Optimal study design for multi-season, multi-species avian monitoring programs

Jamie S. Sanderlin[a,b], William M. Block[a,c], and Joseph L. Ganey[a,d]

[a] Rocky Mountain Research Station
U. S. Forest Service
2500 S. Pine Knoll Dr.
Flagstaff, AZ 86001, USA

[b] jlsanderlin@fs.fed.us

[c] wblock@fs.fed.us

[d] jganey@fs.fed.us

Keywords: community structure and dynamics; multispecies models; occupancy models; survey design and analysis

Abstract: Understanding ecological factors that influence biological diversity is vital for species conservation, and to the success of monitoring programs designed to guide management decisions for these species. Accurate measures of community structure are paramount for understanding ecological factors that influence biological diversity. Species richness can represent community structure during one time period, while community change can be captured via probabilities of local colonization and extinction. Study design guidelines exist for single-species occupancy models, but few recommendations exist for multi-species community occupancy models for either single or multiple seasons. We recently developed study design recommendations for single season, multi-species programs and extend them here to multiple seasons. Statistical advances in Bayesian hierarchical multi-species occupancy models improve our ability to model data from multi-species monitoring programs, but a design trade-off remains between costs of increased effort from spatial and/or temporal replication and accuracy of parameter estimates of occupancy probability, detection probability, species richness, local colonization probability, and local extinction probability. We used simulated data based on two long-term avian data sets from Arizona, USA to explore design and cost trade-offs for avian community monitoring programs over multiple years, while assessing our ability to detect community change. We used study design combinations (number of sites, sampling occasions) and biological conditions (superpopulation size, species assemblage) to explore design tradeoffs. Optimal designs were different based on the parameter of interest, which strengthens the need for clear *a priori* study objectives.