Jasper Ridge Biological Preserve

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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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From the Faculty Director

Chris Field

Jasper Ridge is a remarkable treasure. I know I speak for the entire staff when I say that it is a real privilege to be involved with the Jasper Ridge organization and to interact with the broader JR community. But perhaps most important, it is a real privilege to be involved with the preserve itself—from geology to animal behavior. After more than 30 years of work at Jasper Ridge, I still find myself amazed at the preserve's beauty, diversity, and dynamics. We all plan our schedules around the preserve's dynamics—birding as the sun rises or checking shady pools in the creek at mid-day. For annual dynamics, this might mean looking for the first *Dirca* blossom in late October or the first fawn in April.

Increasingly, both researchers and the broader community are focusing on multi-year or even multi-decade dynamics. In many respects Jasper Ridge truly is an island of nature in a sea of development. Its ecosystems and plant and animal communities provide unparalleled opportunities for studying natural processes. Still, we are seeing long-term trends related to human activity in many aspects of Jasper Ridge structure and function. Several of these, including the gradual filling of Searsville Lake with sediments, the disappearance of the Bay checkerspot butterfly, the gradual dimming of the spring serpentine bloom, and the advance of the Argentine ant, are focal points for research and education in support of the Jasper Ridge mission. Work on understanding the drivers, consequences, and interactions of these longer-term trends can be very important both as basic science and as a foundation for conservation. Some of the best educational opportunities at Jasper Ridge involve helping students and visitors understand the dynamic nature of ecosystems and the pervasive role of human influence.

For many years, the Jasper Ridge researchers and staff viewed careful observation as the best strategy for responding to nearly all of these long-term trends. The cases where we took an activist role in resisting or slowing a long-term trend were the exceptions. In these cases, for example with pulling French broom or tree-of-heaven, we made decisions to intervene only after long discussions, focusing the interventions on cases where the scientific value of a hands-off approach was small, where the risk to important ecosystems of not acting was large, and where there were decent prospects for real improvements with modest investments,

typically the labor of docents or staff.

This year we began rethinking the "observe only" approach to long-term change. With the guidance of the Jasper Ridge advisory committee as well as the research community, we are increasingly asking whether we might not achieve a better balance of research, education, and conservation objectives by intervening more often. Intervention can, of course, take a variety of forms. Pulling French broom is an example at the light-touch end. Dredging Searsville Lake or reintroducing Bay checkerspot butterflies would be much more complicated, both operationally and philosophically. But these more ambitious kinds of intervention also have the potential to provide unique basic knowledge, to help strengthen the knowledge base for restoration, and to help sustain important ecosystem services at Jasper Ridge.

The challenges that need to be addressed in developing the science of intervention ecology are immense. Questions about when to intervene, how much to intervene, and what condition to restore to are among the most difficult we can pose. Part of the reason I prefer the term "intervention" to "restoration" is that, as we address these challenges, we may decide that aggressive restoration to a predetermined state is the exception rather than the rule. Intervention, in contrast, connotes at least the possibility of a more thoughtful approach. Depending on the project, useful intervention might be as large as massive dredging or as subtle as small nudges to species composition. The hallmark of effective interventions will be a combination of careful study (both before and after the intervention), plus thoughtful integration with other knowledge about the system. Effective intervention will also demand an acute awareness of the arc of history and the difficulty of defining any single state as the final goal for restoration activities.

Intervention ecology is clearly coming into focus as the challenge for the future. This is true not only in Jasper Ridge research, but also in the international scientific community. Part of the need for intervention ecology is a consequence of our era, where vast increases in the pressures on ecosystems, from invasive species to climate change, create the risk of losing important species or ecosystem services. But part is a testament to the growing strength of the underlying science. Only with great knowledge does it make sense to begin customizing ecosystems to protect sustainable services.

At Jasper Ridge, intervention ecology will likely be an important theme over many years. The Stanford Environmental Venture Program work on enabling a Bay checkerspot reintroduction is one example, as is the latest thrust of the Jasper Ridge global change experiment. The arrival, in 2010, of the first Jasper Ridge restoration fellow (Prof. Jennifer Funk, Chapman University), and the development of new monitoring capabilities are important steps in building the sophistication of the program and the range of projects considered. In each of the following sections of this report, you will find instances of how intervention ecology is already changing what we do and how we think, regardless of whether an issue traditionally falls within management, research, or education.

In the long run, preserving key species, features, and ecosystem services at Jasper Ridge will likely demand a wide range of interventions. But this is increasingly true of the world as a whole. Historically, Jasper Ridge and its scientific community were key players in the emergence of several new aspects of environmental science, from coevolution to ecosystem physiology. Intervention ecology may well be a major component of the environmental science of the 21st century. Jasper Ridge, both as a site and as the home base for a research community, is well positioned to play a leading role in the development and testing of diverse concepts concerning the prospects, requirements, and limits to intervention ecology.

Management and Operations

Philippe S. Cohen

As I try to gaze into the future and imagine what kind of world my son will inherit, it is clear that continuing as we have in the past is not a viable or responsible option. We live on a planet in need of repair and recovery from generations of abuse. For my son's generation, their burden is to begin much of that recovery and to help repair the relationship between humans and the environment. We can get an inkling of this at Jasper Ridge, which in many ways, has become a kind of global backyard—where we can see and measure the manifestations of processes operating at regional to global scales. Make no mistake, the almost 1,200 acres that make up Jasper Ridge is but a postage stamp in the scheme of things. But what researchers and students are learning at Jasper Ridge and what we need to understand magnifies the importance of this little corner of the globe.

The challenges of the coming century are very different from the last. Our focus on protecting what is left must now shift to repairing what is left. Jasper Ridge will feel these changes. Because the world has changed in ways that can no longer be avoided, Jasper Ridge must move in new directions that increasingly demand more hands-on management.

At the same time, a deeper understanding about how we are connected to natural systems and how this precious planet can be repaired is critical if it is to continue providing essential services. For better or for worse, my son's generation will have to make up lost ground and will need an education that strengthens a deeper sense of how our earth's systems and life forms are the basis of our own existence and the measure of our life's richness. That knowledge, in turn, will need to translate into new ways of doing things, placing gentler, different demands upon the world, and to do this in equitable ways. For Jasper Ridge, that means continuing to help educate students by supporting interdisciplinary and inter-generational sharing of ideas and perspectives that provide direct, empirical understanding for how our environment functions.

When the Stanford Board of Trustees first designated Jasper Ridge as a biological field station in 1973, management believed that in order to maximize opportunities for answering important, fundamental questions about how natural systems function, nature should be allowed to "take its course." This hands-off approach meant that the impact of any activity—whether research, education, or management—should be minimized, unavoidable, or at the very least, reversible. The history of the preserve has proven this to be an astonishingly successful strategy. Jasper Ridge has established a unique research synergy that has consistently resulted in the preserve contributing to our understanding of a complex and rapidly changing world. Researchers have made many important contributions, ranging from how ecosystems function to insights into conservation and population biology, from invasion ecology and plant-animal interactions to geophysics and hydrology.

So just as I'm letting go of my son, I am also struggling with how best to address the threats to the preserve's biota while maintaining conditions for continued research and educational productivity. Intruding into the functioning of natural systems runs contrary to my ecological sensibilities. Yet that is precisely what the future demands with greater, intentional intervention a likely hallmark of the coming years. Today, more than ever, threats ranging from climate change to invasive species, from watershed to fire management, demand a more active, sometimes intrusive approach. Increasingly, the one option that is least viable is the status quo.

For instance, climate change models predict that the Bay Area will likely experience increased intensity and frequency of fires in a region that is characterized by an extensive and growing urban/wildland transition zone. For the preserve, this means that we will need to be more proactive in managing certain habitats and key perimeter areas to reduce the risk of wildfire to neighboring communities. At the same time, we must find ways to monitor our interventions so we can assess and adaptively manage their long-term impacts and not simply add to the growing list of dangers to the preserve's biota.

Invasive species are another tricky issue that increasingly requires a more proactive response. Invasive species are a global problem whose impacts are primarily driven at the local and regional scale. Over a quarter of the plant species at Jasper Ridge are naturalized aliens, yet only a few have significantly altered native ecological communities. It is a fool's errand to think we can eliminate this problem, but standing pat while noxious weeds and other invasive organisms disassemble native communities seems less than responsible stewardship. There are instances of real progress, having almost completely eradicated *Ailanthus altissima* (tree-of-heaven) from the preserve. This does not mean it won't return, as it almost certainly will, but that it is far less likely to become a significant threat and will be much easier to contain.

Other important actions are being taken to navigate the terrain of a changed world. The JR advisory committee, under the faculty director's leadership, is developing policies for calibrating how much intervention is desirable and how risks are balanced with the importance of the questions that need to be answered.

In addition, in the summer of 2010 Jasper Ridge will support a JR restoration ecology fellowship for the first time. Ecology must develop the foundations to support thoughtful, sophisticated, and effective interventions, operating at a range of different scales. This new program will lay the groundwork for the preserve to play an important role in this challenge, starting with the first visiting scholar, Jennifer Funk from Chapman University. Jennifer will experimentally address theoretical questions about whether there are shared traits in plant communities that can be promoted in ways that help resist invasion. The long history of research on JR grasslands makes it an ideal place for this kind of effort.

