BiodivRestore Project „Restolink“

Mid-term meeting and practitioner workshop Jan 15th – Jan 17th 2024

Summary Mid-term meeting

The RESTOLINK midterm meeting, held from 15–17 January 2024 at the University of Barcelona, brought together project partners to review progress across all work packages, identify cross-cutting challenges, and align priorities for the second project phase. The first day was structured around work package presentations, providing an overview of the status of hydromorphological assessments (WP1), biodiversity analyses (WP2), ecosystem functioning measurements (WP3), restoration success and synthesis activities (WP4), data management and stakeholder engagement (WP5), and overall project coordination (WP6). Across WPs, partners reported substantial progress in data collection, while highlighting delays in some regions due to extended field campaigns and analytical bottlenecks, particularly for microbial, bacterial, and tracer-based datasets. A recurring theme was the need for stronger coordination of data analysis responsibilities, harmonized statistical approaches, and clearer timelines for shared outputs. Discussions emphasized the importance of integrating hydromorphology, biodiversity, and ecosystem functioning to assess restoration success consistently across countries and biomes. Partners agreed on the need to standardize site terminology, document restoration measures more systematically, and clarify expectations of restoration effects at different spatial scales. Considerable attention was given to data synthesis, including the suitability of stable isotope and tracer data for comparative analyses, the handling of methodological uncertainties, and the benefits of centralized analyses for metabolism and related processes. Data management, joint storage solutions, and clear publication strategies were identified as priorities to ensure coherence across work packages.

The second day focused on thematic synthesis and stakeholder engagement. Conceptual discussions advanced plans for integrative papers bridging multiple WPs and addressing multifunctionality and climate change in stream restoration. A dedicated roundtable with scientists, managers, and practitioners highlighted strong stakeholder interest in functional indicators of restoration success and identified practical barriers to their implementation (see below). The meeting concluded with a field excursion to a restored stream site, reinforcing links between conceptual discussions and real-world restoration practice. Overall, the midterm meeting strengthened coordination, clarified analytical and synthesis needs, and set a clear agenda for the project's remaining period.

Figure 1. Workshop impression

Figure 2. Visiting Spanish sampling sites

Appendix 1. Participants

Country	Name	Institution	Attendance	WP
BRA	Björn Gücker	Federal University of São João del-Rei	Presence	3
BRA	Davi Gasparini Fernandes Cunha	University of São Paulo	Online	5
ESP	Andrea Butturini	University of Barcelona	Presence	3
ESP	Carles Ferrer	Universitat Politècnica de Catalunya	Presence	1
ESP	Daniel von Schiller	University of Barcelona	Presence	3
ESP	Francesc Sabater	University of Barcelona	Presence	5
ESP	Francisco Núñez	Universitat Politècnica de Catalunya	Presence	1
ESP	Isabel Munoz	University of Barcelona	Presence	2
ESP	Lidia Cañas	University of Barcelona	Presence	2, 3
ESP	Margarita Menéndez	University of Barcelona	Presence	1
GER	Andreas Lorke	University of Koblenz-Landau	Presence	1
GER	Christine Anlanger	University of Koblenz-Landau	Presence	1
GER	Clara Mendoza-Lera	University of Koblenz-Landau	Presence	1
GER	Julia Pasqualini	Helmholtz Centre for Environmental Research – UFZ	Presence	2, 3
GER	Mario Brauns	Helmholtz Centre for Environmental Research – UFZ	Presence	2, 3, 6
GER	Markus Weitere	Helmholtz Centre for Environmental Research – UFZ	Presence	4
GER	Patrick Fink	Helmholtz Centre for Environmental Research – UFZ	Presence	2
SWE	Ryan Sponseller	Umeå University	Presence	4

Summary of the stakeholder roundtable "Ecosystem Functioning as a Tool to Assess Stream Restoration Success"

The stakeholder roundtable was held on 17 January 2024 at the University of Barcelona as part of the RESTOLINK midterm meeting, bringing together river scientists, managers, and practitioners from several European countries and Brazil. The primary objective was to discuss the relevance, feasibility, and challenges of integrating ecosystem-functioning indicators into the assessment of the success of stream and river restoration. The workshop provided a structured forum for exchanging perspectives across scientific, managerial, and practical domains and for identifying barriers and opportunities for functional assessment in restoration practice.

Following a brief introduction, the discussion was framed by a short presentation that clarified key concepts related to ecosystem structure, functioning, and services, and situated functional assessment within existing legislative frameworks, such as the EU Water Framework Directive and the EU Biodiversity Strategy. The presentation highlighted that, despite widespread restoration efforts, many freshwater ecosystems fail to reach good ecological status, and that functional indicators remain underused in European assessments compared to other regions. This set the stage for a critical discussion on why ecosystem functioning is still rarely implemented in restoration evaluation. Stakeholders identified limited technical and financial resources, regulatory constraints, and difficulties in defining clear restoration goals as major challenges when assessing restoration success. These constraints varied across countries. In Brazil, restoration is strongly shaped by basic water quality and sanitation challenges, with functional or hydromorphological restoration remaining rare. In Italy, insufficient integration between restoration planning and monitoring, combined with resistance to methodological innovation and funding limitations, was highlighted. German stakeholders emphasized difficulties related to data availability, long-term monitoring consistency, and the lack of suitable reference conditions due to historical river alteration. Across countries, the absence of baseline data and challenges in aligning ecological objectives with regulatory frameworks were recurring themes.

When asked whether functional assessment is needed, a clear majority of participants agreed that ecosystem functioning should play a role in restoration assessment. However, the discussion revealed substantial uncertainty regarding the interpretation, robustness, and communication of functional indicators. Stakeholders raised concerns about defining reference conditions, understanding whether changes in specific functional metrics represent improvement or degradation, and communicating complex indicators to decision-makers and the public. Perspectives differed between regions, with basic monitoring gaps and those where advanced indicators are politically demanded but difficult to operationalize. Further discussion addressed barriers to implementing functional assessments, including bureaucratic constraints, weak coordination between institutions responsible for restoration and monitoring, and the challenge of balancing biological, hydromorphological, and functional perspectives. Stakeholders stressed that functional indicators are most useful when embedded within clearly defined restoration objectives and supported by appropriate monitoring schemes. Success was consistently defined as goal-dependent, ranging from improvements in water quality and hydromorphological self-sustainability to the recovery of ecosystem processes and services.

The roundtable concluded with a shared recognition that ecosystem functioning has strong potential to complement existing assessment approaches, but that its implementation requires clearer objectives, harmonized methodologies, long-term monitoring strategies, and improved communication between scientists, practitioners, and policymakers. The discussion provided valuable guidance for RESTOLINK's ongoing synthesis activities and highlighted the importance of co-developing functional assessment tools that are scientifically robust, policy-relevant, and practically feasible.

Key messages

Restoration success must be evaluated against clearly defined, process-based objectives: Stakeholders across countries emphasized that restoration cannot be meaningfully assessed without explicit goals defined at the outset. Functional indicators are most valuable when they are directly linked to restoration objectives (e.g., self-sustaining sediment dynamics, nutrient retention, or ecosystem resilience), rather than applied as generic add-ons to biodiversity or structural assessments.

Ecosystem functioning indicators are widely supported but remain underused due to institutional and regulatory barriers: Despite strong stakeholder agreement that functional assessment is needed, implementation is impeded by fragmented governance, rigid regulatory frameworks, and uncertainty about reference conditions and indicator interpretation. Integrating ecosystem functioning into existing legislative instruments (e.g., the Water Framework Directive implementation) is essential to enable practical uptake.

Monitoring and restoration planning must be co-designed and aligned from the start: A recurring message was that monitoring is often initiated too late or disconnected from restoration design, limiting the ability to assess outcomes. Policy frameworks should require that monitoring schemes, potentially including functional indicators, are defined during project planning and adequately resourced for long-term evaluation.

Functional assessment tools must balance scientific robustness with communicability and feasibility: Stakeholders stressed that functional indicators will only influence management and policy if they are interpretable, scalable, and communicable to non-experts. Co-development of indicators with practitioners and policymakers, alongside clear guidance on interpretation and uncertainty, is critical to ensure their acceptance and effective use across regions and restoration contexts.

Appendix 2. Practitioners who participated in the workshop.

Country	**Name**	**Institution**
BRA	Lilian Hengleng	Das Naturland (private company - NBS)
BRA	Marta Lamparelli	São Paulo State Environmental Company
BRA/USA	Maíra Ometto Bezerra	Conservation International
ESP	Albert Sorolla	Naturalea
ESP	Andreu Salvat	Apren
ESP	Enric Sagristà	Imbrica
ESP	Roger Pallàs	Imbrica
ESP	Toni Mas	Consorci Besòs Tordera
GER	Annika Fiskal	Federal Institute of Hydrology (BfG)
GER	Helmut Fischer	Federal Institute of Hydrology (BfG)
GER	Matthias Brunke	State Agency for the Environment Rhineland Palatinate
ITA	Bruno Boz	CIRF-Italian Center for River Restoration
ITA	Rossano Bolpagni	University of Parma
SWE	Daniel Holmqvist	Lycksele kommun
SWE	Henrik Persson	Rewilding Sweden
SWE	Jonathan Nordin	Länsstyrelsen Västerbotten (state agency)

Supplemental Appendix. Slides of the presentations

Quantifying restoration success across biomes by linking biodiversity, multifunctionality and hydromorphological heterogeneity (RESTOLINK)

Work package 1

Present status, Available results
Future work, Problems

Restolink mid-term meeting
15.01.2024

BIODIVRESTORE 2020-2021 CALL

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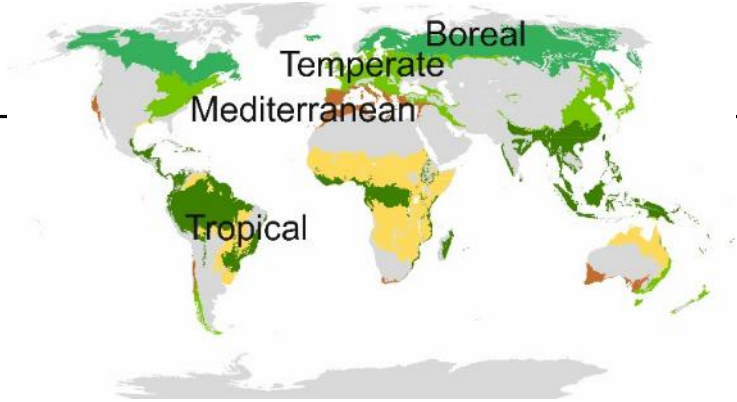
https://restolink.weebly.com/

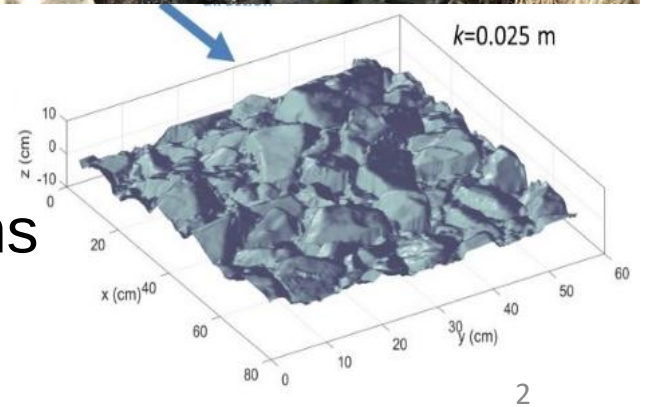
Present status



Flow and turbulence

→ ADV measurements
→ Conservative tracer additions

Small and large scale stream topography



→ Roughness laser scans
→ Topographic survey
→ Pebble counts

Present status

<u>Data collection</u>:

- Germany: all 3 triplets finished (except pebble counts and topographic survey for 2 triplets – planned for spring 2024)
- Spain: 2 out of 3 triplets finished, 3rd triplet planned for spring
- Brazil: 2 out of 3 triplets finished, 3rd triplet planned for (European) spring
- Sweden: Ryan/Lina/Nicolas

→ ca. 770 flow measurements, ca. 195 roughness scans

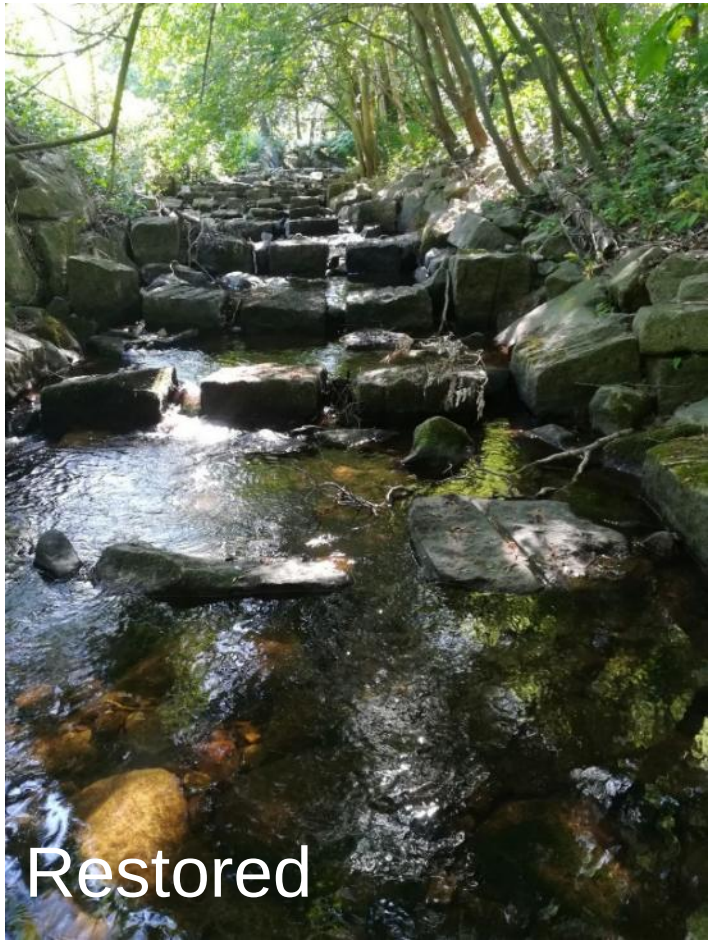
<u>Data processing</u> (of collected data):

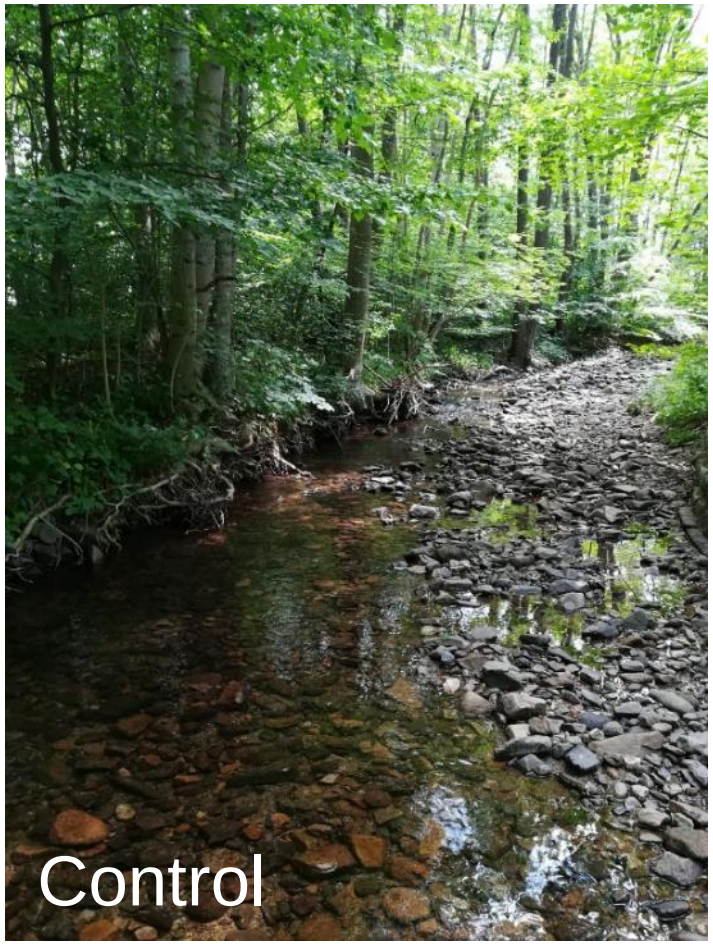
- Flow measurements: 80% finished
- Roughness scans: 20% finished
- Bulk parameters (depths, widths, slopes, pebble counts) : Triplet 1 Germany finished, collection + processing of data from partner countries ongoing

<u>Data analysis and interpretation</u>(of processed data): just beginning

Present status – some impressions of the sampling sites

Germany: Triplet 1 – Ecker 08./09.2022

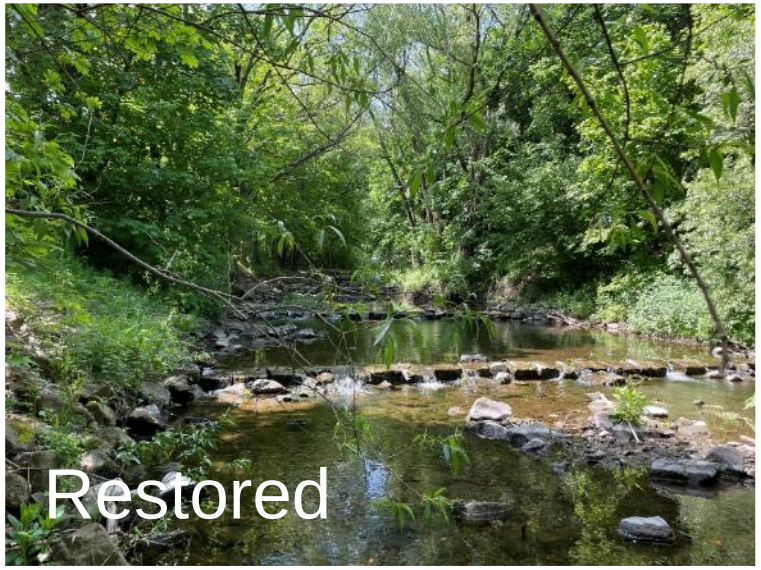




Present status – some impressions of the sampling sites

Germany: Triplet 2 – Ilse 08.2023

Germany: Triplet 3 – Holtemme 09.2023



Present status – some impressions of the sampling sites

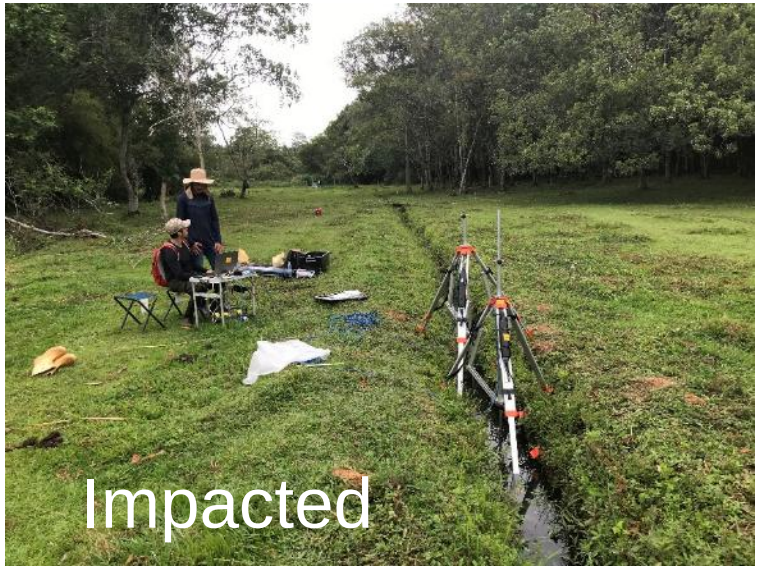
Spain: Triplet 1 – Riera Major 10.2022

Spain: Triplet 2 – Rio Ritort 10.2023

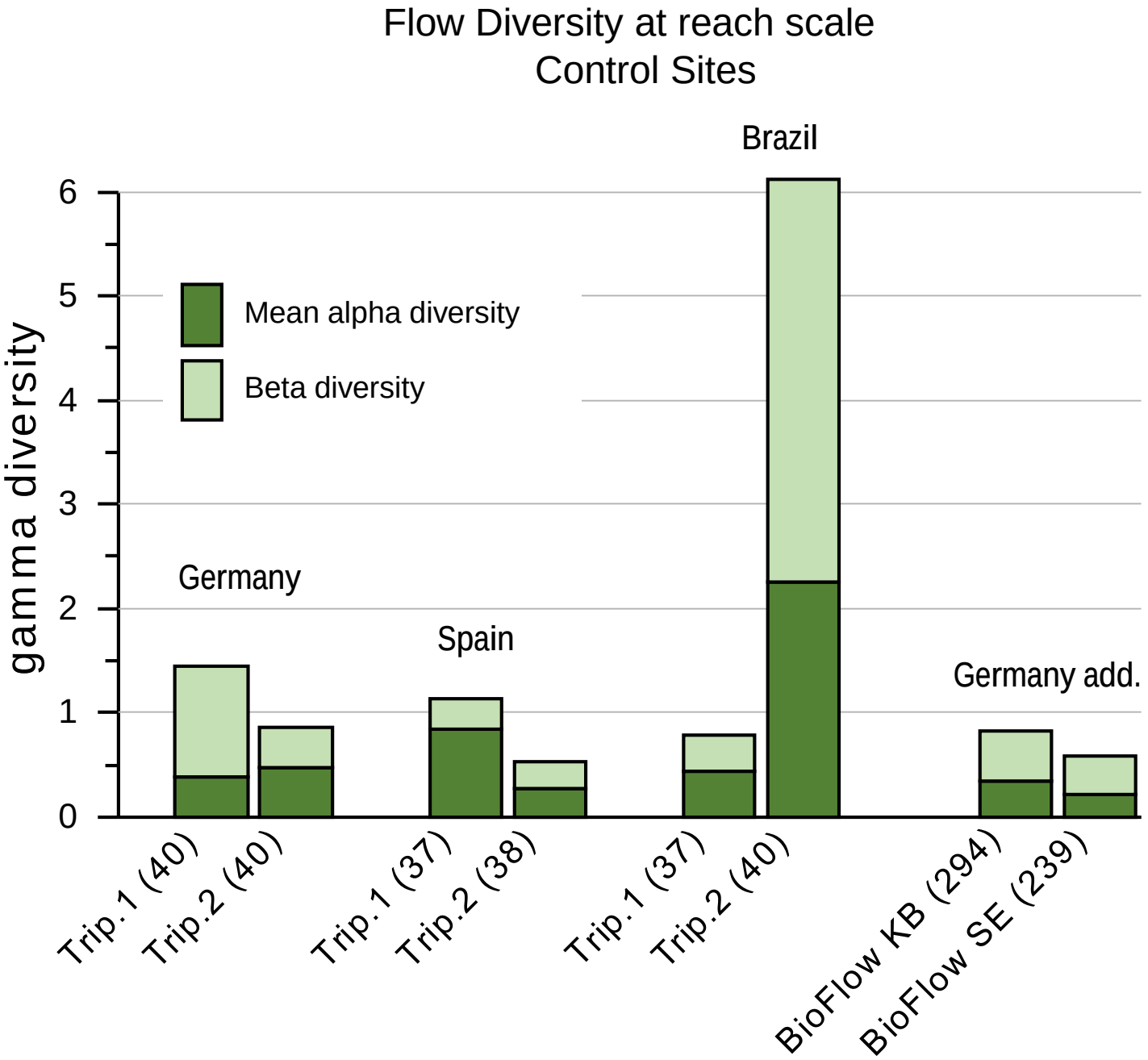
Present status – some impressions of the sampling sites

