that winter nesting sites in buildings help sustain the invasion inside JRBP, but the serpentine grassland is simply too far from the surrounding houses and the Leslie Shao-ming Sun Field Station.

Whereas Argentine ants keep out of the serpentine grassland, the native seed-harvester ant, *Messor andrei* is there in great abundance. *Messor* ants remove or redistribute vast numbers of seeds of selected plant species. During the past year, postdoctoral fellow Noa Pinter-Wollman got to know thirty *Messor* colonies very intimately and individually in a study to determine whether colonies have different temperaments, as evidenced by whether their response to unfamiliar objects is bold versus timid, quick versus slow. Interns Mira Parekh and Alec Mill, and docents Dan Quinn, Anne Rosenthal, and Marguerite Stevens helped with the study.

This is Noa's second time as a member of Deborah Gordon's lab, having first joined right after high school to study another species of harvester ant. During her undergraduate and PhD degrees, Noa moved on to progressively larger animals, first mice and then African elephants, but consistently with a focus on behavior in relation to conservation issues. In the current study, Noa and Mira are especially curious to find out whether *Messor* colonies that routinely come in contact with Argentine ants respond to them more aggressively than colonies encountering Argentine ants for the first time. Their results could have implications for reintroducing native ants into areas where they were displaced by Argentine ants.

A second new ant study is by postdoctoral fellow Lis Nelis. Lis joined the Gordon lab after completing a PhD studying grassland restoration on a remote Chilean island that had been invaded by non-native plants and European rabbits. A provocative result from that study was that exotic rabbits increased the abundance of some native plants and some exotics, rather than simply harming natives as hypothesized. The perspective Lis gained from that work is evident in her study at JRBP. Lis identified pairs of similar plant species, one native and one non-native, that grow in close proximity. Then she examined the species pairs and their surrounding vegetation from a new slant—that of Argentine ants—to see whether Argentine ants distinguish between native and non-native plants.

As Lis explains, "The Argentine ants are impartial resource seekers. They have no coevolved relationships with any of these plant species, so their interactions with plants are driven just by ecological factors." In field plots containing plant pairs such as native coyote brush *(Baccharis pilularis)* and non-native French broom *(Genista monspessulana)*, Lis and two interns, Galen Coppage and Sarah Kaewert, examined whether Argentine ants show any preferences between the plants, such as greater aphid-tending on one species than the other. Thus far Argentine ants appear to be indifferent about whether plants are native or exotic, but they are significantly more likely to visit species that are common, able to form nitrogen-fixing symbioses (e.g., legumes), or infested with scale insects.

Serpentine grassland

Noa's work on *Messor andrei* is part of a critical mass of new studies of serpentine grassland. Following a decade in which serpentine research was down to only a few studies, the renewed interest in serpentine ecology comes at a crucial time. Exotic annual ryegrass *(Lolium multiflorum)* has replaced the colorful native forbs that used to dominate the grassland, such as goldfields *(Lasthenia californica* and *L. gracilis)*. One researcher, professor Nishanta Rajakaruna, returned in 2009 to follow up his doctoral work on the *Lasthenia* populations and was stunned to find so little remaining.

The serpentine grassland was a key factor in the Jasper Ridge advisory committee's decision to integrate research and conservation through new strategies termed "ecological intervention" and to launch a restoration fellowship. Jennifer Funk, a biology professor at Chapman University, became our first restoration fellow. She is studying how native species might regain a foothold in the serpentine and hold on to it.

Jen's approach to serpentine restoration is somewhat similar to a treatment for maintaining an entirely different type of flora—that of the human gut. Like the use of probiotics for maintaining a healthy intestinal flora, Jen envisions managing certain native plant species to boost the serpentine grassland's resistance to invasive species. She expects that the best native species for that purpose will be those most similar to the invasive species we want to replace.

The ecological concept behind Jen's strategy is called "limiting similarity." It holds that all species

in the serpentine should be somewhat similar (all are serpentine-tolerant), but not extremely similar, because competition between two very similar species should result in a clear winner and a clear loser. The concept has been applied successfully in several studies at Jasper Ridge, but never before for the purpose of restoration. Kris Hulvey, for example, found that yellow starthistle *(Centaurea solstitialis)* invasion was reduced in areas that had a sufficient density of native hayfield tarweeds *(Hemizonia congesta)*; both species are tap-rooted, summer-active annuals, which may make them too similar to coexist in substantial numbers (profile, p. 18).

Jen is applying the concept of limiting similarity to the serpentine grassland at large. Last winter she began characterizing the properties of native and invasive species so she could identify pairs of closely matched species for competition trials. In summer, she was joined by intern Madison Hoffacker to collect seeds and set up germination studies to further characterize species. Jen's eventual goal is a field restoration experiment.

Another new study with implications for serpentine restoration is by Dena Vallano, a postdoctoral fellow at UC Santa Cruz. Along the long axis of the serpentine grassland, Dena installed three masts equipped with devices that sample atmospheric pollutants, including several forms of nitrogen pollutants found in automobile exhaust. Her yearlong study compares Jasper Ridge and three other serpentine grasslands differing in proximity to major roads. A similar study by Stuart Weiss in 2002 provides a reference point for detecting changes in pollutant levels.

Dena's work will establish whether nitrogen-containing pollutants are being deposited in amounts that significantly increase the fertility of serpentine soil, which could shift the outcome of competition in favor of invasive species. If that scenario bears out, it may be necessary to remove nitrogen from the ecosystem in order for restoration to have lasting success.

Longitudinal studies

Longterm monitoring of Searsville Reservoir and Dam will be essential in coming decades as decisions are made about managing sediment loads and their effect on both the reservoir and its outflow to San Francisquito Creek. Professor David Freyberg's studies of groundwater behavior have expanded over the past seven years to a network of 13 piezometers—enough years and piezometers to compare groundwater dynamics in very wet years and very dry, and in native soils versus areas of accumulating sediment. The measurements are precise enough to detect daily oscillations in groundwater depth driven by vegetation taking up water and transpiring it. Spencer Sawaske took the lead on the piezometer measurements this year, Jake Krall began analyzing particle size distribution in sediment cores, and Jun Young Kim began developing new mathematical modeling tools for tracking the water balance of the reservoir; all are doctoral students in the Freyberg lab. Eight new sediment cores became available this year thanks to paleoscientists Lysanna Anderson and David Wahl, from Stanford and the US Geological Survey, who used Searsville Reservoir to test a new, highly portable coring platform.

Volunteer groups are responsible for much of the biotic monitoring at JRBP and bring enormous expertise to those efforts. The year's bird surveys were carried out by two dozen volunteers, several of whom regularly posted noteworthy observations. Leonie Batkin and Ron Thorn's sightings included three hatch-year Common Yellowthroats, a Summer Tanager, a Broad-winged Hawk, a Pileated Woodpecker, and a flock of 16 White-faced Ibises flying in formation. On a single day during spring migration, Leonie and Ron recorded a phenomenal 60 species of birds.

