Process-Based Stream Restoration Effectively Alters Riparian Plant Functional Composition and Diversity

Katelyn P. Driscoll, Laurel F. Martinez, Thomas F. Turner

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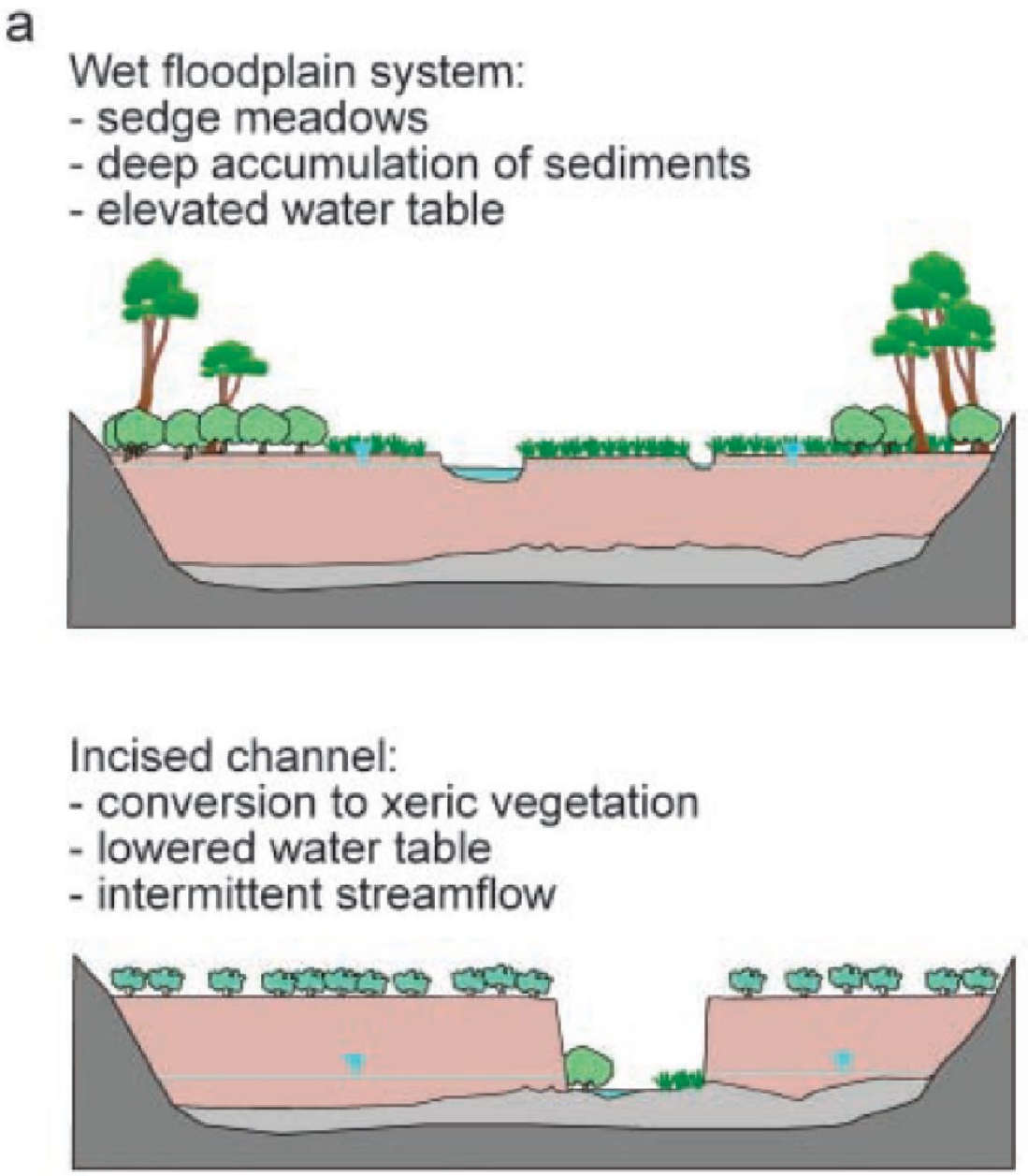
a


