University of California

Natural Reserve System

2010 MATHIAS SYMPOSIUM

Bodega Marine Laboratory/Reserve

February 26-28, 2010

This symposium is supported by the Kenneth S. Norris Endowment Fund for the California Environment provided to the Natural Reserve System by the David and Lucile Packard Foundation

Welcome

Participating Bodega Marine Laboratory (BML) Reserve Staff

Suzanne Olyarnik (PhD UC Davis)
Reserve Manager

Jackie Sones (BA University of New Hampshire)
Reserve Coordinator

Michelle Cooper (MA Sonoma State University)
Reserve Steward

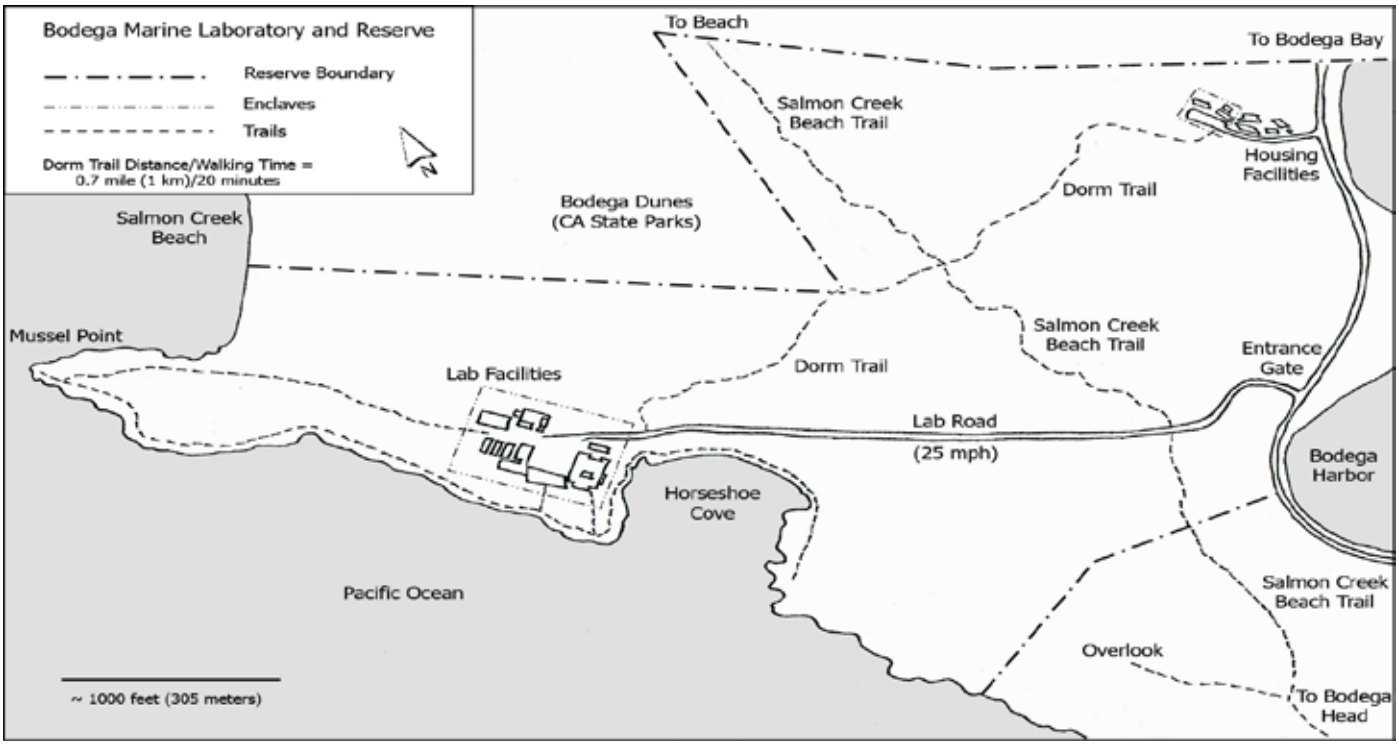
Accommodations, Meals, and Socials

Dorms

It may be convenient for participants to move their belongings into the dorms before nightfall.

Locations where Meals and Events Will Be Hosted

Breakfast will be in the dormitory dining hall.
Lunch, dinner, and socials will be in the BML lounge.
Lectures will be in the BML lecture hall.



2010

Lecturers

Elsa Cleland
Assistant Professor of Ecology, Behavior, and Evolution, UC San Diego
PhD Stanford University

Global environmental changes, such as nitrogen deposition, elevated atmospheric carbon dioxide and shifting precipitation, are altering the availability of basic resources plants need for growth. These changes, along with other factors such as invasive species and disturbance, may be shifting the species composition of ecosystems.

It isn't yet clear why some species increase in abundance, and others decrease, in response to environmental changes. My lab focus is at this dynamic intersection of plant community ecology and ecosystem ecology. Our research seeks to ask fundamental questions about ecosystem structure and function, while contributing to a greater understanding of pressing environmental problems.

Paul Fine
Assistant Professor of Integrative Biology, UC Berkeley
PhD University of Utah

My research investigates the origin and maintenance of Amazonian rain forest tree diversity. I am especially interested in the role that biotic interactions and environmental heterogeneity play in the morphological, functional, and genetic diversity of tropical trees, and how these factors influence the distribution and speciation of plants. An ideal study system is the endemic flora found on the many white-sand forests that are widely dispersed in patches throughout the Amazon basin.

These ancient white-sand deposits constitute habitat islands, surrounded by other terra-firme forests on more fertile soils that harbor edaphic-specialist tree species that are often closely related to their congeners on neighboring soil types. The main thrust of my research is to understand the evolution and maintenance of edaphic specialization by trees to these divergent soil types, and the role of herbivores in this process.