Another noteworthy event is the awarding of an NSF grant submitted by JR staff (lead by Nona Chiariello and Chris Field), "Jasper Ridge: Facilities for Understanding Wildland/Suburban Boundaries," that will put in place infrastructure to provide enhanced monitoring before, during, and after interventions and manipulations. Specifically, this grant will allow for three significant additions for studying the JR landscape and how it interacts with adjacent lands:

1) Installation of a wireless mesh network that covers about 80% of the preserve to enable sensor-based monitoring that is far more intensive and efficient than is currently possible, while at the same time reducing the human footprint for collecting information. This network will be especially valuable for collecting information before and during manipulations. It is also expected that such a network will bring down the costs and difficulties of maintaining long-term research sites.

2) Connected to the wireless mesh network, an installed system of sensors that can collect important information for researchers and management. This includes soil moisture sensors, fire detection sensors, and a system of wireless digital cameras.

3) Acquisition of a portable imaging spectrometer that will make possible close-range remote sensing to allow minimal impact data collection related to structure, phenology, and productivity of Jasper Ridge plant communities.

This infrastructure will focus primarily on our boundaries, providing us with a means to more effectively monitor edge effects, disturbance, and other potential interactions with lands and activities outside the preserve. For instance, little is known about how vegetation management along the perimeter impacts the movement of animals. The cameras and wireless mesh will provide us a means to begin addressing this and other questions.

Over the years, we learn to take for granted that our lives are often constructed into parallel roles—home/work, public/private. This duality can make our lives rich, complex, contradictory, confusing, and at times, seemingly inexplicable. These roles can also occasionally come into stark contrast,

Photo of coyote with a remote wireless digital camera being field tested by Trevor Hébert. Photo was taken on April 8, 2009.

especially when their currents run in different directions. As I watch my seventeen-year-old son prepare himself to enter a world in need of repair, my role as a parent and that of managing Jasper Ridge contrast each other in interesting and sometimes disconcerting ways. The change from a minimalist to more proactive approach to managing JR comes at a time when my role as a parent is arcing along an opposing trajectory. On the one hand, like every parent, I am having to learn to let go of an active daily role in my son's life while simultaneously considering how best to more actively intervene in managing the preserve in order to ensure its future.

Intellectually and intuitively I realize that parenting is increasingly about letting go, avoiding intervention, and knowing less about the details of my son's everyday life. As a parent, I am learning to let my son make his own mistakes and manage the associated consequences. Conversely, the challenges facing the preserve require that I gather more information and work with researchers, the community, and others about how to intervene in the functioning and management of the preserve's biotic communities. I also know that what we learn at Jasper Ridge and the challenges that my son's and future generations face are inextricably connected. We are positioning the preserve to help the next generation manage the consequences of our past mistakes as well as being more knowledgeable about the ecosystem services upon which we depend functions. It is my hope and commitment that in the coming years, Jasper Ridge can help educate current and future generations to be wiser and more knowledgeable than my generation about how to begin the long, arduous healing process while conserving this place that has made so many valuable contributions to understanding natural systems. For better and for worse, Jasper Ridge is a global backyard.

Assistant professor Tadashi Fukami and PhD student Melinda Belisle collecting samples for a new study that analyzes the diversity of microbes living in the nectar of sticky monkey-flower (*Mimulus aurantiacus*). Bags made of fine mesh exclude pollinators and their hitchhiking microbes from some flowers. Accessible flowers, such as those opposite, reveal their pollination status by whether the white stigma is closed (left, visited) or open (right, unvisited).

Research and Monitoring

Nona Chiariello

Researchers from many disciplines and career stages conduct studies at Jasper Ridge with the shared goal of scientific discovery that has fundamental value for understanding and protecting ecosystems. Their research inherently reflects the dynamics and turnover of academic life. Each year, incoming students get started on new projects alongside advanced students who are completing their degrees, and a similar changing of the guard occurs with postdoctoral fellows. But the research community also has firm elements of continuity in the faculty and academic mission of the university.

By comparison with many years, 2008–09 was especially dynamic. Three PhD students who made major contributions to some of the core research programs and outreach at JRBP—May Chui, Claire Lunch, and Jessica Shors—defended their dissertations in spring quarter and moved on in their careers. They are profiled on pages 18–19. A comparable number of new graduate students began exploring potential research topics, as did a new faculty member in biology, assistant professor Tadashi Fukami. In total there were 68 scientific studies (appendix 3), and 35 publications (appendix 4) during 2008–09.

The year was equally dynamic in terms of new directions in research and research policies. But unlike the aspects of research that are driven by the turnover cycle of the student population or equally short research grants, the new directions that were set in place this year reflect the long-term vision and leadership that provide a foundation for nearly all research. The principal factors that contribute to that vision are the intellectual drive of faculty members who establish and sustain long-term research programs within which most graduate students work, the advisory bodies that make the hard and important policy decisions about what kinds of research can and should be permitted, and Stanford's principles and policies within which Jasper Ridge operates.

Just as ecosystems are defined by their dominant species and the infrequent events that reshape them, the landscape of research at Jasper Ridge reflects a consistent vision punctuated by occasional but significant developments in the organization and focus of research. Five such developments occurred during 2008–09 and are of general significance because they shape not only the direction of research at Jasper Ridge but also the broader benefits of the research.

One of those developments has been discussed in detail by Philippe Cohen earlier in this report—a National Science Foundation (NSF) grant that will enable JRBP to provide most of the preserve with wireless internet capability that will interface with various types of monitoring technology. The NSF grant opens the door to many new types of remotely managed research and monitoring by researchers and students who are located virtually anywhere.

The four other major developments involve new research directions in ecology and new or revised policies. Together these developments demonstrate how the Stanford community is insuring the capacity of JRBP to continue its broad contributions to science, conservation, and public understanding.

New research directions in ecology

The past year saw an infusion of new research by Stanford professors Tadashi (Tad) Fukami, Chris Field, and Rodolfo Dirzo. Although their three studies focus on distinct questions and time scales, they have a shared goal of understanding the forces that organize nature into the assemblages we call ecological communities. This goal is a fundamental pursuit in the field of ecology and also has broad significance for understanding how intact communities function, how communities reassemble after they have been invaded by non-native species or altered by climate change, and how much intervention is necessary to help communities recover rather than degrade. These new studies will shape much of the ecological research by students in coming years.

Ecological succession in a drop of nectar

Upon arriving at Stanford in fall of 2008, Tad Fukami began searching for a model system for studying ecological succession. Tad was specifically interested in habitats that are highly replicated and discrete, like the islands of an archipelago, or forest fragments separated by lava flows, which are among his other study systems. He found a Jasper Ridge system that is so accessible, highly replicated, and easy to manipulate that every student majoring in biology will be able to take part in the research. That system consists of the showy, orange flowers of sticky monkey-flower (*Mimulus aurantiacus*) and the microbial communities that inhabit their nectar.

Tad sees *Mimulus* flowers as a microcosm for deriving general principles about how communities establish, change, and respond to perturbations. Sticky monkey-flower is abundant in the chaparral and evergreen woodland. From April to June, it produces a profusion of flowers that are visited by hummingbirds, other pollinators, and nectar thieves. Microbes, including multiple species of yeast, hitchhike on those animals, and establish colonies that grow on the nectar sugar. The result is a complex set of interactions involving competition, nectar harvesting, and assisted migration, all of which drive changes in the microbial community within individual flowers.

To characterize the basic features of the system, Tad was helped in the field by PhD candidates Melinda Belisle, Camila Donatti, and Diamantis Sellis, undergraduates Rahael Gupta and Denis Willett, and volunteer Michael Priest. Results to date indicate that variation across *Mimulus* plants in their date of first flowering is accounted for, in part, by how warm and sunny a plant's microhabitat is. There is also evidence that microbial colonization of nectar is higher in open flowers than in flowers bagged with netting, suggesting the importance of transport by animals for establishing microbes. These findings illustrate the importance of immigration pathway for biodiversity and ecological succession, and the role of the physical environment in regulating biotic interactions.

Melinda and Diamantis have begun research on some exciting aspects of the system. Melinda, with help from high school intern Christine Kyauk, carried out gene sequencing to identify the various yeast present in *Mimulus* nectar. Diamantis is examining how much ultraviolet radiation (from sunlight) passes through flowers and whether it damages yeast colonies. His study is funded by a grant program established by the A.W. Mellon Foundation.

The *Mimulus* study will have significant broader benefits as well. Professor Dmitri Petrov and lecturer Pat Seawell are working with Tad on redesigning the ecology unit of the core biology curriculum to focus on floral ecology of *Mimulus*. Students will sample nectar from flowers and analyze the microbial community as a function of the physical and biotic environment, using metrics Tad's group has tested. The course will accommodate a large number of students visiting repeatedly in small groups through the spring. Students will be required to write a research report, similar to a short journal article, which will satisfy a Stanford graduation requirement termed "writing-in-the-major."

Combining a meaningful exercise, contributions to long-term monitoring, and a writing component, this field unit is well suited to meeting the widely recognized need to strengthen the research aspect of university curricula in introductory biology.

Roger Guevara and professor Rodolfo Dirzo censusing caged and uncaged individuals of soap-plant (*Chlorogalum pomeridianum*) in an ongoing study of the control of vegetation by large herbivores. Roger's yearlong fellowship in Rodolfo's lab was funded by the national science agency in Mexico, CONACyT.

Oak regeneration—a missing generation?

