Riverine community (dis)equilibrium
Appendix

Table S1: Seven trait categories and associated trait modalities used for evaluating functional trait diversity and assessing functional trait abundances. Traits were compiled from Poff et al. (2006).

Trait Category		Modality
Dispersal	Dispersal	(1) Low (< 1 km flight before oviposition)
		(2) High (> 1 km flight before oviposition)
	Flying Strength	(1) Nonflyer
		(2) Weak flyer
		(3) Strong flyer
	Body Size	(1) Small
		(2) Medium
		(3) Large
Habitat	Rheophily	(1) Depositional
		(2) Depositional-erosional
		(3) Erosional
	Thermal Preference	(1) Cold
		(2) Cool-warm
		(3) Warm
	Pollution Tolerance	(1) Sensitive
		(2) Intermediate
		(3) Tolerant
Ecology	Functional Feeding Group	(1) Collector-gatherer (including shredders*)
		(2) Collector-filterer
		(3) Herbivore
		(4) Predator

*Only one shredder was retained in our dataset (*Lepidostoma*) and comprised less than 0.50% of total abundance.

Table S2: Summary statistics [mean (1 standard deviation)] for predictor variables used in the boosted regression tree (BRT) analyses. Ecoregions are abbreviated as: coastal plain = CPL, northern Appalachians = NAP, northern plain = NPL, southern Appalachians = SAP, southern plain = SPL, temperate plain = TPL, western mountains = WMT, upper Midwest = UMW, and xeric = XER. We selected seven environmental variables [total nitrogen (μg L^{-1}, Total N), total phosphorus (μg L^{-1}, Total P), dissolved organic carbon (mg L^{-1}, DOC), large woody debris (m^3 per 100 m, LWD), natural streambed cover (proportion, NAT Cover), algal cover (proportion, ALG Cover), and macrophyte cover (proportion, AQM Cover)], four landscape variables [forested cover (% of basin area, % For), agricultural cover (% of basin area, % Ag), urban cover (% of basin area, % Urb), and impervious surface cover (% of basin area, % ISC)], and seven network [latitude, longitude, basin area (km^2), mean annual flow (m^3 s^{-1}, Mean Flow), mean basin elevation (m, Mean Elevation), range of basin elevation (m, Range Elevation), and site centrality (distance to centroid in km, Centrality)] variables.

