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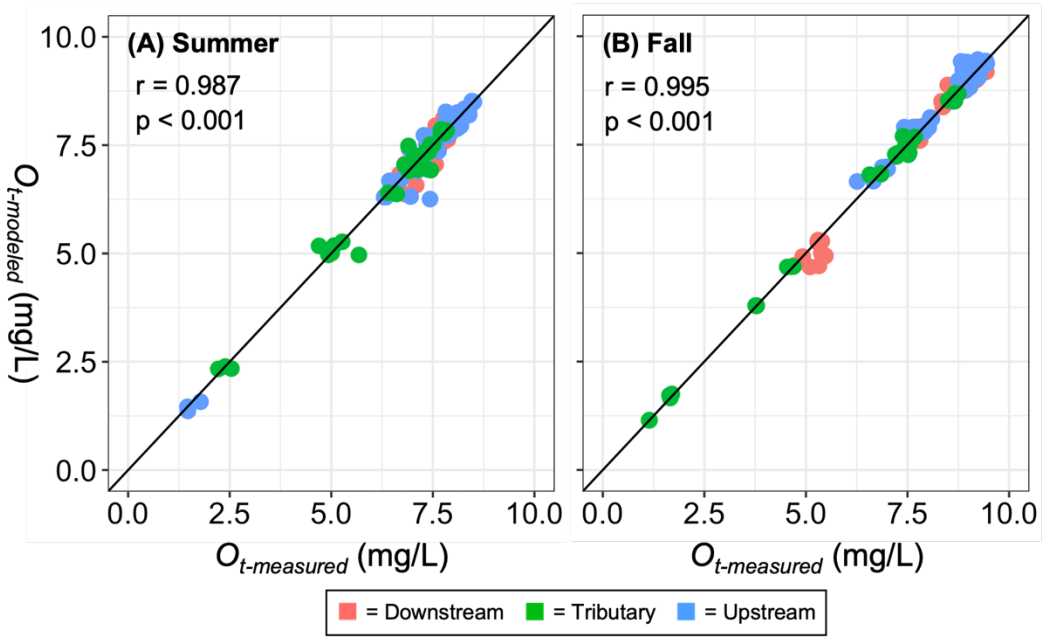
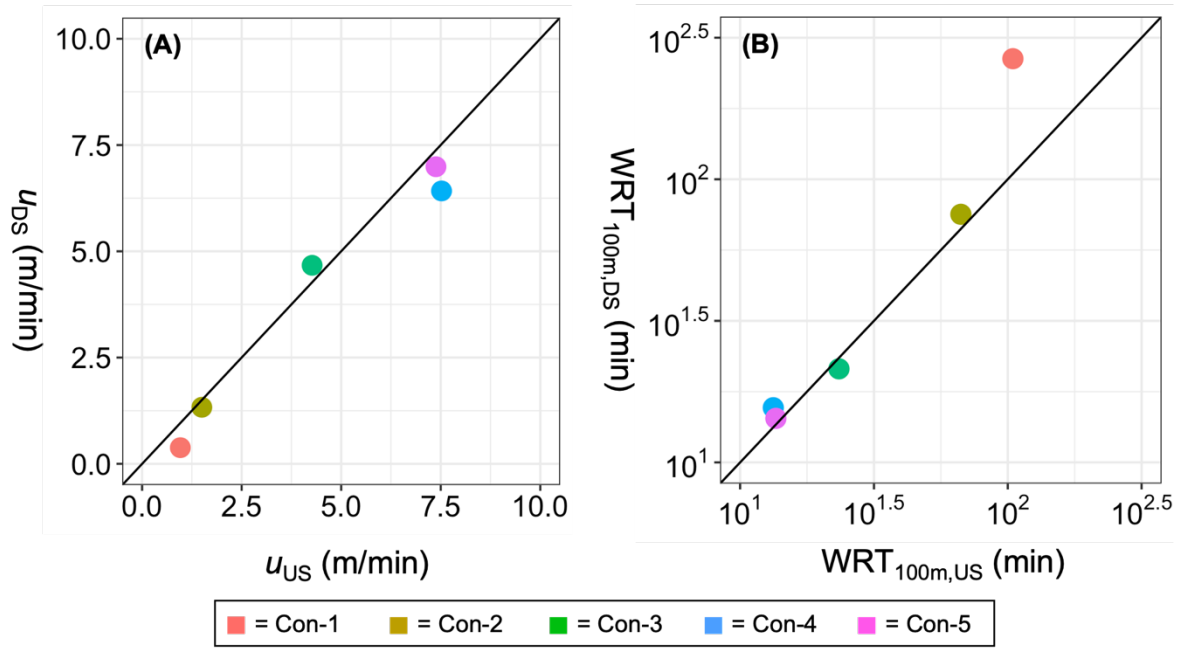
Note: Data and code used in the analyses of this manuscript are available at: http://www.hydroshare.org/resource/c5e687fa040e4707ba922002bafd18fd