b

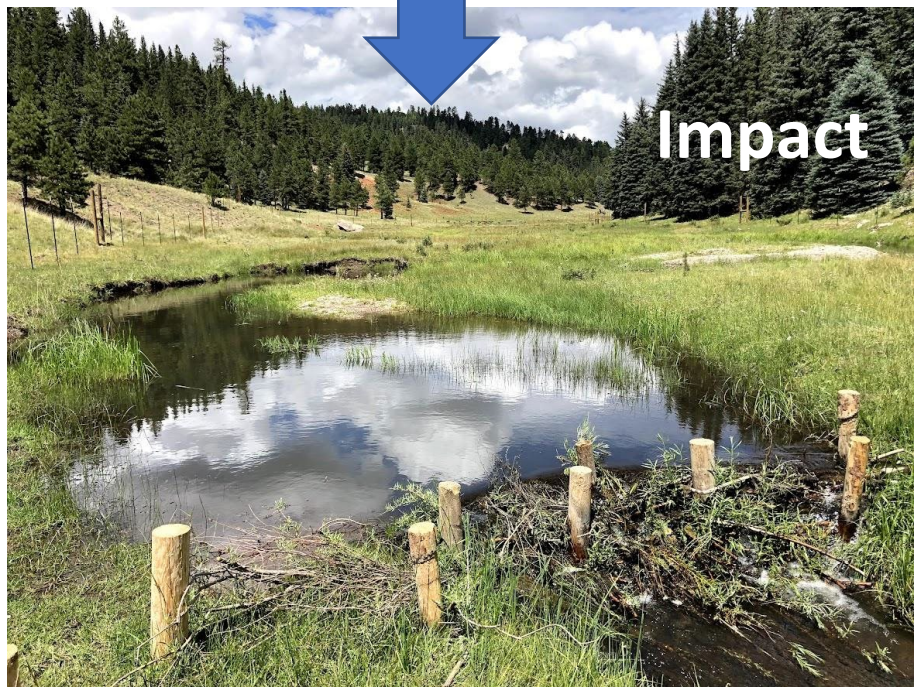
Process-based restoration in Streams

Aims to aggrade channels, slow runoff & retain water and sediment, raise water tables, and increase the magnitude, frequency, & duration of overbank flooding