Brazil: Triplet 1 – Tijuco Preto, Mineirinho, Espraiado 11.2022

Brazil: Triplet 2 – 3 sites, 3 streams 10.2023

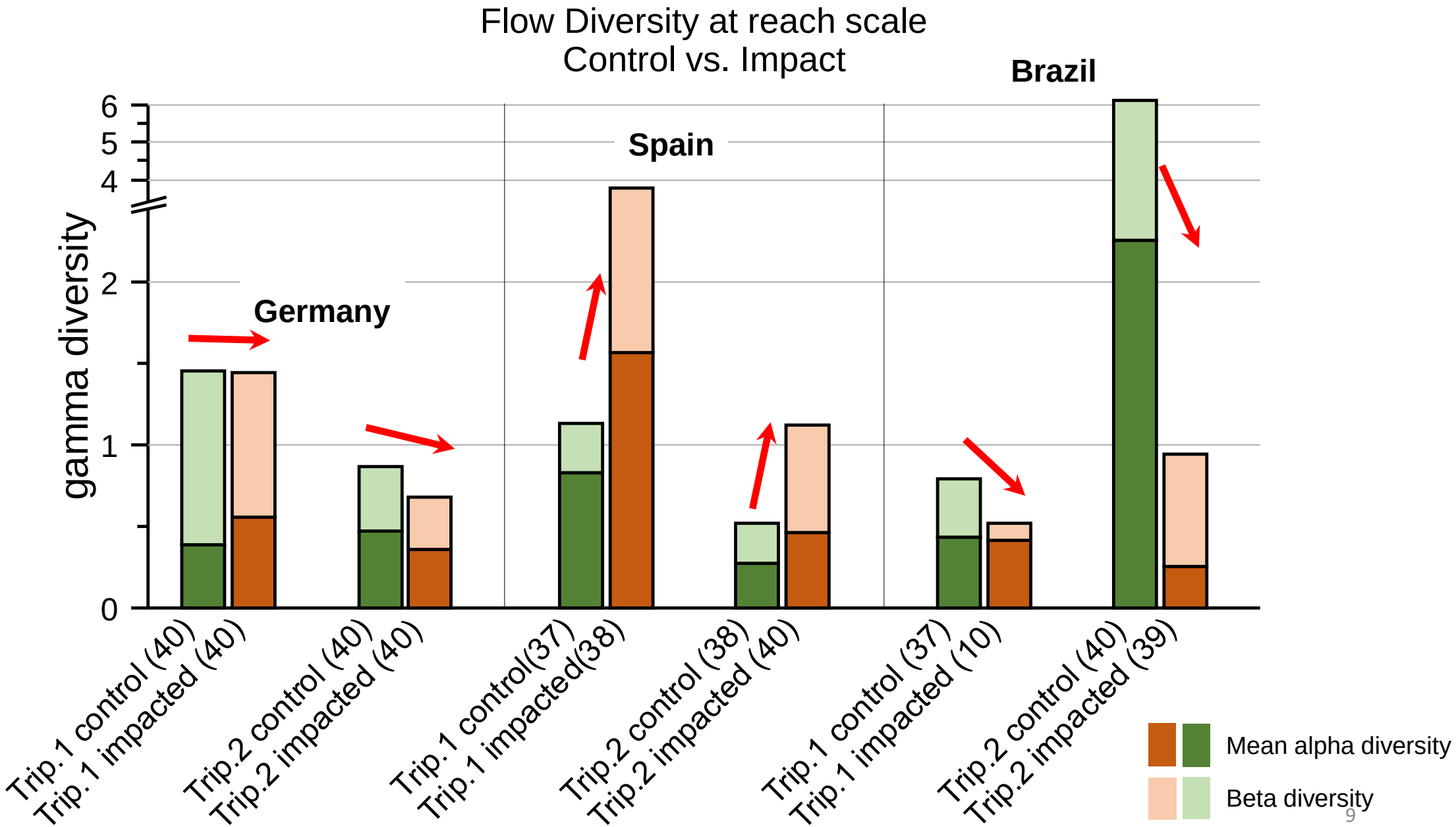


Available results

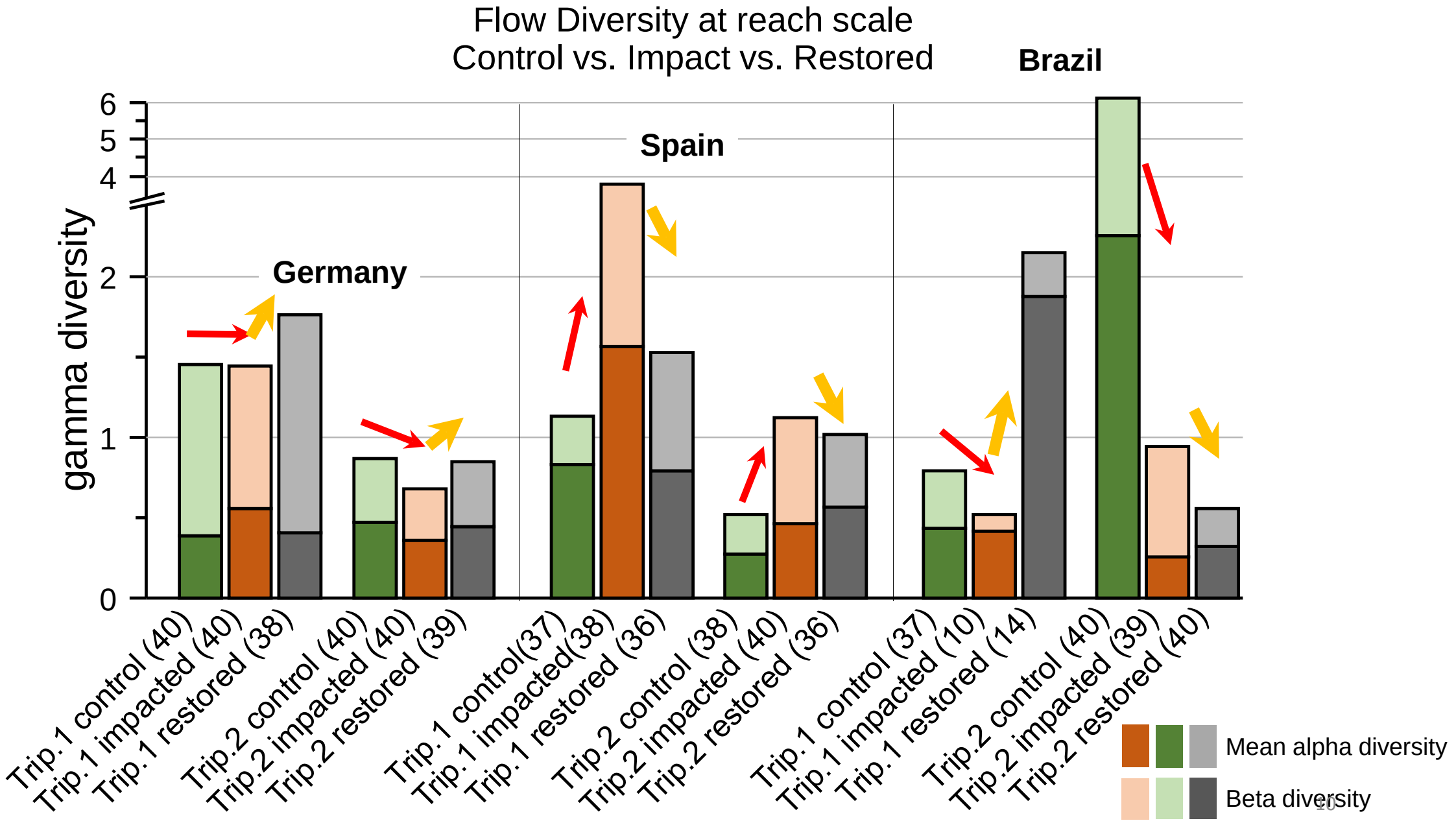


Diver-sity	Flow velocity	Physical description
α	**Temporal flow variability**	**Temporal variance of flow** velocity (~ turbulent kinetic energy)
β	**Spatial flow variability**	**Spatial variance of time-averaged flow velocities**
γ	**Overall flow diversity**	Total **temporal and spatial variance** of flow velocity

Available results



Available results



Future work

Data collection:

- Germany: pebble counts (together with Julia) and topo. survey for 2 triplets – spring 24
- Spain: 3rd triplet (together with UPC) - spring 24
- Brazil: 3rd triplet - (European) spring 24, financing?

Data processing:

- finish up everything – existing data by spring, new data a bit later
- collect pits and pieces data (also form partners if possible)

Data analysis and interpretation

- first: publication strategy
- elaborate synthesis approaches (e.g. tomorrow)
- … let's see, I now have limited time

Paper writing

- tbd

Problems

- Not much really (yet)…
- How to deal with different restoration measures?
- How do we deal with spatial scales (e.g. meso scales at dams)
- Can we include Sweden into WP1?

Quantifying restoration success across biomes by linking biodiversity, multifunctionality and hydromorphological heterogeneity (RESTOLINK)

Sub-project "Gases"

Present status, Available results

Future work, Problems

Restolink mid-term meeting

15.01.2024

BIODIVRESTORE 2020-2021 CALL

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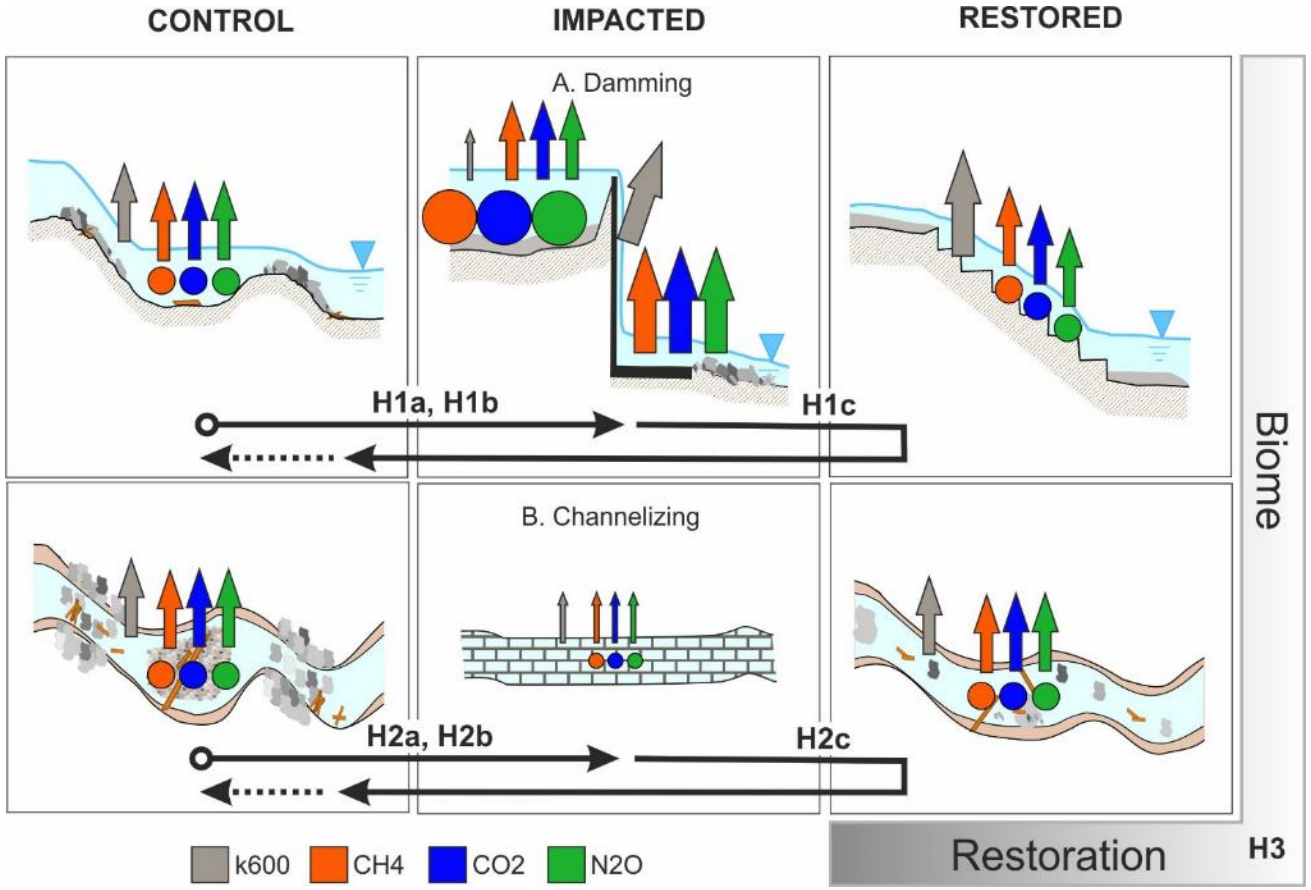
Present status

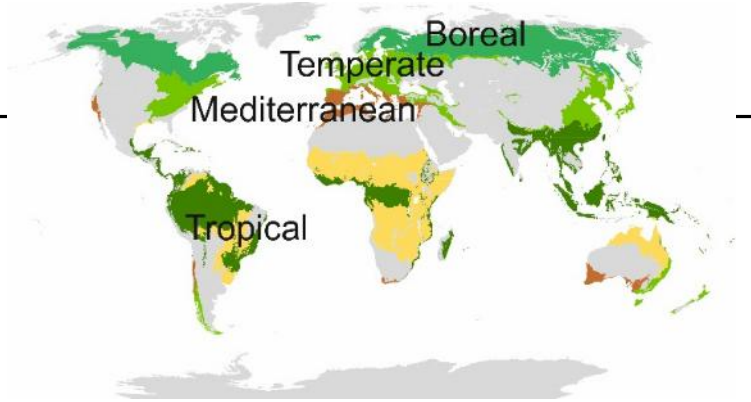
Extension of group by

- Matthias Koschorreck
- Peifang Leng
- Lediane Macron

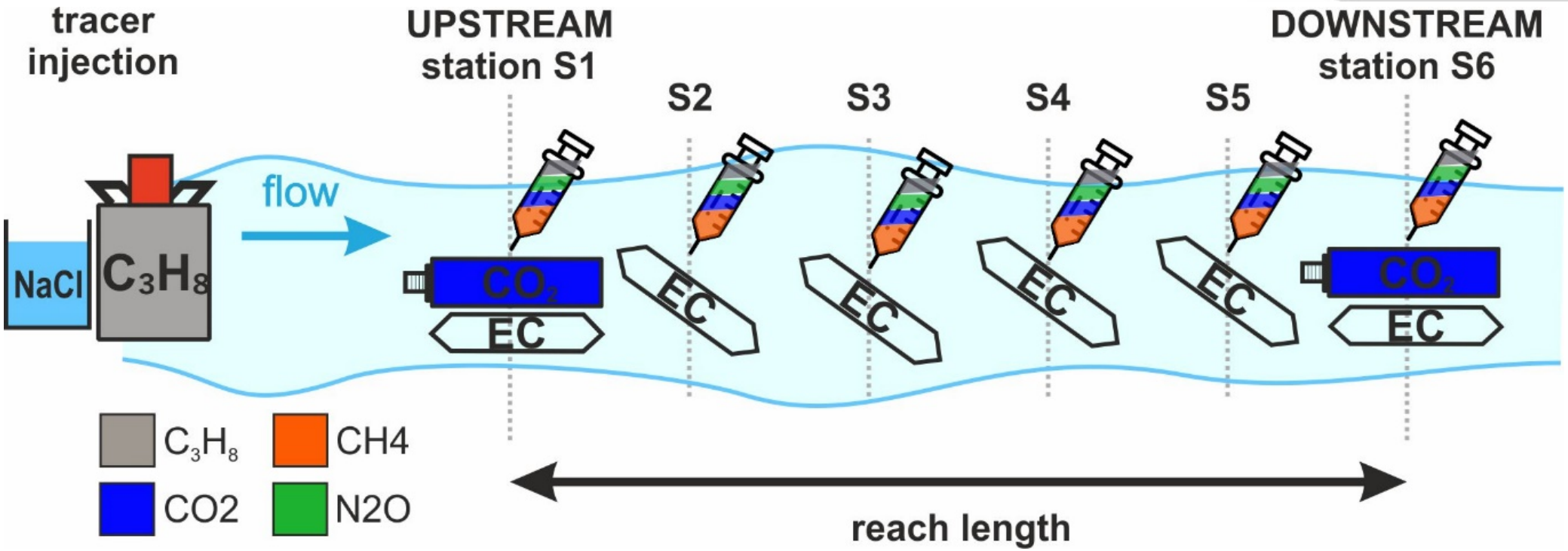


DFG re-submission in December 23

Present status



Reach-scale gas transfer velocities (k600),
Dissolved concentrations and fluxes of CH_4, CO_2, and N_2O



→ Propane gas and NaCl addition
→ Gas samplings (headspace)

Present status

Biome, climate zone, country	Restoration measure	Coordinates Control / impacted / restored	RESTOLINK sampling
Broadleaf forest, Temperate, Germany	Dam Removal (Fig. 2a-c)	51°54'36.79"N, 10°38'43.23"E 51°54'50.03"N, 10°38'23.12"E 51°55'19.00"N, 10°37'54.20"E	08/2022 ✓
	Dam removal	51°50'51.06"N, 10°39'34.33"E 51°51'36.48"N, 10°40'39.08"E 51°51'27.96"N, 10°40'31.88"E	08/2023 ✓
	Dam removal	51°51'09.9"N, 10°48'09.9"E 51°51'20.7"N, 10°48'21.2"E 51°51'37.3"N, 10°48'38.8"E	09/2023 ✓
Mediterranean, Spain	Dam removal	41°53'53.03"N, 2°22'31.76"E 41°54'09.94"N, 2°22'46.64"E 41°54'45.96"N, 2°23'14.85"E	10/2022 ✓
	Dam removal	42°20'46.72"N, 2°24'34.82"E 42°20'09.56"N, 2°24'01.25"E 42°22'03.53"N, 2°24'12.60"E	10/2023 ✓
	Dam removal	To be decided To be decided To be decided	(04/2024)
Cerrado / Atlantic Rainforest, Tropics, Brazil	Diversity increase	21°58'46.23"S, 47°52'23.64"W 22°00'13.20"S, 47°55'54.69"W 22°00'37.42"S, 47°52'31.72"W	11/2022 ?
	Diversity increase	20°59'22.84"S, 44°10'45.87"W 21°06'30.47"S, 44°10'47.41"W 21°06'23.16"S, 44°09'48.61"W	10/2023 ✓
	To be decided	To be decided To be decided To be decided	(04/2024)
Subartic, Boreal, Sweden ?	Diversity Increase (Fig. 2d-f)	63°49'00.48"N, 20°19'58.80"E 63°50'27.78"N, 20°16'07.68"E 63°41'29.90"N, 20°23'11.40"E	09-10/2023
	Diversity increase	63°52'10.31"N, 20°11'18.02"E 63°49'21.22"N, 20°18'36.00"E 63°49'15.10"N, 20°18'23.47"E	09-10/2023
	Diversity increase	63°53'17.27"N, 20°10'18.55"E 63°49'16.72"N, 20°17'29.76"E 63°49'55.67"N, 20°16'32.38"E	09-10/2023

Germany+Spain+Brazil 2023: GC analysis finished last week by Lediane!

Available results

Germany: Triplet 1 – Ecker 08./09.2022

Site	k_{600} m d^{-1}	Dissolved concentration			Reach-scale fluxes		
		CH_4 µmol l^{-1}	CO_2 µmol l^{-1}	N_2O µmol l^{-1}	CH_4 mg m^{-2} d^{-1}	CO_2 mg m^{-2} d^{-1}	N_2O mg m^{-2} d^{-1}
Control	15.0	0.066	26.8	0.022	12.8	4603	6.7
Impacted	5.4 (impoundment: 5.0, spillway: 10. 6, downstream: 3.4)	0.107	47.8	0.025	7.5	5757	2.9
Restored	6.6	0.009	23.2	0.022	0.5	925	2.8

Future work

Data collection and processing (to be discussed):

- Spain: 3rd triplet - spring 24
- Brazil: 3rd triplet - (European) spring 24, financing?
- Other samplings depending on DFG decision?!

Data analysis and interpretation

- Depending on DFG decision?!

Paper writing

- tbd

Problems

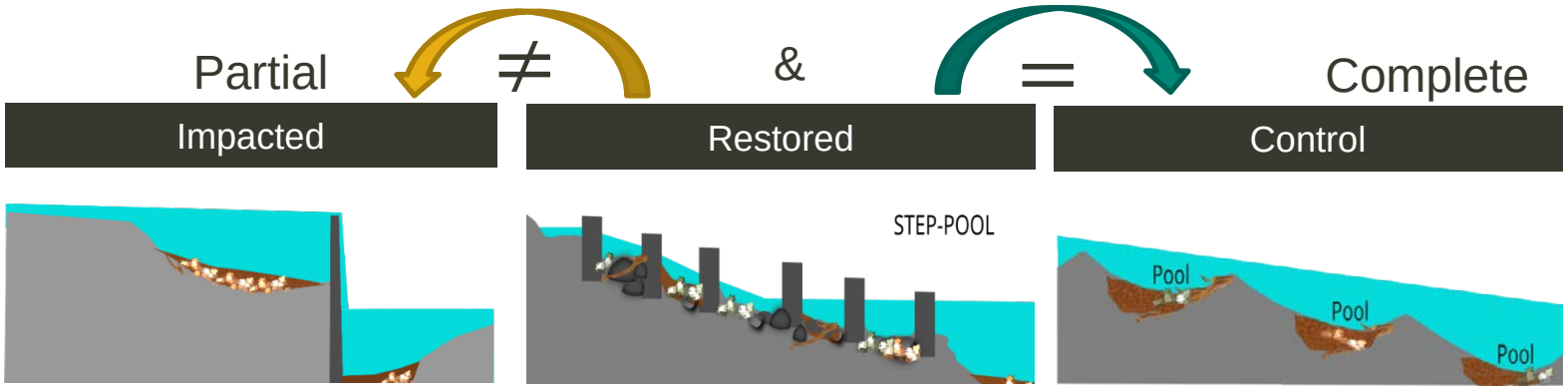
- Not yet…


Thanks
for
listening!