Across JRBP's woody species, no genus is more widely distributed, ecologically dominant, or diverse than *Quercus*, the oak genus. Especially in savanna and woodlands, oaks define the architecture of the plant community as well as the habitat and resources for wildlife. Professor Rodolfo Dirzo and visiting scholar Roger Guevara began a study this year to assess whether the regeneration capacity of Jasper Ridge oaks is sufficient to sustain these communities in the future. If, as the saying goes, an oak's first hundred years are spent growing, the second hundred are spent living, and the third hundred are spent dying, then the long-term health of oak-dominated communities requires more than canopy trees. There also must be understory oaks waiting in the wings.

Rodolfo and Roger found that merely trying to locate seedlings for their study was revealing. Valley oaks (*Quercus lobata*), which are the spreading giants of savanna and open woodland, had very few seedlings, and seedlings of blue oak (*Quercus douglasii*) were barely more numerous. Live oaks (*Quercus agrifolia*) are reproducing successfully but mature trees are at risk of sudden oak death.

For each of these three species of oaks, Rodolfo and Roger marked 75 pairs of seedlings which they will monitor for survival and growth over ten years. Each pair consists of adjacent seedlings matched by height, with one member of the pair randomly assigned to be caged to exclude large herbivores. By determining herbivore constraints on oak regeneration within the historical distribution of these species, this study will add an ecological dimension to studies aimed at predicting the future distribution of oaks based on climate change.

Rodolfo's group is conducting several other studies that have a similar focus on the abundance of herbivores and the magnitude of their impacts on the reproductive success of native plants. Rodolfo and Roger found that protecting soap-plant (*Chlorogalum pomeridianum*) with caging during the vegetative stage quadruples its likelihood of reproducing, even if the plants were browsed prior to being caged. In a separate study, Rodolfo and Eduardo Mendoza recently published results on California buckeye (*Aesculus californica*) showing that its large seeds, which can weigh up to 100g when intact, can lose up to a third of their mass to seed predators and still have more than a 50:50 chance of germinating. These studies illustrate the profound impact of herbivores on JRBP's plant communities as well as some evolutionary adaptations to herbivory in native plant species.

Global change and native grass recovery

Under the direction of professor Chris Field, the Jasper Ridge global change experiment (JRGCE) is forging a new direction for global change studies: strategies for ecological restoration based on ecosystem responses to global change. The JRGCE's new research plan will examine restoration in the context of fire together with the four simulated components of global change that the experiment has imposed for eleven years: increases in atmospheric CO_2, temperature, nitrogen inputs, and precipitation. The study will build new partnerships with local fire and land management agencies on combined strategies for fuel management and restoration.

The new direction for the JRGCE grew out of several years of examining the converse of restoration—invasion by "state-changing species" such as yellow star-thistle (*Centaurea solstitialis*). The new research plan asks whether we can use what we have learned about invasion by star-thistle, or other species, e.g. French broom (*Genista monspessulana*), to shift the grassland in the opposite and stabilizing direction, toward restoration of native perennial grasses. Last January, Chris and I submitted a proposal to the National Science Foundation (NSF) suggesting how we might test the concept.

Our reasoning was guided by recent findings that tie together a decade of star-thistle studies, all of which observed a significant boost in star-thistle growth under elevated CO_2. In some experiments the size of star-thistle plants increased by six-fold under elevated CO_2. That is a dramatic response by any standard, but it is especially huge given that the rest of the grassland tends as much toward a growth decrease under elevated CO_2 as a growth increase. Adhering to the principle that an extraordinary result requires extraordinary level of evidence, the JRGCE spent the past two years conducting permutations of earlier studies in order to explain star-thistle's behavior. We found that star-thistle growth took off under elevated CO_2, but only in certain areas, such as where the plant canopy was relatively sparse as a result of gopher activity or other factors. A synthesis of these results is underway involving a decade of investigators including Jeff Dukes, Scott Loarie, Annie Lindseth, Todd Tobeck, Yuka Estrada, and Chris Andreassi.

The new research plan for the JRGCE tests the hypothesis that some candidate species for restoration efforts, such as the native bunchgrass purple needlegrass (*Nassella pulchra*) and two other native grasses, will benefit slightly more than invasives under certain global change scenarios because they have features at the overlap of taking advantage of resources made available by global change scenarios and limiting the availability of resources that would boost invasives. Preliminary evidence, including projects by undergraduates Ana Deaconu and Julie Smith, suggests that *Nassella* does appear to be favored by elevated CO_2, and the benefit occurs primarily under conditions of a grass cover, rather than disturbed ground. This is the sort of window of opportunity we would look for to give a restoration candidate an edge over invasives. Once

As part of a study of global change effects on ecosystem invasibility, Todd Tobeck, Katherine (KT) Mertes, and Jen Johnson introduce seedlings of five species into the JRGCE based on a layout indicated by temporary, color-coded flagging.

Undergraduate intern Julie Ralph surveying vegetation with PhD student Kyla Dahlin during a study that produced high resolution maps of key woody species at JRBP and the nearby Pulgas Ridge preserve.

the restoration species are established, the research plan will also test whether fire reinforces or reverses their advantage.

In June, NSF awarded a four-year grant to conduct the tests we proposed, and designated the project a component of its focus on "Life in Transition (LiT)." The purpose of LiT is to highlight emerging areas of interdisciplinary research that ask questions such as, "How do the inherent properties of robustness and fragility of biotic networks and feedback loops determine the resilience and susceptibility of life to environmental change?"[1]

The new NSF grant will also allow the JRGCE to continue a range of broader contributions. Chris's leadership roles at the national and international level, and especially within the Intergovernmental Panel on Climate Change, include a strong emphasis on insuring that the results of experimental studies are accurately represented in the scientific consensus on climate change. Closer to home, the new focus on restoration provides a direct link from the JRGCE to management practices that have immediate relevance. Also, the JRGCE will continue to encourage other investigators to use the experiment for compatible studies. Currently, investigators from three other institutions are proposing add-on studies for the JRGCE.

Beyond Jasper Ridge

Viewed together, these three new research directions illustrate ways in which ecological change can be studied at Jasper Ridge through carefully designed experiments that combine many replicates and detailed environmental monitoring. For some questions, however, Jasper Ridge is only a single replicate.

A good example is the long-term study by professor Deborah Gordon and her students to understand the invasiveness of Argentine ants (*Linepithema humile*). This year, PhD student Katherine Fitzgerald carried out the 17th year of the Argentine ant survey at Jasper Ridge and expanded the fall and spring surveys to include Pulgas Ridge and Fremont Older, which are units within the nearby Midpeninsula Regional Open Space District (MROSD). Coupled with the comparative surveys across all three replicate sites, Katherine is taking invasion models she developed for Jasper Ridge and testing them with the MROSD areas. Her predictions are based on habitat models developed from newly acquired LiDAR (Light Detection and Ranging) data.

Undergraduate Julie Ralph used Pulgas Ridge in a similar way to test high resolution models of plant distribution that she developed during a summer internship with PhD student Kyla Dahlin. Julie used LiDAR data from the Carnegie Airborne Observatory (CAO) to characterize the elevation, slope, and monthly solar irradiance for three woody species that Kyla has mapped at JRBP. They then used CAO data for Pulgas Ridge to identify matching environments there, and tested whether the species' distributions were as expected. The method worked very well, averaging 77 percent accuracy across the three species.

Julie suggests that projecting distribution models made at one location onto a similar nearby area could be useful for "finding rare species, determining the threat posed by invasive species, or deciding where to reintroduce new members of a threatened species." Both of the studies carried out at Pulgas Ridge illustrate how Jasper Ridge research involves not only fundamental science but also applications for local conservation issues.

Historical student research

If you took an evening hike across Jasper Ridge this past spring, you may have noticed a student circling around a tall, illuminated cloth drum, occasionally pausing to scoop up a moth that was drawn to the light. On a similar hike in spring of 1959, you would have encountered a student preparing for a night of spying on tarantulas by flashlight, with a cot nearby for an occasional nap. These two studies bracket fifty years of independent student research and illustrate some of the adventure, breadth, and biorhythms of undergraduates who explore Jasper Ridge.

A deeper look at the link between undergraduate research and education reveals fundamental academic questions that the Jasper Ridge advisory committee (p. 5) began to address this year. Scores of studies have affirmed that a combination of independent problem-solving and mentoring by a faculty member represent the best in both learning and teaching. But what about the value of the research itself? Should a student's unpublished observations provide a baseline for follow-up studies by other students or researchers? Could this be accomplished while still protecting the privacy and intellectual property of student authors? Should student research be fully integrated into JRBP's research mission, which places a strong emphasis on dissemination of new knowledge?

These questions are important because of the quality, scope, and historical significance of student research. This spring's moth collector, Allison Dedrick, was surveying for the much-feared "light brown apple moth." One of her mentors was president emeritus Don Kennedy, who was the architect of JRBP's exemption from pesticide spraying during an earlier pest scare, the 1980s medfly outbreak. The tarantula hunter in 1959 was Stewart Brand, who later created the *Whole Earth Catalog* and *CoEvolution Quarterly* and developed a lasting friendship with professor Paul Ehrlich. The moth and tarantula studies are among 300 undergraduate projects that are documented in unpublished student papers from as early as 1941. Many of them are significant contributions to the environmental and academic history of Jasper Ridge.

