


A multi-taxa approach in mountain ecosystems




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Multi-taxa approach

To set the basis for the development of a long term monitoring scheme, focused on multi-taxa community data sampled with easy, cheap and semi-quantitative methodologies

2006-2007

4 years stop

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

2012-2013

4 years stop

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

2018-2019

2024-2025

Objectives

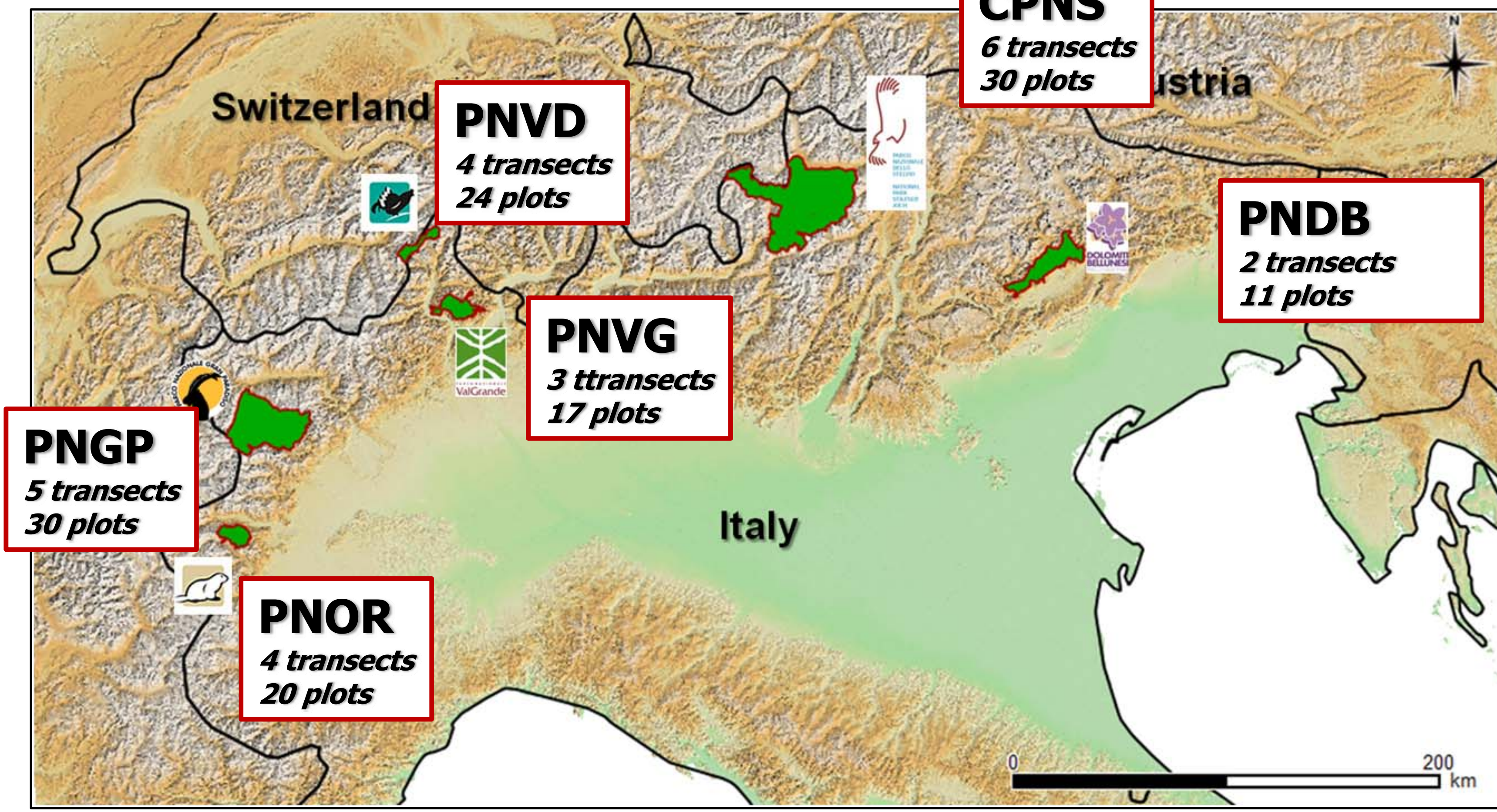
1. To describe animal biodiversity along altitudinal gradients and identify the parameters influencing species' distribution

2. To estimate the risk of biodiversity loss,
also through the application of climate change scenarios

3. To identify the (group of) species and the habitat type more sensitive to environmental and climatic changes,
which can be used as biodiversity/ecological indicators

First period – 3 parks: 2006-2008
Second period – 6 parks: 2012-2014
Third period – 6 parks: 2018-2019

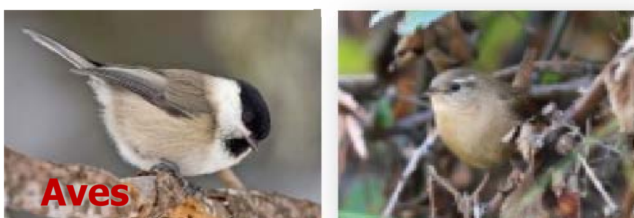
132 plots, 24 altitudinal transects (valleys), 6 parks



7 taxonomic groups

Pitfall traps

9-10 samplings
May-September
every 15 days



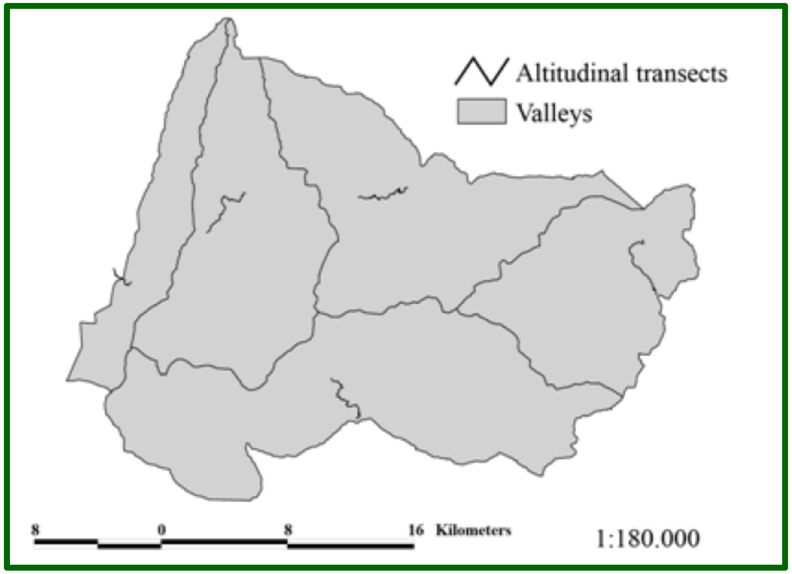
Point counts

2 samplings
April-July

Linear transects

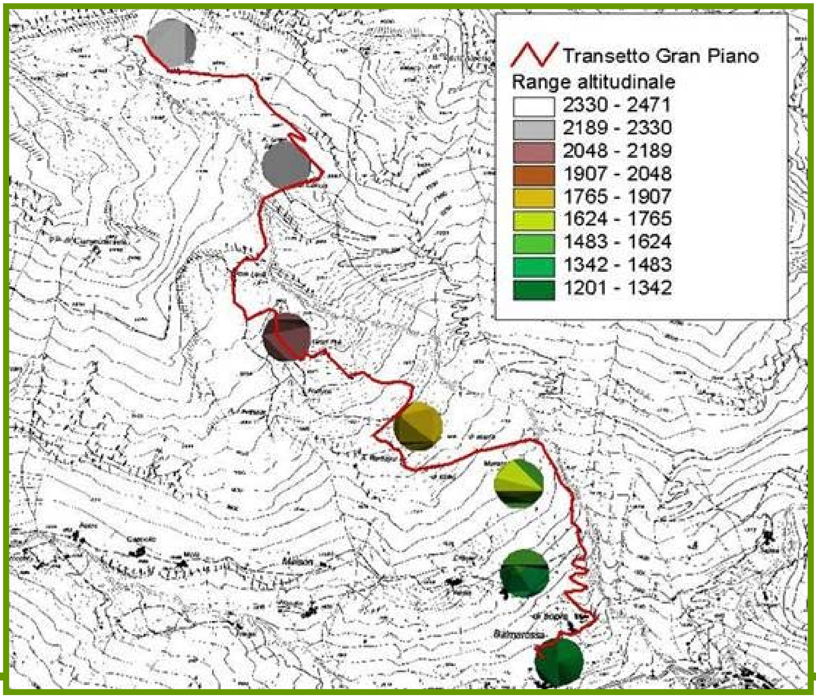
Butterflies:
- 5 samplings
- May-September

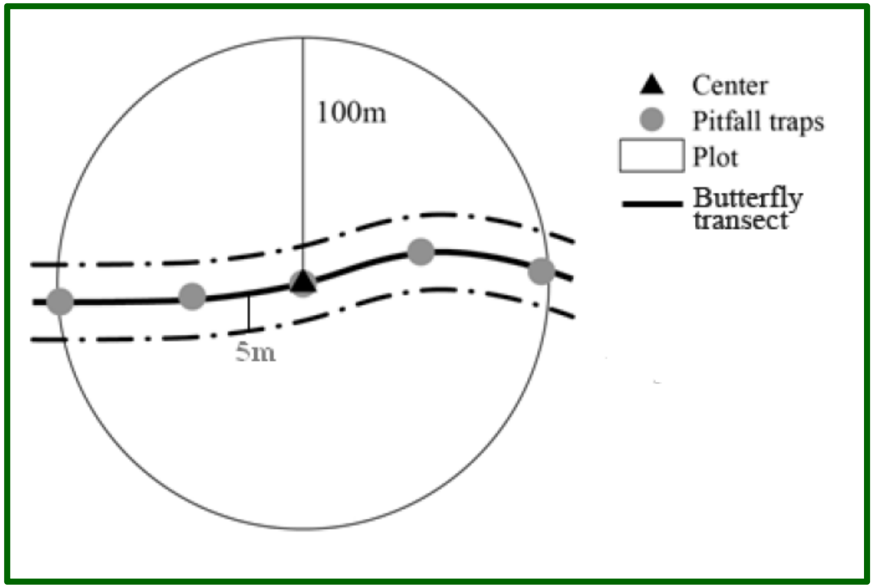
Grasshoppers:
- 3 samplings
- July-September



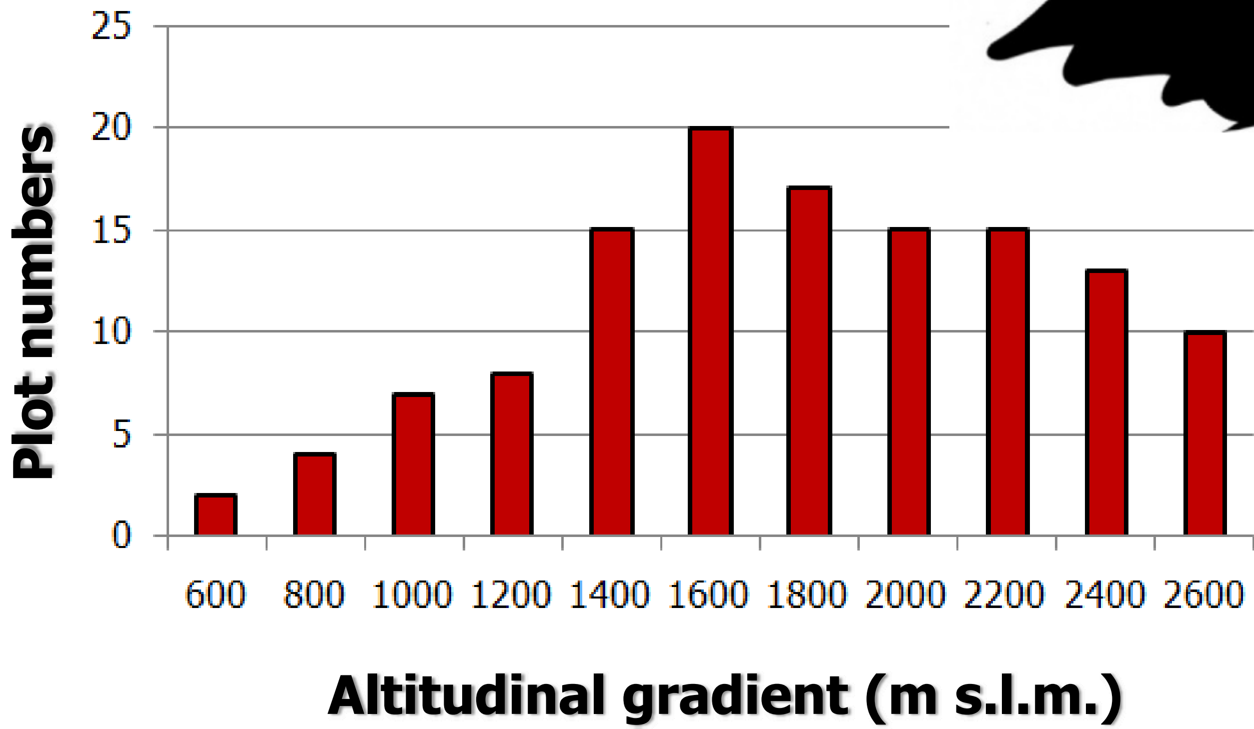
Sampling desing

- 6-7 plots per altitudinal transect (valley)
- altitudinal gradients: 600 - 2700 m
- altitudinal range between plots: 200 m



