JASPER RIDGE BIOLOGICAL PRESERVE 2012-13 ANNUAL REPORT

Stanford | SCHOOL OF HUMANITIES AND SCIENCES

Front cover: Still resting on its empty cocoon, this ceanothus silk moth (*Hyalophora euryalus*) has a wing spread of four to five inches.

JRBP AT 40

On the map, the borders of Jasper Ridge have changed only a little, but conceptually, it is a bigger place than it was in 1973.

The events for the 40th anniversary of the preserve's founding provided the opportunity to reflect on the Jasper Ridge mission and accomplishments while also renewing the sense of community that is so much the preserve's lifeblood. The 40th anniversary also created a space for thinking about the future: about the place of universities in a changing world, the role of field stations in universities, trends in the environmental sciences, and the evolving relationship between humans and the natural environment.

Jasper Ridge turned 40 with a rich legacy of accomplishments. Speakers at the anniversary symposium traced the emergence and flowering of Jasper Ridge roots in population biology, ecosystem physiology, ecosystem services, and global change ecology. Across a range of science disciplines, studies from Jasper Ridge are at the core of the intellectual agenda, and scientists trained and inspired at Jasper Ridge are in leadership positions.

The broad mission of Jasper Ridge, with a focus on research, education, and conservation, is very much the same in 2013 as it was in 1973, but the specific opportunities and challenges are different. In its early years, the preserve was viewed as a sanctuary, a place where natural processes ruled and scientists could observe. Now, the conceptual model of Jasper Ridge is a dynamic system embedded in its context. It still has sanctuary-like dimensions, but many interesting and important aspects of the preserve are changing, from the species composition of the serpentine grassland to the capacity of Searsville Reservoir. Recent Jasper Ridge research and operations emphasize not only these dynamics but also interactions with the broader world, including climate change, species moving back and forth across boundaries, invasive species, and the risk of fire.

The conceptual model of a dynamic system in context also applies to the preserve's educational mission. Jasper Ridge is blazing new trails in science education, especially with the research-centered reimagining of Biology 44Y, Stanford's core field experience for Biology majors. The new lab, for which Tad Fukami received the prestigious *Science* Prize for Inquiry-Based Instruction (IBI) from the American Association for the Advancement of Science, affords early majors genuine research experiences, where the opportunities are rich and there isn't a right answer at the back of the book. 44Y is built around the idea that we learn best when we discover things on our own terms, a concept that could be a perfect Jasper Ridge motto.

Over the next 40 years, I expect the Jasper Ridge mission to stay the same—advancing great research, education, and conservation—with specifics that continue to evolve. It would not surprise me to see the vision of a dynamic system in context move to even more integration, with more research on regional, continental, and global processes. I'm not confident of my ability to predict the future, but I am confident that the combination of brilliant researchers, a committed university, and an enthusiastic local community will generate new approaches and new breakthroughs. A final critical ingredient is flexible funding to serve as a catalyst. Two new funds, the Donald Kennedy endowment from the David and Lucile Packard Foundation and the Director's Fund are wonderful investments in encouraging the research community to shake things up, and to assure that the future is even more interesting than the past. ■

CHRIS FIELD

MANAGEMENT

Celebrating the Past, Preparing for the Future

Anniversaries are opportunities to celebrate and reflect. This past year both took place as we marked the preserve's 40th year as a biological field station. The range of activities reflected the breadth and depth of the preserve's history and programs. There were community celebrations, a symposium, public events on campus and off, and the launch of a new fundraising campaign, in addition to a wealth of new and continuing educational and research activities. All together it made for an exciting, energetic year, one that raised our collective sense of the preserve's importance while giving us a chance to think about how the challenges of the next forty years will compare with those of the last forty.

As I reflect on the past and consider what the future holds, I am encouraged by several important developments from the past year—in land management, fundraising, and infrastructure—that will have a profound impact on how the preserve meets future challenges.

Perhaps most importantly, the work on the future of Searsville Dam and Reservoir has gained traction in terms of both what we are learning and in setting the stage for assessing options that best meet the needs of the University, the preserve, the San Francisquito watershed and its communities. Three groups have convened to work on this effort: a Steering Committee composed of some of Stanford's finest environmental faculty and senior administrators; a working group of Stanford staff (including me) and an advisory group of community representatives that reflects the broad range of watershed interests that might be affected by changes at Searsville. A series of studies has been initiated to inform upcoming discussions about the range of feasible options and, among those, which might be the most appropriate. In addition to describing existing biological conditions, the studies examine the full suite of options for removing sediment from Searsville Reservoir and the implications of letting the reservoir silt in completely. In the coming year, we will focus on understanding potential responses of the downstream watershed to increasing amounts of sediment; the viability of various fish passage strategies; and the repercussions and benefits of different modifications to the dam, including removal. After various strategies and long-term management objectives have been fully considered, a formal set of recommendations will be made to the Provost and President, and then to the Board of Trustees. Once the Board has decided on the most appropriate strategy, we will begin discussions with the many federal and state agencies with permitting jurisdiction.

Another important step in helping to secure the preserve's future has been the establishment of two new endowments. One was established by the David and Lucile Packard Foundation to honor Donald Kennedy's tenure on the foundation's board. Income from this $500,000 endowment will initially be used to support early phase research. We are honored to be chosen as the recipient and especially pleased given Don Kennedy's pivotal role in the Stanford Board of Trustees' decision to formally establish the preserve forty years ago. The other endowment, created through a gift of $105,000 from John and Lysbeth Anderson Working, will support the new "Director's Discretionary Fund," which will allow the faculty and executive director to provide small investments that will make a significant programmatic difference. This could take various forms, such as a new piece of equipment, support for an undergraduate research project, or the setup for a new monitoring program. The hope is that

in coming years additional gifts will help grow this fund and there is already a planned gift commitment to do so. I'm very excited about this new development and look forward to updating you about how these funds are used. These two gifts help build a foundation to assure that Jasper Ridge's future is as bright and productive as its past. It is our plan in coming years to develop new endowments that provide direct support for graduate and undergraduate students and assure that we can continue our visiting artist and restoration fellows programs.