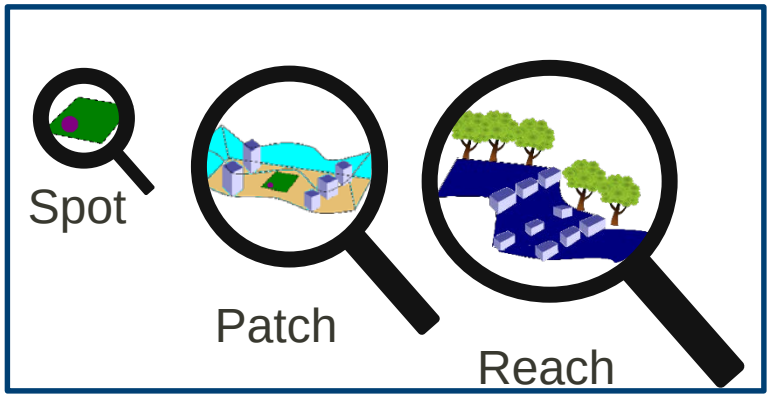
Preliminary results sampling campaign 2022 Germany WP2 & WP3

15 January 2024
RESTOLINK Mid-term meeting
Barcellona

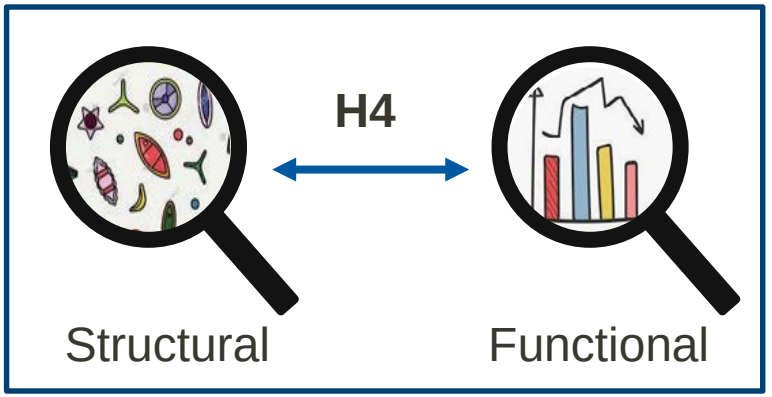
Restoration success



Scaling

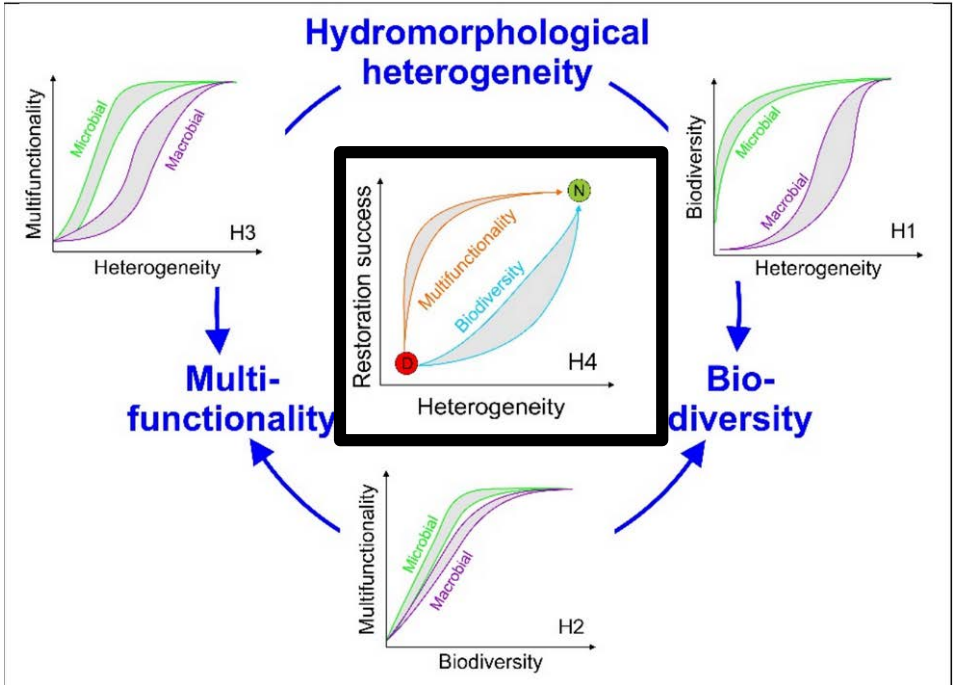


Components

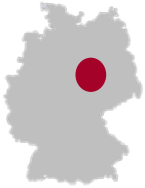


H4

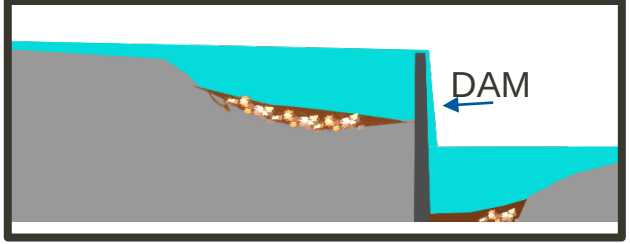
- Success in restoring hydromorphological heterogeneity is achieved earlier for ecosystem multifunctionality than for biodiversity (Fig. 1, H4).

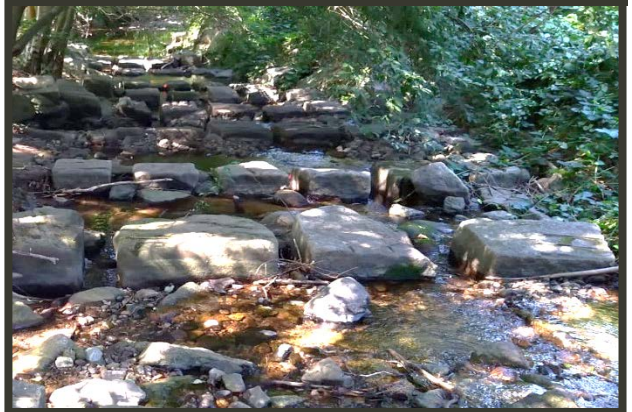


Ecker stream

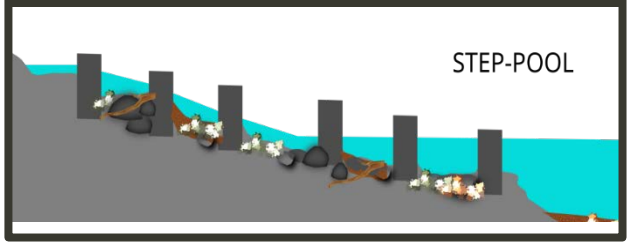


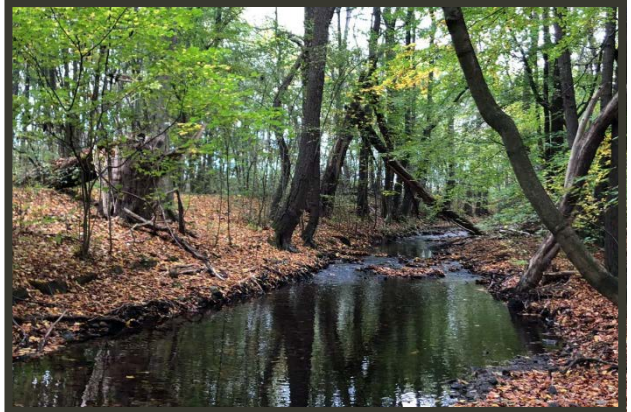
Impacted



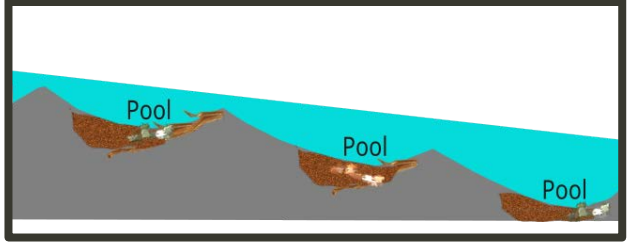


Restored

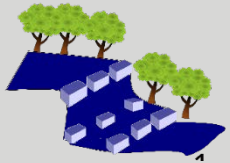
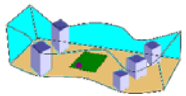




Control



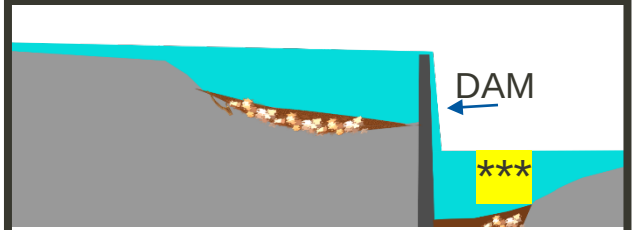
Measured parameters and scales for WP2-WP3

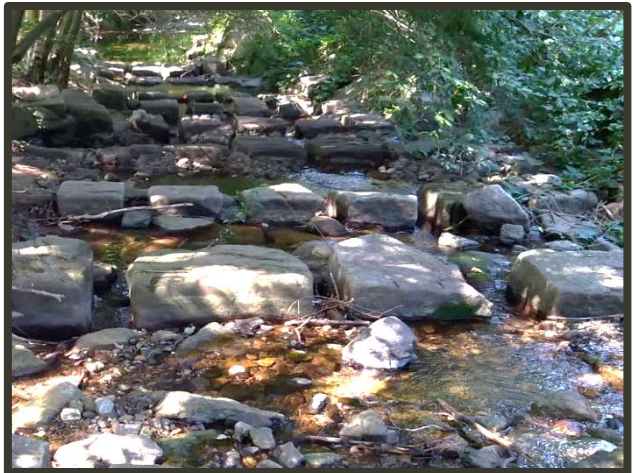
Scale	Structural	Functional
Reach 		Nutrient uptake (Whole stream 15N-NO3 and 13C-DOC uptake, uptake lenght,uptake velocity)
Patch 	Macro. biomass Macro. density Macro. richness	Food Web (Macro.isotope ellipse size) Cotton strip
Spot 	Bact. abundance AFDM Chlrophyll-a	Microbial DOC and NO3 uptake

IMP ? RES

≠

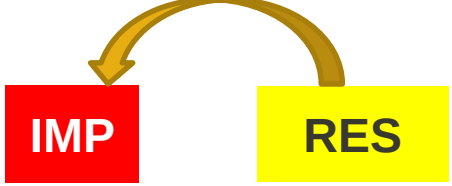
Impacted



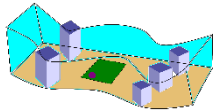


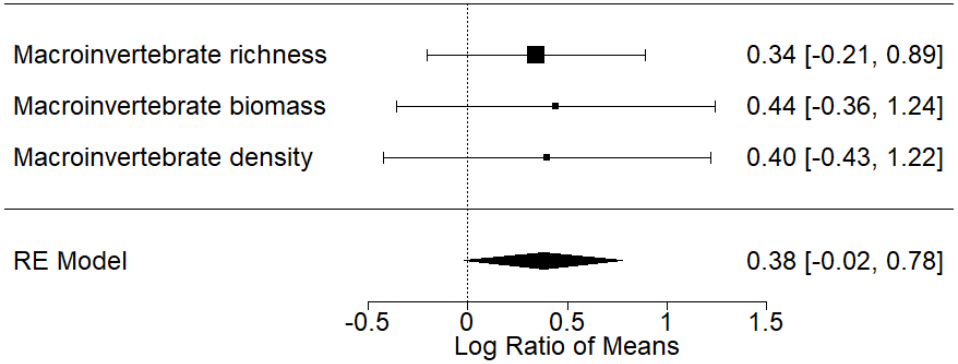
Restored

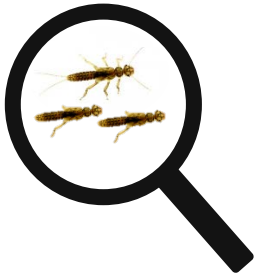
*** samples not included in the results

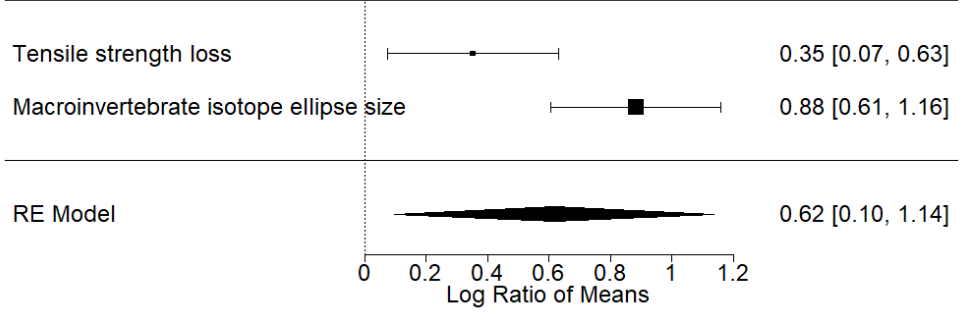

IMP
RES

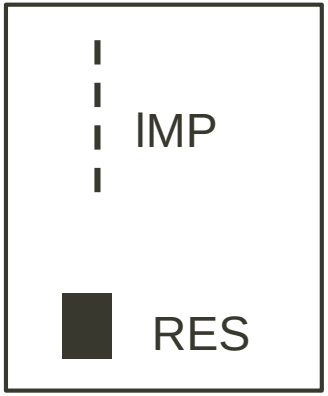
Patch-scale

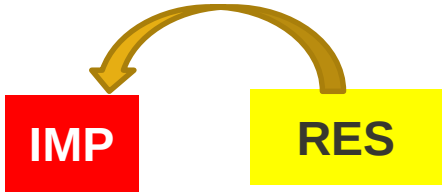



Macroinvertebrate richness
0.34 [-0.21, 0.89]
Macroinvertebrate biomass
0.44 [-0.36, 1.24]
Macroinvertebrate density
0.40 [-0.43, 1.22]
RE Model
0.38 [-0.02, 0.78]
-0.5
0
0.5
1
1.5
Log Ratio of Means

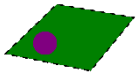


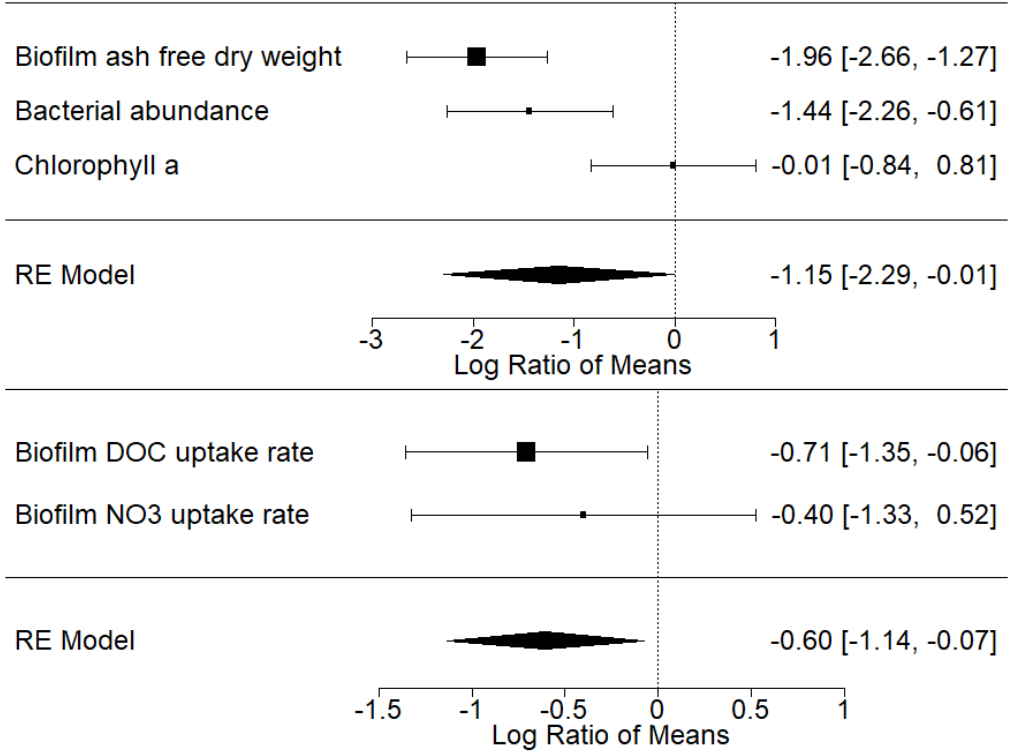

Tensile strength loss
0.35 [0.07, 0.63]
Macroinvertebrate isotope ellipse size
0.88 [0.61, 1.16]
RE Model
0.62 [0.10, 1.14]
0
0.2
0.4
0.6
0.8
1
1.2
Log Ratio of Means

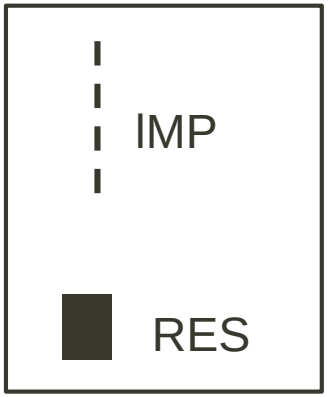

IMP
RES


IMP
RES

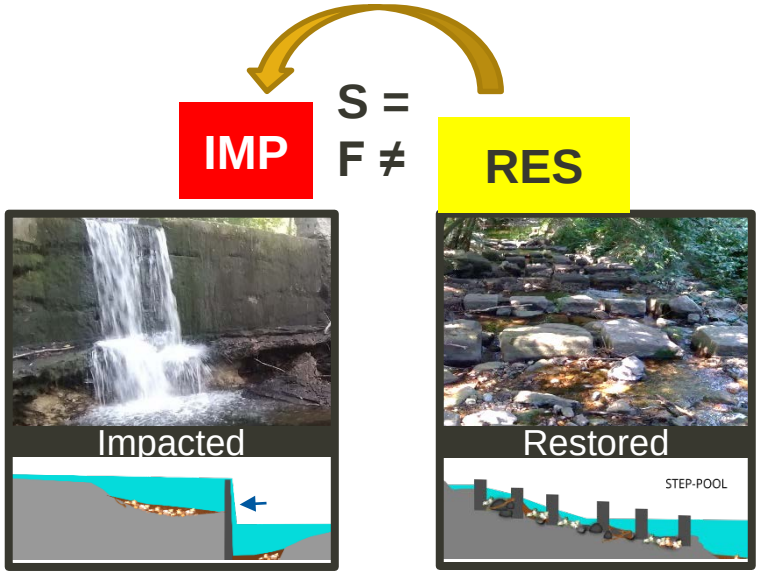
Spot-scale

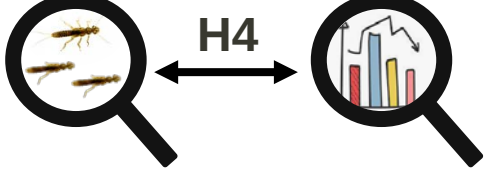



Biofilm ash free dry weight
-1.96 [-2.66, -1.27]
Bacterial abundance
-1.44 [-2.26, -0.61]
Chlorophyll a
-0.01 [-0.84, 0.81]
RE Model
-1.15 [-2.29, -0.01]
-3
-2
-1
0
1
Log Ratio of Means
Biofilm DOC uptake rate
-0.71 [-1.35, -0.06]
Biofilm NO3 uptake rate
-0.40 [-1.33, 0.52]
RE Model
-0.60 [-1.14, -0.07]
-1.5
-1
-0.5
0
0.5
1
Log Ratio of Means


IMP
RES

Summary: Impacted-Restored





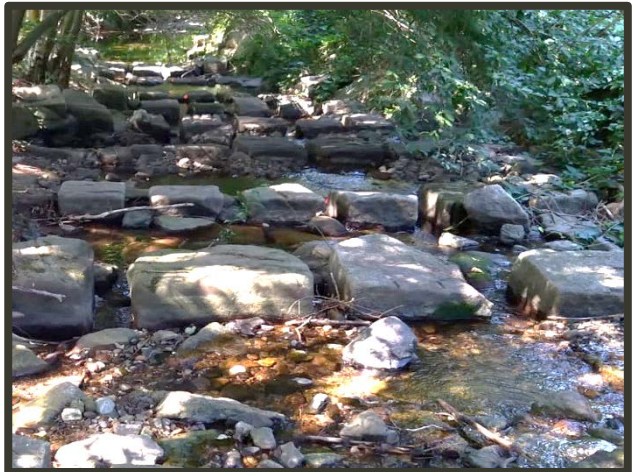
Scale	Structural	Functional
Patch	0.38 [-0.02;0.78] ✓	**0.62 [0.1;1.14]**
Spot	**-1.15 [-2.29;-0.1]**	**-0.6 [-1.14;-0.07]**

Bold = success

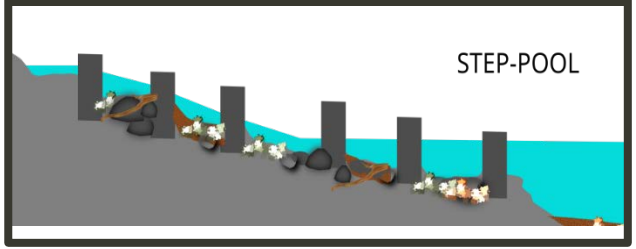
All the component show a restoration success except the macroinvertebrate stuctural components.

