CONVERGES
European Riparian Ecosystems

Ecological restoration of riparian vegetation – a success story

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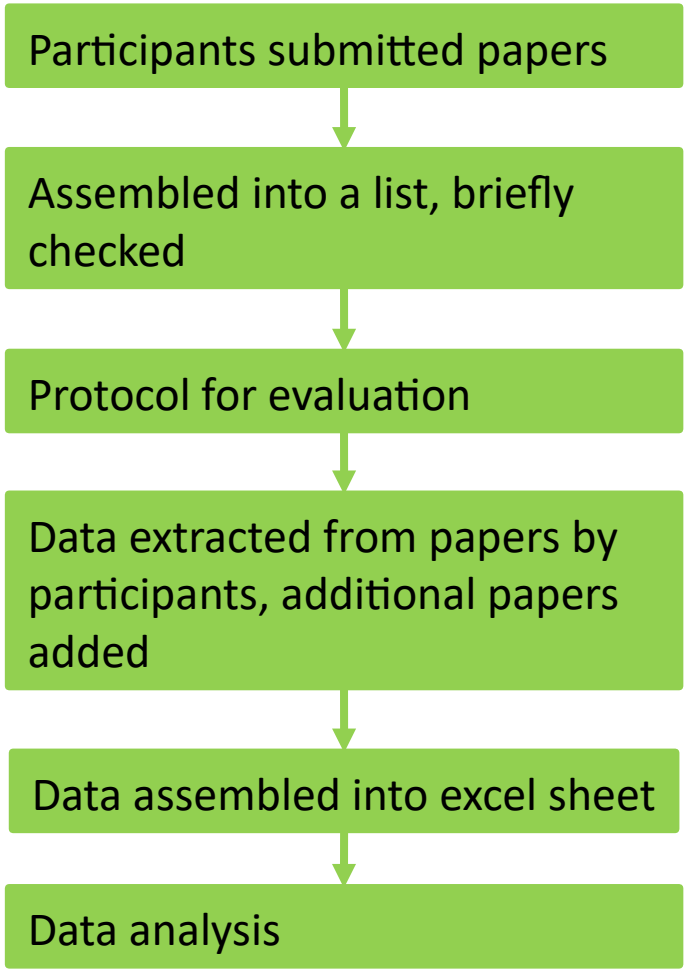
- Ecological restoration – a major response to degradation of riparian zones
- Despite barriers, many restoration and rehabilitation efforts have been implemented – need to evaluate the evidence for their effectiveness
- Which methods are effective? Methods applicable in new areas, in response to additional pressures? Pressures lacking responses?

Aims and methods

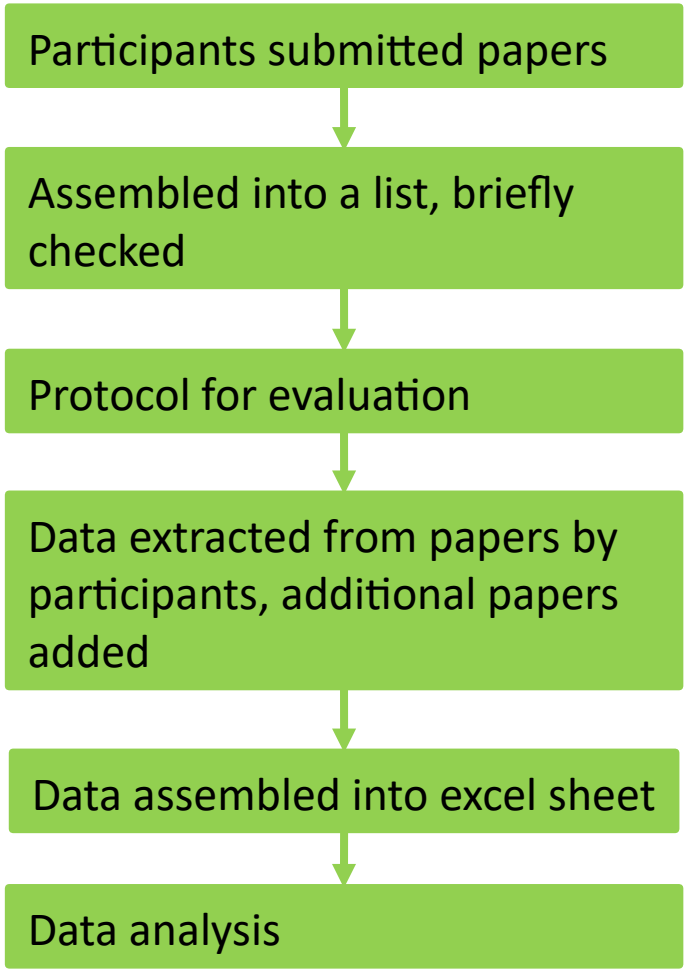
- Assessed the ecological success of previous riparian ecological restoration efforts
- Collect published studies and evaluating them according to a common protocol