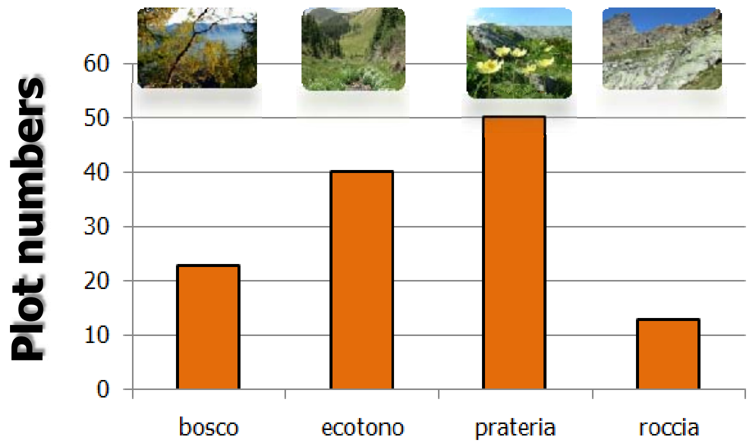


Altitudinal gradients: 600-2700 m

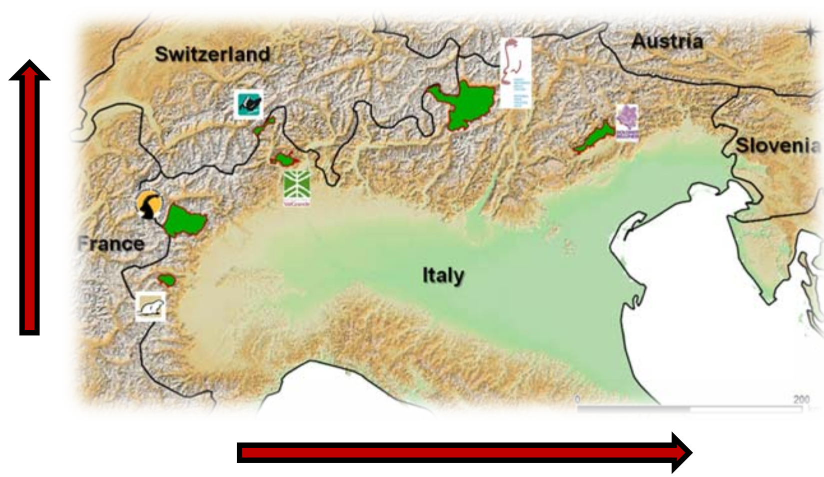


Sampling design

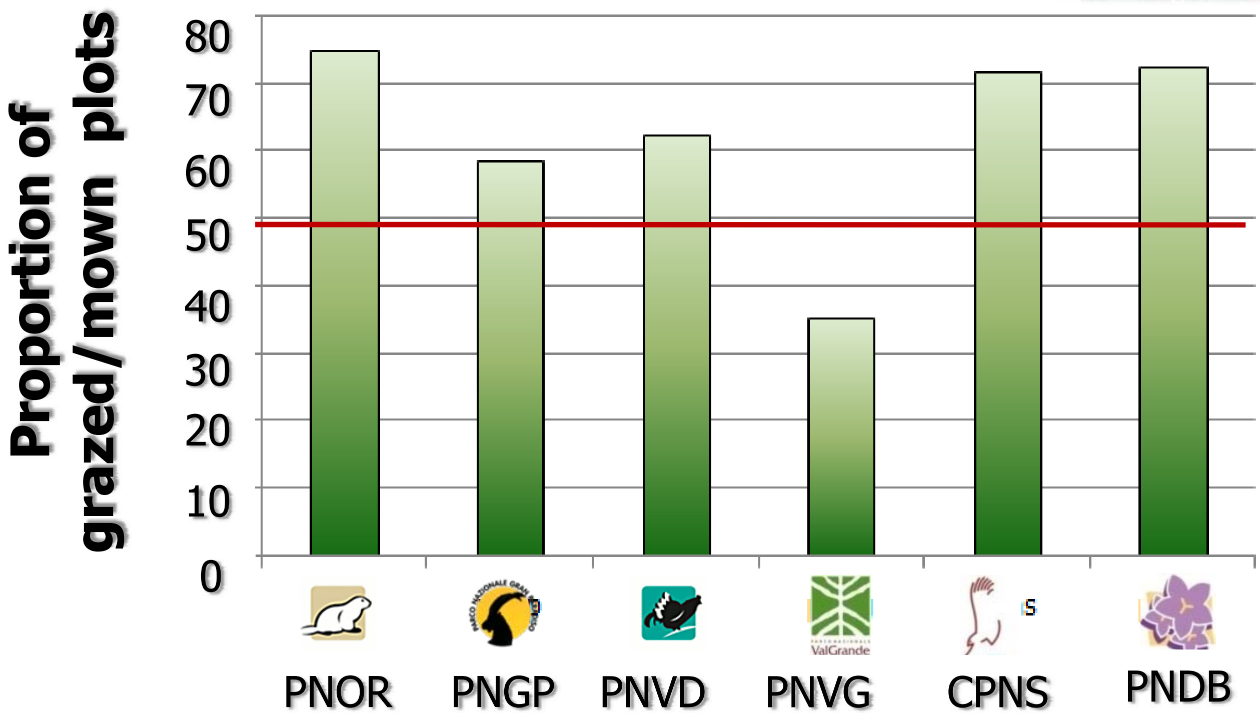
Dominant habitat: woodland, shrubland, grassland, rocky environments



Protected area: PNOR, PNGP, PNVD, PNVG, CPNS, PNDB



What about the anthropic impact?



Overall,

- grazed → 50.8%
- mown → 11.9%
- not managed → 37.3%

How do human activities interact with biodiversity in our study sites?

169 species

58% of the Italian fauna *(290 species, Balletto et al. 2014)*

65 species

19.5% of the Italian fauna *(333 species, Stoch 2003)*

80 species

16.9% of the Italian fauna *(333 species, Stoch 2003)*

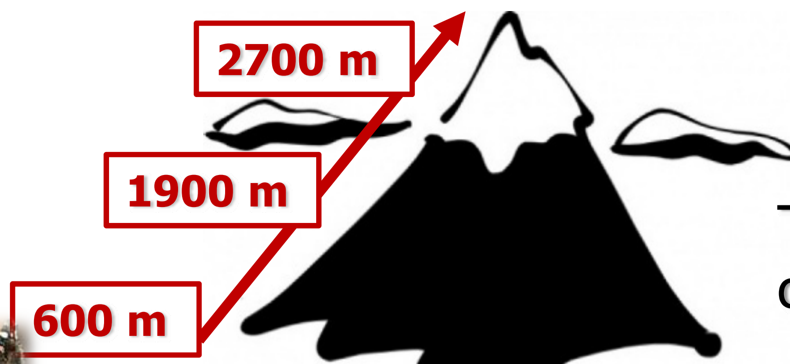
What variables influence species richness?

Species richness ~ Protected area

+ Elevation + Elevation^2

+ Dominant habitat

+ Grazing/Mowing



Temperature: highly correlated with elevation

$r_{Pearson} = -0.943$

Datalogger, DS1922L

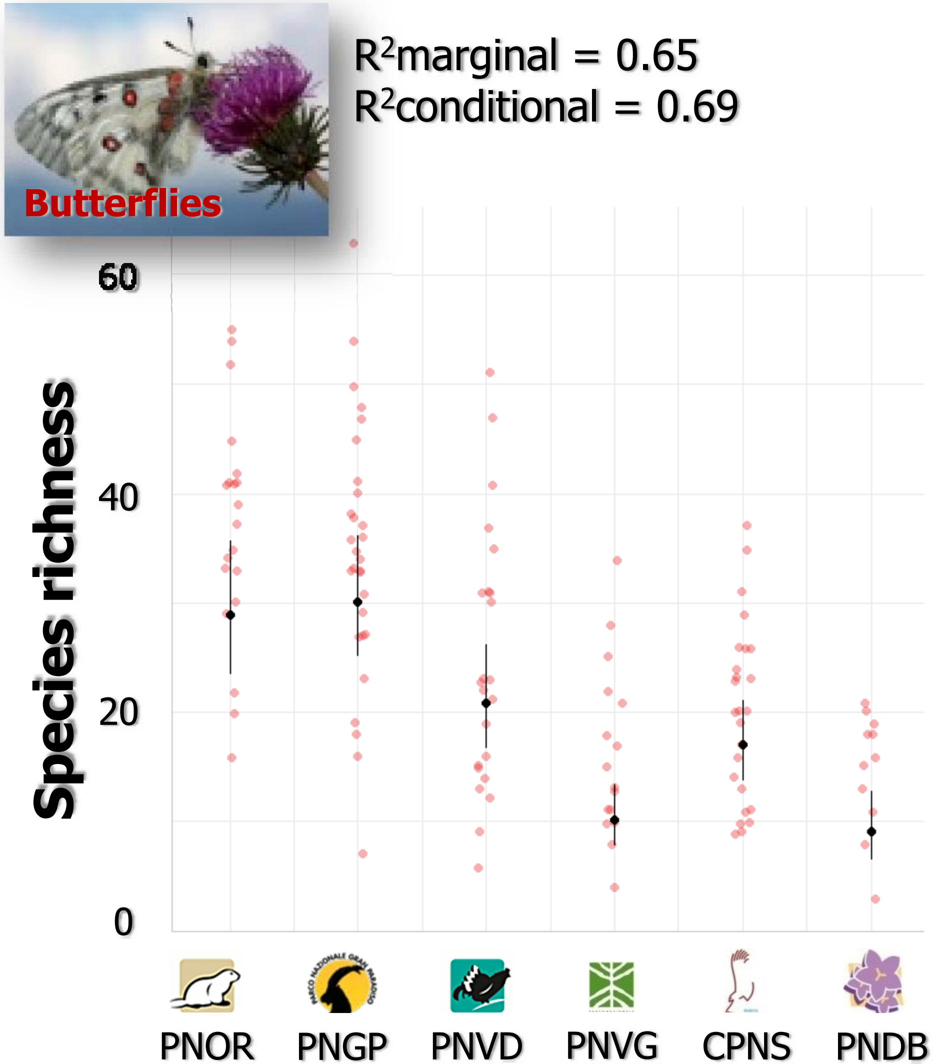
- data collected in 2012-2014
- 124 plots
- comparable samplign effort per plot

GLMM (Generalized linear mixed models), random factor “Valley” (Altitudinal transect)
Response variable distribution (Species richness): Negative binomial
Model selection through AICc
R Software; *glmmTMB*, *MuMIn*, *car* packages

