Natural Reserve System
UNIVERSITY OF CALIFORNIA

2016 MATHIAS SYMPOSIUM

Bodega Marine Laboratory/Reserve
February 26–28

Welcome

The UC Natural Reserve System welcomes you to the 2016 Mathias Symposium at Bodega Marine Laboratory and Reserve. The Mathias Symposium is held biennially to showcase the work of Mildred E. Mathias Graduate Student Research Grant recipients.

The Mathias grant program supports early-career scientists and scholars establishing independent research projects at NRS reserves. Recipients obtain valuable experience applying for and managing research grants while improving our understanding of the natural environment.

Through the Mathias program, UC graduate students have advanced research in marine biology, geology, species evolution, anthropology, the arts, and much more. This year, Mathias grant recipients will present research findings on topics ranging from trout migration, stream morphology, climate warming impacts, sediment records, and much more. Guest speakers Jessica Blois of UC Merced and Benjamin Becker of Point Reyes National Seashore will discuss our ever-changing environment, marine ecology, and careers in science.

The program honors UC Los Angeles botanist and professor Mildred E. Mathias, one of the founders of the NRS. Since the program's inception in 1988, over 425 UC students have received more than $790,000 in Mathias Grant funding.

The Mathias Symposium was made possible by the Kenneth S. Norris Endowment Fund for the California Environment, provided to the NRS by the David and Lucile Packard Foundation. We also thank Patricia Kline and Jill McIntire for their generous support of the Mathias Grant Program. Contributions such as these make the continued success of the program possible.

LOBSANG WANGDU

GUEST SPEAKERS

COURTESY BEN BECKER

Benjamin Becker

Chief Scientist and Marine Ecologist
Point Reyes National Seashore
Ph.D. University of California, Berkeley

Ben Becker is the Chief Scientist and Marine Ecologist at Point Reyes National Seashore. He also manages the Pacific Coast Science and Learning Center, which facilitates external researchers working in the park and the dissemination of new findings to park managers and the public. This includes immersive science programs for Bay Area youth.

CHRIS SWARTH

Jessica Blois

Assistant Professor
School of Natural Sciences, UC Merced
Ph.D. Stanford University

Jessica Blois is a paleoecologist interested in understanding the factors contributing to changes in genes, species, and communities across time and space. She combines field work aimed at broadening our samples of fossil and modern mammals, ancient and modern DNA analysis to understand how genetic diversity is structured spatiotemporally, and paleobiogeographic modeling. Most of her work centers on the small mammals and vegetation of North America over the last 21,000 years. She is particularly interested in teasing apart the roles of environmental versus biotic drivers of biodiversity change, merging data from different kinds of fossil proxies such as mammal bones and plant macrofossils, and merging perspectives from the past and present to help conserve future biodiversity.

SCHEDULE **Friday** *afternoon and evening*

NOON–1:30 P.M.
LUNCH
food service to 12:45 p.m.

2:00–2:40 P.M.
Opening remarks
Erin Marnocha, Program Coordinator, UC Natural Reserve System

Introduction to Bodega Marine Laboratory and Reserve
Suzanne Olyarnik, Reserve Director, Bodega Marine Reserve

2:40–3:05 P.M.
Geologic controls on the distribution of gravel patches: bedrock-forced pools in a boulder- and cobble-bedded river
Allison Pfeiffer, Earth and Planetary Sciences, UC Santa Cruz

3:05–3:30 P.M.
Evolution and ecology of partial migration in a Pacific salmonid
Suzanne Kelson, Environmental Science, Policy, and Management, UC Berkeley

3:30–3:50 P.M.
BREAK

3:50–4:15 P.M.
The genetic basis of adaptation to climate change in a thermally sensitive ant
Maria Tonione, Environmental Science, Policy, and Management, UC Berkeley

4:15–4:40 P.M.
Experimental removal of an introduced pollinator reduces reproductive success of California native clustered tarweed
Annika Nabors, Ecology, Behavior and Evolution, UC San Diego

4:40–6:00 P.M.
TOUR
Bodega Marine Laboratory
Suzanne Olyarnik, Reserve Director, Bodega Marine Reserve

6:00–7:15 P.M.
DINNER
food service to 6:45 p.m.

7:20–8:20 P.M.
LECTURE
Long-term trophic level variation in California Current seabirds from 1880–2005
Benjamin Becker, Chief Scientist and Marine Ecologist, Point Reyes National Seashore

SCHEDULE **Saturday** ***morning***

8:00–9:00 A.M. **BREAKFAST**
food service to 8:45 a.m.