2010 Mathias Symposium

Bodega Marine Laboratory/Reserve
February 26-28, 2010

Friday, February 26, 2010

12:00 - 1:20 p.m	Lunch (Food service 12:00- 12:45 p.m.)
1:30 - 2:15 p.m.	Peggy Fiedler, Director, UC Natural Reserve System - **Opening remarks** Suzanne Olyarnik, Manager, Bodega Marine Reserve - **Introduction to Bodega Marine Laboratory and Reserve**
2:15 - 2:40 p.m.	**Raiding behavior in an obligate slave-making ant** Joe Sapp, Department of Ecology and Evolutionary Biology University of California, Santa Cruz
2:40 - 3:05 p.m.	**Seed preferences of the harvester ant *Pogonomyrmex rugosus* in coastal sage scrub** Christopher Briggs, Department of Entomology University of California, Riverside
3:05 - 3:25 p.m.	Break
3:25 - 3:50 p.m.	**Exploring the causes of natural clearings around Jeffrey pine trees that reduce fire severity in the Eastern Sierra** Sarah Dalrymple, Population Biology Graduate Group University of California, Davis
3:50 - 4:15 p.m.	**Effects of amphibian declines and extinctions on community interactions and stability in alpine lakes in the Sierra Nevada** Thomas C. Smith, Department of Ecology, Evolution, and Marine Biology University of California, Santa Barbara
4:15 - 4:30 p.m.	Break
4:30 - 6:00 p.m.	**Tour of the laboratory** Suzanne Olyarnik and Jackie Sones
6:15 - 7:30 p.m.	Dinner (Food service 6:15 - 7:00 p.m.)
7:45 - 8:45 p.m.	**LECTURE: *Habitat specialization, herbivores, and the diversity of Amazonian trees*** Paul Fine, Assistant Professor of Integrative Biology, UC Berkeley
8:45 - 9:45 p.m.	Social

2010 Mathias Symposium

Bodega Marine Laboratory/Reserve
February 26-28, 2010

Saturday, February 27, 2010

7:30 - 8:30 a.m.	Breakfast (Food Service 7:30 - 8:15 a.m.)
9:00 - 9:25 a.m.	**Mass-dependent survival and dispersal in the California tiger salamander** Christopher Searcy, Department of Evolution and Ecology University of California, Davis
9:25 - 9:50 a.m.	**Can parasites enhance components of host fitness? Host manipulation of a sexual signal in the California fiddler crab, *Uca crenulata*** Adrienne B. Mora, Department of Evolution, Ecology, and Organismal Biology University of California, Riverside
9:50 - 10:15 a.m.	**Demographics and eradication of a new invasive population of *Batillaria attramentaria* in Bodega Harbor, California** Weiskel, H.W.,[1] Byers, J.E.,[2] Huspeni, T.C.,[3] Zabin, C.J.,[4] Bowles, C.M.,[1] Brown, C.,[4] and E.D. Grosholz.[1] [1] University of California, Davis [2] University of Georgia [3] University of Wisconsin, Stevens Point [4] Smithsonian Environmental Research Center
10:15 - 10:35 a.m.	Break
10:35 - 11:00 a.m.	**Rhizosphere bacterial and archaeal biogeography in a California annual grassland** Erin E. Nuccio, Department of Plant and Microbial Biology University of California, Berkeley
11:00 - 11:25 a.m.	**Below-ground interactions between annual seeds and fungal pathogens** Erin Mordecai, Department of Ecology, Evolution, and Marine Biology University of California, Santa Barbara
11:25 - 11:50 a.m.	**Islands of invasion: Dominance of exotic species near living and dead oak trees (*Quercus* spp.) in California grasslands** Karen A. Stahlheber, Department of Ecology, Evolution, and Marine Biology University of California, Santa Barbara
12:00 - 1:30 p.m.	Lunch (Food service 12:00 - 12:45 p.m.)
1:30 - 3:30 p.m.	**Tour of the reserve** Suzanne Olyarnik and Jackie Sones

2010 Mathias Symposium

Bodega Marine Laboratory/Reserve
February 26-28, 2010

Saturday, February 27, 2010

3:45 - 4:10 p.m.	**Recruitment drivers in a California endemic oak, *Quercus lobata*** Blair McLaughlin, Department of Environmental Studies University of California, Santa Cruz
4:10 - 4:35 p.m.	**Range limits, climate change, and adaptive potential: Geographic variation in thermal tolerance in the copepod *Tigriopus californicus*** Morgan W. Kelly, Population Biology Graduate Group University of California, Davis
4:35 - 5:00 p.m.	**Effects of global change on high elevation populations of *Bromus tectorum* in the eastern Sierra Nevada, California** Amy Concilio, Department of Environmental Studies University of California, Santa Cruz
5:00 - 5:25 p.m.	**Native vs. non-native grassland species: Who will win under future global change scenarios?** Nicole Molinari, Department of Ecology, Evolution, and Marine Biology University of California, Santa Barbara
6:15 - 7:30 p.m.	Dinner (Food service 6:15 - 7:00 p.m.)
7:45 - 8:45 p.m.	**LECTURE: *California grassland community and ecosystem responses to environmental change*** Elsa Cleland, Assistant Professor of Ecology, Behavior, and Evolution UC San Diego
8:45 - 9:45 p.m.	**Social**