Members of the advisory committee are beginning to examine several models for creating a voluntary "digital commons" which would make undergraduate research part of an historical archive accessible to a broader community. The committee's primary concerns are insuring voluntary participation by student authors, adequate time for students to consider formal publication of their work, and consistency with fair-use guidelines and Stanford policies.

Allison Dedrick surveying for moths using a custom light trap she built for her senior honors thesis. Her nine-month study did not detect any confirmed individuals of the invasive "light brown apple moth" (*Epiphyas postvittana*).

Alumni authors of early student papers have been enthusiastic about the idea. As Stewart Brand noted, "My study in 1959 was about 50 years after Charles Piper Smith's observation in 1908 of the mingling of the two species [tarantula and "false tarantula"] on Jasper Ridge. Student work now would follow mine by a similar half-century, and you would have the beginnings of a multi-century longitudinal study..."

Updated policy for non-Stanford research

In 1974, a year after Jasper Ridge was formally designated a biological preserve, Stanford policy viewed JRBP as a natural asset which, under Stanford's stewardship, could benefit a larger academic community. Operating guidelines for that policy were revised this year and provide a framework for continuing that benefit.

The policy is embodied in a written agreement that is now required of non-Stanford investigators. Based on guidance from Martha Langill and Ann George, from the offices of the dean of humanities and sciences and the dean of research, the agreement includes terms by which Jasper Ridge can insure uniform application of Stanford policies for all investigators, whatever their affiliation. This includes university-level review of protocols before using certain chemicals or handling vertebrate animals, and adherence to the principle of openness in research. In addition, the agreement requires that each non-Stanford study have a Stanford faculty sponsor who has the time and expertise to assess and contribute to the project's scientific merit for the duration of the study. The faculty sponsor also represents the project before university-level committees.

Thanks to five Stanford professors who agreed to serve as faculty sponsors, seven non-Stanford studies were established this year within the framework of the new agreements. One consists of a very sensitive magnetic field observatory installed by Geometrics, Inc. which generates web-accessible, archived and real-time data[2] that complement similar instruments installed by professor Simon Klemperer and his colleagues, Darcy McPhee and Jonathan Glen. Other new non-Stanford studies include the genetic basis of flower color variation in *Linanthus parviflorus*, by Lorna Watt; a survey of oak regeneration, by Blair McLaughlin; and analysis of factors maintaining adaptive variation in *Lasthenia californica* along a gradient in soil chemistry, by Nishanta Rajakaruna and his student Teri Barry.

Restoration research

Earlier sections of this report have discussed the milestone decision by the advisory committee to develop policies for considering research aimed at restoration or intervention. The advisory committee's decision reflects a continuing implementation of the 2005 strategic plan, which held that JRBP's conservation mission "recognizes that species and biotic communities that are globally rare or diminished in distribution provide opportunities that are both scientifically important and critical to the University's commitment to responsible stewardship."[3]

One focus of the committee's debate on intervention was a proposal that may become a test case for the policy—whether to attempt a reintroduction of the Bay checkerspot butterfly (*Euphydryas editha bayensis*), which is listed federally as a threatened subspecies and has been extinct at JRBP for a decade. The rationale for reintroduction was presented in a paper by PhD candidates Tim Bonebrake, Karrigan Börk, and Jon Christensen. The paper grew out of an interdisciplinary study funded by the Environmental Venture Program of the Woods Institute for the Environment.

While the advisory committee represents only one of many levels of review that a reintroduction would require, the committee's debate highlights some dimensions of evaluating restoration options. An argument in favor of reintroduction is that the long history of very significant research on the Bay checkerspot provides the foundation for a reintroduction study that would become a landmark in conservation biology. But committee members also expressed concern that a reintroduction might focus too many resources on a single conservation goal that could be costly and risky—a "butterfly bailout," to use one committee member's timely metaphor. The debate over reintroduction will continue during the coming year in order to consider review criteria beyond those applied to traditional proposals, including mechanisms for greater coordination with other research, more frequent progress reports, and longer term follow-up.

A theme linking JRBP's new research directions and revised policies is a more integrated mission focused on ecological change and recovery. Faculty director Chris Field, the Jasper Ridge staff, and the advisory committee are working together to help JRBP chart its future path. The process represents the academic community at its best—penetrating and informed debate about issues ranging from education, history, and law to soil chemistry and climate change—a broad and interdisciplinary sweep of the university.

The preserve faces many environmental challenges that are occurring globally, such as invasive species, a changing climate, increased insularity, and altered fire cycles. These changes are complex and fundamental, and they require new tools and ideas together with a more thorough understanding of the past. JRBP is meeting those challenges with new technology, new research directions, careful consideration of options for intervening, and increased recognition of the potential role of studies by undergraduates, past, present and future.

Ross Johnson and Jeff Johnston of Geometrics, Inc. preparing to install a highly sensitive magnetometer near a suite of geophysical instruments operated by several research groups. Together these instruments provide real-time monitoring of the earth's magnetic field in close proximity to monitoring of seismic activity.

Wireless Digital Camera Traps Trevor Hébert

One of the technology success stories at JRBP this past year has been the remote digital camera systems that I have been testing at several locations within the preserve. Both of these cameras succeeded in capturing rare photographs of a mountain lion at Jasper Ridge.

The cameras, or “camera traps” as they are commonly referred to, take a digital photo when the camera’s motion sensor detects an animal moving within its field of view. Each photo is then sent wirelessly by the camera’s built-in radio transmitter to a base station where it is archived. These camera systems are designed to operate autonomously in locations where there is no power or network connection.

An advantage of digital imaging technology is the ability to stamp the photos automatically with important descriptive information, including date and time, user comments and temperature. It is possible to create a software application to automatically process the images to extract this information and store it in a database along with the image.

The cameras are self-contained units with auxiliary photovoltaic panels to charge the batteries. In most locations, they will run indefinitely on solar power with no need to change batteries or perform other maintenance tasks. The camera traps use an infrared flash for nighttime operation at a wavelength that is invisible to humans and most animals. With their camouflage housings, the cameras are difficult to detect when placed carefully in trees or other natural cover. No noise is produced by the camera when a photo is taken.

The ability to blend into the landscape and to function autonomously for long periods of time makes the cameras attractive for wildlife monitoring and security purposes—these particular types of cameras are also used by the National Park Service and other government agencies as well as by wildlife research projects around the world. In the case of wildlife monitoring, the lack of human activity—and scent—around the cameras, the absence of any noise upon activation and the invisible nighttime flash greatly reduce the chance that animals will be frightened by the cameras and learn to avoid them.

Besides the mountain lion, the cameras have routinely photographed another shy predator of the preserve, the coyote, and many other species of animals and birds. The camera traps have also documented several trespassing incidents that otherwise would have gone unnoticed by JRBP staff. It is this ability to give staff a window into previously hidden and undetected phenomena that makes the camera traps an invaluable management tool.

The National Science Foundation (NSF) grant received by the preserve this year included a request for funding to purchase more cameras, with some of them being set aside for student and researcher use. Many of these will be deployed throughout late 2009 and early 2010 along with the preserve-wide wireless mesh network that was also funded by the NSF grant.

A digital camera trap photo of a mountain lion at Jasper Ridge Biological Preserve. The camera operates silently and the nighttime flash is at an infrared wavelength that is probably completely invisible to the animal.

A digital camera trap mounted to a tree. Cameras mounted in this way usually go unnoticed by people and animals passing close by.

Sixth grade students from Eastside College Prep writing their field observations in the redwoods with Stanford student Kristin Hughes.
Opposite page: Redwood High School student, Brian Jensen, measured the diameter at breast height (DBH) of a tree with the help of docent Bill Gomez as part of the Redwood Environmental Academy of Leadership (REAL) program.

Education and Outreach

Cynthia J. Wilber

Looking back at the past year I am struck more than ever by the increasing breadth of education programs at Jasper Ridge. The rich collaborations and opportunities across disciplines have given students, visitors, researchers, docents, and staff alike new questions to ponder and new ideas to add to the mix. Literally, bringing more voices to the table has sparked new conversations, enriched our questions about teaching and learning and helped set goals for environmental education and the broader understanding of science. Teachers and educators, from the university level to early primary grades have contributed much to this dialogue via Jasper Ridge based workshops, classroom collaborations with the preserve, and ongoing communication across groups that include, among others, the California Academy of Sciences, The Ecological Society of America, Stanford Teacher Education Program, the Stanford Office of Science Outreach, the Stanford K-12 Initiative, the Center for the Support of Excellence in Teaching, the Coalition on the Public Understanding of Science and of course the students and teachers themselves. Knowing that our next generation of young scientists, now in middle or high school, will face a rapidly changing and challenging world raises the stakes even higher for meaningful science education, critical thinking skills, and engaged students.

In the past year, Jasper Ridge education programs worked to address this educational need with a broad variety of programs, school partnerships, and life long learners in the local community, as well as nationally and internationally. Much of this has been accomplished with tiered mentoring that combines the skills of Stanford faculty, local teachers, docents, Stanford students and Jasper Ridge staff. This cascade of teaching and learning science, along with field-based experience, ultimately gets passed on by the students to their peers and community.

