Faculty of Environmental Sciences

Predicting change in species distributions from a single snapshot

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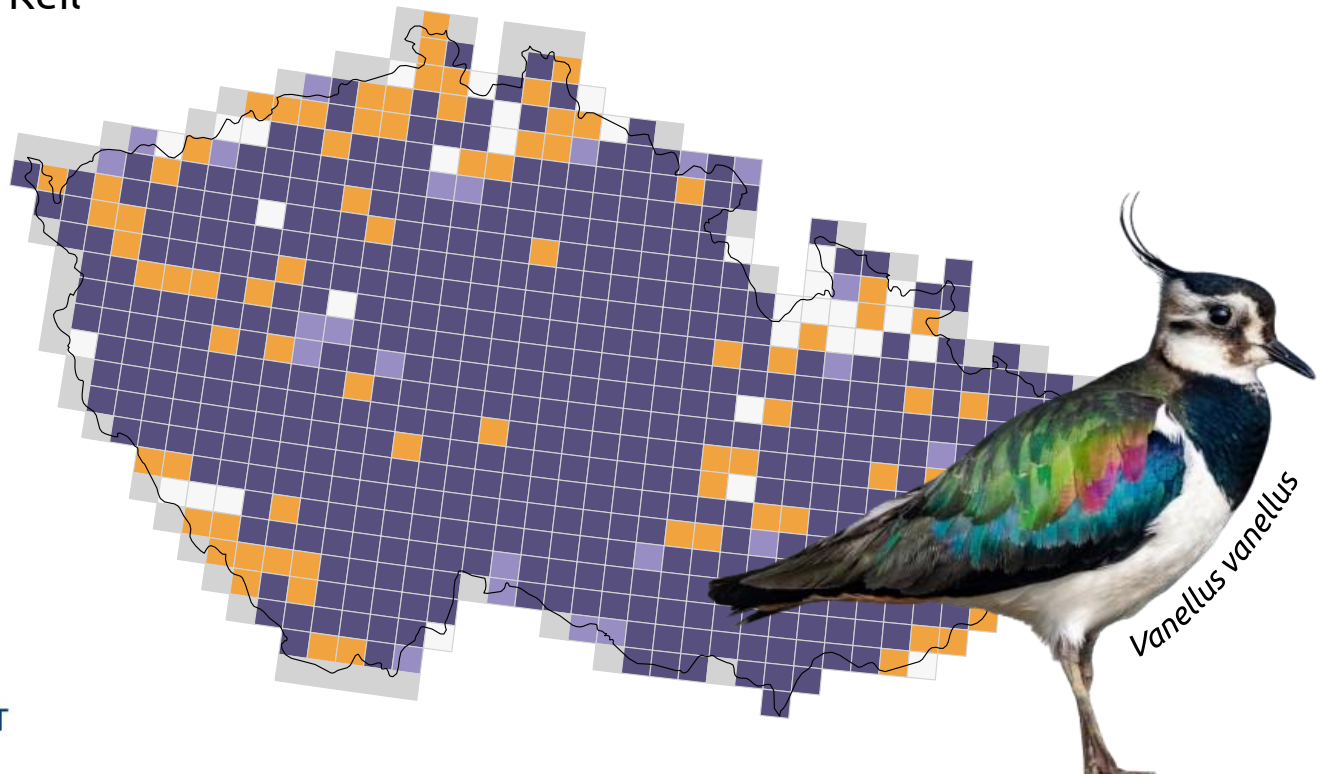

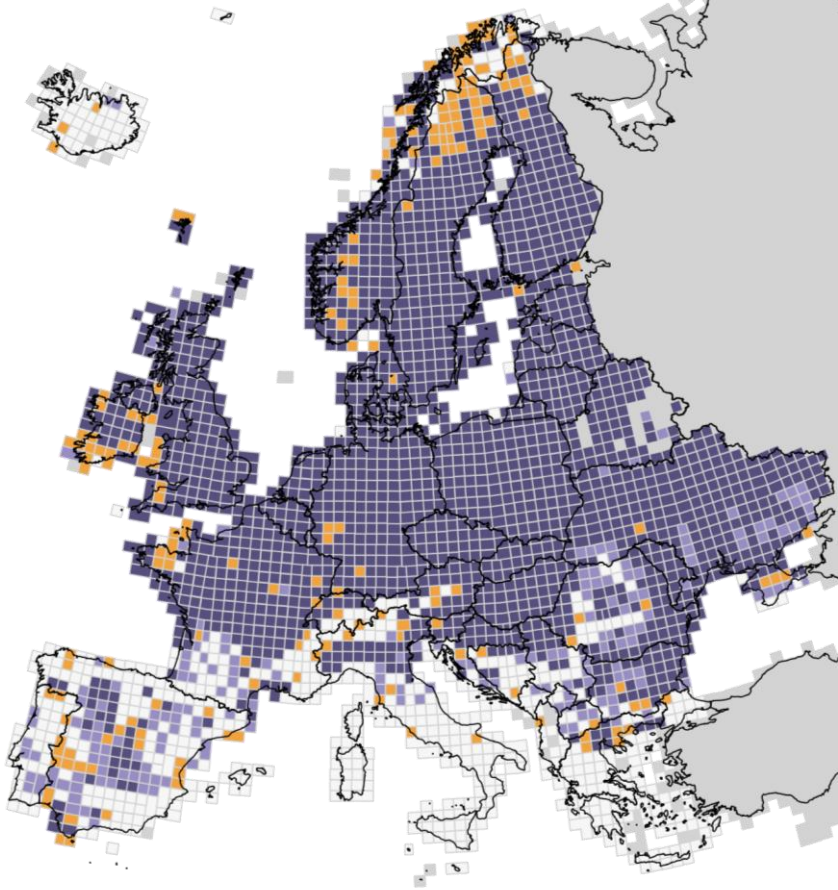

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BEAST Project

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Limited resources

How do we keep track of the changes happening in nature when time and resources are limited?