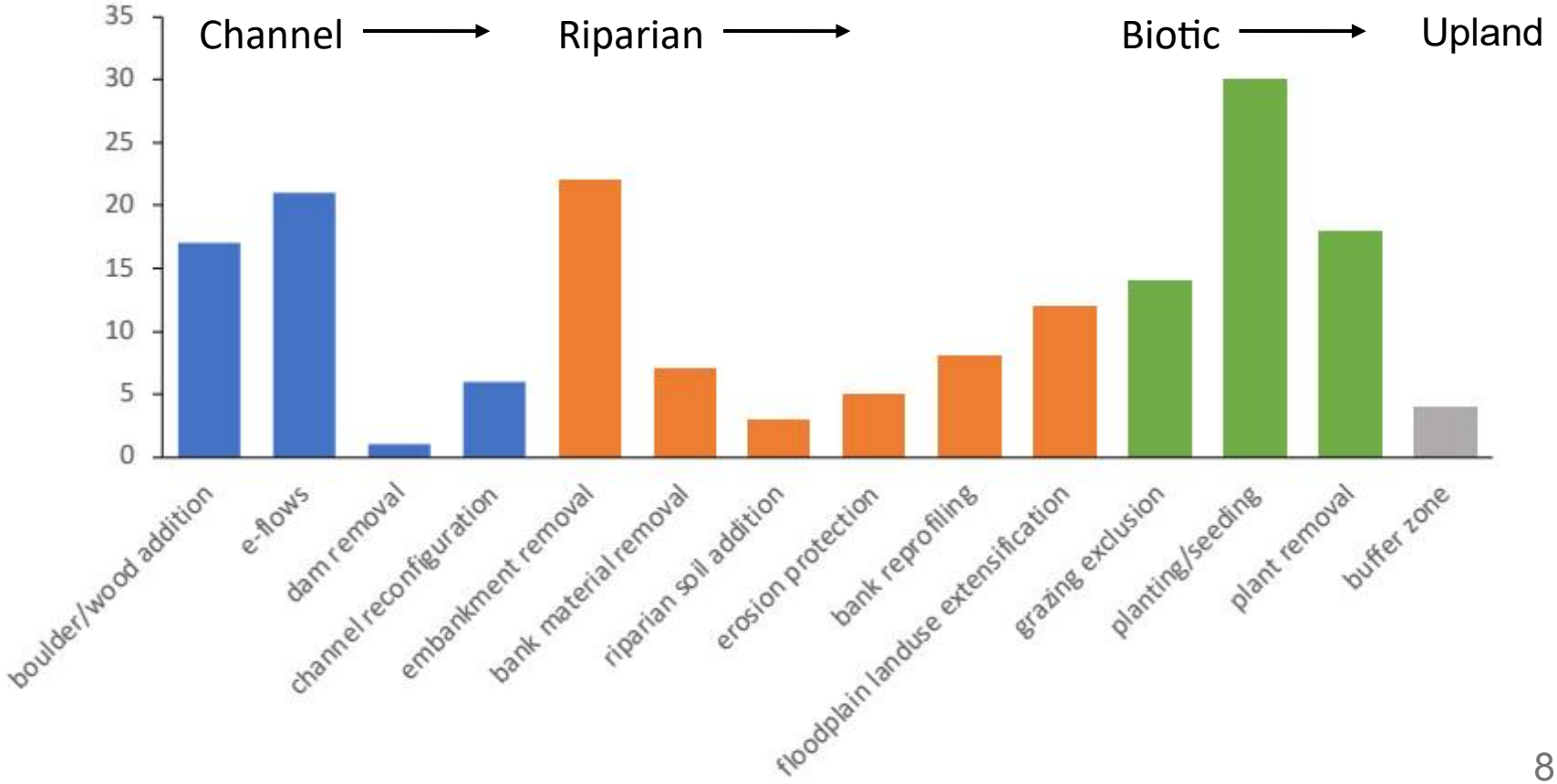
Aspect	definition	method of collecting information
Restoration measure	types of restoration actions.process-based, structural, or species-based	literature review
Reasons for degradation	drivers and pressures causing degradation motivating restoration	literature review
Have drivers of degradation been alleviated or are they ongoing?	spontaneous recovery	expert evaluation based on literature review; need of a database of restoration actions
Riparian ecological processes or conditions promoted	ecological and environmental benefits of the restoration actions	literature review
Ecosystem functions and services	ecosystem functions and services expected to be promoted by the restoration actions	literature review
Spatial scale	local; reach; catchment	expert evaluation based on literature review
Reference condition	Pristine conditions; traditional management	expert evaluation based on literature review
Target conditions or goals	full recovery, partial recovery, reinstate some specific structure or function	expert evaluation based on literature review
Recovery process	Is spontaneous recovery due to removal of pressures expected?	expert evaluation based on literature review
Evaluation of success	Classes in falling degrees of certainty	literature review
Geography	region or biome within Europe	questionnaire or project database needed
Water course types	types of water course	expert evaluation based on literature review
Catchment land cover	Dominating landcover types in the catchment	Corinne land cover classes?
Climate change	Expected effects of climate change on goals for restoration, reference conditions, restoration benefits, relevance and efficacy of the restoration method	expert evaluation based on literature review

