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Temporal and catchment effects on the success of restoration measures in streams

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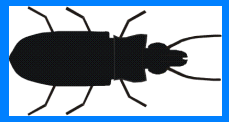
?

Hydromorphology

Fish

Benthic Invertebrates

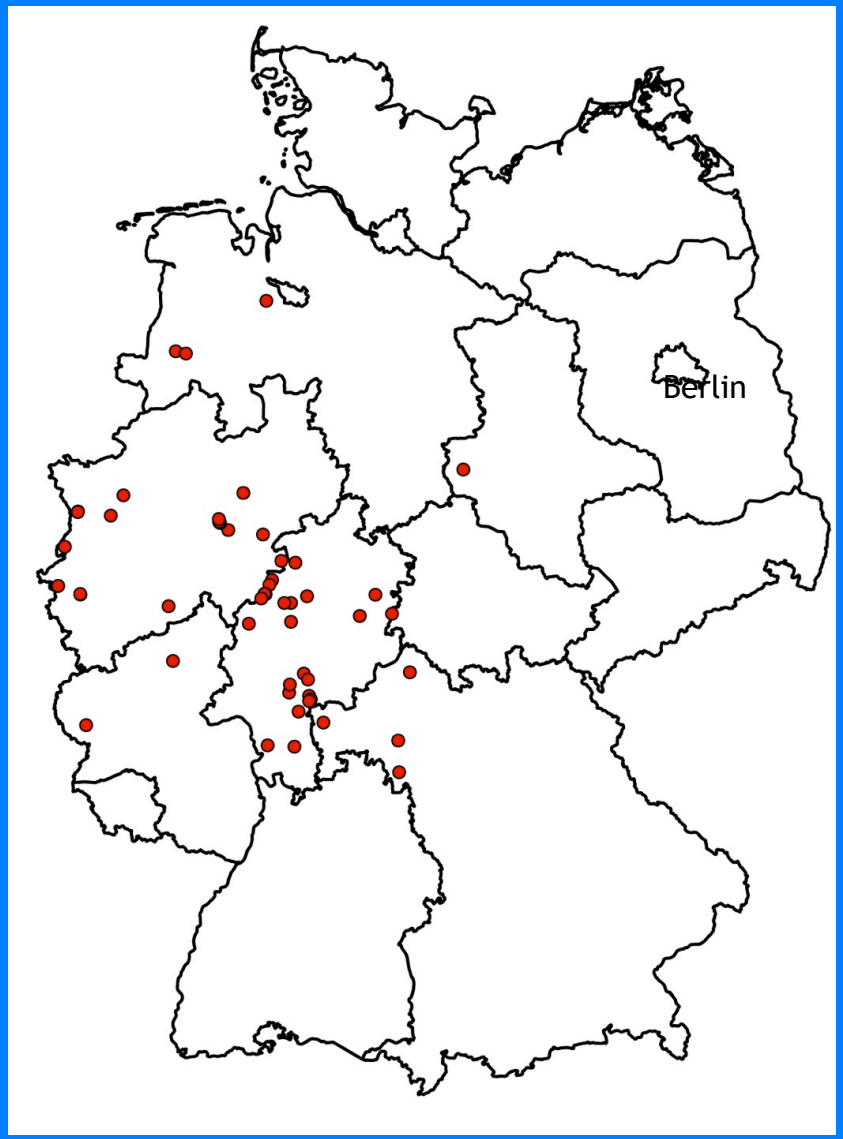
Macrophytes



Riparian Beetles

Floodplain vegetation

Sampling sites



- > 50 restored sites
- between 2007-2018
- Ø length: 1.1 km
- 1-25 years between finalization and sampling
- paired sites (unrestored site for comparison)

Material and Methods

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Standardised sampling of:

- Benthic invertebrates (Haase et al. 2004, Meier et al. 2006)
- Macrophytes (Schaumburg et al. 2004)
- Fish (Diekmann et al. 2005)
- Floodplain vegetation (Jähnig et al. 2009)
- Riparian beetles (Januschke et al. 2011)

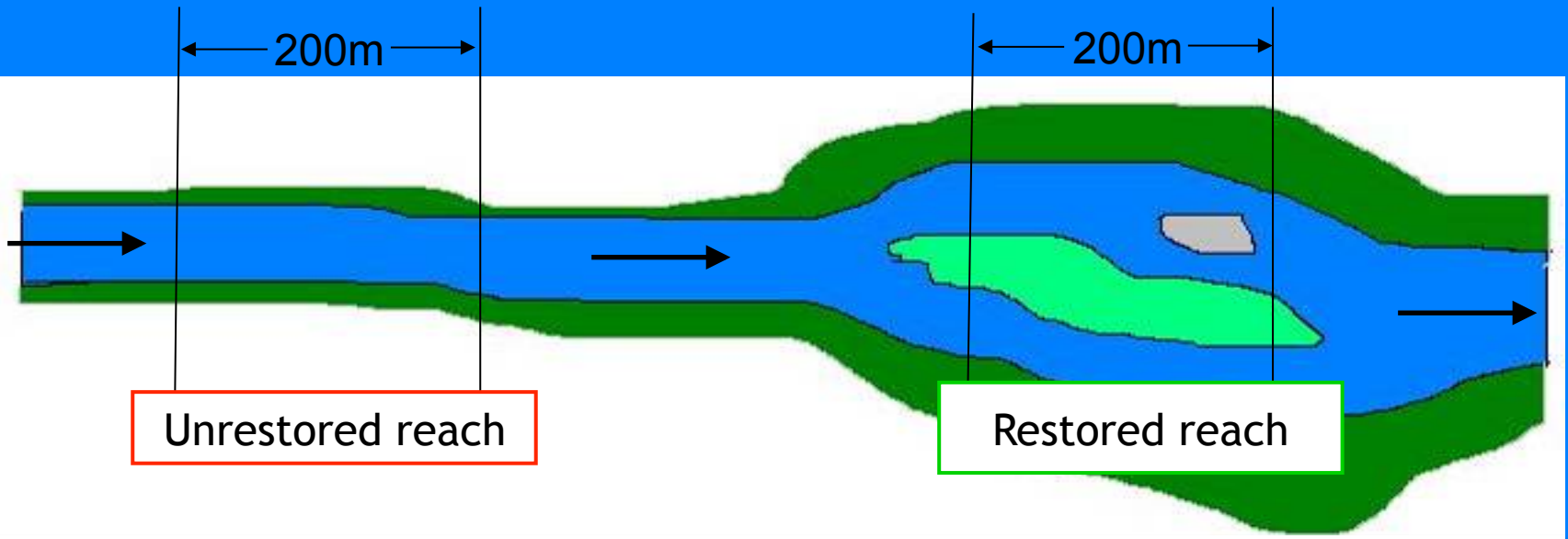
- Hydromorphology (Januschke et al. 2011, Gellert et al. 2014)

Research questions

- Which effect has the factor „time“ on the biology of restored reaches ?

- Which influence has the catchment on the success of restoration measures ?

„space-for-time“- approach



- Fish
- Benthic invertebrates
- Macrophytes
- Floodplain vegetation
- Riparian beetles

