**EU Natura 2000 Biogeographical Seminar Process**
The management of mountain forest habitat types in Natura 2000 sites: experience and case studies from the Continental Biogeographical region (Networking seminar)
Šumava National Park, Czech Republic, 7–9 November 2017

# Restoration and monitoring of degraded montane peatlands

## - aims, challenges and lessons learned

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# Montane peatland habitats

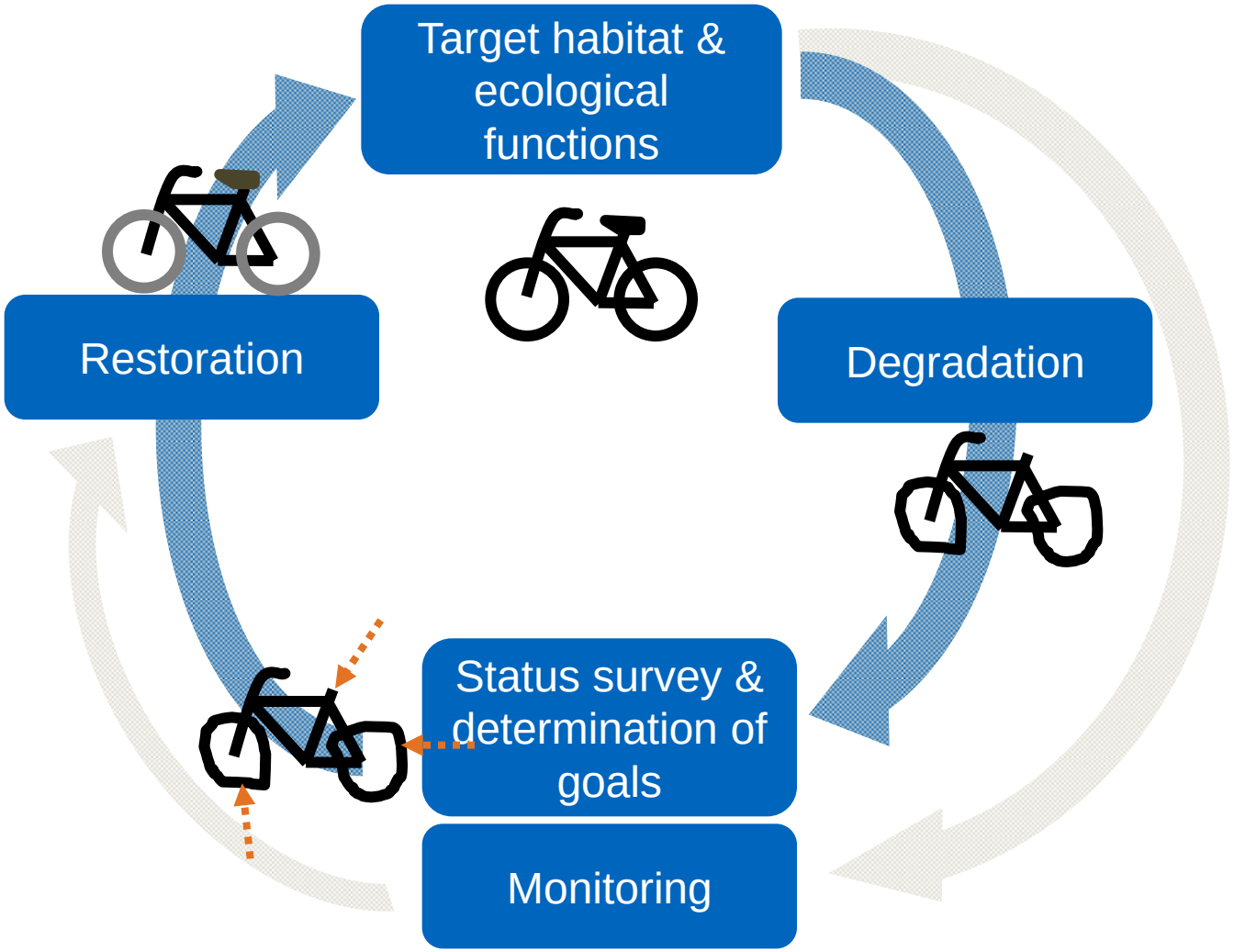
| | |
|---|---|
| **7110*** | Active raised bogs |
| **7120** | Degraded raised bogs still capable of natural regeneration |
| **91D0*** | Bog woodland |
| 7140 | Transition mires and quaking bogs |
| 7150 | Depressions on peat substrates of the *Rhynchosporion* |

→ Accumulation of peat

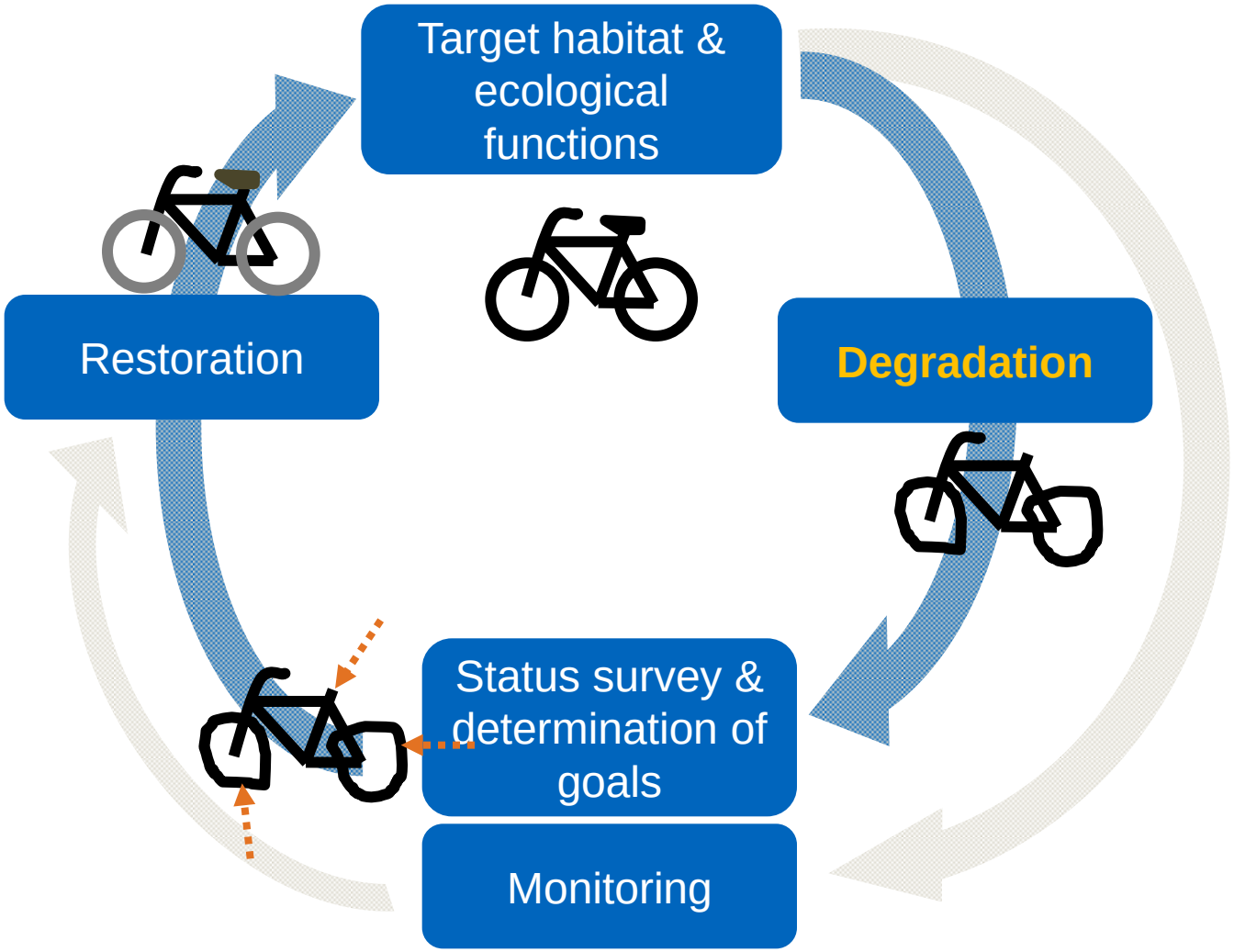
→ Low diversity, but unique species (habitat specialists)

→ Adaptations to oxygen-poor, acidic and nutrient-poor conditions: e.g. mykorrhiza, carnivory, aerenchyma, ...

