Appendix S1 - *Estimating Carrying Capacity for Juvenile Salmon using Quantile Random Forest Models*

Ecospheres

Kevin E. See[1,*], Michael W. Ackerman[1], Richard A. Carmichael[1], Sarah L. Hoffmann[1], Chris Beasley[1]

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[1] Biomark, Inc. 705 South 8th St., Boise, Idaho, 83702, USA

[*] Correspondence: Kevin E. See <Kevin.See@merck.com>

Choosing Habitat Covariates

One of the crucial steps in building this carrying capacity model was choosing which habitat covariates to include. Random forest models naturally incorporate interactions between correlated covariates, which is essential since nearly all habitat variables are considered correlated to one degree or another, however, we aimed to avoid overly redundant variables (i.e., variables that measure similar aspects of the habitat). Further, including too many covariates can result in overfitting of the model (e.g., including as many covariates as data points). Our goal was to select a group of covariates that captured as many different aspects

of the stream habitat (e.g., substrate, flow, riparian condition, channel unit configuration, etc.) as possible, while still holding information about fish densities.

To prevent overfitting, we pared down the more than 100 metrics generated by the CHaMP protocol describing the quantity and quality of fish habitat for each survey site. Habitat metrics were first grouped into broad categories that included channel unit configuration, complexity, fish cover, riparian areas, side channels, stream size, substrate, temperature, water quality, and woody debris. Habitat metrics measuring any large wood volume were scaled by the site length (in 100 m units). To assist in determining the habitat metrics to include in the QRF model, we used the Maximal Information-Based Nonparametric Exploration (MINE) class of statistics (Reshef et al. 2011) to determine those habitat characteristics (covariates) most highly associated with the log of observed parr densities. We calculated the maximal information coefficient (MIC), using the R package *minerva* (Filosi et al. 2019), to measure the strength of the linear or non-linear association between the natural log of fish density and each habitat metric (Reshef et al. 2011). MIC is a measure of correlation that incorporates potential non-linear associations; for example, if there is a quadratic association the MIC value could be high, even when the standard correlation coefficient is low. We excluded categorical variables such as channel type (e.g., meandering, pool-riffle, plane-bed, etc.) because we assumed that other quantitative metrics would capture the differences between those qualitative categorical metrics.

Within each category, metrics were ranked according to their MIC value (Table S1 and Figures S1 and S2). The MIC value of each measured habitat characteristic and parr density was used to inform decisions on which habitat covariates to include in the QRF parr capacity model. We selected one or two variables amongst those with the highest MIC scores within each category, attempting to avoid covariates that were too highly correlated (Table S2), while focusing on covariates we thought could influence fish behavior. For example, cumulative drainage area, mean annual flow and observed discharge are all highly correlated, but fish

really only experience the observed discharge, so we chose to include that metric in our QRF model. We also tried to include covariates that can be directly influenced by rehabilitation actions or have been shown to impact salmonid juvenile density. Finally, we attempted to avoid metrics with too many missing values, or too many zero values, in the data set, as well as metrics that may have too much observer error (Rosgen et al. 2018).

Results

We chose 12 metrics, highlighted in bold in Table S1. Their correlations with each other are displayed in Figure S3. Those with a high correlation coefficient (≥ 0.5 or $\leq$ -0.5) are plotted against each other in Figure S4 to show the variety in values even for pairs of metrics with relatively high correlations.

Literature Cited

Filosi, M., R. Visintainer, and D. Albanese. 2019. Minerva: Maximal information-based nonparametric exploration for variable analysis.

Reshef, D. N., Y. A. Reshef, H. K. Finucane, S. R. Grossman, G. McVean, P. J. Turnbaugh, E. S. Lander, M. Mitzenmacher, and P. C. Sabeti. 2011. Detecting novel associations in large data sets. Science 334:1518–1524.

Rosgen, D., A. Taillacq, B. Rosgen, and D. Geenen. 2018. A technical review of the Columbia Habitat Monitoring Program's protocol, data quality.

Tables

Table S1: MIC statistic for top metrics within each habitat category, sorted by category and MIC value. The percent of records for which each habitat metric measurement was missing or zero is also shown. Metrics selected for the QRF model are in bold.

Category	Name	Abbrv	MIC	Percent Missing	Percent 0-value
Channel Unit	**Channel Unit Frequency**	**CU_Freq**	**0.241**	**0.021**	**0.021**
Channel Unit	Fast Turbulent Frequency	FstTurb_Freq	0.230	0.021	0.082
Channel Unit	Fast NonTurbulent Frequency	FstNT_Freq	0.209	0.021	0.308
Channel Unit	Slow Water Frequency	SlowWater_Freq	0.208	0.021	0.073
Channel Unit	Fast Turbulent Percent	FstTurb_Pct	0.195	0.021	0.082
Channel Unit	Channel Unit Count	CU_Ct	0.189	0.021	0.021
Channel Unit	Fast Turbulent Count	FstTurb_Ct	0.178	0.021	0.082
Channel Unit	Slow Water Percent	SlowWater_Pct	0.177	0.021	0.073
Channel Unit	Fast NonTurbulent Percent	FstNT_Pct	0.169	0.021	0.308
Channel Unit	Fast NonTurbulent Count	FstNT_Ct	0.166	0.021	0.308
Complexity	**Wetted Width To Depth Ratio Avg**	**WetWDRat_Avg**	**0.247**	**0.003**	**0.003**
Complexity	Bankfull Width To Depth Ratio Avg	BfWDRat_Avg	0.245	0.003	0.003
Complexity	**Wetted Depth SD**	**DpthWet_SD**	**0.232**	**0.003**	**0.003**
Complexity	**Wetted Channel Braidedness**	**WetBraid**	**0.212**	**0.003**	**0.003**
Complexity	Bankfull Channel Braidedness	BfBraid	0.211	0.003	0.003
Complexity	Wetted Channel Qualifying Island Count	Wet_QIsland_Ct	0.209	0.003	0.835
Complexity	Bankfull Width CV	BfWdth_CV	0.209	0.003	0.003
Complexity	Bankfull Width To Depth Ratio CV	BfWDRat_CV	0.202	0.003	0.003

Table S1: MIC statistic for top metrics within each habitat category, sorted by category and MIC value. The percent of records for which each habitat metric measurement was missing or zero is also shown. Metrics selected for the QRF model are in bold. *(continued)*

Category	Name	Abbrv	MIC	Percent Missing	Percent 0-value
Complexity	Detrended Elevation SD	DetrendElev_SD	0.196	0.003	0.003
Complexity	Bankfull Channel Qualifying Island Count	Bf_QIsland_Ct	0.193	0.003	0.780
Cover	**Fish Cover: Total**	**FishCovTotal**	**0.225**	**0.021**	**0.030**
Cover	Fish Cover: None	FishCovNone	0.224	0.021	0.021
Cover	Fish Cover: LW	FishCovLW	0.213	0.021	0.155
Cover	Fish Cover: Terrestrial Vegetation	FishCovTVeg	0.204	0.021	0.052
Cover	Percent Undercut by Length	UcutLgth_Pct	0.185	0.000	0.476
Cover	Percent Undercut by Area	UcutArea_Pct	0.184	0.000	0.476
Cover	Fish Cover: Aquatic Vegetation	FishCovAqVeg	0.166	0.296	0.631
Cover	Fish Cover: Artificial	FishCovArt	0.136	0.021	0.851
Riparian	Riparian Cover: Understory	RipCovUstory	0.206	0.000	0.000
Riparian	RipCovUstoryNone	RipCovUstoryNone	0.206	0.000	0.000
Riparian	Riparian Cover: No Canopy	RipCovCanNone	0.194	0.000	0.000
Riparian	**Riparian Cover: Some Canopy**	**RipCovCanSome**	**0.194**	**0.000**	**0.095**
Riparian	Riparian Cover: Big Tree	RipCovBigTree	0.184	0.000	0.183
Riparian	Riparian Cover: Ground	RipCovGrnd	0.182	0.000	0.000
Riparian	RipCovGrndNone	RipCovGrndNone	0.170	0.000	0.003
Riparian	Riparian Cover: Woody	RipCovWood	0.168	0.000	0.000
Riparian	Riparian Cover: Non-Woody	RipCovNonWood	0.166	0.000	0.000
Riparian	Riparian Cover: Coniferous	RipCovConif	0.164	0.009	0.192
Side Channel	Bankfull Side Channel Width	BfSCWdth	0.223	0.796	0.796

