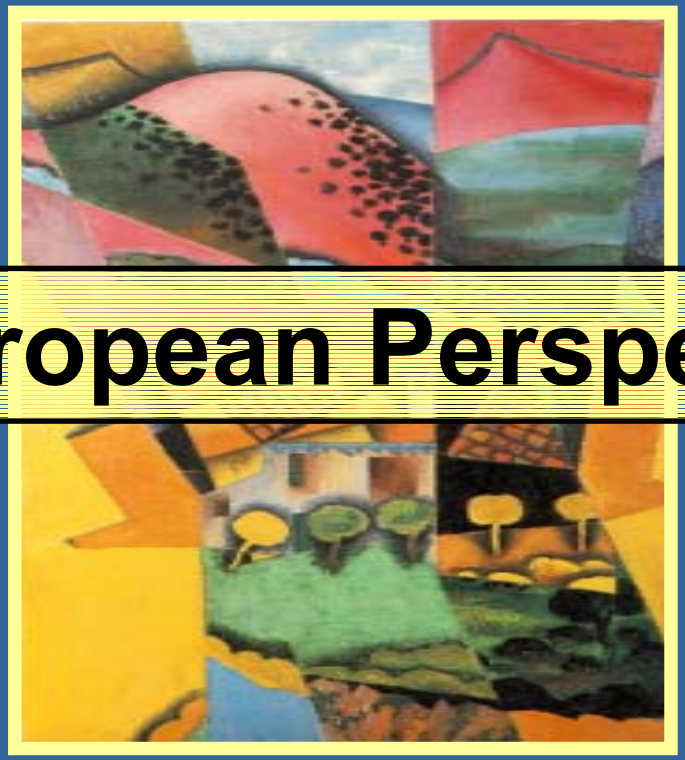
Effects of land abandonment on invertebrate communities



A European Perspective

Volkmar Wolters

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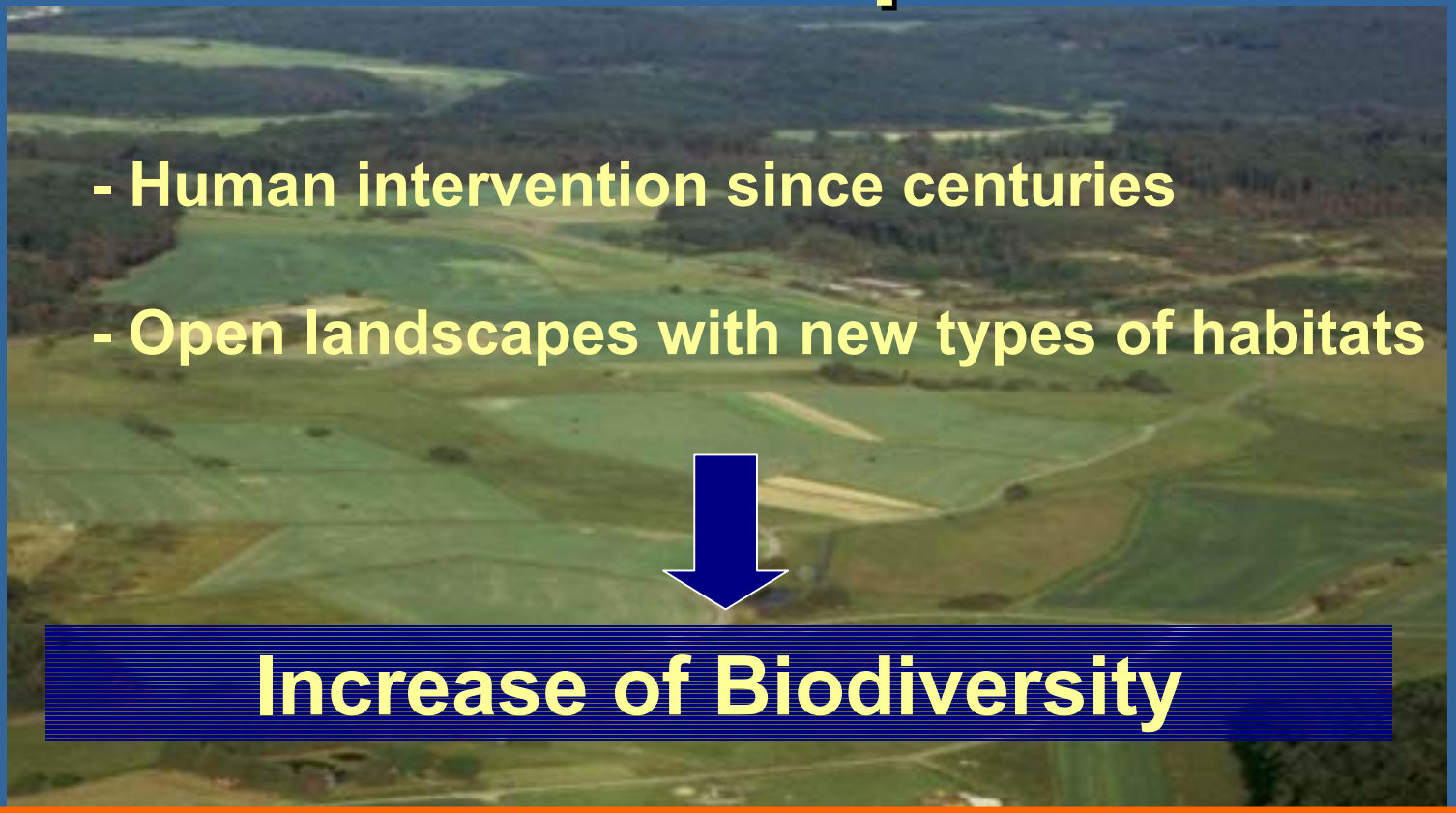
Europe‘s Landscape is ‚Man-made‘

John Constable

Europe‘s Landscape is ‚Man-made‘

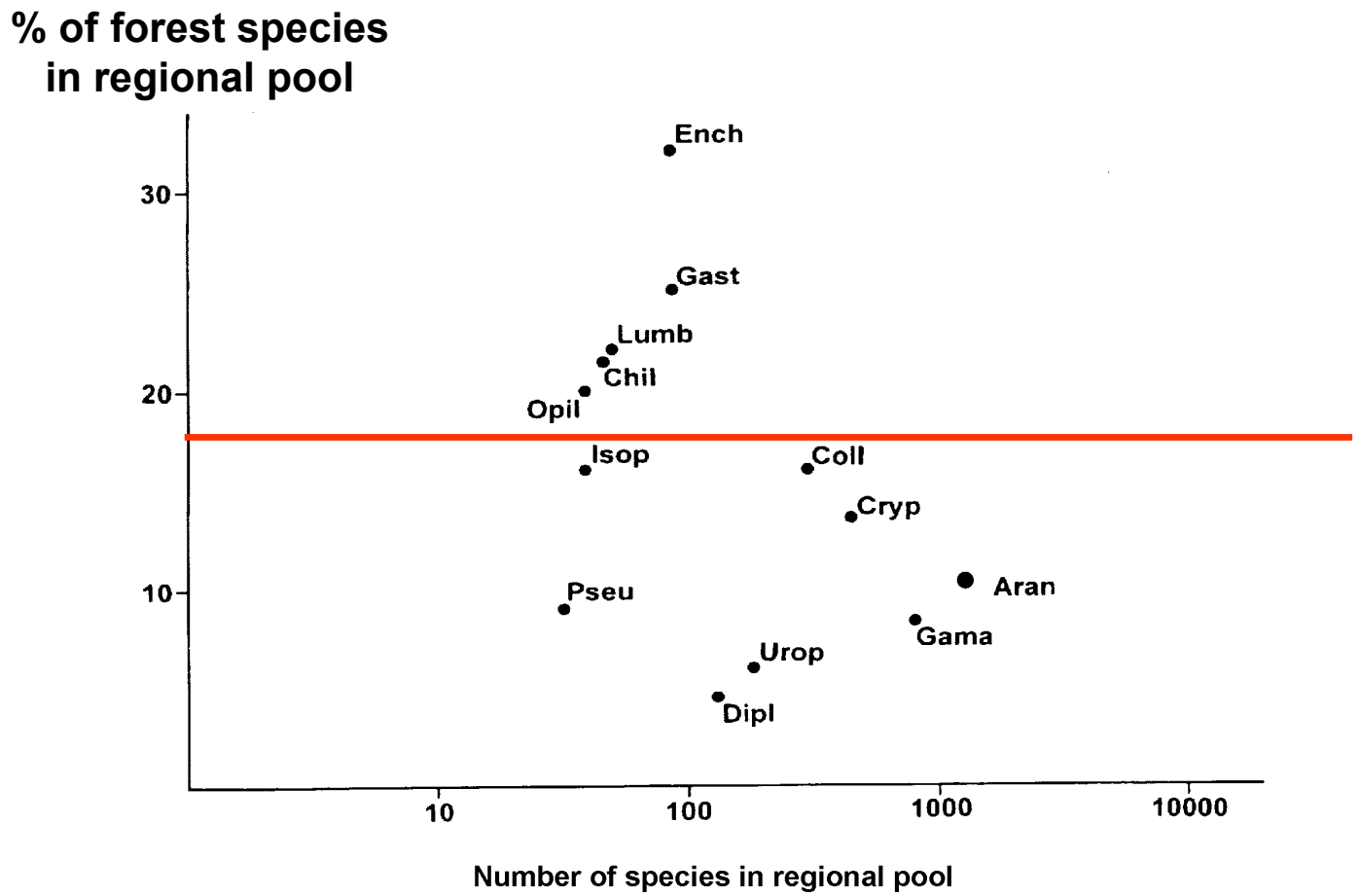
D.C. Magnotto

The cultural landscapes of Europe



Europe's Biodiversity is determined by land use

Native vs. Anthropogenic Habitats



from: Schaefer (1996) (modified)

Abandonment & Biodiversity

- Abandonment
- Succession
- Habitat loss

Biodiversity decline

<u>Challenge to Conservation:</u>
Maintaining the landscape in a state of intermediate disturbance

Facing the Challenge

A Case Study

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Study Regions

Southern Lower Saxony

- **high intensity farming**

Lahn-Dill-Bergland

- **marginal region**
- **low intensity farming**

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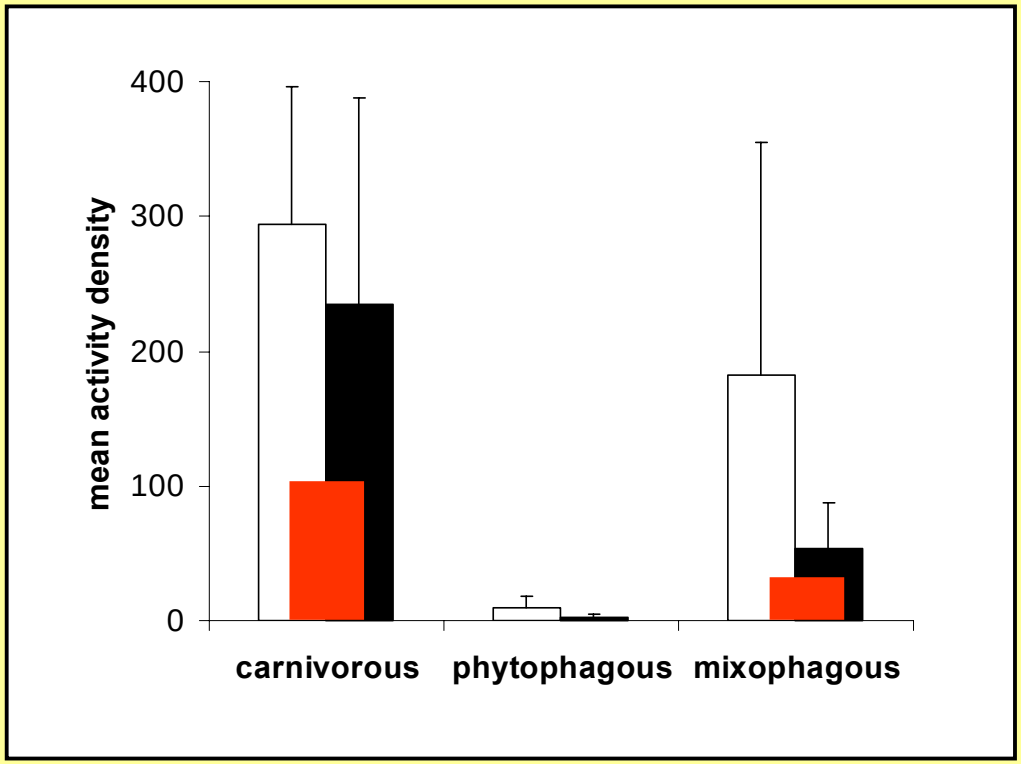
Comparison of the two regions

Species richness of Carabids



Problem

Determining the richness of
invertebrates is *de facto* impossible.

Solution: focussing on taxa that
(i) are functionally important (e.g. Decomposers),
(ii) impact habitat quality (‚Ecosystem engineers'),
(iii) are biodiversity indicators.

