



# STRENGTHENING LANDSCAPE HETEROGENEITY IS THE KEY TO CONSERVE AND RESTORE ANIMAL DIVERSITY IN WETLANDS



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survival plan **woodland** + **nature**

agriculture, nature  
and food quality



# Contents

1. Theory

2. Current management practice

3. Research questions

4. Impact of management

5. Management implications

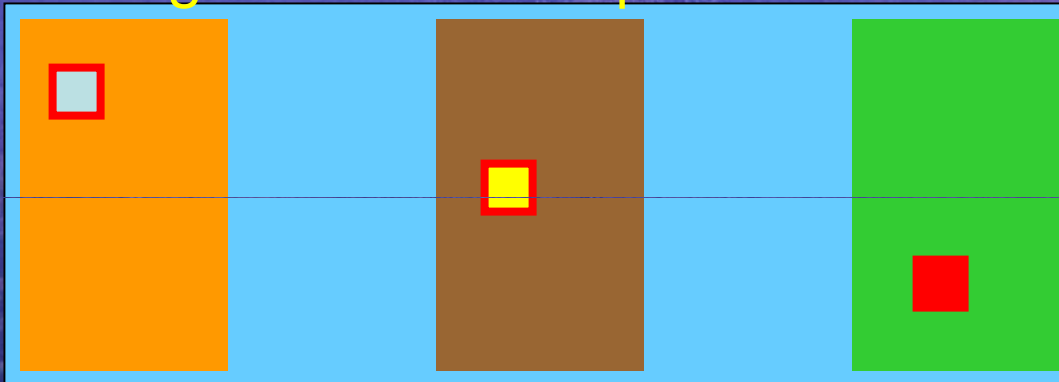
A landscape photograph showing a field of tall grasses in the foreground, leading to a single, large tree in the middle ground. The background consists of a line of trees under a clear blue sky. The entire image has a blue color cast.