H4:Success in restoring hydromorphological heterogeneity is achieved earlier for ecosystem functionality than for biodiversity. ✓

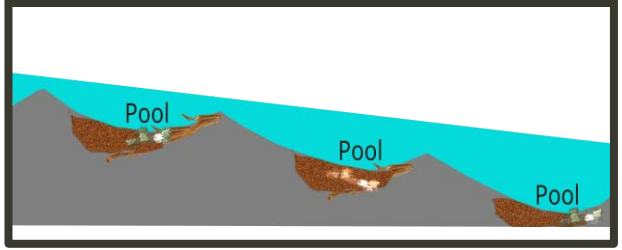
RES ? CON



Restored

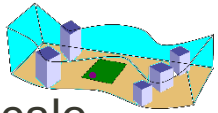


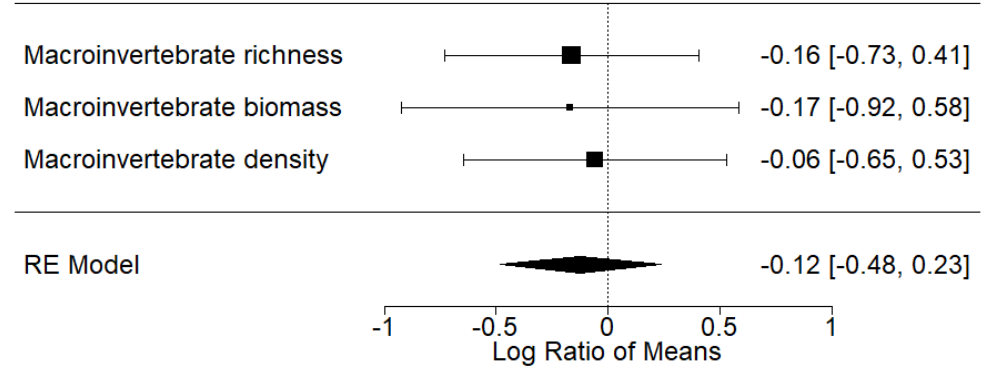
Control

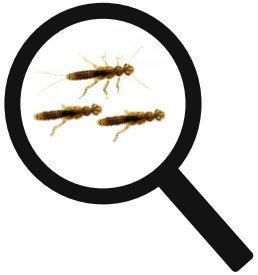


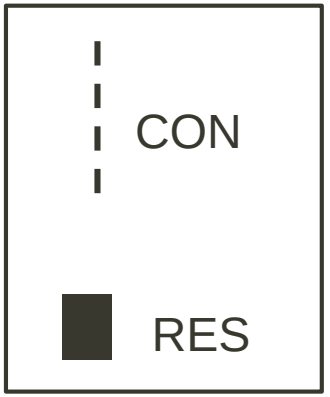
RES = CON

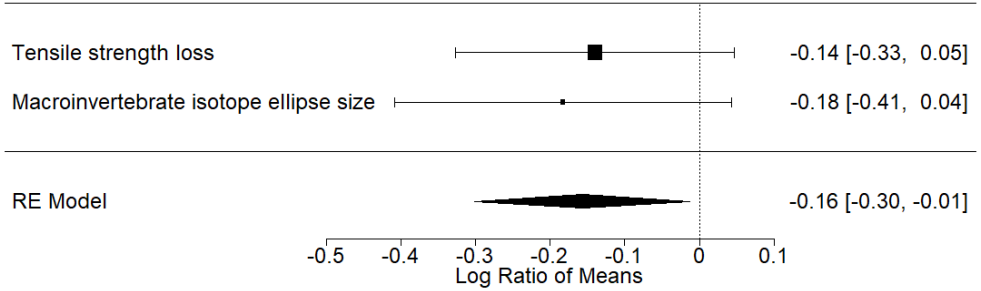
Patch-scale





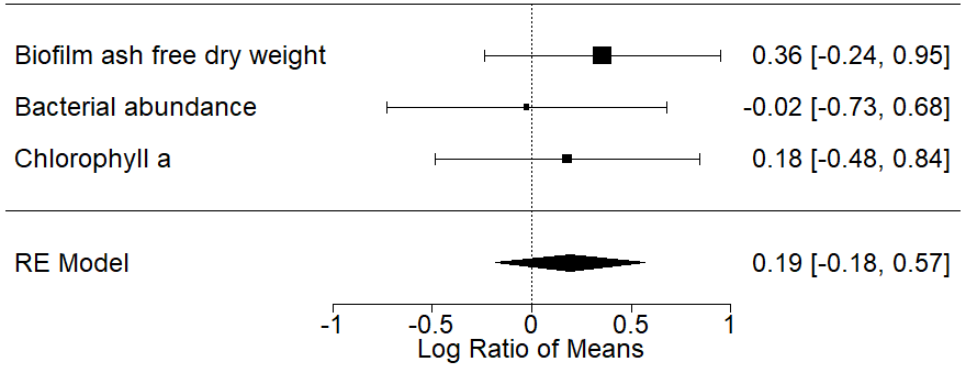


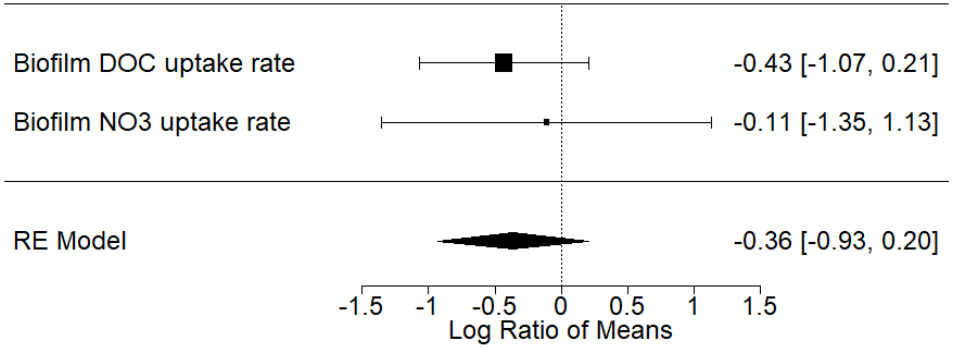


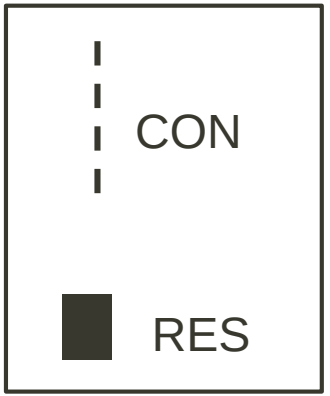



RES
=
CON

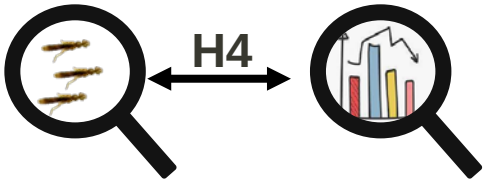
Spot-scale

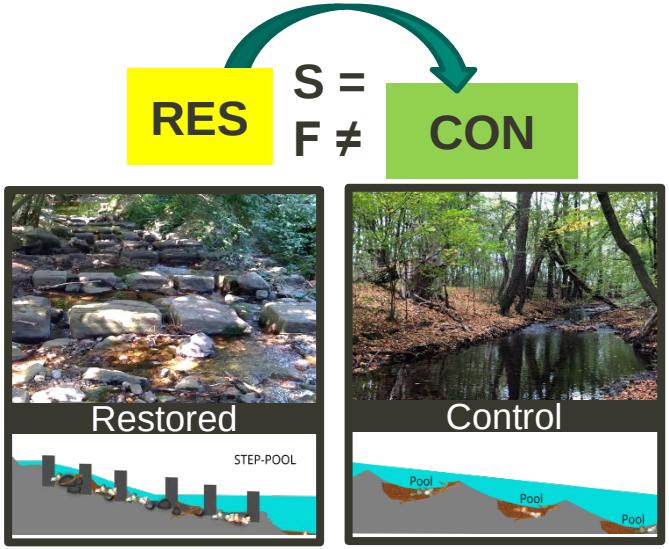

Biofilm ash free dry weight
0.36 [-0.24, 0.95]
Bacterial abundance
-0.02 [-0.73, 0.68]
Chlorophyll a
0.18 [-0.48, 0.84]
RE Model
0.19 [-0.18, 0.57]
-1
-0.5
0
0.5
1
Log Ratio of Means


Biofilm DOC uptake rate
-0.43 [-1.07, 0.21]
Biofilm NO3 uptake rate
-0.11 [-1.35, 1.13]
RE Model
-0.36 [-0.93, 0.20]
-1.5
-1
-0.5
0
0.5
1
1.5
Log Ratio of Means


CON
RES

Summary: Restored-Control





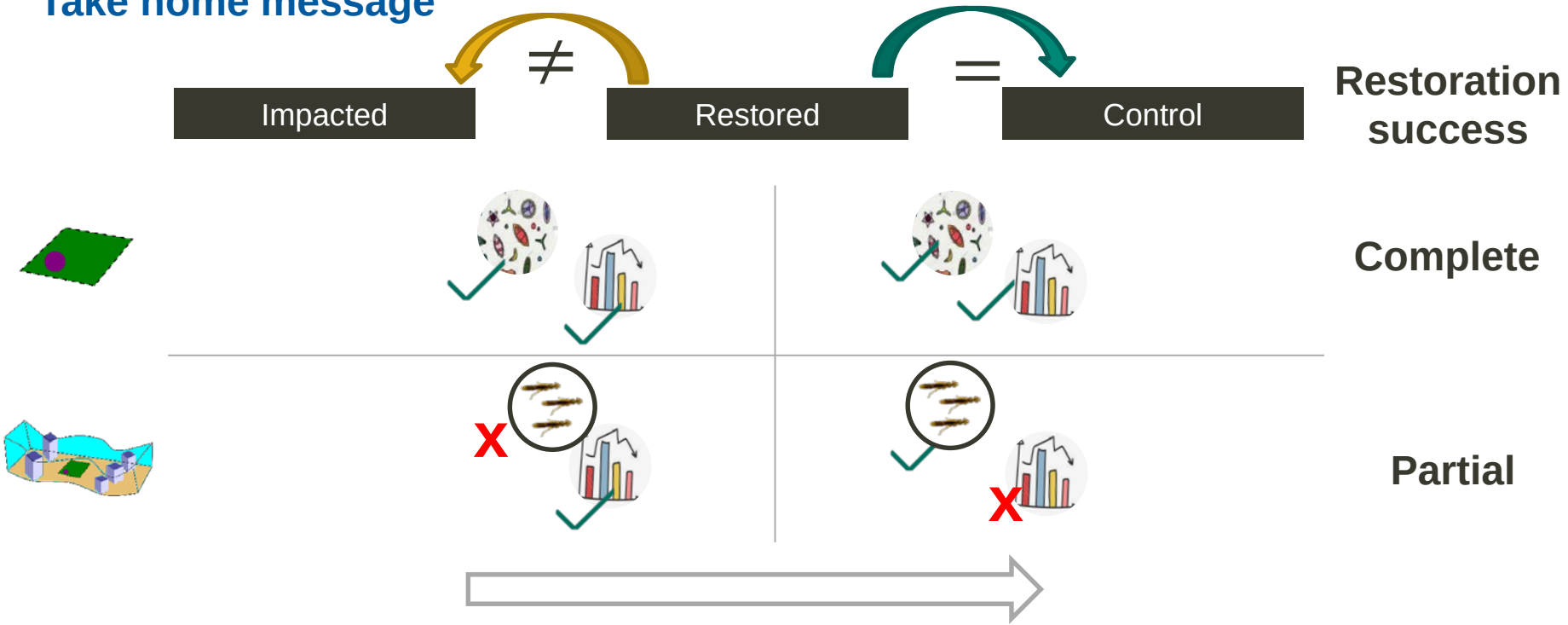
Scale	Structural	Functional
Patch	**-0.12 [-0.48;0.23]** X	-0.16 [-0.3;-0.01]
Spot	**0.19 [-0.18;0.57]**	**-0.36 [-0.93;0.2]**

Bold = success

The functional components do not show a complete recovery.

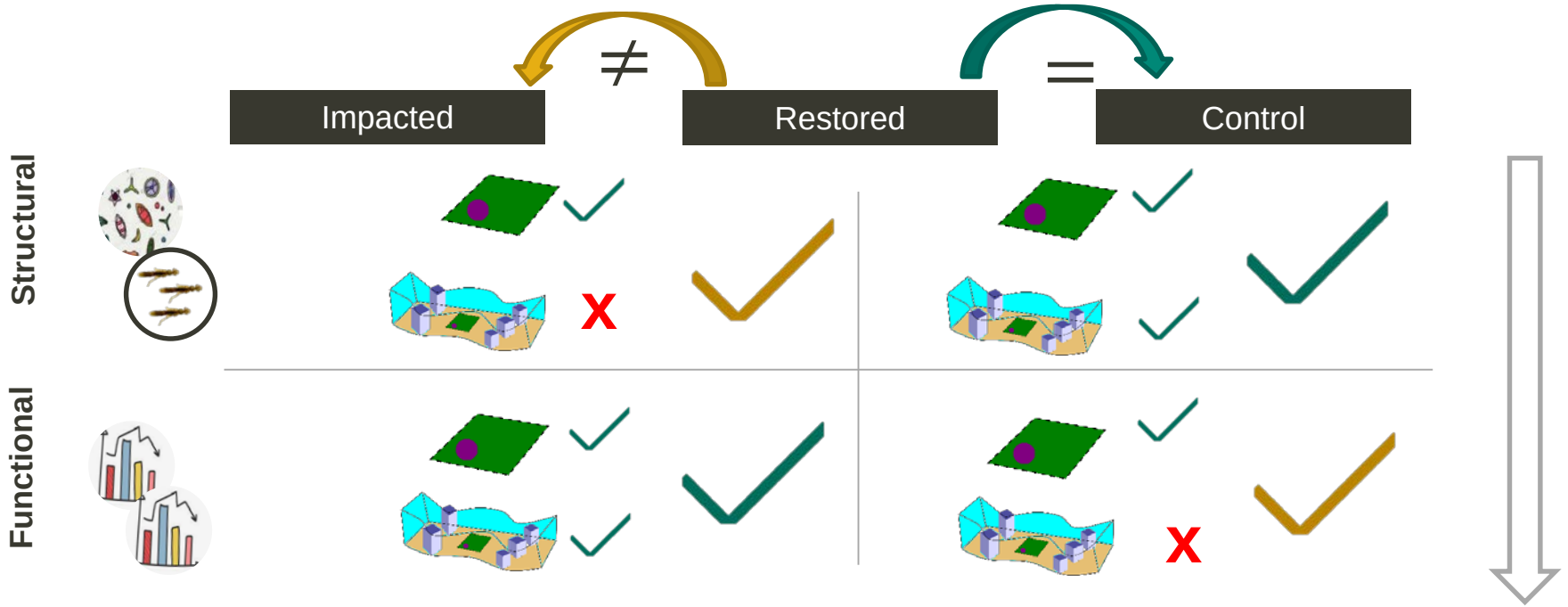
H4: Success in restoring hydromorphological heterogeneity is achieved **earlier** for ecosystem multifunctionality than for biodiversity. X

Take home message



Scale matters: Distinct patter of restoration success at the spot and patch scale → Distinct recovery of microbial and macrobial components. Recovery is complete and faster for the microbial community than for the macrobial one

Take home message



Structural components and functional components show different trajectories. Structural component do not show recovery in the 1° phase (imp vs restored) but in the 2° one. Conversely, functional component show success in the 1° phase (imp vs restored) but not full recovery (res vs control).

Many thanks to Elsa, Juliane, Alexander, Clara, Sven, Ines, Ute, Stephan, Nuria, Anne, Leon, Felix, Alexandra, Dalila, Lediane, Rizwan, Alina, Andrea, Adrian and the GEWANA ladies for field assistance and laboratory analysis. Daniel V.S. for providing the cotton strip data.

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für Bildung
und Forschung

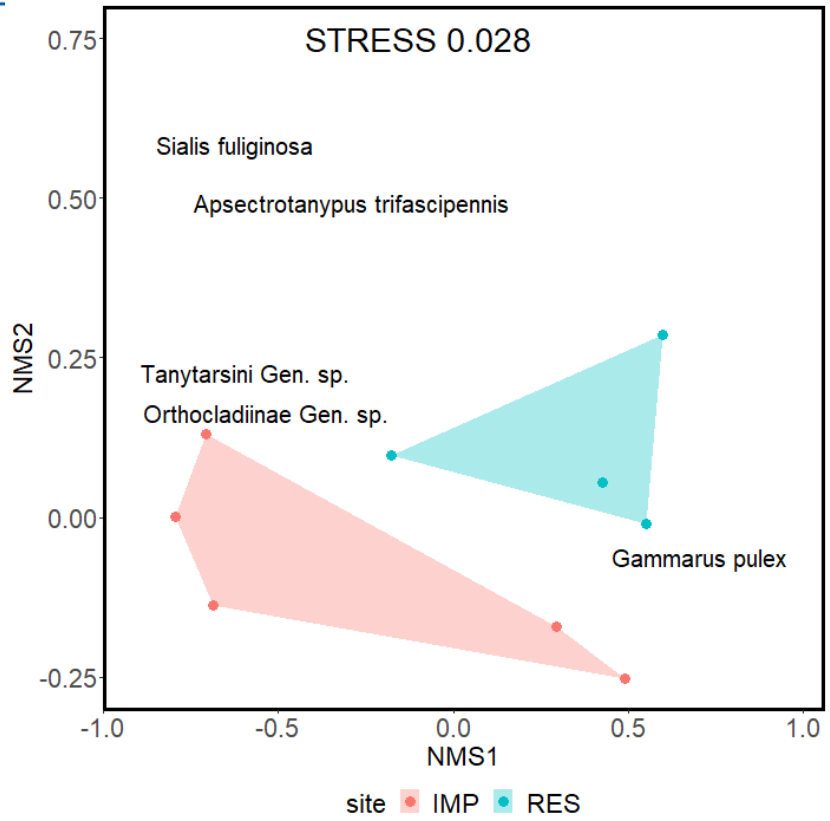
Water JPI

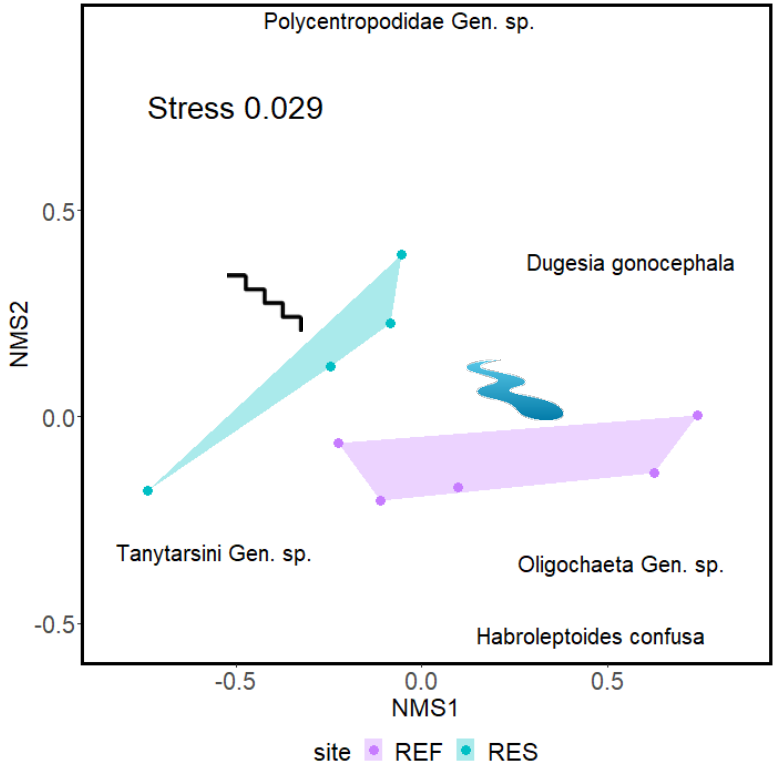
Status of work, available results, problems encountered and future work

- Missing
- Metabolism calculation WP3
- WP3 microbial diversity
- Proposals
- Workshop whole stream uptake?
- Problems:
- Bacterial abundance → needed support from partners (students etc)

- Future work
- Metabolism calculation WP3
- WP3 microbial diversity
- Data analysis
- Writing

NMDS: Macroinvertebrate community composition

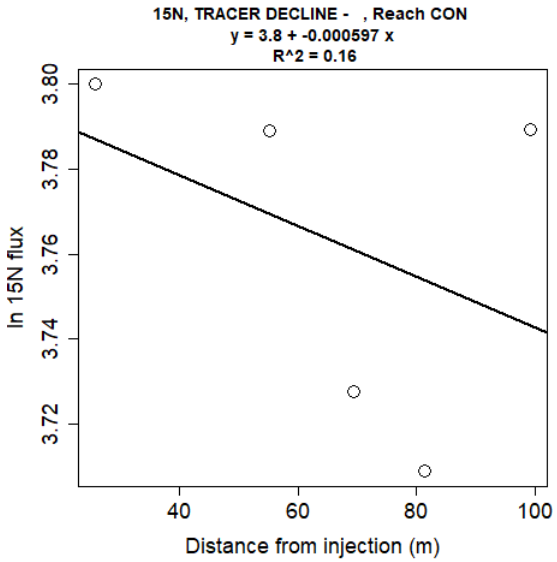




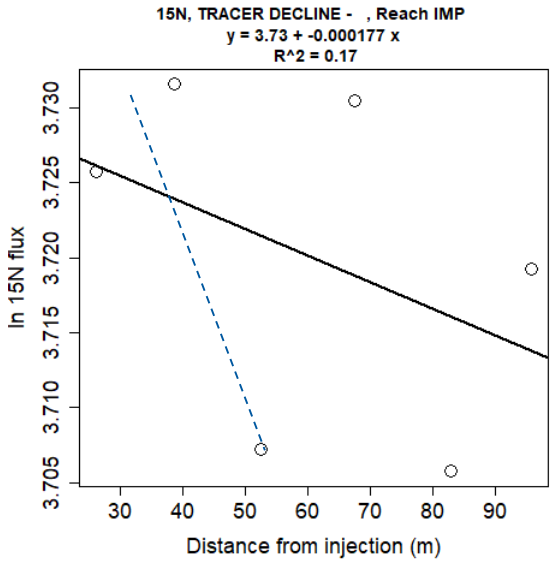
WP3

Tracer decline Ecker
15N (mean of replicates)

