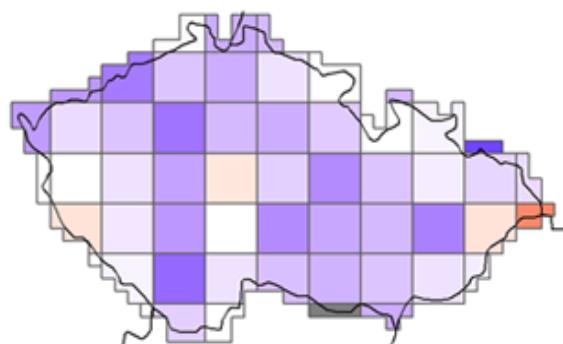
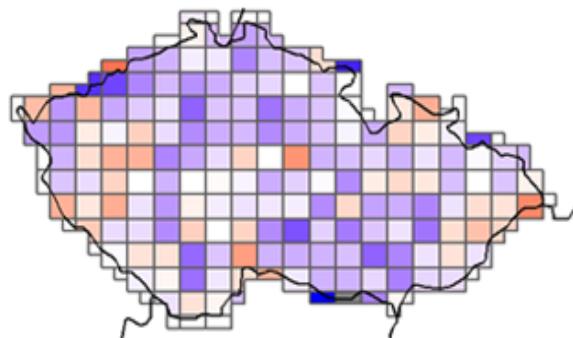
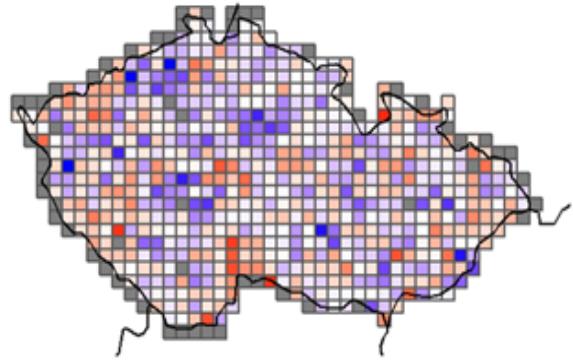


Untangling biodiversity changes across a continuum of spatial scales

PhD Presentation

PhD candidate: François Leroy
Supervisor: Petr Keil
Czech University of Life Sciences
Prague



Biodiversity changes are scale dependent

- Global biodiversity is declining
- Local, regional or national trends are not always similar

Global meta-analysis reveals no net change in local-scale plant biodiversity over time

Mark Vellend^{a,1}, Lander Baeten^{b,c}, Isla H. Myers-Smith^{a,d}, Sarah C. Elmendorf^e, Robin Beauséjour^a, Carissa D. Brown^a, Pieter De Frenne^b, Kris Verheyen^b, and Sonja Wipf^f

REPORT



Assemblage Time Series Reveal Biodiversity Change but Not Systematic Loss

MARIA DORNELAS, NICHOLAS J. GOTELLI, BRIAN MCGILL, HIDEYASU SHIMADZU, FAYE MOYES, CAYA SIEVERS, AND ANNE E. MAGURRAN [Authors Info & Affiliations](#)

SCIENCE • 18 April 2014 • Vol 344, Issue 6181 • pp. 296-299 • DOI:10.1126/science.1248484

Review

CellPress

ECOLOGY LETTERS

Letters | Full Access

More is less: net gain in species richness, but biotic homogenization over 140 years

Fifteen forms of biodiversity trend in the Anthropocene

Brian J. McGill¹, Maria Dornelas², Nicholas J. Gotelli³, and Anne E. Magurran²

Tora Finderup Nielsen Kaj Sand-Jensen, Maria Dornelas, Hans Henrik Bruun

Biodiversity changes are scale dependent

- Global biodiversity is declining
- Local, regional or national trends are not always similar

⇒ Dynamic processes (*i.e.* colonization, extinction, turnover...) vary with spatial scales

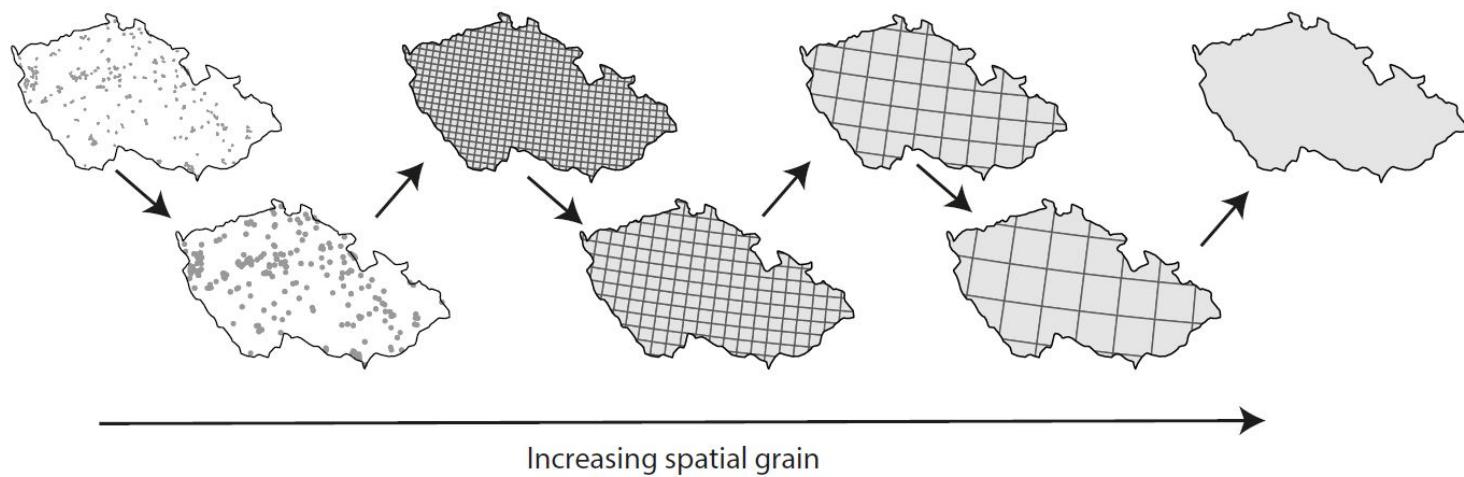
⇒ Biodiversity trends have to be assessed across spatial scales

Objectives

- ⇒ How are avian biodiversity changes scale dependent across Czechia?
- ⇒ Why do we observe this scale dependency of biodiversity changes?

