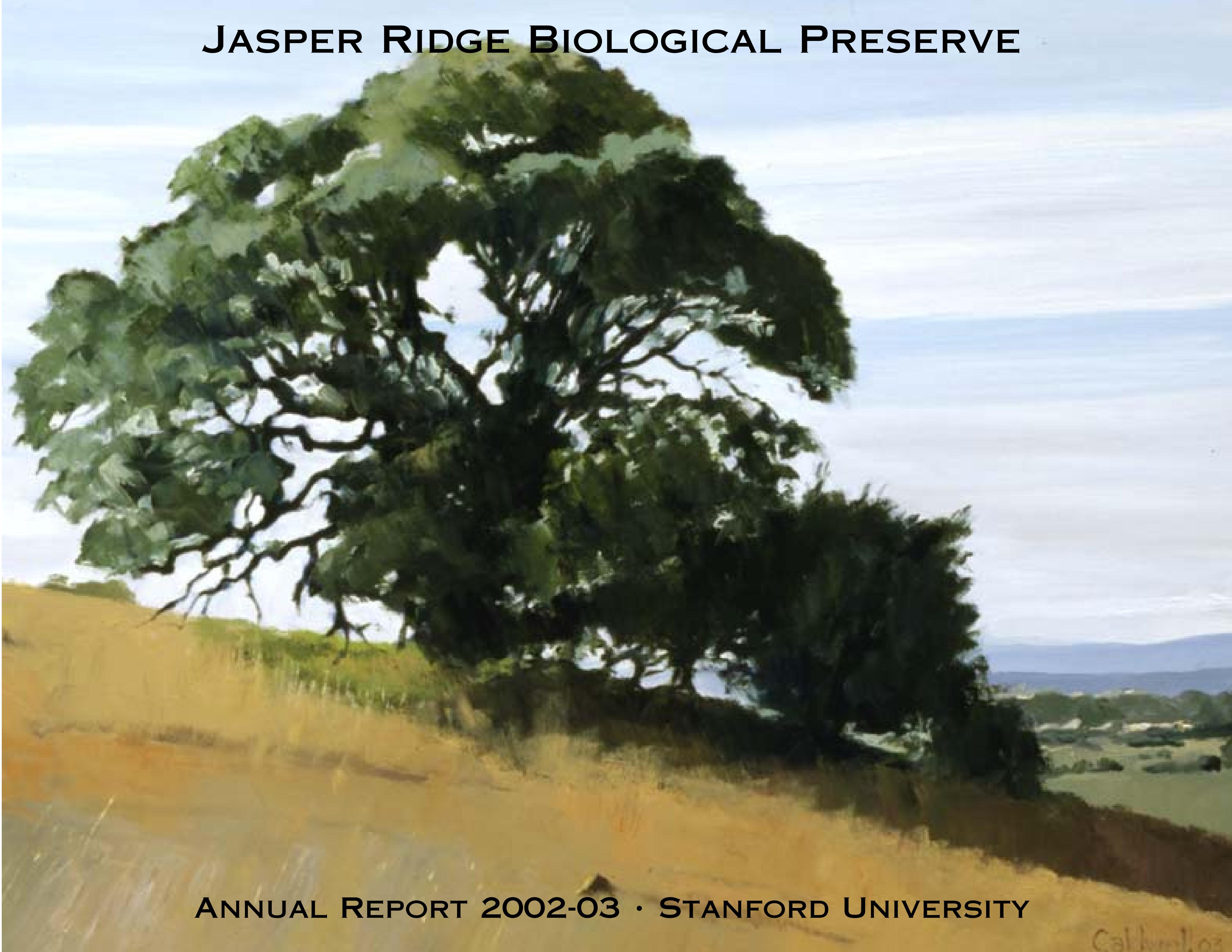
Jasper Ridge Biological Preserve



Annual Report 2002-03 · Stanford University

The most basic rules of the world—the ones we all live by—are ecological rules. You can't study them or even perceive them very well in a classroom or laboratory. Whether one is a botanist, a biologist, or an earth scientist, it's imperative to go out on the mountainside, watch the rain fall over a valley, dig into the earth beneath a fallen tree, or wade a creek for cobbles with sources upstream. The best work in the natural disciplines all starts with observations in nature.

-KENNETH S. NORRIS,
Founder of the University of California
Natural Reserve System

Growth is the goal, it is a condition we associate with success, it is viewed as a desired outcome, and it is one of our cultural mantras. But not all growth is identical, desirable, or sustainable. Acknowledging limits is a hard-won lesson, and in my experience, many of our most creative accomplishments emerge from acknowledging our limits and turning them into new opportunities.

Jasper Ridge is faced with limits to growth and is susceptible to the strains and stresses associated with approaching limits. Some of the growth and the associated constraints are of our own making—the growth in research, class use, tours, and other program activities. These have raised questions about how much activity can be accommodated by the Preserve without compromising the quality of Preserve activities or the unique resources that make the Preserve so invaluable. Other pressures are external to the Preserve and come in all shapes and sizes—development and land use along our boundaries, the political and management realities of residing within an increasingly urbanized landscape, and the regional and global changes that confront us all.

There are numerous paths toward addressing these challenges, and making the right choices is a formidable task. Challenges associated with fire management, the future of Searsville Lake and Dam, and the continuing problems caused by invasive species such as West Nile Virus all demand careful attention. Staying focused on the Preserve's mission without being overwhelmed by the crisis du jour requires considerable clarity and discipline. In an effort to assure a continued focus on the Preserve's future, a Strategic Planning Committee was formed in November of 2002, with Chris Field (Director, Department of Global Ecology, Carnegie Institution of Washington) as its chair. Other members of the Committee include: Professors Deborah Gordon (Biological Sciences) and David Freyberg (Civil and Environmental Engineering); graduate students Will Cornwell and Lisa Moore; community members Bill Gomez, Jeanne Sedgwick, and Irene Brown; Nona Chiariello (Jasper Ridge Research Coordinator), as well as myself. The charge of the Committee is to identify policies and priorities for addressing the broad range of management issues faced by the Preserve in the coming years while prioritizing the major components of the Preserve's mission.

From my perspective, one encouraging feature of the Strategic Planning Committee's formation is that it precisely follows what was outlined near the end of last year's annual report statement—the need to address the challenges of managing the Preserve within the context of an urban-wildland interface. How well we adjust to this context without compromising the mission of the Preserve is the single greatest challenge to the Preserve's continued productivity and viability.

This past year has been marked by several events that bear out the complexities of operating within an urban-wildland interface zone.

On July 26th there was a small grassland fire at the Preserve. While this event was contained to less than two acres, the reactions that it engendered from neighbors and local officials further demonstrated the difficulties of developing and implementing a fire management plan that both protects the mission of the Preserve and reduces the risks to residents near the Preserve.

In anticipation of growing neighbor concerns, the Preserve is currently field-testing a highly sensitive infrared sensor system for monitoring fires. If successful, this will provide an early warning and response system for fires that approach or begin on the Preserve. This is one of several management efforts that the Preserve is engaged in to help ensure that our mission is not compromised while addressing some of the concerns of the surrounding communities.

A second event is the anticipated arrival of West Nile Virus. Given the close proximity of residents to the Preserve's wetland habitat adjacent to Searsville Lake, San Mateo County has expressed concerns about managing potential risks. As a result, County officials are requiring that we proactively manage mosquitoes with a larvicide spray that uses a bacterial agent, *Bacillus sphaericus*. Hence, while being invaded by one invasive species, we must resort to bringing in another non-native species to meet County public health concerns.

This is an expensive undertaking with as yet undetermined management implications that emphasizes the permeable nature of the boundaries between the Preserve and nearby residential properties. I specifically mention these issues because it highlights what will be a continuing source of both stress and opportunity—how to reconcile the demands and expectations of a growing human presence with the ecosystem functions we are trying to understand and sustain.

While this past year has highlighted important challenges, there are also important accomplishments on several fronts. First, we celebrated our first year in our new building, the Leslie Shao-ming Sun Field Station. I'm proud to note that the Sun Field Station was the recipient of the County of San Mateo RecycleWorks Green Building Award and received a merit award from the San Diego Chapter of the American Institute of Architects. In addition, we have installed a complete energy monitoring system to document the performance of the Sun Field Station. Data from the monitoring system can be seen on our website. This system is designed not only to help educate others on the sustainable features of the new building, but also to document the degree to which we achieve one of our original goals—annual energy use resulting in net zero carbon emissions. It is one thing to announce such a goal, it is another to provide a measure of how close we've come to achieving it.