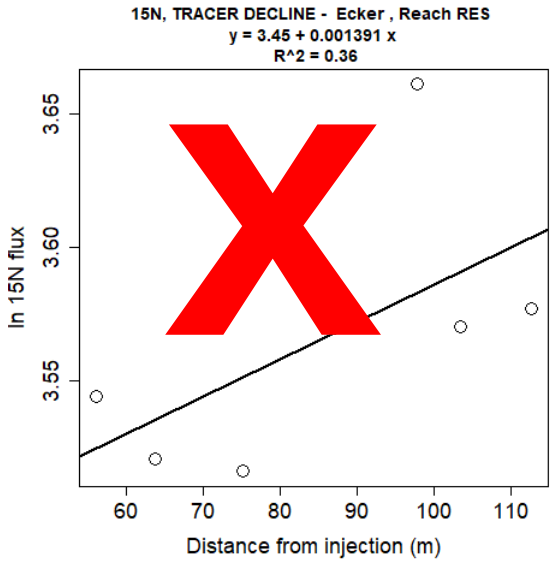
CON



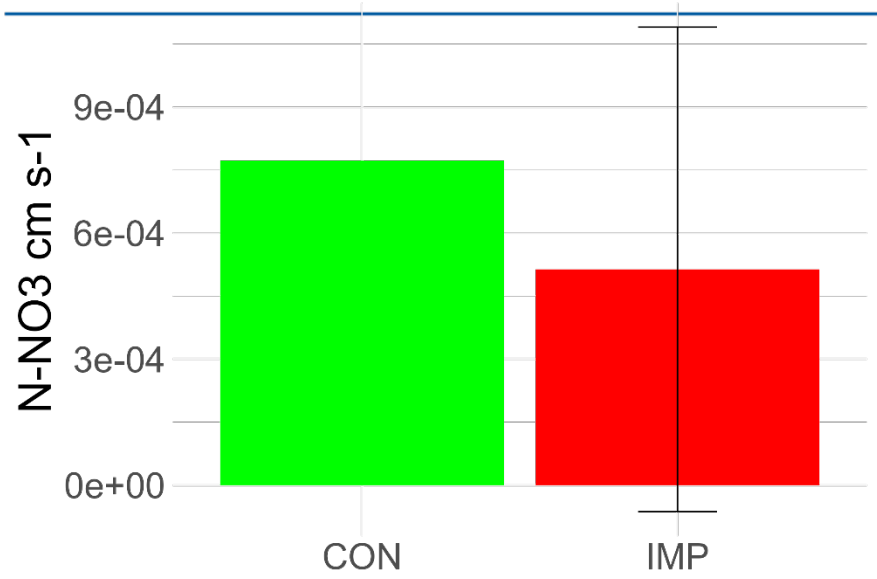
IMP



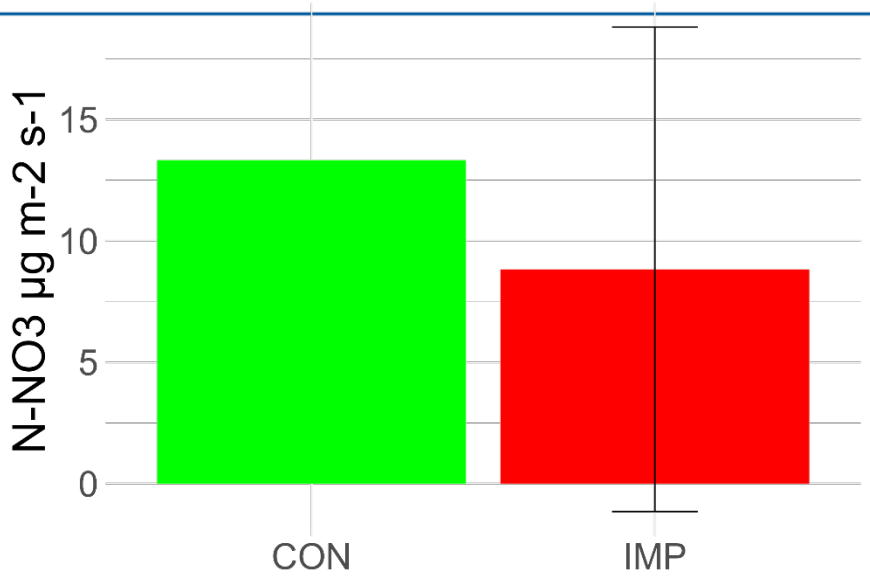
RES



N-NO3 Uptake velocity Ecker



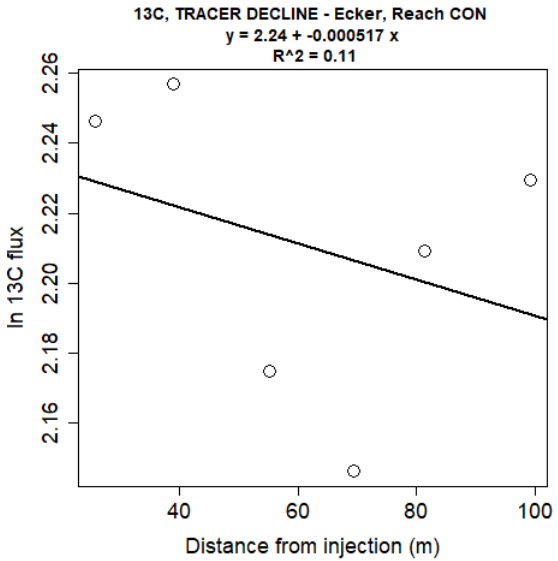
N-NO3 Uptake Ecker



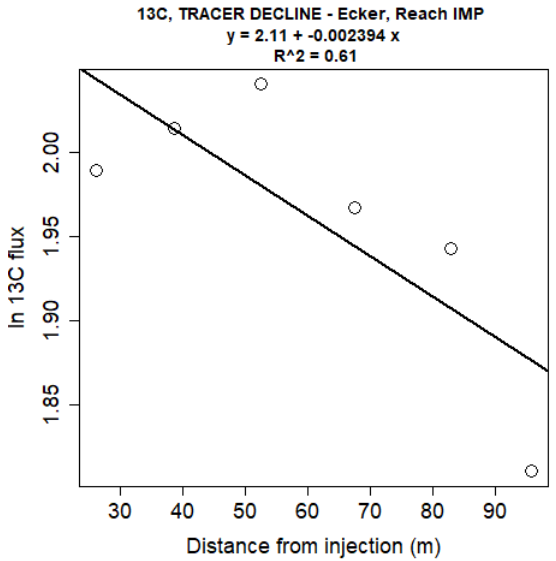
WP3

Tracer decline Ecker
13C (mean all replicates)

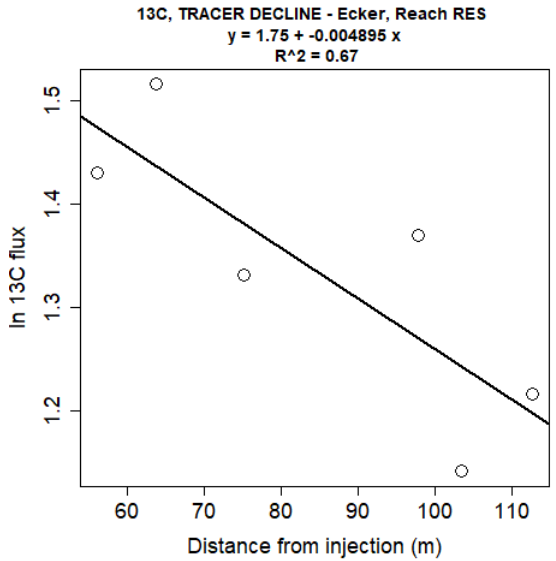
CON



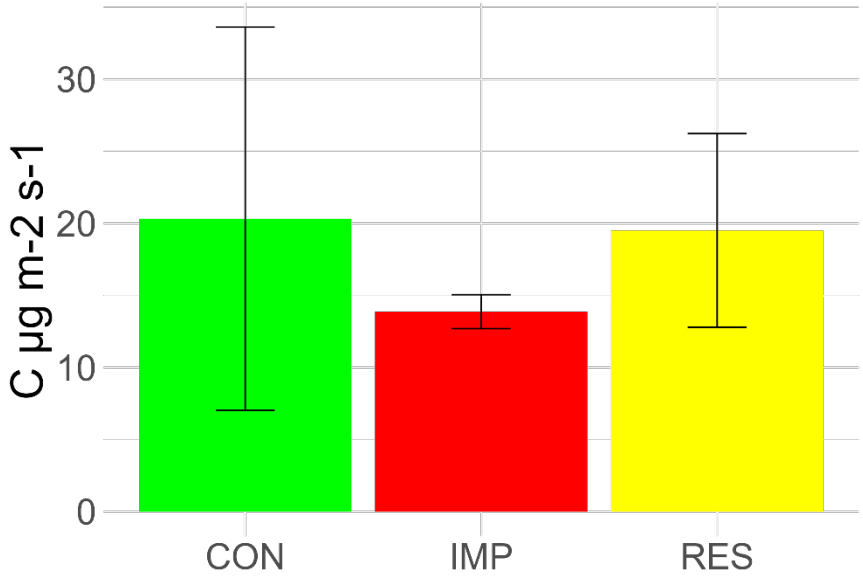
IMP



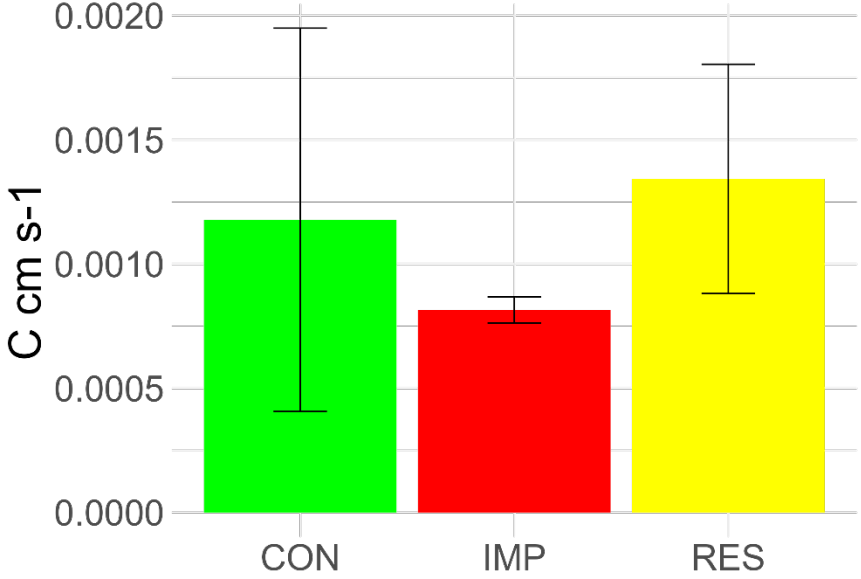
RES

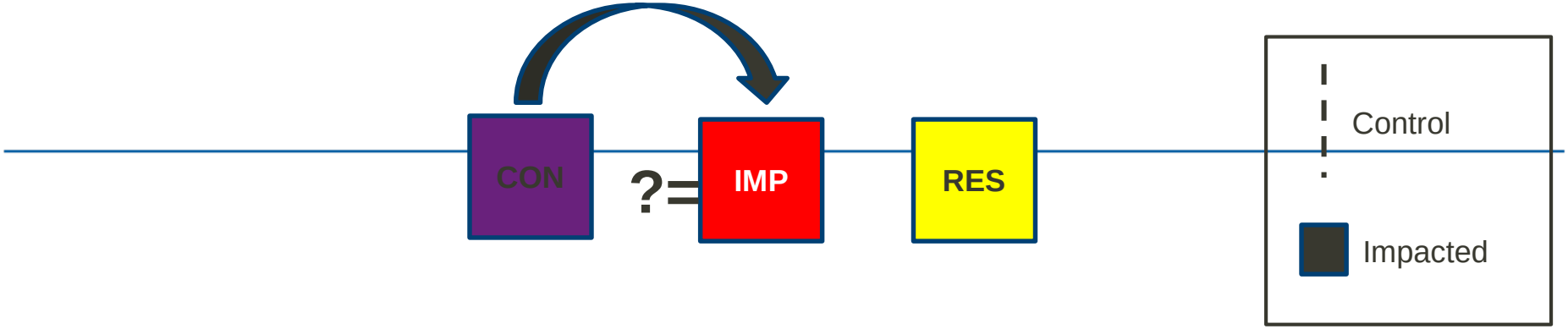


13C Uptake Ecker

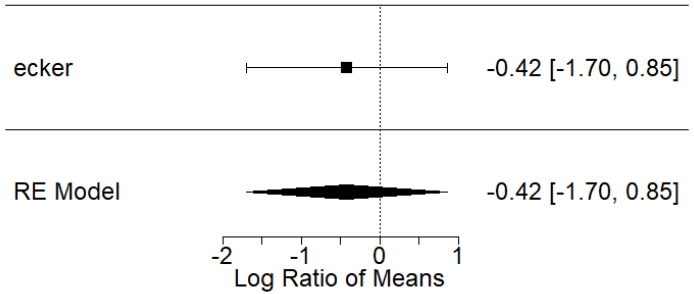


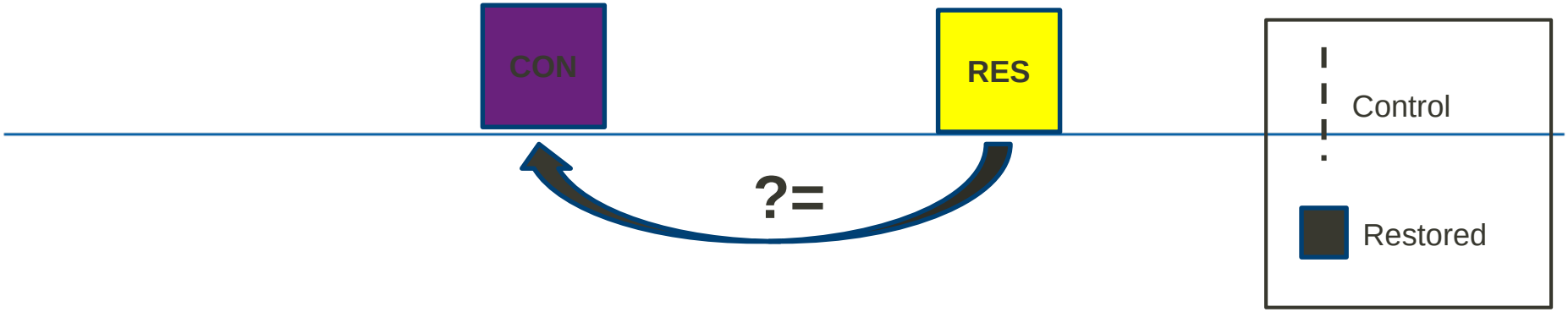
C Uptake velocity Ecker



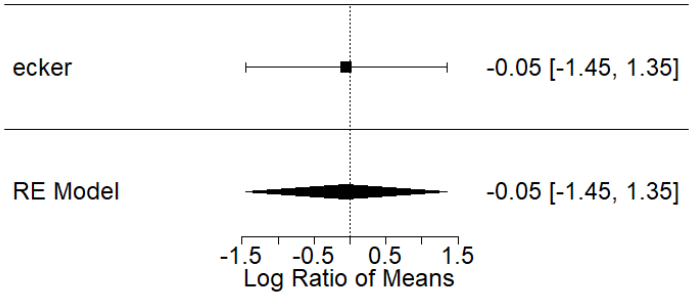


C Reach uptake (microg m-2 s-1)
(Impacted Vs Control)



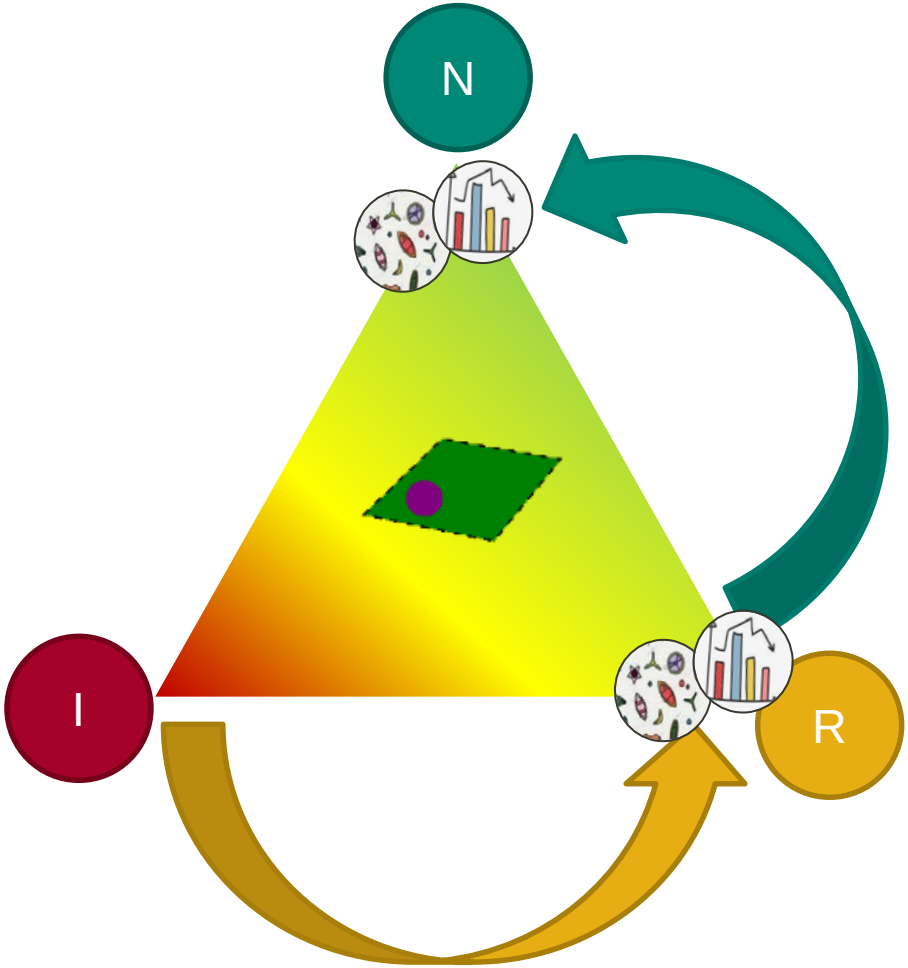


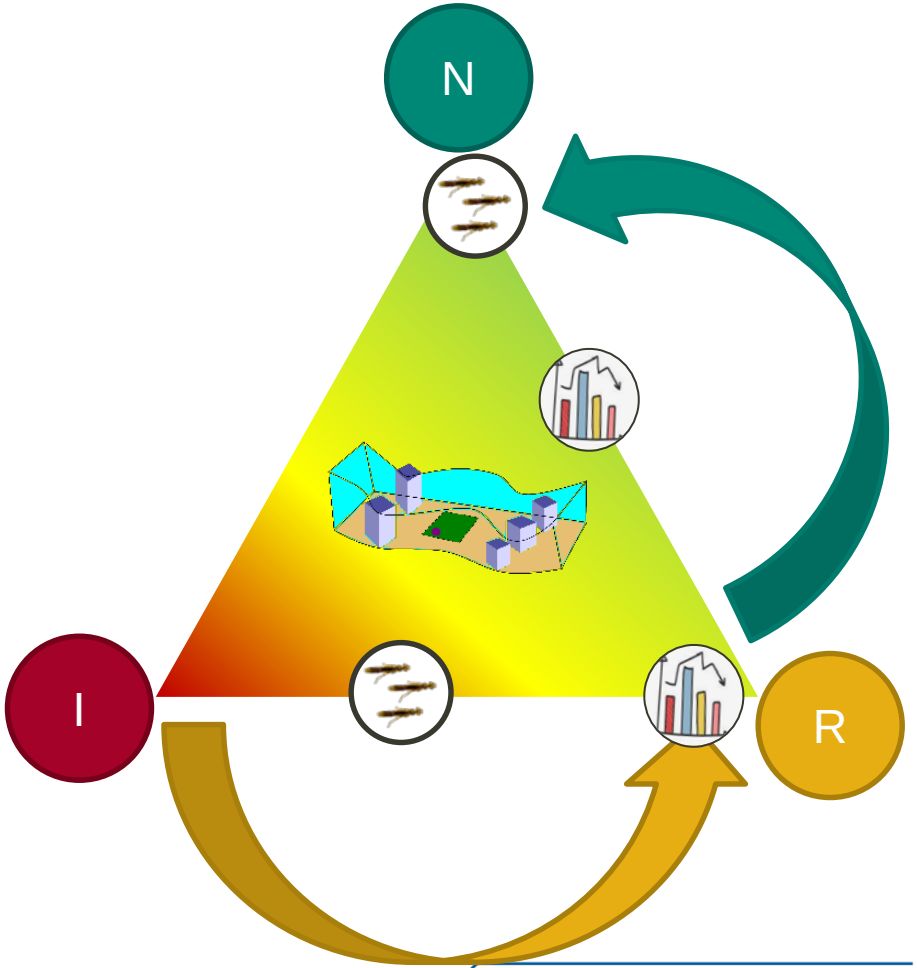
C Reach uptake (microg m-2 s-1)
(Restored Vs Control)



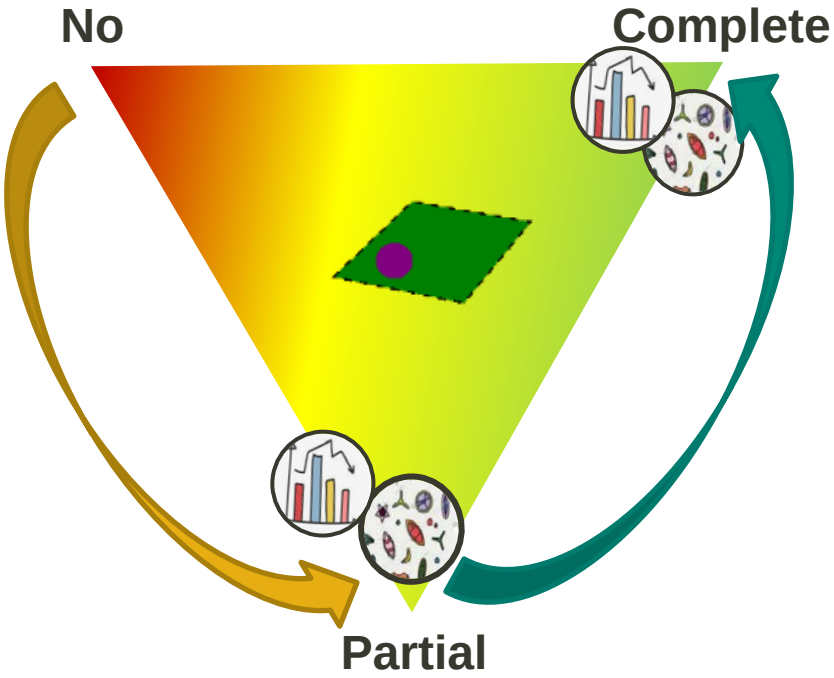
No3 uptake ~ water depth + flow alpha diversity

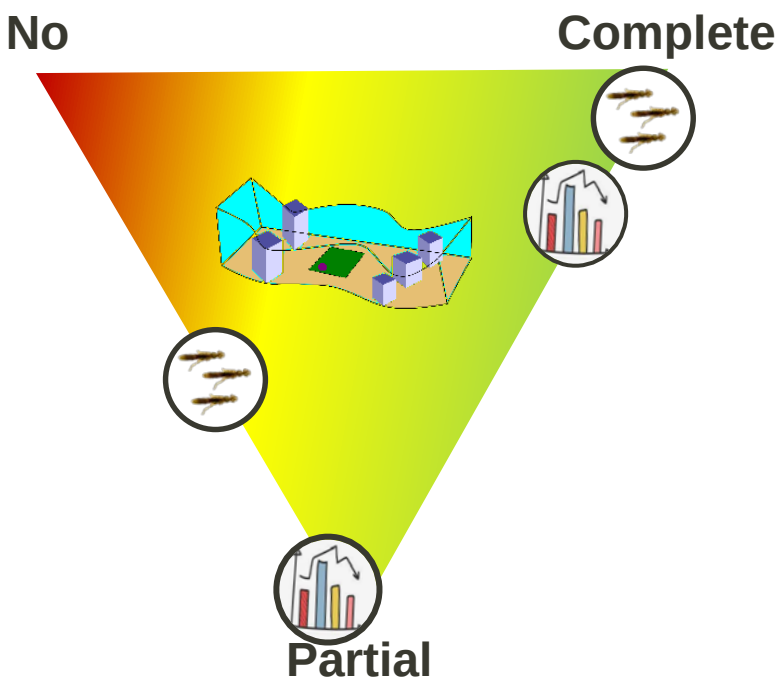
```
Summary for Biofilm NO3 uptake rate :

Call:
glm(formula = `Biofilm NO3 uptake rate` ~ `Water depth` + `Flow alpha diversity`,
    family = "gaussian", data = LOGdf_red)

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)            -3.9418     1.0808  -3.647 0.001033 **
`Water depth`           1.5887     0.3528   4.503 0.000101 ***
`Flow alpha diversity` -0.4190     0.1956  -2.141 0.040766 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 1.76726)
```


