University of California

Natural Reserve System

2008 MATHIAS SYMPOSIUM

Bodega Marine Laboratory/Reserve

February 22-24, 2008

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

Claudia Luke (PhD, Zoology, University of California Berkeley 1989)
Reserve Manager

Jackie Sones (BA, University of New Hampshire 1991)
Reserve Coordinator

Michelle Cooper (MA, Sonoma State University 2007)
Reserve Steward

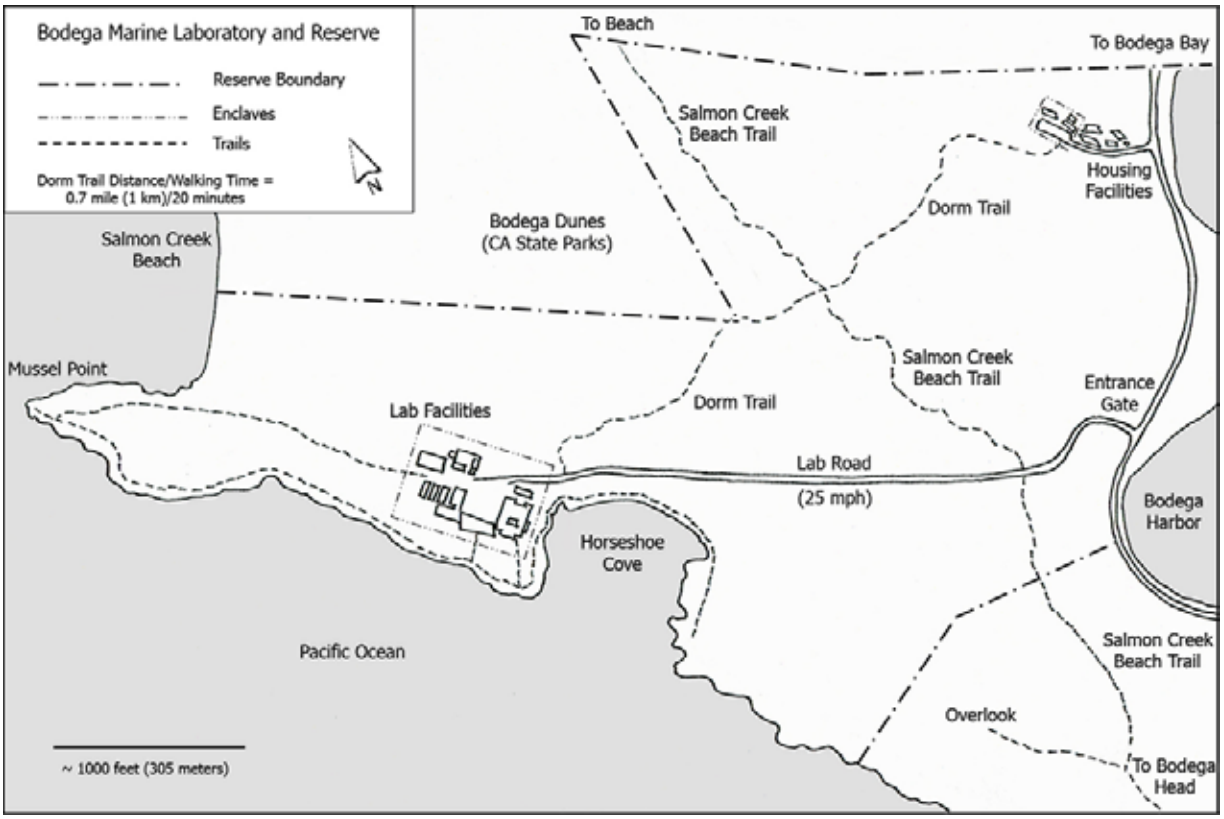
Accommodations, Meals, and Socials

Dorms

It may be convenient for participants to move their belongings into the dorms before nightfall. Good times are before lunch and after 5:00 p.m.

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.



2008

Lecturers

Rosemary Gillespie (PhD, University of Tennessee, Knoxville) is a professor of insect biology and the Schlinger Chair of Systematics in the UC Berkeley Department of Environmental Science, Policy, and Management, and the director of the Essig Museum of Entomology. She is a fellow of the California Academy of Sciences and of the Royal Entomological Society. In 2005, she was the recipient of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

Professor Gillespie's research focuses on understanding evolutionary patterns and processes among populations and species as outlined below. Her primary focus is on islands, particularly remote hotspot islands of the Pacific. Hotspot archipelagoes – in which islands emanate from a single volcanic hotspot from which they are progressively carried away by a geological plate – allow her to examine how communities have changed over time and thus gain insight into the nature of processes shaping communities over evolutionary time. These archipelagoes make it possible to visualize snapshots of evolutionary history. For example, the geological history of the Hawaiian archipelago is relatively well understood, with individual islands arranged linearly by age. Thus, early stages of diversification and community formation can be studied on the island of Hawaii, an island still forming, and compared to progressively later stages on the older islands of Maui, Lanai, Molokai, Oahu, and Kauai. A roughly similar chronological arrangement is found in the archipelagoes of both the Marquesas and the Societies in French Polynesia. [http://nature.berkeley.edu/~gillespi/]

Thomas Smith (PhD, University of California, Berkeley) is a professor in the UCLA Department of Ecology and Evolutionary Biology, founder and director of UCLA's Center for Tropical Research and acting director of the UCLA Institute of the Environment. Smith was a Senior Fulbright Research Scholar and is a fellow of the California Academy of Sciences, the American Ornithologists' Union, and the Zoological Society of London.

Professor Smith has over 20 years of experience working in the rainforests of Africa, Australia, Latin America, and Hawaii. Combining molecular genetics and field biology, Dr. Smith identified a new theory of how speciation occurs in tropical forests. In a series of studies published in the journals *Science, Nature*,and the *Proceedings of the National Academy*, he has shown that for a wide range of taxa in rainforests worldwide, the processes of diversification and speciation take place not only within "biodiversity hotspots" but also along environmental gradients or ecotones representing the transition from one habitat to another. The implications of this discovery are far-reaching. With climate change threatening large-scale shifts in species distributions and the habitats on which they depend, the hotspots of today may not be the hotspots of tomorrow. The results of Dr. Smith's research point to new and more effective ways of prioritizing regions for conservation. Dr. Smith is a frequent consultant to the World Bank and numerous conservation organizations, helping them implement conservation programs and establish new parks in tropical countries. [http://www.ioe.ucla.edu/Ctr/staff/smith_thomas.html]

