Measurements of biodiversity in NW Italian Alps

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Ceresole reale, 10 settembre 2014

A multi taxa approach to assess pattern of congruence and diversity

To set the basis for the development of a long term monitoring scheme, focused on multi-taxa community data

2007-2008

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2007-2008 — **4 yrs stop** — **2012-2013**

A multi taxa approach to assess pattern of congruence and diversity

To set the basis for the development of a long term monitoring scheme, focused on multi-taxa community data

2007-2008 — 4 yrs stop — 2012-2013 — 4 yrs stop — ……

Objectives

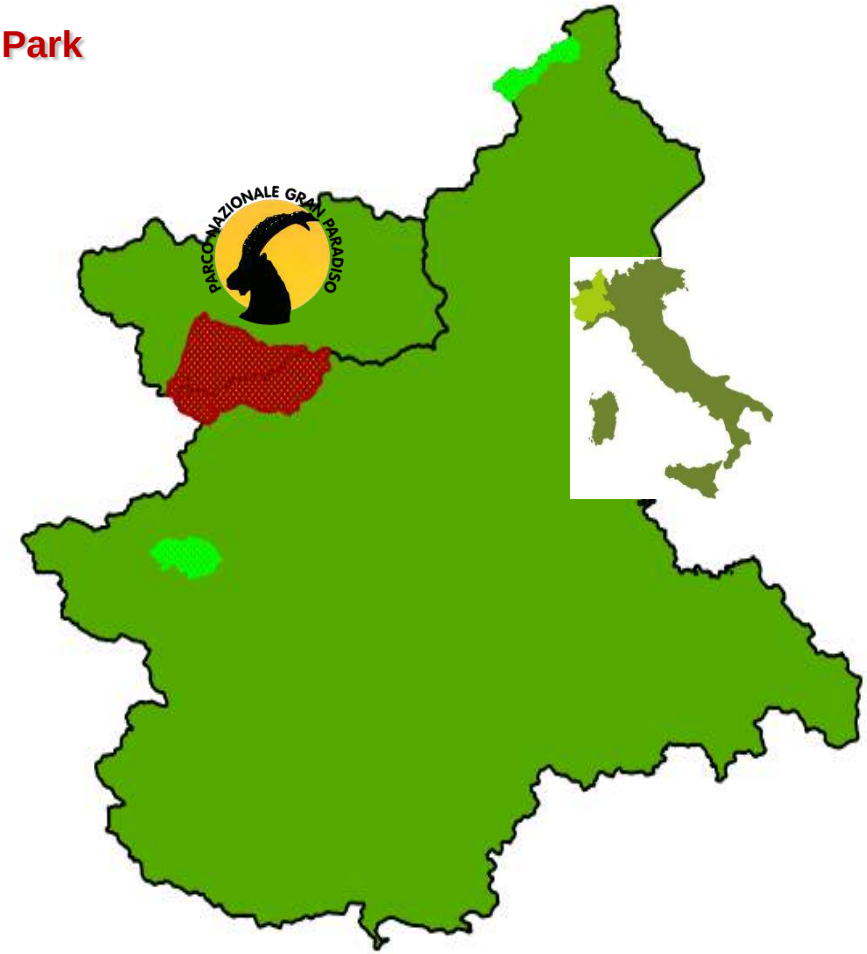
1. To describe animal biodiversity along altitudinal gradients and identify the parameters influencing species' distribution

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

- 2005: Training along 2 altitudinal gradients
- 2006-2007: First “2-years“ of activity - Interreg Gestalp

Gran Paradiso National Park
5 Transects, **30** Plots



- 2005: Training along 2 altitudinal gradients
- 2006-2007: First “2-years“ of activity - Interreg Gestalp
- 2007-2008: Monitoring in other 2 Protected areas

Gran Paradiso National Park
5 Transects, **30** Plots

Orsiera Rocciavré Natural Park
4 Transects, **20** Plots

Alpe Veglia Devero Natural Park
3 Transects, **19** Plots

Comparison of elevational trends in diversity among taxa and among mountain ranges is fundamental in order to gain a more comprehensive understanding of patterns of diversity.

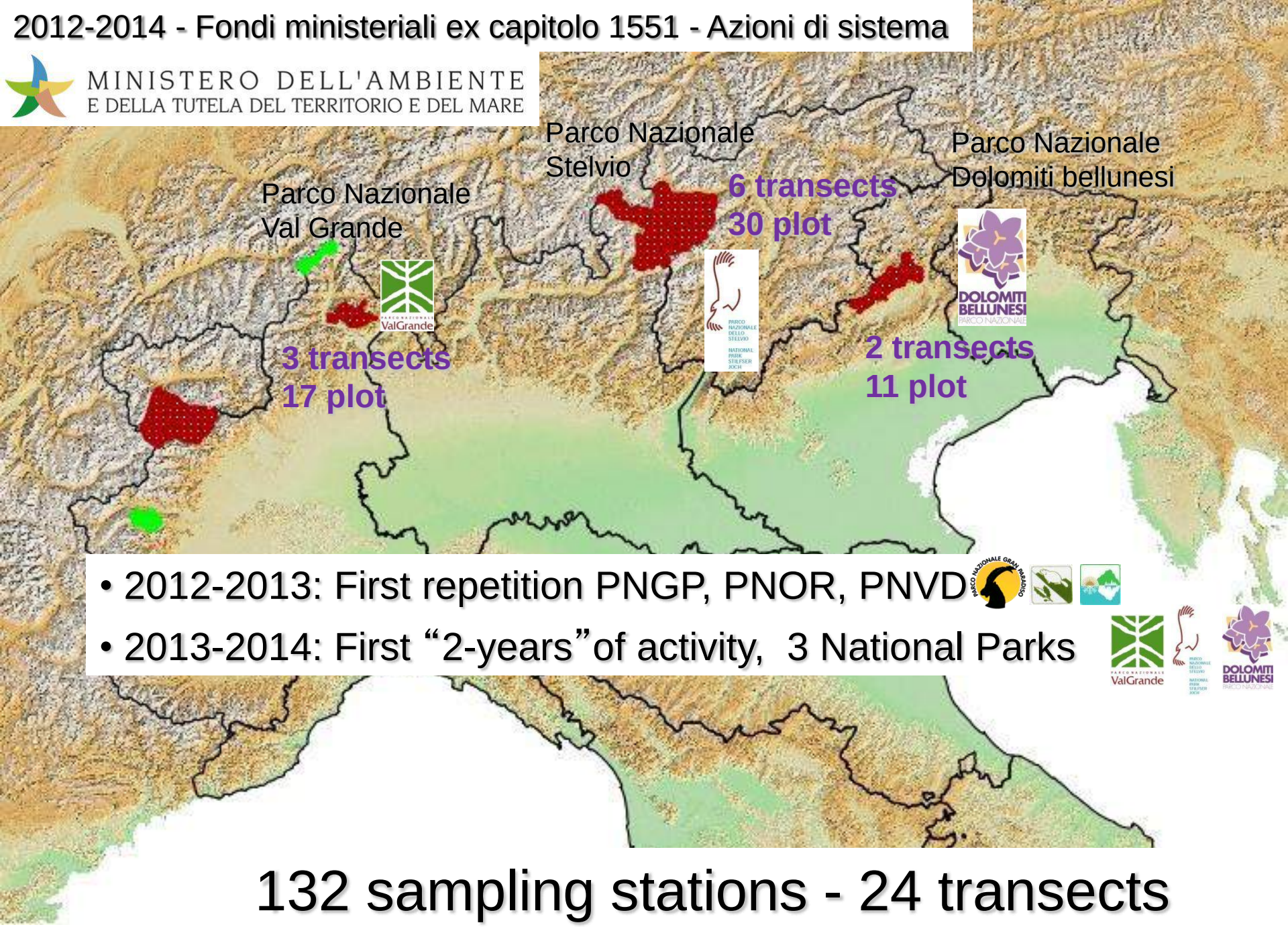
Lomolino, 2001. Elevation gradients of species -density: historical and prospective views. Global Ecology and Biogeography

Conclusive evidence for or against the existence of the predicted biological effects of climate change will come from replication of study with additional taxa in other regions.

Parmesan,1996. Climate and species’ range. Nature

2012-2014 - Fondi ministeriali ex capitolo 1551 - Azioni di sistema

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



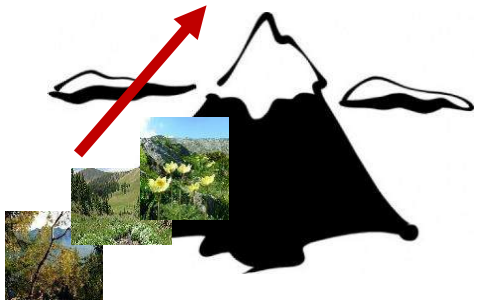
- 2012-2013: First repetition PNGP, PNOR, PNVD
- 2013-2014: First “2-years”of activity, 3 National Parks

132 sampling stations - 24 transects

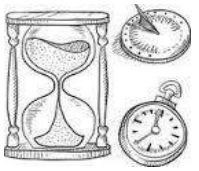
Altitudinal gradients

Natural laboratories to study ecosystem dynamics, biodiversity, and species' distribution response to climate gradients

Rapp and Silman (2012) Diurnal, seasonal, and altitudinal trends in microclimate across a tropical montane cloud forest. Clim Res; Lomolino (2001) Elevation gradients of species-density: historical and prospective views. Global Ecol Biogeogr 10



- reduce as much as possible the confounding factors → Spatial auto-correlation; Aspect - Topoclimate
- logistic constraints → Execution of the monitoring into1-2 days



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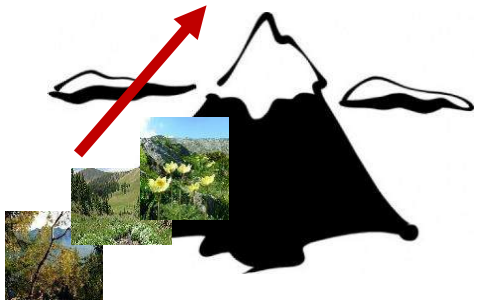

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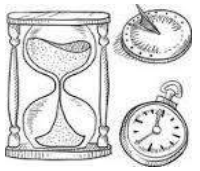