Table S1: MIC statistic for top metrics within each habitat category, sorted by category and MIC value. The percent of records for which each habitat metric measurement was missing or zero is also shown. Metrics selected for the QRF model are in bold. *(continued)*

Category	Name	Abbrv	MIC	Percent Missing	Percent 0-value
Side Channel	Wetted Side Channel Width	WetSCWdth	0.213	0.832	0.832
Side Channel	Wetted Side Channel Percent By Area	WetSC_Pct	0.209	0.021	0.820
Side Channel	SCSm_Freq	SCSm_Freq	0.153	0.021	0.921
Side Channel	SCSm_Ct	SCSm_Ct	0.153	0.021	0.921
Side Channel	SC_Area_Pct	SC_Area_Pct	0.153	0.021	0.921
Size	Mean Annual Flow	MeanU	0.346	0.476	0.476
Size	**Wetted Width Integrated**	**WetWdth_Int**	**0.332**	**0.003**	**0.003**
Size	Bankfull Width Integrated	BfWdthInt	0.324	0.003	0.003
Size	Wetted Width Avg	WetWdth_Avg	0.324	0.003	0.003
Size	Drainage Area (Flowline)	CUMDRAINAG	0.302	0.341	0.341
Size	Bankfull Width Avg	BfWdth_Avg	0.298	0.003	0.003
Size	DpthThlwg_Avg	DpthThlwg_Avg	0.280	0.003	0.003
Size	**Discharge**	**Q**	**0.259**	**0.037**	**0.037**
Size	Bankfull Depth Avg	DpthBf_Avg	0.245	0.018	0.018
Size	Bankfull Depth Max	DpthBf_Max	0.240	0.018	0.018
Substrate	**Substrate < 6mm**	**SubLT6**	**0.237**	**0.049**	**0.055**
Substrate	Substrate < 2mm	SubLT2	0.227	0.049	0.082
Substrate	**Substrate: D16**	**SubD16**	**0.219**	**0.012**	**0.012**
Substrate	Substrate: Embeddedness Avg	SubEmbed_Avg	0.204	0.293	0.317
Substrate	Substrate: D50	SubD50	0.197	0.012	0.012
Substrate	Substrate Est: Sand and Fines	SubEstSandFines	0.190	0.021	0.030
Substrate	Substrate Est: Cobbles	SubEstCbl	0.185	0.021	0.027
Substrate	Substrate: D84	SubD84	0.185	0.012	0.012

Table S1: MIC statistic for top metrics within each habitat category, sorted by category and MIC value. The percent of records for which each habitat metric measurement was missing or zero is also shown. Metrics selected for the QRF model are in bold. *(continued)*

Category	Name	Abbrv	MIC	Percent Missing	Percent 0-value
Substrate	Substrate Est: Boulders	SubEstBldr	0.183	0.021	0.149
Substrate	Substrate: Embeddedness SD	SubEmbed_SD	0.181	0.302	0.320
Temperature	**Avg. August Temperature**	**avg_aug_temp**	**0.272**	**0.000**	**0.000**
Temperature	Elev_M	Elev_M	0.262	0.363	0.363
Temperature	August Temperature	aug_temp	0.188	0.155	0.155
Temperature	Solar Access: Summer Avg	SolarSummr_Avg	0.186	0.070	0.070
WaterQuality	Conductivity	Cond	0.254	0.024	0.027
WaterQuality	Alkalinity	Alk	0.225	0.009	0.027
WaterQuality	Drift Biomass	DriftBioMass	0.000	0.277	0.384
Wood	Large Wood Volume: Bankfull Slow Water	LWVol_BfSlow	0.213	0.003	0.232
Wood	**Large Wood Volume: Wetted Slow Water**	**LWVol_WetSlow**	**0.207**	**0.003**	**0.290**
Wood	Large Wood Frequency: Wetted	LWFreq_Wet	0.199	0.003	0.125
Wood	Large Wood Volume: Bankfull	LWVol_Bf	0.189	0.003	0.085
Wood	Large Wood Volume: Wetted Fast Turbulent	LWVol_WetFstTurb	0.187	0.003	0.274
Wood	Large Wood Frequency: Bankfull	LWFreq_Bf	0.178	0.003	0.085
Wood	Large Wood Volume: Bankfull Fast NonTurbulent	LWVol_BfFstNT	0.175	0.003	0.521
Wood	Large Wood Volume: Wetted	LWVol_Wet	0.166	0.003	0.125
Wood	Large Wood Volume: Wetted Fast NonTurbulent	LWVol_WetFstNT	0.159	0.003	0.595

Table S2: Pearson correlation coefficient between each variable within a habitat category.

Category	Metric 1	Metric 2	r
Channel Unit	Slow Water Frequency	Channel Unit Frequency	0.88
Channel Unit	Slow Water Count	Channel Unit Count	0.87
Channel Unit	Fast Turbulent Frequency	Channel Unit Frequency	0.84
Channel Unit	Fast NonTurbulent Count	Fast NonTurbulent Frequency	0.84
Channel Unit	Fast Turbulent Count	Fast Turbulent Frequency	0.80
Channel Unit	Slow Water Count	Slow Water Frequency	0.77
Channel Unit	Slow Water Percent	Fast Turbulent Percent	-0.74
Channel Unit	Channel Unit Count	Channel Unit Frequency	0.73
Channel Unit	Fast Turbulent Count	Channel Unit Count	0.73
Channel Unit	Slow Water Frequency	Channel Unit Count	0.69
Channel Unit	Fast NonTurbulent Count	Fast NonTurbulent Percent	0.65
Channel Unit	Fast NonTurbulent Frequency	Channel Unit Frequency	0.63
Channel Unit	Fast Turbulent Count	Channel Unit Frequency	0.60
Channel Unit	Slow Water Count	Channel Unit Frequency	0.59
Channel Unit	Slow Water Frequency	Fast Turbulent Frequency	0.59
Channel Unit	Fast Turbulent Frequency	Channel Unit Count	0.56
Channel Unit	Fast NonTurbulent Count	Channel Unit Count	0.56
Channel Unit	Fast Turbulent Percent	Fast NonTurbulent Percent	-0.55
Channel Unit	Slow Water Count	Slow Water Percent	0.54
Channel Unit	Fast NonTurbulent Percent	Fast NonTurbulent Frequency	0.52
Channel Unit	Fast NonTurbulent Frequency	Channel Unit Count	0.46
Channel Unit	Slow Water Percent	Slow Water Frequency	0.46
Channel Unit	Fast Turbulent Percent	Fast NonTurbulent Count	-0.45
Channel Unit	Slow Water Count	Fast Turbulent Count	0.41
Channel Unit	Slow Water Count	Fast Turbulent Percent	-0.40
Channel Unit	Fast NonTurbulent Count	Channel Unit Frequency	0.39
Channel Unit	Fast Turbulent Count	Slow Water Frequency	0.39

