Statement of Research Interests

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Globally, human activities are altering environmental conditions through changes to disturbance regimes, climate, and primary productivity. Attempts to generalize changes in biodiversity in response to these altered environmental conditions have had mixed success because biodiversity patterns are influenced by multiple processes operating at multiple scales. Developing a conceptual model of community assembly that integrates multiple process across multiple scales represent one of the largest challenges to synthesis in community ecology. **The goal of my research is to advance community assembly theory and to apply community assembly theory to pressing environmental issues.** My research combines observational studies, data synthesis, field experiments, functional trait approaches, and advanced statistics and modeling. I have published 14 papers in top journals such as Ecology Letters, Ecology, Journal of Ecology, and Nature Climate Change and I have received funding from the NSF and the Smithsonian. I have been invited to participate in 7 working groups focused on theory development and data synthesis where I have contributed to and led research projects. Below I outline the theoretical framework for my research, how I apply my research to pressing environmental issues, and future directions I would like to pursue at the University of California - Riverside.

<u>Theoretical framework: integrating community assembly mechanisms from local to continental scales.</u> A key challenge at the interface of community ecology, landscape ecology and biogeography is to understand the mechanisms leading to the patterns of diversity we observe in nature. Understanding these mechanisms is complicated by the fact that they operate over many scales. **In my research program I strive to integrate processes across scales – including local interactions among coexisting species, landscape scale disturbances, and continental-scale biogeographic processes (Fig. 1) - to better elucidate the mechanisms of community assembly.** To achieve this goal I have been developing predictions for how patterns of functional trait diversity can help elucidate the multiple ecological processes influencing patterns of biodiversity. As part of my research with Katharine Suding (UC-Irvine), I advanced the current community assembly framework by developing predictions for how functional diversity may be influenced at a local scales by multiple local scale mechanisms: competition via equalizing fitness processes and facilitation (Fig. 1 Competition/Facilitation; Spasojevic & Suding 2012 Journal of

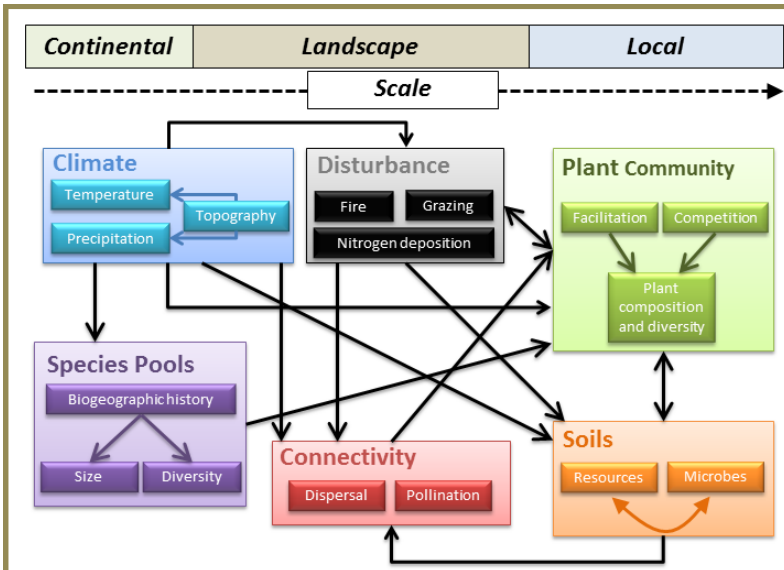

Figure 1. Complex interactions have led to challenges in creating a unified conceptual framework in community ecology. My research seeks to ingrate interacting assembly processes operating at multiple spatial scales to understand patterns of biodiversity. Elucidating these mechanisms is critical for understanding and mitigating vegetation change and species loss in response to global change.

Ecology). I continued to build on this work and developed a framework to integrate trait-based approaches and metacommunity theory to help elucidate the local and landscape scale influences on community structure (Spasojevic et al. 2014 Ecography). Specifically, I demonstrated that we can discern which processes, such as environmental filtering (Fig. 1 Soils) or dispersal (Fig. 1 Connectivity), are structuring ecological communities by analyzing patterns of functional alpha- and beta-diversity. More recently, I have been studying how the potential for a species to persist in a community can be enhanced by intraspecific variation among locally adapted populations. While intraspecific variation in traits is foundational to evolutionary studies, it has yet to be fully integrated into community assembly theory. In collaboration with Jonathan Myers (Washington University in St. Louis), I am exploring how intraspecific trait variation may influence inferences of the importance of key environmental factors (Fig. 1 Soils) on landscape scale spatial variation in community composition (Spasojevic et al. 2014 Ecosphere; Spasojevic et al. *In Review* Journal of Ecology). Ultimately, the multiple processes operating to dictate community structure are constrained by the regional assemblage of species from which communities assemble (the regional species pool). While research has revealed the importance of regional species pools for patterns of biodiversity, we still lack a mechanistic understanding for why this occurs. To tackle this issue, I am currently partnering with the Smithsonian Forest Global Earth Observatory network to conduct a continental scale observational study to develop a framework for how the functional diversity of regional species pools (Fig. 1 Species Pools) interacts with environmental gradients (Fig. 1 Soils) to structure plant communities. Additionally, I am planning to experimentally test this framework with a landscape-scale field experiment that includes manipulations of species-pool functional diversity and fire disturbance (NSF full proposal *In Review*, in collaboration with Jonathan Myers).