The Redwood Environmental Academy of Leadership (REAL) program highlights what broad collaborations like these can accomplish. REAL was created from the Ecology: Learning by Doing grant (Dirzo lab and JRBP) that is now in its second year of funding from the Stanford K-12 Initiative. Students from Redwood High School, the continuation school in the Sequoia High School district, learned essential science and math skills through hands-on ecology in the Cordilleras creek on their campus as well as through field experiences at JRBP. The team included the REAL students, Redwood teachers, Stanford faculty and staff, as well as students from Stanford SEEDS and Jasper Ridge docents. Over the course of the school year, students made impressive gains in their science knowledge by actively doing field ecology experiments including vegetation surveys of both forest and riparian areas, watershed analysis, and plant animal interaction studies using tools that ranged from shovels and tape measures to computers, digital data probes, and smart pens that capture both voice and written notes in a digital format. In the upcoming year this program will include an international component and REAL students will be sharing ideas, questions, data and results via wireless technology with peers in Yucatán and Veracruz, Mexico. In 2009–10 students in each location will collect water quality data, record soil and air temperature, and survey their respective vegetation community data in three very distinct ecosystems.

Working together to question and analyze their data, students will experience science on a global level and build a stronger understanding of earth systems.

The California Academy of Sciences' Teacher Institute on Science and Sustainability brought 30 middle and high school teachers for a workshop in February that included a morning spent comparing and contrasting ecosystems and an afternoon learning field methods with Rodolfo Dirzo. Wearing Tyvek suits to protect them from poison oak, the teachers completed ten transects in mixed woodland, collected and analyzed their data, and brainstormed how to take what they learned to their students. Jill Bible, Curriculum Developer for the Teacher Institute and a Jasper Ridge docent works directly with the teachers to create innovative ways to bring science and sustainability into the classroom.

JR docents and affiliates contributed thousands of hours of time planning and teaching on the trail with other K-12 students from local schools. Some highlights include: multiple field trips with the Sequoia High School environmental science class where students completed a chaparral vegetation survey with Diane Renshaw, a creek studies/water cycle class with the fifth grade from East Palo Alto Charter School led by Tom McFadden that culminated a year long effort on his part teaching science in their classroom, and of course, the Eastside Field Studies class. The 2009 Eastside College Prep 6th graders worked for nine weeks as student researchers alongside Stanford students, Dave Bernstein, Cara Brook, Allison Dedrick, Ben Graves, Kristin Hughes, and Samantha Staley. Susan Gold and Mary Baron also spent every Wednesday with the Eastside team ensuring that each class was a tremendous success.

Many Stanford classes made use of Jasper Ridge resources during academic year 2008–09 and reflected the diversity of educational use overall. Stanford University classes included traditional JR classes like Jasper Ridge Docent Training, Field Studies in Earth Systems, Core Experimental Laboratory, Science of Soils, Watersheds and Wetland, and Introduction to Earth Systems, but also included class visits by Art and Biology, Hands-on Introduction to Astrobiology, Energy Choices for the 21st Century, and Theory and Practice of Environmental Education. For a complete list of educational use see appendix 5.

The growing diversity of education programs has also brought to the table how we can make the best educational impacts while protecting the land

and minimizing human disturbance on the preserve. Teaching teachers influences thousands of students each year as knowledge gained in the field is taken back to classrooms throughout the bay area. Working intensively with other students both at JR and within their school ecosystems over the school year teaches valuable lessons in urban ecology and reinforces for students the need to care for and understand local habitats. Careful thought is given to those programs where we can make a significant educational difference. This combined with the deep reward of witnessing those "light bulb" moments is what inspires and drives our education programs on the trail, in the field, and in the classroom.

From left to right:

1. BIO 96 students Tom McFadden, Sarah Falconer, and Erica Fernandez with a California newt.

2. John Mulrow wiring environmental sensors to a datalogger for monitoring carbon and water fluxes of chaparral during EARTHSYS 189/BIO 206.

3. An aerial photo from April 1975 of the serpentine grassland in bloom taken by Herb Dengler and recently scanned from the original slide to digital format.

4. A mating pair of four-spotted tree crickets, *Oecanthus quadripuntatus*, on a stem of hayfield tarweed, *Hemizonia congesta ssp. luzulifolia*. The male (under the female) attracted her by his song, made by scraping an enlarged file-like vein on one forewing across the hardened margin of the other. The female is feeding on secretions from the male's metathoracic gland. This prolongs mating and allows time for sperm to transfer from the male's external spermatophore which the female will consume once mating is completed.

Jasper Ridge Archives

Each and every year, Jasper Ridge affiliates generously devote their knowledge, time, and expertise to accomplish invaluable tasks for the preserve and this past year a core group of volunteers have been quietly working on a monumental archiving task that will create a important legacy for future generations. Since the earliest years of Stanford University, Jasper Ridge has been blessed with talented photographers, naturalists, and field scientists documenting the preserve and the JRBP archives are rich with thousands of slides, drawings, surveys, and field notebooks that contribute to both the visual and scientific history.

The enormous task of converting and storing these precious resources to digital files is ongoing but in the past year much has been accomplished. Some highlights include the work of Zoe Chandik, who has worked for several years transferring early Jasper Ridge bird census information to computer files. Recently, Zoe completed entering all of Bill and Jean Clark's handwritten bird monitoring observations from 1979–1988 into a spreadsheet so the data can be incorporated into the JRBP bird monitoring database.

Nancy Lund and Dwight Agan have begun the herculean task of scanning slides donated to the preserve from Herb Dengler while Anadel Law has taken on a parallel project of transcribing Herb's many field notebooks.

Cherie Wetzel began scanning slides from the collection of John Hunter Thomas that were kindly donated by Susan Thomas. Many of these slides correspond to early classes taught by John throughout California and at the preserve and will be archived along with notebooks from those classes recently donated by Carol Zabel. More recently, Mary Baron and Gerry Jennings have begun scanning Gerry's slides for future class use including images illustrating the reproductive strategies of the four-spotted tree cricket.

Profiles Academic Milestones and Accomplishments

Joey Blankinship completed his PhD in May at Northern Arizona University with professor Bruce Hungate, and his dissertation was based in part on studies he carried out within the Jasper Ridge global change experiment. Joey examined effects of interactive global changes on soil methane (CH_4) oxidation, microbial community structure, and food web interactions. His work at Jasper Ridge revealed that: (i) interactive global changes are unlikely to enhance the microbial degradation of atmospheric CH_4; and (ii) this annual grassland can actually emit CH_4 in wetter years and in response to increased precipitation. During many visits to Jasper Ridge, Joey also helped measure soil nitrogen cycling and develop soil sampling methods. He is now a postdoctoral research scholar at UC Merced investigating effects of reduced snowfall in the southern Sierra Nevada mountains of California.

May Chui came to Stanford after completing her bachelor study at Lafayette College. During her master's study in the Environmental Fluid Mechanics and Hydrology Program, she undertook various field activities at JRBP with professor David Freyberg to understand the hydrologic system of Searsville Reservoir. The complexity of the system intrigued her to continue in the same research area for her PhD thesis on modeling the hydrologic interactions between Searsville Reservoir and the surrounding groundwater. After finishing her PhD, she relocated to Singapore and is now an assistant professor at National University of Singapore.

Jessica Shors completed her PhD at Stanford in 2009 in ecology and evolution. At Jasper Ridge, she was part of the ongoing project by professor Deborah Gordon's lab examining the displacement of native ants by the invasive Argentine ant (*Linepithema humile*). In addition to contributing to the long-term survey of Argentine ant invasion, Jessica focused her PhD research on whether Argentine ants, after they have displaced native ants, are good substitute protectors of the larvae of the Acmon blue butterfly (*Plebejus acmon*). Protecting the larvae entails defending larvae from predators and parasitoids in exchange for feeding on larval secretions. Jessica found that Argentine ants are better protectors than some native ants and worse than others. While the Acmon blue is a very common member of the "blue" subfamily of butterflies, other members are endangered. Jessica hopes that her findings will help predict the conditions under which endangered species of blue butterflies will be impacted by Argentine ant invasions. She is continuing her interest in the conservation of endangered species as a biologist for an environmental consulting company. She specializes in helping local governments and non-profit companies develop conservation plans for endangered species.

Allison Dedrick combined her interest in invasive species with her love of Jasper Ridge by conducting a survey of JRBP's moth populations and screening for the presence of the invasive light brown apple moth (LBAM), *Epiphyas postvittana*. The survey was the basis of her senior thesis within the Goldman Honors Program in Environmental Science, Technology, and Policy, and professor Carol Boggs served as Allison's primary advisor. Allison constructed a custom light trap to attract moths during 25 evening surveys at seven sites over a period of nine months. Her specimens included representatives of 150 species in 14 families. She did not trap any LBAM specimens but its family, the Tortricidae, was represented with nine confirmed species. The presence of close relatives of LBAM led Allison to conclude that treatments aimed at LBAM might be more harmful to moth populations and ecosystems at JRBP than the arrival of LBAM at the preserve. Allison is currently working with the fisheries crew at Point Reyes National Seashore while thinking about her plans for graduate school.