One of the conclusions of our strategic plan, completed in 2004, just two years after we moved into the Leslie Shaoming Sun Field Station, was that "all of the infrastructure at JRBP should help the preserve fulfill its mission.... The infrastructure at JRBP can also support the preserve's mission through demonstrating a commitment to sustainability and resource protection."

One way we remained true to this vision in 2013 was to make Jasper Ridge the final site for the home designed by Stanford students for the U.S. Department of Energy Solar Decathlon competition (Solardecathlon.gov). This entry, conceived, designed, managed, and built by a team of Stanford students (Solardecathlon.stanford.edu), is a net-zero energy building and fits perfectly with the mission and vision of the preserve.

Working with the Dean's office from the School of Humanities and Sciences and the Stanford student team, we have received the home at Jasper Ridge shortly after the competition concluded, with re-assembly and installation to be completed before the calendar year ends. For the students, the vision for this home "stems from the word 'start'. ... From designing flexible work/living spaces, to programming intuitive touchscreen interfaces to interact with the home, and developing custom software, we believe that we can build a home with the freedom necessary for a new 'start.'"

This start includes "efficiency without sacrificing creativity" and rethinking the entire construction process. For Jasper Ridge, this is another important improvement, resulting in a building "optimized for the temperate climate of coastal California" that will, in the short term, replace the existing ranger residence, and eventually become a facility for long-term visiting researchers and scholars. This exciting new addition will help further the preserve's efforts to enhance and expand program activities without increasing the human footprint. One of the highlights of the past 18 months has been watching the energy, vision, and commitment of the Stanford students dedicated to this project. It is inspiring and humbling to see a project that embodies multidisciplinary education create an outcome that will endure in supporting the preserve's mission. These students have demonstrated that they can generate knowledge and not just absorb it—a goal that educational programs at Jasper Ridge aspire to as well. When I think about how we can help shape the future, this is the sort of collaboration one usually only dreams about!

Other developments of the past year include gifts from the Tom Mudd Jr. Trust, Deborah Stipek Mudd, and other members of the Mudd family, that have jumpstarted the installation of four new bat monitoring stations. These will provide valuable additional support to further David Moreno Mateos' work during his time as the JR Restoration Fellow as well as important biological information to the current Searsville planning initiative.

The coming year will also see the celebration of the 20th anniversary of the ant monitoring program, now run almost entirely by volunteers and docents. Add to that many exciting programs described within the pages of the research and education sections of this report, and it is evident that the preserve is closing four decades of amazing growth with a commitment to meeting the challenges of the next four decades head on.

In many respects, the complex of challenges facing the preserve, such as the future of Searsville Dam mirrors what we as a society, face in the coming decades. How do we intervene and manage landscapes and natural systems so that they remain resilient, continue to provide the services on which we depend, and conserve the amazing variety of life forms that enrich our lives and lie at the heart of our connection to place? This is the core challenge that the world's societies must address. It is my firm conviction that Jasper Ridge is an ideal place for developing approaches to answer these sorts of questions, owing to our experience with difficult management challenges, our long history of research and community engagement, our connection to the leadership of Stanford environmental faculty, and the important academic and biological features of the preserve. ■

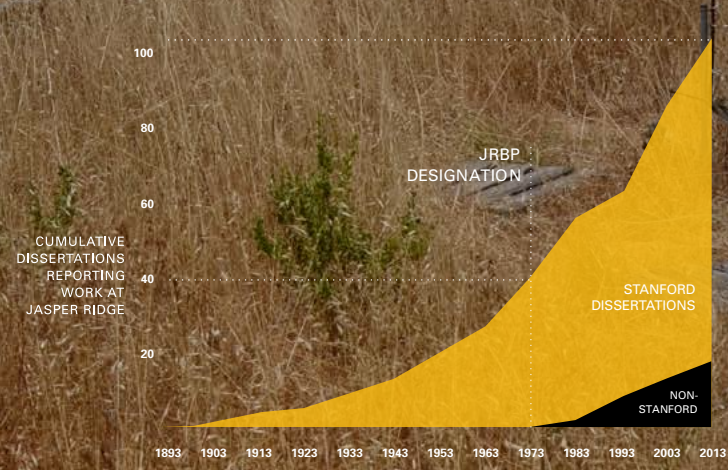
PHILIPPE S. COHEN

RESEARCH AND MONITORING

Summer 2013 survey of native perennial grass restoration in the global change experiment.

Designation as a preserve in 1973 gave Jasper Ridge not only resource protection but also research protection. The resulting benefits for long-term, intensive research are illustrated by the volume of doctoral research: more dissertations were recorded during the four decades after designation than during the eight decades before. The present year continued the trend. Three dissertations were completed, along with a master's thesis and two honors projects, and 26 research papers were published. In total, 71 studies were active during 2012-13 by investigators from nine departments within Stanford and from 21 other institutions. The scope of research is a tribute to Stanford biologists who from the 1950s to the 1970s led the effort to protect Jasper Ridge for long-term research and teaching, and to the faculty who sustain their vision today.