Variable	Ecoregion								
	CPL	NAP	NPL	SAP	SPL	TPL	UMW	WMT	XER
Environmental									
Total N	1283.29	664.01	1314.80	1046.70	1809.89	3558.77	1558.52	251.54	782.36
	(1810.43)	(838.80)	(4167.53)	(2309.52)	(3422.72)	(4082.09)	(1922.09)	(601.52)	(2297.26)
Total P	199.55	56.99	230.96	87.24	455.05	238.53	150.54	126.42	166.96
	(336.10)	(114.48)	(584.58)	(195.46)	(1280.51)	(495.88)	(381.49)	(911.44)	(542.55)
DOC	10.08 (14.70)	4.02 (2.91)	7.85 (5.21)	2.37 (1.82)	4.48 (2.73)	5.57 (8.58)	9..41 (10.11)	1.93 (1.90)	2.94 (2.37)
LWD	2.61 (5.18)	5.37 (8.24)	1.13 (4.15)	4.82 (13.11)	2.83 (10.98)	3.96 (10.08)	3.52 (5.77)	6.30 (13.96)	1.15 (2.50)
NAT Cover	0.39 (0.31)	0.54 (0.34)	0.21 (0.24)	0.37 (0.21)	0.24 (0.22)	0.23 (0.18)	0.29 (0.19)	0.52 (0.40)	0.40 (0.37)
ALG Cover	0.04 (0.12)	0.04 (0.09)	0.05 (0.13)	0.01 (0.04)	0.06 (0.13)	0.04 (0.10)	0.04 (0.10)	0.04 (0.09)	0.07 (0.14)
AQM Cover	0.10 (0.17)	0.05 (0.09)	0.11 (0.18)	0.03 (0.07)	0.07 (0.16)	0.05 (0.16)	0.07 (0.14)	0.08 (0.14)	0.12 (0.18)
Landscape									
% For	39.64 (25.47)	65.69 (27.18)	8.76 (15.91)	62.23 (25.61)	12.42 (16.59)	9.78 (15.66)	38.20 (24.42)	65.86 (21.74)	31.29 (26.64)
% Ag	24.69 (26.66)	15.48 (22.07)	18.60 (21.58)	20.34 (21.66)	26.56 (25.55)	72.16 (24.71)	31.68 (29.80)	0.34 (1.07)	1.78 (5.17)
% Urb	11.65 (19.86)	9.29 (15.47)	1.72 (1.45)	11.45 (18.96)	4.41 (6.37)	8.08 (12.88)	7.07 (14.59)	1.37 (2.53)	1.59 (3.56)
% ISC	2.80 (7.35)	2.12 (4.43)	0.29 (0.17)	2.31 (5.54)	0.83 (2.75)	1.55 (3.80)	1.52 (5.86)	0.24 (0.49)	0.42 (0.95)
Network									
Latitude	33.71 (3.37)	42.79 (3.37)	45.45 (1.63)	36.80 (2.10)	37.21 (3.39)	41.35 (2.79)	44.91 (1.71)	41.71 (4.34)	39.42 (3.25)
Longitude	−86.09 (6.84)	−74.88 (3.84)	−103.84 (3.30)	−83.95 (5.53)	−99.71 (2.59)	−92.30 (4.37)	−89.63 (3.25)	−114.35 (6.27)	−114.09 (4.42)
Basin Area	74.44	79.45	4423.64	171.52	15335.91	525.25	243.81	688.62	5671.01
	(260.34)	(226.01)	(7566.12)	(638.19)	(28135.59)	(1715.87)	(567.93)	(1755.52)	(20665.27)
Mean Flow	0.83 (2.63)	1.23 (3.31)	1.57 (3.74)	2.20 (8.37)	18.62 (50.78)	0.85 (1.50)	1.30 (2.29)	1.88 (4.73)	7.12 (18.97)
Mean Elevation	71.42	373.20	1089.50	358.49	996.35	319.56	336.65	1965.92	1957.40
	(46.25)	(178.08)	(451.04)	(232.92)	(655.02)	(95.01)	(80.00)	(859.14)	(559.95)
Range Elevation	42.84	285.52	665.34	237.58	1058.55	85.99	94.89	982.02	1383.13
	(39.73)	(261.51)	(585.38)	(246.51)	(1271.65)	(71.80)	(66.57)	(595.57)	(728.23)
Centrality	626.61 (208.16)	566.39 (196.10)	456.08 (160.82)	601.24 (209.48)	579.67 (214.03)	650.70 (227.91)	727.24 (217.67)	620.51 (227.77)	683.80 (225.49)

Table S3: Summary of the ANCOVAs comparing environmental filtering against functional trait diversity [functional richness (FRic), functional evenness (FEve), functional divergence (FDiv) and functional dispersion (FDis)]. We report the degrees of freedom (df), F-statistics calculated from type III sums-of-squares, and the effect size (partial eta-squared, η^2_P) for each term in the ANCOVAs.

