Restoring faunal communities: mechanisms and constraints




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Overview

Knowledge for restoration

Problem

1. Bottom up (Life-history tactics)

2. Top down (Red-backed shrike)

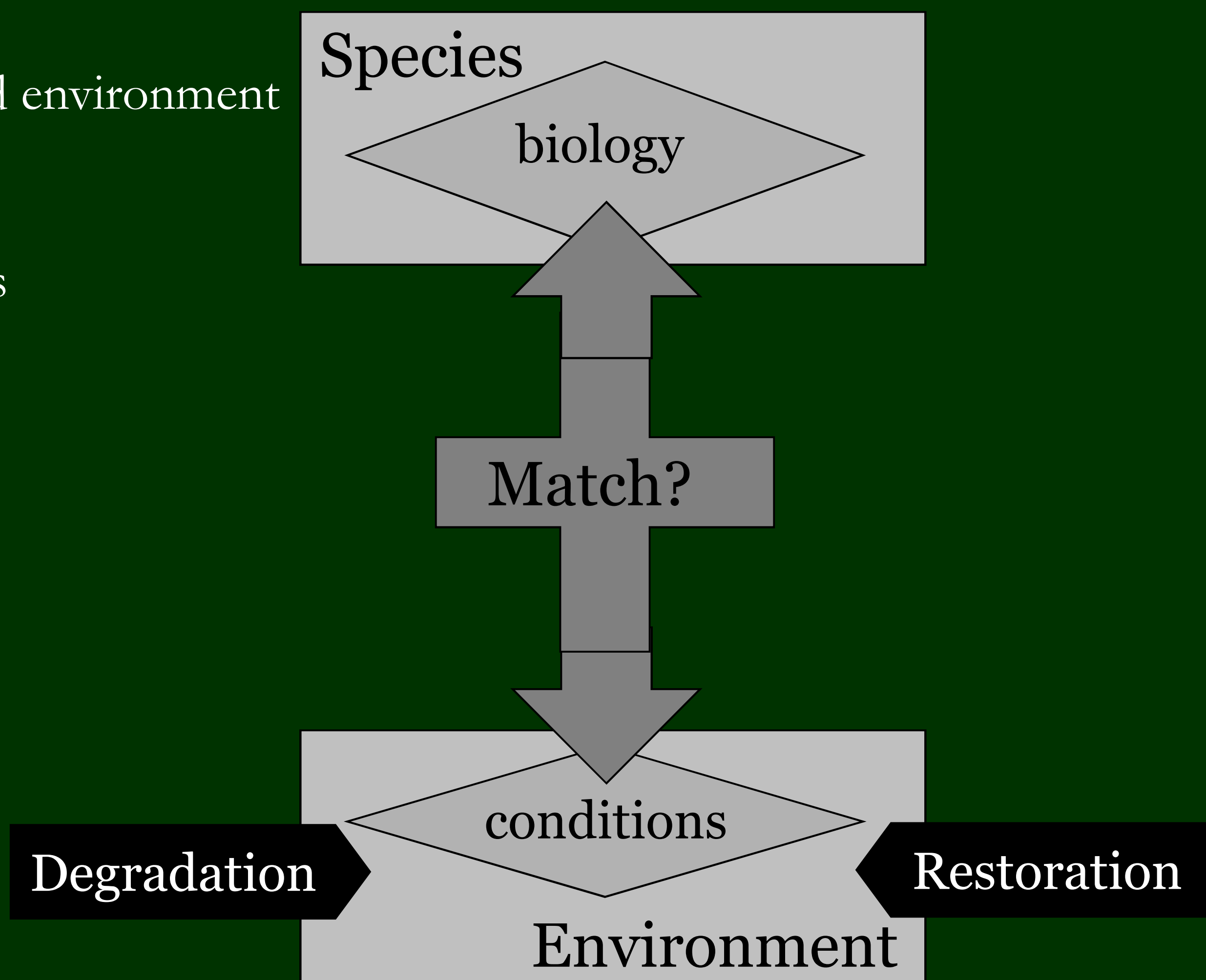
Conclusions and recommendations

Knowledge

How to restore degraded ecosystems?

'*Match*' between species and environment

- Species' biology
- Environmental conditions
- Impact of degradation
- Effect of restoration

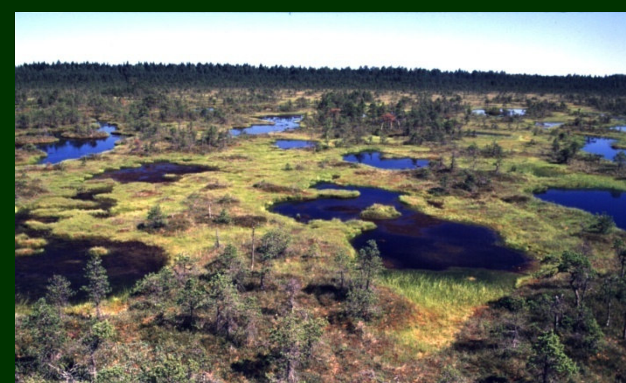


Knowledge

Scaling effects





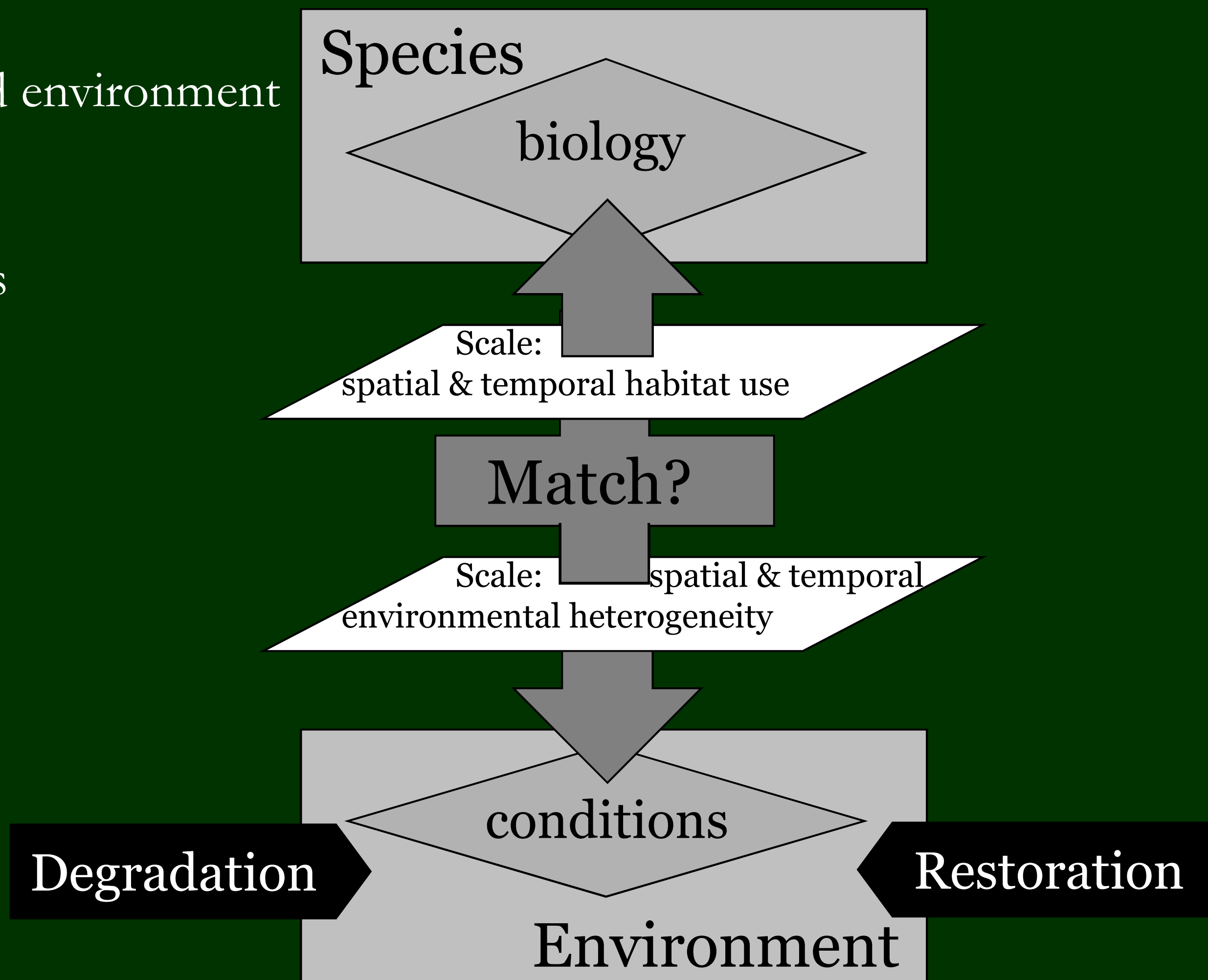



Knowledge

How to restore degraded ecosystems?

'*Match*' between species and environment

- Species' biology
- Environmental conditions
- Impact of degradation
- Effect of restoration
- Scale

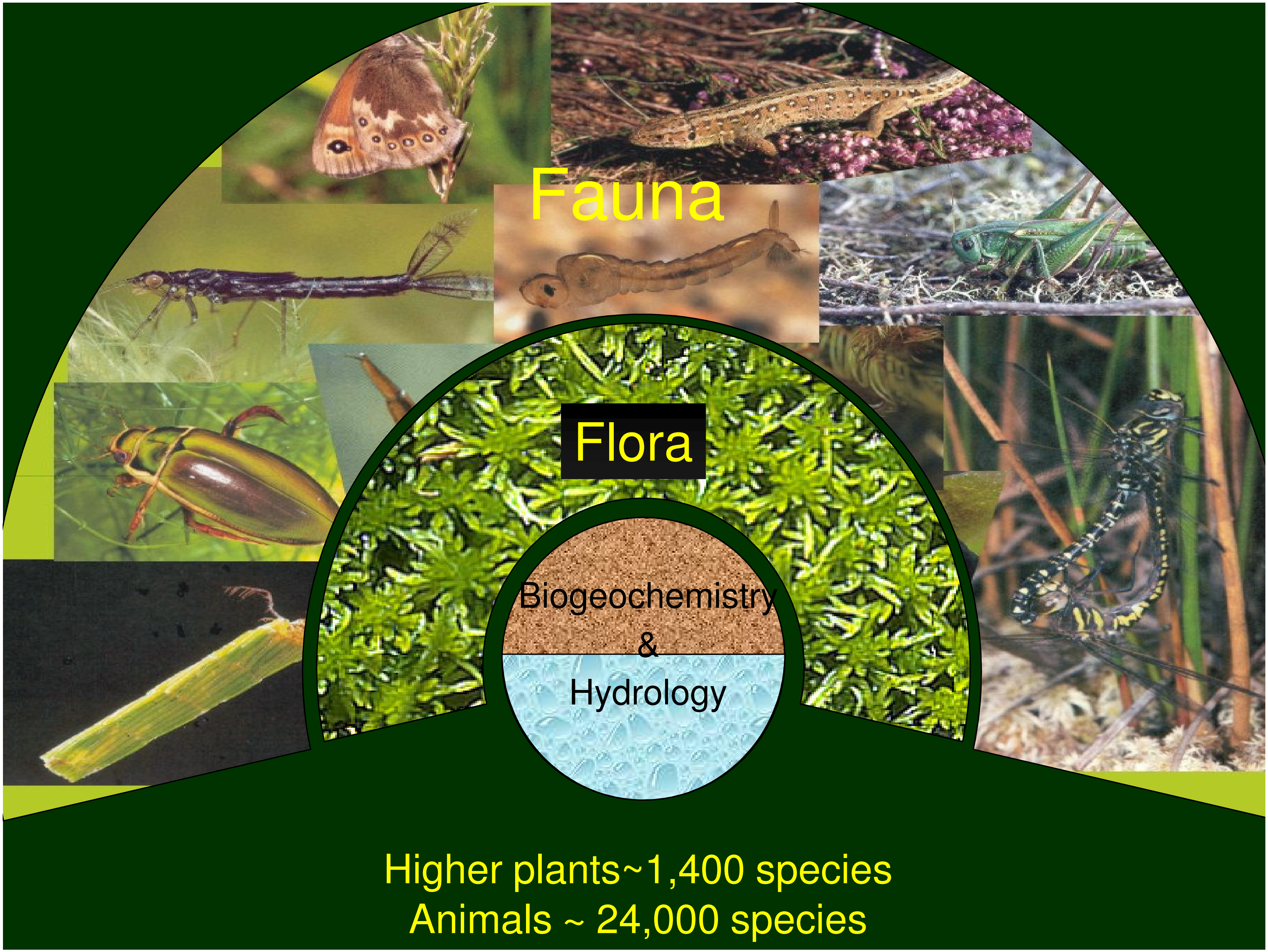


Problem

How to make sense of the large diversity in species - environment relationships?

