Getting more out of your biodiversity data with life-history strategies: a fresh approach to causally link species and their habitat

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agriculture, nature and food quality

survival plan woodland + nature

Rewetting bog remnants
- Degradation
- Results from rewetting

Unraveling species-environment relationships
- Correlations
- Species traits

Life-history strategies
- Development
- Rationale

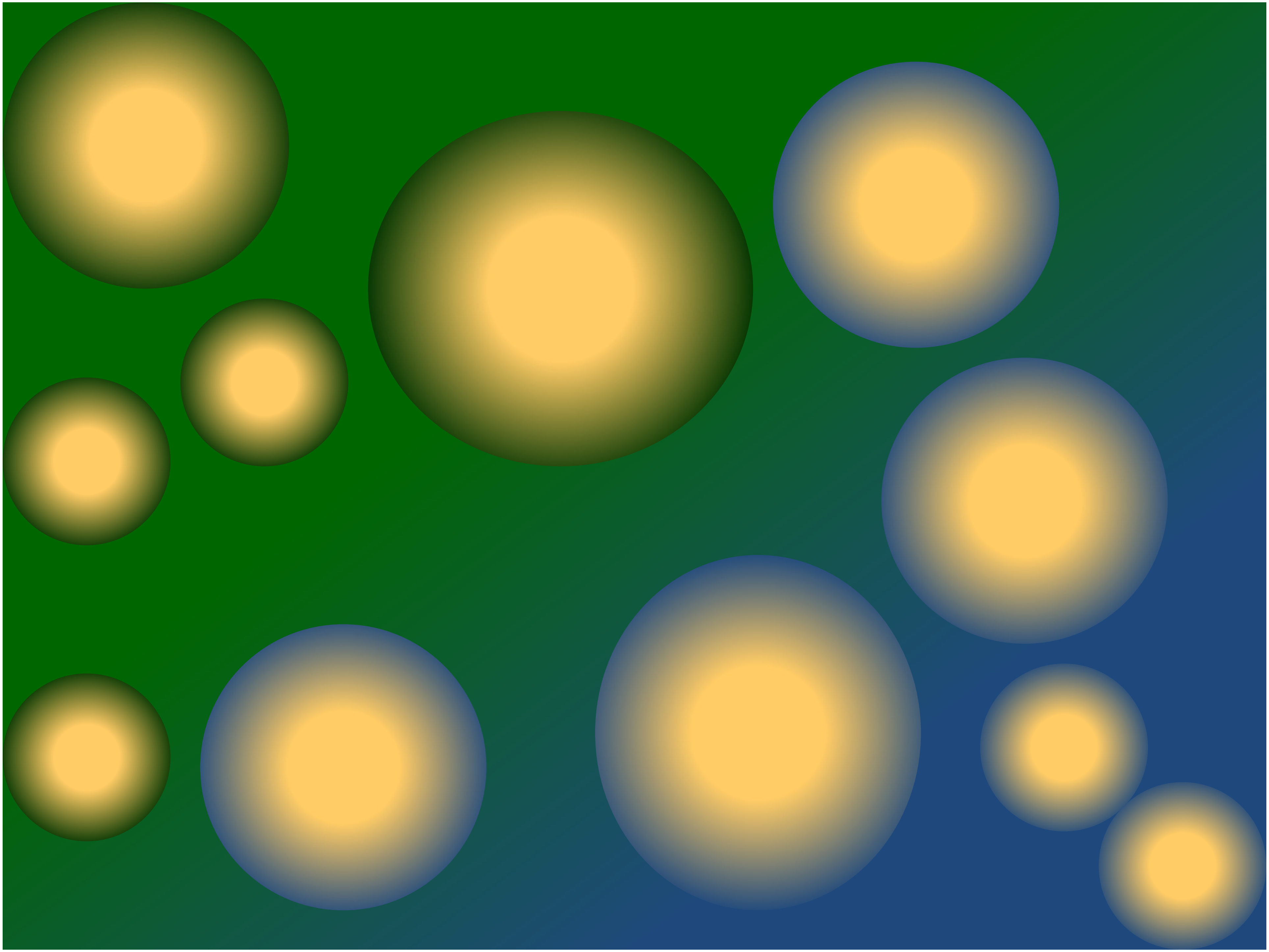
Applying Life-history strategies
- Field data
- Applied ecology (rewetting)

Getting more out of your biodiversity data with life-history strategies

Environment

Species

Theory



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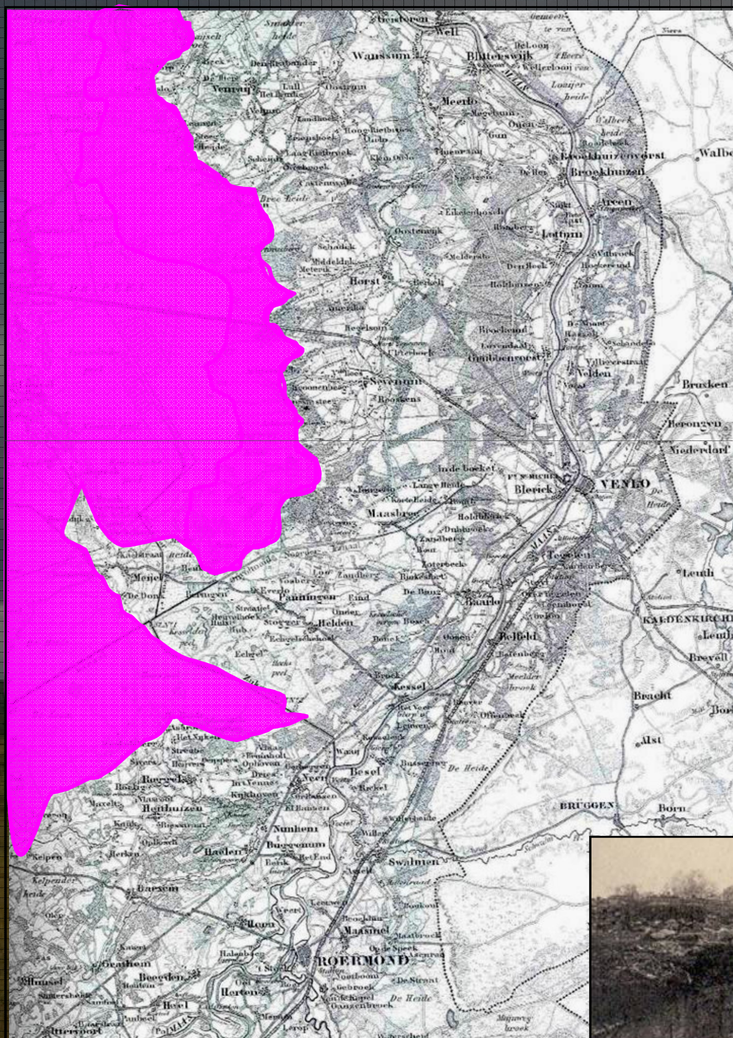
Rewetting of bog remnants

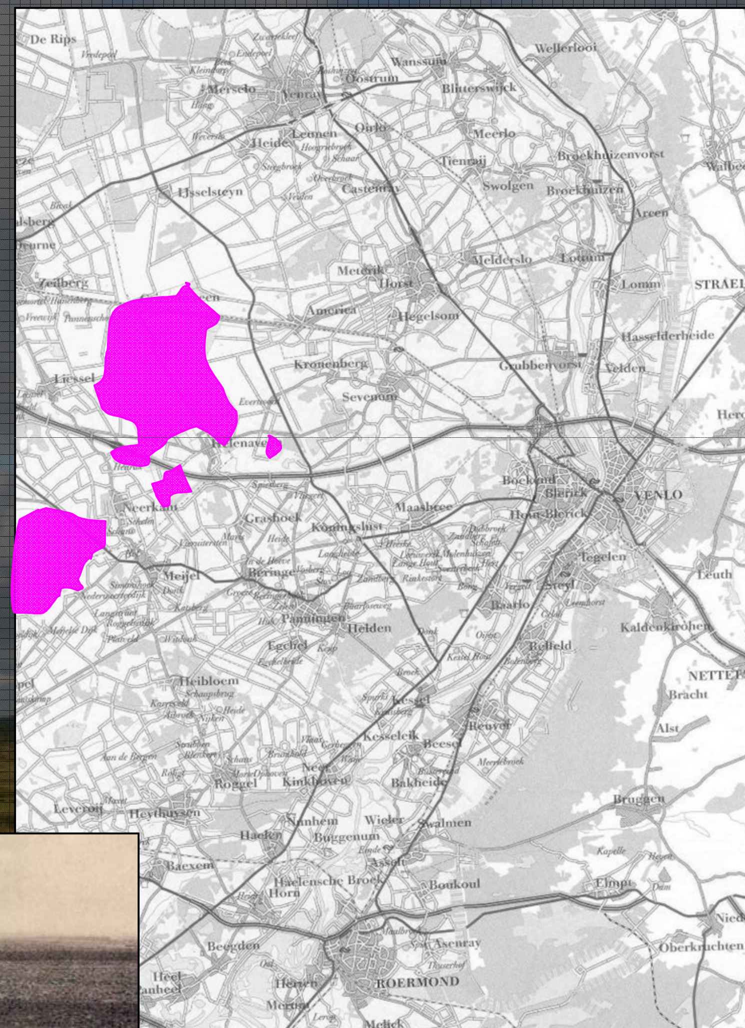
Strongly degraded

peat cutting (desiccation, loss of area)

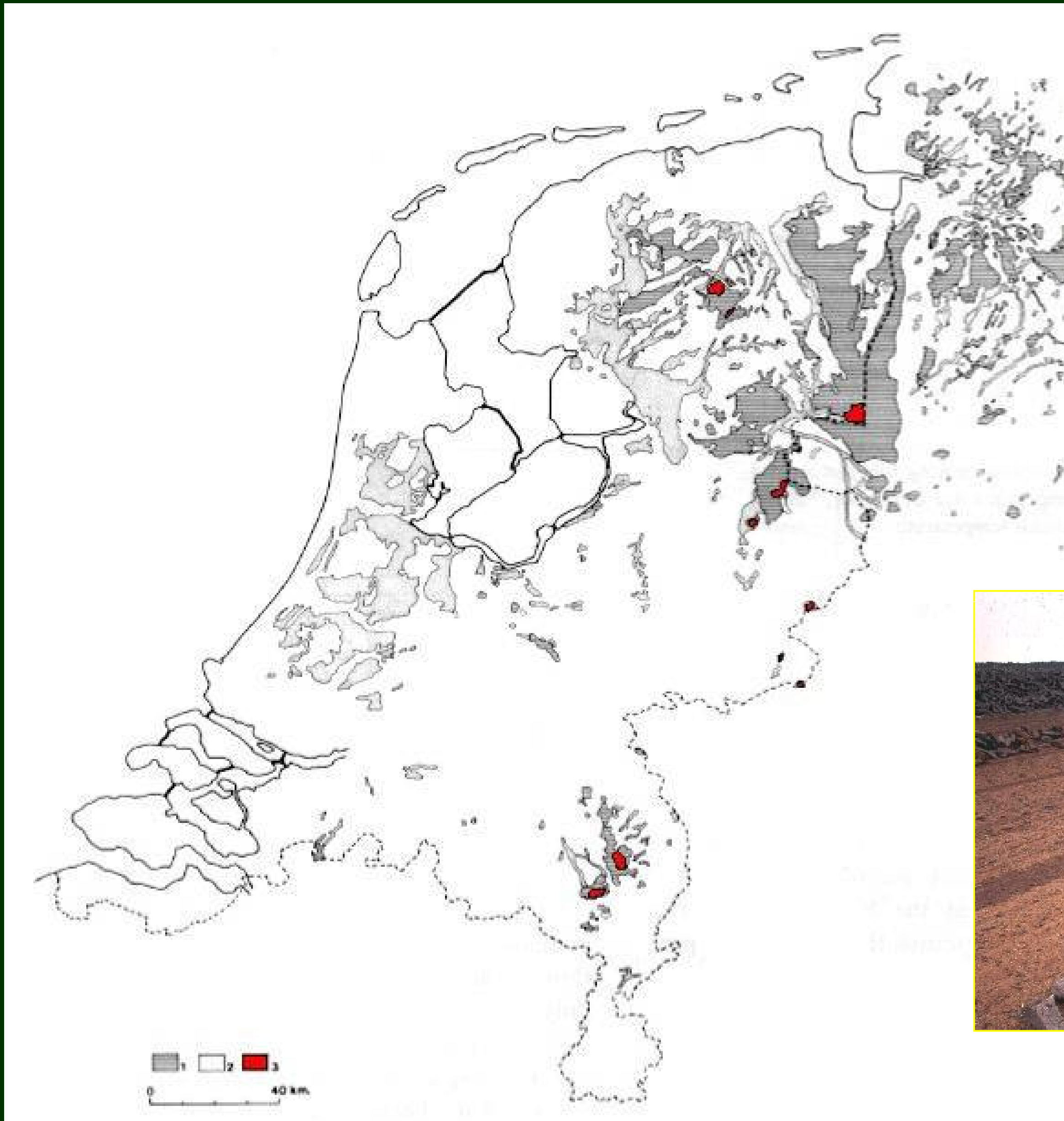
eutrophication (intensive agriculture, decomposition)