Term	df	F	P-value	η^2_P
		FRic		
FRic	1	0.075	0.784	0.000
Ecoregion	8	77.853	< 0.001	0.380
FRic × Ecoregion	8	1.591	0.123	0.012
Residuals	1015			
		FEve		
FEve	1	0.256	0.613	0.000
Ecoregion	8	82.861	< 0.001	0.392
FEve × Ecoregion	8	0.544	0.823	0.004
Residuals	1027			
		FDiv		
FDiv	1	0.076	0.783	0.000
Ecoregion	8	77.745	< 0.001	0.377
FDiv × Ecoregion	8	2.256	0.022	0.017
Residuals	1027			
		FDis		
FDis	1	0.001	0.979	0.000
Ecoregion	8	93.792	< 0.001	0.418
FDis × Ecoregion	8	0.244	0.982	0.002
Residuals	1046			

Table S4: Summary of the ANCOVAs comparing habitat matching against functional trait diversity [functional richness (FRic), functional evenness (FEve), functional divergence (FDiv) and functional dispersion (FDis)]. We report the degrees of freedom (df), F-statistics calculated from type III sums-of-squares, and the effect size (partial eta-squared, η^2_P) for each term in the ANCOVAs.

Term	df	F	P-value	η^2_P
		FRic		
FRic	1	2.373	0.124	0.002
Ecoregion	8	7.915	< 0.001	0.059
FRic × Ecoregion	8	7.388	< 0.001	0.055
Residuals	1015			
		FEve		
FEve	1	4.277	0.039	0.004
Ecoregion	8	3.276	0.001	0.025
FEve × Ecoregion	8	4.337	< 0.001	0.033
Residuals	1027			
		FDiv		
FDiv	1	6.092	0.014	0.006
Ecoregion	8	1.802	0.073	0.014
FDiv × Ecoregion	8	2.322	0.018	0.018
Residuals	1027			
		FDis		
FDis	1	0.968	0.325	0.001
Ecoregion	8	0.669	0.719	0.005
FDis × Ecoregion	8	0.695	0.696	0.005
Residuals	1046			