When I first proposed a new facility for the Preserve, my concern was the growing needs of Jasper Ridge programs. One of the "fuzzier" goals of the new facility noted in the National Science Foundation grant proposal submitted in support of the project was to "capitalize on the synergy between the research, teaching, and volunteer programs." This first year in the Sun Field Station has proven the truth of that statement. One successful program made possible by the expanded and improved space in the Sun Field Station is monthly luncheon roundtable presentations by researchers on topics of interest to the JRBP community. This program, initiated almost entirely by docents, has featured topics ranging from yellow star thistle invasion and management to chemical communication and animal behavior. Roundtables planned for the coming year range from the future of Searsville Lake to the science of global climate change. It is precisely this kind of synergistic activity among all the diverse members of the JRBP community that we look forward to promoting in the Sun Field Station.

This past year has also been marked by the amazing productivity of researchers at Jasper Ridge. I encourage you to review the research highlights, especially the recent work of the labs of David Ackerly and Deborah Gordon. In addition, this past year is marked by major publications emerging from the Jasper Ridge Global Change Experiment. These publications (see Appendix 2) appearing in the journals *Science* and the *Proceedings of the National Academy of Sciences*, have brought into question several assumptions about how grassland ecosystems are likely to respond to global climate change. The body of work that has emerged from this past year is a tangible example of why biological field stations such as Jasper Ridge are so important.

This annual report is the ninth iteration. When I first started this tradition, it was with the intent that it would become a vehicle for communicating the importance of the Preserve to Stanford and neighboring communities, as well as a yearly reminder to supporters and the JRBP community of how their efforts fit into a larger context. As we produce this report each year, I find myself comparing the present with the past. Last year's annual report was acknowledged with a Gold Award for superb craftmanship in the East Bay and Diablo Craftsmen's Club Competition, a testament to the publication skills and talents of Rebecca Young, former GIS and Data Manager. This year we hope to continue this tradition of excellence.

I encourage you to page through this document and read it closely. You will see a remarkable pool of talent and commitment from volunteers, researchers, faculty, students, and committee members. This year, I want to close by acknowledging the staff at Jasper Ridge. Their continued good sprits, commitment, and professionalism are vital to protecting and supporting so much that we celebrate at JRBP.

Research at JRBP this year continued its growing focus on environmental and biotic change. Whereas much of the Preserve's research in the past focused on mechanisms and processes underlying adaptations to the Jasper Ridge environment, a common thread of much current research is how ecosystems function in a changing world. Longtime observers of the Preserve will detect in this annual report a sharpening contrast with the Preserve's history.

Recent discoveries suggest the extent and magnitude of change facing JRBP. Professor Deborah Gordon's research group discovered that Argentine ants invading JRBP not only displace some native species but also disrupt interactions among those that remain. Studies within the multi-investigator Global Change Experiment found that levels of atmospheric CO_2, nitrogen deposition, temperature, and precipitation expected in the next century can alter both plant communities and microbial communities in the soil. And Professor Paul Ehrlich's long-term studies of Bay checkerspot butterflies have linked the butterfly's extinction at JRBP to weather variation associated with climate change. These findings, together with many of the year's publications, point to major changes in the biotic communities of Jasper Ridge. That such a coherent theme emerges from diverse and independent research programs is perhaps the strongest message of all.

The importance of change at JRBP—both realized and anticipated—underscores the value of long-term studies. For example, because of the long duration of the Gordon lab's studies of invasion by Argentine ants, researchers have been able to compare many individual survey points pre- and post-invasion, in addition to using the short-term approach of snapshot comparisons between invaded and uninvaded points. A study organized by former Stanford Ph.D. student Nathan Sanders used both types of comparisons to analyze the spatial distribution of native ant species that withstand invasion. The team found that before invasion, native ant species tend to have more organized communities (with reduced spatial overlap among species), but they change to more random communities (with greater overlap) soon after invasion, a process the researchers term "community disassembly." Had the team used only short-term comparisons of invaded and uninvaded sites, they wouldn't have been able to rule out the possibility that the pattern was due to intrinsic differences between sites that were invaded and those that were not.

The Global Change Experiment, now in its sixth year of studying the response of natural grassland to anticipated environmental changes, experienced change of another sort. In July, a wildfire spread into the experiment and burned a quarter of the study plots. As researchers grappled with the impact, Professor Chris Field proposed a way of moving forward: continuing the main experiment with six replicates of each treatment, and repairing the burned plots so the effects of the fire could be studied with a modified experimental design. After two months of replacing devices that monitor or apply treatments in the

Sixty-six studies were active this year, nearly half of them associated with long-term studies led by investigators from Stanford and the Carnegie Institution. Among researchers from the Stanford campus, three Schools and nine departments or programs were represented. A dozen new studies, including five by visiting investigators, were started in geology, ecology, and phylogeography (topics at the interface of phylogenetics and geography). Principal investigators included 30 faculty and senior scientists, 10 postdoctoral fellows, 12 graduate students, and three undergraduates who produced 38 publications, dissertations, and theses. See Appendices 1 and 2 for details.

burned plots, the experiment was ready for the current growing season and the opportunity to study the interaction between fire and other environmental changes. Because the fire occurred within a long-term experiment, its effects will be interpreted in relation to six years of pre-burn measurements, as well as to ongoing studies of unburned plots.

Of the many aspects of ecosystem change investigated at Jasper Ridge, none is more challenging than freshwater dynamics. With a dam nearing the end of its 'useful' lifespan, a watershed fundamentally altered by the dam, and expected changes in the rainfall regime, the Preserve faces challenges in understanding and managing water resources that affect a large landscape. The remainder of this overview of research examines a diverse set of studies that bear on many water-related issues. UNESCO's designation of 2003 as the International Year of Freshwater Resources is a reminder that such challenges are globally important.

Dynamics of Water Resources

A common theme across diverse studies at JRBP is the importance of annual variation in precipitation. For example, several recent studies have found lasting signatures of extreme rainfall years. One such year was "water year 1998," the twelve month period beginning in October, 1997 and ending in September, 1998, which coincided with the setup of the Global Change Experiment. Researchers made pre-treatment measurements on experimental plots during 1998 so they could later make pre- and post-treatment comparisons, in addition to comparisons across treatments. While the record-setting rainfall of 1998 did not produce the pre-treatment baseline the researchers expected, it allowed them to capture processes that may be equally important. For example, postdoctoral fellow Jeff Dukes found that aboveground plant growth in 1998 was greater than control plots have produced in any year since. Even more importantly, the record rainfall facilitated widespread establishment of perennial grasses and forbs. These perennials were dwarfed by faster-growing annuals in 1998, but their foothold was secured. Dukes found that by 2002, well-established perennials were co-dominant with annuals in a fifth of all study plots, independent of the experimental treatments. Production data for 2003 are the first to suggest a reversal in the expansion of perennials.

Research at Stanford's Center for Conservation Biology now attributes the Bay checkerspot butterfly extinction at JRBP to changes in the frequency of extreme water years. In two papers authored by former CCB researchers John McLaughlin and Jessica Hellmann, CCB Director Carol Boggs, and Professor Paul Ehrlich, a nearly 40-year record of the butterfly's population size is analyzed alongside an even longer record of total precipitation during each growing season. By statistically comparing 20-year intervals along the rainfall record, they found that precipitation totals were more variable after 1971 than before. Mathematical relationships between annual rainfall and butterfly population size suggest that population crashes were very likely after 1971, as indeed occurred, leading to extinction of two independent sub-populations of the Bay checkerspot in 1991 and 1998. The model predicts that if rainfall variability had continued at pre-1971 levels, the butterfly would have persisted at JRBP for centuries longer. Previous studies by Professor Ehrlich's group have shown that drought years threaten the butterfly by prematurely drying up foodplants consumed by larvae, while very wet years tend to be too cold for larvae to grow adequately. Thus, either kind of extreme in local climate conditions can threaten the butterfly.

Habitat Comparisons

Other studies are asking how site-to-site differences in water availability affect the variation in physiological characteristics within plant communities. Such studies may help researchers predict how biotic communities will shift in response to climate change. Will Cornwell, a Ph.D. student working with Stanford Professor David Ackerly, is studying woody species along gradients in water resources, such as from ridgelines to ravines, and from south- to north-facing slopes. He has found that towards the dry end of the gradients, there are opposite patterns in two important indicators of adaptive physiology. The density of wood in stems is more uniform in dry sites than would be expected from a random assemblage of species, while the size of leaves is more variable than expected. These findings suggest that high levels of water stress impose tight constraints on wood density but allow alternative leaf adaptations, such as deciduousness or reduced physiological activity.

Katherine Preston, a researcher and lecturer from the Ackerly lab, has been studying extremes of water availability from an evolutionary perspective. She is comparing leaf and stem properties across pairs of related species from contrasting climates, and has found parallel evolutionary divergence across multiple pairs. Species of dry habitats have properties that mitigate the risk of losing water through their leaves faster than it can be moved through their stems. For example, such species have a reduced total surface area of leaves for stems of a given thickness. These and other traits reduce the likelihood that the threadlike columns of water in the stem will rupture, leaving plants facing a pump-priming dilemma.