Five herbarium volunteers continued documenting the flora of Jasper Ridge and expanded their work from vascular to non-vascular plants, launching the first survey of bryophytes (see p. 16). Also, for the sixth straight year, they worked closely with staff members and researcher Irene Brown to eliminate recurring introductions of stinkwort *(Dittrichia graveolens)*, which is explosively invasive.

The year included a remarkable example of longitudinal research sparked by JRBP's history

Left: Spencer Sawaske teaching Xiaogang HE to measure the depth to groundwater in one of professor David Freyberg's piezometers. **Right:** Corinne Morozumi, a UC Santa Cruz lab manager, and postdoctoral scholar Dena Vallano during their monthly replacement of pollutant-trapping filters in pole-mounted air pollution samplers.

Left: Summer intern Safiyyah Abdul-Khabir and docent Ann Lambrecht GPS'ing and marking the perimeter of a stand of California oatgrass *(Danthonia californica)* as a baseline for studying its expansion. **Right:** Lace lichen *(Ramalina menziesii).*

of student projects. In 1976, Thomas McClure, an undergraduate in professor Hal Mooney's field ecology course, analyzed the lead concentration in lace lichen *(Ramalina menziesii)*. California's use of leaded gasoline was peaking at that time, and Thomas wrote that his results could provide a baseline for measuring the decline in atmospheric lead contamination as leaded gasoline was phased out. That's just what a new publication reports. Paleontologist and docent Léo Laporte, together with Russell Flegal and other colleagues from UC Santa Cruz, report that the lead concentration in *Ramalina* at JRBP has declined to less than one percent of what Thomas measured. Exposure to lead continues at low levels, however, due to resuspension of lead still present in the environment.

Global change and restoration

As resource managers across the globe debate how to steward protected landscapes into an uncertain future, studies of global change have an opportunity, if not a responsibility, to identify strategies for ecological intervention in the context of environmental change. That was the thinking behind principal investigator Chris Field's decision that the Jasper Ridge Global Change Experiment (JRGCE) would begin focusing on grassland restoration. In fall 2009, the experiment's 12th year, the JRGCE team began a four year study examining whether elevated CO_2, warming, added precipitation, and nitrate deposition, alone or in any combination, will facilitate or inhibit restoration of native perennial bunchgrasses in a grassland presently dominated by non-native annuals. Chris describes the experiment as "16 different windows on the future of grassland restoration in California." The study is funded by the National Science Foundation.

To strengthen links with other restoration studies and land managers, the JRGCE chose three of the best studied and most successful restoration species—purple needlegrass *(Nassella pulchra)*, California oatgrass *(Danthonia californica)*, and blue wildrye *(Elymus glaucus)*—the Three Musketeers of grassland restoration in California. Just before the first rains in fall 2009, nearly 1500 seeds were scattered by hand on each of the 128 plots. Anticipating that the outcome of the experiment would depend partly on soil moisture (which is affected by elevated precipitation, CO_2, warming, and many combined treatments in the JRGCE), senior technician Todd Tobeck installed an automated system that monitors soil moisture hourly.

The results as of July 2010 were surprising: the number of perennial seedlings was greater under added precipitation, and lower under added nitrogen, but only in plots where invasives such as yellow starthistle *(Centaurea solstitialis)* and Italian thistle *(Carduus pycnocephalus)* had established during the previous two years. This suggests that restoration strategies may need to be adjusted based on the legacy of invasion at a very local scale. Warming and elevated CO_2 altered the amount of moisture in the soil, but their effects were small relative to the late spring rains, and they did not significantly affect seedling numbers. Summer interns and technicians Safiyyah Abdul-Khabir, Ben Cohen-Stead, Christina Feng, and Julie Morrison spent many hours on hands and knees contributing to these results, and Shane Easter, a new technician, assumed management of the soil moisture data. Christina, Safiyyah, and docent Ann Lambrecht also mapped natural establishment of the three perennial grasses outside the JRGCE plots, and mapped a large, natural stand of *Danthonia* that Ann will continue to monitor.

The JRGCE plots will be surveyed again in fall to measure seedling survival during the grasses' first summer drought. If enough seedlings survive into the 2011 growing season, the team will collaborate with UC Berkeley fire ecologist Scott Stephens on a prescribed burn in half of the JRGCE. The goal is to develop a joint strategy for fuel management and restoration in the context of environmental change.

Community ecology

Since JRBP's strategic plan was completed, new studies have been designed with our more integrated mission in mind. Studies of community ecology provide some of the best examples of links among research, conservation, and education.

Professor Rodolfo Dirzo and visiting scholar Roger Guevara have completed the first year of a longterm study of effects of mammalian herbivory on oak establishment. Their experiment involves 75 matched pairs of adjacent seedlings, one caged to exclude deer and the other uncaged, for each of three oak species. By mid-summer, height growth of caged valley oak seedlings *(Quercus lobata)* significantly exceeded that of uncaged. This surprisingly fast result is evidence that mammalian herbivores are a major force shaping vegetation communities.

The implications of Rodolfo's work extend to regional controls on deer population size. During at least nine months of the past year, camera traps operated by Trevor Hébert, JRBP GIS and Data Manager, revealed puma *(Puma concolor)* presence at JRBP. That finding led Rodolfo to consider whether oak regeneration is part of a "trophic cascade" of effects, with pumas controlling deer population size, and deer controlling oak establishment. That possibility suggests important links between JRBP and other protected areas in the Santa Cruz Mountains used by pumas. Some options for pursuing those links will be addressed by the Jasper Ridge advisory committee this year.

Professor Tadashi Fukami's project on the floral ecology of sticky monkey-flower *(Mimulus aurantiacus)* completed its second year with help from many people, including docent Bill Gomez, postdoctoral fellow Kabir Peay, doctoral students Melinda Belisle, Chase Mendenhall, and Diamantis Sellis, interns Safiyyah Abdul-Khabir, Grace Goldberg, Nathan Kim, Katrina Luna, and Lauren Palumbi, and JRBP staff. Tad is studying relationships among many variables such as light availability, air temperature, flowering time, flower abundance, visits by hummingbirds, and the types and quantity of yeast in the nectar of flowers, in order to understand how microbial communities establish and change over time within the flower nectar. As part of a large initiative on curriculum reform by the Stanford biology department, Tad developed a new undergraduate lab course based on this research (see p. 17).