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Taxa included

Soil

- Ants
- Beetles (Carabids, Staphylinids)
- Spiders
- Diplopods
- Isopods
- Oribatids

Vegetation

- Grasshoppers
- Hymenoptera (Wild bees, aculeate Wasps)
- Syrphids
- Flower visiting beetles

Other groups

- Birds
- Bats
- Insects with aquatic larvae

The Dimensions of Abandonment

(A) Time
- subsequent conversion
- successional changes

(B) Space
- temporal mosaic
- environmental conditions

A: The temporal dimension

Example: Carabids

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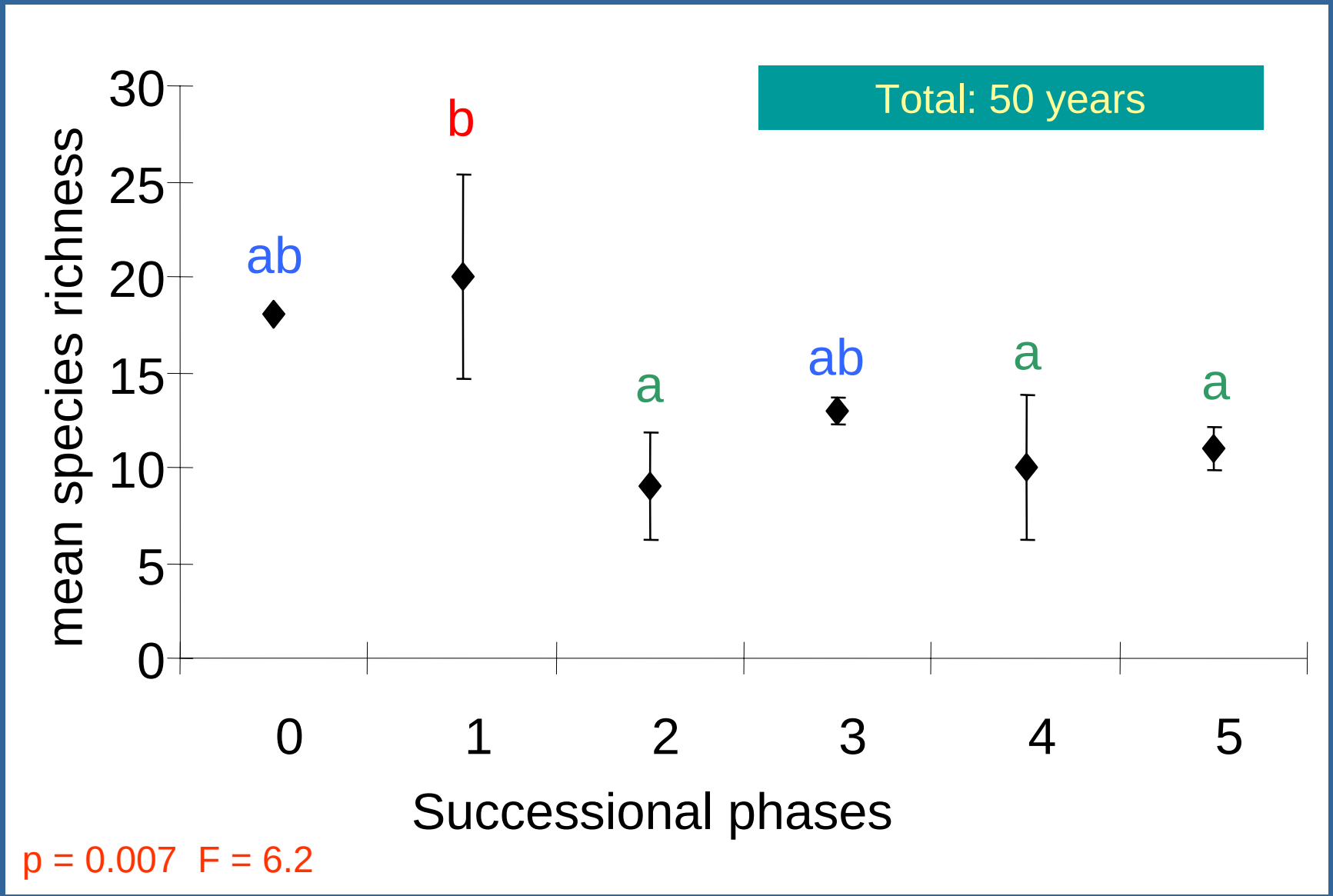
Succession of Carabids



Temporal Pattern

A Arable community

B Transient community

C Grassland community

VE = 11%

+2.5

DCA 2

-1.0

-1.0

DCA 1

+4.0

VE = 38%

A

B

C

Phase

0 A

1 B

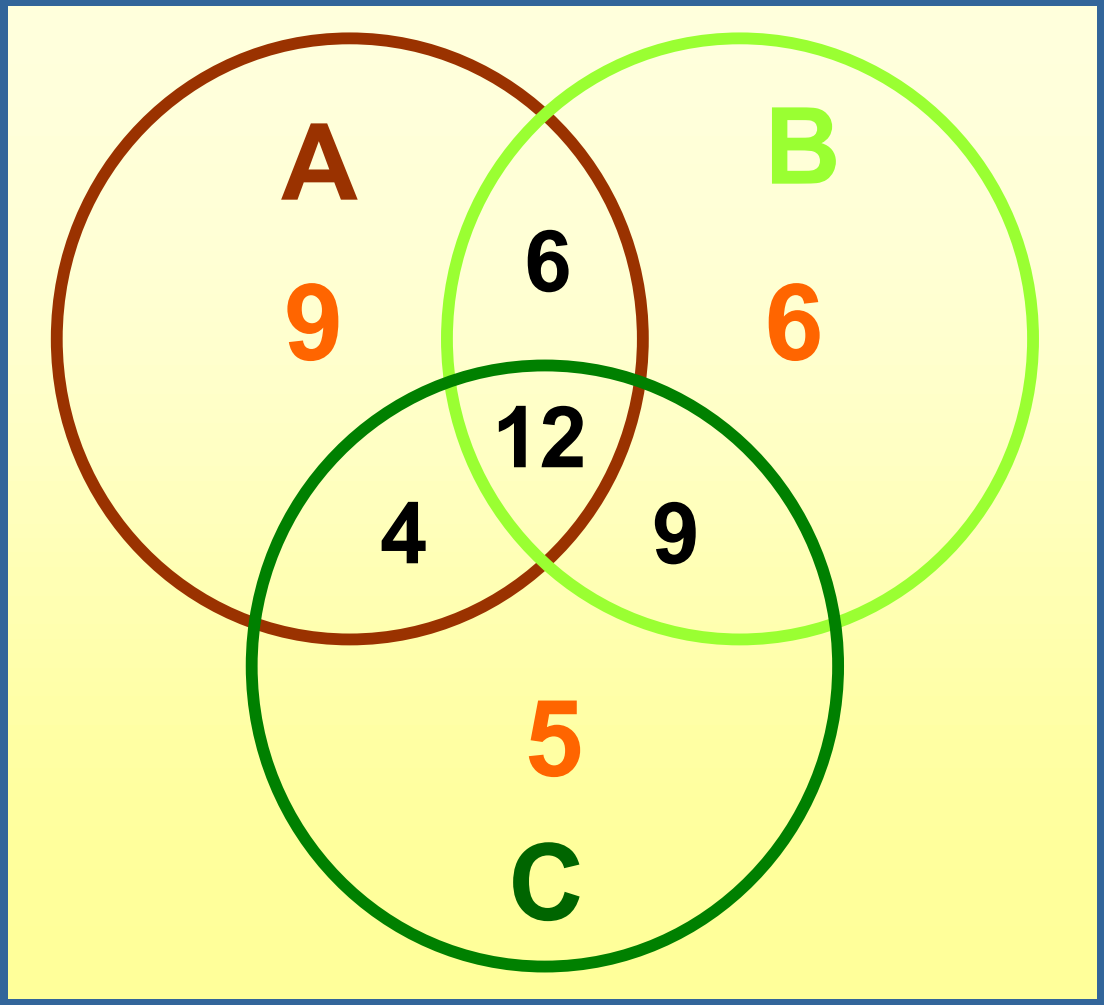
2

3 C

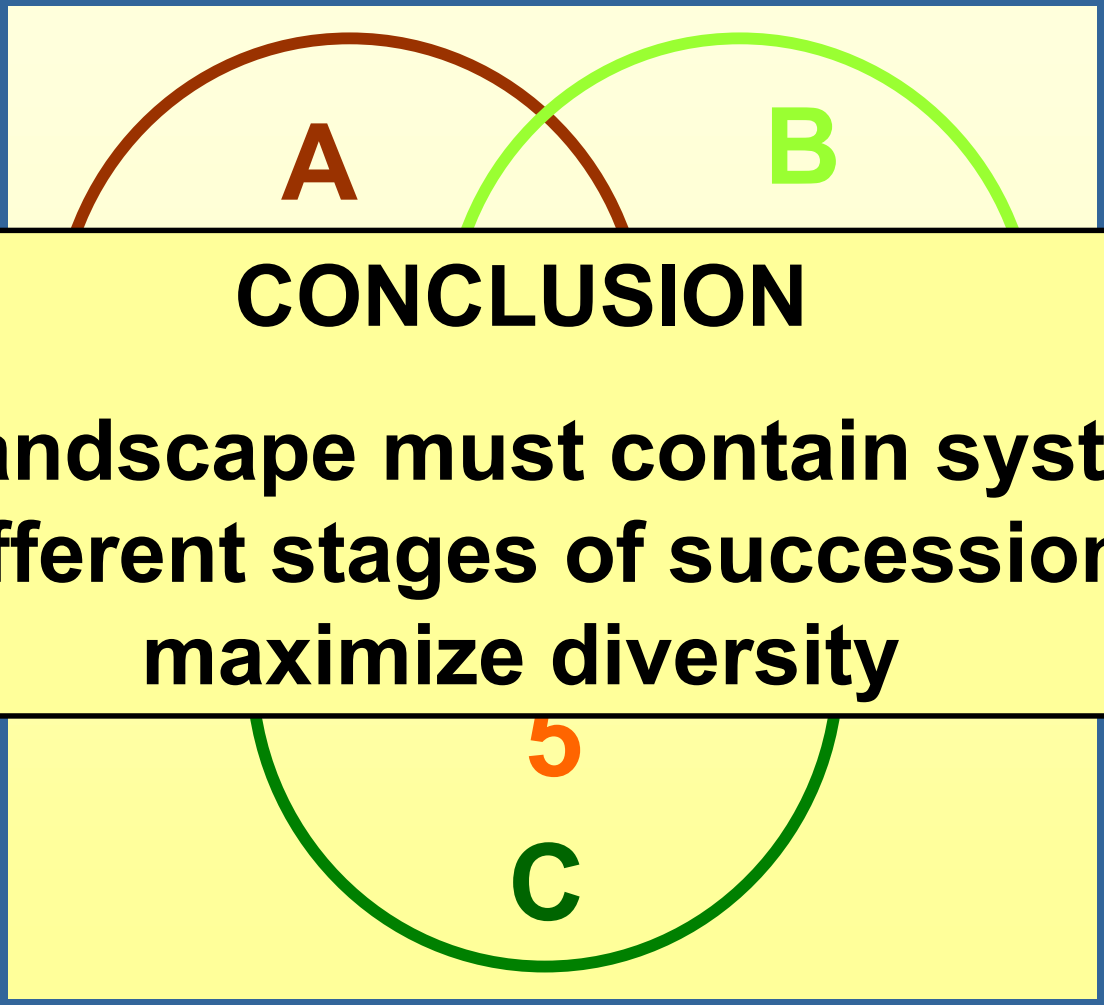
4

5

‘Unique species in time’



‘Unique species in time’



CONCLUSION

The landscape must contain systems at different stages of succession to maximize diversity

B: The spatial dimension

Example: Mosaic landscapes

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Comparison of Land Use Types