N
I
R


N
I
R

UFZ HELMHOLTZ Centre for Environmental Research





RESTOLINK mid-term meeting

January 15-17, 2024

WP5 Data management, dissemination and communication

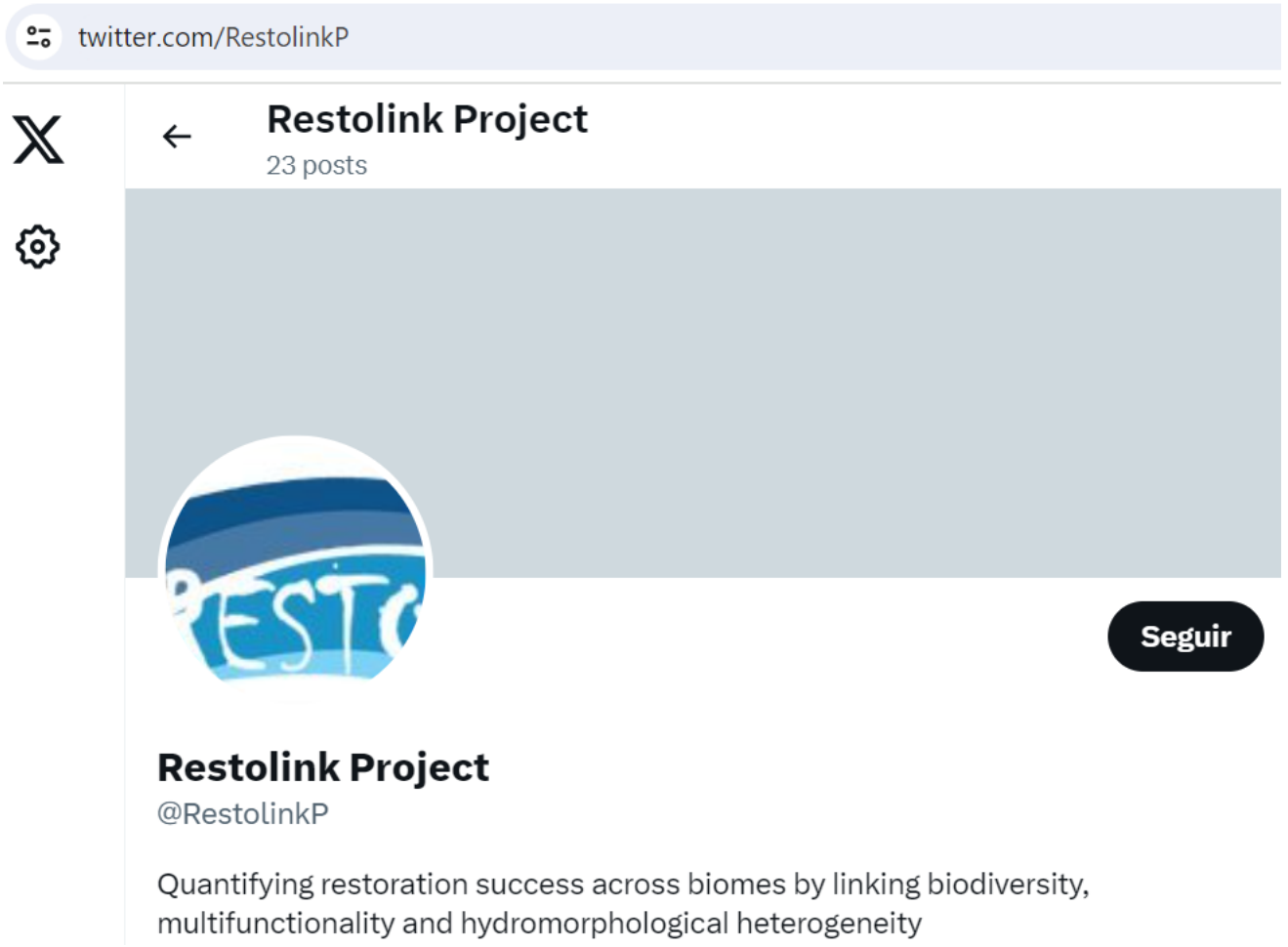
Status of work, available results, problems encountered and future work

Davi Gasparini Fernandes Cunha & Francesc Sabater

Status of work

Milestones/deliverables	Status
Kick-off meeting	Completed
Homepage running (weebly)	Completed
X account running	Completed
Dissemination plan and communication policy	In progress
Data management plan	In progress
Mid-term meeting	In progress
Stakeholder workshop	In progress
Questionnaire with stakeholders	In progress
Summary report of questionnaire results	Not started
Full database published in a repository	Not started
Final meeting and stakeholder workshop	Not started

Results – website and X



Results - dissemination plan and communication policy

AUTHORSHIP STATEMENT – RESTOLINK

Authorship provides credit for contributing to research products, constitutes important professional currency, but also carries responsibility and accountability. This policy is meant to provide guidance for general expectations on authorship for publications generated by RESTOLINK research efforts.

General Principles:

1. Publication quality is important to RESTOLINK researchers, to the integrity of the research program, and is a key part of meeting expectations formulated in the proposal.

2. The underlying philosophy of RESTOLINK emphasizes free sharing of ideas, data, and skills within the project constellation, and encourages multi-authored collaborative papers, as well as fairness in authorship decisions.

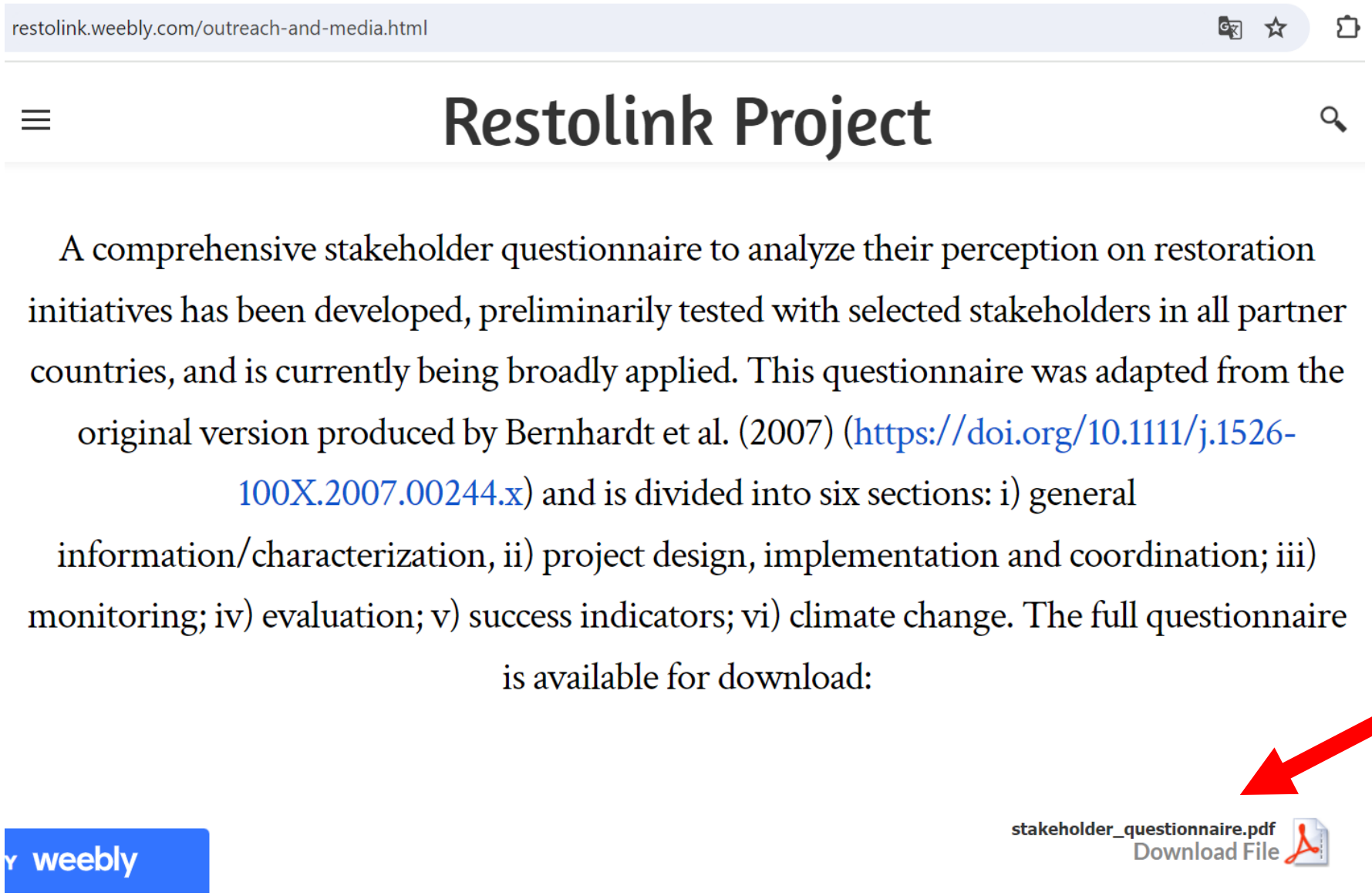
3. RESTOLINK will prioritize opportunities for junior (early career) scientists and scholars to lead key publications and presentations.

4. Individuals who have contributed substantively to project design, data collection, and data analysis should be given opportunity to contribute in a significant way to publications, with authorship based on each individual's contributions.

5. When included on the author list, there is also an expectation to put effort into the manuscript – at a minimum, this includes reading, editing, and generally demonstrating a shared responsibility for the work.

6. In principle, if RESTOLINK manuscripts are based on data collected from **across**

Results – stakeholder questionnaire



Results – stakeholder questionnaire

PART I – GENERAL INFORMATION/CHARACTERIZATION

PART II – PROJECT DESIGN, IMPLEMENTATION AND COORDINATION

PART III – MONITORING

PART IV – EVALUATION

PART V – SUCCESS INDICATORS

PART VI – CLIMATE CHANGE

QUESTIONNAIRE (final version, last update 28/June/2023)

PERCEPTION OF STAKEHOLDERS ON RIVER RESTORATION INITIATIVES

You are being invited to participate in the questionnaire "*Perception of Stakeholders on River Restoration Initiatives*". This questionnaire was adapted from the original version produced by Bernhardt et al. (2007) (https://doi.org/10.1111/j.1526-100X.2007.00244.x). The survey among different stakeholders on river restoration initiatives is part of the transnational RESTOLINK project (*Quantifying restoration success across biomes by linking biodiversity, multifunctionality and hydromorphological heterogeneity*). This project is conducted by researchers from the Helmholtz Centre for Environmental Research (UFZ - Germany), University of São Paulo (USP - Brazil), University of Koblenz-Landau (UKL – Germany), University of Barcelona (UB – Spain), and Umeå University (UmU – Sweden). The primary goal of this project is to develop a novel mechanistic framework for quantifying restoration success that interlinks hydromorphological

~40 questions

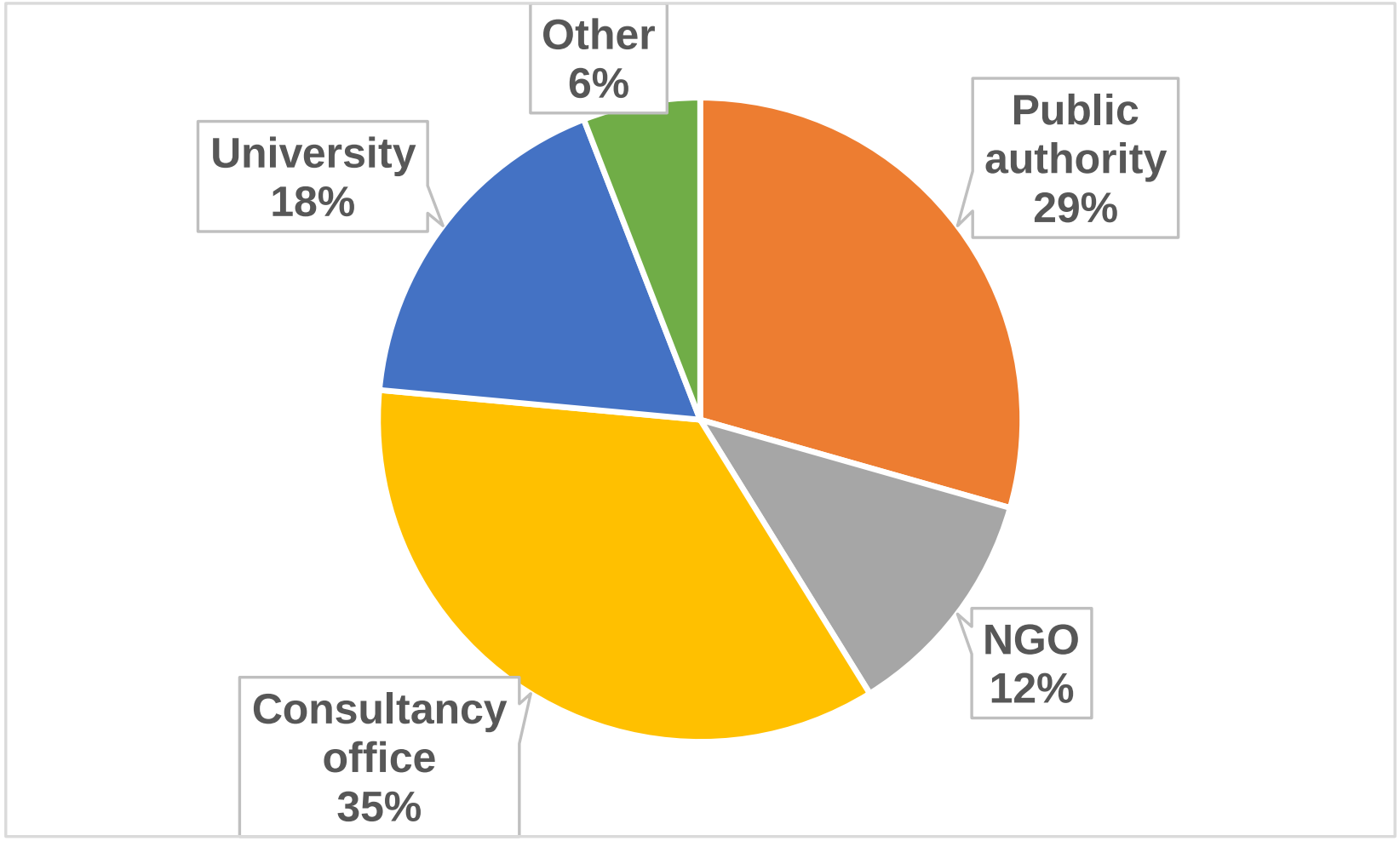
Interviews by phone, zoom or in person

Duration of the interviews

Total of 28 responses so far in Brazil, Germany, Sweden and Spain

(Very) preliminary results from the questionnaire (BRA, SPA, SWE)

Which institution are you from?



(Very) preliminary results from the questionnaire

For how many years have you been involved with restoration projects throughout your career?

Please provide an estimation of the number of restoration projects/initiatives you were involved with throughout your career.

Average: 13 years, 190 projects

Brazil: 10 years, 8 projects
Sweden: 13 years, 8 projects
Spain: 15 years, 494 projects

(Very) preliminary results from the questionnaire (BRA, SPA, SWE)

What were the main measures of river/stream restoration projects you were involved with?

Most cited:

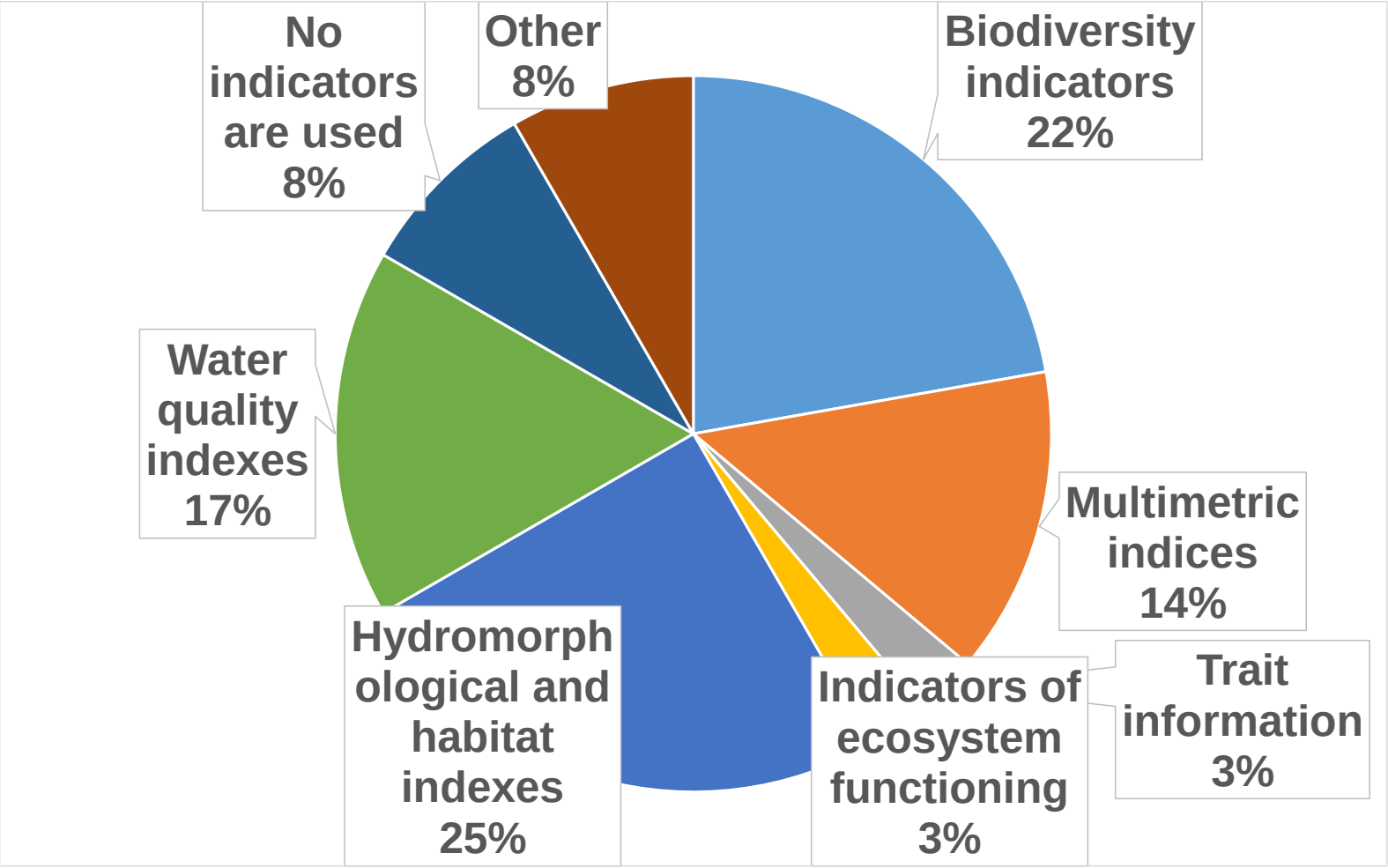
- Bank Stabilization
- In-stream Habitat Improvement
- Channel Reconfiguration
- Dam Removal/Retrofit

Least cited:

- Climate change mitigation
- Land Acquisition
- Flow Modification
- Management of waterborne diseases

(Very) preliminary results from the questionnaire (BRA, SPA, SWE)

Which indicators of restoration success do you commonly use for your projects?



(Very) preliminary results from the questionnaire (BRA, SPA, SWE)

What impedes the application of indicators of ecosystem functioning in your restoration projects?

59%: too complicated/laborious
18%: cannot be connected to existing/previous assessments

Problems encountered

Recruiting stakeholders

Updating website and X regularly

Future work

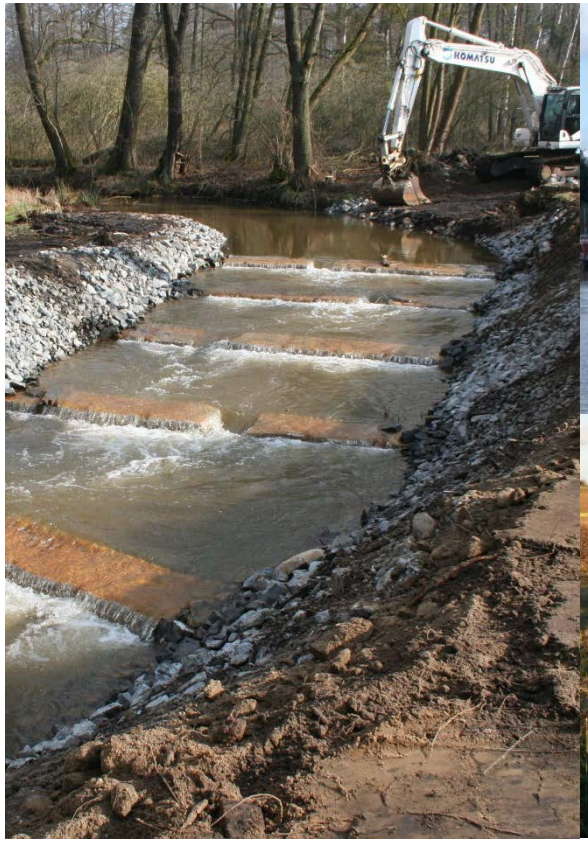
Functional indicators as a complementary tool for freshwater management?