Aims and methods

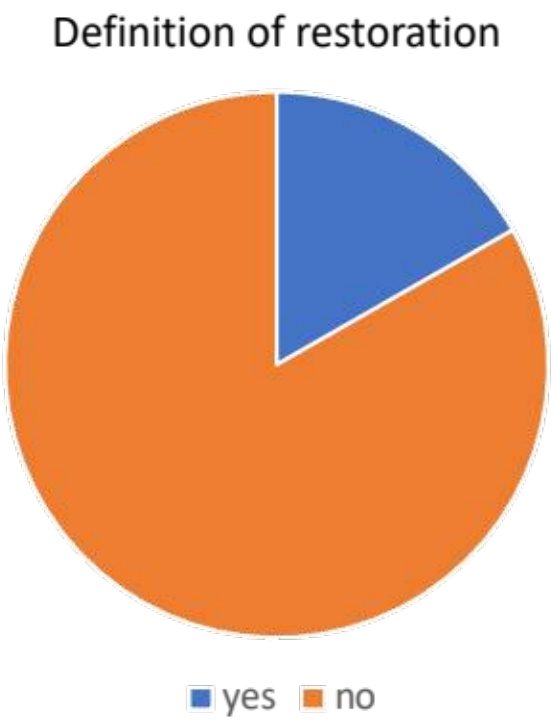
- Assessed the ecological success of previous riparian ecological restoration efforts
- Collect published studies and evaluating them according to a common protocol
- 150 studies
- Pressures and restoration methods
- Expectations (definition of restoration, reference conditions, hypothesis)
- Design of study
- Evaluation of success