In his recently completed Ph.D. dissertation, Nishanta Rajakaruna (University of British Columbia) took an approach that combines elements of both Cornwell's and Preston's work. Rajakaruna asked whether similar patterns of evolutionary divergence occur along gradients of water availability both within sites and across regions. Rajakaruna studied goldfields, *Lasthenia californica*, and found that plants in well-drained ridgetop areas of JRBP were genetically distinct from plants in the soggier swales. The details of their adaptations reflect the complex role of water in ecosystems. Although plants from ridgetops are better adapted to drought, swale plants are better adapted to salt stress, a condition typical of swales, where ions collect after leaching from the slope. These ridge and swale habitats are so common in serpentine grasslands that Rajakaruna considers JRBP a microcosm of conditions and responses across the species' range.

Soil chemistry has another important dimension in serpentine grasslands because of the presence of potentially toxic elements, such as chromium. Chris Oze studied these soils for his Ph.D. dissertation as a model for what to expect in soils contaminated by chromium-laden industrial waste. Oze found that hexavalent chromium—the toxic form—was undetectable in rocks, soils, and clays, but when he turned to the soil solution, he found the opposite—a majority was the toxic form. Experimenting with soil samples in the lab, Oze discovered that the chemical conversion between toxic and benign forms of chromium depends on how long the soil stays wet and how much organic matter and other minerals are present. In the field, groundwater samples from the bedrock serpentinite contained concentrations that exceed limits set by the U.S. Environmental Protection Agency, a result with important implications for managing waste sites.

Global Change Experiment

Many of the complex physiological and evolutionary patterns that will affect responses to future environmental change are being studied in the Jasper Ridge Global Change Experiment, directed by Professor Chris Field (Carnegie Instit.) together with Professors Brendan Bohannan, Harold Mooney, and Peter Vitousek (Stanford), Shauna Somerville (Carnegie Instit.) and James Tiedje (Michigan State Univ.). Added precipitation, applied via sprinkler irrigation after each major rainfall and twice after the season's final rainfall, is included in eight of the experiment's sixteen different treatment combinations, making it possible to study how future increases in precipitation may interact with other environmental changes.

One hypothesis that researchers are testing in the Global Change Experiment is that ecosystem responses to global changes, including increased precipitation, are likely to be shaped by changes in the availability of soil nu-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1. *Using a Sunfleck Ceptometer, Kris Hulvey measures light levels in a grassland microcosm. She and Dr. Erika Zavaleta will use the data to determine the effect of species diversity change on grassland susceptibility to yellow starthistle invasion.*

2. *Jean Knops of the University of Nebraska and Walt Koenig of U.C. Berkeley count acorns in September, 2003 as part of their statewide survey of acorn production by California oaks.*

3. *Ph.D. student Nicole Heller finds and marks an Argentine ant nest as part of a three-year study measuring the survival and growth of individual ant nests.*

4. *Undergraduate Kenny Dixon measures leaf area as part of a study relating plant functional traits and ecological distribution, led by graduate student Will Cornwell and postdoctoral researcher Katherine Preston.*

5. *Grace Hsu, a senior at Saratoga High School, positions a meter-long rod of light sensors at various heights above the ground to study the penetration of light through standing litter to germinating seedlings.*

6. *The Center for Conservation Biology's Jennie Kluse measures vegetative cover with a laser-pointer pin-board sampler.*

7. *Postdoctoral researcher Katherine Preston prepares shoots for a study comparing biomass of leaves and stems in 55 species across light and moisture gradients.*

8. *Ph.D. student Lisa Moore positions a chamber for measuring the rate of soil respiration in a grassland plot.*

9. *Graduate student Virginia Matzek preserves oak leaves in liquid nitrogen for a physiological study of fast and slow growth in plants.*

10. *Duncan Menge, Stanford Class of 2003, takes a soil core from the Jasper Ridge Global Change Experiment for his undergraduate honors thesis work on phosphorus limitation under global change manipulations.*

11. *Center for Conservation Biology research staff Paulo Oliveira collects seedbank samples at a Jasper Ridge reference site for the Stanford Foothills grassland restoration project.*

trients that are essential to plants. Duncan Menge, a Stanford undergraduate, designed his Honors thesis project to find out whether global change factors that relieve limits to plant growth by one nutrient lead to limitation by another. He was particularly interested in relative limitation by nitrogen and phosphorus, two of the most common nutrient limitations to plant growth. He found that added water reduces the amount of an enzyme that frees phosphate ions from organic compounds in the soil, a key step in making those ions available for uptake by plants. From this and other results from his thesis, Menge concluded that added water reduces phosphorus availability but reduces nitrogen availability even more. Studies by postdoctoral fellows Peter Horz and Adrian Barbrook, working with Professor Brendan Bohannan, identify one mechanism behind the altered nitrogen availability. They have found that with added precipitation, there is a decrease in the abundance of bacteria that oxidize ammonium to nitrite, a key step regulating the amount of nitrate available to plants.

Although plants might be expected to compensate for reduced nutrient availability by growing more or deeper roots, Ph.D. student Lisa Moore has found that plots of the Global Change Experiment receiving added moisture have shallower root systems instead. Moore considers this a potentially short-sighted response by the plants because it allows greater growth of shoots early in the season but leaves plants shortchanged later on when drying soils demand more extensive root systems. This trade-off may help explain an important response of annual primary production discovered by postdoctoral fellow Jeff Dukes: increases in the length of the growing season (determined by the dates of the first and last significant rains) tend to produce increases in primary production, whereas augmenting water within a naturally triggered growing season does not. Added moisture does, however, shift the seasonal impact of natural herbivory by snails and slugs. Ph.D. students Halton Peters and Elsa Cleland, together with high school senior Grace Hsu, found that in the treatments with added water, herbivory was diminished in fall and increased in spring, a shift that appears to have significant effects on the composition of the plant community. All of these findings underscore the need for more detailed predictions of the timing of precipitation in regional models of future climate change.

Watershed Studies

Both the timing and amount of precipitation affect the movement of water through ecosystems. Surface runoff and groundwater transport from roughly half the Preserve feed into Searsville Lake, which also drains another 14 square miles of forested slopes on highly erodable geologic formations in the Coast Range. Runoff from the watershed washes soil, rocks, and plant debris into Searsville Lake, which traps roughly ninety percent of the sediment. A century of deposition in the lake has drastically reduced both its area and depth. This year, Stanford Professor David Freyberg began studying how the groundwater in vegetated alluvial areas interacts with the active waterways. His studies have already shown that the summer drawdown of the lake triggers a parallel but delayed decline in groundwater energy. These studies will be important for predicting what will happen to biotically sensitive wetlands in the future.

Groundwater dynamics also affect the extent to which Searsville Lake is storing carbon that would otherwise contribute to increases in atmospheric carbon dioxide, a greenhouse gas. Ph.D. student Asmeret Asefaw Berhe (U.C. Berkeley) is working with a team of scientists from the U.S. Geological Survey who have been studying 40-foot cores of sediment they removed from the lake. Berhe joined them to analyze the fate of carbon that had been carried down from the watershed as plant litter and organic matter in soil. They have found that buried sediments in the deepest area of the lake contain organic carbon that has been largely preserved and will remain so for a thousand years or more if left in place. By contrast, sediment in periodically drained alluvium near the lake's main tributary may be subject to more rapid decomposition and/or less effective burial. The lake is preserving less and less additional carbon, however, because of its decreasing capacity to store sediment.

The dam not only withholds sediment from its outflow creek, San Francisquito, but also alters the seasonal flow characteristics of that creek. At various times since 1996, Jonathan Owens, Chris White, and Barry Hecht of Balance Hydrologics have studied how these changes in outflow might affect native strains of steelhead trout and other stream dwellers. Currently they are measuring flow over the dam and are setting up a station for monitoring water quality in Bear Creek, a major tributary of San Francisquito. Their studies are sponsored by Stanford Utilities and are part of the cooperative Long-Term Monitoring and Assessment Program (LTMAP) for San Francisquito Creek.

Researchers Gordon Holtgrieve and Scott Loarie and Stanford Conservation Biologist Alan Launer have continued their monitoring of San Francisquito Creek for sensitive species such as steelhead and California red-legged frogs, both federally protected species. This year they completed an analysis that suggested that the distribution of red-legged frogs may be constrained to the middle reaches of the creek by both urban development and non-native crustaceans in downstream areas and by invasive species in the upper reaches, especially predatory bullfrogs and bass carried by Searsville Lake's outflow. The team also discovered marked fluctuations in one of the Creek's potentially most disruptive invaders, mitten crabs, which migrate upstream from San Francisco Bay. In 1999 and 2000, the team observed hundreds of crabs as far as two kilometers into JRBP, but in 2002, they saw none. Because crab migration requires moderate streamflow, the researchers suspect that population declines may be caused by either very dry years or wet years with very high streamflow.