Peatcutting



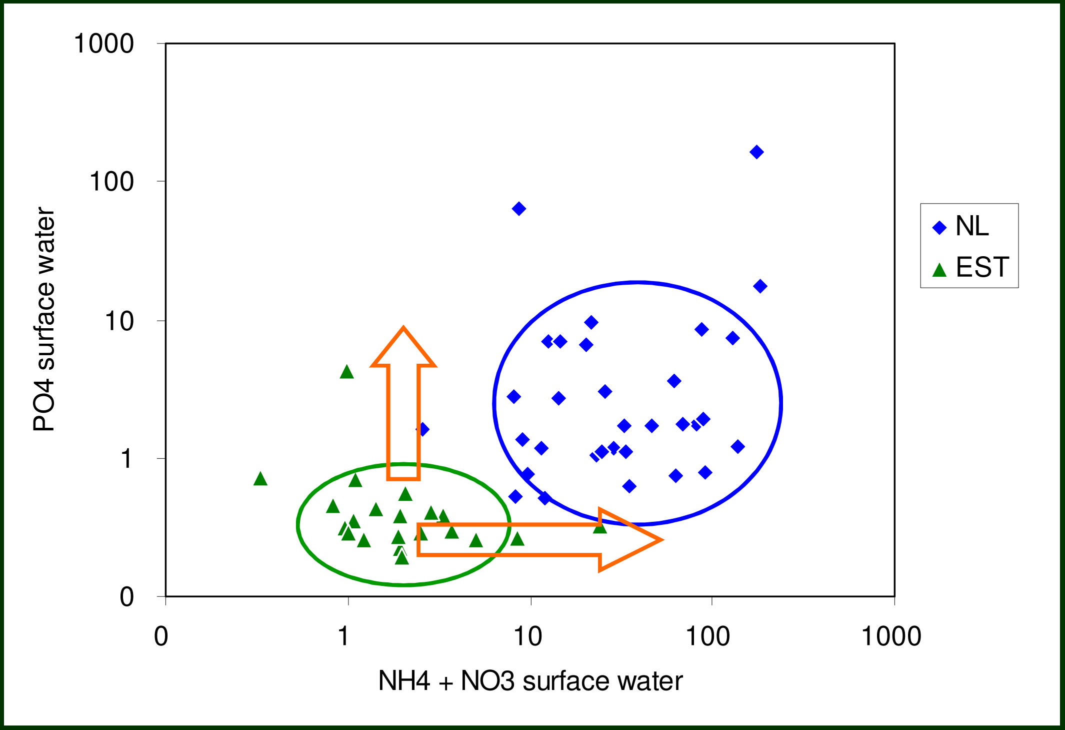


~99% of raised bogs lossed



Source: Verhoeven (ed.), 1992

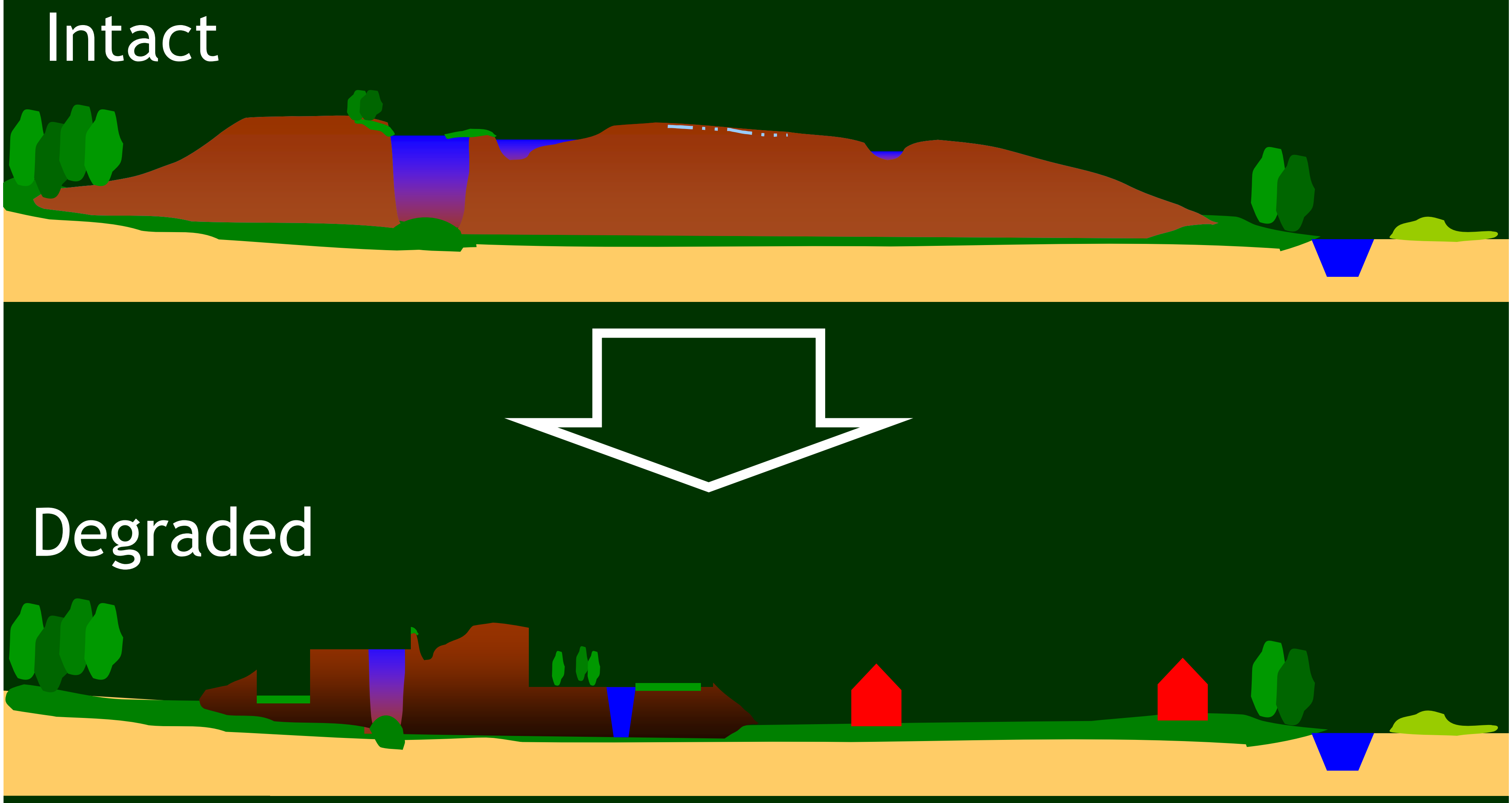
Eutrophication



Degradation of bog remnants

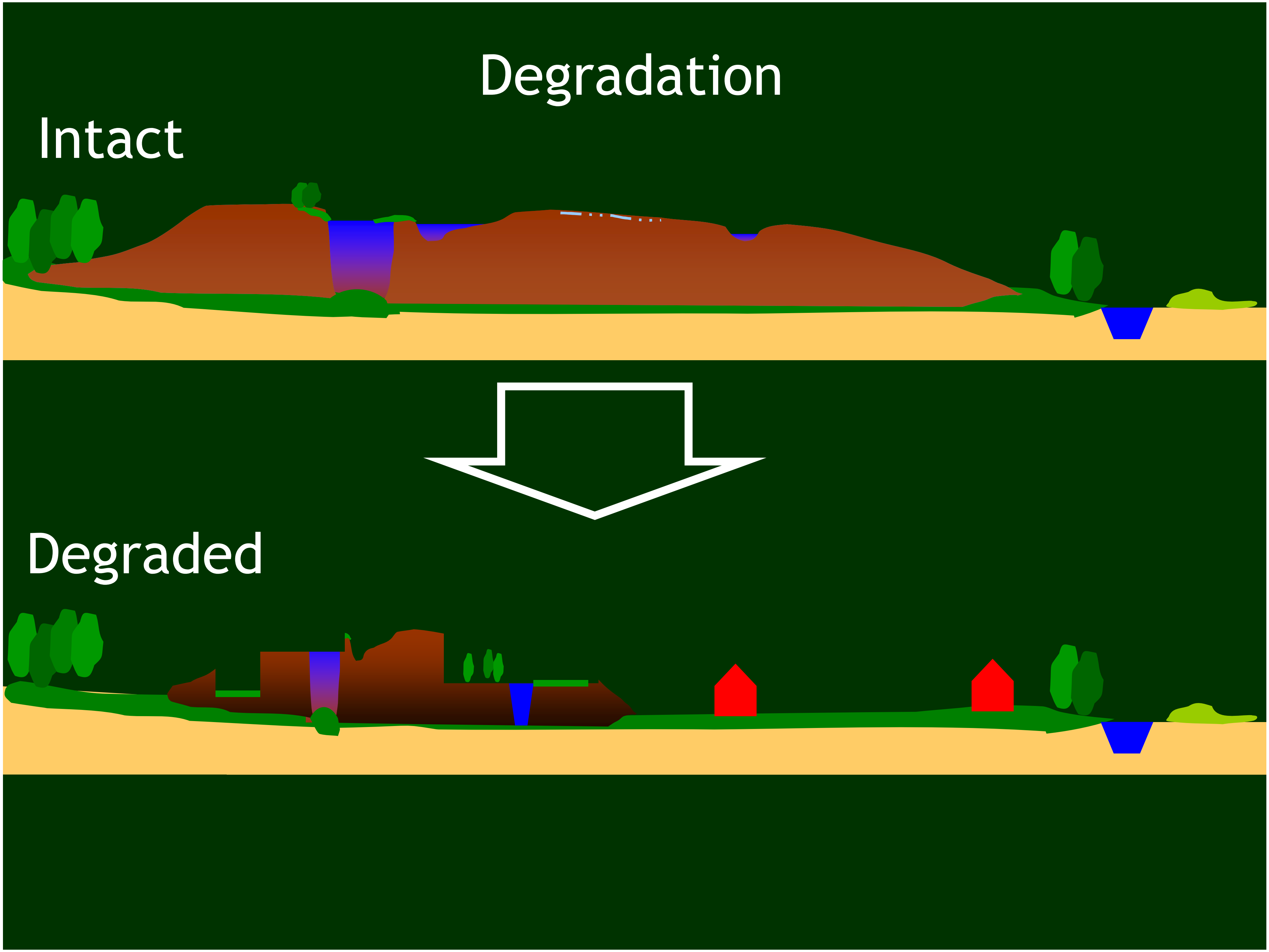
Uniform landscapes lacking variation

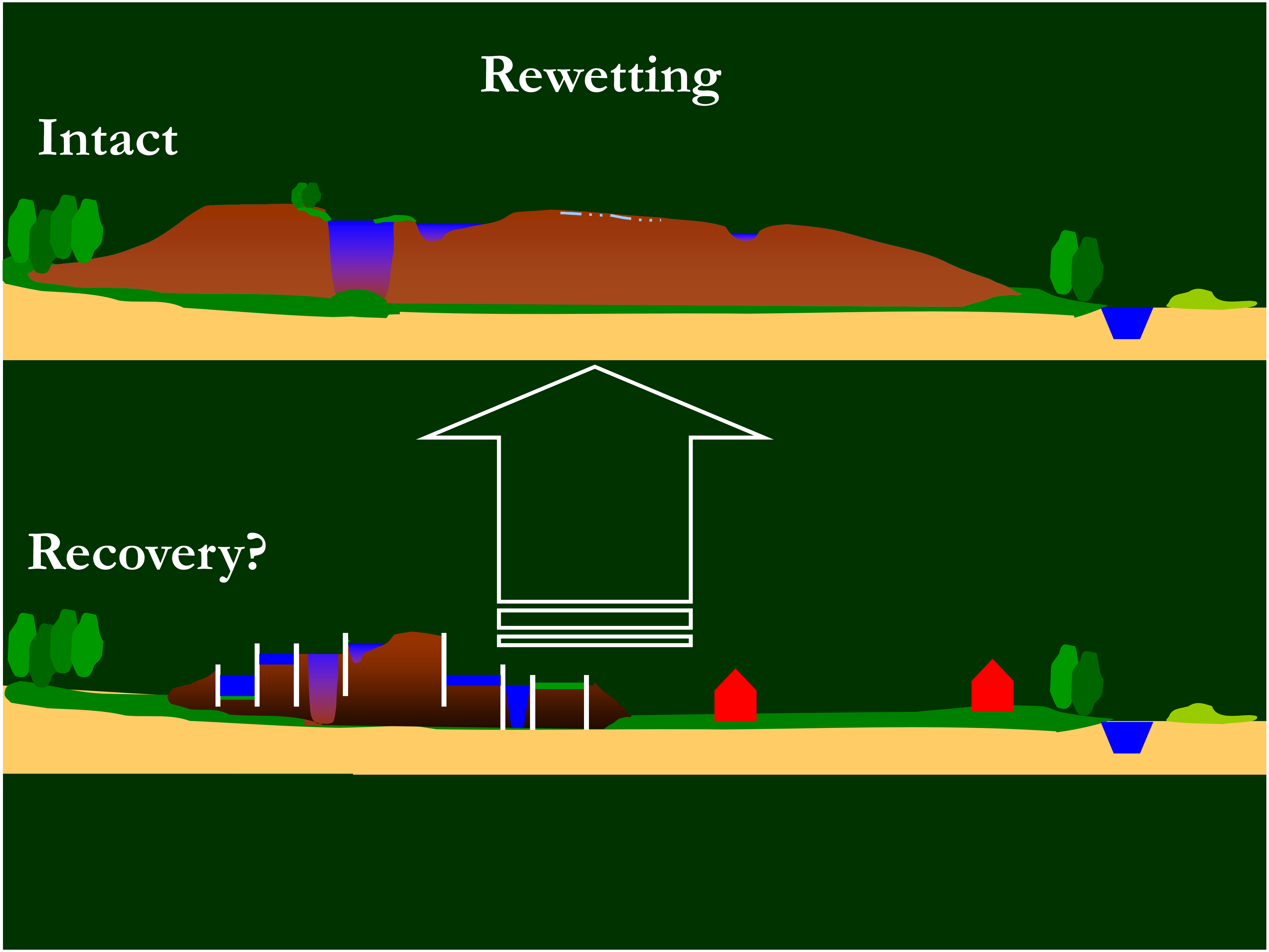
Degradation



Restoration measures

Retention of rainwater
Decrease drainage


Degradation
Intact
Degraded


Rewetting
Intact
Recovery?