Beechie et al. 2010

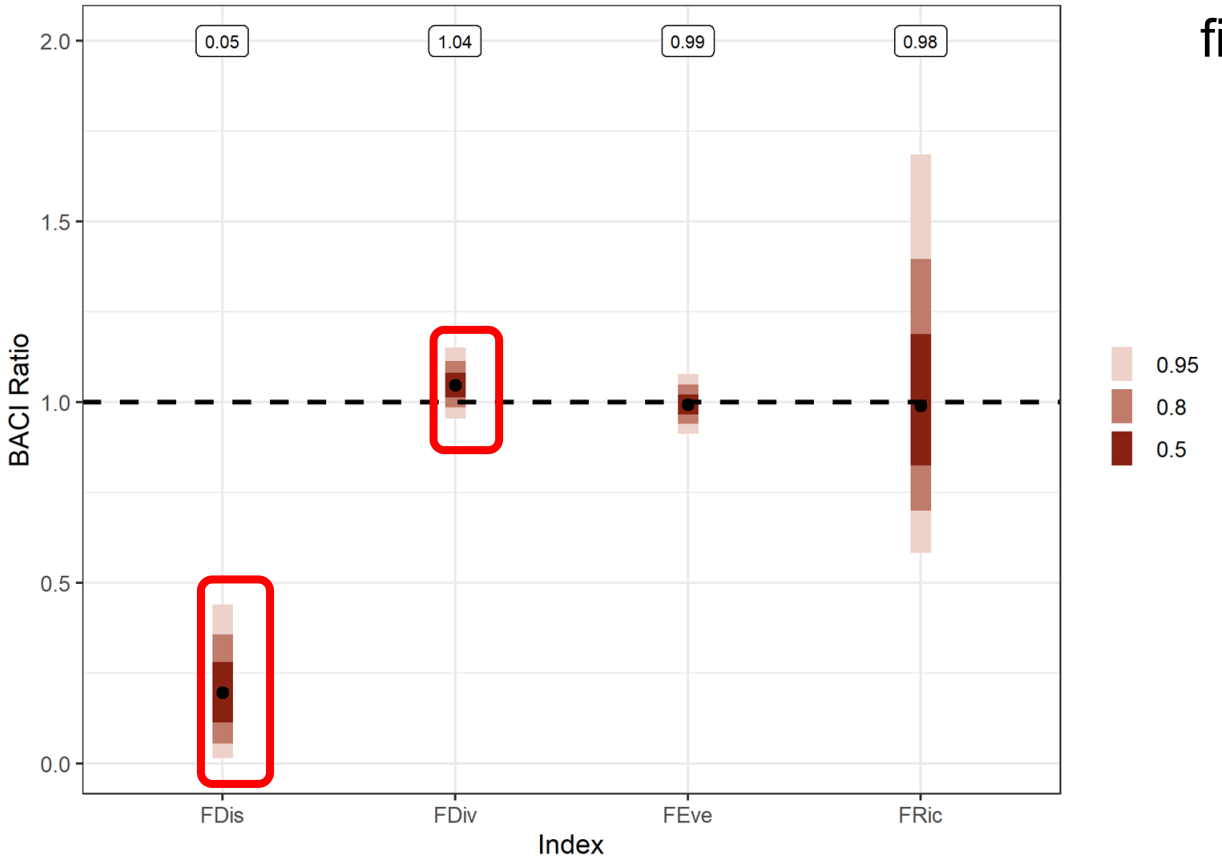
Before



After

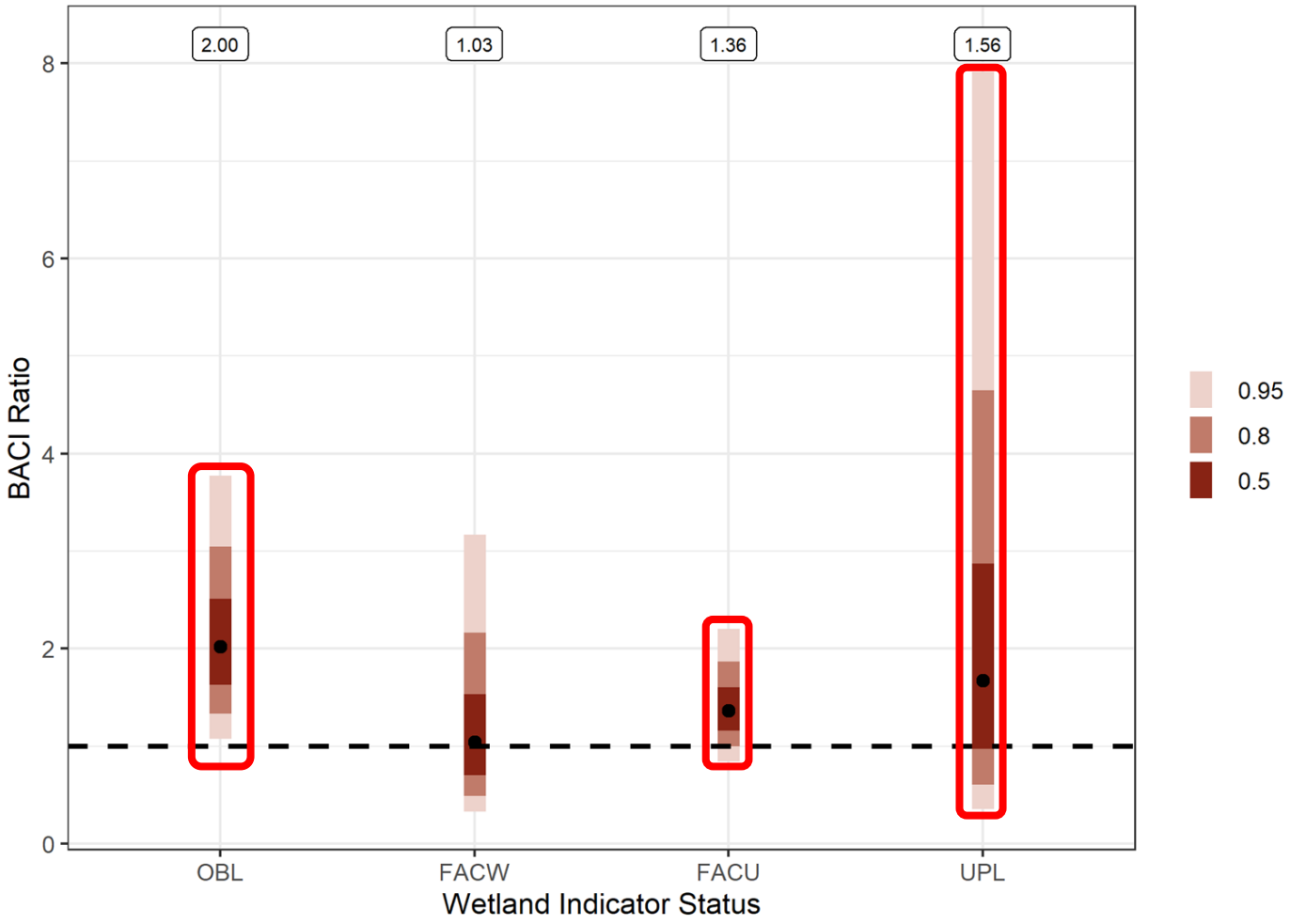
Trait-based approaches

- Functional traits are measurable characteristics of individuals that determine the response of an organism to the environment or describe effect on ecosystem function.
- Community assembly occurs as filtering imposed by disturbance, resource availability, or competition eliminates combinations of traits that are unsuitable for the environment.
- Dominant filters can be identified, and their strength assessed using functional diversity indices that measure the distribution of a community's species and their abundances in trait space, as well as community-weighted values for individual functional traits.
- Process-based restoration is well-suited to trait-based analysis, as it attempts to modify the dominant filters through which streamside plant communities assemble—water availability and fluvial disturbance.
