87

A Bayesian co-abundance modelling approach to measure predator-prey relationships while accounting for detection, environmental covariates, and uncertainty

Understanding predator-prey interactions is a fundamental goal of community ecology. The proliferation of camera trapping has enabled researchers to collect copious amounts of data on rare and cryptic predator and prey communities. However, analytical approaches for studying predator-prey interactions from observational camera trap data remains limited. Specifically accounting for each species' detection probability, shared responses to environmental covariates, and incorporating uncertainty present analytical hurdles for researchers. Here we develop a predator-prey co-abundance model that overcomes previous barriers. First, to overcome problems inferring species interactions from co-occurrence, we utilized N-mixture models to jointly estimate both species abundances, detection probability, and effects from environmental covariates. Second, we ensured parameter convergence and sound ecological inferences from species having vastly different count histories by implementing both an informed zero-inflation Poisson error distribution in the abundance formula and a random sampling unit-sampling occasion effect to account for overdispersion in the detection probability formula. Finally, we implemented a Bayesian hierarchal modelling approach that propagates uncertainty throughout the entire modelling process. As a case study, we tested our model on interacting tiger, clouded leopard, muntjac and sambar deer populations in Southeast Asian tropical forests. We found that tiger abundance had a negative effect on muntjac deer abundance, while clouded leopard abundance had a positive effect on both muntjac and sambar deer abundance. Additionally, our models were considered a good fit based on posterior predictive checks and we examined relationships with environmental covariates that were consistent with literature. This Bayesian co-abundance modelling approach to measure predator-prey relationships overcomes many of the issues ecologists face inferring species interactions from observational data. This approach is widely applicable across species, ecosystems, and sampling approaches and sets the stage for a new era in the mechanistic understanding of food web ecology and trophic cascades.