Comparative studies

Degraded bogremnants (NL)

no restoration measures taken

rewetting

Pristine bog landscapes (Est)

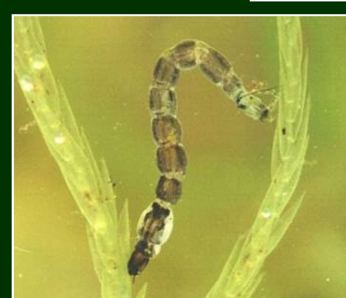
Many different systematic groups:

- Platwormen (Tricladida)
- Bloedzuigers (Hirudinea)
- Borstelwormen (Oligochaeta)
- Waterkevers (Coleoptera)
- Waterwantsen (Hemiptera)
- Libellen (Odonata)
- Haften (Ephemeroptera)
- Steenvliegen (Plecoptera)
- Dansmuggen (Diptera: Chironomidae)
- Meniscusmuggen (Diptera: Dixidae)
- Pluimmuggen (Diptera: Chaoboridae)
- Steekmuggen (Diptera: Culicidae)
- Kokerjuffers (Trichoptera)
- Waterspin (*Argyroneta aquatica*)
- Waterpissebed (*Asellus aquaticus*)

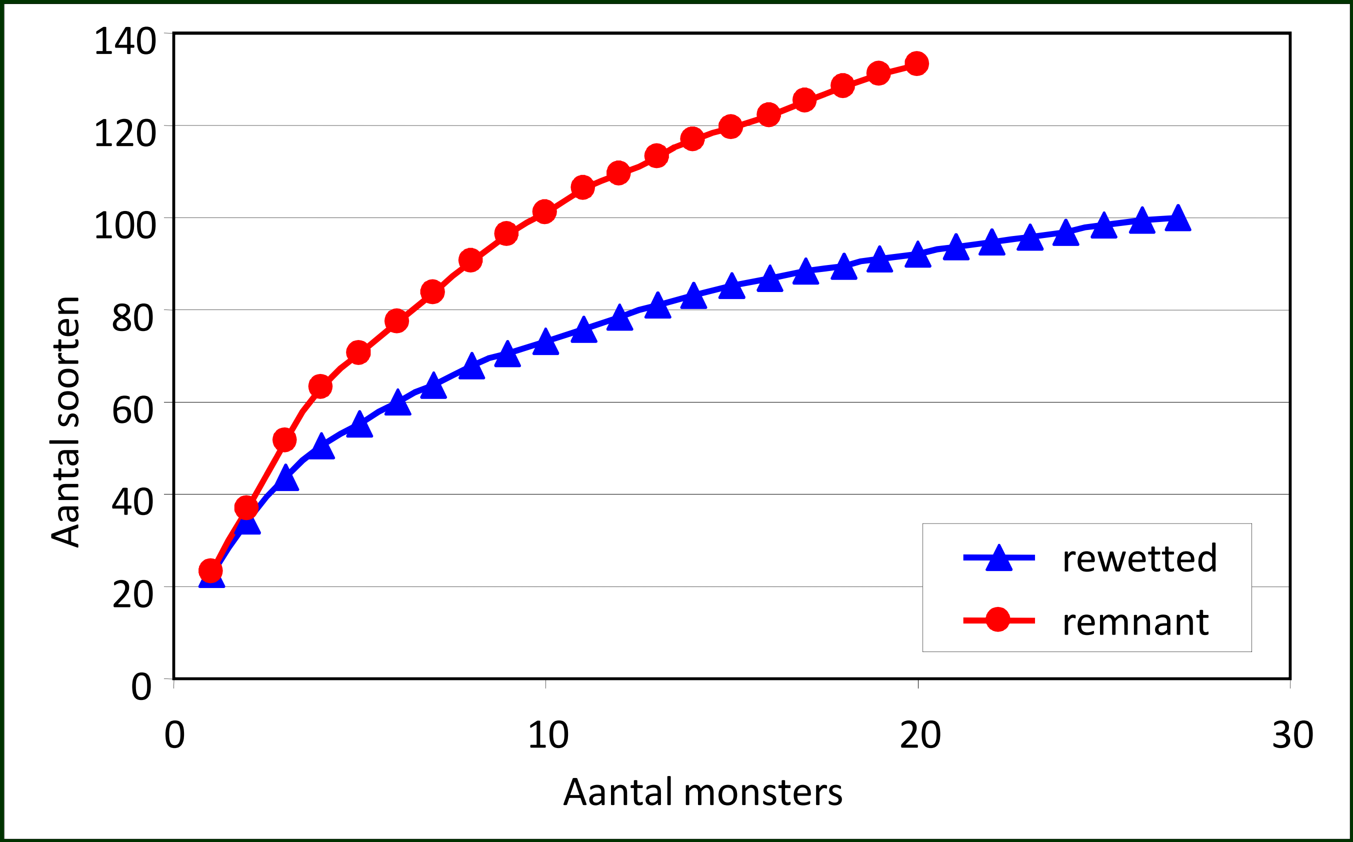






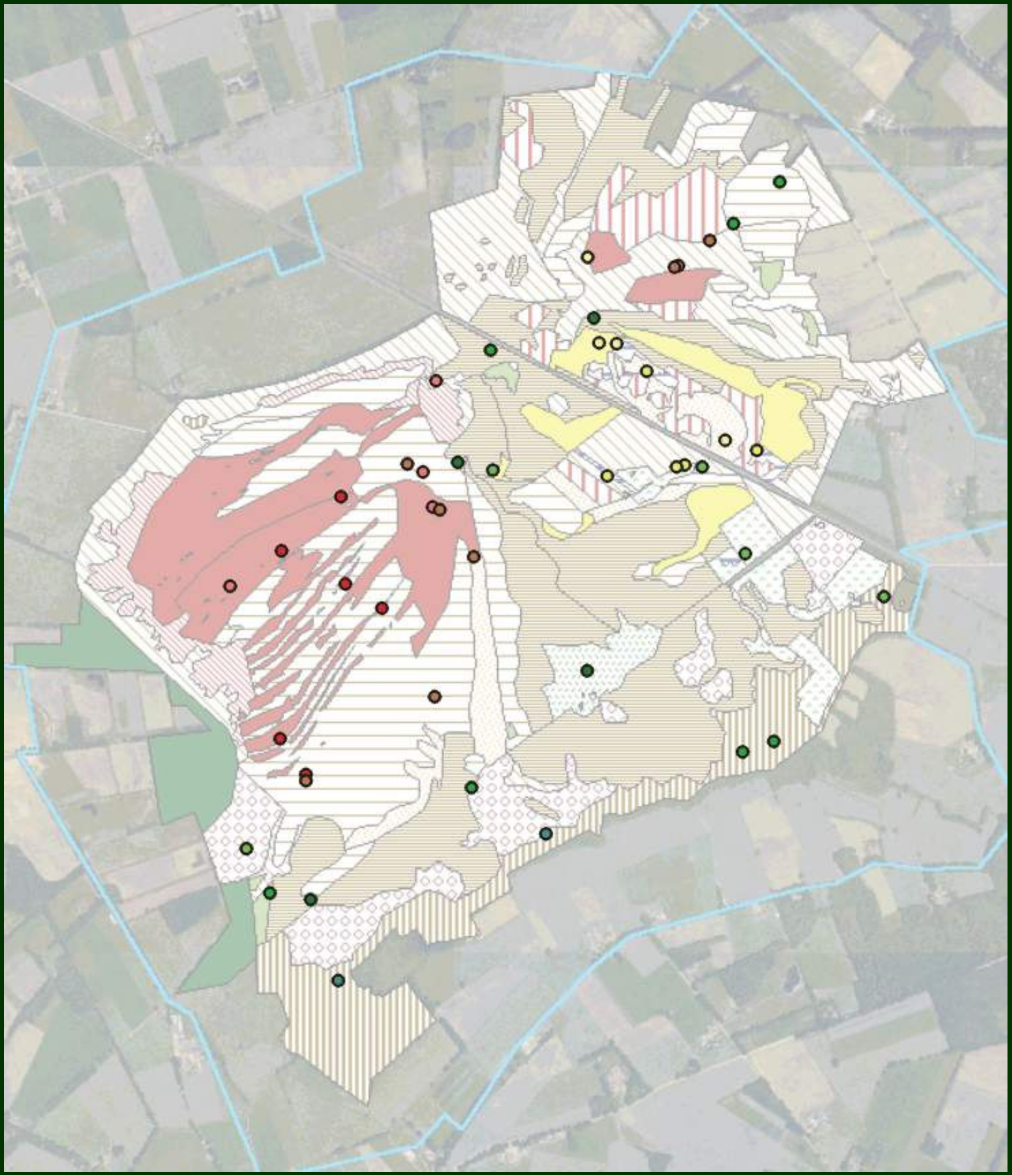


Comparative studies



Relict populations present

Case study Korenburgerveen

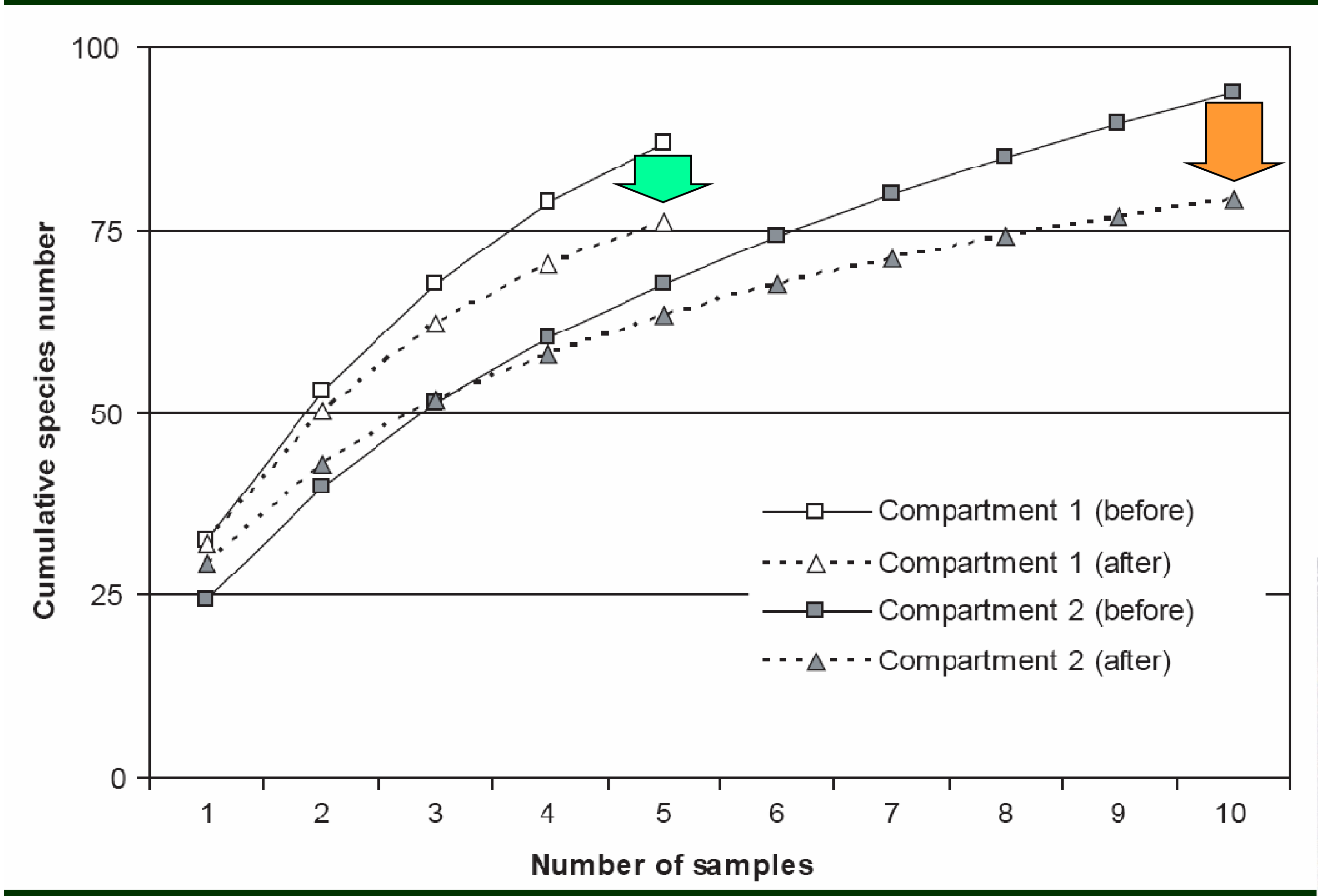


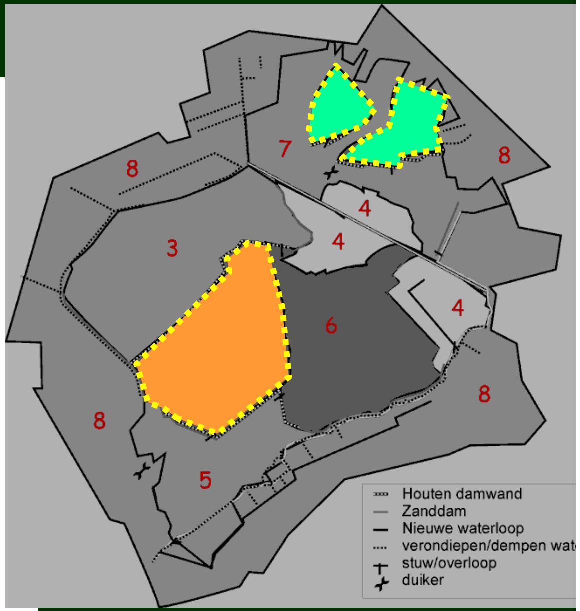
45 waterbodies sampled
- spring & autumn
- before and after measures took effect