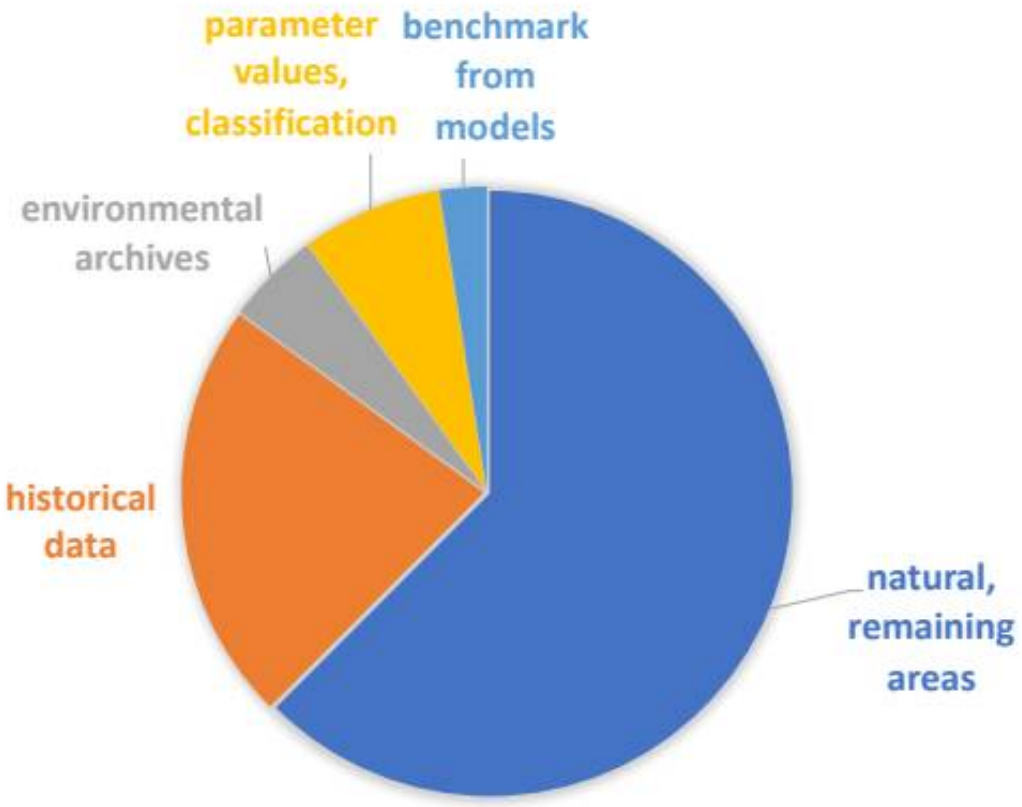
Restoration measures (response to pressures)



