2019 MATHIAS SYMPOSIUM
Bodega Marine Laboratory/Reserve
February 8–10
WELCOME

The UC Natural Reserve System welcomes you to the 2019 Mathias Symposium at Bodega Marine Laboratory and Reserve. The 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.

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, more than 465 UC students have received more than $865,000 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 Graduate Student Research Grant program. Contributions such as theirs make the continued success of the program possible.
GUEST SPEAKERS

Sarah Allen
Science Program Lead, Pacific West Region
National Park Service

Sarah is the Science Program Lead for the Pacific West Region of the National Park Service and Research Coordinator for the Californian Cooperative Ecosystem Studies Unit, located at UC Berkeley. She addresses emerging and complex land/seascape level concerns of a changing environment in parks across the region, including California. Environmental changes challenge managers to be informed by and to inform the public of the science behind decisions. To provide the best available science to managers, Sarah leverages and facilitates researchers and their students to conduct research in and adjacent to parks.

David Ackerly
Dean, College of Natural Resources
UC Berkeley

David Ackerly is Dean of the College of Natural Resources at UC Berkeley. Ackerly's research group studies the impacts of climate change on biodiversity in California, and the implications for conservation and land management. He co-leads the Terrestrial Biodiversity Climate Change Collaborative (TBC3). TBC3—a Berkeley-Pepperwood collaboration—has helped develop high resolution projections for future climate in California, across a range of possible scenarios, and the group works with land managers, NGOs, state agencies and the National Park Service to consider new approaches to manage vegetation in the face of changing conditions. His lab group is currently studying forest recovery following the Tubbs Fire in Sonoma Co. Ackerly also helps lead the Climate Readiness Institute, a group of Berkeley researchers focusing on climate impacts and challenges in the Bay Area. Ackerly is the coordinating lead author of the Bay Area Regional Report for California’s Fourth Climate Assessment.
**Friday afternoon and evening**

**11:00 AM–NOON**
- **Check in** at Dining Hall and settle into lodgings

**NOON–1:00 PM**
- **LUNCH** food service to 12:45 p.m.

**1:45–2:00 PM**
- **Opening remarks**
Peggy Fiedler, Executive Director, UC Natural Reserve System

**2:00–2:25 PM**
- **Introduction to Bodega Marine Laboratory and Reserve**
Suzanne Olyarnik, Director, Bodega Marine Reserve

**2:25–2:40 PM**
- **Characterizing deep-water oxygen variability in the Southern California Bight and seafloor community responses**
Natalya D. Gallo, Scripps Institution of Oceanography, UC San Diego

**2:40–2:55 PM**
- **Sex-specific foraging strategies of a sexually dimorphic marine predator, the northern elephant seal**
Sarah Kienle, Ecology and Evolutionary Biology, UC Santa Cruz

**2:55–3:15 PM**
- **BREAK**

**3:15–3:30 PM**
- **Pinniped taphonomy: Observations from a northern elephant seal breeding colony provide new insights into the taphonomic processes of pinnipeds**
Ana M. Valenzuela-Toro, Ecology and Evolutionary Biology, UC Santa Cruz

**3:30–3:45 PM**
- **Going with the flow, or not: how larvae contend with dynamic ocean environments**
Helen Killeen, Coastal and Marine Science Institute, UC Davis

**3:45–4:00 PM**
- **The consequences of grazing disturbance on the genetic diversity of eelgrass meadows**
Nicole M. Kollars, Evolution and Ecology, UC Davis

**4:00–5:00 PM**
- **TOUR Bodega Marine Lab**
Suzanne Olyarnik, Jackie Sones, Bodega Marine Reserve

**5:00–6:00 PM**
- **SOCIAL HOUR**

**6:00–7:00 PM**
- **DINNER** food service to 6:45 p.m.

**7:15–8:15 PM**
- **LECTURE**
**Stewardship through science for public lands**
Sarah Allen, Science Program Lead, Pacific West Region, National Park Service
**SCHEDULE**