Hydrologic changes occurring at JRBP are critical to the local watershed and representative of broader—sometimes global—challenges. Although research programs at Jasper Ridge are diverse and independent, often they intersect along common themes. For example, several recent studies at JRBP underscore the importance of the hydrologic regime in the evolution of the flora and the composition of communities, while other studies consider processes by which predicted changes in rainfall may alter species and ecosystems in the future. Results from the Global Change Experiment emphasize that the consequences of these changes will depend on other environmental changes and their effects on soil nutrients. In coming years, Searsville Dam and Lake will be an important focal point in local freshwater resources. The dam truncated a steelhead spawning run that once extended from the Bay into the upper reaches of the watershed, and also interrupted the natural flux of sediment from the Coast Range to the Bay. Studies of these impacts, together with monitoring and experimental studies of biotic communities, groundwater, dissolved nutrients, surface flow, and water quality, all provide a growing source of scientific input for managing freshwater resources and contributing to the health of this and other watersheds.

In academic year 2002-03, the new Jean Lane Environmental Education classrooms of the Leslie Shao-Ming Sun Field Station housed a stimulating and diverse range of classes, lectures, workshops, and discussions. Stanford University classes included Core Experimental Laboratory for Ecology (Biology 44Y), Field Studies in Earth Systems (Earth Systems 189), Botany (Biology 120), Jasper Ridge Docent Training (Biology 96), as well as the Quest Scholars Program. Additionally, workshop classes were held quarterly in collaboration with the Stanford Teacher Education Program (STEP) and the Stanford Ecology and Environmental Sciences retreat filled the building with students and faculty in March. During spring quarter, the Eastside College Preparatory School's (ECP) Field Studies class collected and studied their ecosystem data with the help of Stanford undergraduates, and in June, Jasper Ridge hosted a weeklong field trip for Ecological Society of America (ESA) students representing colleges and universities from throughout the United States. For a complete list of instructional use, see Appendix 3.

Biology 44Y brought 250 students to the Preserve for ecology labs during spring quarter. The students collected and analyzed samples of aquatic systems in Corte Madera and San Francisquito Creeks to explore relationships between abiotic factors and macroinvertebrate diversity and abundance. A series of Hester-Dendy sampling plates were placed at various sites in the creeks. These devices, composed of multiple masonite plates divided by nylon spacers, provided artificial substrates for macroinvertebrates and were disassembled by students for specimen examination. The students measured the effects of five abiotic factors: dissolved oxygen, temperature, pH, velocity, and conductivity, on the populations of macroinvertebrates that settled on the plates.

The Jasper Ridge docent class of 2003.

Earth Systems 189 students heard classroom lectures by Stanford faculty members and participated in field studies in the rapidly changing delta region where Corte Madera Creek enters Searsville Lake, a site that is marked by gradients of soil saturation and a pronounced pattern of vegetation succession. Students learned and applied field and laboratory methods in geology, soils, biogeochemistry, and plant ecology as they studied the fundamental workings of this ecosystem. The course emphasized questions and study methods relating to the landforms and rock types resulting from California tectonics, processes involved in soil formation, and nitrogen cycling. Structure, distribution, and the functional properties of the successional plant communities were also investigated by the class.

Spring 2003 marked the fifth year of the Eastside College Preparatory School JRBP Field Studies class. For ten weeks, 15 ECP sixth graders collected data in their ecosystem sites for three hours each Wednesday morning as they worked alongside Stanford undergraduates Laura McClendon, Simha Reddy, and

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1. *Docent and Eastside College Preparatory School mentor Britt Sandler explains the finer details of Jasper Ridge geology in a hands-on class.*

2. *Kim Carlson and Alvin Chin, 2003 docent trainees, test the water potential of a variety of plants using a pressure chamber.*

3. *Biology 44Y students Stephanie Hu, Amrit Rao, Camille Palma, and Lisa Yoshimi pose in their waders with teaching assistant Berry Brosi (holding flow meter) after returning from taking measurements of dissolved oxygen, temperature, pH, velocity, and conductivity in San Francisquito Creek.*

4. *Students from the Ecological Society of America SEEDS (Strategies for Ecology Education, Development, and Sustainability) fieldtrip collect fish traps in the San Francisquito creek with Dr. Alan Launer.*

5. *Local high school science teachers participate in one of a series of workshops sponsored by the Stanford Teacher Education Program (STEP) and JRBP.*

6. *Resident Ranger and local mycologist Brooke Fabricant teaches docents Carol Hake and Betsy Clebsch how to key a specimen.*

7. *Abby Hall and David Martinez inventory what they have caught as part of their Biology 96 terrestrial invertebrate class.*

8. *As part of a field exercise in Earth Systems 189, Alicia Aponte and John Juarez access the upper canopy of a willow stand from the bucket of a lift truck in order to monitor light levels and sample leaves.*

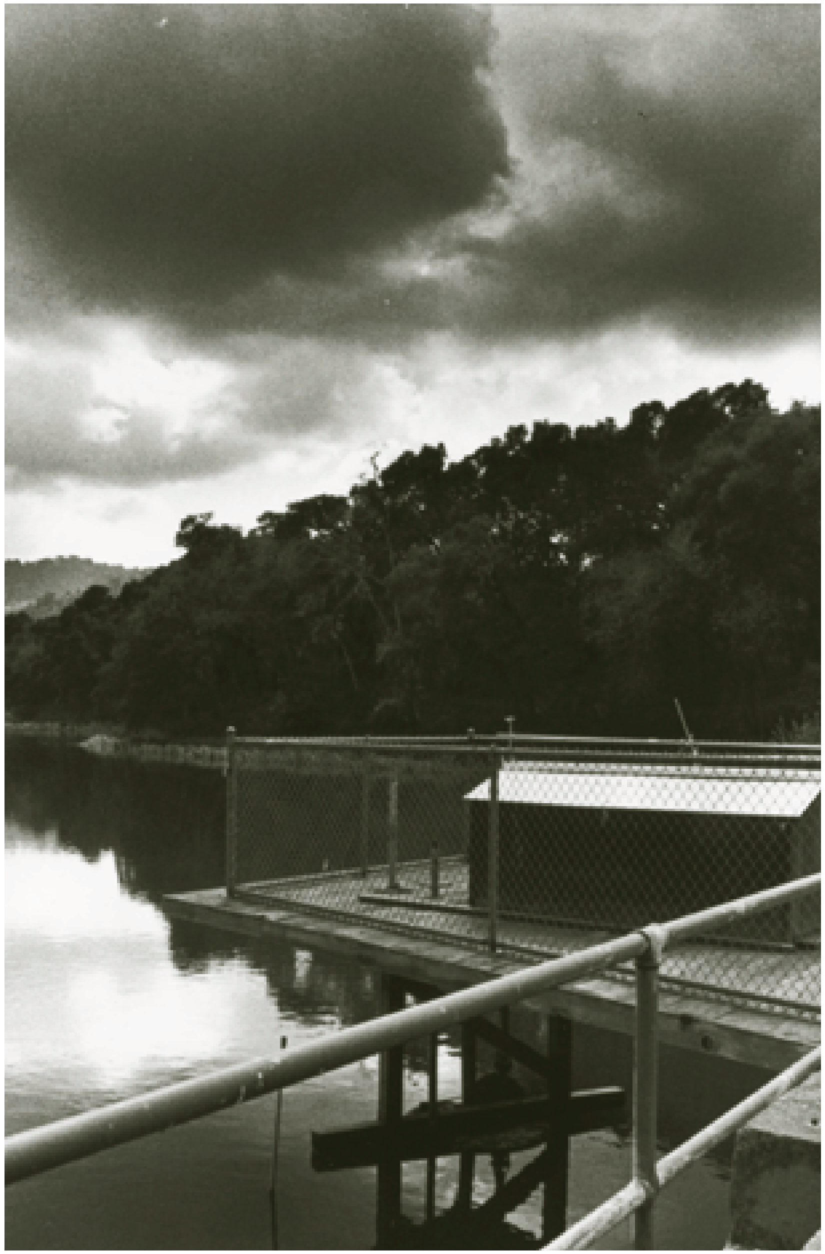
9. *Two Eastside College Preparatory School students carefully examine a field specimen with a hand lens before recording their data.*

10. *Mike Greene, postdoctoral fellow in Dr. Deborah Gordon's lab, explains harvester ant* Pogonomyrmex barbatus *behavior to Jasper Ridge docents during the 2002 Docent Field Trip to the American Museum of Natural History's Southwest Research Station in the Chiricahua Mountains of southeastern Arizona.*

Britt Sandler. In addition to collecting data on air and soil temperatures, relative humidity, and plant growth, the students explored special topics including adaptations (plant and animal), insects, botany, geology, and tracking. Students presented their work to peers and ECP faculty at the end of the quarter.