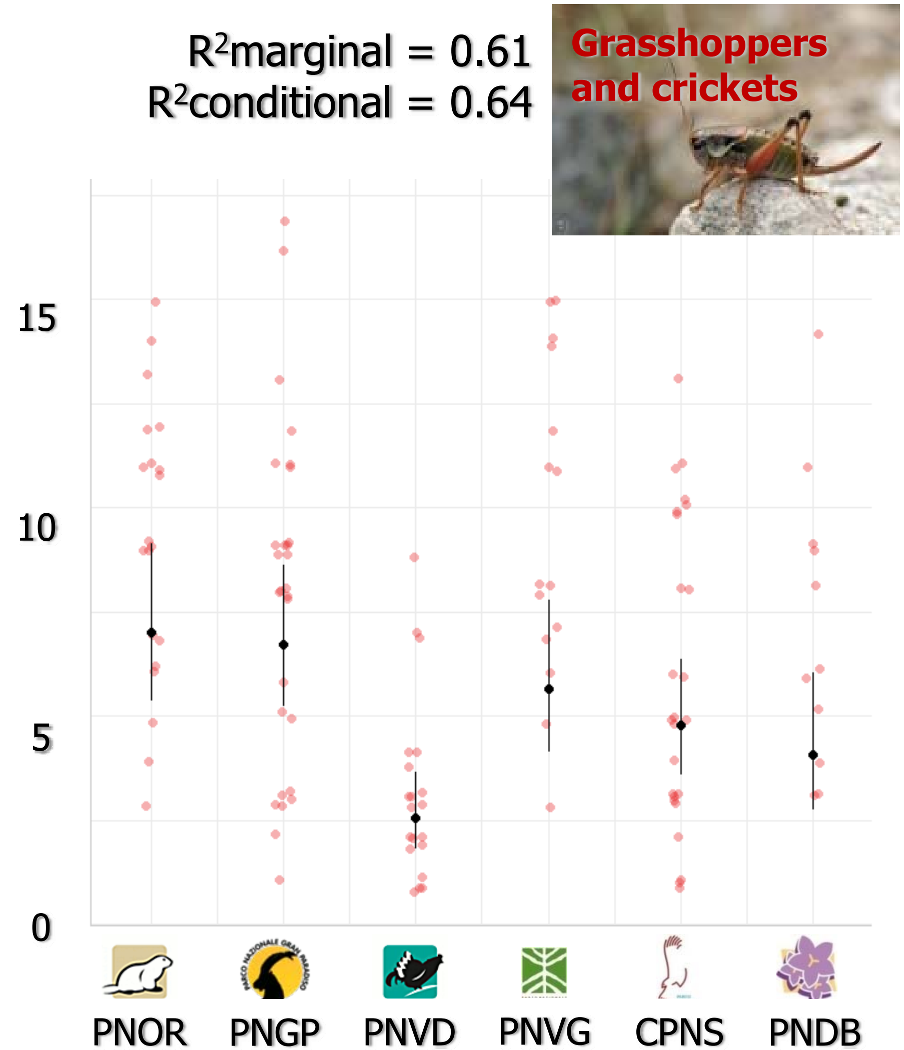
What variables influence species richness?

All considered variables significantly influence **species richness**

R^2marginal = 0.65
R^2conditional = 0.69



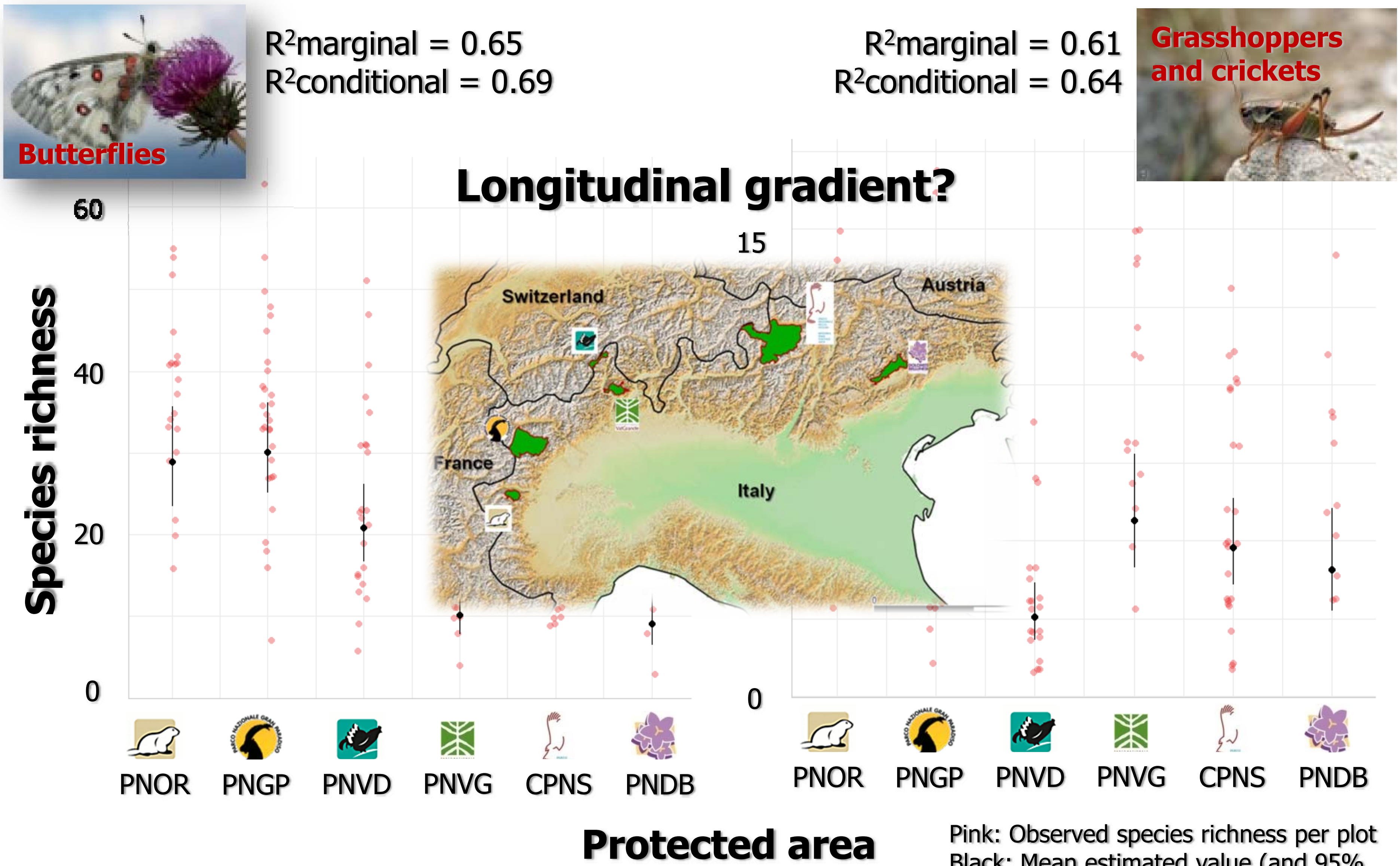
R^2marginal = 0.61
R^2conditional = 0.64



Protected area

Pink: Observed species richness per plot
Black: Mean estimated value (and 95% confidence interval)

What variables influence species richness?



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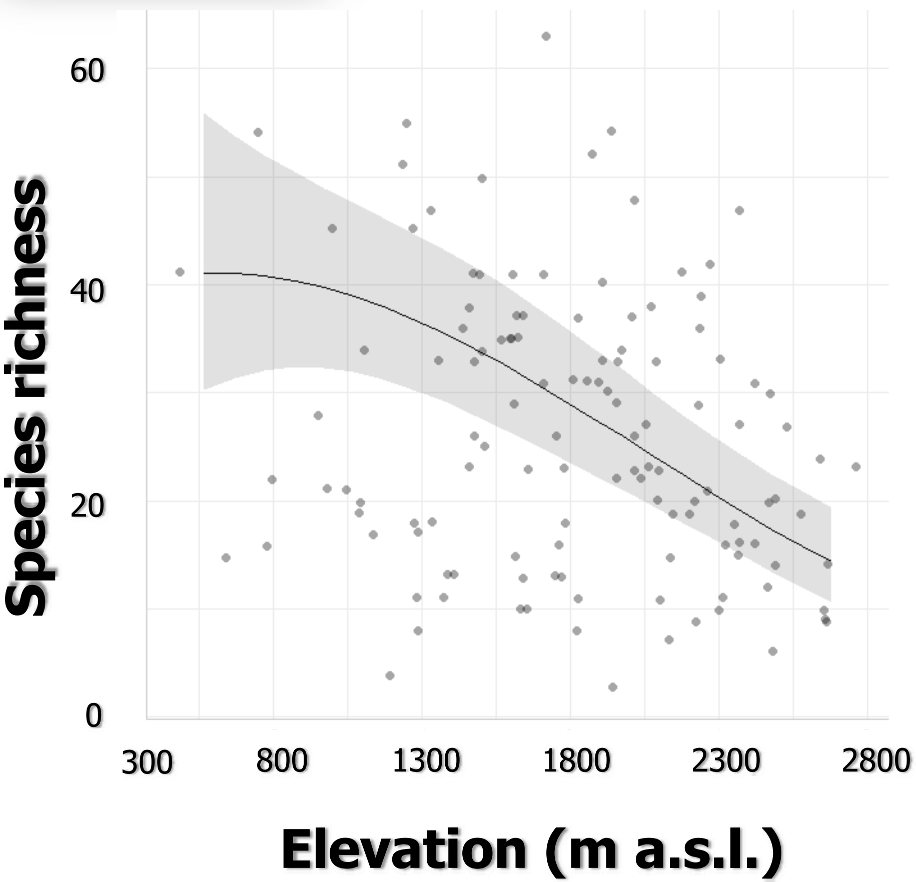
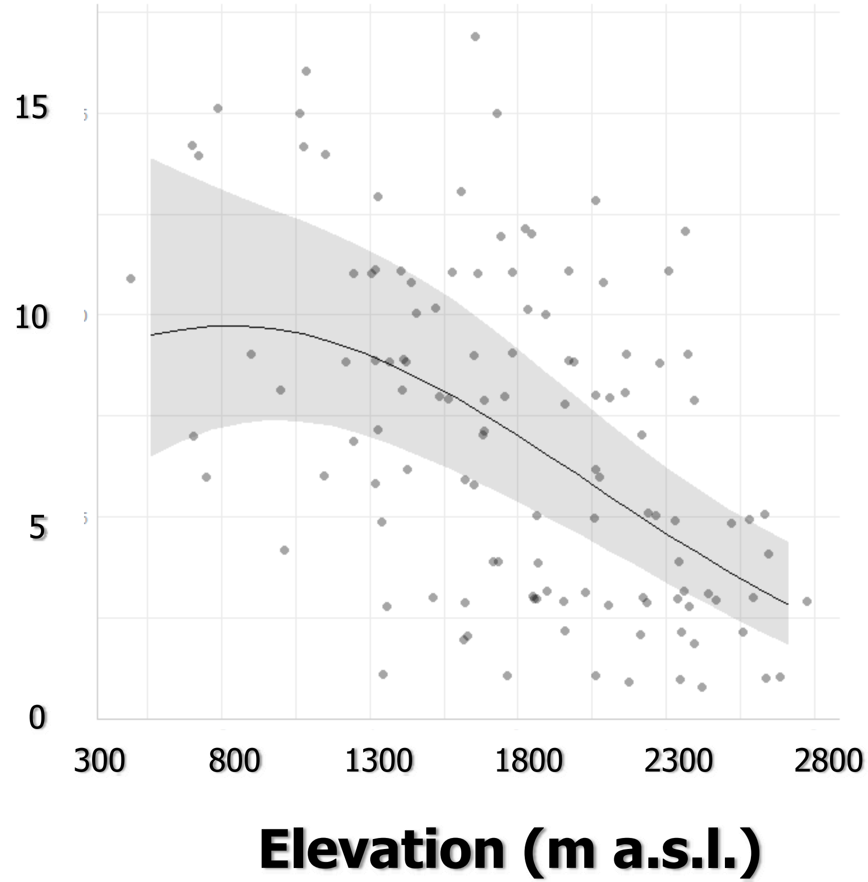
What variables influence species richness?