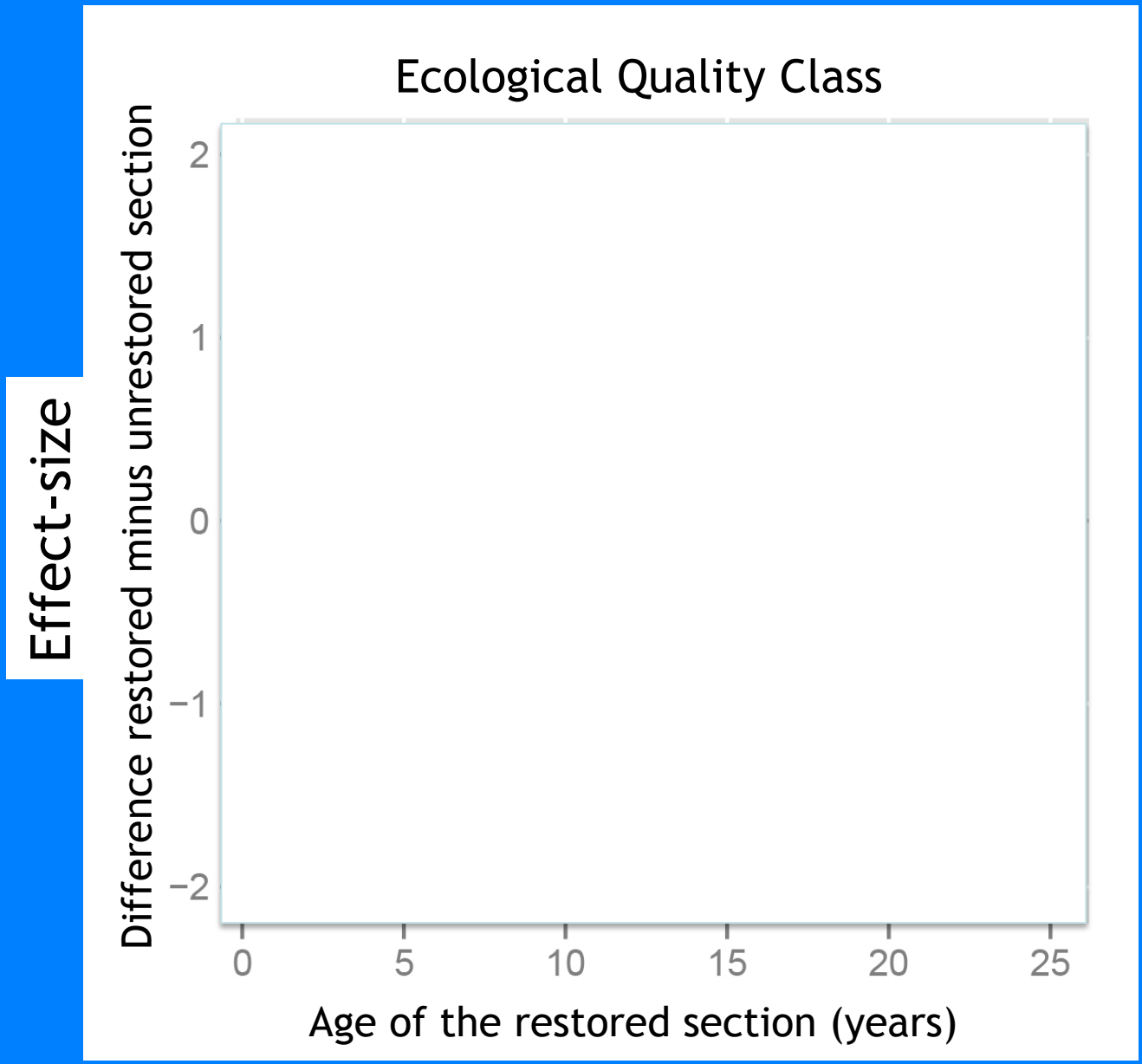
Metric-value

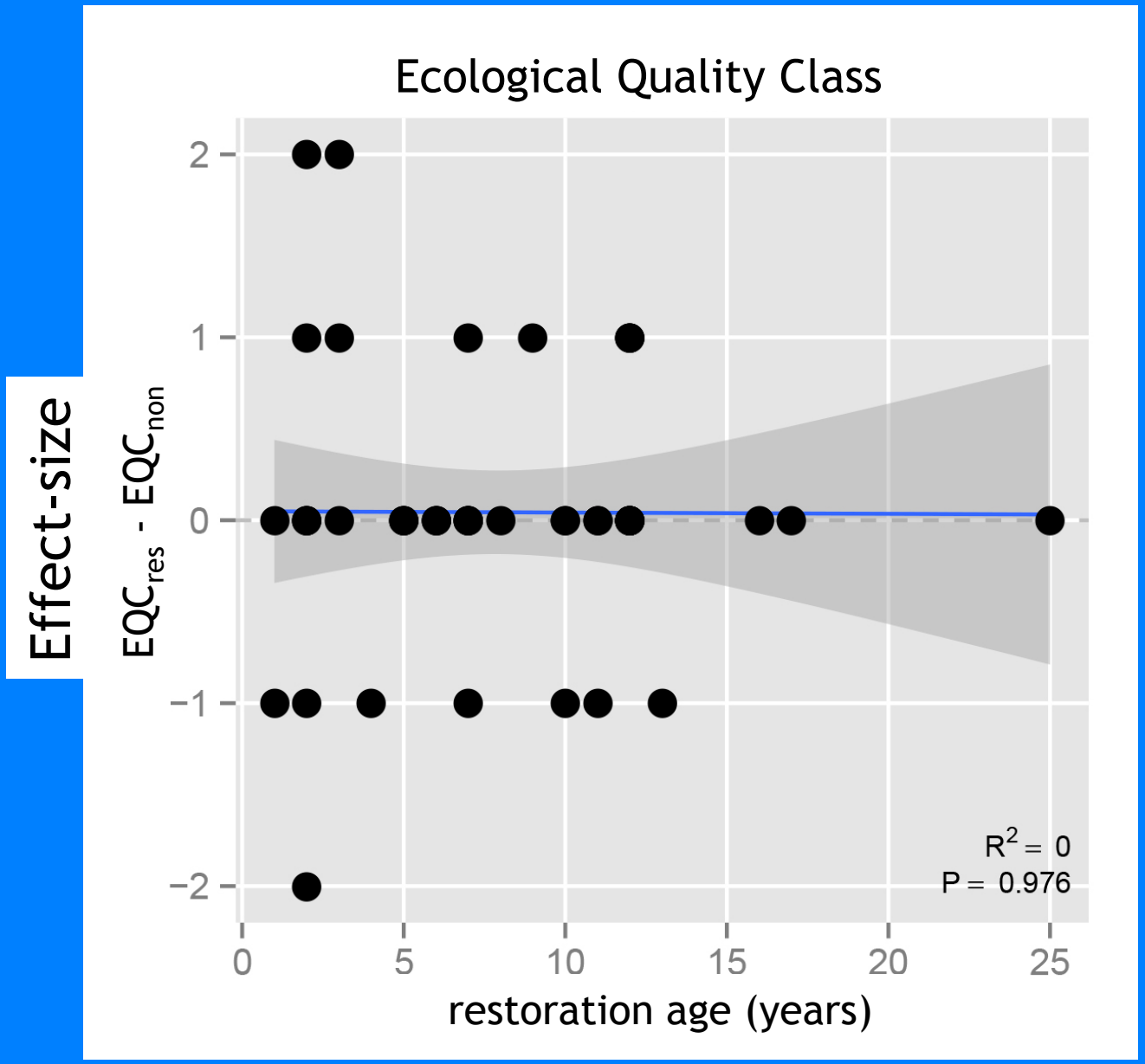
- Fish
- Benthic invertebrates
- Macrophytes
- Floodplain vegetation
- Riparian beetles

Metric-value restored reach minus Metric-value unrestored reach

=

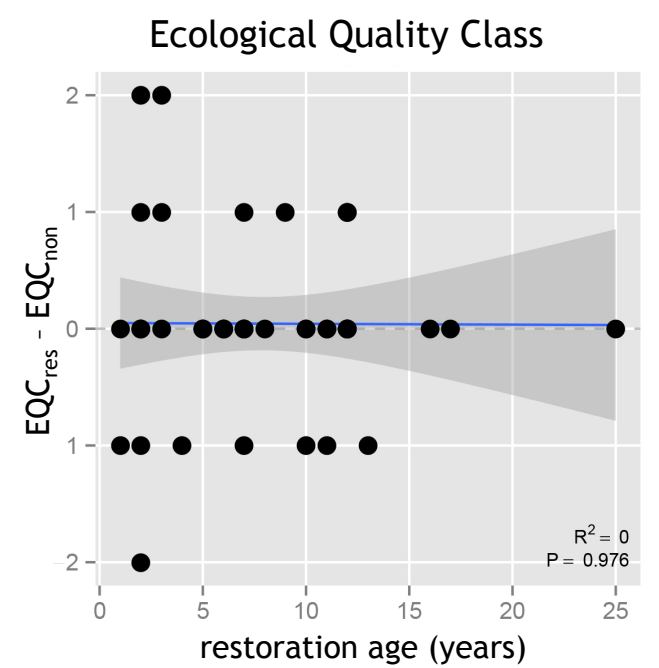
Effect-size

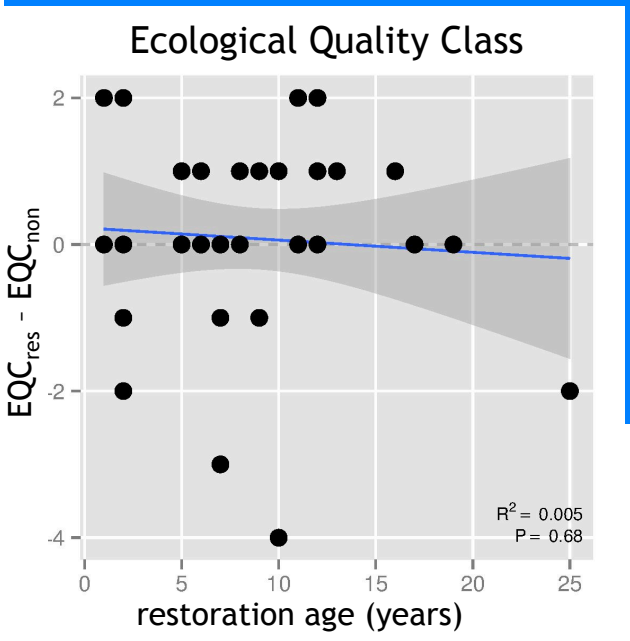

Ecological Quality Class
Effect-size
Difference restored minus unrestored section
2
1
0
−1
−2
0
5
10
15
20
25
Age of the restored section (years)

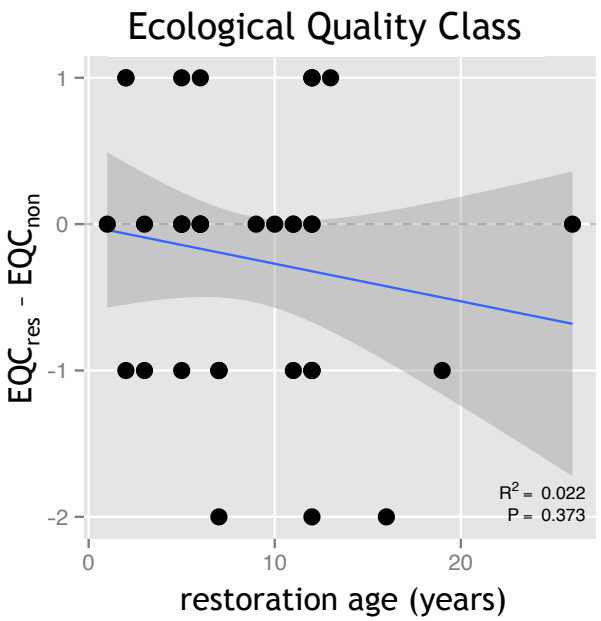

Ecological Quality Class
Effect-size
EQC_res - EQC_non
2
1
0
−1
−2
0
5
10
15
20
25
restoration age (years)
R² = 0
P = 0.976

N=46

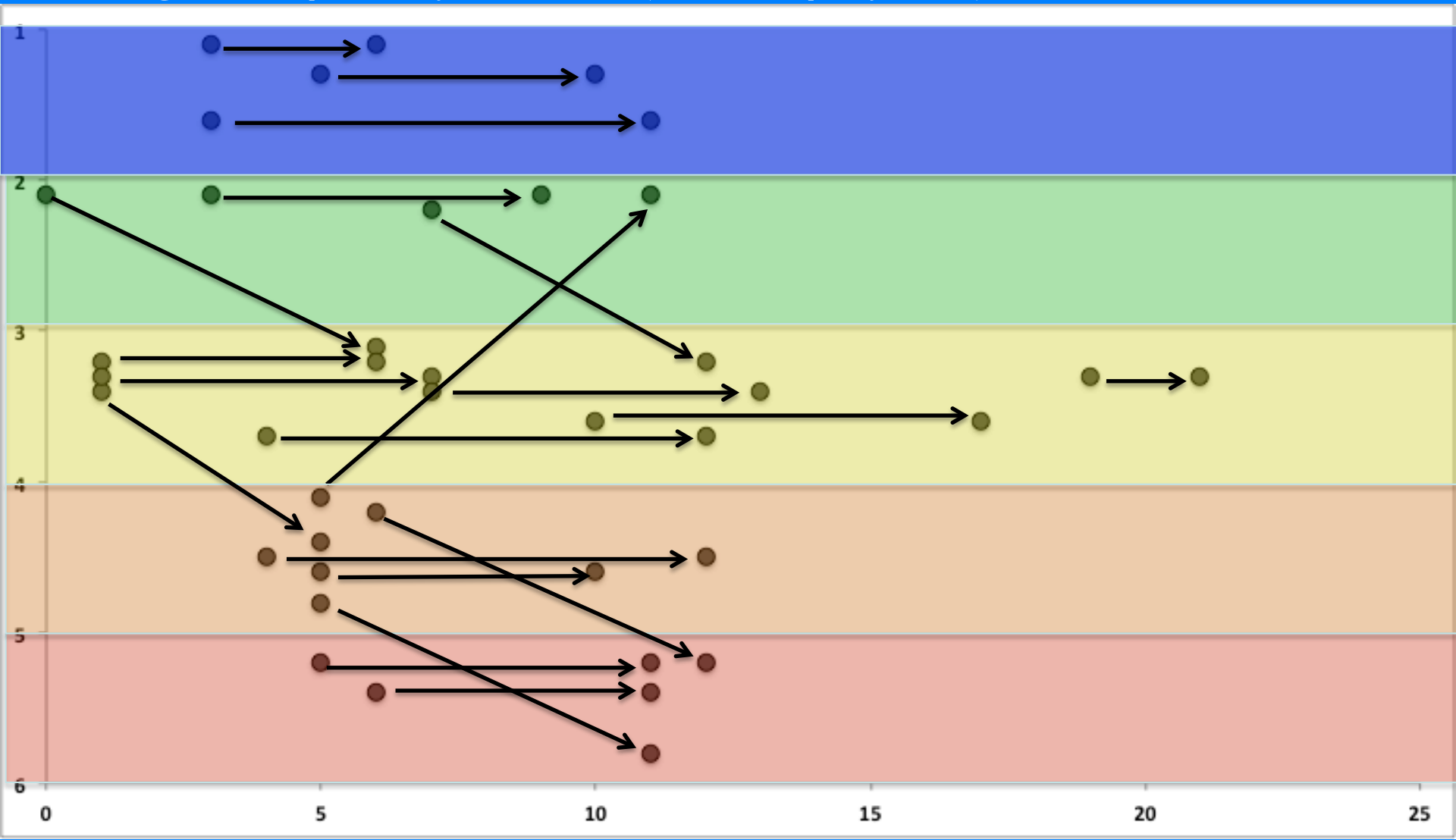
Ecological quality class







Revisiting restored sites: Ecological quality class (Macrophytes)