**Saturday morning**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:00–9:00 AM</td>
<td><strong>BREAKFAST</strong>&lt;br&gt;food service to 8:45 a.m.</td>
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<tr>
<td>9:30–9:45 AM</td>
<td><strong>Learning from the past: a life cycle approach to understanding California mussel declines</strong>&lt;br&gt;Lauren L.M. Pandori, Ecology and Evolutionary Biology, UC Irvine</td>
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<tr>
<td>9:45–10:00 AM</td>
<td><strong>Impacts of Mexacanthina lugubris, a dark unicorn in Southern California intertidal communities</strong>&lt;br&gt;Piper Wallingford, Ecology and Evolutionary Biology, UC Irvine</td>
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<td>10:00–10:15 AM</td>
<td><strong>Causes and consequences of intraspecific variation in Daphnia life history: how can “superfleas” be explained?</strong>&lt;br&gt;Kelsey Lyberger, Evolution and Ecology, UC Davis</td>
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<td>10:15–10:30 AM</td>
<td><strong>Seasonal foraging-mode shifts of Oncorhynchus mykiss in a Mediterranean stream</strong>&lt;br&gt;Gabriel Rossi, Integrative Biology, UC Berkeley</td>
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<td>10:30–10:50 AM</td>
<td><strong>BREAK</strong></td>
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<tr>
<td>10:50–11:05 AM</td>
<td><strong>Translocating sub-soil to the surface reveals independent effects of microclimate and plant inputs on microbial access to soil carbon</strong>&lt;br&gt;Eric Slessarev, Ecology, Evolution and Marine Biology, UC Santa Barbara</td>
</tr>
<tr>
<td>11:05–11:20 AM</td>
<td><strong>Using functional traits to build native grassland communities that are resistant to exotic annual grasses</strong>&lt;br&gt;Maddie Nolan, Ecology, Evolution and Marine Biology, UC Santa Barbara</td>
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<td>11:20–11:35 AM</td>
<td><strong>Physiological sensitivity to historic drought and deluge years for eastern Sierra Nevada conifers</strong>&lt;br&gt;Katherine Ross, Environmental Studies, UC Santa Cruz</td>
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<td>11:35–11:50 AM</td>
<td><strong>Clinal variation and plasticity in California poppy in response to climate change</strong>&lt;br&gt;Elizabeth Ryan, Ecology, Behavior and Evolution, UC San Diego</td>
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<td>NOON–1:15 PM</td>
<td>LUNCH</td>
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| 1:30–3:30 PM | TOUR                                 | Bodega Marine Reserve  
Suzanne Olyarnik, Jackie Sones                                       |
| 3:30–3:50 PM | BREAK                                |                                                                        |
| 3:50–4:05 PM | Seasonal fluctuations in natural selection help maintain genetic diversity | Ben Wasserman, Ecology and Evolutionary Biology, UC Santa Cruz         |
| 4:05–4:20 PM | Phylogeography of carpenter ants from the California Channel Islands: an evolutionary reconstruction based on phylogenomics | Ida Naughton, Ecology, Behavior and Evolution, UC San Diego             |
| 4:20–4:35 PM | Invasive gut microbiome plasticity over time | Amanda Hale, Microbiology, UC Riverside                               |
| 4:35–6:00 PM | FREE TIME                            |                                                                        |
| 6:00–7:00 PM | DINNER                               | food service to 6:45 p.m.                                             |
| 7:15–8:15 PM | LECTURE                              | Fire, climate change, and the future of California’s forests           |  
David Ackerly, Dean, College of Natural Resources, UC Berkeley         |
### SCHEDULE

#### Sunday morning

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<td><strong>Joshua tree aesthetics: a history of grazing and its charismatic yucca</strong></td>
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<td>Julia Sizek, Anthropology, UC Berkeley</td>
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<td>9:45–10:00 AM</td>
<td><strong>Response of small mammal and tick communities to wildfire and implications for tick-borne pathogen maintenance</strong></td>
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<td>Benjamin T. Plourde, School of Veterinary Medicine, UC Davis</td>
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<tr>
<td>10:00–10:15 AM</td>
<td><strong>Exploring how environmental context influences the food-storing decisions of two wild squirrel species using a novel remote data collection device</strong></td>
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<td>Amanda N. Robin, Ecology and Evolutionary Biology, UC Los Angeles</td>
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<tr>
<td>10:15–10:30 AM</td>
<td><strong>Understanding how dark-eyed juncos (Junco hyemalis) differentiate between local and foreign song</strong></td>
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<td>Felisha Wong, Ecology and Evolutionary Biology, UC Los Angeles</td>
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<td>10:30–10:50 AM</td>
<td><strong>BREAK</strong></td>
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<tr>
<td>10:50–11:50 AM</td>
<td><strong>PANEL DISCUSSION</strong></td>
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<td><strong>Career opportunities</strong></td>
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<tr>
<td>11:50–noon</td>
<td><strong>Final remarks</strong></td>
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<tr>
<td>Noon–1:00 PM</td>
<td><strong>LUNCH</strong></td>
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<td>Brown bag lunch available to eat in or to go.</td>
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Characterizing deep-water oxygen variability in the Southern California Bight and seafloor community responses