2008 Mathias Symposium

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Friday, February 22, 2008

12:00 - 1:20 p.m	Lunch (Food service 12:00- 12:45 p.m.)
1:30 - 2:00 p.m.	**Introduction to Bodega Marine Laboratory/Reserve** Claudia Luke, Reserve Manager, Bodega
2:00 - 2:20 p.m.	**The ecology and distribution of an intertidal macroalga: Potential impacts of climate change** Jennifer Skene, Department of Integrative Biology, UCB
2:20 - 2:40 p.m.	**Fog contributions to pedogenesis and hydrology in *Pinus muricata* ecosystems on Santa Cruz Island** Julie Baker, Department of Land, Air and Water Resources, UCD
2:40 - 3:00 p.m.	**Drivers of *Pinus jeffreyi* regeneration at a conifer forest-sagebrush steppe ecotone** Holly Alpert, Environmental Studies Department, UCSC
3:00 - 3:20 p.m.	**Fire history of Jeffrey pine in the eastern Sierra Nevada, Sagehen Experimental Forest** Nicole M. Vaillant, Department of Environmental Science, Policy, and Management, UCB
3:20 - 3:40 p.m.	Break
3:40 - 4:00 p.m.	**A demographic analysis of facilitation of an invasive grass by native shrubs** Alden B. Griffith, Environmental Studies Department, UCSC
4:00 - 4:20 p.m.	**Climate, competition, and soil type: Interactions controlling endemism in serpentine grasslands** Barbara Going, Department of Environmental Science and Policy, UCD
4:20 - 4:40 p.m.	**Developing a mechanistic understanding of the species-area relationship from serpentine habitats** Adam B. Smith, Energy and Resources Group, UCB
4:40 - 5:00 p.m.	**Do resource impacts predict invasion success in a coastal sage scrub community?** Leah J. Goldstein, Department of Ecology and Evolutionary Biology, UCI
5:00 - 6:15 p.m. 6:15 - 7:45 p.m.	Break Dinner (Food service 6:15 - 7:00 p.m.)
8:00 - 9:00 p.m.	**LECTURE: *Using islands to infer community assembly patterns at different scales of space and time*** Rosemary Gillespie, Professor, University of California, Berkeley
9:00 -10:00 p.m.	Social

2008 Mathias Symposium

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Saturday, February 23, 2008

7:30 - 8:30 a.m.	Breakfast (Food Service 7:30 - 8:15 a.m.)
9:00 - 9:20 a.m.	**The effect of native forb abundance on invasion resistance in California grasslands** Kris Hulvey, Department of Environmental Studies, UCSC
9:20 - 9:40 a.m.	**Spatial and temporal variability in survivorship affects long-term persistence of a subterranean microparasite** Karthik Ram, Section of Evolution and Ecology, UCD
9:40 - 10:00 a.m.	**Conservation of terrestrial habitat for California tiger salamanders *(Ambystoma californiense)*** Christopher A. Searcy, Section of Evolution and Ecology, UCD
10:00 - 10:20 a.m.	**Evolution of anti-predator defenses in larvae of a native frog in response to an invasive predator** Katherine M. Pease, Department of Ecology and Evolutionary Biology, UCLA
10:20 - 11:00 a.m.	Break
11:00 - 11:20 a.m.	**Evolutionary genetics of self-incompatibility in three California species *(Papaveraceae)*** Timothy Paape, Department of Ecology, Behavior and Evolution, UCSD
11:20 - 11:40 a.m.	**Gyne investment and implications for colony-founding strategies in harvester ants (genus *Pogonomyrmex*)** Brittany Enzmann, Department of Ecology and Evolutionary Biology, UCLA
11:40 - 12:00 noon	**Ecological consequences of exposure to natural oil contamination: Population-level effects of the multidrug-resistance mechanism** Heather M. Coleman, Bren School of Environmental Science and Management, UCSB
12:15 - 1:30 p.m.	Lunch (Food service 12:15 - 1:00 p.m.)
1:30 - 3:30 p.m.	**Tour of the Reserve** Claudia Luke and Jackie Sones, Reserve Manager and Reserve Coordinator, Bodega
4:00 - 4:20 p.m.	**Living in the margins? An investigation of interior late- and contact-period Chumash residential sites on Limuw (Santa Cruz Island), California** Elizabeth A. Sutton, Department of Anthropology, UCSB

Saturday, February 23, 2008

4:20 - 4:40 p.m.	**Early maritime hunter-gatherer occupation and the initial human migration into the new world, Santa Cruz Island, California** Amy E. Gusick, Department of Anthropology, UCSB
4:40 - 5:00 p.m.	**Relative importance of plant resources in prehistoric diets: Archaeological evidence from Santa Cruz Island** Kristina M. Gill, Department of Anthropology, UCSB
5:00 - 5:20 p.m.	**Non-invasive monitoring of recovering Channel Island fox (*Urocyon littoralis*) populations** Melissa M. Gray, Department of Ecology and Evolutionary Biology, UCLA
6:15 - 7:45 p.m.	Dinner (Food service 6:15 - 7:00 p.m.)
8:00 - 9:00 p.m.	**LECTURE**: ***Putting process on the map: Why ecological gradients are important for preserving biodiversity*** Thomas Smith, Professor, University of California, Los Angeles

2008 Mathias Symposium

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Sunday, February 24, 2008

7:30 - 8:30 a.m.	Breakfast (Food service 7:30 - 8:15 a.m.)
9:00 - 9:20 a.m	**Protection from grazers: An associational defense between kelp and an epiphytic bryozoan?** Sarah Bryson, Department of Ecology and Evolutionary Biology, UCLA
9:20 - 9:40 a.m.	**Effects of fine sediment and grazers on periphyton and nutrient cycling in a coastal river** Michael Limm, Department of Integrative Biology, UCB
9:40 - 10:00 a.m	**Where does maritime end and interior begin? Land-use policy dilemmas and the potential use of ecophysiology to help delimit the landward distribution of maritime chaparral along the central California coast** Michael C. Vasey, Department of Environmental Studies, UCSC
10:00 - 10:20 a.m.	**Water isotopes of coast redwood saplings reveal summertime hydration status and water dynamics at the leaf level** Emily Limm, Integrative Biology
10:20 - 10:40 a.m	Break
10:40 - 11:00 a.m	**Vocal individuality in ground squirrel alarm calls** Kimberly A. Pollard, Department of Ecology and Evolutionary Biology, UCLA
11:20 - 11:40 a.m.	**Physiological and behavioral responses of leopard sharks (*Triakis semifasciata*) to salinity change** W. Wesley Dowd, Graduate Group in Ecology, UCD
11:40 - 11:50 a.m.	**Closing comments** Alex Glazer, Director, UC Natural Reserve System
11:50 - 12:10 p.m.	Break
12:10 - 1:30 p.m	Lunch [End of symposium]