9:00–9:25 A.M. **Using historic photographs to document plant species range shifts over 35+ years in the arid Deep Canyon Transect**
Sarah Skikne, Environmental Studies, UC Santa Cruz

9:25–9:50 A.M. **Mustard mayhem! Pinning the origin and pathways of a highly invasive species**
Daniel Winkler, Ecology and Evolutionary Biology, UC Irvine

9:50–10:15 A.M. **Descent to the underworld: climate change opens gap in distribution of American pika in the Sierra Nevada, USA**
Joseph Stewart, Ecology and Evolutionary Biology, UC Santa Cruz

10:15–10:35 A.M. **BREAK**

10:35–11:00 A.M. **Explaining community assembly processes along the California rocky shore**
Laura Elsberry, Ecology and Evolutionary Biology, UC Irvine

11:00–11:25 A.M. **Variation in decomposition rates and the enzymatic constraints of microbial communities across a climate gradient in southern California**
Nameer Baker, Ecology and Evolutionary Biology, UC Irvine

11:25–11:50 A.M. **Genetic and environmental drivers for host population persistence vs. die-off in the face of pathogen invasion**
Mary Toothman, Ecology, Evolution, and Marine Biology, UC Santa Barbara

SCHEDULE **Saturday** ***afternoon and evening***

NOON–1:15 P.M.

LUNCH
food service to 12:45 p.m.

1:20–1:45 P.M.

Center vs. edge—spatial variation in demographic responses to climate manipulations
Meagan Oldfather, Integrative Biology, UC Berkeley

1:45–2:10 P.M.

Assessing drivers of change in California forests using a comprehensive historical dataset
Kelly Easterday, Environmental Science, Policy, and Management, UC Berkeley

2:10–4:00 P.M.

TOUR
Bodega Marine Reserve
Suzanne Olyarnik, Reserve Director, and Lewis Reed, Reserve Steward, Bodega Marine Reserve

6:00–7:15 P.M.

DINNER
food service to 6:45 p.m.

7:20–8:20 P.M.

LECTURE
Ecological processes in a changing environment: perspectives from the past
Jessica Blois, Assistant Professor, School of Natural Sciences, UC Merced

SCHEDULE **Sunday *morning***

8:00–9:00 A.M. **BREAKFAST**
food service to 8:45 a.m.

9:00–9:25 A.M. **Sedimentary record of recent flood events from Sauces Canyon, Santa Cruz Island, California**
Laura Reynolds, Earth Science, UC Santa Barbara

9:25–9:50 A.M. **Interactions between salt marsh plants across a latitudinal gradient: the effect of environment and population**
Akana Noto, Biological Sciences, UC San Diego

9:50–10:10 A.M. **BREAK**

10:15–10:35 A.M. **Invasions in the Eel: current status of invasive organisms in the South Fork of the Eel River**
Philip Georgakakos, Integrative Biology, UC Berkeley

10:35–11:00 A.M. **How much does phenology matter? An assessment of phenology dynamics in *Lasthenia californica***
Rachael Olliff, Integrative Biology, UC Berkeley

11:00 A.M.–NOON **PANEL DISCUSSION**
Career opportunities
Benjamin Becker, Point Reyes National Seashore
Jessica Blois, UC Merced
Michael Hamilton, Blue Oak Ranch Reserve, UC Berkeley
Erin Marnocha, UC Natural Reserve System
Suzanne Olyarnik, Bodega Marine Reserve, UC Davis

NOON–1:15 P.M. **LUNCH**
food service to 12:45 p.m.

Geologic controls on the distribution of gravel patches: bedrock-forced pools in a boulder- and cobble-bedded river

Allison Pfeiffer, Earth and Planetary Sciences, UC Santa Cruz

Salmon lay their eggs in nests dug out of the gravel on the bed of a stream. Because salmon cannot move grains over a certain size, the distribution of moveable gravel within a river system is an important control on the distribution of salmon habitat. However, not all salmon-bearing streams have gravel beds. Big Creek, a steep drainage in the Santa Lucia Mountains of central California, supports an endangered steelhead (*Oncorhynchus mykiss*) population despite its cobble- and boulder-covered bed. Considered on the broad scale, the geomorphology of this river should support little to no salmonid habitat; yet steelhead come back to breed there every year. In Big Creek, critical spawning habitat exists only in small patches, where fine sediment collects in an otherwise cobble- and boulder-bedded channel. This leads to the question: where are gravel patches in Big Creek, and what factors control that distribution? Based on my initial findings, the distribution of gravel patches is correlated with the occurrence of bedrock-forced pools. The location of these pools, in turn, is controlled by the presence or absence of erosion-resistant bedrock lithology.

