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Summary

Characterising species distributions is a fundamental challenge in ecology. Understanding the effects of changing environmental conditions on species distributions is required for conservation efforts and spatial planning. However, mapping distributions are challenging for many species that reside in inaccessible terrain such as marine environments and mountainous regions. To follow their movements, remote sensors can be attached to animals that record location, movement, physiological parameters, and environmental conditions. These telemetry data have intrinsic properties, such as strong spatiotemporal autocorrelation due to successively observed animal locations, and study areas defined by the animals themselves can range over wide geographical areas. We propose to develop statistical advances that accommodate complexities in such data to allow robust predictions of changes in species distributions.

In regions with complex topography, previous approaches to species distribution models assume stationary autocorrelation fields, assuming dependence continues across boundaries homogeneously, which produces 'leaking' across barriers. A "Different Terrain" model has been developed, which uses a flexible random effect on autocorrelation. It is based on stochastic partial differential equations combined with integrated nested Laplace approximation (INLA) and has adaptable range parameters to account for non-stationarity and boundary effects.

Key research objectives

1. Develop the Different Terrain model for the boundary problem using animal movement data and environmental covariates.
2. Based on knowledge of animal behaviour, area-dependent autocorrelation will be applied to animal movement data.
3. Can area-dependent autocorrelation be used to indicate types of activity?

Data

Telemetry data from grey seals (*Halichoerus grypus*) tagged in the Netherlands will be analysed. They are central place foragers, travelling to their at-sea feeding grounds before returning to haul out on land. Foraging behaviour typically produces focused repetitive movements in a small area, whilst travelling behaviour can be demonstrated by directed movement over large distances. Our new models will use different spatial autocorrelation structures in the foraging and travelling areas (based on informative priors).



Grey seal with telemetry tag (photo credit: SMRU).

Like other large raptors, black eagles (*Aquila verreauxii*) rely heavily on uplift for flight, generated either by thermal updrafts or the flow of air over steep slopes. Their movements inside (soaring) and outside updrafts are different and so fields of varying spatial autocorrelation will be implemented.



Black eagle (photo credit: Mario Moreno).