Abstracts

FRIDAY AFTERNOON SESSION

The Ecology and Distribution of an Intertidal Macroalga: Potential Impacts of Climate Change
Jennifer Skene, Department of Integrative Biology
University of California, Berkeley

Understanding the processes that shape species distributions is a critical research question, as global warming is altering the earth's climate and species distributions are shifting in response. Species' distributions are often limited by propagule dispersal, biotic interactions, and abiotic factors, which may be altered a result of climate change. This study examines factors that affect the survival of the macroalga *Pelvetiopsis limitata,* during two life history stages. Distributed in the upper zone of the rocky intertidal, it is exposed to air for more time than other intertidal organisms, and may be amongst the first to respond to changes in air temperature. A demographic study of adults was begun at the Bodega Marine Reserve in July 2004, to examine how growth and mortality rates vary with tidal elevation, exposure to wave action, and season, which affect air, sea and substrate temperature, wind speed and direction, and fog cover. Results to date indicate that mortality rates of adults are highest in the winter; strong winter waves that rip algae from the rock pose a greater threat to population persistence than do desiccating high temperatures during the summer. However, pilot experiments examining the effect of substrate temperature, tidal elevation and shading by conspecifics on *P. limitata* embryo survival indicate that high temperatures may be critical in determining propagule establishment. These results indicate that warming will be detrimental to the young life history stage, while winter storms, predicted to increase in intensity as the result of climate change, will negatively impact adult populations**.**

Fog contributions to pedogenesis and hydrology in *Pinus muricata* ecosystems on Santa Cruz Island
Julie Baker, Department of Land, Air and Water Resources
University of California, Davis

In the Mediterranean-type climates that occur over much of California, water is severely limited during the summer months. Interception of fog water can be a locally important source of plant-available water and groundwater recharge in foggy coastal areas, but the importance of fog precipitation in pedogenic mineral formation is unknown. Stable isotopes incorporated into pedogenic minerals may record water source and availability as they reflect equilibrium conditions with the soil solution at the time of formation. Soils in *Pinus muricata* (Bishop Pine) canopy and adjacent grassland were compared on two parent materials, a chlorite schist and a rhyolitic tuff. Smectites dominate the fine clay (<0.2 mm) fraction in the soil formed on rhyolitic tuff, while kaolinite and halloysite dominate the fine clay fraction of the soils formed on schist. Stable ^{2}H and ^{18}O isotope analyses of precipitation (rain and fog) and soil solution samples indicate a depletion of the heavier isotopes in the rainwater compared to fog. Soil solution samples from

surface horizons measured during precipitation events show a shift in isotope ratios to heavier values during fog events and lighter values during rain events, but generally increase with depth as packets of water influenced by evaporation infiltrate deeper into the profile. ^{2}H values in fine clay phyllosilicates at both pine sites also reflect this increase.

Drivers of *Pinus jeffreyi* regeneration at a conifer forest-sagebrush steppe ecotone

Holly Alpert, Environmental Studies Department
University of California, Santa Cruz

Although studies of treelines typically focus on high-elevation boundaries between forests and alpine ecosystems, low-elevation treelines, such as those between forests and shrubland, are also of interest in thinking about how climate change will affect species distributions. This research focuses on large-scale precipitation and small-scale microhabitat drivers of *Pinus jeffreyi* regeneration at a forest-shrubland ecotone in eastern California. Germination and establishment were examined by planting *P. jeffreyi* seeds and seedlings into areas of altered snow depth (increased, decreased, and ambient snow depth) and microhabitat (under the potential nurse species *Artemisia tridentata* and *Purshia tridentata* and in open intershrub spaces), and monitoring survival and growth throughout two growing seasons. Soil water availability, photosynthetically-active radiation (PAR), air temperature, and soil temperature were measured in the snow depth and microhabitat treatments. Of the 1,500 seedlings planted between the two years, only two remained alive as of October, 2007. Seedlings planted under the two shrub species predominantly died from herbivory, whereas seedlings planted in open intershrub spaces died more often from drought. There were differences in PAR between shrub canopies and intershrub spaces, but there were no differences in soil or air temperature, soil moisture, seed germination, or seedling growth among microhabitat or snow depth treatments. No effects of altered snow depth on seedling survival have been observed to date. Results suggest that microhabitat niches may be equally if not more important than changes in precipitation patterns for *Pinus jeffreyi* establishment at this ecotone.

Fire History of Jeffrey pine in the eastern Sierra Nevada, Sagehen Experimental Forest

Nicole M. Vaillant, Department of Environmental Science, Policy, and Management
University of California, Berkeley

Recently in California, and elsewhere in the western United States, there has been a movement toward landscape level fuel treatments to reduce the potential effects of catastrophic wildland fire. Understanding the historic fire regime is important for land managers when deciding on treatment scenarios for application today. Often times fire regimes are looked at over two time periods: pre-settlement and post-settlement. At Sagehen Experimental Forest, the pre-settlement fire regime may have been influenced by the Washoe tribe. The Washoe tribe was a nomadic tribe that spent summers on the northern shores of Lake Tahoe and used higher elevation forests and meadows for hunting and gathering in the fall months. The post-settlement fire regime was most likely impacted by the Comstock Lode. In addition to the mill along Sagehen Creek, early USGS maps show the majority of lower elevation stands within Sagehen to have been culled by 1902. In addition to anthropogenic influences, climatic drivers, such as drought cycles, shape fire regimes. This study will look at both fire perimeter maps within Sagehen (from the early 1900s to present) and fire scar samples. Forty-two samples were collected from lower elevation Jeffrey-pine and Jeffrey-pine mixed-conifer stands in five unique locations at Sagehen. Using both methods, past fire perimeters and dendrochonology, it is possible to reconstruct the fire return interval, the seasonality of fires, and test the influence of climatic drivers.