# Restoration and conservation process



# Restoration and conservation process

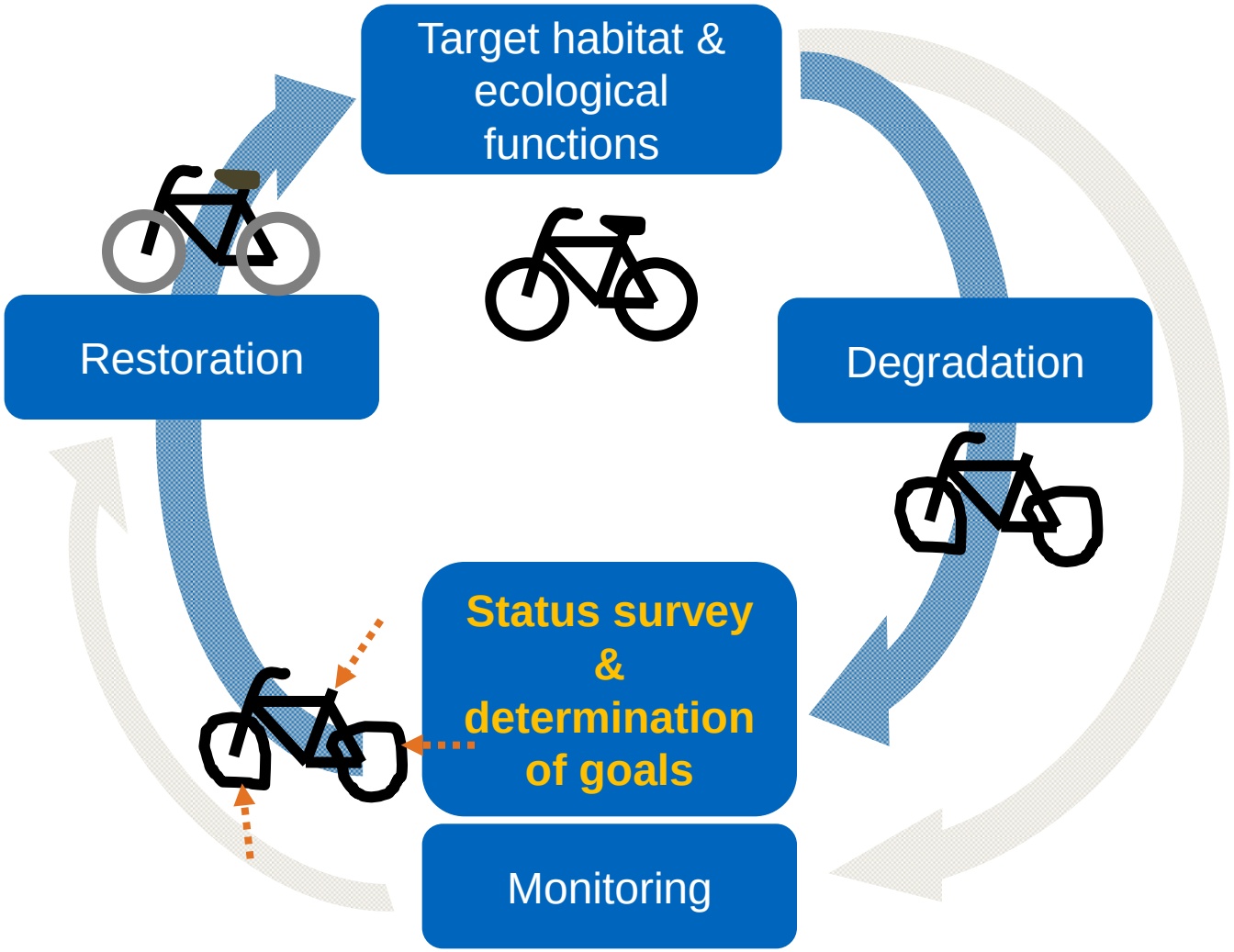


# Degradation

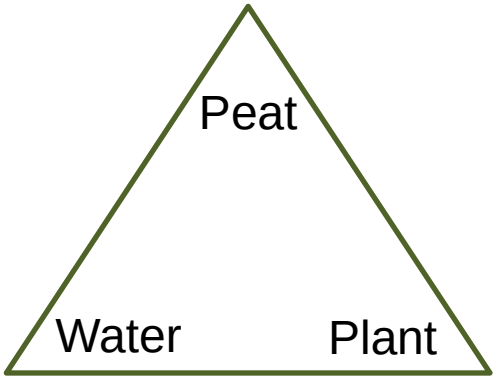
Drainage

Afforestation

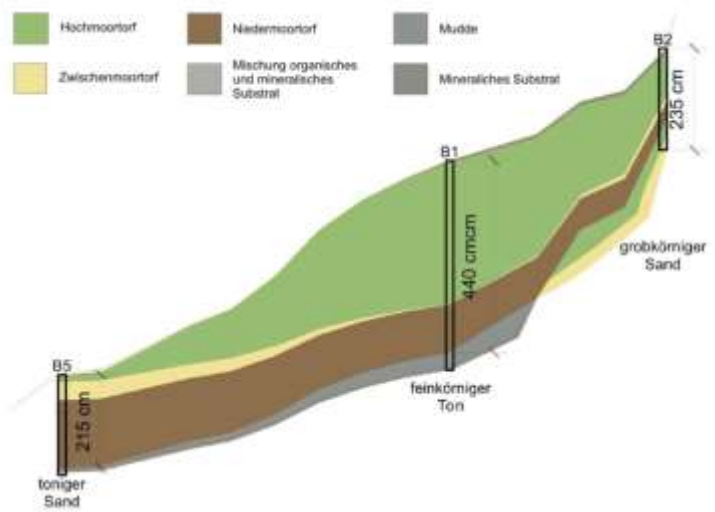
# Restoration and conservation process



# Status survey

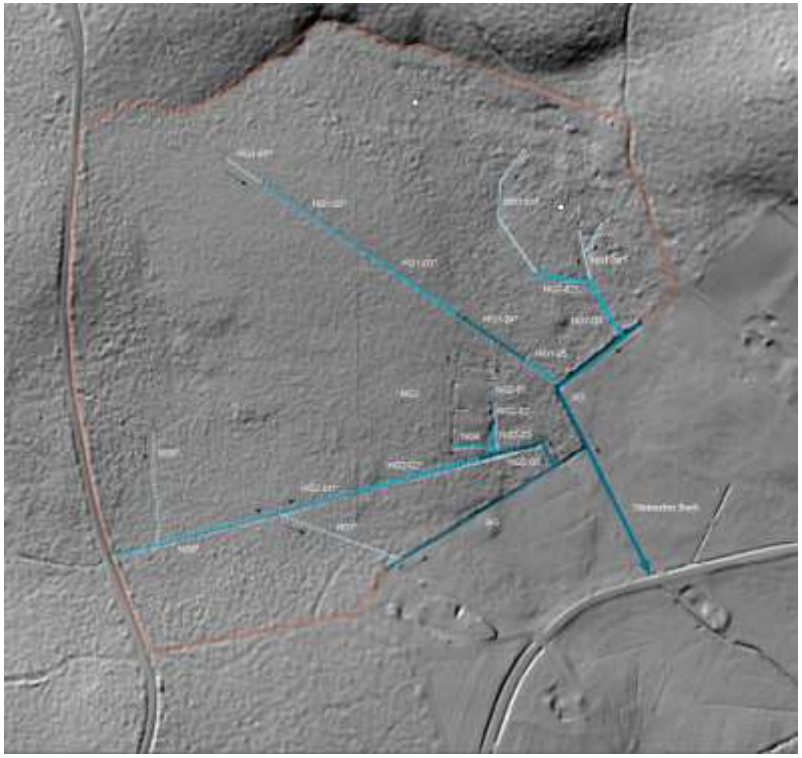


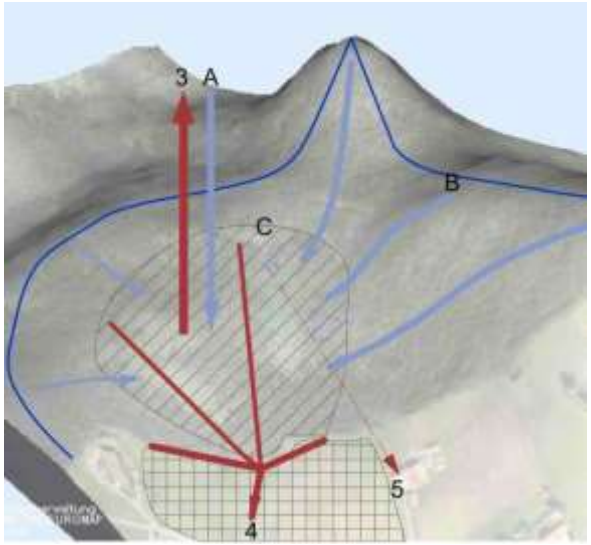

# Status survey




- Peat
- Peatland type

# Status survey






- Water regime
- Impacts of drainage

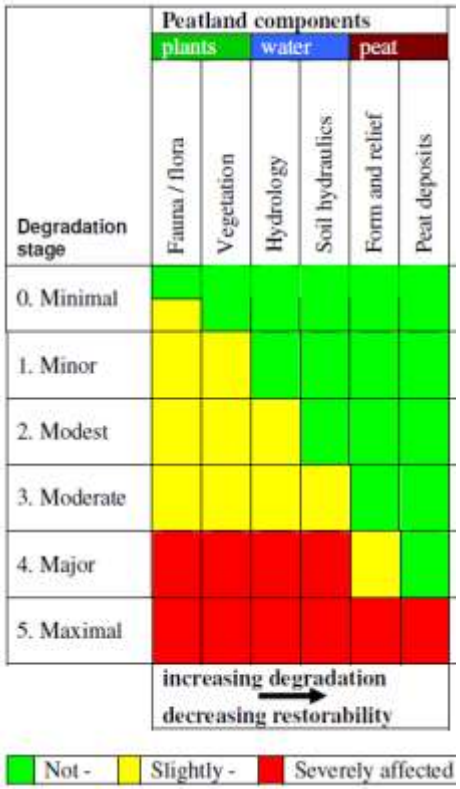
# Status survey

- Vegetation
- (Fauna)