Temporal design

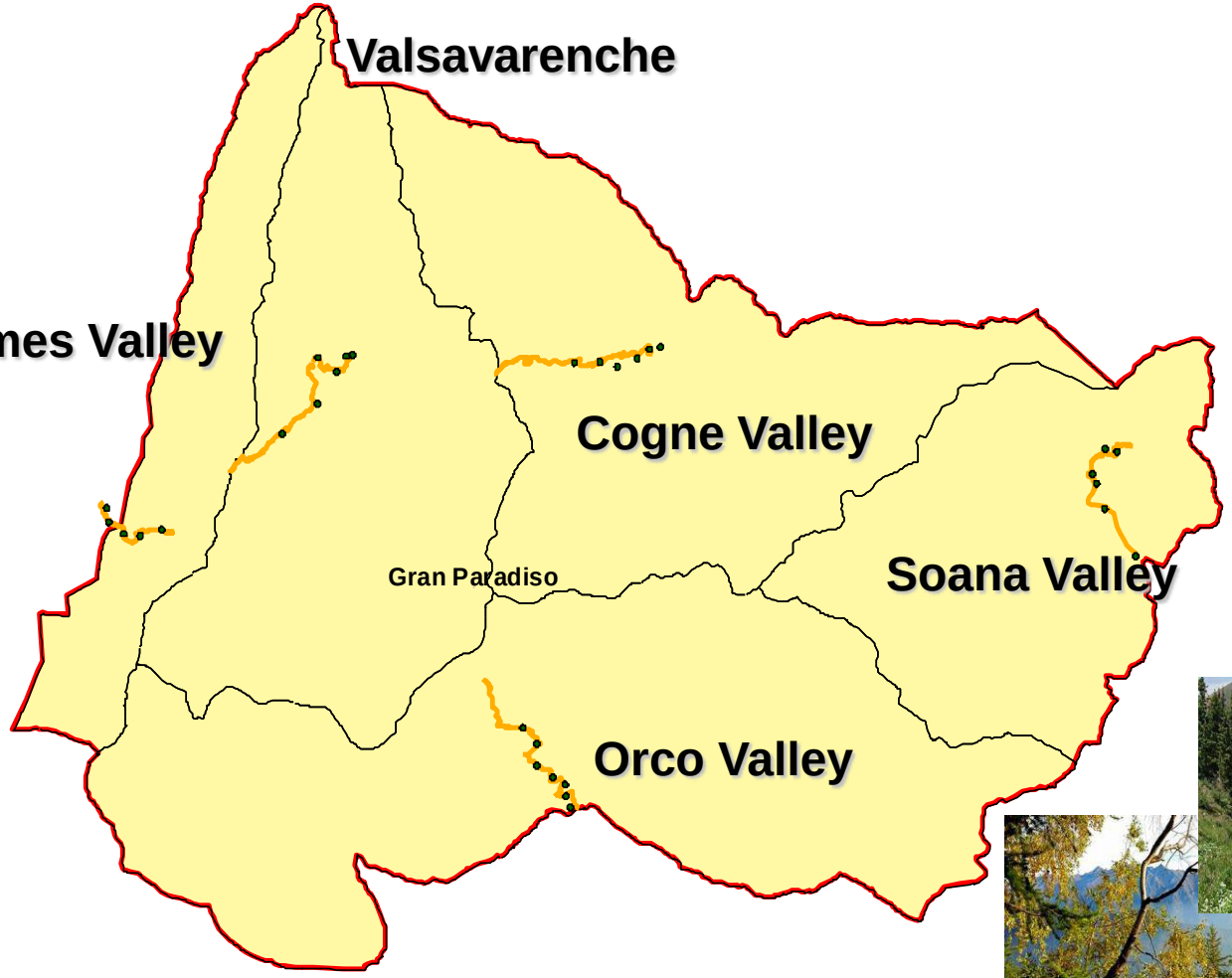
Montane Ecosystems

- unfavourable weather (*harsh environment*)
- high inter-annual variability

Monitored Taxa

- yearly fluctuation (e.g., population dynamic, mainly invertebrates
- life cycle (e.g., many invertebrates with 2-years development cycle)

Sampling design - Choosing the plots



Alpine:
above the *tree species line*

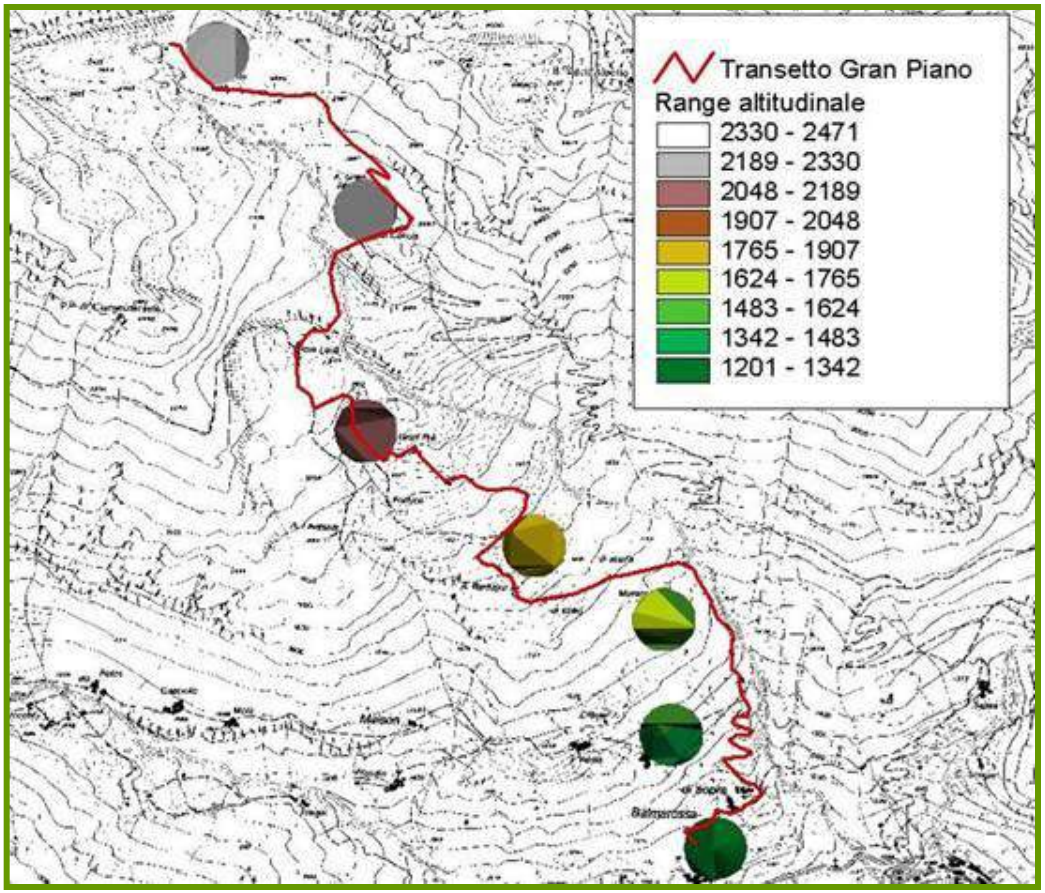
Subalpine:
between the *timberline* and the *tree species line*

Montane:
under the *timberline*

Altitudinal gradient: 1200-2800 m a.s.l.
Altitudinal zonation
Vegetation belts: high-montane, subalpine, alpine (characterised by a specific vegetation and climate)

Theurillat and Guisan 2001 - Climatic Change; Körner et al. 2011 - Alp Bot

6-7 plots per transect

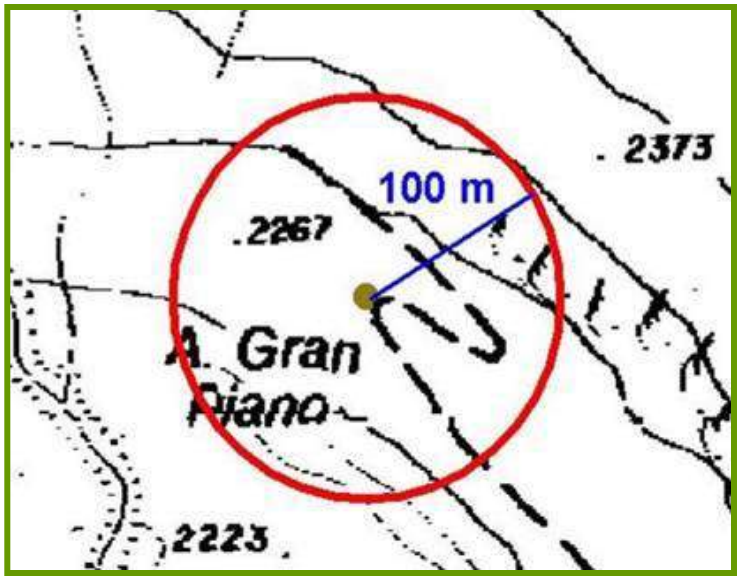


Difference in height between plots:

- 200 m
- independence

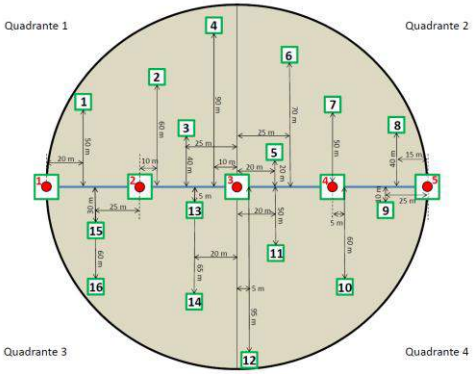
Sampling unit:

- plot with a radius of 100 m
- 1 diameter easy to walk trough



Plot characterization - Environmental variables

1. First Description



Dominant habitat types

Anthropic pressure

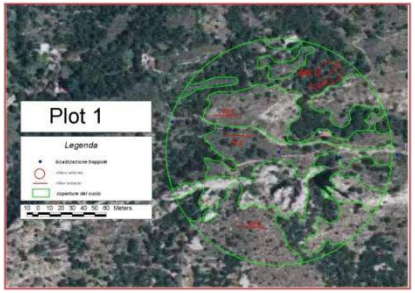
Micro-habitat

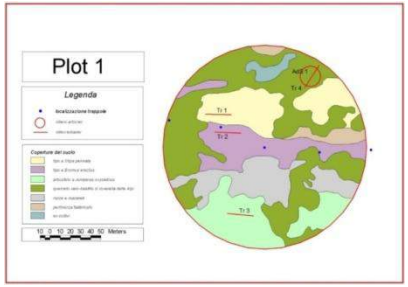
21 random points

2. Botanical surveys

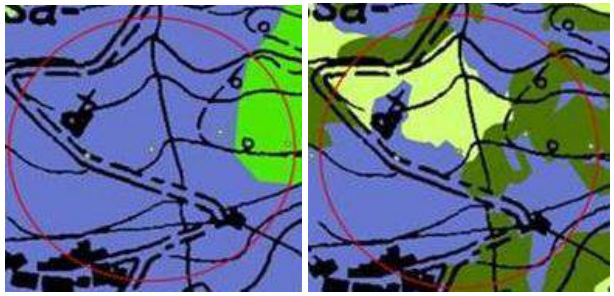
3. Quantification of habitat types

Analysis of aerial photos and vegetation maps





Drone mapping systems (***experimental***)