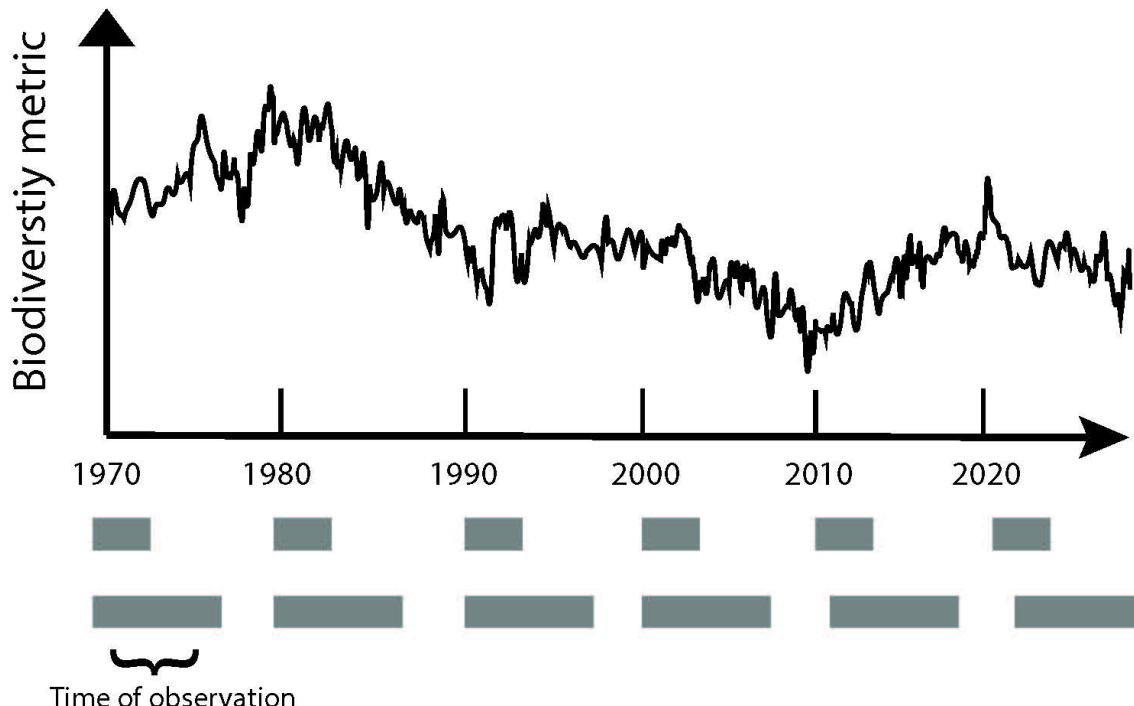
Scales

- Spatial scale = Spatial grain



Scales

- Temporal scale = Temporal grain



Biodiversity data

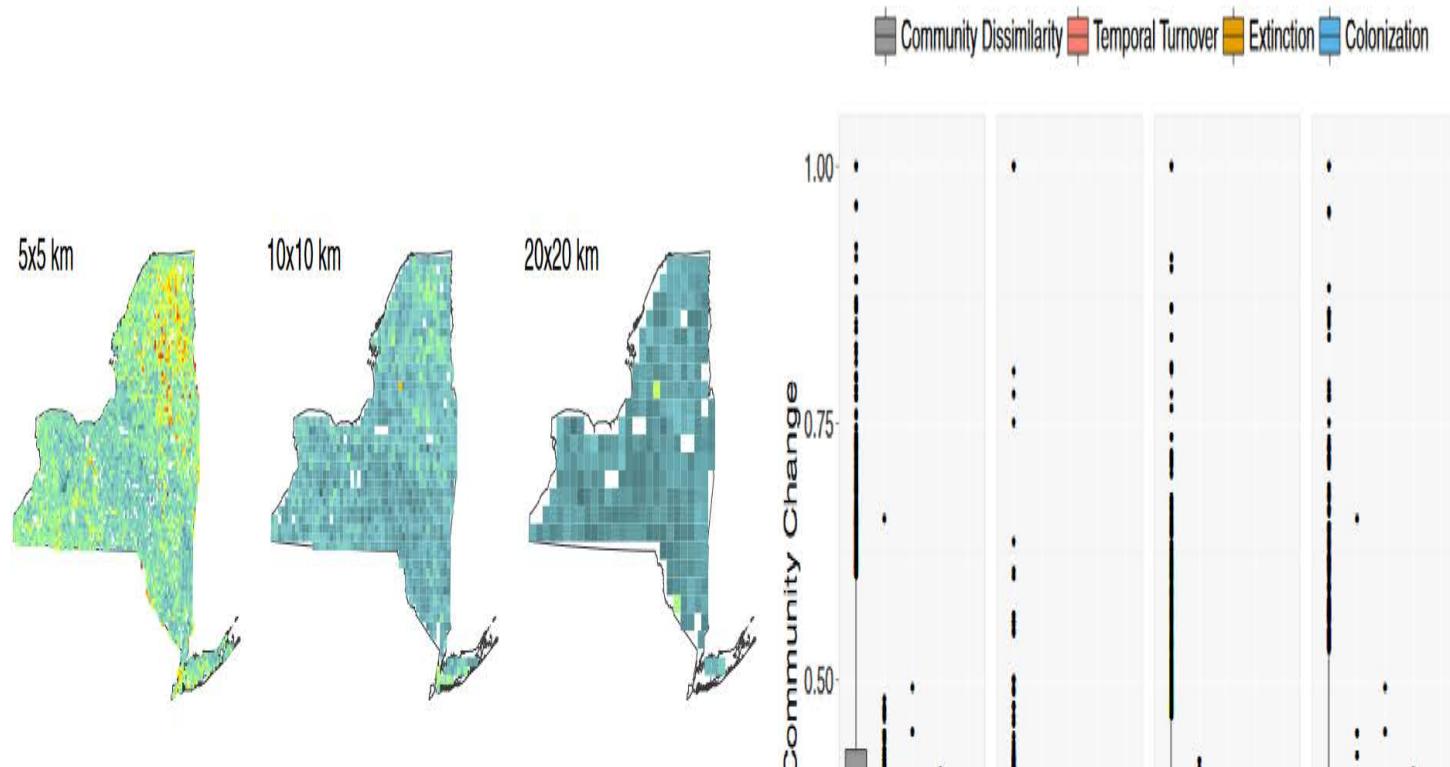
- One dataset express the biodiversity at its specific spatial and temporal grains
- Data heterogeneity in spatial and temporal grains and extent
- Lack of data

Problem:

With the actual data, it is not straight forward to assess biodiversity trends for a continuum of spatial scales