Altitudinal gradient



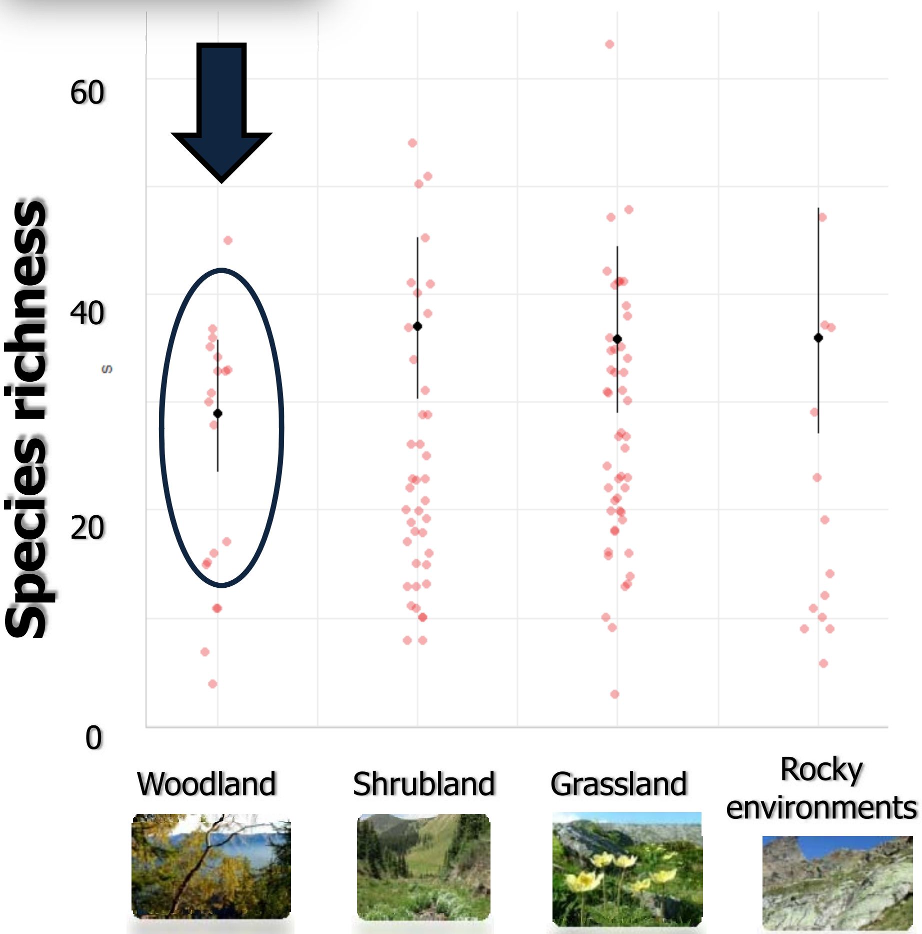


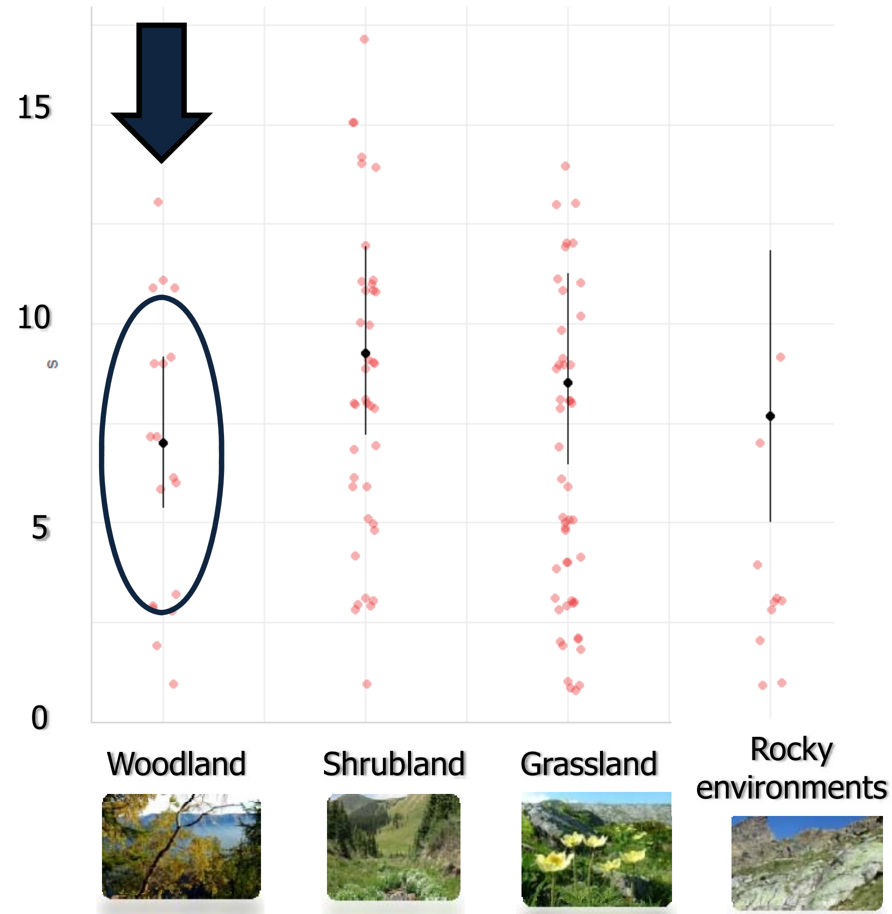
Data variability
(partly captured by the random factor)

What variables influence species richness?

Dominant habitat

Weaker signal
Variability in the data
Overlapping confindence intervals





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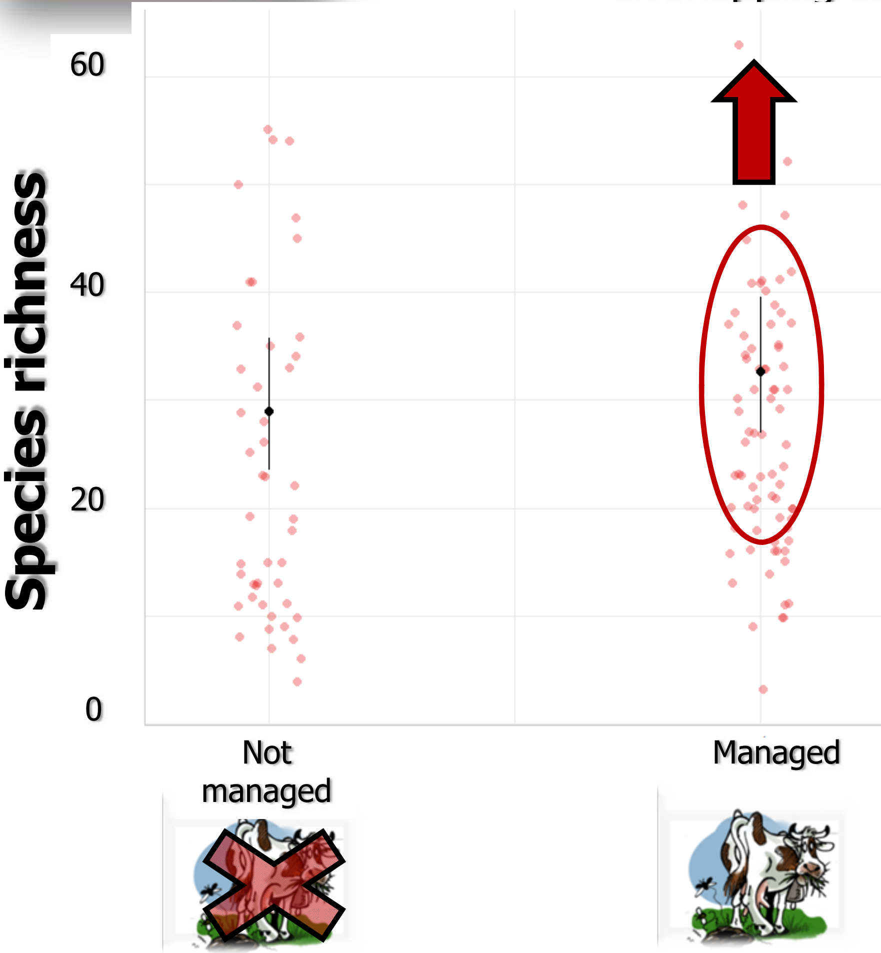
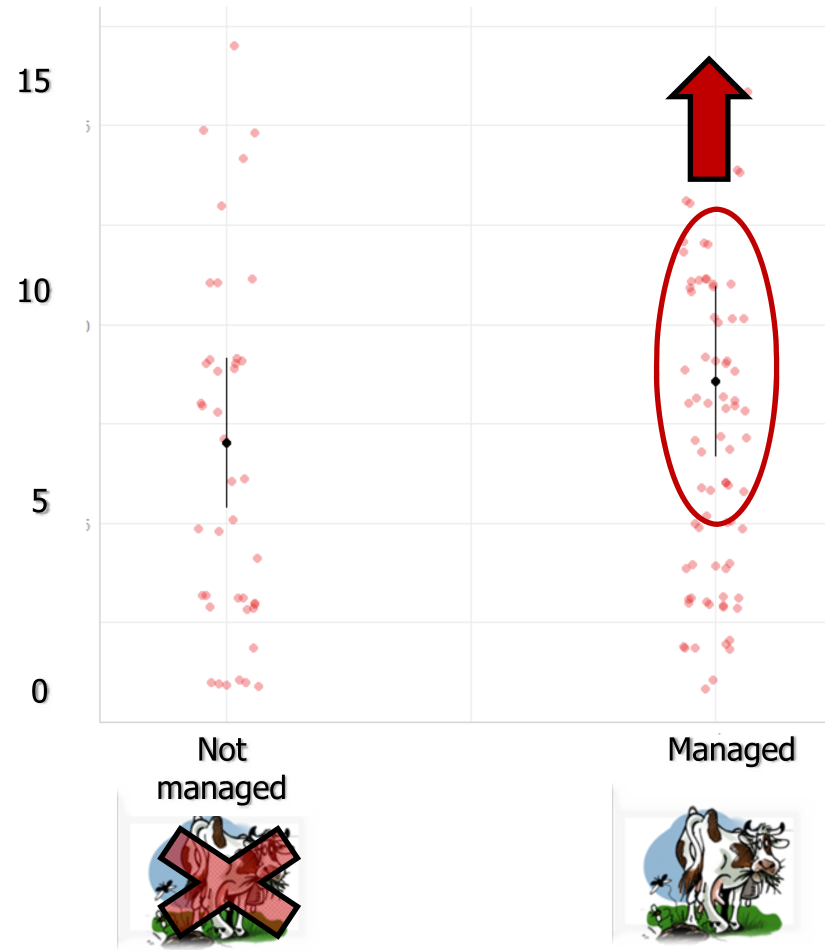
What variables influence species richness?

Management

Weaker signal
Variability in the data
Overlapping confindence intervals





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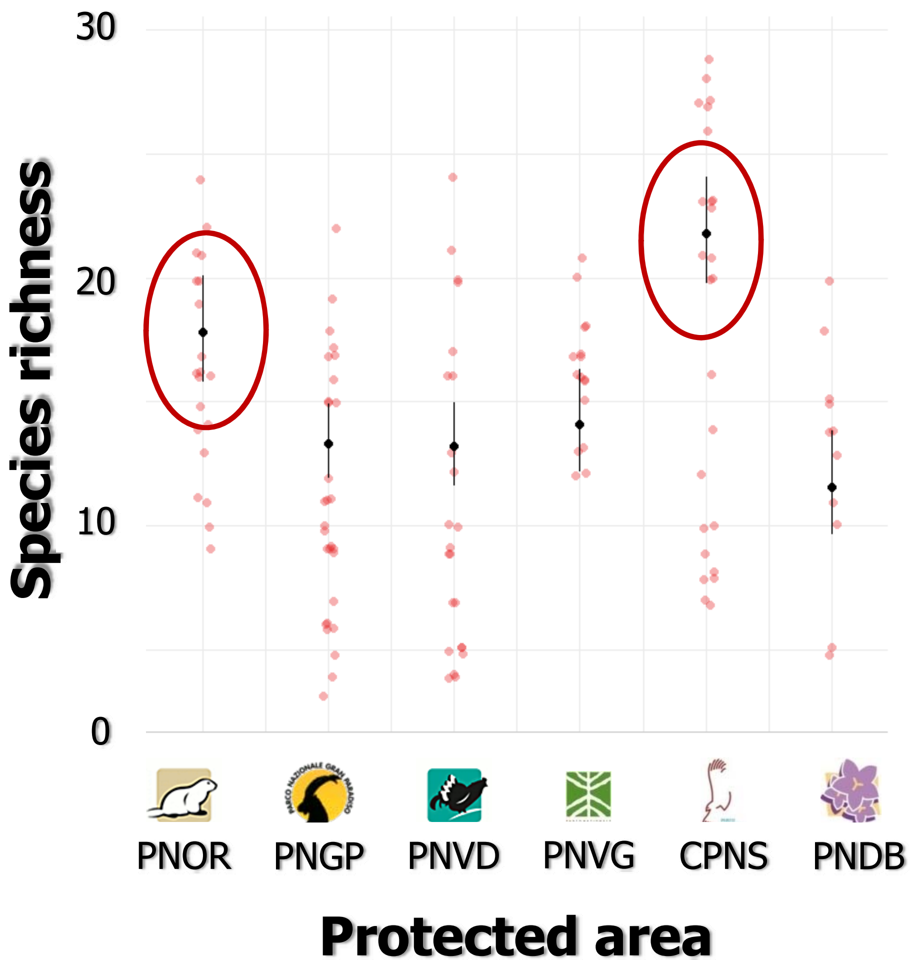