The ESA Strategies for Ecology Education, Development, and Sustainability (SEEDS) Program began in 1996 as a collaborative effort to work towards increasing the number of minorities in the field of ecology. Student field trips are an important component of the program and aim to foster greater student identification with ecology through direct field experience. In June of 2003, JRBP hosted the SEEDS field trip to Northern California which included two days of field work at Jasper Ridge, a visit to Hopkins Marine Station in Monterey, and other sites in the Bay Area. Attendees included 17 students from ten schools, three SEEDS faculty, three staff members from the Ecological Society of America, and one participant from the All Nations Louis Stokes Alliance for Minority Participation (ANLSAMP). More information about the SEEDS program is available at http://esa.org/seeds/.

In academic year 2002-2003, JRBP collaborated with faculty and staff of the Stanford Teacher Education Program (STEP) and held



quarterly teacher training workshops for local middle and high school teachers. Participants gained experience working with new technology for data collection and curriculum design. Utilizing soil temperature probes and specialized software from Vernier, workshop teachers will collaborate during academic year 2003-2004 in a multi-school soil temperature experiment. Students at collaborating schools will have the opportunity to do hands-on field science at their own campus and will develop valuable skills in quantitative analysis as they compare the results of the various locations. These data, which will represent several microclimates in the Bay Area, including soil temperature data from the Jasper Ridge Global Change Experiment (JRGCE), will be entered into a web-based data set and accessible by all participants. The JRBP/STEP/local schools environmental education model provides an opportunity for thousands of students to engage in meaningful scientific activity each year without excessively increasing human use of the Preserve.

The 2003 docent class (Biology 96) was the first to use the new Jean Lane Environmental classroom for lectures and indoor work. Stanford faculty, JRBP staff, docents, and local experts taught classes on subjects such as valuing ecosystem services, geology, soils, hydrology, botany, tracking, terrestrial invertebrates, and global climate change. The class also spent many wet Thursday afternoons in the field, learning first-hand the intricacies of natural history, ecology, and environmental science at the Preserve. In June, these 19 new docents were officially graduated into the JRBP docent community.

Bio 96 and the Jasper Ridge community exemplify the efforts of instructors and students to provide opportunities for inquiry-based education in ecology and provide a bridge between education (both formal and informal) and the volunteer base of the Preserve.

Looking to the future and the consistent increase in demand for meaningful environmental education, new collaborations at the Preserve are aimed at teacher education and intensive field classes for selected schools. Docent participation is key to the success of these new models. The JRBP/STEP liaison reflects the efforts and expertise of docents Margaret Krebs, Rosa Navarro, Monya Baker, Misty Sato and Bill Gomez. Eastside College Preparatory School's field classes involve a quarter-long mentoring commitment by Stanford docents each year, and docents contribute to the success of Biology 44Y and other classes annually.

Educational opportunities for the JRBP community also continue to increase—many the direct result of docent efforts. Two notable examples of docent-generated education in 2002-03 were the monthly lunch time round-table discussions and the remarkable JR chat list which has provided amazingly broad information to docents via e-mail. Both of these efforts were initially made possible by the generous investment of energy by John Kriewall and Bill Gomez and have been supported enthusiastically by the community.

Malaise insect traps were used to collect insects nightly at the JRBP permanent bat station at Searsville Lake between June and September 2003.

Increasingly, docents have provided valuable contributions to the JRBP research community. In 2002-03 docents contributed to research in many areas including global climate change, ant research, bat research, water quality testing, bird censuses and more. Over a quarter of the docent community participated in these efforts.

The work of docent Tom Mudd was particularly impressive this year. Tom observed enormous and unaccountable variation in bat activity from night to night at the permanent bat station at Searsville Lake and consulted with emeriti professors of statistics, Lincoln Moses (docent) and Bill Brown (JRBP birder). Analysis of the bat data began with the assistance of Stanford graduate student Sam Hui. After consulting with entomologist Paul Arnaud of the California Academy of Sciences and JRBP researcher, Irene Brown, insect abundance was added as a variable.

With the help of docents Patrick Hsieh, Bill Gomez, Dexter Hake, and John Working, high school senior Tim Sun, and Preserve staff, insects were collected nightly using Malaise traps at the bat station between June and September 2003 to investigate the relationship between insect abundance and bat activity. The results of this study, entitled *The Relationship Between Bat Activity, Insect Abundance, and Weather Conditions* were presented at the North American Symposium on Bat Research in October 2003 in Lincoln, Nebraska.

Visitors to the new Sun Field Station are often awed by the energy-saving attributes of this "green" facility and leave having learned substantial lessons about energy conservation and sustainability. Much less obvious, but just as central to the operations of the Preserve, is the energy contributed by the Preserve's phenomenal docent community.

Docent efforts are the hidden energy source that fuels considerable and significant work often without acknowledgment. In 2002-03, this inexhaustible energy source generously supported the Preserve in efforts that ranged from teaching and tours to data collection, physical labor, and a multitude of other tasks.

We thank you.

Appendix 1: Research Projects

Project	Principal Investigator(s)	Department or Division	Institution
Comparative ecology and life history of chaparral shrub species	Ackerly, David	Biological Sciences	Stanford University
Functional diversity of California woody plant communities	Cornwell, Will	Biological Sciences	Stanford University
Stem-allometry and hydraulic conductivity in chaparral plants	Preston, Katherine	Biological Sciences	Stanford University
Community assembly on serpentine chaparral	Rajakaruna, Nishanta	Biological Sciences	Stanford University
Reference surveys for Stanford Foothills Restoration Project	Anderson, Sean; Oliveira, Paulo	Center for Conservation Biology	Stanford University
Annual grassland responses to litter manipulation	Amatangelo, Kathryn	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Biosystematics of *Hilara*, *Medetera*, and parasitoids of Tachinidae	Arnaud, Paul	Entomology	Cal. Academy of Sciences
Carbon burial and preservation in Searsville and other lake environments	Berhe, Asmeret Asefaw	Environ. Sci., Policy & Mgmt.	Univ. of California, Berkeley
Variation in heavy metal tolerance in *Lasthenia californica*	Rajakaruna, Nishanta	Botany	Univ. of British Columbia
Population biology of the butterfly *Euphydryas chalcedona*	Brown, Irene	JRBP	
San Francisquito watershed mapping	Cohen, Brian		GreenInfo Network
Magnesium cycles in California serpentine areas: Edgewood Park and JRBP	Coleman, Robert; Oze, Christopher;	Geological & Environmental Sciences	Stanford University
	Skinner, Catherine	Geology & Geophysics	Yale University
Mammalian herbivores as mediators of community structure and soil fertility	Cushman, Hall	Biology	Sonoma State University
Functional trait comparison among different grass floras	Diaz, Sandra	Instituto Multidisciplinario de Biologia Vegetal	Universidad Nacional de Cordoba, Argentina
Long-term studies of *Euphydryas editha bayensis*	Ehrlich, Paul; Boggs, Carol	Biological Sciences & CCB	Stanford University
Jasper Ridge Global Change Experiment	Field, Christopher;	Global Ecology	Carnegie Instit. of Washington
	Bohannan, Brendan; Mooney, Harold; Vitousek, Peter	Biological Sciences	Stanford University
	Somerville, Shauna	Plant Biology	Carnegie Instit. of Washington
Spectral measurements of biomass and vegetation structure	Asner, Greg	Global Ecology	Carnegie Instit. of Washington
Global change, potential nitrification and denitrification	Barnard, Romain	Biological Sciences	Northern Arizona University
Effects of global change on methane oxidation	Blankinship, Joey	Biological Sciences	Northern Arizona University
Spectral measurement of aboveground vegetation dynamics	Chiariello, Nona	Biological Sciences	Stanford University
Population and species effects on biogeochemistry	Cleland, Elsa	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Responses of grassland productivity to global change	Dukes, Jeff	Global Ecology	Carnegie Instit. of Washington
Plant organic compounds and microbial functional diversity	Henry, Hugh	Biological Sciences	Stanford University
Response of soil bacterial communities to elevated CO_2	Horz, Peter	Biological Sciences	Stanford University
Effects of global change on soil nitrogen cycling	Hungate, Bruce	Biological Sciences	Northern Arizona University
Dynamics of slug populations	Hsu, Grace		Saratoga High School
Responses of soil carbon to global change	Juarez, John	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Phosphorus limitation under global change manipulations	Menge, Duncan	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Belowground effects of multiple global changes	Moore, Lisa	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Belowground dynamics of carbon, nitrogen, and biomass	Shaw, Rebecca	Global Ecology	Carnegie Instit. of Washington
Changes in gene expression in *Geranium dissectum* and *Avena barbata*	Thayer, Sue	Global Ecology	Carnegie Instit. of Washington
Isotopic analysis of respiratory carbon dynamics	Torn, Margaret	Center for Isotope Geochemistry	Lawrence Berkeley Nat'l. Lab.
Videorecording of seasonal changes for remote sensing course development	Fleishman, Erica	Center for Conservation Biology	Stanford University
	Seto, Karen	Ctr. for Environ. Science & Policy	Stanford University
Ground water flow in Searsville Lake sediments and lake-ground water exchange	Freyberg, David; Kim, Dongkyun	Civil & Environmental Engineering	Stanford University