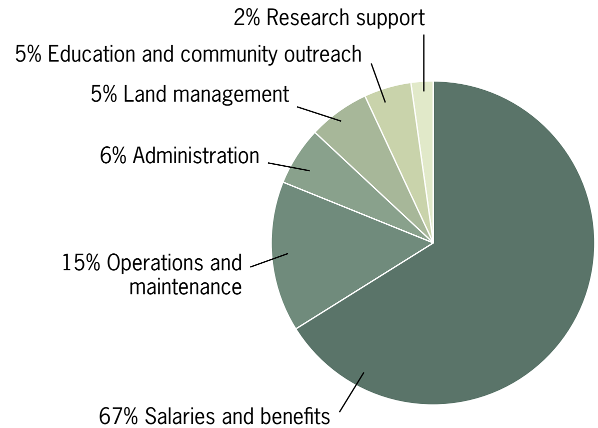
Claire Lunch completed her PhD in May in Stanford's biology department. Her dissertation was devoted to the dynamics of plant productivity in the Jasper Ridge global change experiment (JRGCE), where she monitored plant activity and gas exchange intensively throughout the growing seasons of 2006 and 2007. These were, respectively, the experiment's wettest and driest years so far. She found a strong influence of naturally occurring variation in environmental conditions on the growth and carbon uptake of Jasper Ridge grasslands, with the dry year having greater uptake of carbon by the ecosystem than release of carbon (a carbon sink) and the opposite in the wet year (a carbon source). During her time at Stanford, Claire also worked on several other projects at Jasper Ridge, including an investigation of the role of slugs in star-thistle distribution, and a revisit of plant physiological studies carried out in the early 1980s. She is now a postdoctoral scientist at the Marine Biological Laboratory in Woods Hole, Massachusetts, working on photosynthesis in single-celled algae.

The 2009 docent class walking toward a mixed woodland area to learn firsthand how to survey a forest ecosystem: Becca Castro, Ana Deaconu, Krista Doersch, Phil Eastman, Sarah Falconer, Erica Fernandez, Annemarie Golz, Kristin Hughes, Carol Johnson, Annie Lindseth, Bob McCowan, Tom McFadden, Ruth Nuckolls, Jenny Rempel, Jenny Saltzman, Brian Scoles, Bob Siegel, Julie Smith, Briana Swette, Kenji Tanabe, Adam Ting, Cherie Wetzel and Denis Willett.

Appendix 1: 2008–09 Financial Summary

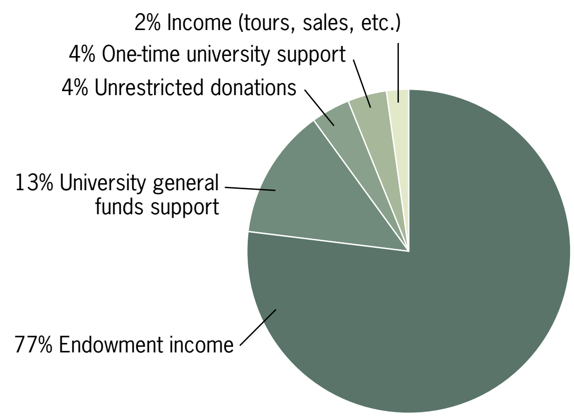
Expense summary

Salaries and benefits	$586,078
Operations and maintenance	128,731
Administration	48,773
Land management	46,566
Education and community outreach	44,045
Research support	17,651
Total	**$871,844**



Revenue summary

Endowment income	$754,846
University general funds support	128,876
Unrestricted donations	42,143
One-time university support	34,437
Income (tours, sales, etc.)	22,982
Total	**$983,284**

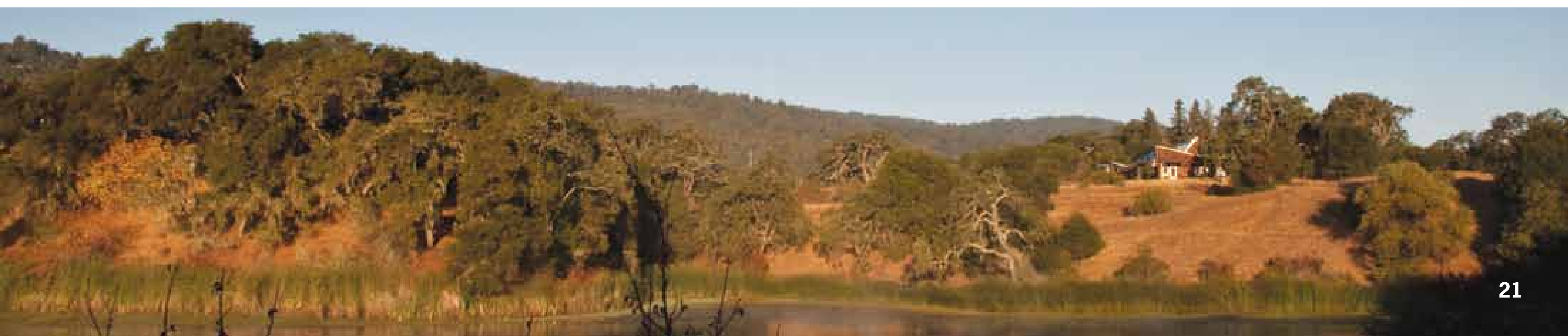


Revenues exceeded expenses in large part due to significant cost cutting in response to anticipated revenue shortfalls over the next two years. While Jasper Ridge depends heavily on endowment payout, Stanford University has projected that endowment payout will shrink by 10% for the coming fiscal year and 15% for fiscal year 2011. Currently, projections for the 2010 fiscal year are that we will break even if unrestricted donations stay at about the same levels as FY09. For FY11 we project a shortfall of about $85,000 that will likely be covered by existing reserves.

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 the support the community of donors has provided over the years. We offer our sincere gratitude to our donors for your continuing generosity. The following is a list of those who made unrestricted gifts to the preserve from September 1, 2008 to August 31, 2009.

James and Anne Allen
Paul H., Jr., and Madeline L. Arnaud
Leonie F. Batkin
Kathleen Bennett and Tom Malloy
Monika B. and Olle Björkman
Sharon Brauman
Ross D. and JoAnn Bright
Irene L. and Robert W. Brown
Robert R. Buell
Ruth Buneman
Bill and Jean Clark
L. Robert and Mary H. Dodge
Mary E. H. N. Engelbrecht
W. G. and Charlotte Ernst
Theodore H. Geballe
Carol and Dexter Hake
Benjamin C. and Ruth Hammett
Mary Henry and Rajpal Sandhu
Mary Page Hufty
Dirk D. and Charlene Kabcenell
Margaret Krebs
Mr. and Mrs. Marcus A. Krupp
Peter and Suzanne LaTourrette
Targe and Barbara Lindsay
Arthur (Art) and Audrey Matula
Elizabeth J. and William F. Meehan
Lisa A. Moore
John R. Page, Jr.
Richard and Joan B. Posilippo
Charles R. Preuss
Charles P. Quinn
Deborah Hickenlooper Rohan
Patricia C. Schmidt
Shack Riders
Elizabeth A. Soderstrom
Marguerite Stevens
Deborah J. Stipek
Sara Timby and John Rawlings
Ruth and Eugene W. Troetschler
Ms. Virginia Beard and Mr. Richard Van Andel
Jon and Sharon Velton
Judith L. Wagner
Dieter R. and Susan H. Walz
John W. Working and Lysbeth Warren
Steven Bradley and Lois Schertz Willett
Paul B. and Jennefer L. Wineman
Woodside-Atherton Garden Club
Richard I. Yankwich



Appendix 3: Research Projects

Project	Principal Investigator(s) or Coordinator	Department or Division	Institution
Spectral imaging and waveform light detection and ranging (wLiDAR)	Greg Asner, Chris Field	Fac, Global Ecology	Carnegie Institution
Controls on landscape-level variability in a Mediterranean-type ecosystem	Kyla Dahlin	GS, Biology & Global Ecology	Stanford Univ. & Carnegie Inst.
High resolution species distribution modeling	Julie Ralph	UG, Math & Comp. Sci.	Stanford University
Broadband seismic monitoring	Greg Beroza	Fac, Geophysics	Stanford University
	Bill Karavas	SS, Berkeley Dig. Seismic Net.	UC Berkeley
Population biology of the butterfly *Euphydryas chalcedona*	Irene Brown	Vol, JRBP	
Collection and mapping of the flora of Jasper Ridge by volunteers	Nona Chiariello	SS, JRBP	Stanford University
Effects of mammalian herbivory on growth and reproduction of oaks	Hall Cushman	Fac, Biology	Sonoma State University
	Laura Saunders	GS, Biology	Sonoma State University
Survey for presence of the light brown apple moth	Allison Dedrick	UG, Earth Systems	Stanford University
Mammalian diversity, abundance, and activity	Rodolfo Dirzo	Fac, Biology	Stanford University
Behavioral response to camera traps	Eric Abelson	GS, Biology	Stanford University
Population genetics of *Microtus californicus*	Rachel Adams	GS, Biology	Stanford University
Herbivory and seed predation on Jasper Ridge plants	Rodolfo Dirzo	Fac, Biology	Stanford University
Effects of herbivory on reproduction by *Chlorogalum pomeridianum*	Roger Guevara	Fac, Dept. de Biología Evolutiva	Instituto de Ecología, Mexico
Rates of survival, growth, and herbivory for three native oak species	Roger Guevara	Fac, Dept. de Biología Evolutiva	Instituto de Ecología, Mexico
Long-term studies of *Euphydryas editha bayensis* and feasibility of reintroduction	Paul Ehrlich, Carol Boggs	Fac, Biology	Stanford University
	Scott Fendorf	Fac, Env. Earth System Science	Stanford University
	Chris Field	Fac, Global Ecology	Carnegie Institution
	Buzz Thompson	Fac, Law School	Stanford University
	Richard White	Fac, History	Stanford University
Feasibility study of serpentine habitat creation	Tim Bonebrake	GS, Biology	Stanford University
Historical distribution of the Bay checkerspot and its food plants	Jon Christensen	GS, History	Stanford University
Long-term monitoring of ecosystem processes by eddy covariance	Chris Field, Joe Berry	Fac, Global Ecology	Carnegie Institution