# 1. Theory

Relationship heterogeneity – animal diversity

# Importance of heterogeneity

homogenous landscape



1. additive

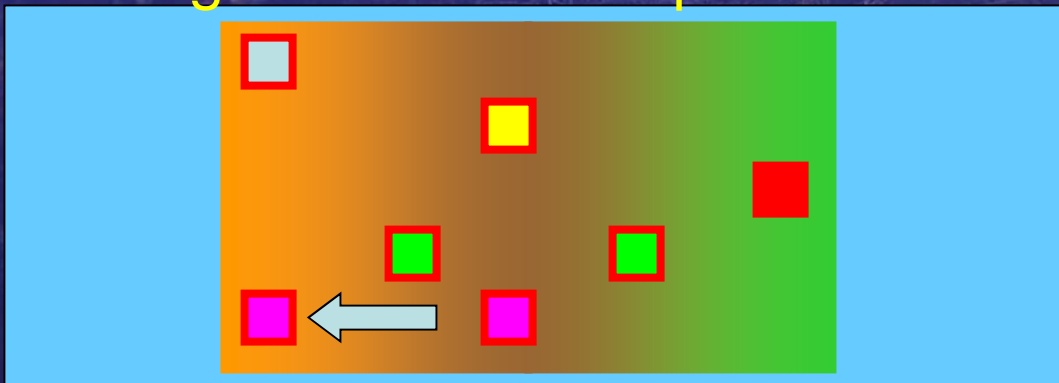
2. synergistic

2a gradients

2b multihabitat use

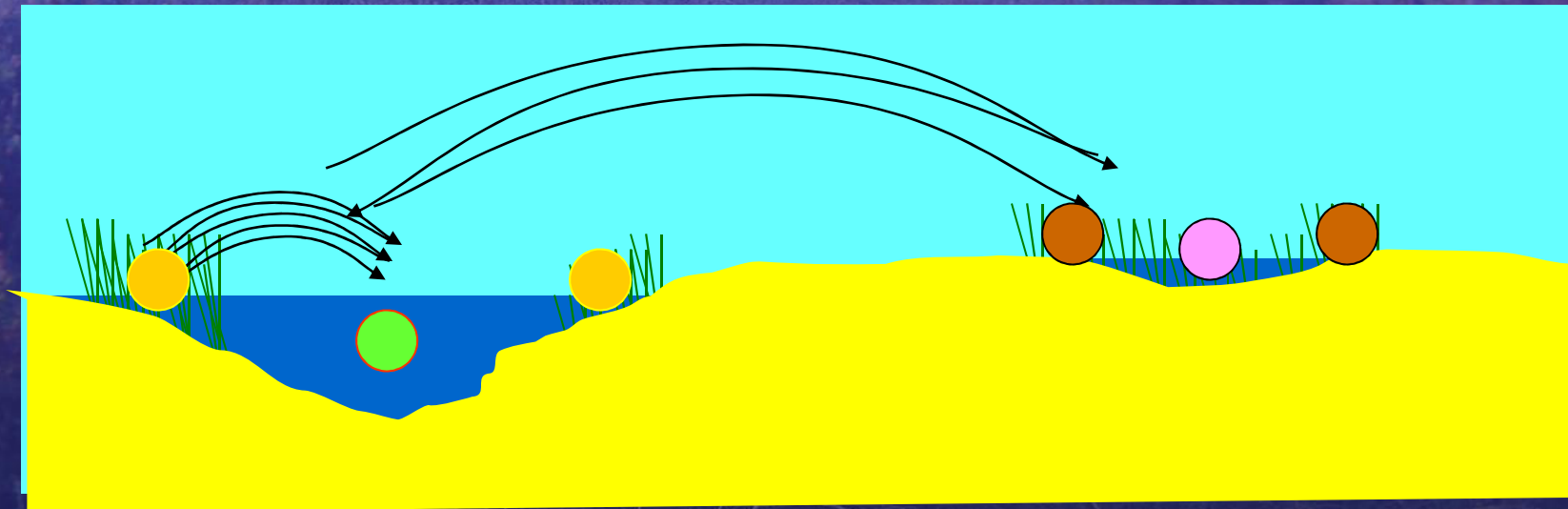
2c spreading of risk

heterogeneous landscape



# Importance of heterogeneity

- food
- shelter
- reproduce
- pupate



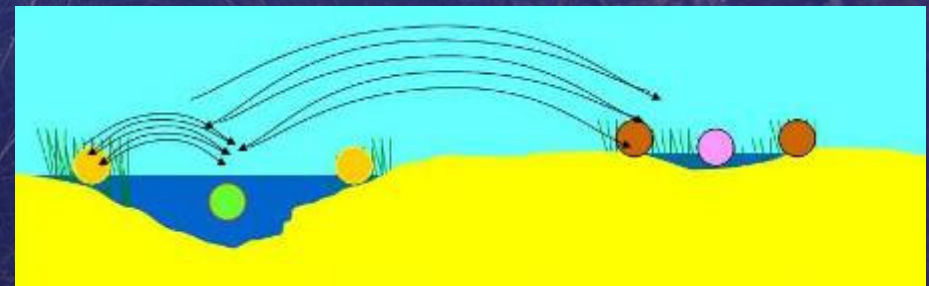


Flight capacity  
Feeding group  
Oviposition requirements  
Lifespan

'match' between fauna and landscape



Variation watertypes  
Spatial configuration





# 1. Theory

Relationship heterogeneity – animal diversity

Mobility necessity for multihabitat use

Match species & landscapes

Effects of degradation

Degradation of patch quality



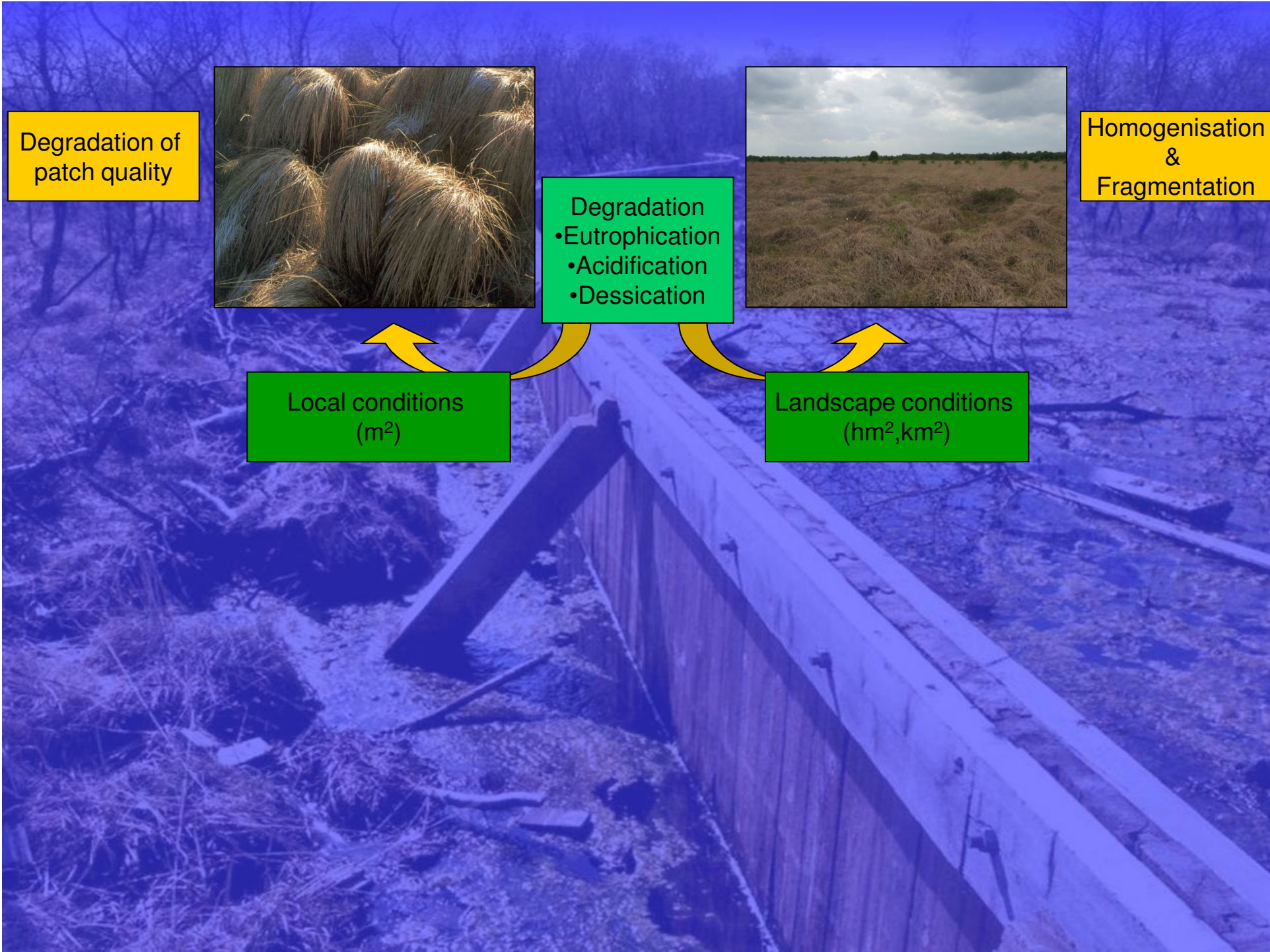
Degradation  
•Eutrophication  
•Acidification  
•Dessication



Homogenisation & Fragmentation

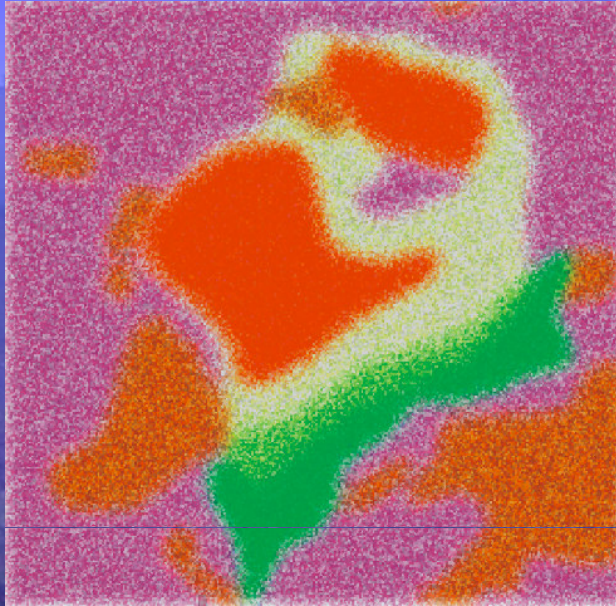
Local conditions  
(m<sup>2</sup>)

Landscape conditions  
(hm<sup>2</sup>, km<sup>2</sup>)