Limited information

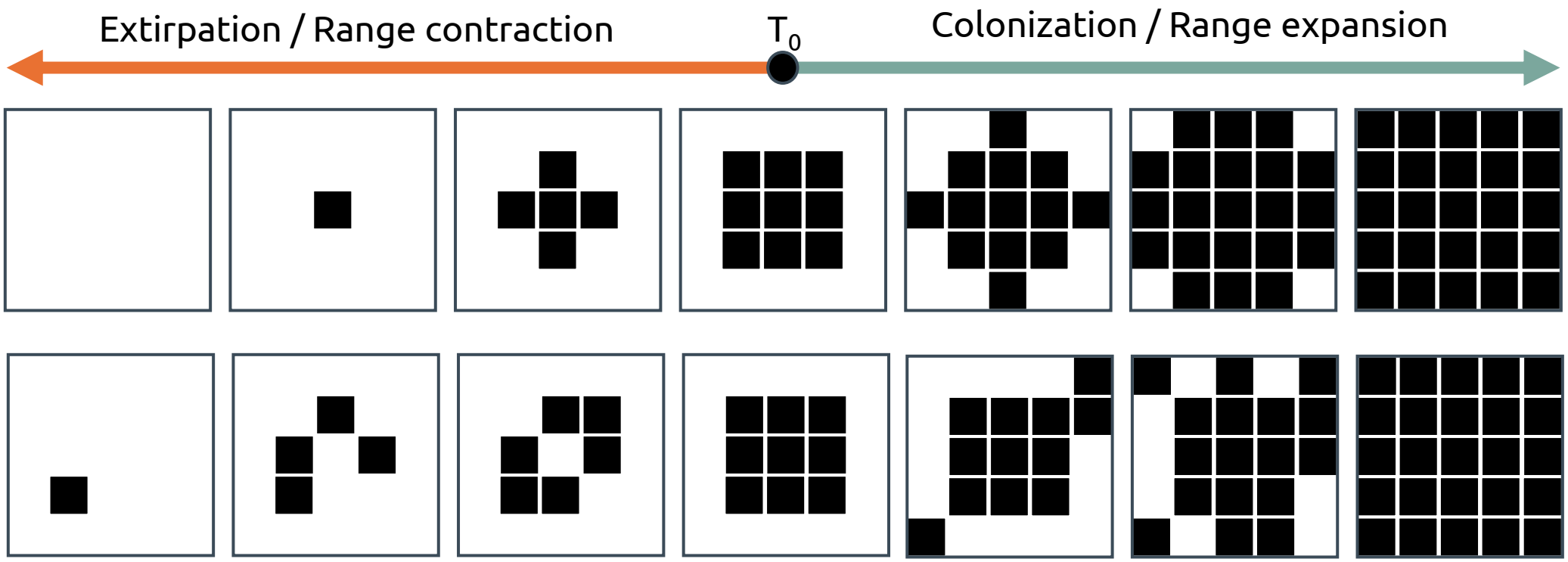
Limited resources

Can we uncover biodiversity dynamics **without repeated monitoring?**

Limited information

Imprints of temporal change

Colonization and **extinction/extirpation** change a species' distribution



Defining temporal change for single species

Magnitude of change

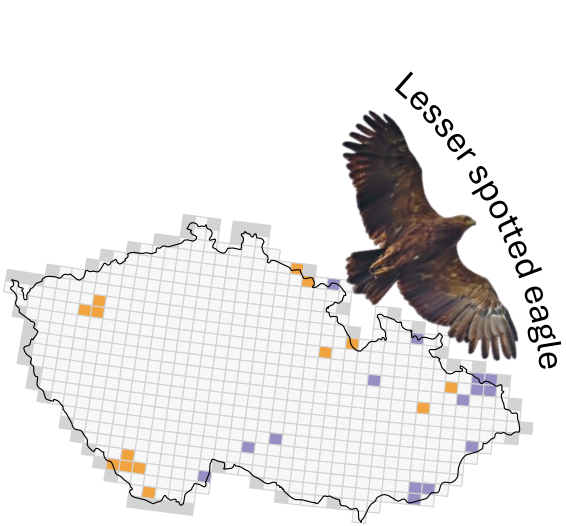
Change in **which sites** are occupied

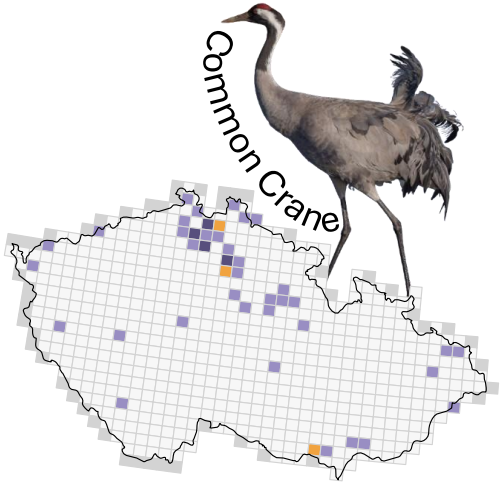
Jaccard similarity

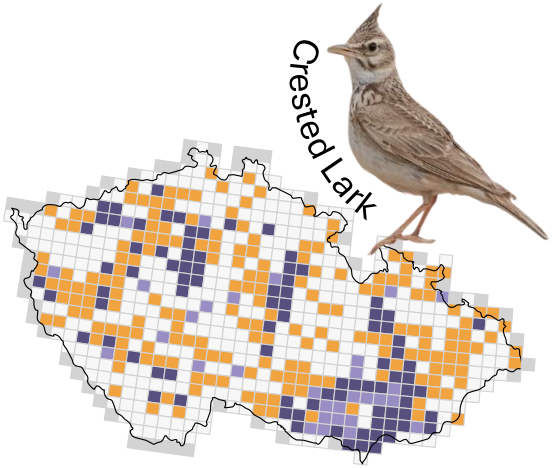
Direction of change

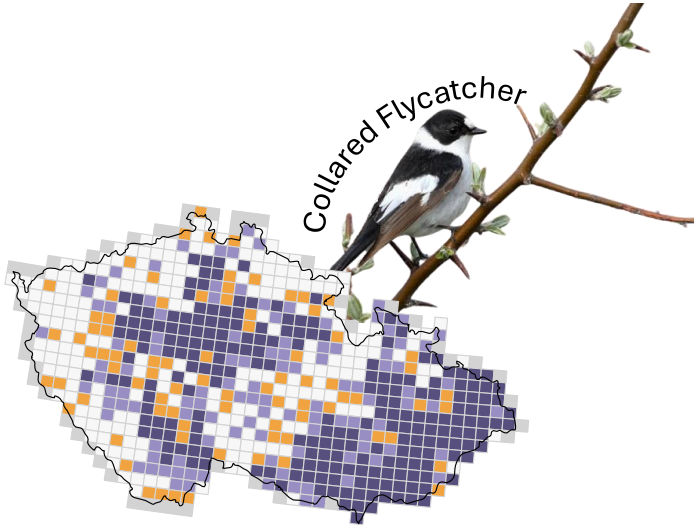
Change in how **much area** is occupied