Abstracts

A demographic analysis of facilitation of an invasive grass by native shrubs
Alden B. Griffith, Environmental Studies Department
University of California, Santa Cruz

Much of biological invasion theory is built upon models of negative ecological interactions, but the importance of positive interactions in specific invasions is gaining attention. This research demographically examines the role of facilitation of the invasive annual grass, *Bromus tectorum*, by native shrubs in the western Great Basin Desert. Plots were established under the canopies of the shrubs *Artemisia tridentata* and *Purshia tridentata,* and in intershrub spaces near Mammoth Lakes, CA (elevation 2150 m). Modeled *B. tectorum* population growth under shrub canopies was significantly greater than in intershrub spaces in 2005, and the reproductive potential of seedlings was significantly greater under shrub canopies in 2006. In both years, positive effects of shrub microhabitats were demonstrated by positive contributions of growth and survival rates, even when the net effect was non-significant. These results demonstrate that native shrubs can positively influence the growth of invasive populations of *B. tectorum* at high elevation, although the interaction is variable between shrub species and years. While much of the impact of *B. tectorum* is associated with intershrub populations that promote fire continuity, shrub microhabitats may be important for boosting initial population sizes and may function as overall population seed sources.

Climate, competition, and soil type: interactions controlling endemism in serpentine grasslands
Barbara Going, Department of Environmental Science and Policy
University of California, Davis

Serpentine edaphic endemics, plant species that are specialized on serpentine soil, form a large proportion of California's plant diversity, yet little is known of ecological interactions contributing to their restriction to such an abiotically harsh substrate. It has been hypothesized that competition from superior competitors is the proximate cause for edaphic endemism because soil specialists are incapable of fast growth in more benign soils. In addition, endemism may vary along climate gradients, such that endemics are more specialized when climate conditions are favorable because they are less able to take advantage of an increase in resources, such as water availability. This study is designed to experimentally test the hypotheses that 1) competition from other species on benign soils is the mechanism of soil restriction and 2) soil restriction is stronger in climatically favorable environments. I am testing the effects of competition and three levels of water availability on the performance of three serpentine endemics and three non-endemic congeners on and off serpentine soil. To further explore how climatic gradients contribute to endemism the three serpentine endemics are being grown with or without competition at three different locations along California's precipitation gradient. The results of this study will have broader implications for predicting the success of edaphic endemic plant species under different climate change scenarios. Current "climate envelope" models assume that species niches are primarily controlled by climate and may not accurately predict the distribution of species whose niches may be controlled by interactions among abiotic and biotic factors.

Developing a Mechanistic Understanding of the Species-Area Relationship from Serpentine Habitats

Adam B. Smith, Energy and Resources Group
University of California, Berkeley

Though ecologists have known for over two centuries that the number of species rises with the size of the area sampled, we have yet to understand the relative contribution of ecological processes structuring the species-area relationship (SAR). The leading hypotheses are that larger areas 1) sample more individuals and thus more species (the sampling hypothesis); 2) harbor more heterogeneity and thus allow niche partitioning (the spatial heterogeneity hypothesis); 3) diminish the probability that a population goes extinct (the island biogeography hypothesis); 4) dilute localized biotic interactions like competition (the biotic interaction hypothesis). In 2006 I established an experiment on serpentine grasslands at UC McLaughlin Natural Reserve to test the relative merit of these hypotheses in structuring the SAR. I demarcated 35 2×2-m plots and censused all vascular plant species within them in 2006 and 2007 (and will continue in 2008) and from this data constructed SARs for each plot. Numerical analyses of abundances indicate that the sampling hypothesis does not fully explain the rise in species with area. To assess the other hypotheses, after the initial census, I imposed three types of manipulations and their crosses on the plots: reduction of immigration from outside plots (island biogeography), reduction of recruitment from inside plots (island biogeography/biotic interactions), and soil homogenization (spatial heterogeneity). Preliminary analyses indicate that soil heterogeneity and recruitment have the most pronounced effect.

Do resource impacts predict invasion success in a coastal sage scrub community?

Leah J. Goldstein, Department of Ecology and Evolutionary Biology
University of California, Irvine

The successful invasion of exotic species in native communities has led to the generalization that exotic invasives are often better resource competitors than native species. Few studies have directly tested R* competition theory in the context of invasions by exotic plants, but R* (measured as resource availability in monoculture) indicates resource impacts and requirements, and so can lead to useful predictions about invasion success. We hypothesized that 1) successful invaders will have a lower R* than native species, and 2) natives with a lower R* than exotic species should be able to resist invasion. We estimated R* for light, nitrogen, and water in monocultures of native coastal sage scrub shrub (CSS) species and in monocultures of two exotic herbaceous species that are problematic invaders in CSS. Additionally, we measured invasion success by experimental invasion of exotics and native shrub seedlings into native and exotic monocultures. Exotic monocultures did not reduce resources below levels found in native monocultures: native monocultures had lower light, lower soil moisture, and lower nitrogen availability. Experimental invasions supported the prediction that lower R* should provide invasion resistance, as exotic invaders had lower biomass in native shrub monocultures than exotic monocultures. In contrast to predictions, however, native seedlings had lower biomass in exotic monocultures than native monocultures. Rather than being strong competitors, exotics may rely on traits providing an advantage during transient conditions when resource availability is high. Comparisons of exotic R* with temporal resource variability in native communities may help pinpoint windows of opportunity for invasives.

Abstracts

SATURDAY MORNING SESSION

The Effect of Native Forb Abundance on Invasion Resistance in California Grasslands
Kris Hulvey, Department of Environmental Studies
University of California, Santa Cruz

Yellow starthistle negatively impacts California grasslands through losses of forage quality, native species, and landscape aesthetics. We conducted two experiments, one in pots at Stanford's Jasper Ridge Biological Preserve, and a second in the grasslands of McLaughlin Reserve, focused on the competitive interactions between starthistle, *Centaurea solstitialis,* and the native tarweed, *Hemizonia congesta.* We investigated whether tarweed abundance declines affect grassland vulnerability to starthistle invasion. This is important because changes in species abundance are more common than extinctions, and ecosystem functions such as invasion resistance may be mediated by such changes. In the first experiment, we created grassland microcosms with varying tarweed abundance levels. We invaded half the microcosms with starthistle and gauged invasion resistance by measuring final starthistle biomass and flower number. To investigate possible mechanisms driving the relationship between tarweed abundance and invasion, we measured soil moisture, nutrient availability, and available light. In the second experiment, we invaded grassland plots containing a natural range of tarweed abundance levels with starthistle. We gauged invasion resistance by measuring final starthistle abundance, biomass, and flower number, and investigated mechanism by measuring soil moisture and available light. In pots, we found tarweed affected invasion resistance, with increasing tarweed abundance resulting in less starthistle biomass and flower production. Soil moisture was the only measured factor that explained this relationship; pots with greater tarweed abundances used more water. In the field, it was uncertain if tarweed abundance affected invasion because few starthistle plants survived in any plot, possibly due to this year's drought conditions.