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Channel Unit	Slow Water Frequency	Fast NonTurbulent Frequency	0.38
Channel Unit	Fast Turbulent Percent	Fast NonTurbulent Frequency	-0.37
Channel Unit	Fast Turbulent Frequency	Fast NonTurbulent Frequency	0.36
Channel Unit	Fast Turbulent Percent	Slow Water Frequency	-0.31
Channel Unit	Slow Water Count	Fast Turbulent Frequency	0.30
Channel Unit	Slow Water Count	Fast NonTurbulent Count	0.29
Channel Unit	Fast Turbulent Percent	Channel Unit Count	-0.26
Channel Unit	Fast Turbulent Count	Fast Turbulent Percent	0.26
Channel Unit	Slow Water Percent	Channel Unit Count	0.26
Channel Unit	Slow Water Percent	Channel Unit Frequency	0.21
Channel Unit	Slow Water Count	Fast NonTurbulent Frequency	0.21
Channel Unit	Fast NonTurbulent Count	Slow Water Frequency	0.20
Channel Unit	Fast Turbulent Count	Fast NonTurbulent Frequency	0.19
Channel Unit	Fast Turbulent Count	Fast NonTurbulent Count	0.19
Channel Unit	Fast Turbulent Percent	Channel Unit Frequency	-0.19
Channel Unit	Fast Turbulent Count	Fast NonTurbulent Percent	-0.19
Channel Unit	Fast Turbulent Percent	Fast Turbulent Frequency	0.18
Channel Unit	Slow Water Percent	Fast Turbulent Count	-0.17
Channel Unit	Fast NonTurbulent Percent	Fast Turbulent Frequency	-0.16
Channel Unit	Slow Water Percent	Fast NonTurbulent Percent	-0.14
Channel Unit	Fast NonTurbulent Count	Fast Turbulent Frequency	0.13
Channel Unit	Fast NonTurbulent Percent	Slow Water Frequency	-0.11
Channel Unit	Slow Water Count	Fast NonTurbulent Percent	-0.09
Channel Unit	Slow Water Percent	Fast Turbulent Frequency	-0.09
Channel Unit	Fast NonTurbulent Percent	Channel Unit Count	0.06
Channel Unit	Slow Water Percent	Fast NonTurbulent Frequency	0.03

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Channel Unit	Fast NonTurbulent Percent	Channel Unit Frequency	0.02
Channel Unit	Slow Water Percent	Fast NonTurbulent Count	0.01
Complexity	Bankfull Width CV	Bankfull Width To Depth Ratio CV	0.84
Complexity	Wetted Channel Braidedness	Bankfull Channel Braidedness	0.83
Complexity	Bankfull Width To Depth Ratio Avg	Wetted Width To Depth Ratio Avg	0.78
Complexity	Wetted Channel Braidedness	Wetted Channel Qualifying Island Count	0.78
Complexity	Bankfull Channel Braidedness	Bankfull Channel Qualifying Island Count	0.78
Complexity	Bankfull Width CV	Wetted Width CV	0.76
Complexity	Wetted Channel Qualifying Island Count	Bankfull Channel Qualifying Island Count	0.76
Complexity	Wetted Channel Braidedness	Bankfull Channel Qualifying Island Count	0.66
Complexity	Bankfull Channel Braidedness	Wetted Channel Qualifying Island Count	0.61
Complexity	Bankfull Width To Depth Ratio CV	Wetted Width CV	0.57
Complexity	Wetted Width CV	Wetted Width To Depth Ratio CV	0.57
Complexity	Thalweg Depth CV	Wetted Width To Depth Ratio CV	0.51
Complexity	Bankfull Width To Depth Ratio CV	Wetted Width To Depth Ratio CV	0.50

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Bankfull Width CV	Wetted Width To Depth Ratio CV	0.46
Complexity	Thalweg Depth CV	Wetted Width CV	0.44
Complexity	Wetted Depth SD	Bankfull Width To Depth Ratio Avg	0.35
Complexity	Thalweg Depth CV	Bankfull Width To Depth Ratio CV	0.30
Complexity	Thalweg Depth CV	Bankfull Width CV	0.29
Complexity	Wetted Channel Qualifying Island Count	Bankfull Width CV	0.25
Complexity	Bankfull Channel Qualifying Island Count	Bankfull Width CV	0.25
Complexity	Sinuosity	Wetted Depth SD	0.24
Complexity	Detrended Elevation SD	Wetted Depth SD	0.23
Complexity	Bankfull Width CV	Wetted Width To Depth Ratio Avg	-0.23
Complexity	Bankfull Channel Qualifying Island Count	Bankfull Width To Depth Ratio CV	0.23
Complexity	Wetted Channel Qualifying Island Count	Bankfull Width To Depth Ratio CV	0.22
Complexity	Wetted Channel Braidedness	Bankfull Width CV	0.21
Complexity	Bankfull Channel Braidedness	Bankfull Width CV	0.21
Complexity	Wetted Depth SD	Wetted Width To Depth Ratio Avg	0.21
Complexity	Sinuosity	Wetted Width To Depth Ratio CV	0.20

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Bankfull Width To Depth Ratio CV	Wetted Width To Depth Ratio Avg	-0.20
Complexity	Bankfull Channel Qualifying Island Count	Wetted Width CV	0.20
Complexity	Sinuosity	Bankfull Width To Depth Ratio CV	0.20
Complexity	Bankfull Channel Braidedness	Bankfull Width To Depth Ratio CV	0.19
Complexity	Wetted Channel Qualifying Island Count	Wetted Width CV	0.19
Complexity	Detrended Elevation SD	Bankfull Width To Depth Ratio CV	-0.19
Complexity	Sinuosity	Thalweg Depth CV	0.19
Complexity	Wetted Channel Braidedness	Bankfull Width To Depth Ratio CV	0.18
Complexity	Bankfull Channel Braidedness	Wetted Width CV	0.17
Complexity	Wetted Channel Braidedness	Bankfull Width To Depth Ratio Avg	0.17
Complexity	Bankfull Channel Braidedness	Bankfull Width To Depth Ratio Avg	0.16
Complexity	Detrended Elevation SD	Bankfull Width CV	-0.16
Complexity	Wetted Channel Braidedness	Wetted Width CV	0.16
Complexity	Sinuosity	Wetted Width CV	0.14
Complexity	Sinuosity	Bankfull Width CV	0.14
Complexity	Detrended Elevation SD	Wetted Width CV	-0.13

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Detrended Elevation SD	Wetted Width To Depth Ratio CV	-0.13
Complexity	Sinuosity	Wetted Width To Depth Ratio Avg	-0.12
Complexity	Wetted Channel Qualifying Island Count	Bankfull Width To Depth Ratio Avg	0.12
Complexity	Bankfull Channel Qualifying Island Count	Wetted Width To Depth Ratio CV	0.11
Complexity	Bankfull Channel Qualifying Island Count	Bankfull Width To Depth Ratio Avg	0.11
Complexity	Detrended Elevation SD	Thalweg Depth CV	-0.11
Complexity	Bankfull Channel Braidedness	Wetted Width To Depth Ratio CV	0.10
Complexity	Sinuosity	Detrended Elevation SD	-0.10
Complexity	Bankfull Width To Depth Ratio Avg	Wetted Width CV	0.10
Complexity	Detrended Elevation SD	Bankfull Channel Qualifying Island Count	-0.09
Complexity	Detrended Elevation SD	Wetted Channel Qualifying Island Count	-0.09
Complexity	Wetted Channel Qualifying Island Count	Wetted Width To Depth Ratio CV	0.08
Complexity	Wetted Width CV	Wetted Width To Depth Ratio Avg	-0.08
Complexity	Bankfull Channel Braidedness	Wetted Depth SD	0.08