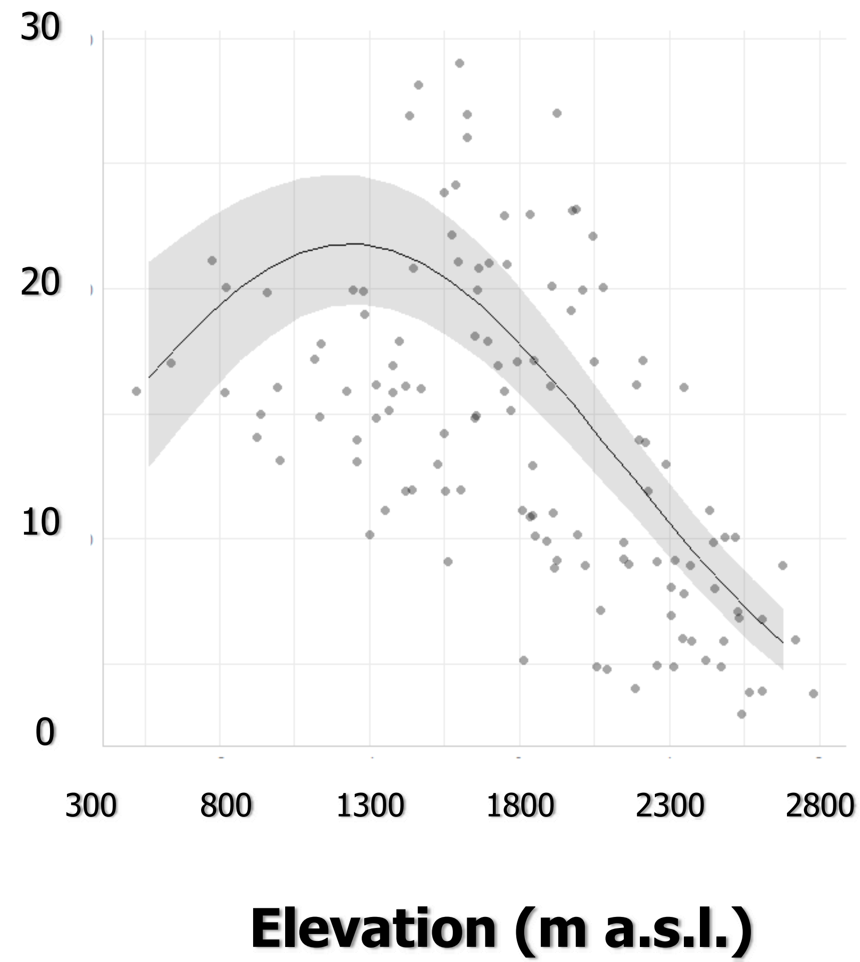

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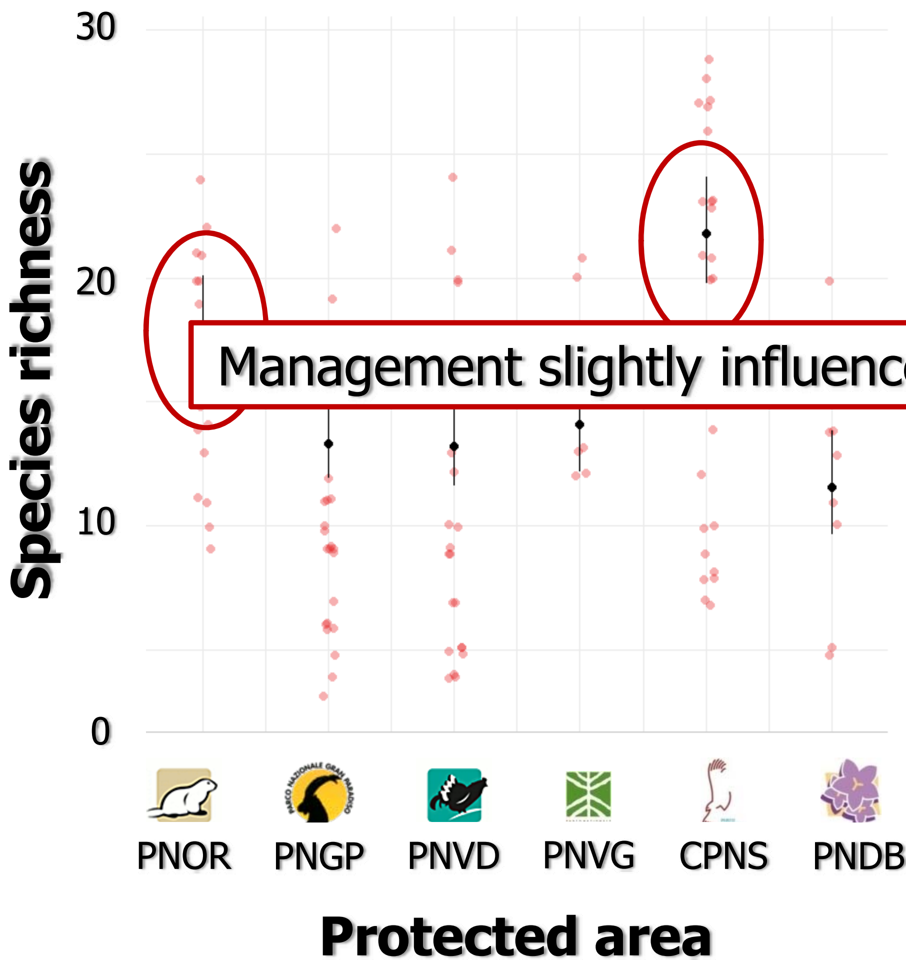

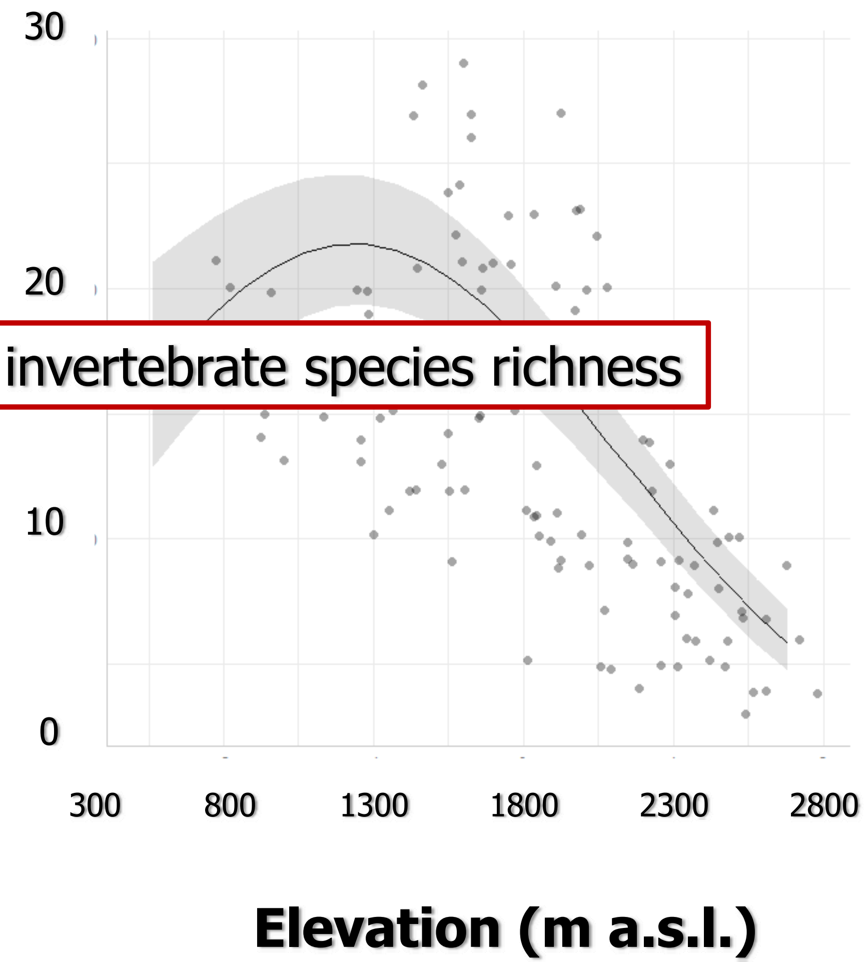

Management slightly influences invertebrate species richness

Pink: Observed species richness per plot
Black: Mean estimated value (and 95% confidence interval)

What happens to community composition?

Variation partitioning has been used to quantify the proportion due to different variables

Altitude
Climate - summer mean plot temperature
Habitat
Management - manged/not managed)
Spatial component - modeled using Moran's Eigenvector Maps, from transect centroid (MEM.valley) and park centroid coordinates (MEM.park)

Distance-based RDA
Software R, *rda.cca, spdep* packages

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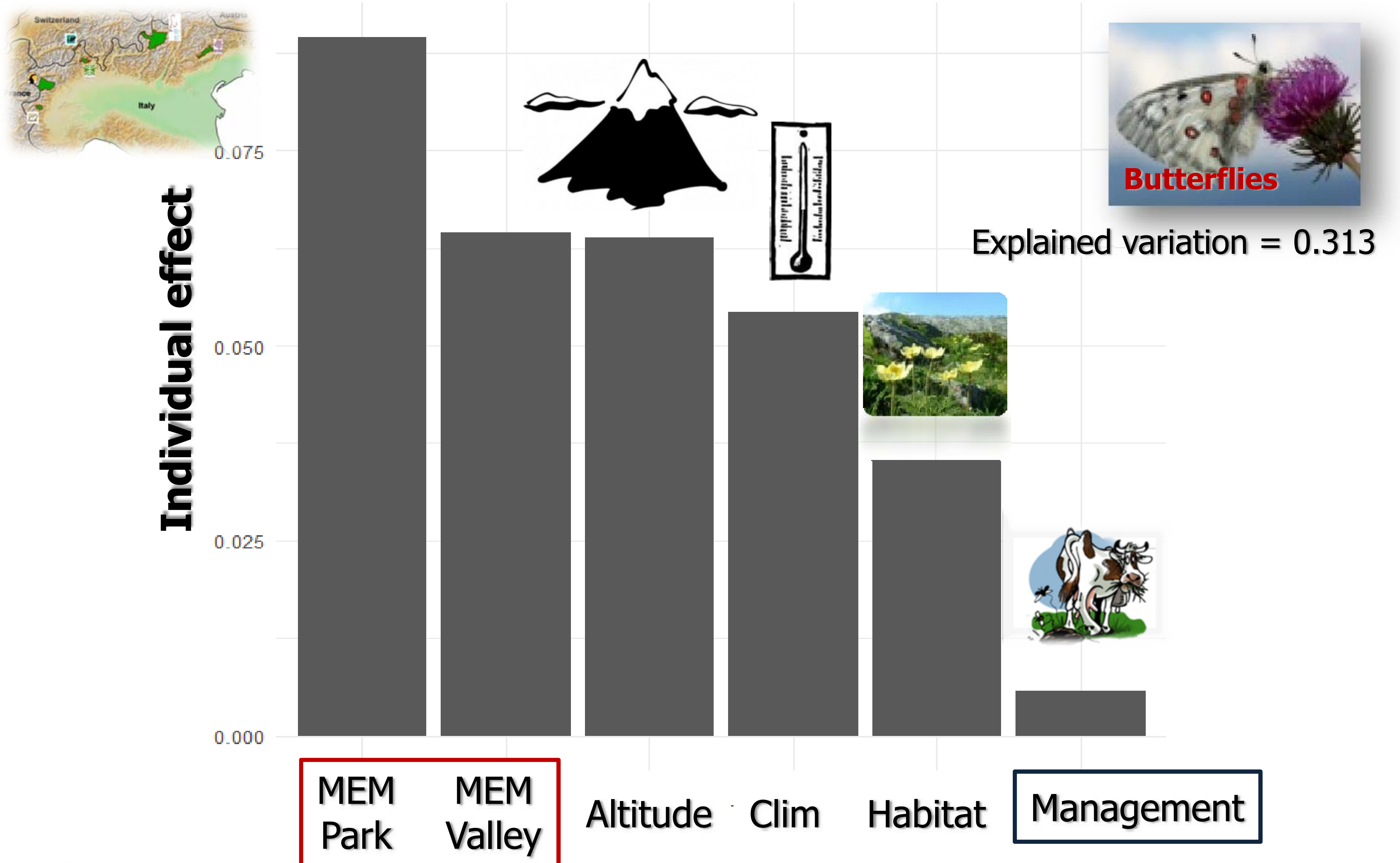