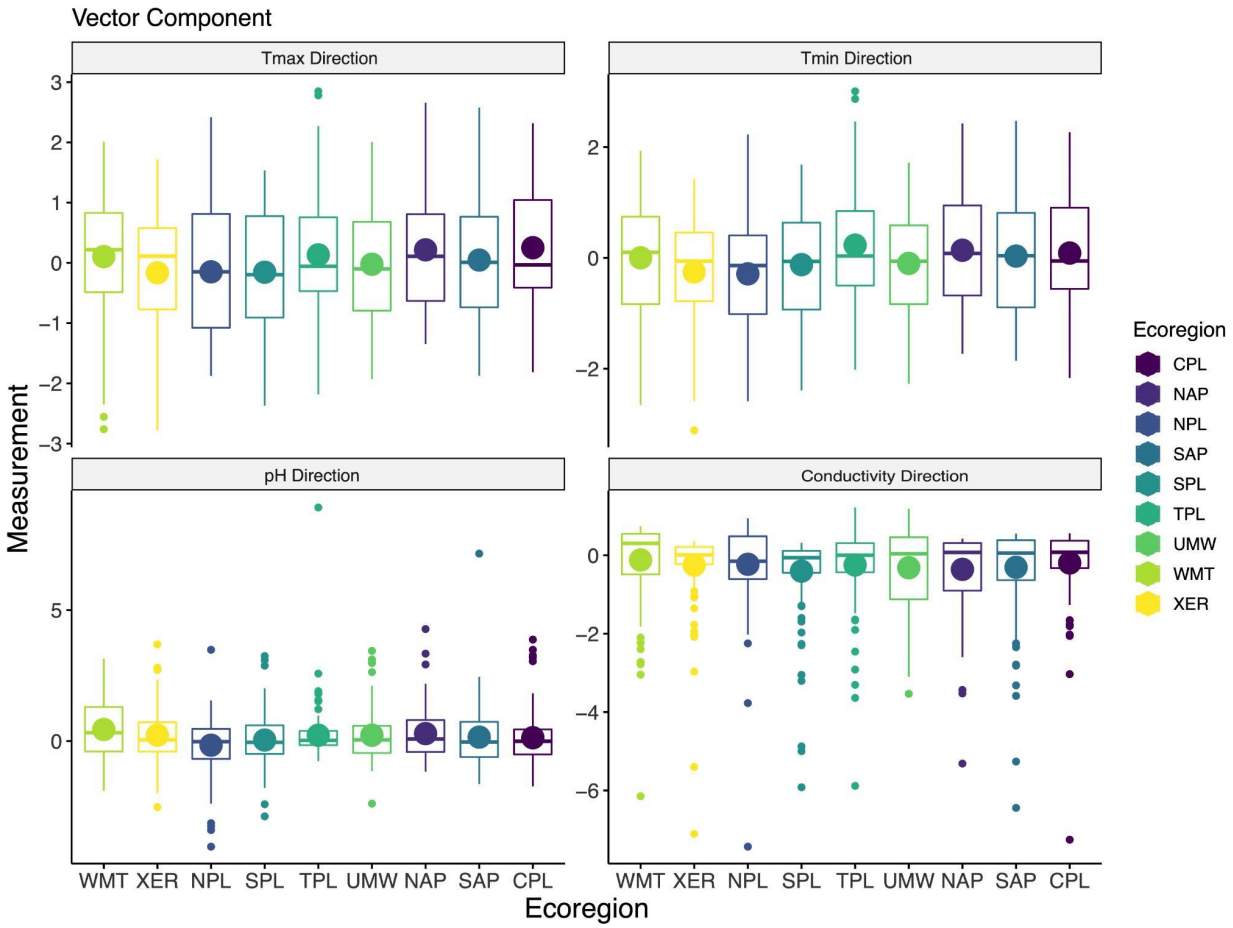

Figure S1: Facet plot of habitat matching vector components by ecoregion (Tmax = maximum temperature, Tmin = minimum temperature, pH, and conductivity). Large circles represent the mean and boxplots display the interquartile range (0.25, 0.75), minimum, and maximum, with smaller circles indicating outliers. Negative values indicate habitat matching and positive values indicate habitat mismatch. Ecoregions are arranged on the x-axis in approximate position based on longitude.