Images of plots
regularly spaced in time
(every 5 years)

in collaboration with the Botanical Service

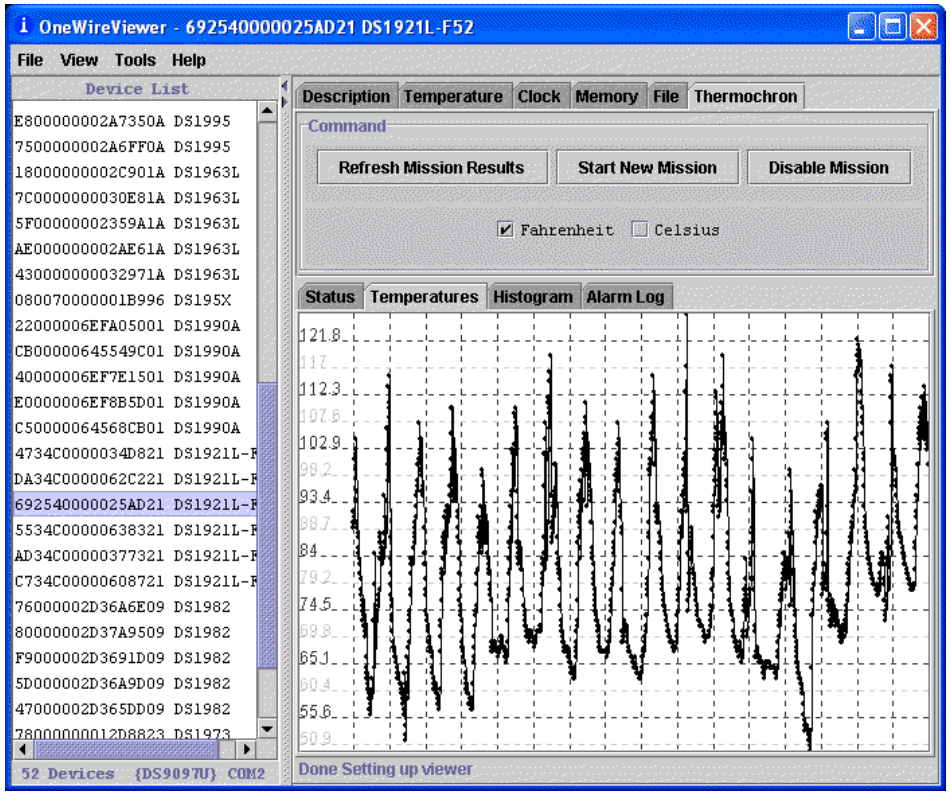
Plot characterization - Environmental variables

Microclimatic conditions

Datalogger: Thermochron iButton, DS1922L

Set: data every hour, resolution of 0.5°

Time period: May-October



Data collection - Monitoring of animal communities in field

Because of the complexity of biodiversity, surrogates such as subsets of species, species assemblages and habitat types have to be used as measures of biodiversity

Margules and Pressey (2000) Systematic conservation planning. Nature 405

Choice of indicator → Scientific coordination

Previous experience

Prof. Giuseppe Bogliani - Università di Pavia

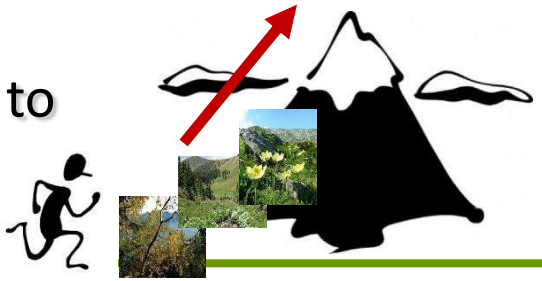
- Biodiversità Animale in Ambiente Urbano. Il caso della città di Pavia

Giordano et al. 2002 - FLA

- Biodiversità animale degli ambienti terrestri nei parchi del Ticino

Bogliani et al. 2003 - Ed. Il Guado

Adaptation of the monitoring scheme to mountain ecosystems



Data collection - Monitoring of animal communities in field

Pitfall traps

Point counts

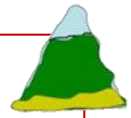
Line transects

Census techniques as much as possible

- **Easy to apply**
- **Standardized**
- **Cheap**

Repeatability over time (4 years stop) of transects in order to analyse variations

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



Measure biodiversity status

Baseline against which identify future changes

Tool for estimating conservation value

Planning highly focused conservation action

Active management to reduce environmental stressors

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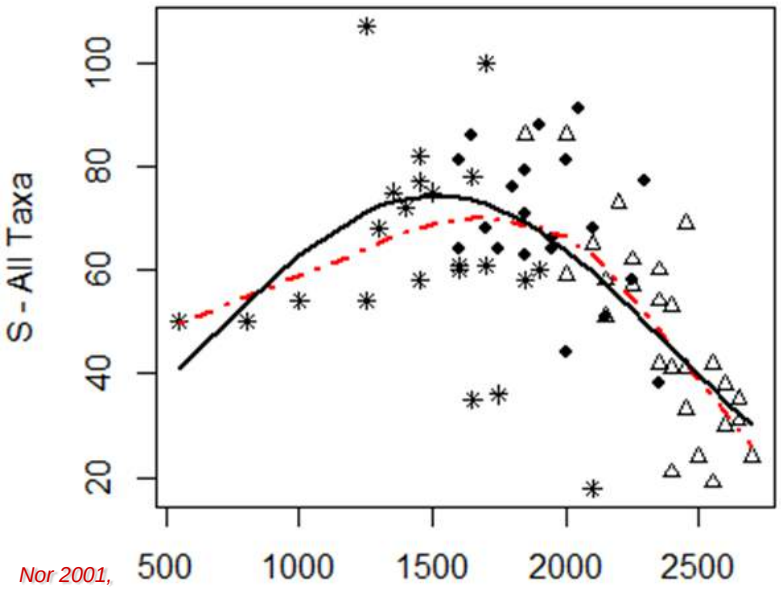
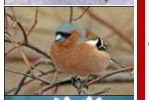


Nor 2001, Sànchez-Cordero 2001, Sheng Li et al. 2003

	Alt	Temp	Str Div	Tree%	TShr%	LShr%	HerbL%	Rock%
	-0.435**	0.415*	0.147	0.374	0.154	0.273	0.028	-0.509**
	-0.208	0.198	0.009	-0.232	0.061	-0.145	0.373	-0.225
	-0.566**	0.565**	0.289	0.428**	0.326	0.248	-0.111	-0.367
	-0.409**	0.485**	0.313	0.306	0.386*	0.318	-0.007	-0.054
	-0.449**	0.451**	0.089	0.289	0.246	0.284	0.048	-0.422**
S_{tot}	-0.519**	0.562**	0.192	0.302	0.270	0.272	0.104	-0.406*

StrDiv=Structural Diversity
Tree%=percentage of tree coverage
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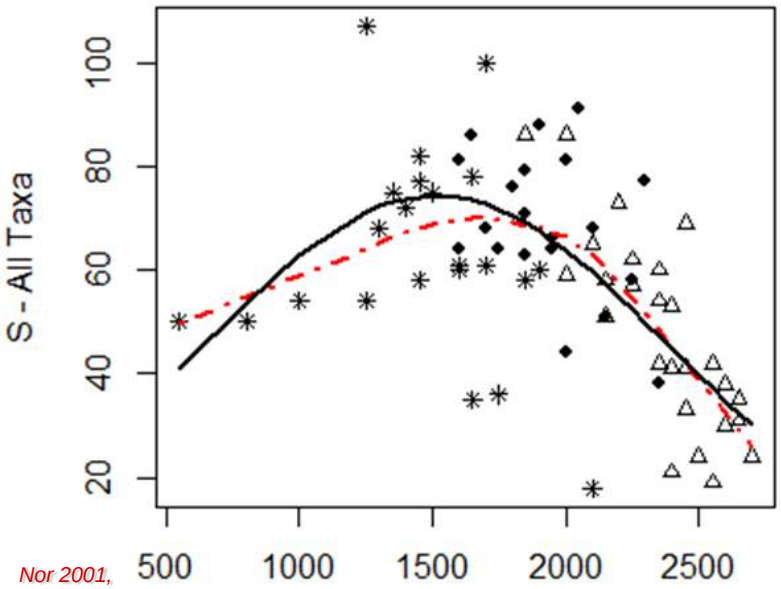

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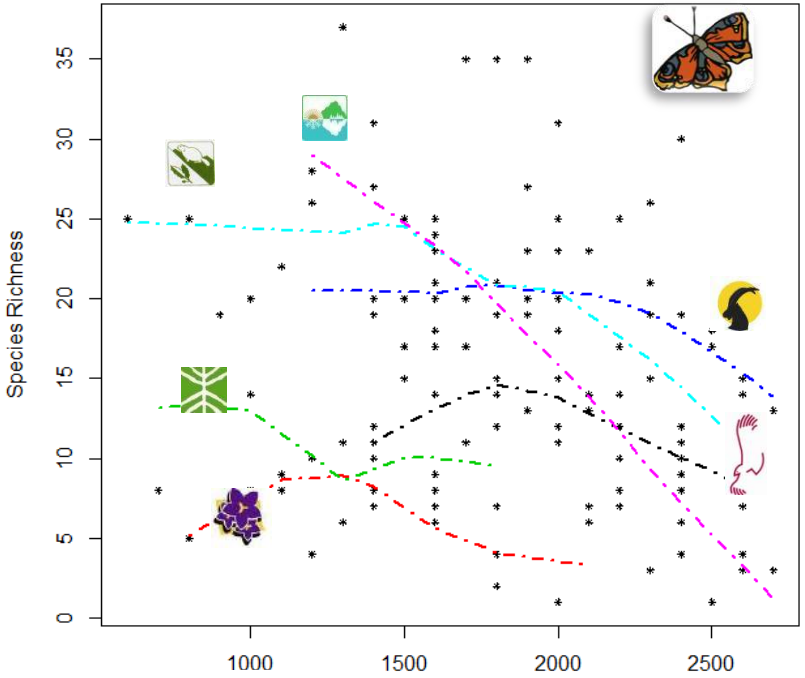