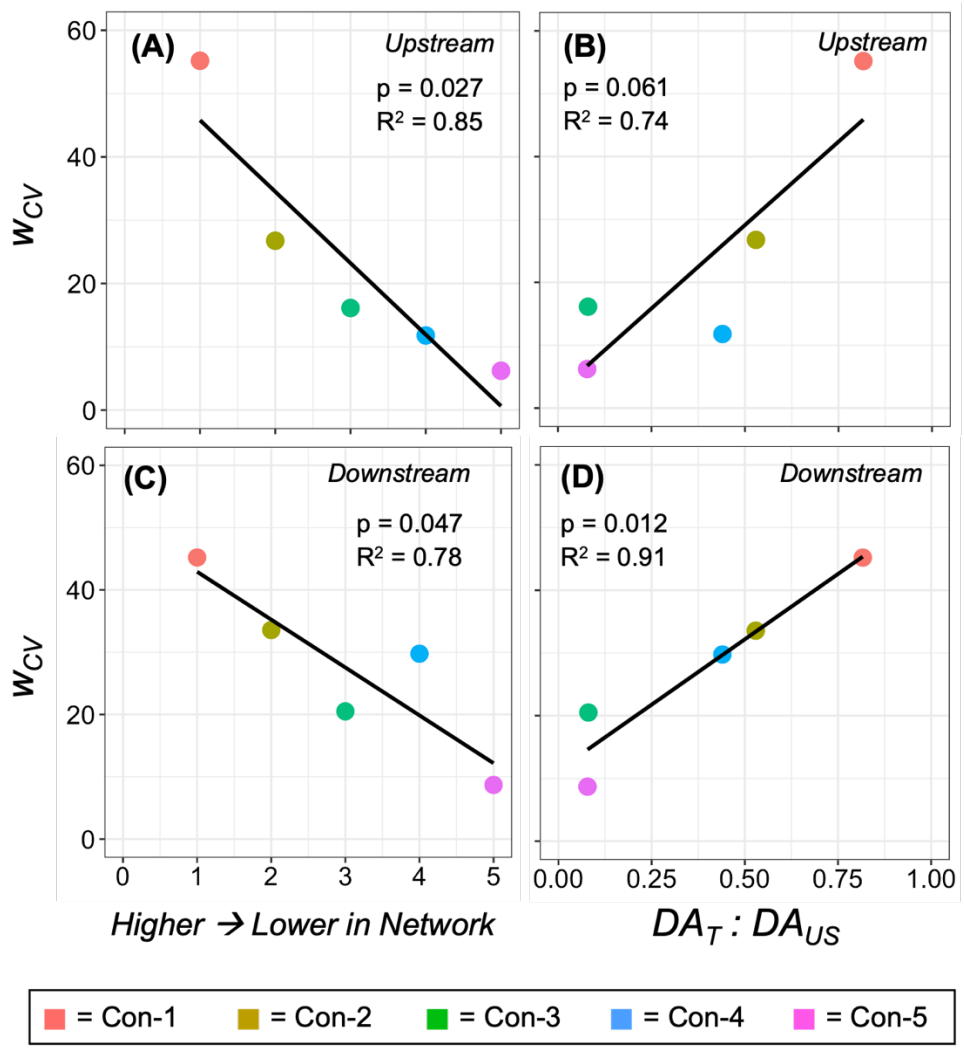
Supplementary Figure 1: Modeled final dissolved oxygen concentration based on water column microbial respiration rates ($O_{t\text{-}modeled}$, mg/L) versus measured final dissolved oxygen concentration ($O_{t\text{-}measured}$, mg/L) for all summer (A) and fall (B) microbial respiration assays. Black lines represent $O_{t\text{-}modeled} = O_{t\text{-}measured}$. Pearson correlation coefficients (r) and p-values are included for both summer and fall results. Microbial respiration assays conducted in downstream, tributary, and upstream reaches of a confluence are represented by different colors.