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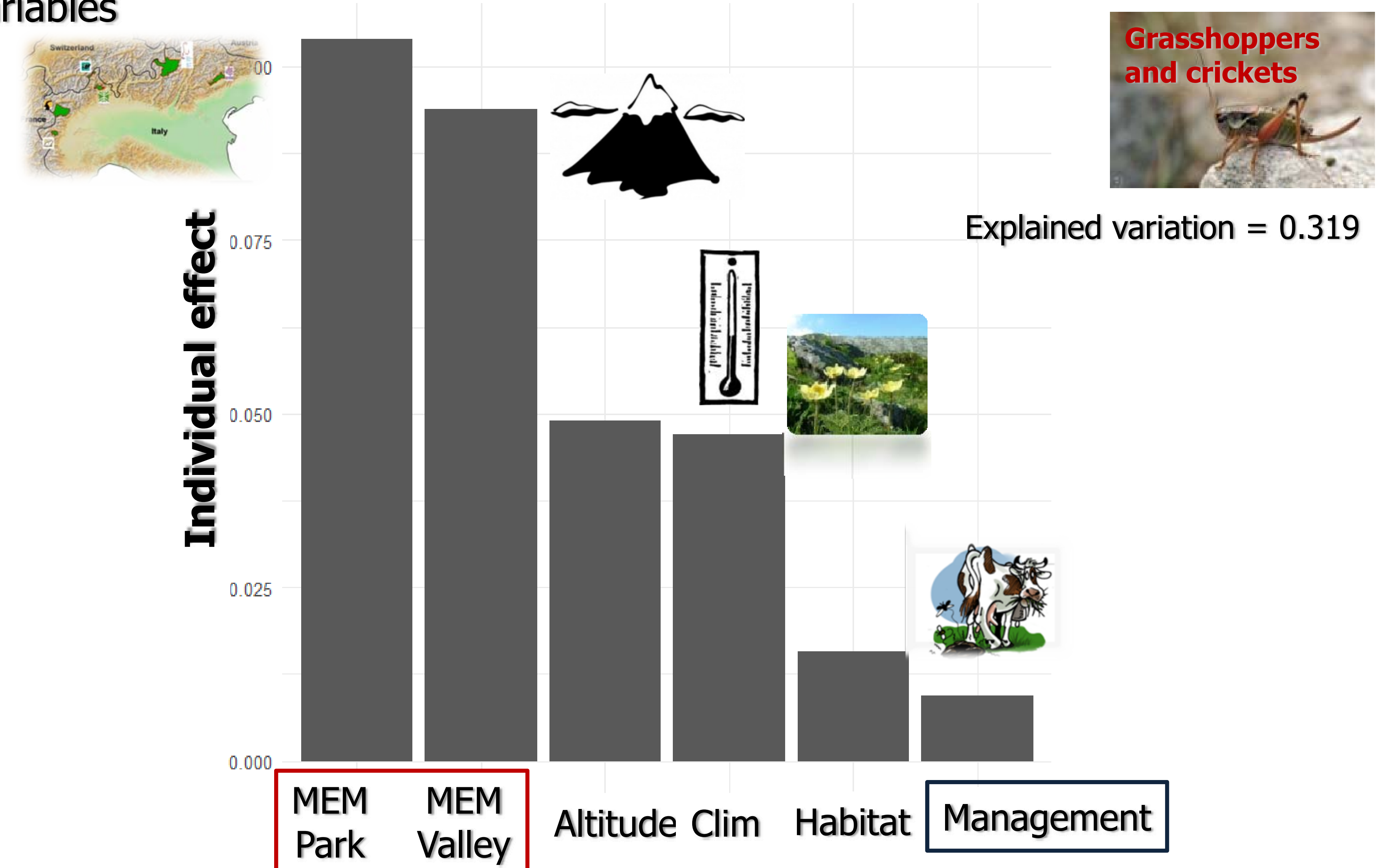

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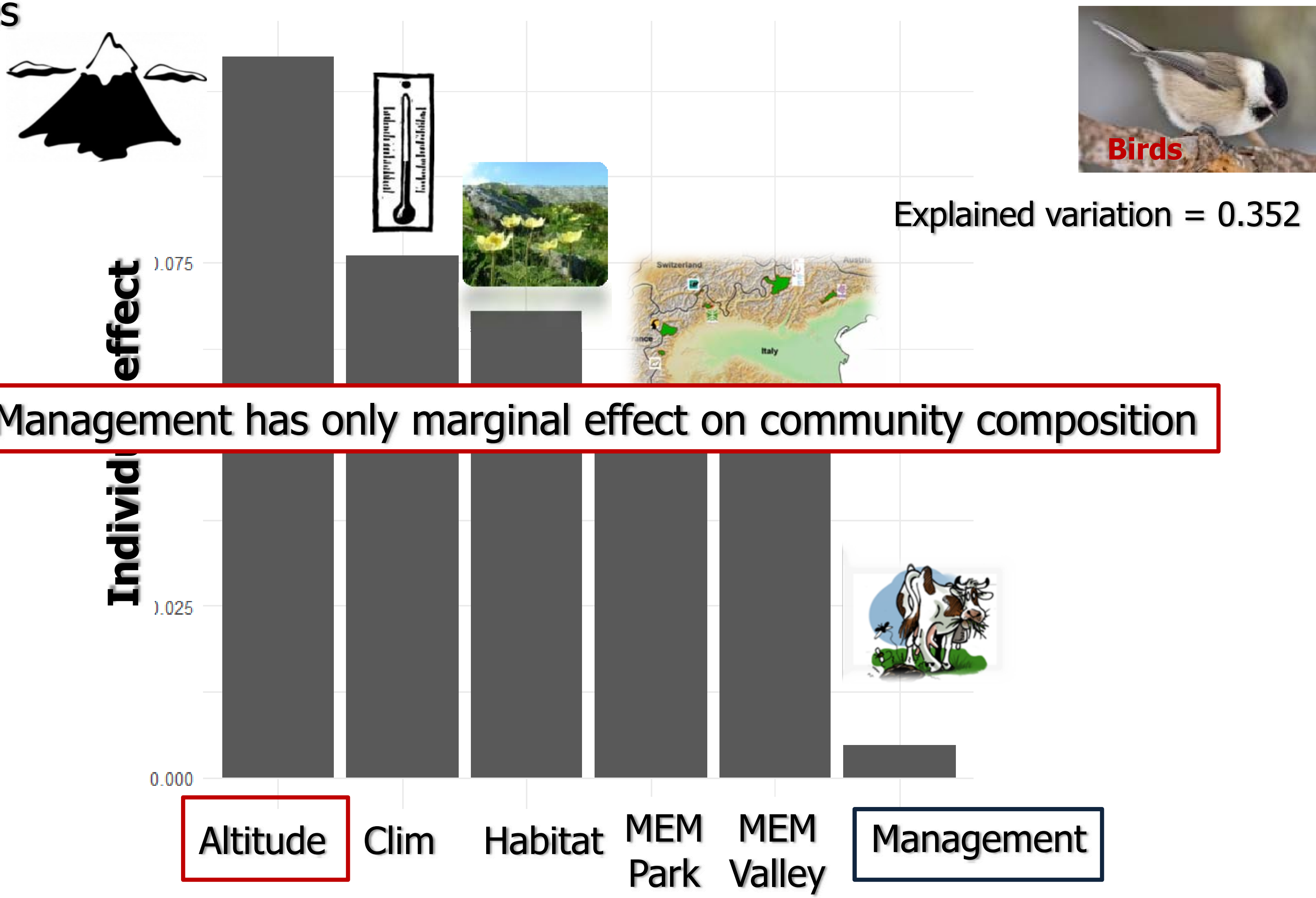
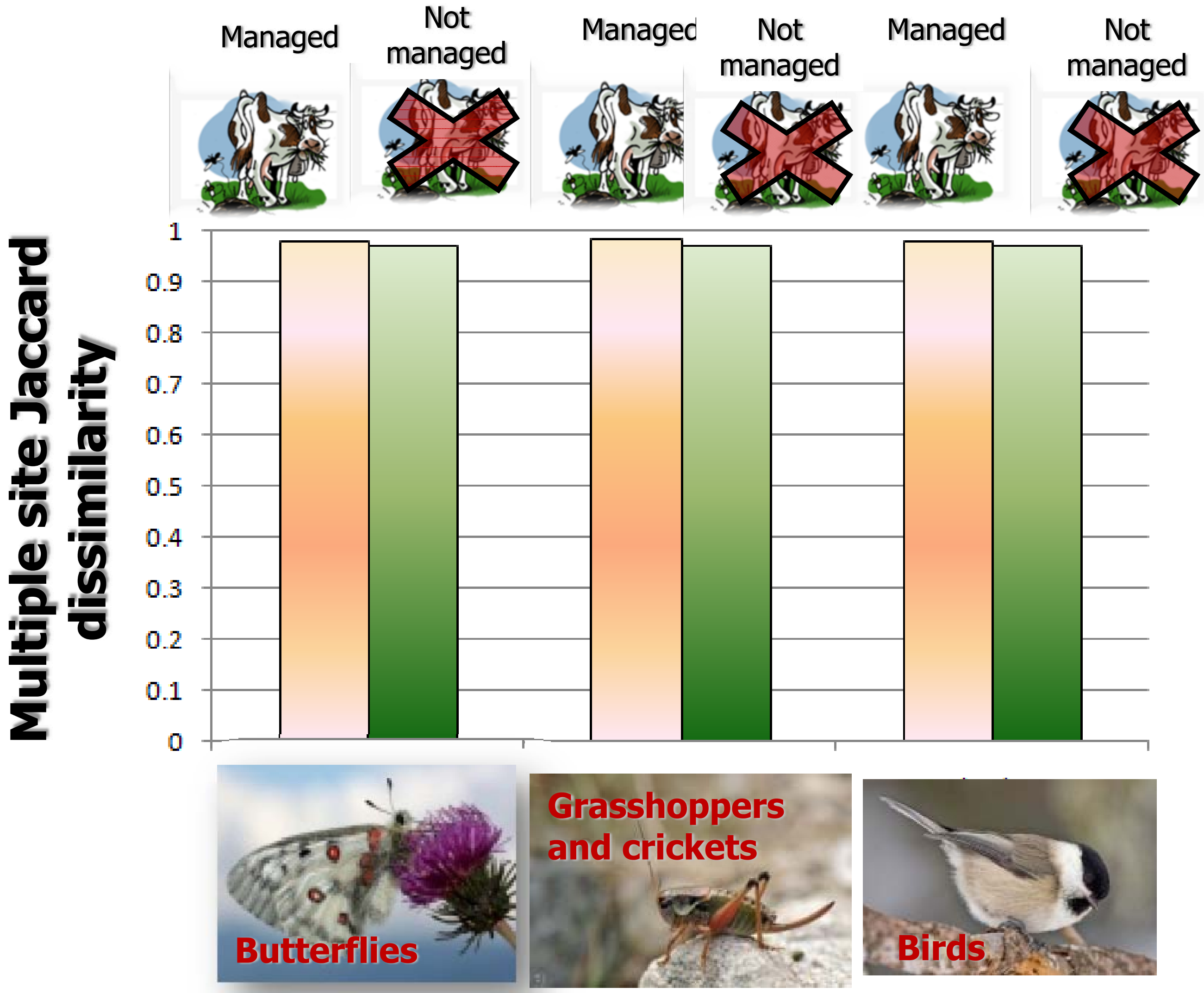


Distance-based RDA
Software R, *rda.cca, spdep* packages

What happens to community composition?