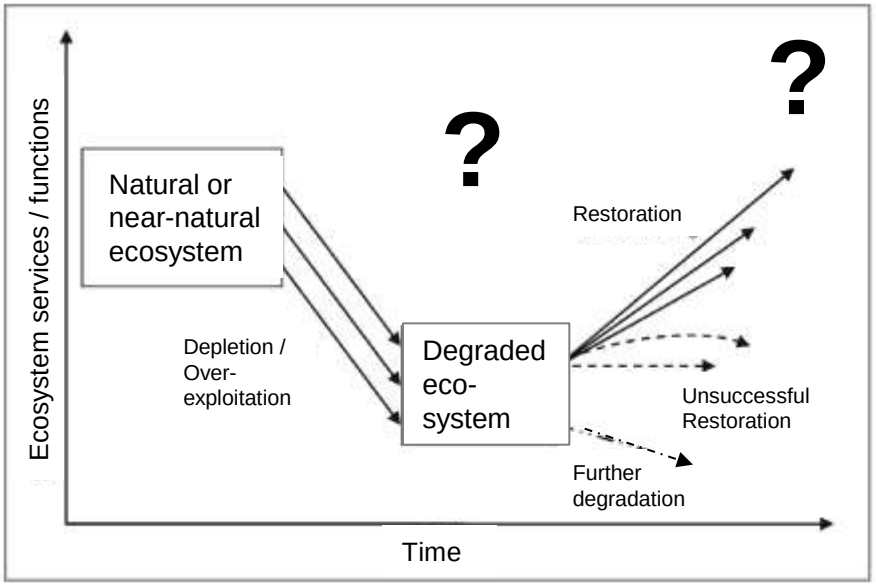
# Status survey and determination of goals

→ **Assessment of overall status**

→ **Determination of goals**




Schumann & Joosten 2008




Zerbe et al. 2009

# Determination of goals

1) Site conditions

A)



B)

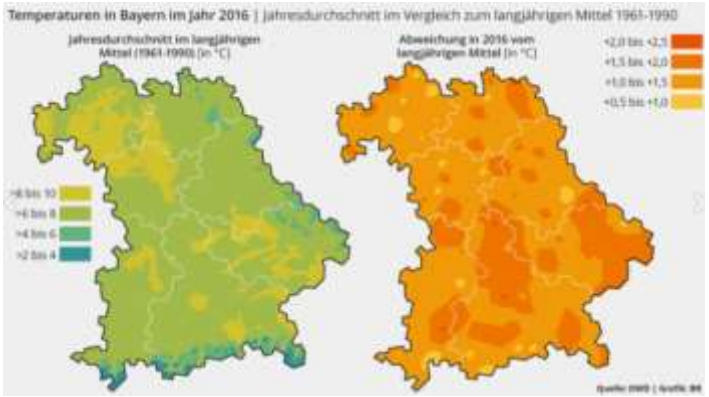


→ **Realistic** objectives and targets

# Determination of goals

2) Limitations

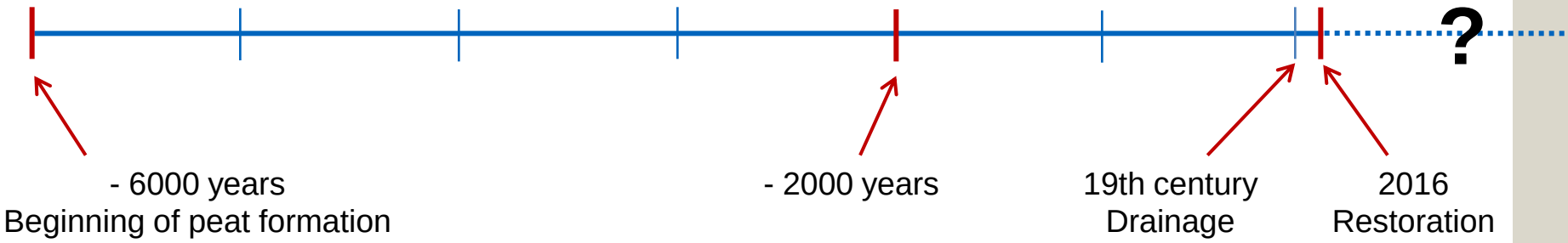
– Irreversible changes of peat characteristics and hydrologic conditions
– Nitrogen deposition
– Global Change
– Fragmentation
– …




**Full „regeneration“ often not feasible**

# Determination of goals

## 3) Time scale of peatland restoration




June 2016
Before measure implementation

August 2016
After spruce removal

October 2016
After measure implementation

April 2017

# Determination of goals

3) Time scale of peatland restoration

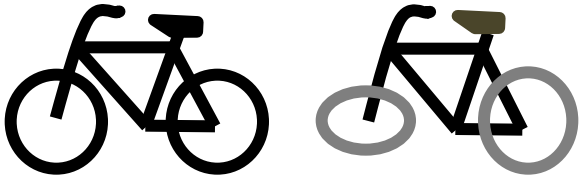
Habitats of Community interest:
10 - 30 years

Ecosystem functions (acrotelm formation, peat accummulation):
100 - 1000 years

# Determination of goals

**Summary**

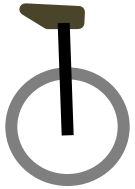
Thorough analysis and consideration of **feasible restoration goals** (case by case)



*1. Restoration towards near-natural state*

*or*

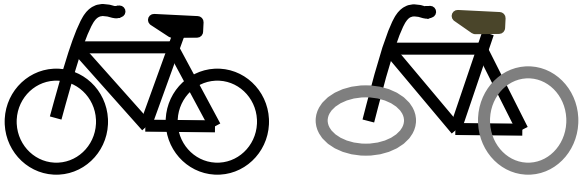
*2. Alternative restoration targets*



# Determination of goals

**Summary**

Thorough analysis and consideration of **feasible restoration goals** (case by case)



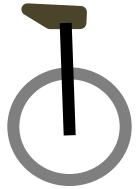
1. *Restoration towards near-natural state*

*or*

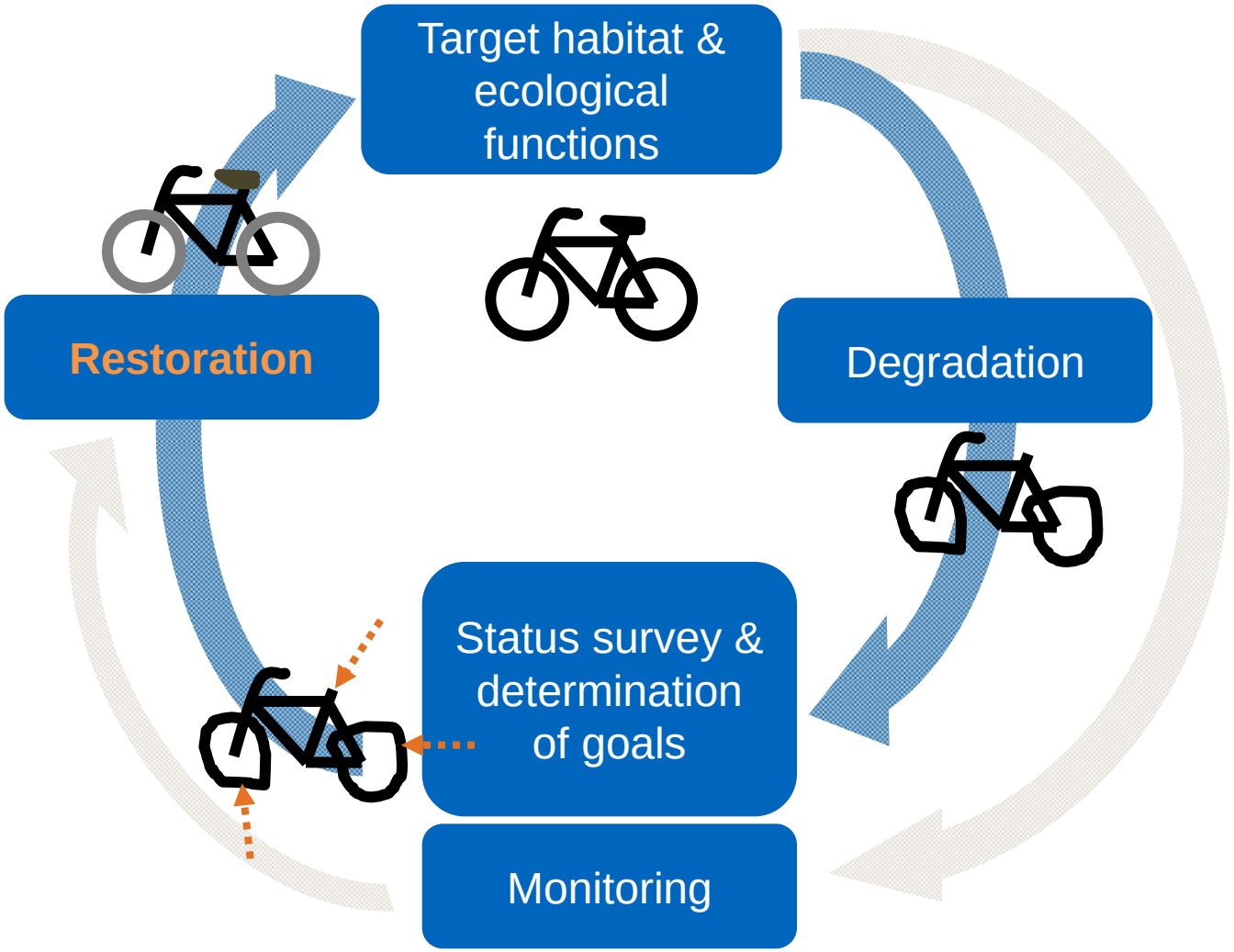
2. *Alternative restoration targets:*
   - In Natura 2000 sites: special attention to protected habitats and species

   but also

   - Maximum possible recovery of important ecosystem functions and services (climate mitigation, process conservation, water retention etc.)