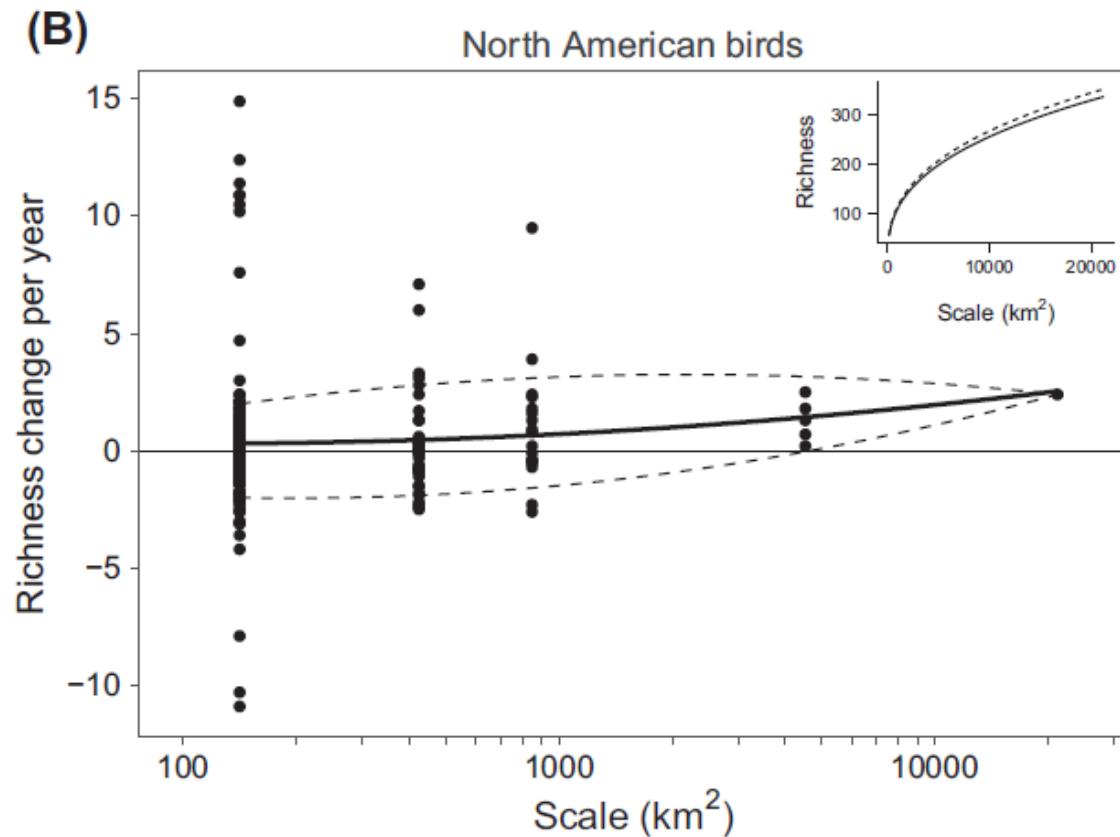
Spatial aggregation

Jarzyna *et al.* (2015)



Spatial aggregation

Chase *et al.* (2019)



Model

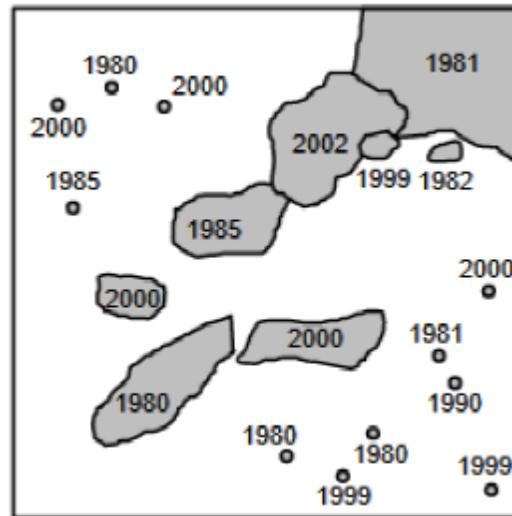
- Use biodiversity data with heterogeneous: **spatial grain, temporal grain, location, spatial extent and temporal extent.**
- Use this component as **covariates** to predict species richness at desired (spatial & temporal) grain and location (in space & time)

Keil & Chase

Interpolation of biodiversity change

Interpolation of temporal biodiversity change, loss, and gain across scales: a machine learning approach

Petr Keil ^{1*} c/o Jonathan M. Chase ^{2,3}



Model

In practice:

```
treeBasedModel(species richness ~ area,  
temporal grain,  
latitude,  
longitude,  
date)      -> Species-area relationship  
           -> Species-time relationship  
           -> Location in space  
           -> Location in space  
           -> Location in time
```

Tree based models: the flexibility grasps the interactions between **species area/time relationship** and their location in space and time.

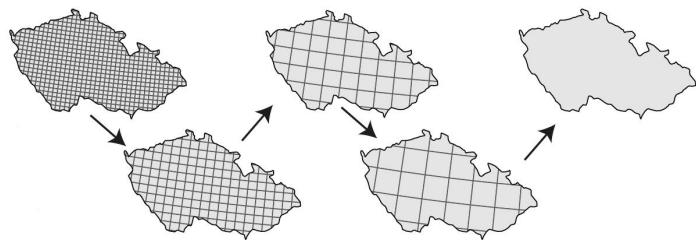
The species-area and species-time relationships allows to down/upscale species richness

⇒ **We need data at different spatial and temporal grains**

Bird atlas of Czech Republic

Spatial scales

Large scale dataset. Ranging from less than 100 Km² to 80 000 Km² (the entire Czech Republic)