- Scaling effects
- Intraspecific differences (during life cycle)

Growing Reproducing


Fauna
Flora
Biogeochemistry
&
Hydrology
Higher plants~1,400 species
Animals ~ 24,000 species

Problem

How to make sense of the large diversity in species - environment relationships?

- Scaling effects
- Intraspecific differences (during life cycle)
- Interspecific differences (many species)

Aggregation	1.	Life-history tactics in aquatic invertebrates
Selection	2.	Red-backed shrike in coastal dunes

Life-history tactics in aquatic invertebrates

How to make sense of the large diversity in species - environment relationships?

Aggregate species with similar functional relations to their environment

Species traits - causal mechanisms

Life-history tactics in aquatic invertebrates

How to make sense of the large diversity in species traits?

Development time	Passive dispersal
Morphology	Egg size
Diapause stage	Adult life span
Diapause period	Egg number
Dispersal capacity	Number of clutches
Active dispersal	...

Combine traits in **life-history tactics**

"a set of co-adapted traits designed, by natural selection, to solve particular ecological problems"

Stearns, 1976

Life-history tactics in aquatic invertebrates

Trade-off

Investments in one trait ⟶ less resources for another trait.

Growth and development

Egg size and egg number

...

Life-history tactics in aquatic invertebrates

Trade-off

Investments in one trait ⟶ less resources for another trait.

Growth and development

Egg size and egg number

...

Functional combination

Investments in one trait ⟶ increases benefits or lowers costs for another trait.

Few eggs and brood care

Gills in damselflies for respiration and locomotion

...

Life-history tactics in aquatic invertebrates

How to make sense of the large diversity in species traits?

Different traits combinations may be functionally similar

Egg protection:

- endophytical oviposition
- gelatinous matrix
- brood care
- ovoviviparous

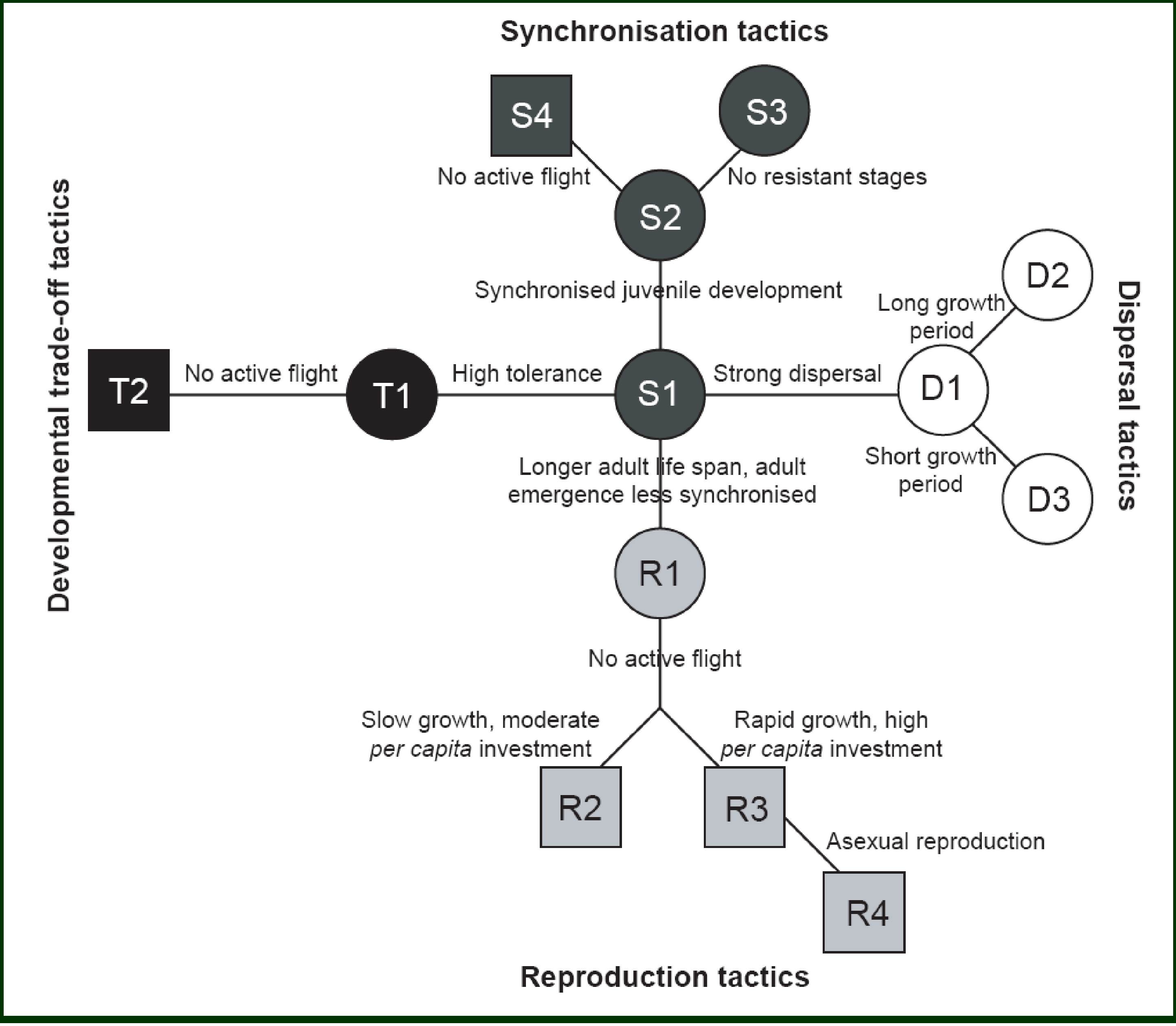
Life-history tactics in aquatic invertebrates

How to make sense of the large diversity in species traits?

Interrelations between traits
Functional interpretation

13 life-history tactics

Life-history tactics in aquatic invertebrates

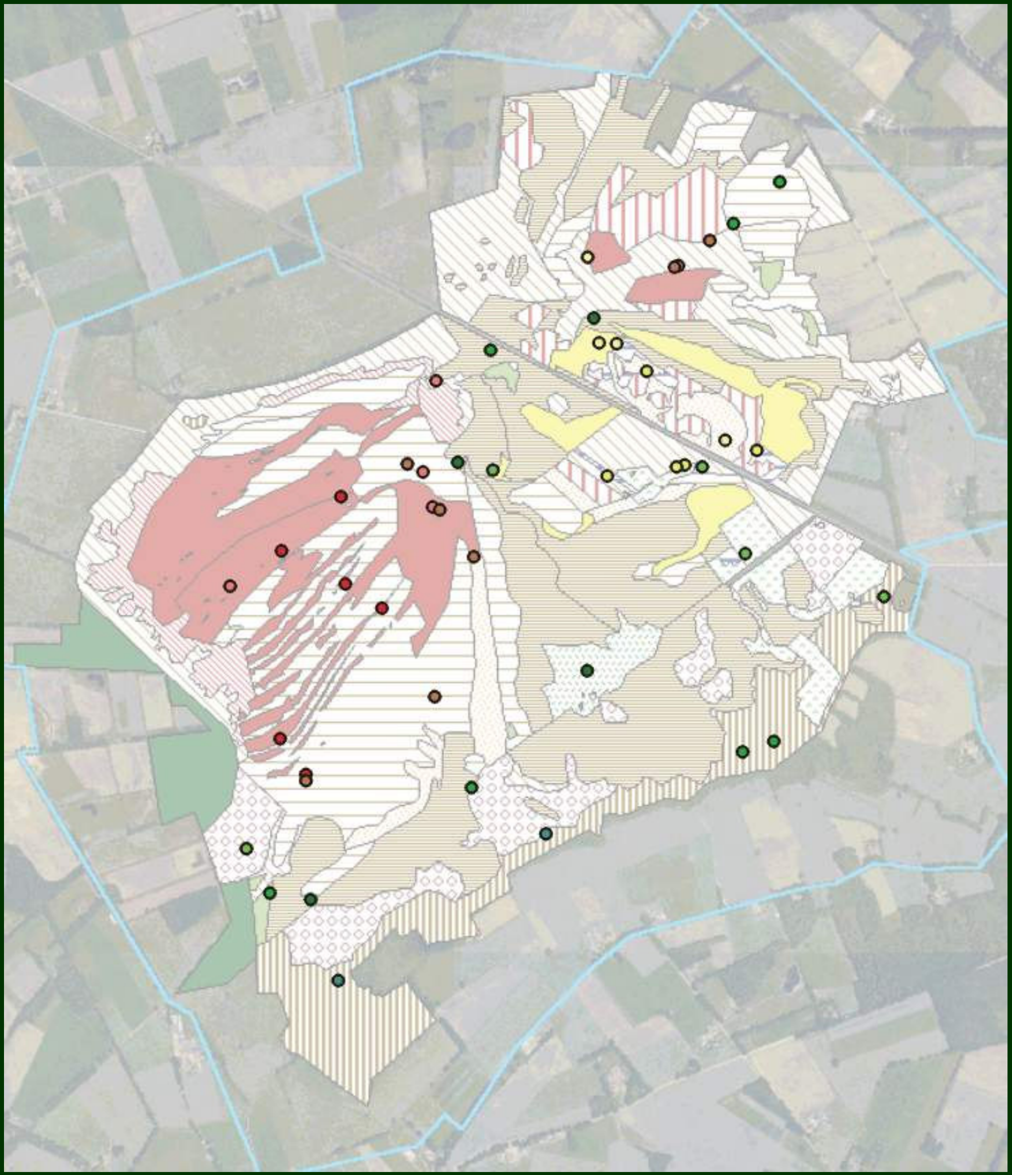


Life-history tactics in aquatic invertebrates

Application to evaluate effects of rewetting measures in raised bogs

Evaluating effects of rewetting measures in raised bog with tactics

Case study Korenburgerveen



45 waters sampled
- spring (april-may)
- autumn (september-november)