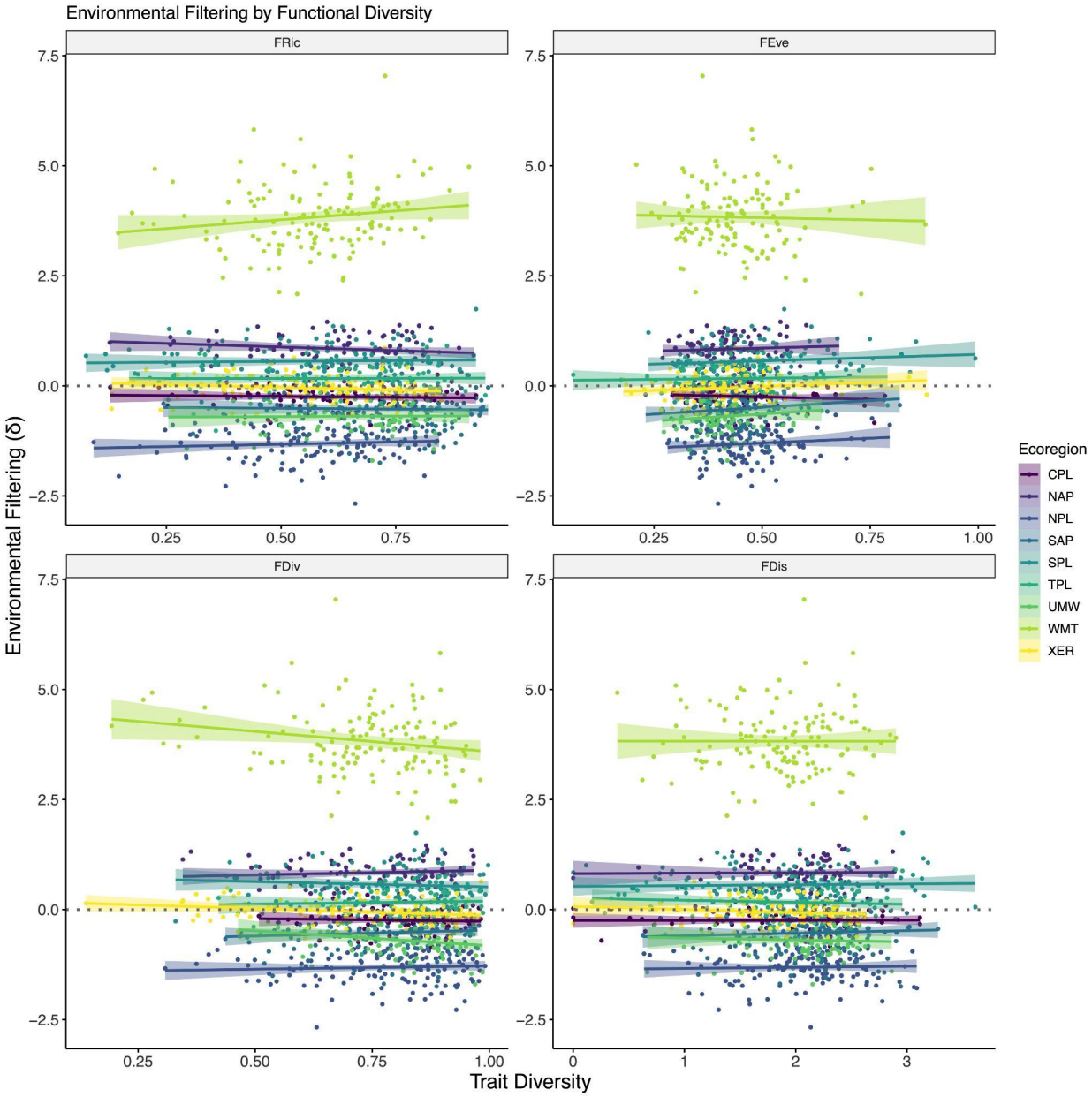

Figure S2: Facet plot of environmental filtering against functional richness (FRic), functional evenness (FEve), functional divergence (FDiv) and functional dispersion (FDis), with separate lines for each ecoregion. Lines are lines-of-best fit (± 95% confidence interval) from ANCOVA models, allowing the slope and intercept to vary by ecoregion. Negative values indicate environmental filtering and positive values indicate environmental permissiveness. Model statistics are provided in Appendix Table S3.