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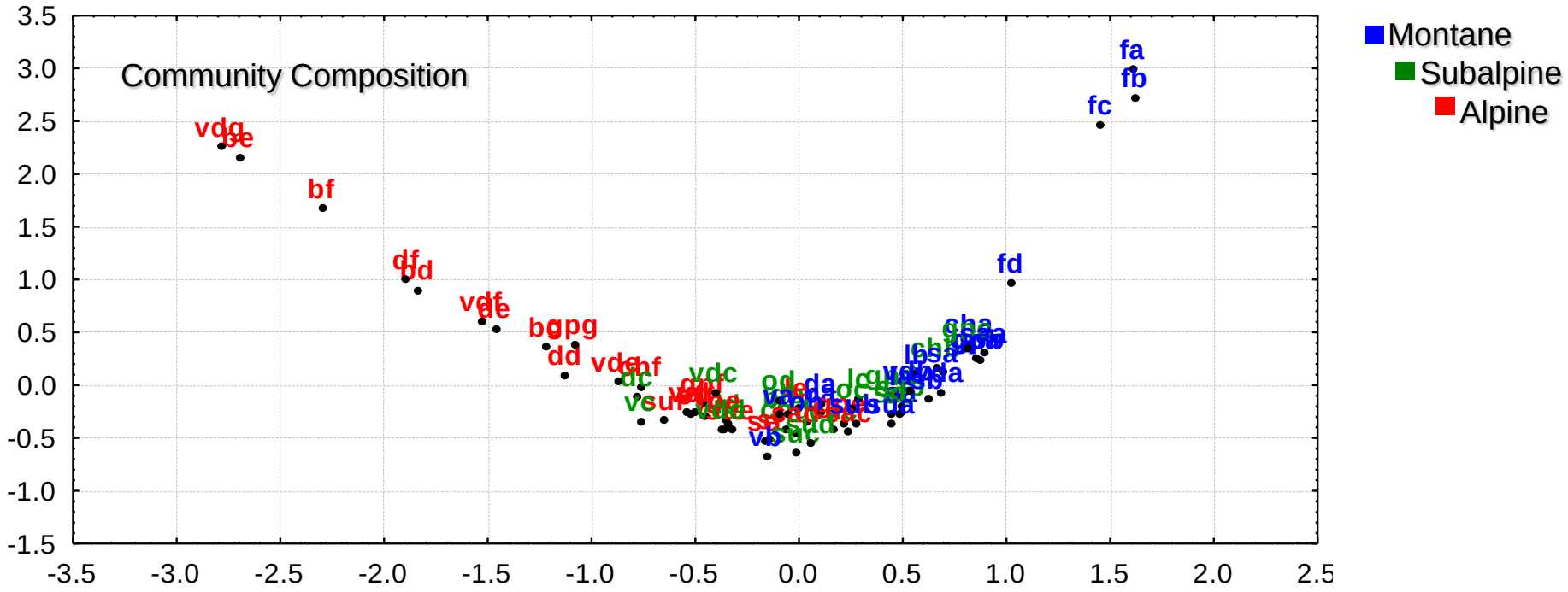

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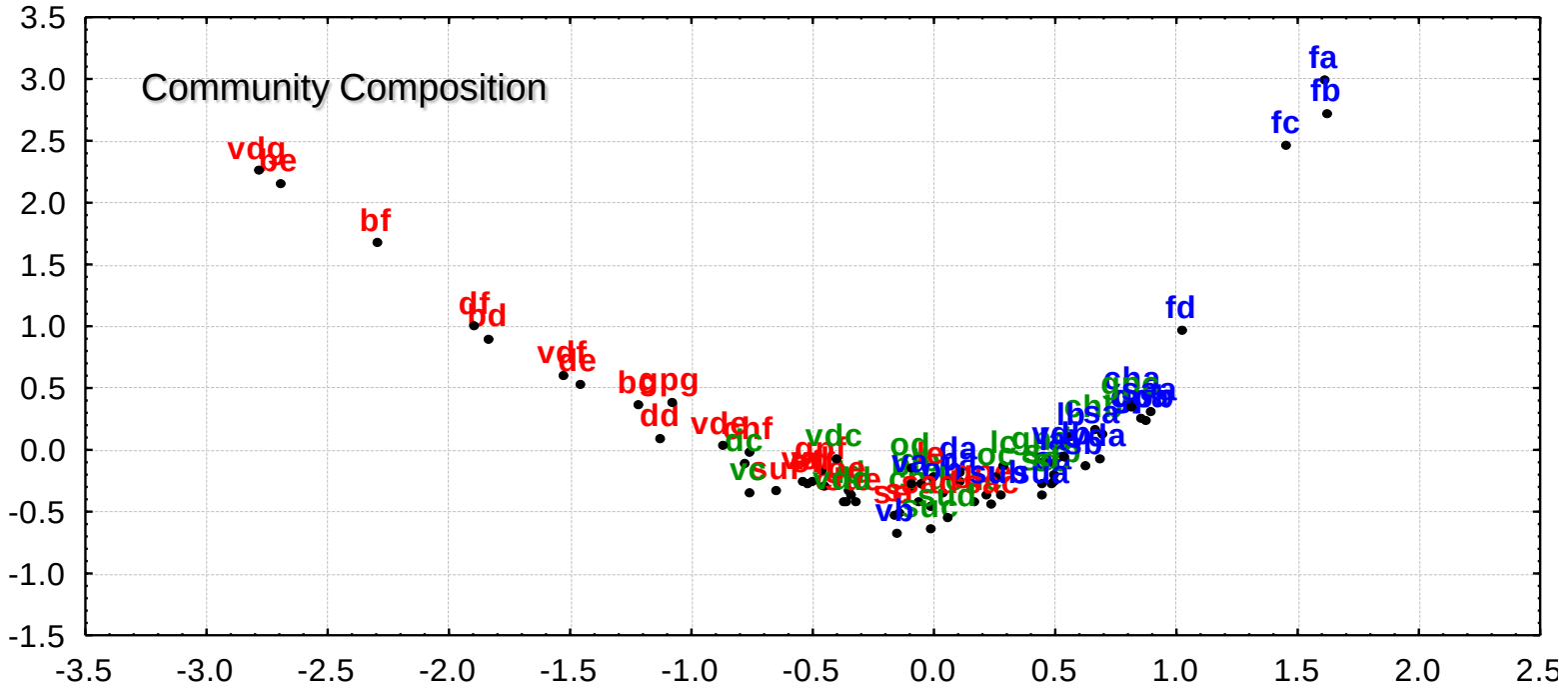

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	-0.574**	0.623**	0.293	0.328	0.418*	0.261	-0.112	-0.026
	0.911**	-0.852**	-0.430**	-0.800**	-0.674**	-0.377*	0.388*	0.234
	0.860**	-0.882**	-0.353	-0.610**	-0.612**	-0.191	0.276	0.043
	-0.818**	0.849**	0.400**	0.500**	0.581**	0.171	-0.158	-0.117
ScoreAx1$_{tot}$	**-0.889****	**0.918****	**0.399***	**0.569****	**0.600****	**0.214**	**-0.212**	**-0.138**

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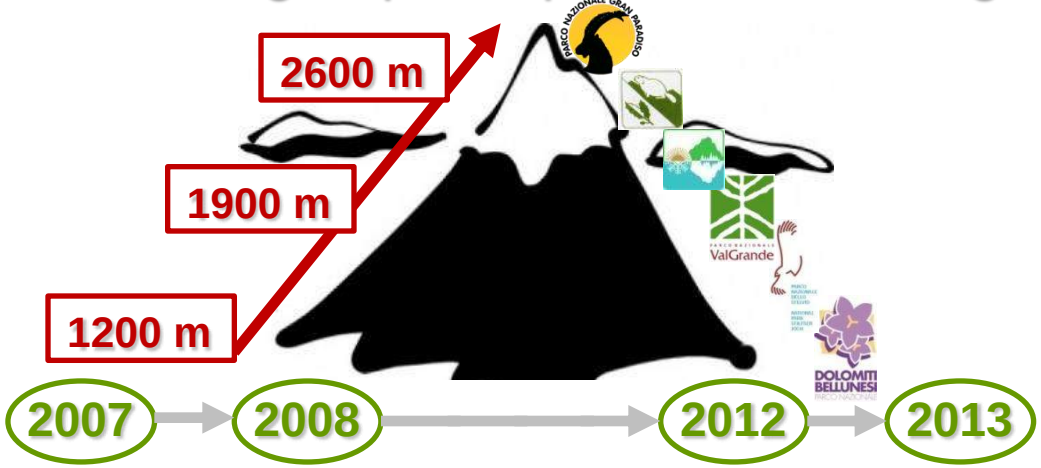
Temporal and Spatial β-diversity

Work in Progress

- Change in community structure through space and time

Species or functional groups responsible of change



- Time-series analysis

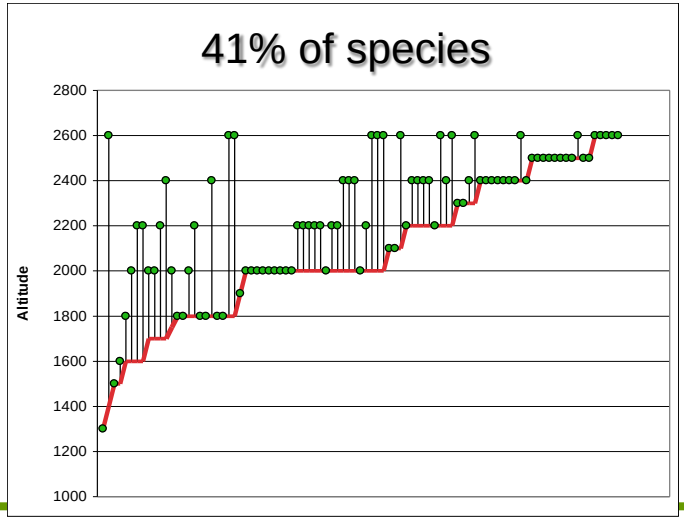
Continuous *vs* interrupted monitoring

9 years vs *2 years monitoring-4 years stop-2 years monitoring*

2 transects in PNGP

- Comparison between historical datasets

1996-2006 Mean differences 380 m



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

Forecast biodiversity status

Identify the threshold beyond which the risk of biodiversity loss will be extremely elevated