209 samples

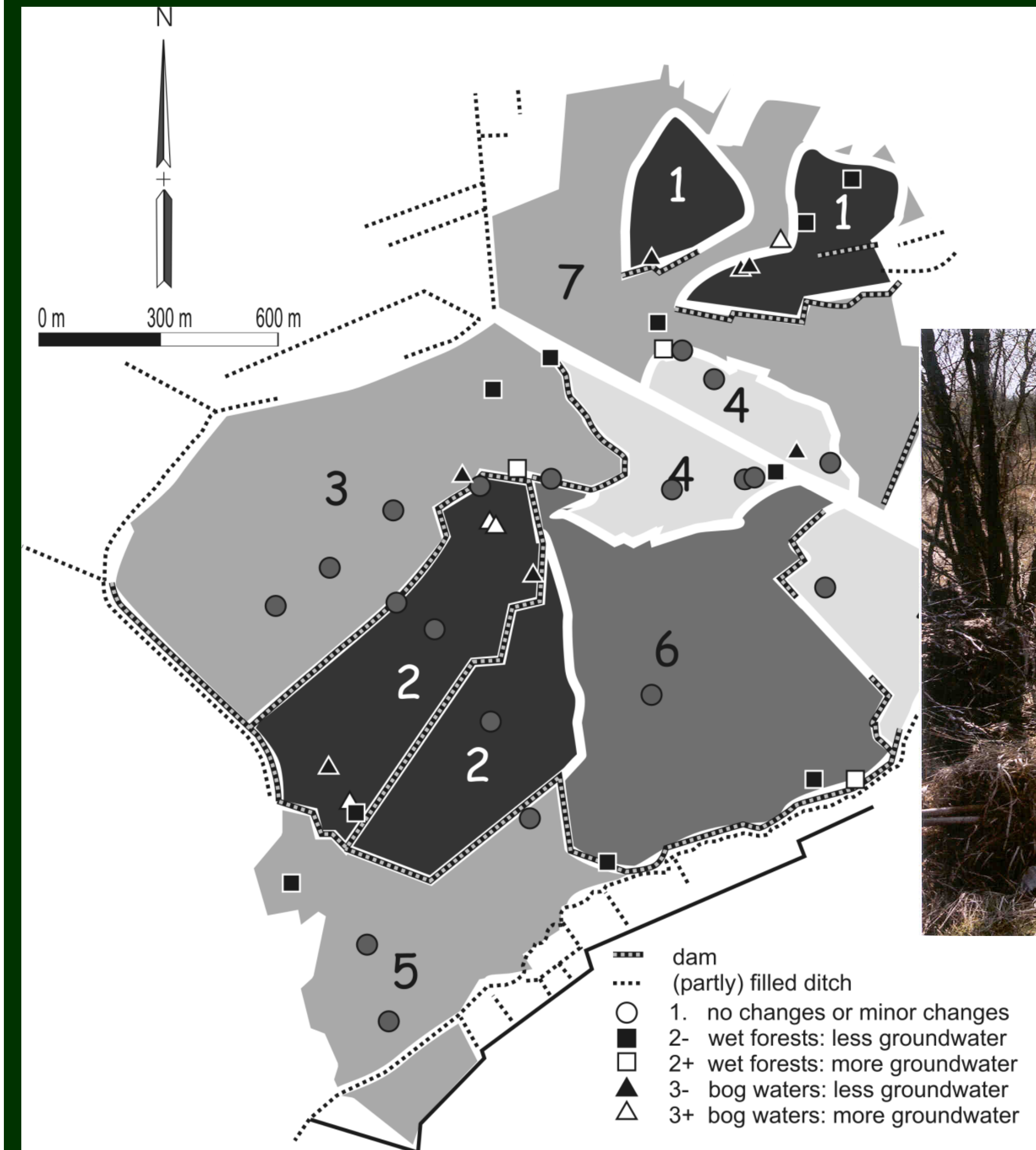
Aquatic invertebrate groups identified:

Scientific name	Common name
Tricladia	Flatworms
Hirudinea	Leeches
Coleoptera	Beetles
Hemiptera	True bugs
Odonata	Dragonflies & Damselflies
Trichoptera	Caddisflies
Chaoboridae	Phantom midges
Chironomidae	Nonbiting midges
Dixidae	Meniscus flies
Rest (e.g. *Asellus aquaticus*, *Argyroneta aquatica*)	Waterspider, Aquatic sowbug

>145.000 individuals

267 taxa

Evaluating effects of rewetting measures in raised bog with tactics



Rewetting
- Increase retention of rainwater
- Decrease drainage

Evaluating effects of rewetting measures in raised bog with tactics

Water bodies in forest

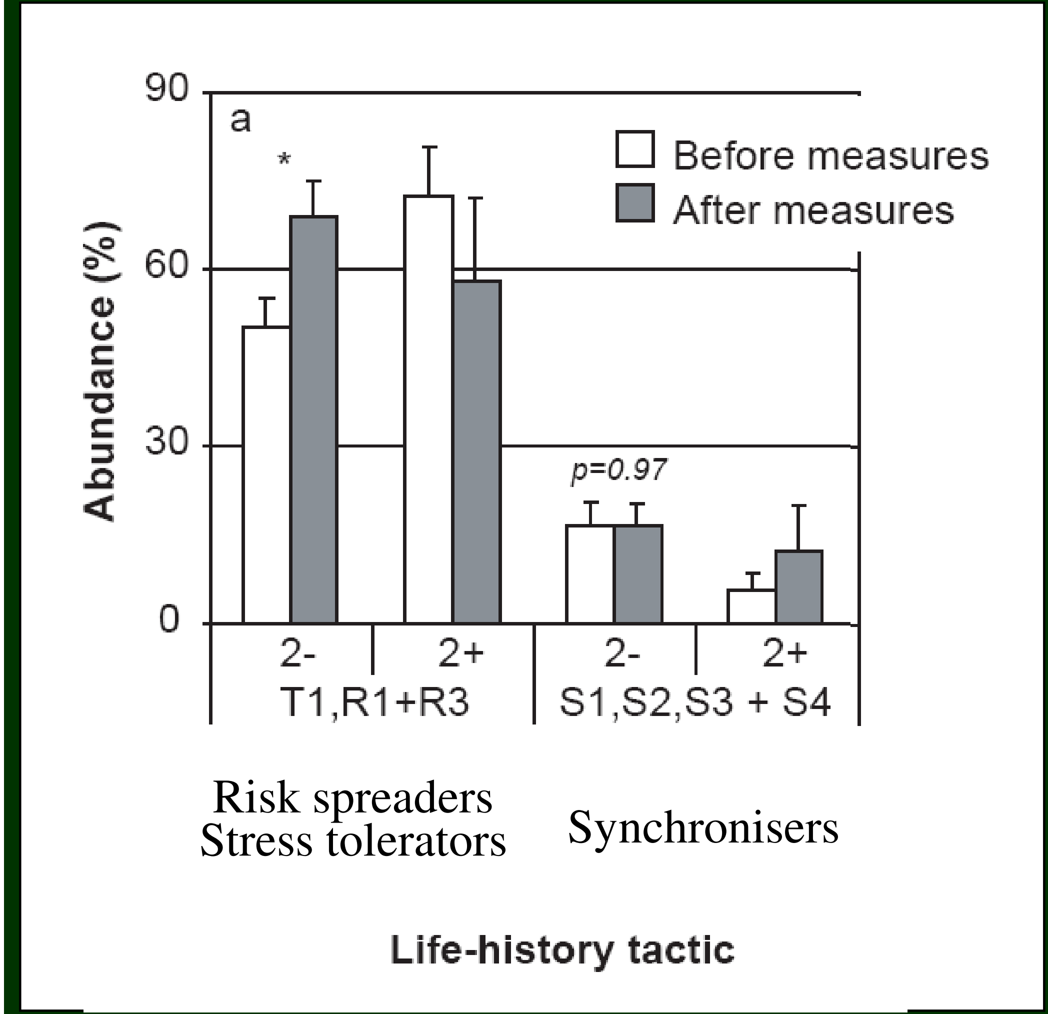
•Higher water table
•Stagnation
•Mobilisation of nutrients
•Increase of *Glyceria maxima*

