

sDiv working group meeting report

“sToration - Applying Coexistence Theory to Restoration Ecology and Adaptive Management”

As human influence over Earth’s ecosystems increases, the need to restore ecosystems becomes even more pressing. Theory from community ecology provides a platform for generalizing lessons from successful restoration settings to broader contexts. While, to date, the development of restoration ecology has primarily built on theories of succession and community assembly, ongoing environmental change and species invasions may stymie restoration practices and are difficult to incorporate in these traditional theoretical models of restoration. As one of the most pervasive conceptual frameworks in community ecology, modern coexistence theory provides a foundation for understanding not only how restored communities will assemble, but also their resilience to invasive species and the importance of environmental disturbances in maintaining biodiversity. While a call for integration has been voiced between modern coexistence theory and the goals of ecological restoration, unification remains evasive.

Our working group brings together experts from basic and applied fields with the aim of **creating a usable coexistence theory for restoration**. Doing so has led to exciting cross-talk between subdisciplines and folks with expertise spanning different systems, methods, and key literatures. As such, our first working group focused on brainstorming ideas and included short presentations for participants new to a given system or theory. From this initial brainstorming, we currently focus on two case-study ecosystems: vernal pools and an annual plant understory due to (a) their long history of study and (b) their ideal datasets for synthesis of theory with restoration practices.

We have made exciting strides to create a usable coexistence theory, where theoretical insights inform several restoration practices. In particular, our analyses of the vernal pools systems show that analyses of species’ intrinsic growth rates and low-density growth rates can be key indicators for restoration success and may show early warnings before species’ abundances dip to numbers of concern. Furthermore, using an annual plant understory system, our work highlights how applications of coexistence theory can inform practical management actions that can either help promote growth rates for species of conservation concern or, alternatively, hinder growth for exotics. Finally, model-data synthesis in our

working group has led to an additional project where we have extended a statistical method for working with data with a high number of explanatory variables (sparse modeling tools) for estimating species interaction coefficients in high diversity systems (Weiss-Lehman et al., accepted; Ecology Letters). We believe this is a key step forward in making coexistence theory more usable, as it now allows us to incorporate realistic levels of species diversity. We are excited about many additional applications of this method both in the working group and in future collaborations and extensions.

At this point, our working group has met once in person and twice virtually due to the pandemic. While we are excited to eventually (hopefully) meet in person again, we are fortunate that our in-person meeting really fostered momentum that we have been able to maintain online. Our working groups have been a mix of small and large group brainstorming, structured work time to focus on playing with datasets, creating and refining figures, writing, and editing text. We additionally work asynchronously between group meetings with some small virtual meet-ups as needed. The general working atmosphere has been supportive, collaborative, and we think really fun. It has fostered additional brainstorming and side projects between subsets of the working group participants. We have been really happy with sDiv's support, especially during our in-person meeting. sDiv did a wonderful job supporting our group both logistically and scientifically, for example through our presentation in the seminar series, which allowed us to interact and get to know more folks at iDiv. We have been appreciative of sDiv's flexibility during the pandemic, their offer to provide childcare for virtual meetings, and allowing us to extend our funding in the hopes of an in-person follow-up meeting sometime soon.