Over the past four years, a cornerstone of integrated research and teaching has been built by professor Tad Fukami using microorganisms that live in the floral nectar of *Mimulus* to study historical contingency in ecological communities. In 2012-13, Tad expanded the study, funded by a new five-year grant from the National Science Foundation's Faculty Early Career Development (CAREER) Program. Those grants are NSF's "most prestigious awards in support of junior faculty who exemplify the



role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations." Tad's expanded research includes a second field site on Stanford lands, a second Jasper Ridge plant species *(Pedicularis densiflora)*, and additional aspects of plant reproductive biology.

2012-13 was a culminating year for several graduate and undergraduate studies that grew out of faculty research, and our report includes essays from six. Professor David Freyberg's (PhD '81) research on Searsville Reservoir was the context for a doctoral study of sedimentation. Doctoral and honors projects on *Mimulus* grew out of Tad Fukami's work. The characteristics and consequences of mammal and insect movements were examined by three students who were advised by professor Rodolfo Dirzo, one jointly with restoration fellow David Moreno Mateos. From outside Stanford, professors Kathleen Kay and Nishanta Rajakaruna advised two graduate studies of goldfields *(Lasthenia)* in serpentine grassland along slope-driven gradients in soil chemistry. A recurring theme of the contributed essays is how movements of water, soil, and organisms define networks of diversity, disturbance, and resource transfer among habitats.

We also have a report from the herbarium volunteers on their efforts to make JRBP's enormously diverse flora more available to researchers everywhere.

The year was rich with interns and visitors. Summer interns included Makulumy Alexander-Hills '16 and Tera Johnson (global change experiment); Sophie Christel '15 (*Mimulus* ecology); Neala Creasy (electromagnetic monitoring); Rachel Fox, Eddie Hill, and Mark Valentine '15 (wetland—upland insect fluxes); and Emily Solly (survey of root turnover). Visiting researchers included investigators from six countries, making it a very international year. ■

NONA CHIARIELLO

(Top) **MELINDA BELISLE (PhD '13)** speaking at JRBP's 40th anniversary symposium about her doctoral work on sticky monkeyflower, *Mimulus aurantiacus* (bottom). Melinda also helped professor Tad Fukami develop and test *Mimulus*-based curriculum and field studies for the core undergraduate lab, Biology 44Y.

Hummingbirds caught on camera

RACHEL POWELL, '13

In Spring 2013, I completed my honors thesis on microbes living in *Mimulus* nectar. Most biology students learn about *Mimulus* floral ecology when they take professor Tad Fukami's Bio 44Y course and investigate how hummingbird visitation affects nectar microbes. I was interested in the opposite question—how the microbial community in floral nectar could affect hummingbird feeding preferences.

While reading about research by the Fukami lab, I wondered whether camera trapping could provide more information about hummingbird behavior. Previous results indicated that one common bacterium, *Gluconobacter* sp., made the nectar so acidic it could discourage hummingbirds from visiting. I thought hummingbirds might spend less time feeding from flowers with *Gluconobacter*-inoculated nectar, and learn over time to avoid them completely.

I used camera traps on trail 10 and fire road E in the chaparral to film hummingbird visits to real and artificial *Mimulus* flowers that I had inoculated with *Gluconobacter* or a common yeast strain. Then, I used the videos to calculate time spent at each flower and overall visitation rates.

In the end, I did not find a significant difference between visits to flowers with *Gluconobacter* and those without. However, I think that revisions to my study methods may yield a different result. This summer, Sophie Christel ('15) picked up where I left off and has filmed additional experiments. I enjoyed getting to know Jasper Ridge, and having the opportunity to add to the volume of research. ■

Interaction of insects and wetlands

MINH CHAU N. HO, ‘13

It’s not easy to track the movements of insects. However, understanding the patterns of insect movement, or dispersal habits, is a key to understanding the exchange of nutrients between water and land. Many insects need both aquatic and terrestrial habitats for their life cycle. As they move, they provide food for both land and water insectivores such as birds, bats, and fish, sustaining food webs in both ecosystems.

For nine months, I worked with David Moreno Mateos on a survey of insect movement based on malaise traps at the boundaries of four aquatic habitats, labeled at right. We found greater movement of insects toward water (white arrows) than away (orange arrows), and traffic was greatest during summer months when many insects hatch and swarm to mate (arrow length indicates the flux of insect biomass during the month when flux was greatest). As this trend was absent in control traps inland, we concluded that insects are attracted to these water bodies.

The four aquatic sites differed dramatically. Middle Marsh attracted an incredible amount of insects, possibly because its dense vegetation provides a cool, moist habitat and abundant food resources. More insects traveled away from Searsville Reservoir than other sites, possibly because its extensive, open water provides egg-laying habitats for many insects that emerge to feed on land.

Results from this study suggest many avenues for future work. Do insectivores forage or nest more on aquatic boundaries to take advantage of this insect traffic? What percentage of the insect community does the lake and marsh support in comparison with terrestrial habitats? Insect behavioral study is a good approach to understanding nutrient flows in a landscape, as it can tell us much about the nutrient availability in ecosystems. ■

A sediment-impacted reservoir

JACOB KRALL, PhD ‘13

Searsville Reservoir and the wetland area upstream of it are dynamic environments with respect to sediment transport and deposition. Corte Madera Creek, which empties into the main body of the reservoir, carries the majority of the sediment entering the reservoir, approximately 90%. Even modest flood events on Corte Madera cause overbank flows and transport of a fraction of the inflowing sediment. The wetland floodplain onto which the sediment settles was previously open water, part of the main reservoir. While no longer in the open water portion of the reservoir, this environment continues to accumulate a substantial fraction of the sediment transported by Corte Madera Creek. Inflowing sediment is also transported to the reservoir and deposited below its surface, further reducing the capacity of the reservoir and building up future floodplain.