Ecological consequences of partial migration in a salmonid fish

Suzanne Kelson, Environmental Science, Policy, and Management, UC Berkeley

Partial migration is an evolutionary fascinating phenomenon in which only some individuals from a population migrate to utilize of distant resources. *Oncorhynchus mykiss* is a threatened, partially migratory species. Within one stream, some individuals migrate to the ocean (steelhead trout) while others remain in freshwater (rainbow trout). Here I focus on how geomorphology and hydrology determines the frequency of resident vs. migratory genotypes, which has effects for stream ecology. I predicted that waterfalls would select against migratory adults who are travelling upstream to reach breeding grounds, and can only ascend in flood events. I genotyped almost 2000 fish from two streams at a region in the genome that is closely linked with migration (Pearse et al. 2014). I found that the largest waterfall on one stream (3.1 m high) strongly influences the distribution of resident and migratory life history genotypes (72% resident genotypes above vs. 44% below). I found differences in density and size structure associated with each life history. The density of age-0 fish is almost 4x higher in migratory regions, while the density of age-1 and older individuals is significantly lower ($P < 0.05$ for both comparisons). There are clear conservation applications to understanding the evolution and ecology of partial migration in *O. mykiss*. Migratory *O. mykiss* are federally protected throughout California, while resident trout are not. Understanding the extent to which resident and migratory fish spatially overlap, potentially interbreed, and differ in their ecology, could have implications for the level of protection that each life history receives.

The genetic basis of adaptation to climate change in a thermally sensitive ant

Maria Tonione, Environmental Science, Policy, and Management, UC Berkeley

Human-mediated climate change will continue to exert strong selective pressure on species in rapidly changing environments. Adaptation by these species will determine their fate: some will be unable to rapidly adapt, and will go extinct. Others will adapt to the new conditions, and perhaps thrive. Some will experience range shifts as they track optimal conditions. Understanding the mechanisms and pace of adaptation to climatic changes is crucial to predicting which of these fates a species will experience. I am investigating the genetic basis of thermal adaptation in a species of ant that is a cold-temperature specialist (the winter ant, *Prenolepis imparis*). I am doing thermal physiology experiments, high-throughput sequencing, and phylogenetic reconstruction using both mitochondria and nuclear DNA. For thermal physiology, I am collecting microclimate information across seven populations in California. I will then compare activity levels at these different populations at high and low temperatures. My preliminary data across seven populations suggest that ants from high elevation tolerate heat better and recover from chill-coma faster than sites from low elevations. In order to understand what genes are important for heat stress, I am also analyzing gene expression levels at extreme temperatures using RNA sequencing (RNAseq). My RNA sequencing data has allowed me to identify candidates for heat stress adaptation. In addition, with identified genes from the RNAseq screen, I will do an exon capture in order to reconstruct the phylogeny. Future plans include testing functionality of these gene candidates using RNA interference (RNAi) to halt production of these genes.

Experimental removal of an introduced pollinator reduces reproductive success of California native clustered tarweed

Annika Nabors, Ecology, Behavior and Evolution, UC San Diego

Honey bees (*Apis mellifera*), introduced worldwide by humans, are often a numerically dominant pollinator in non-managed ecosystems, but surprisingly few experimental studies have examined the effect of honey bee visitation on wild plant reproduction. I experimentally removed honey bees from plots of clustered tarweed (*Deinandra fasciculata*: Madiinae), a native annual forb, to measure the contribution of *Apis* visitation to tarweed seed set. While removal of *Apis* did reduce seed set, the much higher rate of honey bee visitation suggests that honey bees contribute modestly to seed set compared to non-*Apis* pollinators. Honey bees visit more than three times as many capitula per visitor, yet their removal results in only a 15 percent decrease in seed set. Visits by non-*Apis* visitors significantly increased when *Apis* was removed, indicating possible competition between *Apis* and other insects. In ecosystems where honey bees become numerically dominant, they can contribute a significant proportion of visits to native plants. *Apis* removal may negatively affect plant reproduction, especially during years in which native pollinators are relatively uncommon because of lack of floral resources, but it may also release native pollinators from competitive displacement.