The conventional approach

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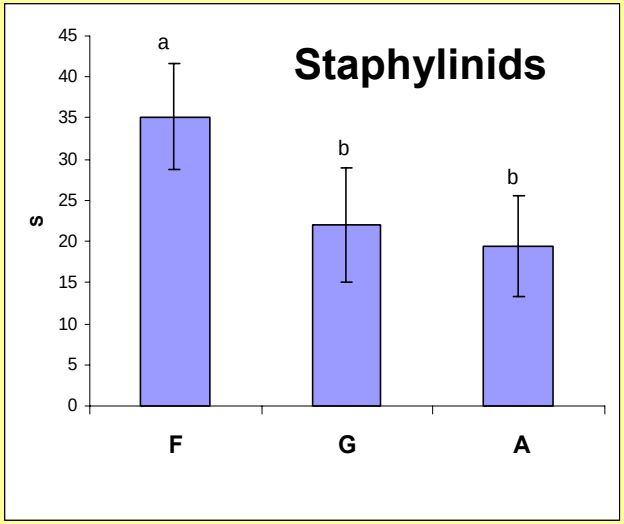
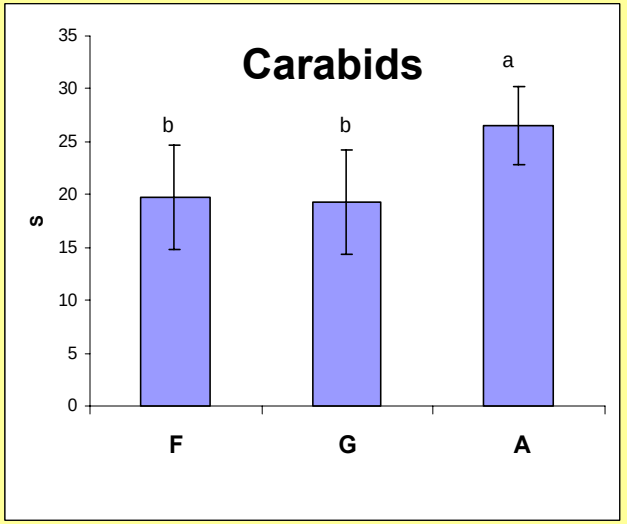
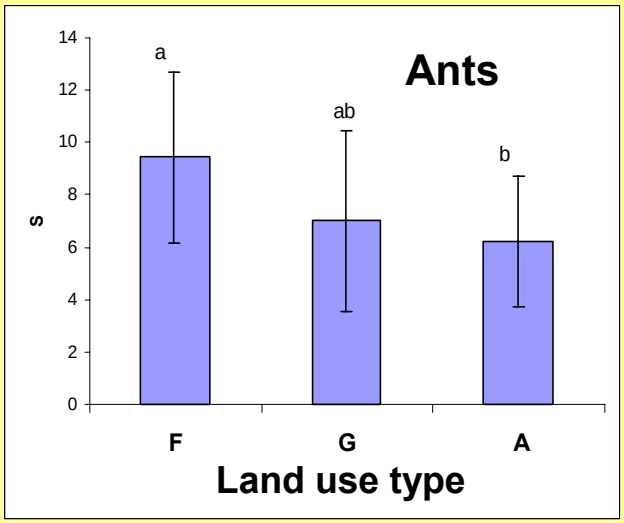
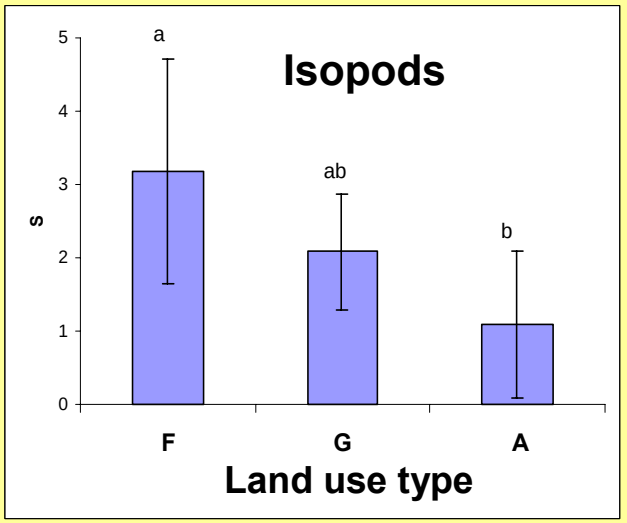
Macroinvertebrates









F: Fallow land
G: Grassland
A: Arable land

All habitat types contribute to invertebrate richness

	total	% unique species in		
	species richness	arable land	fallow land	grassland
staphylinids	153	16	29	9
carabids	100	21	16	1
ants	27	11	19	4

Staphylinids

Carabids

Ants

All habitat types contribute to invertebrate richness

	total	% unique species in		
staph				
carab				
ants				

CONCLUSION

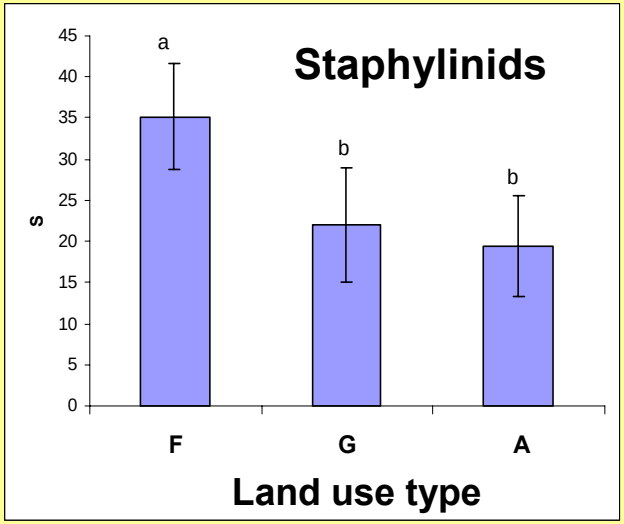
The landscape must contain a variety of land use types to maximize diversity

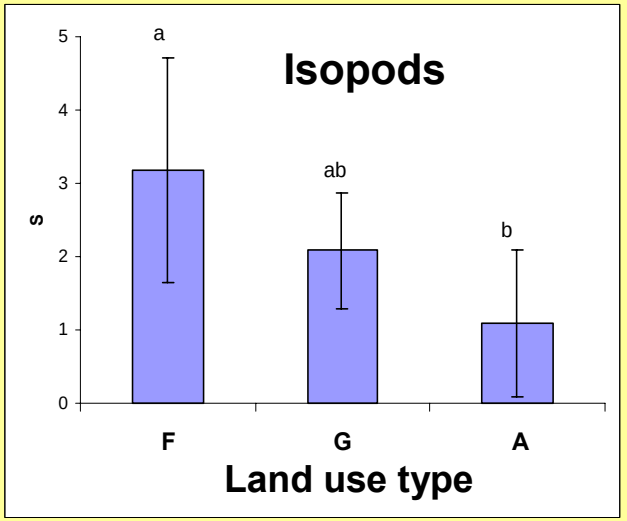
Staphylinids

Carabids

Ants

But what explains the variability within the land use types?





F: Fallow land
G: Grassland
A: Arable land

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B: The spatial dimension

The landscape context:

Environmental gradients

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Topography

CAS Computer aided sampling and landscape characterization tool

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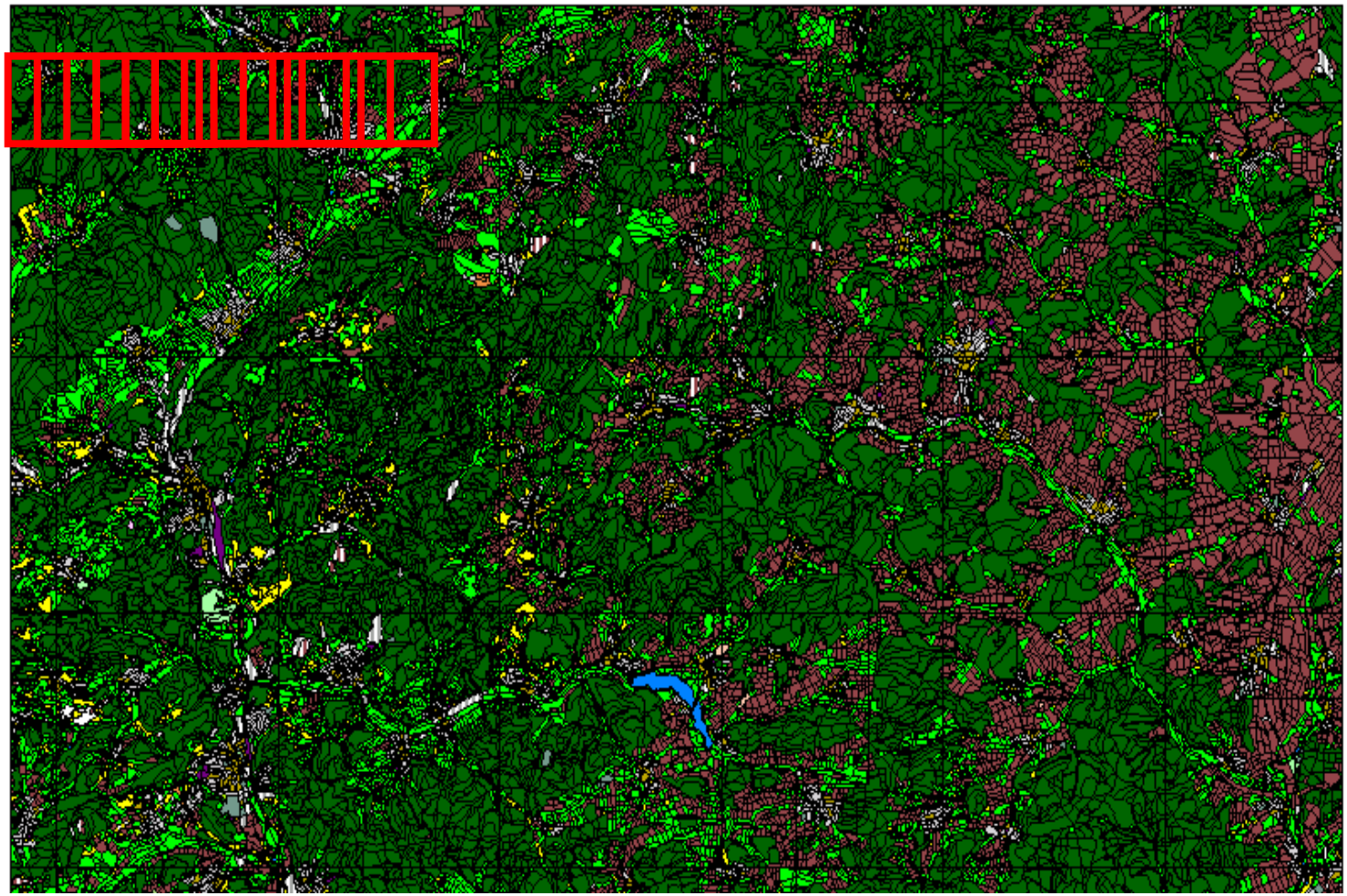
Land use types



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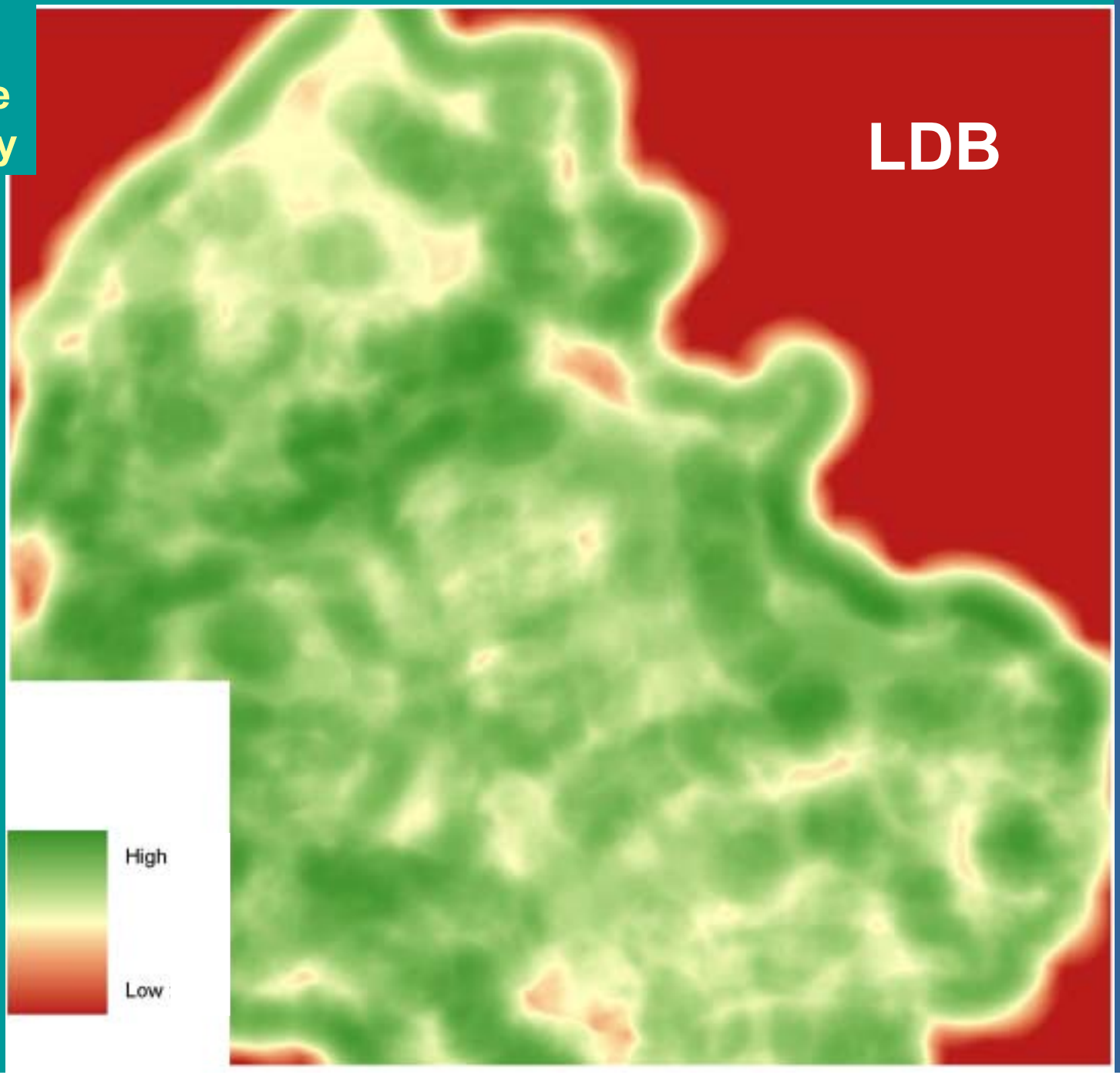
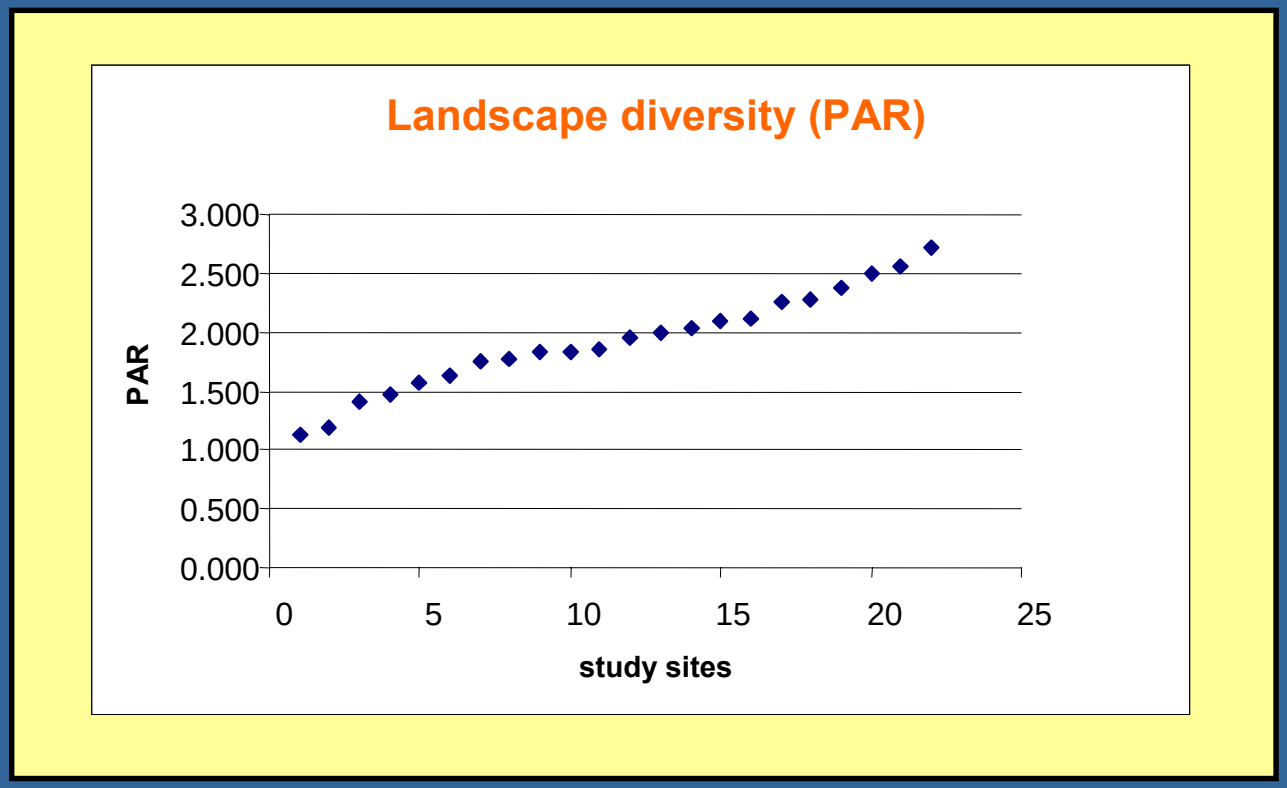
PAR: Index of Landscape Complexity



