18TH ANNUAL
BAY AREA CONSERVATION BIOLOGY SYMPOSIUM

Santa Cruz, CA
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Abstracts in Full

KEYNOTE TALKS

Jim Estes

Ecology and conservation biology: a 50 year retrospection on change

Dr. Jim Estes is a Distinguished Professor of Ecology and Evolutionary Biology at the University of California, Santa Cruz. He is respected as a pioneer of trophic cascades research, particularly in his work on the ecological role of sea otters in key forest ecosystems. Jim is the recipient of the U.S. Geological Survey's Schumaker Award, the Western Society of Naturalists' Lifetime Achievement Award, and the American Society of Mammalogists' C. Hart Merriam Award.

Karen Poiani

What will it take to be a Conservation Action Hero in the Anthropocene?

Dr. Karen Poiani is the CEO of Island Conservation, a nonprofit organization dedicated to the removal of invasive species from islands. She has a diverse background working for conservation organizations, including the Nature Conservancy and the Gordon and Betty Moore Foundation. Karen has worked from local to global scales on a wide range of conservation issues and was an early proponent of landscape-level conservation and the maintenance of functional landscapes.

ENVIRONMENTAL LAW PANEL

Nicholas Whipps (moderator), Jenny Loda, Dr. Tim Duane

Law in the age of deregulation

The White House has taken significant deregulatory steps in its first few months. However, the President's power is actually quite limited: both the Constitution and statutes such as the Clean Water Act, the Clean Air Act, and the Administrative Procedure Act require agencies such as the Environmental Protection Agency (EPA) to go through a complex notice-and-comment rulemaking process to undo a predecessor's regulations. The law panel will address the following issues: What are the limits on presidential power to repeal environmental legislation? Where are the key levers for blocking such efforts? Moreover, what can the states and local government do to resist administrative policies?

Nicholas Whipps joined Wittwer Parkin LLP as an attorney in 2016. Mr. Whipps is dedicated to protecting the environment. Immediately prior to joining Wittwer Parkin, he worked for two years as a Lawyers for America legal fellow at the Center for Biological Diversity, focusing on environmental and species conservation. In that position, he developed and litigated several cases, gaining experience with a host of state and federal environmental laws. Mr. Whipps graduated magna cum laude from U.C. Hastings College of the Law in 2015, with a concentration in environmental law.

Jenny Loda is the Reptile and Amphibian Staff Attorney at the Center for Biological Diversity. She is dedicated to protecting rare amphibians and reptiles across the country. She holds a law degree from Lewis & Clark Law School with a certificate in environmental and natural resources law, a master's of science in wildlife biology from Iowa State University, and a bachelor's in ecology, behavior, and evolution from the University of California, San Diego. Before joining the Center, she ran her own law practice focused on sustainable business and environmental law and held numerous internships; before law school, she worked on wildlife research and habitat restoration in California, Hawaii and Iowa.

Dr. Tim Duane is an attorney with more than three decades of professional experience in the fields of energy, climate, land use, natural resources, water, and environmental policy, planning, and law. He began working in the renewable energy industry in 1979 and published his first reports discussing climate change in 1990. He is a leading expert on "greening the grid" and the regulatory permitting challenges of renewable energy development. Duane is Professor of Environmental Studies at UCSC, the Stanley Legro Visiting Professor in Environmental Law at the University of San Diego School of Law, and a licensed CA attorney.

ORAL PRESENTATIONS

Briana Abrahms

Climate mediates the costs and benefits of site fidelity in a marine predator, the northern elephant seal

A population's ability to cope with environmental change is influenced by the cumulative behavioral and fitness consequences of individual habitat selection strategies. Site fidelity is theorized to confer a fitness advantage in unpredictable environments over long timescales, yet may be maladaptive in environments undergoing long-term change. To date, a shortage of long-term datasets that combine movement and performance data has limited understanding of the relative short- and long-term benefits of site fidelity, and the effects of different climate conditions on these trade-offs. We brought together a 10-year satellite tracking dataset on northern elephant seal (*Mirounga angustirostris*) migratory movements, individual mass gain metrics, and oceanographic data to examine a) the long-term benefits of site fidelity, b) the relative benefits of site fidelity under different climate conditions represented by the Pacific Decadal Oscillation (PDO) Index, and c) the variability of oceanographic conditions characterizing foraging areas. We developed a site fidelity index to quantify the spatial consistency of migration patterns for individuals tracked over multiple years.

Our results reveal two markedly different habitat selection strategies within the population: a high site fidelity strategy facilitating moderate rewards and low risk, and a low site fidelity strategy facilitating potentially high rewards and high risk. Moreover, we show that large-scale climate conditions mediate the relative success of these strategies. Individuals with high site fidelity outperformed individuals with low site fidelity under neutral climate conditions ($p < 0.05$), had lower interannual variation in their mass gain with site fidelity index explaining 68% of the variability observed, and used areas that had relatively stable resources over time. In contrast, individuals with low site fidelity performed best during positive phases of the PDO ($p<0.05$), had higher variation in mass gain among years, and foraged in areas with less habitat predictability. Our findings suggest that site fidelity is beneficial over long timescales by yielding reliable success across years, but given that climate variability is increasing in the North Pacific, this strategic advantage may be reduced as a result of long-term environmental change. By empirically testing the effects of climate variability on habitat selection strategies, our study offers a first glimpse into the behavioral and adaptive responses of marine predators to new climate regimes.

Christopher Anderson

Using remote sensing to address the problem of pattern and scale in ecology

Ecological patterns and processes are scale-dependent, and these scale dependencies vary among and within ecological systems and taxonomic groups. However, the analytical use of spatiotemporal scales in ecology have often been arbitrary and organism or process-specific. Remote sensing technologies present an opportunity to understand ecological patterns and processes systematically at multiple scales by collecting global-scale, standardized, and repeat measurements. In this talk I discuss how remote sensing addresses issues of ecological scaling,

and how remote sensing can be used to translate ecological patterns and processes across spatial, temporal, and organismic scales.

Rachael E. Blake
Temporal and spatial patterns in the central Gulf of Alaska groundfish community

Authors: Rachael E. Blake, A. Ole Shelton, Colette L. Ward, Mary E. Hunsicker, Anne B. Hollowed

The ecological and anthropogenic factors structuring temporal and spatial patterns of community composition, diversity, and stability are rarely examined a large scales, especially in marine ecosystems. We used geostatistically modeled groundfish abundance and biomass from the Alaska Fisheries Science Center trawl survey data (1984 – 2015) to compare multiple community metrics for 55 species in the Central Gulf of Alaska (CGOA). This long time-series data spanned many potential large-scale stressors including the Exxon Valdez oil spill, a climate-regime shift, and decadal-scale oceanographic cycles (e.g. Pacific Decadal Oscillation). Our study areas in the CGOA were all at depths from 50 - 150 m, and ranged from Prince William Sound in the East to the Aleutian Islands in the West. We found that areas more exposed to oil spill stressors had more negative trends in total groundfish biomass than unexposed areas, and that this change was driven primarily by reductions in the abundance of the apex predator guild. These apex predators included biomass dominant species (e.g. Halibut), which showed no spatial turnover across our sites. In contrast, community composition of biomass sub-dominant species showed strong spatial turnover along a longitudinal gradient. Despite this strong turnover, species richness, diversity (alpha, beta, and functional) were remarkably similar among study areas. This suggests that community structure, but not composition, was conserved across a spatially expansive area despite a large-scale stressor.

Daniel R. Brumbaugh
Developing a framework for co-management of marine protected areas in The Bahamas

Marine protected areas (MPAs) have been exponentially increasing in total global coverage over the last several decades. Unfortunately, in many parts of the world, MPA management capacities that were historically too low have not been increasing apace, resulting in a proliferation of "paper parks." To address this problem, MPA managers in The Bahamas have recently started to consider new co-management approaches to strengthen their management capacities. This presentation will draw from the literature on co-management of common-pool resources, an analysis of Bahamian resource management legislation, and interactions with stakeholders from four different study areas to provide an overview of some of the potential challenges and opportunities facing transitions to MPA co-management in The Bahamas. The presentation will conclude with discussion of some practical suggestions for how Bahamian MPA managers could move forward with co-management.

Katherine Teresa Charton
Assessing elevational connectivity in California's mountain ranges to inform conservation priorities for climate change

Empirical data suggest that species' ranges have shifted both upslope and downslope along elevational gradients in mountain ranges over the past century. Heterogeneity in the direction of range shifts within and among taxa highlights the difficulty and uncertainty in predicting future species' distributions. Consequently, networks of protected areas (PAs) will become increasingly important to safeguard species and facilitate their movement along elevational gradients in response to a changing climate. We believe that assessing the elevational connectivity of PAs in mountain ranges is a novel strategy to inform managers of both gaps in PA coverage as well as priority areas for future protection. We developed four indices of elevational connectivity between PAs and calculated these metrics using high-resolution digital elevation models for several distinct mountain ranges in California, a highly biodiverse region with varied topography. Our indices included measures of (1) geographic distance between PAs, (2) elevational coverage of PAs, (3) three-dimensional distance between PAs, and (4) least-cost path between PAs, where cost is defined by both geographic distance and elevation change. Our results reveal stark variability in each of these indices across our focal mountain ranges. For example, we found that elevational coverage of the Coast Range and the Sierra Nevada is similar, but geographic connectivity between PAs is higher in the Sierra Nevada. Furthermore, within the Sierra Nevada, elevational coverage is six times higher in the central Sierra region than in the northern Sierra, and four times higher than in the southern Sierra. Comparing indices across mountain ranges can be used to determine priority areas for protection along elevational gradients to enhance both geographic and elevational connectivity, ultimately facilitating species adaptation to climate change. These indices have exploratory value in isolation, but also could be combined into a single connectivity score. While we apply these indices to California's mountain ranges in this study, we emphasize that our indices and methodology can provide a framework to be applied to any montane region globally.