LECTURE

Long-term trophic level variation of California Current seabirds from 1880–2005

Benjamin H. Becker, Chief Scientist and Marine Ecologist, Point Reyes National Seashore

Prey availability and quality can affect seabird reproductive success, survivorship, and long-term population persistence. A key question is to what degree dietary variation in seabirds is explained by top-down (human harvesting of prey) or bottom-up effects (natural variability, climate change) on prey availability. We sought to test the relative importance of these factors by examining variation in diet (trophic level) and niche width (dietary diversity) in five species of California Current seabirds from the 1880s–2005 using stable carbon and nitrogen isotope ratios of feathers from museum specimens. To ensure that isotope signatures represented the California Current, we chose seabird species that underwent both basic and alternate molt in or near central California: common murre (*Uria aalge*), marbled murrelet (*Brachyramphus marmoratus*), tufted puffin (*Fratercula cirrhata*), pelagic cormorant (*Phalacrocorax pelagicus*), and Cassin's auklet (*Ptychoramphus aleuticus*). Overall, trophic level declined for most species over the study period, suggesting less reliance on fish and more on invertebrates. Most of the decline in trophic level was explained simply by time, suggesting long-term monotonic changes. However, relationships to oceanic indices and prey harvest will also be discussed.

Using historic photographs to document plant species range shifts over 35+ years in the arid Deep Canyon Transect

Sarah Skikne, Environmental Studies, UC Santa Cruz

While species have on average shifted poleward and upward in elevation concurrent with recent climate change, individual species range shifts have been idiosyncratic. To explore the mechanisms driving this variation, we developed a method to use untapped historic data to document range shifts in dozens of plant species along a steep elevational gradient in the arid Deep Canyon Transect, which spans 2600 m in elevation over 35 km in Riverside County, CA. In the late 1970s, sites spanning this gradient were permanently marked and photographed. In 2015, we re-located and re-photographed the exact views of these photos. Using ArcGIS and monoplotting software, we have extracted geo-referenced data on plant distributions in paired historic-modern photos. These methods allow us to track changes in perennial species abundance, and in the establishment, growth and mortality of individual plants, providing a new and efficient approach for mapping multi-species range shifts over the last 35+ years. We will combine findings from these efforts with complementary data on changes in vertebrate and plant species taken using traditional transect-based sampling to provide a comprehensive view of community change in the area and a platform for exploring the role of species interactions in range shifts. Our work demonstrates the potential to study responses to climate change through the use of largely underutilized historic photographs and to develop long-term re-photography programs to aid in monitoring range shifts and implementing appropriate conservation actions as climate change advances.

Mustard mayhem! Pinning the origin and pathways of a highly invasive species

Daniel Winkler, Ecology and Evolutionary Biology, UC Irvine

The invasive Sahara mustard (*Brassica tournefortii*) is having ever-greater impacts on natural ecosystems across the southwestern United States. This invader has become increasingly common in semi-arid regions including all counties in southern California and throughout the southwest United States and northwest Mexico. In areas where invasion rates are high, biodiversity is declining, native species are becoming displaced or extinct, and natural resources are being altered. Conservation efforts are stalling and stakeholders are discouraged by their limited options for response. Individual plants can produce over 16,000 seeds that disperse via small mammals, flowing water, wind, and human transport. The number of seeds a single plant can produce has likely contributed to the species' rapid spread into habitats ranging from Los Angeles, CA to El Paso, TX. We collected and sequenced genetic samples from across Sahara mustard's contemporary invasion extent to determine introduction sites and map the spread of Sahara mustard in the United States. Additionally, we collected seeds from 1,000+ individuals, a subset of which were grown in a common garden to test for trait variation. Preliminary results will be presented and future directions will be discussed.

Descent to the underworld: climate change opens gap in distribution of American pika in the Sierra Nevada, USA

Joseph Stewart, Ecology and Evolutionary Biology, UC Santa Cruz

Contemporary climate change has been documented as the cause of range contractions at the edge of many species distributions but has not previously been documented as a cause of extirpation of core habitat within contiguous areas of a species' range. Here, we document the extirpation of the American pika (*Ochotona princeps*), a temperature-sensitive small mammal, from the Pluto triangle, a 165 km^2 area around Mount Pluto, California, mildly isolated by distance, river, lake, and non-suitable habitats from circumferential pika-inhabited areas. While nearby sites surrounding the triangle still maintain pikas, our radiocarbon analysis of pika feces recovered within the triangle indicates that former patch occupancy ranges from pre-atomic bomb testing to 1955. Despite an abundance of suitable habitat, climate warming, ongoing since approximately the 1920s and aggravated since the 1970s, appears to have precipitated their regional demise. This is the first modern account of an apparent climate-mediated regional extirpation of a species within a broad contiguous area of its distribution. The finding suggests that even core areas of species habitat may be vulnerable to climate change within a timeframe of decades.