Identify potential “vulnerability and safety”

Promote adaptive management

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

Biodiversity Monitoring Project

Environmental Predictors

Species data

Climate change scenarios

Output

Temp

Temperature
Altitude

Tempark

Temperature
Altitude
Geography

All

Temperature
Altitude
Geography
VegetationCover

1.5 Min
1 Degree
1.5 Max

Current situation

Predictions

1. Species
2. Plot
3. Community
4. Belts

> increase of *minimum temperature* Beniston (2006)

> increase of *maximum temperature* Ciccarelli et al (2008)

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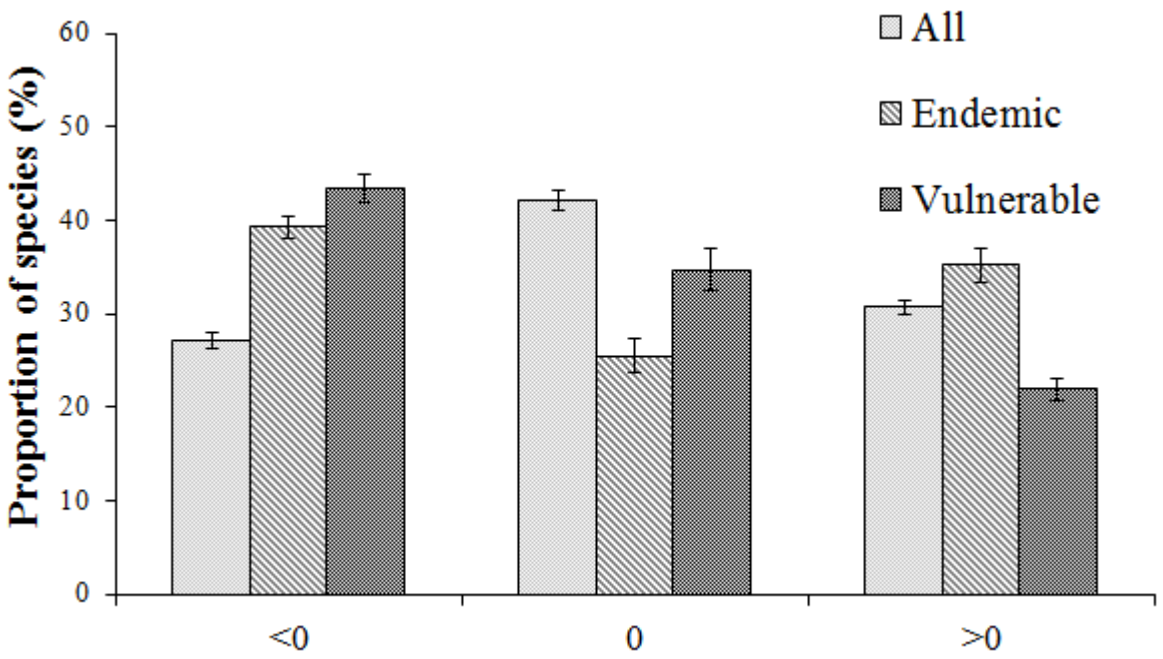
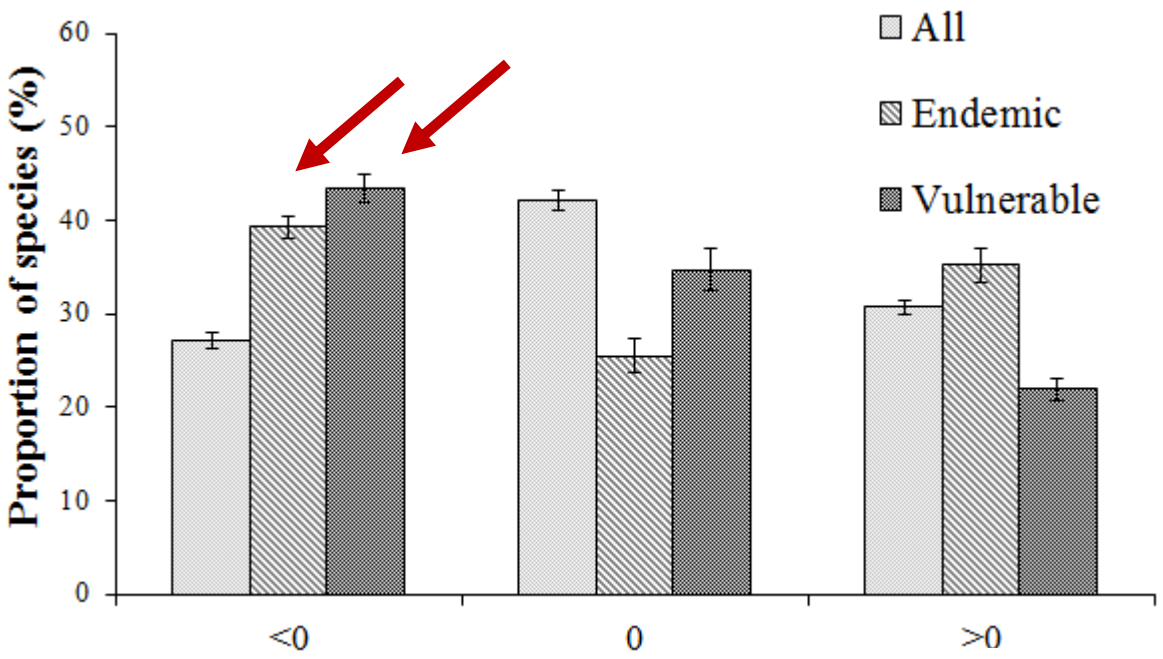
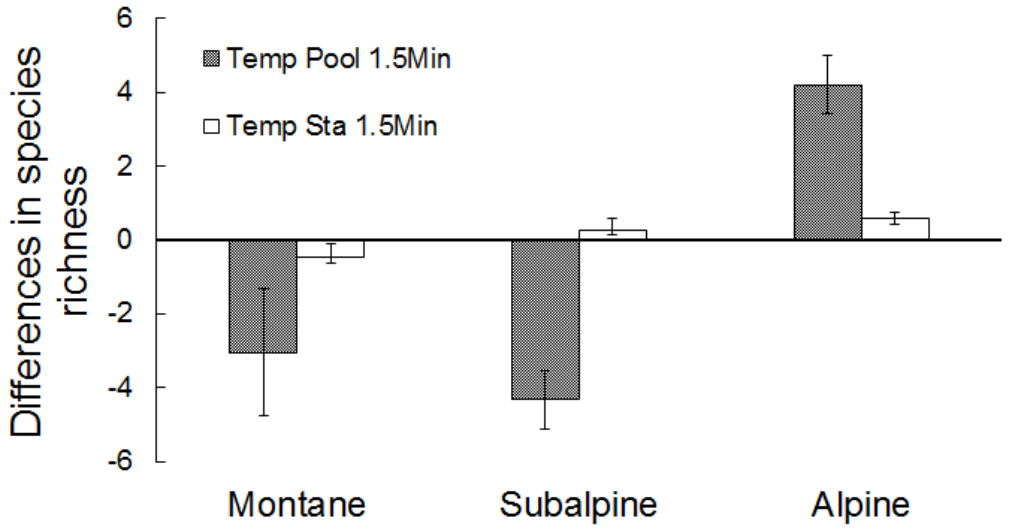




For endemic and vulnerable species decreased the number of occupied plots

Species richness increased in the alpine belt



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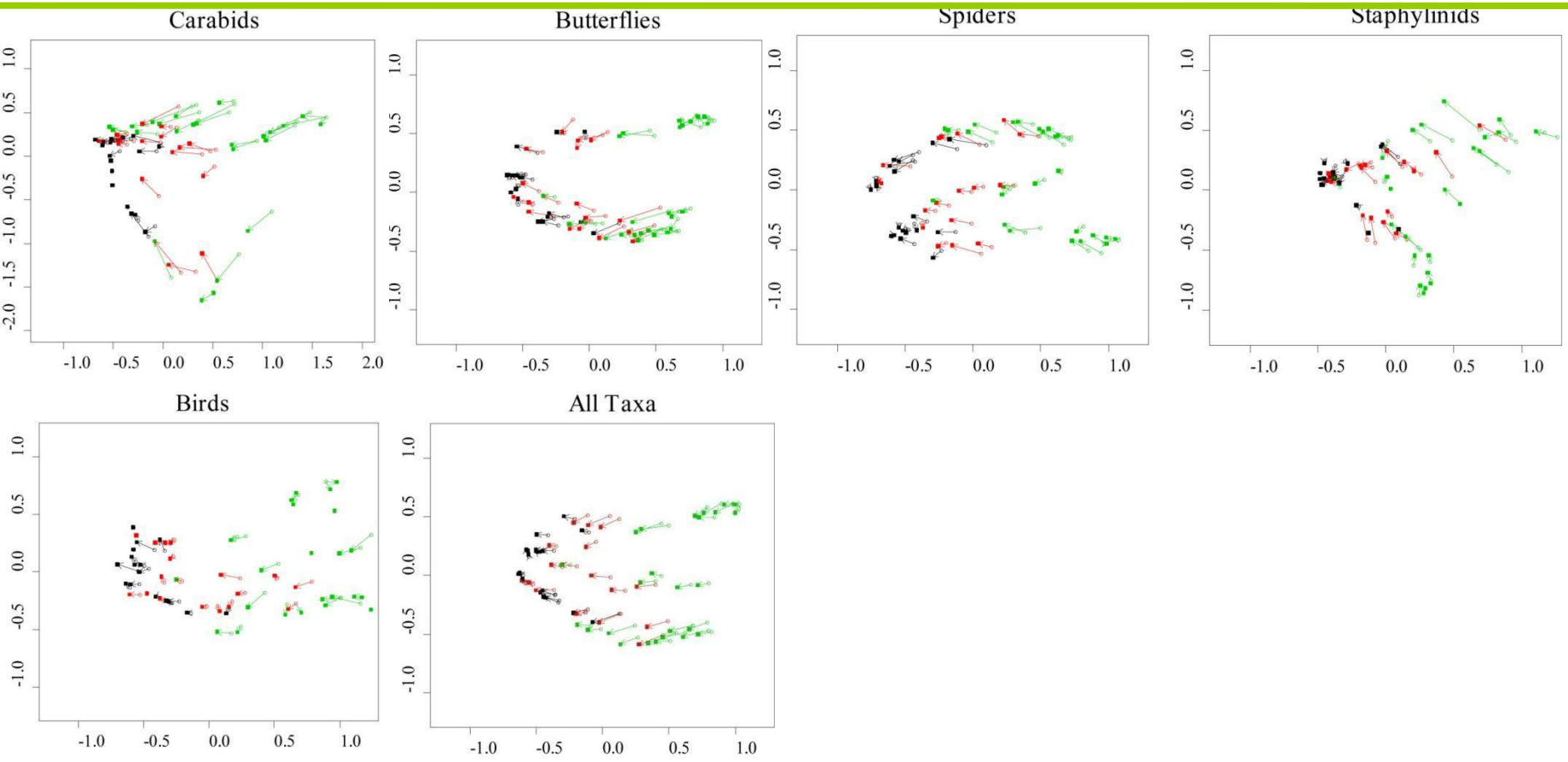