Hyeyeong Choe

Rarity and diversity patterns of plant species using national survey data

Species observations could be used in determination of rarity, and this potentially offers a new tool for regional conservation planning. In this study, we classify the geographic distribution of plant species in South Korea into modified versions of the Rabinowitz framework using the national surveys. We estimated the range size and abundance of 2,628 plant species by calculating distance and area among surveyed points, and counted the number of vegetation types overlapped with surveyed points as the surrogate of habitat specificity. Then, we classified species into one of seven types of rarity. Rabinowitz proposed the seven types of species rarity using three variables: geographic range, habitat specificity, and local population size in 1981. We calculated species richness for all species and for Rabinowitz's categories of species. The average maximum distance (Dmax) between two records of the same species was 267 km, and the average circular area range size (CA5) was 48. High species richness areas are almost evenly distributed across the country using all or common species. However, the species richness in rarity categories was high in the northeastern mountainous parts of South Korea and coastal areas especially for species with narrow geographic ranges. Many habitat specialists with wide geographic ranges also occur the northeastern parts of South Korea. We suggest some eastern parts as priority conservation areas. Our approach using national data collections could provide

helpful ideas for organizations planning large-scale ecosystem surveys as well as could provide conservation plant lists and complementary measures for the ongoing national projects collecting natural ecosystem information. We also warn about the subjectivity of classification and the reasonable spatial scale for the application of rarity classification.

Lindsay T. Cook

You are what you eat: Pollinator response to drought is predicted by both floral and bee life history metrics

Drought is a major agent of environmental change that can affect all types of life across an ecosystem, not only on a direct, individual level but also through impacts on other species in an organism's interaction network. While much research has been done on plants' response to drought, there has been relatively little inquiry into the response of pollinator communities tied to these floral resources, and less still on how the interactions between plants and pollinators may influence pollinators' hardiness in drought. In this study, we use life history traits of plant and bee species to predict these species' abundance in response to drought and further examining whether floral and interaction metrics may predict the survival of bee species. Using data gathered from Yosemite plant-pollinator networks before and after the onset of the recent California drought, we assess how various life history traits predict plant and pollinator abundance. Our assessments for both groups consist of three binary traits that the literature associates with resistance to disturbance, which we compile into plant and pollinator drought hardiness scores. We also examine several interaction metrics, such as pollinators' specialization in choice of floral hosts, in predicting pollinator abundance under drought. Ultimately, we are able to create a composite model that showed that life history traits and the reliance of a bee species on drought hardy plants are both significant predictors for the response of bee species in the onset of drought. We find that life history traits associated with pollinator hardiness in other types of ecological disturbances might predict more vulnerability in response to drought. In addition, even though interaction terms involving specialization are not significant, drought hardiness of floral hosts is a strong predictor, suggesting that network-level interactions play a role in determining response to drought and warrant further investigation.

Justin Cummings

Changing the faces of conservation: An approach from the Doris Duke Conservation Scholars Program

Land, water and wildlife conservation have never faced greater challenges or opportunities. The challenges to conservation posed by growing wealth disparity, mobility, and populations and by climate, atmospheric, and other rapid directional changes are without precedent. Fortunately, opportunities for conservation, with its expanding relevance to remaking humanity's approach to living on Earth, have never been greater. Conservation needs to harness the broadest possible appeal and constituency to succeed. Ongoing demographic and economic trends mean that an effective constituency must be racially, ethnically and socioeconomically diverse, and more urban than ever. This talk will focus on the Doris Duke Conservation Scholars Program at UCSC's efforts

to increase diversity in conservation, and highlight the importance of increasing diversity in the field of conservation.

Tanya Diamond
Highway 17 Wildlife Connectivity Project

The Santa Cruz Mountains are becoming increasingly isolated by habitat fragmentation due to roads and housing developments, which is making it more difficult for wildlife to travel in and out of the mountain range. To maintain healthy wildlife populations, animals need to be able to find resources such as food and water, find viable mates to maintain genetically viable populations, and juveniles need to have the ability to disperse out of their parental home range to establish their own. Animal vehicle collisions are one of the leading causes for wildlife mortality in the United States (Road Ecology 2003). A total of 407 animals have been recorded hit on Highway 17 in the past 7 years from the town of Los Gatos to the Scotts Valley (Caltrans roadkill data 2000-2011, Pathways for Wildlife). Each year, within the past 8 years, 1 or more mountain lions have been hit on Highway 17. One of the reasons there is such a high rate of roadkill incidents is because Highway 17 currently lacks the appropriate culverts and bridges for animals to cross underneath the highway. In September 2013, Midpeninsula Regional Open Space District, Peninsula Open Space Trust and Pathways for Wildlife joined as project partners to work with collaborators; Nancy Siepel at Caltrans District 5, the UC Santa Cruz Puma Project, the Department of Fish and Wildlife, and Santa Clara County Parks to identify the best location for a wildlife crossing structure on Highway 17 in Santa Clara County for animals to use to safely cross underneath the road. Four different types of data were used to determine where to install the culvert modeling from the 1) UCSC Puma Project & Bay Area Critical Linkages 2) Caltrans Roadkill Data & Roadkill Surveys conducted by Pathways for Wildlife 3) UCSC Puma Project: Radio Collar Data and 4) Camera Monitoring by Pathways for Wildlife. The data collected from this project has identified two locations in which to install wildlife crossing structures, which now both in design phases. The installation of crossing structures with directional fencing to guide animals to the crossing structure would greatly enhance the ability for wildlife to safely cross under Highway 17 and provide an ideal solution for preventing animal-vehicle collisions at this location. This win-win solution would also help maintain healthy animal populations by increasing the ability for genetic flow to occur between populations.

Paul Elsen
Which mountains pass? Gaps in protection along elevational gradients worldwide

Protected areas (PAs) are the dominant strategy for conserving biodiversity and sustaining life on Earth. Globally, mountain ranges are considered “cradles of biodiversity”, holding disproportionate numbers of endemic, threatened, and overall species. Elevated rates of warming in mountain ranges have resulted in significant shifts in species distributions up and down elevational gradients. Well-distributed PAs in mountain ranges are therefore not only essential to sustaining current patterns of biodiversity, but also to facilitating species movement and adaptation to climate change. We analyzed the elevational distribution of 31,042 PAs in nearly 1,000 mountain ranges around the world using the highest resolution global digital

elevation model available, as well as the distribution of total land area in each mountain range. Globally, as expected, we found that the total area protected in mountain ranges declined with elevation, and that this pattern was roughly consistent across each of the six continents we analyzed. However, owing to regional differences in underlying topography, we found that the proportion of protected land by elevation varied substantially across continents. Africa, Asia, and North America were characterized by protecting increasing proportions of land area with elevation, while Europe and Oceania had peak proportions of protected lands at mid elevations. South America had relatively equal proportions of protected lands across all elevations. Consequently, additional protections required to meet the 17% Aichi Target would need to be allocated in low-mid elevations (<2500 m) of Africa, upper elevations (>2500 m) of Oceania, low (<500 m) and high (>3500 m) elevations of Europe, and all elevations of South America. Despite a prevalent bias towards protecting high elevation lands globally, our results reveal stark regional contrasts in the elevational zones that should be prioritized for future protection.

Morgan Gray

Highway to hell: Road networks decrease genetic connectivity in a small mammal

By mid-century the combined length of all roads on earth will be enough to encircle the planet more than 600 times; with expanded impacts on wildlife including mortality, habitat loss, and population isolation. One way to mitigate the impacts of roads to sustain life on Earth is to conserve and restore habitat connectivity, allowing species to persist around human development. We take an interdisciplinary approach in combining spatial and genetic data to improve our understanding of structural and functional connectivity in human-modified habitat. Spatial models can predict structural connectivity, and genetic approaches can reveal how land use barriers influence gene flow among populations – a measure of functional connectivity. However, few studies have compared structural connectivity model predictions with functional connectivity in the form of quantified road impacts on gene flow, nor shown evidence of population isolation associated with fragmentation. Here we evaluated the genetic diversity and structure of mitochondrial DNA sequences for 61 ground squirrels from populations separated by a major freeway. Genetic structuring was assessed using interpolation analysis, and landscape permeability was evaluated with Mantel tests and resistance surfaces. Based on haplotypes across 615 base pairs, the genetic similarity among populations on the same side of roads was higher than among populations separated by major roads, in particular, a large freeway. These results indicate that habitat fragmentation by roads was a barrier to gene flow in ground squirrels, resulting in quantitative differences in genetic structure and diversity between populations. Considering both structural connectivity associated with land use and functional connectivity at the molecular level can provide insight for conservation management and land use planning to sustain wildlife populations amidst expanding development.