Mario Brauns

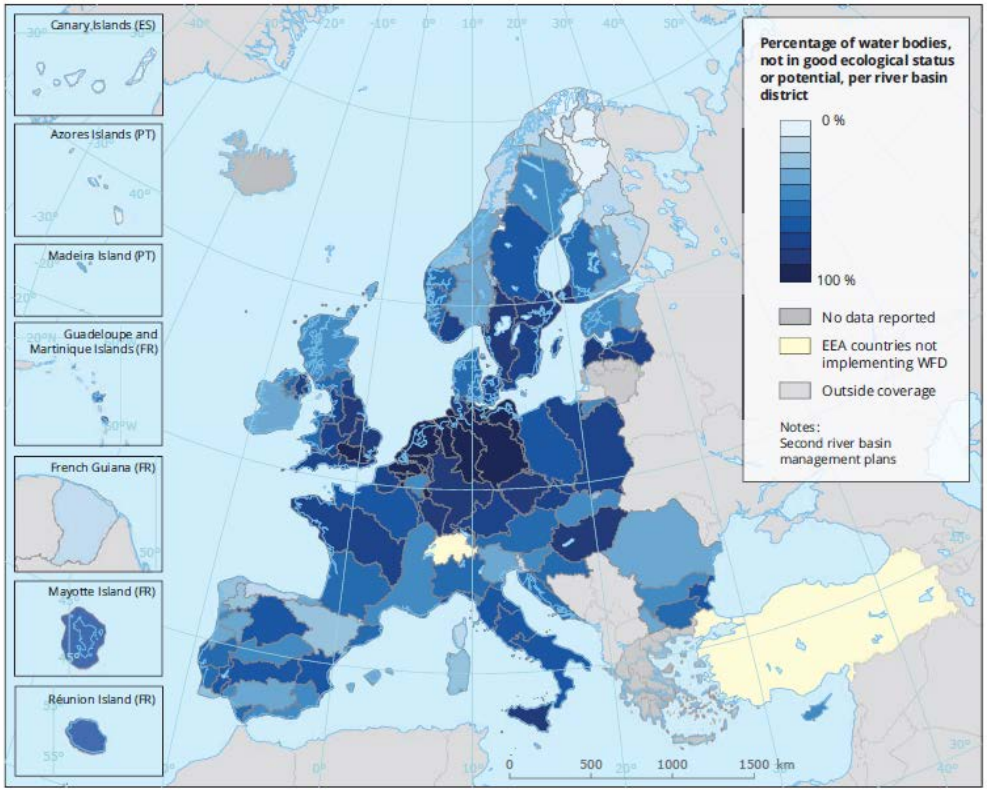
Some definitions

- *Ecosystem structure*: Ecosystem property evaluated with point-in-time measurements, commonly used for status assessments, e.g., biodiversity, community composition
- *Ecosystem function*: Ecosystem property that changes with time, synonym for “rate” or “process” (*sensu* Jax 2005), e.g., oxygen metabolism, leaf litter decomposition
- *Ecosystem service*: Ecosystem property that is directly useful to humans, e.g., provisioning of drinking water

Freshwater management in the 21st century



Ecological status of European waterbodies and floodplains

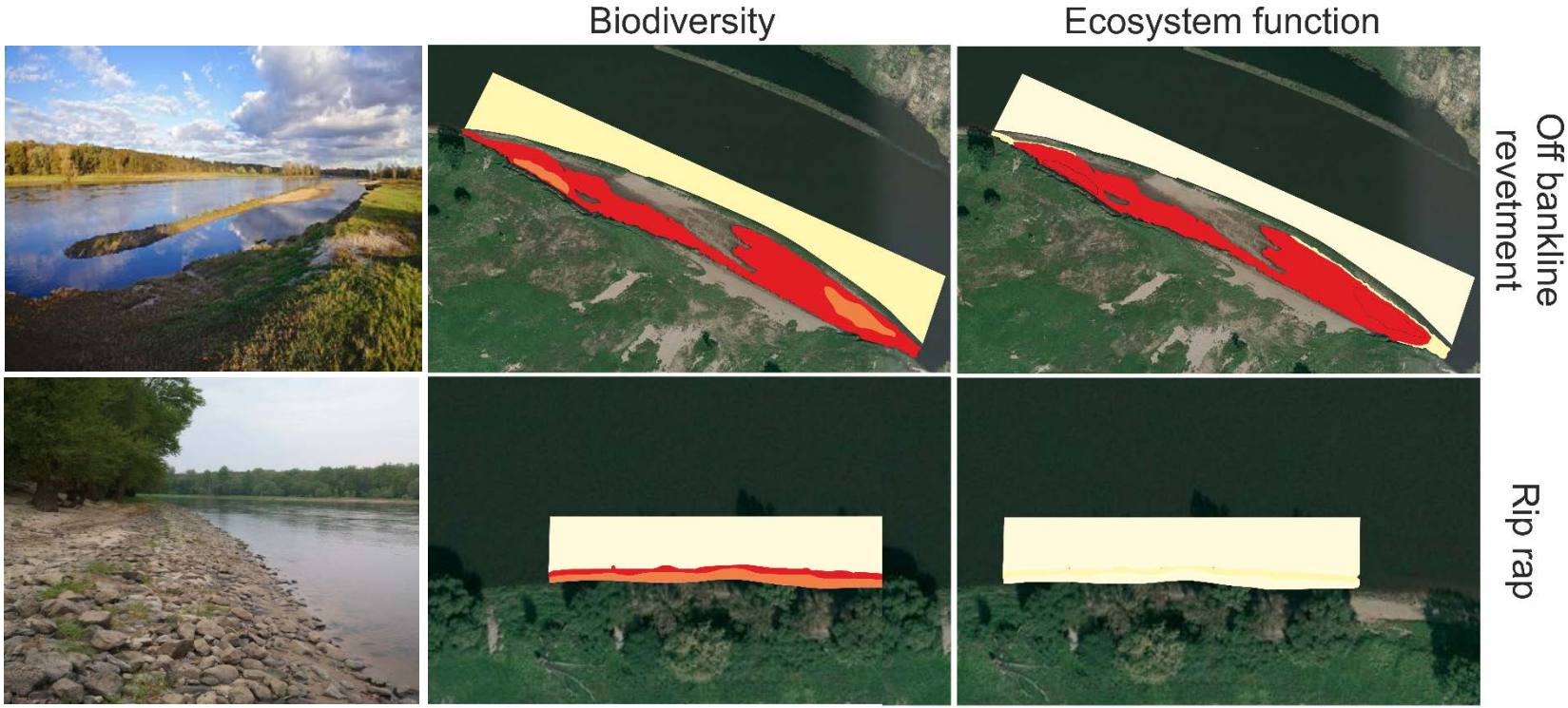


EEA 2018, ECT 2020

More than just biodiversity – ecosystem functioning

- EU-WFD article 21: „Ecological status is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, …"
- EU Biodiversity strategy 2030, article 2.2.7 "Greater efforts are needed to restore freshwater ecosystems and the natural functions of rivers in order to achieve the objectives of the Water Framework Directive"
- Aichi target 8: "By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity"
- Aichi target 19: "By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared …."

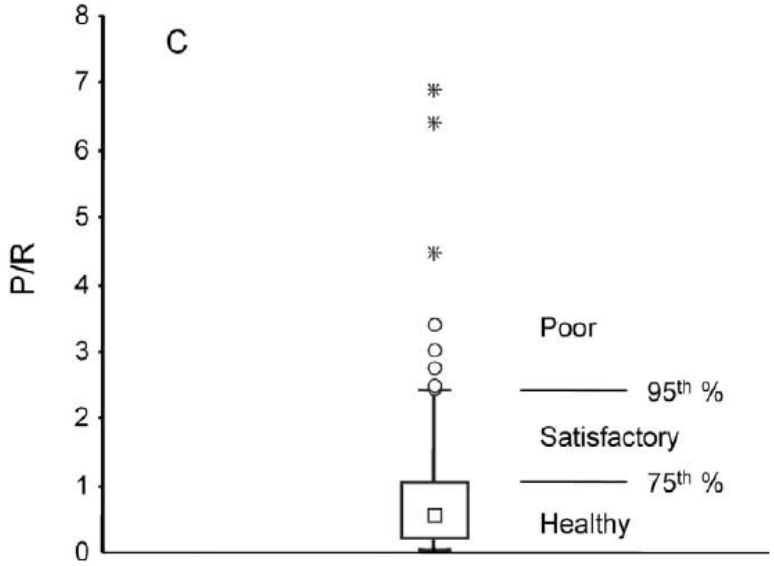
Is reduced diversity followed by reduced functioning?



Brabender, ..., Brauns (2016): *Hydrobiologia*

Available functional indicators

Ecosystem metabolism



Young et al. 2008

Summary

- Ecosystem functioning is important property of freshwaters
- Not considered in current assessments approaches despite several legislative frameworks
- Diversity and functioning are not always positively related
- Potentially suitable functional indicators are available

→ Why is a management of ecosystem functions neither developed nor implemented?

Guiding questions

- Is there a need of a functional assessment?
- Does global change accelerate the need for complementary assessment approaches?
- What impedes its implementation?
- Which metrics have the highest potential?
- Are there strong differences among countries?
- Would you be willing to contribute to the development a functional assessment?

Quantifying restoration success across biomes by linking biodiversity, multifunctionality and hydromorphological heterogeneity (RESTOLINK)

Data syntheses

BIODIVRESTORE 2020-2021 CALL

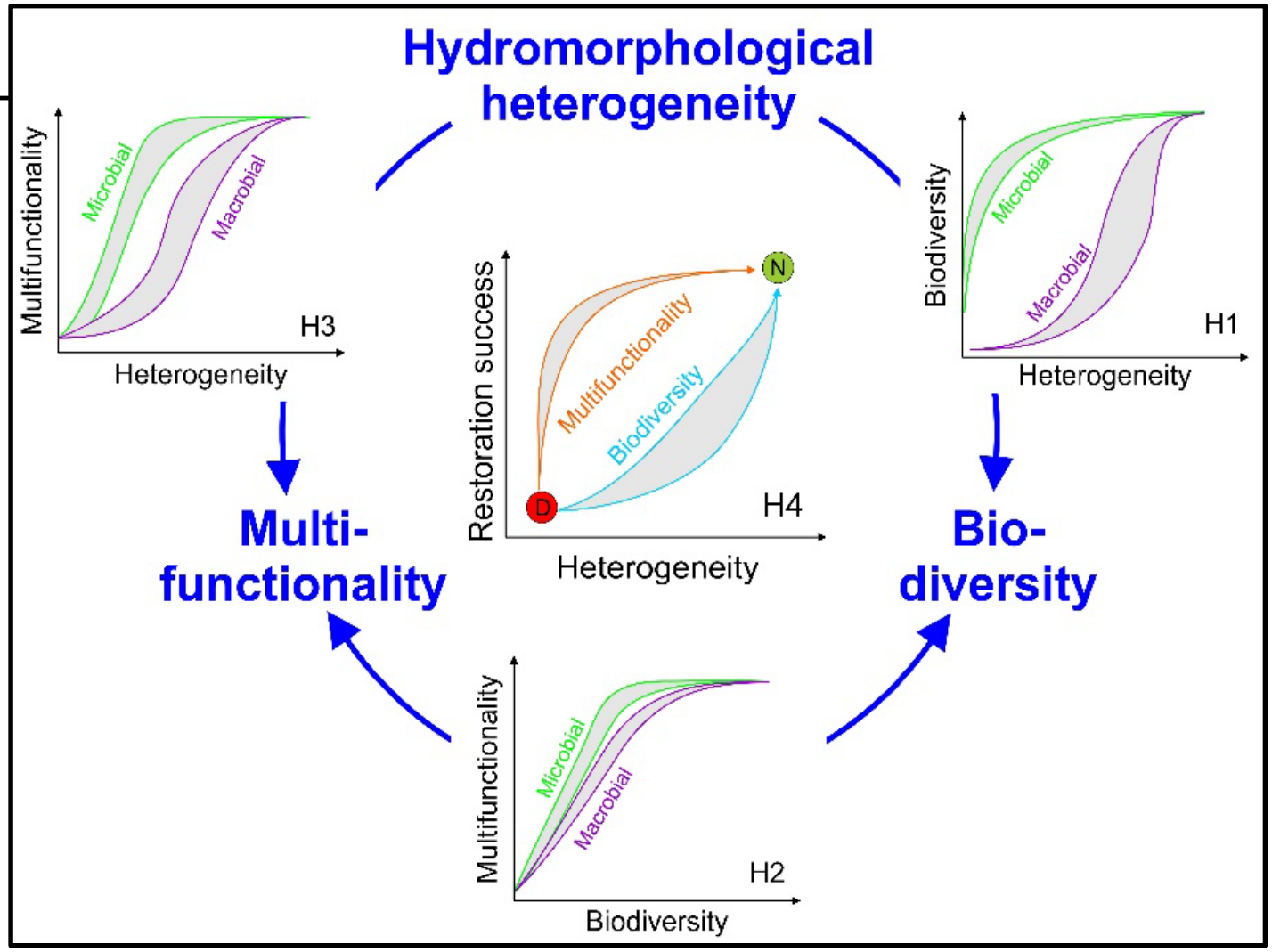
@RestolinkP

https://restolink.weebly.com/

Hypotheses

H1 + H3:

- Biodiversity and ecosystem functioning are positively related to **hydromorphological heterogeneity** for micro- and macroorganisms … . We expect differences in the shape of both trajectories, given that the **body size and mobility** of a given species drive its niche requirements (→ **comment: varying spatial scales within reach**). Moreover, we predict that **biome-specific differences** in biodiversity should be larger for macroorganisms …

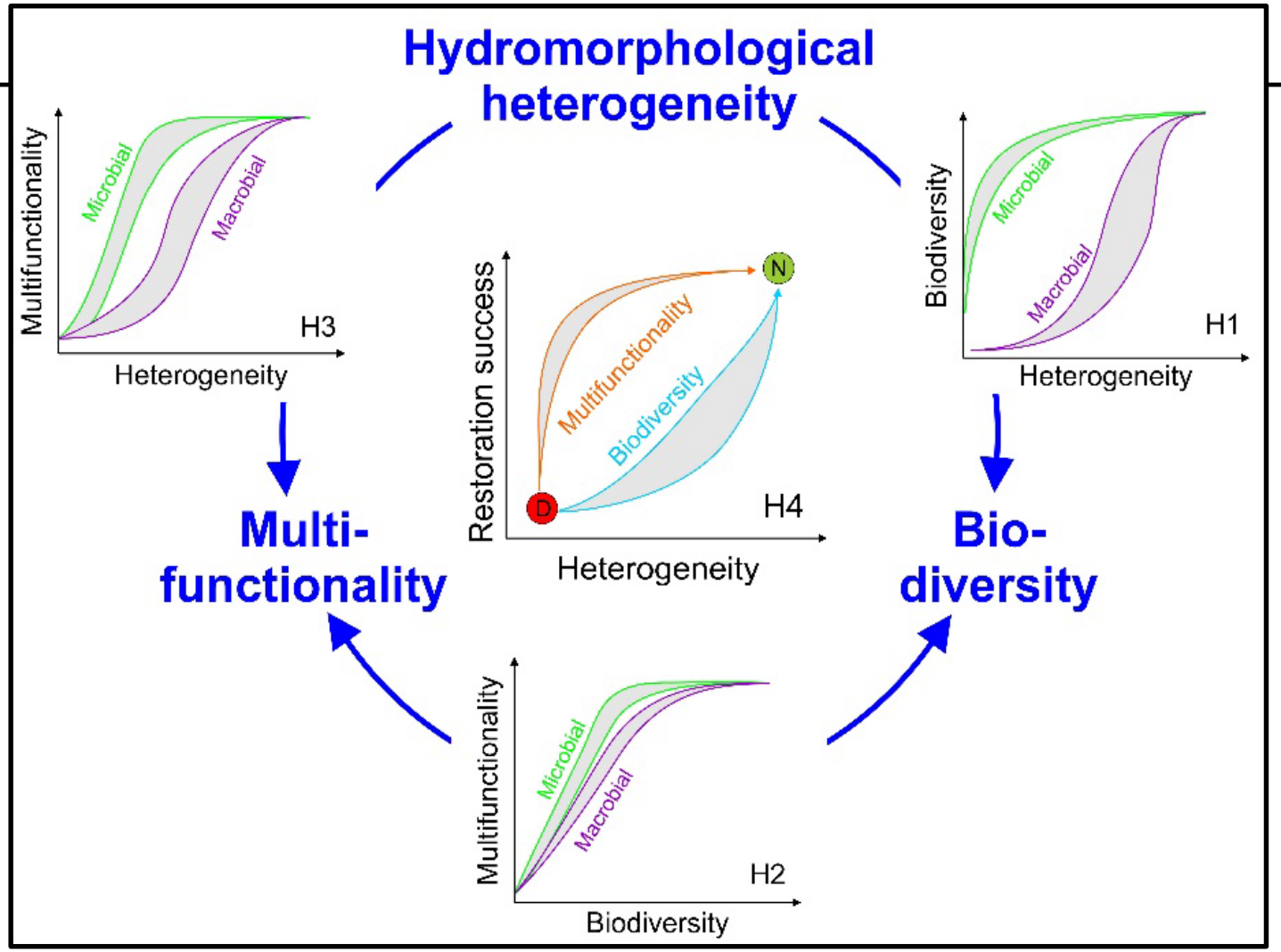


- **Microbially-driven functions** may benefit from **mass transfer processes**, which are related to temporal variances of flow and can be high already at **small spatial scales**.

H4: **Success in restoring hydromorphological heterogeneity** is achieved earlier for ecosystem multifunctionality than for biodiversity

Hypotheses

H2: Biodiversity scales asymptotically with multifunctionality (Fig. 1, H2) because few species contribute disproportionately to ecosystem functioning → certain species are responsible for most processes → functionally key species that are primarily microbes and that the inter-biome variability is primarily driven by the degree of functional redundancy.



H1 + H3 + H4 - Matching of diversities - suggestions

α diversity: **diversity** at a **spot** (i.e., micro-scale)

γ diversity: **overall diversity** of different spots **within** region (i.e., **mesohabitat, reach**)

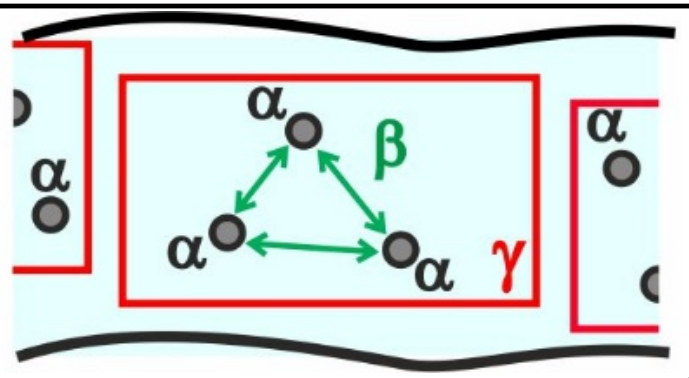
β diversity: changes in diversity **between spots** (within region)

⇩

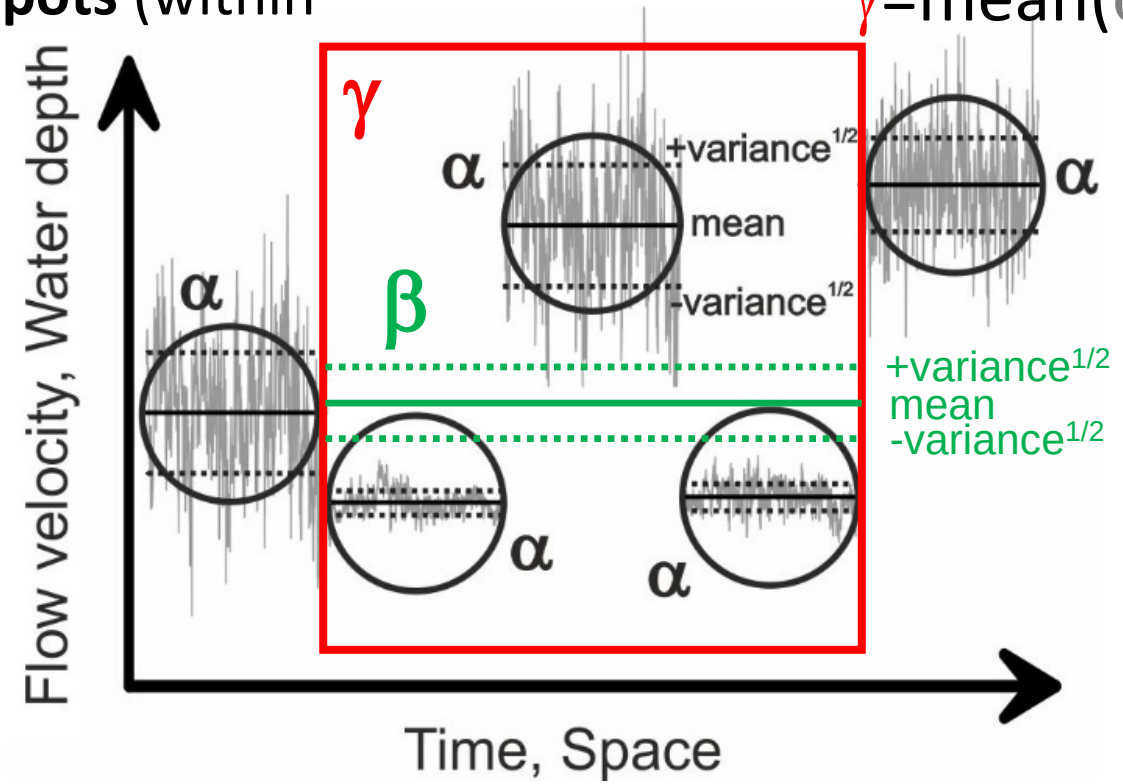
α diversity: **variance** measured at a **spot**

γ diversity: **variance of varies spots** within a pre-defined region

β diversity = γ − mean(α) → **variance of the means** around the overall mean

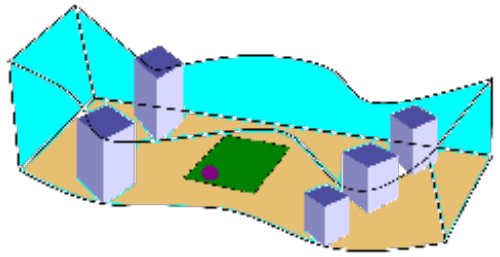


γ=mean(α)+β

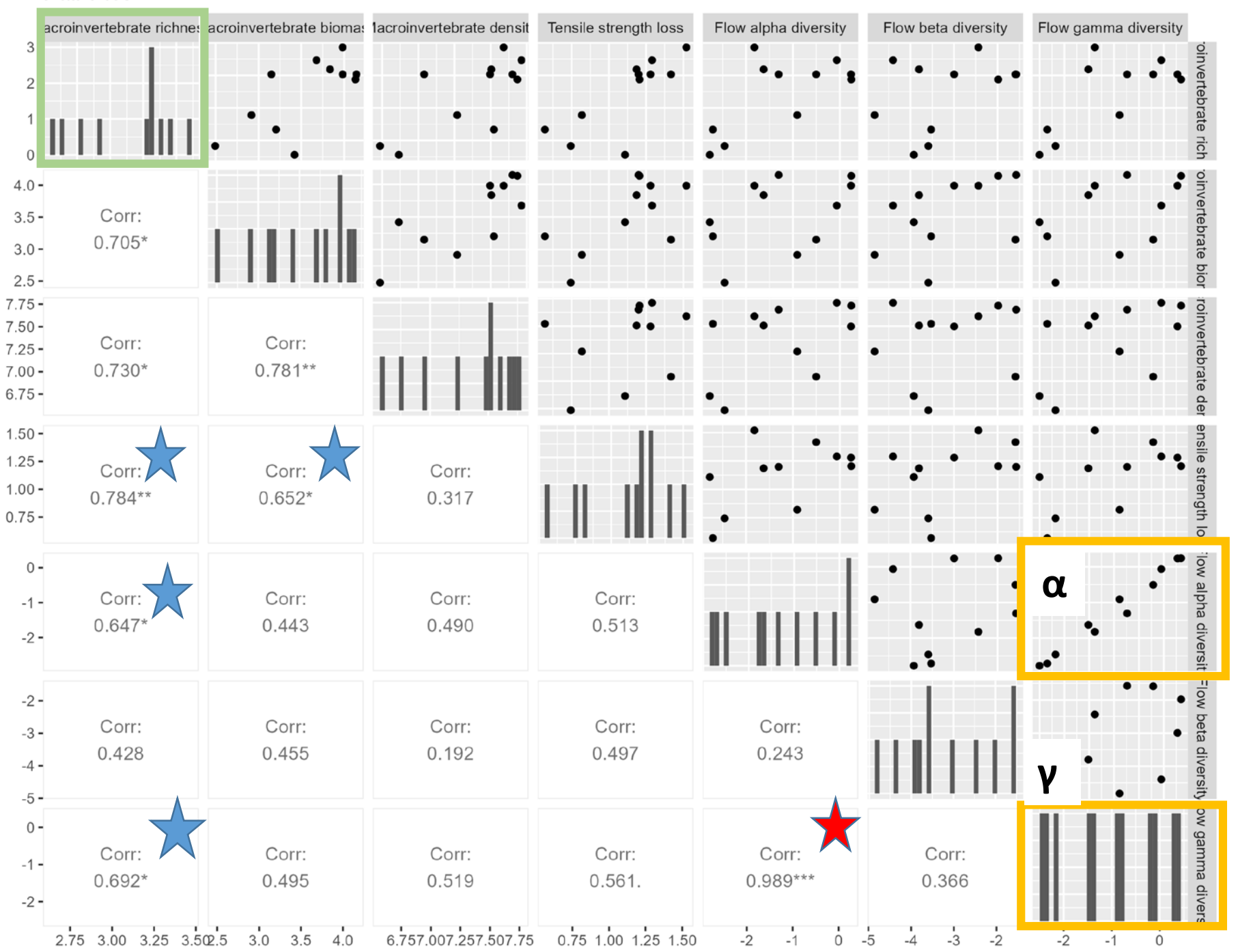


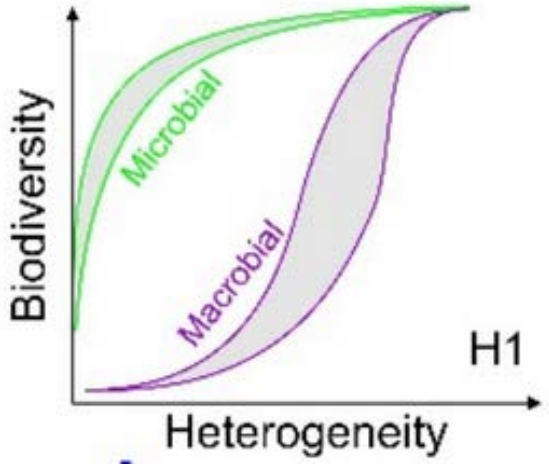
Anlanger, C., Noss, C., Risse-Buhl U., Brauns, M., von Schiller D., Weitere, M. and Lorke, A. Linking hydromorphological diversity to biodiversity and functioning in running waters (again in prep.).