209 samples

>145.000 individuals
>267 taxa

Case study Korenburgerveen





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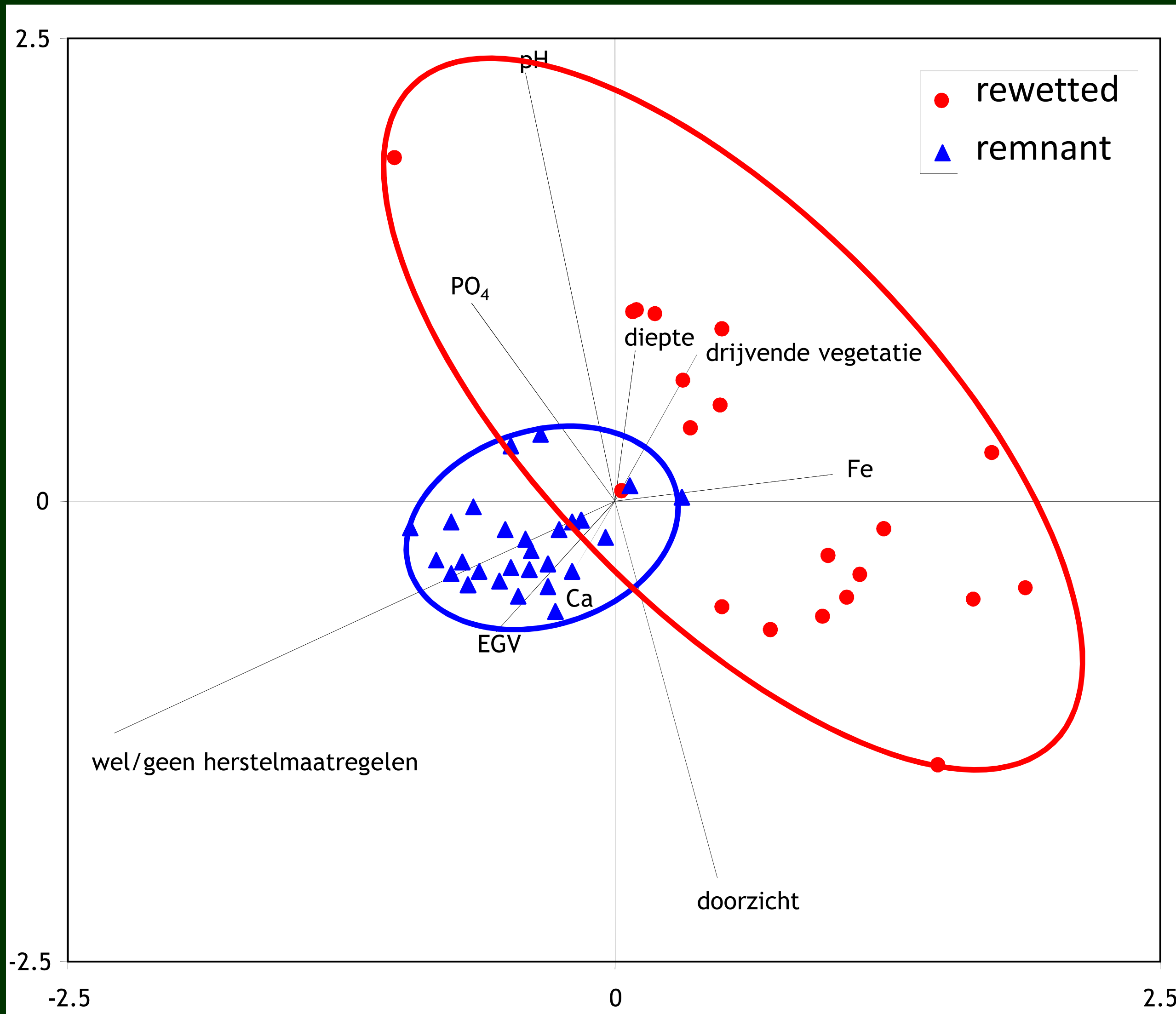
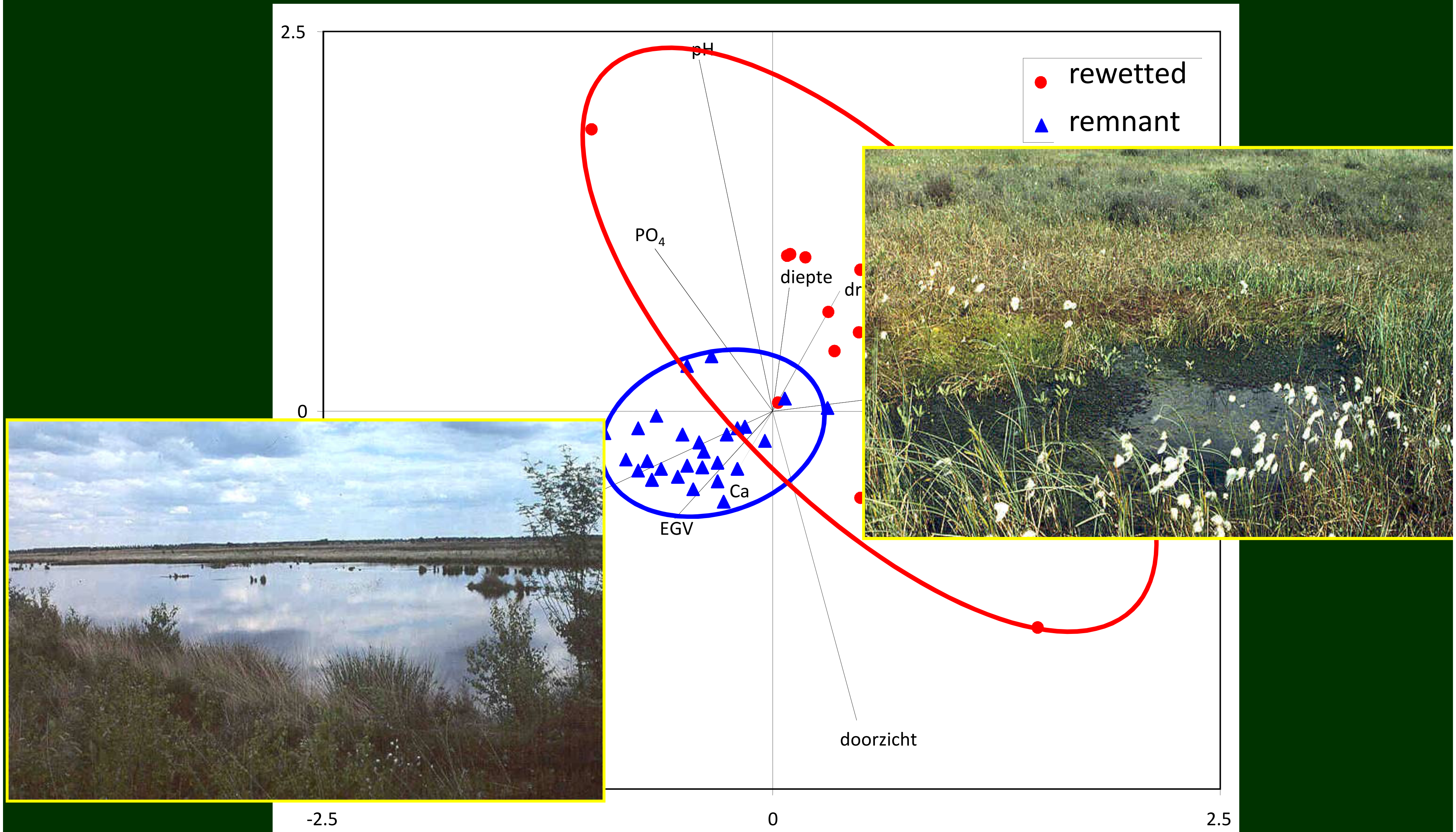


More of the same after rewetting

Comparative studies



More of the same after rewetting

Rewetting bog remnants

- Degradation
- Results from rewetting

Unraveling species-environment relationships

- Correlations
- Species traits

Life-history strategies

- Development
- Rationale

Applying Life-history strategies

- Field data
- Applied ecology (rewetting)

Getting more out of your biodiversity data with life-history strategies

Unraveling species-environment relationships

Two approaches

Single species - mechanistic – experiments

Communities - descriptive - surveys

Community ecology:
General rules to explain patterns in the distribution of species

Watt (1971):
'If we do not develop a strong theoretical core that will bring all parts of ecology back together, we shall all be washed out to sea in an immense tide of unrelated information'.

Acidity: 3,9 (3,4 - 4,4)
Depth: 78 cm (39 - 140)
Size: 39 m^2 (2 - 190)
Nitrate: 7.6 $\mu mol \cdot l^{-1}$ (0 - 22,5)
Shading
Substratum
Vegetation cover
et cetera…

Species

Match species and environment

Match?

Problems
1. Many conditions

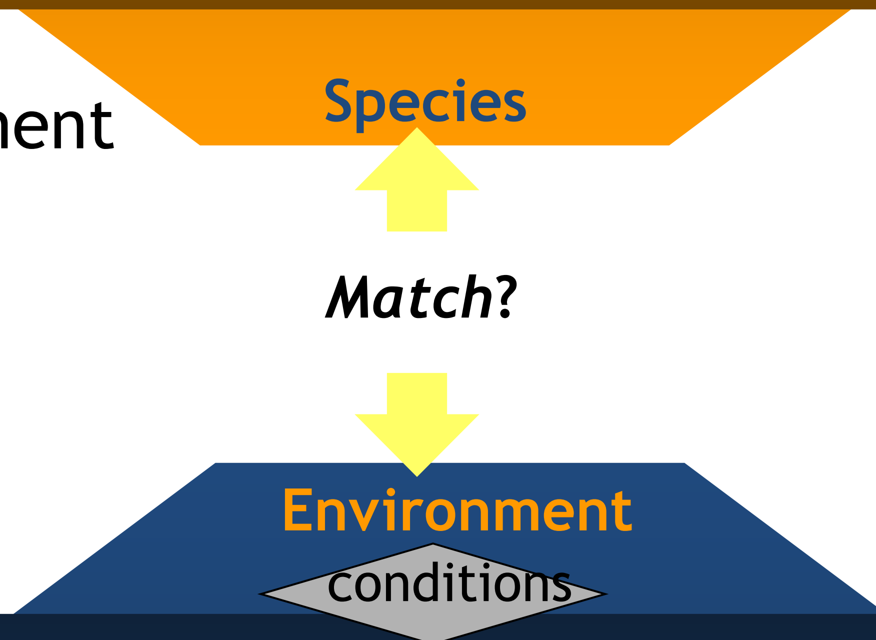
Environment

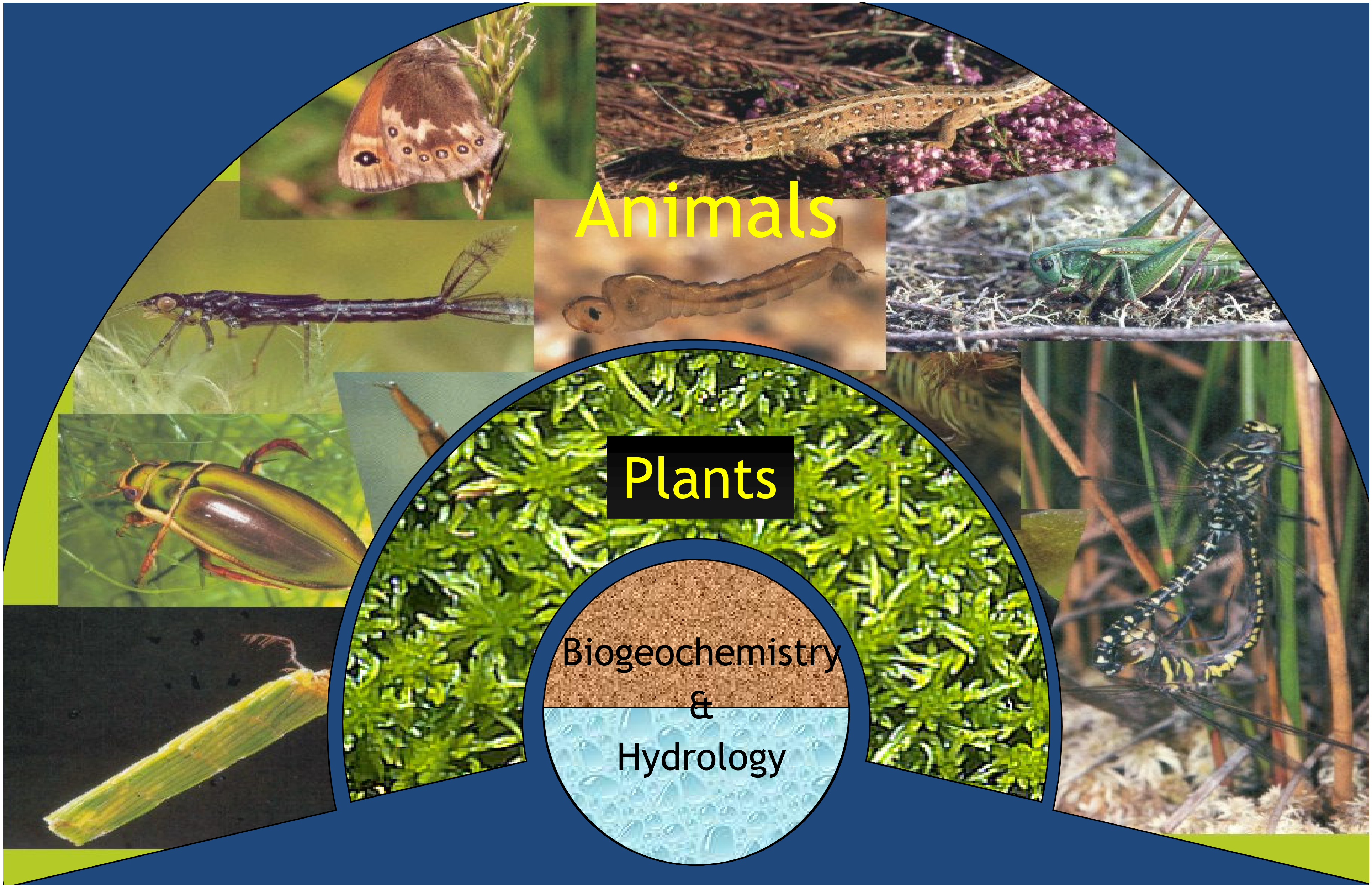
conditions

Match species and environment

Problems

1. Many conditions
2. Many species





Higher plants~1,400 species
Animals ~ 24,000 species

species traits

Species

Match species and environment

Problems
1. Many conditions
2. Many species
3. Causality?

***Match*?**

Environment

conditions

Degradation

Restoration

‘changing landscapes’

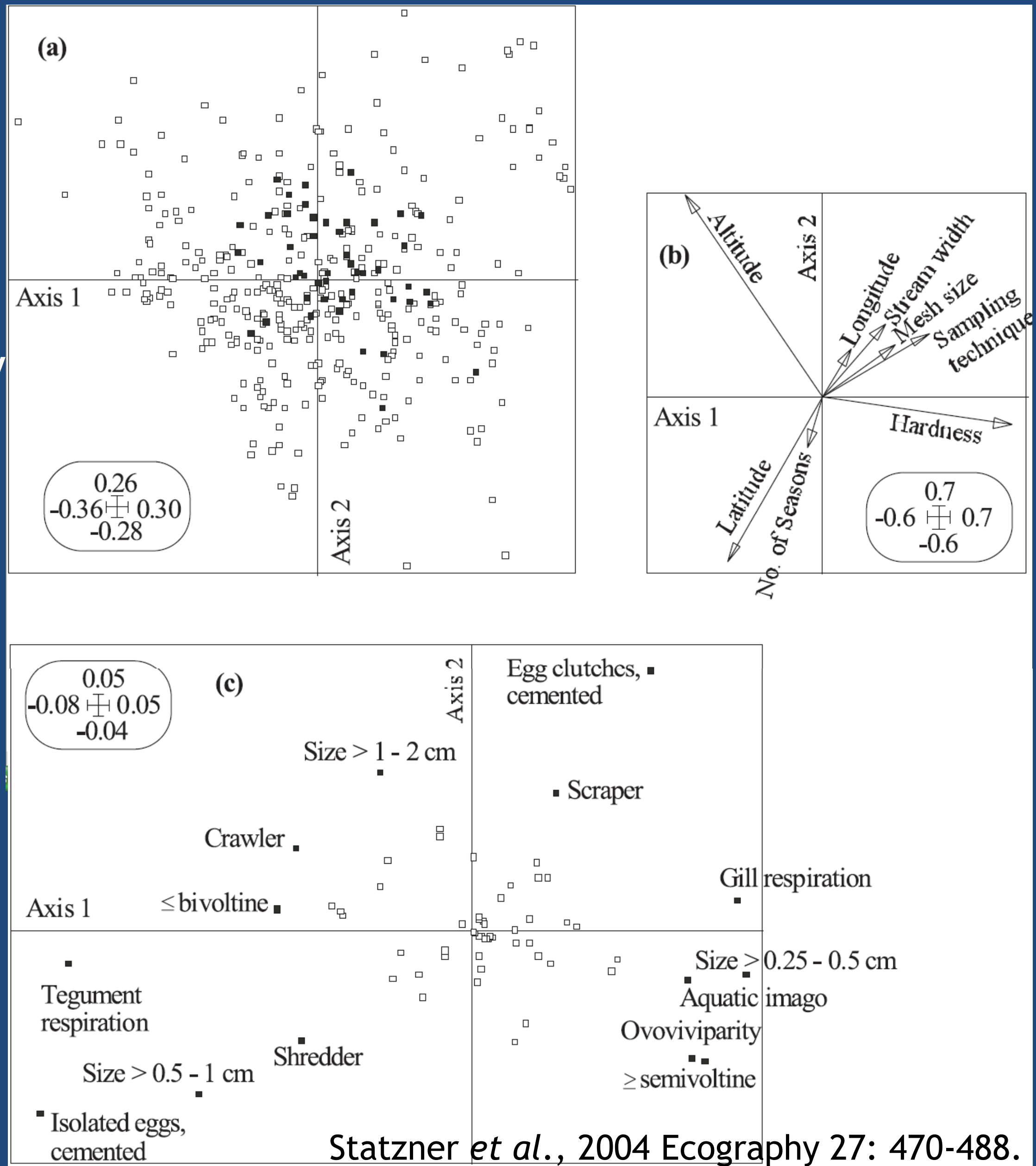
Previous analyses incorporating species traits

Difficulties:

A posteriori
- Ad hoc explanations
- Predictions performed poorly

Relationships among traits
- Averaging out
- Alternative suites

Explanation for patterns in species occurrence?