For my dissertation, I worked on quantifying the magnitude and spatial distribution of sediment deposition on the floodplain. I used sediment traps consisting of 15cm x 15cm squares of synthetic turf, held in place with a nail, to quantify sedimentation at various locations under flood events ranging from modest to major. I also used computer modeling to make comparisons with my field observations and to conduct numerical experiments to study the key drivers of the sediment processes. My results will help predict where sedimentation is likely to occur in the future, both within and upstream of the reservoir, and when the reservoir will fill completely.

Each year, about one percent of global reservoir storage capacity is lost due to sedimentation. My research is a step towards understanding the morphology of heavily sediment-impacted reservoirs and their surrounding areas. ■

Due to sediment transport and deposition, the open water area of Searsville Reservoir is now much reduced from its historical extent (approximated by the blue line). Sediment traps (above) placed in areas of the Corte Madera Creek floodplain (white dots) record the amount of deposition when the creek overtops its banks. The orange line is the JRBP boundary.

Missed sightings: are animals avoiding humans at Jasper Ridge?

ERIC ABELSON, PhD '13

Do wildlife species at Jasper Ridge avoid humans? Do coyotes avoid bobcats, or is it the other way around? One would expect deer to avoid pumas, but does evidence support this? Using photographs from motion-activated camera systems (camera traps), I am delving into the temporal relationships between humans and mammalian wildlife, and also among wildlife species.

I am poring over many thousands of images from camera traps that have been recording since 2008. While an image may be worth a thousand words, analyzing camera-trap images begins with the very process of converting images into words. I collaborated with Stanford computer scientists to design PhotoSpread, a program that makes the laborious task of labeling each image faster and more efficient. With help from undergraduates, I am using PhotoSpread to turn the images into a database in which each photo becomes a record that includes species identity, number of animals, and direction of travel, along with data already attached to the photo, such as the time stamp.

The database is a goldmine of temporal relationships. I will examine how closely in time a particular trail is used by puma and humans, or by various predator-prey and predator-predator combinations, such as coyote-rabbit, puma-deer, and bobcat-coyote.

An unexpected trend emerged early in the project: pumas were captured more frequently on the long-term Jasper Ridge camera traps than on camera traps I installed earlier. Because the long-term camera systems are predominantly on fire roads, whereas my cameras are on small game trails, I have begun examining how the type of trail might influence its use by wildlife. ■

The effect of physical damage on understory plants

TESS MORGRIDGE, '13

While the trophic effects of grazing, browsing, and seed predation by vertebrates on plant communities are well researched, the effects of non-trophic damage (physical damage not associated with herbivory) have been poorly explored. To address this knowledge gap, I studied the effects of physical damage by vertebrates on seedling models, made of bamboo, wire, and plastic chair glides, in an oak savanna. I "planted" seedling models of two heights (10cm and 30cm) and monitored whether they became bent (damaged) or flattened (dead). In preliminary tests, vertebrate behavior was not altered in response to my seedling models, allowing me to observe physical damage without confounding results.

Regardless of their size, seedling models that showed damage at a given survey were more likely to be considered dead at the next survey, although the degree of likelihood varied by site. In follow-up studies, I found that real seedlings experienced significant mortality due to physical damage; however, real seedlings are more resilient, resulting in decreased mortality compared to the seedling models. I carried out parallel studies in a Mexican rainforest, and the results were similar.

My findings may help explain why some oak species are experiencing low regeneration rates at Jasper Ridge. Seedling model mortality was greatest in sites where the dominant was valley oak *(Quercus lobata)*, the oak that is regenerating most poorly. In my studies and perhaps very broadly, non-trophic damage appears significant and suggests that anthropogenic impacts on vertebrates can affect vegetation via their physical impacts on plants. ■