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Wetted Depth SD	Wetted Width To Depth Ratio CV	0.08
Complexity	Detrended Elevation SD	Wetted Width To Depth Ratio Avg	0.08
Complexity	Detrended Elevation SD	Wetted Channel Braidedness	-0.07
Complexity	Thalweg Depth CV	Bankfull Channel Qualifying Island Count	0.07
Complexity	Detrended Elevation SD	Bankfull Channel Braidedness	-0.07
Complexity	Wetted Depth SD	Bankfull Width To Depth Ratio CV	0.07
Complexity	Bankfull Width To Depth Ratio CV	Bankfull Width To Depth Ratio Avg	0.07
Complexity	Bankfull Channel Braidedness	Wetted Width To Depth Ratio Avg	0.07
Complexity	Wetted Channel Braidedness	Wetted Depth SD	0.06
Complexity	Thalweg Depth CV	Wetted Depth SD	0.06
Complexity	Thalweg Depth CV	Bankfull Channel Braidedness	0.06
Complexity	Sinuosity	Bankfull Channel Qualifying Island Count	0.06
Complexity	Wetted Channel Braidedness	Wetted Width To Depth Ratio CV	0.06
Complexity	Sinuosity	Wetted Channel Qualifying Island Count	0.06
Complexity	Wetted Depth SD	Wetted Width CV	0.05
Complexity	Wetted Channel Braidedness	Wetted Width To Depth Ratio Avg	0.04

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Bankfull Width To Depth Ratio Avg	Wetted Width To Depth Ratio CV	0.04
Complexity	Thalweg Depth CV	Wetted Width To Depth Ratio Avg	-0.04
Complexity	Sinuosity	Bankfull Channel Braidedness	0.03
Complexity	Thalweg Depth CV	Bankfull Width To Depth Ratio Avg	-0.03
Complexity	Bankfull Channel Qualifying Island Count	Wetted Depth SD	0.03
Complexity	Wetted Width To Depth Ratio CV	Wetted Width To Depth Ratio Avg	0.03
Complexity	Thalweg Depth CV	Wetted Channel Qualifying Island Count	0.02
Complexity	Wetted Channel Qualifying Island Count	Wetted Width To Depth Ratio Avg	-0.02
Complexity	Sinuosity	Bankfull Width To Depth Ratio Avg	0.02
Complexity	Wetted Depth SD	Bankfull Width CV	0.02
Complexity	Sinuosity	Wetted Channel Braidedness	0.02
Complexity	Bankfull Width CV	Bankfull Width To Depth Ratio Avg	0.01
Complexity	Detrended Elevation SD	Bankfull Width To Depth Ratio Avg	-0.01
Complexity	Wetted Channel Qualifying Island Count	Wetted Depth SD	0.01
Complexity	Thalweg Depth CV	Wetted Channel Braidedness	0.01

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Complexity	Bankfull Channel Qualifying Island Count	Wetted Width To Depth Ratio Avg	-0.01
Cover	Fish Cover: None	Fish Cover: Total	-0.94
Cover	Percent Undercut by Length	Percent Undercut by Area	0.80
Cover	Fish Cover: Aquatic Vegetation	Fish Cover: Total	0.70
Cover	Fish Cover: Terrestrial Vegetation	Fish Cover: Total	0.68
Cover	Fish Cover: None	Fish Cover: Aquatic Vegetation	-0.67
Cover	Fish Cover: Terrestrial Vegetation	Fish Cover: None	-0.65
Cover	Fish Cover: LW	Fish Cover: Total	0.54
Cover	Fish Cover: LW	Fish Cover: None	-0.50
Cover	Fish Cover: LW	Fish Cover: Terrestrial Vegetation	0.35
Cover	Fish Cover: Total	Percent Undercut by Area	0.29
Cover	Fish Cover: Aquatic Vegetation	Percent Undercut by Length	0.28
Cover	Fish Cover: None	Percent Undercut by Area	-0.27
Cover	Fish Cover: Total	Percent Undercut by Length	0.25
Cover	Fish Cover: None	Percent Undercut by Length	-0.22
Cover	Fish Cover: LW	Percent Undercut by Area	0.20
Cover	Fish Cover: Terrestrial Vegetation	Percent Undercut by Area	0.20
Cover	Fish Cover: Aquatic Vegetation	Percent Undercut by Area	0.18
Cover	Fish Cover: Artificial	Fish Cover: None	-0.12
Cover	Fish Cover: Artificial	Fish Cover: Total	0.11
Cover	Fish Cover: LW	Percent Undercut by Length	0.11

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Cover	Fish Cover: Artificial	Fish Cover: Aquatic Vegetation	0.07
Cover	Fish Cover: Terrestrial Vegetation	Percent Undercut by Length	0.06
Cover	Fish Cover: Artificial	Percent Undercut by Length	-0.05
Cover	Fish Cover: Artificial	Percent Undercut by Area	-0.03
Cover	Fish Cover: LW	Fish Cover: Aquatic Vegetation	-0.02
Cover	Fish Cover: Terrestrial Vegetation	Fish Cover: Aquatic Vegetation	0.02
Cover	Fish Cover: LW	Fish Cover: Artificial	0.02
Cover	Fish Cover: Terrestrial Vegetation	Fish Cover: Artificial	-0.01
Riparian	Riparian Cover: Understory	RipCovUstoryNone	-1.00
Riparian	Riparian Cover: No Canopy	Riparian Cover: Some Canopy	-1.00
Riparian	Riparian Cover: Ground	RipCovGrndNone	-0.99
Riparian	Riparian Cover: Understory	Riparian Cover: Woody	0.85
Riparian	Riparian Cover: Woody	RipCovUstoryNone	-0.85
Riparian	Riparian Cover: Ground	Riparian Cover: Non-Woody	0.83
Riparian	Riparian Cover: Big Tree	Riparian Cover: No Canopy	-0.83
Riparian	Riparian Cover: Big Tree	Riparian Cover: Some Canopy	0.83
Riparian	Riparian Cover: Non-Woody	RipCovGrndNone	-0.83
Riparian	Riparian Cover: Woody	Riparian Cover: No Canopy	-0.73
Riparian	Riparian Cover: Woody	Riparian Cover: Some Canopy	0.73
Riparian	Riparian Cover: Big Tree	Riparian Cover: Coniferous	0.59
Riparian	Riparian Cover: Big Tree	Riparian Cover: Woody	0.59
Riparian	Riparian Cover: Coniferous	Riparian Cover: No Canopy	-0.52
Riparian	Riparian Cover: Coniferous	Riparian Cover: Some Canopy	0.52

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Riparian	Riparian Cover: Understory	Riparian Cover: No Canopy	-0.49
Riparian	Riparian Cover: Understory	Riparian Cover: Some Canopy	0.49
Riparian	Riparian Cover: No Canopy	RipCovUstoryNone	0.49
Riparian	RipCovUstoryNone	Riparian Cover: Some Canopy	-0.49
Riparian	Riparian Cover: Coniferous	Riparian Cover: Woody	0.43
Riparian	Riparian Cover: Big Tree	Riparian Cover: Understory	0.35
Riparian	Riparian Cover: Big Tree	RipCovUstoryNone	-0.35
Riparian	Riparian Cover: Coniferous	Riparian Cover: Understory	0.24
Riparian	Riparian Cover: Coniferous	RipCovUstoryNone	-0.24
Riparian	Riparian Cover: Non-Woody	Riparian Cover: Woody	-0.21
Riparian	Riparian Cover: Big Tree	Riparian Cover: Non-Woody	-0.20
Riparian	Riparian Cover: Non-Woody	Riparian Cover: No Canopy	0.17
Riparian	Riparian Cover: Non-Woody	Riparian Cover: Some Canopy	-0.17
Riparian	RipCovUstoryNone	RipCovGrndNone	0.17
Riparian	Riparian Cover: Understory	RipCovGrndNone	-0.17
Riparian	Riparian Cover: Ground	Riparian Cover: Understory	0.16
Riparian	Riparian Cover: Ground	RipCovUstoryNone	-0.16
Riparian	Riparian Cover: Woody	RipCovGrndNone	-0.16
Riparian	Riparian Cover: Ground	Riparian Cover: Woody	0.15
Riparian	Riparian Cover: Coniferous	Riparian Cover: Non-Woody	-0.13
Riparian	Riparian Cover: Big Tree	Riparian Cover: Ground	-0.12
Riparian	Riparian Cover: Big Tree	RipCovGrndNone	0.11
Riparian	Riparian Cover: Ground	Riparian Cover: No Canopy	0.09
Riparian	Riparian Cover: Ground	Riparian Cover: Some Canopy	-0.09
Riparian	Riparian Cover: No Canopy	RipCovGrndNone	-0.08
Riparian	RipCovGrndNone	Riparian Cover: Some Canopy	0.08