We compared multiple site dissimilarity among managed and not managed plots



Multiple site Jaccard dissimilarity
Software R, *betapart* package

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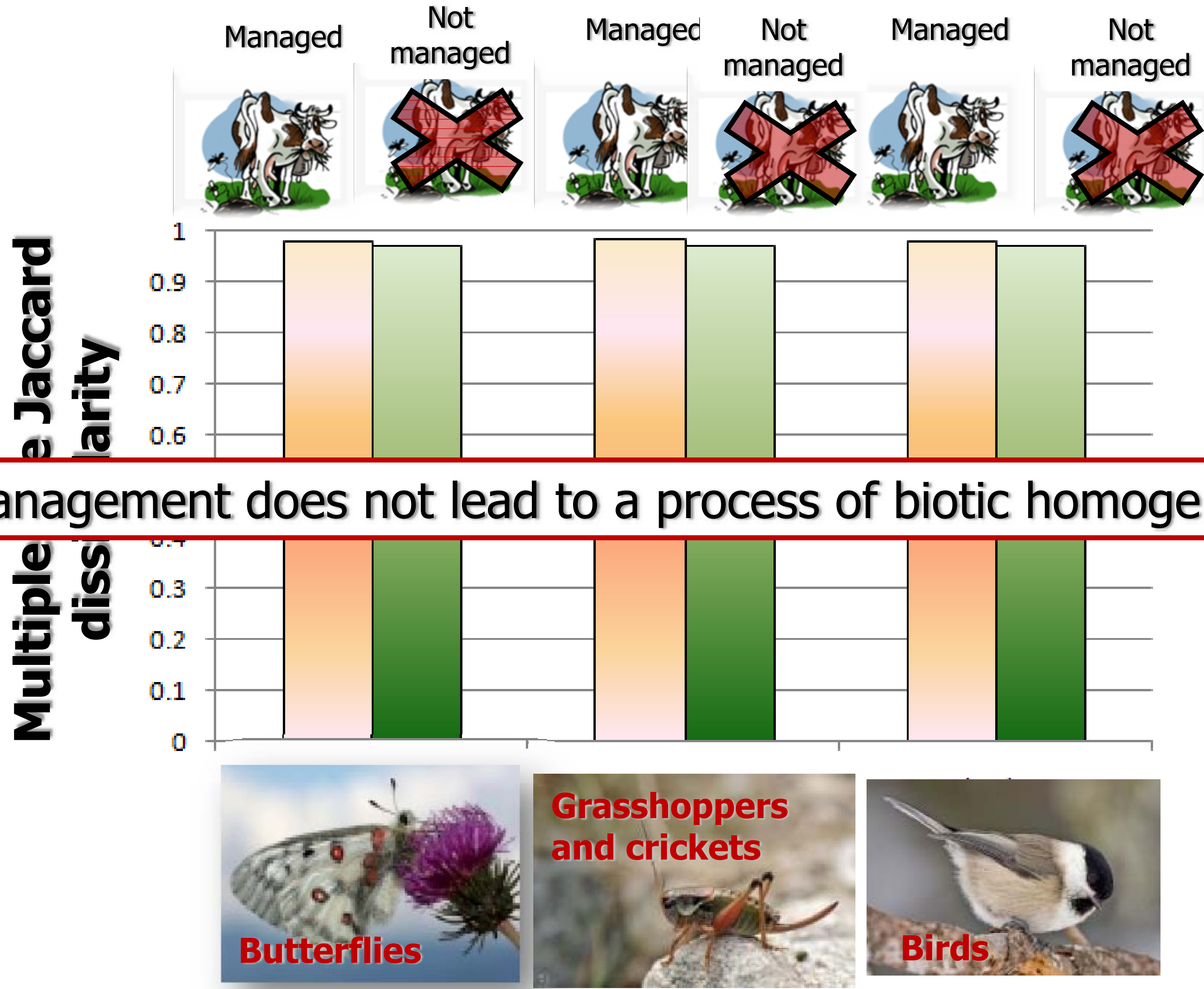


Management does not lead to a process of biotic homogenization

Multiple Site Spatial Dissimilarity (Jaccard index)
CI through 1000 simulations of 50 sites
Software R; *betapart* package

But is anything changing over time?

Has species richness changed over time?

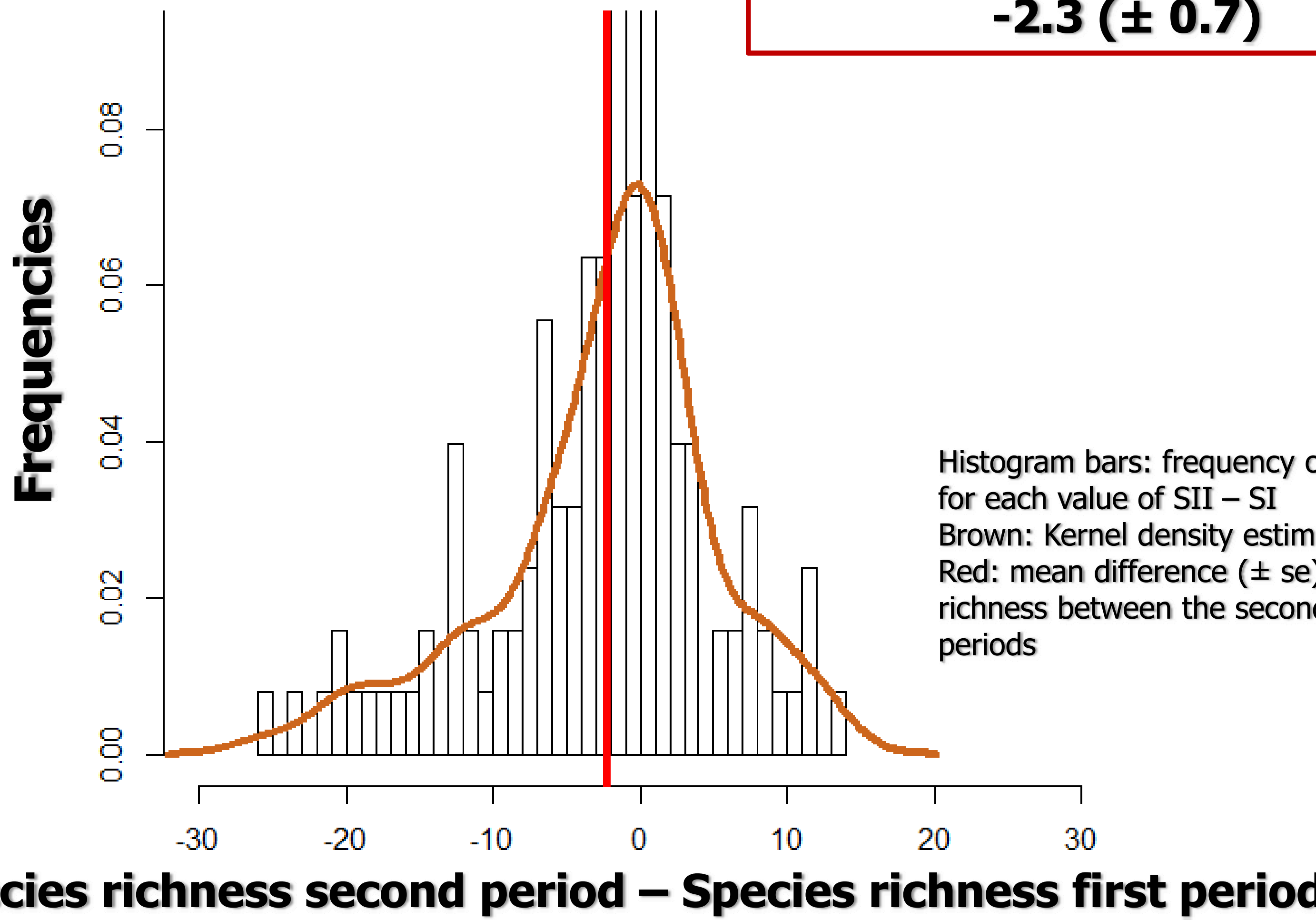
2012-2014 *vs.* 2018-2019

Small, but significant decrease

Paired t-test, 126 plots, 999 permutations

$t = -3.36$, $p = 0.003$

Mean difference (± se) between second and first time period = **-2.3 (± 0.7)**



Histogram bars: frequency of observations for each value of SII – SI

Brown: Kernel density estimate

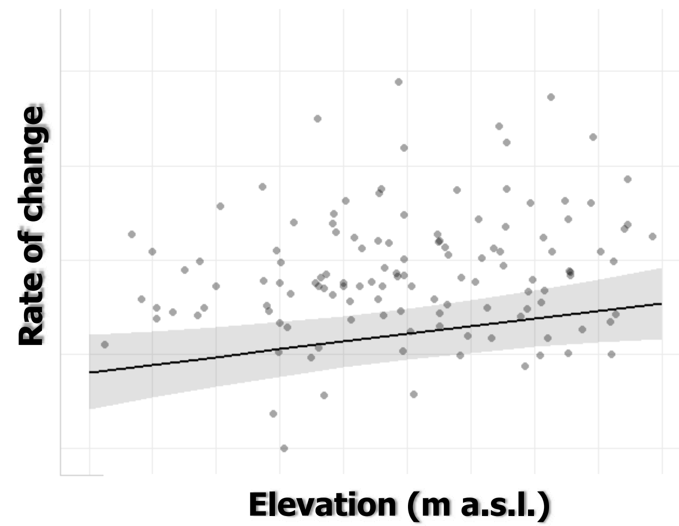
Red: mean difference (± se) of species richness between the second and first two periods

Is it possible to observe a pattern in the rate of change?

Rate of change =
(Species richness first period – Species richness second period) /
Species richness first period

Rate of change ~
Protected area + Elevation + Elevation^2 + Dominant habitat +
Temperature change + Management

R^2marginal = 0.35
R^2conditional = 0.40



LMM (Linear Mixed Models), random factor "Valley" (Altitudinal transect)
Model selection through AICc
Software R; *MuMIn*, *car* packages

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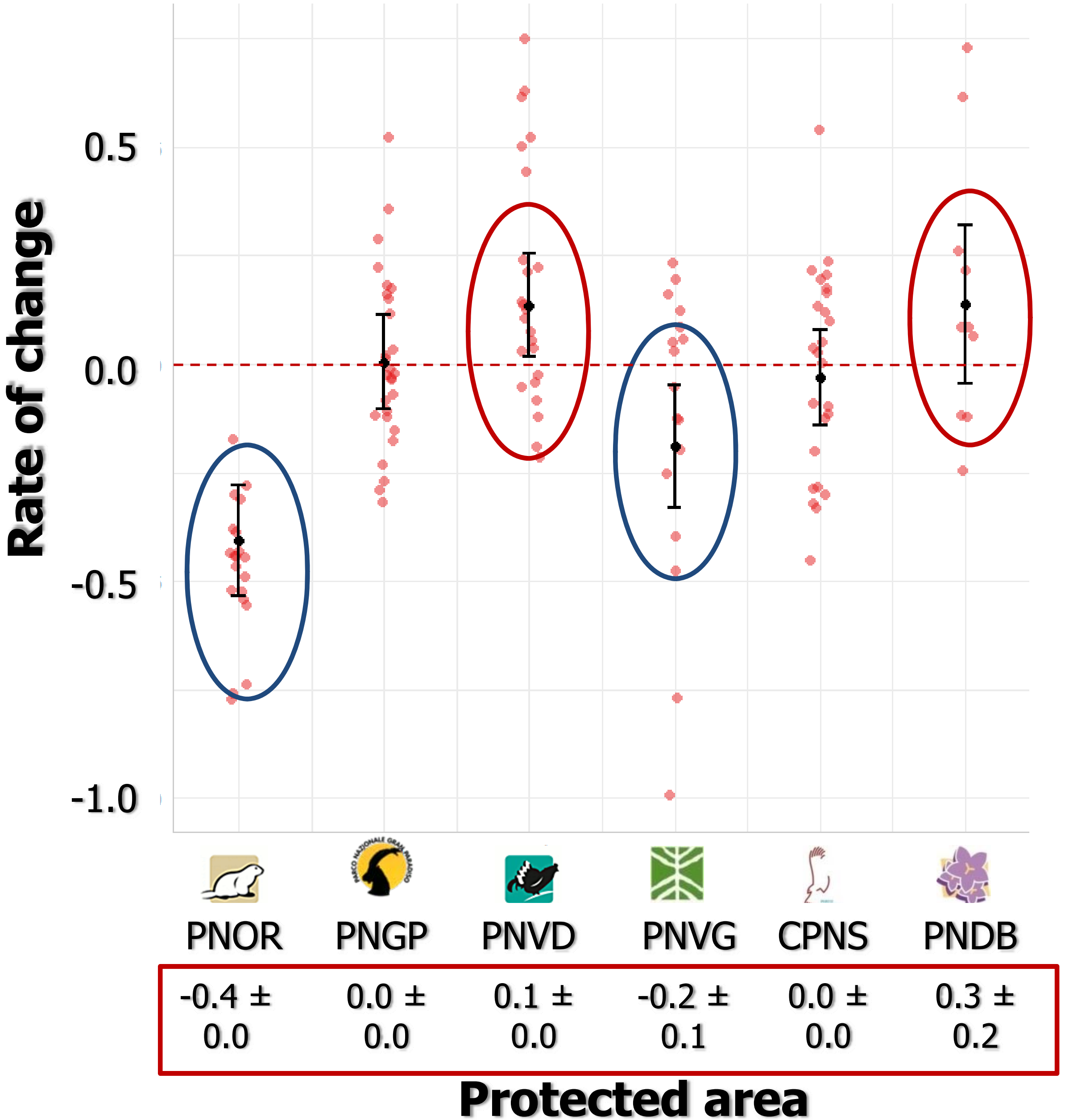


Species are not all the same....