Years after the finalization of the restoration measure

n=20

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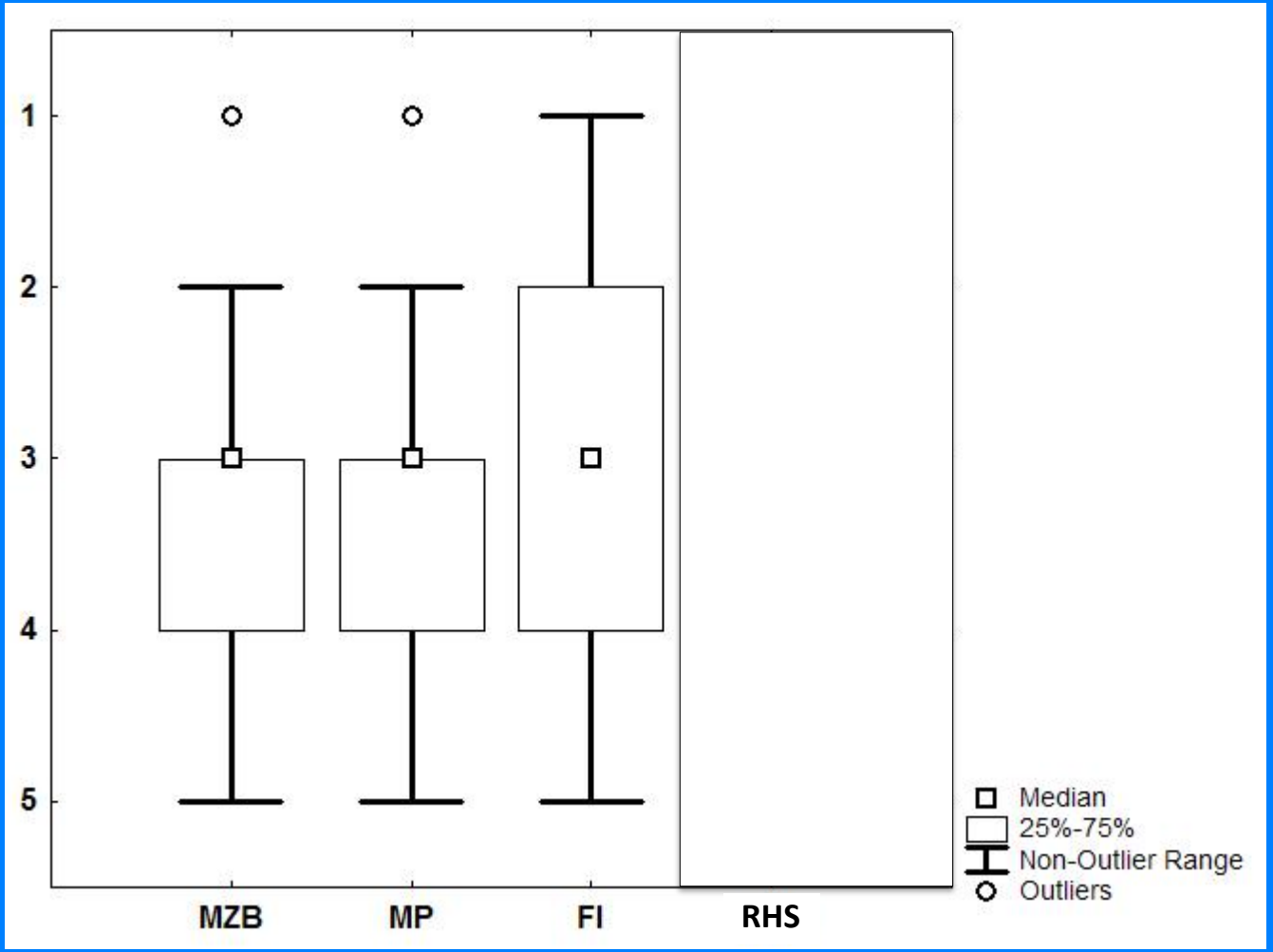
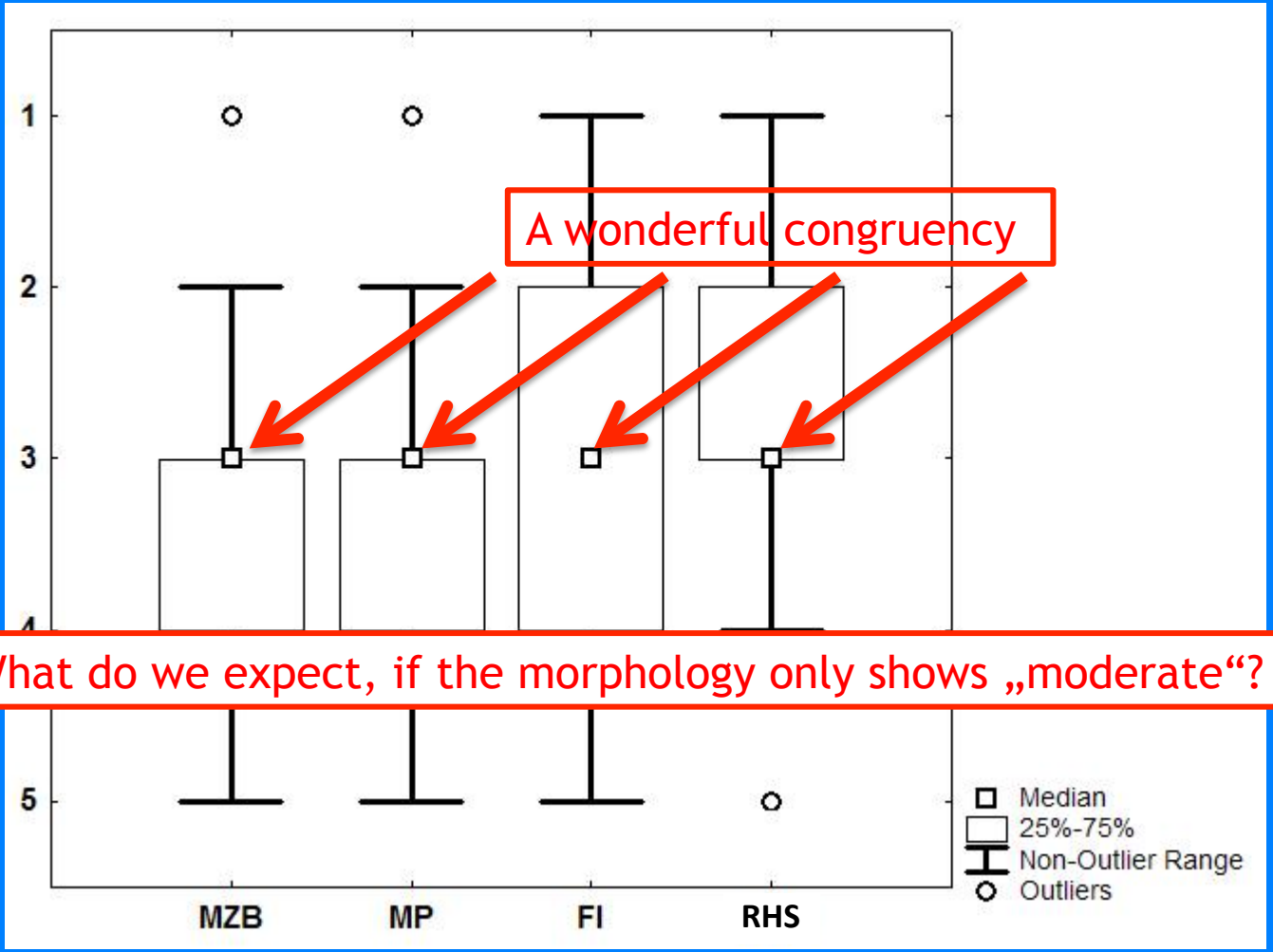
Ecological Quality Class changes in 2 steps in time (2008-2013)

EQC + RHS of the restored sections



N=65

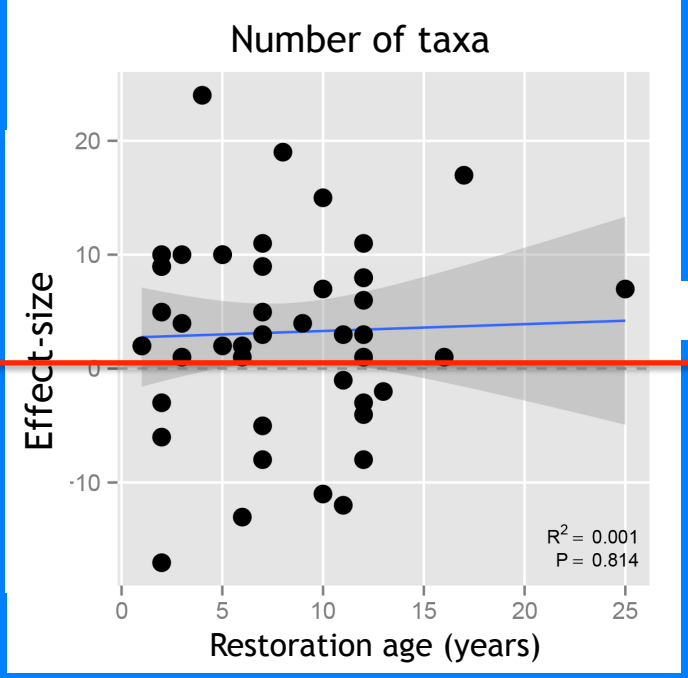
EQC + RHS of the restored sections



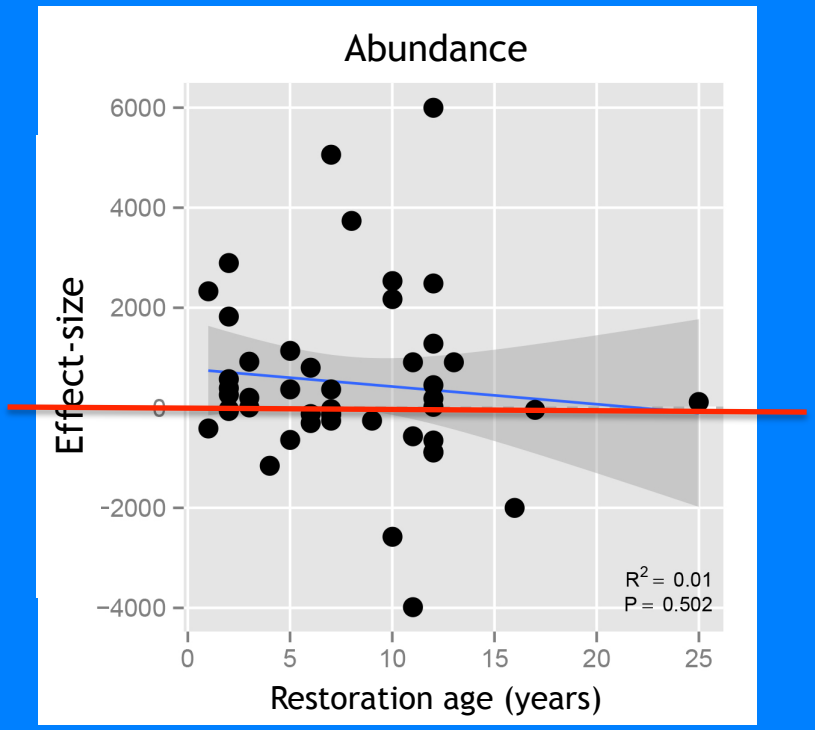
A wonderful congruency

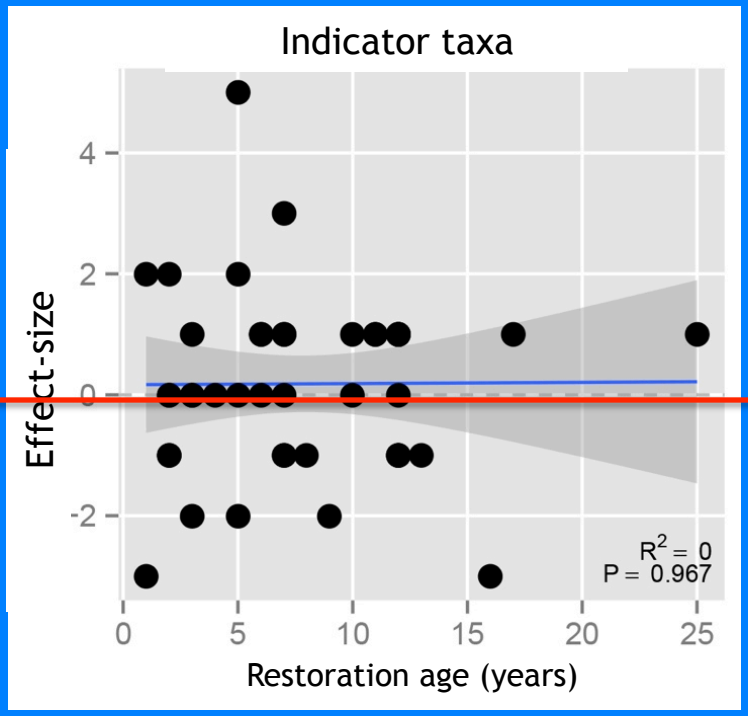
What do we expect, if the morphology only shows „moderate“?