Pristine



degradation

Degraded





# 1. Theory

## Relationship heterogeneity – animal diversity

Mobility necessity for multihabitat use

Match species & landscapes

## Effects of degradation

Small scale: decrease in patch quality

Large scale: fragmentation & homogenisation

## Effects of restoration

## 2. Practice

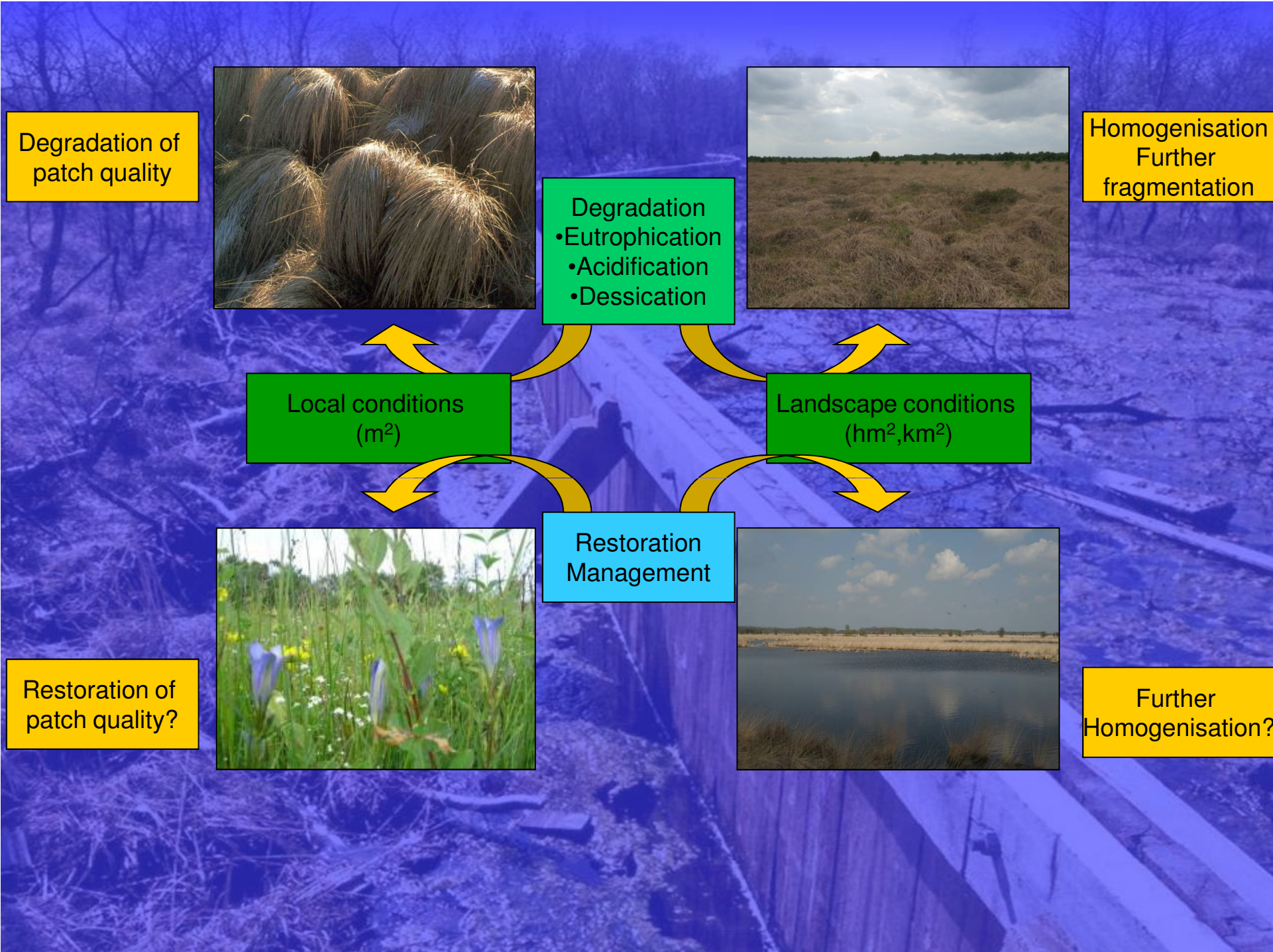
Effects of restoration



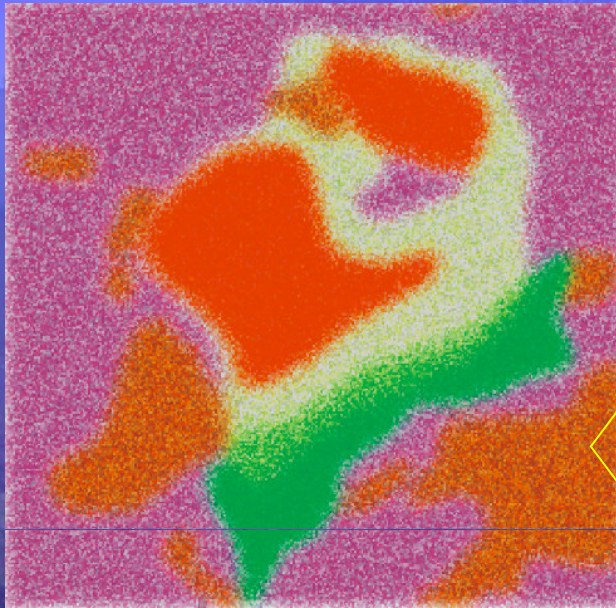
# Current restoration practices



Largescaled  
≡ *Fast*  
Intensive

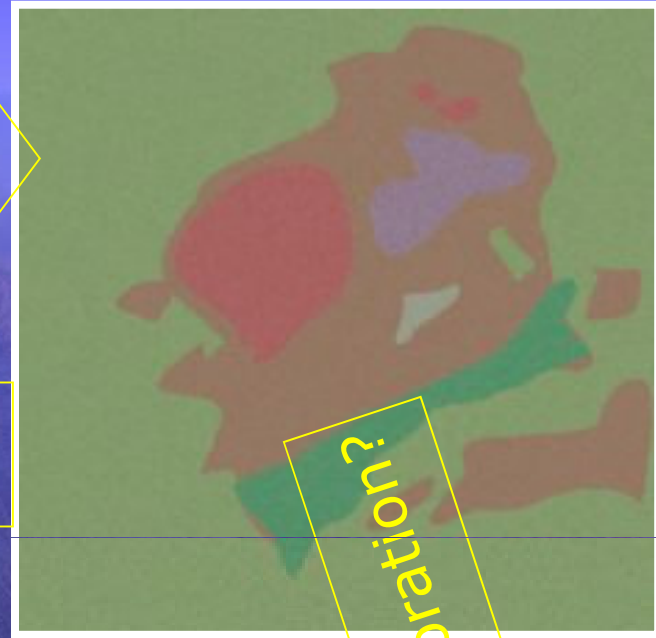


Pristine

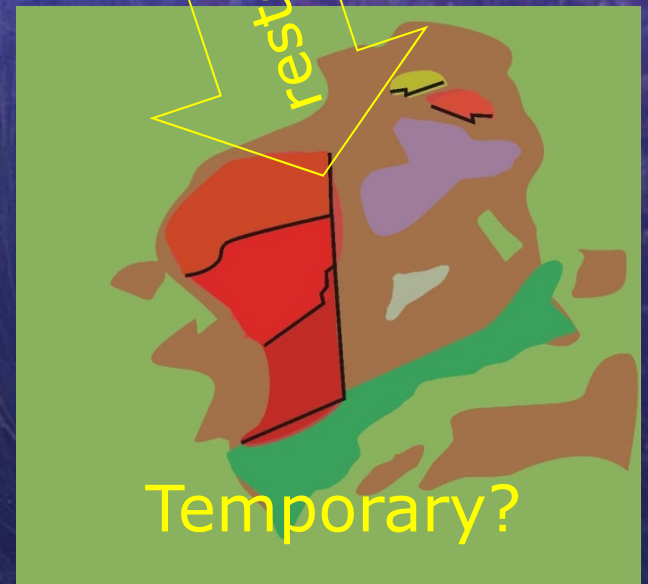


degradation

Degraded



restoration?



Temporary?

## 2. Practice

Effects of restoration

Shock effects

Further homogenisation



### 3. Research questions

Effects of restoration measures on:

- Species turnover
- Biotic homogenisation



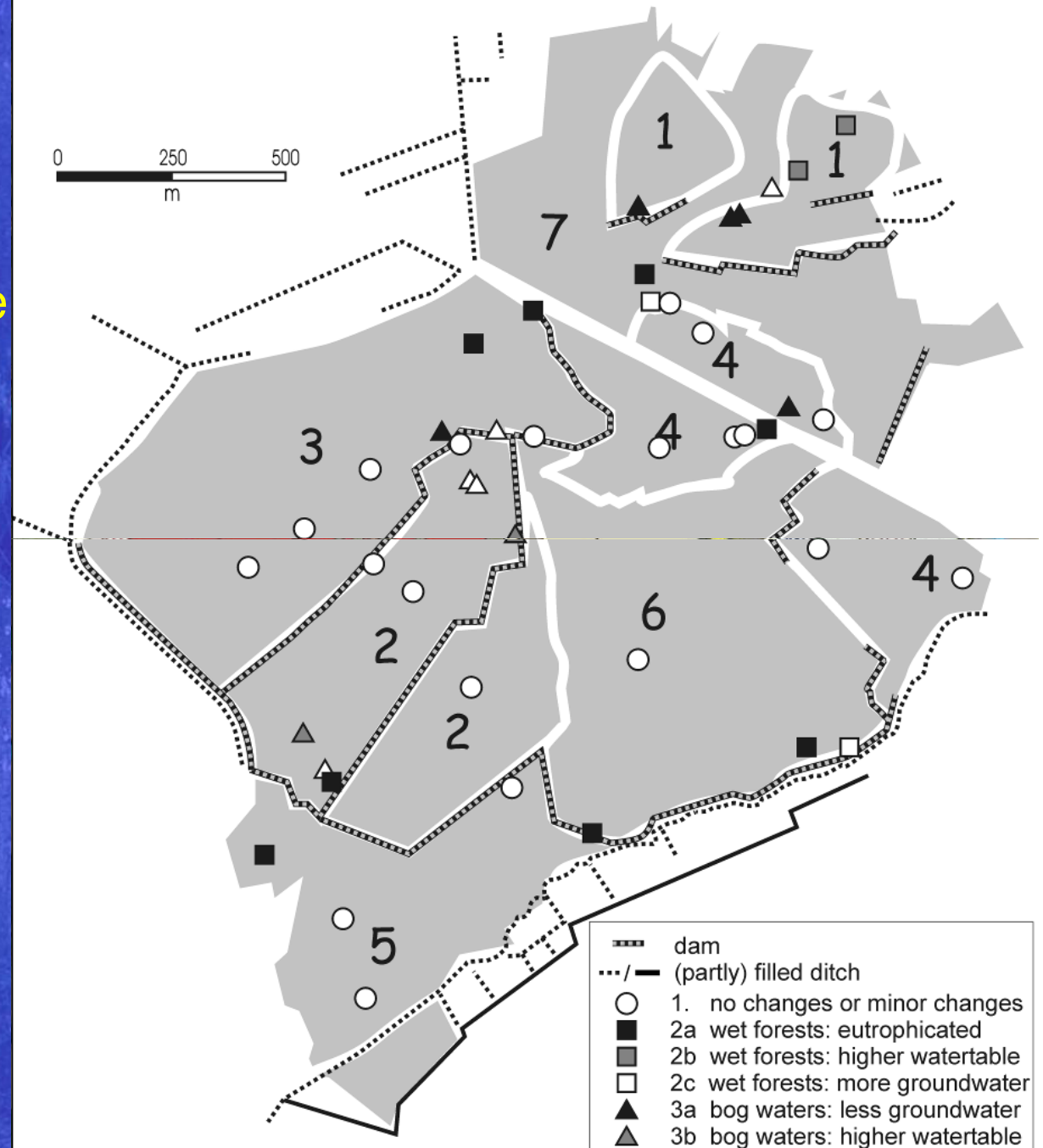
# Compare situation before and after

Heterogeneous landscape

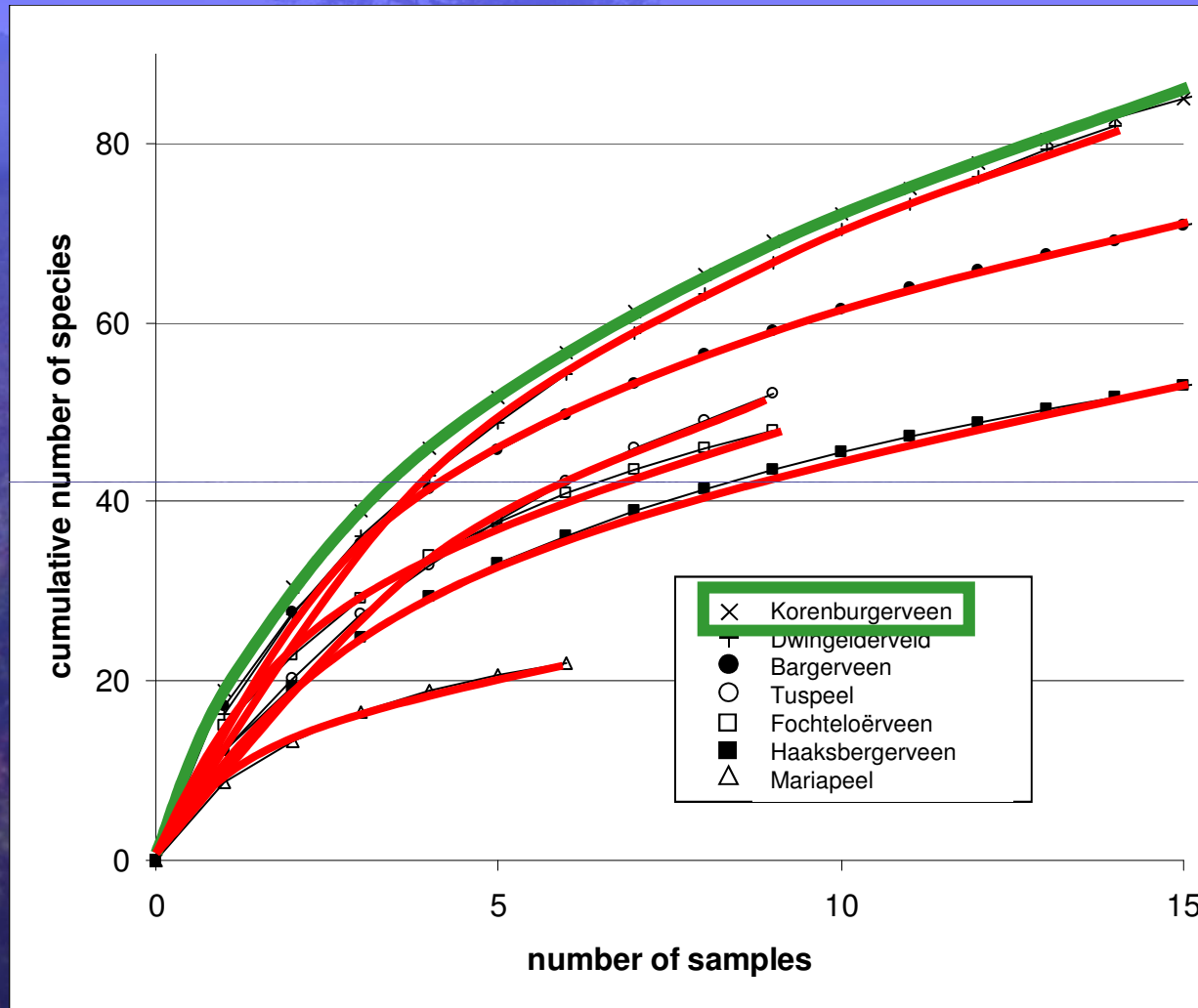
Rewetting measures

1 prior: 2000-2002

2 after: 2004

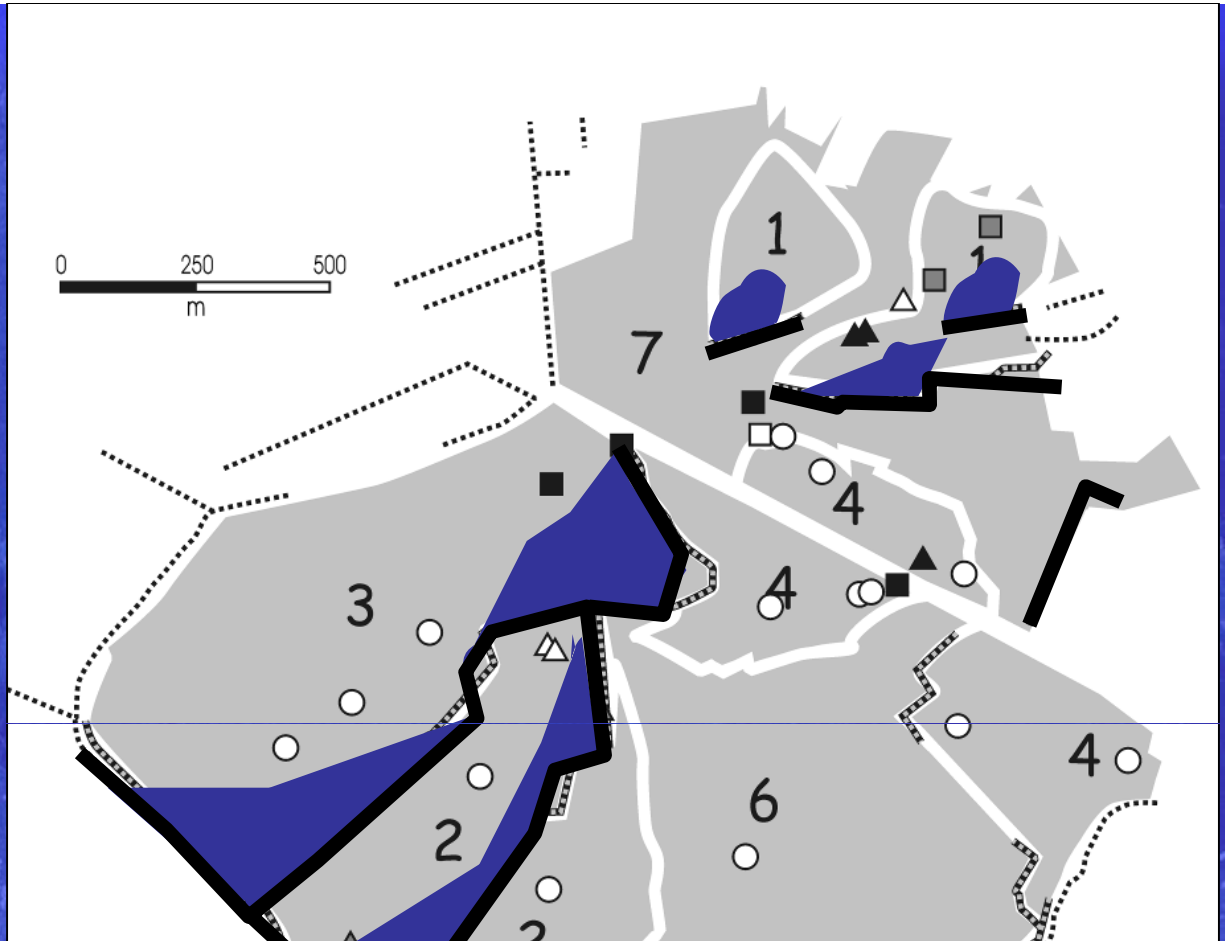


# Comparison with other bog remnants



High biodiversity including relic populations of characteristic species

Compare situation  
before and after



→ Less variation in watertypes  
→ Less transitions between habitats