Explaining community assembly processes along the California rocky shore

Laura Elsberry, Ecology and Evolutionary Biology, UC Irvine

A major goal of community ecology is to understand how communities are formed and which abiotic and biotic conditions constrain community assembly. Null model analyses have allowed ecologists to examine presence-absence data to identify whether random or deterministic processes are acting on communities and whether species interactions are positive or negative. At eight rocky intertidal sites along the California coast, we used 10 randomly placed transects and identified species at each vertical 0.5 m interval. We collected water samples at each site to quantify abiotic factors such as salinity, nutrients, and chlorophyll a. We then analyzed the data using co-occurrence models to determine community assembly processes. We found that deterministic processes were acting on the California coast as a whole. However, at the site level we found that most sites were randomly assembled, but deterministic processes characterized two sites. Nutrient availability increased with increasing latitude, suggesting that nutrient limitation may be acting as an environmental filter along the California coastline. Positive associations between species also seem to be important in determining coast-wide community assembly processes, with positive associations being more common in southern California than northern California. Positive associations dominating southern sites may indicate that southern sites are more physically stressful than northern sites. Understanding how communities are assembled and the drivers of these processes can help ecologists predict how communities will respond to changing abiotic and biotic conditions.

Variation in decomposition rates and the enzymatic constraints of microbial communities across a climate gradient in southern California

Nameer Baker, Ecology and Evolutionary Biology, UC Irvine

The return of organic carbon to the atmosphere through terrestrial decomposition is mediated through the breakdown of complex organic polymers by extracellular enzymes produced by microbial decomposer communities. It is unclear how microbial diversity constrains enzymatic potential, making it difficult to predict future carbon cycling under climate change scenarios that could alter microbial community composition. To address this question, we transplanted fine-pore nylon mesh "microbial cage" litterbags containing grassland litter with and without local inoculum across five sites in southern California, spanning a gradient of 4.0–24.5° C in mean annual temperature and 129–630 mm mean annual precipitation. Litterbags were deployed in November 2014 and collected in March, June, September, and December 2015. In addition to mass loss, collected litterbags were assayed for potential activity, substrate affinity, and temperature sensitivity of nine classes of extracellular enzymes. We hypothesized that enzymatic characteristics of the microbial communities in our litterbags would come to resemble that found in microbial communities local to each site. Our results did not support this hypothesis: instead, we found that the temperature sensitivity and substrate affinity of extracellular enzymes appear to be tightly constrained by either community origin or litter chemistry, despite the fact that significant differences in these enzymatic characteristics can be observed when comparing litter local to each site.

Genetic and environmental drivers for population persistence vs. die-off in the face of pathogen invasion

Mary Toothman, Ecology, Evolution, and Marine Biology, UC Santa Barbara

Batrachochytrium dendrobatidis (Bd) is a pathogenic fungus that causes chytridiomycosis, a skin disease responsible for declines and extinctions in amphibian species worldwide, including mountain yellow legged (MYL) frogs, *Rana muscosa* and *Rana sierrae*, in California's Sierra Nevada. While most populations invaded by Bd are extirpated, a few have declined but rebounded to stable populations, persisting with sub-lethal Bd infections. Our research group's main objective has been to understand how this happens. Laboratory experiments have confirmed that MYL frogs resist or tolerate Bd reinfection if their first infection is cleared before it causes mortality. What factors allow this immune response to work in Bd-positive, persisting MYL frog populations, but not in extirpated populations? Do favorable genetic and immunological traits allow some individuals to survive Bd infection and lead to population rebound? Most genetics and gene expression analysis has required sacrificing animal subjects to acquire samples, and I discuss non-destructive techniques I am developing to answer these questions. Do environmental factors like water chemistry, substrate type and aquatic community influence Bd's ability to colonize outside the host and therefore its ability to infect frogs? It is generally understood that disease spread is influenced by the external environment, but attempts to quantify environmental effects influencing Bd invasions are few. I hypothesize that some combinations of individual frog traits and environmental factors can push populations toward either persistence or extirpation, and discuss methods I am using to determine any correlations between these factors and actual population outcomes. With this information, I hope to inform ecological models exploring Bd-MYL frog disease dynamics developed by our research group, provide information that aids in successful conservation efforts, and predict the impact and outcome of new outbreaks. Understanding the combined effects of host traits and environmental factors could be used to manage emerging disease systems, including human diseases and especially other emerging fungal diseases.

