

Supplement to the article: Schulz-Zunkel et al.: Effective restoration measures in river-floodplain ecosystems: lessons learned from the 'Wilde Mulde' project

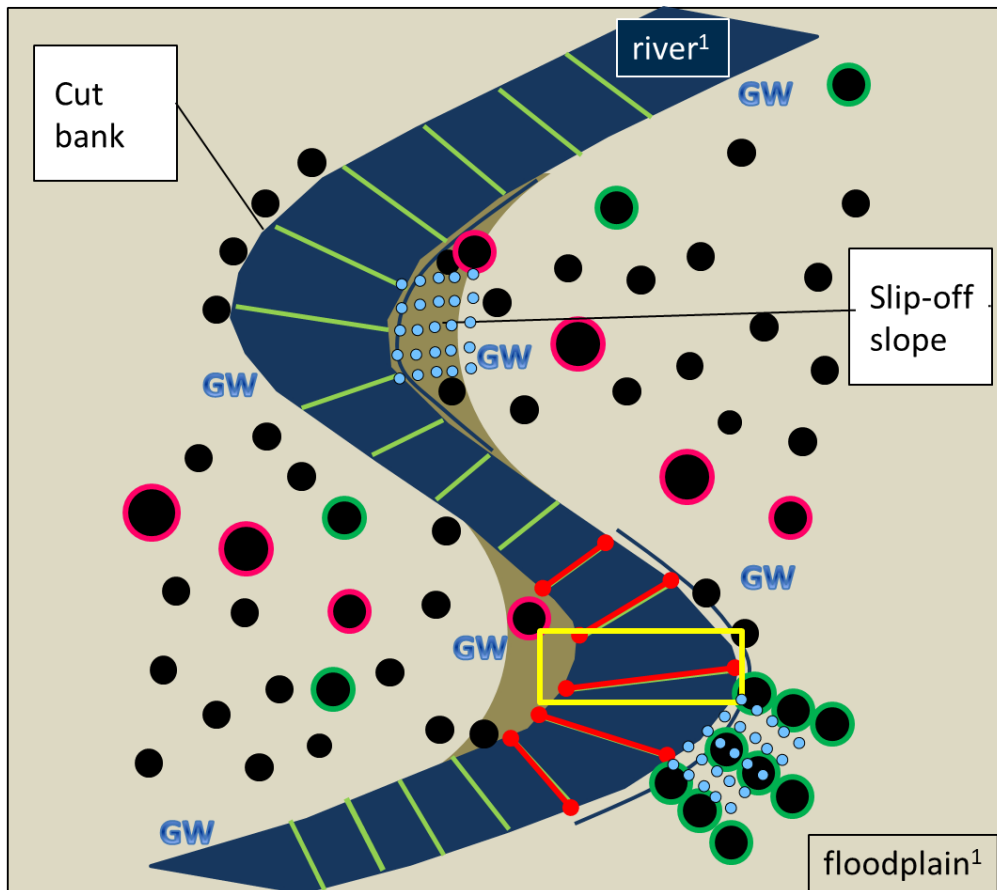


Figure S1: Monitoring design for the investigated indicators based on sampling plots and transects.

(Green and red lines: transects in the river for measuring morphological (topography by echo sounding and grain size by point sampling) and hydraulic (water depth by echo sounding and flow velocity with acoustic doppler devices ADV and ADCP) parameters // aquatic biodiversity² (macroinvertebrates & fish according to the EU-WFD; ecosystem functions; **Yellow rectangle:** sampling plot macrophytes and riparian vegetation were mapped in monitoring plots of approx. 100 m width using the LONDO scale (Dierschke 1994); **Black lines:** transect for two dragonfly species of the EU-Habitat Directive (Dziock et al. 2009; **Light blue dots:** pitfall traps for ground beetles (Sprössig et al. 2020; Sprössig et al., this special issue), **Black dots:** Vegetation plots (Seele-Dilbat et al. this issue; **Green circles:** plots for soil characteristics (AG Boden KA5, 2005) and soil sampling for standard laboratory analysis (pollutants); **Red circles:** plots for soil characteristics (AG Boden KA5,

2005) and soil sampling for standard laboratory analysis (nutrients); **GW**: Groundwater monitoring sites

¹ high resolution scans of the floodplain (3 x 3 cm from structure from motion) and river bed (1 x 1 m from echo sounding) topography

² Sample sites for macroinvertebrates, fish and ecosystem functions were chosen to cover the major geomorphic structures (cut bank, slip-off slope, thalweg) and the variation within these structures. We samples at three spots within each structure that marked the beginning, middle and end of the structure. Macroinvertebrates were sampled from three spots per site and geomorphic structure with a Surber sampler (500µm mesh). At each spot, we took five replicates equalling to a sampled area of 0.375 m². Replicated samples were pooled into a composite sample per spot and preserved in 70% alcohol. Macroinvertebrates were sorted, counted and identified to species or genus, except for Oligochaeta (order level) and Diptera (family level) excluding Chironomidae (species or genus level) in the laboratory.