Gradients of landscape complexity



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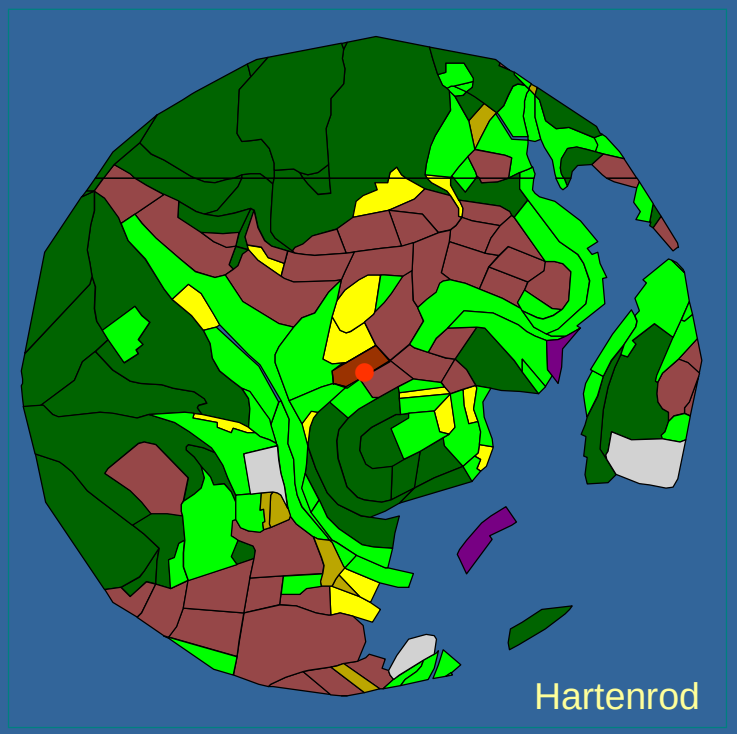
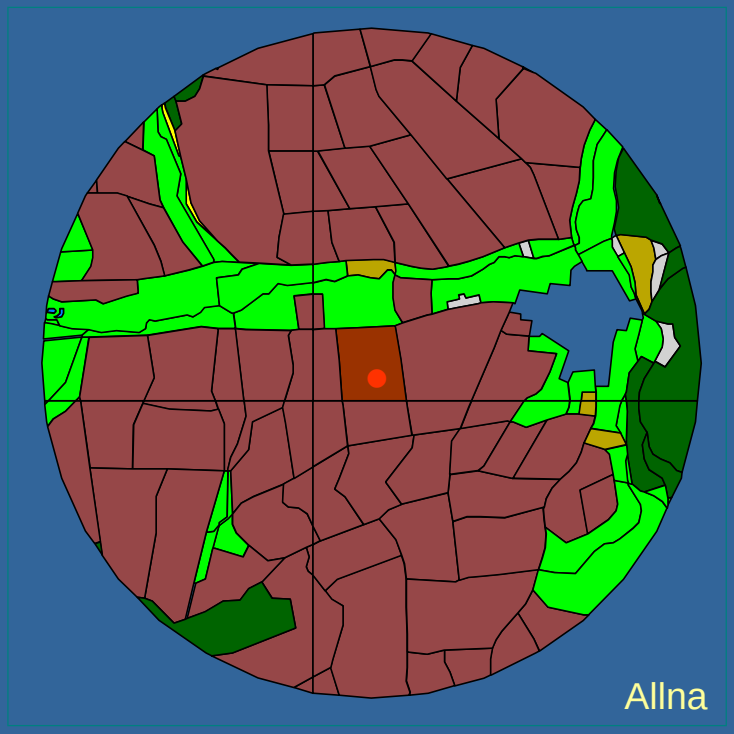
Landscape context (PAR)
Bee diversity in rape fields





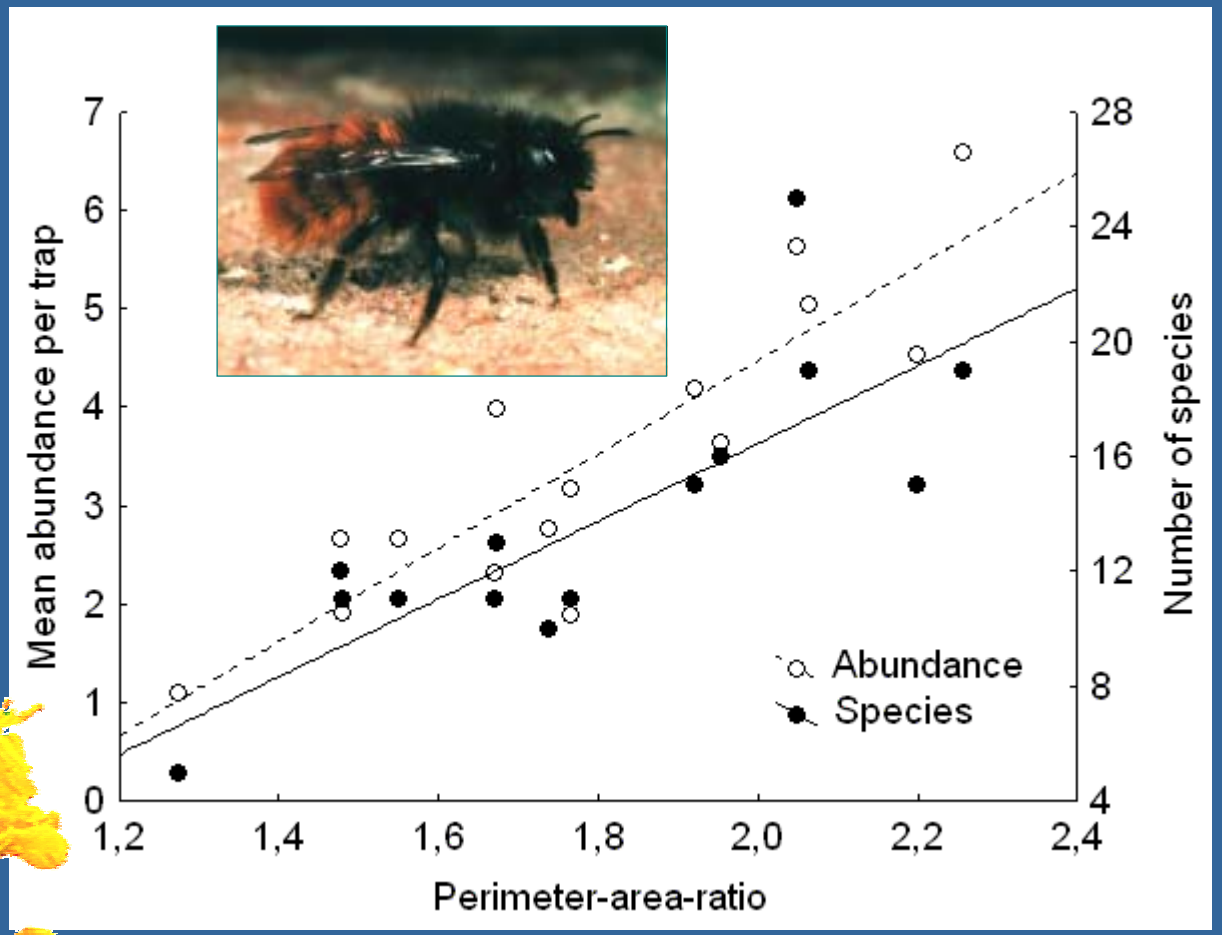
1 km

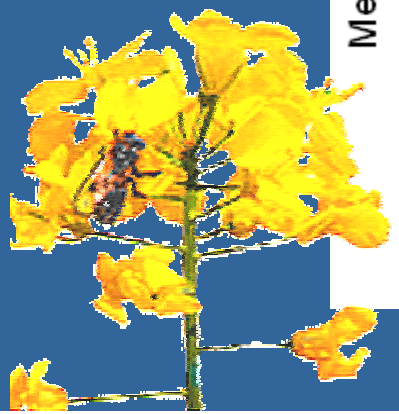
Arable land
Grassland

Forest
Fallow (Shrubs)

N

Abundance and richness increase with complexity of the surrounding landscape





Cross-scale Analysis

An integrative approach

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Cross-scale descriptors of landscape pattern

Patch

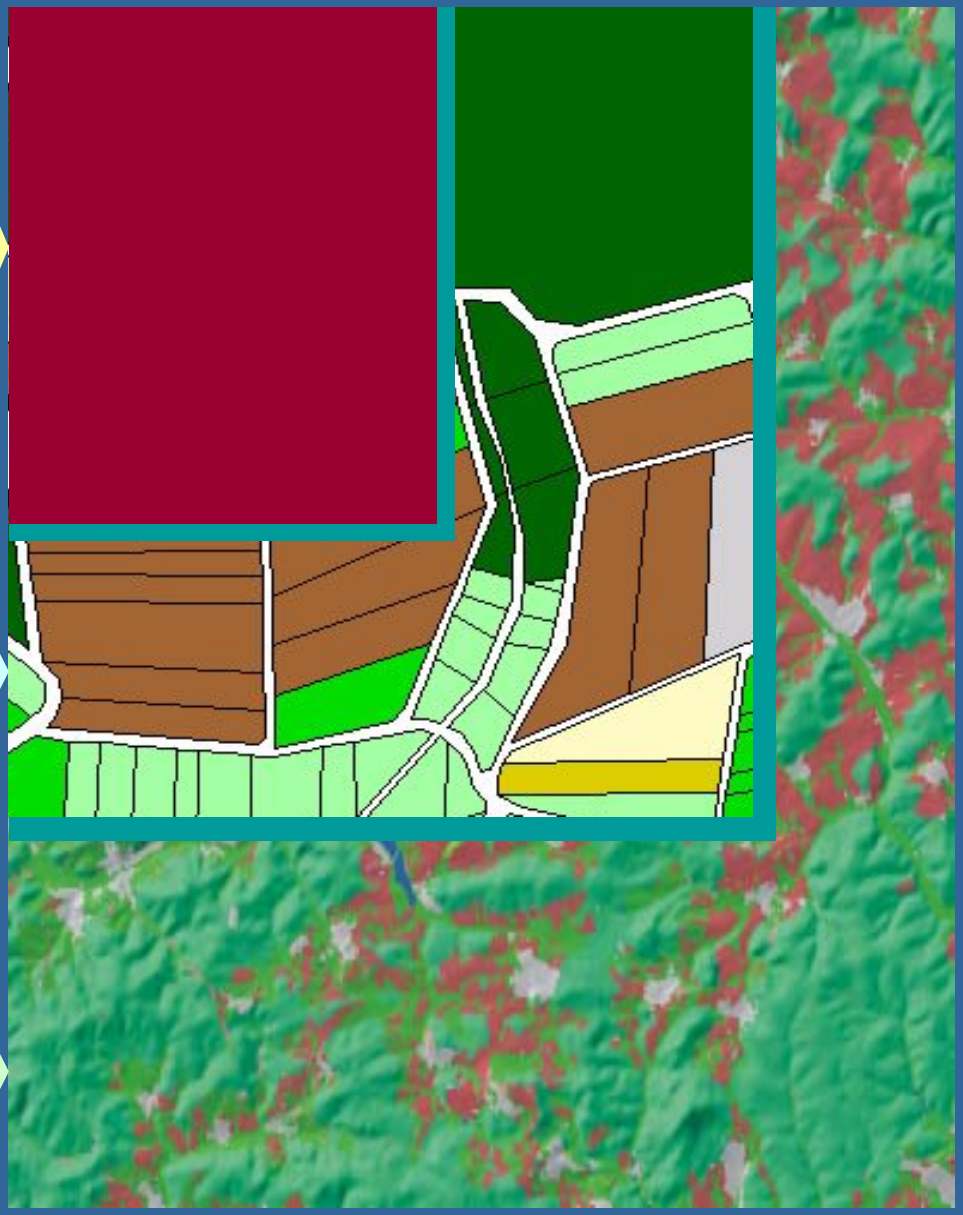
- Land use
- Soil characteristics
- Patch size
- Micro-heterogeneity
- ...