More variable and unpredictable environment

Evaluating effects of rewetting measures in raised bog with tactics

More groundwater influence
cyclic, predictable environment

Evaluating effects of rewetting measures in raised bog with tactics



Evaluating effects of rewetting measures in raised bog with tactics

Bog pools

- Higher water table
- Stagnation
- Less groundwater

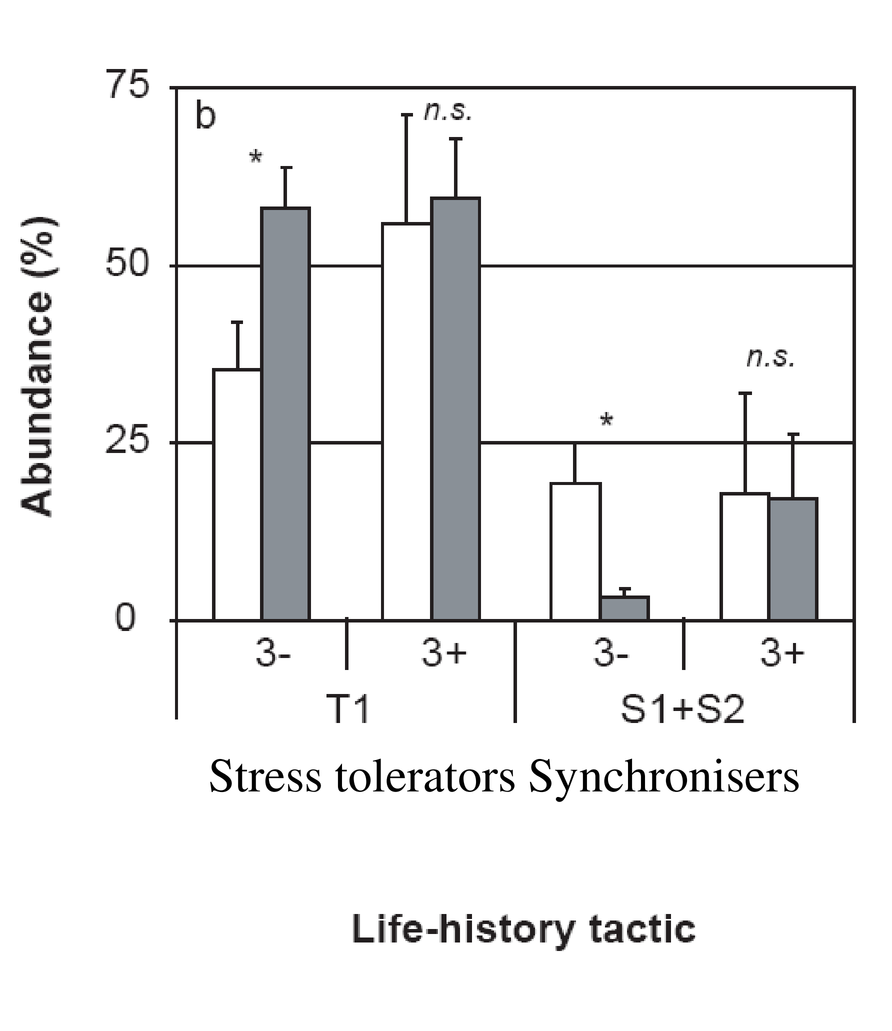
More harsh and constant environment

Evaluating effects of rewetting measures in raised bog with tactics

Bog pools

Not a harsher environment

Evaluating effects of rewetting measures in raised bog with tactics



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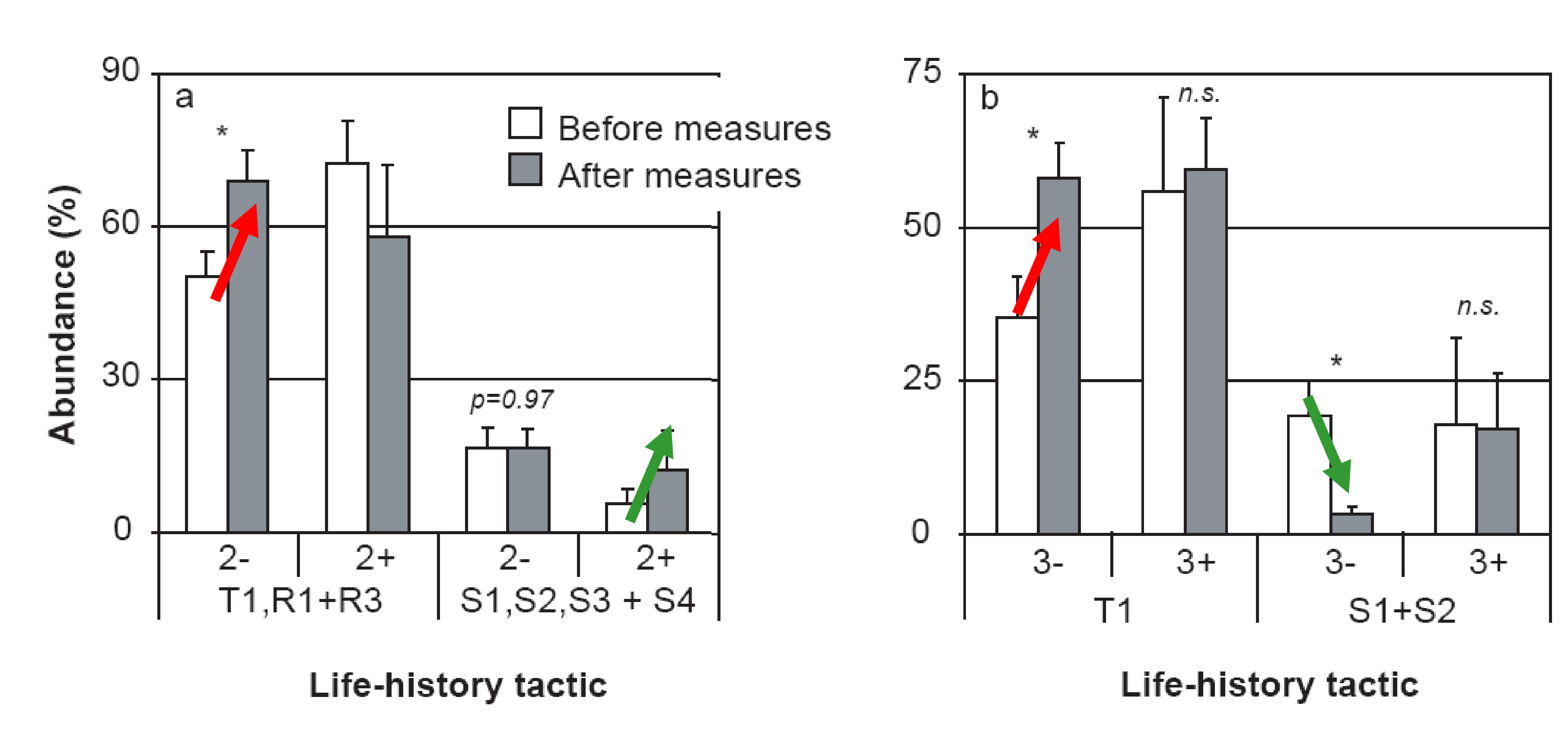
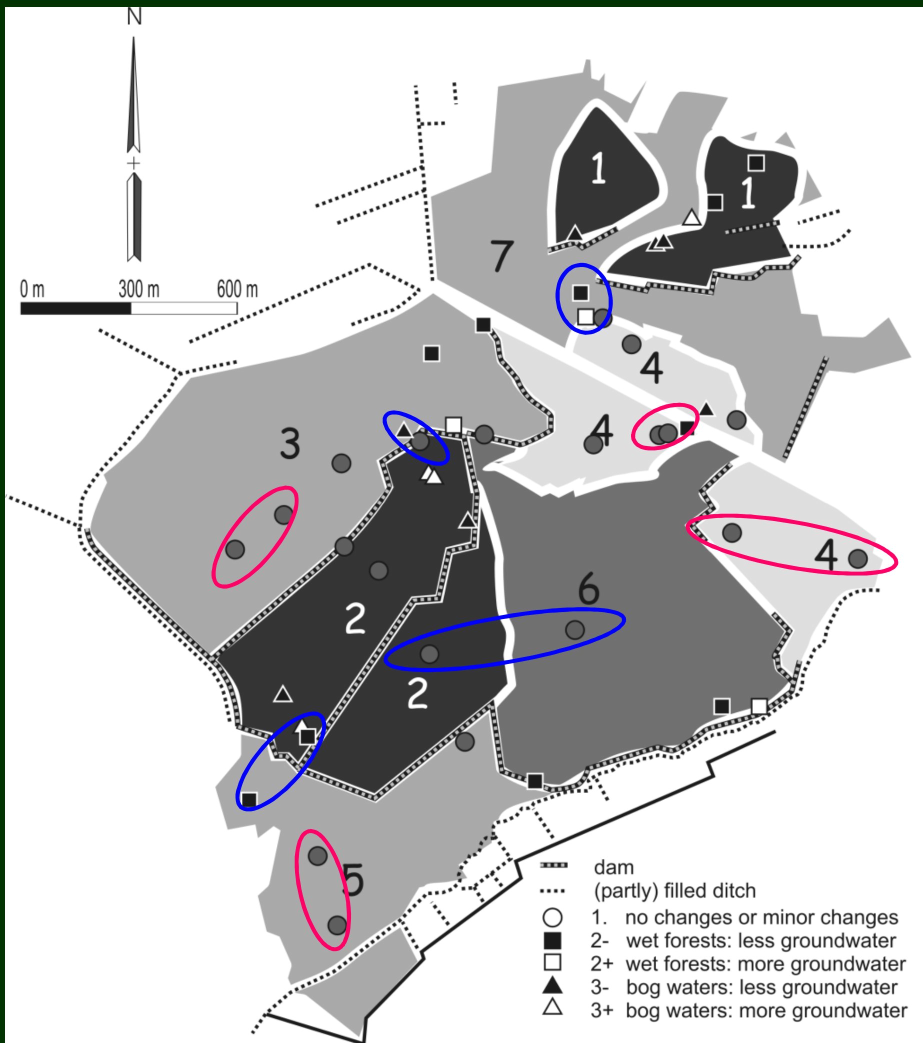
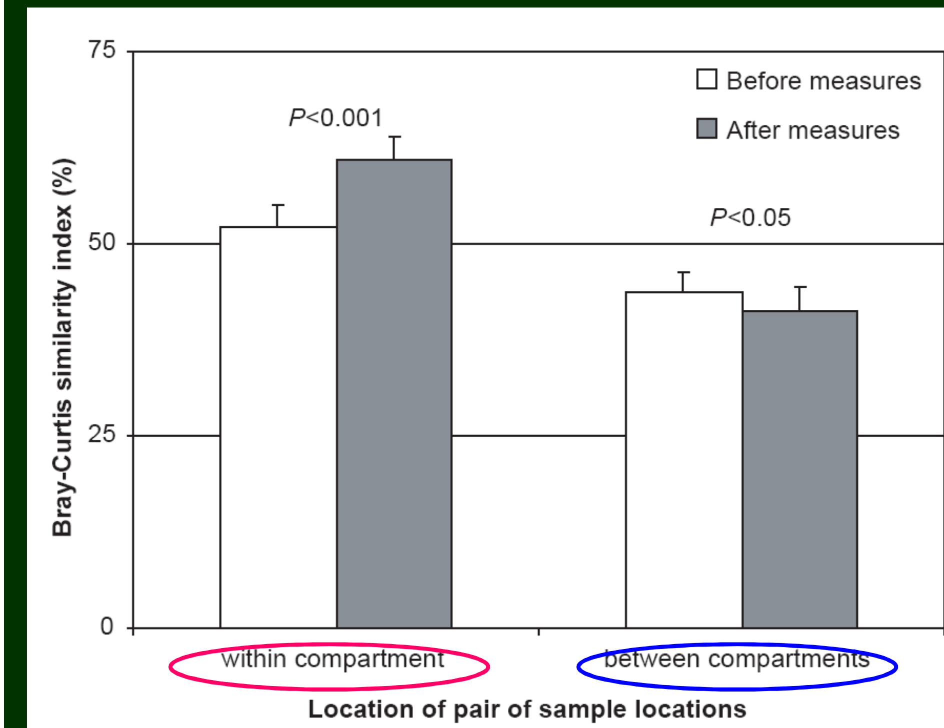


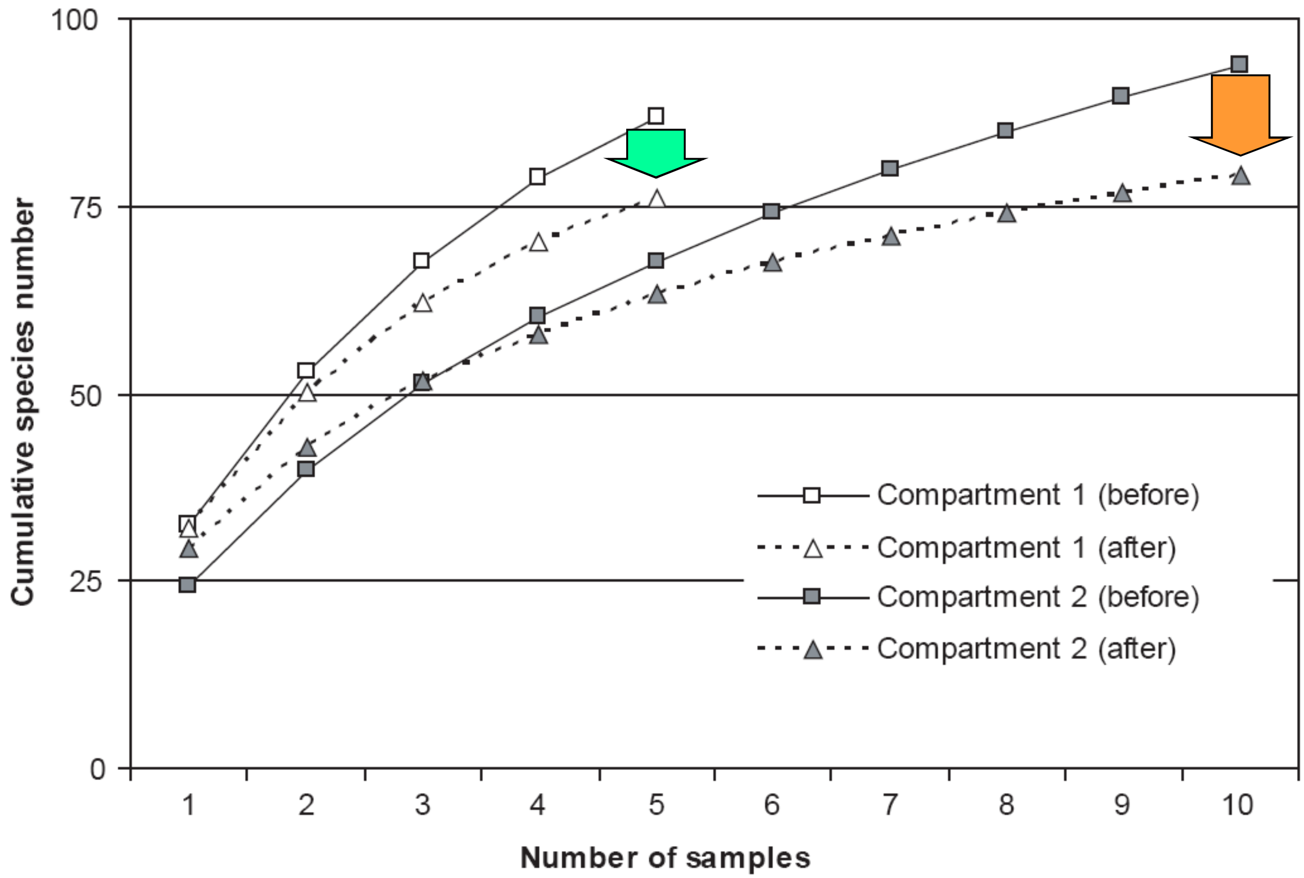
Evaluating effects of rewetting measures in raised bog with tactics

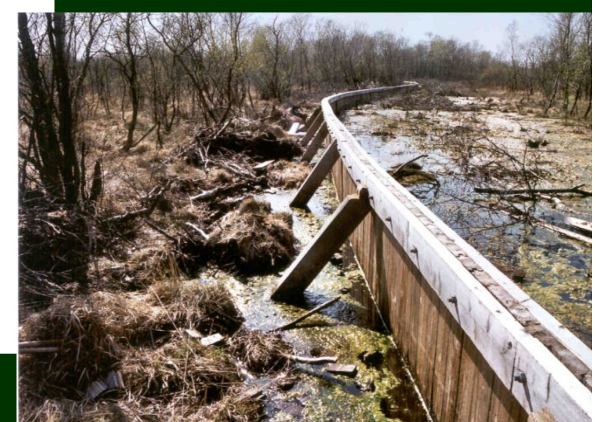




Rewetting measures as a filter, causing a functional homogenisation

Evaluating effects of rewetting measures in raised bog with tactics





functional homogenisation decreases species number

Evaluating effects of rewetting measures in raised bog with tactics

Groundwater influence:

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

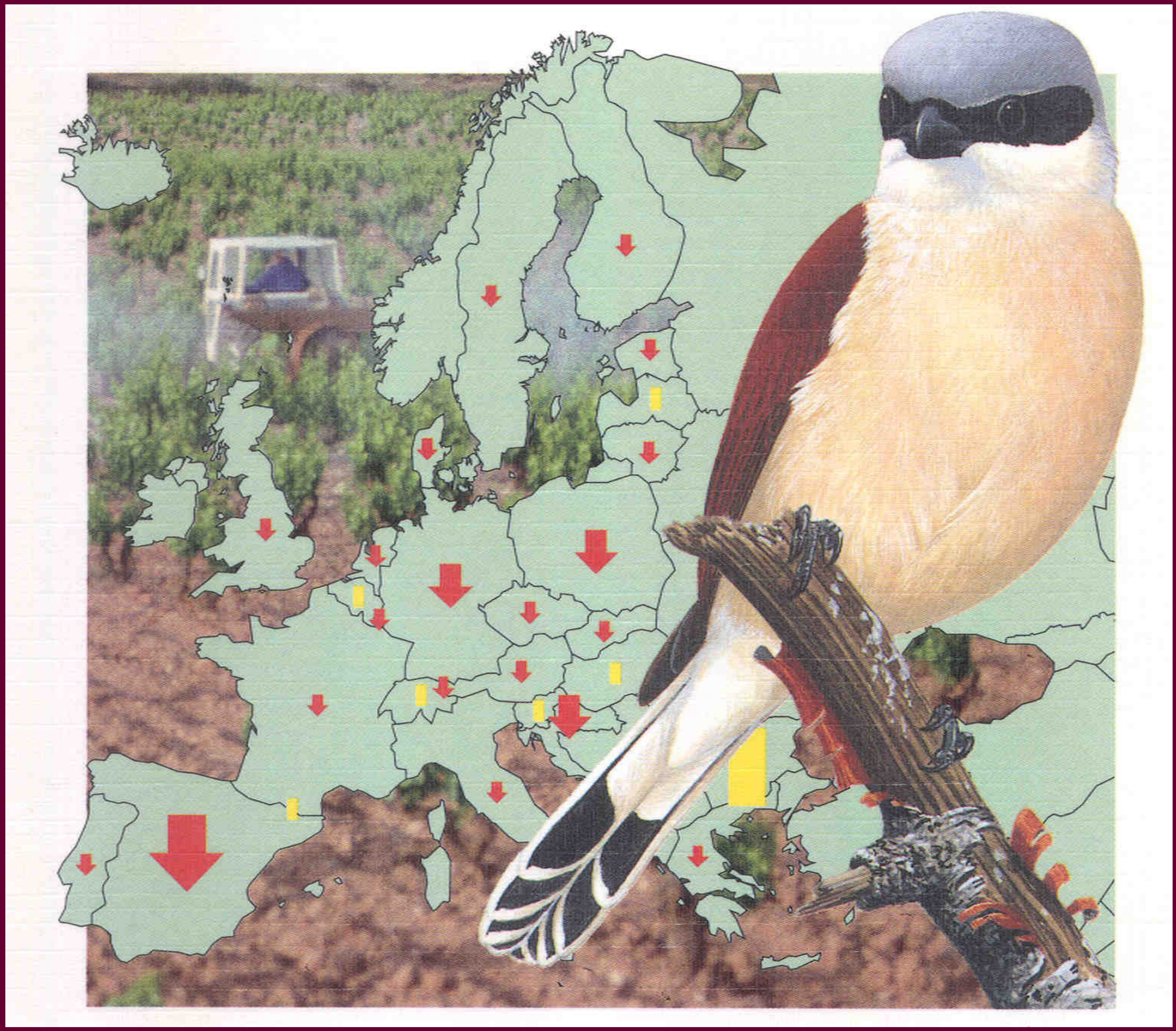
Restore regional groundwater is a more promising restoration strategy

Problem

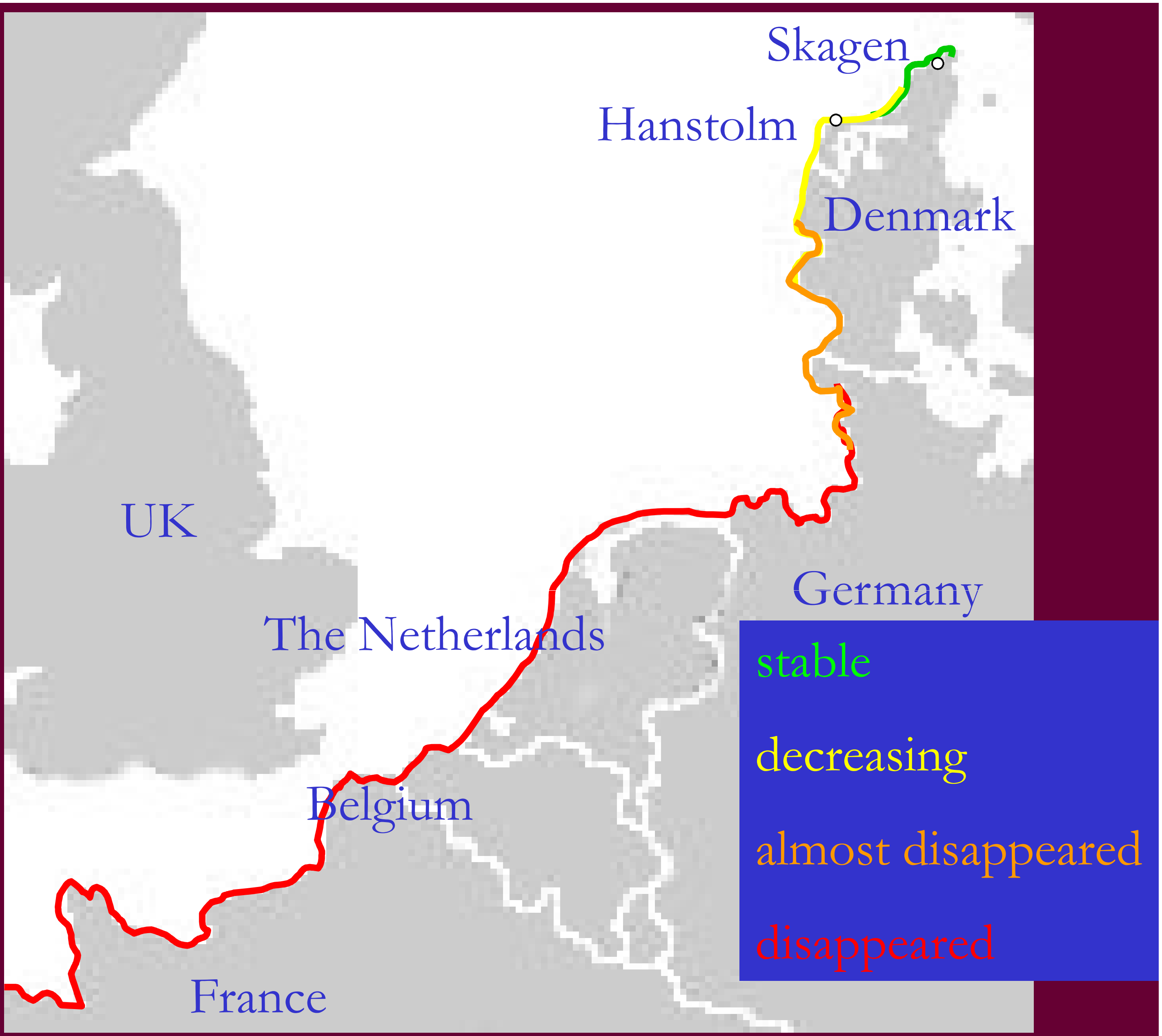
How to make sense of the large diversity in species - environment relationships?

Aggregation 1. Life-history tactics in aquatic invertebrates
Selection 2. Red-backed shrike in coastal dunes

Red-backed shrike in coastal dunes

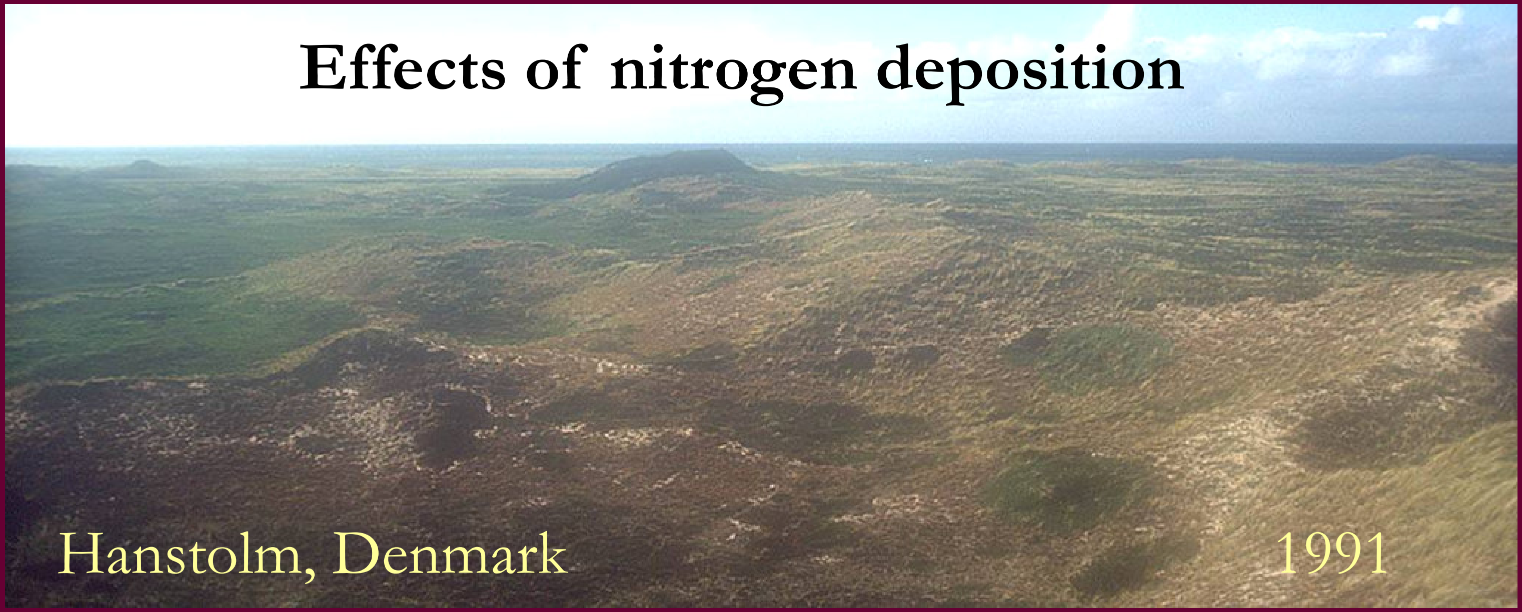


Europe-wide decline of Red-backed shrike (*Lanius collurio*) Tucker & Heath (1994)



