Species interactions and movement: modeling environmental effects on community dynamics

Understanding how communities respond to environmental change is frustrated by the fact that both species interactions and movement affect biodiversity in unseen ways. To evaluate the contributions of species interactions on community growth, dynamic models that are capable of capturing non-linear responses to the environment and the redistribution of species across a spatial range are required. We develop a time-series framework that models the effects of environment-species interactions as well as species-species interactions on population growth within a community. We adopt a hierarchical Bayesian approach, enabling probabilistic uncertainty quantification in the model parameters. Novel aspects of our model include allowing for species redistribution across a spatial region, and addressing the issue of zero inflation where data exhibit a high incidence of zeros. To evaluate the impacts of interactions and movement on population growth, we apply our model using citizen science data through eBird, a global citizen science database dedicated to birds. To do so, we also present a novel method of aggregating the spatially biased eBird data collected at point-level. Using illustrative regions in North Carolina and Virginia, we model communities of six bird species. The results provide evidence of non-linear responses to interactions with the environment and other species, and demonstrate a pattern of strong intraspecific competition coupled with many weak interspecific species interactions. Stability analysis suggests that extrinsic forces beyond the components incorporated in the model provide assistance in regulating the system. A separate application to Northeast Fisheries Science Center trawl data demonstrates a method of learning how environmental change impacts redistribution of fish populations.