Proceedings of the CEB Fall 2013 Faculty Workshop

Workshop Agenda: Wednesday, Sept. 18, 9:15am - noon, Student Center, Doheny Room B

9:15am	Continental Breakfast	
9:30am	Meeting Introduction	Kimball/Huxman
CEB research projects		
9:35am	Symbiotic microbes, water stress, & ecosystem services	Kathleen Treseder
9:42am	Impacts of Invasive Black Mustard on Pollination of Natives	Diane Campbell
9:49am	Soil bacterial communities associated with native and exotic plant species	Steve Allison
9:56am	Changing precipitation patterns & invasive fountain grass populations	Ann Sakai/Steve Weller
10:10am	Global Change Experiment	Mike Goulden
10:17am	Habitat quality of Cactus Wren	Kailen Mooney & Kathleen Treseder
10:24am	Break	
Research Integration and Knowledge Networks		
10:34am	Fish Diversity & Trophic Structure in Crystal Cove State Park	Donovan German
10:41am	Education & Outreach at CCA	Jen Martiny
10:48am	CEB intern programs	Jessica Pratt
10:55am	UCI Eco Preserve	Peter Bowler
11:02am	CEB & Knowledge Networks	Sarah Kimball
11:10am	General Discussion	
CEB Strategies and Opportunities for the Upcoming Year		
11:30am	Identification of Priorities	Travis Huxman

Workshop Presentations

Project Name: Fungi in Restoration Ecology
UCI Investigator(s): Kathleen Treseder
Graduate Student(s): Mia Maltz
Undergraduate Students: A. Swanson, O. Onumundo, P. Tang, C. Nguyen, and A. Bruce
High School Students: Francis Yang, Adithi Iyer, and Naman Jain
External Partners: Megan Lulow and Jutta Burger

Project Description: Fungal species perform a variety of ecosystem services that are of interest to restoration ecologists and land managers. For instance, they can improve nutrient uptake by plants by forming symbiosis with plant roots (as "mycorrhizal" fungi). This action can facilitate the establishment of native plants. Our objectives are to determine (1) how environmental degradation (e.g., invasive plants) alters soil fungi, (2) whether standard restoration practices can indirectly restore fungal communities, (3) whether fungi can be directly restored via the development of new restoration protocols, and (4) which metrics can be used by land managers to assess the need for—and success of—fungal restoration in target ecosystems.

We have performed a suite of experiments to meet each objective:

1. In Quail Hill Preserve, we found that black mustard invasion directly inhibits mycorrhizal fungi from colonizing native plants, leading to a reduction in native plant growth.
2. Also in Quail Hill, the removal of black mustard indirectly improves mycorrhizal fungal growth, with a corresponding increase in benefits to native plants.
3. In the joint IRC-UCI preliminary restoration project, we inoculated plots with dry- versus mesic-adapted mycorrhizal fungi. Nevertheless, we did not detect a noticeable effect on the ability of native seedlings to tolerate drought.
4. We conducted a synthesis of 195 published studies to establish that measurements of % root length colonized by mycorrhizal fungi are an effective, inexpensive, and non-technical means of quantifying how well mycorrhizal fungi are benefiting host plants in ecosystems.

Currently, we are performing DNA barcoding in two major experiments to expand upon Objective 2. First, we are assessing the extent to which herbicide applications and mowing in the "Grow/Kill" restoration might inhibit or facilitate, respectively, the growth of mycorrhizal fungi. Second, in the Maintenance Experiment, we are examining whether revegetation with multiple plant functional groups (e.g., grasses + forbs + shrubs) leads to greater fungal diversity than revegetation with a single plant functional group (e.g., grasses alone).

Implications for Practice:

- We suggest a "rule of thumb" that for every 50 percentage point increase in mycorrhizal colonization of plants conferred by a particular practice, plant growth doubles.
- Plant invasions (especially black mustard) can be detrimental to belowground organisms, but removal of non-natives can restore belowground communities.
- Techniques for directly manipulating fungi in restoration work remain elusive, but we will keep working on this objective.

Publication: Treseder, K. K. 2013. Marschner Review: The extent of mycorrhizal colonization of roots and its influence on plant growth and phosphorus content. Plant and Soil 371:1-13.

Presentation: Maltz, M. R. and K. K. Treseder. 2013. Fungal community response to restoration-based disturbance in degraded semi-arid landscapes. Phytopathology 103:89.