Noel A. Heim

*An ecological shift in the Pacific mole crab (*Emerita analoga*) population at Ocean Beach, San Francisco*

The Pacific mole crab (*Emerita analoga*) is an important invertebrate species inhabiting intertidal sandy beaches along the California coast. The Long-term Monitoring Program and Experiential Training for Students (LiMPETS) has been collecting data on the abundance, size, and fertility of Pacific mole crabs at Ocean Beach, San Francisco since 2001. Long-term macroecological records are necessary to recognizing ecological changes induced by human-mediated climate change, oil spills, and other environmental catastrophes. The LiMPETS data constitutes one of the longest macroecological records of for an intertidal sandy species in California. These data are not immune to the problems of "shifting baselines", nevertheless they reveal crucial information on recent seasonal and interannual variation in this Pacific mole crab population. An abrupt and sustained increase in sea surface temperature in mid-2014 is associated with several shifts in the Ocean Beach Pacific mole crab population. These changes include an increase in total abundance, a decrease in size, and a decrease in fertility (i.e., proportion of ovigerous females). Mole crabs have been shown to show source-sink population dynamics: source habitats have high fertility and supply recruits to sink habitats, which have relatively low fertility. These data suggest that Ocean Beach, which had previously been a source habitat, may become a sink where both environmental quality and fertility are reduced. The populations dynamics at Ocean Beach demonstrate that the Pacific mole crab is sensitive to climate change and may serve as a bellwether for broader ecological changes along the California coast.

Lisa Hunt

Using the Species at Risk index as a tool for adaptive management to reduce impacts of pesticides to aquatic ecosystems

The Species at Risk pesticides index (SPEARpesticides) is a trait-based approach to evaluating responses of aquatic macroinvertebrate communities to pesticides. It was developed in Europe and has recently been adapted and applied to multiple regions of North and South America. In intensive agricultural regions in Argentina and California where there are almost no riparian buffers, we found a clear relationship between pesticide levels and changes to macroinvertebrate communities (measured by correlation between pesticide levels and SPEARpesticides values, with R2 of 0.35 to 0.53). In intensive agricultural regions in Paraguay and Brazil where there are large riparian buffers, the SPEARpesticides index did not indicate any clear effect of pesticides on macroinvertebrate communities. In California, we used the SPEARpesticides index in conjunction with a watershed-based model (Soil and Water Assessment Tool) to predict how pesticide-related impacts to aquatic ecosystems would be affected by climate change. We concluded that without changes to management practices, there would be increases in pesticide application and in effects to macroinvertebrate communities. We are currently using the SPEAR and SWAT tools to model various scenarios with implementation of different management practices, focusing on increasing riparian buffers.

Alison Ke

Contrasting vegetation structure and avian taxonomic, functional, and phylogenetic diversity between IUCN protection levels

Reaching the CBD's goal to protect 17% of the world's land by 2020 would not guarantee effective biodiversity conservation. In the IUCN's classification system, the contribution of a protected area (PA) to biodiversity conservation is judged based on a category ranging from I–VI. Categories I–IV are more restrictive and do not allow any resource production, while categories V and VI are 'sustainable use', permitting resource production alongside nature conservation. Almost 50% of the area of PAs are sustainable use, and if sustainable use PAs are ineffective, the area considered to contribute to biodiversity conservation is drastically reduced. We conducted point counts during June – July 2016 to sample the bird community and measured vegetation structure within strict protection, sustainable use, and unprotected areas in a tropical savanna biodiversity hotspot. We calculated taxonomic diversity (TD), functional diversity (FD), and phylogenetic diversity (PD), and evaluated (1) the difference in vegetation structure between areas with strict protection, sustainable use, and no protection, (2) the differences in bird TD, FD, and PD between the three protection levels, and (3) whether vegetation structure influences bird TD, FD, and PD. Strict protection had greater canopy layer diversity than both sustainable use and unprotected areas. Sustainable use had greater TD than strict protection, while both strict protection and sustainable use had greater PD than unprotected areas. Shrub cover had a negative effect on bird PD. Our results demonstrate the effectiveness of PAs in protecting PD, provide insight into the role of sustainable use PAs in biodiversity conservation, and show that only focusing on TD may be detrimental to other dimensions of biodiversity.

Emily Kearney

Natural areas increase fruit set but do not decrease pollen limitation in cacao

Agriculture dominates 40% of terrestrial environments, producing food and products that sustain human life but replacing highly-biodiverse habitats. As demand for food increases from changing diets and increased population, it falls on scientists and farmers to find ways to balance biodiversity conservation with agricultural intensification. Win-wins like saving natural habitat that exports pest control agents or implementing no-till systems that increase soil biodiversity and water retention are still being uncovered. Yet, research has primarily focused on crops outside of their native range which limits understanding of interaction-based ecosystem services like pollination. Cacao, a cash crop grown primarily by small-holder farmers to diversify their livelihoods, has been gaining research momentum recently. Studies from Ghana and Indonesia have shown proximity to natural landscapes, like primary rainforest, does not increase pollination services to cacao. However, little research has been done within the Upper Amazon Basin, the native range of T. cacao. We examined how different landscape contexts affected pollination dynamics on cacao farms in Ecuador. We used pollen limitation as our measure of pollination service, comparing hand pollination treatments with open pollination treatments in fields surrounded by four different landscape contexts (agricultural, forest fragment adjacent, forest reserve adjacent, and forest reserve embedded). While natural areas did not increase pollination rates nor decrease pollen limitation, proximity to natural areas did increase fruit set from hand pollination. Our results suggest natural areas might be providing resources other than pollinators to cacao farms. More study is needed to know what types of resources are being exporting to fields and how to increase pollination through management strategies instead of the protection of natural areas.

Annika Keeley

Prioritizing connectivity to facilitate range shifts: a new conservation science challenge

While habitat connectivity research is several decades old, prioritizing landscape connectivity to facilitate range shifts in response to climate change is a new conservation challenge. We systematically reviewed the literature on modeling approaches that integrate connectivity and climate change science to analyze the emerging solutions. We identified 66 original studies and 31 essays and reviews published between 2003 and 2017. Studies either assess landscape connectivity in zones where species' ranges are shifting, design pathways along which the studied species can move, or prioritize landscape structures that will facilitate plant and animal range shifts. Approaches include linking protected areas, geomorphic features such as land facets, or desirable atmospheric conditions. To detect major pathways along which species ranges will shift in response to climate change, some studies (N=7) modeled current and predicted ranges of hundreds of species based on climatic preferences. Others avoided species specific approaches and/or future climate predictions to reduce uncertainty, but relied on geomorphic features, environmental gradients, or naturalness alone (N=11). Numerous papers (N=17) assessed connectivity using current and predicted species distribution models (SDMs) for select focal species, while others (N=11) assessed connectivity for focal species without applying SDMs. Few studies were more biologically informed, relying on detailed species information on dispersal, vegetation, and observed responses to the built environment (N=3). A surprisingly large number of methods (N=22) have been developed to map linkages; those that stem from least cost path analyses were employed most frequently. With only 6 papers using more than one method, little information is available to compare the effect of different methods on linkage delineation and prioritization. To facilitate selection of appropriate climate-wise connectivity models for landscape planning, we will categorize approaches with respect to their connectivity goals, landscape context, data requirements, planning scale and output. Strengths and weaknesses will be discussed.

Nickolas Knightly

Why conservation cannot succeed unless "inner science" and "outer science" join forces

In 1968, the systems scientist Gregory Bateson convened a conference on "the effects of conscious purpose on human adaptation." Rachel Carson's "Silent Spring" had come out 6 years earlier, and a growing number of people had become alerted to the negative side effects of many aspects of human culture, especially Western culture. Bateson came to think of the problem of conservation as a systemic epistemological problem, or what we might call a holistic problem in human knowing. Though he was a lifelong atheist, Bateson began developing an "epistemology of the sacred," because he came to the conclusion that this systemic problem, ultimately leading to climate collapse, was in some important way a "spiritual" problem. In this talk, I will explain how Bateson arrived at this conclusion, and I will show how the "inner science" of philosophical psychology and ethics (i.e. philosophy as a way of life) fits with the "outer science" of ecology (and other sciences) to help bring us closer to the transformation of our way of knowing that Bateson saw as essential, but which he was only able to sketch. As we get closer to this new

epistemology, our scientists, our sciences, and our societies will reap many benefits, and in the end it may be the only viable way for us to keep as many species thriving as possible—including the human species.

Monika Krach
Science Education Specialist

Citizen science projects can empower students as science learners and practitioners by enhancing students' understanding of science content and process, exposing them to science careers, and increasing their awareness of environmental issues on local and global scales. A citizen science program invites members of the public to collaborate with professional scientists on scientific research. By examining the successful youth-based citizen science program LiMPETS (Long-term Monitoring Program and Experiential Training for Students), this presentation will discuss the benefits of citizen science including educational outcomes, scientific results that inform natural resource management, and environmental stewardship.

Alex Krohn
*Conservation genomics and captive reintroductions of endangered Amargosa voles (*Microtus californicus scirpensis*)*

Understanding population genetic structure and levels of genetic variation is critical for the conservation of imperiled populations, especially when captive reintroductions are planned. We sequenced thousands of loci of endangered Amargosa Voles (*Microtus californicus scirpensis*) and other desert-dwelling California Voles (*Microtus californicus*) to determine how Amargosa Voles are related to other California Voles, how genetic variation is partitioned in wild Amargosa Voles and how much genetic variation is captured within the captive colony of Amargosa Voles, which are planned for reintroduction into the wild. We discuss our findings in light of the planned reintroductions and the management of genetically impoverished populations.