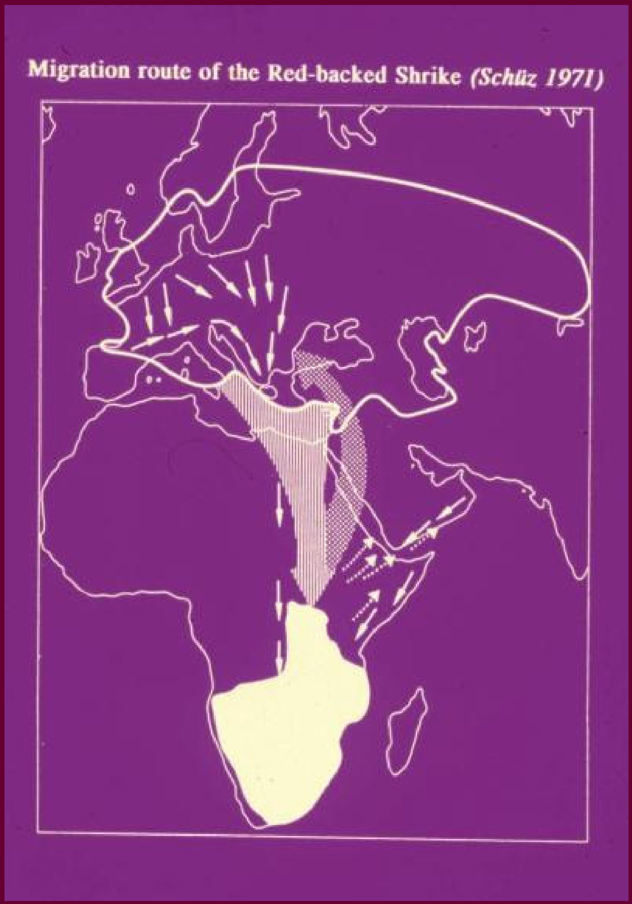
Strong decline in coastal dunes

Red-backed shrike in coastal dunes



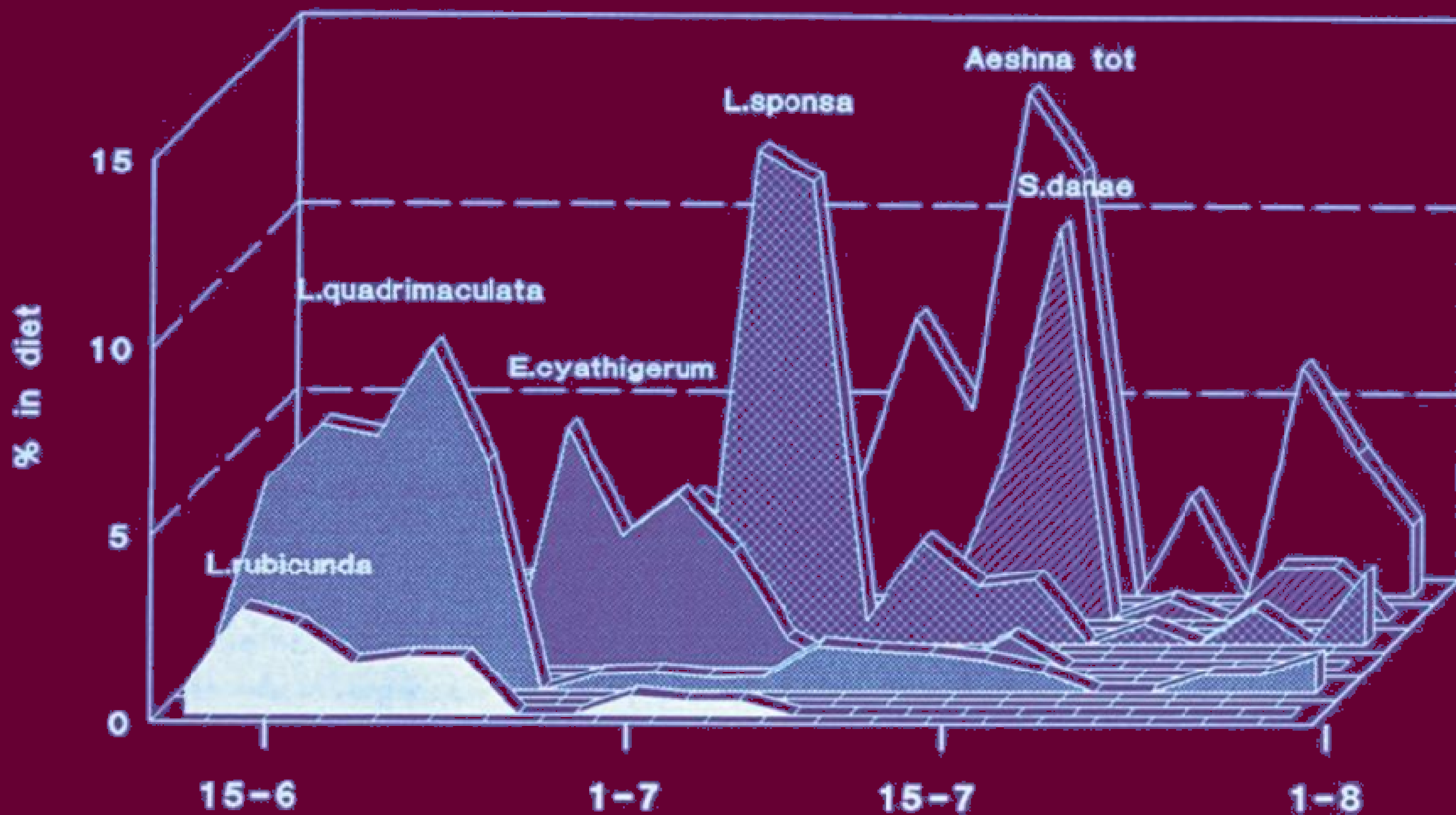
Red-backed shrike in coastal dunes

- seasonal migrating
- single prey, large prey
- diverse diet
  (large insects & small vertebrates)



Red-backed shrike in coastal dunes

Diet contribution of odonata species



Seasonal and diurnal shifts in prey choice

Diverse diet needed for sufficient food during breeding period

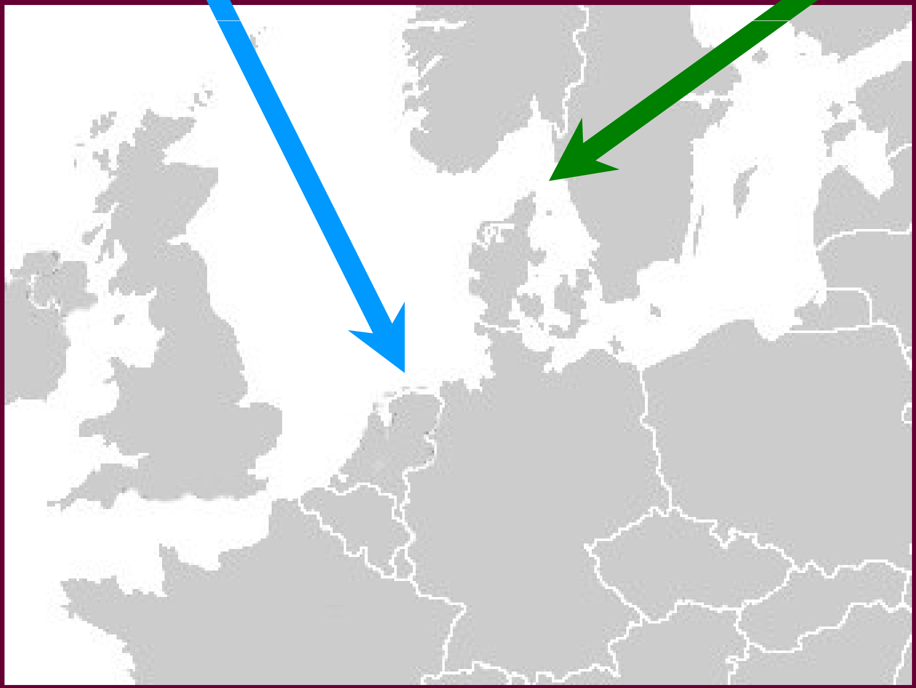
Red-backed shrike in coastal dunes

Testing the foodweb hypothesis...