Results obtained this year demonstrate how tractable the *Mimulus* system is. Some aspects of floral ecology, such as flowering date, correlate with features of the environment, such as the amount of sunlight received in winter. The team is using multiple techniques to study hummingbird visitation, which is the delivery route for microbes to *Mimulus* flowers, including 16 species of yeast the team has identified in *Mimulus* nectar. Taken together, their findings indicate that nectar-living yeast form communities that are complex, diverse, experimentally tractable, and likely to reveal general properties about how ecological communities respond to their environment.

Intervention ecology

Looking back at the year's research, JRBP's more integrated mission is evident in the goals we have set and the way we are approaching them. Undergraduates play a big part in those efforts and bring intense commitment to research that leads to conservation action. Nearly all of the studies described here included one or more student interns this past summer. In addition to conducting research, the interns participated in a weekly summer program led by five professors and two postdoctoral fellows whose research encompasses nearly every ecosystem at Jasper Ridge.

Intervention ecology is the science of halting or reversing damage to ecosystems and the services they provide. Successful intervention will involve ambitious and creative thinking. It will also need judicious action and longterm commitment because the effects will outlast a typical experiment or research grant. To insure that we adequately assess the longterm outcome of any intervention, our first attempts build on existing studies that demonstrate an ongoing commitment and provide the basis for an intervention strategy. Those efforts are aimed at creating new foci of restoration and developing the experience needed to take on even bigger challenges.

Professor Rodolfo Dirzo and visiting scholar Roger Guevara comparing the heights of two valley oak seedlings *(Quercus lobata)* a year after one member of the matched pair was caged to exclude large herbivores.

Education and Outreach

Cynthia J. Wilber

The Jasper Ridge education program began in 1975, when Herb Dengler trained five volunteers to lead tours teaching the natural history of the preserve. That year spent exploring the intricacies of the ridge set in motion a program that now serves an increasingly broad community. Three of those five recruits, Betsy Clebsch, Ann Lambrecht, and Lennie Roberts are still active in various aspects of the JRBP community, illustrating clearly the lasting commitment of JRBP docents and affiliates.

Thirty-five years later, Bio 96/docent class students still spend months exploring the intricacies of the preserve and learning to communicate effectively their knowledge of research and natural history. The class of 2010 also completed an impressive array of projects contributing to Jasper Ridge research, K-12 outreach, and public participation in science.

Four students worked with *Dirca* researcher, Bill Graves of Iowa State University, on two separate projects. Tay Vanderlip and Tommy Fehrenbach investigated the relationship between the San Francisco dusky-footed woodrat *(Neotoma fuscipes)* and the extensive pruning found on *Dirca* located near chaparral communities, to determine if the pruning was indeed the work of woodrats. Undergrads Judee Burr and Mila Re assisted with a trial comparing *Dirca occidentalis* and the even-more rare *Dirca mexicana* at Dish Hill on the Stanford campus. They experienced firsthand how to design and establish a research plot, including randomization, transplanting, protecting seedlings from animals, and providing mulch and irrigation. Judee and Mila subsequently monitored environmental conditions at the site and collected data on seedling development. Bill Graves is comparing this information to data he's gathering at sites in Washington, Iowa, Rhode Island, and Virginia, where the trial is being replicated.

Other student projects included an investigation of anthropogenic effects on blue oak woodlands, San Francisquito creek biotic surveys, an interactive archaeological dig for teaching and learning, the creation of a K-12 curricula that will be available online for teachers, soap plant *(Chlorogalum pomeridianum)* exclosure monitoring, a redwood canopy survey, the organization of the first Stanford BioBlitz, and more.

Opposite page: Bio 96 students Tay Vanderlip, Walt Hays, Alice Cummings, and Jill Watt surveying insects with Irene Brown.

Right: Eastside Field Studies students collecting soil temperature data in the chaparral.

Left: Jasper Ridge docents Dave Bernstein and Toni Corelli identifying grasses during a vegetation survey.

Middle: Bio 96 student Samantha Larson ascending a redwood tree to survey for epiphytes in the canopy.

Above: Students Jill Watt, Aleema Jamal and Mila Re using the Munsell color chart to determine soil type during a class with soil scientist Scott Fendorf.

The preserve is exceedingly fortunate to have many dedicated affiliates who worked on a wealth of projects, contributed to ongoing research, participated in outreach education, and led hundreds of tours for classes and the public. A 2010 effort that highlights one of these essential contributions is a new herbarium project. The herbarium team (Toni Corelli, Paul Heiple, Ann Lambrecht, and John Rawlings) worked with Jim Shevock, coauthor of the book "California Mosses" (2009) and Research Associate at the California Academy of Sciences (CAS), on an inventory of Bryophytes (mosses, liverworts, hornworts) found at the preserve. To date, about 70 species have been collected, identified, and vouchers have been deposited in both the CAS and Jasper Ridge herbaria. The inventory will be continued during winter and spring 2011 and several sites will be selected for long term monitoring of changes in abundance and species by the herbarium team. Prior to this effort the knowledge of this important part of the plant kingdom was poorly known for Jasper Ridge.

Twenty Stanford classes utilized the preserve during the 2009-10 academic year and reflect the diversity of educational use overall. Stanford courses include JR-based instruction like Jasper Ridge Docent Training, Pilot 44Y, and the Core Experimental Laboratory. A complete list of the classes that visited JR for field experiences or tours can be found in appendix 5 (p. 26-27).

Jasper Ridge K-12 outreach was again an amazing success thanks to a web of collaborators that includes Stanford faculty and students, JR affiliates and staff and participating schools and organizations. For a full list of K-12 outreach activities, see appendix 5.

The 2010 Eastside Field Studies with the sixth grade class of Eastside College Prep, and teachers Suney Park and Anne Carpenter completed eight weeks of hands-on field science at JR under the guidance of their Stanford mentor teachers (also docents) Dave Bernstein, Cara Brook, Aleema Jamal, Sarah Macway, Jenny Rempel, Kenji Tanabe,

and Adam Ting along with the invaluable help of Mary Baron, Susan Gold, Jess McNally and Betsy Meehan. The Jasper Ridge/Eastside model of tiered mentoring and experiential education has proven itself time and again. Truth be told though, the sixth graders of 2010 pushed us all to provide even more challenging curricula—all the more impressive considering we apply California 9th to 12th grade standards to their Jasper Ridge field studies.

The Redwood Environmental Academy of Leadership (REAL) program, which had its origins as a Stanford K-12 Initiative grant (Dirzo and Wilber) successfully transitioned to an academy class within the Sequoia Union High School district with support from the district as well as a NOAA Be-Wet grant. Jasper Ridge faculty, staff, docents, students, and the Stanford SEEDS program (http://jrbp.stanford.edu/jr-seeds) have been key to the success of this program. Recent Stanford alumnus Jhanvi Shriram documented key REAL highlights in several short films that can be seen at http://jrbp.stanford.edu/jr-real/.