Log Ratio AOO



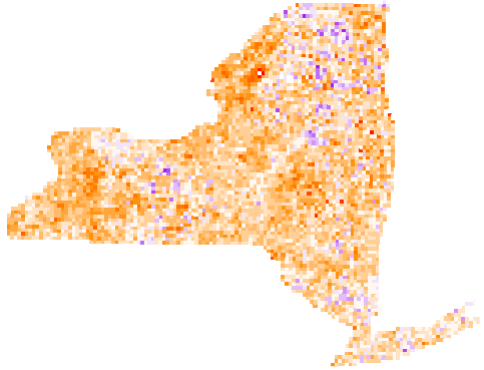


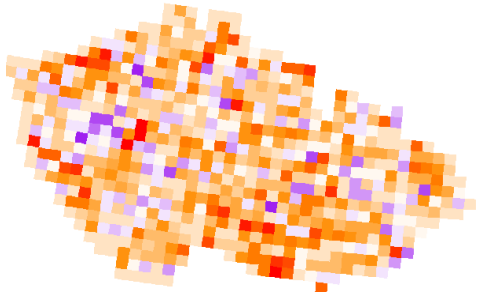


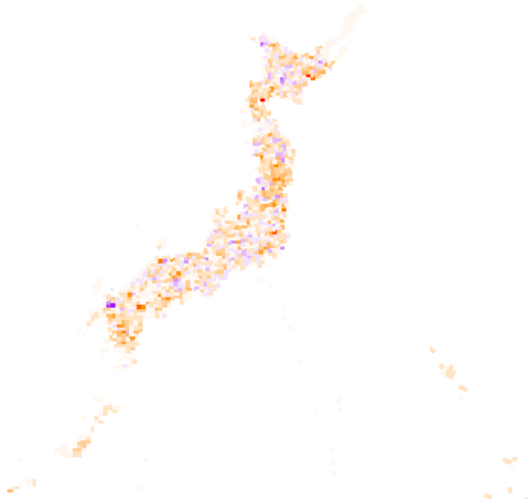


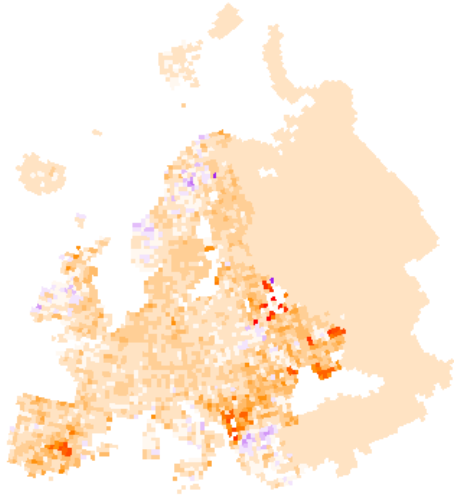
Stable Occupancy | Newly Colonized | Newly Extirpated | Not Occupied | Not Sampled

Breeding Bird Atlases



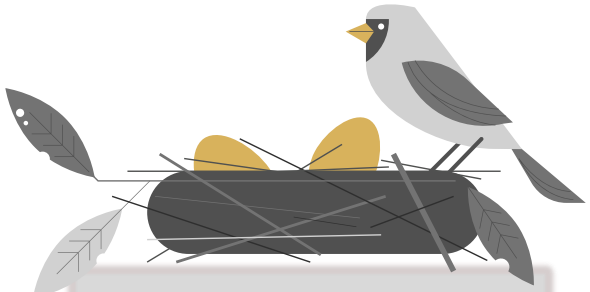






	New York State	Czech Republic	Japan	Europe
Spatial scale	5 x 5 km	10 x 10 km	20 x 20 km	50 x 50 km
Temporal scale (2 replications)	[1980 – 1985] [6yrs]	[1985-1989] [5 yrs]	[1997 – 2002] [6 yrs]	[1972 – 1995] [24 yrs]
	[2000 – 2005] [6yrs]	[2001-2003] [3 yrs]	[2016 – 2021] [6 yrs]	[2013 – 2017] [5 yrs]