Project	Principal Investigator(s)	Department or Division	Institution
Climate-vegetation relationships in Mediterranean ecosystems	Garcia, Monica	LAWR/Agricultural Sciences	U.C. Davis/Pol. Univ Madrid (Spain)
Calochortus phylogeography	Givnish, Thomas	Botany	Univ. of Wisconsin-Madison
Argentine ant (*Linepithema humile*) invasion and the response of native ants	Gordon, Deborah	Biological Sciences	Stanford University
Effects of tending by Argentine ants on Homoptera abundance	Fleming-Davies, Arietta	Biological Sciences	Stanford University
Chemical ecology of the Argentine ant	Greene, Michael	Biological Sciences	Stanford University
Population dynamics of the Argentine ant in JRBP	Heller, Nicole	Biological Sciences	Stanford University
Gene flow and sex-biased dispersal in Argentine ant invasions	Ingram, Krista	Biological Sciences	Stanford University
Mammals of JRBP	Hadly, Elizabeth	Biological Sciences	Stanford University
Applied paleoethnoecology of the San Francisco Bay peninsula	Hammett, Julia	Social Science	Truckee Meadows Comm. Coll.
Monitoring of water flow and quality	Hecht, Barry; Owens, Jonathan		Balance Hydrologics, Inc.
Simulation of hydrologic response and sediment transport after dam removal	Heppner, Christopher	Geological & Environmental Sciences	Stanford University
Effects of rainfall variability and gopher removal on serpentine grassland	Hobbs, Richard	Environmental Science	Murdoch University, Australia
GPS mapping for the San Francisquito Archaeological Research Project GIS	Jones, Laura	Campus Archaeology	Stanford University
Earthquake prediction from precursory electromagnetic anomalies	McPhee, Darcy; Klemperer, Simon	Geophysics	Stanford University
Natural barriers to Argentine ant invasion: the role of transitional environments	Kark, Salit; Heller, Nicole; Young, Rebecca	Biological Sciences JRBP	Stanford University Stanford University
Regional surveys of annual acorn production	Koenig, Walter	Hastings Natural History Reserv.	Univ. of California, Berkeley
Carbon cycling in shrub and grassland landscapes invaded by exotics	Koteen, Laurie	Energy and Resources Group	Univ. of California, Berkeley
Broad band seismic monitoring	Kovach, Robert	Geophysics Berkeley Digital Seismic Network	Stanford University Univ. of California, Berkeley U.S. Geological Survey
Survey of San Francisquito Creek and removal of exotics	Launer, Alan	Center for Conservation Biology	Stanford University
Terrestrial plant stoichiometry	Matzek, Virginia	Biological Sciences	Stanford University
Long-term monitoring of ecosystem processes by eddy flux	Merchant, George; Field, Christopher Kaduk, Joerg	Global Ecology	Carnegie Instit. of Washington University of Leicester
Photochemical changes in natural organics in Searsville Lake water	Mill, Theodore	Atmos. Chem. & Space Physics	SRI International
Stability of chromium(III) in the soil environment	Oze, Christopher	Geological & Environmental Sciences	Stanford University
Mapping of invasive plants along Santa Clara County creeks	Peritz, Jennifer		Santa Clara Valley Audubon Soc.
The role of herbivores in structuring plant community composition	Peters, Halton	Biological Sciences & Global Ecology	Stanford Univ. & Carnegie Inst.
Evolutionary dynamics of flower color polymorphism in *Linanthus parviflorus*	Schemske, Douglas	Plant Biology	Michigan State University
Assessment of *Brachypodium distachyon* for studies of cereal genomics	Somerville, Christopher	Plant Biology	Carnegie Instit. of Washington
Fire history of JRBP and the region	Stephens, Scott Cohen, Philippe	Envir. Science, Policy, & Mgmt. JRBP	Univ. of California, Berkeley Stanford University
Passive cumulative monitoring of nitrogenous atmospheric pollutants and ozone	Weiss, Stuart Luth, David		
Long-term acoustical monitoring of bat activity	Mudd, Thomas	JRBP	
Biodiversity and grassland invasions	Zavaleta, Erika; Hulvey, Kris	Integrative Biology	Univ. of California, Berkeley

Ackerly, D.D. (2003) Community assembly, niche conservatism and adaptive evolution in changing environments. International Journal of Plant Sciences 164: S165-S184.

Ackerly, D.D. Functional strategies of chaparral shrubs in relation to seasonal water deficit and disturbance. Ecological Monographs (in press).

Ackerly, D.D., Knight, C.A., Weiss, S.B., Barton, K., and Starmer, K.P. (2002) Leaf size, specific leaf area and microhabitat distribution of woody plants in a California chaparral: contrasting patterns in species level and community level analyses. Oecologia 130: 440-457.

Dukes, J.S. (2002) Comparison of the effect of elevated CO_2 on an invasive species (*Centaurea solstitialis*) in monoculture and community settings. Plant Ecology 160: 225-234.

Dukes, J.S. (2002) Species composition and diversity affect grassland susceptibility and response to invasion. Ecological Applications 12: 602-617.

Dukes, J.S. and Hungate, B.A. (2002) Elevated CO_2 and litter decomposition in California annual grasslands: which mechanisms matter? Ecosystems 5: 171-183.

Dukes, J.S. and Mooney, H.A. Biological invaders disrupt ecosystem processes in western North America. Revista Chilena de Historia Natural (in press)

Evelyn, Michelle Jean (2002) Ecological consequences of forest fragmentation: Bats and birds in human-dominated landscapes. Ph.D. Dissertation, Department of Biological Sciences, Stanford University.

Evelyn, M., Stiles, D. and Young, R. Conservation of bats in urban landscapes: roost selection by *Myotis yumanensis* in a residential area in California. Biological Conservation (in press).

Gee, L., Neuhauser, D., Dreger, D., Pasyanos, M., Uhrhammer, R., and Romanowicz, B. The Rapid Earthquake Data Integration Project. In: W. Lee (ed) Handbook of Earthquake and Engineering Seismology, IASPEI (in press).

Higgins, P.A.T., Jackson, R.B., desRosier, J.M., and Field, C.B. (2002) Root production and demography in a California annual grassland under elevated atmospheric carbon dioxide. Global Change Biology 8: 841-850.

Ingram, K.K. and Gordon, D.M. Genetic analysis of dispersal dynamics in an invading population of Argentine ants, *Linepithema humile*. Ecology (in press).

Jackson, R.B., Linder, C.R., Lynch, M., Purugganan, M., Somerville, S. and Thayer, S. (2002) Linking molecular insight and ecological research. Trends in Ecology and Evolution 17: 409-414.

Karakelian, Darcy (2002) Ultra-low frequency electromagnetic signals associated with earthquakes and fault creep in California. Ph.D. Dissertation, Department of Geophysics, Stanford University.

Kerr, Amber C. (2002) Soil nitrogen dynamics under simulated global changes in a California annual grassland. M.S. Thesis, Earth Systems Program, Stanford University.

Knight, Charles Alexander (2002) The evolutionary and ecological physiology of plant thermal tolerance. Ph.D. Dissertation, Department of Biological Sciences, Stanford University.

Knight, C.A. and Ackerly, D.D. (2002) An ecological and evolutionary analysis of photosynthetic thermotolerance using the temperature dependent increase in steady-state fluorescence. Oecologia 130: 505-514.

Koenig, W. D., Kelly, D., Sork, V.L., Duncan, R.P., Elkinton, J.S, Peltonen, M.S., and Westfall, R.D. (2003) Dissecting components of population-level variation in seed production and the evolution of masting behavior. Oikos: 581-591.

Lund, Christopher (2002) Ecosystem carbon and water budgets under elevated atmospheric carbon dioxide concentration in two California grasslands. Ph.D. Dissertation, Department of Biological Sciences, Stanford University.

McLaughlin, J.F., Hellmann, J.J., Boggs, C.L., and Ehrlich, P.R. (2002) Climate change hastens population extinctions. Proceedings of the National Academy of Sciences 99: 6070-6074.

McLaughlin, J.F., Hellmann, J.J., Boggs, C.L., and Ehrlich, P.R. (2002) The route to extinction: population dynamics of a threatened butterfly. Oecologia 132: 538-548.