Center vs. edge—spatial variation in demographic responses to climate manipulations

Meagan Oldfather, Integrative Biology, UC Berkeley

Predicting shifts in species distributions in response to changing climate requires a better understanding of the fundamental mechanisms underlying range limits. Refining range shift predictions can be achieved by incorporating individual-based vital rates and local climate variables, increased spatial variation among studied populations, and exposure of individuals to climate variables outside of the historical range of variation. Since 2013, I have surveyed 16 populations of *Ivesia lycopodioides* var. *scandularis* (Rosaceae) across the entirety of its altitudinal range in the White Mountains, CA. Monitoring individuals from three zones: lower elevation limit (LE), upper elevation limit (UE), and center of range (C), I am examining how demographic rates vary depending on stage-structure, as well as microclimatic soil moisture and temperature. In the 2015 growing season, I experimentally manipulated the temperature and soil moisture at nine populations and measured demographic responses compared to ambient conditions. Heating and watering affected multiple demographic rates, and the effect depended on the population's zone. Heating had a negative effect on reproductive output of C, but a positive effect in the UE. The combination of watering and heating increased flowering in C populations, ameliorating the negative effect of heating. Heating and watering had a positive effect on recruitment in LE populations, but no effect on recruitment in the other zones. The treatments only had an effect on individual growth in the edge populations. Additional seasons of manipulation will allow for estimates of additional demographic rates, and the opportunity to model population-level effects.

Assessing drivers of change in California forests using a comprehensive historical dataset

Kelly Easterday, Environmental Science, Policy, and Management, UC Berkeley

Scholarly research indicates that climate change will have profound effects on the distribution, function, and productivity of California's forests. Human interactions with forested landscapes including fire suppression and resource extraction add yet another layer of complexity to our understanding of the relative contributions of climate change and anthropogenic land management practices as drivers of change. For example, changes in California's forest structure towards smaller, denser forests across the state has been attributed to climate change-related temperature increases and declining water availability, as well as to historical management practices such as fire suppression and logging. Disentangling how these management and climatic drivers of change act interact on the landscape is critical to developing sound policy and land management practices in coming centuries. To understand these interactions and their resulting landscape-scale trajectories, we must examine landownership patterns. Ownership patterns help to explain much of the variation in land management practices, current patterns of vegetation cover types, and trajectories of land cover change. Land ownership and related management practices produce distinct signatures on landscapes, creating patterns that influence a variety of ecological processes. In this study I use a comprehensive historical dataset, the Vegetation Type Mapping project, and a modern forest inventory dataset, FIA, to analyze how much variation in vegetation composition and structure over a nearly 100-year period can be explained by land ownership. Where change is left unexplained by ownership hints that there may be larger climatic influences at play.

LECTURE

Ecological processes in a changing environment: perspectives from the past

Jessica Blois, Assistant Professor, School of Natural Sciences, University of California, Merced

Understanding the patterns of and mechanisms underlying biodiversity change is important given the many factors that may influence future species and communities. To provide a long-term context for recent and future biodiversity changes, my research explores the influence of two potential primary drivers of biodiversity change: climate and associations between species. In this talk, I focus on several projects that use the Quaternary fossil record of the past 21,000 years to disentangle these two potential drivers, and in the process, explore the robustness of models commonly used to project future biodiversity changes. Overall, Quaternary fossil assemblages show strong signals of environmental structuring, which implies that, at least at broad scales, climate-based models are relatively good for predicting changes in species and communities. Interactions between species are likely influencing assemblage structure and diversity as well; incorporating associations between taxa into models could lead to relatively greater predictive ability, particularly across periods of substantial climate change. Despite improved understanding of the factors structuring Quaternary biodiversity, models perform poorly with increasing amounts of climate change and regardless of whether associations are included or not, so care needs to be taken when projecting biodiversity changes into potential no-analog climates of the future.