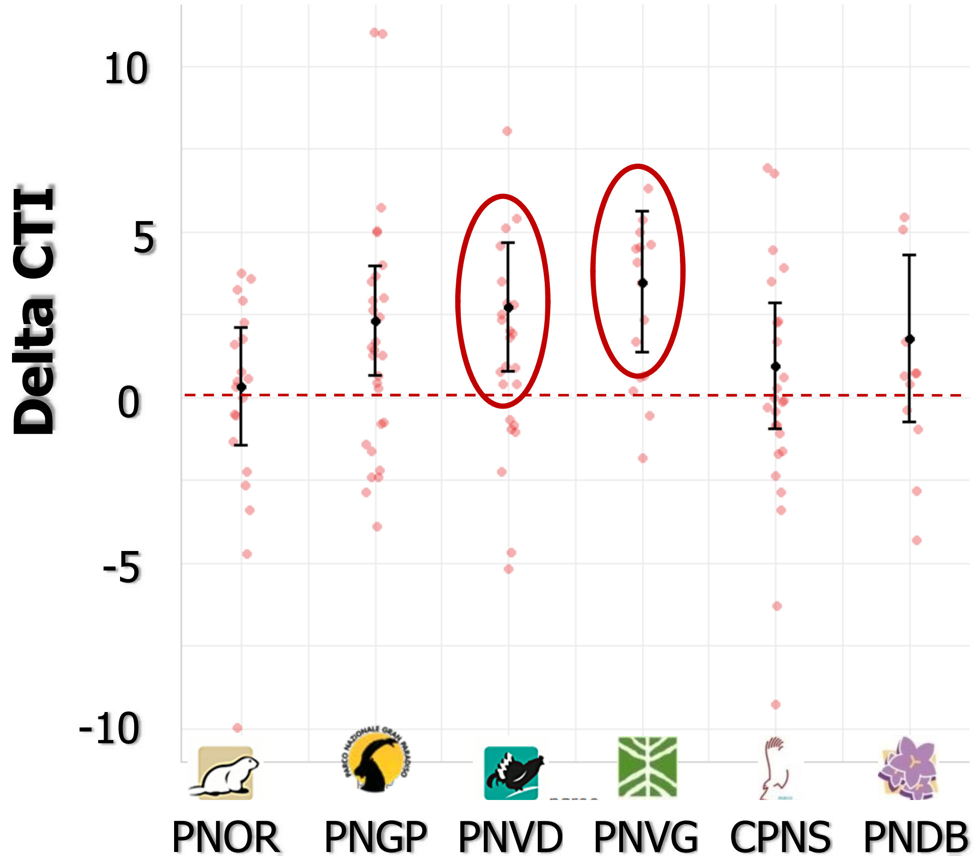
Community Temperature Index

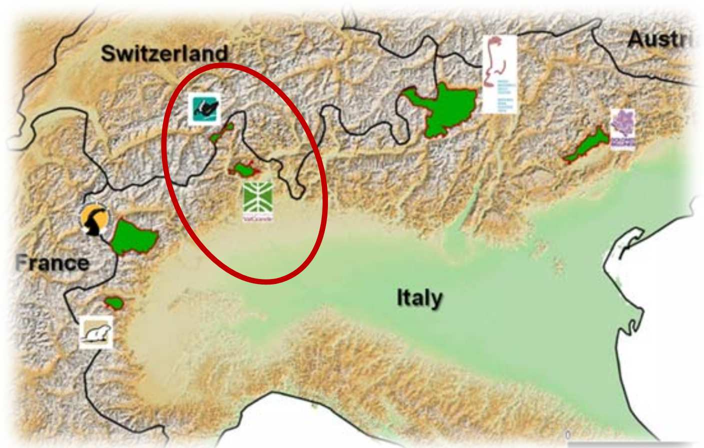
- ***Community Temperature Index (CTI)*** significantly **increased**

Paired t-test, 126 plots, 999 permutations; t = -3.36, p = 0.003

- The ***change*** is mainly related to the ***geographic position of the plots***

R^2 marginal=0.13, R^2 conditional=0.13; Protected area, p=0.029





Species Temperature Index obtained from the species distribution in the Alpine biogeographical region on a 10x10 km grid (CkMap Project; Balletto *et al.* 2007)

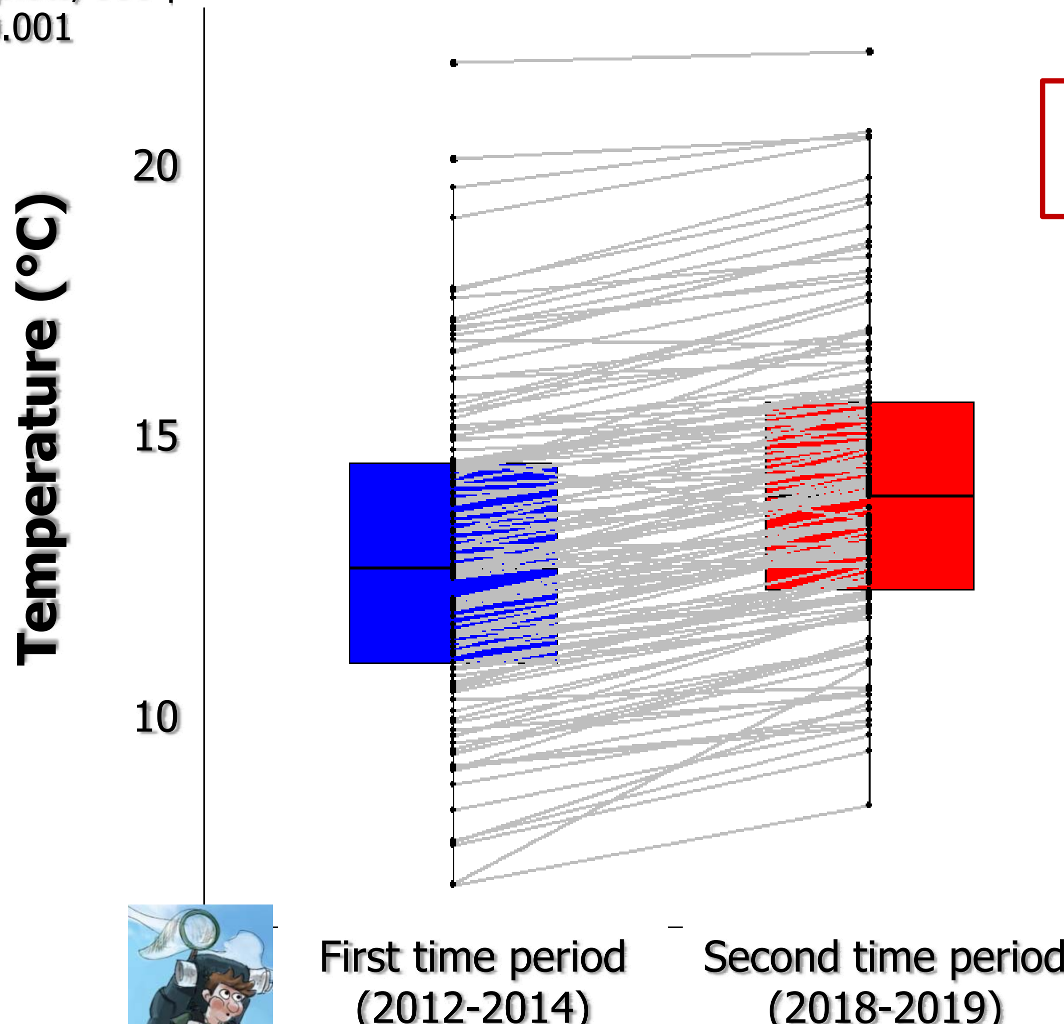
North Italy *Temperature data* from EuroLST dataset (Metz *et al.* 2014)

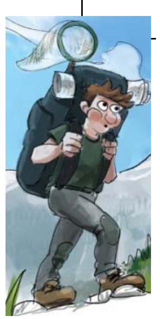
Analysis of changes in Community Temperature Index: LMM, Model selection through AICc

Has anything else changed over time?

Significant summer temperature increase

Paired t-test, 130 plots, 999 permutations
t = -22.354, p = 0.001





Mean increase =
+1.3 °C

Field data (July-September)
Datalogger, DS1922L

...so what?

• Biodiversity is characterised by complex and dynamic interactions, often difficult to fully understand in the short term

• Grazing (followed by mowing) is a widespread presence in Alpine protected areas

• In our study sites, grazing is not negatively impacting biodiversity, supporting heterogeneous communities
Grazing is obviously not the main force, but it influences the composition of communities and the species present - even when extensive and low impact (as in our case)
So it has strong potential to modify cenoses!

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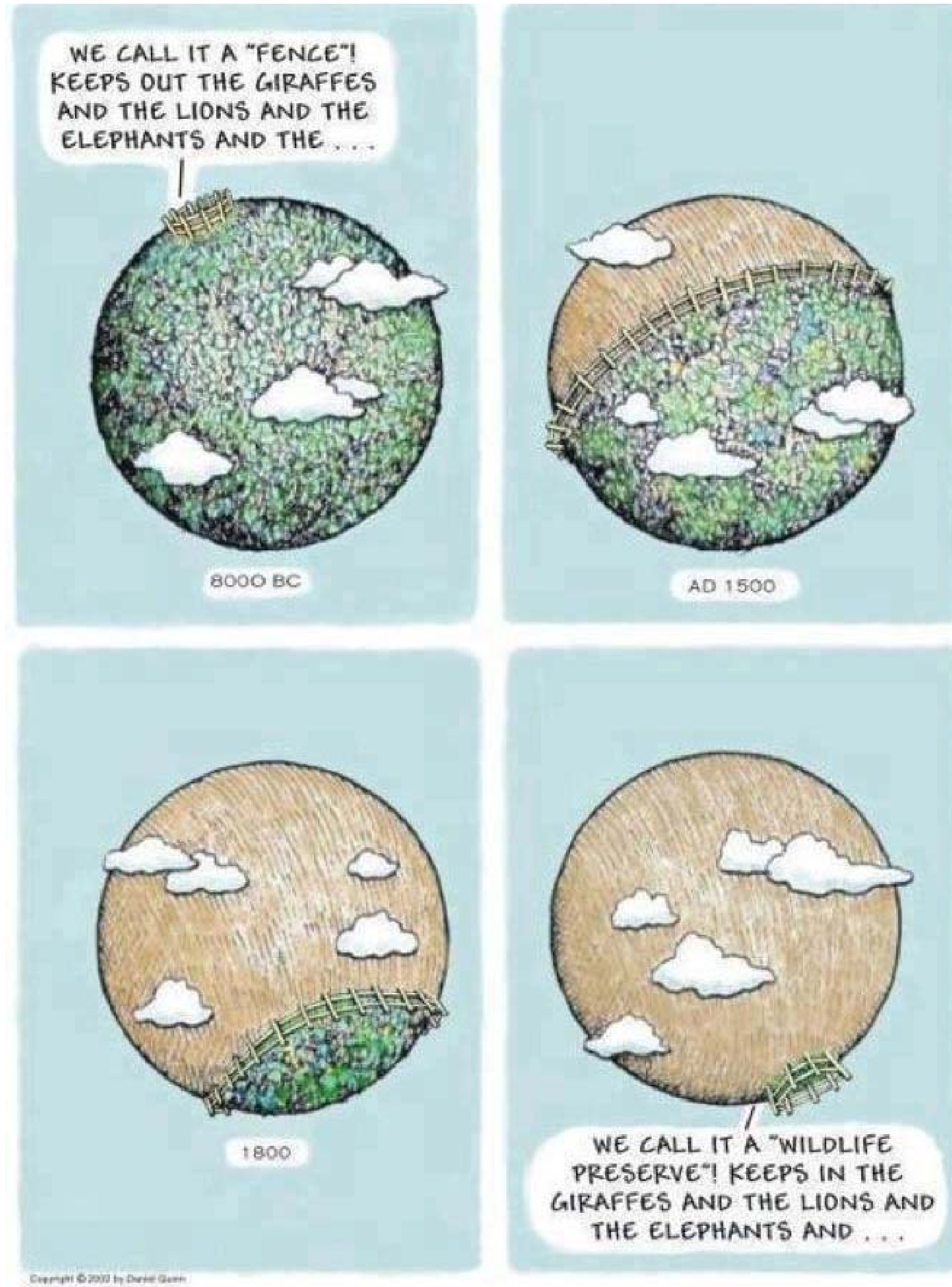
So it has strong potential to modify cenoses!

• Biodiversity is under pressure…rapid changes to which organisms are already responding

• Take into account biodiversity needs when introducing further changes, even in the traditional grazing system
(e.g. earlier grazing period, search for new grazing areas, …)

• Actions should be calibrated (*also at local scale*), considering the potential effects on wild communities, especially in protected areas

The Fence



Thanks for your attention!