Oze, Christopher (2003) Chromium geochemistry of serpentinites and serpentine soils. Ph.D. Dissertation, Department of Geological and Environmental Sciences, Stanford University.

Oze, C., Fendorf, S., Bird, D., and Coleman, R. Chromium geochemistry of serpentinized ultramafic rocks and serpentine soils from the Franciscan complex of California. American Journal of Science (in press).

Porter, S., Palhegyi, G., Haltiner, J., and Hecht, B. (2003) Developing an assessment method to address impacts from urbanization on stream channel stability. Proceedings of the American Water Resources Association Annual Conference.

Preston, K.A. and Ackerly, D.D. Hydraulic architecture and the evolution of shoot allometry in contrasting climates. American Journal of Botany (in press).

Rajakaruna, Nishanta (2002) Evolution and differentiation of edaphic races in the *Lasthenia californica* complex (Asteraceae:Heliantheae). Ph.D. Dissertation, Department of Botany, University of British Columbia.

Rajakaruna, N. (2003) Edaphic differentiation in *Lasthenia*: A model for studies in evolutionary ecology. Madroño 50: 34-40.

Rajakaruna, N., Baldwin, B.G., Chan, R., Desrochers, A.M., Bohm, B.A., and Whitton, J. (2003) Edaphic races and phylogenetic taxa in the *Lasthenia californica* complex (Asteraceae: Heliantheae): an hypothesis of parallel evolution. Molecular Ecology 12: 1675-1679.

Rajakaruna, N., Bradfield, G.E., Bohm, B.A., and Whitton, J. (2003) Adaptive differentiation in response to water stress by edaphic races of *Lasthenia californica* (Asteraceae). International Journal of Plant Sciences 164: 371-376.

Rajakaruna,N., Siddiqi, M.Y., Whitton,J., Bohm, B.A., and Glass, A.D.M. (2003) Differential responses to Na^+/K^+ and Ca^{2+}/Mg^{2+} in two edaphic races of the *Lasthenia californica* (Asteraceae) complex: A case for parallel evolution of physiological traits. New Phytologist 15: 93-

Rillig, M.C., Wright, S.F., Shaw, M.R., and Field, C.B. (2002) Artificial ecosystem warming positively affects arbuscular mycorrhizae but decreases soil aggregation. Oikos 97: 52-58.

Sanders, N.J., Gotelli, N.J., Heller, N.E., and Gordon, D.M. (2003) Community disassembly by an invasive species. Proceedings of the National Academy of Sciences 100: 2474-2477.

Shaw, M.R., Zavaleta, E.S., Chiariello, N.R., Cleland, E.E., Mooney, H.A., and Field, C.B. (2002) Grassland responses to global environmental changes suppressed by elevated CO_2. Science 298: 1987-1990.

Tajima, F., Megnin, C., Dreger, D., and Romanowicz, B. (2002) Feasibility of real-time broadband waveform inversion for simultaneous moment tensor and centroid location determination. Bulletin of the Seismological Society of America 92: 739-750.

Thomas, Brian D. (2002) Legumes and nitrogen fixation in an annual grassland: responses to herbivory and climate change. Ph.D. Dissertation, Department of Biological Sciences, Stanford University.

Zavaleta, E.S, Shaw, M.R., Chiariello, N.R., Mooney, H.A., and Field, C.B. (2003) Additive effects of simulated climate changes, elevated CO_2, and nitrogen deposition on grassland diversity. Proceedings of the National Academy of Sciences 100: 7650-7654.

Zavaleta, E.S, Shaw, M.R., Chiariello, N.R., Thomas, B.D., Cleland, E.E., Field, C.B., and Mooney, H.A. Responses of a California grassland community to three years of experimental climate change, elevated CO_2 and N deposition. Ecological Monographs (in press).

Zavaleta, E.S., Thomas, B.D., Chiariello, N.R., Asner, G.P. and Field, C. B. (2003) Plants reverse warming effect on ecosystem water balance. Proceedings of the National Academy of Sciences 100: 9892-9893.

Stanford University Classes (2,622)

Anth Sci 3	Introduction to Prehistoric Archaeological Sites (Rick)
Anth Sci 149	Archaeological Field Methods (Bandy)
Arch 19	Historical Archaeological Field Methods, Continuing Studies (Jones, Bandy)
Art Hist 150A	American Architecture and Urbanism (Littman)
Bio 13	Wildflower Families of the Bay Area, Continuing Studies (Corelli)
Bio 35	Trees and Shrubs of the San Francisco Bay Region, Continuing Studies (Corelli)
Bio 44Y	Core Experimental Lab (Malladi, Yelton)
Bio 96A/B	JRBP Docent Training Program (Vitousek)
Bio 117	Biology and Global Change (Matson, Vitousek, Mooney)
BIO 120	General Botany (Preston)
Bio 223	Plant Taxonomy (Preston, Cornwell, Ray)
CEE 31Q	Accessing Architecture Through Drawing (Walters)
CEE 61Q	Big Dams, City Hall, and the Sierra Club (Kitanidis)
CEE 166D	Water Resources (Freyberg)
CEE 176A	Energy Efficient Buildings (Masters)
CTL 60	Investigating Stanford's Treasures (Moser)
Esys 10	Introduction to Earth Systems (Ernst)
Esys 189	Field Studies in Earth Systems (Chiariello, Fendorf, Ackerly, Matson, Miller)
GES 175	Science of Soils (Fendorf)
Phi 133	Major Figures in 20th-Century Philosophy (Føllesdal)
Urb 172	Green Architecture (Jacobson)
Urb 181	Environmentally Sustainable Cities (Cushing)
-	Quest Scholars Program (Ackerly)
-	History of Stanford Architecture (Kwan)

Non-Stanford University Classes (148)

Bio 13	Santa Clara University, Investigations in Ecology & Evolution (Edgerly-Rooks)
Bio 103	Cañada College, Native Plants and Wildflowers (Steiner)
CE 140	Santa Clara Univ., Water Resources Engineering (Perry)
720958X	De Anza College, Natural History of the Bay Area (West-Bourke)
ES 79	De Anza College, Renewable and Alternative Energy Systems (Gould)
-	Ecological Society of America, Strategies for Ecology Education, Development, and Sustainability

Stanford Organizations (1,299)

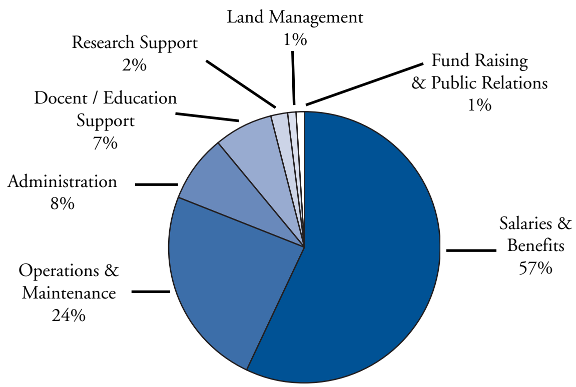
Association of Chinese Students and Scholars at Stanford
Bechtel International Center
Beeline Group
Center for Comparative Studies in Race and Ethnicity
Center for Advanced Study in the Behavioral Sciences
Cantor Center for Visual Arts
Department of Biological Sciences
Department of Civil and Environmental Engineering
Department of Physics
Digital Vision Fellowship Program
Escondido Village
Faculty Women's Club
Graduate School of Business
Hopkins Marine Station
Information Technology Systems and Services
Master of Liberal Arts Alumni
Medical School Alums
Office of Technology Licensing
Quillen Dorm
Robinson Dorm
School of Engineering
School of Medicine
Stanford Alumni Club of Los Gatos / Saratoga
Stanford Environmental Law Society
Stanford Libraries Staff Association
Stanford Management Company
Stanford Teacher Education Program
Stanford University Board of Trustees
Stanford University Emeriti Board of Trustees
Synergy House
Toyon Dorm
Undergraduate Advising Center

Other Organizations (2,848)

The American Society of Landscape Architects
Ano Nuevo State Reserve
Anshen + Allen
California Garden and Landscape History Society
California Native Plant Society
Canopy
Carnegie Institution of Washington
Chartwell School
Crystal Springs School
Eastside College Preparatory School
Edgewood County Park and Natural Preserve
Environmental Defense
Environmental Volunteers
Filoli Docents & Horticulturists
Fitzgerald Marine Reserve
The Forum
Foundation for Global Community
Gamble Garden
Golden Gate Biosphere Reserve
Gunn High School
Hillsdale High School
Menlo School
Menopausal Men's Marching Group
Muwekma Tribe
Palo Alto Fire Department
The Peninsula School
Portola Valley Ranch
Rob Wellington Quigley Architectural Firm
Rocky Mountain Biological Laboratory
San Mateo County Parks and Recreation
San Mateo County RecycleWorks
Santa Clara Valley Audubon Society
Sequoia Audubon
Sierra Club New York
Swedish Women's Educational Association
Town of Portola Valley
Union of Concerned Scientists
University Corporation for Atmospheric Research
US Green Building Council
Wild Bird Center of San Carlos
Woodside-Atherton Garden Club
Woodside High School
Young Presidents' Organization