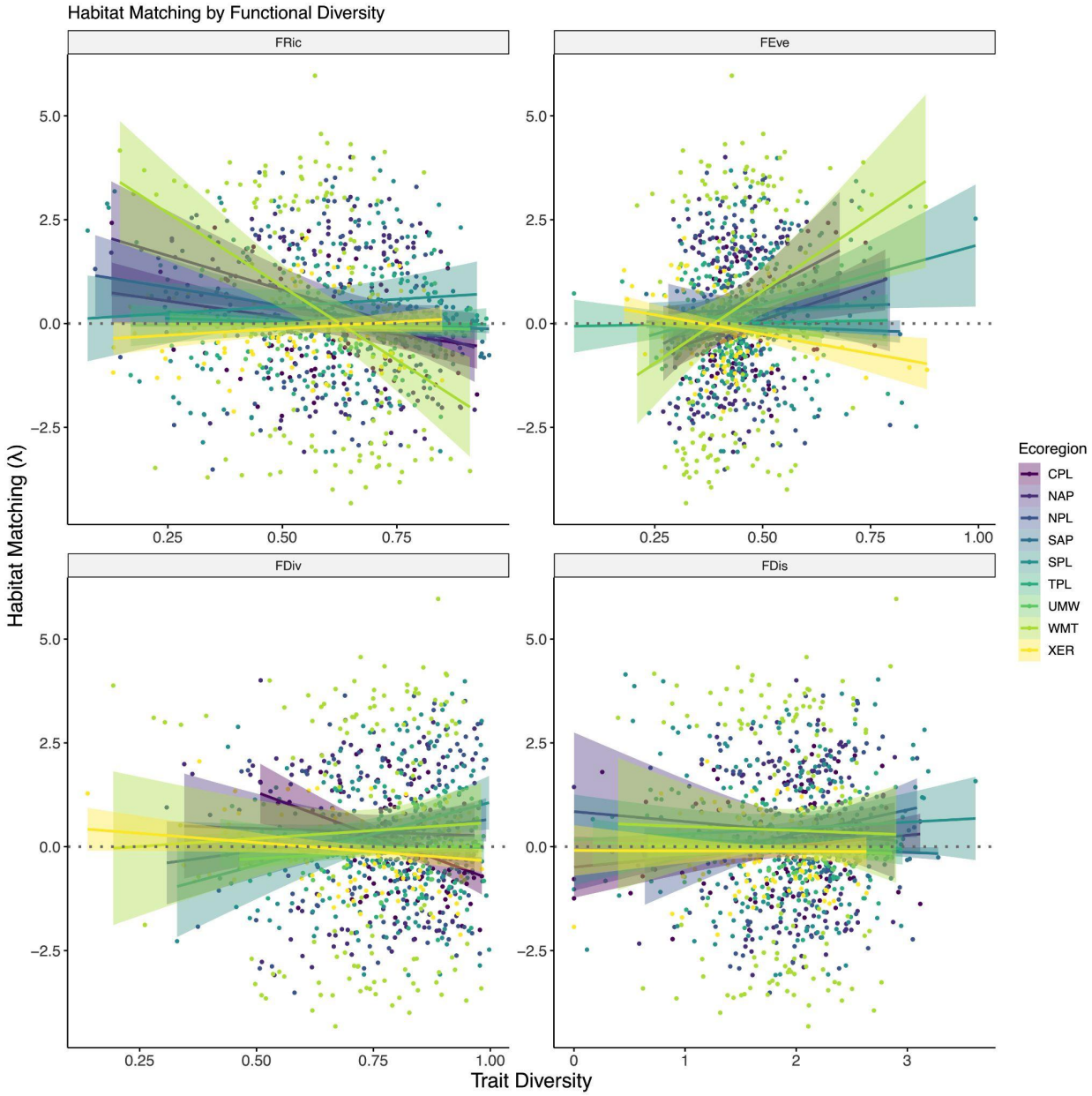

Figure S3: Facet plot of habitat matching against functional richness (FRic), functional evenness (FEve), functional divergence (FDiv) and functional dispersion (FDis), with separate lines for each ecoregion. Lines are lines-of-best fit (± 95% confidence interval) from ANCOVA models, allowing the slope and intercept to vary by ecoregion. Negative values indicate environmental filtering and positive values indicate environmental permissiveness. Model statistics are provided in Appendix Table S4.

