ON THE BAYESIAN ESTIMATION OF A CLOSED POPULATION SIZE IN THE PRESENCE OF HETEROGENEITY AND MODEL UNCERTAINTY

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The estimation of population sizes has a long history and is often of interest within wildlife populations. We consider data obtained via capture-recapture studies of closed populations, where there are no births, deaths or migration within the study period. The assumptions that are made concerning the catchability of the animals throughout the study generally have a direct impact on the corresponding estimate of the total population. We consider three possible types of influence on the catchability of the animals: time effects, behavioural effects (trap response) and heterogeneity effects. In general, it is often unknown what combination of effects, if any, may be present for any given dataset. Conditional on the underlying model, an estimate of the total population can be obtained, but different models often provide very different estimates of the total population size of interest.

We provide a unified Bayesian framework that is able to allow each model to be fitted to the data, and obtain an estimate of the total population size. In addition, we are able to quantitatively discriminate between the competing models via posterior model probabilities, estimated via the Reversible jump Markov chain Monte Carlo algorithm, and obtain a model-averaged estimate of the total population size, incorporating both parameter and model uncertainty. We illustrate the methodology by considering a real data set relating to a population of dolphin in the Moray Firth, where there is strong evidence for the presence of time effects and heterogeneity. We note that ignoring this heterogeneity effect provides substantially lower estimates of the total population size.