Natalya D. Gallo, Scripps Institution of Oceanography, UC San Diego

When scientists study climate change, the focus is usually on changes to mean conditions. However, animals live in temporally variable environments, which influence organism exposure histories and vulnerabilities to climate change. One manifestation of climate change, decreasing ocean oxygen, has been recorded over the last 30 years in nearshore, upper-slope depths in the Southern California Bight. How these changes compare to the magnitude of natural variability experienced by seafloor communities at short timescales was unknown. An autonomous nanolander collected high-frequency T, O2, pH, and salinity data and benthic community responses 100–400 m deep off San Diego to determine timescales of natural environmental variability, changes in variability with water depth, and community responses to variability. The diurnal oxygen range at all depths exceeded the annual long-term trend in oxygen loss. Depths of 200 and 400 m showed high oxygen variability relative to the mean, which may help buffer against deoxygenation stress by providing periods of relatively high oxygen conditions across daily and weekly timescales. Communities do not respond to large natural O2, T, and pH variability occurring over shorter time-scales, but day-night differences are apparent. Over five-month, seasonal timescales, community responses do correlate with differences in environmental conditions. The transition from fish-dominated to invertebrate-dominated communities is associated with lower oxygen conditions, suggesting a useful ecological indicator of hypoxia. Small and easy to use with small boats, nanolanders are powerful tools for studying environmental variability and seafloor community responses, and improve our understanding of community vulnerability to climate driven environmental change.

Sex-specific foraging strategies of a sexually dimorphic marine predator, the northern elephant seal

Sarah Kienle, Ecology and Evolutionary Biology, UC Santa Cruz

Many sexually dimorphic species exhibit intraspecific niche divergence, often resulting in the sexes occupying different ecological niches. However, little is known about the foraging behavior of wide-ranging, deep-diving marine predators. We documented sex-specific foraging strategies in a large, sexually dimorphic marine predator, the northern elephant seal (Mirounga angustirostris). We coupled satellite telemetry, diving behavior, and foraging success metrics from 39 adult male and 152 adult female seals and showed that males and females differed in most key foraging metrics. Males are benthic continental shelf predators with small foraging areas and high foraging success, as measured by mass and energy gain. Males were extremely consistent in their feeding behavior, showing little to no flexibility. Females are primarily mesopelagic predators with large foraging areas and moderate to low foraging success. Females show more behavioral flexibility than males; females vary feeding strategies by season, where females on the post-breeding foraging trip (February–May) have small foraging areas, short pelagic foraging dives with low efficiency, and low foraging success compared to females on the post-molt trip (May–January). There was little to no overlap between male and female foraging strategies, indicating the sexes act as different ecological species in benthic and mesopelagic North Pacific habitats. There is a trade-off between survival and foraging success: males have a lower survival rate than females but higher foraging success. Males may adopt a riskier foraging strategy to attain and maintain the large body sizes required to compete for mating opportunities, while females may adopt a risk-adverse strategy to maximize lifetime reproductive fitness.
Pinniped taphonomy: Observations from a northern elephant seal breeding colony provide new insights into the taphonomic processes of pinnipeds

Ana M. Valenzuela-Toro, Ecology and Evolutionary Biology, UC Santa Cruz

The fidelity of reconstructions of ancient communities relies on how closely fossil assemblages capture the ecological attributes of the original living communities. Therefore, understanding the processes that occur between the death of organisms and their final burial and potential fossilization are critical, constituting the core of taphonomy. In particular, taphonomic studies on bone assemblages of living populations have provided valuable insights about the properties of the source population. Actualistic studies on vertebrate taphonomy have been focused on terrestrial mammals, and little is known about the taphonomic processes affecting the record of marine mammals. Pinnipeds (seals, sea lions, fur seals) exhibit an extensive fossil and archaeological record, the interpretation of which is often impeded by the lack of research on their taphonomic processes. I present the preliminary results of a taphonomic study performed in a modern breeding colony of northern elephant seals (NES; *Mirounga angustirostris*) located at Año Nuevo State Park, San Mateo County, California. We performed direct observations along linear transects. We recorded more than 350 isolated bones and 30 pinniped carcasses in variable states of decomposition and levels of completeness. Most of the remains were identified as belonging to NES pups, followed by adult and subadult California sea lions (*Zalophus californianus*), revealing some differences with respect to the source community. Overall, these results underline the need for new and more exhaustive studies incorporating knowledge of the functional anatomy and natural history of the species, to elucidate the taphonomic processes involved in modern, archaeological, and fossil assemblages containing pinnipeds.