In late spring 2010, the REAL water quality data collection project went global with students in Mexico, Bolivia, Guatemala, and Puerto Rico participating and contributing their data using Livescribe digital pens and recorders. As this program continues to expand REAL students will be able to compare and analyze data from San Francisquito creek at Jasper Ridge as well as the Cordilleras creek on their campus with students in locations around the world.

This program is a powerful example of what the collaborative efforts of researchers, faculty, students and local schools coupled with innovative technologies can achieve in furthering the public understanding of science, while inspiring young people around the world to broaden their knowledge.

A New Core Course in Biology

Jasper Ridge is participating in a major curriculum reform by Stanford's biology department to offer an authentic field research experience to every student in a majors' course, the Core Experimental Lab, or 44Y. To meet that challenge, professor Tadashi Fukami developed and taught a new version, Pilot 44Y, based on his research on the floral ecology of sticky monkey-flower *(Mimulus aurantiacus)*. In the photo of Pilot 44Y above, Tad is in the left foreground. Lecturer Pat Seawell and teaching assistants Melinda Belisle and Diamantis Sellis helped design and teach the course.

Pilot 44Y focuses on time-series data on four biotic factors (yeasts, plants, birds, and butterfly larvae) and three abiotic factors (light, water, and temperature). Students collaborate to collect data on biotic factors such as yeast and flower abundances, pollination status, and nectar volume. In a campus laboratory, they use molecular techniques to identify yeast species. Abiotic factors are tracked by various means, including temperature sensors in ventilated shields (right photo). As the course proceeds, students generate hypotheses regarding interactions between biotic and abiotic factors, and learn how to use the massive data set to test them.

This past spring, Pilot 44Y was offered simultaneously with a previous version of 44Y, and the lab benches at the Leslie Shao-ming Sun Field Station were divided up between them. Doctoral students Sara Brownell and Matt Kloser, working with education professor Rich Shavelson, carried out a side-by-side assessment focusing on "matched" students in the two courses. They conducted pre- and post-course surveys, classroom and field observations, and student interviews. In all aspects relevant to an authentic research experience, Pilot 44Y was significantly more successful: students collaborated more with peers, discussed conceptual topics more often, and became more interested in research during the quarter.

This year, Tad will build on Pilot 44Y's successful design, expand its enrollment, and incorporate a garden population of *Mimulus* on campus.

Academic Milestones and Accomplishments

Tim Bonebrake completed his PhD in 2010 examining adaptation to climate and the implications for species facing future environmental change. His work focused on checkerspot butterflies throughout North and Central America. To assess the feasibility of habitat creation for the Bay checkerspot butterfly *(Euphydryas editha)*, which has been extinct at JRBP since 1998, he tested the importance of different soil properties for native and non-native plant species. In particular, he and collaborators Ryan Navratil, Carol Boggs, Scott Fendorf, Chris Field, and Paul Ehrlich found that shallow soil depth and low soil moisture availability reduce the establishment of non-native plant species (a persistent threat to Bay checkerspot habitat). Climate change and habitat loss both have contributed to the Bay checkerspot decline. Tim's research suggests that restoration or even habitat creation efforts focusing on soil properties could be beneficial for the recovery of *E. editha*. Tim is now a postdoctoral scientist in the department of Atmospheric and Oceanic Sciences at UCLA and continues to study the effects of climate change on species.

Katherine Fitzgerald successfully defended her doctoral dissertation at Stanford in July. Her research focused on the invasive Argentine ant, *Linepithema humile*, and both continued and built on the monitoring of invasion conducted since 1993 by students of her advisor, professor Deborah Gordon. Katherine's research arose from her observation that the Argentine ant invasion appeared to have stalled at Jasper Ridge, or perhaps even retreated. She examined how the ants' movements depended on factors such as the distance to human-caused disturbance, amount of canopy cover, and presence of the native winter ant, *Prenolepis imparis*. She found that Argentine ants rarely invaded sites more than 400m from disturbed areas, and when they did arrive at such sites, they did not stay long. They tended to retreat from shady sites, and the presence of *Prenolepis* inhibited their spread. Katherine used the longterm data to simulate invasion over even longer time periods. Those simulations predict good news: if current trends continue, the Argentine ant will never invade the central areas of Jasper Ridge, leaving a refuge for the native ant community.

Kris Hulvey completed her PhD in March at UC Santa Cruz. Her dissertation focused on relationships between the abundance of individual grassland species and ecosystem processes that people rely on for their well-being. At Jasper Ridge, Kris examined the role native plants can play in resisting non-native plant invasion in California grasslands, in particular focusing on the noxious invader yellow starthistle *(Centaurea solstitialis)*. Kris found native hayfield tarweed *(Hemizonia congesta)* appeared to compete strongly with starthistle for resources, but invasion resistance depended on the tarweed's abundance; once tarweed density dropped below a particular density, starthistle invasion increased significantly. The Jasper Ridge study led to two restoration projects with land managers in central California, which Kris hopes will highlight how restoration with native species might create grasslands less vulnerable to invasion. After finishing her PhD, Kris began work on another Mediterranean ecosystem as a postdoctoral research scholar in professor Richard Hobbs's Ecosystem Restoration Laboratory at the University of Western Australia. Her current work focuses on ecosystem restoration and management in the face of directional global change.

Katie Turner completed her BA in anthropological science at Stanford and then stayed another year to complete a Master's degree in 2010. Her thesis compared archived faunal remains from an archaeological site within Jasper Ridge and two other sites in the San Francisquito Creek watershed. Katie's goal was to use the faunal remains to help clarify the diet and behavior of prehistoric inhabitants who harvested shellfish from San Francisco Bay and the Pacific Coast. Accurately reconstructing the diet of the sites' inhabitants required a better understanding of the food-processing strategies they used—whether shellfish were transported whole or processed in the field. Using a model developed by human behavioral ecologists, Katie made and tested predictions for each of six species of shellfish regarding the tradeoffs in time and energy associated with processing versus transporting to each of the three archaeological sites from both the bay shore and the Pacific coast. In July, Katie became an archaeological technician for Stanford Land Use and Planning, and is shown here re-mapping an archaeological site at Jasper Ridge.

Sara Brownell, a PhD candidate in biology, was a recipient of the Walter J. Gores Award for Excellence in Teaching, Stanford's highest teaching honor. She received the award at the university commencement in June. Sara was praised for her "passion for science education and her efforts to communicate the value and implications of scientific research to the public." She also was honored "for masterful teaching, underscoring her belief that the responsibility to educate is paramount in every scientist's education and career." During Spring 2010, Sara and Matt Kloser (a doctoral student in science education and masters student in biology) spent part of every week at Jasper Ridge making a comparative evaluation of the existing core experimental lab (BIO 44Y) and a new pilot version of BIO 44Y that focuses on floral ecology of *Mimulus*. Their analysis is discussed on page 17.