Spatial and Temporal Variability in Survivorship affects Long Term Persistence of a Subterranean Microparasite
Karthik Ram, Section of Evolution and Ecology
University of California, Davis

The long-term persistence and stability of host-pathogen interactions are often strongly affected by spatial distribution of the interacting populations. This is particularly true in seasonal systems where conditions for pathogen survival and host availability vary over time. My study occurs in the context of a trophic cascade which involves a microparasitic entomopathogenic nematode (*Heterohabditis marelatus*, hereafter EPNs) as the natural enemy of a root-feeding ghost moth caterpillar *(Hepialus californicus)* found on lupine bushes *(Lupinus arboreus).* In the absence of EPNs, root-feeding caterpillars can kill and destroy large stands of lupines, especially in dry years. EPNs, when present, suppress such ghost moth outbreaks

thereby protecting the lupines. EPNs depend strongly on moisture for movement and persistence. Given the seasonal nature of the environment where moisture regimes and host availability vary dramatically, it is unclear how EPNs persist. Our 13-year dataset shows considerable variation in EPN incidence among sites. I tested whether these differences were because of variation in survivorship. Using a known initial EPN number, I estimated the daily mortality rates for each of our sites. A negative binomial model fit the data well (Pearson's X2/df = 0.898). I used these mortality rates in a fully stochastic model for host-pathogen interactions in seasonal environments to calculate EPN extinction probabilities for a single season. Results from the survivorship experiment did not explain the full range of incidence patterns. Given the nature of these results, I hypothesize that dispersal is an important mechanism in explaining the discrepancy between model predictions and field observations.

Conservation of terrestrial habitat for California tiger salamanders *(Ambystoma californiense)*
Christopher A. Searcy, Section of Evolution and Ecology
University of California, Davis

Across its range, the California tiger salamander is listed as either endangered or threatened under the U.S. Endangered Species Act. As a result, there is much concern about protecting appropriate habitat for this species. This is challenging, because California tiger salamanders spend over 95% of their adult lives in mammal burrows, making it very difficult to determine which portions of the landscape they are utilizing. This study sought to determine the distribution of California tiger salamanders across the terrestrial landscape using an array of 164 drift fences at the Jepson Prairie Reserve. A total of 10,042 salamanders were caught over the course of two years using this drift fence array. In addition, data on a number of habitat parameters, such as distance from shoreline of the pond, elevation, mammal activity, and vegetation were collected from each fence. Model selection was used to search for correlations between the density of salamander captures and these habitat parameters, revealing that salamander density is influenced by both distance from the shoreline of a breeding pond and elevation above the pond surface. This indicates that higher conservation priorities and mitigation values should be assigned to land that is closer to breeding ponds and at a higher elevation. In addition, it was shown that California tiger salamander densities vary both between years and between ponds. It is thus important to understand both spatial and temporal heterogeneity before making conservation decisions for this species.

Evolution of Anti-predator Defenses in Larvae of a Native Frog in Response to an Invasive Predator
Katherine M. Pease, Department of Ecology and Evolutionary Biology
University of California, Los Angeles

Invasive species are widely recognized as a serious ecological threat; the evolutionary impacts of invasions may be equally as threatening, yet remain relatively unstudied. Invasive species can act as a strong selection pressure, causing evolution in native species through predation, competition, or parasitism. The proposed project will determine whether Pacific treefrog *(Pseudacris regilla)* tadpoles are

adapting to the invasive predator, the red swamp crayfish *(Procambarus clarkii)* in the Santa Monica Mountains of southern California. I will examine differences in the anti-predator adaptations (morphological and behavioral) between tadpoles from streams with crayfish and tadpoles from streams without crayfish. Preliminary results show that tadpoles from streams with crayfish are significantly different in morphology than tadpoles from streams without crayfish. I will determine if the predator is acting as an agent of natural selection by performing predation experiments and comparing survival rates of prey that coexist with the predator to prey that are naïve to the predator. In order to determine whether the anti-predator traits are inducible and/or heritable, I will conduct a common garden experiment, rearing tadpoles in the lab from field-collected eggs in the presence and absence of predator cues. Finally, I will determine the population genetic structure of *P. regilla* to determine levels of gene flow and whether there are natural or human barriers to gene flow. The proposed study will show whether a native species is able to adapt to a novel invasive predator and has broader implications for understanding and predicting interactions between native and invasive species.

Evolutionary genetics of self-incompatibility in three California species (*Papaveraceae*)

Timothy Paape, Department of Ecology, Behavior and Evolution
University of California, San Diego

I am examining the evolutionary genetics of the gametophytic self-incompatibility (GSI) locus of the *Papaveraceae* plant family. The S-locus in this family has previously been characterized at the molecular level in two species, *Papaver rhoeas* and *P. nudicaule.* The limited sequence data from these species has enabled the amplification of 65 sequences that represent potential alleles from a homologous S-locus from *Argemone munita, Romneya coulteri,* and *Platystemon californicus*, all of which are California natives. The S-locus of this family represents a non-homologous system of self-recognition from other plant families possessing GSI including the *Rosaceae, Solanaceae,* and *Scrophulariaceae*. I am currently conducting greenhouse and natural population studies in the three California species that will determine allelic function, number of alleles, levels of sequence divergence, and sites of positive selection within each sampled species. Previous studies of S-loci have revealed extensive trans-specific evolution in which the age of the alleles often pre-dates the speciation event that separated various taxa. Preliminary genealogical analyses have showed that the potential S-alleles from the California species exhibit an overall lower range of diversity than the four published *Papaver* alleles. Greenhouse crosses have also revealed that some individuals possess linked polymorphism that may or may not also be involved in SI. I am designing in vitro assays to test the function of suspected alleles and potential duplicates.

Gyne investment and implications for colony founding strategies in harvester ants *(*genus *Pogonomyrmex)*

Brittany Enzmann, Department of Ecology and Evolutionary Biology
University of California, Los Angeles

Colony founding is a critical stage in social insect life history. In ants, workers provision future queens (gynes) that later mate, disperse, and use one of several strategies to found colonies. Reproduction thus involves individual gynes that found new colonies and the collective behavior of workers that invest colony resources into sexual production. Claustrality is a variable gyne characteristic directly linked to colony investment. Fully claustral gynes are large and require many stored reserves to raise their first worker brood without foraging, while semi-claustral gynes are small and require fewer reserves as they forage during colony initiation. In the harvester ant genus *Pogonomyrmex*, claustral, semi-claustral, and facultative (both) variants exist across species. My project aims to determine the colony investment costs for producing these three gyne variants. Specifically, I will compare lipids, protein, carbohydrates, and metabolic rates and measure the expression of a storage protein (Hexamerin II) of gynes throughout development. I will also perform a field supplementation experiment on a facultative species to assess the phenotypic plasticity of the trait and whether gyne claustrality is affected by resource quality. Specifically, lipids, protein, and Hexamerin II expression will be compared between colonies supplemented with protein resources, carbohydrate resources, both, and controls. Investigating proximate questions of investment and social control over claustrality will give insight on how its variation may have evolved and is maintained. It will also serve as a prime example of how a reproductive trait is implicated at both individual and colony levels in a social insect.