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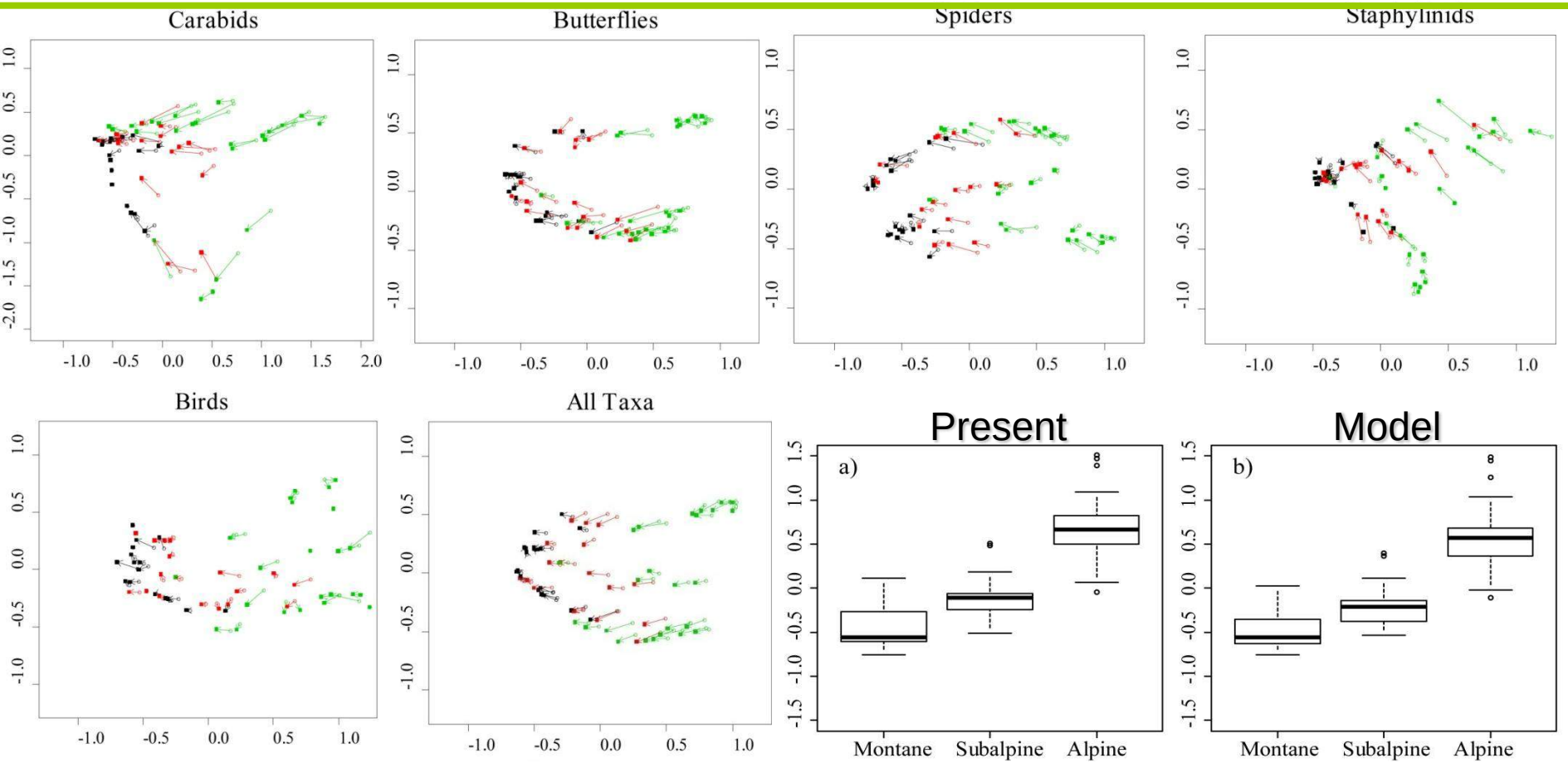


Temperature

Altitude

- *Alpine*
- *Subalpine*
- *Montane*

Develop more detailed scenarios to identify the threshold beyond which the risk of biodiversity loss will be extremely elevated

Detailed knowledge of

- Local transformation of land use

Aerial photographs, drones

- Climatic maps, focused on local trends

- Analysis of anthropic pressures over time

Tourism, pastoral activities

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

Effective biodiversity monitoring

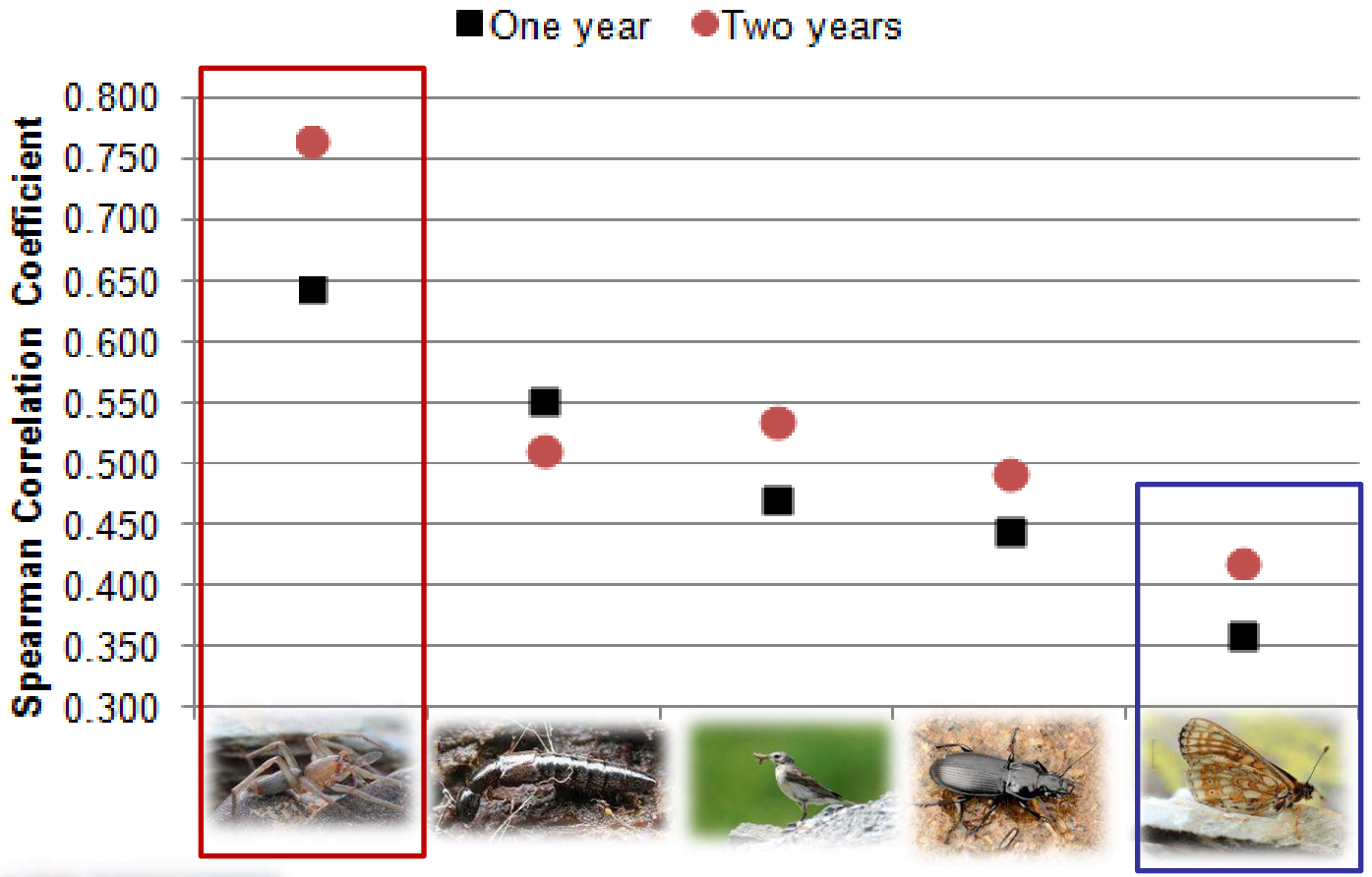
Simplify the monitoring, as much as possible
Providing, at the same time, a representative picture

Take them into account in developing management strategies (infrastructures, winter sports…)