Sedimentary record of recent flood events from Sauces Canyon, Santa Cruz Island, California

Laura Reynolds, Earth Science, UC Santa Barbara

The coastline of Santa Cruz Island, Ventura County, California, has a long history of environmental change due to anthropogenic modification, tectonic events, climate changes, and impacts from short-duration natural hazards such as storms, tsunamis, and wildfires. While past studies have addressed the environmental history recorded in sediments preserved in the lakes, estuaries, and offshore environments of the other Channel Islands, no sediment cores, to our knowledge, have been taken from the small estuaries that often exist at the mouths of coastal canyons along Santa Cruz Island. Here we show preliminary results from a transect of seven vibracores up to 1.5 m in length taken from the estuary located at the mouth of Sauces Canyon (Cañada de los Sauces), along the southwest coast of Santa Cruz Island. These cores show four distinct, correlative, fining-upward packages above bedrock. Each 10–50 cm package has a sharp or erosional base and fines upward from gravel and pebbles to organic-rich clay. Charcoal fragments counted at the 125-250 μ and >250 μ size fractions vary regularly throughout the mud units, without distinct peaks commonly associated with fire or erosional events. Two radiocarbon dates of plant fragments taken at 30 and 80 cm depths in core SCI14-03 returned modern ages (calibrated using CALIBOMB (Reimer et al., 2004) to 1956–2006 A.D.), while one radiocarbon date (microscopic charcoal, likely reworked) returned an age of ~5000 yrs BP. Preliminary Pb-210 data provides support for the younger radiocarbon ages, suggesting the top three packages are less than 150 years old. Therefore, we hypothesize that each of these fining upward packages represents a high-intensity terrestrially derived flood event separated by clay accumulation and re-establishment of wetland vegetation during periods of quiescence. The present geochronological data indicate at least three such events have occurred in the last 150 years, but higher-resolution geochronology is necessary before a recurrence interval and mechanism can be established with confidence.

Interactions between salt marsh plants across a latitudinal gradient: the effect of environment and population

Akana Noto, Biological Sciences, UC San Diego

Latitudinal variation in species interaction strength is generally thought to be associated with changes in the environment. However, geographic variation in interaction strength could be due to differences in the plants themselves, as plant populations along geographic gradients are often adapted to local conditions. Studies of geographic variation in species interactions among salt marsh plants have been done on the east coast of the United States, but rarely on the west coast, which experiences different variations in environmental stress. I investigated whether interactions among salt marsh plants varied at six salt marshes along the California coast and whether any variation was due to environmental differences among locations or differences in plant populations. In a neighbor removal experiment, I found that interaction strength varied among sites, but contrary to previous studies, this variation was not latitudinal. Variation in strength of competition may be due in part to environmental conditions, such as soil salinity, that do not vary latitudinally. A common garden experiment using plants from all six salt marshes was consistent with the field experiment and showed that plants interacted differently depending on their source, but not in a latitudinal way. Source population had a larger effect on interaction strength than precipitation, despite its effect on soil salinity. These studies suggest that interactions among plants in west coast salt marshes do not display clear latitudinal patterns and that population differences may drive geographic variation in species interactions as much as the environment.

Invasions in the Eel: current status of invasive organisms in the South Fork of the Eel River

Philip Georgakakos, Integrative Biology, UC Berkeley

Many ecosystems are experiencing increasing rates of colonization by organisms that were not historically part of the species assemblage. Freshwater aquatic habitats of the west are particularly impacted by invasions. In this talk I will explore the current state of some invasive organisms in the South Fork of the Eel River. I will present data collected during weekly snorkel surveys from May to August 2015 of nine large pools that cover a twelve-kilometer stretch of river. Key findings include: (i) seasonal range extension of Sacramento pikeminnow (*Ptychocheilus grandis*) eight kilometers upstream as river temperatures increase; (ii) associated decrease in potential prey fishes; and (iii) low non-native abundance in headwaters. These results have implications that headwater river reaches can be important refugia for native species and maintain native biodiversity in a highly altered system.

How much does phenology matter? An assessment of phenology dynamics in *Lasthenia californica*

Rachael Olliff, Integrative Biology, UC Berkeley

Restoration strategies have a crucial need for empirically supported practices that will increase success as well as broad-scale applicability. Phenology differences in seed source populations may lead to novel species interactions in the restored community. Keeping phenology in mind while planning restoration projects may be critical for retaining important species interactions, mitigating invasions, and maintaining ecosystem function. But how much does phenology really matter? To investigate this question I examine phenology patterns in *Lasthenia californica*, an annual forb commonly used in grassland restoration. This species is found across California (including in 11 of the UC Natural Reserves), blooms in early spring, and requires pollinators for successful seed set. To study phenology dynamics in *L. californica*, I combine field observations, greenhouse studies, and historical records from across its range. I am currently working on field projects at the UC Davis McLaughlin Reserve to determine the effects of precipitation, soil type, and competition on flowering time. I am also monitoring the timing of other plant community members as well as pollinators. In addition, I am investigating the potential for population differentiation in the greenhouse to examine the dynamic interactions of range and phenological timing. Experiments and observations in the next few years will further our understanding of the phenology of this species, and the implications for restoration and management practices.