# Selection of suitable restoration methods



# Selection of suitable restoration methods

Restoration / improvement of abiotic site conditions

→ Rewetting

→ (Deforestation)

→ (Improvement of the catchment area)

Supporting measures for habitat development

→ Re-introduction of species

# Restoration measures

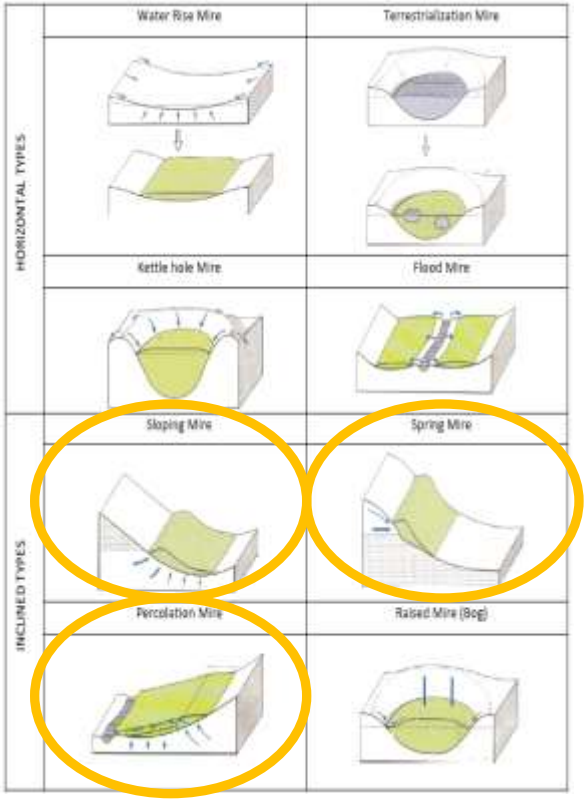
Planning and construction of rewetting dams


Large number of different techniques according to different site conditions

# Selection of suitable restoration methods

*Montane peatlands* → inclined types:

Spring mires – sloping mires – percolation mires




→ Rewetting measures difficult

# Restoration measures

Complete infilling of drainage ditches on slopes

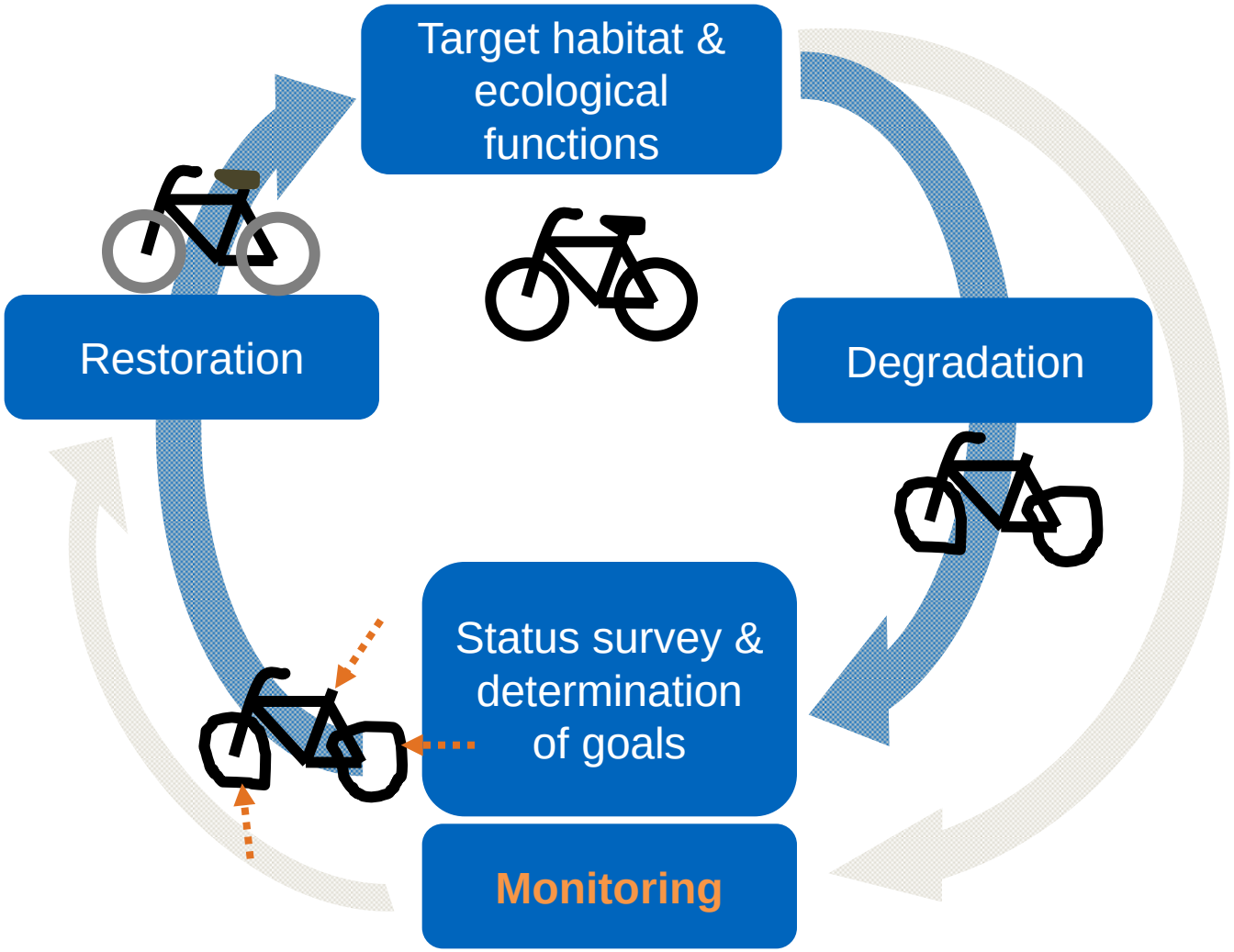





# Restoration measures

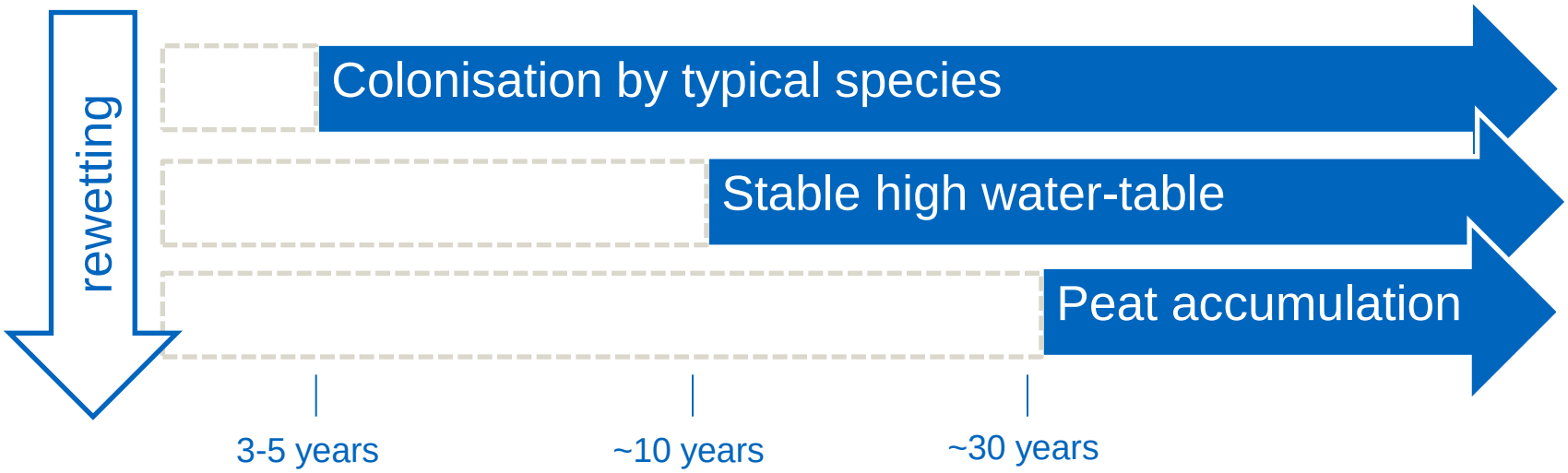
Selective tree removal or deforestation

# Restoration and conservation process



# Monitoring

Expected trajectory from literature [1]