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Riparian	Riparian Cover: Coniferous	RipCovGrndNone	-0.01
Riparian	Riparian Cover: Non-Woody	Riparian Cover: Understory	-0.01
Riparian	Riparian Cover: Non-Woody	RipCovUstoryNone	0.01
Riparian	Riparian Cover: Coniferous	Riparian Cover: Ground	0.00
Side Channel	SCSm_Freq	SCSm_Ct	0.90
Side Channel	SCSm_Freq	SC_Area_Pct	0.49
Side Channel	SCSm_Ct	SC_Area_Pct	0.49
Side Channel	Wetted Side Channel Percent By Area	SCSm_Ct	0.44
Side Channel	Wetted Side Channel Percent By Area	SCSm_Freq	0.40
Side Channel	Wetted Side Channel Percent By Area	SC_Area_Pct	0.30
Size	Wetted Width Integrated	Wetted Width Avg	0.98
Size	Bankfull Width Integrated	Bankfull Width Avg	0.97
Size	Bankfull Width Avg	Wetted Width Avg	0.95
Size	Wetted Width Integrated	Bankfull Width Avg	0.95
Size	Wetted Width Integrated	Bankfull Width Integrated	0.92
Size	Bankfull Width Integrated	Wetted Width Avg	0.91
Size	Bankfull Depth Avg	DpthThlwg_Avg	0.85
Size	Bankfull Depth Max	DpthThlwg_Avg	0.84
Size	Bankfull Width Avg	Bankfull Depth Avg	0.83
Size	Wetted Width Avg	Bankfull Depth Avg	0.82
Size	Wetted Width Avg	Discharge	0.82
Size	Bankfull Depth Max	Bankfull Depth Avg	0.82
Size	Bankfull Depth Max	Residual Pool Depth	0.81

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Size	Wetted Width Integrated	Discharge	0.79
Size	Bankfull Width Integrated	Bankfull Depth Avg	0.79
Size	Wetted Width Integrated	Bankfull Depth Avg	0.79
Size	Wetted Width Avg	DpthThlwg_Avg	0.79
Size	Wetted Width Integrated	DpthThlwg_Avg	0.78
Size	Bankfull Width Avg	DpthThlwg_Avg	0.77
Size	Bankfull Width Avg	Discharge	0.77
Size	DpthThlwg_Avg	Residual Pool Depth	0.76
Size	Bankfull Width Integrated	DpthThlwg_Avg	0.75
Size	Bankfull Width Integrated	Discharge	0.74
Size	Bankfull Width Avg	Bankfull Depth Max	0.74
Size	DpthThlwg_Avg	Discharge	0.74
Size	Drainage Area (Flowline)	Wetted Width Avg	0.73
Size	Bankfull Width Integrated	Bankfull Depth Max	0.73
Size	Drainage Area (Flowline)	Wetted Width Integrated	0.72
Size	Drainage Area (Flowline)	Bankfull Width Avg	0.72
Size	Drainage Area (Flowline)	Discharge	0.70
Size	Wetted Width Avg	Bankfull Depth Max	0.70
Size	Bankfull Width Avg	Residual Pool Depth	0.69
Size	Wetted Width Integrated	Bankfull Depth Max	0.69
Size	Drainage Area (Flowline)	Bankfull Width Integrated	0.68
Size	Bankfull Depth Avg	Residual Pool Depth	0.68
Size	Bankfull Depth Avg	Discharge	0.68
Size	Wetted Width Avg	Residual Pool Depth	0.67
Size	Wetted Width Integrated	Residual Pool Depth	0.67
Size	Bankfull Width Integrated	Residual Pool Depth	0.67

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Size	Residual Pool Depth	Discharge	0.60
Size	Bankfull Depth Max	Discharge	0.59
Size	Drainage Area (Flowline)	Bankfull Depth Avg	0.56
Size	Drainage Area (Flowline)	Residual Pool Depth	0.54
Size	Drainage Area (Flowline)	DpthThlwg_Avg	0.52
Size	Drainage Area (Flowline)	Bankfull Depth Max	0.46
Size	Gradient	Bankfull Width Avg	-0.44
Size	Gradient	Bankfull Width Integrated	-0.43
Size	Gradient	Wetted Width Avg	-0.42
Size	Gradient	Wetted Width Integrated	-0.42
Size	Gradient	DpthThlwg_Avg	-0.39
Size	Gradient	Residual Pool Depth	-0.33
Size	Gradient	Bankfull Depth Avg	-0.33
Size	Drainage Area (Flowline)	Gradient	-0.31
Size	Gradient	Bankfull Depth Max	-0.31
Size	Gradient	Discharge	-0.30
Size	Precipitation	Drainage Area (Flowline)	-0.15
Size	Precipitation	Bankfull Depth Avg	0.11
Size	Precipitation	Bankfull Depth Max	0.10
Size	Precipitation	DpthThlwg_Avg	0.09
Size	Precipitation	Discharge	-0.05
Size	Precipitation	Gradient	0.03
Size	Precipitation	Wetted Width Integrated	-0.02
Size	Precipitation	Bankfull Width Integrated	-0.02
Size	Precipitation	Wetted Width Avg	-0.02
Size	Precipitation	Bankfull Width Avg	-0.01

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Size	Precipitation	Residual Pool Depth	-0.01
Substrate	Substrate < 2mm	Substrate < 6mm	0.95
Substrate	Substrate: D50	Substrate: D84	0.87
Substrate	Substrate: Embeddedness Avg	Substrate: Embeddedness SD	0.86
Substrate	Substrate: D84	Substrate Est: Boulders	0.80
Substrate	Substrate: D50	Substrate Est: Boulders	0.71
Substrate	Substrate < 2mm	Substrate Est: Sand and Fines	0.68
Substrate	Substrate < 6mm	Substrate Est: Sand and Fines	0.67
Substrate	Substrate Est: Sand and Fines	Substrate Est: Cobbles	-0.67
Substrate	Substrate: D16	Substrate: D50	0.61
Substrate	Substrate Est: Coarse and Fine Gravel	Substrate Est: Boulders	-0.59
Substrate	Substrate: D84	Substrate Est: Coarse and Fine Gravel	-0.52
Substrate	Substrate < 6mm	Substrate Est: Cobbles	-0.46
Substrate	Substrate: D50	Substrate Est: Sand and Fines	-0.45
Substrate	Substrate: D16	Substrate Est: Sand and Fines	-0.43
Substrate	Substrate < 2mm	Substrate Est: Cobbles	-0.43
Substrate	Substrate: D50	Substrate Est: Coarse and Fine Gravel	-0.43
Substrate	Substrate: D16	Substrate Est: Cobbles	0.42
Substrate	Substrate: Embeddedness Avg	Substrate < 2mm	0.42
Substrate	Substrate: D16	Substrate < 6mm	-0.42
Substrate	Substrate: Embeddedness Avg	Substrate Est: Sand and Fines	0.40
Substrate	Substrate: D50	Substrate Est: Cobbles	0.40
Substrate	Substrate: D84	Substrate Est: Sand and Fines	-0.39