Random Forest



Temporal Change

(single species)

~

Direction

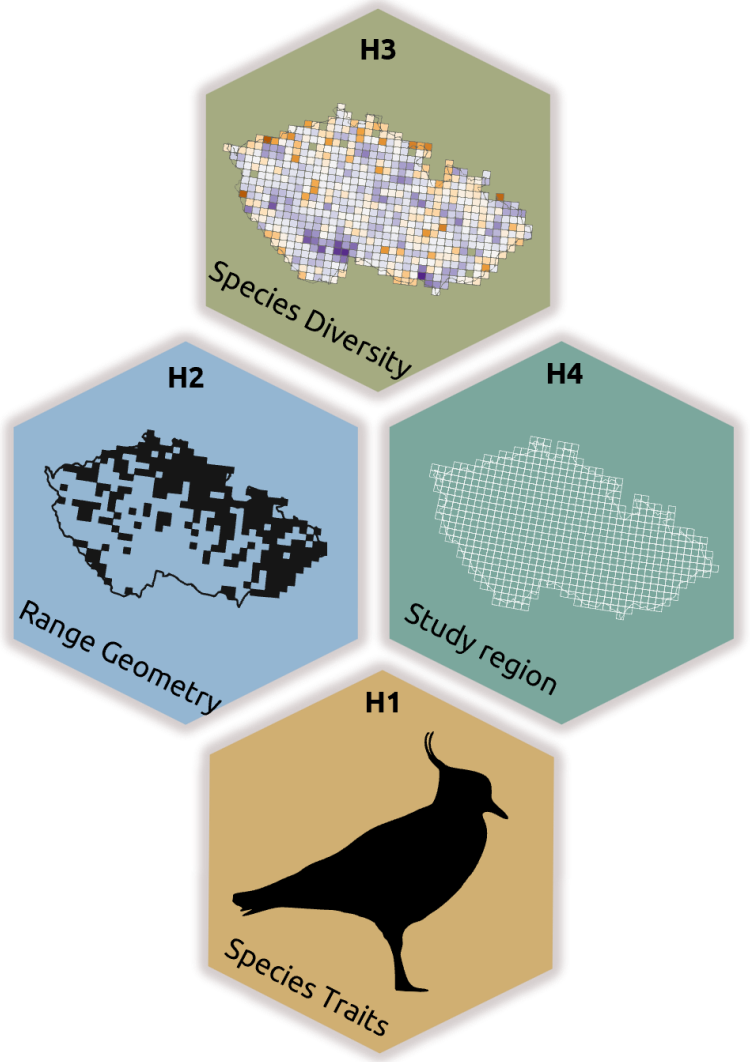
Magnitude

Log Ratio AOO

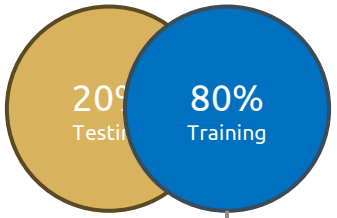
$$lnRR\ AOO = ln\left(\frac{AOO_{time2}}{AOO_{time1}}\right)$$

Jaccard Similarity

$$J = \frac{|cells_{time1} \cap cells_{time2}|}{|cells_{time1} \cup cells_{time2}|}$$