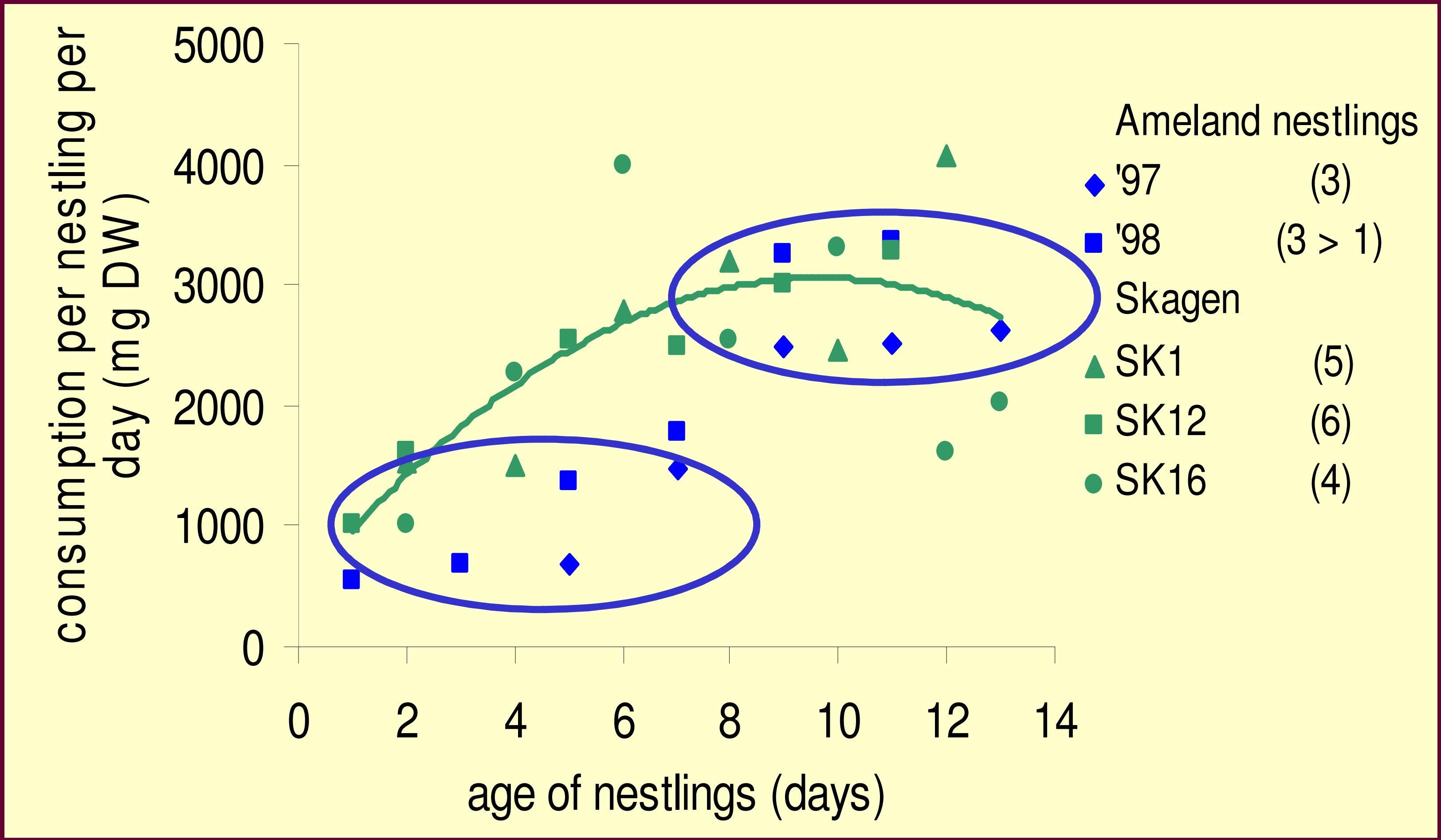
Degraded ⟺ **Intact**

Last Dutch pairs in 1998/1999 on Ameland, Netherlands

Vital population in Skagen, Denmark

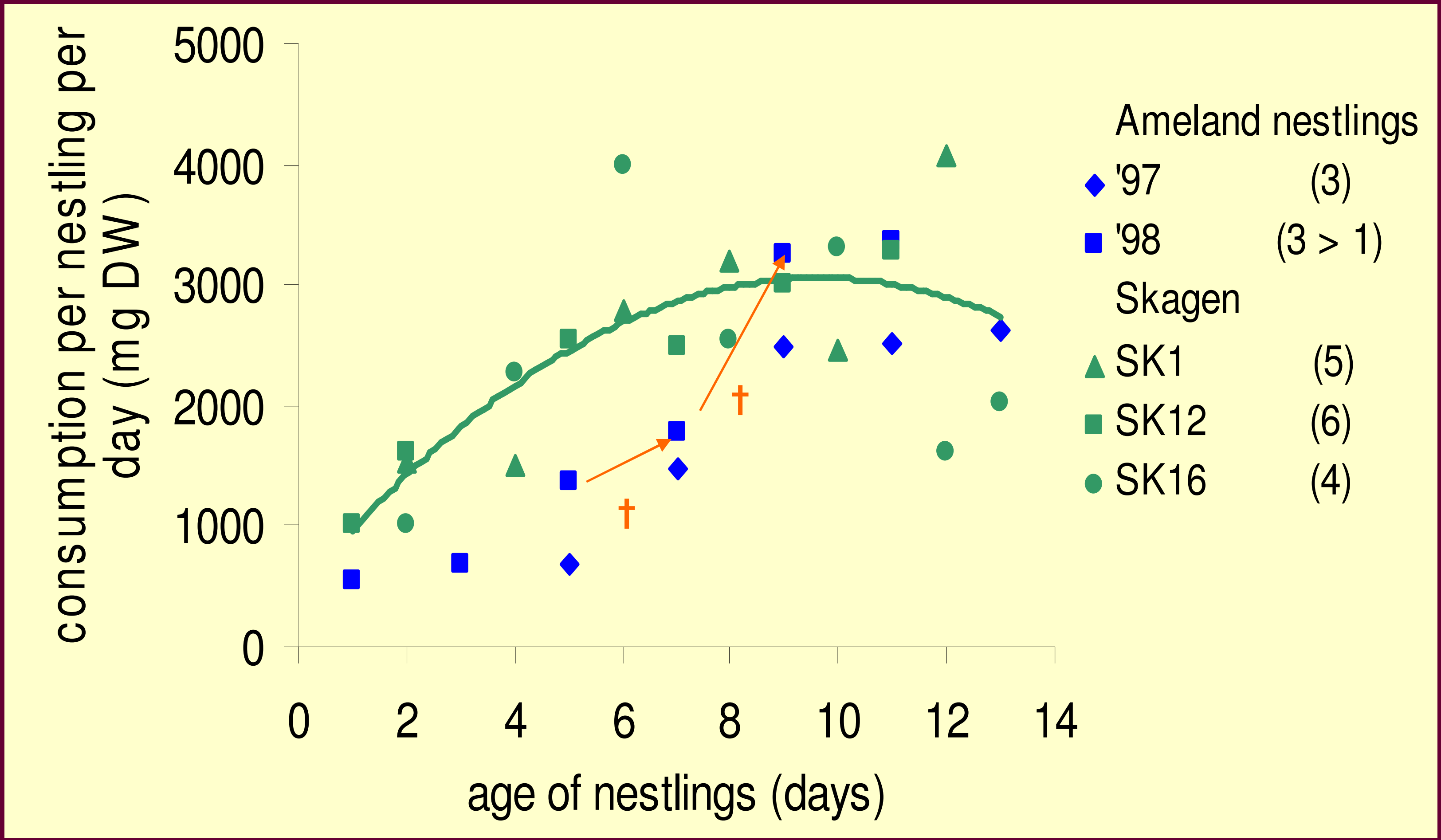


Red-backed shrike in coastal dunes



Consumption by nestlings

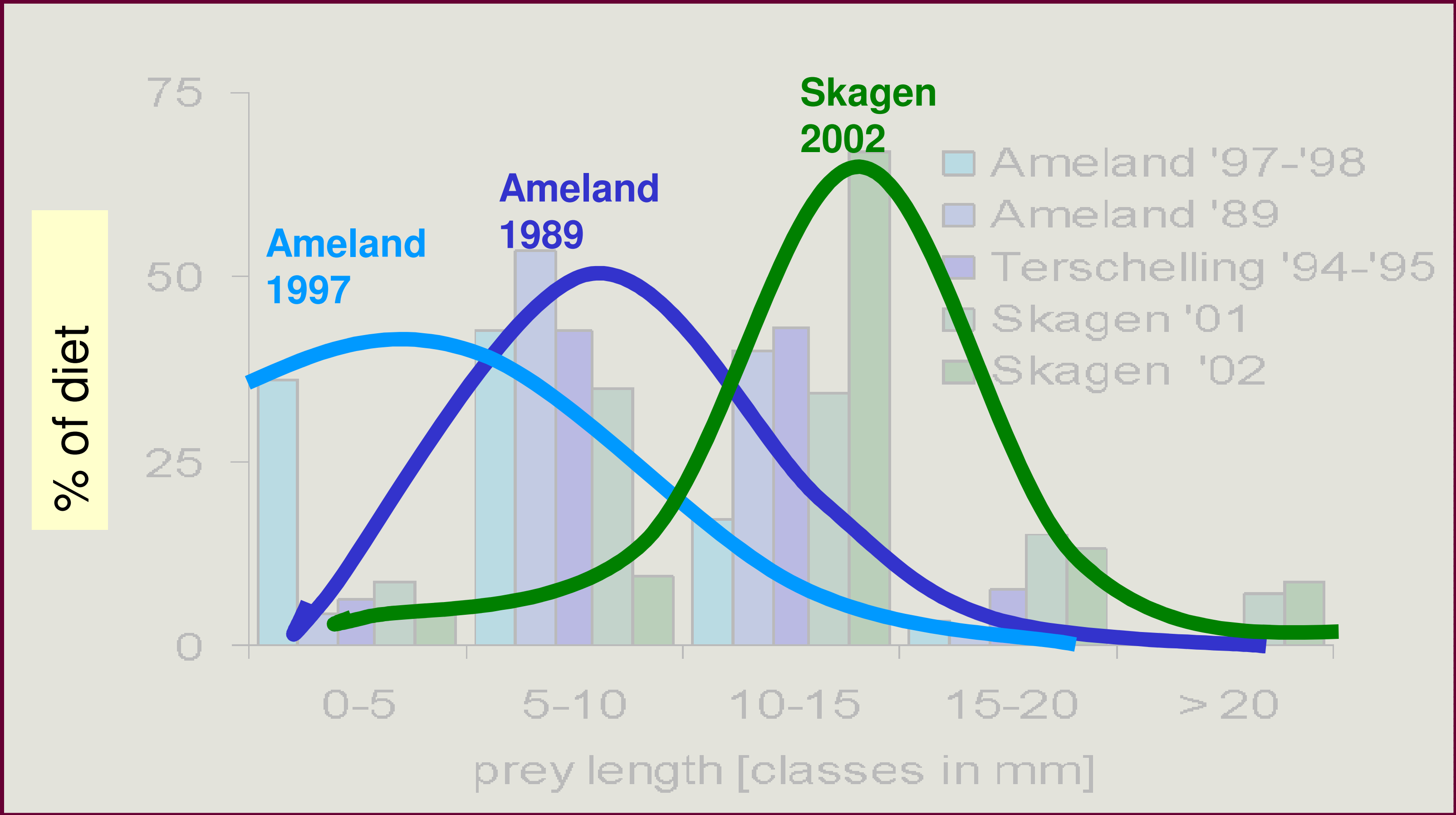
Red-backed shrike in coastal dunes



Consumption by nestlings

Food is sufficient for the needs of the few or the one

Red-backed shrike in coastal dunes



Prey size in adult diet

Degradation associated with smaller prey

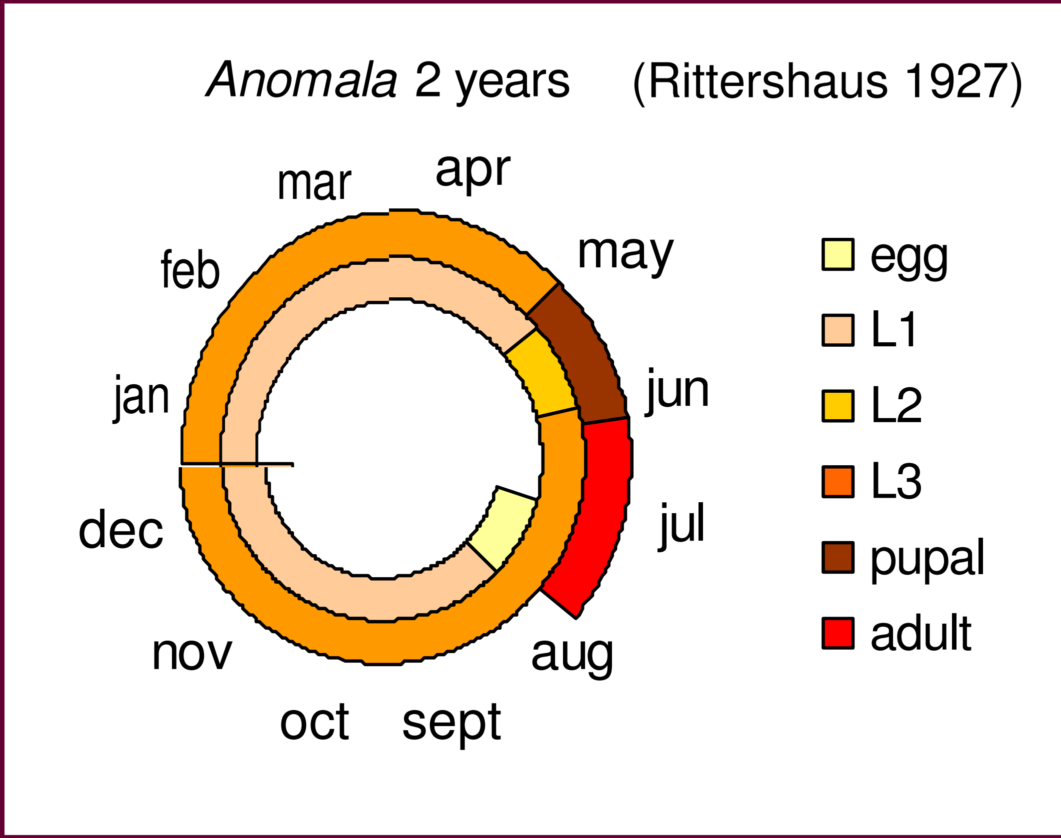
Red-backed shrike in coastal dunes

Diet composition

	Ameland '89	Ameland '97-'98	Terschelling '94-'95	Skagen '02
Beetles	79,0	34,5	25,7	56,1
Scarabids	*49,5*	*3,9*	*7,0*	*46,5*
Carabids	*5,5*	*7,9*	*2,6*	*3,3*
Weevils	*6,9*	*8,3*	*9,2*	*1,7*
Other	*17.1*	*12.5*	*6.9*	*4.6*
Hymenoptera	17,1	55,9	62,6	30,8
Bumblebees	*11,9*	*4,0*	*33,4*	*14,4*
Ants	*2,0*	*44,9*	*19,3*	*7,0*
Other	*3,2*	*7,1*	*10,0*	*9,4*
Other	3,9	9,5	11,7	13,1
n. pellets	115	35	63	52
n. ind. prey	1381	864	629	458