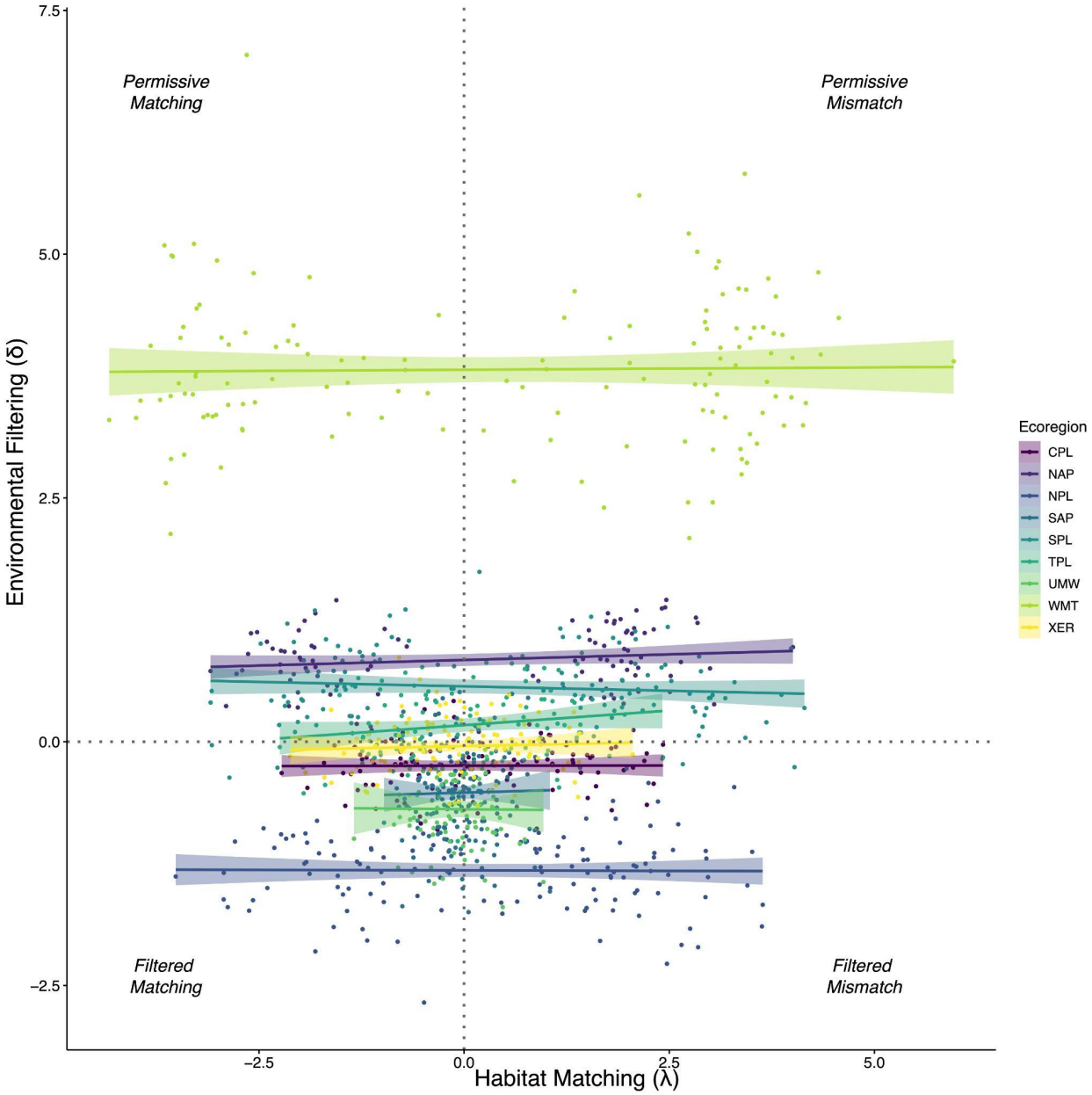

Figure S4: Plot of environmental filtering against habitat matching, with separate lines for each ecoregion. Lines are lines-of-best fit (± 95% confidence interval) from a linear mixed-effects model, whereby environmental filtering was regressed against habitat matching and ecoregion was fitted as a random intercept; we allowed slopes to vary in the figure to aid in interpretation. There was no relationship between environmental filtering and habitat matching (β = 0.005, standard error = 0.008, df = 1068.026, t = 0.554), with ecoregion explaining the majority of the variation ($R^2 \cong 0.90$). We fitted the linear mixed-effects model using `lmer()` in the `lme4` (Bates et al., 2015) and `lmerTest` (Kuznetsova et al., 2017) packages, with model assumptions evaluated using `check_model()` in the `performance` package (Lüdecke et al., 2021).