N=65

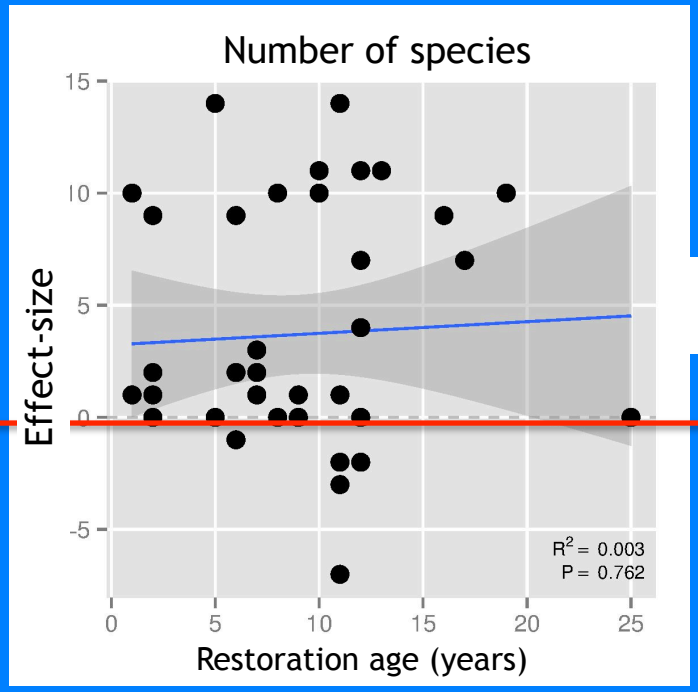

Number of taxa
Effect-size
Restoration age (years)
R^2 = 0.001
P = 0.814

3 ± 8 Taxa

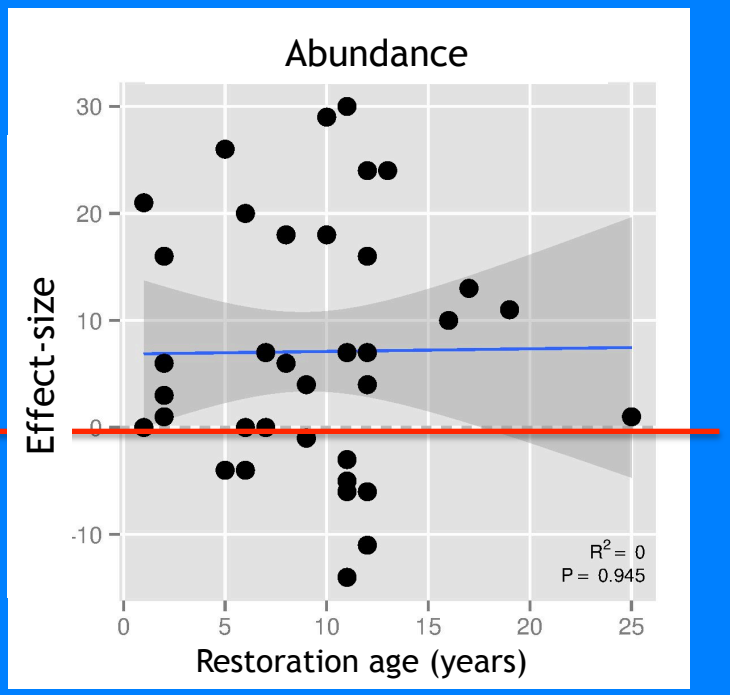

Abundance
Effect-size
Restoration age (years)
R^2 = 0.01
P = 0.502

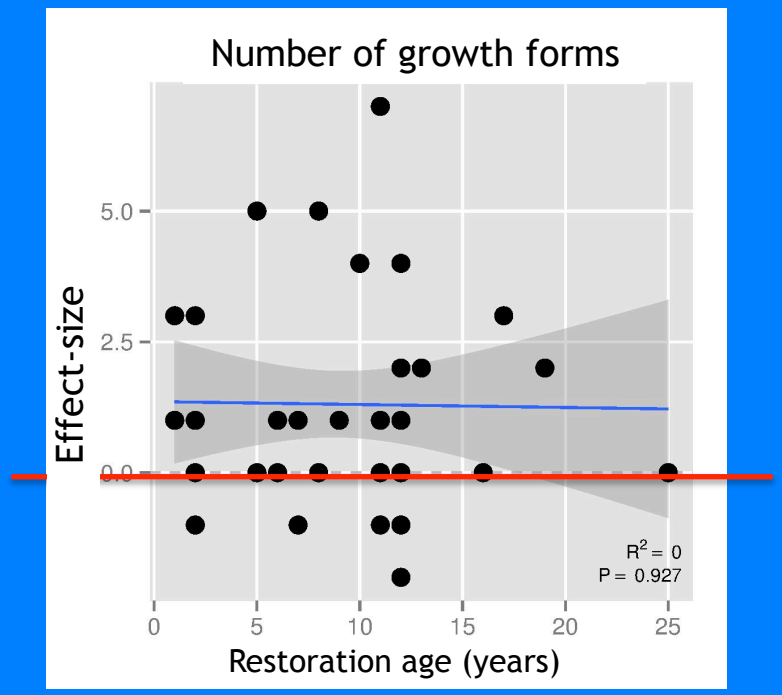

Indicator taxa
Effect-size
Restoration age (years)
R^2 = 0
P = 0.967

N=46

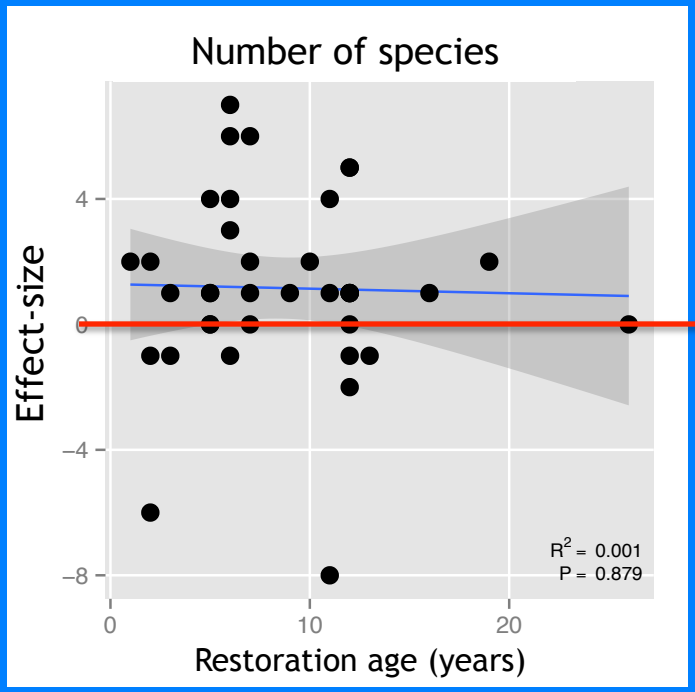


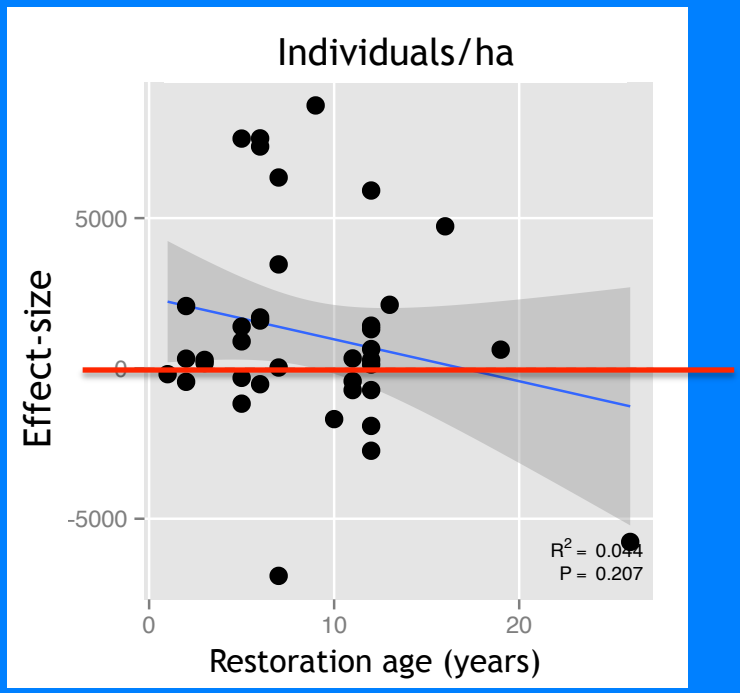
4 Taxa
46.6 %





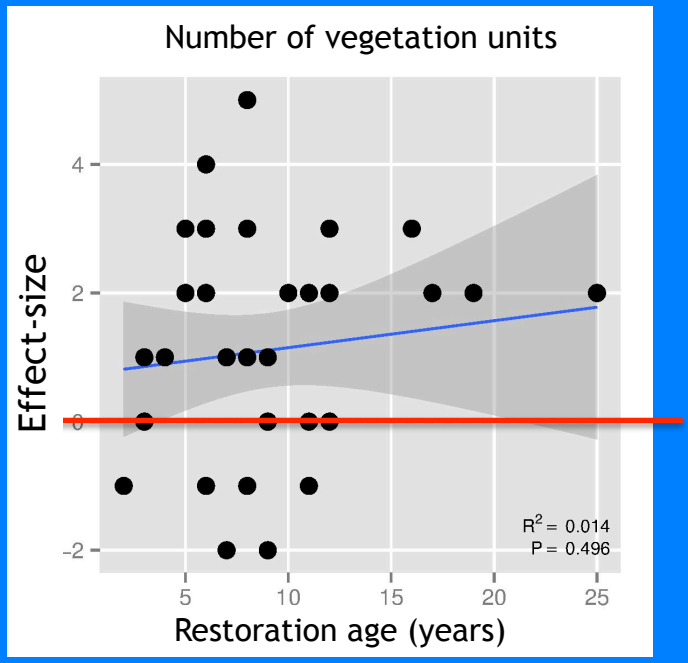
N=46

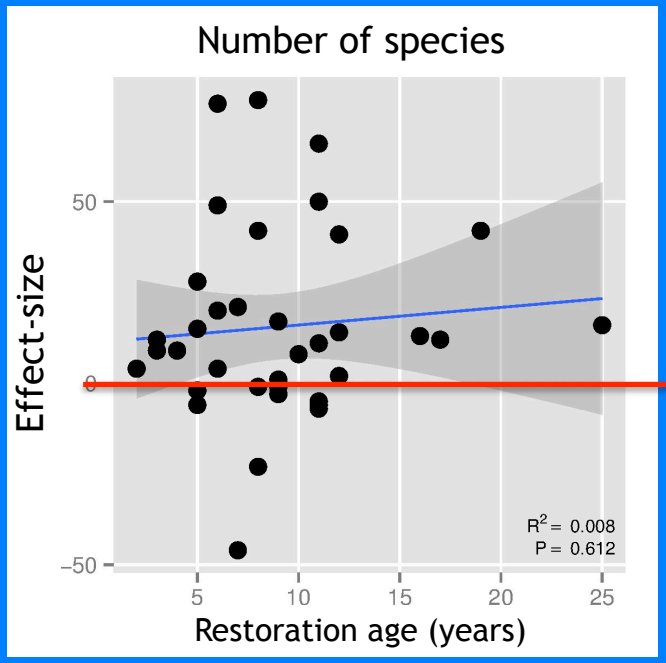

Number of species
Effect-size
4
0
−4
−8
0
10
20
Restoration age (years)
R2 = 0.001
P = 0.879

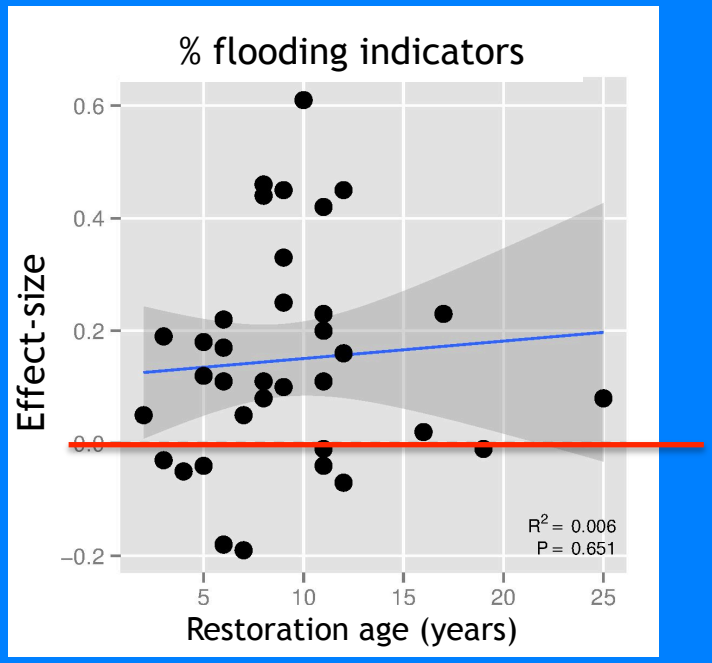

Individuals/ha
Effect-size
5000
0
-5000
0
10
20
Restoration age (years)
R2 = 0.044
P = 0.207