Statzner *et al.*, 2004 Ecography 27: 470-488.

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Life-history strategies - a fresh approach

Start from species traits

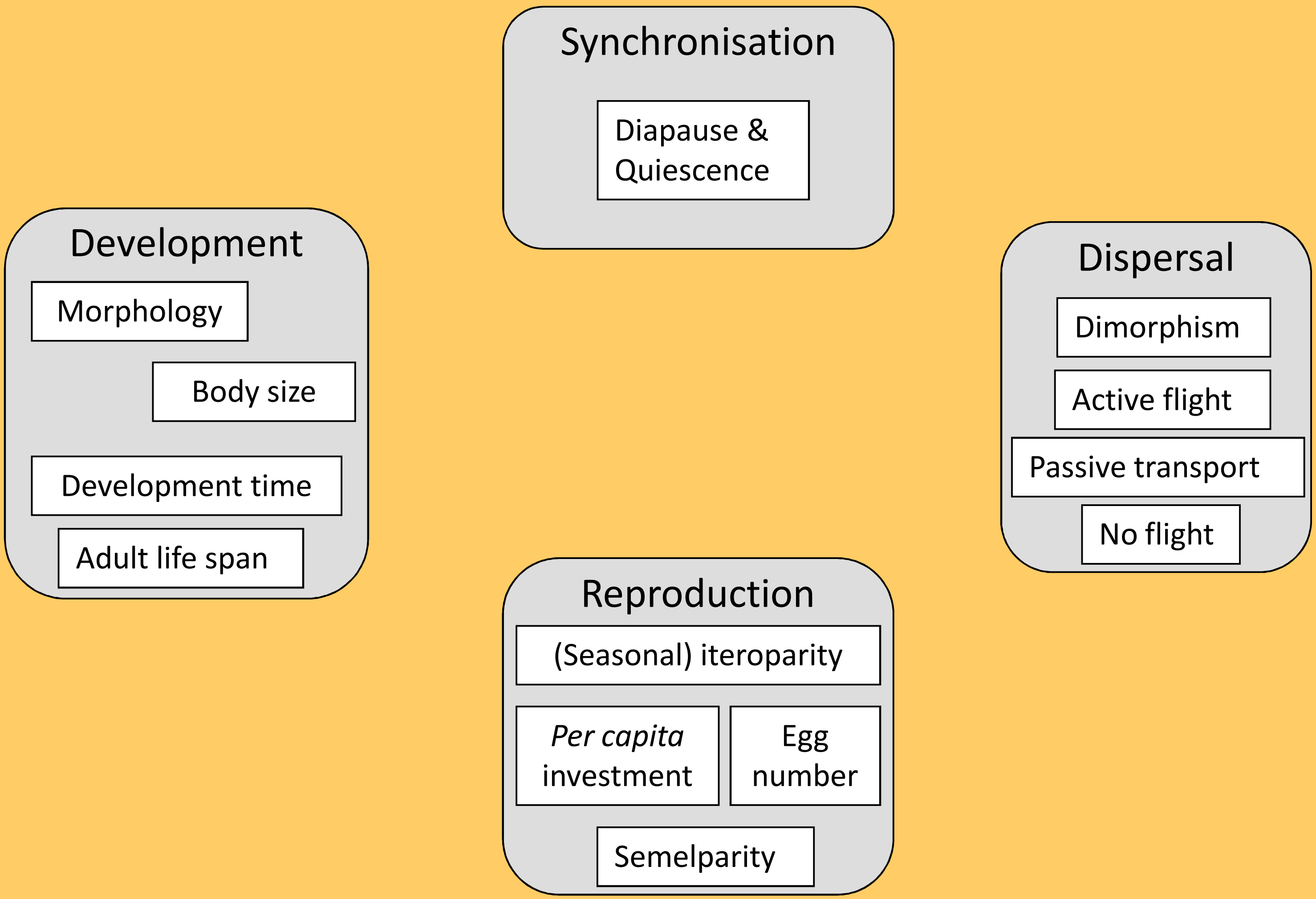
Define functionally equivalent groups *a priori* based on trait combinations

Life-history strategies:

> "sets of co-evolved traits which enable a species to deal with a range of ecological problems."
>
> Stearns (1976) Quarterly Review of Biology 51: 3-47.

Test theoretically defined groups with empirical data.

Life-history strategies in aquatic macroinvertebrates

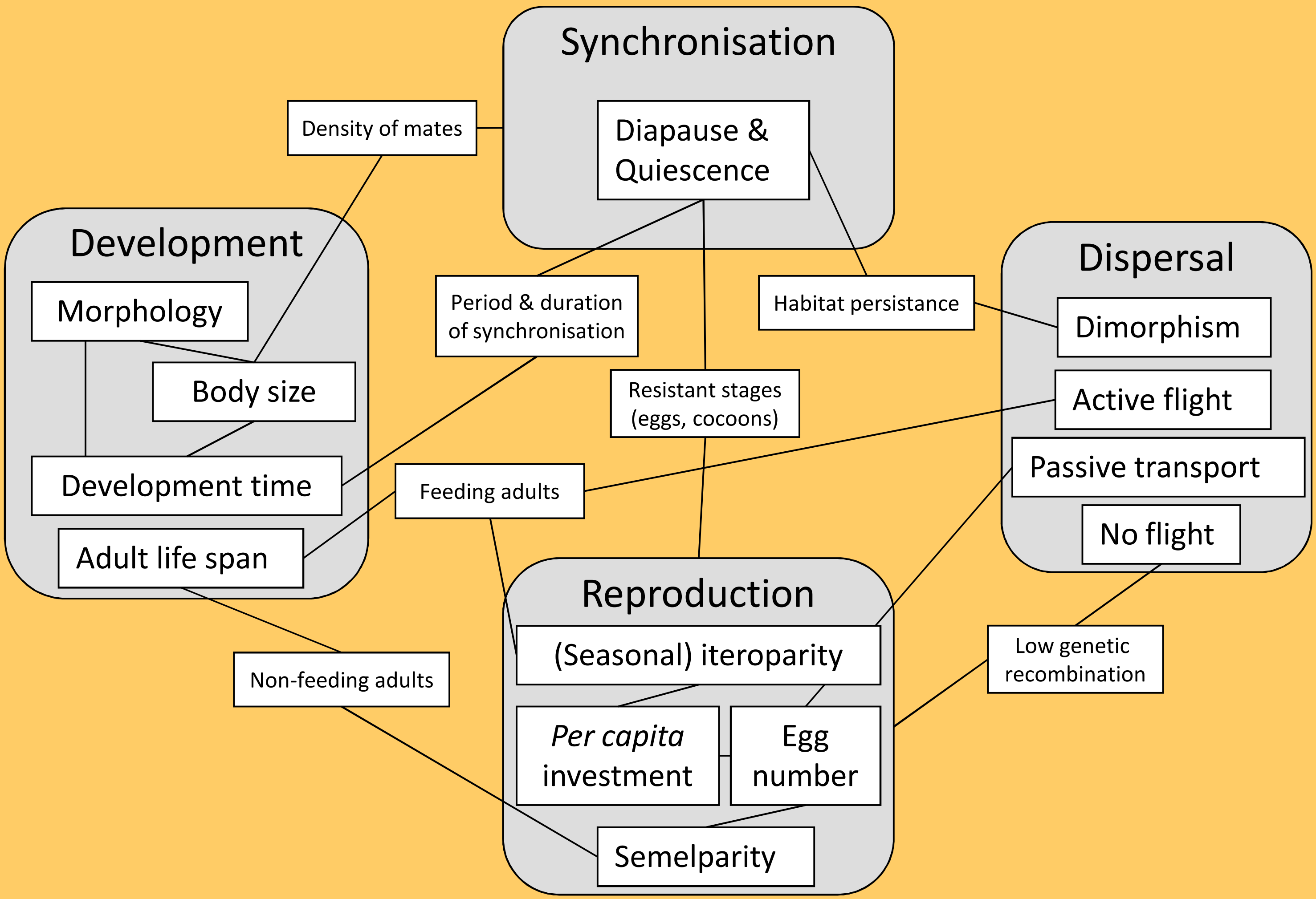


Life-history strategies in aquatic macroinvertebrates

Consider multiple traits acting in concert

- -Relationships among traits (trade-offs and spin-offs)
- -Investment in traits

Life-history strategies in aquatic macroinvertebrates



Life-history strategies in aquatic macroinvertebrates

Trade-off
Investments in one trait ⟶ less resources for another trait.

- Growth and development
- Egg size and egg number
- ...

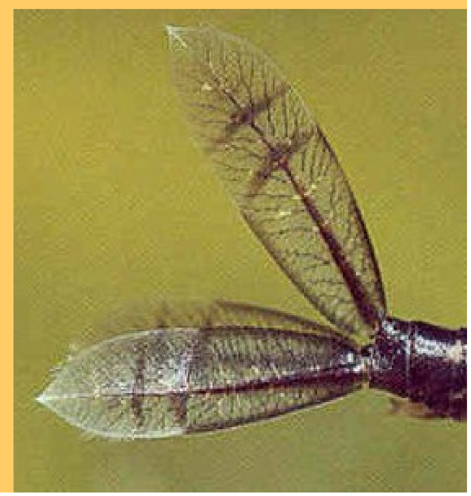
Life-history strategies in aquatic macroinvertebrates

Trade-off
Investments in one trait $\longrightarrow$ less resources for another trait.

Growth and development
Egg size and egg number
...

Spinn-off
Investments in one trait $\longrightarrow$ increases benefits or lowers costs for another

Few eggs and brood care
Gills in damselflies for respiration and locomotion
...



Life-history strategies in aquatic macroinvertebrates

Consider multiple traits acting in concert

- Relationships among traits (trade-offs and spin-offs)
- Investment in traits

Function of traits and combinations of traits

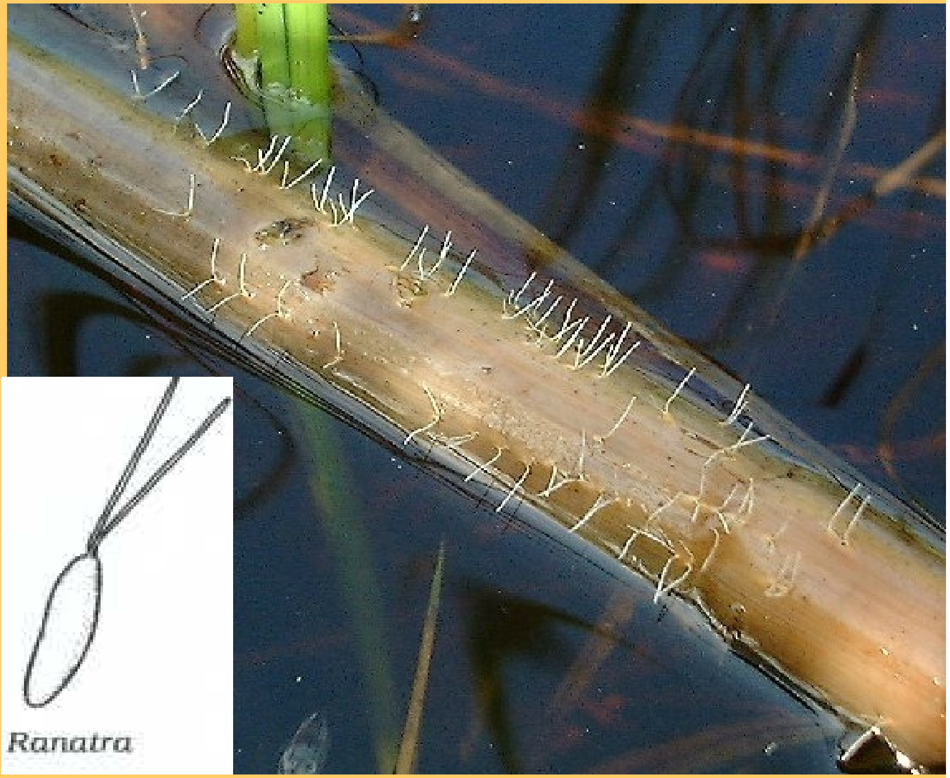
- In light of other traits of a species
- Relative differences (similar body plan)
- Alternative suites (different body plan)

Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:

- endophytical oviposition



Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:
- endophytical oviposition
- gelatinous matrix

Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:

- endophytical oviposition
- gelatinous matrix
- brood care

Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:
- endophytical oviposition
- gelatinous matrix
- brood care
- ovoviviparous

Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:
- endophytical oviposition
- gelatinous matrix
- brood care
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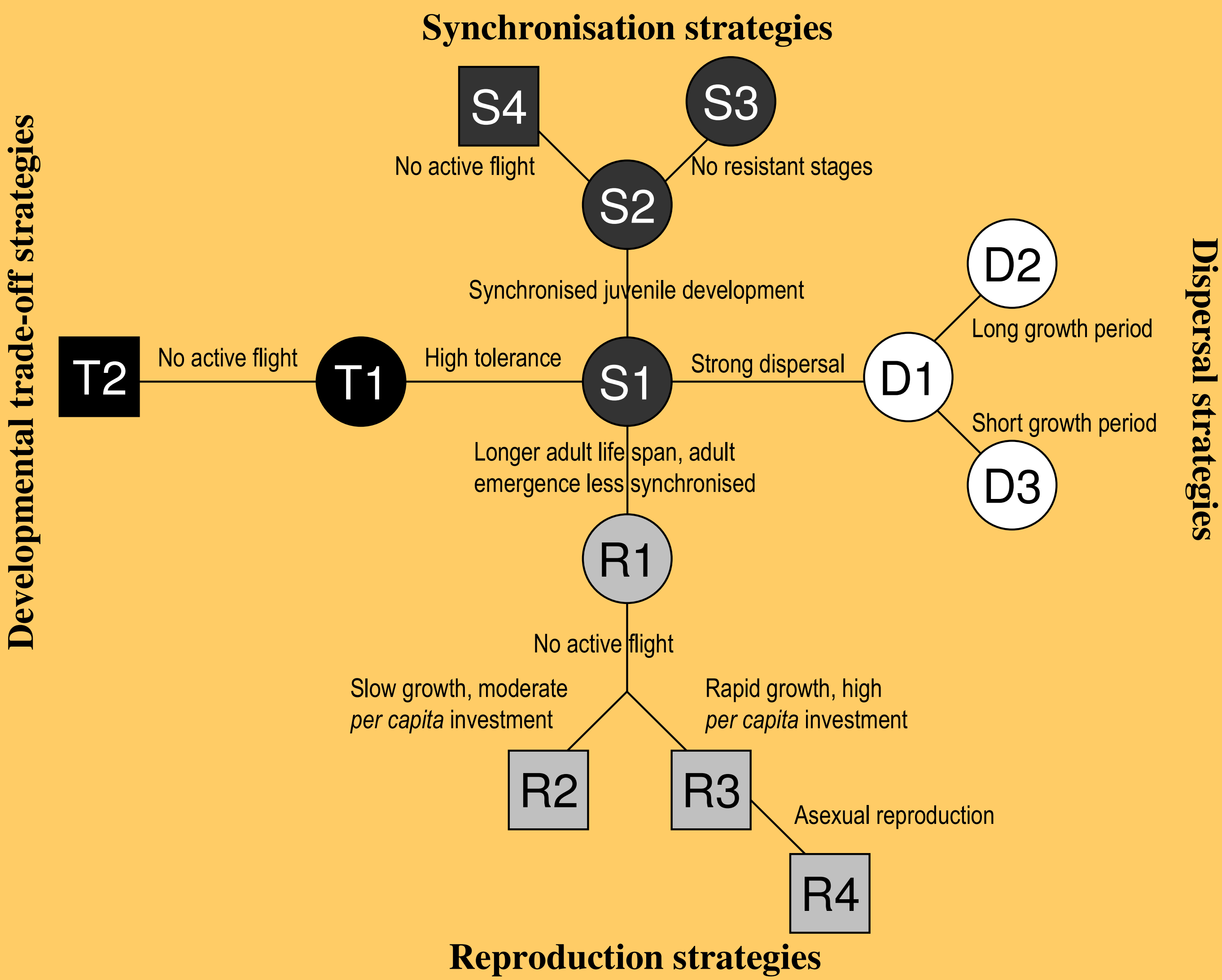
Life-history strategies in aquatic macroinvertebrates

Considering multiple traits acting in concert

Function of traits and combinations of traits

13 life-history strategies

Life-history strategies in aquatic macroinvertebrates



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Applying Life-history strategies

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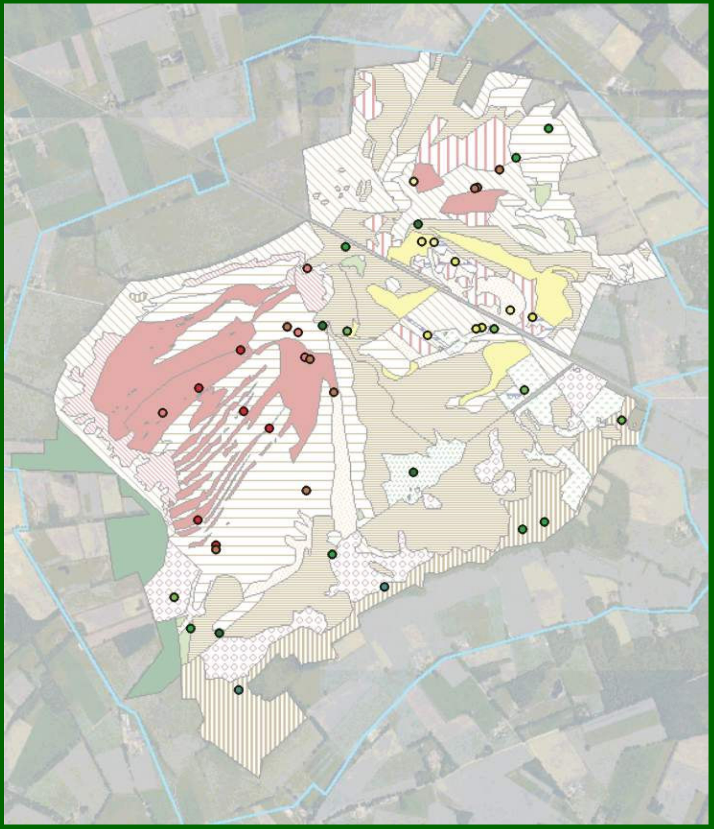
Getting more out of your biodiversity data with life-history strategies

Applying life-history strategies to field data

45 waters sampled

>145.000 individuals
>267 taxa



Applying life-history strategies to field data

Functional classification spanning different systematic groups

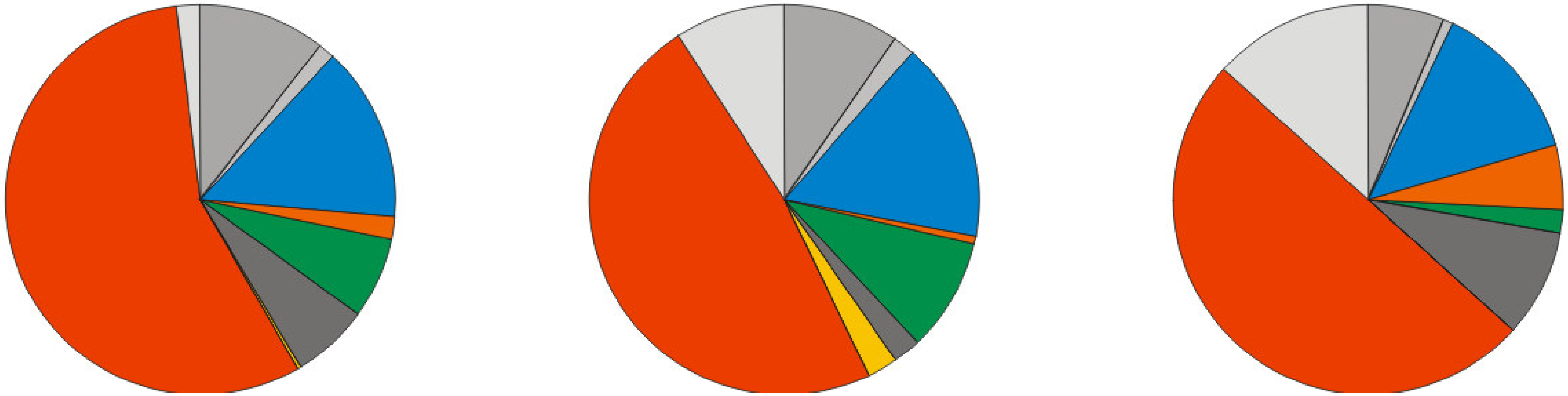
		Life-history strategy												
Systematic group	Total	D1	D2	D3	S1	S2	S3	S4	R1	R2	R3	R4	T1	T2
Arachnida	1 (1)												1	
Coleoptera	86 (7)	22			2	8	22		19				12	1
Crustacea	1 (1)										1			
Diptera	64 (6)	15		9	13	6			2				19	
Ephemeroptera	1 (1)		1											
Hemiptera	20 (4)	6		3					7				4	
Hirudinea	6 (3)							2		2	2			
Megaloptera	1 (1)												1	
Odonata	15 (4)		3		2	4							6	
Oligochaeta	23 (3)							9				8		6
Plecoptera	1 (1)												1	
Trichoptera	15 (4)	1			2	7							5	
Tricladida	4 (2)							2		2				

Bog pools (n=18)

large bog pools (6)

small bog pools (6)

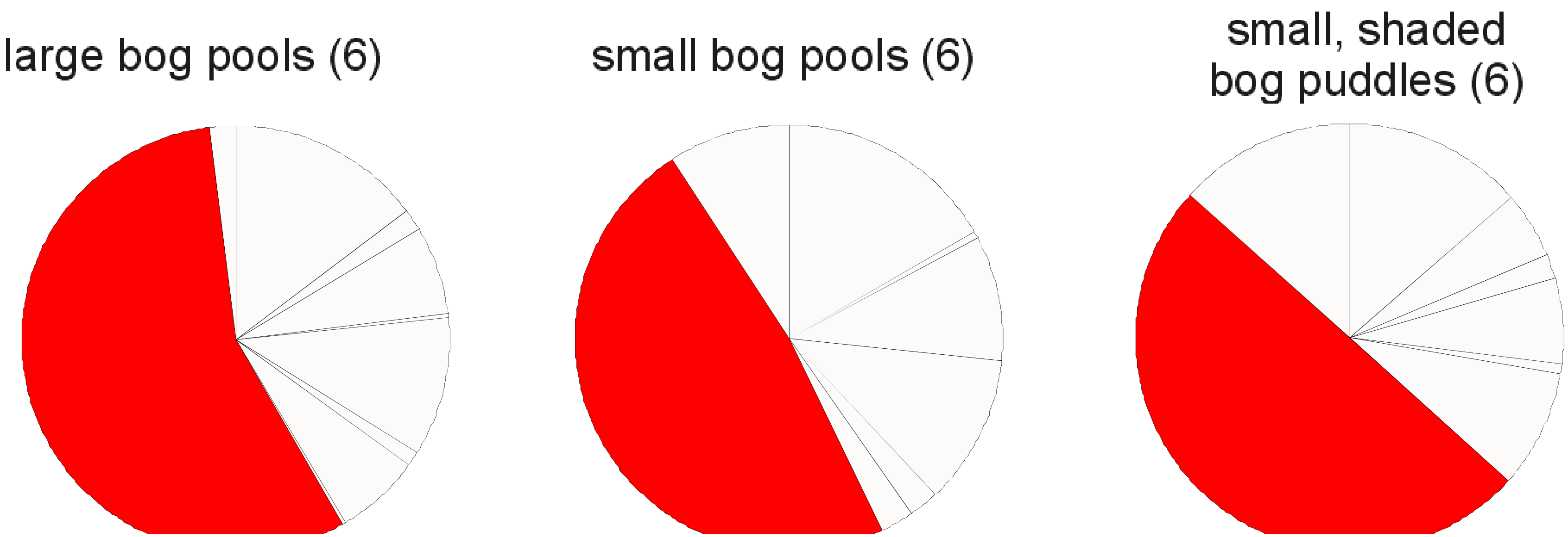
small, shaded bog puddles (6)



High investments in physiological tolerance, constraining other investments

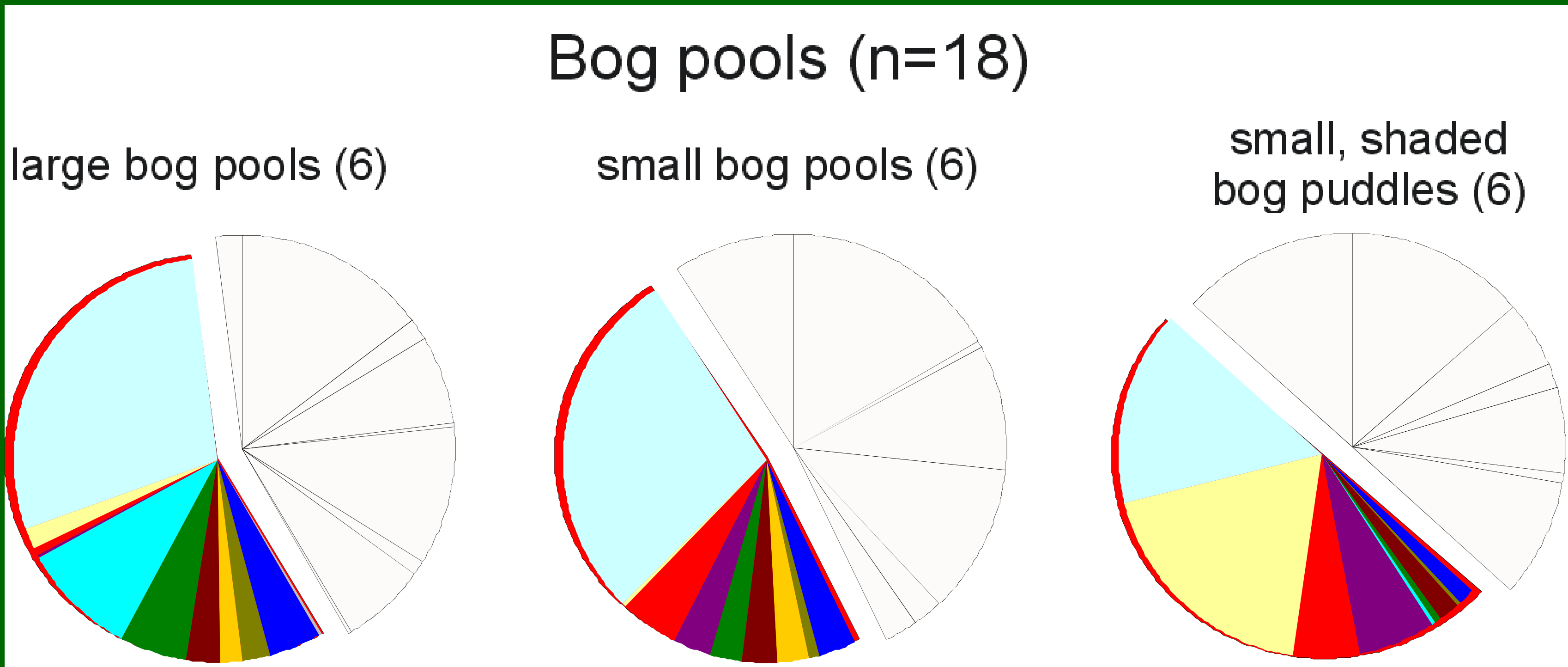
Habitat suitability as a key aspect

Bog pools (n=18)



High investments in physiological tolerance, constraining other investments

Habitat suitability as a key aspect

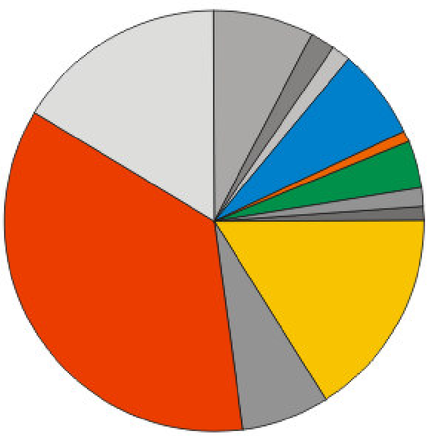


Habitat suitability as a key aspect
Differences in abundance aggregated

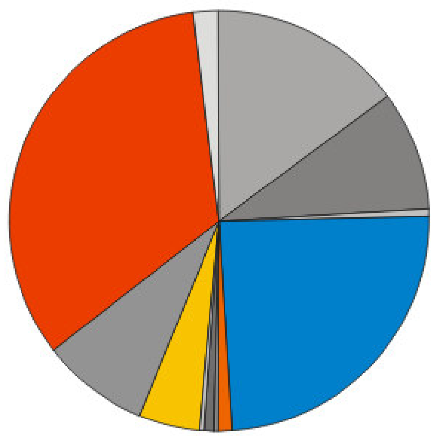


Mesotrophic waters (n=14)