Ecological consequences of exposure to natural oil contamination: Population-level effects of the multidrug resistance mechanism

Heather M. Coleman, Bren School of Environmental Science and Management
University of California, Santa Barbara

Microbial metabolites of naturally occurring hydrocarbons, such as crude oil, are substrates of P-glycoprotein (P-gp) transport proteins. Given the abundance of life near areas of natural oil seepage, resident animals might be expected to suppress the toxicity of crude oil biodegraded water-soluble fractions (BWSF) using such transporters. Consistent with this hypothesis, our results indicate that the sea urchin, *Strongylocentrotus purpuratus,* exhibits different levels of multidrug resistance transport activity as a function of its habitat when exposed to BWSF and fluorescent calcein-AM. Embryos from control parents accumulated 1.7-fold more calcein, indicating a significantly ($P < 0.001$) lower multidrug efflux activity than embryos of animals collected from an oil seep. Furthermore, *S. purpuratus* exhibit similarly greater efflux activity ($P < 0.001$) in embryos from an oil seep when exposed to known synthetic inhibitors of both P-gp and multidrug resistance-associated protein (MRP): MK571, PSC833, musk xylene, and galaxolide. Therefore, urchins that are pre-exposed to natural hydrocarbon contamination confer multiple types of xenobiotic resistance proteins to their progeny. Since there can be a significant energetic cost to production and storage of these proteins in eggs, a question raised by this finding is whether a population-level cost of this adaptive change in transporter activity exists. Future research will examine the reproductive costs (via the gonadosomatic index) of adaptation to oil seeps and the energetic costs of accumulating transporters in eggs. Incorporating this information into larger scale dynamic energy models will provide insight into the population-level effects of transporter-mediated adaptation to contaminants.

Abstracts

SATURDAY AFTERNOON SESSION

Living in the margins? An investigation of interior Late and Contact period Chumash residential sites on Limuw (Santa Cruz Island), California
Elizabeth A. Sutton, Department of Anthropology
University of California, Santa Barbara

Archaeologists studying the indigenous peoples living in the Santa Barbara Channel Region, known collectively today as the Chumash, have relied on two types of sources to reconstruct Late and Contact period Chumash settlement systems: 1) the incomplete and highly conflicting reports of sixteenth and seventeenth century seafaring Spanish explorers and 2) the late nineteenth and early twentieth century ethnographic accounts of Chumash consultants. While this information has proven to be extremely valuable in providing a general understanding of Chumash lifeways, it has been too convenient to focus research on the highly visible villages described in these accounts and reconstruct Chumash settlement patterns based solely on data from these large sites. While these accounts portray the Chumash of the Channel Islands as living in large, densely populated coastal villages during the Contact period, recent investigations have revealed two small interior residential sites on Santa Cruz Island that have been dated to the Late and Contact periods. The existence of these sites calls into question the accuracy of current models of Island Chumash settlement patterns which dismiss the possibility of residential settlement during these time periods in the “marginal” interior areas of the Channel Islands, and in addition may represent an exception to the anthropological correlation of complex hunter-gatherers with an aggregated, sedentary settlement pattern. Further research at these sites will attempt to refine site occupation chronology and determine seasonality of use. An attempt to locate and document other interior residential sites will also be made.

Early maritime hunter-gatherer occupation and the initial human migration into the New World, Santa Cruz Island, California
Amy E. Gusick, Department of Anthropology
University of California, Santa Barbara

Although we have made much progress towards a better understanding of Pacific maritime cultures, little evidence has been recovered to support a coastal route for the initial human migration into the New World. Despite this hypothesis having received widespread support in recent years, more definitive research that supports a coastal migration must be conducted in order to solidify it as a viable alternative to the antiquate, ice-free corridor migration hypothesis. Santa Cruz Island represents a key piece of this research. The first humans migrating into the Americas could have utilized Santa Cruz Island for its environmental conditions (marine productivity and fresh water sources), morphological features (rock shelters and accessibility to marine resources), accessibility by watercraft and close proximity to the mainland. In fact, hundreds of cultural deposits have been identified on Santa Cruz Island; however, none of them are Pleistocene in age,

placing them out of the possibility of being related to a Pleistocene coastal migration. My research focuses on the identification of cultural deposits located on Santa Cruz Island that can be considered to support a coastal route for the initial human migration into the New World. By utilizing settlement and subsistence patterns identified at early sites located on adjacent islands, I have located five cultural deposits that may inform our understanding of the role that Santa Cruz Island played in the initial peopling of the New World.

Relative Importance of Plant Resources in Prehistoric Diets: Archaeological Evidence from Santa Cruz Island

Kristina M. Gill, Department of Anthropology
University of California, Santa Barbara

Although many archaeological investigations have been conducted on Santa Cruz Island, these studies tend to focus on coastal areas, with an emphasis placed on the study of faunal remains in prehistoric diet reconstruction. Relatively little work has been conducted in interior areas, with almost no attention placed on the role of plant remains in subsistence strategies. Ethnographic information indicates that plants were integral to Chumash culture, not only for subsistence, but also for medicinal, ceremonial, and functional purposes. Due to the low visibility of plant remains in archaeological sites, and the time-consuming analysis required to study them, we know very little about prehistoric usage of plants in the Santa Barbara Channel area. With this in mind, several archaeological sites on Santa Cruz Island have been selected for further investigation. These include Middle and Late Holocene sites located in the Central Valley and a bedrock mortar complex located on the northern ridge, near Diablo Peak. An analysis of these sites, and the plant remains from them, will provide a better understanding of not only prehistoric subsistence practices, but also ceremonial, medicinal, and functional practices related to plants.