No peatland has reached all these goals so far.[2]

! Monitorings are often done too early and very short (1-3 years).[3]

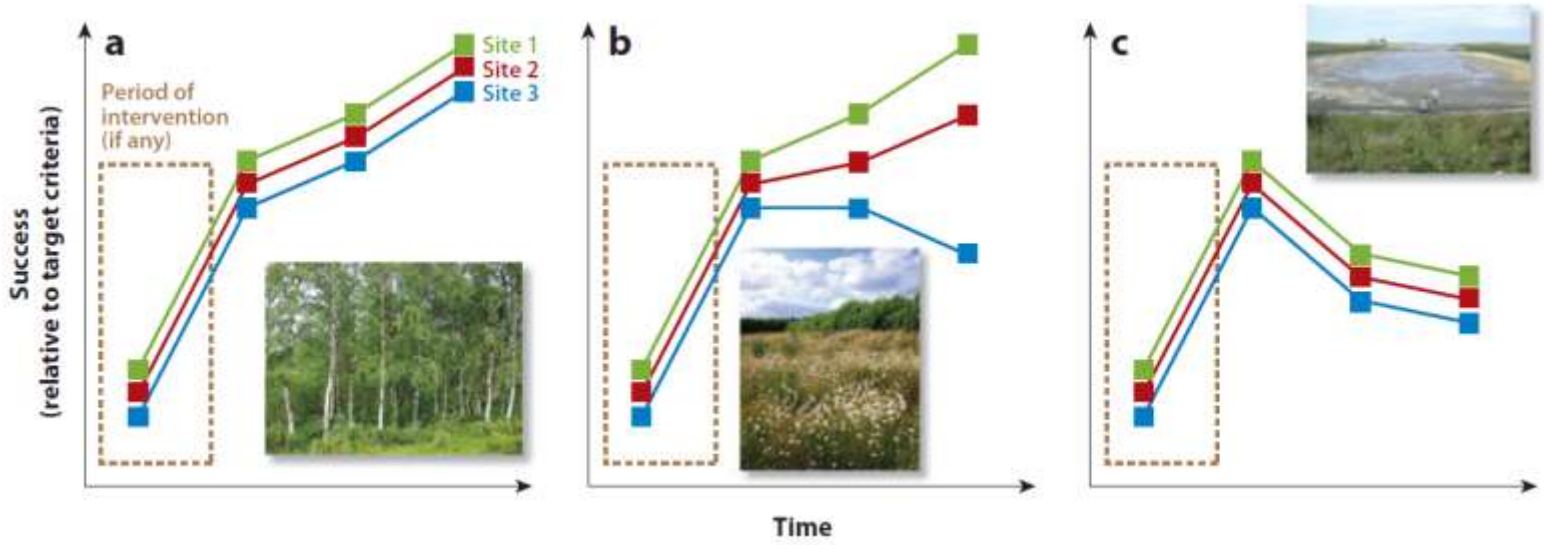
**Progress is not always linear**.[4]

1) Rochefort et al. 2003 2) Gorham & Rochefort 2003 2) Kollmann et al. 2016 3) Matthews et al. 2009

# Monitoring

Monitoring possible restoration trajectories (not only peatlands!)

Restoration success as a dynamic concept across **space** and **time**[1]




All sites converge towards target state over time

Unintended divergence across sites

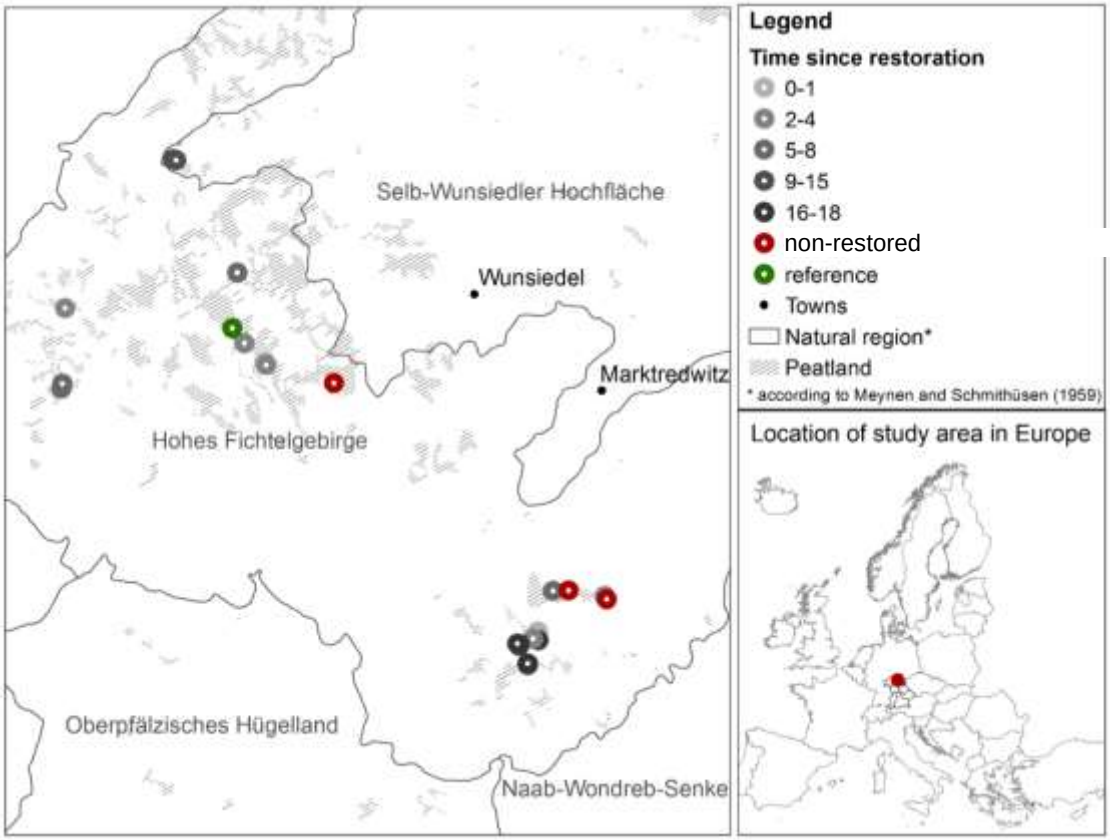
All deviate from target goal

→ Same measures do not always lead to same target

1) Suding 2011

# Monitoring: Example ‚Fichtelgebirge‘

Comparison of sites of ‚different age‘




**Restoration measures**: Rewetting by ditch blocking and tree removal

**Goal**: Recovery of characteristic biodiversity (species, structure, composition)

# Monitoring: Example ‚Fichtelgebirge‘

Mapping of **vegetation, dragonflies** and **butterflies**

# Monitoring: Example ‚Fichtelgebirge‘

**Results in „pictures“**

Non restored

< Time since restoration

Reference

Restoration

# Monitoring: Example ‚Fichtelgebirge‘

**Results: Vegetation diversity**

- 50 vascular plants, 53 mosses & liverworts (13 *Sphagnum* ssp.)
- 16 red list ssp. (Germany or Bavaria)
- 16 habitat specialists, e.g. *Andromeda polifolia, Drosera rotundifolia, Eriophorum vaginatum, Vaccinium oxycoccos*