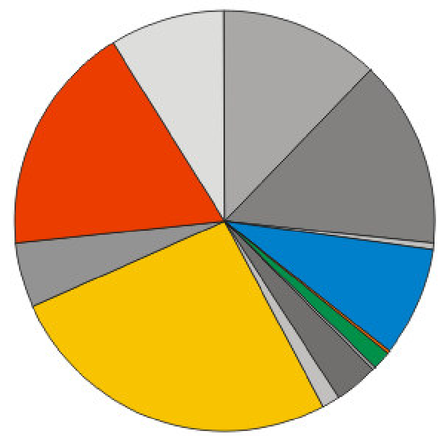
shallow mesotrophic puddles (4)



mesotrophic pools (5)



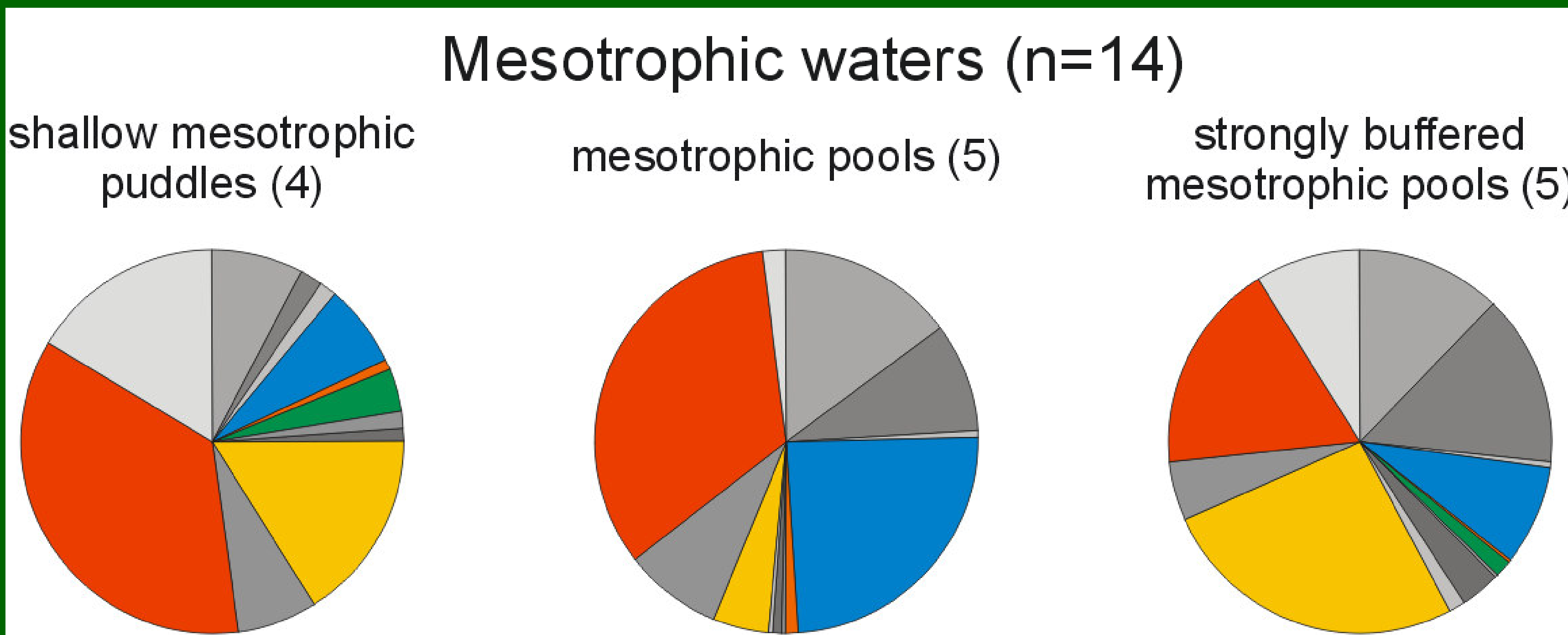
strongly buffered mesotrophic pools (5)



High investments in physiological tolerance, constraining other investments

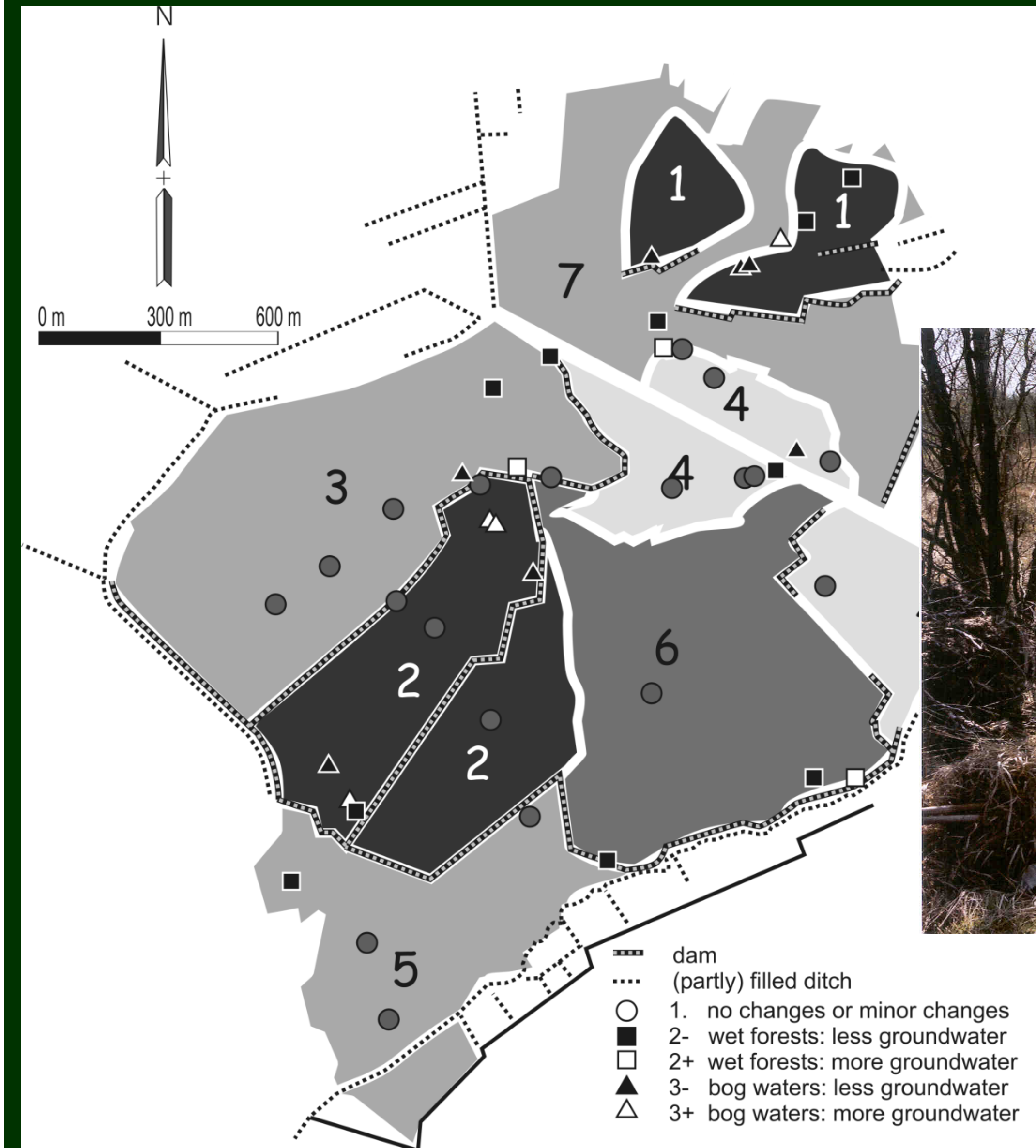
Long larval development with synchronised emergence of short-lived adults

High per capita investment and several successive reproduction events



Predictability and stability as a key aspect

Evaluating the effects of rewetting measures



Rewetting
- Increase retention of rainwater
- Decrease drainage

Evaluating the effects of rewetting measures

Water bodies in forest

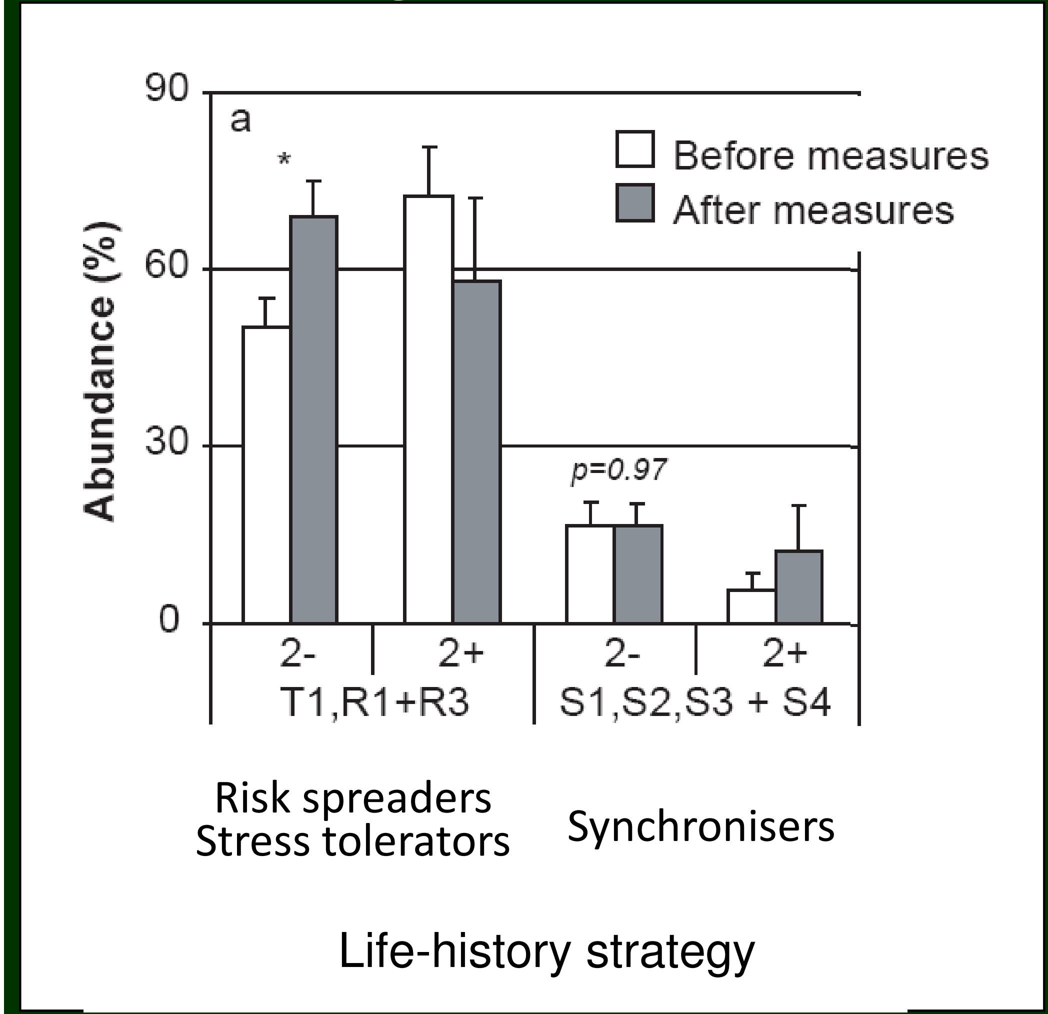
- Higher water table
- Stagnation
- Mobilisation of nutrients
- Increase of *Glyceria maxima*

