Spatially explicit maximum likelihood methods for capture–recapture studies

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Live-trapping capture–recapture studies of animal populations with fixed trap locations inevitably have a spatial component: animals close to traps are more likely to be caught than those far away. This is not addressed in conventional closed-population estimates of abundance and without the spatial component, rigorous estimates of density cannot be obtained. We propose new, flexible capture–recapture models that use the capture locations to estimate animal locations and spatially-referenced capture probability. The models are likelihood-based and hence allow use of likelihood-based methods of model selection. Density is an explicit parameter, and the evaluation of its dependence on spatial or temporal covariates is therefore straightforward. Additional (nonspatial) variation in capture probability may be modelled as in conventional capture–recapture.

The method is tested by simulation, using a model in which capture probability depends only on location relative to traps. Point estimators are found to be unbiased and standard error estimators almost unbiased. The method is used to estimate the density of Red-eyed Vireos (*Vireo olivaceus*) from mist-netting data from the Patuxent Research Refuge, Maryland, U.S.A.. Estimates agree well with those from an existing spatially explicit method based on inverse prediction. A variety of additional spatially explicit models are fitted; these include models with temporal stratification, behavioral response and heterogeneous animal home ranges.