Non-invasive Monitoring of Recovering Channel Island fox *(Urocyon littoralis)* Populations

Melissa M. Gray, Department of Ecology and Evolutionary Biology
University of California, Los Angeles

Genotyping scat samples has emerged as a promising population monitoring tool for many organisms. This method was applied to recovering populations of Channel Island fox *(Urocyon littoralis)*. The island fox, endemic to the Channel Islands off the coast of Southern California, declined by over 95% in the 1990s due to predation by golden eagles *(Aquila chrysaetos)*. This was the impetus for listing the island fox as federally endangered. Since then, intensive removal of golden eagles has taken place, and captive breeding has increased island fox populations to the point where release back into the wild has begun. The success of wild population recovery is being tracked via population monitoring, which so far has been accomplished by costly and labor intensive live-trapping and radiotelemetry methods. The feasibility of monitoring the island fox populations long term by means of non invasive sampling of scat was explored. Appropriate study sites were selected on Santa Cruz Island, which currently has a population of 150+ individuals and on San Miguel Island, which has a population of about 50 individuals. Comparisons with data from radiotelemetry, live-trapping, and genotypes from blood samples have served as a means to evaluate the effectiveness of fecal genotyping as a population monitoring tool. The effectiveness of these methods is currently being evaluated and, if proven competent, could result in a more precise and cost-effective means to monitor the population for the long term, which will enable managers to better determine whether island fox recovery is successfull.

Abstracts

SUNDAY MORNING SESSION

Protection from grazers: an associational defense between kelp and an epiphytic bryozoan?
Sarah Bryson, Department of Ecology and Evolutionary Biology
University of California, Los Angeles

Due to close proximity, hosts and epiphytes potentially exert strong ecological influences on each other. In the case of kelp, associated epiphytes may negatively impact the host due to shading and blocking nutrient uptake. However, an epiphyte can reduce the susceptibility of its host to herbivory. This research examines whether an epiphytic bryozoan, *Membranipora membranacea*, provides an associational refuge from herbivory for its host giant kelp. I hypothesized that the presence of *Membranipora* reduces the grazing damage on kelp inflicted by small grazers. Individual invertebrate grazer species were tested in the laboratory to determine their feeding preferences for kelp with or without *Membranipora*. Almost all grazers (Norris' topsnail, top snails, Lacuna snails, amphipods, and kelp isopods) were found to have a strong preference for kelp without the bryozoan. However, kelp crabs showed a preference for kelp encrusted with *Membranipora*. Field surveys indicate a slight reduction of grazing on kelp blades heavily encrusted with *Membranipora* in areas dominated by small grazers in the canopy. These results suggest that while some protection from herbivores may be gained when *Membranipora* is present, it is unlikely to outweigh the overall costs of hosting the epiphyte.

Effects of fine sediment and grazers on periphyton and nutrient cycling in a coastal river
Michael Limm, Department of Integrative Biology
University of California, Berkeley

Excessive loading of fine sediment is one of the most serious impacts of land-use on stream ecosystems in arid and semi-arid environments. Detrimental direct effects of excessive fine sediment are well documented for fish, invertebrates, and buried periphyton. Periphyton growing on clear surfaces may also be indirectly affected by deposited fine sediment, but these indirect effects remain poorly known. Two hypothesized mechanisms for indirect effects of fine deposited sediment on periphyton include hydraulic changes resulting from a smoothed riverbed, and changes in ambient grazer biota resulting from embedded substrates. We manipulated fine sediment in experimental channels and quantified periphyton accrual, metabolism, and nutrient uptake under both natural and reduced grazer conditions. Grazers were reduced by electric fence chargers surrounding experimental tiles in each sediment treatment, allowing us to contrast the indirect effect of altered food web dynamics from the direct effect of altered hydraulic conditions. Results after thirty and sixty days suggest periphyton was not affected by hydraulic contrasts imposed by our sediment manipulation. While periphyton accrual, metabolism, and nutrient uptake did not differ among sediment manipulations, ambient grazing stimulated greater nitrogen uptake and greater metabolism per unit mass. Our results suggest under low flow summer conditions grazer effects outweigh any indirect hydraulic effects of a smoother bed due to deposited fine sediment, and food web composition and/or dynamics can alter nutrient cycling in a coastal river.

Where does maritime end and interior begin? Land use policy dilemmas and the potential use of ecophysiology to help delimit the landward distribution of maritime chaparral along the central California coast

Michael C. Vasey, Department of Environmental Studies
University of California, Santa Cruz

Chaparral is a quintessential Mediterranean-type shrubland in California. Although it covers vast areas in the mountains of interior California, there are several more restricted stands of chaparral along the central California coast called “maritime chaparral.” Maritime chaparral is rich in rare endemic species. Because of its limited distribution, concentration of local endemics, and threats of urbanization in this region, maritime chaparral is designated as a protected sensitive natural community under CEQA and the California Coastal Commission protects maritime chaparral as an Environmentally Sensitive Habitat Area. These regulatory protections have resulted in a land use policy storm that threatens to become increasingly costly and acrimonious. At issue is the difficulty in distinguishing “maritime” from “interior” chaparral. In this study, I hypothesize that maritime chaparral distribution is influenced by the moderating effects of coastal fog on drought effects caused by California’s long, hot summer. Using data from four core research sites established along a heavy fog to no fog gradient, I demonstrate that water potentials in *Arctostaphylos* are much less negative (less drought stress) in maritime versus interior habitats. Further, by the end of the dry season, water potential metrics help to clarify the status of a potentially questionable chaparral site. Other ecophysiology parameters (such as PSII fluorescence) reinforce these findings. Subject to further studies designed to validate these patterns and identify causal mechanisms, the use of ecophysiology tests in contentious cases might provide objective criteria to help resolve this “maritime versus interior” land use policy question and help diffuse this dilemma.

Water Isotopes of Coast Redwood Saplings Reveal Summertime Hydration Status and Water Dynamics at the Leaf Level

Emily Limm, Department of Integrative Biology
University of California, Berkeley

The Angelo Coast Range Reserve in Mendocino County contains a relict population of old-growth coast redwood trees. These redwoods grow at the eastern edge of the redwood range, tucked behind coast range mountains that prevent marine fog from bringing a water subsidy into the forest during the summer months. To understand if redwoods growing outside of the belt suffer from severe drought stress during the summer, I measured the level of water stress in 6 redwood saplings diurnally following a multiple-day heat wave in July 2006. Additionally, I sampled stem water for isotopic analysis to identify the water source used by each sapling and sampled 3 cohort of leaves from each sapling diurnally to evaluate isotopic differences in leaf water between the leaf age classes. I found that despite the severe heat experienced by the saplings in the 10 days prior to sampling, the saplings showed no signs of drought stress. The isotopic composition of the stem water revealed that the redwoods were likely using predominately South Fork Eel River water, a consistently available water source throughout the summer season. Additionally, I determined that the redwood leaf cohorts maintain consistent differences in water isotope composition overnight, showing significant leaf water isotopic enrichment in younger leaves. Due to the arrangement of redwood foliage along branches, the age of leaf cohorts is correlated with position and further investigation is required to interpret whether the age of the leaf or its position along the branch influences evaporative enrichment in redwood leaves.

