



Hierarchical spatial modelling for applied population and community ecology

Jeffrey W. Doser, Marc Kéry,
Gesa von Hirschheydt

24-27 June 2024





Spatial multi- species hierarchical distance sampling models

Jeffrey W. Doser
24-27 June 2024



Multi-species HDS models

- Many forms of transect surveys or point count surveys collect data on multiple species.
- Just like we have seen with occupancy models, GLMMs, and N-mixture models, we can extend single-species HDS models to a multi-species framework

Methods in Ecology and Evolution



Research Article | Free Access

A hierarchical distance sampling model to estimate abundance and covariate associations of species and communities

Rahel Sollmann Beth Gardner, Kathryn A. Williams, Andrew T. Gilbert, Richard R. Veit

First published: 08 December 2015 | <https://doi.org/10.1111/2041-210X.12518> | Citations: 43

Multi-species distance sampling data

$i = 1, 2, \dots, I$ species

$j = 1, 2, \dots, J$ sites

$k = 1, 2, \dots, K$ distance bands

Species 3

Site	0-25m	25-50m	50-100m	100-150m
1	3	1	0	0
2	1	1	0	0
3	0	1	2	0
4	2	0	0	1

Species 2

Site	0-25m	25-50m	50-100m	100-150m
1	3	2	0	0
2	4	0	0	0
3	0	0	0	0
4	0	3	1	0

Species 1

Site	0-25m	25-50m	50-100m	100-150m
1	0	1	0	0
2	1	0	0	0
3	1	0	0	0
4	0	1	1	0

Three types of multi-species HDS models in spAbundance

1. Multi-species HDS models ($msDS$)
 - Species are modelled hierarchically (as random effects)
 - No residual species correlations

Three types of multi-species HDS models in spAbundance

1. Multi-species HDS models ($msDS$)

- Species are modelled hierarchically (as random effects)
- No residual species correlations

2. Latent factor multi-species HDS models ($lfMSDS$)

- Species are modelled hierarchically (as random effects)
- Residual species correlations

Three types of multi-species HDS models in spAbundance

1. Multi-species HDS models (m_{SDS})
 - Species are modelled hierarchically (as random effects)
 - No residual species correlations
2. Latent factor multi-species HDS models (l_{fMsDS})
 - Species are modelled hierarchically (as random effects)
 - Residual species correlations
3. Spatial factor multi-species HDS models (s_{fMsDS})
 - Species are modelled hierarchically (as random effects)
 - Residual species correlations
 - Spatial autocorrelation

Three types of multi-species HDS models in spAbundance


1. Multi-species HDS models ($msDS$)
 - Species are modelled hierarchically (as random effects)
 - No residual species correlations
2. Latent factor multi-species HDS models ($lfMSDS$)
 - Species are modelled hierarchically (as random effects)
 - Residual species correlations
3. Spatial factor multi-species HDS models ($slfMSDS$)
 - Species are modelled hierarchically (as random effects)
 - Residual species correlations
 - Spatial autocorrelation

Work in groups to write out the equations for one of these model types using what we have learned so far. We will fill in the next three slides as a class.

Multi-species HDS models (msDS)

Latent factor multi-species HDS models (lfMsDS)

Spatial factor multi-species HDS models (sfMsDS)



Exercise: estimating forest bird density in the northeastern US

14-multi-species-hds-harv-forest.R