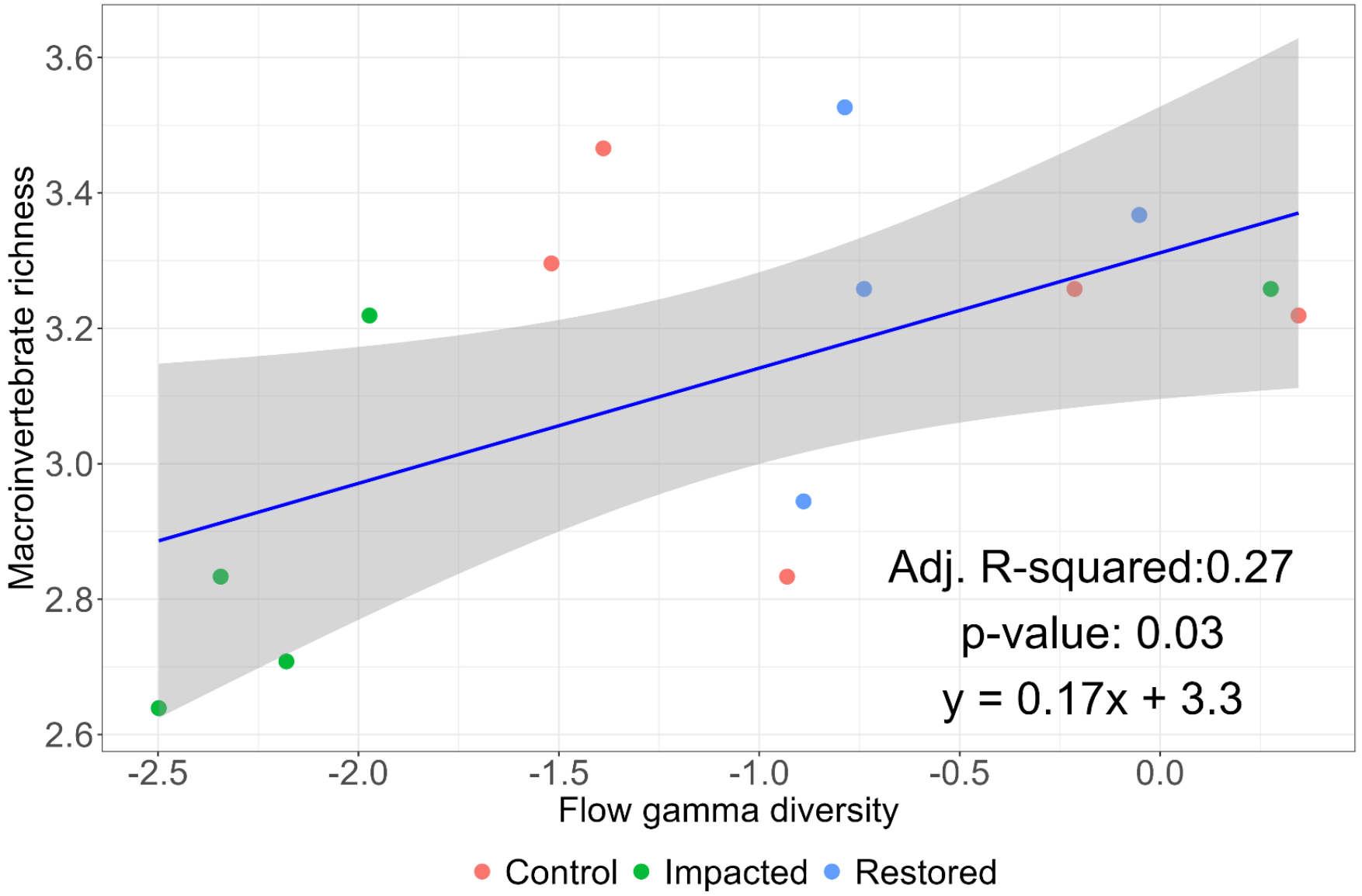
Correlation plots on the **log** transformed data



Variables	Sig	
Macro richness–tensile strenght loss	**	+
Macro richness–Flow alpha velocity	*	+
Macro richness–Flow gamma velocity	*	+
Macro biomass–tensile strenght **loss**	*	+

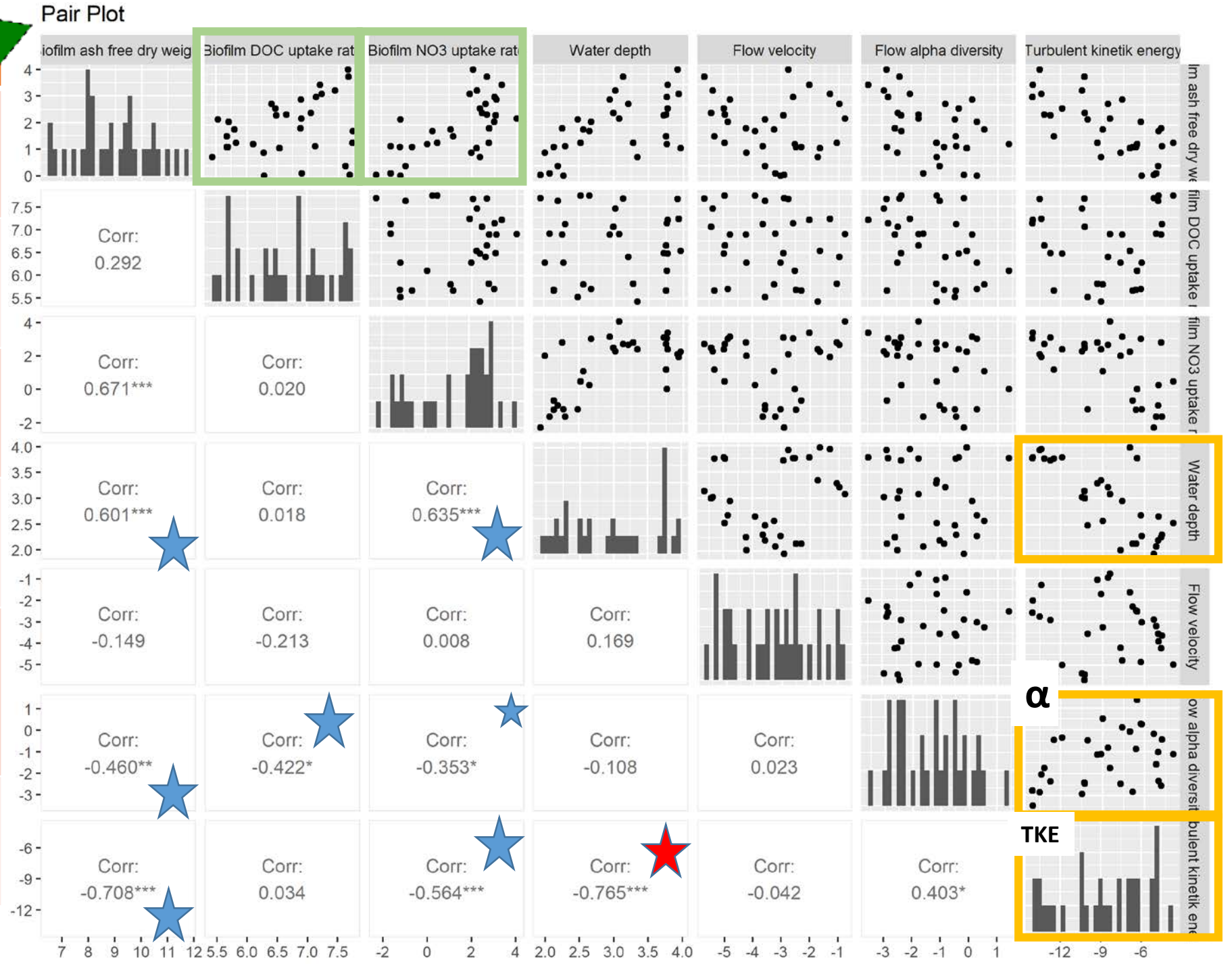


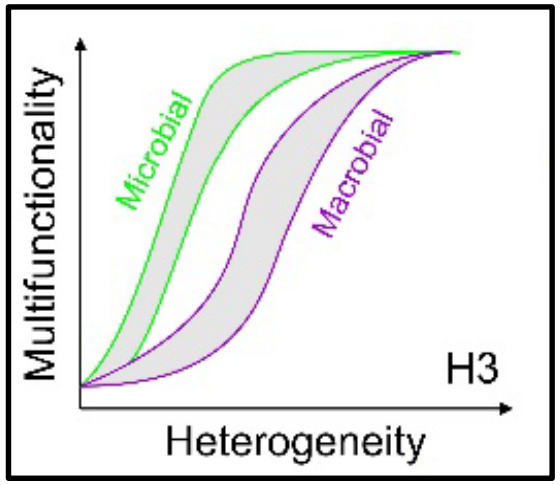

Biodiversity
Microbial
Macrobial
H1
Heterogeneity


Macroinvertebrate richness
3.6
3.4
3.2
3.0
2.8
2.6
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
Flow gamma diversity
Adj. R-squared:0.27
p-value: 0.03
y = 0.17x + 3.3
Control
Impacted
Restored

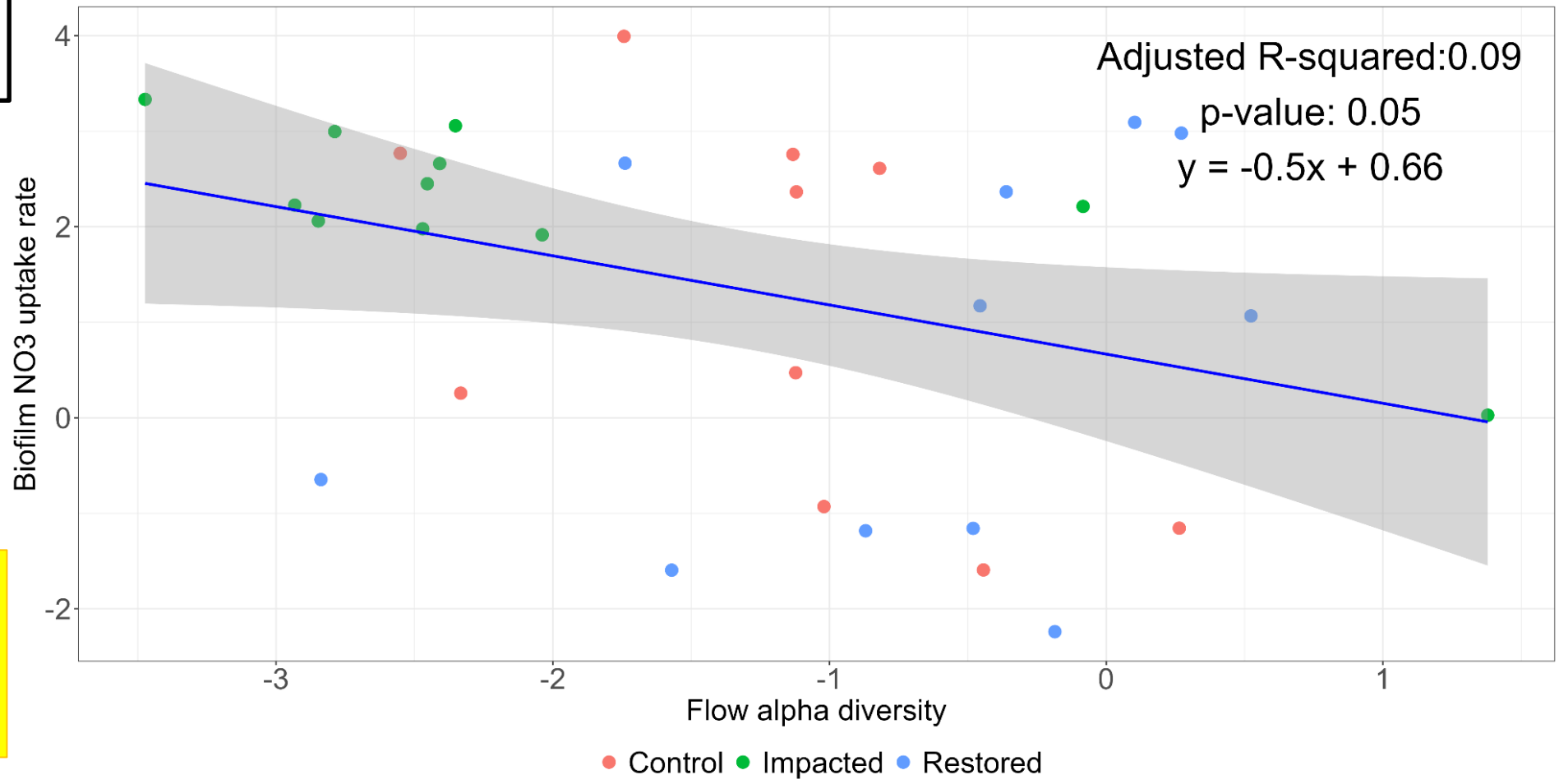
Variables	Sig	
DOC uptake – flow alpha diversity	*	-
NO3 uptake-water depth	***	+
NO3 uptake-TKA	***	-
NO3 uptake- alpha diversity	***	-

LOG transfomed!
0 uptake values removed because of logTransformation gives inf.
Discussion: how to transform the data





LOG transfomed!
0 values removed because of logTransformation

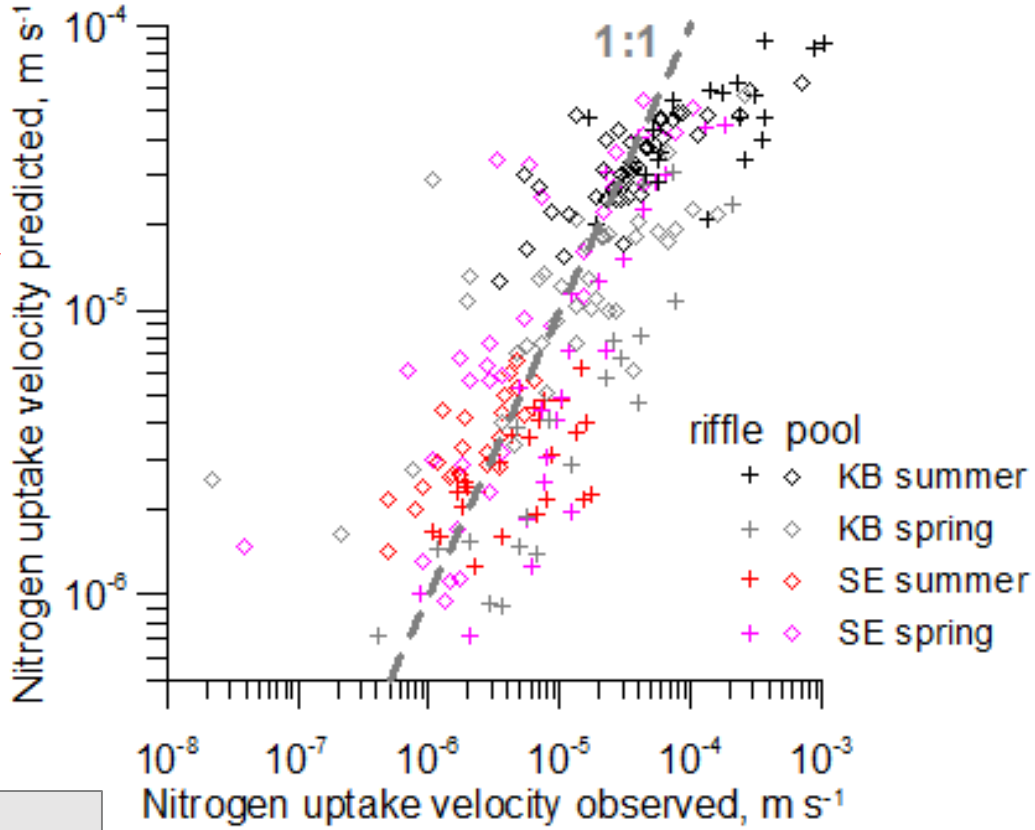


H3 – mass transfer and uptake

Background:
The nitrogen uptake velocity of the streambed V (→ uptake efficiency) is controlled by two processes:

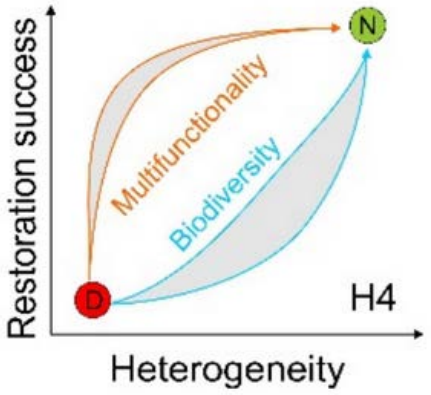
1. the hydraulic mass transfer through the concentration boundary layer k
2. uptake velocity of biofilms V_{Biof}

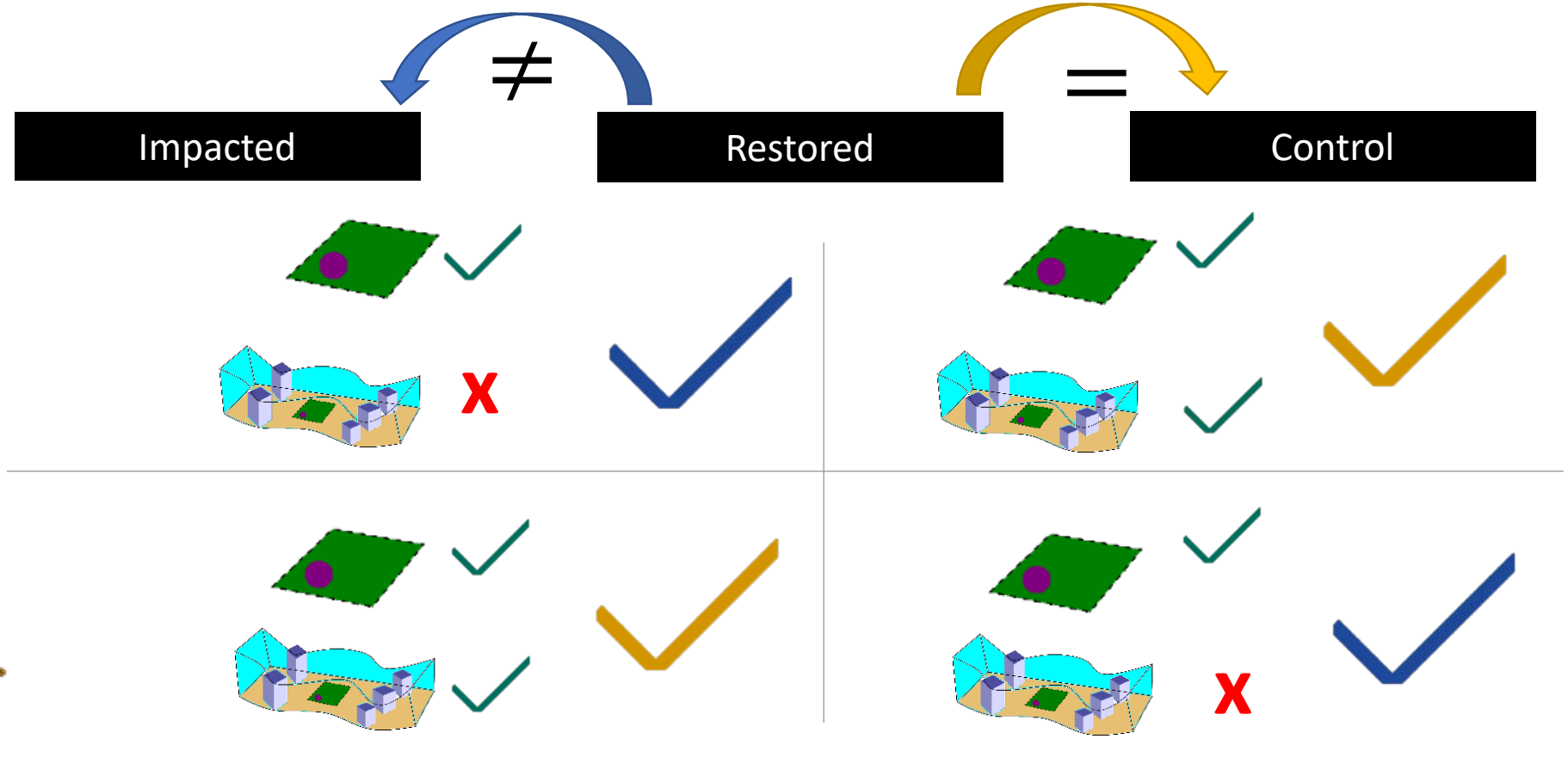
predicted
→ k = f (turbulent dissipation rate at the sediment-water interface)
→ V_{Biof} = f (biofilm biomass)



observed
Field experiments with stable isotope tracer

Within-stream variation can be explained by the **turbulent dissipation rate** as a function of hydraulic mass transfer and the **biofilm dry mass** as a function of biofilm characteristics (Anlanger et al., 2021).





Structural components and functional components show different trajectories.
Structural component do not show recovery in the 1° phase (imp vs restored) but in the 2° one. Conversely, functional component show success in the 1° phase (imp vs restored) but not full recovery (res vs control).

Discussion

- Publication strategy – what data can we use to answer which hypothesis
- Which data to publish together/ which not
- How to put the multifunctionality on the y axis?
- How to define restoration success for H4?
- Which spatial and temporal scales to address? E.g. is there a gap between reach and biome – should we overcome it?