Abstracts

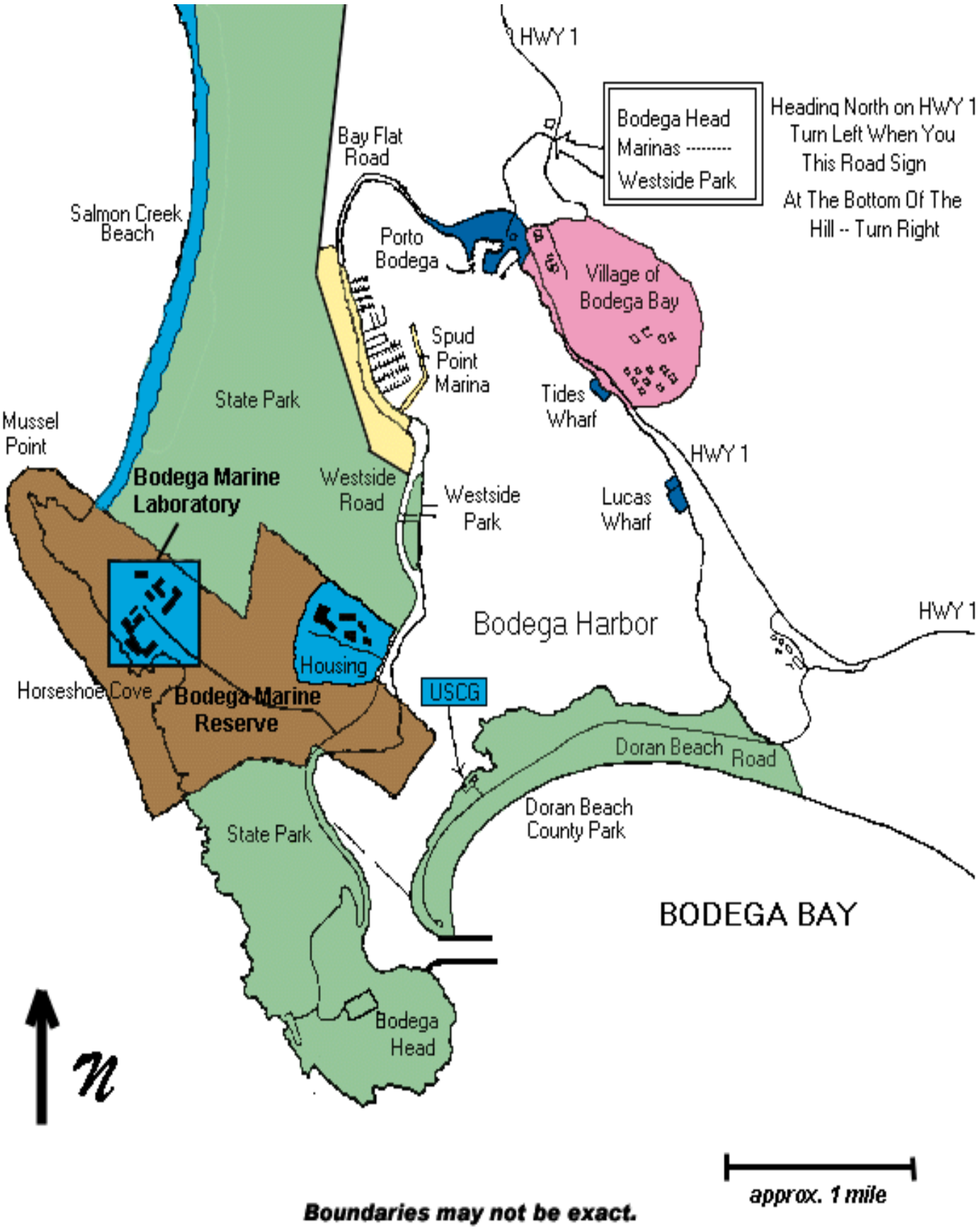
Vocal individuality in ground squirrel alarm calls
Kimberly A. Pollard, Department of Ecology and Evolutionary Biology
University of California, Los Angeles

Individuality can reveal itself in a variety of ways—behavior, physical appearance, scent, voice—but how do individualistic traits evolve? Individual distinctiveness aids individual recognition, which is critical for many functions that occur within groups of social animals. We predict these needs will be greater in larger social groups, and therefore that evolution will favor increases in individual distinctiveness in species with larger social group sizes. Using the alarm calls of ground-dwelling sciurid rodents (ground squirrels and their relatives), we describe, quantify, and compare vocal distinctiveness and address adaptive questions about how and why individuality evolves. The latest results from UC Reserve species and other species will be discussed.

Physiological and behavioral responses of leopard sharks *(Triakis semifasciata)* to salinity change
W. Wesley Dowd, Graduate Group in Ecology
University of California, Davis

Physiological responses to environmental changes can occur at several organizational levels (molecular, cellular, organismal) and over several time-scales. Behavioral responses may complement or even override physiology, requiring an integrative approach to relate laboratory results to ecological consequences. Here, we assess both physiological and behavioral responses of leopard sharks *(Triakis semifasciata)* to laboratory salinity changes. Sharks were acclimated to 60%, 80%, or 100% seawater for 48 hours (short-term) or 3 weeks (long-term). Plasma samples were analyzed for osmolyte concentrations to assess organismal osmoregulatory status. To assess underlying molecular mechanisms, we identified several proteins that were up- or down-regulated in osmoregulatory tissues (gill, rectal gland) during salinity change using a proteomics approach (i.e., 2-dimensional electrophoresis and mass spectrometry). The functions of these proteins were assessed using bioinformatics databases and pathway analysis software. Behavioral responses (swimming activity) were monitored using focal animal surveys and point sampling. Changes in plasma osmolality, sodium, and chloride concentrations lagged behind changes in the salinity of the water, and the osmotic gradient between shark and environment was greatest at 24 hours. Sharks remained hyperosmotic but hypoionic to the medium in short and long-term experiments. In the short-term swimming activity increased in lower salinities. Meanwhile, individuals in 60% seawater in the long-term treatment responded behaviorally by reducing their activity by ~50%, suggesting a long-term behavioral tradeoff for increased costs of osmoregulation. These multi-level laboratory results provide a baseline for comparison with ongoing field studies to evaluate tradeoffs between physiology and behavior in wild sharks inhabiting dynamic estuarine systems.

MAP OF BODEGA HEAD



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

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