# Changes in environmental conditions

## 1. Unchanged



## 2. Changed water bodies in forest

- Higher water table: less ground water (2-)
- More ground water influence (2+)

Before

After

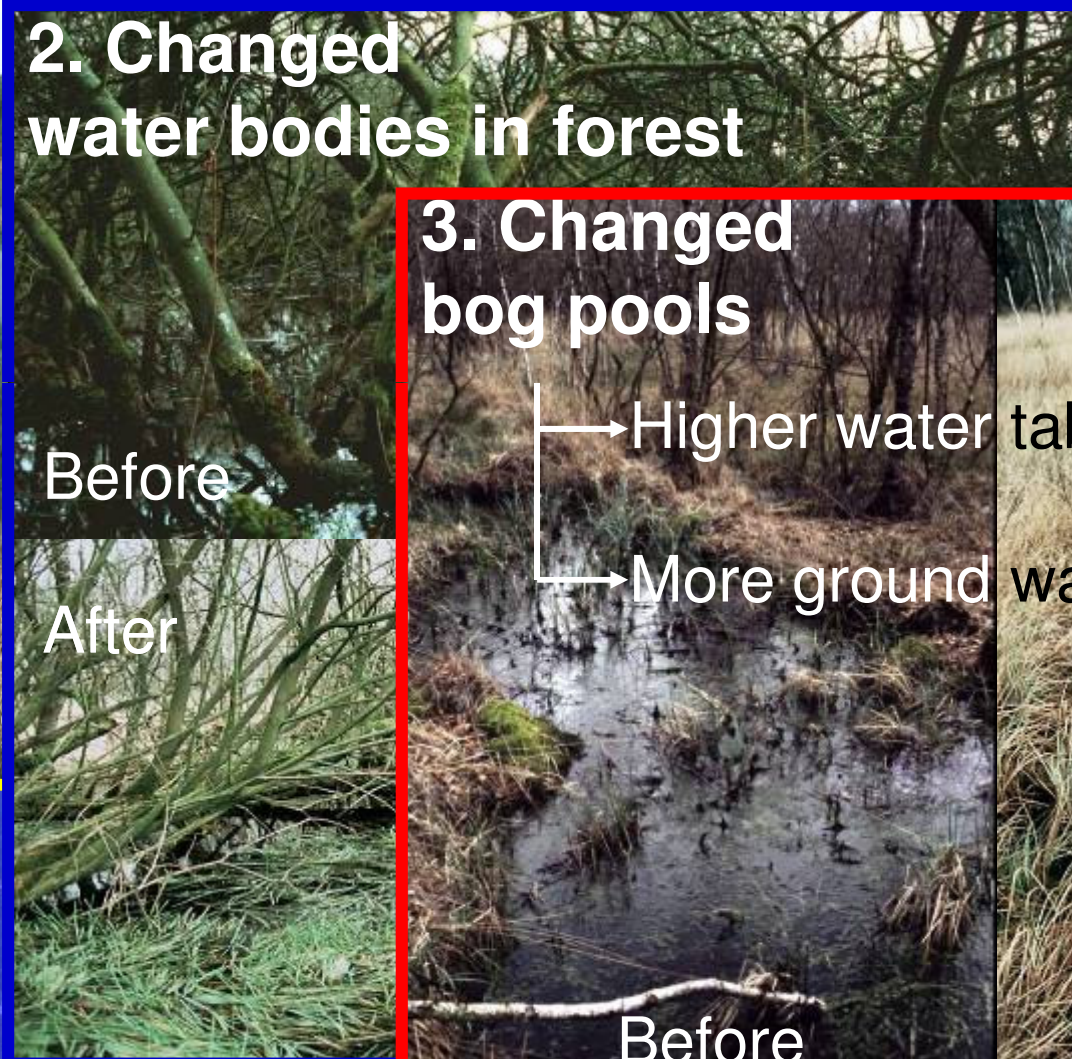


# Changes in environmental conditions

## 1. Unchanged



## 2. Changed water bodies in forest



## 3. Changed bog pools



### 3. Research questions

Effects of restoration measures on:

- Species turnover
- Biotic homogenisation

Relate to changes in environmental conditions

Different scales

(water body, changed water bodies, compartment, entire reserve)