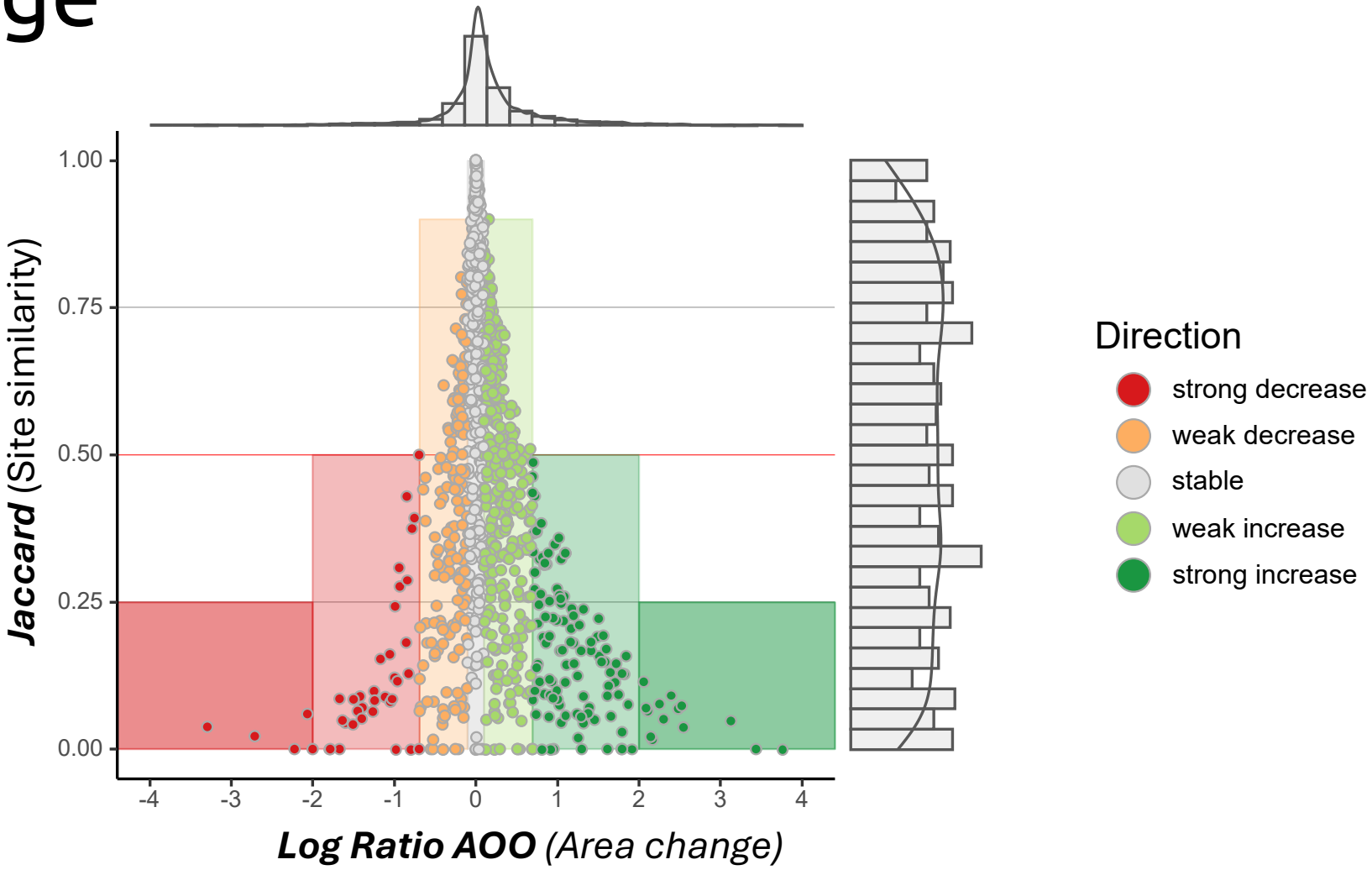


The Model



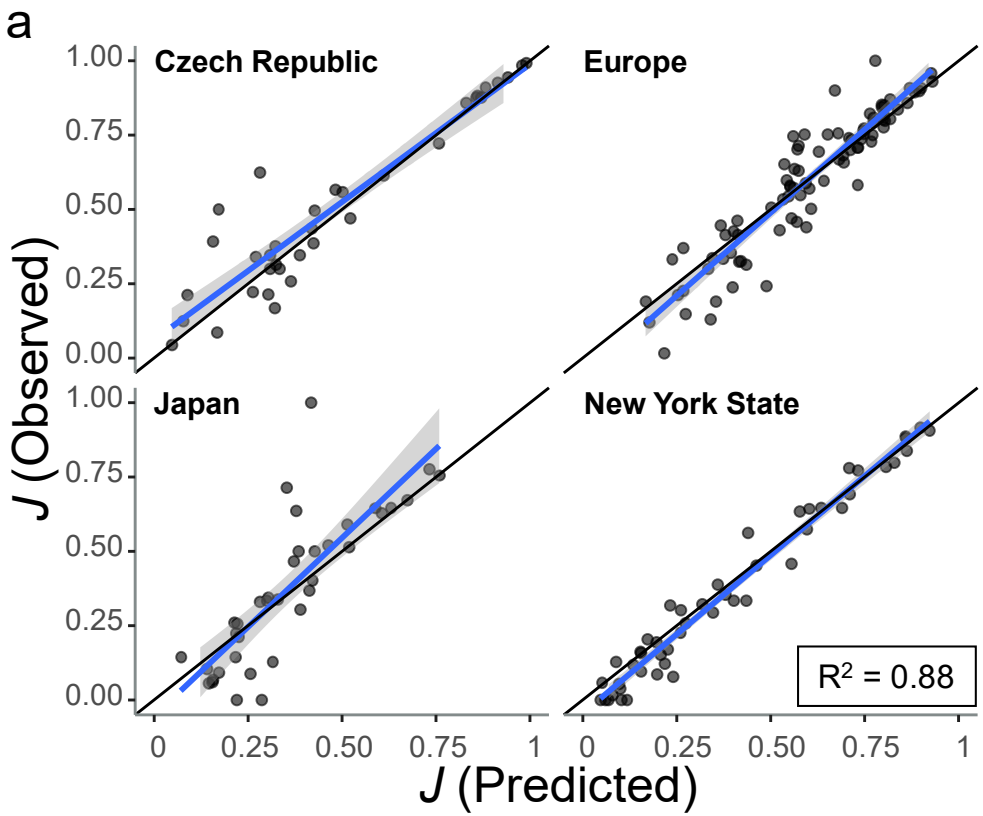
3x repeated 10-fold cross-validation

Mismatch between magnitude and direction of change



20%
Testing

Model predictive performance



20% independent validation-data

- Observed = measured from the data (**true observed change**)
- Predicted = predicted from the model from the static snapshot of the first sampling period (**estimated change**)

