

# Hierarchical spatial modelling for applied population and community ecology

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Workshop dates: 24-27 June 2024

## Course information

**Instructors:** Jeff Doser and Marc Kéry

**Teaching Assistant:** Gesa von Hirschheydt

**Venue:** Swiss Ornithological Institute, Sempach, Switzerland

**Computers:** Bring your own laptop with R installed and R packages `spOccupancy` and `spAbundance`

**Registration:** 500 francs (normal rate), 350 francs (student rate)

## Course description

Hierarchical models have been widely deployed for the modelling of species distribution and abundance, because they enable one to separately model the actual quantity of interest (e.g., presence/absence or abundance) from measurement errors commonly found in ecological data sets. When modelling species distributions/abundance across large spatial domains and/or using a large number of observed locations, accommodating spatial autocorrelation becomes increasingly important. Failing to account for measurement errors and/or residual spatial autocorrelation (i.e., remaining spatial autocorrelation after accounting for environmental covariates) can lead to biased and overly

precise estimates, potentially jeopardizing scientific conclusions and management decisions based on such data sets.

In this workshop, we present highly scalable approaches for hierarchical Bayesian spatial modelling of species distributions and abundance. This course focuses on practical implementation of hierarchical spatial models using the **spOccupancy** and **spAbundance** R packages. Course topics include:

1. Introduction to hierarchical and spatial modelling
  - Hierarchical Bayesian models in ecology
  - Introduction to spatial statistics (e.g., kriging, Gaussian Processes)
  - Spatial modelling of big data
2. Spatial modelling of binary detection-nondetection data with **spOccupancy**
  - Single-species spatial occupancy models
  - Multi-species spatial occupancy models
  - Joint species distribution models with imperfect detection
  - Spatially-varying coefficient occupancy models
3. Spatial modelling of count data with **spAbundance**
  - Single-species spatial GLMMs
  - Single-species spatial N-mixture models
  - Single-species spatial hierarchical distance sampling models
  - Abundance-based joint species distribution models with imperfect detection

This intermediate-level course offers lecture, discussion, and hands-on exercises, with approximately 70% of the time on lectures and 30% of the time on exercises. We do not assume previous experience with Bayesian statistics, spatial statistics, or **spOccupancy/spAbundance**, although participants with basic knowledge of these areas will experience a gentler learning curve. We do require a good working knowledge of modern regression methods (e.g., linear models, generalized linear models) and of program R.

## Application instructions

Please send an email to Jeff Doser ([doserjef@msu.edu](mailto:doserjef@msu.edu)) and Marc Kéry ([marc.kery@vogelwarte.ch](mailto:marc.kery@vogelwarte.ch)). In the email, briefly describe your

background and knowledge in statistical modelling, R, and occupancy/N-mixture models by **29 March 2024**. Workshop invitations will be sent out shortly thereafter.

One or two course fee waivers will be available provided we get a sufficient number of paying sign-ups. To apply, please send us a description (at most 0.5 page) of why the course would be important for your work and why you should get a waiver.

## GitHub Code Repository

Code for all course lectures and exercises will be provided on a GitHub repository closer to the workshop dates.