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Animal density estimation for unmarked population using spatially explicit model

Obtaining abundance and density estimates is crucial for wildlife conservation and management. Capture-recapture (CR) models are popular to obtain such estimates in ecological statistics. CR models often incorporate different sources of heterogeneity such as individual and temporal heterogeneity. The development of spatial capture-recapture (SCR), using an array of traps permits additional spatial density to be estimated. However, standard CR-type models require individual to be uniquely identified which is often infeasible in the practice e.g., camera trap data. Chandler and Royle (2013) extend the mixture model to the SCR case, permitting the estimation of abundance when individuals cannot be uniquely identified. In this model, conditional on the number of individuals in the study are, and their associated activity centers, the number of animals observed at each camera trap in given time interval is assumed to be Poisson. Fitting this model faces two challenges due to the unobserved activity centers and the unknown total individuals. Bayesian-data augmentation is often used in handling the missing information by introducing the upper population limit, i.e. using a super-population approach. However, this algorithm can be (very) slow and exhibit poor mixing so that it does not efficiently scale to larger population/studies. In this work, we develop a new Bayesian model fitting approach that does not require the specification a priori of an upper population limit using a reversible jump approach, and discuss its efficient implementation. We demonstrate the improvements in terms of model fitting via a simulation study before fitting the model to the camera-trap data of the barking deer collected in Ujung Kulon National Park, Indonesia.