BODEGA MARINE RESERVE

STAFF

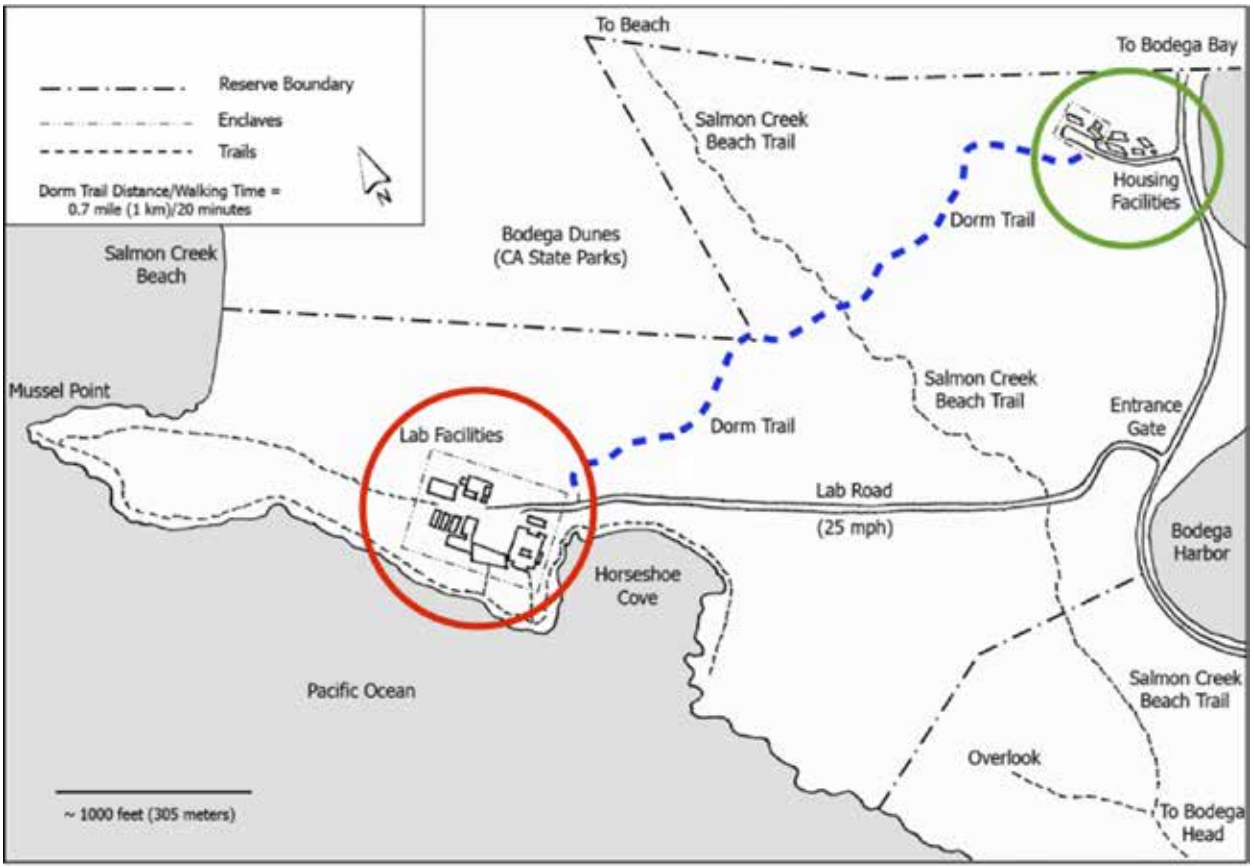
Suzanne Olyarnik
Reserve Manager

Jackie Sones
Research Coordinator

Lewis Reed
Reserve Steward

MAP

Breakfasts will be served in the Dining Hall of the **housing area**.
All other symposium activities will be at **Bodega Marine Laboratory**.



BODEGA MARINE RESERVE

HOUSING FACILITIES

Natural Reserve System

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