The 2010 docent class watching water rush over Searsville dam after a very rainy spring: Jared Brewer, Judee Burr, Alice Cummings, Tommy Fehrenbach, Christina Feng, Joe Ferrell, Kimberly Gibson, Walt Hays, JR Heard, Aleema Jamal, Chim Chune Ko, Samantha Larson, Annie Loggins, Sarah Macway, Jess McNally, Rachael Monosson, Whit Parker, Mila Re, Tay Vanderlip, Linda Vlasic and Jill Watt. A second photo is on page 26.

Wireless Broadband Infrastructure: Mesh Network

Trevor Hébert

Last year, the preserve received funding from the National Science Foundation to install an outdoor wireless mesh network that will extend Internet connectivity to at least 80% of Jasper Ridge lands. This project is funded by the two-year, $249,582 award from the Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML) grant program.

Wireless mesh networks are a reliable and flexible networking solution for outdoor settings. Each node in the mesh network functions as both a wireless access point and a relay that communicates with adjacent nodes. Because of redundant links between end-user devices (such as data loggers, field computers, wireless sensors, etc.) and mesh nodes, the network can automatically reconfigure itself if a mesh node fails, preventing a loss of connectivity. New nodes can also be added to expand or change the network without interfering with existing connections.

As of late summer, we have deployed seven mesh network nodes, providing wireless Internet service to about 25% of the preserve, including most of the area west of Searsville Lake, the ridge top and serpentine grassland, and the Escobar gate area. Ultimately, the planned network will consist of up to 25 nodes located throughout the preserve.

Each node consists of a guyed utility mast, a solar power supply, and a weatherproof outdoor Wi-Fi access point. The utility masts raise mesh node antennas above tree cover and topographic features that would block wireless communication between nodes. Depending on nearby obstructions, the masts need to be 15 to 35 feet tall. In some cases, antennas can be mounted to buildings or other structures. Two of the installed access points are gateway nodes with wired access to the existing Jasper Ridge and Stanford University broadband network. These gateways allow data transfer between sensors and other networked devices within the wireless network, and devices used by researchers at the Leslie Shao-ming Sun Field Station, the Stanford University main campus, and other off-site locations. We will eventually install additional, remote gateway nodes to improve bandwidth in areas most distant from the Sun Field Station's wired broadband connection. This will help prevent loss of bandwidth over many hops through the mesh network.

For this system we are using mesh networking technology purchased from Ruckus Wireless, based in Sunnyvale, California. The Ruckus system features technologies for optimizing bandwidth and range under difficult transmission conditions caused by radio interference, heavy network usage, and physical obstructions in the environment. Network configuration and management controllers allow non-network engineers to operate and maintain the network, minimizing the need for additional staffing.

Along with these technologies, each communications station has a custom-designed solar power system that keeps the Wi-Fi access points running year-round on solar power and batteries alone. Last winter, the power system was tested by a storm which kept the skies continuously cloudy for a week. During this near- worst-case scenario, the battery bank performed exactly as designed and kept the wireless mesh network up and running.

Though still in the early stages of deployment, the wireless mesh network already enables continuous, remote data logging for three research projects, and provides Wi-Fi service for the preserve's two on-site staff residences. In the spring and early summer, the wireless mesh network also made possible a pilot study that used wireless video cameras to monitor and identify marked hummingbirds as they visited *Mimulus aurantiacus* flowers at two different sites. Over time, the wireless mesh network will become a key component of JRBP's research capability and physical infrastructure.

Appendix 1: Financial Summary & Projection

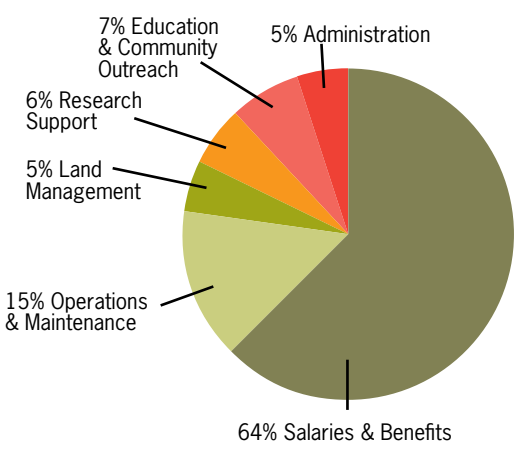
Financial Summary 2010

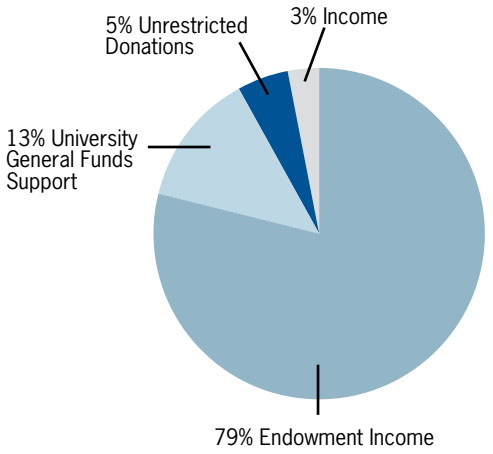
Expense Summary

Salaries & Benefits	$558,267
Operations & Maintenance	128,102
Land Management	40,663
Research Support	49,865
Education & Community Outreach	57,537
Administration	41,001
Total	**$875,435**

Revenue Summary

Endowment Income	$713,085
University General Funds Support	$117,701
Unrestricted Donations	$47,220
Income (tours, sales, etc.)	$24,357
Total	**$902,363**





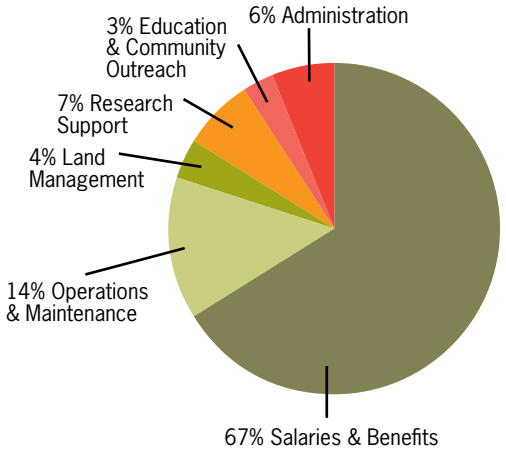
Fiscal Year 2011 Projections

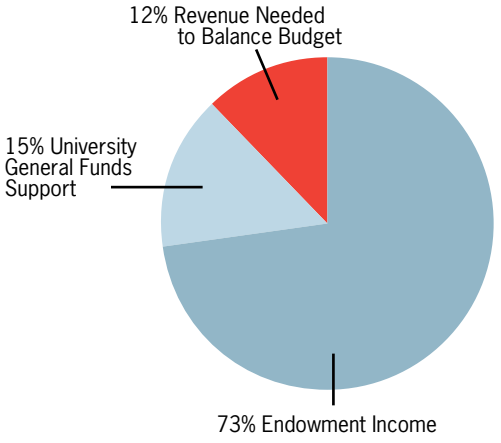
Projected Expenses

Salaries & Benefits	$576,771
Operations & Maintenance	$119,430
Land Management	$30,800
Research Support	$62,827
Education & Community Outreach	$24,045
Administration	$49,950
Total	**$863,823**