Neighbourhood

- Land-use diversity
- Contrast
- Similarity
- Edge length
- ...

Landscape

- Fragmentation
- Shape complexity
- Fractal dimension
- Topography
- ...



Cross-scale determinants of local species richness

Patch

- Environmental constraints
- Resource partitioning
- Competition
- Multitrophic interactions
- ...

Neighbourhood

- Spill over
- Multi habitat usage
- Shelter
- Annual recolonisation
- ...

Landscape

- Regional species pool
- Dispersal
- Metapopulation dynamics
- ...

local species richness ?

General Regression Models (GRM)

(stepwise forward)

Patch

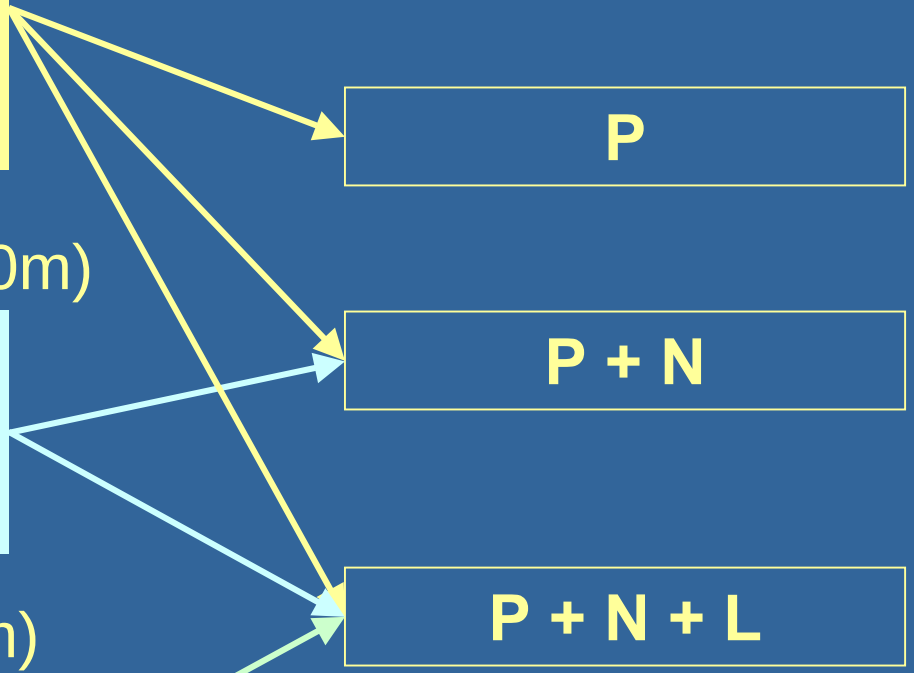
- Nitrogen-fertilization
- Disturbance
- Insolation
- Wetness of soils

Neighbourhood (500 x 500m)

- Cover of grassland (%)
- Cover of forest (%)
- Perimeter-to-area ratio

Landscape (4000 x 4000m)

- Cover of arable land (%)
- Mean slope (topography)
- Perimeter-to-area ratio



Example: Soil macroinvertebrate diversity

Cross-scale determinants in an agricultural landscape

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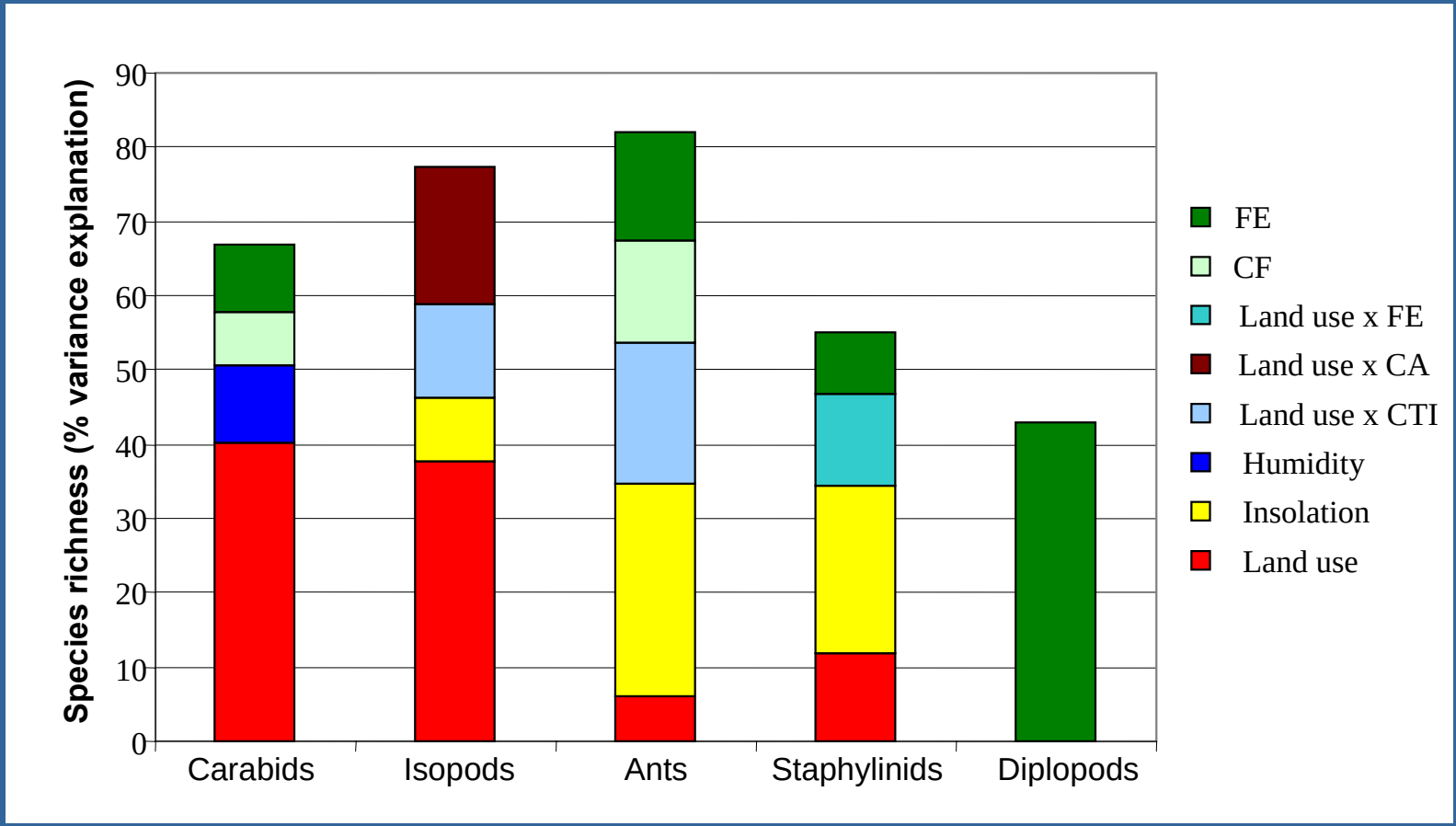
Macroinvertebrates
GRM-approach



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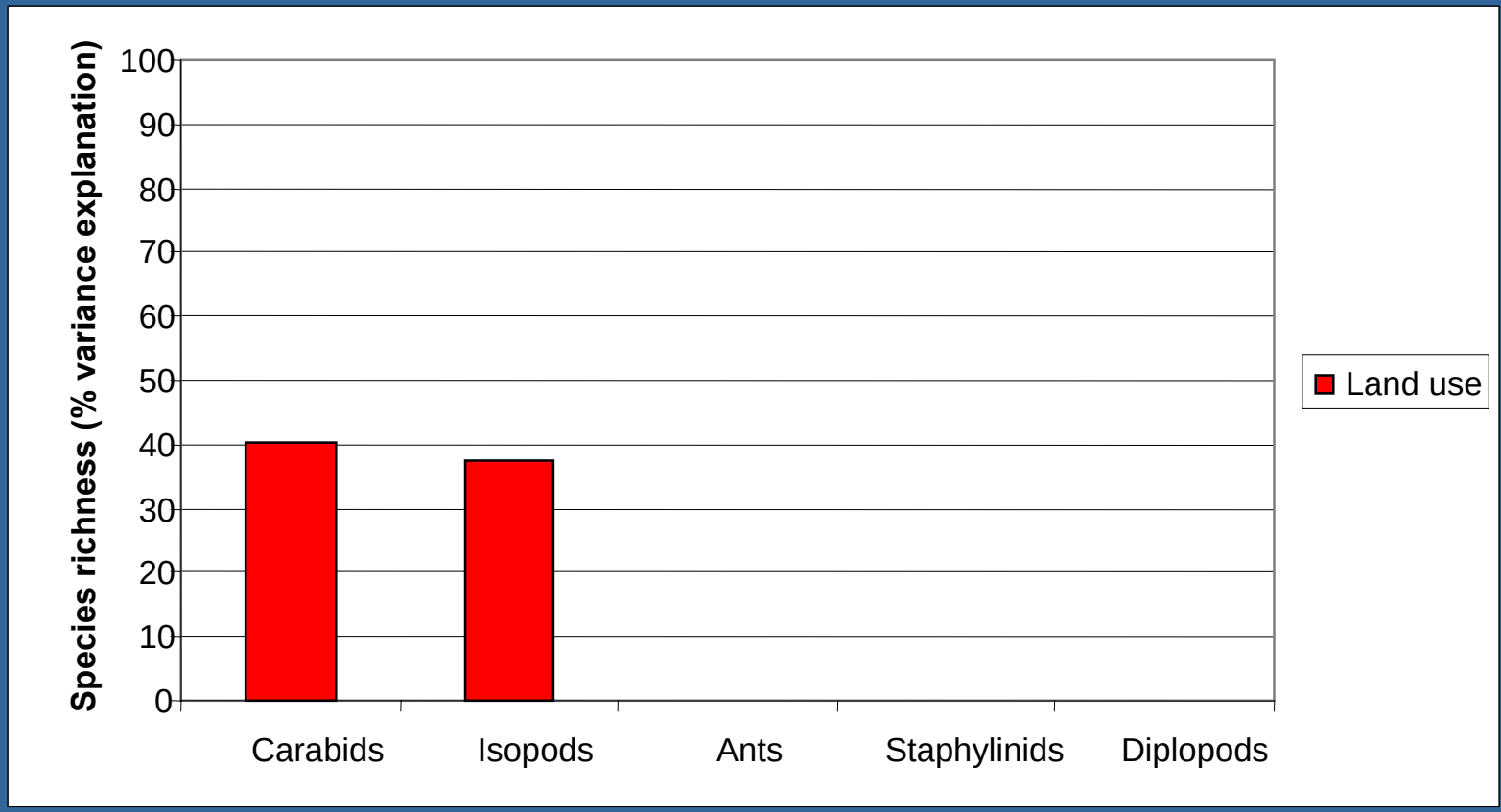
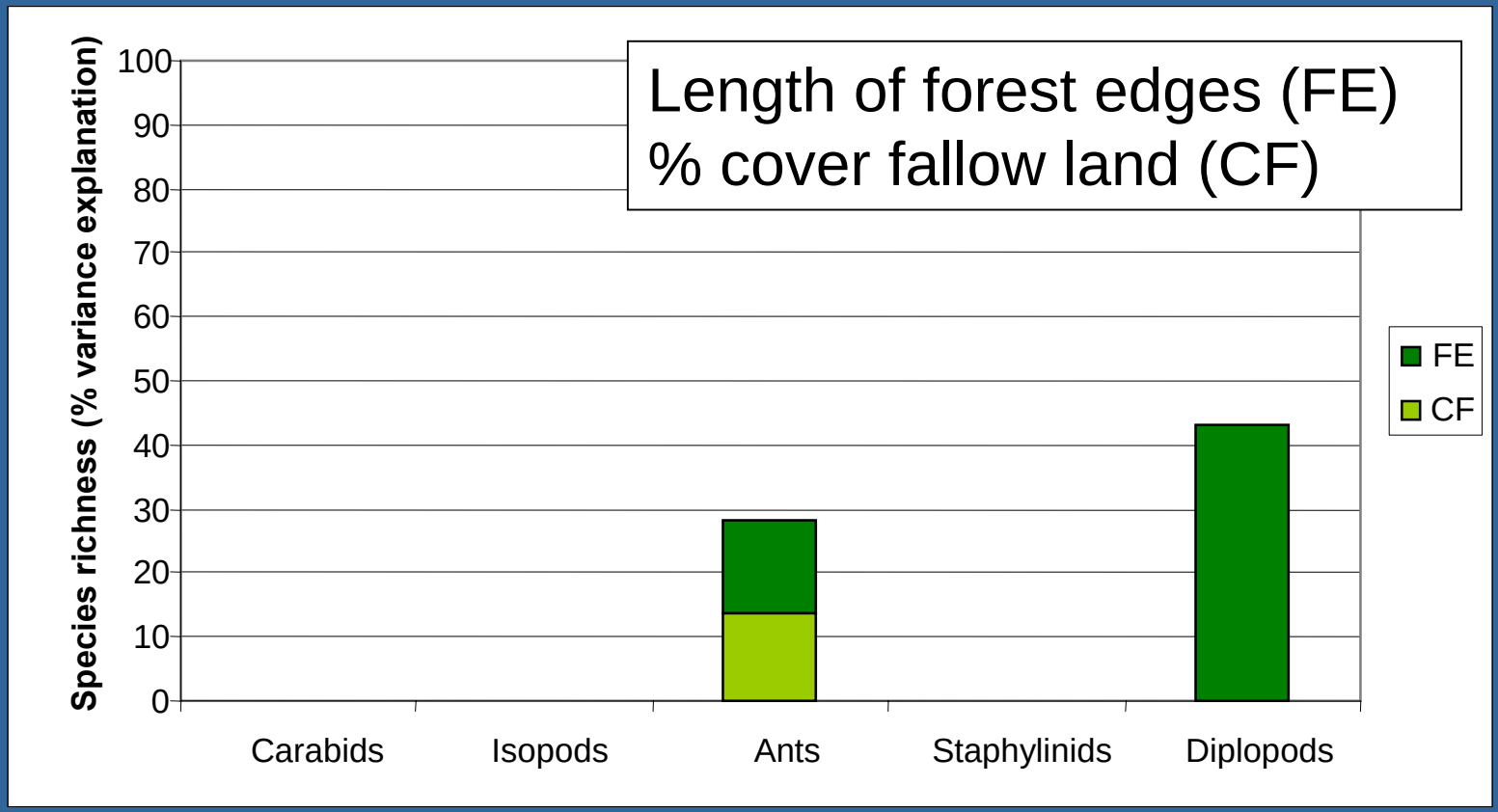
Land use type