Project Name: Impacts of invasive Black Mustard (*Brassica nigra*) on pollination of natives
UCI Investigator(s): Diane Campbell
Graduate Student(s): Daniela Bruckman [PhD project]
Undergraduate Students: Stephanie Fong [Campus-wide honors thesis], Daisy Manaspal, Austin Nubla, Laura Song, Grace Yu [Biological Sciences Excellence in Research]
External Partners: J. Burger [Irvine Ranch Conservancy (IRC)]

Project Description: Pollination by animals occurs in 87% of flowering plant species. These pollinator services can be disrupted by invasion of introduced species. An invasive plant with attractive flowers can draw pollinators away from native plants. Even if total visitation is not changed by presence of the invasive, the species assemblage visiting the flowers may change to less effective pollinators. Pollen can be transferred between flowers of invasive and native plants, causing loss of conspecific pollen to stigmas of another species or deposition of heterospecific pollen that interferes with seed set. Our research investigates the potential for such impacts due to invasion of *Brassica nigra* on Irvine Ranchlands. Our first goal was to determine whether manipulating flowers in small plots changes the visitation rate, pollen receipt, seed set and/or mix of pollinators visiting the native *Phacelia parryi.* Due to low rainfall during spring 2013 and poor germination, we modified the proposed design to set out potted plants in areas with different densities of *B. nigra* (high density, low density, near *Brassica*, far from *Brassica*). Plants in high density patches had more *B. nigra* pollen on the stigma, which can interfere with seed production by *P. parryi.* When *P. parryi* is surrounded by more heterospecific flowers other than the invasive, it receives a higher proportion of flower visits from native insects rather than the introduced honeybee. In 2012- 2013, we compared the relative effectiveness of these pollinators based on a single visit for 228 flowers. A visit by a native solitary bee or bumblebee led to higher pollen deposition and more seeds than did a visit by a honeybee. Thus, the composition of the floral neighborhood can change the assemblage of visiting insects so that less effective pollinators are present. As most studies of pollination impacts utilize small scale manipulations, a second goal was to evaluate the impact of larger-scale manipulations of *B. nigra* on insect visitation, using an ongoing experiment by the IRC on degraded land. In 2011-2012 we added additional seed of native species to the mix already present and *B. nigra* seed to half of each of four 60' x 23' blocks. Flower visitation was recorded simultaneously in both halves of a block for 127 hours. Presence of *B. nigra* reduced visitation to *Grindelia camporum* and *Phacelia cicutaria*, while having no detectable effect on visitation to three other native species.

Implications for Practice:

- Effects of floral composition on pollination can operate by changing the relative abundance of native versus introduced pollinators. Native insects are more effective at pollinating than are honeybees for one test native species. These results suggest that more attention should be paid to conservation / restoration of native pollinators on local lands.
- The invasive *Brassica nigra* can impact pollination of native plants, and some impacts may be ameliorated by relatively small-scale weeding around at-risk natives.

Publications/Presentations:

Bruckman, D. 2013. The effects of invasive pollen on the seed set of a native plant. Poster presented at California Invasive Species Council Symposium, Oct. 2013.

Bruckman, D. and Campbell, D. 2013. The effects of floral neighborhood and an invasive plant on the pollination of *Phacelia parryi*. Poster at Ecological Society of America, Aug. 2013.

Project Name: Response of soil bacterial communities associated with native and exotic plant species to management, climate, and pollution disturbances in a coastal grassland
UCI Investigator(s): Steven Allison, Emma Aronson (postdoc)
Graduate Student(s):
Undergraduate Students: Mary Hanna, Stephen Kim (UCI)
External Partners: Lars Higdon (IRC)

Project Description:

The coastal grasslands of California are threatened by the invasion of exotic plant species. Microbial biodiversity influences key ecosystem services provided by soils. Thus, understanding how invasions impact the soil microbial community associated with coastal grasslands may be critical to the long-term maintenance of ecosystem function. Microbial communities in the soil have been shown to differ between native and exotic grass species in forests, and the same might be true for coastal grasslands. We investigated whether the level of invasion and/or restoration impacted the soil microbial community composition of Bee Flat Canyon soils. We analyzed community composition on November 30, 2011 and March 20, 2013, using 454 pyrosequencing of the 16S rRNA gene in samples collected along 9 transects (3 locations per 2 m transect). Transects were located in sites representing four vegetation restoration categories: native (50-100% native), passive (30-50% native), partial (15-30% native), and full restoration (0-15% native).