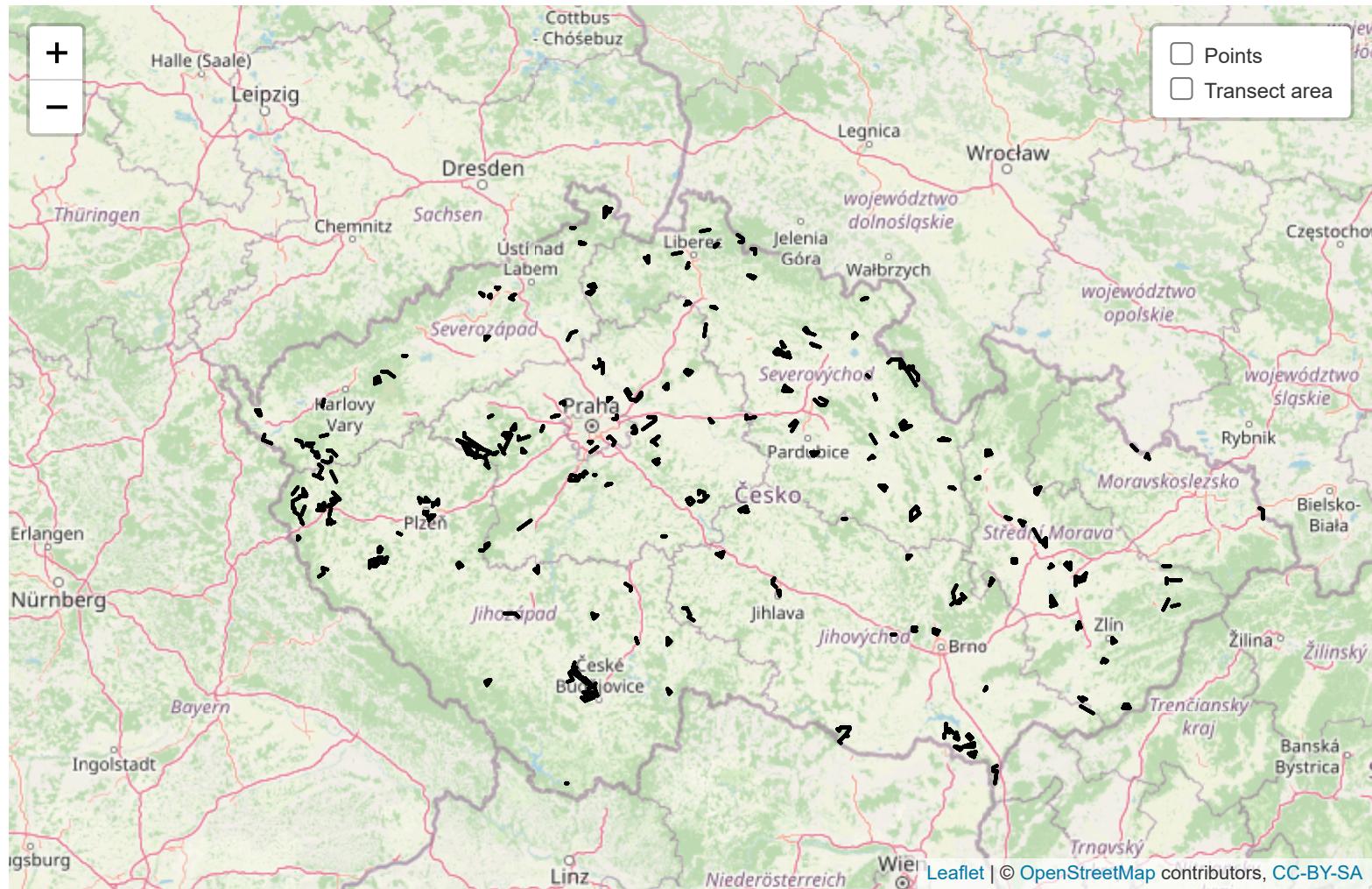
Temporal scales

3 time periods, 3 different time spans:

- M2 = 1985-1989 (5 years)
- M3 = 2001-2003 (3 years)
- M4 = 2014-2017 (4 years)

⇒ The model homogenize the temporal grain and the sampling effort

Breeding bird survey (BBS)

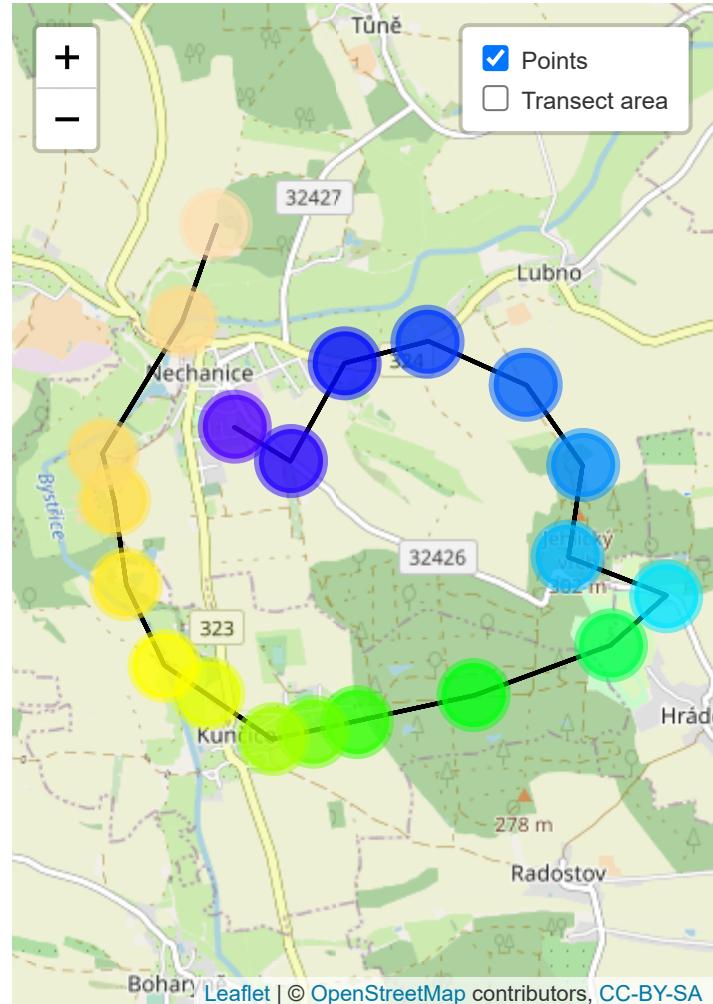


Breeding bird survey (BBS) dataset

Spatial scales: very local

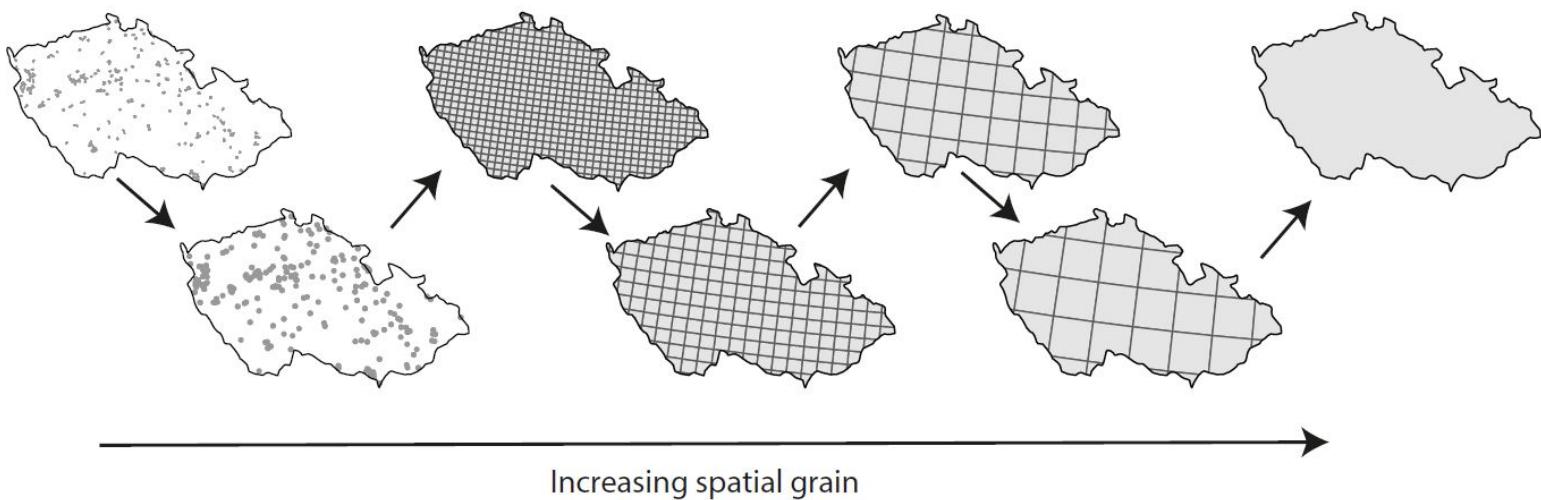
Temporal scales: from 0.5 year to 10+ years