Age structure
Effect-size
3
2
1
0
−1
0
10
20
Restoration age (years)
R2 = 0.008
P = 0.738

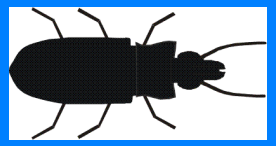
N=38

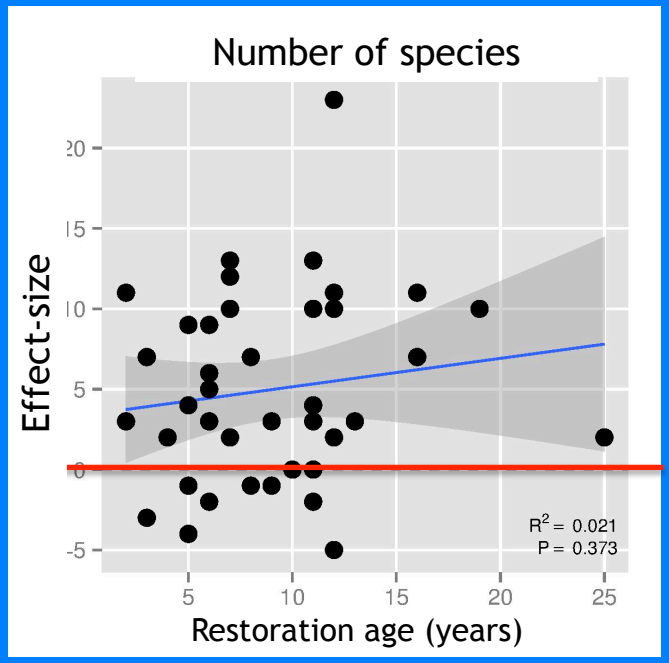

Number of vegetation units
Effect-size
Restoration age (years)
R^2 = 0.014
P = 0.496

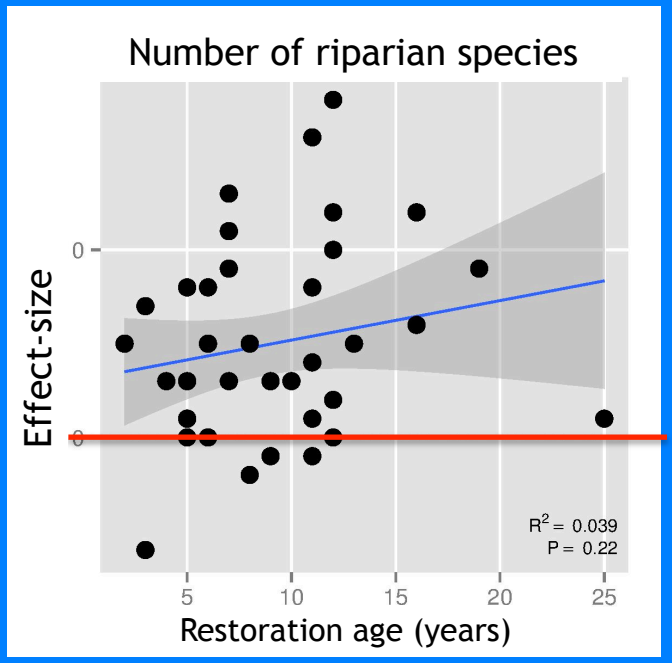

Number of species
Effect-size
Restoration age (years)
R^2 = 0.008
P = 0.612

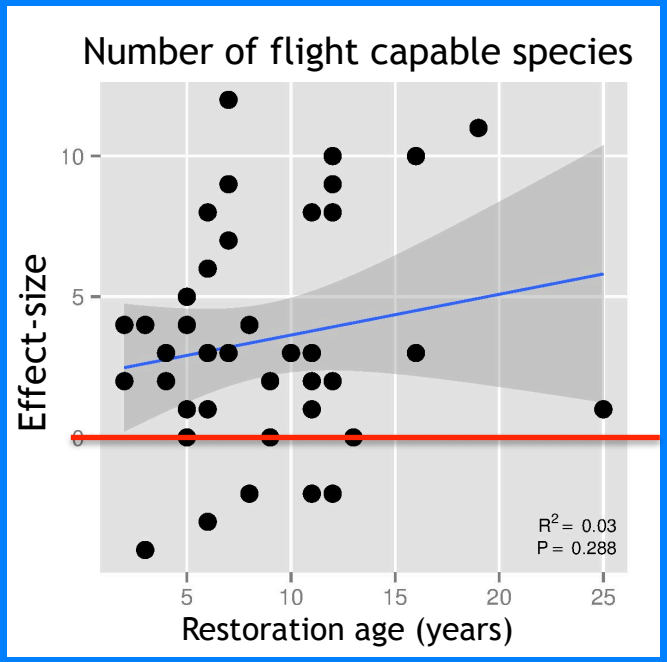

% flooding indicators
Effect-size
Restoration age (years)
R^2 = 0.006
P = 0.651

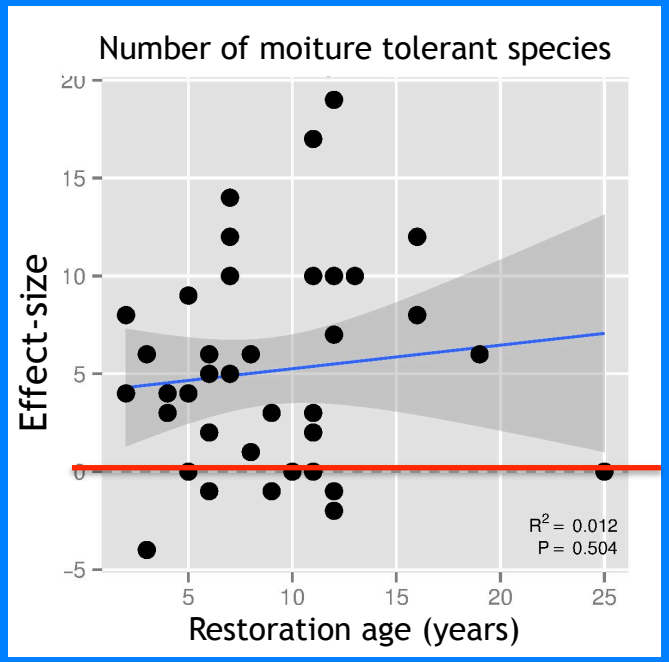
N=40




Number of species
Effect-size
Restoration age (years)
R^2 = 0.021
P = 0.373


Number of riparian species
Effect-size
Restoration age (years)
R^2 = 0.039
P = 0.22


Number of flight capable species
Effect-size
Restoration age (years)
R^2 = 0.03
P = 0.288


Number of moiture tolerant species
Effect-size
Restoration age (years)
R^2 = 0.012
P = 0.504

N=40

Summary

- The factor time does not play a significant role for the ecological quality class (within the first 20 years!)

- Several metrics show improvements in restored sections independent of the time axis

2nd research question

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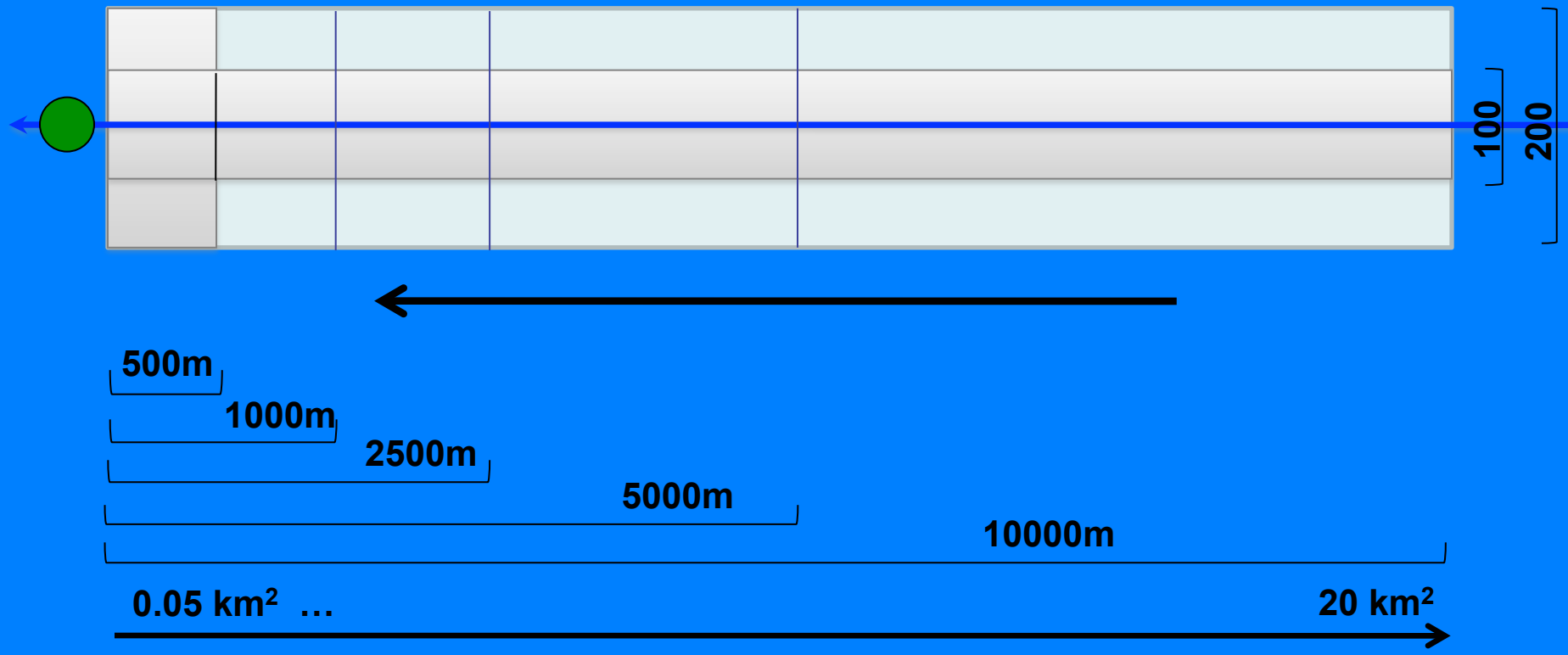
Which influence has the catchment on the success on restoration measures ?

- What is the effect of land use practices upstream on the stream biota in restored stretches?
- What is the effect of the physical river habitat quality upstream on the stream biota in restored stretches?
- What is the effect of the land use practices in the whole catchment on the stream biota in restored stretches?

Land use and river physical habitat assessment in 10 different buffer sizes upstream