Projected Revenue

Endowment Income	$629,934
University General Funds Support	$132,963
Revenue Needed to Balance Budget	$100,926
Total	**$863,823**





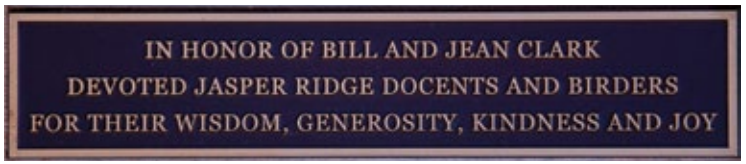
FY10 saw a 10% decline in endowment income and FY11 will show another 15% decline. Hence, endowment revenue will have declined from a high of $829,846 in FY09 to a projected $629,934 for FY11. This decline in endowment revenue is projected to end with FY11. A combination of enforced vacation leave and some unexpected project cost savings avoided a shortfall and left a small surplus that will help balance a projected shortfall for this fiscal year. If donations and revenue are comparable to FY10, the projected shortfall will be about $30,000. This will be covered by reserves and any additional unrestricted donations. Education & Community Outreach for FY10 includes purchase of a new minivan. In both years, the Research Support category includes support for the JR Restoration Ecology Fellowship.

Appendix 2: Donors

Through most of its history, Jasper Ridge has been able to manage unanticipated challenges and respond in innovative and nimble fashion while supporting a high level of research and educational productivity. That flexibility rests upon our community of donors, and we offer our sincere gratitude for your continuing generosity. The following is a list of those who made unrestricted gifts to the preserve from September 1, 2009 to August 31, 2010.

Leonie F. Batkin
Nancy C. & Clayton W. Bavor
Monika B. and Olle Bjorkman
Irene L. & Robert W. Brown
Robert R. Buell
Ruth Buneman
Boyce W. Burge & Linda Lotspeich
David G. & Catherine P. Clark
Bill & Jean Clark
Carolyn C. & William Clebsch
L. Robert & Mary H. Dodge
Molly Hurlbut Engelbrecht
W. G. & Charlotte Ernst
Theodore H. Geballe
Margaret Green
Carol & Dexter Hake
Benjamin C. & Ruth Hammett
Mary Henry & Rajpal Sandhu
Leo M. & Florence A. Holub
Mary Page Hufty
Dirk D. & Charlene Kabcenell
Anthony J. & Judith H. Kramer
Margaret Krebs
Mr. & Mrs. Marcus A. Krupp
Léo & Margaret Laporte
Peter & Suzanne LaTourrette
Targe & Barbara Lindsay
Elizabeth J. & William F. Meehan
Barbara Working Milligan
John R. Page, Jr.
Arnold A. Peterson
Charles R. Preuss
Charles P. Quinn
Lenore L. Roberts
Deborah Hickenlooper Rohan
Jessie Schilling
Shack Riders
Marguerite Stevens
Eric Strandberg & Hally Swift
The Rev. Marylou McClure Taylor
Sara Timby & John Rawlings
Ms. Virginia Beard & Mr. Richard Van Andel
Dieter R. & Susan H. Walz
Steven Bradley & Lois Schertz Willett
Dr. Kathy Sue Williams
Paul B. & Jennefer L. Wineman
Woodside-Atherton Garden Club
Jane Woodward
Lysbeth W. Working
John W. Working
Richard I. Yankwich

Bill and Jean Clark were honored for more than three decades of service and support to the preserve with a bench and plaque (below):



If you would like to make a gift to support Jasper Ridge, please contact Gift Processing at (650) 725-4360 or http://givingtostanford.stanford.edu

Appendix 3: Summary of Research Activity

	Projects	Faculty	SS/PD	Grad	UGrad	Vol & tech
STANFORD UNIVERSITY						
School of Humanities & Sciences						
Anthropology	1			1		
Biology	14	6	4	12	10	14
History	1			1		
Jasper Ridge	4		2			30
School of Earth Sciences						
Environmental Earth System Science	4	1	1		2	
Geophysics	3	2		1		
School of Engineering						
Civil & Environmental Engineering	5	1		5	2	
Land, Buildings and Real Estate						
Heritage Services	1		1			3
Land Use & Environmental Planning	1		1			4

	Projects	Faculty	SS/PD	Grad	Other
Non-Stanford					
Balance Hydrologics, Inc.	1		3		
California Academy of Sciences	1		1		
Carnegie Institution for Science	3	3			
Geometrics, Inc.	1		2		
Helmoltz Centre for Environmental Research, Germany	1	1			
Instituto de Ecología, Mexico	1		1		
Iowa State University	1	1			
Murdoch University, Australia	1	1	1		
San Jose State University	1	1		1	
SRI International	1		1		
US Geological Survey	3		5		
Université Paris-Sud, France	1	1		1	
University of California, Berkeley	2	1	1		1
University of California, Davis	2	1		1	
University of California, San Diego	1				1
University of California, Santa Cruz	2	1	1		1
University of Oregon	1	1	1		

The breadth of research activity by the Stanford community is illustrated above left. Members of six departments and three administrative units participated in Jasper Ridge studies. For any given department, the number of research projects (Projects) reflects the total number of studies in which members of that department participated. Interdisciplinary studies are included in the counts for several departments, hence the sum of projects in the table slightly exceeds the actual total number of projects. The columns for Faculty, SS/PD (staff or senior scientists and postdoctoral fellows), Grad (masters and doctoral students), UGrad (undergraduates), and Vol & tech (volunteers and technicians) indicate the number of individuals at different academic levels who participated in research. Individuals with multiple departmental affiliations are assigned a fractional count for each of those departments. Therefore the totals for these columns indicate the number of people at each academic level who participated in research. Most of the UGrad research is by summer research interns; the numbers do not include projects that were course requirements. The table at right provides similar information for non-Stanford investigators.