Bryan Largay
Science based management at the local level

The Land Trust of Santa Cruz County protects and manages about 14,000 acres across more than 50 properties. Guided by a regional long term plan, the Conservation Blueprint for Santa Cruz County, the organization advances several land protection and stewardship programs. Conservation of biodiversity is one of several major themes guiding our work; others include water resources, recreation, and sustainable working lands. We often focus on projects with multiple benefits, which typically means finding a balance where objectives run into conflict. Conservation biology work of our stewardship program includes: grazing grasslands for Ohlone tiger beetles and rare plants, managing weeds and trespass in the Santa Cruz sandhills for rare plants and insects, managing farmland to improve water quality, and restoring historically farmed wetlands and coastal prairie. We provide recreational access to connect people with nature and foster the conservationists of tomorrow.

Katherine McClure

Native bird increases disease transmission of invasive avian malaria in lowland Hawaii

Avian malaria is a mosquito-borne disease that caused the extirpation of most native birds from the Hawaiian lowlands. Yet populations of a malaria-tolerant native bird, the Hawaii amakihi (*Chlorodrepanis virens*) are currently expanding in lowland forests, providing a unique ecological opportunity to explore transmission patterns in communities dominated by native and introduced bird species. We fit generalized linear mixed models to field-collected mosquito infection data from 8 sites in wet lowland forests on the Big Island of Hawaii to examine patterns and drivers of disease transmission of avian malaria. From 2011-1013, prevalence of avian malaria in the primary vector of avian malaria, *Culex quinquefasciatus*, increased significantly with the density of the Hawaii amakihi, despite a striking mosquito abundance gradient in which fully introduced avian host communities harbored significantly more mosquitoes. Interestingly, the density of infected mosquitoes increased significantly in completely introduced avian communities, indicating that avian malaria disease risk is higher in introduced communities despite lower prevalence in the vector relative to sites with natives. Our findings suggest key roles for both native and introduced birds in malaria transmission in lowland Hawaii. We hypothesize that mosquito abundance may limit the continued spread of the Hawaii amakihi in the lowlands, with implications for the recovery and conservation of native Hawaiian birds in the face of climate change and widespread land use change.

Erin McCreless

Strategic prioritization of islands for invasive mammal eradications to protect globally threatened vertebrates

Islands are crucial to the conservation of biodiversity. A leading threat to island species is invasive mammals. The eradication of invasive mammals from islands is a powerful tool for protecting island species and ecosystems. However, the global scope of mammal invasions greatly outweighs resources available for eradications. Eradication efforts on islands, therefore, must be prioritized. We quantified the benefits and costs of eradications on islands globally, and implemented an optimization model to identify the most cost-effective sets of islands for eradications. Specifically, we estimated the extinction risk caused by invasive mammals to each IUCN-listed Critically Endangered and Endangered terrestrial vertebrate species, and identified sets of islands on which invasive mammal eradication would achieve a series of increasingly ambitious conservation thresholds, in terms of the number of island populations of each threatened species, for the minimum cost. Our results indicated that eradications on 135 islands would lead to substantial reductions in extinction risk for 132 of the most threatened island species globally. This approach builds on previous island prioritization efforts by: 1) explicitly, quantitatively evaluating biodiversity benefits, 2) integrating robust benefit and cost estimates across islands to identify cost-efficient islands for eradication, and 3) treating the island prioritization problem systematically by considering islands as sets rather than as individual, entirely independent entities. In addition to identifying sets of high-priority islands that should be a focus for global eradication efforts, this study illustrates a flexible approach to conservation prioritization that can be easily adapted to other conservation decision-making situations. This

type of strategic return-on-investment approach is critical for achieving the greatest possible conservation gains in a world of limited resources.

Alex McInturff

A new place for stories: obligations and opportunities for storytelling in conservation

In his foundational article "What is Conservation Biology?", Michael Soule writes "In crisis disciplines, one must act before knowing all the facts; crisis disciplines are thus a mixture of science and art, and their pursuit requires intuition as well as information." Since this article was published three decades ago, conservation biology has largely focused its energies on formalizing and memorializing its scientific findings. There is no doubt this empirical turn has developed vital methods and tools, enabled links between science and policy, and fortified the discipline's credibility within the broader biological sciences. Nevertheless, Soule's intuition that conservation biology requires a kinship with art, and particularly with storytelling, has persisted beneath the surface of the discipline in at least three important ways. First, as a crisis discipline, conservation biology remains firmly attached to questions not just of valuation but of value, which have always relied on stories and myth for expression and enrichment. Second, conservationists continue find that stories are at least as effective as logic in communicating results and precipitating action. Fortunately, conservation science lends itself to narrative arcs by demonstrating evidence of change. Revelations of the degradation and restoration of biological diversity rhyme with myths of loss and redemption, and create important roles for storytelling in conservation projects. Third, as the conservation tent continues to expand beyond just understanding what humans have done to understanding why, there is an increasingly pressing need for listening to the stories that accompany human behavior. Conservation continues to thrive as an empirical discipline. As our speakers will share, embracing the opportunities and obligations of storytelling will allow conservation to engage even more deeply with a complex world and to take on more compassionate and comprehensive challenges.

Jennie Miller

Refining solutions to human-wildlife conflict through comparing realities to people's perceptions of carnivore threats: Lessons from tigers and leopards in India

Human-carnivore conflict is challenging to assess and resolve because it is shaped by both the realities and people's perceptions of carnivore threats. Whether perceptions align with realities can have implications for conflict mitigation: misalignments can lead to heightened and indiscriminant persecution of carnivores whereas alignments can offer deeper insights into human- carnivore interactions. To explore the utility and applications of this emerging technique, we applied a landscape-scale spatial analysis of livestock killed by tigers and leopards in Kanha Tiger Reserve, India to model and map observed attack risk, and surveyed owners of livestock for their rankings of threats across habitats to map perceived attack risk.

Because >400 livestock are depredated each year in the region, we expected to find misalignments between observed and perceived risk. Yet our results showed that people accurately perceived spatial differences between tiger and leopard hunting patterns, and expected greater threat in areas with high values of observed risk for both carnivores. Observed

tiger risk to livestock was greatest near dense forests and at moderate distances from human activity while leopard risk was greatest near open vegetation. Owners' perception of threats largely did not depend on environmental conditions surrounding their village (spatial location, dominant land-use or observed carnivore risk). Surveys revealed that owners who previously lost livestock to carnivores used more livestock protection methods than those who had no prior losses, and that owners who had recently lost livestock for the first time expressed greater interest in changing their protection methods than those who experienced prior losses.

Our findings suggest that in systems where realities and perceptions of carnivore risk align, conservation programs and policies can optimize conservation outcomes by (1) improving the effectiveness of livestock protection methods and (2) working with owners who have recently lost livestock and are most willing to invest effort in adapting protection strategies to mitigate human-carnivore conflict. This technique of comparing realities to perceptions of carnivore threats to livestock offers insight into the linkages underlying social-ecological systems and could help refine strategies for mitigating human-wildlife conflict at sites around the world.

Ryan Mykita
Public lands in the era of Trump

A discussion of forthcoming legislation on public lands.

Elissa Olimpi
Bats respond to habitat type and landscape context in an agricultural hotspot

Agriculture is both a dominant habitat type and a driver of biodiversity loss. Structural connectivity is vital to maintaining biodiversity in agricultural landscapes and determines the diversity and distribution of species. However, it is often unclear how to best manage species that provide valuable ecosystem services to agriculture. Mobile species in higher trophic levels generally respond to factors at larger scales; however, for insectivorous bats, the availability of insect prey also drives patterns in foraging, and insects respond to habitat at smaller scales. Developing bat-friendly recommendations is critical to the long-term conservation of bats and their associated pest suppression services in agricultural matrices.

We assessed the effects of agricultural intensification at various scales on bats using passive acoustic monitoring data from 54 sites in the Central Coast Region, CA on farms and natural habitat patches spanning a range of landscape contexts. We hypothesized that habitat type (farm vs. natural habitat) and landscape context would impact bat communities, with stronger responses to landscape-scale factors. We found that both habitat type and landscape-scale factors impact bat communities. Natural habitat had greater bat activity than farms, and natural habitat and farms showed differences in bat community composition. At the landscape scale, the amount of surrounding agriculture and distance from the coast predicted bat species richness and activity. Factors across scales interact, pointing toward the importance of conserving small forest fragments in intensive agricultural areas. Application of our findings could decrease the negative effects of agriculture and prevent regional declines in bat biodiversity, as well as enhance benefits to farmers in the form of free, natural pest suppression.

Phoebe Parker-Shames
The Cannabis Conundrum: A review of current impacts on wildlife and proposal for future research

Cannabis cultivation is a multi-billion-dollar industry and one of the fastest growing markets in the US. Amid a wave of recent state legalizations, cannabis' impacts on the environment remain vastly understudied. I will review the major research in the Western US on the impacts of cannabis cultivation on wildlife, especially terrestrial effects of land conversion and rodenticide use. I will identify key gaps in knowledge and outline a proposal to study the patterns of land use and effects of private-land cannabis cultivation on wildlife in Southern Oregon and Northern California. I argue for the use of stakeholder engagement with local growers and other land owners to address conservation questions on this rapid land use change.