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Substrate	Substrate: D16	Substrate < 2mm	-0.39
Substrate	Substrate: D50	Substrate < 6mm	-0.38
Substrate	Substrate: Embeddedness Avg	Substrate < 6mm	0.38
Substrate	Substrate: D16	Substrate: D84	0.38
Substrate	Substrate Est: Sand and Fines	Substrate Est: Boulders	-0.36
Substrate	Substrate: D50	Substrate < 2mm	-0.35
Substrate	Substrate: Embeddedness SD	Substrate < 2mm	0.34
Substrate	Substrate: D84	Substrate Est: Cobbles	0.33
Substrate	Substrate: Embeddedness SD	Substrate Est: Sand and Fines	0.31
Substrate	Substrate: Embeddedness SD	Substrate < 6mm	0.31
Substrate	Substrate: Embeddedness Avg	Substrate: D16	-0.30
Substrate	Substrate Est: Coarse and Fine Gravel	Substrate Est: Cobbles	-0.30
Substrate	Substrate: D16	Substrate Est: Boulders	0.29
Substrate	Substrate: D84	Substrate < 6mm	-0.28
Substrate	Substrate: Embeddedness SD	Substrate: D16	-0.27
Substrate	Substrate: Embeddedness Avg	Substrate Est: Cobbles	-0.25
Substrate	Substrate: D84	Substrate < 2mm	-0.25
Substrate	Substrate Est: Coarse and Fine Gravel	Substrate Est: Sand and Fines	-0.23
Substrate	Substrate < 2mm	Substrate Est: Coarse and Fine Gravel	-0.22
Substrate	Substrate Est: Boulders	Substrate Est: Cobbles	0.22
Substrate	Substrate < 6mm	Substrate Est: Boulders	-0.19
Substrate	Substrate: Embeddedness SD	Substrate Est: Cobbles	-0.19
Substrate	Substrate < 2mm	Substrate Est: Boulders	-0.19

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Substrate	Substrate: Embeddedness Avg	Substrate Est: Coarse and Fine Gravel	-0.18
Substrate	Substrate < 6mm	Substrate Est: Coarse and Fine Gravel	-0.18
Substrate	Substrate: Embeddedness Avg	Substrate: D50	-0.17
Substrate	Substrate: Embeddedness SD	Substrate Est: Coarse and Fine Gravel	-0.15
Substrate	Substrate: Embeddedness SD	Substrate: D50	-0.13
Substrate	Substrate: D16	Substrate Est: Coarse and Fine Gravel	-0.12
Substrate	Substrate: Embeddedness Avg	Substrate: D84	-0.08
Substrate	Substrate: Embeddedness SD	Substrate: D84	-0.05
Substrate	Substrate: Embeddedness Avg	Substrate Est: Boulders	-0.03
Substrate	Substrate: Embeddedness SD	Substrate Est: Boulders	-0.02
Temperature	Avg. August Temperature	August Temperature	0.98
Temperature	Elev_M	Avg. August Temperature	-0.61
Temperature	Elev_M	August Temperature	-0.61
Temperature	Solar Access: Summer Avg	August Temperature	0.19
Temperature	Solar Access: Summer Avg	Avg. August Temperature	0.13
Temperature	Elev_M	Solar Access: Summer Avg	0.12
Water Quality	Conductivity	Alkalinity	0.78
Water Quality	Alkalinity	Drift Biomass	0.16
Water Quality	Conductivity	Drift Biomass	0.16
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Volume: Bankfull Slow Water	0.91
Wood	Large Wood Frequency: Wetted	Large Wood Frequency: Bankfull	0.91

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Wood	Large Wood Volume: Wetted	Large Wood Volume: Bankfull	0.90
Wood	Large Wood Volume: Wetted	Large Wood Volume: Wetted Slow Water	0.88
Wood	Large Wood Volume: Bankfull	Large Wood Volume: Bankfull Slow Water	0.84
Wood	Large Wood Volume: Wetted	Large Wood Volume: Bankfull Slow Water	0.81
Wood	Large Wood Volume: Wetted Fast NonTurbulent	Large Wood Volume: Bankfull Fast NonTurbulent	0.79
Wood	Large Wood Volume: Bankfull	Large Wood Volume: Wetted Slow Water	0.78
Wood	Large Wood Volume: Wetted	Large Wood Volume: Wetted Fast NonTurbulent	0.60
Wood	Large Wood Volume: Bankfull	Large Wood Volume: Bankfull Fast NonTurbulent	0.56
Wood	Large Wood Volume: Bankfull	Large Wood Frequency: Bankfull	0.56
Wood	Large Wood Volume: Wetted	Large Wood Volume: Wetted Fast Turbulent	0.53
Wood	Large Wood Volume: Wetted	Large Wood Volume: Bankfull Fast NonTurbulent	0.52
Wood	Large Wood Volume: Wetted	Large Wood Frequency: Wetted	0.51
Wood	Large Wood Volume: Wetted	Large Wood Frequency: Bankfull	0.51
Wood	Large Wood Volume: Bankfull	Large Wood Volume: Wetted Fast NonTurbulent	0.50
Wood	Large Wood Volume: Bankfull	Large Wood Volume: Wetted Fast Turbulent	0.50

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Wood	Large Wood Volume: Bankfull	Large Wood Frequency: Wetted	0.45
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Volume: Wetted Fast NonTurbulent	0.45
Wood	Large Wood Volume: Bankfull Slow Water	Large Wood Frequency: Bankfull	0.43
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Frequency: Wetted	0.42
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Volume: Bankfull Fast NonTurbulent	0.40
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Frequency: Bankfull	0.40
Wood	Large Wood Volume: Bankfull Slow Water	Large Wood Volume: Wetted Fast NonTurbulent	0.39
Wood	Large Wood Volume: Bankfull Slow Water	Large Wood Frequency: Wetted	0.39
Wood	Large Wood Volume: Bankfull Slow Water	Large Wood Volume: Bankfull Fast NonTurbulent	0.38
Wood	Large Wood Volume: Wetted Fast Turbulent	Large Wood Frequency: Bankfull	0.37
Wood	Large Wood Volume: Wetted Fast Turbulent	Large Wood Frequency: Wetted	0.35
Wood	Large Wood Frequency: Bankfull	Large Wood Volume: Bankfull Fast NonTurbulent	0.27
Wood	Large Wood Volume: Wetted Fast NonTurbulent	Large Wood Frequency: Wetted	0.24

Table S2: Pearson correlation coefficient between each variable within a habitat category. *(continued)*

Category	Metric 1	Metric 2	r
Wood	Large Wood Frequency: Wetted	Large Wood Volume: Bankfull Fast NonTurbulent	0.22
Wood	Large Wood Volume: Wetted Fast NonTurbulent	Large Wood Frequency: Bankfull	0.22
Wood	Large Wood Volume: Wetted Slow Water	Large Wood Volume: Wetted Fast Turbulent	0.15
Wood	Large Wood Volume: Bankfull Slow Water	Large Wood Volume: Wetted Fast Turbulent	0.14
Wood	Large Wood Volume: Wetted Fast Turbulent	Large Wood Volume: Wetted Fast NonTurbulent	0.12
Wood	Large Wood Volume: Wetted Fast Turbulent	Large Wood Volume: Bankfull Fast NonTurbulent	0.12