Together, these examples of my research demonstrate how I am working to improve conceptual models of community assembly by integrating multiple ecological processes operating at multiple scales. Specifically, this body of work can help reveal how plant-environment interactions influence patterns of biodiversity across scales. Integrating ecological processes across scales to understand the mechanisms influencing patterns of biodiversity will continue to be one of the driving themes of my research program for the next 5-10 years. This integrative, multiscale approach serves as the backbone for how I tackle pressing environmental issues.

Applications to environmental issues: applying community assembly theory to understand and mitigate vegetation change and species loss due to global change. I believe that community assembly theory provides a powerful framework for understanding how multiple global change factors are influencing individual species, changing plant communities and altering ecosystem function. Thus, a second complementary theme of my research program is to apply community assembly theory to help understand vegetation change and to help mitigate species loss due to global change. I approach this topic with a combination of data synthesis and field experiments.

Ecological systems are changing at an unprecedented rate, and as scientists we are pressed to provide agencies, land managers and the public with useful predictions for understanding where to focus conservation efforts. Evaluating patterns of vegetation change and the potential for ecological resilience within a system requires a multi-disciplinary approach that leverages expertise across many disciplines and scales. For example, the woodland and forest ecosystems of the Four-Corners region of the United States are experiencing changes in fire regimes. To understand the mechanisms that may influence these ecosystems' resilience in productivity to these fires (Fig. 1 Disturbance), I am currently collaborating with landscape and ecosystem-ecologists. Specifically, I am leading a collaborative project combining the tools used in continental scale studies of biodiversity (remote sensing, trait databases) with theoretical advances developed from local scale experiments to ask if functional diversity influences the recovery of ecosystem productivity after wildfire. Using structural equation modeling, I found that landscape scale topographic heterogeneity and local scale diversity in functional traits associated with fire tolerance/resistance interact to influence which plant communities are more resilient in productivity to wildfires (Spasojevic et al. *In Revision* Global Change Biology). Determining what influences ecosystem resilience is critical for conserving biodiversity and ecosystem function in the face of global change and will be a focus of my research program for the next 5-10 years. My collaborators and I will be writing a NASA grant this spring to expand the remote sensing component of this work. At UC-Riverside I would seek NSF funding to experimentally test the scale at which the mechanisms underlying ecosystem resilience are most important for the resilience of local ecosystems to disturbances such as wildfires and drought.

Attempts to understand species responses to climate change have been hindered by only considering continental scale climatic variables (Fig. 1 Climate). Recent research has demonstrated that incorporating landscape scale processes, such as dispersal (Fig. 1 Connectivity), improve predicted species responses to climate change. One important but largely unanswered question about floristic responses to climate change is how local scale biotic interactions such as competition, facilitation (Fig. 1 Plant Community) and plant–soil feedbacks (Fig. 1 Soils) will influence the ability of species to survive climate warming via natural dispersal or assisted relocation. In a field experiment in the Oregon Siskiyou Mountains, I found that north facing slopes were as much as 7°C cooler in maximum temperature than the adjacent (<400m apart) south facing slope, suggesting the north facing slopes may serve as important microrefugia from rising temperatures. Incredibly, two of three focal plant species had higher population success in these cooler microclimates than in their home ranges, suggesting that the time when migration is critical for species survival may be relatively imminent. Moreover, I found that the success of these species was enhanced by above- and belowground facilitation by the resident plant community in cool microclimates. My results provide some of the first experimental evidence of two important factors that may buffer the impacts of climate change on plants: local scale facilitation and landscape scale rugged topography (Spasojevic et al. 2014 Ecology Letters). Generalizing the importance of topographic microclimates and biotic interactions is critical for accurately assessing how species will respond to climate change and will be one focus of my research program for the next 5-10 years.

<u>**University of California - Riverside would be the ideal places to continue my research.**</u> At UC-Riverside I would use the skills that I have developed in experimental ecology, observational studies and data synthesis to explore fundamental questions in ecology and address environmental issues. I would use the skills that I have developed in experimental ecology, observational studies and data synthesis to explore fundamental questions in ecology and address pressing environmental issues. Having studied local, landscape, and continental scale mechanisms for community assembly, I am uniquely poised to advance conceptual models in community ecology. **Integrating ecological processes across multiple scales to understand the mechanisms influencing patterns of biodiversity will be one of the driving themes of my research program for the next 5-10 years,** and I am excited to conduct this work using a combination of large scale assembly experiments, observational studies across biogeographic gradients and modeling at UC-Riverside. **The other driving theme of my research program over the next 5-10 years will be developing a general framework for understanding ecosystem resilience and how species interactions influence which species may be able to survive climatic warming.** I am excited to conduct this work through a combination of data synthesis, modeling and experiments capitalizing on the unique flora and rugged topography of California. I am excited about the opportunities UC-Riverside would provide for further developing my research and I look forward to incorporating students at all levels deeper into my research program. The wealth of opportunities for collaboration, research facilities, environmental experts and natural laboratories makes UC-Riverside an extraordinary place to pursue my research program.