On the November 30, 2011, sampling date, the microbial communities differed significantly ($P = 0.003$, analysis of similarity) by restoration category. Passive restoration and native categories had distinct microbial communities, whereas microbial communities in partial and full restoration categories were not significantly different from one another or the other categories. We also observed a weak but significant positive relationship between percent bare ground and microbial diversity ($R^2 = 0.16$, $P = 0.021$). However, a regression of microbial diversity against percent native cover was not significant. These results suggest that areas dominated by exotic plants and bare ground harbor substantial microbial diversity. Such a pattern may be due to interannual variation in plant communities whereby different plant communities occur at a given site across years, thereby sustaining a diverse microbial community. In support of this mechanism, we found that native cover did not differ significantly among *a priori* restoration categories (native, passive, etc.). Restoration activities and temporal variation likely altered plant community composition since the sites were assigned to restoration categories. Thus soil microbial communities may reflect a legacy of previous plant community composition.

Implications for Practice:

Restoration (or invasion) of native plant communities may not alter associated microbial communities, at least on small spatial and temporal scales. Therefore changes in microbial communities and functions may lag changes in plant communities.

Publications/Presentations:

Aronson, E., and S. D. Allison. 2013. Drought and N addition in a grassland control soil N_2O release and *Nitrospirae* relative abundance. Presented to the International Conference on Nitrification (ICoN3), Tokyo, Japan, September 2-5, 2013.

Aronson, E.L. and S.D. Allison. 2012. Meta-analysis of environmental impacts on nitrous oxide release in response to N amendment. Frontiers in Microbiology 3:272. DOI:10.3389/fmicb.2012.00272

Project Name: Limits to fountain grass distribution in natural areas of Orange County
UCI Investigator(s): Ann Sakai & Stephen Weller
Undergraduate Students: Kate Cary (Excellence in Research project, winner of the Robert Ernst Prize for Excellence in Research in Plant Biology, Nasser Hasan (data collection)
Project Description: The ecological and economic impacts of invasive species have long been recognized (e.g., see Sakai et al. 2001, Seabloom et al. 2006), but factors underlying invasion of natural communities and thus methods for preventing invasion are much less understood. We studied the invasiveness of fountain grass (*Cenchrus setaceus*) in five populations located in coastal sage scrub (CSS) communities of Orange County, CA. In parts of Los Angeles County and San Diego County, fountain grass has invaded CSS communities (Cal-IPC maps; L. Sweet, pers. comm), and apparently occurs in much larger populations than in CSS communities of the Irvine Ranch Conservancy (IRC) and surrounding lands, where it occurs in relatively small populations. At present, it is unclear whether these populations are in a lag period and have equal potential to become invasive, or if only some of these populations have the potential to become invasive because of differing environmental conditions. Our results indicate that fountain grass is most likely to be invasive along stream channels and in areas closer to the coast with more moderate temperatures and fog, where we found populations with greater evidence of recent recruitment of seedlings. Carbon and nitrogen levels were reduced in areas where fountain grass had invaded relative to surrounding CSS habitat, although we do not know whether this is a cause or consequence of fountain grass invasion. Only 13 fountain grass seedlings emerged in a large-scale seed bank experiment including all five populations, providing little evidence for an extensive seed bank.

Implications for Practice:

- Populations of fountain grass in Orange County that we investigated seem most vigorous along intermittent streams and in areas close to the coast with more moderate temperatures and more fog. Seedlings and younger plants are much more common in these habitats.
- Fountain grass may establish most successfully in areas with low nutrient status that have less vegetation.
- Despite the production of numerous propagules in populations, few seedlings of fountain grass emerged in seed bank experiments relative to native species and other invasive species.
- The greatest threat of invasiveness for fountain grass occurs along drainages with increased moisture and with the possibility of spread of propagules to new areas. Control measures are probably most important in these habitats.
- Areas near the coast appear to provide conditions favorable to expansion of fountain grass, although additional studies of populations in these areas are necessary to verify the effects of lower temperatures and increased moisture on establishment of fountain grass in these regions.

Publications/Presentations:

Cary, Katharine. 2013. Invasive potential of fountain grass (*Cenchrus setaceus*) populations in central Orange County. Excellence in Research Presentation, Department of Ecology and Evolutionary Biology, UC Irvine.

Project Name: Assessing the importance of arthropod abundance, community composition, and habitat structure as determinants of habitat quality for Cactus Wren (*Campylorhynchus brunneicapillus*).