- and the whole catchment upstream

Results

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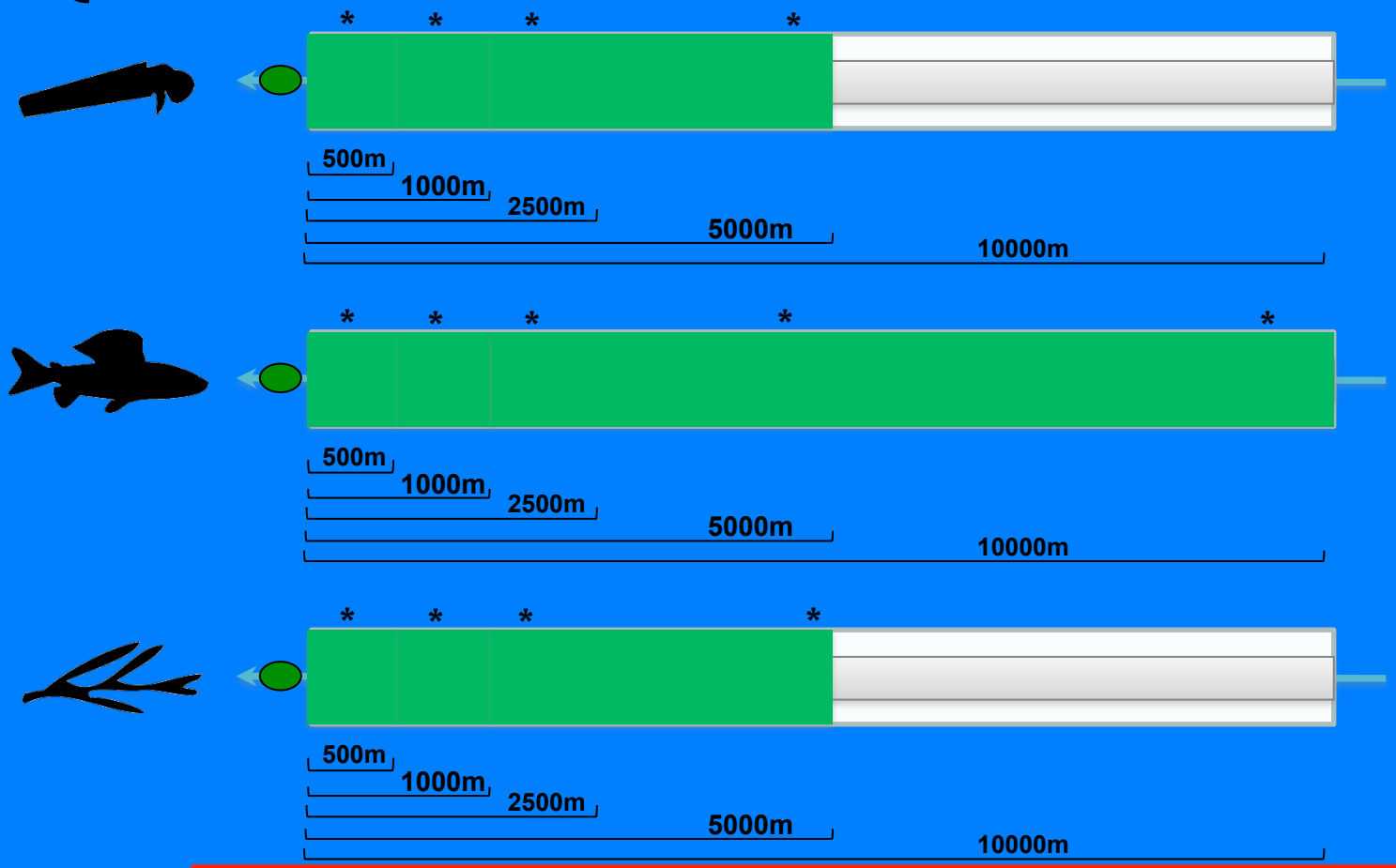
EQR

River habitat structure upstream

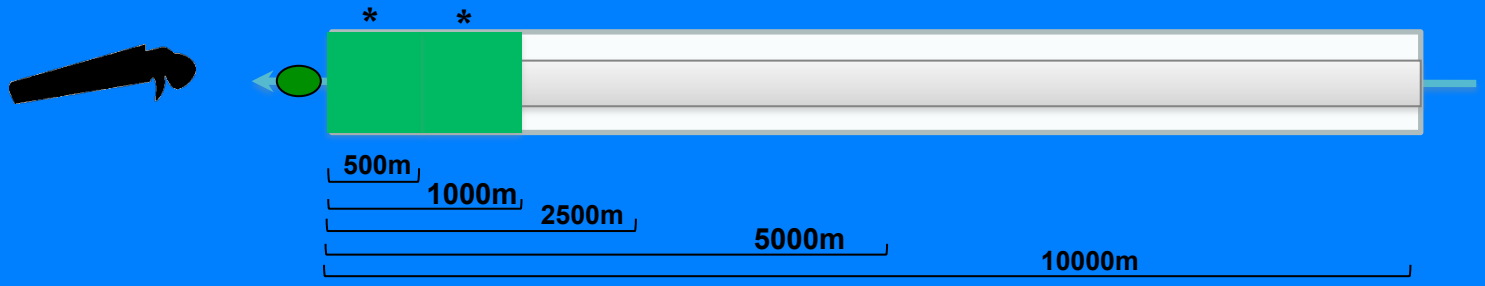


→ Positive/negative effects depending on the morphological status

But: No significant correlation with the morphological status of the site itself!

Buffer land use upstream

EQR



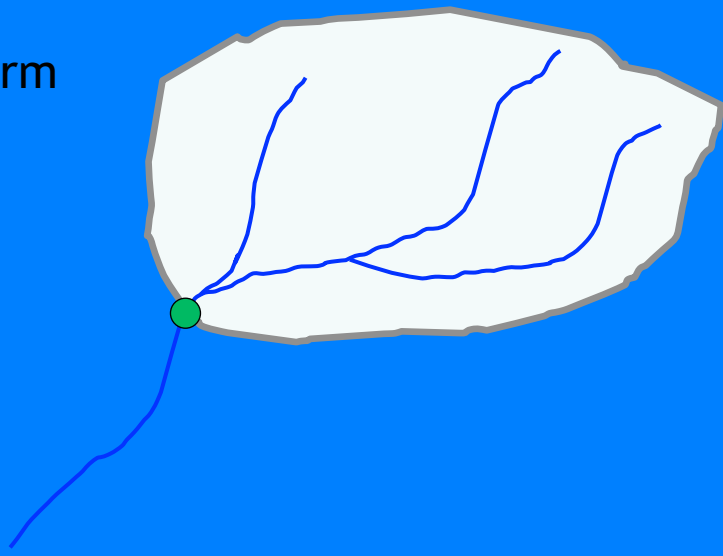
→ Near-natural land use upstream causes positive effects on the communities in restored reaches

→ But in fish: only long near-natural sections are significant

Land use in the whole catchment upstream

EQR

No significant effect of any land use form



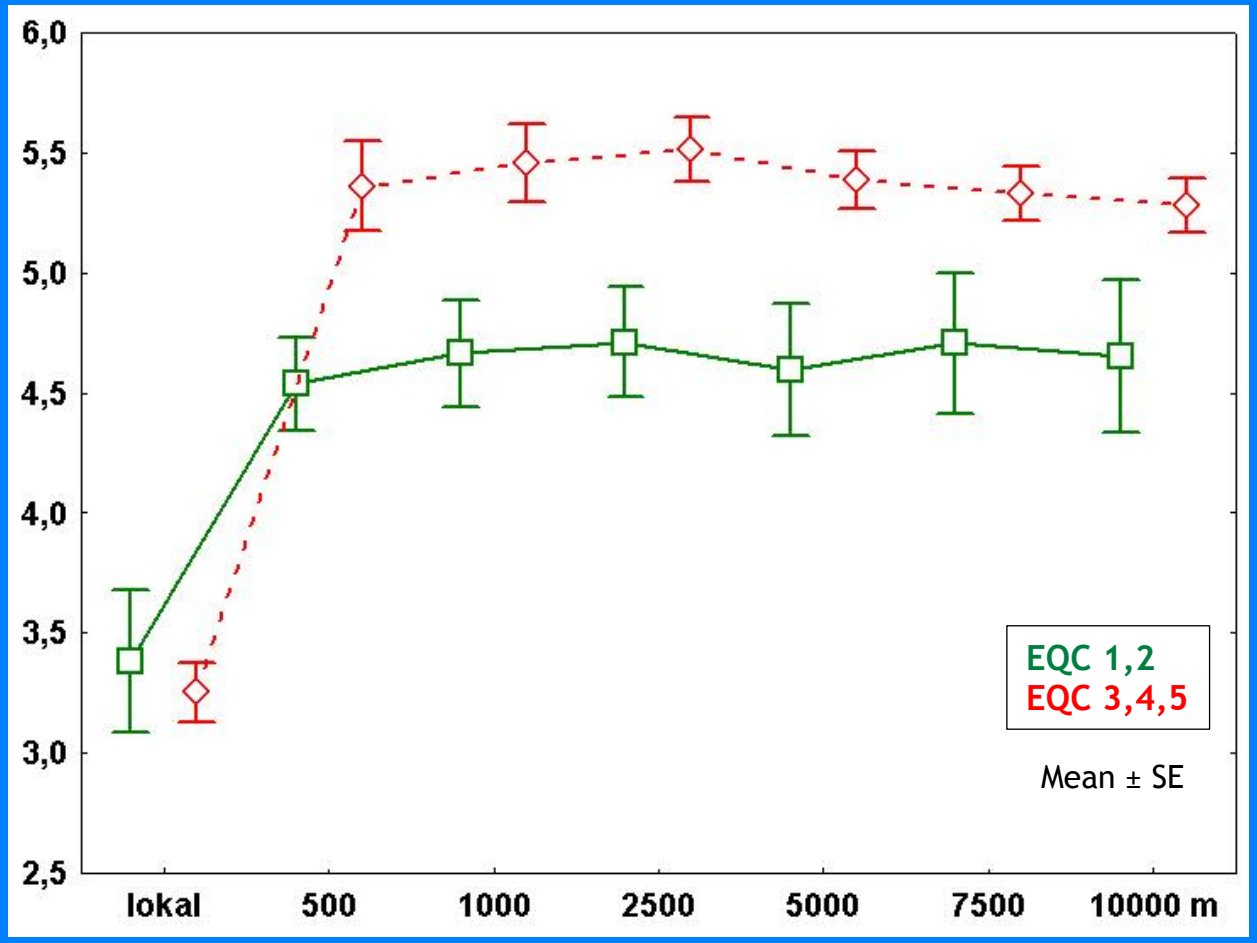
Coniferous forest	*** (+)**
Arable land	n.s.
Mixed forest	n.s.

No significant effect of any land use form

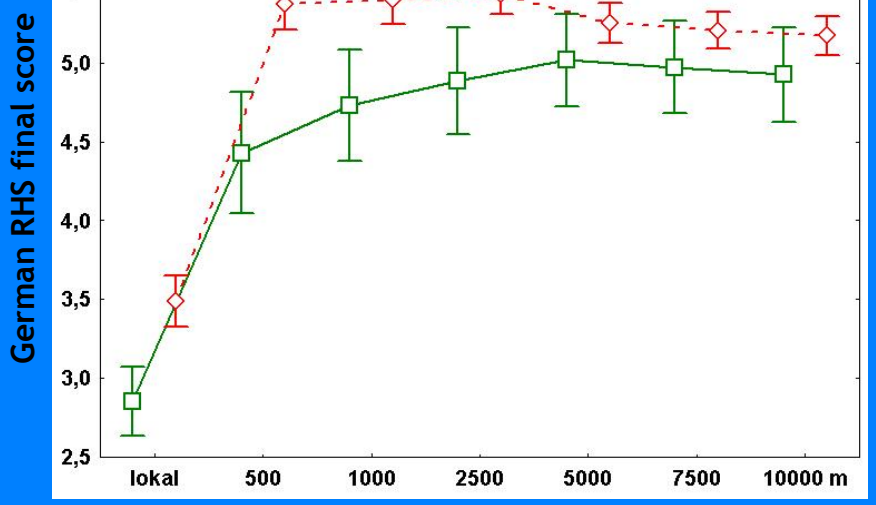
Ecological Quality Class (acc. WFD)