For a complete list of research projects, access http://jrbp.stanford.edu/research2010

Brown Bag Lunch Lectures

October 2009: Nona Chiariello, Staff Scientist
Jasper Ridge Biological Preserve

The Jasper Ridge Global Change Experiment:
Phase Four—Fire and Restoration

November: Elton Sherwin, Senior Managing Director
Ridgewood Capital

Why Being Green is Not Enough

December: Paul Ehrlich, Bing Professor of Population Studies
Senior Fellow, Woods Institute for the Environment

The World, the MAHB (Millennium Assessment of Human Behavior), and Jasper Ridge

January 2010: Nicole Ardoin, Assistant Professor of Education
Center Fellow, Woods Institute for the Environment

Sense of Place and Environmental Behavior:
Communicating and Educating for Environmental Change

February: Robert Buelteman, Photographer

The Evolutionary Image

March: Scott Loarie, Postdoctoral Fellow
Department of Global Ecology, Carnegie Institution

The Velocity of Climate Change

April: Chris Field, JRBP Faculty Director
Professor of Biology & Environmental Earth System Science

Jasper Ridge Biological Preserve Town Meeting

May: Melissa Armstrong, Diversity Programs Manager
Ecological Society of America

with Stanford SEEDS students Kate Lowry, Mattias Lanas, and Kimberly Gibson

Strategies for Ecology Education, Diversity and Sustainability (SEEDS): a program of the Ecological Society of America

Appendix 4: Publications

Adams RI, Hadly EA. 2010. High levels of gene flow in the California vole *(Microtus californicus)* are consistent across spatial scales. Western North American Naturalist 70(3): 296-311.

Avrahami S, Bohannan BJM. 2009. N_2O emission rates in a California meadow soil are influenced by fertilizer level, soil moisture and the community structure of ammonia-oxidizing bacteria. Global Change Biology 15(3): 643-655.

Blankinship JC, Brown JR, Dijkstra P, Hungate BA. 2010. Effects of interactive global changes on methane uptake in an annual grassland. Journal of Geophysical Research—Biogeosciences 115: G02008, doi: 10. 1029/2009JG001097.

Bonebrake TC. 2010. Global change implications of adaptation to climatic variability. Dissertation, Department of Biology, Stanford University.

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Appendix 5: Educational Use

Stanford University Classes (1731*)

APPPHYS 79N	Energy Options for the 21st Century (Fox, Geballe)
BIO 101	Ecology (Dirzo, Vitousek)
BIO 44Y	Core Experimental Laboratory (Malladi)
BIO 44Y Pilot	Core Experimental Laboratory (Fukami)
BIO 96A,B	Jasper Ridge Docent Training (Dirzo, Wilber)
BIO 117	Biology and Global Change (Vitousek , Arrigo)
CEE 136	Green Architecture (Barton)
CEE 166D/266D	Water Resources and Water Hazards Field Trips (Freyberg)
CEE 266W	Water and Energy of the Colorado River (Freyberg)
CEE 276E	Environmental Toxicants (Ong)
EARTHSYS 10	Introduction to Earth Systems (Ernst)
EDUC 332X	Theory and Practice of Environmental Education (Ardoin)
EESS 155	Science of Soils (Fendorf)
HUMBIO 55V/MI 115D	Human Virology Inquiry Project II (Siegel)
INDE 220	Health and Human Disease I; Basic Principles (Siegel)
NATIVEAM 25SI	Our Country, Our Way of Life; Indigenous Peoples and Environmental Justice (Wilcox, Peralto, Chase)
SCI 30	Insects: Creatures that Run the World (Boggs)
MI 175SC	Smallpox: Past, Present, and Future (Siegel)
SGSI	Green Technologies for Climate Stabilization and Energy Security (Masters)
SWiM WFA	Wilderness First Aid class (SWiM staff)

Stanford and Affiliated Groups (484*)

2010 Walk the Farm
Aldo Leopold Leadership Program
Center for Advanced Study and Behavioral Sciences (CASBS)
Center for Biomedical Informatics; Interdepartmental Program
Center for International Security and Cooperation, CISAC
Department of Global Ecology
Department of Psychiatry
First Nations' Futures Institute
Freshmen Sophomore College (FroSoCo)
Graduate School of Business Alumni Association
Larkin Dorm
Natural Capital Project
School of Earth Sciences, Geoscape Bay Area Teachers
Stanford Emergency Medical Service
Stanford Humanities Center
Stanford Institute for Creativity and the Arts
Stanford University Alumni Association
Stanford University Controller's Office
Stanford University Information Technology Services
Stanford University Office of Development Staff
Stanford University Office of Science Outreach
Stanford University Visitor Center Docents
Storey House
Twain House
Volunteers in Asia
Western Conservation Finance Program/Woods Institute:
Land Trust Alliance

Other College/University Classes (70*)

California College of Arts: Art and Climate
Cañada College: Native Plants and Wildflowers
Foothill College: Environmental Horticulture and the Urban Landscape

K-12 Groups (1176*)

Boys and Girls Club, East Palo Alto
Corte Madera School
Eastside College Preparatory School
Environmental Volunteers
Menlo Atherton High School
Redwood Environmental Academy of Leadership (REAL)
The Nueva School
Woodside High School
Youth Community Service (YCS)

Other Groups (577*)

Acterra Stewardship
Audubon Society
Borel Bank
Building Futures Now
Cal Academy/JRBP Teacher Professional Development Workshop
California Native Plant Society (CNPS)
Channing House
Committee for Green Foothills Board of Directors
Conservation Strategy Fund
Delta Sigma Theta Sorority, Inc.
Exploring A Sense Of Place
Filoli Docents
Fire Safe San Mateo County
Gray Hawks
Hidden Villa Interns
Humanist Community of Silicon Valley
Institute of Transpersonal Psychology
Intergovernmental Panel On Climate Change (IPCC)
Jepson Herbarium Poaceae Workshop
Midpeninsula Regional Open Space District (MROSD)
Palo Alto Senior Walking Group
Pi Beta Phi Alumni Club Palo Alto
Rocky Mountain Biological Laboratory Board of Trustees
San Carlos Green
Sempervirens Fund Board of Directors
Sierra Club
Stevenson House
The Wildlife Society
UNESCO, Division of Ecological and Earth Sciences
U.S. Department of Agriculture

*Number of visits. One visit = one person entering Preserve on one day. These numbers represent an underestimate; as they do not include informal nor research use.