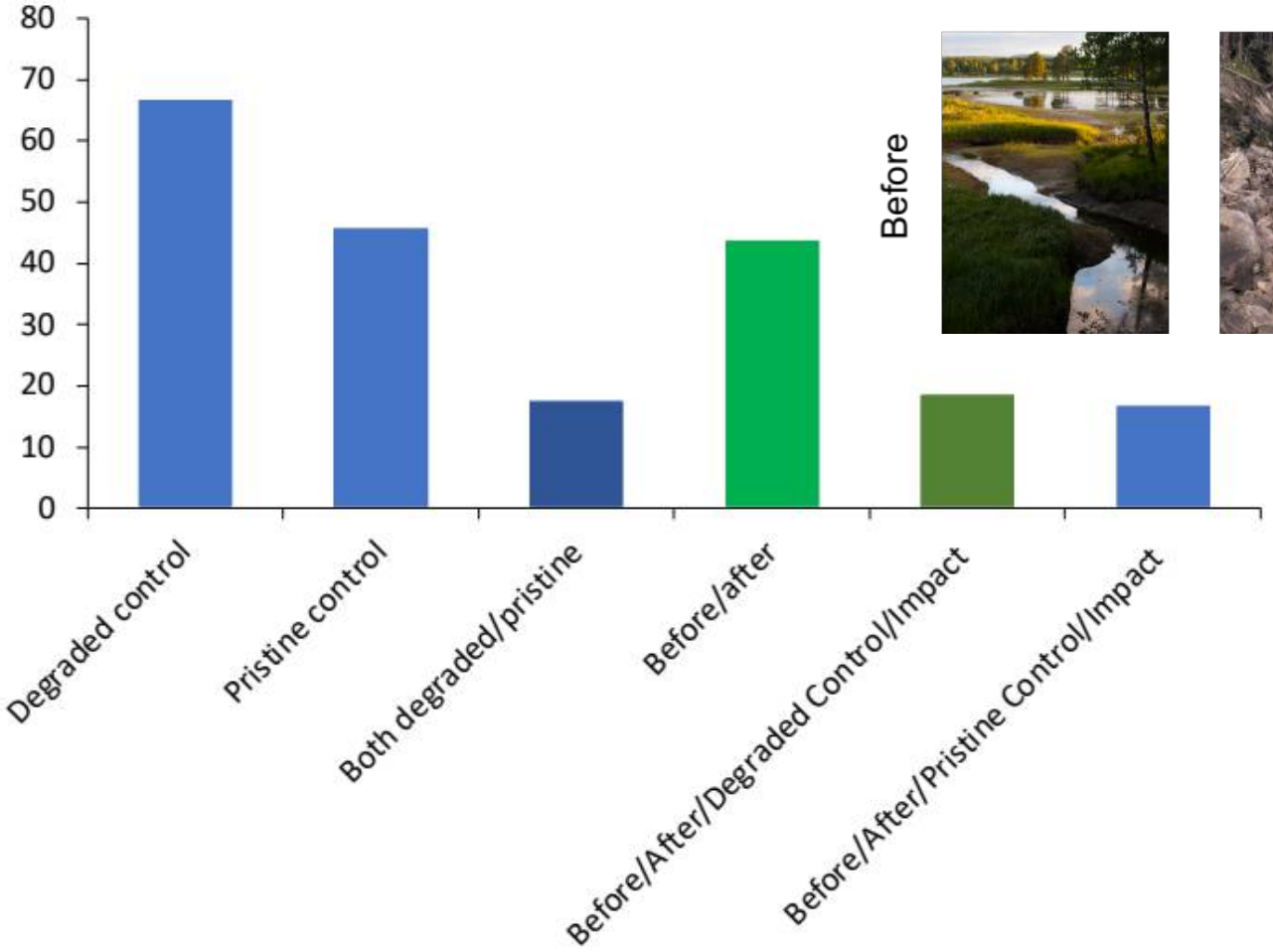
Targets, goals and expectations



Types of references used



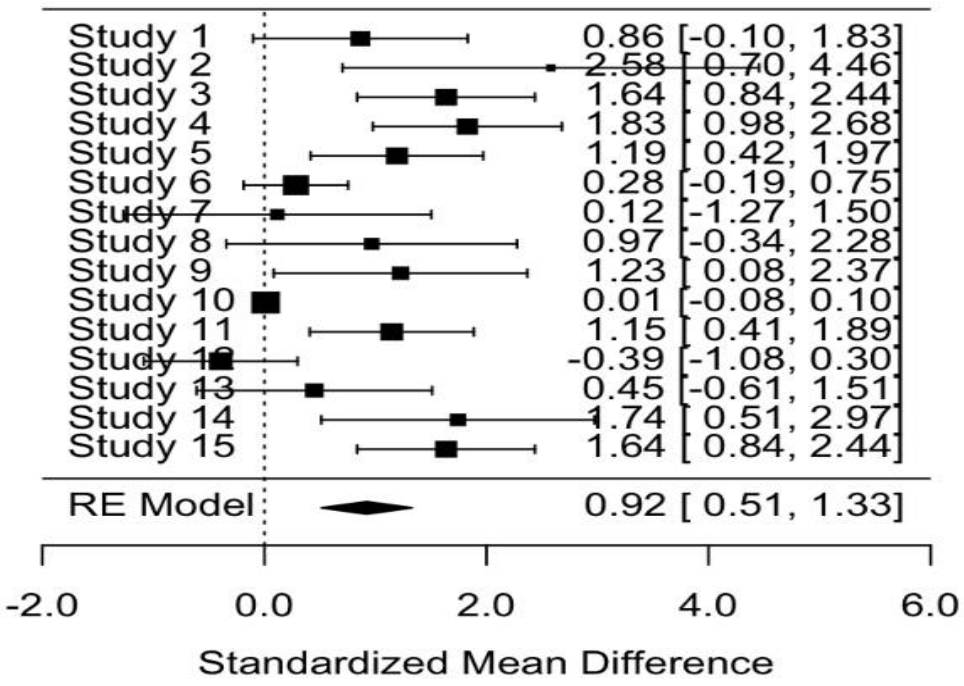
Study design



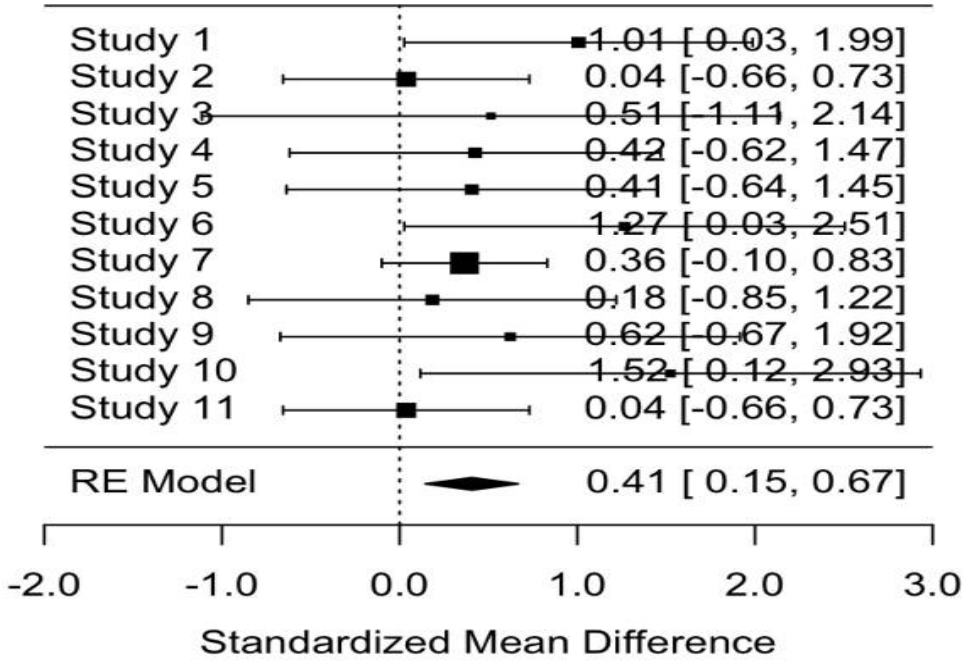
Evaluation of restoration sucess – meta analysis

- Weighted average of effect sizes of group of studies
- Sample size, standard deviations and means
- Random effects model
- Restored/unrestored or before/after
- Time since restoration ignored
- metafor package in R
- Webplotdigitizer to digitize data from graphs

Effect of restoration on riparian plant species richness



Effect of restoration on native riparian plant cover



Meta analysis for each restoration method and target variable

Restoration method	Variable	Effect size	*p*-value
Boulder/woood addition	Riparian species richness	0.50	<0.05
E-flows	Riparian species richness	0.26	0.43
Grazing exclusion	Riparian species richness	0.44	<0.05
Planting & seeding	Native species richness	1.46	<0.0001
Planting & seeding	Native plant cover	0.39	0.07
Plant removal	Native plant cover	0.56	0.20

Conclusions regarding methods

- Most studies of riparian restoration do not define restoration – but is this a problem?
- Most studies describe reference conditions, targets and do state a hypothesis
- Most studies either have controls or use before/after data, BACI-designs are rare (but probably impractical to execute in many cases)
- Means, variances and sample sizes should be reported in the era of online supplements!
- Restoration methods chosen to be direct responses to pressures – opportunity to choose methods restoring natural processes instead

Conclusions – restoration

- Restoration of riparian vegetation is mostly effective (in contrast to e.g. macroinvertebrates) – positive examples
- Do not take multiple studies with individually limited statistical power as evidence of lack of effect
- General environmental monitoring programmes are not necessarily effective in evaluating restoration success
- Riparian restoration can be implemented more widely – ready for upscaling!
- Restoration can help adapt riverine ecosystems to climate change and mitigate climate-change effects


Thank you!

Publication bias? Funnel plots