More variable and unpredictable environment

Evaluating the effects of rewetting measures

More groundwater influence
cyclic, predictable environment

Evaluating the effects of rewetting measures



Evaluating the effects of rewetting measures

Bog pools

- Higher water table
- Stagnation
- Less groundwater

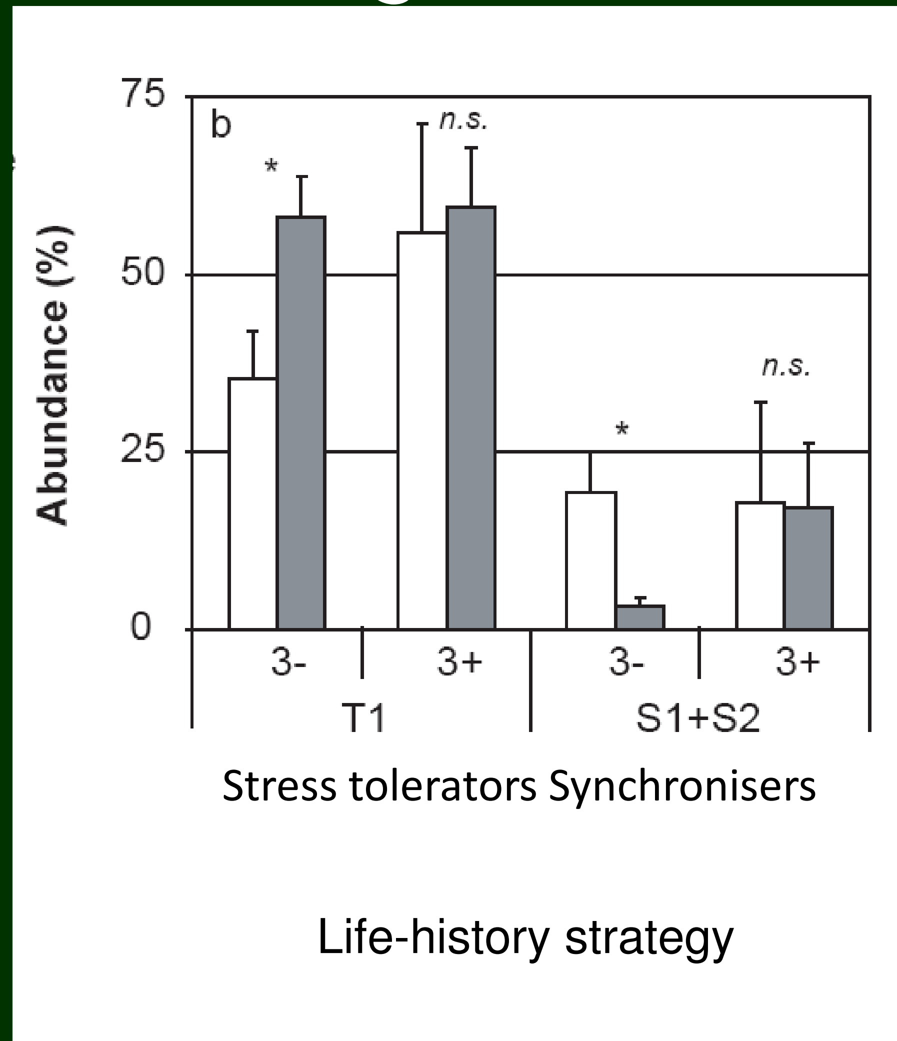
More harsh and constant environment

Evaluating the effects of rewetting measures

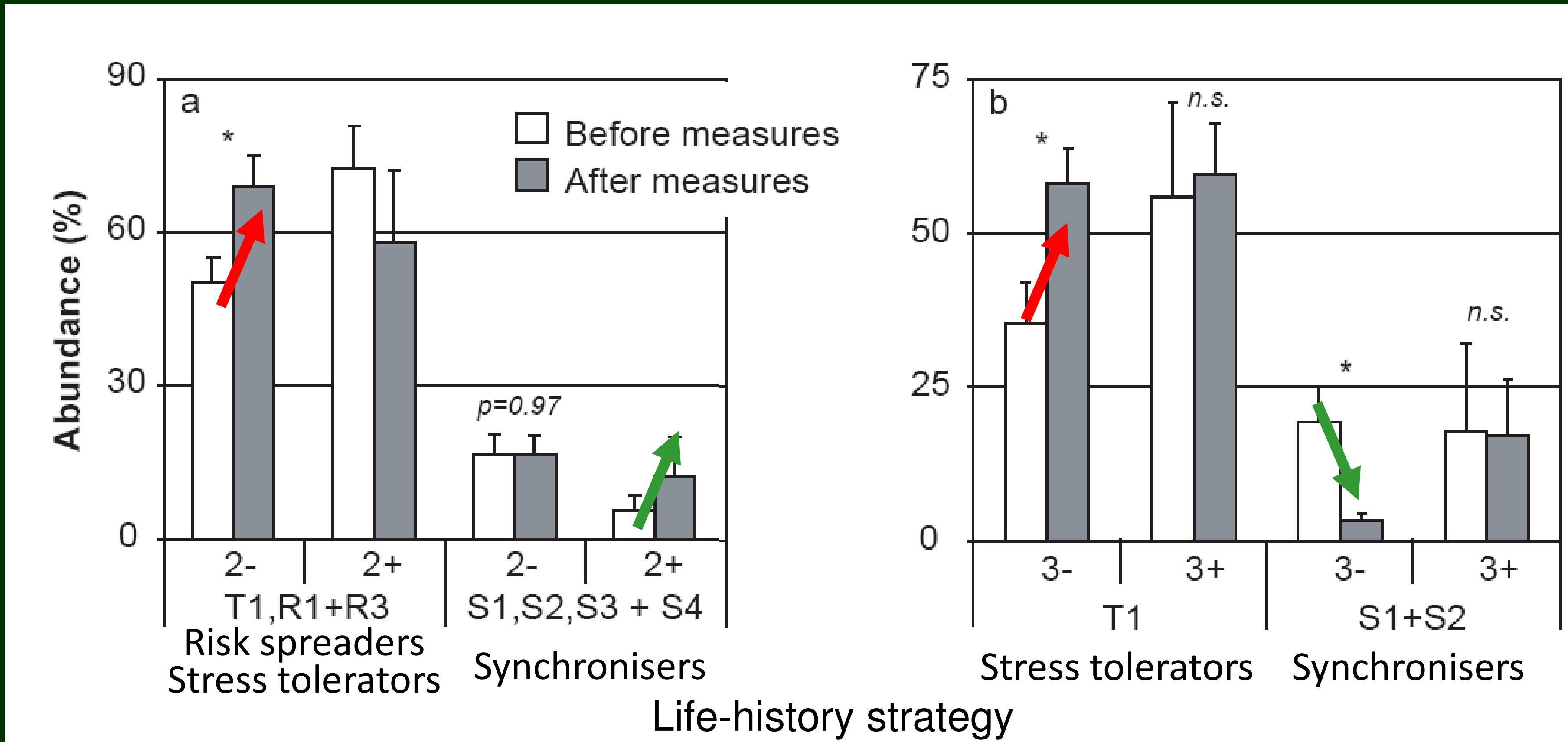
Bog pools

Not a harsher environment

Evaluating the effects of rewetting measures



Evaluating the effects of rewetting measures



Evaluating the effects of rewetting measures

Groundwater influence:

- Stable, minerotrophic transitions (biodiversity hotspots)
- Minerotrophic influence important for primary and secundary succession
- Important driver for landscape heterogeneity

Restore regional groundwater is a promising restoration strategy

Rewetting bog remnants

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Unraveling species-environment relationships

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Life-history strategies

- Development
- Rationale

Applying Life-history strategies

- Field data
- Fundamental ecology (abundance-occupancy relationships)
- Applied ecology (rewetting)

Getting more out of your biodiversity data with life-history strategies

Problems
1. Many conditions
2. Many species
3. Causality?

Life-history strategies
1. Integrated response
2. Group species
3. Explain and predict

Causality → *Community ecology*: underlying mechanisms

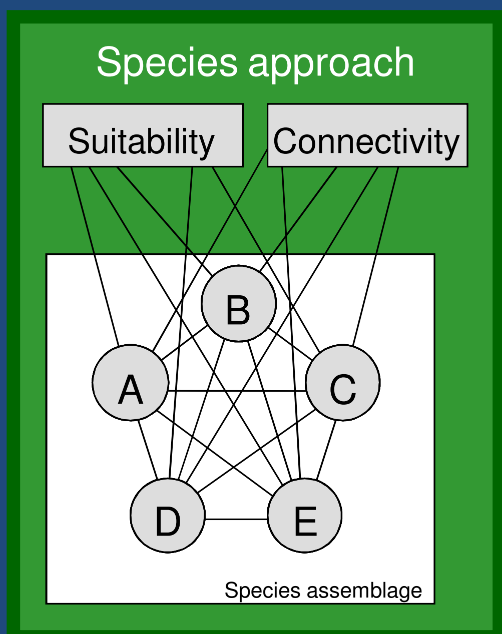
Aggregation → *Restoration ecology*: functionally complete

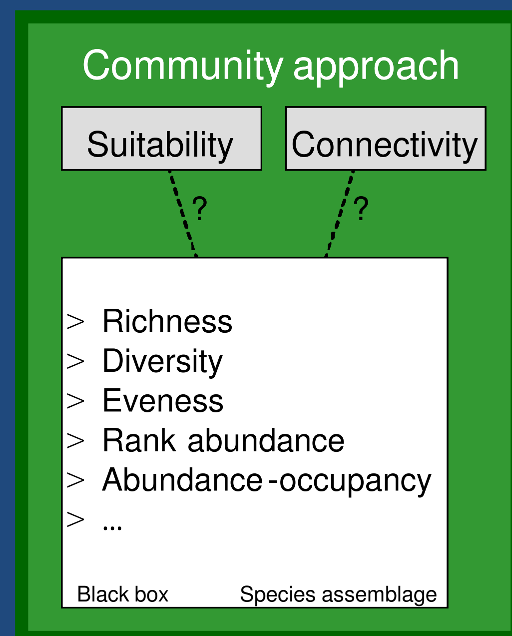
  

Getting more out of your biodiversity data

Single species - mechanisms - experiments
Communities - descriptions - surveys

Strong points	Species approach	Community approach
Aggregation	-	+++
Causality	+++	-





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Single species - mechanisms - experiments
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Strong points	Species approach	Community approach
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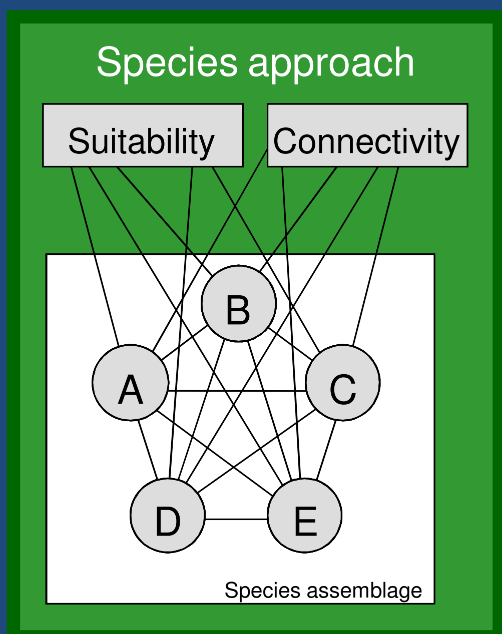

Life-history strategies
1. Integrated response
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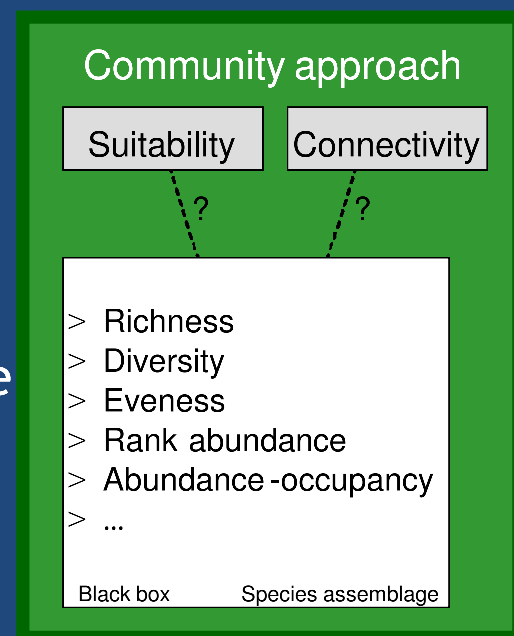
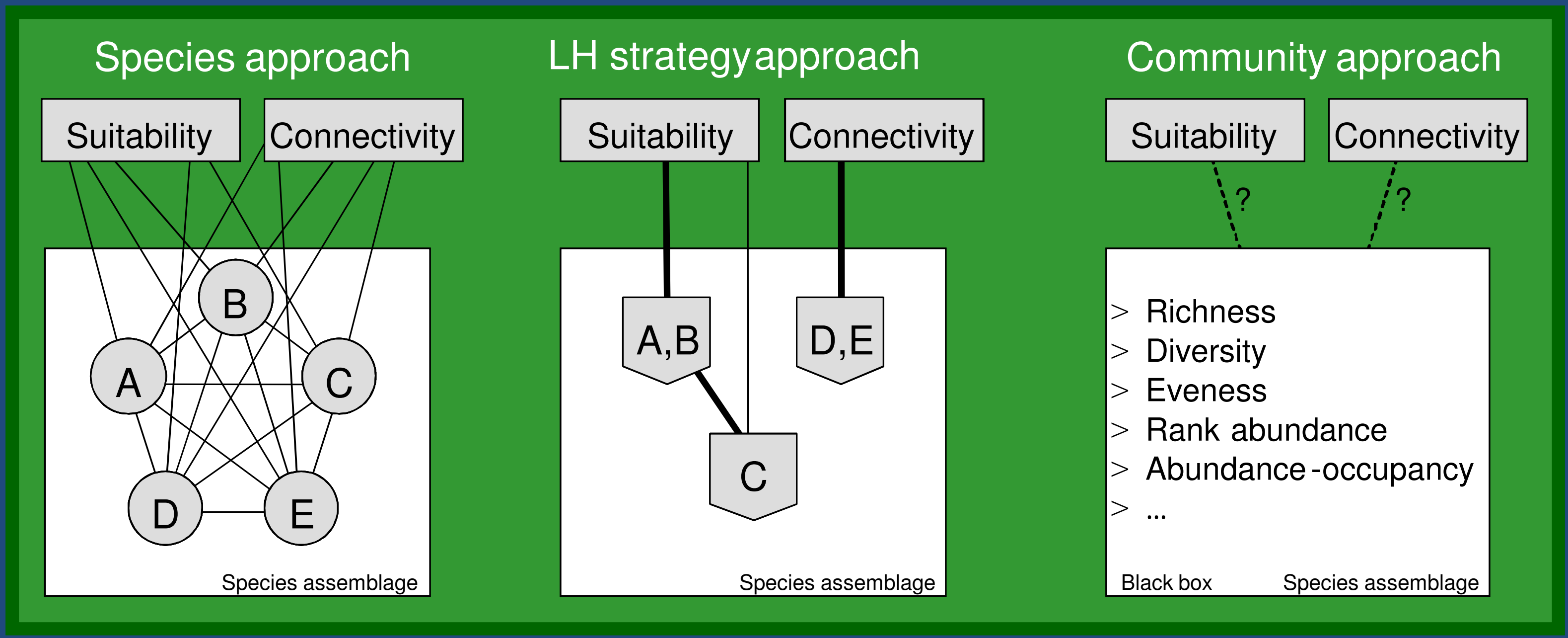


Getting more out of your biodiversity data

Single species - mechanisms - experiments
Communities - descriptions - surveys

Strong points	Species approach	Life-history strategies	Community approach
Aggregation	-	++	+++
Causality	+++	++	-



Thank you for your attention!

Verberk WCEP (2010) *Life-history strategies: a fresh approach to causally link species and their habitat.* In: Carlo F de & Bassano A (eds) Freshwater Ecosystems and Aquaculture Research. Nova Publishers, New York. ISBN: 978-1-60741-707-1

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 der Velde G & Esselink H (2010) Explaining abundance-occupancy relationships in specialists and generalists: a case study on aquatic macroinvertebrates in standing waters. *Journal of Animal Ecology* 79: 589-601.

Verberk WCEP, Siepel H & Esselink H (2008) Life-history strategies in freshwater macroinvertebrates. *Freshwater Biology* 53: 1722-1738.

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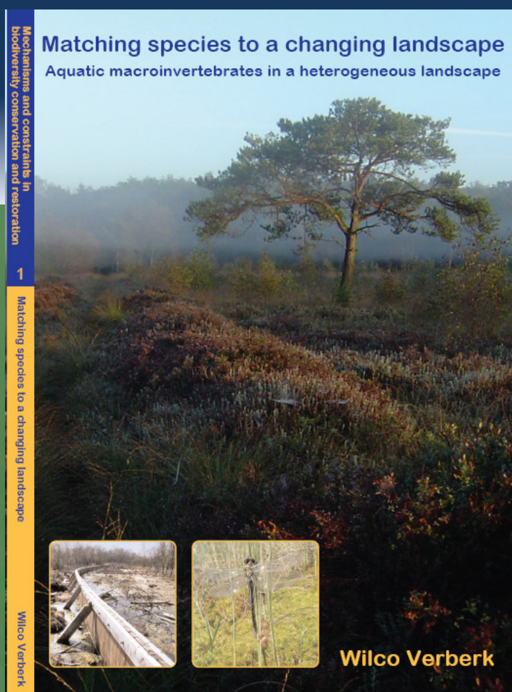
Verberk W.C.E.P. (2008) Matching species to a changing landscape – Aquatic macroinvertebrates in a heterogeneous landscape. PhD thesis, Radboud University Nijmegen.



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