80% Training

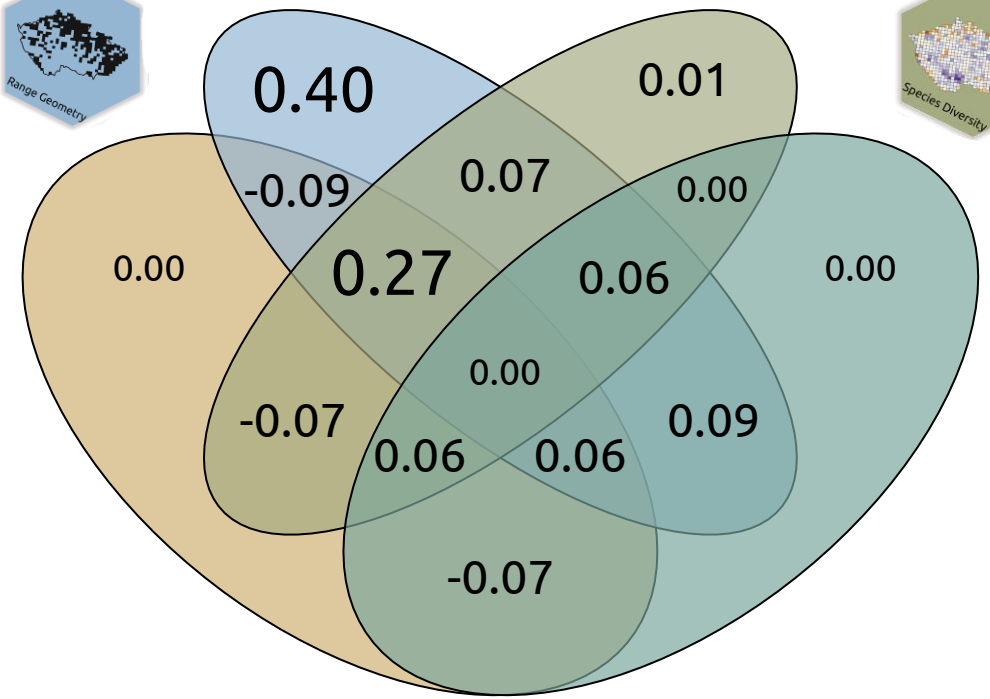
Variation partitioning

H2 - Range Geometry
$R^2 = 0.85$

H3 - Species Diversity
$R^2 = 0.39$

H1 - Species Traits
$R^2 = 0.15$

H4 – Study region
$R^2 = 0.20$



Full model $R^2 = 0.772$
Residuals = 0.228

Key Messages

- Despite **zero net-change**, species ranges are **highly dynamic**.
- We can predict **how dynamic,** but not if it's good or bad
- Static data can **capture** signals of dynamic processes (range geometry!)

How can we use this?

- Estimation of change trend for species **without temporal data**
- **Prioritization** of highly dynamic species to promote monitoring in the field

Thanks to the **team**



Gabriel Ortega Solís,
Carmen Soria &
Petr Keil

Data holders:

Czechia	*Japan*	*New York State*	*Europe*
Karel Šťastný **Vladimír Bejček**	**Mutsuyuki Ueta**	Open (thanks to **Julie Harte**)	**Sergi Herrando** **Verena Keller**