Key to abbreviations used:

Fac = faculty
GS = graduate student
PD = postdoctoral fellow
SS = staff or senior scientist
UG = undergraduate
Vol = docent and/or volunteer

Project	Principal Investigator(s) or Coordinator	Department or Division	Institution
Jasper Ridge global change experiment (JRGCE)	Chris Field	Fac, Global Ecology	Carnegie Institution
	Hal Mooney, Peter Vitousek	Fac, Biology	Stanford University
Effects of global change on methane oxidation	Joey Blankinship	GS, Biological Sciences	Northern Arizona Univ.
Response of microbial communities to global change	Brendan Bohannan	Fac., Ctr. for Ecol. & Evol. Biol.	University of Oregon
Spectral measurement of aboveground vegetation dynamics	Nona Chiariello	SS, Biology	Stanford University
Global change effects on establishment by the native *Nassella pulchra*	Ana Deaconu	UG, Earth Systems	Stanford University
Trace gas fluxes under simulated global changes	Paul Dijkstra	SS, Biological Sciences	Northern Arizona Univ.
Effects of global change on soil nitrogen cycling	Bruce Hungate	Fac, Biological Sciences	Northern Arizona Univ.
Whole-system gas exchange of the JRGCE	Claire Lunch	GS, Biol. Sci. & Global Ecol.	Stanford Univ. & Carnegie Inst.
Nitrification and denitrification under altered climate	Paul Leadley; Audrey Niboyet	Fac; GS, Ecol., Systém, Evol.	Université Paris-Sud (France)
Role of fungal community composition in soil carbon dynamics	Rebecca Mueller	GS, Ctr. for Ecol. & Evol. Biol.	University of Oregon
Reproductive ecology of *Nassella pulchra* under global change treatments	Julie Smith	UG, Earth Systems	Stanford University
Chemical characterization of soil organic matter responses to global change	Ted Raab	SS, Biology	Stanford University
The water balance of Searsville Reservoir and its sediments under existing and possible future conditions	David Freyberg	Fac, Civil & Envir. Engineering	Stanford University
Heat-tracer study of subsurface water in Searsville sediments	Rae Brownsberger	UG, Civil & Envir. Engineering	Stanford University
Numerical modeling of surface-subsurface water flow	May Chui	GS, Civil & Envir. Engineering	Stanford University
GIS-based animation of measured ground water heads in Searsville sediments	Xue Feng	UG, Civil & Envir. Engineering	Stanford University
Evaporation measurement and estimation	Jun Young Kim	GS, Civil & Envir. Engineering	Stanford University
Sediment deposition and mobilization in Searsville Reservoir	Jake Krall	GS, Civil & Envir. Engineering	Stanford University
Floral ecology of *Mimulus aurantiacus*	Tadashi Fukami	Fac, Biology	Stanford University
Sequence diversity of yeast community within nectar	Melinda Belisle	GS, Biology	Stanford University
UV irradiance and spectral properties of *Mimulus* flowers	Diamantis Sellis	GS, Biology	Stanford University
Argentine ant (*Linepithema humile*) invasion and the response of native ants	Deborah Gordon	Fac, Biology	Stanford University
Seasonal polydomy, budding, and the spread of the Argentine ant	Katherine Fitzgerald	GS, Biology	Stanford University
Effects of Argentine and native ants on Lycaenid butterflies	Jessica Shors	GS, Biology	Stanford University
Determinants of the distribution and reproductive success of *Dirca occidentalis*	William Graves	Fac, Horticulture	Iowa State University
Long-term monitoring of birds by volunteers	Trevor Hébert	SS, JRBP	Stanford University
Monitoring of water flow and quality	Barry Hecht, Jonathan Owens, Chris White	SS	Balance Hydrologics, Inc.
Retrieval of vegetation parameters related to seasonality, drought, and wildfire risk based on LiDAR and hyperspectral data	Mark Helmlinger	SS, Sensors & Instruments	Northrop Grumman Space Tech.

Project	Principal Investigator(s) or Coordinator	Department or Division	Institution
Effects of rainfall variability and gopher removal on serpentine grassland	Richard Hobbs	Fac, Wildlife & Ecol.	Murdoch University (Australia)
Total field magnetic monitoring system	Ross Johnson	SS	Geometrics, Inc.
Prehistory of Jasper Ridge	Laura Jones	SS, Heritage Services	Stanford University
Earthquake prediction from precursory electromagnetic anomalies	Simon Klemperer	Fac, Geophysics	Stanford University
	Darcy McPhee, Jonathan Glen	SS, Geophysical Unit	US Geological Survey
Earth's field magnetic resonance measurements	Elliot Grunewald	GS, Geophysics	Stanford University
Regional surveys of annual acorn production, oak phenology, and pollen release	Walter Koenig William Carmen	Fac, Hastings Nat. Hist. Res.	UC Berkeley Ctr. for Environ. Citizenship
Repeat of a 1976 analysis of lead in the lichen *Ramalina menziesii*	Léo Laporte	Vol, JRBP	
Survey of San Francisquito Creek and removal of exotics	Alan Launer	SS, Land use & environ. plan.	Stanford University
Restoration, monitoring, student & public outreach in San Francisquito Creek Watershed	Alan Launer	SS, Land use & environ. plan.	Stanford University
San Francisquito Creek habitat characterization	Ryan Navratil	SS	San Francisquito Wtrshed Coun.
	Paul Rich, Stuart Weiss	SS	Creekside Ctr. for Earth Observ.
Seasonality of eating habits and prey selection of raptors in serpentine grassland	Targe Lindsay	Vol, JRBP	
Revisiting leaf-level physiology after 30 years and a 15 percent rise in CO_2	Claire Lunch	GS, Biology & Global Ecol.	Stanford Univ. & Carnegie Inst.
Monitoring and collection of insects	Pierre Martineau, Ted Mill	Vol, JRBP	
Oak regeneration survey	Blair McLaughlin	GS, Environmental Studies	UC Santa Cruz
Biodiversity and abundance of reptiles in California grassland	Doug McCauley	GS, Biology	Stanford University
Photochemical changes in natural organics in Searsville Lake water	Ted Mill	SS, Chemistry	SRI International
Microbially mediated transformations of arsenic and selenium in lake sediments	Larry Miller	SS, Water resources	US Geological Survey
Residual dry matter, species composition, and invasion in serpentine grassland	Jae Pasari	GS, Environmental Studies	UC Santa Cruz
Legume-rhizobial interactions in *Lotus wrangelianus* on and off serpentine soils	Stephanie Porter	GS, Population Biology	UC Davis
Speciation in the *Lasthenia californica* complex	Nishanta Rajakaruna	Fac, Biological Sciences	San Jose State University
Local adaptation in the *Lasthenia californica* complex	Teri Barry	GS, Biological Sciences	San Jose State University
Remote and ground-based measures of vegetation water content	Susan Ustin	Fac, Land, Air & Water Res.	UC Davis
Distribution of *Leptosiphon* on serpentine and sandstone soil	Lorna Watt	GS, Plant Biology	Michigan State University
Visual survey and sampling of California bay trees for sudden oak death	Denis Willett Jan Talbert	UG, Earth Systems Vol, JRBP	Stanford University

Appendix 4: Publications

Amatangelo KL, Dukes JS, Field CB. 2008. Responses of a California annual grassland to litter manipulation. Journal of Vegetation Science 19:605-612.

Ayres E, Wall DH, Simmons BL, Field CB, Milchunas DG, Morgan JA, Roy J. 2008. Belowground nematode herbivores are resistant to elevated atmospheric CO_2 concentrations in grassland ecosystems. Soil Biology and Biochemistry 40(4):978-985.

Blankinship JC. 2009. Belowground feedbacks to global environmental change. Dissertation. Northern Arizona University.

Blankinship JC, Brown JR, Dijkstra P, Hungate BA. Interactive global changes unlikely to enhance methane uptake in an annual grassland. Journal of Geophysical Research—Biogeosciences. (in press).