Ecological quality class	 n = 39	 n = 42	 n = 42
1, 2	9	14	7
3, 4, 5	30	28	35

G-RHS in the quality classes upstream

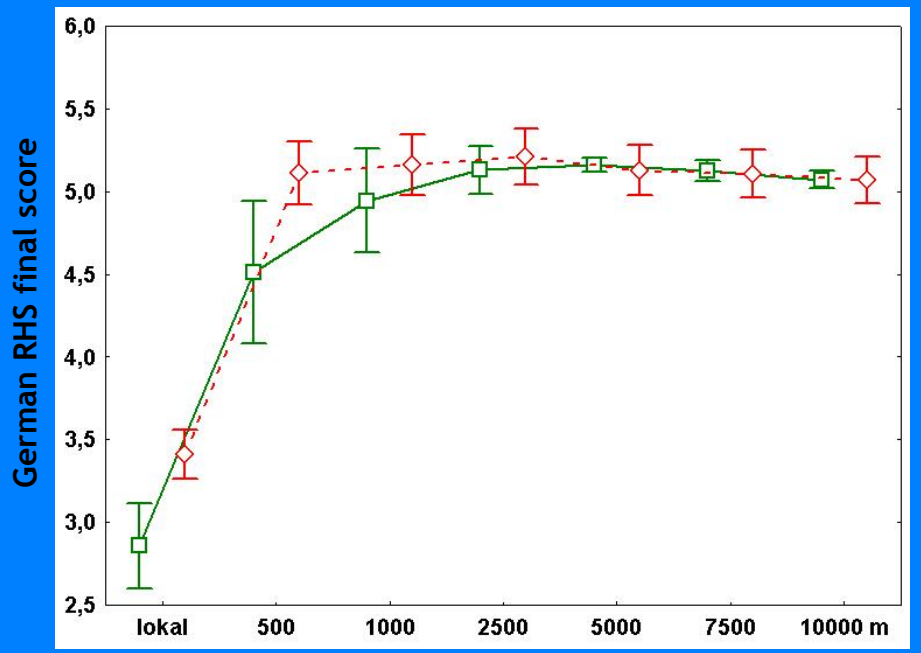


G-RHS in the quality classes upstream

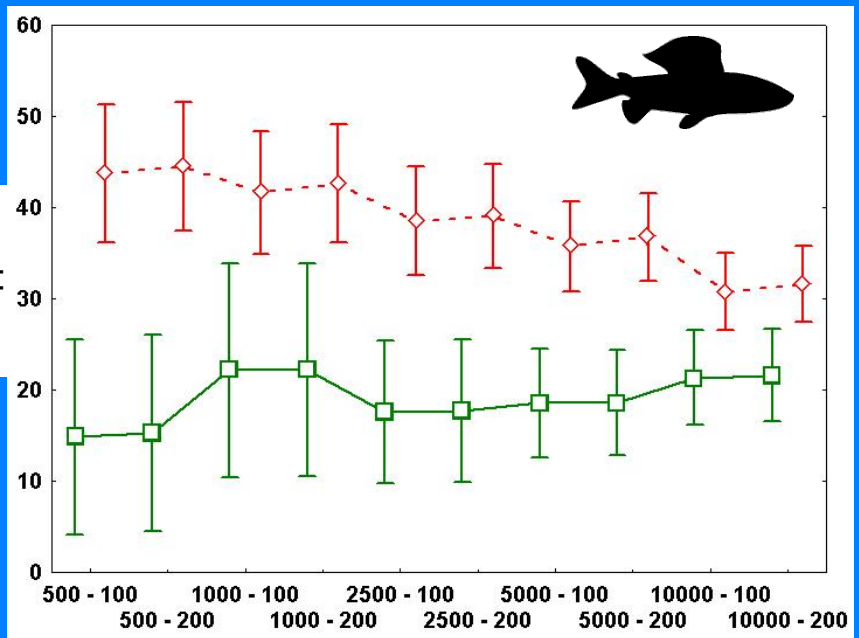


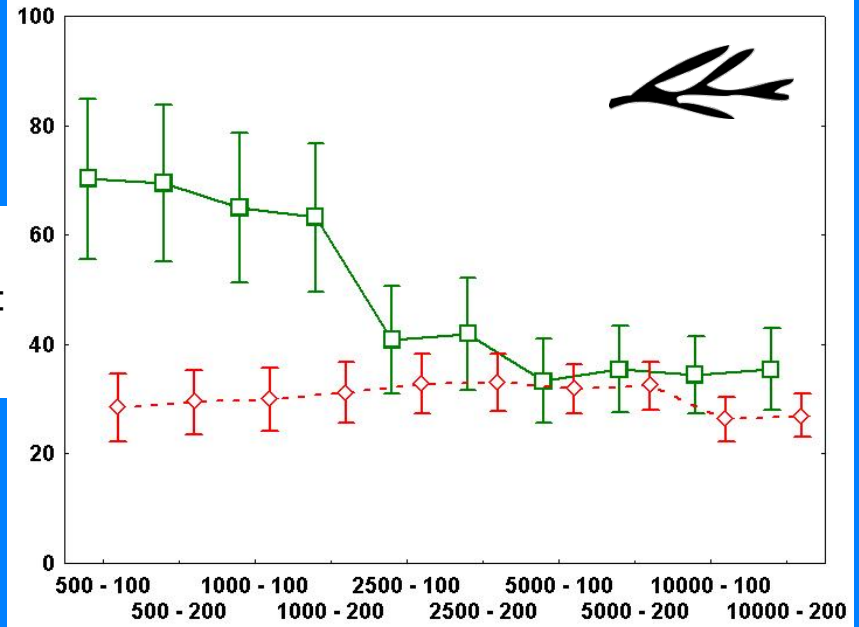
EQC 1,2
EQC 3,4,5

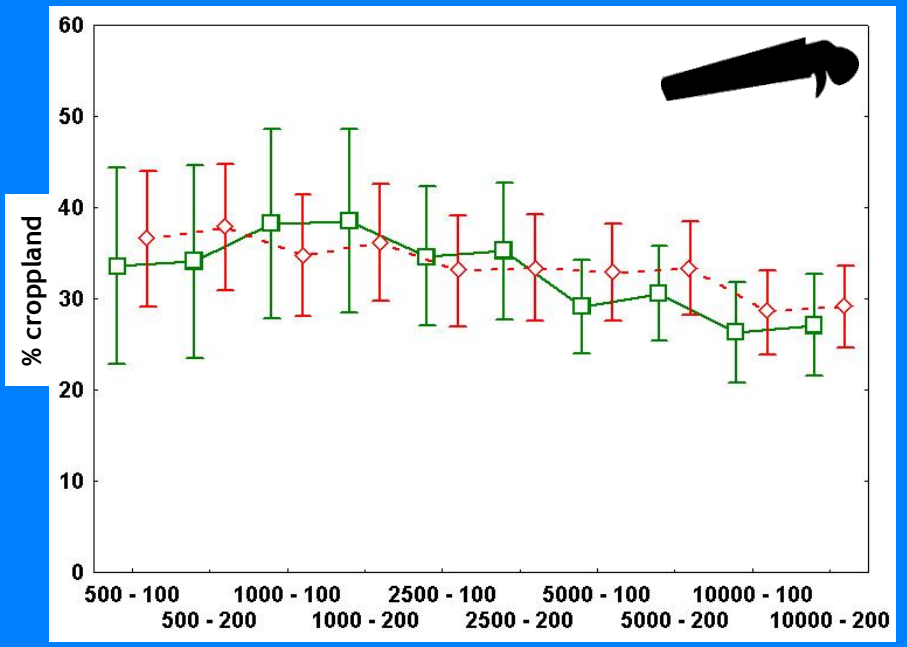
Mean ± SE



Arable land in the quality classes upstream



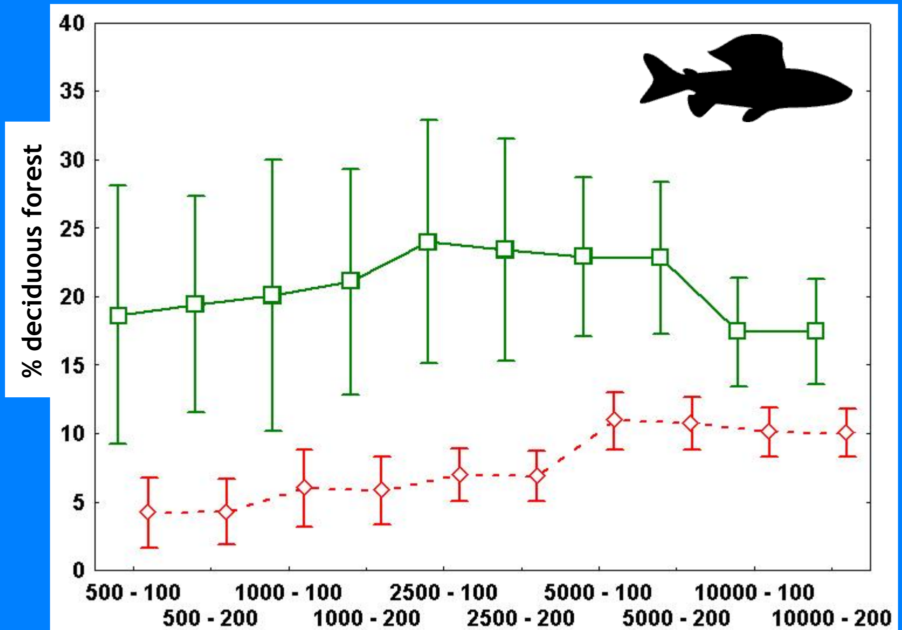


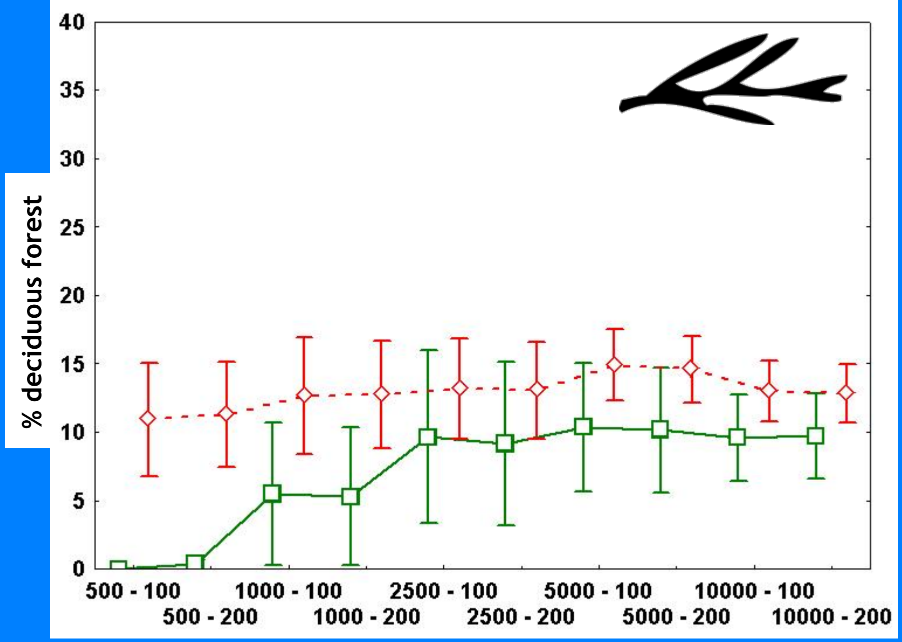


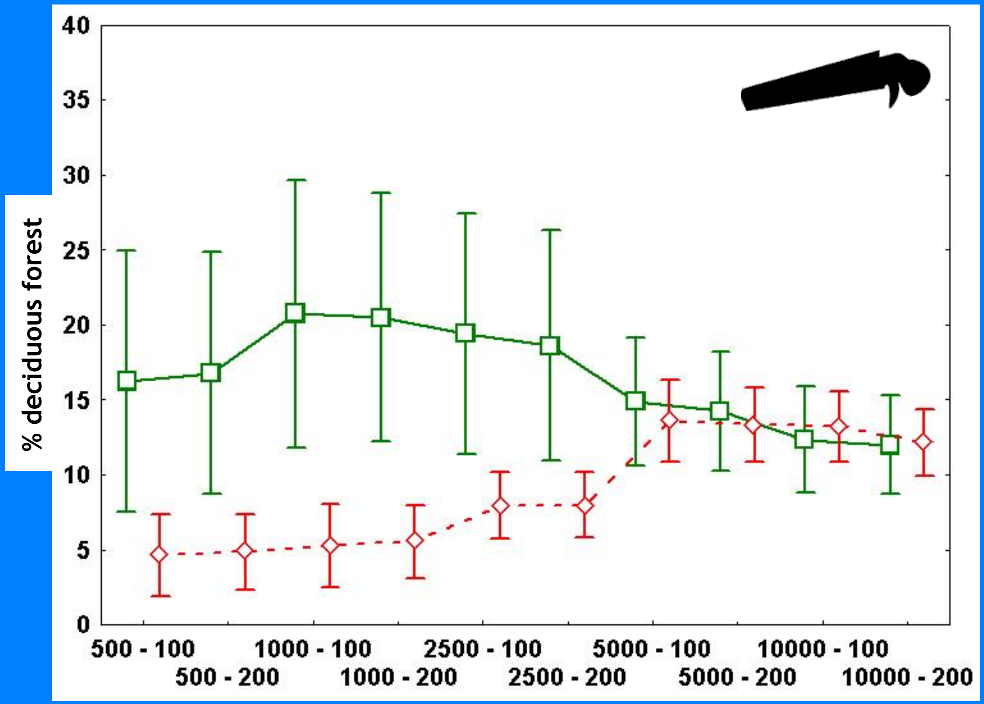
EQC 1,2
EQC 3,4,5

Mean ± SE

Deciduous forest in the quality classes upstream



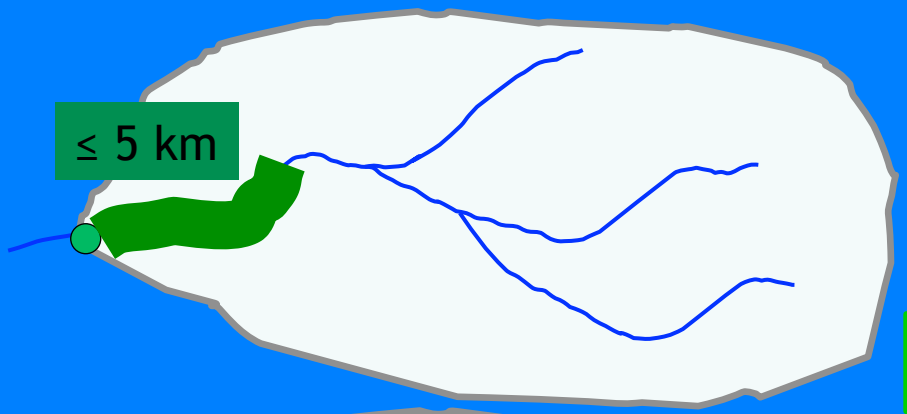




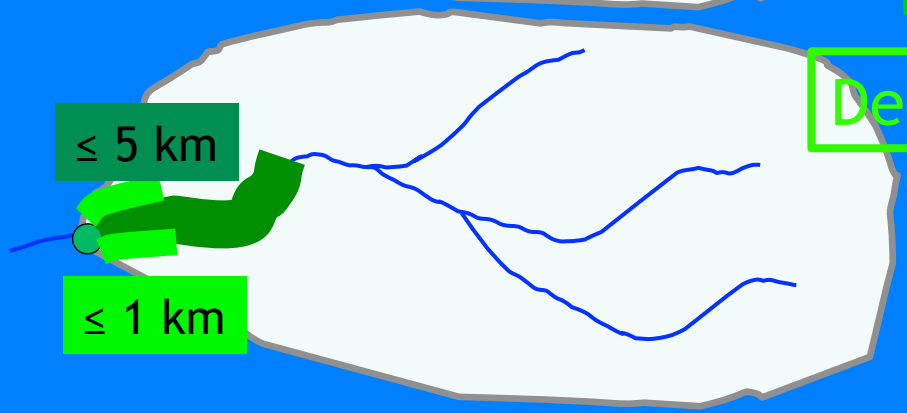
EQC 1,2
EQC 3,4,5

Mean ± SE

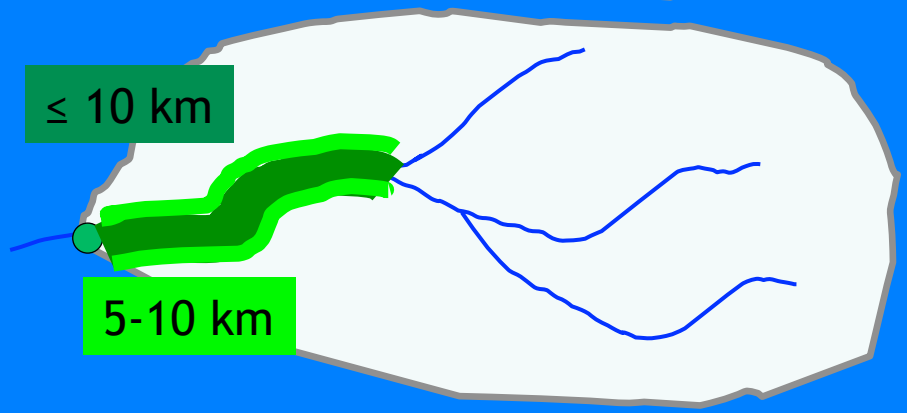
River habitat structure and near-natural land use



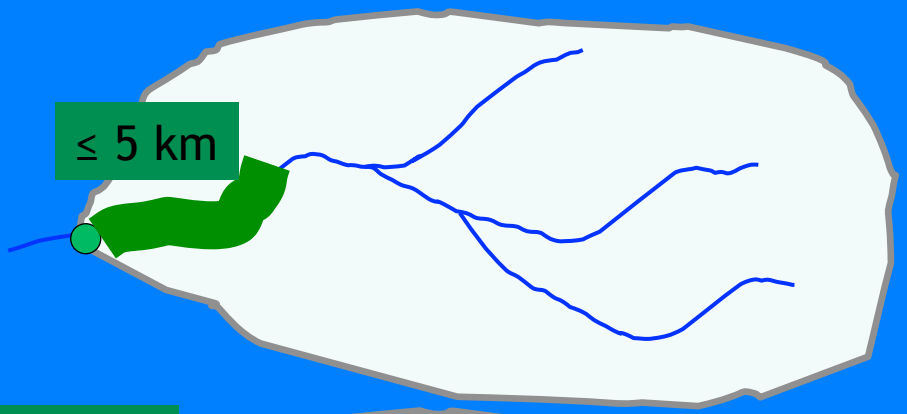
G-RHS

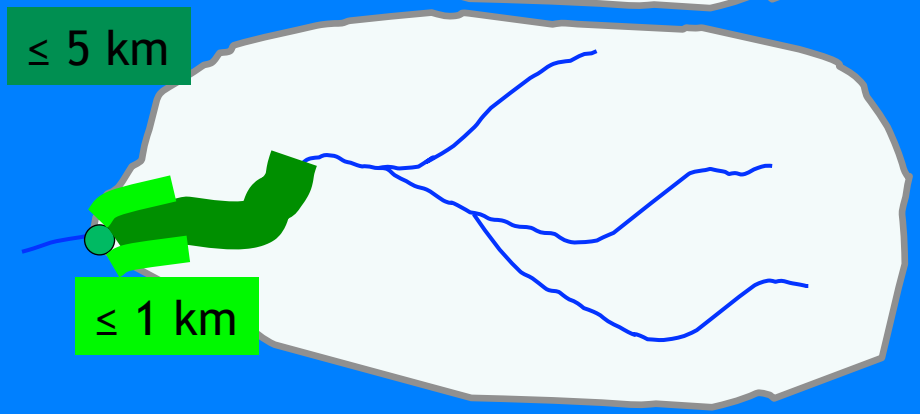


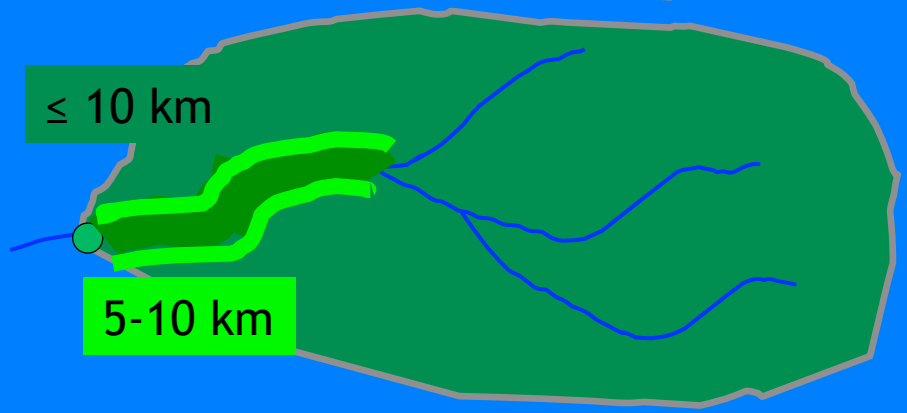
Deciduous forest



River habitat structure and near-natural land use



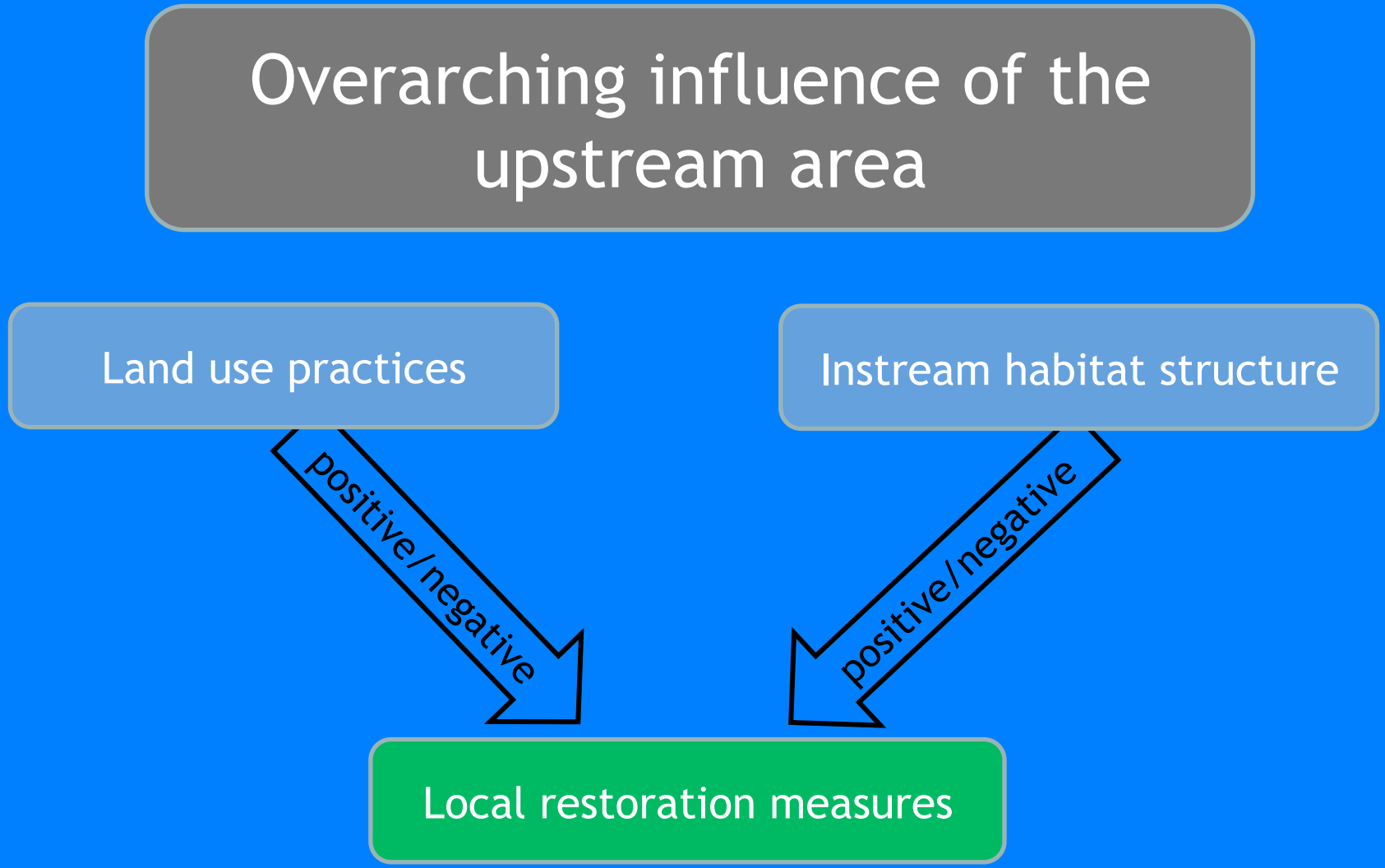




Forest

Results

- The river habitat structure upstream of a restored section is of crucial relevance for effects on the biota
- Already (≥) 20 % of deciduous forest in a buffer strip upstream of a restored section has positive effects on the stream biota