- Trait data for many plant species is available in databases such as TRY or PLANTS. These data can be combined with species abundance data already collected through monitoring at many restoration sites.
- Several R packages, including FD, exist for calculating indices of functional diversity or community-weighted mean trait values.



BDAs substantially modified environmental filters & slightly altered ecosystem function.

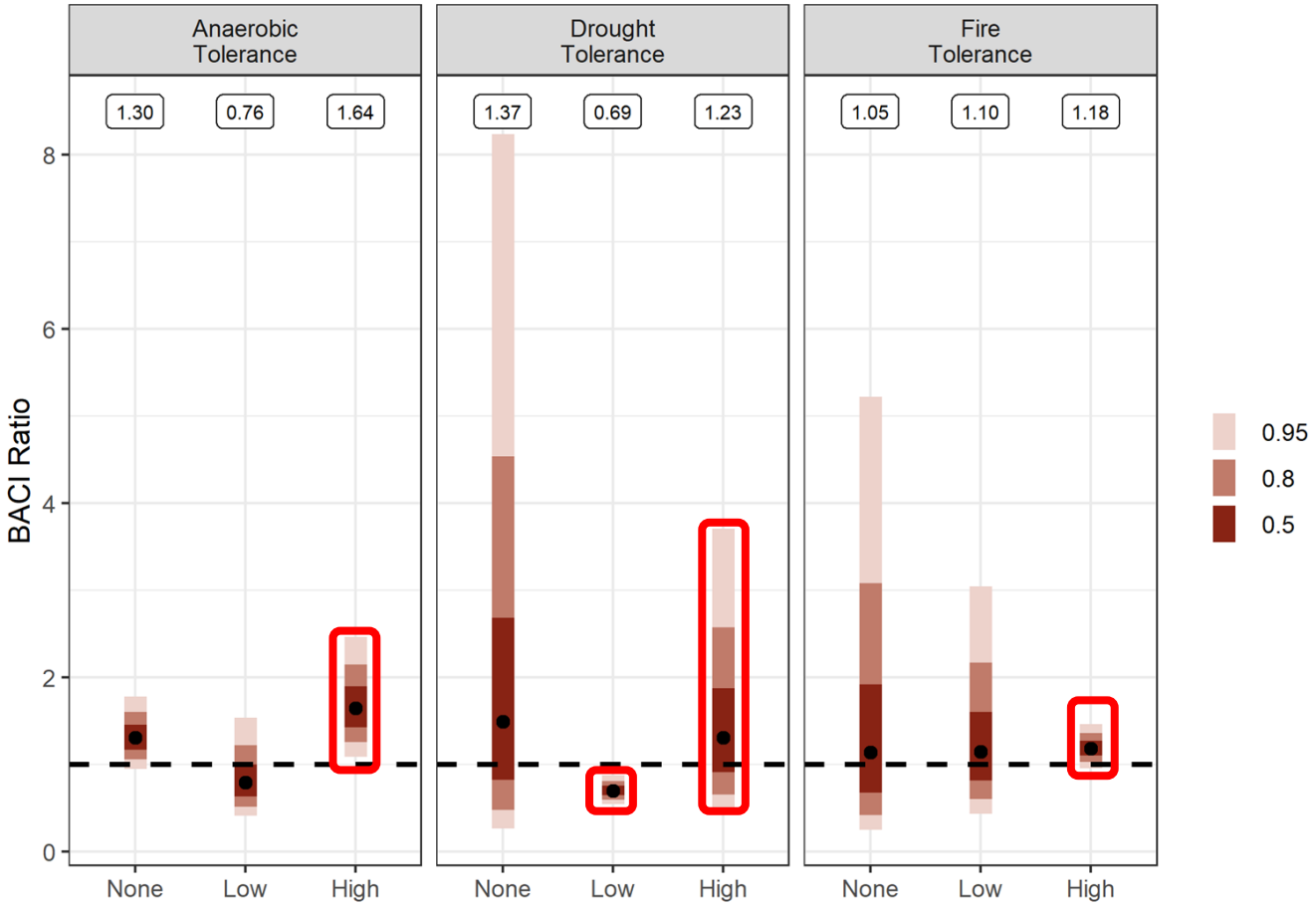
	BDAs			
	> 0 %	≥ 20 %	≥ 30 %	≥ 50 %
Increase				
Dispersion	0.00	0.00	0.00	0.00
Divergence	0.83	0.00	0.00	0.00
Richness	0.49	0.24	0.16	0.06
Evenness	0.44	0.00	0.00	0.00
Decrease				
Dispersion	1.00	1.00	1.00	0.99
Divergence	0.17	0.00	0.00	0.00
Richness	0.51	0.21	0.10	0.01
Evenness	0.56	0.00	0.00	0.00