⇒ The model predict species richness for missing years

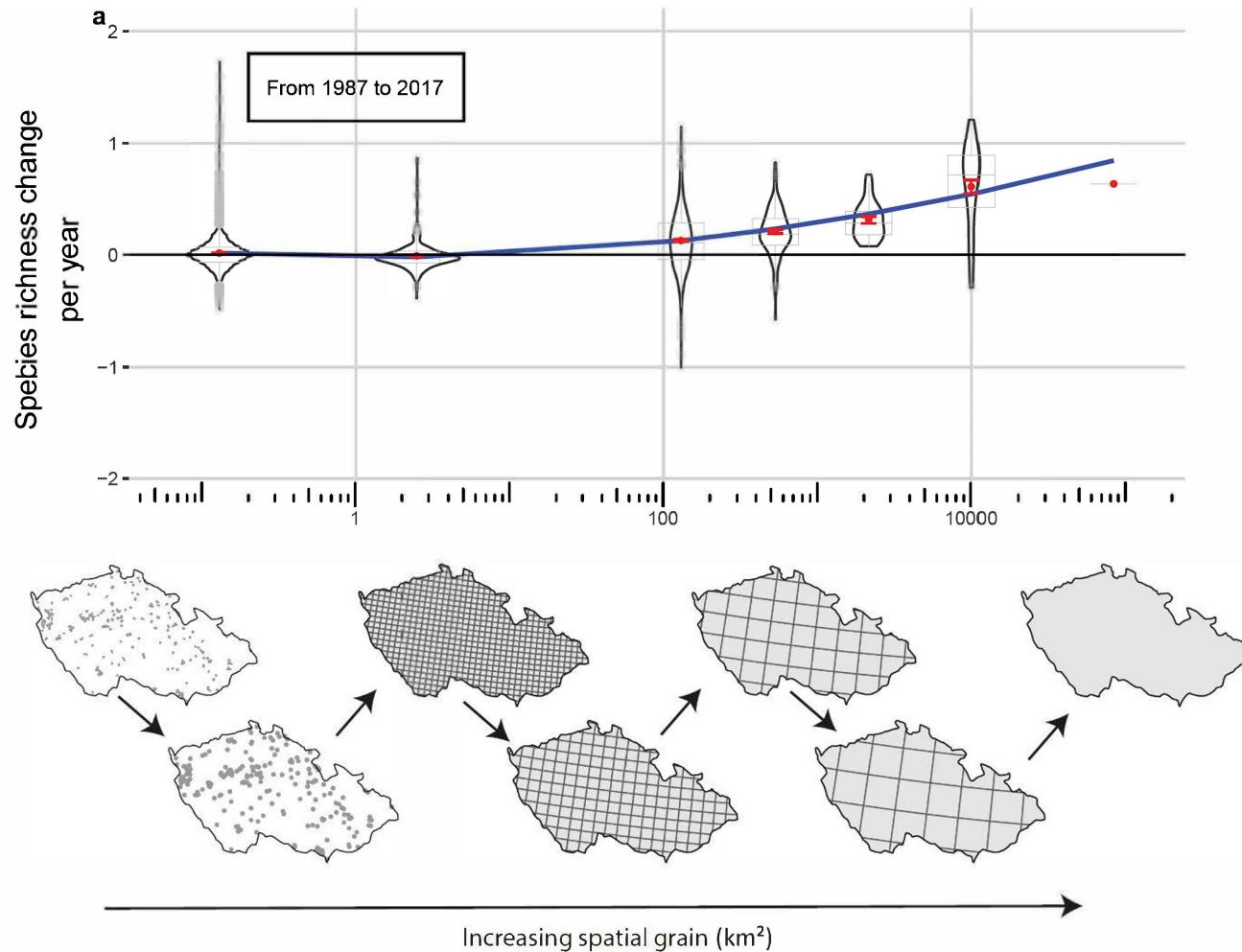


Richness change across scales

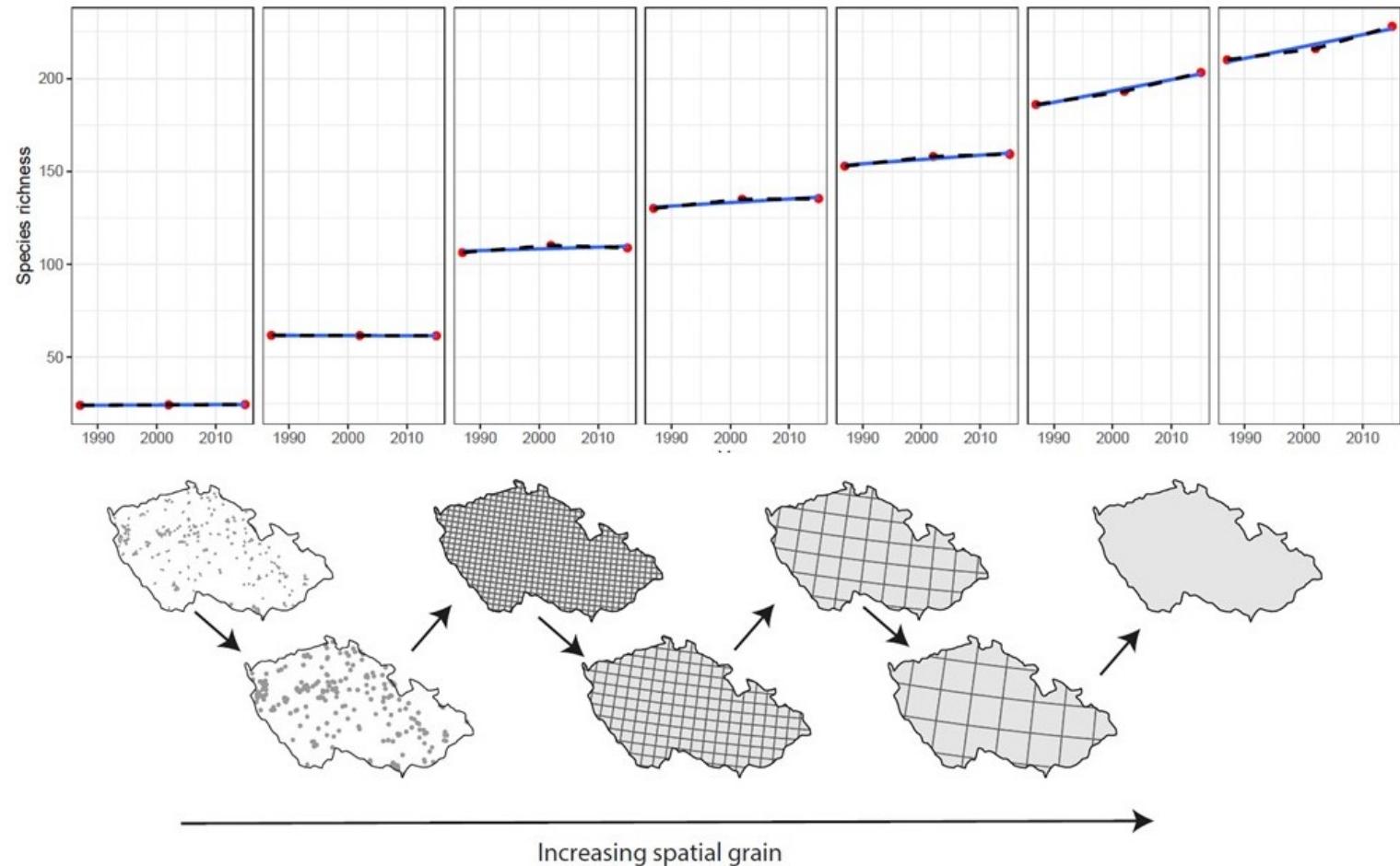
- For each spatial scale: predictions of species richness from 1987 to 2017
- Assessment of the species richness change per year