→ But not everywhere and at every successional stage


*Andromeda polifolia*

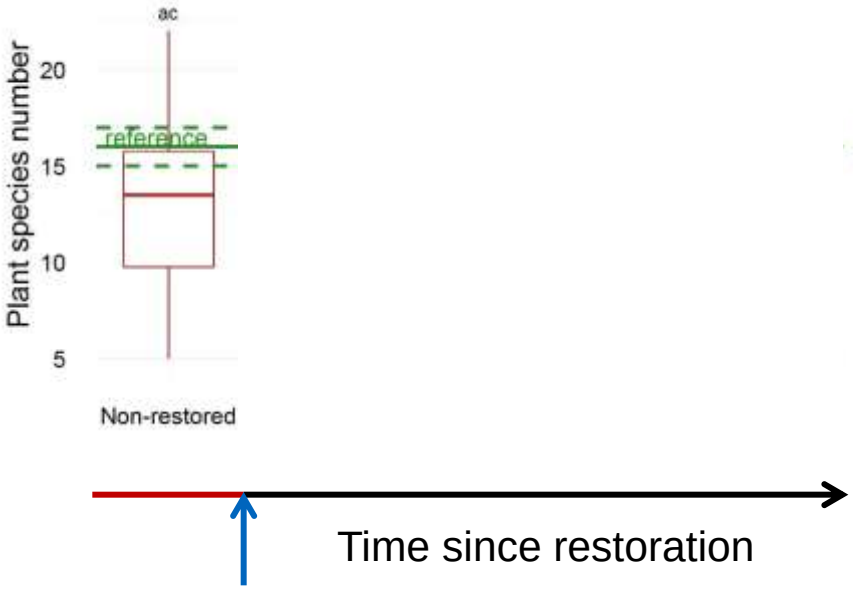

*Drosera rotundifolia*


*Vaccinium oxycoccos*

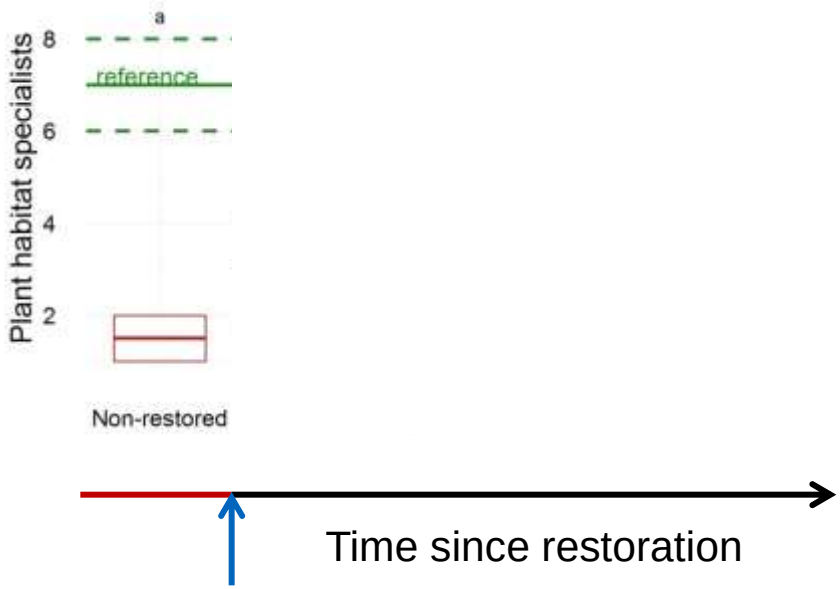
# Monitoring: Example ‚Fichtelgebirge‘

**Results: Vegetation diversity**

All species



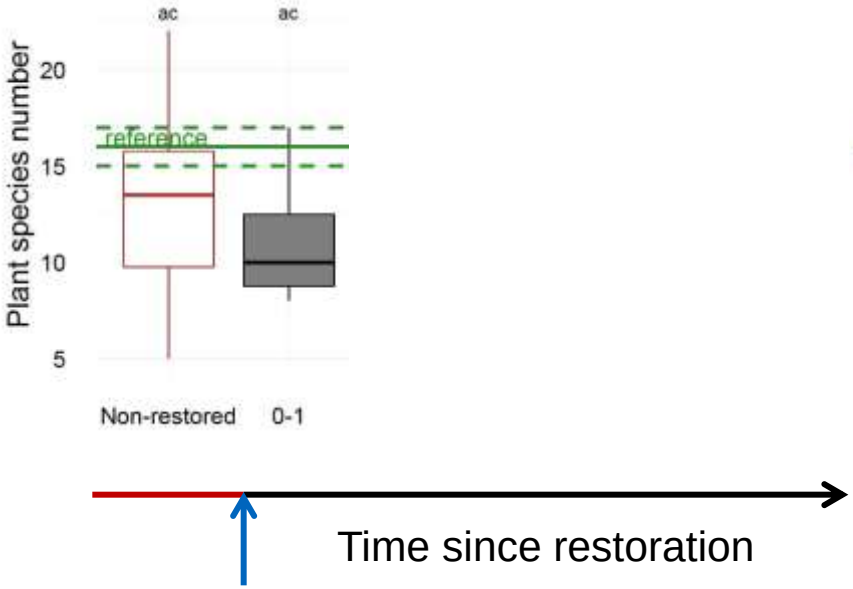

Specialists



# Monitoring: Example ‚Fichtelgebirge‘

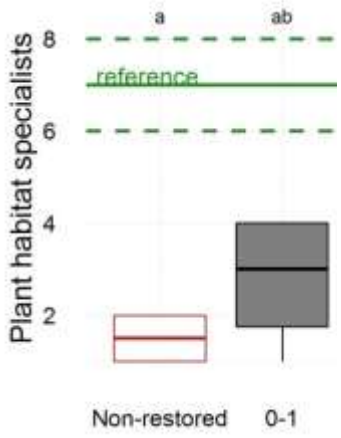
**Results: Vegetation diversity**

All species




Time since restoration

Specialists

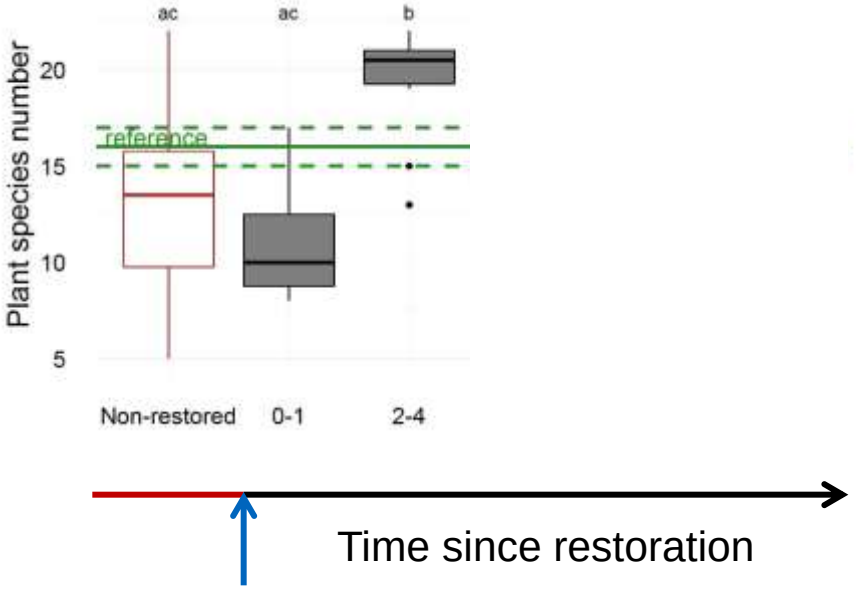



Time since restoration

# Monitoring: Example ‚Fichtelgebirge‘

**Results: Vegetation diversity**

All species

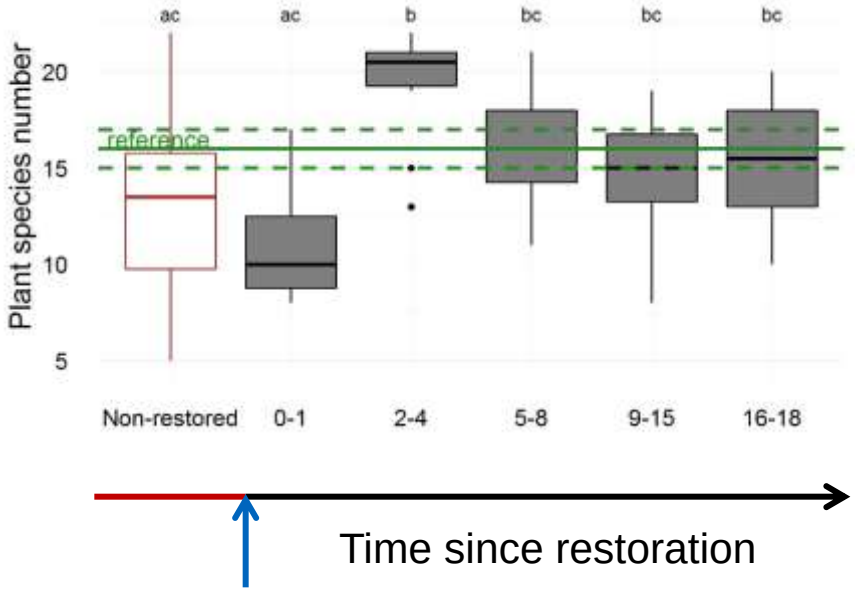



Specialists

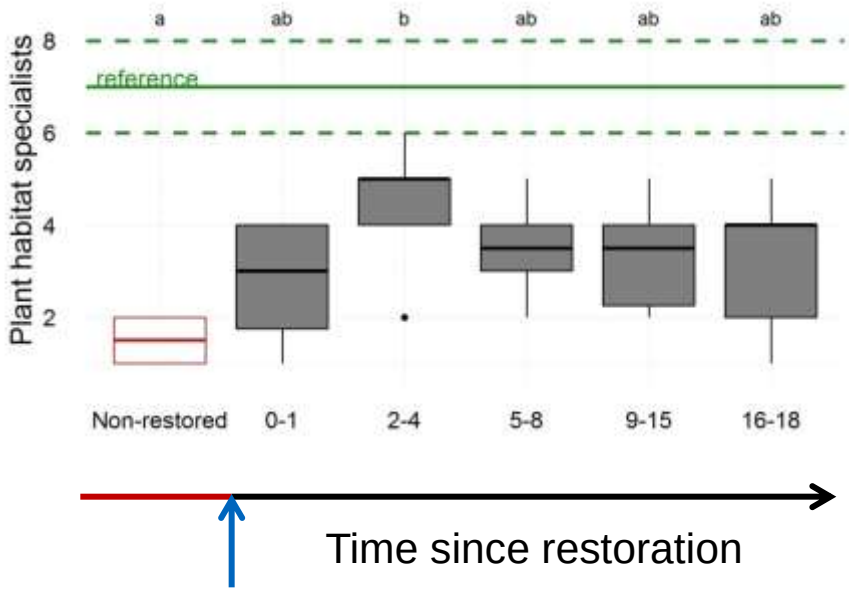
# Monitoring: Example ‚Fichtelgebirge‘

## Results: Vegetation diversity

All species

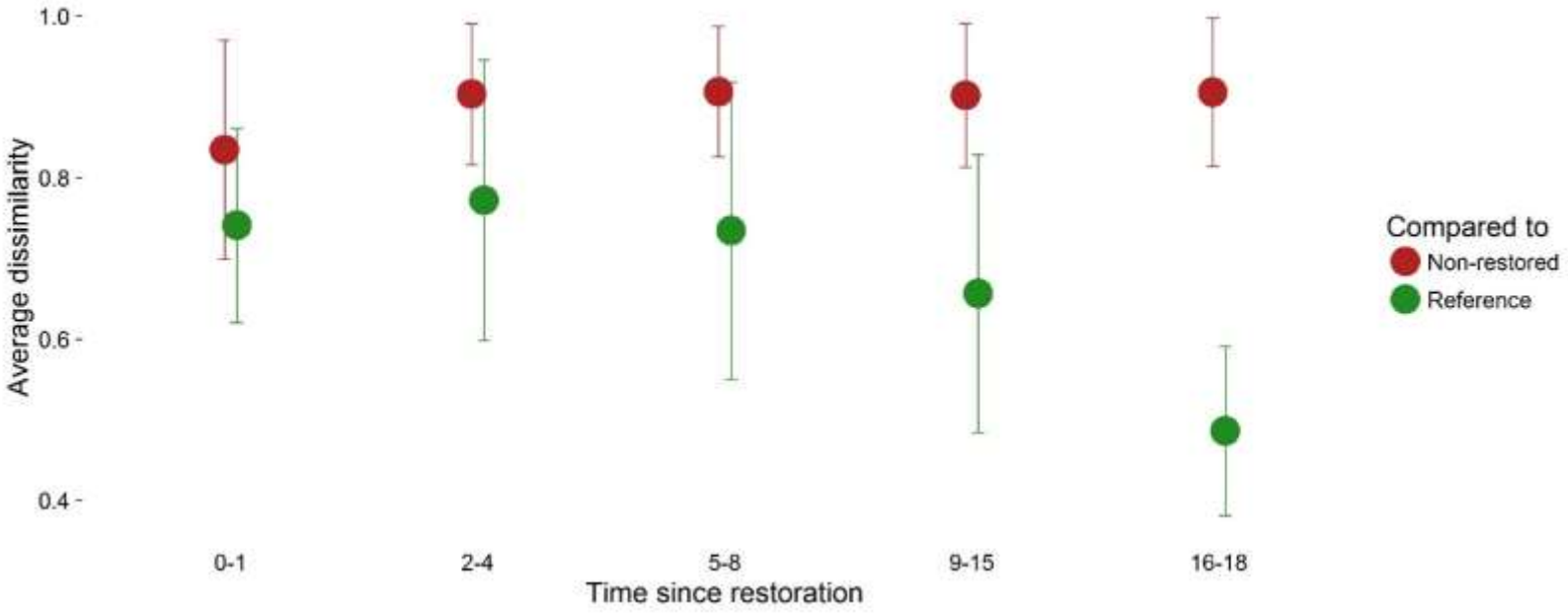



Specialists



# Monitoring: Example ‚Fichtelgebirge‘

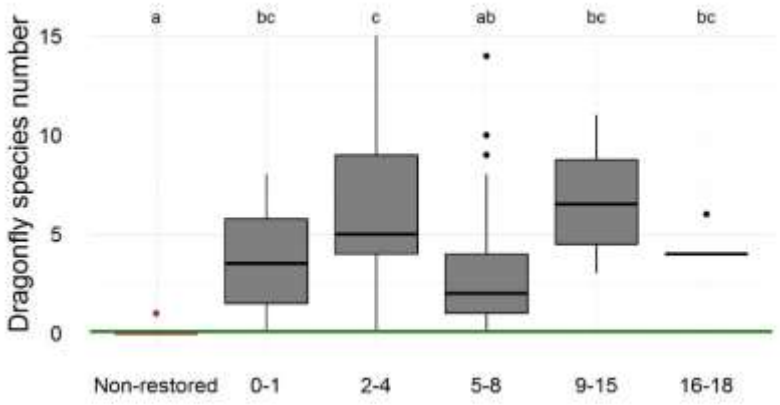
## Results: Vegetation composition

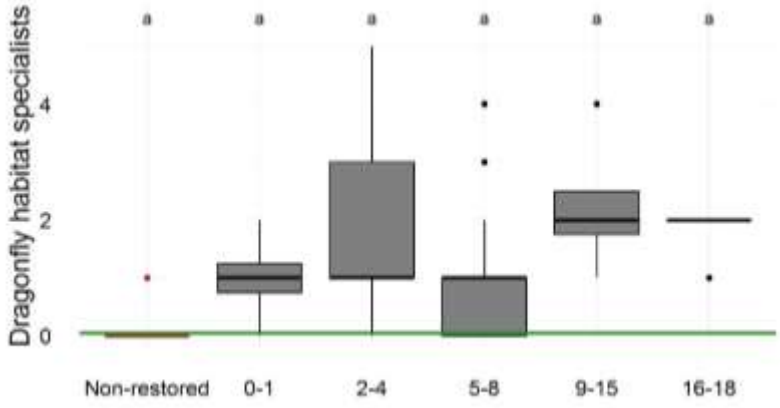



→ Progression towards reference conditions
→ Dissimilarity still > 0.4 (some species still absent: *A. polifolia, D. rotundifolia*)
→ Progression to be continued?

# Monitoring: Example ‚Fichtelgebirge‘

## Results: Dragonflies



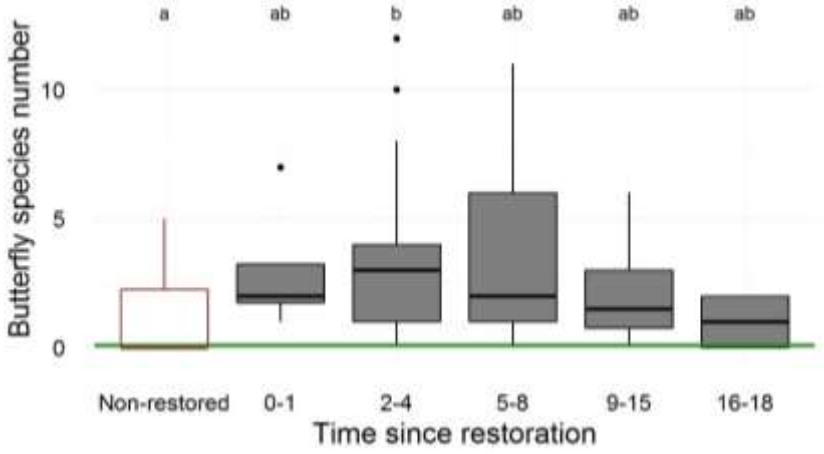

- 34 species, 14 red list ssp.
- 7 habitat specialists

*e.g. Aeshna juncea, Coenagrion hastulatum, Leucorrhinia dubia, Somatochlora alpestris*

*Leucorrhinia dubia*

# Monitoring: Example ‚Fichtelgebirge‘

## Results: Butterflies




- 36 species, only generalists

→ Despite presence of host plants

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

- Better than degraded state, worse than intact state

→ **Is this restoration success?**

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

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Depends on the **goals**

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

- Better than degraded state, worse than intact state

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Depends on the **goals**

- Vegetation composition moves in the right direction

→ **Is this progression to be continued?**

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

- Better than degraded state, worse than intact state

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Depends on the **goals**

- Vegetation composition moves in the right direction

→ **Is this progression to be continued?**

Longer monitoring needed
→ Peatlands are „slow“

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

- Better than degraded state, worse than intact state

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Depends on the **goals**

- Vegetation composition moves in the right direction

→ **Is this progression to be continued?**

Longer monitoring needed
→ Peatlands are „slow“

- Missing species

→ **How can we improve the current state?**

# Monitoring: Example ‚Fichtelgebirge‘

**Conclusions and (open) questions**

- Better than degraded state, worse than intact state

→ **Is this restoration success?**

- Vegetation composition moves in the right direction

→ **Is this progression to be continued?**

- Missing species

→ **How can we improve the current state?**

→ Is **site** or **dispersal limitation** the problem?

**Improve site !!**
e.g. dam reinforcement

**Improve connectivity** and **reintroduce species**

Depends on the **goals**

Longer monitoring needed
→ Peatlands are „slow“

Depends on the underlying causes!