BDAs substantially increased the cover of obligate wetland plants, as well as the cover of facultative and obligate upland plants.

	BDAs			
	> 0 %	≥ 20 %	≥ 30 %	≥ 50 %
Increase				
OBL	0.99	0.95	0.91	0.82
FACW	0.53	0.40	0.35	0.26
FACU	0.90	0.70	0.57	0.35
UPL	0.74	0.66	0.62	0.55
Decrease				
OBL	0.01	0.00	0.00	0.00
FACW	0.47	0.33	0.25	0.11
FACU	0.10	0.02	0.00	0.00
UPL	0.26	0.18	0.14	0.06

BDAs impacted the anaerobic, drought, and fire tolerance of the streamside plant community.



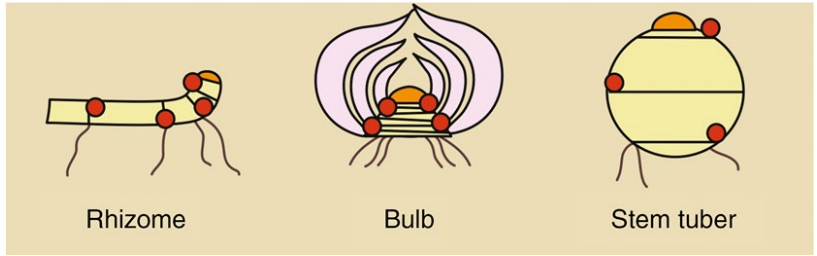
		BDAs			
		> 0 %	≥ 20 %	≥ 30 %	≥ 50 %
Increase					
Anaerobic Tolerance	High	0.99	0.94	0.87	0.67
	Low	0.25	0.11	0.07	0.03
	None	0.95	0.70	0.51	0.19
Drought Tolerance	High	0.69	0.57	0.51	0.41
	Low	0.00	0.00	0.00	0.00
	None	0.69	0.61	0.58	0.51
Fire Tolerance	High	0.94	0.46	0.20	0.01
	Low	0.62	0.47	0.41	0.30
	None	0.58	0.49	0.45	0.37
Decrease					
Anaerobic Tolerance	High	0.01	0.00	0.00	0.00
	Low	0.75	0.51	0.35	0.09
	None	0.05	0.00	0.00	0.00
Drought Tolerance	High	0.31	0.18	0.12	0.04
	Low	1.00	0.87	0.50	0.00
	None	0.31	0.23	0.18	0.10
Fire Tolerance	High	0.06	0.00	0.00	0.00
	Low	0.38	0.23	0.16	0.05
	None	0.42	0.31	0.25	0.14