Richness changes across scales



Richness changes across scales

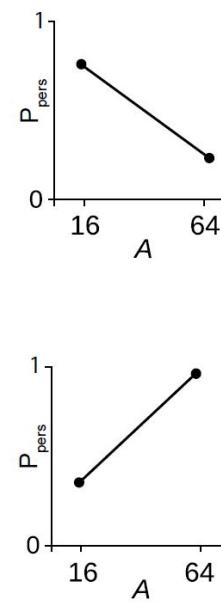
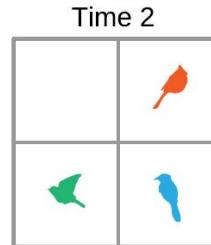
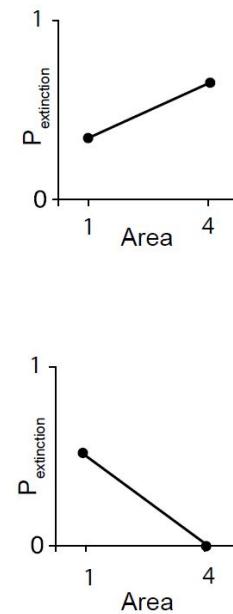
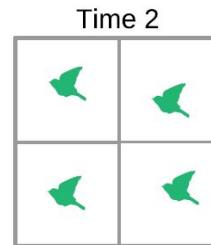
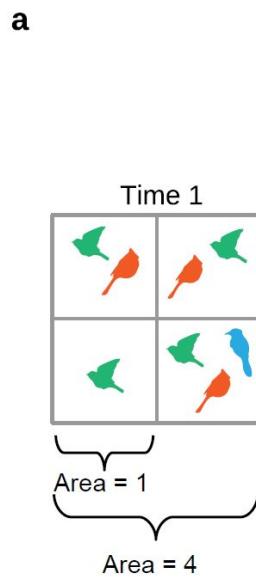


Colonization, extinction, persistence across scales

- Species richness change is the sum of these 3 processes
- Assessment across scales

Colonization, extinction, persistence across scales

Extinction

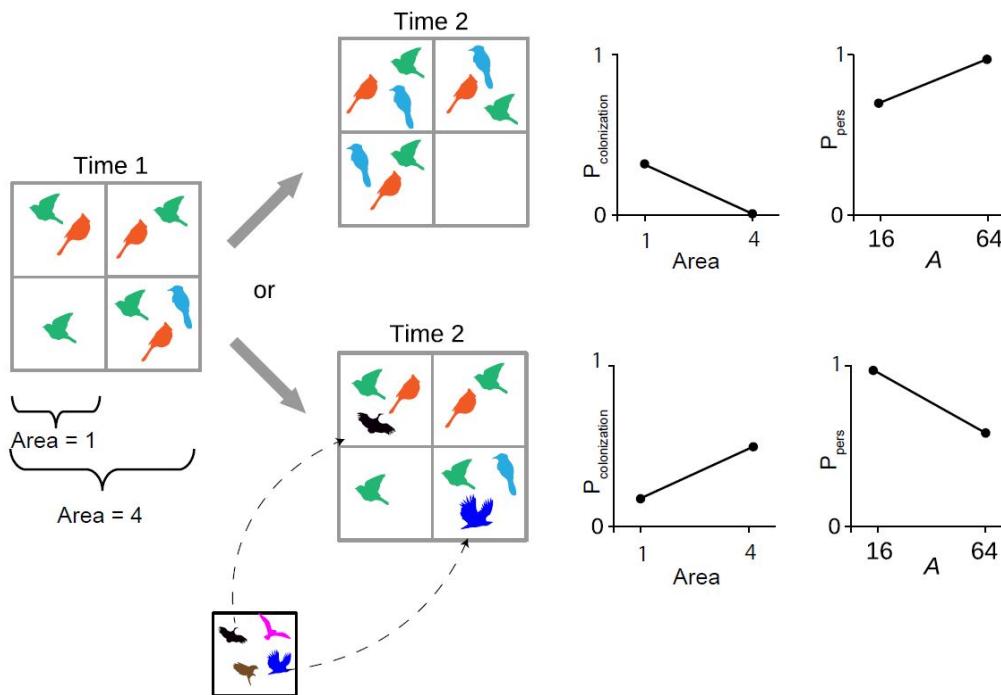


modified from Keil et al. (2017)