2010 Mathias Symposium

Bodega Marine Laboratory/Reserve
February 26-28, 2010

Sunday, February 28, 2010

7:30 - 8:30 a.m.	Breakfast (Food service 7:30 - 8:15 a.m.)
9:00 - 9:25 a.m	**Spatial variation in prehistoric settlement strategies on Santa Cruz Island** H. B. Thakar, Department of Anthropology University of California, Santa Barbara
9:25 - 9:50 a.m.	**The intra- and interspecific impact of evolutionary-feedback in the wild: An experimental assessment** Martin M. Turcotte, Department of Evolution, Ecology, and Organismal Biology University of California, Riverside
9:50 - 10:15 a.m	**Examination of a highly variable plumage trait in the sexually dichromatic American kestrel (*Falco sparverius*)** Elizabeth A. Wommack Department of Integrative Biology and the Museum of Vertebrate Zoology University of California, Berkeley
10:15 - 10:35 a.m	Break
10:35 - 11:00 a.m	**Effects of nitrogen enrichment on the functioning of microbial communities in California salt marshes** Irina C. Irvine, Department of Ecology and Evolutionary Biology University of California, Irvine
11:00 - 11:25 a.m.	**Investigating tree mortality at multiple spatial and temporal scales in the Bishop pine forest on Santa Cruz Island, California** Sara Baguskas, Department of Geography University of California, Santa Barbara
11:25 - 11:50 a.m.	**Non-chemical restoration techniques in California sage scrub: Testing variations of agricultural solarization adapted for use in wildlands** Kristin A. Weathers, Department of Botany and Plant Sciences University of California, Riverside
12:00 - 1:30 p.m	Lunch (Food service 12:00 - 12:45 p.m.)

Abstracts

FRIDAY AFTERNOON SESSION

Raiding behavior in an obligate slave-making ant
Joe Sapp, Department of Ecology and Evolutionary Biology
University of California, Santa Cruz

Social parasites are a powerful system to study many aspects of host-parasite interactions. The socially parasitic "slave-making" ant *Polyergus breviceps* raids neighboring nests to capture brood (larvae and pupae) from several species of ant in the genus *Formica*. These stolen brood are reared to adulthood by existing *Formica* "slaves" and become workers for the *P. breviceps* nest, which they mistake as their own due to chemical imprinting. My research focuses on two aspects of the raiding behavior of *P. breviceps*. First, I investigate how colonies allocate resources to raids and how these allocations affect raid success. By videotaping raid columns, I can estimate raid efficiency, resource allocation, and raid success among several neighboring nests. Second, I am interested in the factors that mediate competition among slave-maker nests. Though *P. breviceps* is described as highly aggressive towards conspecifics elsewhere, preliminary data suggests a more complicated picture: Conspecific raids do occur, usually with the ultimate destruction of the raided colony. However, raid ranges appear to overlap extensively among *P. breviceps* nests and occasionally raids from different nests cross each other with no visible interaction between raiders. I suspect that relatedness and host preference both play a role in the observed spatial pattern of raids and the range of interactions observed among neighboring *P. breviceps* nests.

Seed preferences of the harvester ant *Pogonomyrmex rugosus* in coastal sage scrub
Christopher Briggs, Department of Entomology
University of California, Riverside

The coastal sage scrub vegetation type (CSS) is an excellent setting for investigating harvester ant interactions with exotic plant seeds; harvester ants are abundant in CSS, and CSS is frequently invaded by several exotic plant species. Exotic plants in CSS change fire frequency, soil hydrology, and other ecosystem properties, potentially harming several endangered species found there. Harvester ants can be the dominant seed predators on plants by collecting and eating seeds, and they are known to influence plant communities. This study focuses on the harvester ant *Pogonomyrmex rugosus* to determine what seeds *P. rugosus* foragers collect in CSS, and whether *P. rugosus* foragers exhibit preferences for particular plant species. Observations show that *P. rugosus* carried seeds of exotic *Erodium cicutarium* and *Brassica tournefortii* on 11% and 46% (respectively) of return trips to the nest, and only a very few carried native seeds such as *Encelia farinosa*. When compared to the proportions of seed species found in the field, *P. rugosus* showed preference against *E. farinosa* and *B. tournefortii*, and preference for *E. cicutarium*. Cafeteria-style experiments confirmed these preferences and also showed that native *Eriogonum fasciculatum* seeds were preferred even less than *E. farinosa* and *B. tournefortii*. Thus, *P. rugosus* in CSS has frequent interactions with exotic *E. cicutarium* and *B. tournefortii*, involving the movement and likely destruction of large numbers of seeds. Future studies may be able to determine whether seed collection by *P. rugosus* constitutes a significant predation pressure on *E. cicutarium* and *B. tournefortii* populations.

Exploring the causes of natural clearings around Jeffrey pine trees that reduce fire severity in the Eastern Sierra

Sarah Dalrymple, Population Biology Graduate Group
University of California, Davis

Plants in fire-prone landscapes often have adaptations that allow them to cope with fire damage. For example, Jeffrey pines have thick bark and self-pruned branches that resist heat damage and prevent fires from spreading to the tree crown. Recent observations indicate that a more indirect fire-resistance strategy also exists for Jeffrey pines. Following fires, ring-shaped clearings, free of litter, are maintained around tree trunks, even when needles accumulate elsewhere on the forest floor. Evidence from the 2007 Angora Fire in South Lake Tahoe suggests that these clearings reduce both damage and mortality to trees. Therefore, determining the forces responsible for maintaining clearings is crucial to understanding a novel mechanism of fire resistance in trees. In the Inyo National Forest south of Mono Lake, 74 (± 24)% of trees in recently burned forest have clearings compared to 18 (± 12)% in unburned forest. Thus fire likely initiates clearing formation and clearings were probably common under natural fire regimes. Abiotic factors, such as wind and stem flow, probably influence clearings, but ants may also play a role in maintaining clearings around trees. The ant *Formica sibylla prefers* exposed nest sites and is found nesting in a majority of clearings (62 ± 19%) in sampled plots. Experiments run over the last two summers suggest that ants may play a role in removing needles deposited in clearings, but that this behavior is not contingent on the ants having an active nest entrance in the clearing. Future work will focus on the importance of clearings to ants.