Going with the flow, or not: how larvae contend with dynamic ocean environments

Helen Killeen, Coastal and Marine Science Institute, UC Davis

The vast majority of marine animals reproduce by releasing free-floating eggs or larvae directly into the water column. While ubiquitous, this life history characteristic has tradeoffs. For example, dispersing fish larvae can exploit productive regions distant from adult habitats, but they are also susceptible to being swept away from suitable settlement locations by strong ocean currents. The balance between benefits and drawbacks of life as plankton determines larval mortality rates and subsequent recruitment to adult populations. To examine whether larvae are able to mediate their chances of being advected from suitable habitat in strong currents, I quantified marine fish larval distributions on the central coast of California where currents are seasonally very strong. Observed distributions showed that larvae are able to stay close to shore even when currents moving offshore were strong. Different species exhibited different distributions, suggesting that species-specific behavior and depth preference play a role in retaining larvae nearshore. These findings contradict the prevailing assumption for this region that advection of larvae from shore limits marine fish populations. Further research examining the importance of other abiotic and biotic factors for larval mortality rates will improve our understanding of this poorly understood life history stage and the population dynamics of marine species.
**ABSTRACTS**

**Friday afternoon and evening**

**LECTURE**

**Stewardship through science for public lands**

*Sarah Allen, National Park Service*

National Parks and other public lands are entrusted with the stewardship of some of the nation’s most important and vulnerable natural and cultural resources. In the Pacific West Region of the National Park Service (NPS), stewardship spans the Pacific Ocean, from the National Park of American Samoa and rare coral reefs, to Hawaii Volcanoes NP and recent active volcano eruptions, to Olympic National Park and large-scale riverine restoration, to Yosemite National Park and mega wildfires, to Channel Islands National Park and biologically diverse kelp forests. Some National Parks are experiencing high rates of ecological change, and research with partners such as the University of California and its Natural Reserve System are informing park managers how ecosystems are changing, what is at risk, and the uncertainty of future changes. Rather than looking back in time to guide resource stewardship, parks face unchartered land- and seascapes, which require new ways to imagine and plan future stewardship strategies.

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**ABSTRACTS**

**The consequences of grazing disturbance on the genetic diversity of eelgrass meadows**

*Nicole M. Kollars, Evolution and Ecology, UC Davis*

Eelgrass meadows, comprised of the seagrass *Zostera marina*, serve as an essential winter food source for Pacific brant geese. Previous research has shown that the genetic diversity (the number of unique clones) of eelgrass is important in helping eelgrass populations recover from the biomass removal caused by grazing. However, we do not know how the act of grazing affects the genetic diversity of the eelgrass. Does grazing reduce, maintain, or enhance genetic diversity? To address this question, I conducted a field experiment in Bodega Harbor, CA, that mimics grazing disturbance and measures how changes in disturbance intensity affect the number of unique clones present in the meadow. Preliminary results showed that a “normal disturbance” level (i.e., clipped twice during the grazing season) did not affect the clonal diversity of meadows. However, samples from the “absence of disturbance” and “intense disturbance” treatments still need to be genotyped. Because the genetic diversity of eelgrass is important to its persistence, understanding the direct impacts of geese on the genetic diversity of eelgrass is essential to understanding how changes in grazing intensity will affect the long-term sustainability of eelgrass populations.
Learning from the past: a life cycle approach to understanding California mussel declines

Lauren L.M. Pandori, Ecology and Evolutionary Biology, UC Irvine

California mussels (*Mytilus californianus*) are a critical foundation species which support a diverse assemblage of associated species in the intertidal zone. Mirroring global trends among habitat-forming species, *M. californianus* biomass and cover have declined 30-50% in southern California since the 1970s, leading to reductions in species diversity of 58% on average. Proposed contributors for declines include changes in larval transport, increased human disturbance, and increased environmental stress likely to occur as a consequence of the warming climate. Given that thermal sensitivity and exposure differ across life stages, we developed a life stage-structured population dynamics model for California mussels with the objectives of: (1) investigating the effects of temperature on demographic rates, (2) identifying vulnerable life stages, and (3) predicting growth and extinction risks under a future climate scenario. We conducted experiments at Kenneth M. Norris Rancho Marino Reserve (Cambria, CA) and Crystal Cove State Park (Newport Beach, CA) that monitored thermal conditions, mussel distributions, and four demographic rates: fecundity, recruitment, survival, and growth. We found that thermal conditions and patterns of growth differed across tide heights, leading to differing patterns of vulnerability. Data collected will be used to develop a life stage-based population dynamics model to predict growth and extinction risks under changing thermal conditions.