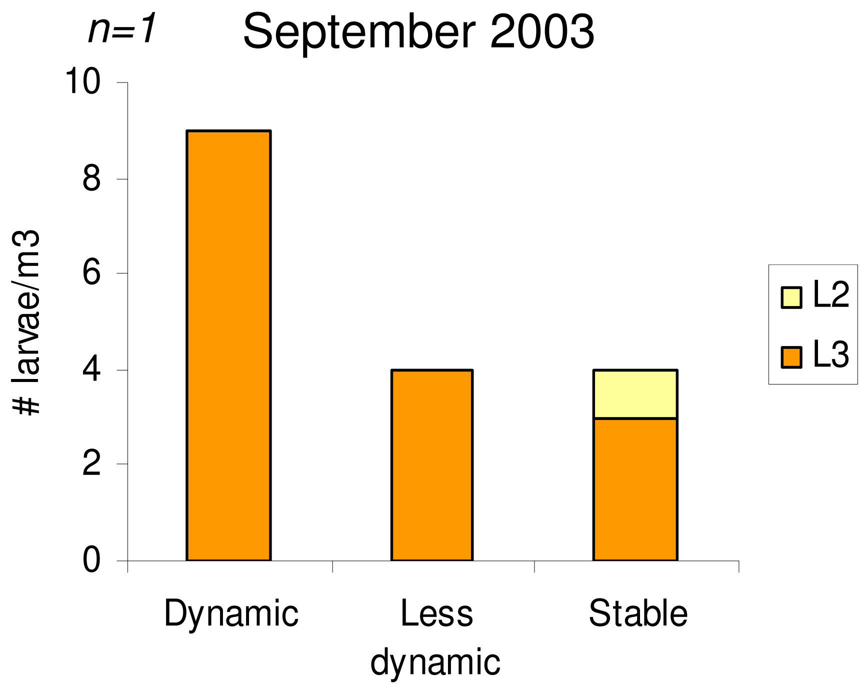
Missing link in the food web

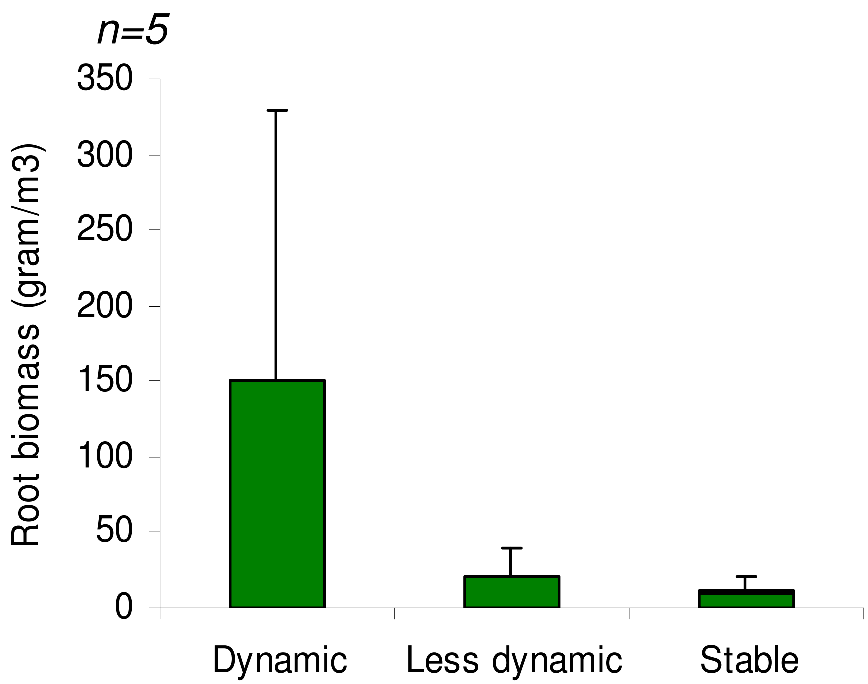
Red-backed shrike in coastal dunes
Life cycle Anomala dubia



Red-backed shrike in coastal dunes

Density of larvae: intact Danish dunes



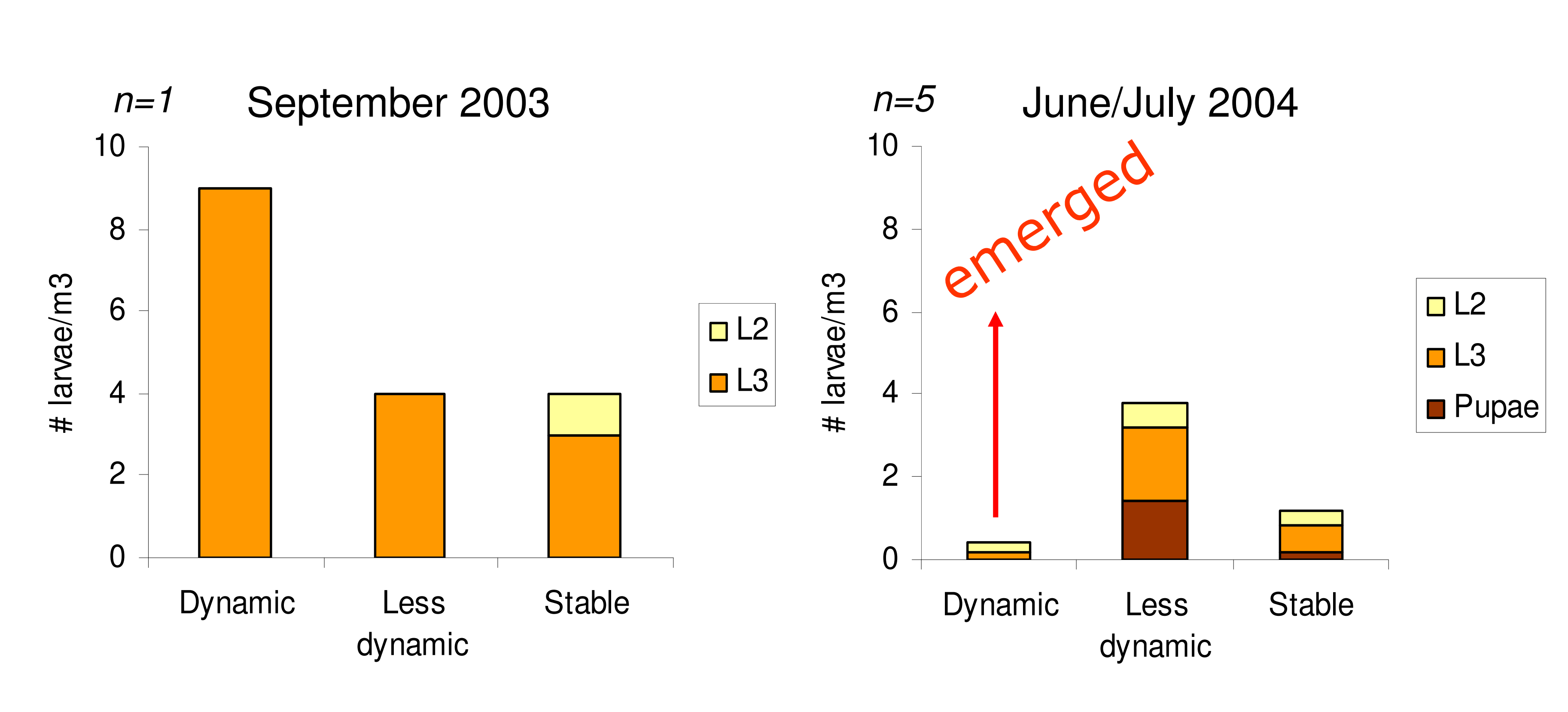


Highest density of larvae in dynamic dunes

High vital root biomass in dynamic dunes

Red-backed shrike in coastal dunes

Density of larvae: intact Danish dunes



Highest density of larvae in dynamic dunes

High vital root biomass in dynamic dunes

Possibly a 1-year life cycle in dynamic dunes

Red-backed shrike in coastal dunes

Use species to trace changes across the ecosystem

- increased vegetation succession
- changes in microclimate (soil fauna)
- lower heterogeneity and prey availability (carnivores)

Restore eolian activity is a promising restoration strategy

Conclusions and recommendations

How to restore degraded ecosystems?

'*Match*' between species and environment

- Species' biology
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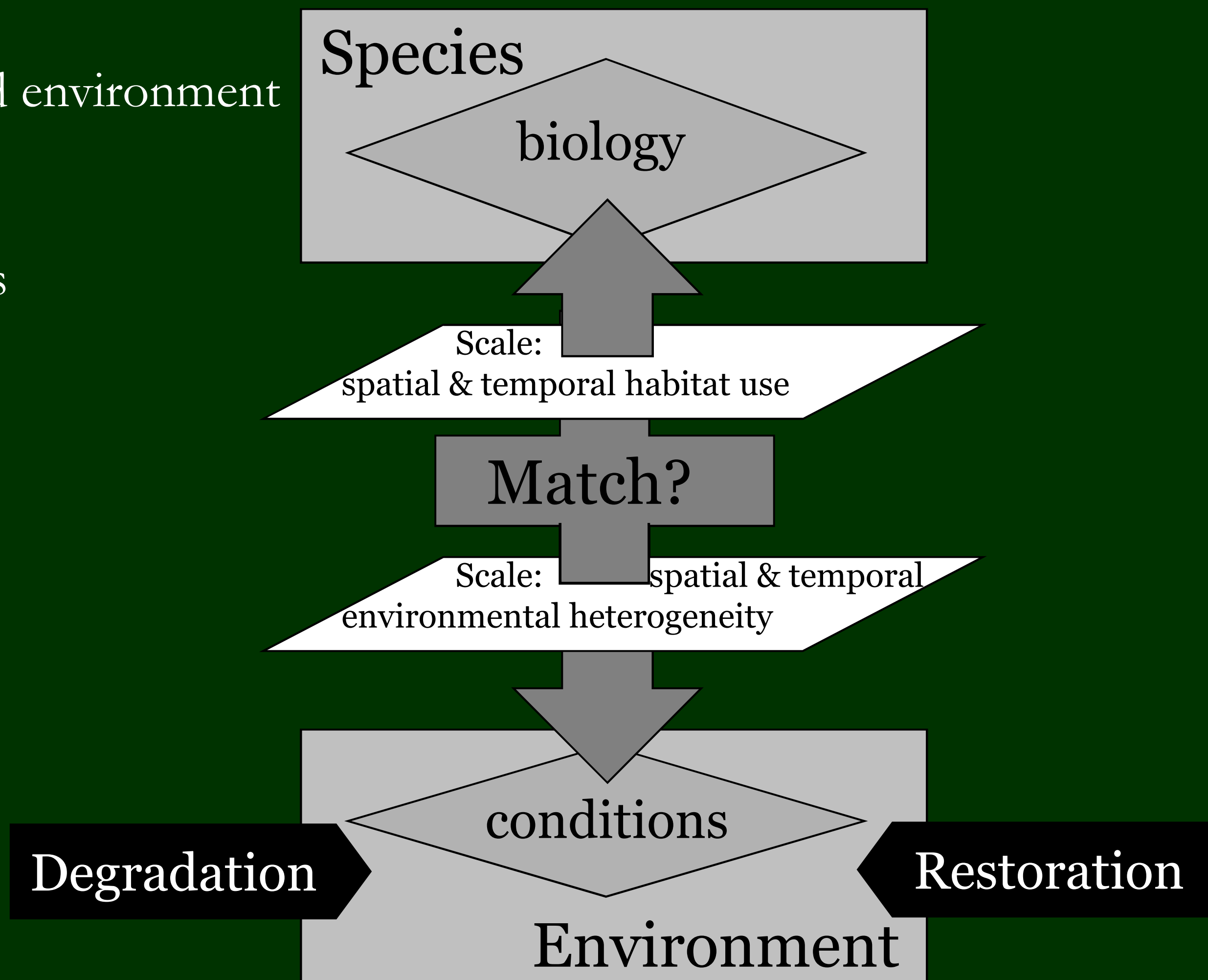
- Impact of degradation
- Effect of restoration
- Scale



Conclusions and recommendations

How to restore degraded ecosystems?

Mismatch $\xrightarrow[\textit{Bottom up: aggregation}]{\textit{Topdown: selection}}$ Match

Conserve and restore landscape heterogeneity

- Include different habitat types and their transitions
- Management: phased and on a small scale
- Strengthen underlying keyprocesses
  eolian activity and regional groundwater

Matching species to changing landscapes
Restoring faunal communities

Thank you for your attention!

Questions?