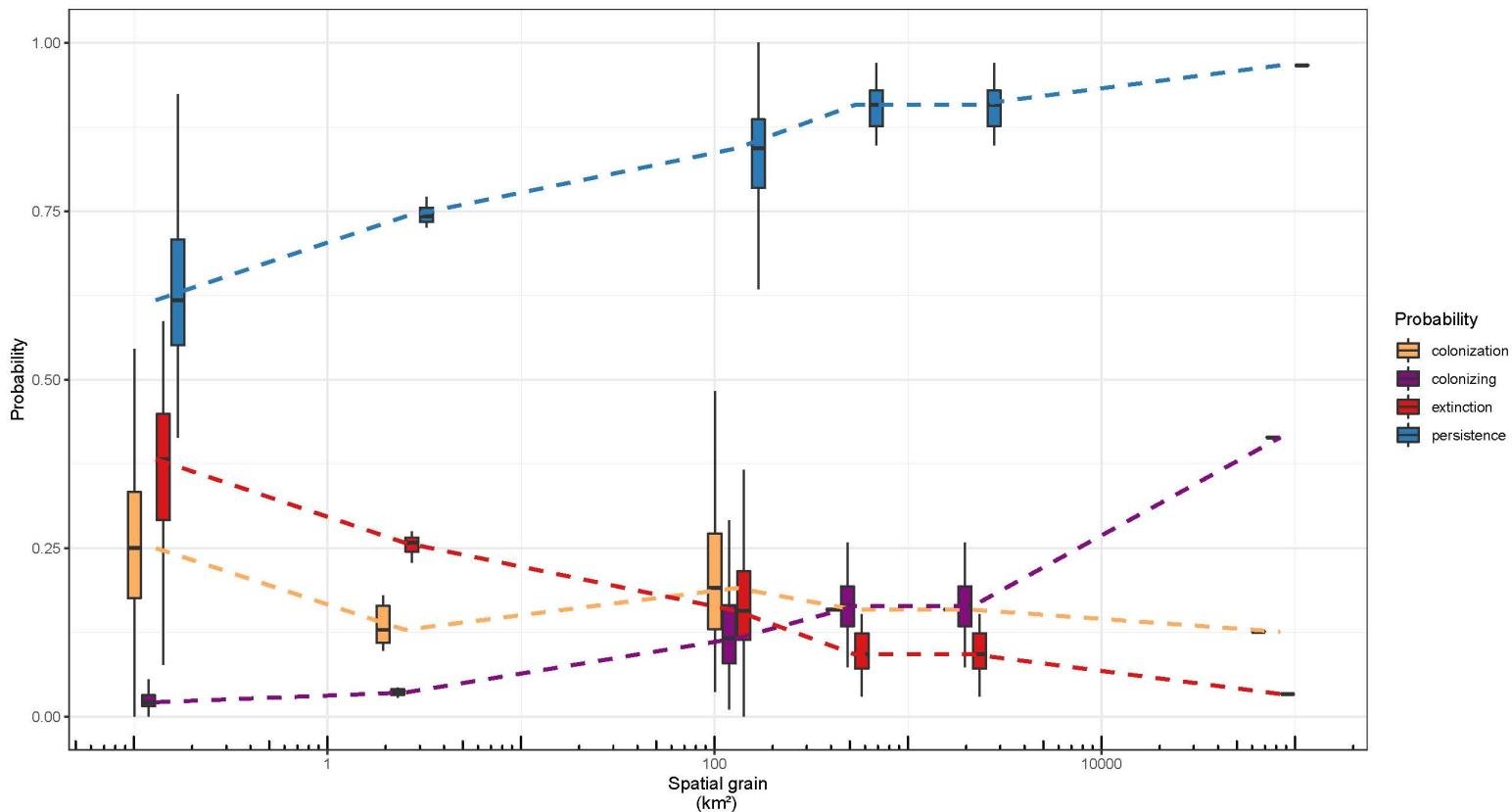
Colonization, extinction, persistence across scales