Impacts of *Mexacanthina lugubris*, a dark unicorn in Southern California intertidal communities

Piper Wallingford, Ecology and Evolutionary Biology, UC Irvine

The effects of climate-driven range shifts are well documented, but the impacts of range-shifting species on native communities are relatively unknown. In Southern California, the dark unicorn whelk *Mexacanthina lugubris* has been shifting northward from its native Baja California, Mexico range, which could lead to increased competition with endemic whelks and increased predation on shared prey species. To assess the effects of *M. lugubris* on local intertidal communities, we surveyed 10 Southern California sites over the course of a year to determine spatial overlap with native species and conducted feeding experiments to assess competitive interactions with native whelks and predation of native mussels and barnacles. Finally, thermal tolerance trials were run to predict how future climate change could alter species’ distributions and competitive ability. We found that *M. lugubris* was able to utilize space higher in the intertidal compared to local competitors and was often more abundant than native species in areas where establishment occurred recently. Additionally, *M. lugubris* had a greater impact on prey than native competitors and was more robust in the face of thermal stress. Understanding the potential for competition with local species can help determine how expanding species may impact communities, and whether these impacts could increase under future warming.
Causes and consequences of intraspecific variation in Daphnia life history: how can “superfleas” be explained?

Kelsey Lyberger, Evolution and Ecology, UC Davis

How variation is maintained in natural populations remains a fundamental question in ecology. Previous studies have found that Daphnia clones exhibit substantial variation in vital rates, including so called “superflea” clones, which are younger yet larger at maturity. The existence of superfleas contradicts classic life-history theory, which assumes there are tradeoffs between growth and reproduction. One explanation is that, as resource abundance varies, individuals face a tradeoff between being well adapted to high- or low-resource environments. I tested this mechanism in a laboratory setting by measuring life-history traits of the two Daphnia clones found in McLaughlin Natural Reserve's Otter Pond under high and low resources. I found support for the hypothesis that superfleas are only super when resources are high. To further investigate this question in a natural environment, I monitored changes in genotype frequency, population sizes, and resource abundance in replicate enclosures in Otter Pond. I found the superflea clone took over regardless of starting genotype frequency. However, small, short-term fluctuations in resources do not explain changes in genotype frequency, and a longer time frame is needed to determine whether longer-term, seasonal resource availability explains the coexistence of the two clonal types.

Seasonal foraging-mode shifts of Oncorhynchus mykiss in a Mediterranean stream

Gabriel Rossi, Integrative Biology, UC Berkeley

For stream dwelling fishes, behavioral flexibility can allow individuals to survive and grow under changing contexts of food availability, competition, predation, and experience. Juvenile salmon and steelhead engage in a range of foraging tactics, including drift foraging—where fish hold focal points in the water column and make short forays to intercept drifting prey; search foraging—where foraging is not associated with a focal point, and benthic foraging—where benthic prey are captured by forceful attacks at the substrate. Diel shifts in foraging behavior have been observed in many salmonids but seasonal, population-scale behavioral shifts in response to ecological gradients have been studied more rarely. In fisheries management, habitat suitability has traditionally been based on fish response to hydraulic and physical habitat factors while food web dynamics, biotic interactions, and foraging mode have been notably excluded. Yet these ecological interactions have profound effects on the growth and success of juvenile salmonids and, therefore, on the recovery of imperiled adult populations. This study evaluates the phenology of steelhead (O. mykiss) foraging behavior and benthic invertebrate drift in a Mediterranean stream between May and August of 2016. This study seeks to identify whether a phenological pattern of juvenile steelhead foraging behavior and within-pool movement exists during the spring-fall period, and, if so, to explore some drivers of that pattern. Finally, I will synthesize some of the implications to seasonal foraging mode shifts on water and habitat management outcomes.
Translocating sub-soil to the surface reveals independent effects of microclimate and plant inputs on microbial access to soil carbon

Eric Slessarev, Ecology, Evolution and Marine Biology, UC Santa Barbara

Depth within the soil profile is a major control on the residence time of soil carbon. Both plant inputs and microclimatic fluctuations decline with depth in the soil profile; both may influence microbial access to C, and thus C residence times. I assessed the influence of plant inputs and microclimate separately by translocating subsurface soil samples (50–60 cm depth) to the surface for 18 months across three NRS reserves, and then either excluded plant inputs or allowed plant growth in the translocated soil. Translocated soil increased in microbial biomass after 18 months of surface exposure without plant inputs, while water extractable organic carbon concentrations remained unaffected. Allowing plant growth increased microbial biomass further while also increasing water extractable organic carbon. Respiration pulses from wetting dry, translocated soil were smaller on a relative basis than pulses from dry subsurface soil that remained in-situ, indicating acclimation to repeated wetting and drying cycles at the surface. These results show that climatic fluctuations at the soil surface are sufficient to increase the availability of native soil C, promote growth of microbial biomass, and change the sensitivity of microbes to hydrologic perturbations.