Effects of amphibian declines and extinctions on community interactions and stability in alpine lakes in the Sierra Nevada

Thomas C. Smith, Department of Ecology, Evolution, and Marine Biology
University of California, Santa Barbara

The current rate and scale of species declines and extinctions are comparable to those of previous mass extinction events. Amphibians in particular have suffered dramatic mortality from anthropogenic disturbances such as habitat destruction and introduction of invasive species, as well as natural stressors such as emerging infectious disease. These declines translate to losses of consumer abundance and biomass in freshwater and terrestrial communities. Due to the ontogenic diet shifts associated with amphibian metamorphosis, these losses frequently occur across two trophic levels and are akin to loss of two species from communities. This suggests that amphibian declines and extinctions will have notable effects on communities. To assess the role of declining mountain yellow-legged frogs in alpine lake communities of the Sierra Nevada and potential effects of local extinctions, a two consumer-single resource experiment was conducted from mid-July to mid-September 2009. Earlier data indicated natural densities of the dominant primary consumers in Sierra lakes, and this data was used to establish experimental densities of mayfly larvae and tadpoles, which were placed in seventeen enclosures in each of two lakes in the Sierra backcountry. Biomass and growth rate of benthic producers and each consumer were measured, and will be compared to quantify the impact of each consumer on the resource, and to detect and measure competitive interactions. In addition, a concurrent long-term observational study will compare lake nutrient concentrations, algal production and diversity, and macroinvertebrate diversity to amphibian density and disease status in a dozen lakes over several years.

Abstracts

SATURDAY MORNING SESSION

Mass-dependent survival and dispersal in the California tiger salamander
Christopher Searcy, Department of Evolution and Ecology
University of California, Davis

Due to the fossorial nature of ambystomatid salamanders, few studies have captured these species in the terrestrial landscape. This has made it difficult to learn about demography and metapopulation dynamics among non-breeding stages of this group. Using a drift-fence array that stretches up to one kilometer from the edge of their breeding pond, we investigated survival between non-breeding stages of the California tiger salamander and dispersal of this species into the terrestrial environment. Tracking individual salamanders was made possible through the use of a pattern recognition program and subdermal alphanumeric tags. Implanting 2,335 metamorphs and photographing 3,114 adults and juveniles yielded 850 recapture events. These data revealed that larger individuals are more likely to survive between years during both the adult and juvenile stages, and are more likely to reach maturity from the juvenile stage. In addition, larger metamorphs disperse farther from the breeding pond. The importance of these trends is seen in the fact that average metamorph mass in the 18 cohorts examined in this study varied almost threefold between 5.3 g and 14.78 g. Thus, the average individual in the largest cohort has an 18-fold higher probability of surviving to maturity and will disperse 550 m further from the breeding pond than the average individual in the smallest cohort. This will introduce huge temporal variation into the population dynamics of this species, with certain cohorts having a much higher probability of contributing individuals to future generations and contributing dispersers to neighboring breeding ponds.

Can parasites enhance components of host fitness? Host manipulation of a sexual signal in the California fiddler crab, *Uca crenulata*
Adrienne B. Mora, Department of Evolution, Ecology, and Organismal Biology
University of California, Riverside

Many parasites adaptively alter host biology to maximize transmission and completion of their life cycles (termed “host manipulation”) at the expense of host fitness. In parasite-increased trophic transmission, the behavior of an intermediate host is modified to facilitate predation by a final host, often by intensifying a risky behavior that makes the host more conspicuous to a predator. Generally, parasites that employ this strategy are under strong selection to optimize transmission by predation, because they only reach sexual maturation and reproduce in the predatory final host. Although host manipulation is known to confer fitness advantages for parasites, cases of manipulation that enhance components of host fitness are not known. However, if the modified host behavior is used in mate attraction, then parasitism can provide short-term benefits to the host by intensifying a sexually selected signal. This presents a paradox, for parasites may shorten the life span of hosts by increasing susceptibility to predation, but they could increase their short-term reproductive success by intensifying behaviors used in mate acquisition. Using field and laboratory studies, I will examine how trophically transmitted parasites influence sexual signaling in fiddler crabs, and the effects that these interactions have on host mating success. Results from this work will help elucidate how parasites influence the evolution of host sexual signals, and may reveal a new role for parasites in sexual selection.

Demographics and eradication of a new invasive population of *Batillaria attramentaria* in Bodega Harbor, California

Weiskel, H.W.,[1] Byers, J.E.,[2] Huspeni, T.C.,[3] Zabin, C.J.,[4] Bowles, C.M.,[1] Brown, C.,[4] and E.D. Grosholz.[1]
[1] University of California, Davis
[2] University of Georgia
[3] University of Wisconsin, Stevens Point
[4] Smithsonian Environmental Research Center

Few data exist describing founder populations in marine systems. New invasions can elucidate founder processes, but are frequently not detected until populations are well-established. In April 2007, we discovered the first known population of *Batillaria attramentaria*, a mud snail native to Japan, in Bodega Harbor, California. This discovery offers an opportunity to investigate early invasion dynamics of a species that has been detrimental to West Coast mudflat communities for decades. In addition to obtaining demographic data, we also initiated an eradication effort. Field surveys from 2007-2009 show a steady increase in mean densities and a modal size class shifting towards smaller individuals (from 10-14.99 mm to 5-9.99 mm), reflecting strong recruitment. Rates of trematode parasitism have increased from 0-7.5% in the size class at which the snails are most likely to first become infected (20-24.99 mm), but have decreased in the overall population. This pattern contrasts sharply with infection rates of 42% in an established population in Tomales Bay. The Bodega Harbor results are consistent with an increase in the proportion of juvenile snails in a successfully establishing population. Approximately 22,000 and 19,000 adult snails were removed by hand in 2007 and 2008, respectively, as part of the eradication effort. New techniques are currently being tested, including vacuum collection for more effective surficial snail removal. The results from this population characterization and eradication effort will further our understanding of founder populations of invasive species and permit evaluation of eradication efforts in soft sediments.