Impact


Control

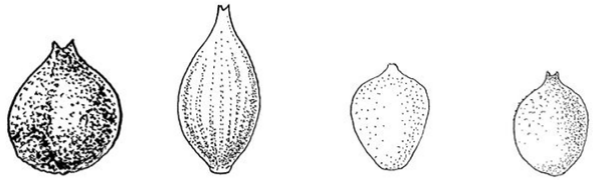
Persistence Niche

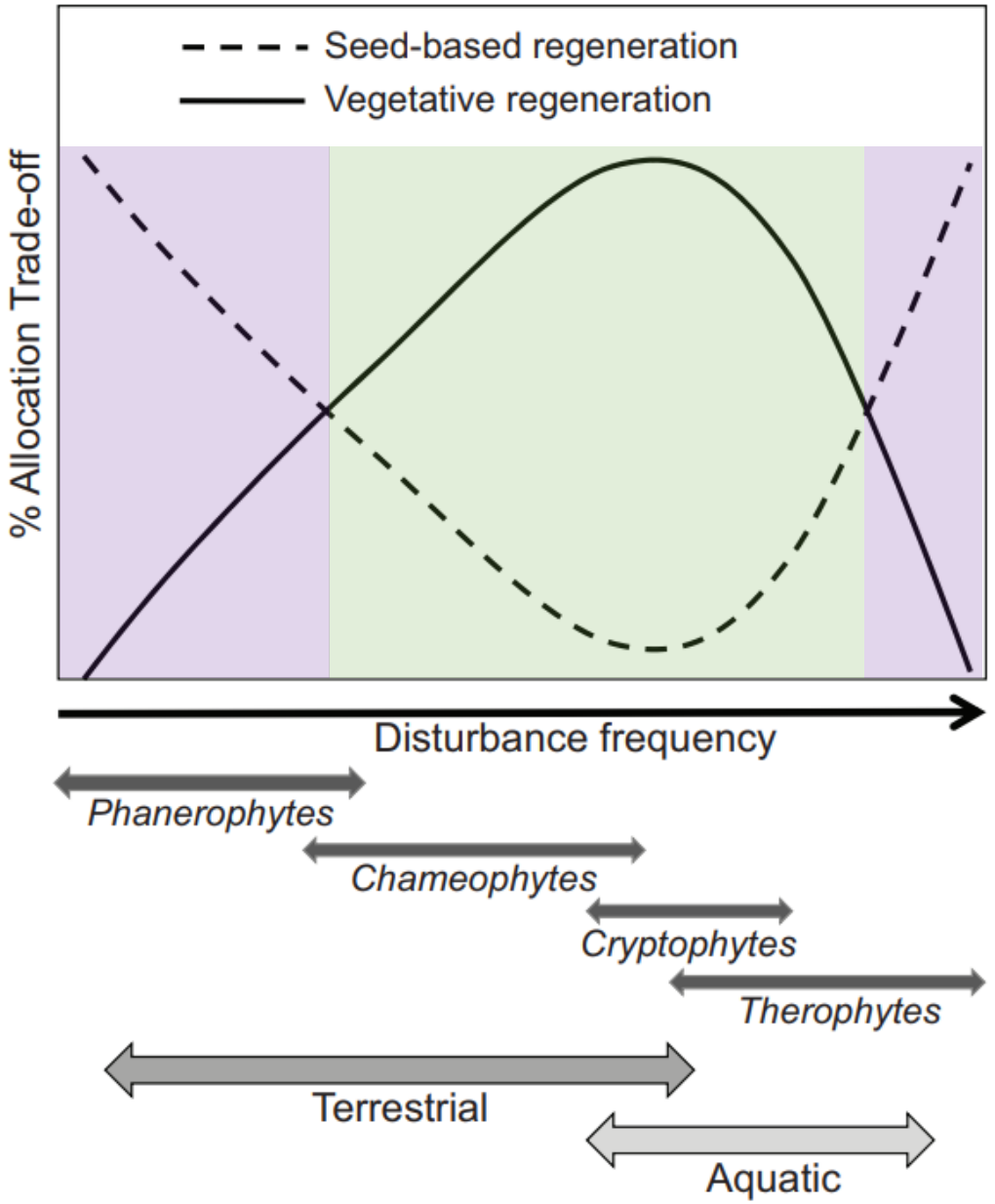
- Plant resprouting abilities drives recruitment
- Belowground bud banks