Using functional traits to build native grassland communities that are resistant to exotic annual grasses

Maddie Nolan, Ecology, Evolution and Marine Biology, UC Santa Barbara

Grasslands in California’s coast ranges were historically dominated by a diverse mixture of bunchgrasses and forbs. Yet today, these lands are dominated by exotic annual grasses and forbs, particularly where past agricultural activities disrupted the root systems of perennial plants. Without human intervention, these former agricultural sites remain dominated by exotic species, with little to no natural succession back to native species assemblages over many decades. Throughout California, restoration activities in these habitats have focused on the reestablishment of a small number of species, particularly the perennial bunchgrass *Stipa pulchra*. However, plant richness in California grasslands arises from forb and not grass diversity, so the failure of grassland restoration could be due, in part, to a lack of forbs in restored communities. Apart from being lower in species richness, restored communities that do not have native forbs could be missing important functional traits that help restored grasslands resist reinvasion by exotic annual grasses. My research proposes to quantify the diversity of functional traits across native grassland species and the common exotic annual grass *Avena fatua*. The information can be used to create theoretical assemblages of native grassland species that functionally overlap with *Avena fatua* and resist the establishment of this noxious exotic species. This research could provide valuable insights into the mechanisms controlling the continued dominance of *Avena fatua* and other exotic annual grasses in California grasslands.
Physiological sensitivity to historic drought and deluge years for eastern Sierra Nevada conifers

Katherine Ross, Environmental Studies, UC Santa Cruz

Projections of future precipitation trends in California suggest greater interannual variability, while higher temperatures increase risk of drought. By comparing spatial and temporal variation in photosynthesis, growth, and water status between unusually wet and dry years, across an elevation gradient, this study improves our understanding of the mechanistic pathways by which dominant conifer species respond to climate change. Recent years provide a rare opportunity to quantify conifer sensitivity to high and low precipitation extremes likely to become more common, as well as interactions between elevation and annual differences in precipitation reflecting within range differences. Photosynthesis, stem water potential, and CO2 response curves were measured for Abies magnifica, Pinus contorta, and P. jeffreyi at four sites along a 500 m elevation gradient in the eastern Sierra Nevada near Mammoth Lakes. Measurements from 2016–2018 started at the end of a historic drought and included the especially wet winter of 2017. Stomatal conductance was significantly greater earlier in the season in 2016 and 2018, but reached a maximum later in the season in 2017. Photosynthesis followed a similar pattern, but was only significantly lower later in the season in 2016. By contrast, no differences were found between elevations. Needle length was lower for the 2014 and 2015 cohorts than those from later years, but only for the lowest two elevations. Interactive effects of elevation, species, and year on photosynthetic carbon gain and needle biomass may help explain tree response patterns to extreme drought. These findings can inform future forest management strategies.

Clinal variation and plasticity in California poppy in response to climate change

Elizabeth Ryan, Ecology, Behavior and Evolution, UC San Diego

Predicting plant species responses to climate change can be complicated by population-level variation in plasticity. Yet predictive species distribution models assume current distributions are determined solely by climate, not biotic factors, and species do not have distinct populations with varied potential to adapt to climate change. We examined clinal variation in phenological traits and fitness, and plastic responses to environmental change, for 21 populations of California poppy along a clinal gradient across California characterized by a threefold increase in precipitation. Plants were grown in treatments approximating the precipitation regimes of the wettest and driest sites, and in the presence or absence of home soil. Phenological plant traits (emergence timing, flowering timing, growing season length) and fitness (biomass and seed production) both exhibited clinal variation. Southern populations emerged later, flowered earlier, had shorter growing seasons, and had higher fitness (biomass and seed production) than northern populations. Northern populations exhibited greater plasticity in emergence timing when grown in home soil, and four of the twenty-one populations produced more biomass in the presence of home soil. While flowering timing did not respond plasticly to either precipitation or soil treatment, ample water precipitation lengthened growing season more for plants from northern populations, but increased growth (i.e. biomass) more for plants from southern populations. Thus, arid, warm populations that tolerate conditions north of current distributions are particularly promising candidates for assisted migration. Current predictive modeling approaches may be insufficient for species exhibiting clinal variation and high population-level variation in plasticity.
Seasonal fluctuations in natural selection help maintain genetic diversity

*Ben Wasserman, Ecology and Evolutionary Biology, UC Santa Cruz*

Natural selection allows populations to adapt to their environments. The selection caused by changing environments may fluctuate over time. The effects of such fluctuating selection on the long-term evolution of populations is not well understood. Moderate fluctuations in the strength and direction of selection may lead to the persistence of genetic diversity in a population, whereas large fluctuations may lead to the loss of alleles and a reduction in genetic diversity. We tested whether fluctuations in natural selection due to seasonal environmental shifts can function to maintain genetic diversity in a system where stable selection would drive a population to fixation. We studied how differences in the annual rainfall and subsequent lagoon breaching affect the evolution of armor morphology and the underlying genes in threespine stickleback (*Gasterosteus aculeatus*), which are known to correlate with freshwater or marine residency in other stickleback populations. In stickleback inhabiting intermittently ocean-connected estuaries, we found that traits and genotypes associated with freshwater and marine residency fluctuate seasonally as predicted over four years—less armored during the dry summer and fall, and more armored in the wet winter and spring. We will discuss the importance of interannual variation in breaching intensity for the maintenance of genetic diversity.