Rhizosphere bacterial and archaeal biogeography in a California annual grassland

Erin E. Nuccio, Department of Plant and Microbial Biology
University of California, Berkeley

Despite the massive number of microbial species on earth, little is known about the environmental patterns that structure microbial diversity. Within the last ten years, developments in molecular techniques are making it possible to observe biogeographic patterns of microbes. The central goal of biogeography is to document and understand spatial patterns of biological diversity. However, only a handful of studies have attempted to uncover biogeographic patterns in soil microbial communities, and it is still mostly unknown what environmental factors are responsible for their structure. As microorganisms are at the heart of many soil biogeochemical cycles, the patterns of soil microbial communities across landscapes are intertwined with the functioning and health of ecosystems. I am studying how soil characteristics shape the bacterial and archaeal communities in the annual grassland ecosystem at Sedgwick Reserve, specifically the communities associated with a common annual grass, *Avena barbata*. The millimeters of soil that directly surround a root, referred to as the rhizosphere, are a critical habitat in the soil ecosystem. While the rhizosphere comprises only 1-2% of the total soil volume, the rhizosphere can provide 30-40% of the total soil organic carbon input. I will sample the rhizosphere of *A. barbata* over space and use a high-throughput phylogenetic microarray (G3 PhyloChip) to deeply sample the microbial community. This research will provide insight into the patterns of microbial communities across a landscape and the soil characteristics that shape those patterns.

Abstracts

Below-ground interactions between annual seeds and fungal pathogens

Erin Mordecai, Department of Ecology, Evolution, and Marine Biology
University of California, Santa Barbara

Seed banks are important for many annual plant species in California grasslands; however, the factors that impact seed survival in the soil are poorly understood. In particular, below-ground pathogens can mediate plant species interactions by reducing seed survival. Pathogens may have different impacts on grasses and forbs and on native and exotic species. Exotic grasses may promote pathogen growth by depositing thick thatch layers that harbor microbes and keep the soil relatively warm and moist. I examined the influence of season, thatch, and fungal pathogens on seed survival by placing the seeds of two exotic grasses, one native grass, and four native forbs in mesh seed bags in the summer of 2008 and the winter and spring of 2009. Seed bags were buried on serpentine hummocks in grasslands in Sedgwick Reserve, and treated with factorial combinations of thatch removal and fungicide addition. Overall, seed survival was much lower during the winter and spring than in the summer, as measured by seed germination in the lab. In the winter, seed survival improved with fungicide application. There was a strong season by fungicide interaction, as fungicide application had no effect in the summer. Thatch treatments also had no effect on seed survival. The effects of season and fungicide on survival varied somewhat across species, with five out of six species following the same general pattern. Seed mortality is therefore significantly higher in the winter than in summer, and winter mortality is partially ameliorated by fungicide. This supports the hypothesis that seeds that do not germinate with the first winter rains face fungal attack and low survival. Since forbs are much more likely than grasses to bank seeds between seasons, this overwinter mortality probably indirectly benefits exotic grasses over their native forb competitors.

Islands of invasion: Dominance of exotic species near living and dead oak trees (*Quercus* spp.) in California grasslands

Karen A. Stahlheber, Department of Ecology, Evolution, and Marine Biology
University of California, Santa Barbara

Invasive exotic species present significant threats to native plant abundance and diversity, and their success frequently relates to the availability of resources. Savanna trees in many locations increase nutrients and moderate the microclimate under their canopies, creating fertile islands. Oak trees are a common, highly valued part of many California grasslands, yet observations indicate the relative dominance of exotics and natives changes in their vicinity. To study this distribution, I surveyed vegetation composition, soil characteristics, and productivity around 11 *Quercus agrifolia,* 10 *Q. lobata*, and 6 *Q. lobata* snags at the Sedgwick Reserve in Los Olivos, CA. At each tree I ran transects oriented to the cardinal directions from the trunk into open grassland. Richness and diversity of both native and exotic plants declined beneath the canopy; however, total cover of exotics increased. Many exotic species attained their greatest cover underneath and at the edge of the canopy, creating a composition distinct from the nearby grassland. Dramatic differences in the soil conditions beneath the trees, especially moisture and organic carbon, correlate to

these differences. Next to the trunks of dead oak trees, species diversity remained significantly lower than neighboring open grassland, indicating residual effects of past trees. Additionally, *Q. agrifolia* oak trees were associated with higher diversity immediately outside their canopies compared to the deciduous *Q. lobata*. Both deciduous and evergreen oak canopy environments favor exotic grasses and forbs at the expense of native plants, an effect which may continue following the death of the tree.

SATURDAY AFTERNOON SESSION

Recruitment drivers in a California endemic oak, *Quercus lobata*
Blair McLaughlin, Department of Environmental Studies
University of California, Santa Cruz

Questions on the importance of top-down vs. bottom-up effects have long occupied ecologists. Recent work has begun to delve into how these factors may shift in strength across both time and space, challenging the traditional paradigm of classification and presenting new questions on the appropriate scale of study. We looked at bottom-up forces (competition for resources) and top-down forces (herbivory) on *Quercus lobata* at the sapling stage, where a bottleneck to reproduction occurs. We found that the relative importance of these factors shifts across a precipitation gradient with top-down forces more important at the wetter end of the gradient and bottom-up forces more important at the dryer end of the gradient. Ours is the first study to look at the extent of variation in top-down vs. bottom-up factors in plant populations across a spatial precipitation gradient. Our field study looks at sapling recruitment dynamics at 15 separate sites across the *Q. lobata* distribution, including oak savanna and woodland community types spanning a precipitation range of 18-35 inches average annual rainfall. We present our field data in the context of a meta-analysis of planting experiments on *Q. lobata* seedling performance and dendro-chronological analysis of a subset of our samples. We argue that the strength of top-down vs. bottom-up limitation on sapling recruitment shifts across space depending on rainfall. Additionally, we include data on resurveyed sites to look at trends in recruitment over time. A better understanding of the importance of weather in shifting limitation in keystone species is integral to conservation ecology in natural populations that span large spatial gradients, particularly in the context of a changing climate.