Carabids: Arable land > Grassland / Fallow land

Isopods: Fallow land > Grassland > Arable land

Landscape matrix

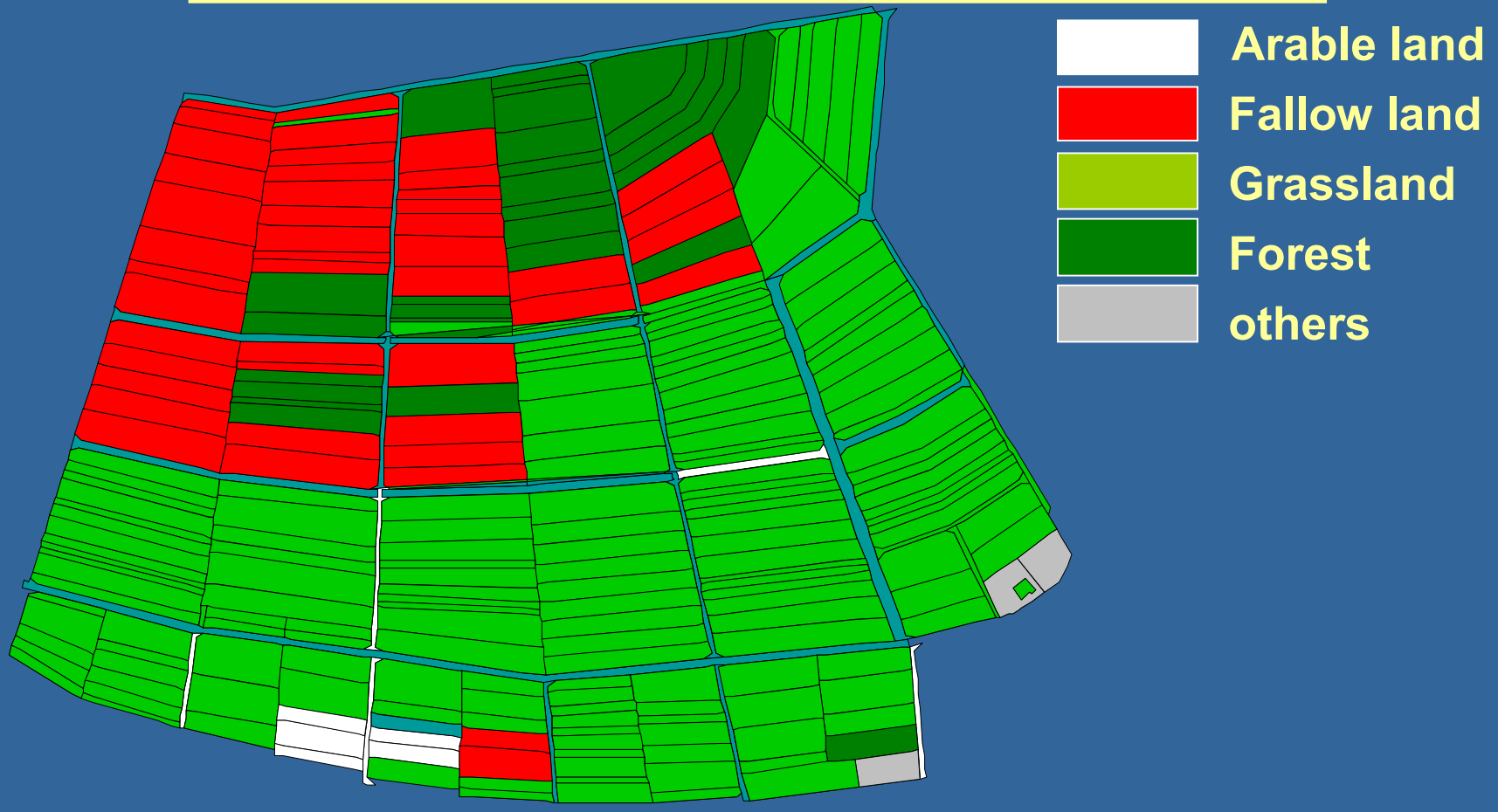


Ants: Fallow land - negative, length of forest edges - positive

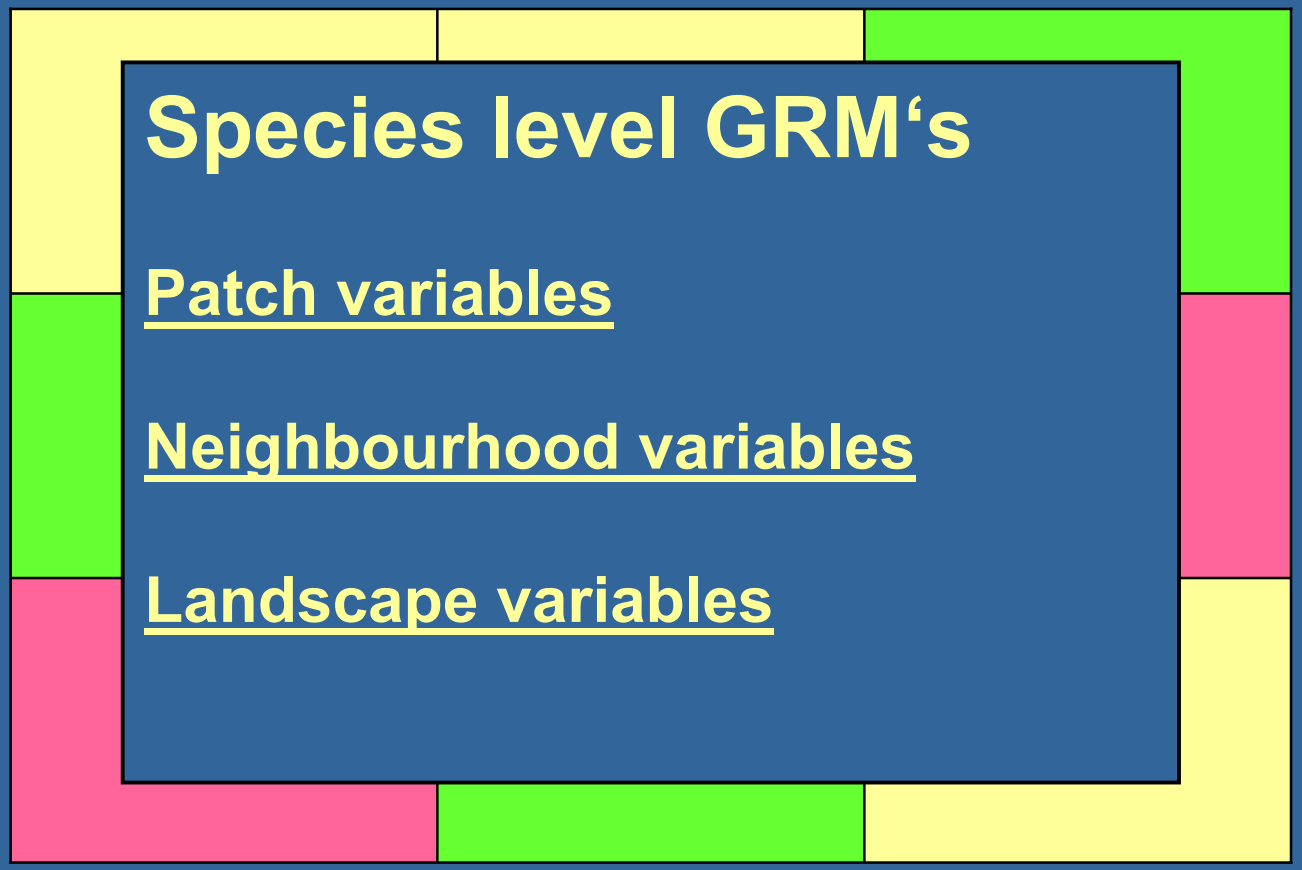
Diplopods: length of forest edges - positive

How to use this information?

➔Biodiversity scenarios



Predicting species richness

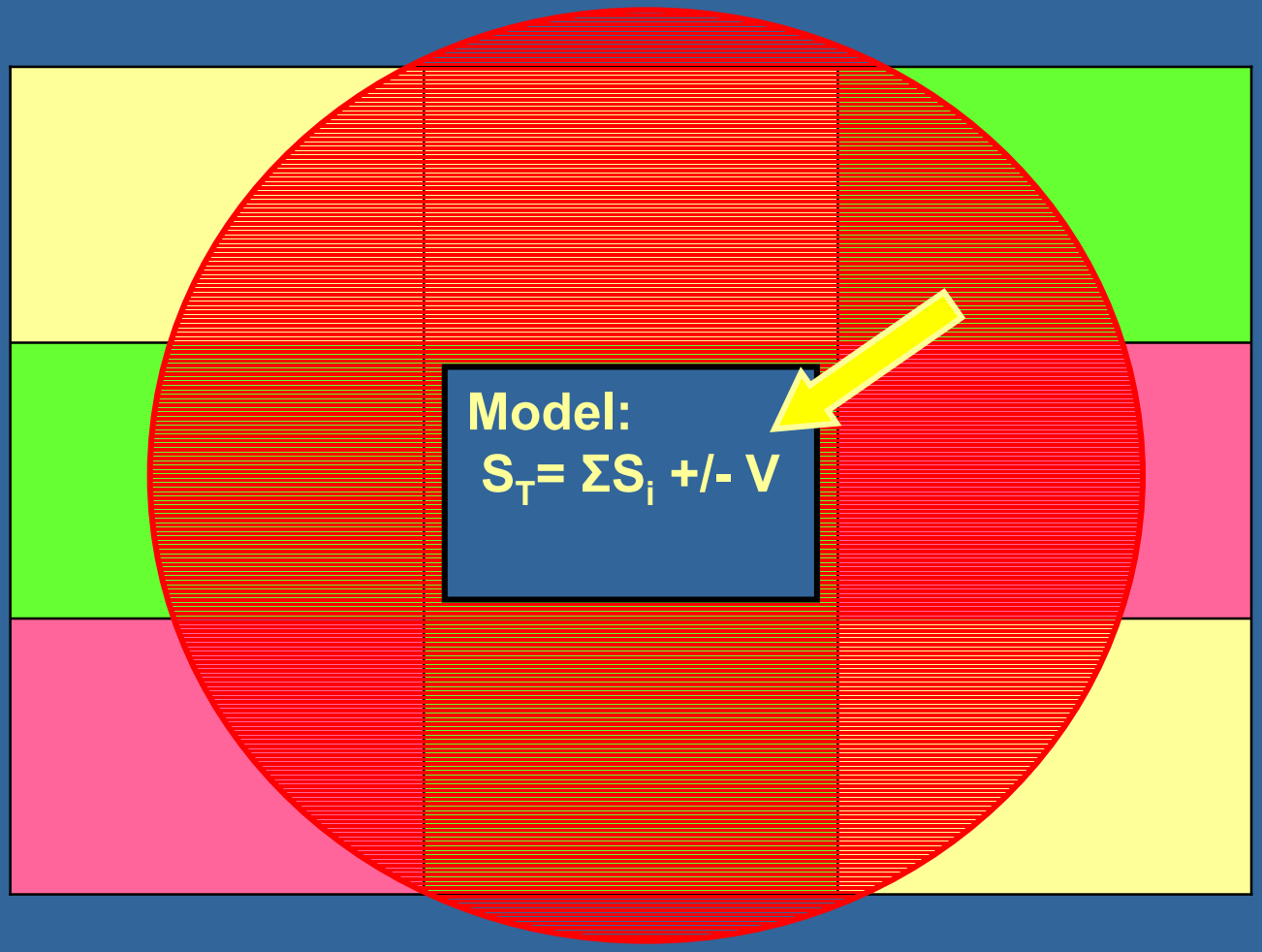


Grassland

Arable land

Fallow land

Analysis per area
(moving window)



