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Estimating the temporal scale of time series predictors on abundance and occurrence

Species abundance and occurrence respond to predictors at different spatial and temporal scales. Methods have emerged that calculate composite predictors across multiple scales by assigning weights to each scale and estimating weights within the model, but model development has focused on spatial scales. Here, we incorporate time series of explanatory variables as composite predictors into models of abundance/occurrence, estimating weights for each time step as a declining function of 'time distance' from the focal year (ie, in which the response variable was measured). We performed a simulation study for abundance/occurrence models with and without imperfect detection, with a composite predictor based on a 10-year annual time series and weights following a half-normal function with temporal scale parameter sigma. We varied effect size of the composite predictor (on the log scale), beta, from 0.5 to 1.3; sigma from 1 to 4; and sample size from 100 to 250.

We found that all model types were able to estimate sigma and beta with small average bias in some scenarios. The number of simulations returning estimates and estimate precision decreased, and variability of estimates across simulations increased, in occurrence relative to abundance models, and in models with imperfect detection. Estimates were more accurate as beta increased, and for sigma = 2.5.

We applied the occupancy version of the time scale model to snare detection data from two protected areas in Viet Nam, to evaluate how annual snare removal efforts from 2011 to 2018 affected snare occurrence in 2019, while accounting for other static predictors and imperfect snare detection. Prior snare removal efforts negatively affected snare occurrence. Annual weights for prior snare removal effort dropped sharply after year 1, with 98% of all weight concentrated in the first three years prior to 2019; uncertainty in sigma was high.

The temporal scale model produced on average unbiased estimates of relationships between composite predictors and state variables, but accuracy of sigma estimates is likely limited by the often coarse (i.e., annual) resolution of predictor time series and, for larger sigma, by time series length.