Estimating abundance from multi-state closed capture-recapture data

Hannah Worthington[a], **Rachel McCrea**[b], **Ruth King**[a], **Byron J.T. Morgan**[b] and **Richard Griffiths**[b]

[a] University of St Andrews
hw233@st-andrews.ac.uk

[b] University of Kent

Keywords: Closed population; abundance; capture heterogeneity; Great crested newts

Abstract: The aim of this work is to estimate the size of a closed population from ecological capture-recapture data. Typical capture-recapture data is recorded in a binary form indicating on which capture occasions each individual was or was not captured. There are a number of models which can be fitted to capture-recapture data and in particular models have been developed to allow for heterogeneous capture probabilities which more accurately reflect the biological behaviour. However, in many cases the data is not recorded in a simple binary format and instead records the discrete state in which the individuals are observed, for instance, 'breeding' or 'not breeding'. In our case we consider data relating to great crested newts where the states relate to different ponds. We still assume that the population as a whole is closed but we allow individuals to move between ponds within the study period. The use of the additional state information can be justified by considering that state-dependent capture probabilities may be different and failure to account for this would result in biased population estimates. By allowing the capture probabilities to be state-dependent we need to model the transitions between states since the state of an individual will not be observed at every capture occasion (i.e. when we miss the individual). The multi-state model we develop here can be considered as a closed form capture-recapture equivalent of the Arnason-Schwarz model for open capture-recapture data and allows individuals to move between states with varying capture probability.

We use simulation to demonstrate how the estimate of population size can be biased when movement between the different states is not accounted for and to assess the performance of the multi-state model in comparison to existing heterogeneity models. We also consider the issue of state uncertainty before applying the multi-state model to an ecological data set on Great crested newts.