Hierarchical Models for Spatial Capture-Recapture Data

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Estimating density is a fundamental objective of many animal population studies. Application of methods for estimating population size from ostensibly closed populations is widespread, but ineffective for estimating absolute density because most populations are subject to short-term movements or so-called temporary emigration. This phenomenon invalidates the resulting estimates because the effective sample area is unknown. A number of ad hoc methods involving the adjustment of estimates based on heuristic considerations are in widespread use. In this paper, a hierarchical modeling framework for spatial capture-recapture data is proposed. The hierarchical model consists of a process model, describing the locations of individuals (in the form of an 'activity center') and their movements. The observation model describes the probability of encounter as a function of location. I develop a framework for Bayesian analysis of this class of models based on data augmentation, which allows for a straightforward implementation in the freely available software WinBUGS or in R. Two examples are given. First, I consider a problem in which a prescribed area (e.g., a transect or quadrat) is subjected to multiple searches of uniform intensity. Thus, individuals can go undetected because they are not within the plot boundaries during the survey, or because they are present but undetected. I also consider the classical design/protocol in which an array or grid of traps is used in a capture-recapture study. This is common in small mammal studies based on trapping grids, camera trap studies of carnivores, and genetic sampling of bears based on DNA.