Phylogeography of carpenter ants from the California Channel Islands: an evolutionary reconstruction based on phylogenomics

*Ida Naughton, Ecology, Behavior and Evolution, UC San Diego*

The California Channel Islands support a wealth of biodiversity and are home to numerous threatened and endemic species. While the plants and vertebrates of this archipelago have received considerable attention from biologists in recent decades, an understanding of the insect fauna remains incomplete. With relatively modest capacities for over water dispersal, ants tend to exhibit intriguing biogeographic patterns. On the Channel Islands, for example, ants provide apparent examples of relictual distributions, disjunct distributions, and island endemism. Carpenter ants (*Camponotus*) are a historically old and hyper diverse ant genus with a worldwide distribution; just over twenty species of *Camponotus* occur in California, including numerous taxa that are endemic to the California Floristic Province. Here I present the preliminary results of a comparative phylogeographic study of eight *Camponotus* taxa that occur on the Channel Islands. I sampled workers of eight taxa of carpenter ants in several locations on each island in which they occur, and across their range in the California Floristic Province, including six UC NRS reserves. For each sample, I extracted total genomic DNA, constructed DNA libraries using KAPA DNA Hyperprep kits, and enriched pooled libraries for ~1510 ultraconserved elements. I sent pooled, enriched libraries to the Vincent J. Coates Genomics Sequencing Laboratory at UC Berkeley for 150 bp pair end sequencing on a HighSeq 4000. Preliminary analyses reveal interesting patterns of differentiation and help clarify the taxonomic status of several putative island endemics.
Invasive gut microbiome plasticity over time

Amanda Hale, Microbiology, UC Riverside

The gut microbiome of a species may provide insight into the limits of its range. I am investigating the hypothesis that a species’ tolerance for diverse habitats stems, at least in part, from the ability of its gut to adapt to a novel microbial community. This study explores the bacterial gut microbiomes of ants native to Southern California, and their ability to adapt to novel environments. Ants native to southern California have few physical adaptations to extreme desert environments, and yet some species persist from the coast to the Mojave and Colorado deserts, with a variety of elevational tolerances. Other species, however, have highly restrictive ranges. Gut microbiome plasticity may play a role in the ability of ants to tolerate California’s rich variety of biomes. My study compares the relative abundances of viable gut bacteria in multiple ant species over time, as the ants are maintained in a novel lab environment on a consistent diet.

LECTURE

Fire, climate change, and the future of California’s forests

David Ackerly, College of Natural Resources, UC Berkeley

Tune in to the news in California and you’re likely to hear about yet another wildfire somewhere in the state, forcing people from their homes and threatening their lives. The fires burn through forests and shrublands, leaving a scorched landscape. But if you return a few years later, you’ll see hillsides covered in lush growth with oaks and other hardwoods resprouting and the dead trunks of burned trees poking through to the sky. Fire has been a part of California’s ecosystems for millions of years; our native flora is adapted to recover and regrow. However, a changing climate and decades of our own well-intentioned practices are leading to larger and more intense fires. This talk will examine the history of fire, the responses of native ecosystems, and projections for the coming century.
Joshua tree aesthetics: a history of grazing and its charismatic yucca

Julia Sizek, Anthropology, UC Berkeley

As for many potentially endangered species, the protection of Yucca brevifolia forges strong ties between the plants and their habitat. Under future climate regimes, scientists anticipate that current distributions of Joshua trees—based on past climatic conditions—will no longer align with their future habitats. In this paper, I examine one habitat where the charismatic yucca thrives, showing that the landscape supporting dense, aesthetically pleasing stands of Joshua trees was one indelibly shaped by large-scale grazing in the East Mojave. Following a history of desert aesthetics that links idealized desert landscapes to intensive grazing regimes over the last 150 years, I argue that grazing landscapes labeled as Joshua tree woodland or Joshua tree shrubland became an aesthetic expectation for the East Mojave that persists today. Contributing to social scientific literature on contemporary anthropogenic change and historical ecology, I argue that understanding the historical change of Joshua tree habitat can reshape our understanding of the charismatic yucca under anticipated climate change regimes and Anthropocene ruination, unsettling relationships between past and future.