Range limits, climate change, and adaptive potential: Geographic variation in thermal tolerance in the copepod *Tigriopus californicus*
Morgan W. Kelly, Population Biology Graduate Group
University of California, Davis

The rapid pace of anthropogenic climate change represents an unprecedented threat to the planet's biological diversity. Models predicting species' responses to climate change have focused on range shifts rather than adaptation. However, there is a growing appreciation that most species will exhibit some combination of adaptation and range shifts. The ability to adapt to a changing climate will depend on the magnitude of genetic variation for environmental tolerance and also on how this variation is distributed among populations within a species. We are using the intertidal copepod *Tigriopus californicus* to examine the potential for an evolutionary response to climate change and to test hypotheses about patterns of quantitative genetic variation in edge vs. center populations. Our results indicate that *T. californicus* is locally adapted to thermal conditions, with the greatest thermal tolerance in populations from southern California. Our data

also show a narrow range of variation in thermal tolerance within populations as compared to the species as a whole. We are now using selection experiments to measure heritable variation in thermal tolerance within populations. After five generations, all selected lines had greater thermal tolerance than unselected controls; however, lines from southern populations showed a smaller response, suggesting decreased heritability of thermal tolerance in these populations. Our results suggest that in species with strong local adaptation, range-wide occurrence data may fail to predict population-level variation in environmental tolerance. Our data also suggest that populations from equator-ward populations may have a diminished capacity to adapt to climate change.

Effects of global change on high-elevation populations of *Bromus tectorum* in the eastern Sierra Nevada, California

Amy Concilio, Department of Environmental Studies
University of California, Santa Cruz

Bromus tectorum is an exotic annual grass that was introduced into the U.S. from Eurasia in the late 1800s. It has since spread through much of the Great Basin Desert, displacing native shrub and bunchgrass communities and altering fire regimes. At high elevation, *B. tectorum* is only present in small populations. However, agents of global change may facilitate its spread. My dissertation research will explore how altered precipitation patterns, increased temperature, and increased Nitrogen (N) deposition might affect *B. tectorum* spread in the eastern Sierra Nevada, CA. In 2008, study plots were set up in three dominant microhabitats and exposed to varying levels of simulated spring rain coupled with ambient and increased N-deposition. *B. tectorum* generally responded with increased growth and fecundity when given supplemental water, and the combined effect of supplemental water and N additions increased *B. tectorum* growth over ambient conditions in *Artemisia tridentata* microhabitats. No differences in native plant species composition were apparent after one year of treatments. However, these preliminary results suggest that *B. tectorum* may become more widespread at high elevations with a shift from winter snow to spring rain and that increased N-deposition may further exacerbate the problem. This year, I will measure *B. tectorum* response to changing snowpack, increased rain-on-snow events, and increased spring rain at varying elevations. Collectively, data from the two years of study will help identify times and places across the landscape that may be most prone to cheatgrass invasion under future climatic and edaphic conditions.

Native vs. non-native grassland species: Who will win under future global change scenarios?
Nicole Molinari, Department of Ecology, Evolution, and Marine Biology
University of California, Santa Barbara

Global change is projected to be the main driver of ecosystem change and biodiversity loss over the next century. Ecosystem change may be mediated through the promotion of non-native species by particular global change scenarios. Many of California's grasslands have already been affected by the presence of non-native plant species and global environmental changes could exacerbate these impacts. California's grasslands are largely thought to be water and nitrogen limited. Alterations in precipitation and nitrogen cycling are therefore likely to influence the restoration potential of non-native dominated sites as well as the persistence of native plant communities. My research seeks to understand how rainfall reduction and repackaging (fewer, more intense events), along with nitrogen deposition will alter invasibility and diversity in remnant native grasslands compared to adjacent non-native dominated grasslands at Sedgwick Reserve. I am adding seeds of the dominant non-native grass, *Bromus diandrus*, to native sites and seeds of the native bunchgrass, *Nassella pulchra*, to non-native sites while altering rainfall amount and distribution, along with increasing nitrogen deposition. Data collected thus far suggests that the non-native annual grass, *B. diandrus*, will be favored under both increased nitrogen deposition and decreased rainfall. By contrast, repackaged rainfall patterns appear to decrease the success of this non-native species. Alternatively, few *N. pulchra* individuals established in non-native dominated sites regardless of treatment. Currently, *N. pulchra* seedlings are being planted into each treatment to assess the effects of global change on the success of this native bunchgrass once already germinated.

SUNDAY MORNING SESSION

Spatial variation in prehistoric settlement strategies on Santa Cruz Island
H. B. Thakar, Department of Anthropology
University of California, Santa Barbara

The ancestors of the modern Chumash colonized the northern Channel Islands as early as 13,500 years ago. Throughout this long history of occupation, archaeological evidence indicates that the prehistoric inhabitants of Santa Cruz Island maintained a hunting and gathering lifeway. Despite this significant continuity, there is also ample evidence of variation through time in both subsistence strategies and mobility patterns. An investigation of diachronic variation in land and resource use must consider that adaptation to environmental variability is known to condition many aspects of hunter-gatherer subsistence and settlement. Essential economic resource availability on Santa Cruz Island is known to be both spatially and temporally discontinuous. Ethnographic analogy and cultural ecology indicate that hunter gatherers, who lack significant storage capacities, often contend with resource fluctuation through variation in subsistence and settlement patterns. The impacts of these adaptive strategies would have been far-reaching in prehistoric Chumash society, affecting the nutritional and demographic status of the population as well as technological development and social organization. This research project completed an intensive pedestrian survey of two large watersheds on Santa Cruz Island. GIS modeling has suggested that the shorter, less ecologically diverse watersheds of the northern coast are lower ranked than the large Cañada Christy watershed of the western portion of the Island. The documentation of archaeological deposits in these two geographic areas appears to correlate well with the expectations derived from geospatial modeling. There is distinctive variation in the quantity and character of archaeological deposits in the watersheds surveyed on the northern coast and the watershed surveyed on the western coast.