A century and a half of plant observations

JOHN RAWLINGS

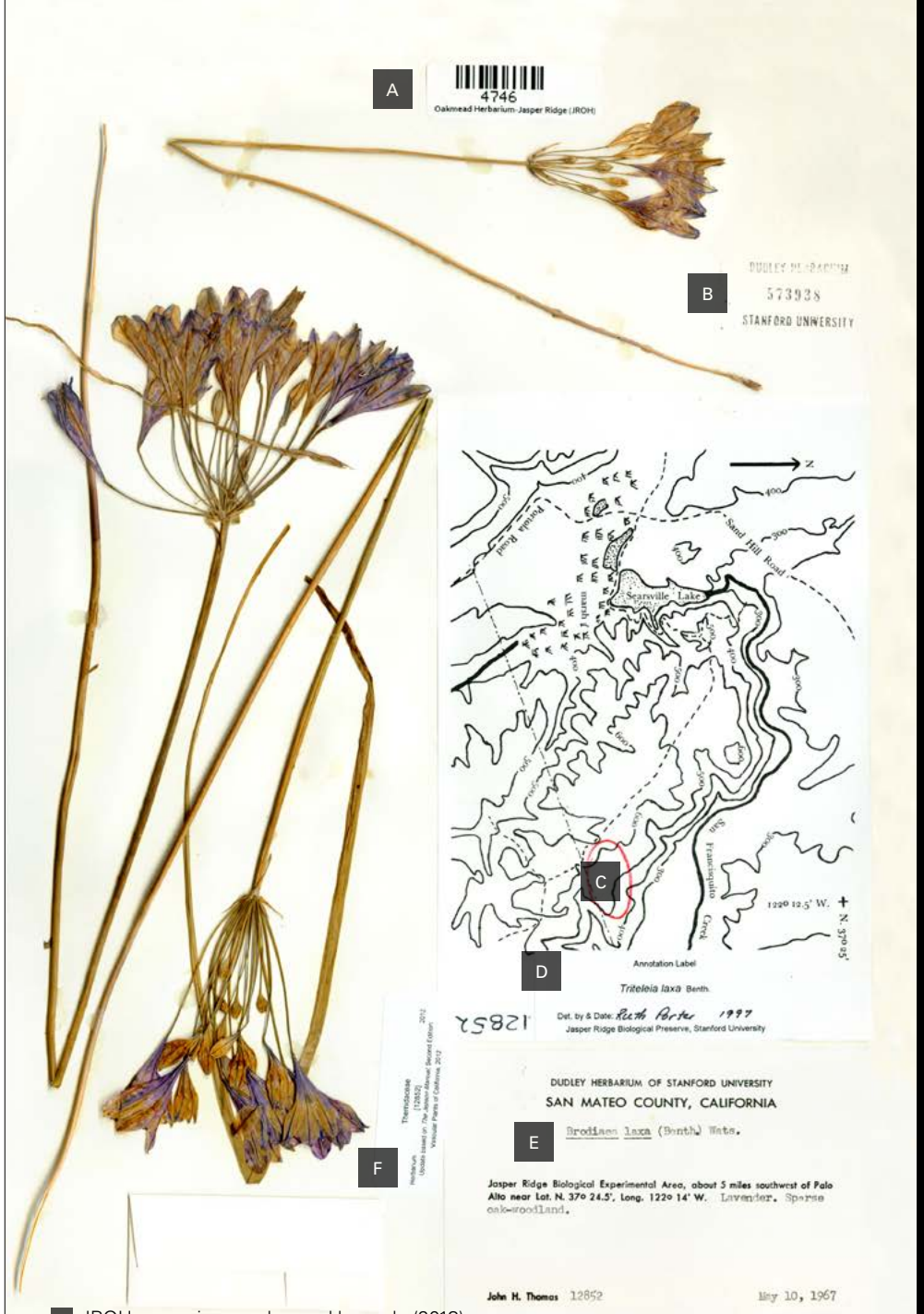
Walking over every hill and dale of the preserve during a year's course, one could be introduced to almost 10% of the vascular plants of California. Some of the state's most eminent botanists documented this diversity, and the Jasper Ridge Oakmead Herbarium and Collections (JROH) preserves that record from 1867 to the present.

In 1992 John Thomas, the most prodigious collector of the preserve's flora, estimated that it comprised about 600 species, subspecies, and varieties. At that time 400 Jasper Ridge plants were vouchered, i.e., documented by pressed specimens in organized herbaria. Twenty years on, the JROH has almost 6,000 specimen sheets of 794 vascular plants, plus collections of bryoflora and lichens.

Thanks to transcription by Zoe Chandik, the field notes of naturalist Herb Dengler are becoming more accessible. We have followed Herb's field notes and footsteps in search of plants he noted, such as paradoxical phalaris, congested plectritis, and miniature suncup. Our ongoing explorations result in new plant locations, vouchers, and discovery of plants never before recorded in the preserve.

Our goal is to compile, organize, and disseminate via the JROH webpage 150 years of floristic information: JROH specimens in the Consortium of California Herbaria; an annotated vascular plant list with links to thousands of georeferenced plant photos; a field observation database spanning 20 years of observations by Carol Zabel and Ann Lambrecht; special surveys and lists, including arrival dates of invasive exotics; a bibliography and links to historical documents.

My fellow herbarium volunteers in 2012-13 were Teri Barry, Toni Corelli, Alice Cummings, Karin Eckelmeyer ('62), Paul Heiple, Ann Lambrecht, and Diane Renshaw. ■



A JROH accession number and barcode (2013)
B Dudley Herbarium accession label and number
C JRBP map with red oval indicating collection site
D Annotation label with name change to *Triteleia laxa* (1997)
E Original label by collector John H. Thomas with earlier name *Brodiaea laxa* (1967)
F Annotation indicating change in family name (2012)

Long considered a single species, these yellow-flowered goldfields may be *Lasthenia gracilis*, or *L. californica*, or a mixture of the two in the narrow and imperceptible transition zone from one species to the other. Their purple-flowered companion, *Triteleia laxa*, has undergone taxonomic revision, too, as indicated on the herbarium sheet (opposite) together with ecological and curatorial information.

Upslope downslope: coexistence of two goldfields

JENN YOST, PhD '13, UC SANTA CRUZ
TERI BARRY, MS '13, SAN JOSE STATE

Imagine walking through a spring wildflower display at Jasper Ridge. Goldfields *(Lasthenia)* blanket the ground, and there are dashes of purple *Triteleia*, pink *Castilleja*, and hot pink *Leptosiphon*. The yellow of the goldfields is sometimes easy to ignore, as it provides the backdrop for other colorful spring blooms. Yet here at Jasper Ridge, the yellow is providing insights into how evolution works; it is a rare instance of two barely distinguishable, "cryptic" species coexisting.

For our graduate research we conducted separate but carefully integrated studies to unravel how two nearly identical species can grow together on the same hillside and not hybridize. This question is important for understanding how new species evolve and how species are maintained. In our studies of goldfields, we considered how soil chemistry affects different aspects of the plants' biology.

We found that fertile hybrids can be made when the two species, *L. californica* and *L. gracilis*, are crossed in the greenhouse. Surprisingly, the two species are adapted to different regions of the hillside crossed by trail 9, with *L. gracilis* occurring at the top (near fire road F) and *L. californica* occurring at the bottom. The two regions differ enough in soil chemistry to support differently adapted species and prevent them from growing intermixed.