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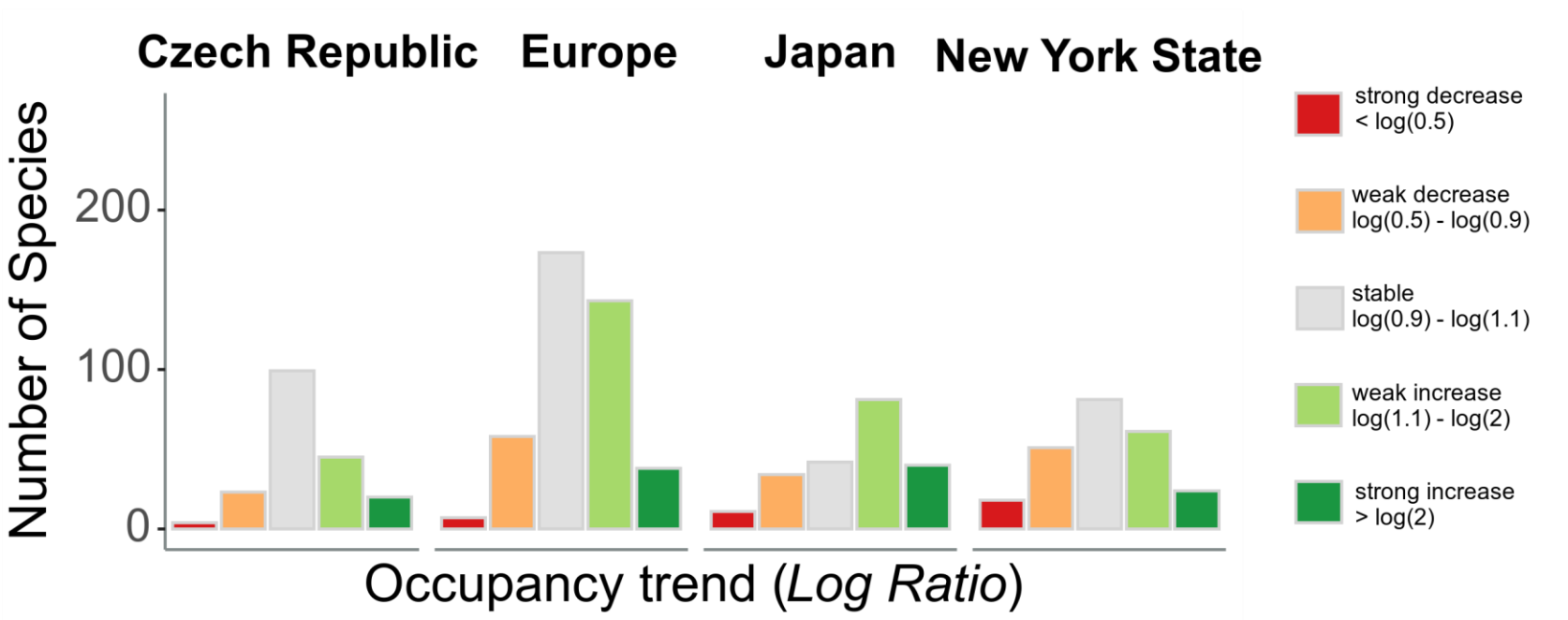
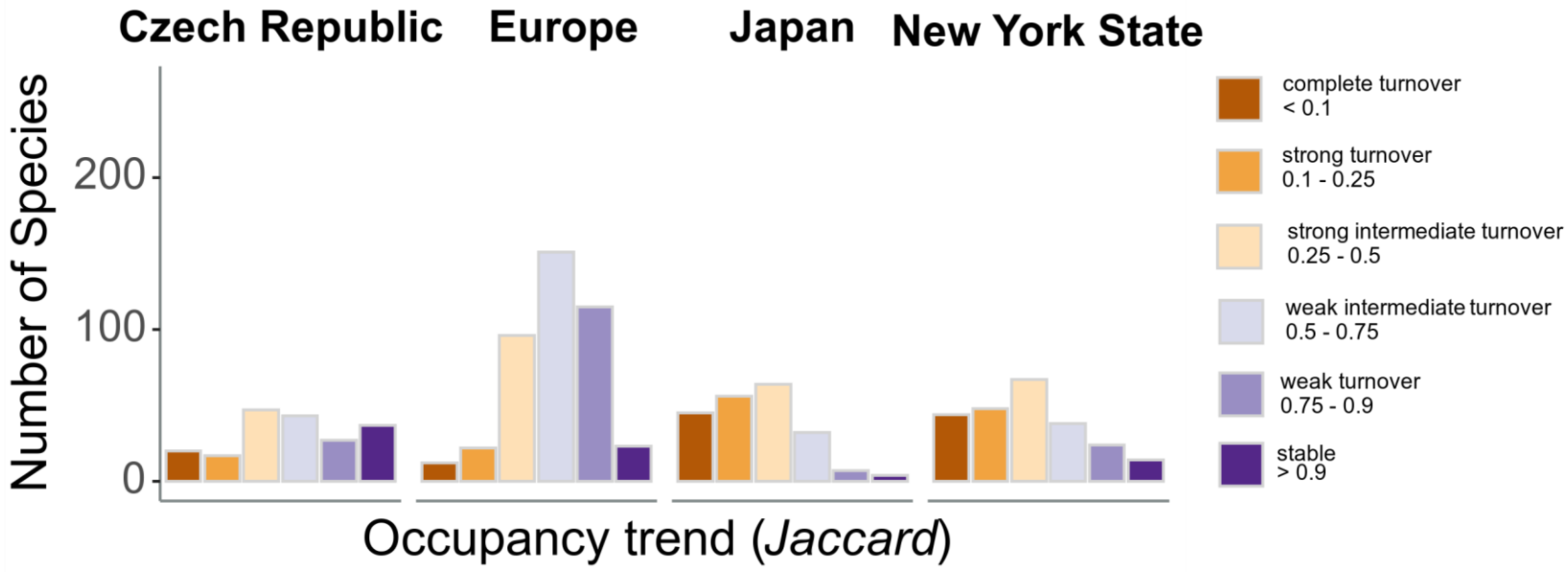
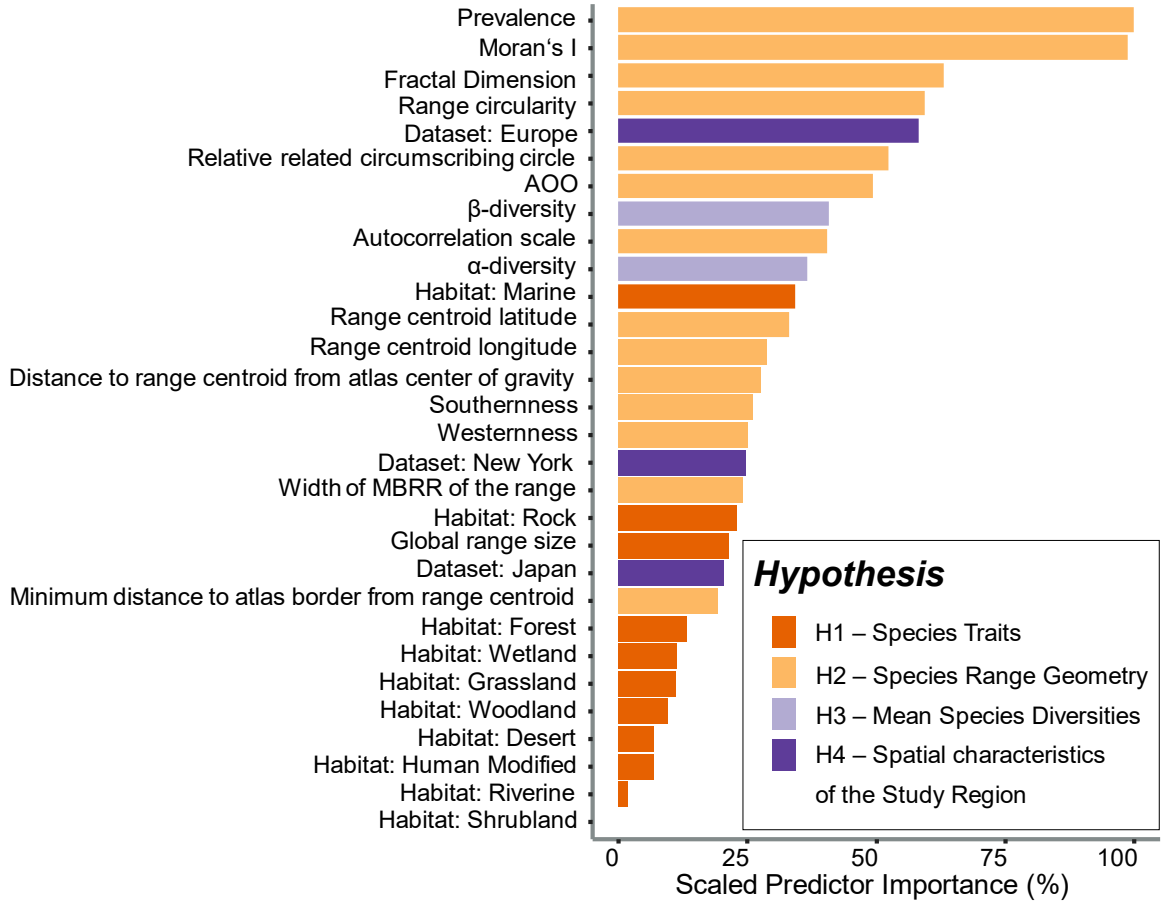