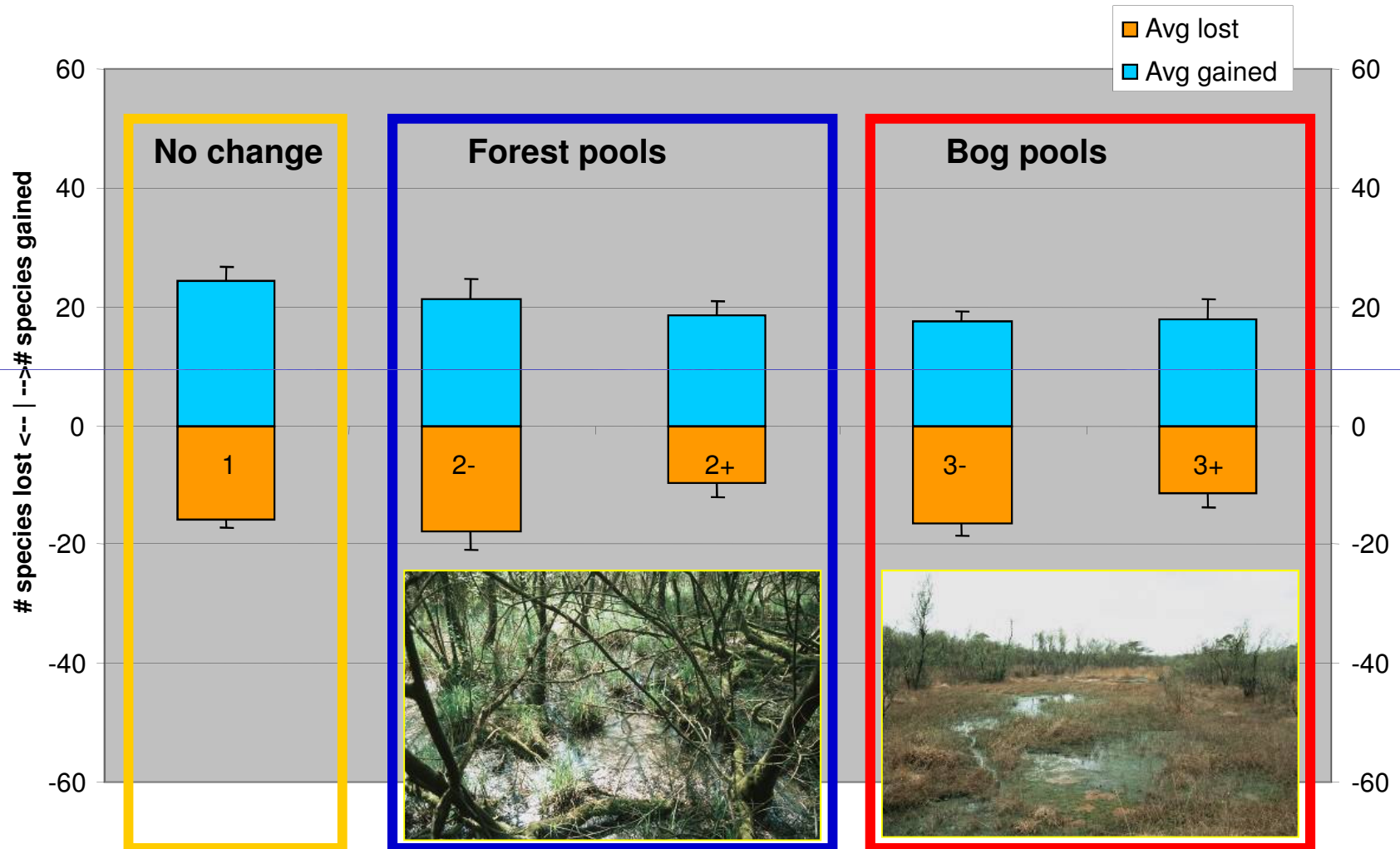
A blue-tinted photograph of a scorpion on a branch. The scorpion is positioned in the center, with its pincers (pedipalps) raised and its segmented tail (metasoma) curved upwards. The background is a solid blue color, and the branch it is on is also blue-tinted.

## 4. Impact of restoration management

Species turnover (differences in diversity)?