Flowering time differences, seed set, and reduced viability or fertility of hybrids are additional factors that can prevent the two species from sharing genes. One question that everyone

asked was whether pollen can move between the two species. Answering that question required following pollinators in flight and measuring the distance between visited flowers. Another successful approach was to mark flowers with fluorescent powder, allow pollinators to visit the flower heads, and then measure how far the powder was detected away from the marked flowers. This required searching for fluorescent powder with an ultraviolet light after dark. It was a springtime rave! Jasper Ridge took on a whole new look, a darker and fluorescent look. These studies allow us to understand how being adapted to different habitats contributes to reproductive isolation.

The patterns observed in goldfields at Jasper Ridge are providing insights into how ecology shapes the speciation process. ■

Lasthenia flower heads marked with fluorescent powder, in daylight and under ultraviolet light at night.

EDUCATION AND OUTREACH

The 2012-2013 academic year was remarkably busy for the Jasper Ridge education program and included classes from Stanford as well as other colleges and universities, local high schools and other K-12, teacher workshops and classes and younger K-12 classes teaching and learning in our remarkable 1200-acre classroom.

For a more personal glimpse into what these programs accomplish I have asked Sophia Christel ’15, Mike Massey BA ’03, PhD’13, Tom McFadden ’08 and Stu Koretz to reflect on their experiences and work at the preserve and how it informs their own teaching and learning.

CYNTHIA WILBER

SOPHIA CHRISTEL, ‘15

Taking Bio 105 as a freshman was the best choice I’ve made thus far at Stanford. Not only did I discover JR as a place of learning, natural beauty, and ecological value, I found a haven in its winding trails and fragrant chaparral. It was something I couldn’t find anywhere on campus, and having those few hours of breathing space each week helped me immensely as I finished my first year of college.

Jasper Ridge invites meditation. I love to stand on the dam and absorb the sun and the wind as I gaze out at the Gadwalls on the water. Equally peaceful is the bottle-tinted shade of Leonard's Bridge, as the riparian woodland thrums with birdsong on a cool spring morning. It was there, in fact, that I found inspiration for my upcoming Honors Thesis. I'm an avid birder, so for my final project in 105 I decided to survey the birds in the riparian area on trail 13. Since the riparian foliage is often too dense for birding by sight, I had to know the songs and calls of the 45 species I might encounter in that area. About the same time, I began helping Rob Furrow with the monthly bird survey of transect A. The skills that I developed through those two endeavors will be essential when I start my thesis this coming winter.

I will compare methods of bird monitoring—transect counts, point counts, and audio recordings—across different habitat types to determine which methods yield the highest species diversity and density. I expect to find that different methods are suited to different habitats yielding data which could inform changes to the regular bird counts on the preserve. The audio recordings are also an exciting new experiment. High-tech microphones will capture bird sounds as they go about their business undisturbed by human presence. I'm hoping this less intrusive method could enhance monitoring in habitats with high-density vegetation.

I think the best thing about the docent program is getting to share knowledge and inspire others. When I rushed into an information session for prospective freshmen last year, buzzing from a morning of birding and an excess of caffeine, I may not have been the most articulate in describing why I adored JR. But what I lacked in elegant wording I hope I made up for in enthusiasm. After all, anyone willing to get up at six a.m. and tromp around in the winter cold must have something extraordinary to motivate them. And for me, the preserve fills that niche quite nicely.

MIKE MASSEY, BA '03, PhD '13

I arrived at Jasper Ridge very, very late in my Stanford career: though I was an undergraduate from 1999 to 2003, and came back for my doctoral studies from 2008 to 2013, I didn't make it to the Ridge until the last six months of my nine year adventure. I'm so glad I didn't miss out! My experiences in and out of class will enrich and inform my understanding of natural systems, my teaching and research, and my life for many years to come. I will pass on to my own students the echoes of the things I learned during six intensely fun, educational, and rewarding months of training.

I've spent the last eight years of my life becoming a soil scientist, focusing intensely on the chemical cycles in the world around us and the world under our feet. But like so many other students, I come from a suburban/urban background, and even my field research has been in controlled environments such as farms or carefully managed contaminated areas. I love to visit National Parks and to get outside, but until I made it to Jasper Ridge, I never really had the opportunity to intensively learn about a single place. Additionally, the focus on experiential education was both highly effective for me as a learner, and very helpful for me as a teacher.

In many ways, my experience at Jasper Ridge was a necessary "baptism" for me as a natural scientist, in the tradition of the great naturalist and scientist John Muir: here was a place where I could make connections. I could connect with the land, the natural and human history, the staff and visitors to Jasper Ridge. I could examine the connections between systems.

My experiences are already beginning to reverberate in that I was fortunate to guide a group of students from my new institution, California State University, East Bay, in the spring of 2013. As my relationship with Jasper Ridge matures in the coming years, I hope to bring many more students, researchers, and other visitors to this unique and wonderful place that I love. It took me a while to discover the Ridge, but I'm so glad I did–Jasper Ridge is a true jewel, and an amazing resource for science, education, and preservation.

TOM MCFADDEN, '08

I received an excellent education in human biology at Stanford, but JRBP offered me a chance to explore ecology, and conservation biology while providing innovative educational experiences for populations across the Bay Area.

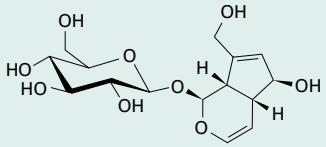
My class project included making a music video called "Clouds Make it Rain" with 5th graders from East Palo Alto Charter school. This experience sparked three years of traveling the world making educational music videos with kids. I made songs with Proyecto Itzaes in Mexico, with Kyoto University in Japan, and with Kiwis of all ages during my Fulbright experience in New Zealand.