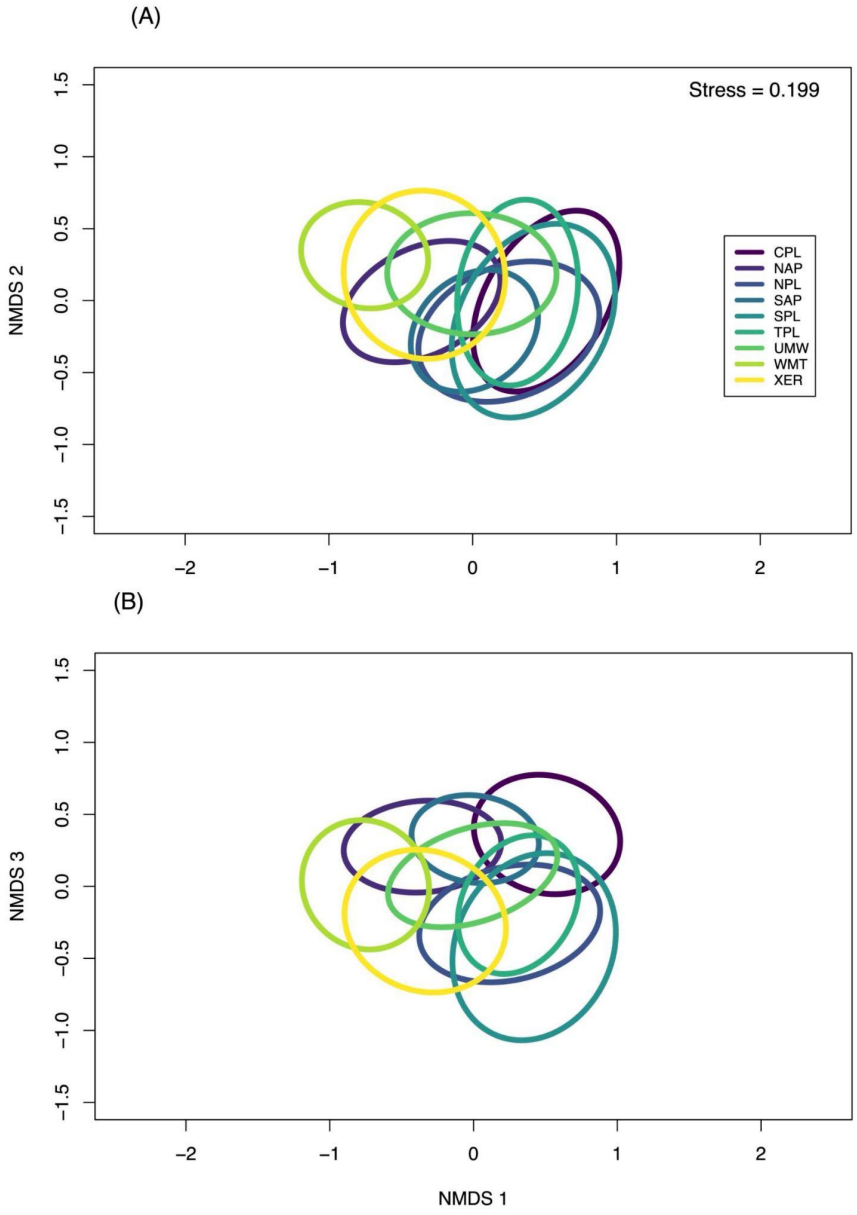

Figure S5: Non-metric multi-dimensional scaling plot of the Bray-Curtis dissimilarity of macroinvertebrate community composition among ecoregions. Three dimensions were required to achieve adequate stress in ordination space, and dimensions 1 and 2 are presented in panel (A) and dimensions 1 and 3 are presented in panel (B); dimension 1 is held constant on the x-axis for reference. Each ecoregion displayed a distinct community composition. (PERMANOVA, R^2 = 0.083, $P < 0.001$). We conducted the PERMANOVA with 10000 permutations using the `adonis()` function (Oksanen et al., 2020).

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