# Thank you for your attention!

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NEEMO GEIE /Particip GmbH

Project ‚Fichtelgebirge‘ funded by the Bavarian State Ministry of the Environment and Consumer Protection

funded by
Bavarian State Ministry of the Environment and Consumer Protection

# Appendix

# Phytometer experiments

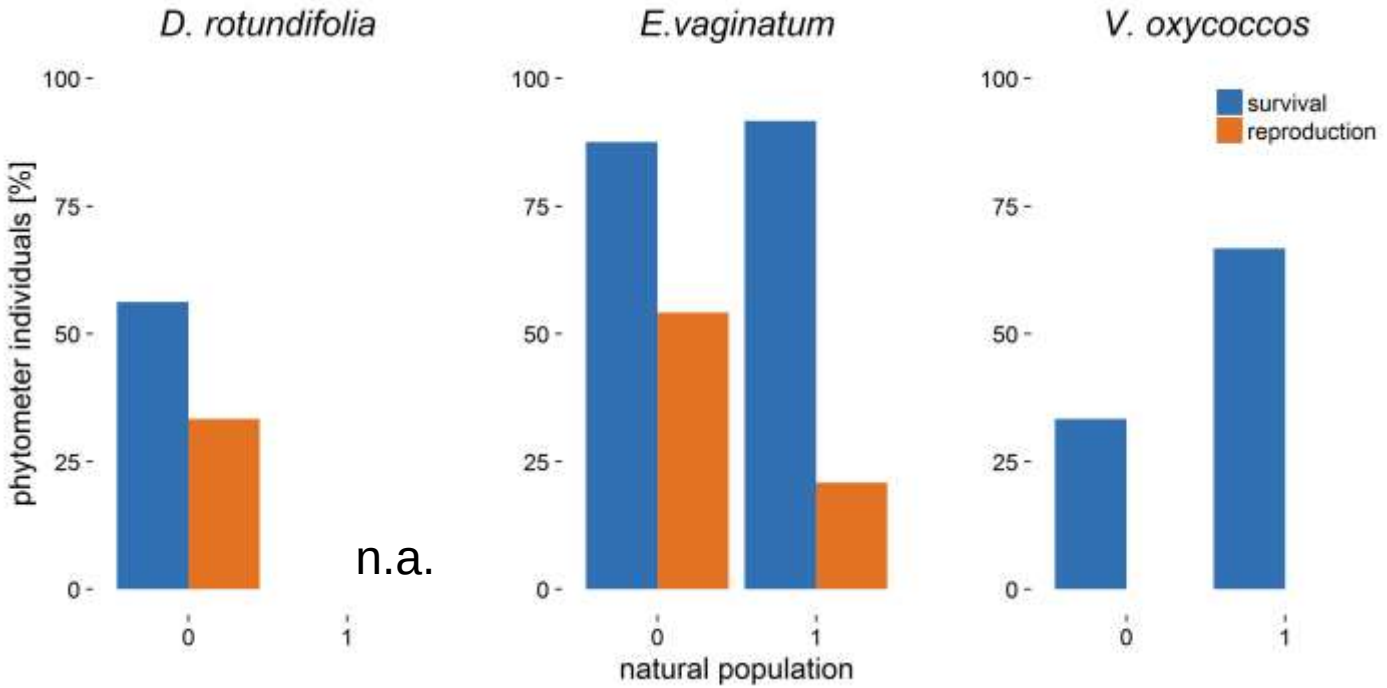
When common descriptive approaches are not sufficient, **experimental approaches** may help:

**Phytometers** are experimentally transplanted to indicate between site differences via their performance (survival, growth, reproduction)

Comparison of phytometer performance and natural populations.

# Phytometer experiments

Phytometer survival and reproduction (%)
in comparison with naturally occuring populations (1/0)



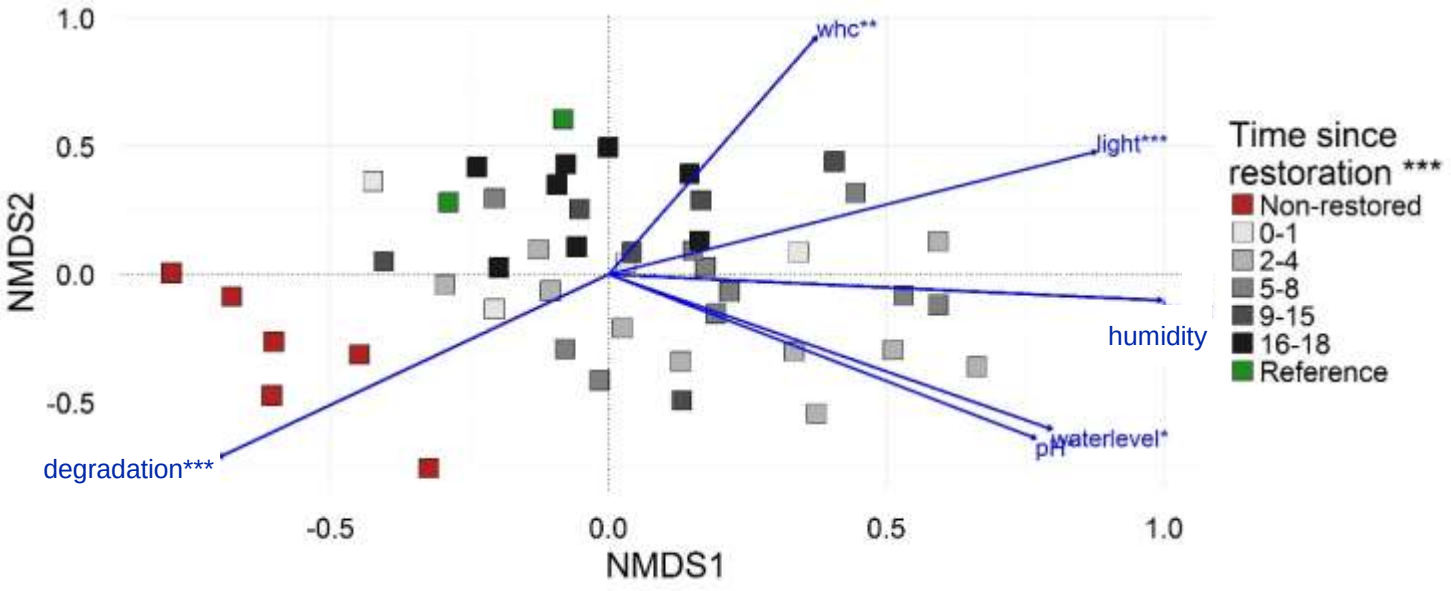

dispersal and site limited

dispersal limited

mainly site limited

# Vegetation composition

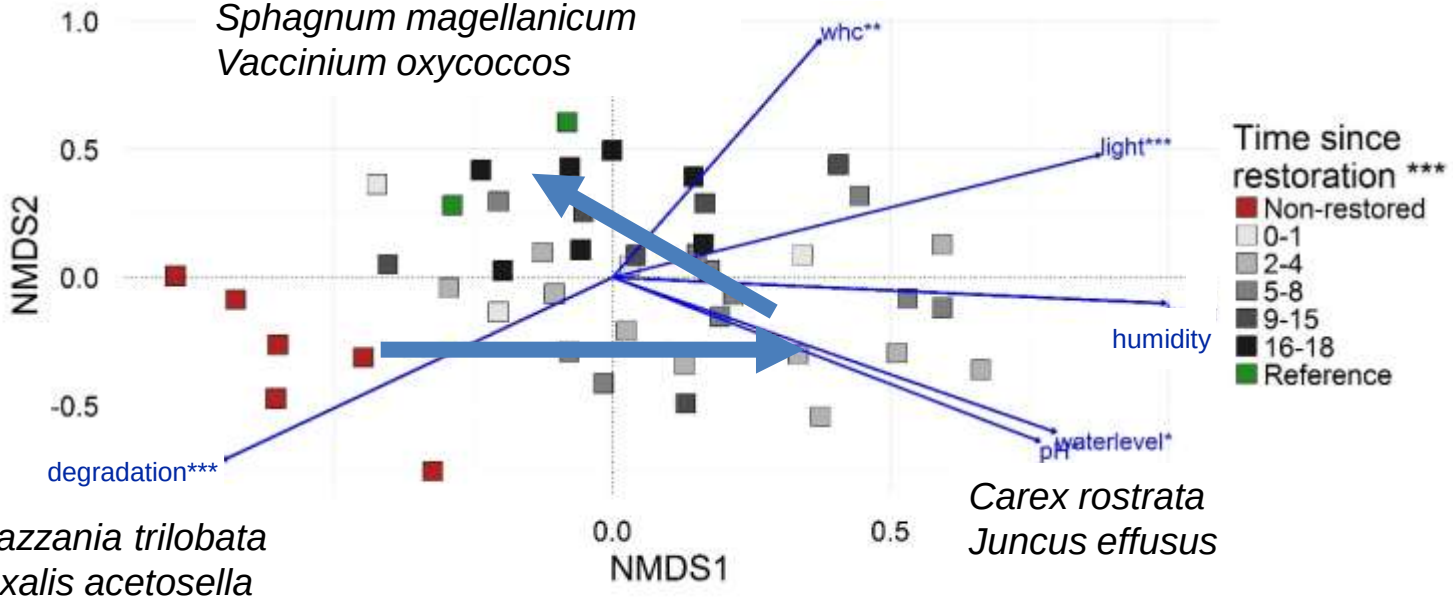
## Results: Vegetation composition




→ Clear difference to pre-restoration community
→ Progression towards reference?

# Vegetation composition

*Andromeda polifolia*
*Drosera rotundifolia*
*Eriophorum vaginatum*
*Sphagnum capillifolium*
*Sphagnum magellanicum*
*Vaccinium oxycoccos*




*Carex rostrata*
*Juncus effusus*

*Bazzania trilobata*
*Oxalis acetosella*
*Plagiumnium undulatum*
*Sphagnum palustre*

→ Clear difference to pre-restoration community
→ Progression towards reference, some species still absent: *A. polifolia, D. rotundifolia*