Early warning signs of changes

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

Biodiversity Surrogates



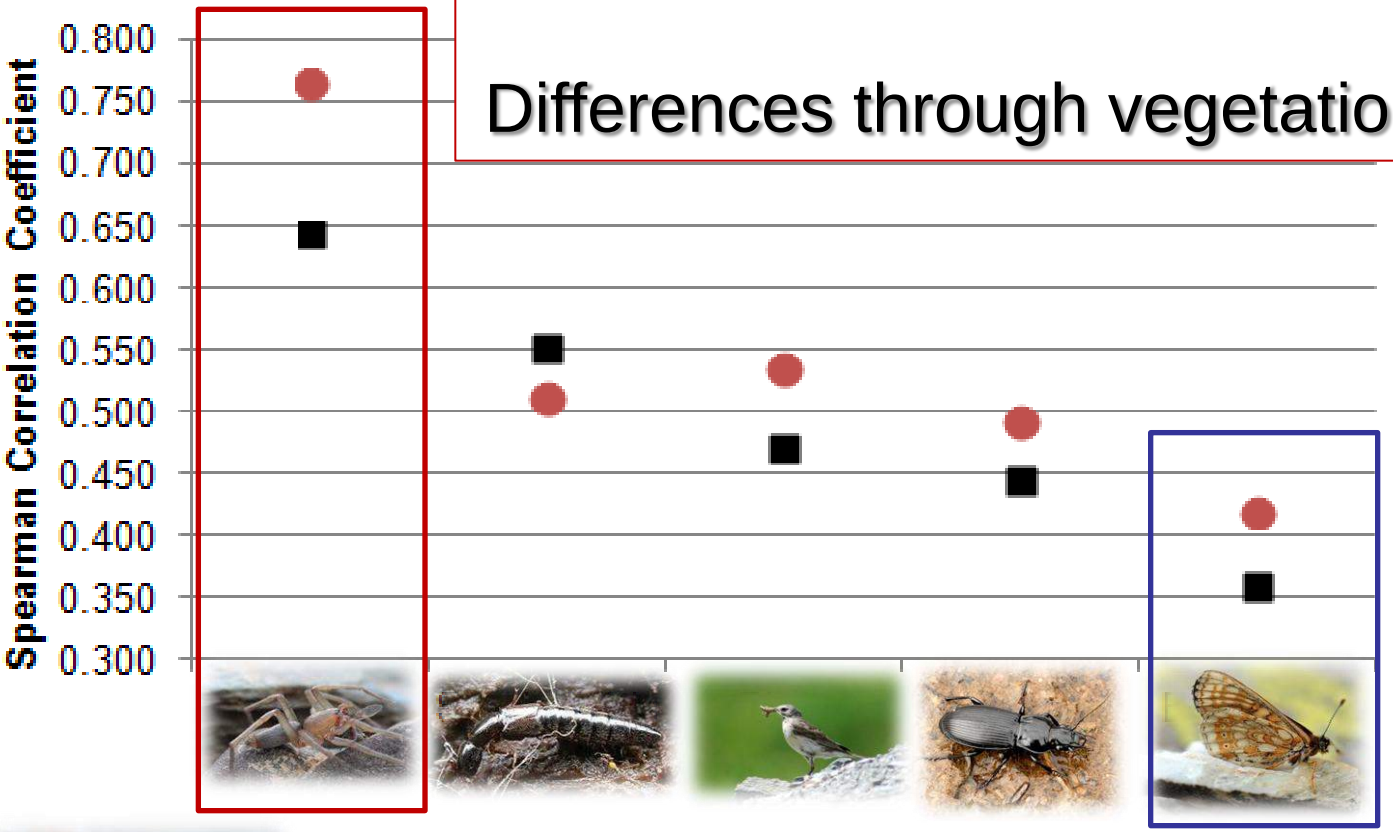
One year ρ=0.645, p<0.001

Two years ρ=0.765, p<0.001

Biodiversity Surrogates

Congruence in geography (Parks)

Differences through vegetation belt



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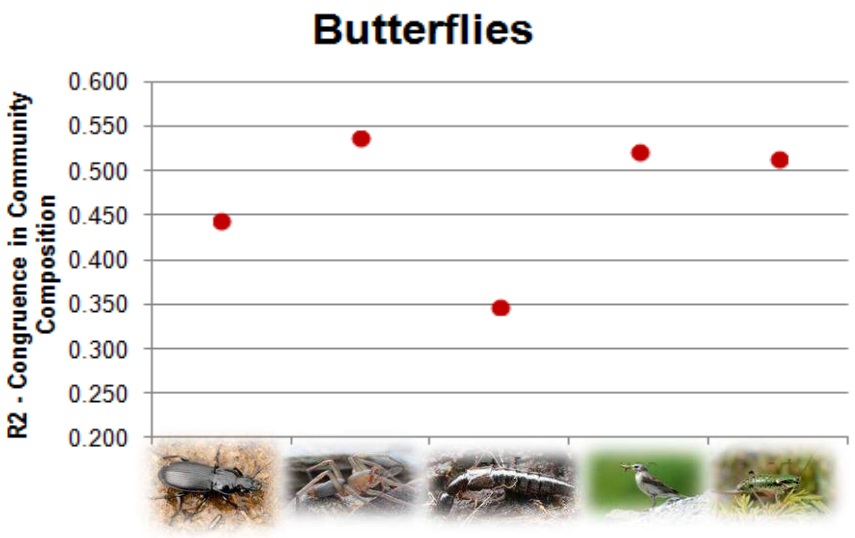
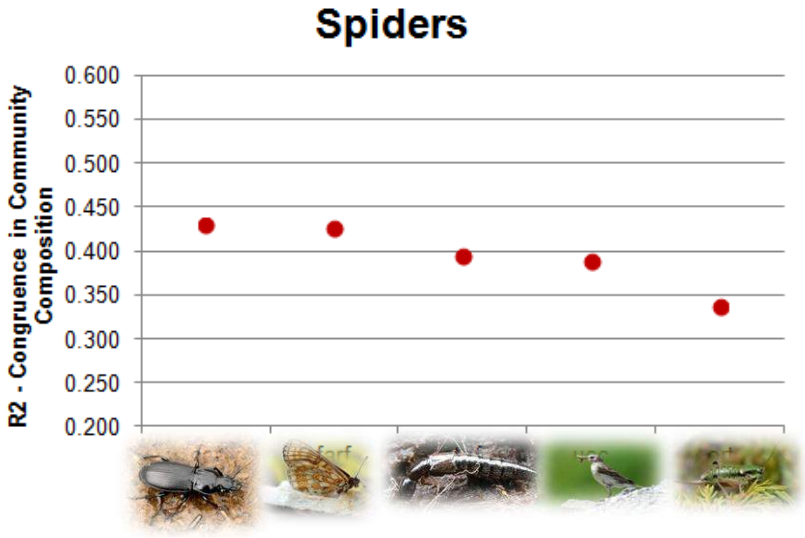
Not only species richness?

Community composition – Environmental Indicators





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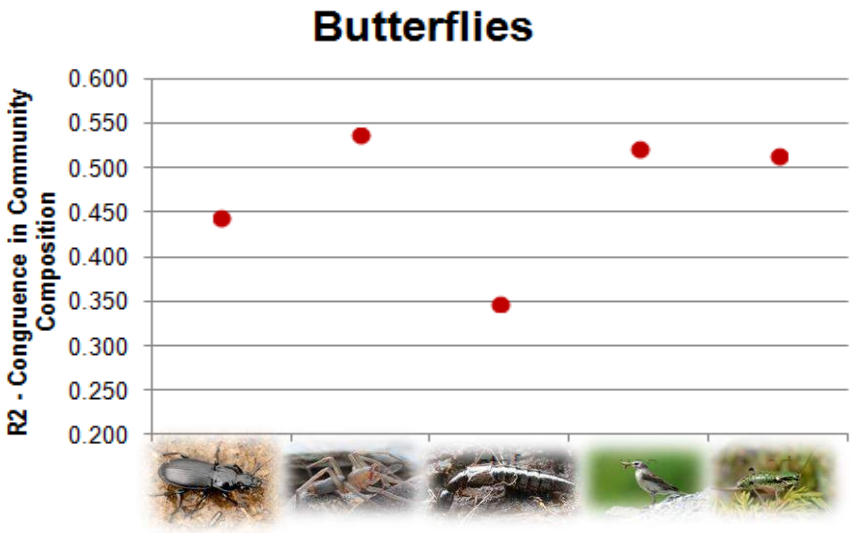
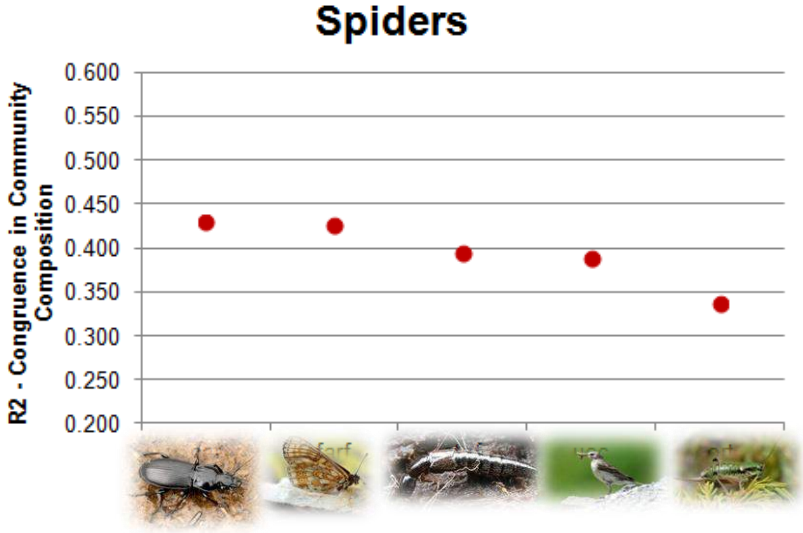


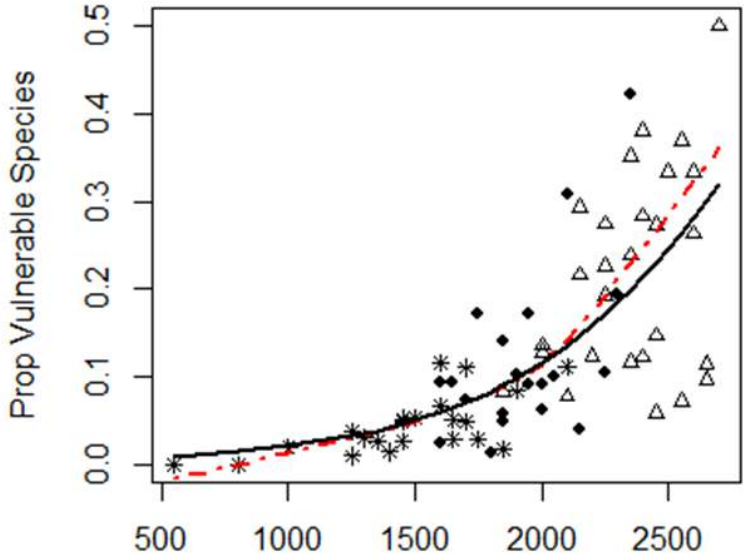


Functional Diversity

Rare species
Endemic species
Life history traits
Ecological specialization

?