Regeneration Niche

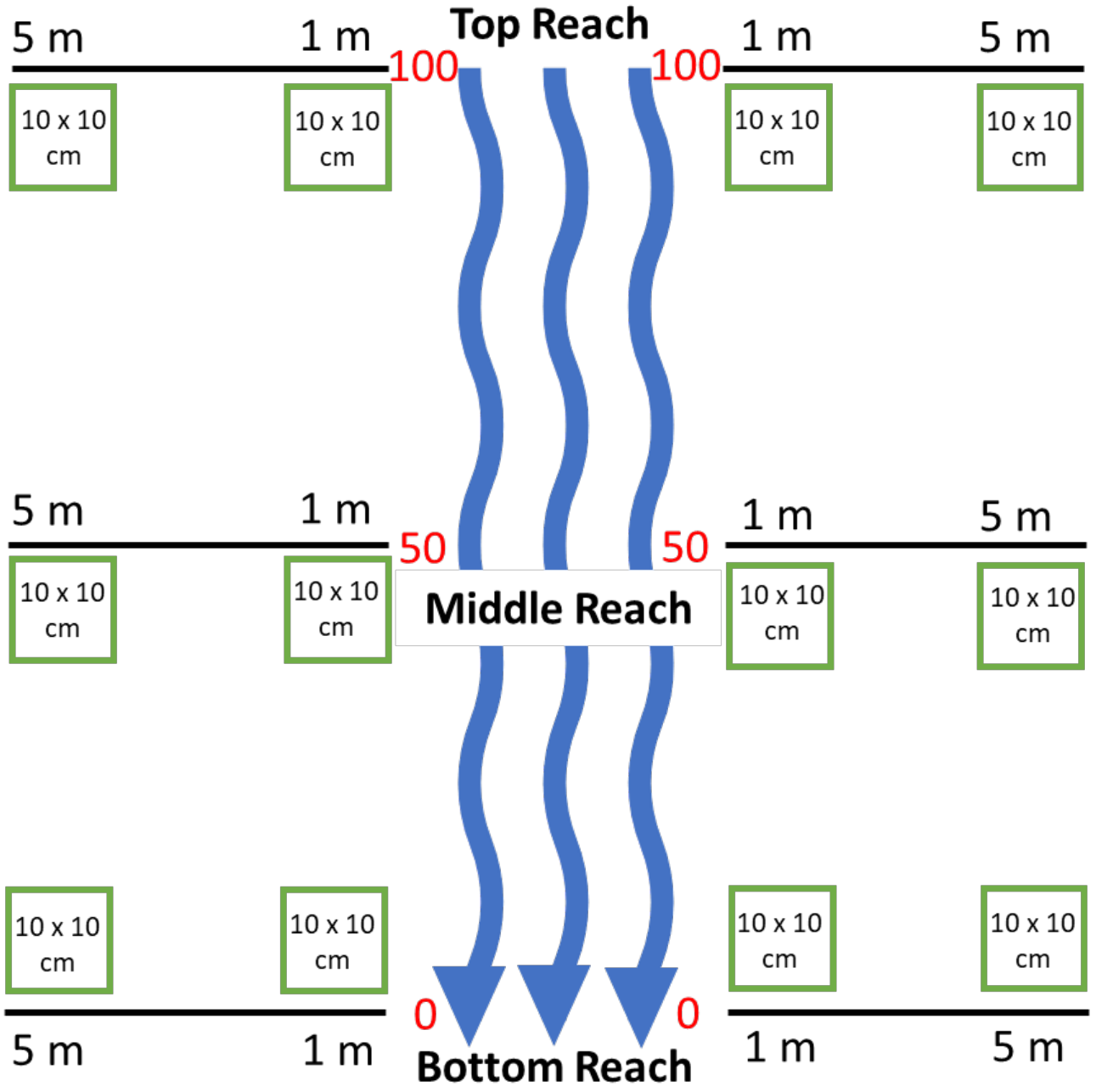
- Seedling requirements drives recruitment
- Soil seed bank