Upon returning to California, I literally jumped straight back into the Jasper Ridge community. My first week back I worked with the Redwood Environmental Academy of Leadership (REAL) program to help them make a song about water conservation called "Save the Fishes." The video captures something special about how these students interact with each other, with the world, and with their environment. The REAL students have since used this video to discuss municipal water issues with the Redwood City Council and other local organizations. In May 2013, I accompanied two of the students to a live performance of their song at the Sustainability Showcase held at NASA Ames, sparking rave reviews among Bay Area conservationists and leading to many new opportunities for the students.

I was also fortunate to volunteer with the Eastside Field Studies program at JRBP in 2013, in which the 6th graders from Eastside College Prep in East Palo Alto attend weekly field classes at the preserve. Students were expected to collect accurate data, ask intelligent questions, connect across disciplines, and acquire a tremendous amount of new ecological knowledge in a very limited amount of time. These students consistently met and exceeded these expectations, displaying a love of learning and a love of scientific inquiry that will serve them well throughout their education.

Thanks to Jasper Ridge, students in the REAL program, Eastside, and others have access to a complex, demanding, and empowering scientific education. I feel lucky to be back home. ■

EUPHYDRYAS CHALCEDONA (VARIABLE CHECKERSPOT) LARVA



Euphydryas (Checkerspot) adults oviposit on and larvae prefer eating plants such as *Mimulus* (Monkey-flower) species that contain iridoid glycosides such as aucubin. This makes them less palatable to predators such as birds.

QUESTION

How do you think a female butterfly recognizes the plant on which she will lay her eggs?

ANSWER

Butterflies have chemical sensors on the front feet which enable them to recognize chemicals in their host plants.

EN.WIKIPEDIA.ORG/WIKI/FILE:AUCUBIN_SKELETAL.SVG

JRBP continuing education

STU KORETZ

Chemistry plays a large role in the ecological interactions of plants, yet it's not unusual for non-chemists to be a bit intimidated by this subject. This year, as part of the Jasper Ridge Continuing Education program, I presented a class and field exercise designed to make this topic an engaging learning experience for docents and through the docents to tour participants as well, by presenting the topic from the perspective of the ecological principles involved and by focusing on concrete examples involving plants commonly seen at Jasper Ridge.

We discussed the fact that many plants make use of chemical signals (often involving scents and colors) to communicate with mutualists such as pollinators and seed dispersers, and also use, for example, bitter chemicals to fend off enemies such as herbivores. Following a classroom based presentation we went out on the trail, where we stopped and discussed a number of examples as we came to the plants. We concentrated on how some specific examples could be used to illustrate underlying ecological principles to tour participants, enhancing the learning opportunities of tours by adding stories illustrating ecological interactions.

One fascinating concept that we covered on the trail is the fact that sometimes animals make use of plant chemicals for their own defense. For example, Dusky-footed woodrats have been reported to place partially chewed leaves of California bay laurel in their nests, and it has been suggested that this repels ectoparasites. Is it possible that this behavior has been selected over evolutionary timescales as a result of a fitness advantage related to avoidance of insect-born disease? We can ask questions like this on the

trail to generate meaningful discussions on topics such as interdependencies among species and how one might go about trying to show such a link.

As another interesting example of how animals can use plant chemicals in their own defense, many species of the checkerspot butterflies consume plant material high in bitter-tasting iridoid glycosides. The checkerspots are able to sequester these chemicals such that while they don't harm the butterflies, they cause the butterflies to be unpalatable to predatory birds. With this example as well, important questions and concepts related to ecological and evolutionary processes can then follow.

A significant piece of learning for class participants was that the key underlying concepts are easily understood and can be communicated effectively to an audience of any age. Even very young children can understand that the scent and colors of flowers (due to chemicals) can attract bees and birds, which pollinate plants. This can lead to further trailside teaching appropriate to the level of a tour group, for example by discussing the role of chemical communication in the co-evolution of plants and their pollinators and enemies, or even going into some detail of the chemistry itself. ■

TECHNOLOGY

Echolocation call sonogram for Yuma myotis bat *(Myotis yumanensis)* generated by Sonobat analysis software.

The Sonobat software can identify the species of bat from its echolocation call by analyzing characteristics such as call frequency, bandwidth, duration, interval, heel, slope and harmonics.

Ultrasonic bat recording microphone at the edge of Searsville Lake

Acoustic Monitoring of Bats

Bats are important to our ecosystem, consuming large quantities of insects such as mosquitoes and moths. The fact that they are nocturnal, flying animals makes them challenging to study. Acoustic monitoring allows detection and recording of the ultrasonic echolocation calls bats make as they navigate and hunt. The calls are different enough from species to species to be used as a reliable method of identification. Species diversity and seasonal abundance can be determined in a non-invasive way.

Over the summer of 2013, Jasper Ridge docent Tom Malloy and I put in place four acoustic bat monitoring stations which by October had made over 136,000 recordings of bat calls. Stations were located near Jasper Ridge Restoration Fellow David Moreno Mateos' insect traps to correlate bat predation with his insect abundance data.

Each acoustic recording station consists of a Binary Acoustics Technology FR-125 field recorder, ultrasonic microphone, solar power station, and WiFi radio for uploading recordings automatically via the JRBP outdoor wireless network. 16 out of 17 California species have been identified using sophisticated software to analyze the acoustic characteristics of each recorded echolocation call. Tom has employed his programming talents to help automate the archiving and analysis of the recording files and will participate in ongoing efforts to help researchers analyze and use the data.