UCI Investigator(s): Kailen Mooney and Kathleen Treseder
Graduate Student(s): Jessica Pratt
Undergraduate Students: Heros Amerkhanian, Hong Chen, Andrew Datu, Roman Guerrero, Shaun Hu, Gary Laborada, Tricia Lee, Lawrence Liu, Elizabeth Mack, Allen Phan, Kaitlyn Schimizu, James Su, Thi Tran
External Partners: Riley Pratt, Jutta Burger [IRC], Milan Mitovich, Kris Preston [NROC]

Project Description: Cactus Wrens (*Campylorhynchus brunneicapillus*) are year round residents of coastal sage scrub (CSS) plant communities whose populations are in decline, and are thus one of three Target Species conserved under Orange County's Central and Coastal Natural Community Conservation Plan/Habitat Conservation Plan. The observed decline of wrens leads to the hypothesis that food availability is playing a role. This research has four primary goals: (1) Document wren foraging preference and prey capture success for different habitat elements. (2) Quantify arthropod abundance and community composition in each habitat element. (3) Test for associations between wren foraging patterns and prey capture success among habitat elements. And (4) Identify wren diet from fecal samples. The study is based upon eight wren territories distributed across three regions. Arthropods were sampled a total of five times between 2011 and 2012 from each of the following eight habitat elements within each territory: bare ground, annual grass, black mustard (*Brassica nigra*), mexican elderberry (*Sambucus nigra*), lemonade berry (*Rhus integrifolia*), prickly-pear cactus (*Opuntia oricola/Opuntia littoralis*), Buckwheat (*Eriogonum fasciculatum*), and California sage (*Artemisia californica*). Each of the 65,000 specimens collected was subsequently identified to Order and measured in length to the nearest mm. Concurrent with arthropod sampling, Wren nesting was monitored (8 territories in 2011, 4 territories in 2012) to document nest establishment, egg laying, hatching, and fledging. Approximately 60 fecal samples were collected from nestlings for molecular analysis. DNA has been extracted and amplified from most of these samples, and when this process is complete all samples will be sequenced and analyzed for arthropod identification from so called bar-coding regions of the genome.

Implications for Practice:

The goal of this study is to test for a causal link between plant community structure, arthropod availability, and nesting success in Wrens. By establishing which arthropod taxa are the basis of nestling diets, and which elements of the coastal sage scrub habitat provide those arthropod taxa, land managers can better assess Wren habitat quality and tailor management practices towards promoting Wren success.

Publications/Presentations:

Pratt, R.T., Treseder, K.K., Burger, J.C., Preston, K. Mooney, K.A. 2013. Assessing the importance of arthropod abundance, community composition, and habitat structure as determinants of habitat quality for Cactus Wren (*Campylorhynchus brunneicapillus*). 98th Annual meeting of the Ecological Society of America.

Project Name: Cost-Effectiveness of Ecological Restoration
UCI Investigator(s): Sarah Kimball & Travis Huxman
Graduate Student(s): Alexandra Race [data collection]
Undergraduate Students: Rosemary Garcia, Roxanne Murillo, Rosie Said, Sara Isozaki, [data collection]
External Partners: M. Lulow, K. Balzsas, Q. Sorenson [IRC], M. Mitovich [NROC]

Project Description: One fundamental goal in conservation biology is to understand the interplay between the ecology that results in effective restoration and the business/economic practices that control costs. In highly degraded habitat, this requires evaluating the cost-effectiveness of methods at each of the three main phases of restoration: (1) site preparation, (2) seeding & planting, and (3) maintenance. The site preparation phase consists of removing non-natives to prepare the area for natives. The seeding & planting phase consists of adding native seeds and/or plants to the site. The maintenance phase consists of continuing to remove non-native species after the natives have started to become established. Our goal was to determine practices by which restoration practitioners can obtain the lowest cover and density of non-native plants and the highest cover and density of native plants at the lowest cost. We used a large-scale collaborative restoration project (~65 acres) conducted in collaboration with the Irvine Ranch Conservancy in the Santa Ana Mountains. Site preparation began in 2009, and different areas were seeded or planted in 2010, 2011, or 2012. All costs of equipment, seeds and plants, and labor were recorded. Data on germination of non-native species were collected in each year, while data on germination of natives was collected the first year of seeding and planting. Late season cover of native species was collected in all areas in the final year of the study. Native plant performance, such as height, survival, and density of natives, were also collected in certain years and treatment combinations to address specific questions regarding best methods. Site preparation expenditure was negatively related to native plant cover due to decreasing precipitation over the course of the study. Seeding & planting expenses (including transporting salvaged topsoil) mostly controlled native plant cover. Irrigation to help plant establishment was not cost-effective. Frequent maintenance resulted in greater native plant cover, with greatest success on N-facing slopes.