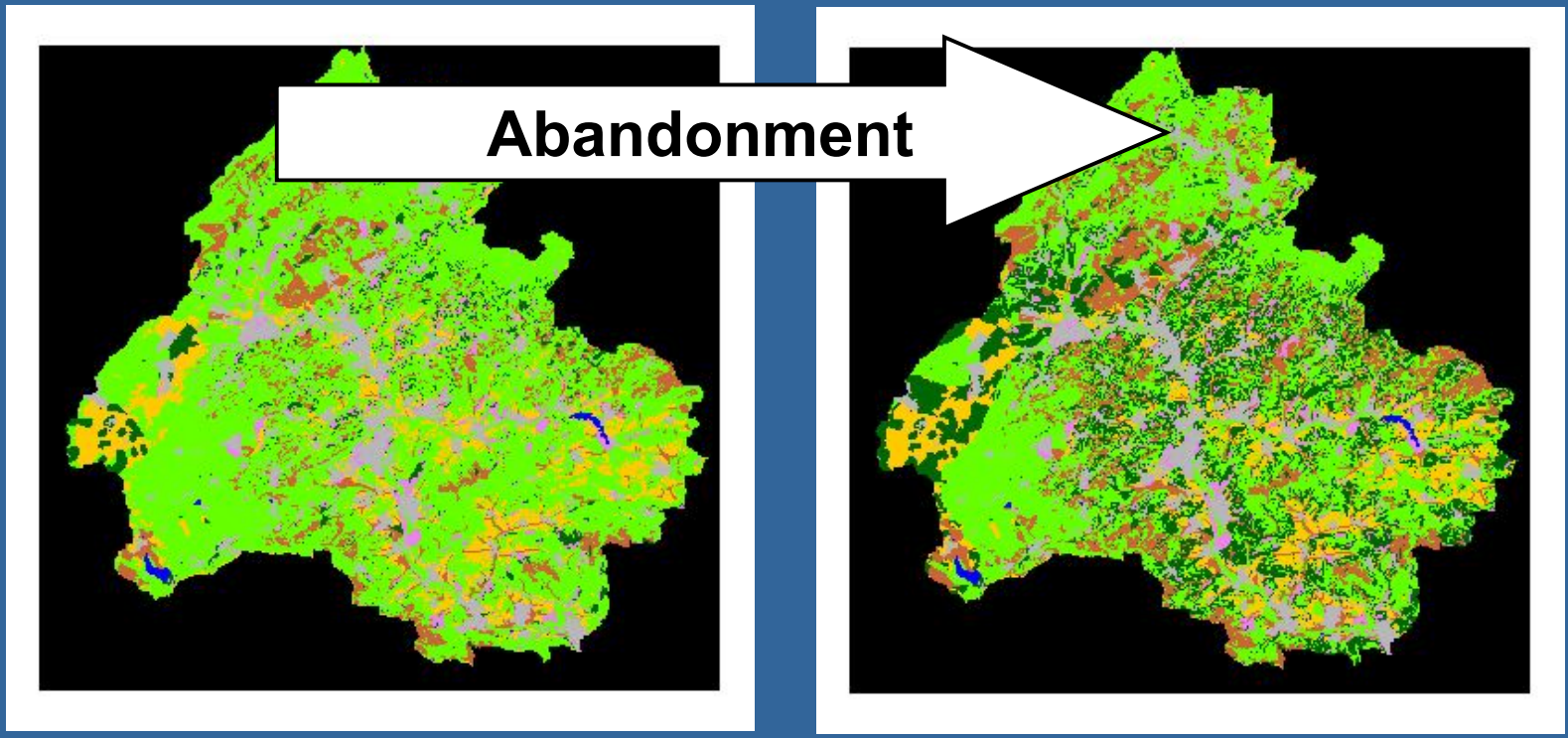
Grassland

Arable land

Fallow land

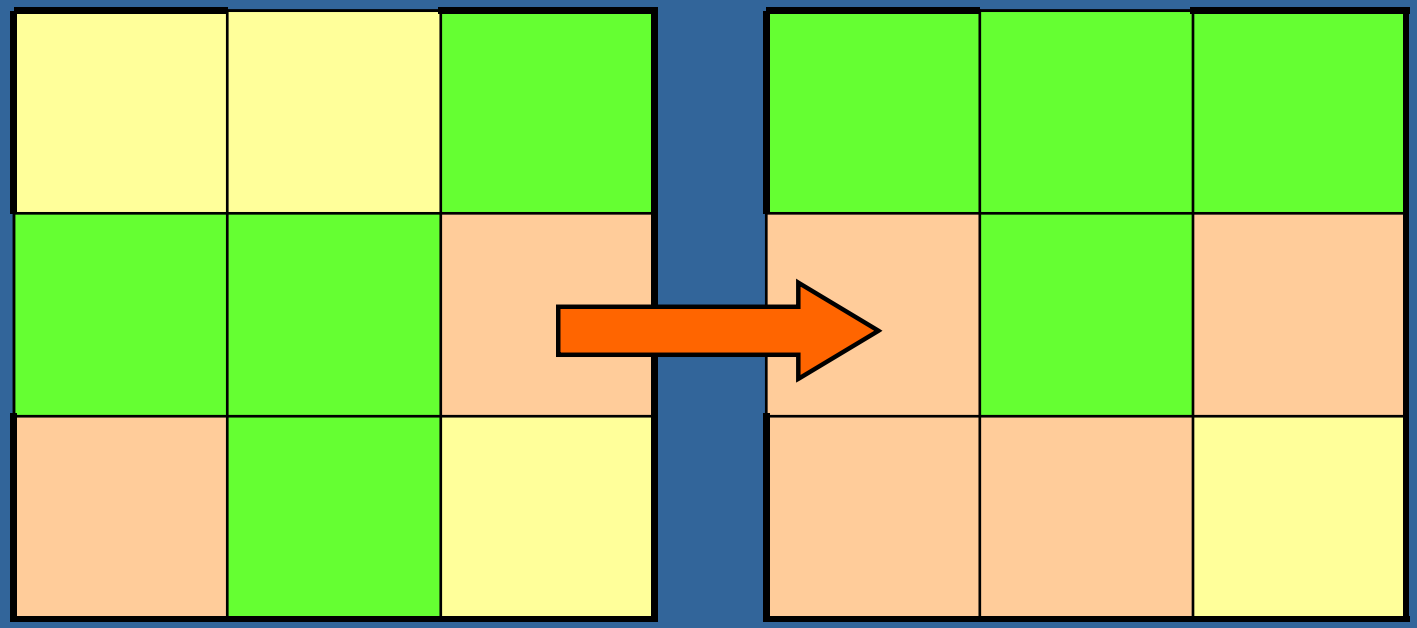
Simulating the Consequences of Abandonment

(based on Economic scenarios)



Variable: Average size of area under management

Modeling of biodiversity scenarios



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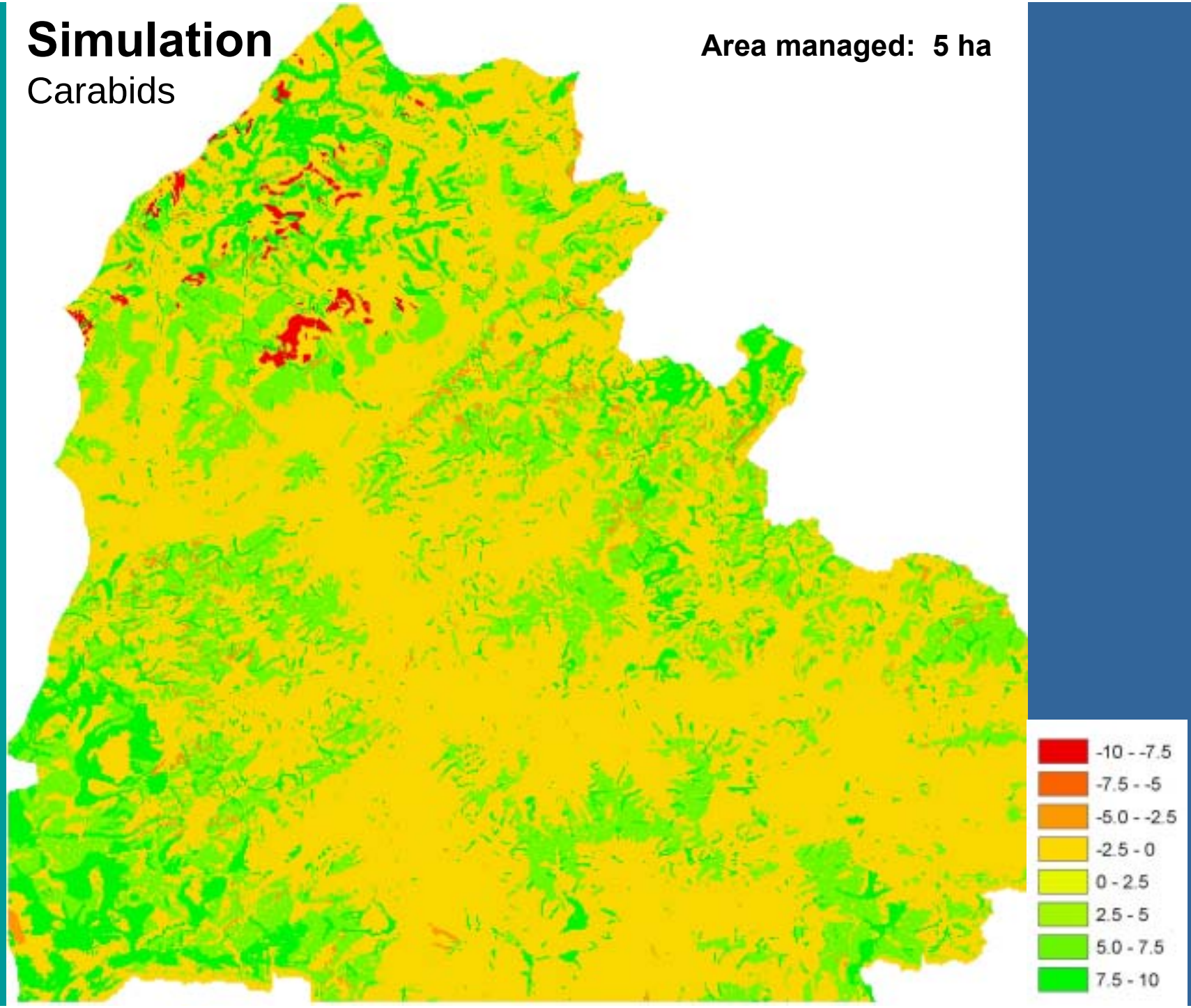
Simulation