# Local (alfa) diversity

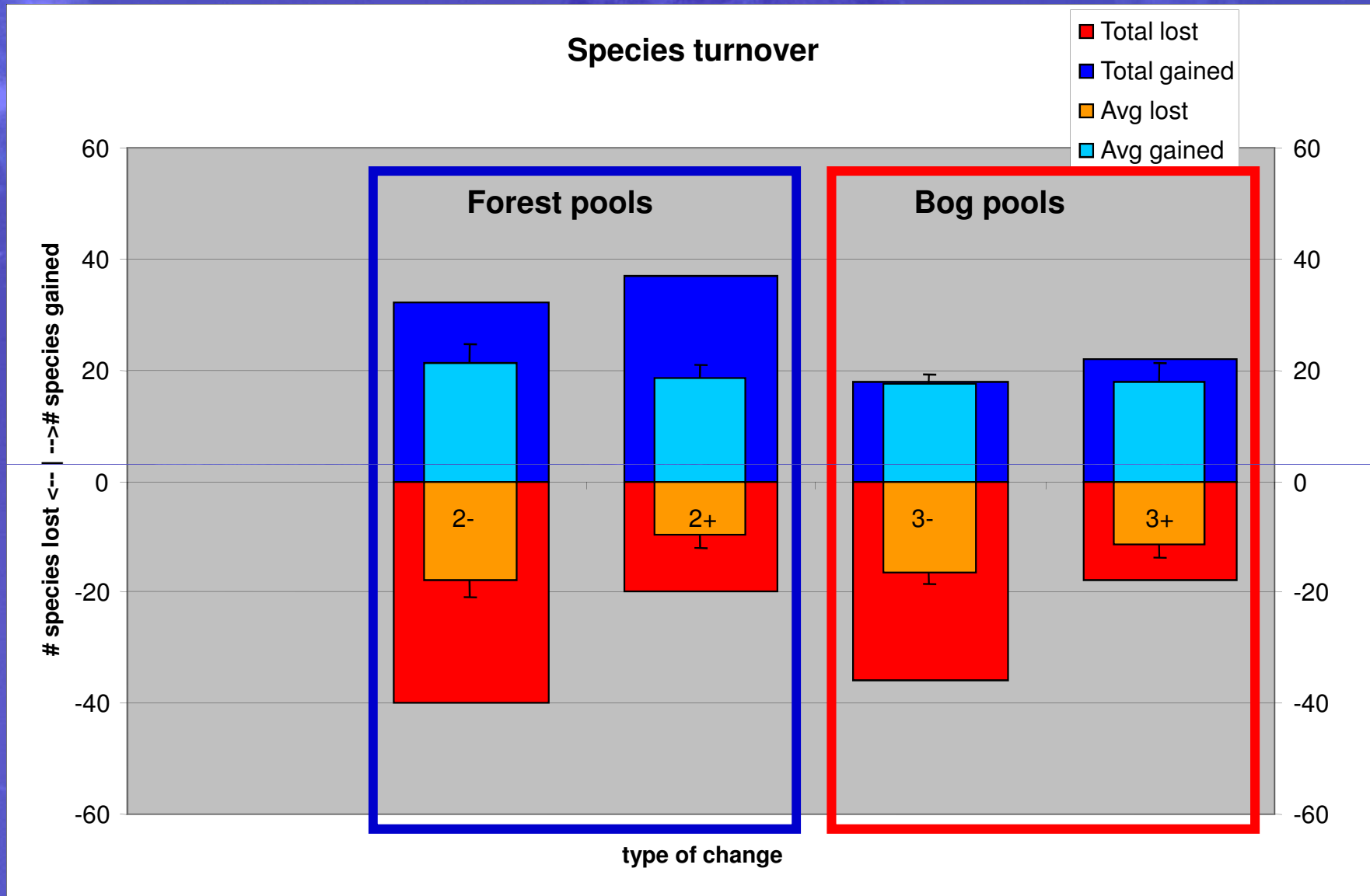
## Species turnover



Gains exceed losses



# Cumulative (beta & gamma) diversity



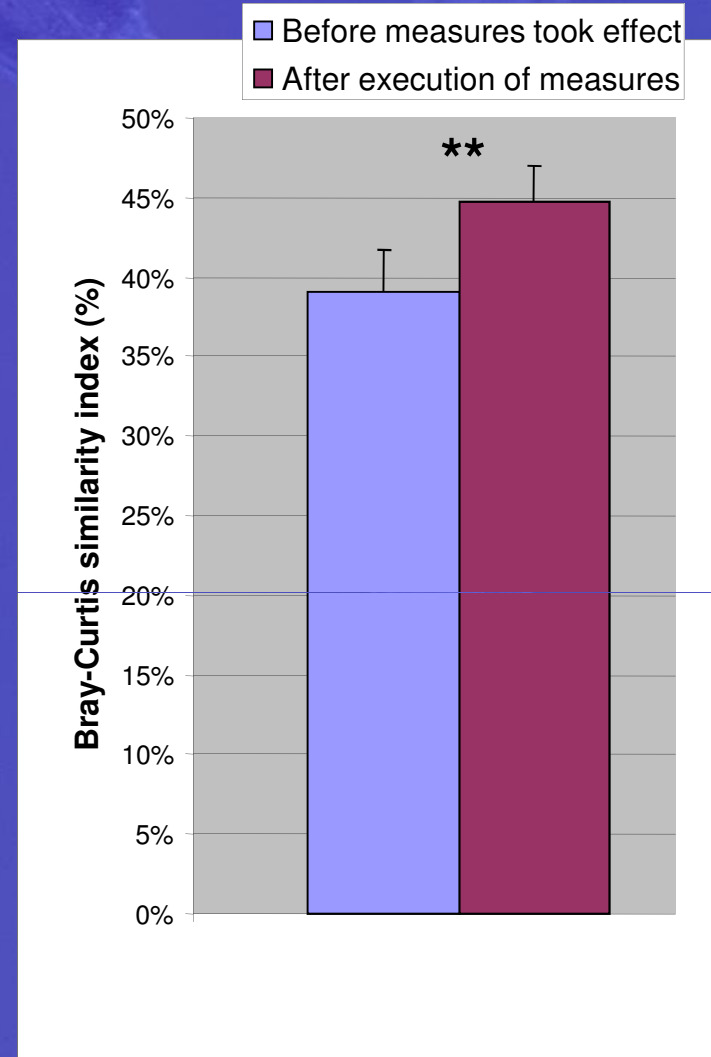
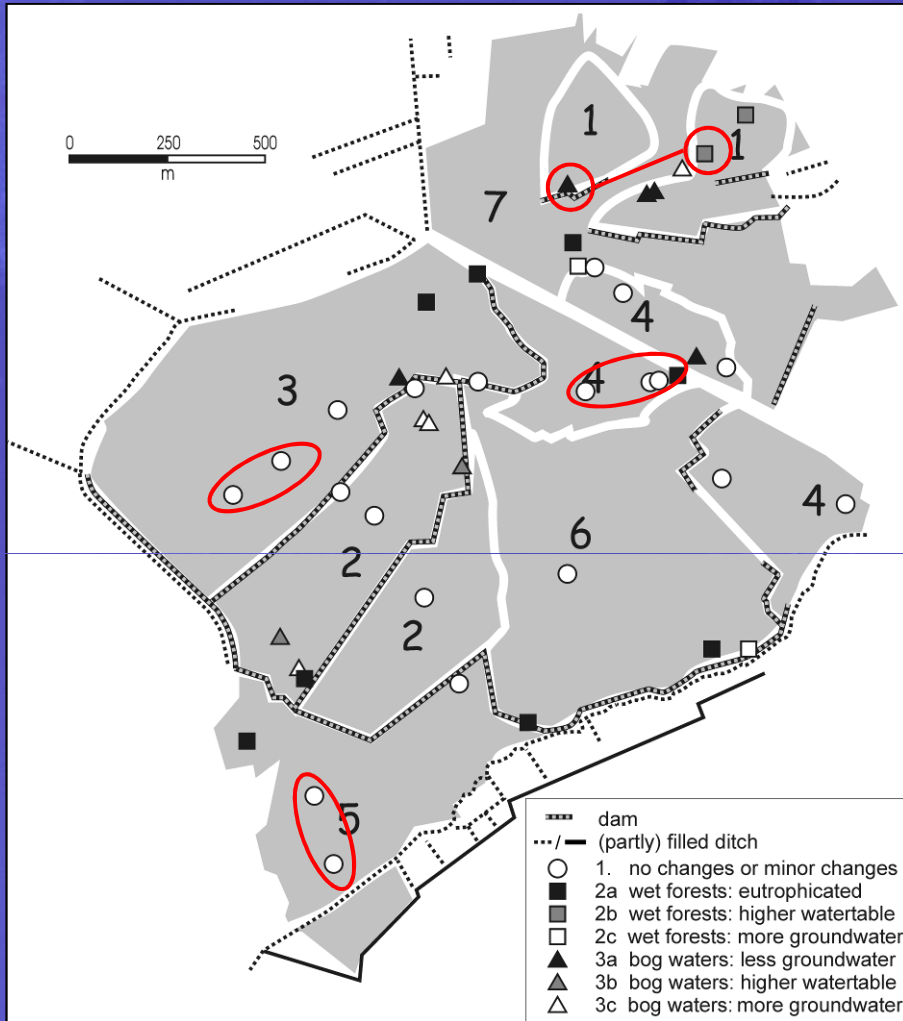
Higher water tables: Losses exceed gains  
More groundwater: Gains exceed losses

A blue-tinted photograph of a scorpion on a plant stem. The scorpion is positioned vertically, with its pincers at the top and its tail at the bottom. The plant stem is on the left side of the frame. The background is a solid blue color.