Response of small mammal and tick communities to wildfire and implications for tick-borne pathogen maintenance

Benjamin T. Plourde, School of Veterinary Medicine, UC Davis

The risk of tick-borne disease across landscapes is determined by interactions among species at a fine spatial scale. Ecosystem disturbances can change these interactions and modify tick-borne disease maintenance cycles. In July 2015, the Wragg Fire burned much of Stebbins Cold Canyon Reserve. Previous research characterized tick and small mammal communities within the reserve. The area is endemic for tick-borne pathogens of humans including Borrelia burgdorferi, the causative agent of Lyme disease. This study documents the post-fire status of ticks and small mammals at Cold Canyon and describes their recovery over two years. Camera trapping within three months post-fire documented the presence of mice (Peromyscus spp.) and one dusky-footed woodrat (Neotoma fuscipes). Live-trapping was conducted from January 2016–August 2017. Density estimates for small mammals were low throughout 2016, ranging from 8–20 unique individuals across the 2 ha study plot. By April 2017, density was estimated at >200 mice and woodrats. California voles (Microtus californicus) and house mice (Mus musculus) were detected for the first time 20 months post-fire, increasing species richness and other diversity indices. The site was periodically flagged for free-living ticks and trapped animals routinely inspected for attached ticks. Over 20 months of intermittent flagging, only one free-living tick was collected. Just 8% of live-trapped animals were found with attached ticks upon first capture during a three-day trapping session. These data suggest small mammals recover quickly after wildfire and may overshoot pre-fire population sizes. A combination of predator release and resource abundance may underlie these observations. Ticks were slow to recover, but present throughout.
Exploring how environmental context influences the food-storing decisions of two wild squirrel species using a novel remote data collection device

Amanda N. Robin, Ecology and Evolutionary Biology, UC Los Angeles

A deceptively simple task in nature, finding food, still requires an animal to make a series of complex decisions in a variety of differing circumstances. The challenge for a food-hoarding species—whether to immediately consume an item or cache it for the future—is an ideal experimental system to test predictions of how trade-off decisions in foraging are impacted by state-dependent factors. We are studying this in two wild food-storing rodent species, Western grey squirrels (Sciurus griseus) and California ground squirrels (Otospermophilus beecheyi). Survival in both species depends upon making thousands of efficient economic decisions during seasons of food abundance. Participants are implanted with passive integrated transponders (PIT-tags) and trained to come to a data collection device that presents a choice between a cacheable item and an item that must be eaten immediately. The custom hardware and software performs cognitive testing in the field without the presence of an experimenter. An RFID microchip reader recognizes individuals and two choice tunnels serve as scales connected to a data recording device. When the RFID reader is triggered, the appropriate food reward dispenses, a weight for the individual is recorded, and a video is taken. Through standardized auto-shaping methods, squirrels learn that one tunnel will produce a nut powder that must be eaten immediately, and the second tunnel will produce an in-shell cacheable item. With this simple binary choice, we can measure preferences and behaviors of each individual relative to their body condition, time of day, competition level, and level of predation risk.

Understanding how dark-eyed juncos (Junco hyemalis) differentiate between local and foreign song

Felisha Wong, Ecology and Evolutionary Biology, UC Los Angeles

The purpose of this research is to determine how dark-eyed juncos (Junco hyemalis) respond to different populations’ songs, how these songs differ, and what components of songs individuals use to discriminate among the songs of different populations. I will record the songs of male dark-eyed juncos in three urban populations and three natural habitat populations: UC Los Angeles; UC San Diego; UC Santa Barbara; the San Jacinto James Reserve; the Angeles National Forest; and the San Bernardino National Forest. I will construct playback recordings of each location’s songs and expose males from each population to songs from all six populations. I will measure a range of aggression traits, including: (1) male’s closest approach to the speaker; (2) delay before approaching within 1 m and 5 m; (3) delay before the male’s first flyover; (4) number of flyovers; (5) time spent singing in response; and (6) time spent within 1 m and 5 m of the speaker. Each population’s songs will also be analyzed to determine differences in frequency, trill rate, song length, and syllable length. After determining these differences, recordings will be manipulated to control for one of these variables and played back to each population to see which elicits the most aggressively reactions. I predict that each population will respond more aggressively to the songs from their own population than to those from a foreign population and that the songs from each urban location will be more similar to each other than to those from natural habitats.
BODÉGА MARINE RESERVE

STAFF

Suzanne Olyarnik  Reserve Director
Jackie Sones  Research Coordinator

EVENT LOCATIONS

Breakfasts will be served in the Dining Hall of the housing facilities. All other symposium activities will take place at Bodega Marine Laboratory.

The walk from the housing facilities to the laboratory along the Dorm Trail takes about 30 minutes, so please budget plenty of time. You may also drive between the two locations along the Lab Road.
BODEGA MARINE RESERVE

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