Direction

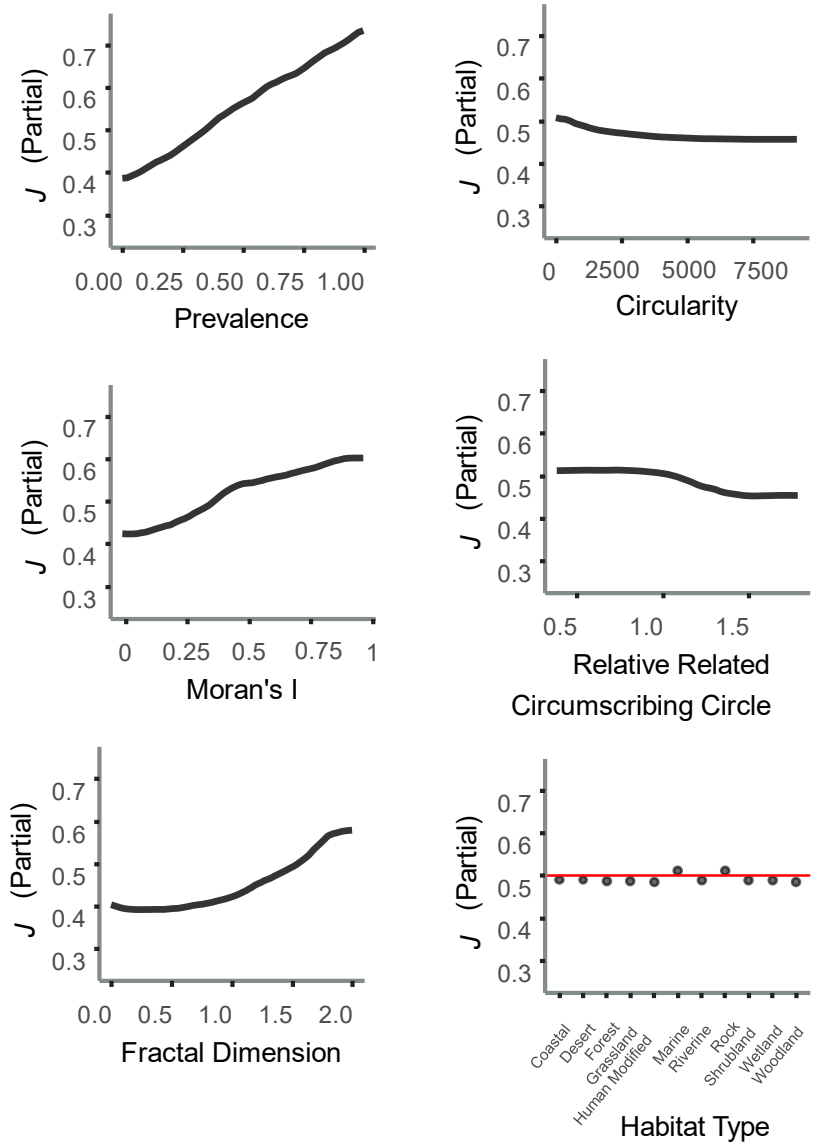


Magnitude

a


Prevalence
Moran's I
Fractal Dimension
Range circularity
Dataset: Europe
Relative related circumscribing circle
AOO
β-diversity
Autocorrelation scale
α-diversity
Habitat: Marine
Range centroid latitude
Range centroid longitude
Distance to range centroid from atlas center of gravity
Southernness
Westernness
Dataset: New York
Width of MBRR of the range
Habitat: Rock
Global range size
Dataset: Japan
Minimum distance to atlas border from range centroid
Habitat: Forest
Habitat: Wetland
Habitat: Grassland
Habitat: Woodland
Habitat: Desert
Habitat: Human Modified
Habitat: Riverine
Habitat: Shrubland
0
25
50
75
100
Scaled Predictor Importance (%)
Hypothesis
H1 – Species Traits
H2 – Species Range Geometry
H3 – Mean Species Diversities
H4 – Spatial characteristics of the Study Region

b


J (Partial)
Prevalence
Circularity
Moran's I
Relative Related Circumscribing Circle
Fractal Dimension
Habitat Type
Coastal
Desert
Forest
Grassland
Human Modified
Marine
Riverine
Rock
Shrubland
Wetland
Woodland