Figures

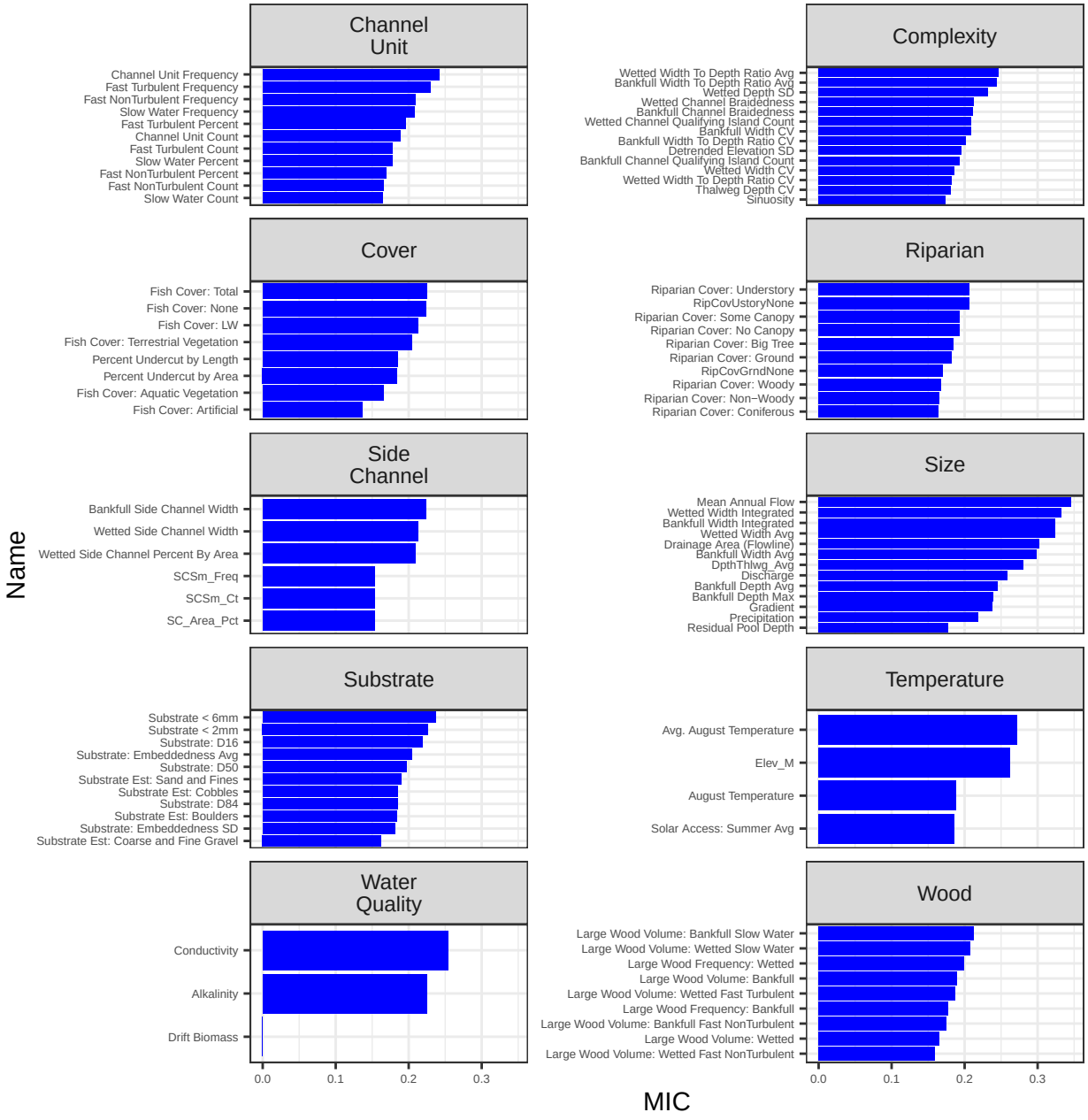

Figure S1: Barplots of MIC statistics, faceted by habitat category.

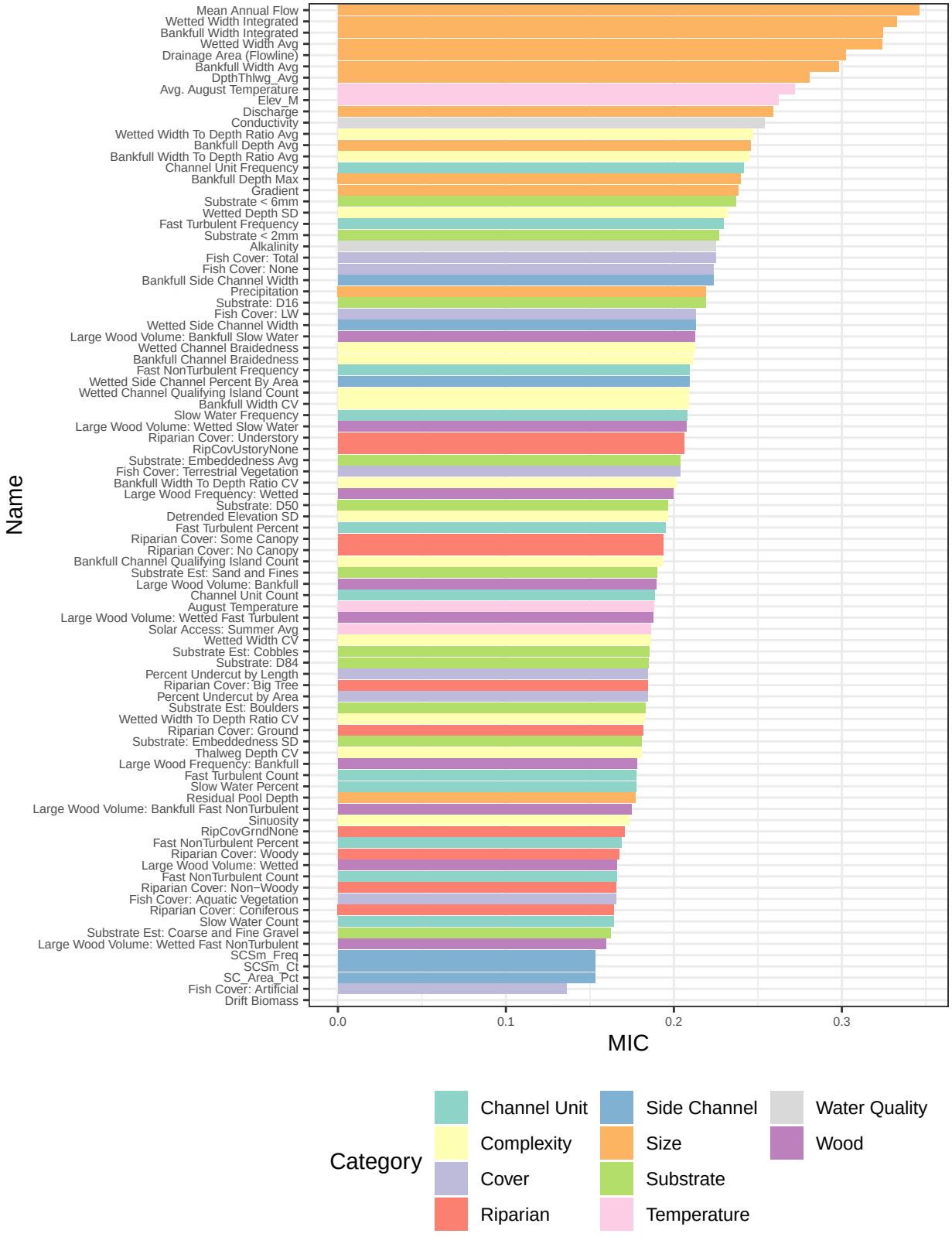

Figure S2: Barplot of MIC statistics, colored by habitat category.