Colonization

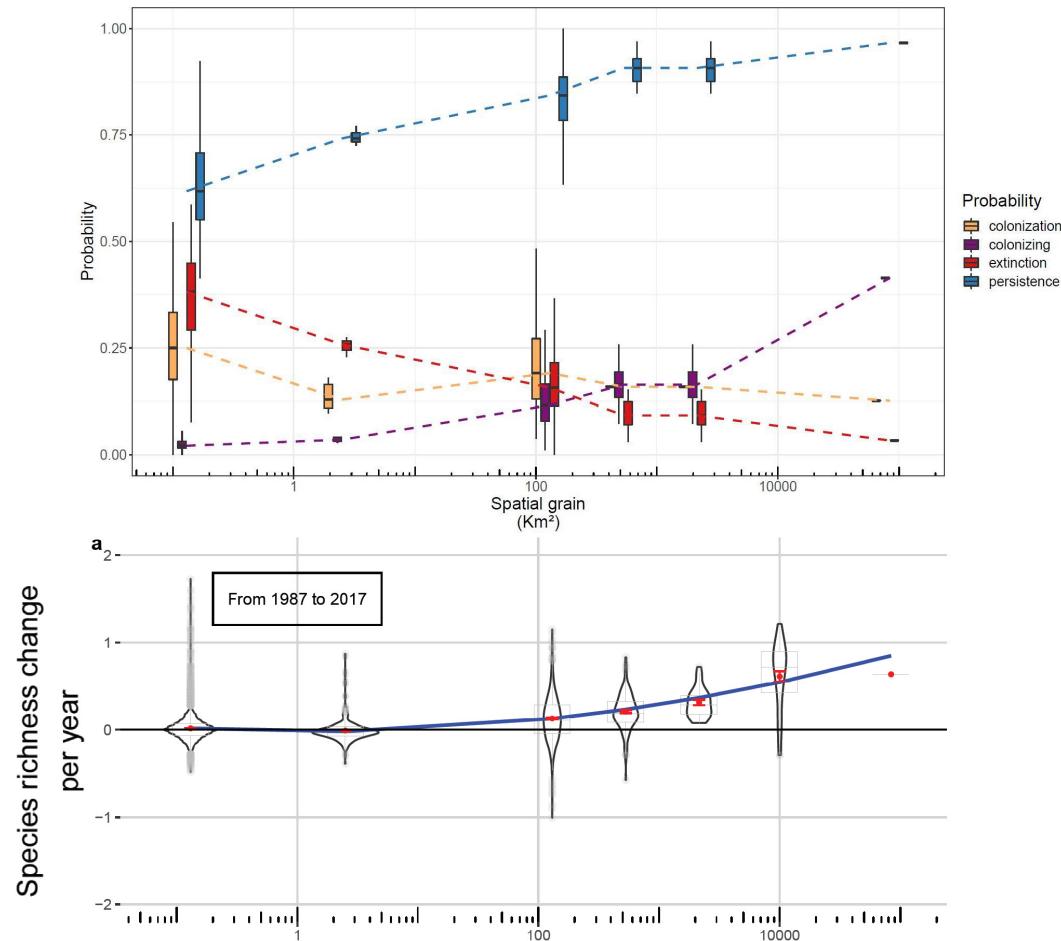
b



Colonization, extinction, persistence across scales



Colonization, extinction, persistence across scales



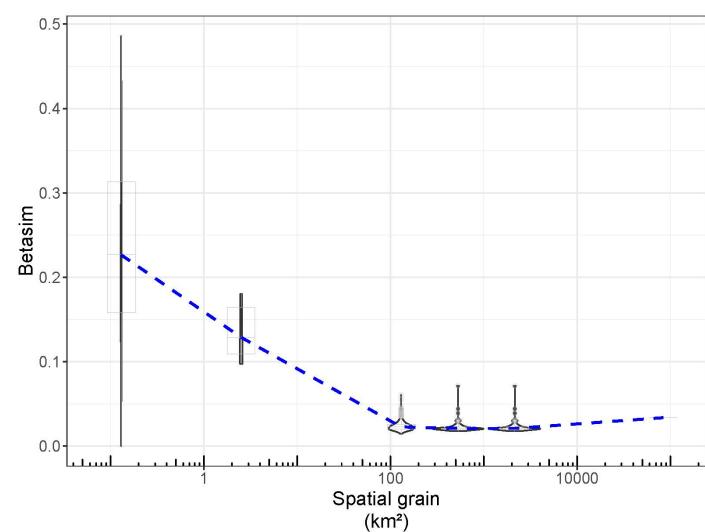
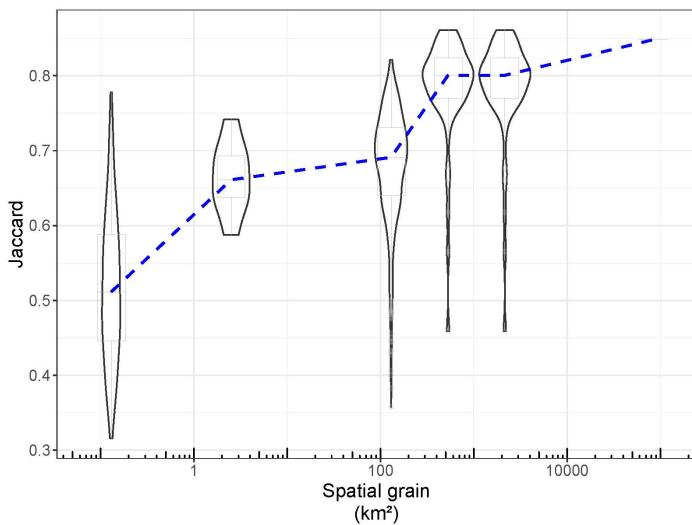
Beta-diversity across scales

Similarity index:

$$jaccard = \frac{pers}{pers+col+ext}$$

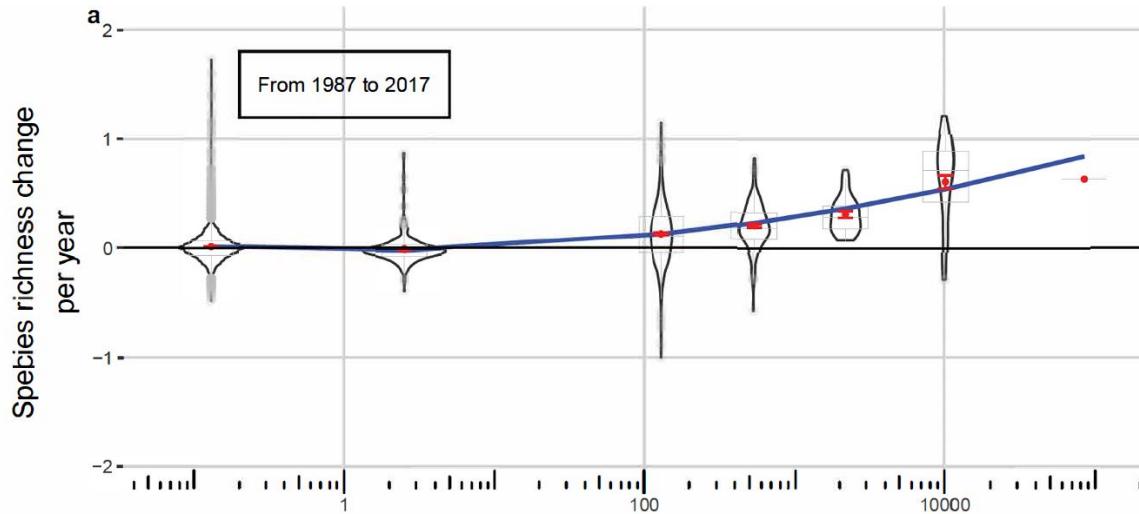
Dissimilarity index

$$betasim = \frac{\min(ext,col)}{pers+\min(ext,col)}$$



Conclusion

This pattern:



Can be explained by the spatial scaling of dynamic processes:

- ↗ persistence with increasing spatial grain
- different ↘ slope of extinction and colonization with increasing spatial grain
- ↘ temporal turnover with increasing spatial grain

Conclusion

- ⇒ As colonization, extinction and persistence are scale dependent, we observe a scale dependency of biodiversity change
- ⇒ Assessing biodiversity trends at national scale doesn't inform much about local dynamic and vice-versa
- ⇒ Using heterogeneous dataset allows to model biodiversity at location and time where data is missing

Thank you for your attention

✉️ leroy@fzp.cz



👉 <https://frslry.github.io/>

Supplementary slides

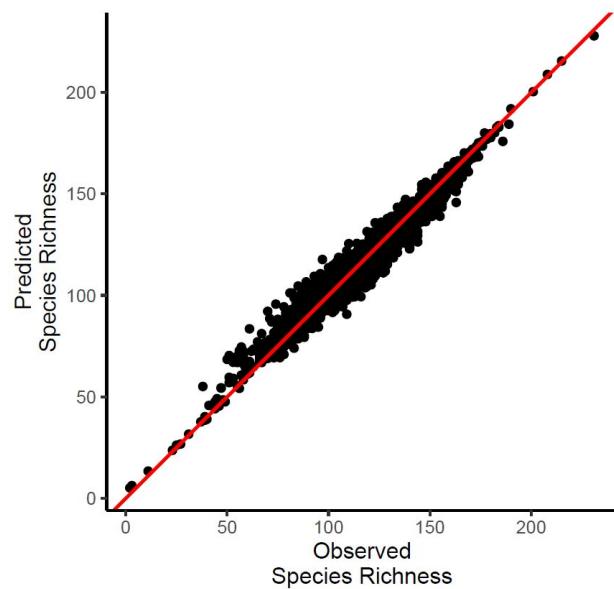
Performance

Atlas model

XGBoost

$$R^2 = 0.77$$

$$MAE = 9$$

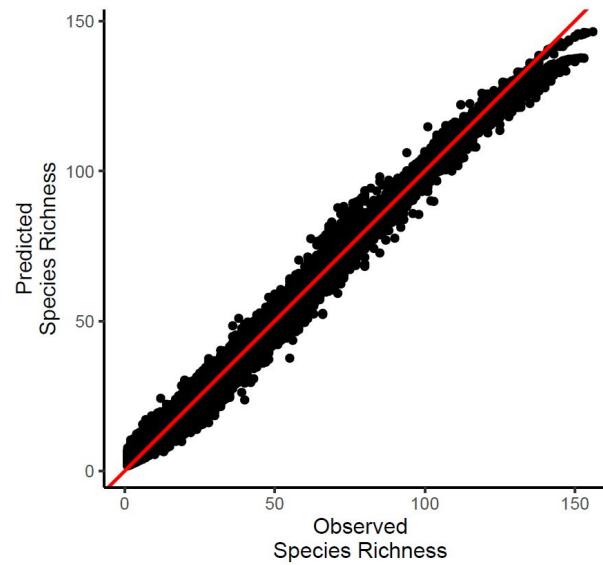


BBS model

RandomForest

$$R^2 = 0.74$$

$$MAE = 10$$



And what about temporal scaling?