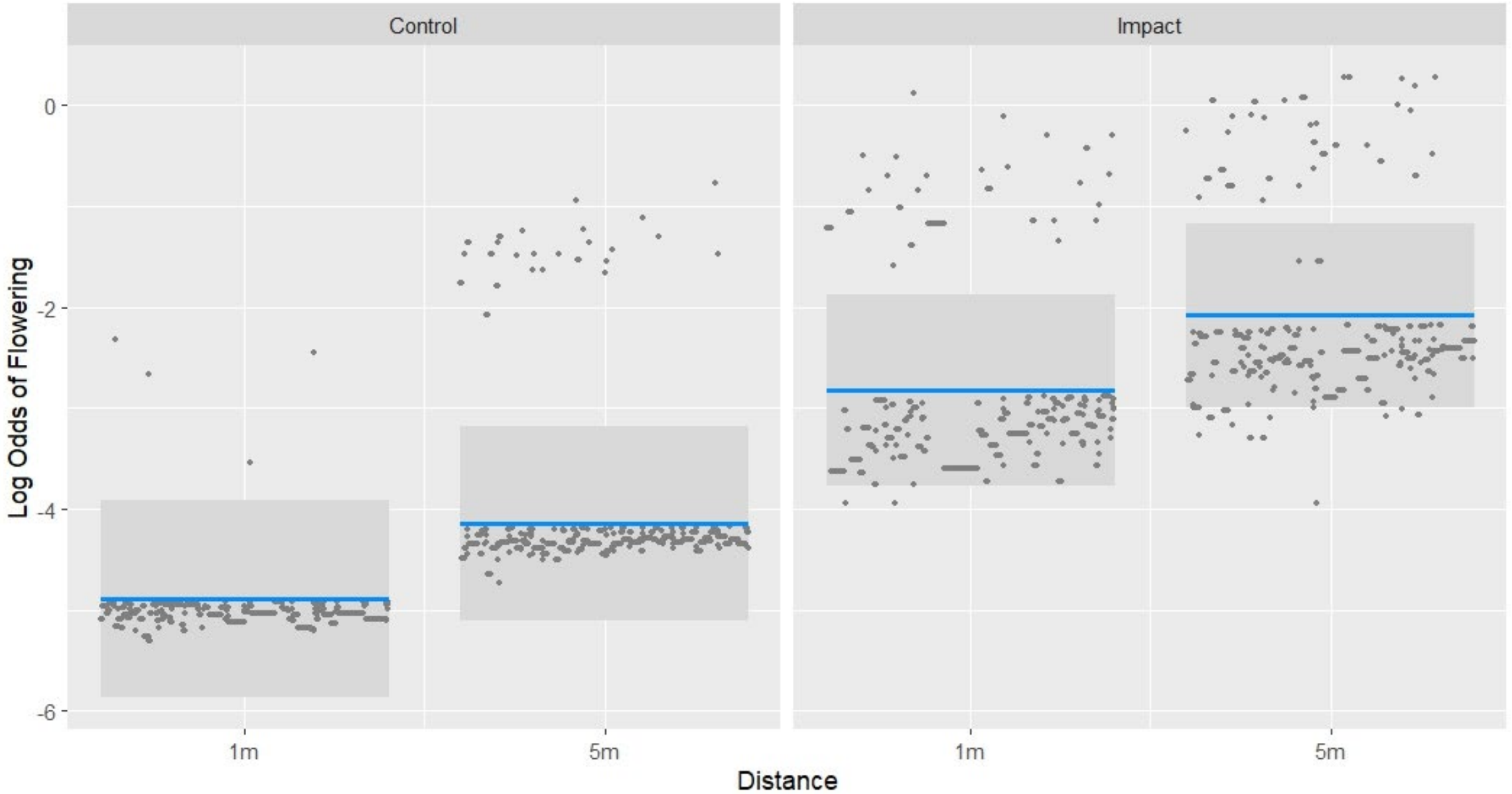
Clarke et al. 2015

- Flowering and non-flowering stem counts



- Rhizome length and mass

More clonal investment closer to the stream
More seed investment farther from the stream



Summary

- Bayesian analysis of BACI data provides more easily interpreted results and a probability of effect size to consider when balancing trade-offs between cost of restoration, conservation, or no action.
- Indices of functional diversity can be used to evaluate whether restoration modifies environmental filters and ecosystem function.
- Lower functional diversity can be an appropriate restoration target.
- Community-weighted trait values for wetland indicator status & traits that respond to water availability and fluvial disturbance can be used to determine if restoration recovered a riparian plant community.
- Trait databases can be combined with typical plant species monitoring that already occurs at many restoration sites to complete trait-based evaluation of restoration success.
- Monitoring reproductive strategies can be useful for determining where seeding techniques will be most effective.
- The importance of clonal growth in riparian ecosystems underscores how new techniques like sodding could benefit recruitment.

Questions?

Acknowledgements

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