Devon Pearse
Adaptation and conservation in the age of genomics

Research on the genomic basis of adaptation in natural populations has made spectacular progress in the past few years, largely due to the advances in sequencing technology and analysis. Without question, the resulting genomic data has and will continue to improve our understanding of regions of the genome under selection and extend our knowledge of the genetic basis of adaptation evolution. What is far less clear, but has been the focus of active discussion, is how such information can or should transfer into conservation practice, complimenting more typical uses of genetic data in conservation. Before such applications can be realized, careful consideration must be given to the implications of using specific targets of selection to set conservation priorities. Here I discuss the key issues for the incorporation of adaptive genomic variation in conservation and management, using examples associated with specific phenotypes in salmonids and other taxa to illustrate scenarios in which adaptive genomic data could be used to inform conservation or restoration, the practical considerations and potential pitfalls of such efforts, and the importance of validating inferences drawn from new genomic data before applying them in conservation practice.

Diana Madrigal Ruiz
Using meta-population viability analysis to determine relative extinction risk among threatened seabirds

Population viability analyses are frequently used to assess and manage threatened species. However incorporating metapopulation structure is an important, often lacking component. Here we apply a meta-population viability analysis (mPVA) to all globally threatened seabirds. We incorporate demographic population data at the metapopulation level, including threats, to formulate a stage-structured, stochastic mPVA. We apply this mPVA to the world's 93 threatened seabird species to determine their relative extinction risk and help focus conservation efforts on the species at highest extinction risk. We validate our results by testing the predictive accuracy at various levels, including population, species, family, and taxonomic group. Our preliminary results index seabird extinction risk by species and across family. Our results highlight the

importance of including metapopulation structure in predicative modeling of threatened species and demonstrate the scalability of modeling extinction probability.

Sarah Skikne

Historic re-photography reveals processes underlying plant species range shifts over 35+ years in the arid Deep Canyon Transect

On average, species have already shifted upwards in latitude and elevation in tandem with recent climate change. However, climate-induced range shifts in arid ecosystems are understudied. With predictions for increasing aridity in the southwestern U.S., deeper understanding of species' natural adaptive capacities is needed to guide conservation. To document and explore the ecological mechanisms underlying plant species range shifts in an arid ecosystem, we used untapped historical data from a steep elevational gradient in the Deep Canyon Transect, which spans 2600m in elevation over 35km in Riverside County, CA. In the late 1970s, sites spanning this gradient were permanently marked and photographed. Since then, climate has changed rapidly in the area. In 2015, we re-located and re-photographed the same sites. We developed methods in ArcGIS to extract data on the establishment, growth and mortality of individual plants across the elevation gradient from these paired historic-modern photos. Species we measured include agave (*Agave deserti*), palo verde (*Cercidium floridum*), two cholla species (*Cylindropuntia bigelovii* and *C. ganderi*), ocotillo (*Fouquieria splendens*), creosote (*Larrea tridentata*) and mojave yucca (*Yucca schidigera*). By comparing the distribution and size of individuals at the two time periods across the elevational gradient, we can document demographic shifts by elevation. For example, preliminary results for *A. deserti* show that individual growth, but not births or survival, increases with elevation. Our results illustrate variation in the various demographic processes that underlie range shifts, offering new insights into the trajectory and natural adaptive capacity of this desert community under future climate change.

Jeffrey Smith

Predicting species level responses to deforestation in neotropical birds

There is now growing evidence that the most significant impacts of human induced global change on biodiversity will not be through absolute losses of local diversity, but rather through changing assemblages of species. Species that are well adapted to human interventions (i.e. land-use change) are expected to thrive under growing human pressure at the expense of more sensitive species. Determining how species respond to these pressures is therefore critical to conservation efforts. We combine a long-term dataset of Costa Rican bird diversity with species ranges, functional traits, and emerging high-resolution remote sensing products to estimate the affinity of 740 bird species for forest (natural) and non-forested (altered) habitats. From these affinities, we generate current predictions of bird species richness and abundance that align well at a coarse resolution with existing models of bird diversity. However, we are able to detect much finer spatial variability than the global models; variability that aligns well with land-use data. We then use this approach to project how each individual species, as well as the bird community as a whole, will change under a variety of land-use scenarios (i.e. deforestation and reforestation). Interestingly, we do not predict strong declines in total abundance or richness with further land-

use change, but specific predictions for each species show great variability. These findings reinforce the emerging consensus in the field that there will be 'winners' and 'losers' with increasing anthropogenic pressures and also shows a potential pathway to predict the success of both the community as a whole and individual species in response to these drivers.

Joseph Stewart

Apparent climate-mediated loss and fragmentation of core habitat of the American pika in the northern Sierra Nevada, California, USA

Contemporary climate change has been widely documented as the apparent cause of range contraction at the edge of many species distributions but documentation of climate change as a cause of extirpation and fragmentation of the interior of a species' core habitat has been lacking. Here, we report the extirpation of the American pika (*Ochotona princeps*), a temperature-sensitive small mammal, from a 165-km2 area located within its core habitat in California's Sierra Nevada mountains. While sites surrounding the area still maintain pikas, radiocarbon analysis of pika fecal pellets recovered within this area indicate that former patch occupancy ranges from before atomic bomb testing to ca. 1991. Despite an abundance of suitable rocky habitat, climate warming appears to have precipitated their regional demise. Weather station data reveal a 1.9C° rise in local temperature and a significant decline in snowpack over the period of record, 1909-2015, pushing pika habitat into increasingly tenuous climate conditions during the period of extirpation. This is among the first accounts of an apparently climate- mediated, modern, regional extirpation of a species from an interior portion of its geographic distribution, resulting in habitat fragmentation.

Sarah McKay Strobel

The sensory ecology of a nearshore top predator: a behavioral assessment of active touch in sea otters

The establishment of healthy predator populations can be essential for balanced ecosystem functioning. Through natural dispersal patterns and facilitated reintroductions, sea otters (*Enhydra lutris*) are expanding along the coastline of California into nearshore habitat unoccupied by this top predator for the past 200 years. Due to their trophic position and high daily metabolic requirements, sea otters can have large-scale effects on community structure. Sea otters consume a variety of cryptic benthic invertebrates in conditions that are often turbid or poorly lit. However, the proximate mechanisms (i.e., sensory and cognitive abilities) that enable sea otters to identify and select potential prey items are virtually unknown. While their underwater behavior has not been described, sea otters are assumed to rely on an enhanced sense of touch to forage in patches with complex topographic features. To explore this possibility, we used behavioral psychophysical methods to investigate sea otter tactile abilities in air and under water for both paws and whiskers. We used a two-alternative forced choice procedure to measure the ability of a trained sea otter to discriminate between pairs of stimuli that differed in texture using only her paws or only her whiskers. For each tactile structure in each medium, we measured the subject's discrimination threshold, as well as corresponding latency (i.e., decision time) and behavioral strategy. Our subject maintained equal sensitivity in air and underwater, and the

sensitivities of both tactile structures were comparable to those of other marine and tactile specialists. However, the subject's paw discrimination threshold was lower than her whisker discrimination threshold, indicating that paws may be the more sensitive tactile structure in sea otters. The results from these controlled experiments support that sea otters have sensitive and quick active touch with their paws and whiskers, which corresponds to our observations of their surface behavior. Our findings provide insight into how sea otters may use active touch to detect, discriminate, and manipulate hard-shelled invertebrate prey. In general, this research informs our interpretation of underwater foraging behavior, providing a basis to understand how this behaviorally flexible top predator interacts with its environment.

Megan A. Supple

Landscape genomic techniques aid seed sourcing decisions for reforestation under climate change

Long lived species with slow migration rates are potentially vulnerable to environmental changes because of their limited ability to move with favorable conditions. Reforestation projects can assist migration of adaptive alleles in these species by selecting seeds that are well adapted to current conditions and predicted future climates. *Eucalyptus melliodora* is a foundation tree species of an endangered woodland community in southeastern Australia with numerous active reforestation projects. Through a citizen science project, hundreds of mature trees were genotyped from across the species' geographic distribution. We modeled genomic variation as a function of geographic distance and key environmental variables, generating spatial maps of potential seed sources for given reforestation sites. Our results suggest that the common practice of strict local sourcing of seeds is suboptimal and that predicted future environmental conditions need to be considered when deciding seed sources for reforestation.

Max Tarjan

Thirty-five years of colonial waterbird monitoring by citizen scientists

Colonial waterbirds are essential components of wetland and aquatic habitats across the globe. These species play key roles within their ecosystem, require specific habitat types and qualities, and thereby can be viewed as biological indicators of environmental health and function. In densely inhabited areas like the San Francisco Bay, human encroachment and habitat degradation are a few of the many factors that affect wetland habitats and colonial waterbird populations. In an effort to track the health of breeding populations and to document responses to habitat change, the San Francisco Bay Bird Observatory (SFBBO) has monitored nesting colonial waterbirds throughout the Bay Area since 1982. Over 35 years, SFBBO has trained hundreds of citizen scientists to count nests, chicks, and adults during the breeding season (March-August). The substantial effort of citizen scientists has yielded data on nesting activity of 18 species of herons, egrets, cormorants, gulls, and terns at 133 sites. The resulting dataset offers insight into colonial waterbird ecology, including population and phenological changes over three decades and species interactions. This information is shared with landowners, resource agencies, and other conservation organizations and contributes to the conservation and management of these species. Citizen scientists also connect community members with local habitats. In the past

year alone, 65 citizen scientists conducted fieldwork and led more than 20 community outreach events. The resulting community awareness has inspired further efforts to conserve waterbirds and their habitats.