## 4. Impact of restoration management

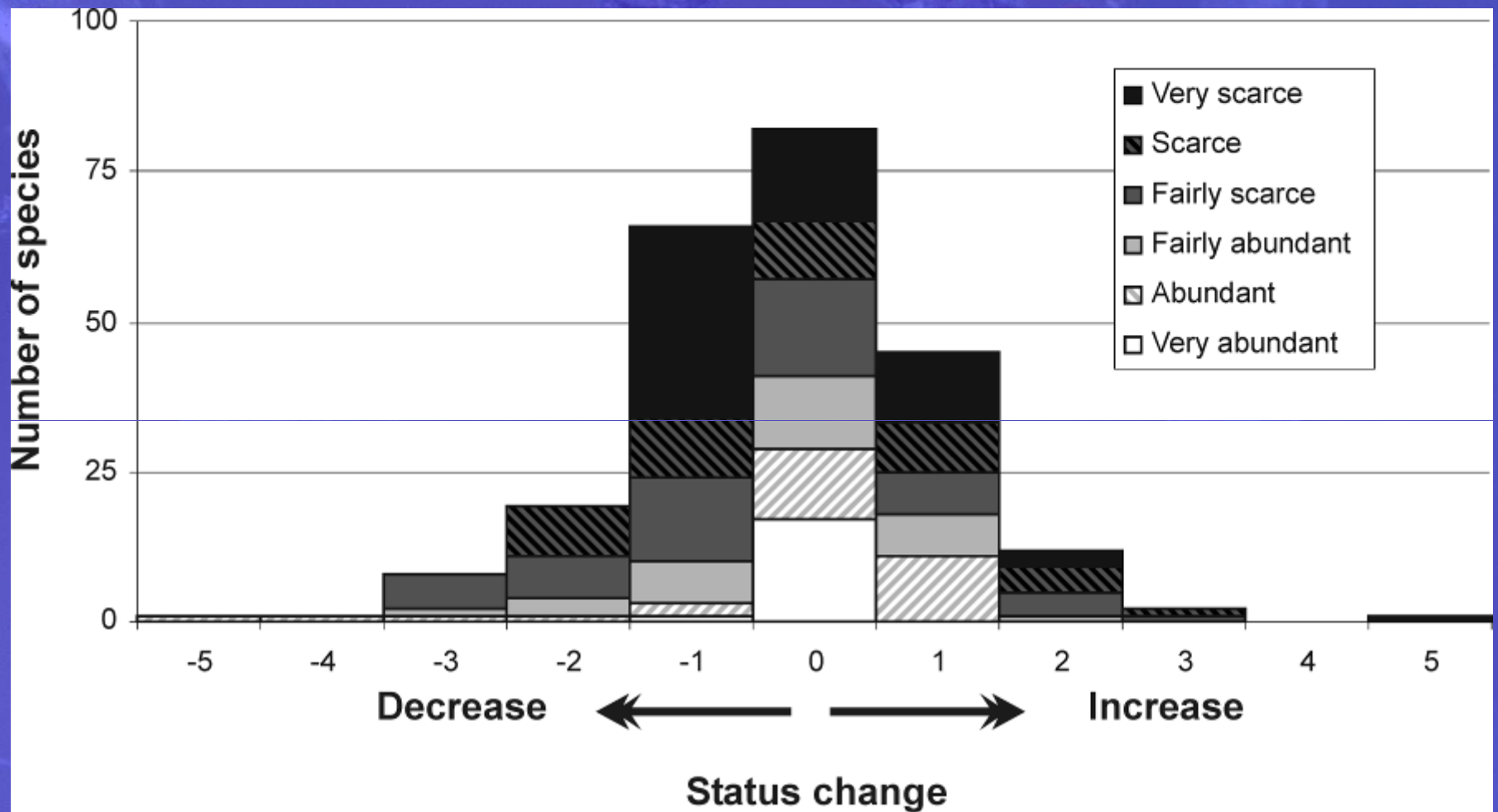
Species turnover (differences in diversity)?  
Homogenisation?

# Spatial scale of compartments



Sites located in same compartment become more similar

# Spatial scale of entire reserve



Abundant species profit most from changes

## 5. Management implications

### Summary results

Impact of rewetting measures on range of spatial scales

- Cumulative species losses exceed gains
- Higher similarity within compartments
- Abundant species become more abundant



Shock effects & Homogenisation

## 5. Management implications

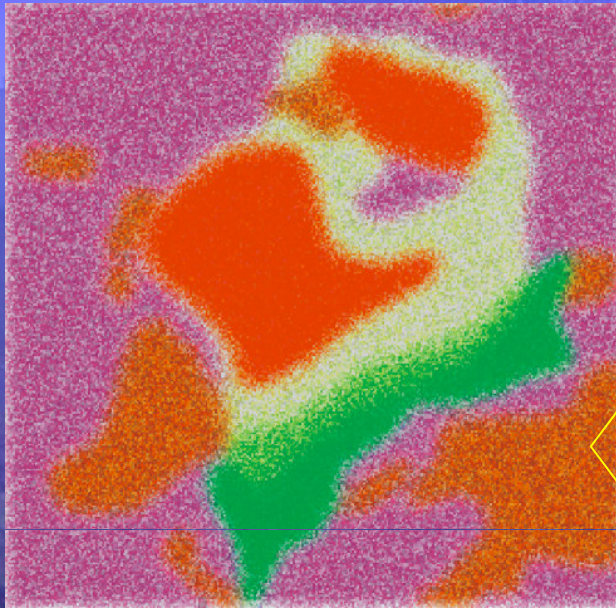
Short term: conserve relic populations

- Stop further degradation
- Preserve existing habitat heterogeneity  
(small scale patch work or slow and reversible)

Long term: restore processes

- Strengthen landscape heterogeneity  
(focus on larger scale eco-hydrological relations)
- Gradual transition from current situation to future situation

Pristine



Degraded



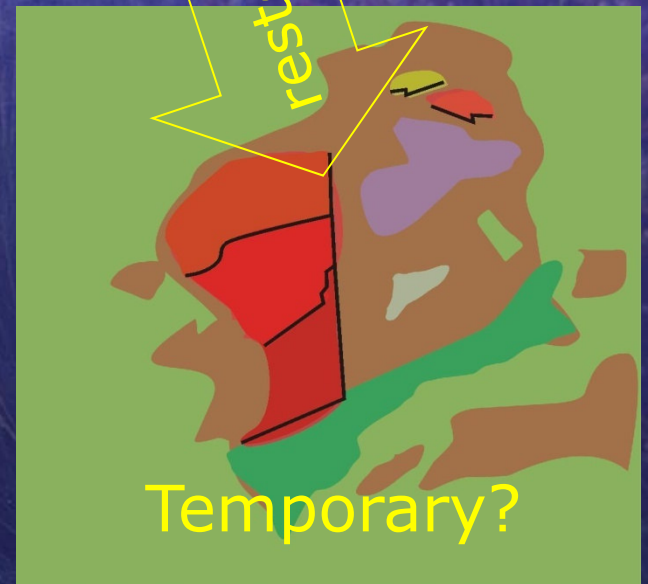
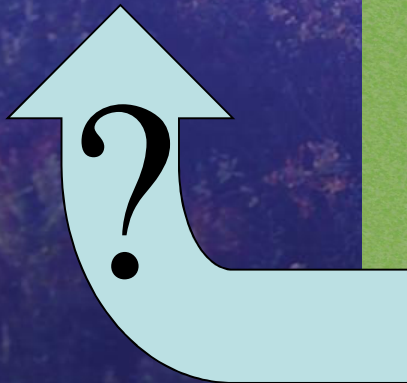
degradation

restoration?

Alternative?

restoration?

Temporary?



A misty landscape with a large tree in the foreground and a forest in the background. The scene is hazy, with a soft light filtering through the trees. The colors are muted, with a lot of greys and blues, suggesting an overcast day or early morning fog. The tree in the foreground is a large, spreading deciduous tree, possibly a maple or similar, with its branches reaching out. In the background, a dense forest of trees is visible, their forms softened by the mist. The overall mood is quiet and somewhat melancholic.

# Questions?

Literature:

**Verberk WCEP, Leuven RSEW, van Duinen GA & Esselink H (2010)** Loss of environmental heterogeneity and aquatic macroinvertebrate diversity following large-scale restoration management. *Basic and Applied Ecology* 11: 440-449.

**Verberk WCEP, van Duinen GA, Brock AMT, Leuven RSEW, Sipel H, Verdonschot PFM, van der Velde G & Esselink H (2006)** Importance of landscape heterogeneity for the conservation of aquatic macroinvertebrate diversity in bog landscapes. *Journal for Nature Conservation* 14: 78-90.

**Verberk WCEP, Kuper JT, van Duinen GA & Esselink H (2006)** Changes in macroinvertebrate richness and diversity following large scale rewetting measures in a heterogeneous bog landscape. *Proceedings of the Section Experimental and Applied Entomology of the Netherlands Entomological Society (NEV)* 17: 27-36.