Bayesian implementation of a spatial capture recapture model to infer sex-specific density gradients in a mountain ungulate

Authors: Hendrik Edelhoff[1*]; Cyril Milleret [2]; Pierre Dupont[2]; Richard Bischof[2] & Wibke Peters[1]

[1] Wildlife Biology and Management Research Unit, Bavarian State Institute of Forestry, Freising, Germany

[2] Faculty of Environmental Management and Natural Resource Management, Norwegian University of Life Sciences, Ås, Norway

*corresponding author: hendrik.edelhoff@lwf.bayern.de; ORCID 0000-0001-6354-8952

Abstract

In investigating sex-specific habitat selection and space use in Alpine chamois (Rupicapra rupicapra r.), we leveraged single-season Bayesian spatial capture-recapture (SCR) models tailored with sex-specific parameters to discern patterns of population density across two varying landscapes in the Alps, Germany. Central to our approach was the dual-component SCR model, integrating an ecological process for modeling the distribution of individual activity centers (ACs) and a detection process conditional on proximity to these ACs. This model framework facilitated a nuanced examination of location-driven variations in chamois density by separately estimating ecological and observation process parameters for both sexes across different study areas.
The ecological component of the SCR model, crucial for determining local densities and the impact of various habitat covariates, treats the actual locations of ACs as latent variables, enabling the exploration of spatial distribution as a point process akin to advanced resource selection functions. Density estimates were derived from the spatial arrangement of ACs within each study area. Employing an inhomogeneous Bernoulli point process, our model accounted for the influence of eight key habitat covariates on AC distribution, reflecting sex-specific habitat preferences.

Our implementation utilized the Bayesian modeling package nimble within the R programming environment, employing reversible jump Markov-chain Monte Carlo (rjMCMC) sampling for robust model and parameter space exploration. This approach, enhanced by the latest SCR functionalities in nimbleSCR, ensured efficient parameter estimation through local state space evaluation. This methodological rigor underscores the sophistication of our Bayesian implementation in addressing the complexities of sex-specific spatial dynamics in Alpine chamois.

Keywords: hierarchical modelling, point processes, population density, environmental gradients, habitat selection