This project will complement and build upon the research of Tom Mudd, who operated several acoustical bat monitoring stations from 2001 until he passed away in 2007. ■

TREVOR HEBERT

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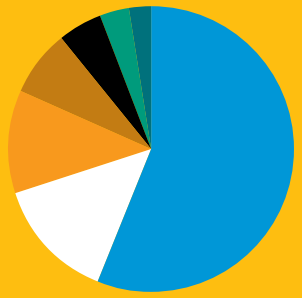
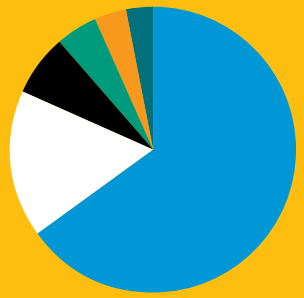
FINANCIAL SUMMARY

2013 Expenses



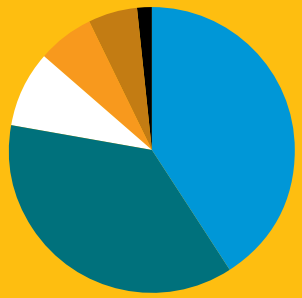
Salaries & Benefits	620,498	56.3%
Operations and Maintenance	152,877	13.9%
Research Support [1]	127,795	11.6%
40th Anniversary Events & Fundraising	82,309	7.5%
Administration	54,199	4.9%
Land Management	38,836	3.5%
Education & Community Outreach	25,669	2.3%
Total Expenses	**1,102,184**	**100.0%**

2014 Projected Expenses



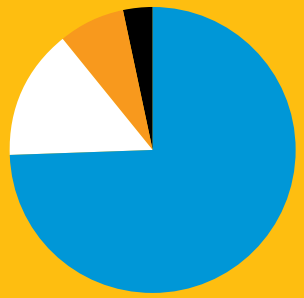
Salaries & Benefits	632,316	65.2%
Operations & Maintenance [4]	161,700	16.7%
Administration	66,990	6.9%
Land Management	46,200	4.8%
Research Support	35,000	3.6%
Education & Community Outreach	27,038	2.8%
Total Projected Expenses	**969,244**	**100.0%**

2013 Revenues



Endowments	675,283	41.1%
New endowment donations [2]	605,000	36.9%
General Funds from H&S	139,608	8.5%
Unrestricted donations	104,456	6.4%
Other support [3]	92,727	5.6%
Income	24,254	1.5%
Total Revenues	**1,641,328**	**100%**

2014 Projected Revenues



Endowments	723,075	74.6%
General Funds from H&S	143,617	14.8%
Unrestricted Donations [5]	72,552	7.5%
Income	30,000	3.1%
Total Projected Revenues	**969,244**	**100.0%**

STAFF

Chris Field PhD '81, Faculty director
Philippe Cohen PhD, Executive director
Nona Chiariello PhD '81, Staff scientist
Cindy Wilber Education coordinator
Trevor Hebert GIS and data manager
Carolyn Taylor Administrative associate
Cary Tronson Operations manager
Jeff Vance Special projects technician
Brooke Fabricant Resident ranger
Steven Gomez Temp. maintenance assistant

[1] Includes $102,720 to support the JR Restoration Fellow, including supplies & field assistance.

[2] Two new endowments created during FY13: Don Kennedy Endowment, a $500,000 gift from the David and Lucile Packard Fdn; Jasper Ridge Director's Fund, a $105,000 gift from John and Lysbeth Anderson Working.

[3] JR Restoration Fellowship partially funded by the Searsville Studies project ($51,227); Additional support for 40th anniversary activities and events (H&S Dean's office, Precourt Institute for Energy, Stanford Continuing Studies, Woods Institute for the Environment, Dirk and Charlene Kabcenell Fdn.).

[4] Includes planned purchase of minivan.

[5] Amount determined by projected budget shortfall.

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 Environmental Earth System Science
Nicole Ardoin School of Education
Melinda Belisle Graduate student, Biology
Rodolfo Dirzo Biology
Paul Ehrlich Biology
David Freyberg Civil and Environmental Engineering
Tadashi Fukami Biology
Elizabeth Hadly Biology
David Kennedy History
Katherine Maher Geological and Environmental Sciences
Harold Mooney Biology
Kabir Peay Biology
Nona Chiariello Ex-officio, Jasper Ridge
Philippe Cohen Ex-officio, Jasper Ridge

JASPER RIDGE COORDINATING COMMITTEE

The JRCC is composed of individuals from Stanford and non-Stanford organizations representing the broad range of groups the preserve interacts with and provides advice and guidance to the executive director on significant management challenges facing the preserve.

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Julie Anderson Midpeninsula Regional Open Space District
Leonie Batkin Stanford Real Estate Operations
Angela Bernheisel California Department of Forestry and Fire Protection
Rick DeBenedetti Woodside Trail Club
Denise Enea Woodside Fire Protection District
Jerry Hearn Acterra and Jasper Ridge docent
David Lenox University Architect/Campus Planning and Design
Jean McCown Stanford University Government/Community Relations
Betsy Morgenthaler Jasper Ridge docent
Trish Mulvey Palo Alto Community Volunteer
Ellen Natesan San Francisco Water Department
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Chris Shay Director of Facilities and Capital Planning H&S Dean's Office
Joel Silverman Midpeninsula Regional Open Space District
David Smernoff Acterra
Matthew Tiews Executive Director of Arts Programs H&S Dean's Office
Sally Tomlinson Environmental Volunteers
Susan Witebsky SLAC National Accelerator Laboratory
Eric Wright Senior University Counsel
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Michael Krall Portrait on page 15
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DESIGN

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APPENDICES

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This generous community of donors provided essential gifts between Sept. 1, 2012—Aug. 31, 2013.

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JASPER RIDGE BIOLOGICAL PRESERVE

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Perched on western leatherwood (*Dirca occidentalis*), a flower crab spider (*Misumena* sp.) grasps an ambushed solitary bee.