Abstracts

The intra- and interspecific impact of evolutionary-feedback in the wild: An experimental assessment

Martin M. Turcotte, Department of Evolution, Ecology, and Organismal Biology
University of California, Riverside

Rapid evolution, occurring within a dozen generations or less, is now commonly observed in nature. Yet, most ecological studies assume that evolution is too slow to impact short-term ecological dynamics. Recent theoretical models and a few laboratory studies, however, have shown that rapid evolution can feedback to impact concurrent population dynamics (Ecological-Evolutionary Feedback). This remains to be experimentally tested in the wild. Using a natural aphid (*Myzus persicae*) and mustard (*Hirschfeldia incana*) system, I tested the following hypotheses/predictions: (1) if evolution can influence ecological dynamics, then evolving populations will increase in population size at a faster rate than non-evolving controls, (2) if aphid evolution has interspecific feedback, then plants harboring evolving aphids will suffer greater damage, and (3) if Ecological-Evolutionary Feedback depends on the rate of evolution, then populations with more genetic variation will differ from their controls to a greater extent. These hypotheses were tested by manipulating the amount of genetic variation in intrinsic growth rate within replicated populations at the Motte Rimrock reserve. This created treatments that differ in the occurrence and rate of evolution (changes in clonal frequencies). As expected, populations with more genetic variation evolved faster. Aphids were counted twice a week, and evolving populations grew at a faster rate than appropriate non-evolving control populations. Moreover, I observed that the rate of rapid evolution was positively correlated with its impact on population dynamics. These results have important implications for applied studies of population dynamics, such as pest management.

Examination of a highly variable plumage trait in the sexually dichromatic American kestrel (*Falco sparverius*)

Elizabeth A. Wommack, Department of Integrative Biology and the Museum of Vertebrate Zoology
University of California, Berkeley

The American Kestrel (*Falco sparverius*) is the only kestrel within the New World and is arguably the most sexually dichromatic falcon in coloration. Male kestrels display distinct plumage coloration from females starting in their first year and will continue to do so throughout their lives. In addition to these dichromatic plumage traits, male American Kestrels also show a high degree of variability in individual coloration for certain color patterns, particularly in the patterning on their tail. The high degree of variability found in the plumage traits of male kestrels has often been considered a detriment in attempts to understand the mechanisms generating these dichromatic colors. Previous work has focused on traits that are found to be consistent in color and have ignored variable plumage colorations. However, this approach has led to little understanding on why certain traits are maintained or allowed to vary within the species. This study aims to examine the presence of variation in these unique plumage characteristics at an individual level, by testing the use of highly variable patterns in the tail of male American Kestrels during the breeding season. Three basic behavioral hypotheses will be tested at nest box sites in Northern California. The hypotheses to be examined are: (i) intersexual selection, where females show preference for one tail pattern over another; (ii)

status signaling, in which the trait is used as a signal in competition between individuals; and (iii) individual recognition, where the pattern aids in the correct identification of specific individuals.

Effects of nitrogen enrichment on the functioning of microbial communities in California salt marshes

Irina C. Irvine, Department of Ecology and Evolutionary Biology
University of California, Irvine

Salt marsh ecosystems are sensitive to the effects of eutrophication. To examine the relationship between nitrogen (N) enrichment, microbial composition, and ecosystem functioning, I established a gradient of N addition treatments in three southern California salt marshes that differ in their sedimentary N levels [Carpenteria Salt Marsh Reserve (CSM), Morro Bay Estuary (MBE) and Tijuana River Estuary (TRE)]. In July 2008, I began adding slow-release urea to 35 plots (seven levels with five replicates) in each of the three marshes. In February 2009, I measured a variety of plant, microbial, and nutrient variables. I assayed changes in ecosystem functioning in terms of gas fluxes and carbon mineralization. At 7 months, the methane and carbon dioxide emissions, carbon mineralization (CO2), sedimentary ammonium and C:N, plant biomass and C:N, methanotroph abundance, ammonification and nitrification rates exhibit linear responses to N-addition. Importantly, I found striking differences in the responses to N addition between marshes. In CSM, NH4 appears to be accumulating. CSM has slower N process rates, suggesting that CSM is not cycling N as quickly as either TRE or MBE, which appears to cycle the fastest. The salt marsh ecosystem service of taking up nitrogen (minus N leaching) may be diminished at CSM. I also observed significant differences in carbon mineralization among plots, suggesting that plot-scale differences in substrates and/or microbial composition affect this process rate. In the future, this experimental gradient will assist in making quantitative predictions of how salt marshes will respond under future nutrient scenarios.

Investigating tree mortality at multiple spatial and temporal scales in the Bishop pine forest on Santa Cruz Island, California