Supplementary Table 1: Two-way ANOVA p-values for specific conductivity (SpC), microbial respiration rate (k_{DO}), dissolved organic carbon (DOC), specific ultraviolet absorbance at 254 nm ($SUVA_{254}$), peak C (C), peak T (T), peak C: peak T (C:T), ammonium (NH_4-N), nitrate (NO_3-N), and soluble reactive phosphorus (SRP) for each confluence. Season (summer vs. fall) and reach (US vs. DS) were treated as fixed effects. For all tests, we assigned a significance level of $p < 0.05$. Significant results are bolded. Significant interactions were interpreted as differences in upstream vs. downstream parameter values were seasonally-dependent.

Parameter	Comparison	Con-1	Con-2	Con-3	Con-4	Con-5
SpC	Su vs. F	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
	US vs. DS	0.078	**<0.001**	**<0.001**	**<0.001**	0.051
	Interaction	0.115	**<0.001**	0.075	**<0.001**	0.874
k_{DO}	Su vs. F	0.286	**0.005**	0.714	0.289	0.246
	US vs. DS	**0.016**	0.103	0.248	0.487	0.279
	Interaction	**<0.001**	0.135	0.813	0.898	**0.018**
DOC	Su vs. F	**0.006**	**<0.001**	**<0.001**	**<0.001**	0.060
	US vs. DS	0.688	0.973	0.255	**0.014**	0.380
	Interaction	0.835	0.678	0.283	0.220	0.055
$SUVA_{254}$	Su vs. F	0.135	**0.018**	0.380	**<0.001**	**<0.001**
	US vs. DS	0.293	**0.019**	0.202	**0.008**	0.485
	Interaction	0.544	**0.017**	0.167	**0.028**	0.269
C	Su vs. F	0.068	**0.002**	**<0.001**	0.055	**<0.001**
	US vs. DS	0.180	0.575	**0.007**	0.678	0.366
	Interaction	0.323	0.707	**0.002**	**0.025**	**<0.001**
T	Su vs. F	**0.002**	**<0.001**	**<0.001**	**0.001**	**<0.001**
	US vs. DS	**0.031**	0.148	0.634	0.659	**0.021**
	Interaction	**0.009**	**0.009**	0.096	0.244	0.078
C:T	Su vs. F	**0.044**	0.068	0.229	**0.011**	**<0.001**
	US vs. DS	0.268	0.094	**0.013**	0.885	0.155
	Interaction	0.220	0.064	**0.001**	0.058	**<0.001**
NH_4-N	Su vs. F	**0.038**	0.179	**<0.001**	**0.017**	**0.004**
	US vs. DS	0.894	0.884	**0.021**	0.278	0.314
	Interaction	0.360	0.058	0.062	0.211	0.157
NO_3-N	Su vs. F	**<0.001**	**0.009**	**<0.001**	**<0.001**	**<0.001**
	US vs. DS	**0.001**	**<0.001**	**0.011**	0.656	0.144
	Interaction	**0.002**	0.091	0.526	0.079	0.340
SRP	Su vs. F	0.116	**0.023**	**<0.001**	**<0.001**	**<0.001**
	US vs. DS	0.215	0.618	0.413	**<0.001**	0.691
	Interaction	0.379	**0.031**	0.841	**<0.001**	0.732



Supplementary Figure 2: Downstream reach-scale velocity (u_{DS}, m/min) versus upstream reach-scale velocity (u_{US}, m/min; A) and downstream water residence time normalized to a 100 meter reach ($WRT_{100m,DS}$, min) versus upstream water residence time normalized to a 100 meter reach ($WRT_{100m,US}$, min; B). Black lines are 1:1 line for downstream and upstream u and WRT_{100m}, respectively. Each confluence is represented by a different color.



Supplementary Figure 3: Reach-scale coefficient of variation for wetted width (w_{cv}) versus confluence position in the network (A for upstream reaches, C for downstream reaches) and w_{cv} versus the ratio of tributary (T) and upstream (US) watershed drainage areas (DA_T:DA_{US}; B for upstream reaches, D for downstream reaches) for each confluence. Each confluence is represented by a different color. Black lines are linear fits of the data. R^2 values from simple linear regressions are included for all parameters.