- High percentages of arable land in the buffer strip have significant negative effects on the fish community


Overarching influence of the upstream area
Land use practices
Instream habitat structure
positive/negative
positive/negative
Local restoration measures

Conclusions

- Hydromorphological site-specific restoration measures do not guarantee an improvement of the ecological quality class
- River habitat structure and the land use in corridors upstream of a site has a bigger influence on the ecological quality than the land use in the whole catchment
- The more natural the land use and habitat structure upstream – the higher the chance of a good ecological quality in restored reaches

Finally

- Restoration success is not a matter of time but a matter of **near-natural river morphology** and **near-natural land use** upstream of the sites

- Money should be spend wisely: more on **riparian buffer improvements** than on reach brilliance

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Acknowledgement and funding

UNIVERSITÄT DUISBURG ESSEN

- Planungsbüro Koenzen
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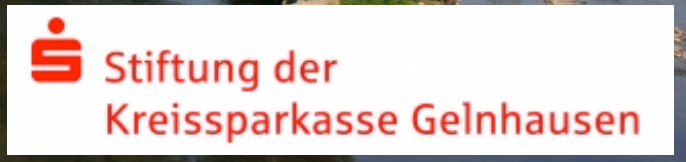
- Schwalmverband
- ABU Soest



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What are your experiences?

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