Vanessa ZoBell
Impacts of deforestation on passerine avifauna in the Opunohu Valley of Mo'orea, French Polynesia

Human expansion has negatively impacted biodiversity. Oceanic islands have some of the most diverse, endemic biodiversity. Endemism leads to vulnerability due to the isolated and discrete nature of oceanic islands. Birds are indicator species that adapt to change very quickly. By analyzing birds, we can investigate how changes in behavior and abundance may occur for different species in the future. Nine passerine bird species were studied with automated acoustic recording devices. Recording devices were placed in agricultural, forest, and mixed habitats. Three invasive species preferred agriculture areas and low canopy cover, based on call frequency and detection probability. Native bird detectability was significantly lower than invasive bird detectability. Occupancy was above 0.8 for all species, except for the gray-green fruit dove that was >0.6. Native bird populations are at risk, based on their calling number and detection probability.

Rachel Zuercher
Social and ecological dynamics of the commercial, nearshore fishery in central California

Small-scale fisheries play a pivotal role in many coastal communities, but are increasingly vulnerable to environmental and socioeconomic changes. Disturbances such as large-scale oceanographic shifts and management changes can have major impacts on fish populations and fishing communities alike. However, understanding of the interactions between social and environmental factors that influence fishery outcomes is incomplete. Using the California nearshore fishery as a case study, I explore social-ecological coupling, focusing on feedbacks among biophysical dynamics, human behavior, market demand and governance. This work highlights ways that social, economic and biophysical factors interact to influence ecosystem services, fishing practices and fishery outcomes.

POSTER PRESENTATIONS

Quratulain Ahmed
Assessing bird diversity and ecosystem services in spring flooded alfalfa fields

California has lost over 90% of the wetlands that once supported hundreds of bird species and millions of individual birds. Much of this loss is due to conversion to agriculture, which relies on California's diminishing water supply for irrigation. A particularly water intensive crop in California is alfalfa. Alfalfa is one of the state's highest acreage crops, and is typically flood-irrigated. Due to water scarcity, many famers have been pressured into transitioning to sub-surface drip irrigation. However, flood irrigated fields are potentially useful to birds. In addition to this, raptors and other carnivorous birds could provide rodent-pest control services for farmers in flooded fields. We will present results from a recent and ongoing pilot study to analyze the effects of flood and drip irrigation on avian diversity, and to quantify the ecosystem services provided by carnivorous birds in Northern California alfalfa fields.

Joan Kirsti Brennan
Foraging behavior of bees in an incompletely restored coastal dune system

This study investigates the effect of habitat restoration on the foraging choices of bee communities of the coastal sand dunes in and around Fort Ord, California, and provides a survey of extant bee species in the area. Much has been done to restore the coastal dunes of California, but the effect of dune restoration on pollinators has received little scientific attention. Wild bees are often the most important pollinators in an ecosystem, making them a suitable group to use to evaluate restoration measures. Additionally, the bees of this region have not been well cataloged. I used pan traps and netting to collect bees at eight pairs of plots along the coast. Much of the coast in this area is heavily invaded by *Carpobrotus edulis* X *chilensis* (ice plant). At each site I established a pair of plots: one was located in an area that had received restoration treatments (removal of *Carpobrotus* and reintroduction of native plants) and an adjacent plot was located on untreated dune (covered by *Carpobrotus*). Preliminary data indicate greater bee abundance and species richness in treated sites. This data will inform future management decisions regarding both restoration plantings and the health of restored ecosystems.

Miranda Conlon
Water for elephants: effects of African elephants on areas surrounding artificial waterholes in Kruger National Park

The effects of African elephants (*Loxodonta africana*) on vegetation surrounding waterholes are presented in the form of piospheres, or gradients of utilization radiating out from a resource hotspot. In addition to their influence on vegetation community composition, it has also been suggested that elephants may exclude other animals from water. This study examines elephant effects on vegetation and animal presence at four artificial waterholes in the southern part of the Kruger National Park (KNP). Using camera traps and dung counts, we determined which species visit each waterhole, and how their temporal utilization of the waterhole compares with that of

elephants. We conducted vegetation surveys starting at the waterhole and extending 300 m away to test for piosphere effects, and ultimately confirmed the presence of this effect surrounding the artificial water points. Additionally, we found that elephant activity at the waterholes was greatest during daylight hours and their presence did not appear to affect the behaviours of other mammals. The uniformity of observed impact across the four distinct study sites suggests that elephants have little or no preference between vegetation types during the dry season. Finally, although a variety of mammal species were found to utilize these sites, elephant exclusion from water could not be supported. Our findings provide useful information for the future management of water distribution, especially within Kruger National Park.

Darko Cotoras

A glimpse of the biodiversity from Empire Cave (UC Santa Cruz)

Formed within the fractured marble bedrock of the central coast of California's largest karst landscape, Empire Cave is the primary habitat of a diverse assembly of organisms, several of which are restricted to the cave environment. While over 70 invertebrate species have been found within the Cave Gulch cave system, which includes Empire Cave, at least 40 are known to call Empire Cave home. Of these, several are thought to be endemic, including MacKenzie's cave amphipod (*Stygobromus mackenziei*), a pseudoscorpion (*Neochthonius imperialis*) and an undescribed aquatic isopod (*Calasellus* sp. nov.). Among the rarest species is the spider *Meta dolloff* (Tetragnathidae), which was originally described from Cave Gulch. Despite its rare fauna, assessment of the cave's biodiversity is rarely done and no formal monitoring program exists. Here we present a poster that illustrates findings from an informal field survey in fall 2016, where the biodiversity discovered included one vertebrate, four hexapods, two myriapods, one oligochaeta, six arachnids and two fungi. The cave is a highly sensitive ecosystem that has experienced vandalism and other human-induced impacts, activities that threaten its unique species. The objective of this poster is to raise awareness about the cryptic and special species living in Empire Cave and to promote appreciation and more respectful practices from visitors to the very accessible cave. The poster will be permanently exhibited on campus and available for download from the Kenneth S. Norris Center for Natural History and the UCSC Campus Natural Reserve websites.

Nevin Cullen

Effect of invasives on plant-pollinator relationships in the Mt. Tamalpias watershed

A wide variety of invasive plants are known to reduce native plant diversity through competition for space, nutrients, pollinators or other resources. These invasive plants may also have the potential to alter the pollinator-plant bipartite network, which in turn could have cascading impacts on plant reproduction. In this study we determined the effects of the exotic weed, *Genista monspessulana* on pollinator activity rates (recording floral visitation rates in visits/flower/hour) and species richness on a selection of 7 native and 4 non-native plant species in 12 grassland sites in Marin County, CA invaded by *G. monspessulana*. We measured reproductive success of the select plant species by collecting fruits and counting seeds to determine fruit set and seed set. We observed and collected bees approximately every 3 weeks.

In early 2017 we will work with local land management agencies to remove *G. monspessulana* from 6 of our sites, after which we will re-sample all sites as described above. This will allow us to make a before-and-after comparison of the effects of *G. monspessulana*. We expect to find a difference in pollinator visitation rates, pollinator composition and seed set of focal plant species. The type and intensity of differences we see should indicate how *G. monspessulana* is affecting local plant-pollinator networks. Our results will inform land managers of implications on local native and non-native plants and pollinators when removing significant expanses of *G. monspessulana*.

Melissa Douglas

Reserves in reverse and back again: Changing access status of Stornetta Ranch and the resulting effect on red abalone populations

The Stornetta Ranch, just south of Point Arena in Mendocino County, CA, historically consisted of 1711 acres of private property including 2.5 miles of coastline. Prior to 2004, this coastline had virtually no public access or harvesting, making it a 'de facto' reserve. The area was opened to the public in June, 2004 and harvesting of red abalone (Haliotis rufescens) immediately began. In May, 2010 the Stornetta Lands were added to the existing Sea Lion Cove State Marine Conservation Area and were once again closed to abalone fishing. Just prior to the area being opened to the public in 2004, the Multi-Agency Rocky Intertidal Network (MARINe) and Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) worked with the California Department of Fish and Wildlife (CDFW) to perform a preliminary intertidal survey of Stornetta. A large population of red abalone was found during the survey. Since then, annual monitoring of the intertidal abalone population has occurred to determine both the effects of harvesting, and, after 2010, it's subsequent response to the area's closure. To accomplish this, in 2005 a number of permanent plots were established. Due to the influence of Sea Lion Rocks (essentially an offshore island) the plots differed in wave exposure and, therefore, the composition of intertidal algae and organisms. Initially the results suggested that the plot closest to the coastal access point was the most heavily impacted by harvesting. Specifically, there was a marked absence of individuals of legal size in the plot closest to the access point compared with those farther away. However, by year 2 virtually no legal sized individuals were found in any of the plots. Since the closure in 2010, there has been an overall increase in the number of individuals which appears to be due mostly to a large increase in numbers in the most wave exposed plots. This suggests that, in addition to the lack of harvesting, other environmental/ biological factors can influence population size. These results suggest that changes in access status can have dramatic consequences on red abalone populations. As other privately owned coastal lands in California are changed to public access, monitoring programs such as described here may provide the insights needed to effectively manage these areas.