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** chapters of the state of the preserve assessment:*
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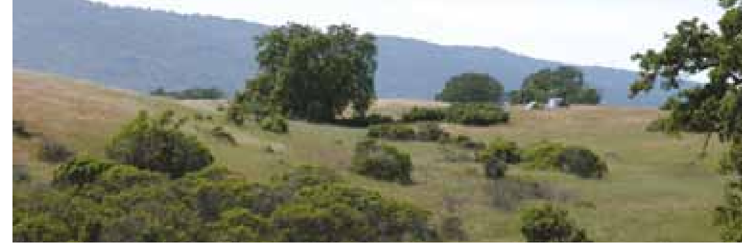

Appendix 5: Educational Use

Stanford University Classes (1670*)

ANTHRO 3	Introduction to Prehistoric Archaeology (Rick)
APPPHYS 79N	Energy Choices for the 21st Century (Fox, Geballe)
ARTSTUDI 184	Art and Biology (Wight)
BIO 44Y	Core Experimental Laboratory (Malladi)
BIO 96A,B	Jasper Ridge Docent Training (Wilber, Dirzo)
BIO 101	Ecology (Dirzo, Vitousek)
BIO 125	Ecosystems of California (Mooney)
BIO 164/264	Biosphere-Atmosphere Interactions (Field, Berry)
CEE 166A/266A	Watersheds and Wetlands (Freyberg)
CHEMENG 11SC	Energy Technologies for a Sustainable Future (Bent, Clemens)
EARTHSYS 10	Introduction to Earth Systems (Ernst)
EARTHSYS 189/BIO 206	Field Studies in Earth Systems (Chiariello et al.)
EDUC 332X	Theory and Practice of Environmental Education (Ardoin)
EESS 155	Science of Soils (Fendorf)
GEOPHYS 25	Hands-on Introduction to Astrobiology (Sleep)
GSB SGSI	Energy for Sustainability: Technologies and Policies for Climate Stabilization and Energy Security (Masters)
GSB SGSI	Global Warming: Good Science or Bad Politics? (Schneider, Root)
HUMBIO 16SC	Stanford Safari: Field Observations in Our Own Backyard (Siegel)
PWR 1SW	The Rhetoric of Stanford: From the Foothills to the Bay (Wyle)

Other College and University Classes (82*)

De Anza College: Natural History of the Bay Area
San Jose State University: Plant Communities of California
Santa Clara University: Water Resources Engineering

*Number of visits. One visit = one person entering preserve on one day. These numbers represent an underestimate; they do not include informal use or research use.

Stanford and Affiliated Groups (707*)

2009 Walk the Farm
Arrigo Lab
Bechtel International Center
Biology Department
Center for the Advanced Study in the Behavioral Sciences
Center for Conservation Biology (CCB)
Center for Ocean Solutions (COS)
Controller's Office
Department of Biology
Department of Psychology
Engineers for a Sustainable World
Environmental Law students
First Nations' Futures Institute
Gift Processing Department
Graduate School of Business, alumni association
Graduate School of Business, City Management and Urban Planning, Chinese mayors
Haas Center for Public Service
Knight Fellows
Lane Medical Library
Muwekma House
Office of Development
Office of Technology Licensing
Office of the University Registrar
SLAC Association for Student Seminars
SLAC National Accelerator Laboratory
Stanford Campus at Peking University
Stanford Green Living Council
Stanford Kayak Club
Stanford-Singapore Partnership Program (SSP)
Stanford University Medical Center Alumni Association
Storey House
Strategic Collaborative Research Initiatives

K–12 Groups (906*)
East Palo Alto Charter School
Eastside College Preparatory School
Education Program for Gifted Youth
Environmental Volunteers
Gunn High School
Hidden Villa Interns
Palo Alto High School
Redwood Environmental Academy
of Leadership (REAL)
School of Earth Sciences, high school interns
Sequoia High School
Woodside High School

Other Groups (1810*)
Actel Corporation
American Association for the Advancement of
Science, Pacific Division (AAAS-PD)
Coalition on the Public Understanding
of Science (COPUS)
California Academy of Sciences
California Science Teachers Association
Christ Church Portola Valley
City of Portola Valley
Conservation Strategy Fund
CV Therapeutics
Exploring a Sense of Place
Fitzgerald Marine Reserve
Midpeninsula Regional Open
Space District (MROSD)
Muwekma Ohlone Tribe
NASA Ames Research Center
Neighbors Abroad, Oaxaca, Mexico
Palo Alto Camera Club
Portola Valley Garden Club
Portola Valley Ranch
Salmonid Restoration Federation
San Francisco Bay Bird Observatory
San Mateo County Fire Safe Committee
Santa Clara Valley Audubon Society
Science Writers of America
Society for Conservation Biology, Central
California Coast Chapter
Stevenson House
The Terraces
Western Field Ornithologists
Woodside Fire Protection District

2008–09 Brown Bag Lunch Lectures

October: **Fahmida Ahmed**
Manager of Sustainability Programs
Stanford University
"Sustainable Stanford"

November: **Jim Watanabe**
Hopkins Marine Station
Stanford University
"At home in a kelp forest: an introduction to the Hopkins Marine Life Refuge"

December: **Adam Wolf**
graduate student, Stanford University
"Permafrost: a case study of climate as Rube Goldberg machine"

January: **Jasper Ridge Herbarium Team: Toni Corelli, Paul Heiple, Ann Lambrecht, John Rawlings, Liz Schwerer**
JRBP, Stanford University
"Status of vascular plants at JRBP"

February: **Nishi Rajakaruna**
Assistant Professor, Department of Biological Sciences
San Jose State University
"Edaphic differentiation in the California flora: case studies"

March: **Jessica Shors**
graduate student, Stanford University
"Invasive Argentine ants and their impacts on native ants, blue butterflies, and habitat restoration projects"

April: **Tadashi Fukami**
Assistant Professor of Biology
Stanford University
"Ecological community assembly: messages from test-tube and floral-nectar microbes"

May: **Chris Field**
Professor of Biology and of Environmental Earth System Science
Stanford University
"Intergovernmental Panel on Climate Change"

JRBP Staff

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Philippe Cohen, PhD, administrative director
Nona Chiariello, PhD, research coordinator
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
Chandra Nicola, temporary maintenance assistant

Endnotes

1. http://www.nsf.gov/pubs/2008/nsf08078/nsf08078.jsp
2. http://support.geometrics.com:8080/LiveGraph/index.html
3. http://jrbp.stanford.edu/stratplan.php

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12 NC **13** camera trap, TH
14 AC **15** *top* CW; *bottom* LC
16 CW, NC **17** HD, GJ
18 NC **19** *top* NC; *bottom* NC, RS
20 DQ **21** DQ
22 GN **23** DK
24 DQ **25** DQ
26 EA **27** NC
28 PC
Back cover TH

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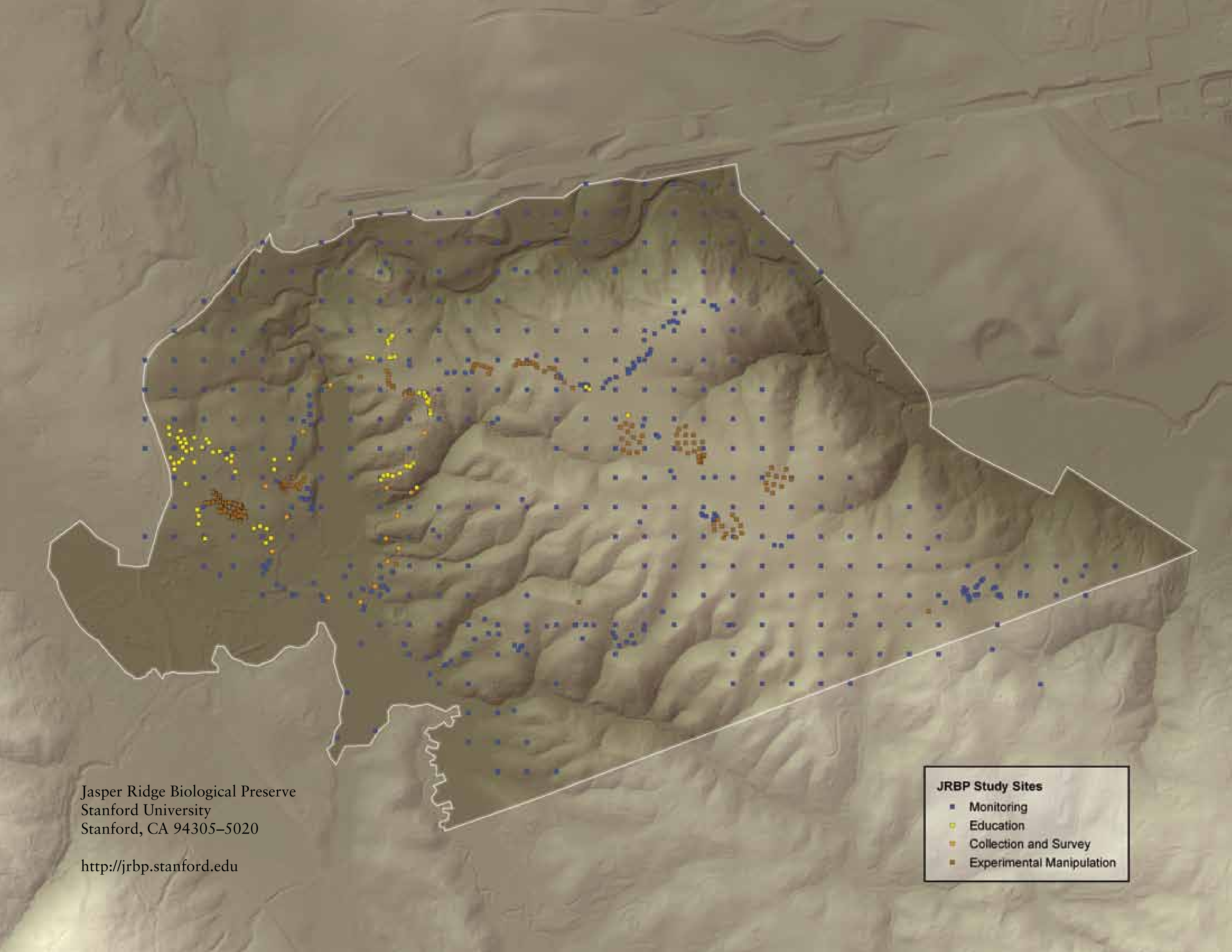

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