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



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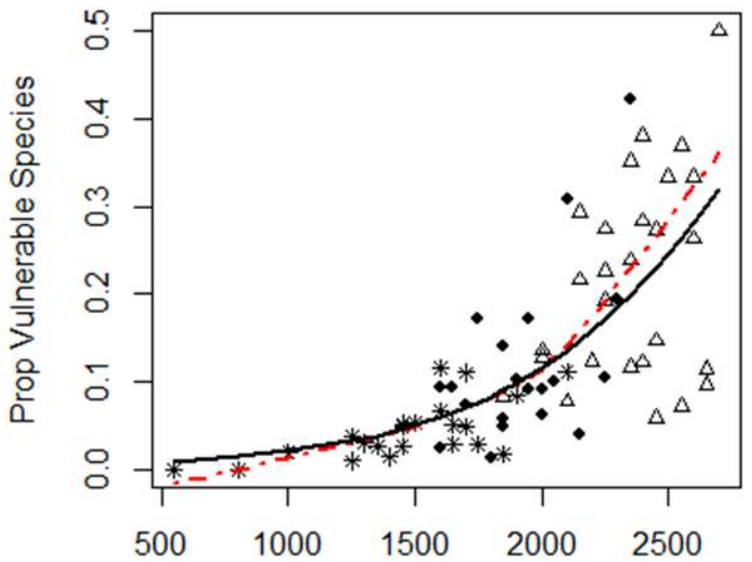
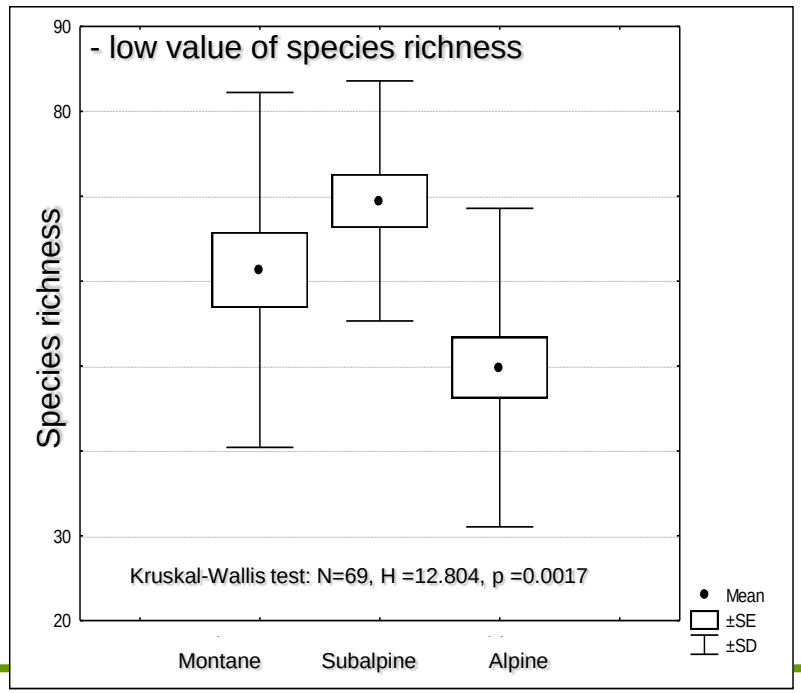
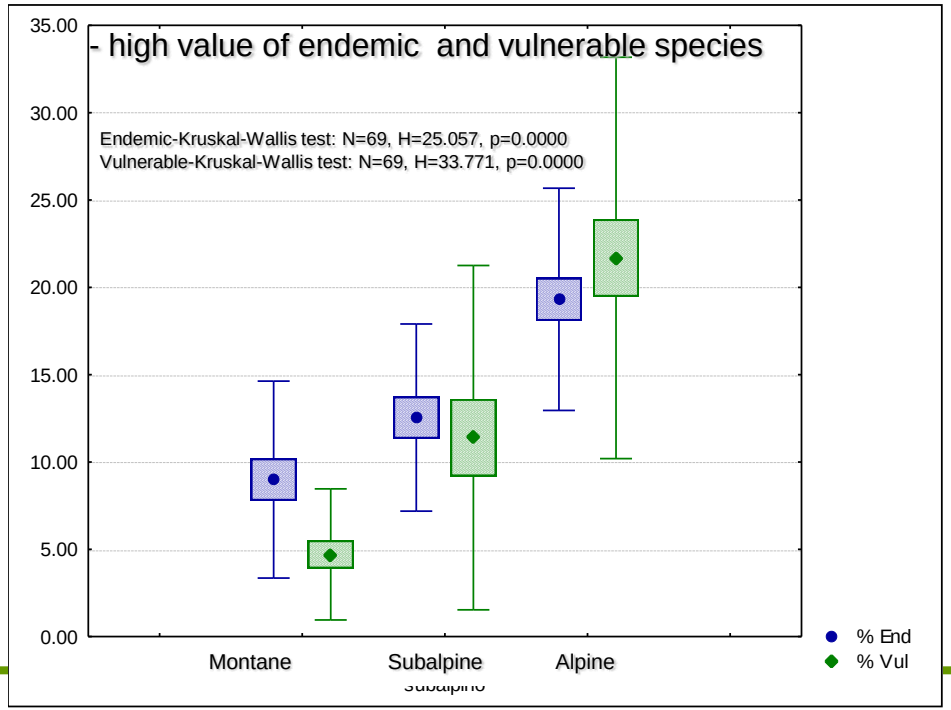






Improve the mechanistic comprehension of biodiversity

- Functional Diversity

Detailed ecological information

- Body size along altitudinal gradient

Using carabids as a model taxon

- Species and community composition estimators

- Climatic/environmental indicators

Differences between communities

Single species as indicators

This project provides to the parks useful instruments:

In the ***short time***:

-better knowledge of the protected area

-adress the management actions and conservation plans

In the ***long time***:

-litmus test of any change

-effectiveness of management action

Parks should act as test for non protected areas

Thanks specially to:

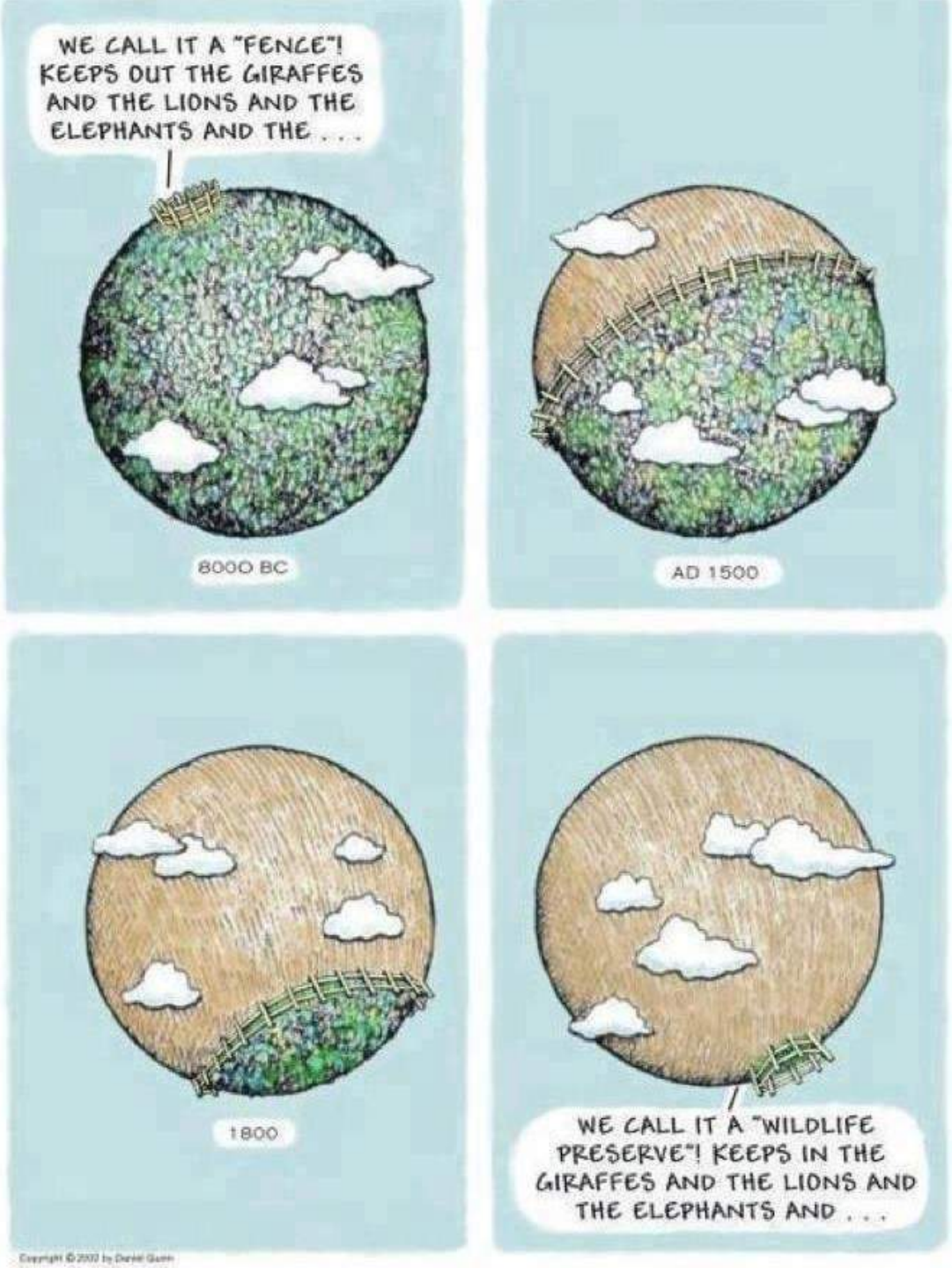
all the ***parks*** (Directors, technicians and wardens) that enthusiastically join the project 

the ***wardens*** that provide essential help in the field work

the ***experts*** that has been determining hundreds and hundreds of samples

the ***students*** and ***collaborator***s that go up and down along our altitudinal transects providing useful suggestions

The Fence



And thanks for your attention!