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Chris Andrews: Insert card (all other images)
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Eliza K. Jewett: Insert card (*Calochortus alba*)
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In Memoriam

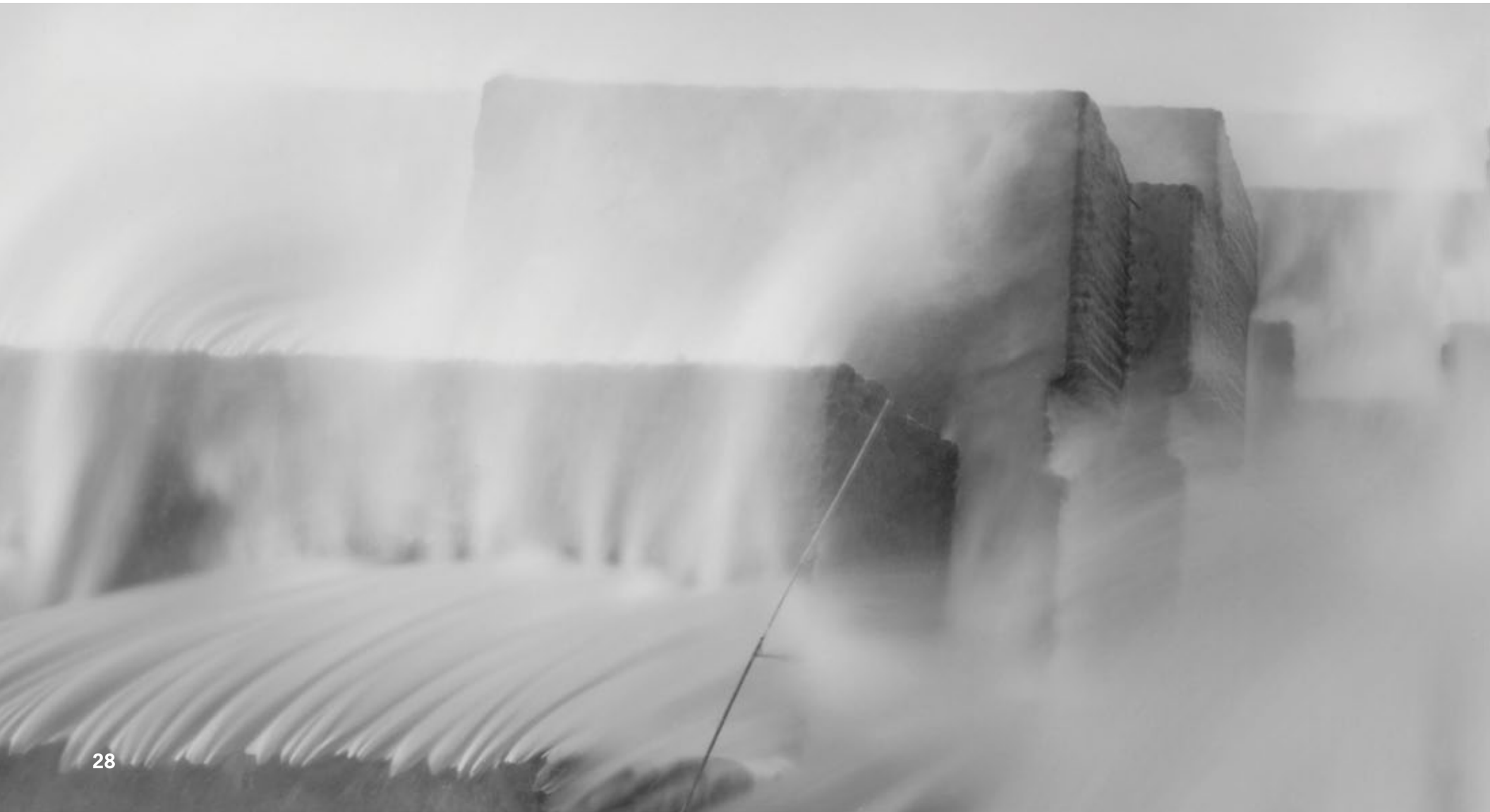
http://jrbp.stanford.edu/memoriam2010

Judy Robertson

Judy Robertson, JRBP docent class instructor, former president of the California Lichen Society, and an expert on local lichens passed away peacefully at home, on July 10, 2010, following a two-year battle with cancer. This past spring, unable to teach a formal lichen class for JRBP, Judy still contributed significantly to student work by identifying specimens from the redwood canopy that had been collected by Stanford undergraduate Samantha Larson. Judy's enthusiasm for teaching and sharing her encyclopedic knowledge of lichens inspired many JRBP students.

Leo Holub

From the moment Leo arrived at Stanford in 1960, he helped produce photographs of Jasper Ridge, including providing graphics support for the earliest campaigns to establish the preserve. His early photos of Paul Ehrlich's research in the serpentine were used to formally establish the preserve as a biological field station. After providing graphic support for several Stanford fundraising campaigns, he became an art lecturer at the university, but his connection and visits to the preserve never waned. While Leo's photograhic talents received broad recognition (including photos in the Smithsonian Archives), several of his photos were used in the initial and early Jasper Ridge annual reports. His unassuming, kind, and gentle demeanor left an indelible mark within the JR community.



Bill Lane

Bill Lane will best be remembered for his remarkable generosity of spirit, for having the vision to help protect our most precious lands, and his capacity to find ways to make life richer for all those around him. As neighbor, equestrian, and donor, he left an indelible mark on the preserve. While the preserve represented only a small part of his generosity and active life, Bill and his wife Jean (a Jasper Ridge docent for over 35 years) made the lead gift that gave life to the campaign for the award winning Leslie Shao-ming Sun Field Station. Like so many others, the preserve is a better place thanks to Bill's enthusiastic support and generosity. His familiar, boyish grin will be missed.

Stephen Schneider

The world of climate science has lost one of its greatest minds and strongest voices. Steve was a leading member of the climate science community for over 40 years, working from a base at Stanford from 1992-2010. An expert in both the physics and impacts of climate change, Steve published more than 450 scientific papers and advised the administrations of 8 presidents. Although prodigiously productive as a scientist, Steve probably realized his greatest impacts as an educator and spokesperson. A gripping and eloquent speaker, he had a remarkable ability to help people understand why they should care about an issue. With torrents of words, clear analysis, and memorable jokes, Steve could turn a phrase that not only crystallized an important idea but also lodged it in your memory. Steve's message was one of single-minded focus on scientific integrity, clear communication, and passing a sustainable world to future generations.

Elisabeth Hansot

Elisabeth Hansot, a Jasper Ridge docent since 2007 and Stanford University senior lecturer in Political Science, passed away peacefully at home September 9, 2010 following a recurrence of cancer. Elisabeth cared deeply about animals, the environment, and essential social opportunities. She worked with great dedication to create positive change in her community.

Storm Runoff, Searsville Dam (2010). © Robert Buelteman

The mission of Jasper Ridge Biological Preserve is to contribute to the understanding of the Earth's natural systems through research, education, and protection of the preserve's resources.

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Buckeye Leaves (2010). This photogram of a Buckeye leaf cluster was made by visiting artist Robert Buelteman in the Leslie Shao-Ming Sun Field Station. © Robert Buelteman