Appendix 4: Financial Summary: 2002-03 Fiscal Year

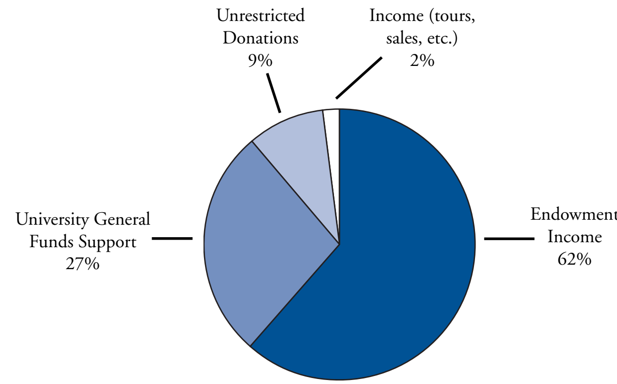
Expense Summary - $730,350



Salaries & Benefits	414,325
Operations & Maintenance	177,601
Administration	59,383
Docent / Education Support	52,739
Research Support	14,017
Land Management	6,412
Fund Raising & Public Relations	5,873

Expenses exceeded revenue due to several one-time costs associated with the move into the Leslie Shao-ming Sun Field Station: These expenses totaled $76,580 and included installation of a cistern, additional casework and countertops, classroom furnishings and projectors, shelving, and lockers. The base operating budget without one-time expenses associated with the move into the Sun Field Station came to $677,183. This is about $4,000 less than the last fiscal year.

Revenue Summary - $708,361



Endowment Income	435,654
University General Funds Support	194,000
Unrestricted Donations	64,909
Income (tours, sales, etc.)	13,798

Unrestricted donations included pledges of $10,000 associated with the capital campaign for the Leslie Shao-ming Sun Field Station. The shortfall between expenses and revenue is partly a result of a reduction in endowment payout and was covered by unrestricted donor accounts.

Unrestricted Gifts, September 1, 2002 –August 31, 2003

Amber Foundation
Anonymous
Paul H. & Madeline L. Arnaud, Jr.
Richard K. Arnold
Leonie Batkin
Nancy & Dr. Clayton Bavor
Kathleen Bennett & Thomas J. Malloy
Monika Björkman
Irene Brown
Robert R. Buell
James Caldwell
Dudley B. & Curtis R. Carlson
Jack Chin
William H. Clark
Mary H. & Robert Dodge
Carol A. & Luis E. Ebner
Karin A. Ecklemeyer
Nancy H. & David W. Ferguson
Edward M. Fryer
Sara A. Fultz
Stephen J. Galli, M.D.
Lindy G. Gardiner
Margaret E. Green
Evelyn D. & Walter Haas, Jr. Fund
Carol & Dexter Hake
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Earl F. & Patricia Cashel Schmidt, Jr.
Albert & Joel Wells Schreck
Shack Riders
Rolf G. Spamer, DDS
Peter D. Stent
Anthony Sun
The Rev. Marylou McClure Taylor
Ruth & Eugene W. Troetschler
Anne E. Warren
Richard J. & Louise Wiesner
Eleanor J. Wood
Woodside-Atherton Garden Club
John Working
Sunia I. Yang
Richard I. Yankwich & M. Megan McCaslin
William H. & Annette J. Young

David Ackerly
Molly Aeck
Kathryn Amatangelo
Sean Anderson
Chris Andrews
Michael Anthony
Paul Arnaud
Ron Arps
Greg Asner
Marianne Austin
Monya Baker
Matthew Bandy
Marisha Banister
Mary Baron
Nancy Bavor
Kathleen Bennett
Asmeret Asefaw Berhe
Joseph Berry
Radika Bhaskar
Monika Björkman
Kindel Blau-Launer
Carol Boggs
Brendan Bohannan
Sharon Brauman
Kathleen Brizgys
Bill Brown
Irene Brown
Bob Buell
Gene Bulf
Ruth Buneman
Al Butner
Kim Carlson
Nicholas Casey
Sally Casey
Ted Chandik
Zoe Chandik
Andrew Chang
Audrey Chang
Aleksendr Chebanov
Carl Cheney
Nona Chiariello
Alvin Chin
Jack Chin
Jean Clark
William Clark
Betsy Clebsch
Elsa Cleland
Brian Cohen
Philippe Cohen
Robert Coleman
Heather Cooley
Toni Corelli
Will Cornwell
Stella Cousins
Jenny Creelman
Rig Currie
Hall Cushman
Gretchen Daily
Yvonne Daley
Marge De Staebler
Fran Delagi
Kenneth Dixon
Bob Dodge
Janet Doell
Ted Dolton
Kim Dongkyun
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Michael Eckert
Janice Edgerly-Rooks
Edwin Ehmke
Paul Ehrlich
Lisa Ehrlich
Linda Elkind
Claire Elliot
Gary Ernst
Irene Estelle
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Brooke Fabricant
Natasha Fabricant
Ron Fark
John Fay
Scott Fendorf
Christopher Field
Susan Finlayson
Forrest Fleischman
Erica Fleishman
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Tony Fraser-Smith
David Freyberg
Chris Friedel
Zoë Friedman-Cohen
Edward Fryer
Dania Gamble
Monica Garcia
Jihan Gearon
Susan Gere
Thomas Givnish
John Glathe
Bill Gomez
Deborah Gordon
Carol Graham
Leda Beth Gray
Margaret Green
Michael Greene
Alan Grundmann
Jessica Guh
Elizabeth Hadly
Carol Hake
Dexter Hake
Abby Hall
Becca Hall
Brad Hall
Tim Hall
Julia Hammett
Stephen Hass
Chip Haven
Barry Hecht
Nicole Heller
Hugh Henry
Christopher Heppner
Richard Hobbs
Justin Holl
Gordon Holtgrieve
Leo Holub
Whitney Hopkins
Hans-Peter Horz
Shelley Hou
Patrick Hsieh
Grace Hsu
Mary Hufty
Lia Hull
Kris Hulvey
Bruce Hungate
Krista Ingram
Peter Jacke
Debi Jamison
Richard Jeffers
Gerry Jennings
Eliza Jewett
Laura Jones
John Juarez
Tamara Juarez
Joerg Kaduk
Salit Kark
Marcia Keimer
Donald Kennedy
Bill Kirsher
Gary Kittleson
Simon Klemperer
Charles Knight
Walter Koenig
Diana Koin
Laurie Koteen
Robert Kovach
Margaret Krebs
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Ann Lambrecht
Jean Lane
Aranzazu Lascurain
Peter LaTourrette
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Tom Lindsay
Scott Loarie
Flora Lu
Chris Lund
Nancy Lund
David Luth
JJ Markman
Christine Martens
David Martinez
Judy Mason
Don Mason
Pamela Matson
Virginia Matzek
Margaret Mayfield
Laura McLendon
Ann McMillan
Darcy McPhee
Laura McVittie
Ethel Meece
Duncan Menge
George Merchant
Tom Merigan
Deanna Messinger
Ted Mill
Elizabeth Miller
Lawrence Miller
Linda Bea Miller
Michael Milne
Michele Minihane
Harold Mooney
Lisa Moore
Betsy Morgenthaler
Lincoln Moses
Tom Mudd
Muwekma Tribe
Karen Nagy
Rosa Navarro
John-O Niles
Paulo Oliveira
Pamela Olson
Tamsin Orion
Jonathan Owens
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Anna Paret
George Parks
Jennifer Peritz
Ross Perlin
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In Memoriam

Konrad B. Krauskopf, a pioneer in the field of geochemistry, a member of the Stanford University faculty since 1939 and a Jasper Ridge geology instructor, died at his campus home on May 4, 2003 at age 92. Krauskopf was one of very few scientists in the late 1930s who helped define the emerging field of geochemistry, which combined the concepts of physical chemistry with those of geology. Krauskopf "provided scientists with the original defining texts in geochemistry and physical geology," according to Gary Ernst, Jasper Ridge instructor and Stanford Professor of Earth Sciences. In a career spanning more than six decades, Krauskopf led numerous geological and mapping expeditions to such places as the Pacific Northwest, the Sierra Nevada and White Inyo Ranges, the Transmexican Volcanic Belt, and coastal Norway. His pioneering research and academic achievements earned him numerous honors, including the Legendary Geoscientist Award from the American Geological Institute in 2000 and the Distinguished Public Service Medal from the Mineralogical Society of America in 1994. He was a member of the National Academy of Sciences and the American Philosophical Society.