Implications for Practice:

- After one year of site preparation, it may be best to seed or plant natives when wet weather is in the forecast. Additional site preparation is not always cost-effective.
- After natives are established, money spent on additional removal of non-natives should result in higher cover of natives.
- The same money and effort spent on restoration will result in greater cover of native plants on N-facing than S-facing slopes.
- Using salvaged topsoil results in a high cover of native plants but is also very costly. Other methods can result in equally high cover of native plants but not in high diversity.
- Irrigation may not be the most cost-effective method of restoration. Seeding and planting timed with winter rains may lead to high cover of native plants at a lower cost.

Publications/Presentations:

Kimball S, Lulow M, Balzsas K, Burger J, Huxman T (in prep) Cost Effectiveness of Ecological Restoration. Proceedings of the National Academy of Science.

Project Name: Conservation Research and Outreach Training Program for Undergraduates
UCI Investigator(s): Travis Huxman, Sarah Kimball, Jessica Pratt, Donovan German, Jennifer Martiny
Graduate Student(s): Jennifer Long
Undergraduate Student(s): Katherine Chin, Nicole Larson, Bertha Mok, Danny Feliciano, Alicia Fong, Jasmine Domingo, Kinshuk Chatterjee, Rachel Pennington, Mackenzie Peich, Caitlin Lim, Elyse Marsh, Elizabeth Niehaus, Hailey Laskey
External Partners: Harry Helling, Sara Ludovise, Holly Fletcher
Project Description: Part of the mission of the Center for Environmental Biology (CEB) is "to educate the next generation of environmental biologists and stewards". Environmental biologists often work in interdisciplinary settings with both public, private, non-profit, government, and academic partners, and require a strong scientific background, experience in data management and analysis, effective communication skills, and outreach experience. With this in mind, CEB's research and education/outreach internship program for undergraduate students aims to accomplish several goals – (1) introduce students to environmental research with a heavy STEM emphasis, (2) bring students into research projects that have been created with environmental practitioners to solve real-world challenges through a unique partnership with the Irvine Ranch Conservancy, and (3) expose students to informal STEM engagement activities with the public through partnerships with a unique California State Park Non-Profit Association (the Crystal Cove Alliance, CCA). This program is a one-year internship, coordinated through the CEB for a cohort of 10-15 undergraduate students, taking part in research throughout Orange County and participating in outreach at Crystal Cove State Park. The outreach experience is facilitated by outreach specialists in CEB and at CCA, and will be aligned with an informal science education certificate program through UCI's Cal Teach and School of Education. A capstone experience for a select group of this cohort (5 students) occurs in the subsequent summer, focused on developing specific curriculum that embeds STEM into environmental exercises for middle-school informal science programs. Program activities include weekly research and outreach seminars and training sessions for CEB's undergraduate interns, research site orientation for students, assigned internship duties (e.g. participating in research and data collection, conducting K-12 science outreach programs), and an end-of-year assessment and development workshop involving student interns, environmental practitioners, master teachers, and CEB staff.
Program Impacts to Date:

- The research component of this program, piloted during academic year 2012-13, included 12 undergraduate students who conducted >1500 hours of research under the tutelage of CEB faculty and land managers at the Irvine Ranch Conservancy.
- An outreach effort in the lab of Jennifer Martiny (which serves as a model for the capstone portion of CEB's program) involved two undergraduate student researchers who developed an outreach activity based on Martiny's research. This activity on ocean viruses was led by students 56 times during 9 open houses that attracted >750 visitors at Crystal Cove State Park in 2013.
- An outreach effort in the lab of Donovan German helped develop curriculum for Citizen Science Cruises run through CEB's partner, the Crystal Cove Alliance. This research-based curriculum involves a digital fishing activity in kelp forest in order to assess species presence/absence in different habitats (upper, mid, and benthic) in both Crystal Cove State Park and an adjacent Marine Protected Area. Over 40 citizen science cruises are operated each year with approximately 25 K-12 students present on each cruise.

CEB's student interns will be serving as informal science educators on the citizen science cruises operating in 2014. More information can be found here: http://www.crystalcovebeachcottages.com/education/schoolprograms.php

- For the 2013-14 academic year, 14 UCI undergraduate students were selected for participation CEB's Research and Outreach Internship Program. During fall quarter, 2013, student interns completed more than 680 hours of research and outreach activities related to CEB's mission and goals described above.