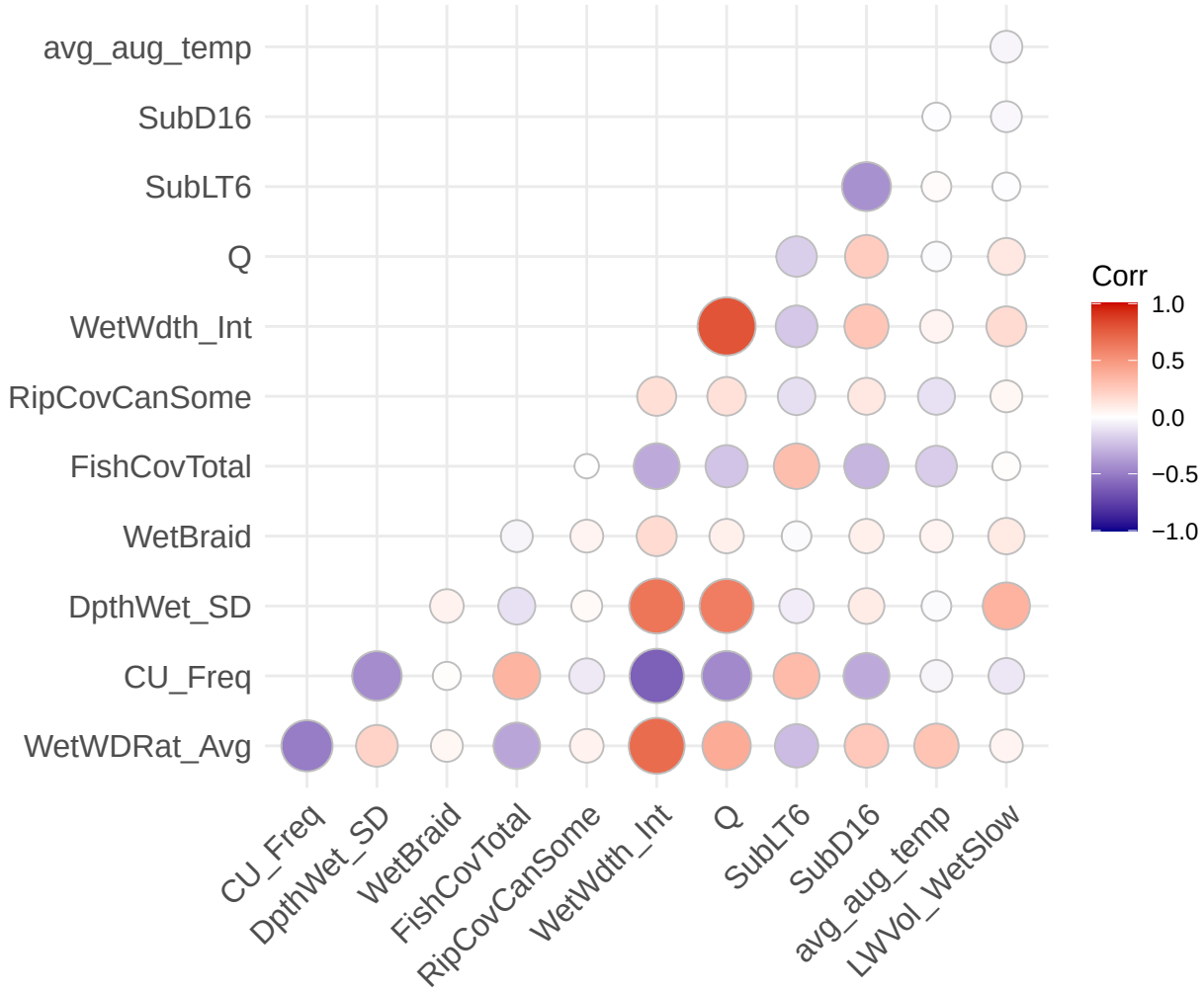

Figure S3: Correlation plot of habitat metrics used in the QRF model.

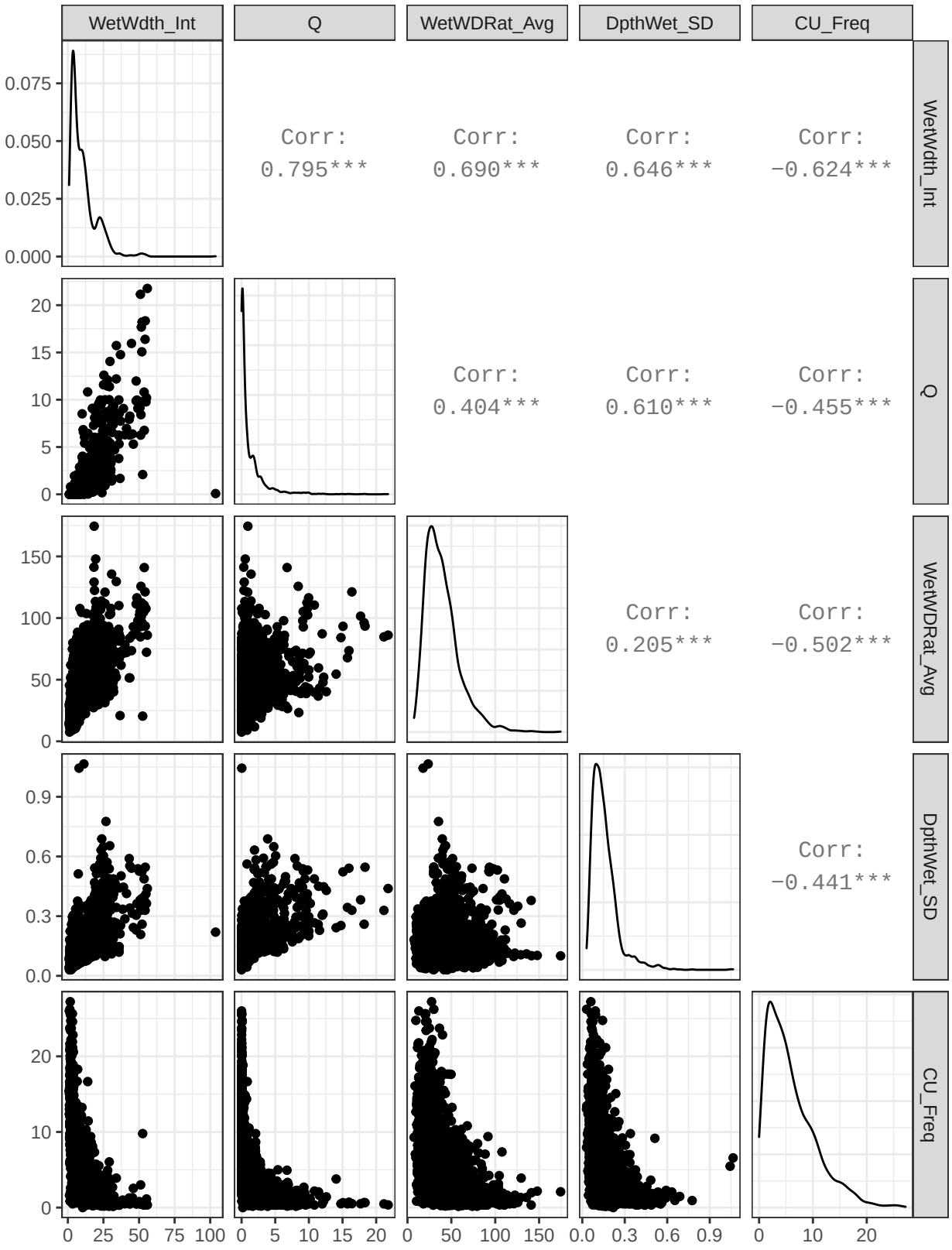

Figure S4: Pairs plot of habitat metrics used in QRF model with a correlation coefficient greater than 0.5 or less than -0.5.