Monika Egerer

Biodiversity conservation and ecosystem service provision through urban food cultivation

Urbanization and the conversion of natural habitat into impervious cover is associated with local and regional biodiversity loss. Thus, urban greenspaces like parks and gardens become important

reservoirs of biodiversity conservation in the urban landscape matrix. The recent popularity of urban agriculture has led to an increase in the cultivation of greenspaces for urban food production, and these agro-ecosystems may be sites of high biodiversity due to local habitat management. Food production relies heavily on ecosystem services like pollination and pest control provided by urban biodiversity. Yet, we are still elucidating the links between landscape features (e.g., impervious cover), local habitat management (e.g., groundcover characteristics), and facets of biodiversity (e.g., species diversity) that provide these crucial services. In this talk, I draw on the results of five years of research on beneficial insect communities in 25 community gardens across the California central coast to demonstrate that urban agro-ecosystems conserve and support biodiversity and ecosystem services in cities.

Nathaniel Fletcher
An assessment of black abalone populations and habitat on the California Channel Islands and the potential effects of sea otter re-establishment on recovery
Authors: Fletcher, N.C., Melanson, K.L., Anderson, L.M., Raimondi, P.T.

The Endangered Species Act provides very little guidance for managing the interactions between two listed species. A goal of this project is to provide critical information for a multi-species approach to the management and restoration efforts for two listed species: black abalone (*Haliotis cracherodii*) and southern sea otters (*Enhydra lutris nereis*). Black abalone populations have declined dramatically in southern California, including the Channel Islands, as a result of withering syndrome. Prior to this decline, densities of black abalone in the Channel Islands were exceptionally high. Due to a lack of harvest and natural predation, many abalone on the islands were found in the open. By contrast, in central California, where black abalone and sea otters co-occur, abalone are more likely to be found in refuge habitat (deep cracks and crevices). Sea otters currently range as far south as Gaviota (Santa Barbara County) and their range continues to expand southward and to the northern Channel Islands. If the distribution of remaining black abalone in the northern Channel Islands reflects pre-disease habitat associations, these abalone would be vulnerable to future otter predation, which is problematic for their recovery. We surveyed large representative segments of suitable abalone habitat at each of the four northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa). Within each segment we counted, sized, and determined the refuge habitat quality for all abalone found. Then we estimated the proportion of good, moderate, and poor abalone habitat, in regards to refuge value, for each segment. We also surveyed San Nicolas Island using the same protocol. San Nicolas Island provides an opportunity for comparison with the four northern islands as sea otters have been present here since a 1987 translocation effort. We used the results of these surveys to: 1) determine black abalone population size (per island), 2) produce spatially explicit estimates of habitat quality, 3) produce a database of spatially explicit abalone locations, 4) develop spatially explicit metrics of vulnerability to otter re-establishment on the northern Channel Islands.

Victoria Heyse
Monitoring allows adaptive management of nuisance species in urban environments

California Gull (*Larus californicus*) populations in San Francisco Bay have increased dramatically over the past three decades. In this urban ecosystem, gulls frequently forage at local landfills and take advantage of other anthropogenic food resources. Gulls also prey on smaller and less abundant nesting waterbirds. California Gull population growth is a pressing concern for management of the San Francisco Bay estuary. Historically, California Gulls nested on levees and dry salt ponds, but up to 90% of former salt ponds are being converted to tidal marsh by the South Bay Salt Pond Restoration Project. As restoration progresses on nearly 15,000 acres, it is unclear how California Gulls will redistribute and how other waterbird populations will respond to this rapidly growing predator population. Information on what drives gull population growth and how gulls respond to landscape changes will help predict the ecological impact of future tidal marsh restoration activities in San Francisco Bay. The San Francisco Bay Bird Observatory (SFBBO) leads a California Gull nesting survey each spring to collect data on all known breeding locations in the Bay Area. Movements in response to restoration are also tracked by re-sighting the 1,000+ gulls that were banded at local breeding colonies in 2008-2010. Over the past 30 years, SFBBO has documented a rapid increase from only 24 birds in the early 1980s to over 50,000 in 2014. This increase may have been facilitated by landfills and other anthropogenic food resources in a highly urbanized landscape. In the past five years, hazing efforts and abatement have successfully kept gulls from foraging at local landfills and nesting near sensitive species. From 2014 to 2016, populations declined to an estimated 38,040 breeding California Gulls. The causes of this decline merit investigation to better inform adaptive management of local and similar ecosystems.

Elena Huynh

Recruitment patterns of sessile invertebrates in the San Francisco Bay

The San Francisco Bay is a dynamic estuary that harbors many different biological communities. The bay has become one of the most invaded estuaries in the world due to historical shipping routes transporting goods as well as non-native marine species. These non-indigenous species have established themselves in the bay, some of which are sessile invertebrates. Found on hard substrates such as boat hulls and docks, these invertebrate communities are comprised of a great diversity of organisms with unique life histories. Understanding patterns in their recruitment is a useful way to study broader concepts such as succession, community development and climate change.

In this observational study, we ask how the recruitment of dominant sessile invertebrate taxa differ between 3 sites in the San Francisco Bay. We measured recruitment and environmental factors (temperature and salinity) biweekly at three sites---the San Francisco Marina, Loch Lomond Marina (San Rafael, CA) and the Richmond Marina. Settlement panels were placed in each site at a 1 meter depth for two weeks starting May 2016. We found that pulses of recruitment for each taxa of interest occurred asynchronously between sites, but all sites exhibited a strong effect of seasonality with little to no recruitment during the wet winter. Although temperature and salinity did not show direct correlations with taxa recruitment, distinct site differences and flow regime may help explain the patterns we observed.

Samantha Klein

Impacts of Hong Kong trawling ban on Chinese white dolphin feeding behavior and mortality

The Chinese white dolphin (*Sousa chinensis*) population in Hong Kong has been decreasing rapidly, declining by 26% in the past four years. This decline is partly due to fishing boat related mortalities. In the past, this population has often followed fishing boats as a source of food. To analyze the affect of the trawling ban on dolphin feeding behavior I used vessel-based population survey data from 2010 to 2015. I compared the number of sightings of dolphin-fishing boat feeding associations before and after the 2012 trawling ban. Additionally, using land-based survey data from 2011-2016 I evaluated how the percentage of dolphin sightings associated with fishing boats has changed around the economically important village of Tai O after the trawling ban. I also examined the cause of death in dolphin stranding cases before and after the trawling ban. I found that there has been a significant decrease in vessel-based sightings of dolphins feeding behind all types of fishing boats and a decrease in fishing boat related dolphin deaths post-trawling ban (2013-2015) compared to pre-trawling ban (2010-2013).

Monika Krach
Science Education Specialist

LiMPETS (Long-term Monitoring Program and Experiential Training for Students) is a citizen science program in which students, educators and volunteer groups monitor ecological changes along the coast of California's National Marine Sanctuaries. Through this statewide program, over 6,000 citizens annually participate in a hands-on, scientific endeavor that increases their knowledge of the marine environment, creating a new generation of informed and engaged ocean stewards. Beyond the educational value of the program, the power of LiMPETS lies in the large quantity of data collected along the coastline of the Greater Farallones and Monterey Bay National Marine Sanctuaries. By consistent and frequent monitoring, LiMPETS has established a baseline from which we can better address current and future impacts, including the impacts of ocean acidification, sea-level rise, warming waters, and increased storm severity and frequency. LiMPETS collects abundance data on 5 of the GFNMS Climate-Smart taxa (sea lettuces, green pin-cushion, coralline algae, mussels, and sea stars) and 7 of the GFNMS Ocean-Climate Indicators (surfgrasses, giant green anemone, sunburst anemone, mussels, pink acorn barnacle, leaf barnacle, and the ochre sea star). Data from the past 10 years reveal regular seasonal fluctuations in algal abundances, massive declines in ochre sea stars, expansions of mussel beds, boom and bust patterns of storm-sensitive algae, and subtle geographic expansion of the sunburst anemone.

Zeka Kuspa
*Assessment of the glucocorticoid stress response in the critically endangered California condor (*Gymnogyps californianus*) at multiple time scales*

Vertebrates respond to stressful stimuli with the secretion of glucocorticoid (GC) hormones and measurements of these hormones in wild species can provide insight into physiological responses to environmental and human-induced stressors. California condors are a critically endangered and intensively managed avian species for which no GC studies have been performed. The availability of commercial immunoassay kits, especially those that do not require radioactive

materials, have increased the accessibility of hormone measurements for researchers and field biologists. However, few of these kits have been validated for non-plasma sample types, and measuring a baseline stress level from blood sampling can be challenging if not logistically infeasible in wild animals. Indirect measures of plasma GC (e.g., GC levels in saliva, feces, urine, hair, feathers) allow for less-invasive sampling procedures and also allow for assessment of baseline GC levels in field settings because there is a time-lag between GC elevation in circulation and elevation in those peripheral samples. Here we evaluated two commercially available corticosterone immunoassay kits, a competitive corticosterone enzyme-linked immunosorbent assay (ELISA) and a corticosterone I125 double antibody radioimmunoassay (RIA) kit, for use with California condor plasma, urates, and feather samples. We found the RIA kit to be reliable for GC and metabolite (GC(m)) measurement in all three sample types. Notably, GC(m) values were not comparable between the two kits for any sample type, highlighting the need for caution when comparing immunoassay results across methods. RIA measurements of total GC in condor plasma collected from 33 condors within 15 minutes of a handling stressor were highly variable (range: 13 – 189 ng/mL, median: 71 ng/mL, n=42) suggesting notable individual differences in stress response, but within range of GC measurements in other avian species. In response to acute stress caused by capture and handling, we measured a 1.6 – 35-fold increase in urate GC(m) concentrations within 2 hours post-stressor, providing a biological validation for our measurement method. Feather GC(m) concentrations were within expected ranges for bird feathers (range=5.7-33.5 ng/g, median= 9.3 ng/g), but additional work is needed to interpret changes in GC(m) concentrations between and within condor feathers. In light of the value of GC(m) measurements to environmental research, we emphasize the need for extensive validation of commercial immunoassay kits before use with novel species and non-plasma sample types.