References

AG Boden (2005): Bodenkundliche Kartieranleitung, 5. Auflage, Hannover.

Dierschke, H. 1994: Pflanzensoziologie. Stuttgart. 683 S.

Sprössig, C., Buchholz, S. & Dziock, F. 2020: Defining the baseline for river restoration: comparing carabid beetle diversity of natural and human-impacted riparian habitats. *Journal of Insect Conservation* 24 (5), 805–820.

Dziock, F., K. Wacowska, S. Siegl, T. Briesenick & Ernst, R. 2009: Erfassung und Bewertung der Vorkommen der Asiatischen Keiljungfer und der Grünen Flussjungfer an der Elbe bei Roßlau. *Naturschutz im Land Sachsen-Anhalt* 46, 169-175.

Table S1: Location of the study sites and the implemented measures

study sites and implemented measures	width	length	upstream until	
Impact site: 'Installation of Large Wood', whole	51°47'57.69"N	12°16'27.99"E	51°48'0.70"N	12°16'44.03"E
Large Wood_01	51°51'44.62"N	12°15'7.45"E		
Large Wood_02	51°51'26.91"N	12°15'29.42"E		
Large Wood_03	51°47'59.79"N	12°16'6.82"E		
Large Wood_04	51°47'58.74"N	12°16'8.87"E		
Large Wood_05	51°47'55.78"N	12°16'18.29"E		
Large Wood_06	51°47'58.52"N	12°16'28.53"E		
Control site Natural River Bank, whole				
Control site Natural River Bank, cut-off bank	51°46'16.56"N	12°17'50.49"E	51°46'1.00"N	12°18'3.12"E
Control site Natural River Bank, cut-off bank	51°46'15.69"N	12°17'48.14"E	51°46'7.08"N	12°17'49.41"E
Control site Natural River Bank, slip-off slope eastern bank	51°46'16.04"N	12°17'51.72"E	51°46'8.39"N	12°17'51.31"E
Control site Natural River Bank, slip-off slope western bank (gravel bar)	51°46'6.20"N	12°17'52.20"E	51°46'0.32"N	12°18'0.94"E
Impact site, Removal of rip-rap, whole	51°45'15.71"N	12°18'21.97"E	51°44'39.49"N	12°18'30.77"E
Impact site, Removal of rip-rap, slip-off slope	51°44'56.75"N	12°18'28.84"E	51°44'40.71"N	12°18'29.90"
Impact site, Removal of rip-rap, cut-off bank	51°44'58.46"N	12°18'30.34"E	51°44'43.37"N	12°18'39.18"E
Control site, rip-rap, whole	51°43'56.78"N	12°18'1.21"E	51°43'40.41"N	12°17'36.15"E
			flow length approx. 880 m	
Impact site re-connection of a former side-arm			51°51'58.09"N	12°14'12.30"E
re-connection point to the Mulde river	51°52'1.73"N	12°14'53.54"E		

Table S2: Single indicators of different organism groups that were used as biological indicators to test for the effect of the restoration measures installation of large wood (LW) and removal of rip-rap (RR) at different spatial scales (local versus reach-scale; local-scale refers to effects measured at single strata that were directly affected by the impact (river, cutbank); reach-scale effects were measured for RR only, referring to effects measured at several strata (cutbank, slip-off slope, river) integrated for the whole meander curve).

[0: no effect; ↗ positive effect towards natural conditions; ↘ reducing effect; effects that were not investigated are shown with light grey highlighted fields]

	Large wood (LW)			Removal of rip-rap (RR)					
	local-scale (LW _{ls})			local-scale (RR _{ls})			reach-scale (RR _{rs})		
	BACI	BA	CI	BACI	BA	CI	BACI	BA	CI
Biological indicators									
Macroinvertebrates			0	0			0		
Abundance			0	0			0		
Diversity			0	0			0		
Fish			↗				↗↘		
Abundance			↗				↗		
Species richness/Diversity							↗↘		
Biomass (total)							↗		
Age-Structure							↗		
relevant keystone species (FFH)							↗		
Dragonflies				0					
Abundance of <i>Ophiogomphus cecilia</i>				0					
Abundance of <i>Gomphus vulgatissimus</i>				0					
FFH conservation status of <i>Ophiogomphus cecilia</i>				0					
FFH conservation status of <i>Gomphus flavipes</i>				0					
Carabids				0 ↗					
Species richness				0					
Functional evenness				0					
Functional dispersion				0					
Functional divergence				0					
Species of conservation concern				↗					
Indicator species for nature sites				↗					
Indicator species for managed sites				↘					
Vegetation				0					
Taxonomic composition				↗					
Functional composition				0					
Species richness				0					
Functional richness				↗					
Functional dispersion				0					
Functional uniqueness				0					
Spatial β-diversity				↗					
Temporal β-diversity				↗					
Birds				↗					
Breeding birds (keystone species)				↗					