Carabids

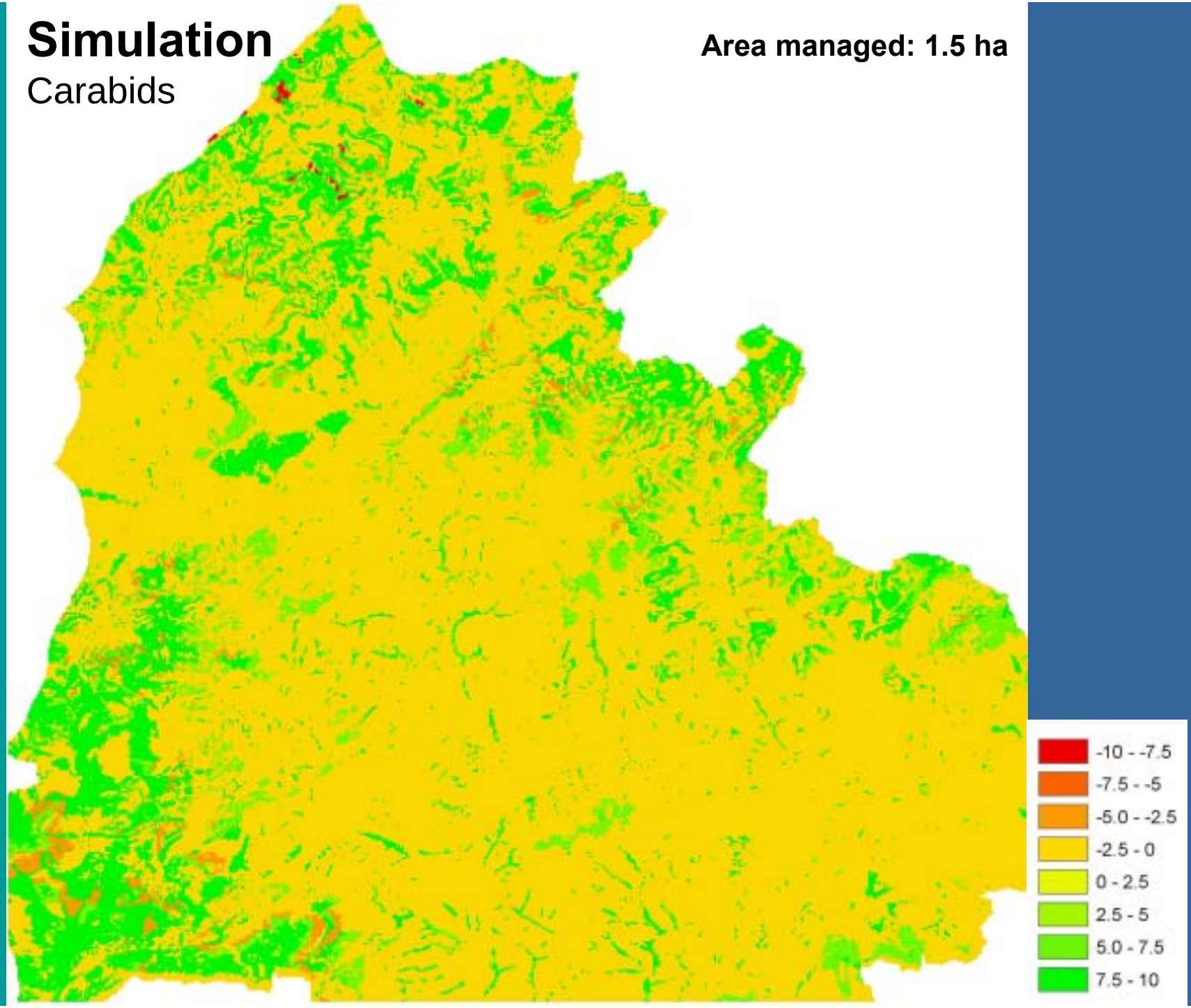
Area managed: 5 ha



Simulation

Carabids

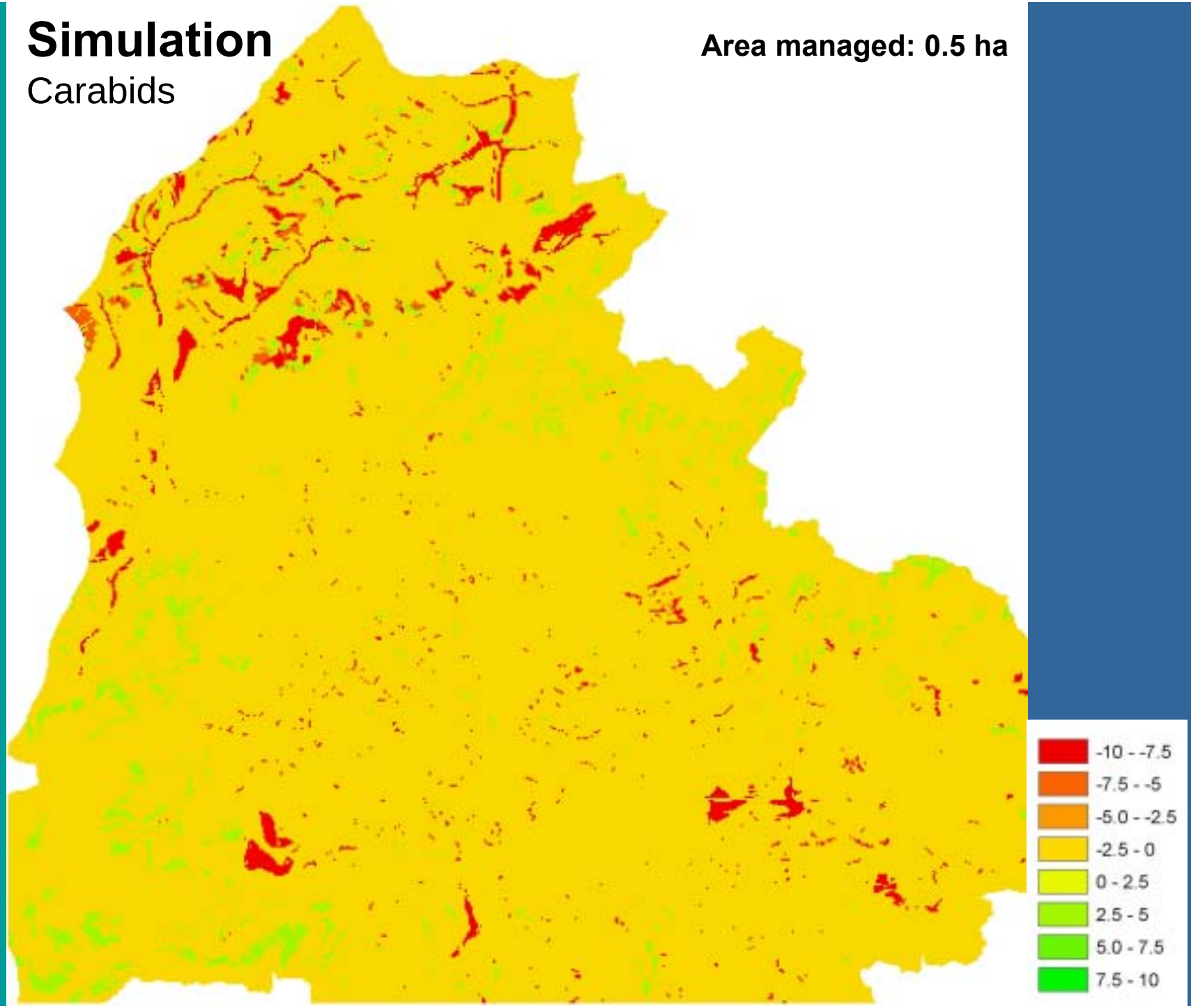
Area managed: 1.5 ha



Simulation

Carabids

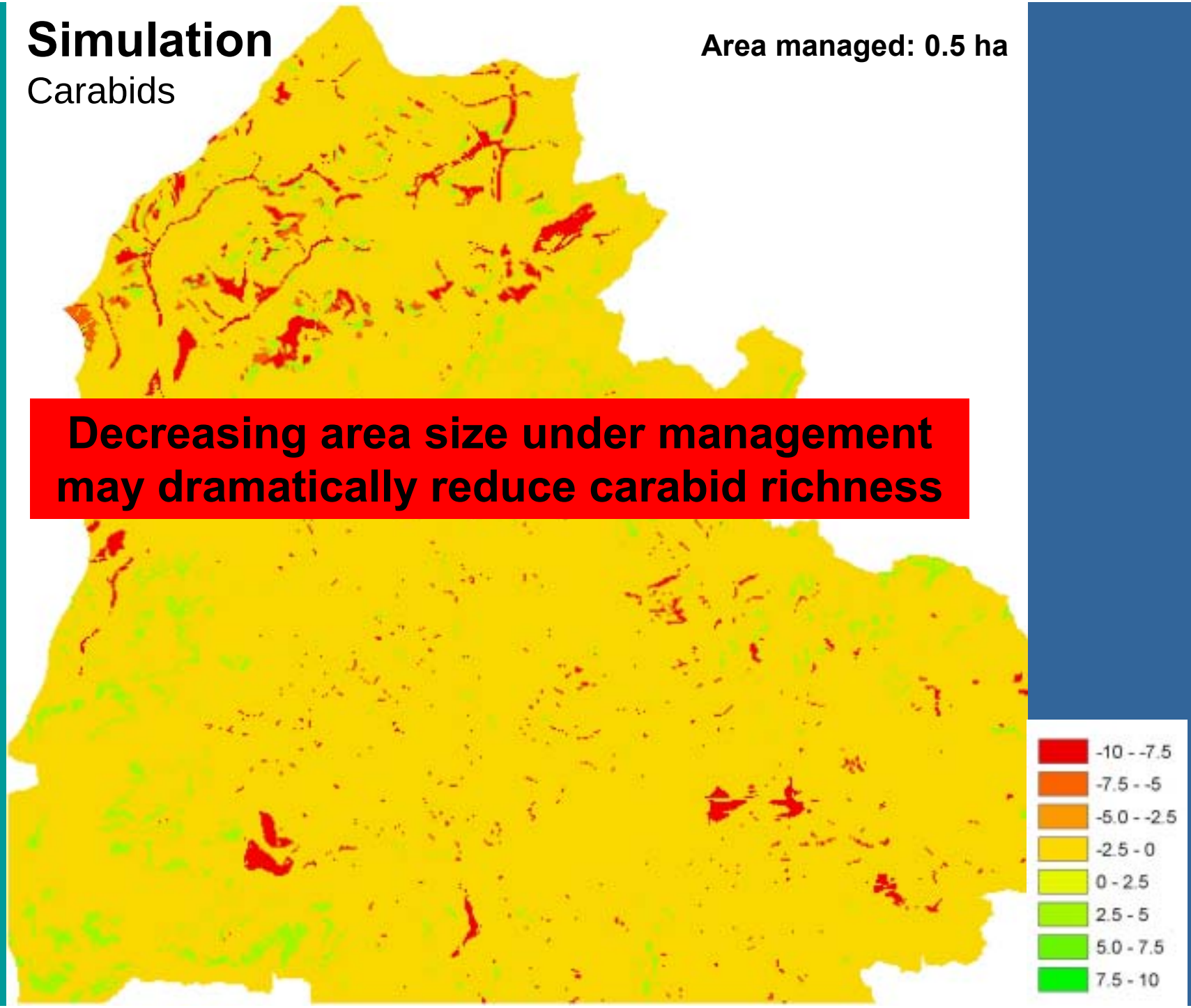
Area managed: 0.5 ha



Simulation

Carabids

Area managed: 0.5 ha



Decreasing area size under management may dramatically reduce carabid richness

Conclusions

- Interlinked temporal and spatial dimensions
- Maximizing diversity by the parallel availability of
  a. systems at different stages of succession
  b. a variety of land use types
- Richness depends on factors acting across scales
- Taxa and functional groups respond differently
- Biodiversity scenarios:
  a. Linking economic and ecological information
  b. Biodiversity change at the landscape scale

Conclusion;
You need a good team....!

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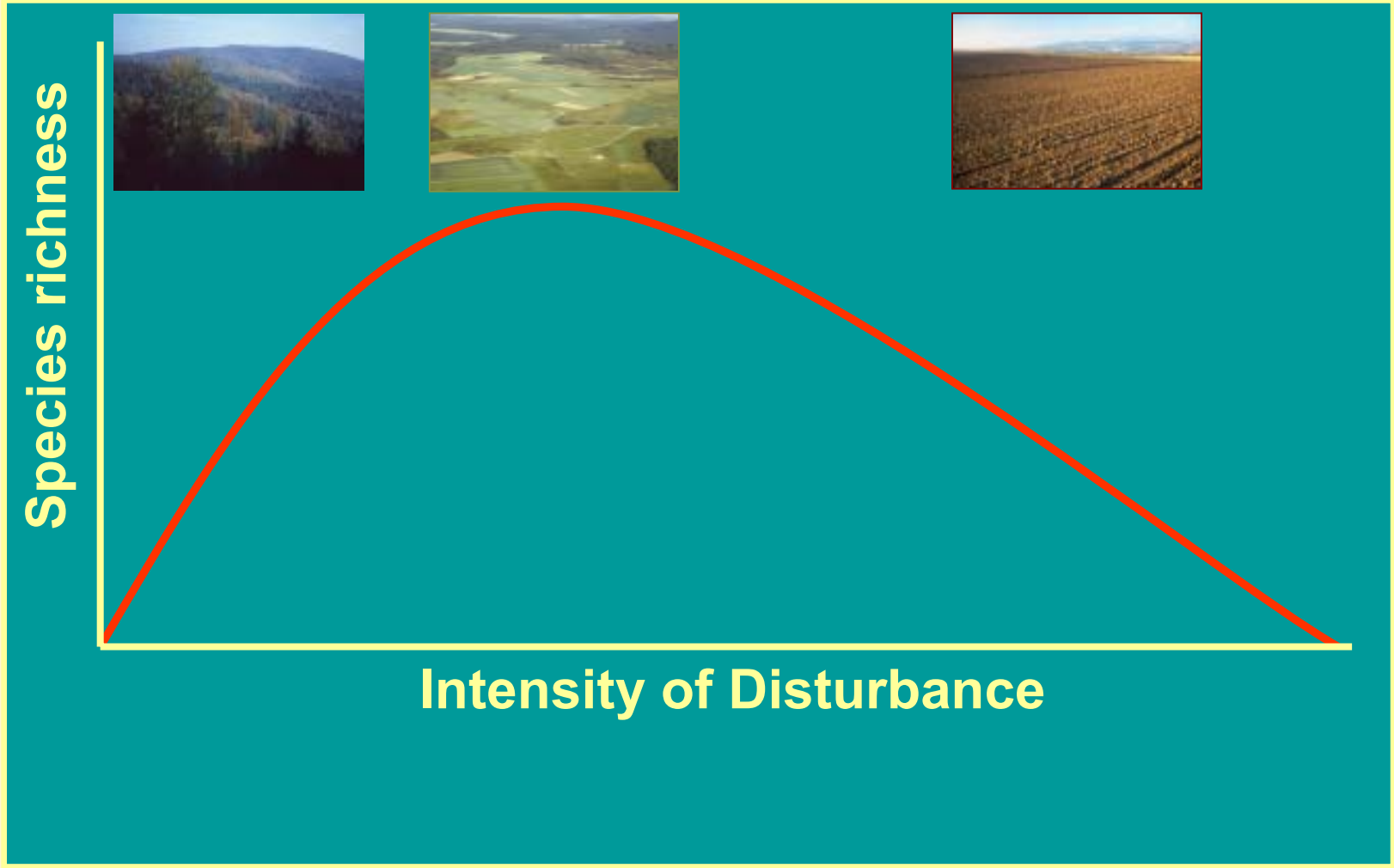
The end...

The end...

‚Intermediate Disturbance Hypothesis‘



Connell 1978

Abandonment: Turning back the wheel?