Sara Baguskas, Department of Geography
University of California, Santa Barbara

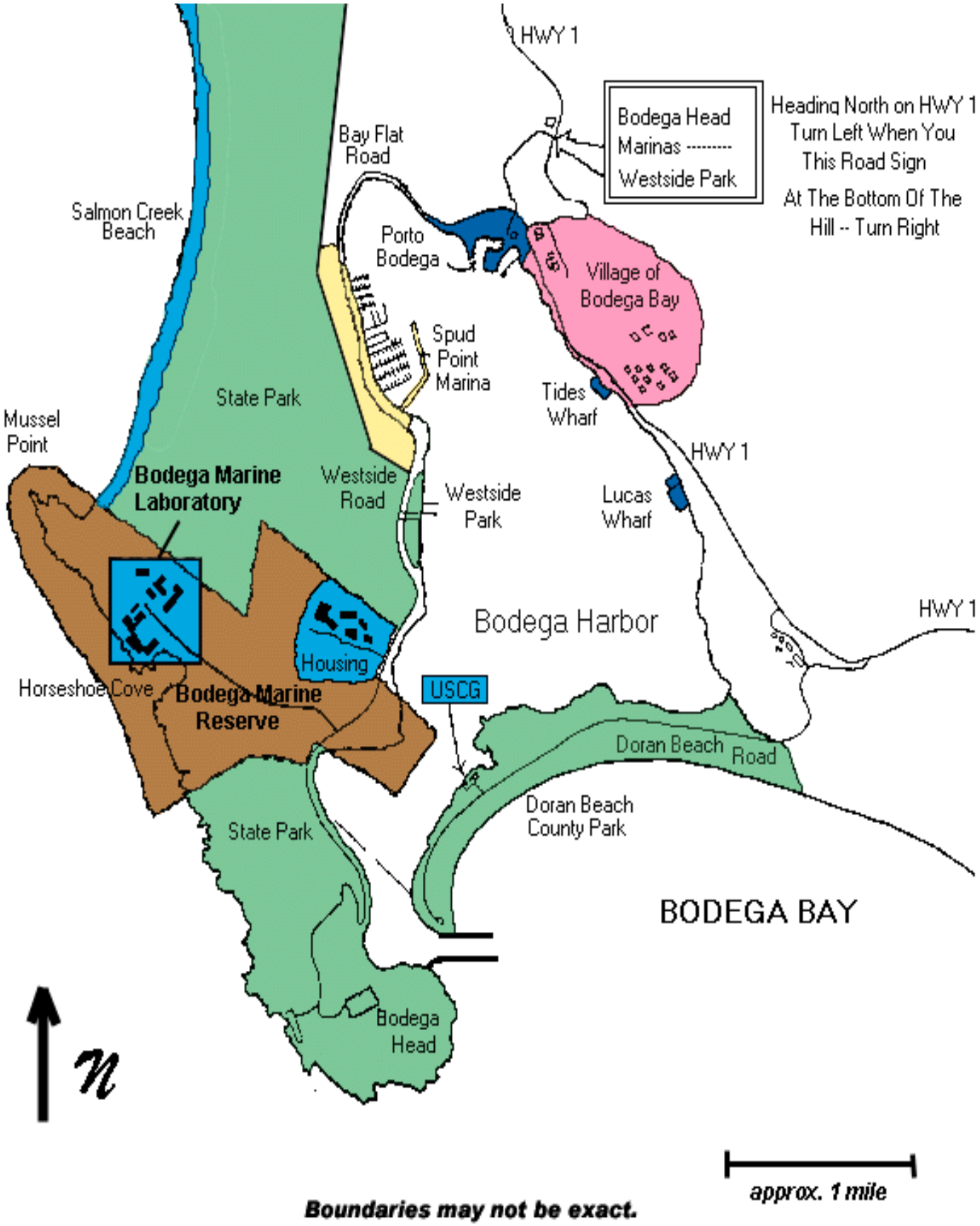
The rate of tree mortality has increased across the western United States in recent decades, and many studies attribute the cause to water-stress induced by regional warming. To date, the geographical scope of study regions affected by widespread tree mortality in the American West has largely been limited to continental, montane climates. Much less is known about mortality events in other climatic regions, such as coastal forests. The relatively unvarying nature of the coastal, maritime climate has traditionally been assumed to buffer these forests from large climate variations; however, we have observed rapid tree mortality in this region, which suggests coastal forests may be as susceptible to drought-induced mortality as inland forest locations. Santa Cruz Island (SCI), one of the California Channel Islands, harbors numerous relict and endemic plant species, including Bishop pine (*Pinus muricata*). Following extreme drought in southern California in two of the last three years, widespread mortality of Bishop pines on Santa Cruz Island (SCI) has become evident. Bishop pine populations are restricted to the fog-belt of coastal California and northern Baja California; therefore, a major reduction of existing populations on SCI would greatly reduce the distribution of the species as a whole. Because this population is at a range boundary, determining controls mortality and range dynamics for this species should be more easily elucidated. The focus of my research is to investigate the spatial and temporal patterns of Bishop pine mortality on SCI and to identify the key biotic and abiotic factors that best explain the mortality event.

Abstracts

Non-chemical restoration techniques in California sage scrub: Testing variations of agricultural solarization adapted for use in wildlands

Kristin A. Weathers, Department of Botany and Plant Sciences
University of California, Riverside

Exotic propagules often greatly outnumber native seeds in the soil seed bank of invaded plant communities. This makes restoration very difficult, often requiring multiple years of invasive species management to establish native species. Solarization, a technique used in agriculture, places clear plastic over moist soil during the summer. This heats the soil as high as 55^{o} C, killing weed seed. Two studies used variations of the method successfully in a wildland setting. One study used irrigation and clear plastic during the summer, while another applied black plastic during the winter with no irrigation. Our goal was to compare the success of plastic color (black, clear, and no plastic), season of application (winter and summer) and level of soil disturbance (tilling, scraping, and no disturbance) in reducing exotic weed seeds in the seed bank. Plots were not irrigated. Preliminary results show that clear plastic placed in the summer controlled the most species. Black plastic winter treatment did not control exotic broadleaf species as well as clear plastic. The study shows that combinations of winter and summer solarization with black and/or clear plastic provide a range of techniques for managers who need an alternative non-chemical invasive control method in invaded plant communities.


HWY 1
Bodega Head
Marinas ---------
Westside Park
Heading North on HWY 1
Turn Left When You
This Road Sign
At The Bottom Of The
Hill -- Turn Right
Bay Flat
Road
Salmon Creek
Beach
Porto
Bodega
Village of
Bodega Bay
Spud
Point
Marina
State Park
Tides
Wharf
Mussel
Point
Bodega Marine
Laboratory
Westside
Road
Westside
Park
Lucas
Wharf
HWY 1
Bodega Harbor
HWY 1
Housing
Horseshoe Cove
Bodega Marine
Reserve
USCG
Doran Beach
Road
Doran Beach
County Park
State Park
BODEGA BAY
Bodega
Head
n
approx. 1 mile
Boundaries may not be exact.

University of California • Natural Reserve System
Division of Academic Affairs • Office of Research and Graduate Studies
1111 Franklin Street, Oakland, CA 94607

phone 510-987-0150 • http://nrs.ucop.edu