Rebecca Nelson and Dylan MacArthur-Waltz
*Thermal tolerance, seasonal partitioning of activity, and coexistence of the native winter ant (*Prenolepis imparis*) and the invasive Argentine ant (*Linepithema humile*)*
Authors: Dylan MacArthur-Waltz, Rebecca Nelson, Deborah Gordon

The Argentine ant (*Linepithema humile*) is an invasive species that has spread to Mediterranean climates worldwide, associated with losses in native arthropod biodiversity in its invasive range. In northern California, a 24-year survey of ant distributions in the Jasper Ridge Biological Preserve of Stanford University show that the native winter ant (*Prenolepis imparis*) is the native species best able to coexist with Argentine ants. Both species tend homopteran scales for food. Previous research suggests that these species' coexistence may depend on seasonal partitioning: winter ants are active primarily in the winter, while Argentine ants are active primarily in the warmer months.

We investigated the physiological basis of seasonal partitioning in Argentine and winter ants by a) testing critical thermal limits (CTmax and CTmin), and b) measuring the relation of temperature and Argentine ant and winter ant walking speed. While both species respond similarly to high temperatures, we found small differences between the two species' critical thermal minima that may allow winter ants to remain functional at ecologically relevant temperatures between 1-3

°C, while at those low temperatures Argentine ants enter chill coma, a paralytic state. In ants, walking speed tends to be highly dependent on temperature, with slower walking speed at colder temperatures. We found that winter ants' walking speeds are significantly less temperature-dependent than those of Argentine ants, which may allow the winter ants to remain active at lower winter temperatures. These results suggest that the crucial separation of activity periods occurs at low temperatures, and that partitioning based on differences in temperature tolerance promotes the coexistence of the native winter ant with the invasive Argentine ant.

Anna Nisi

Puma survival in a fragmented landscape

Land use change and habitat fragmentation are a widespread and ongoing processes worldwide and are key threats to large carnivore populations. Living in a human-dominated landscape often comes with increased risk of anthropogenic mortality as well as indirect behavioral and energetic costs, which may impact individual survival and population dynamics. The puma (*Puma concolor*) population in the Santa Cruz Mountains presents an ideal study system to investigate how habitat fragmentation impacts large carnivore survival, as animals occupy a range of different levels of human use or development in this variegated landscape. In this poster, I will present preliminary results from a survival analysis aiming to characterize the impacts of habitat fragmentation on adult puma survival. I have integrated spatial data from collared pumas into a Cox proportional hazards model to investigate whether housing density within an animal's home range impacts survival probability after controlling for demographic factors, and how temporal scale in home range calculation influences that relationship. I will also consider how habitat fragmentation impacts cause-specific mortality probabilities, and discuss how Bayesian methods may be used to determine whether anthropogenic mortality is additive or compensatory.

Shannon O'Brien

Niche differentiation among small mammals of the Alexander Archipelago in Southeast Alaska

The impact of competition and predation on niche width is commonly studied, however, we know little about how these ecological factors vary among small mammals that co-occur across multiple mainland and island localities that vary in size and species composition. To assess the potential roles that competition and predation play in structuring small mammal communities, we quantified the carbon (δ13C) and nitrogen (δ15N) isotopic niche widths of 6 small mammal species distributed across the Alexander Archipelago and adjacent mainland. Species examined consisted of 2 insectivorous shrews (*Sorex cinereus*, *S. monticola*), 3 primarily herbivorous rodents (*Microtus longicaudus*, *M. oeconomus*, *M. pennsylvanicus*), and 1 omnivorous rodent (*Peromyscus keeni*). We sampled islands that varied with respect to size and species richness; data from these localities were compared to data from more diverse mammal communities on the adjacent mainland. Isotopic niche data were combined with information provided by natural history accounts to test the predictions that dietary niche width will be greater for individuals living in less diverse communities and on islands with fewer potential predators. For all species, isotopic niche widths decreased by ~50% on the mainland relative to the islands. Additionally, isotopic niche widths for all species decreased with increased potential for competition and

increased risk of predation. Our findings have the potential to influence conservation and management strategies in this archipelago through increased understanding of how key community-level interactions vary across localities within this complex landscape.

Gisele Miglioranza Rizzi

Skeletal Lead: Assessing the true magnitude of lead poisoning in California Condors

Lead poisoning is precluding the recovery of the endangered California condor. But the true impact of lead poisoning on condor mortality is likely underestimated, given that the cause of mortality for birds recovered dead from the wild is often difficult to diagnose. Thus, there is need for an accurate lead exposure biomarker that reflects a condor's lead poisoning status at the time of death that can be used to more accurately determine whether lead poisoning contributed to or was the cause of mortality. Human studies have shown that bone lead levels reflect cumulative exposure and health effects. However, little is known about lead accumulation in condor bones, and the extent that lead levels in different bone types reflect exposure history and mortality risk. We investigated how lead concentrations vary across California condor bones (femur, humerus and tibiotarsus) and bone regions (diaphysis, or proximal and distal epiphyses) to determine which bones are most diagnostic of lead poisoning. Results from nine condors with different lead exposure histories (not-exposed, lead-exposed, lead poisoning cause of death) indicate that lead-exposed condors possess bone lead levels (range ~10–200 ug/g) >50-fold higher that unexposed birds (~0.5–1 ug/g), and that bone lead levels varied by 3–13-fold between bones within exposed condors, but only by ~2-fold between bones in unexposed birds. Moreover, our data suggest that the proximal tibiotarsus epiphysis lead levels are most reflective of recent acute exposure, while the diaphyses are most reflective of long-term cumulative exposure. This approach will be applied to other condor mortality cases of unknown cause of death to better determine the fuller impact of lead poisoning on condor mortality.

Stephanie Saffouri

Impacts of invasive Limonium on a native congener in San Francisco Bay salt marshes

Coastal salt marshes in San Francisco Bay have seen aggressive expansion of invasive plants, displacing native species and the broader communities and functions they support. Two recent invasives, *Limonium ramosissimum* and *Limonium duriusculum*, thrive in the mid to upper salt marsh and marsh-terrestrial ecotone–areas that host high species richness and provide critical habitat for endangered vertebrates. Marsh patches containing invasive *Limonium* have experienced a marked decline in native halophytes, including the only *Limonium* native to California: the Western marsh rosemary, *Limonium californicum*.

My project investigates the relative invasion potential of *L. ramosissimum* and *L. duriusculum* and their impacts on the growth and fecundity of *L. californicum*. Given the spatial proximity, overlapping flowering periods, and relatedness, there is definite potential for the congeners to compete for pollinator services. The reproductive mechanisms for these species are still unresolved, and shifting pollinator habits may favor the spread of one species over another. Through controlled pollinations, I examined self-compatiblity, the effect of interspecific pollination, and potential for hybridization among the native and non-native *Limonium*. My

results will show how invasive *Limonium* interacts with native species and what the potential is to affect salt marsh biodiversity. This work will provide a mechanistic understanding of wetland invasion more generally and provide new information about the reproductive strategies within the highly-variable *Limonium* genus.

Amy Petersen Wynes

A comparison of stand structure and composition following selective-harvest at Byrne-Milliron Forest

The effects of selective-harvest on forest composition and structure in the southern range of the coast redwood (*Sequoia sempervirens*) forest have not been well documented. This case study focused on the Byrne-Milliron Forest in Santa Cruz County where selective-harvest is currently the primary method of timber extraction. The purpose of this research was to determine how forest structure and composition varied in regard to harvest intensity and management goals. We sampled 100 plots in the Byrne-Milliron Forest across five harvest sites. All sites had been essentially clear-cut in the late 19th or early 20th century, and subsequently selectively harvested in the late 20th and early 21st century. Four of the five sites have been managed primarily for timber production, while the fifth site, the Late Successional Unit (LSU), has been managed for old-forest conditions as well as timber production. We predicted the LSU would contain more late seral features, and that the presence of these features would be positively correlated to years since harvest, and negatively correlated to percentage cut and number of harvest re-entries. Data analysis procedures included one-way analysis of variance (ANOVA) for comparison between sites, and Pearson product-moment coefficient for correlations between variables. As expected, the LSU exhibited the most developed old-forest features, including the lowest stand density and exotic species richness among all sites evaluated. In addition, it contained the highest percentage of coast redwood associated herbaceous species and large woody debris (LWD). Results also indicated that percentage cut was the strongest predictor for canopy cover, stand density, LWD, and the cover of coast redwood associated herbaceous species. Our findings suggest that a lower percentage cut is more effective in maintaining conditions commonly associated with late seral forests such as snags, fire hollows, complex canopy structures and LWD, and these features can be present in selectively harvested stands if carefully managed."