



Supplement of

Water column respiration in the Yakima River basin is explained by temperature, nutrients, and suspended solids

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Table S1. Key climate, vegetation structure and function, topography, and wildfire potential variables and statistical moments used in the Columbia River basin catchment cluster analysis.

Variable Name	Description
catchment_ID	Catchment ID number
AreaSqKM	Area of each catchment in sq km
herb_cov_evc_MAX	LANDFIRE - Herbaceous Existing Vegetation Cover (maximum value per catchment)
herb_cov_evc_MEAN	LANDFIRE - Herbaceous Existing Vegetation Cover (mean value per catchment)
herb_cov_evc_MIN	LANDFIRE - Herbaceous Existing Vegetation Cover (minimum value per catchment)
herb_cov_evc_STD	LANDFIRE - Herbaceous Existing Vegetation Cover (standard deviation per catchment)
herb_hgt_evh_MAX	LANDFIRE - Herbaceous Existing Vegetation Height (maximum value per catchment)
herb_hgt_evh_MEAN	LANDFIRE - Herbaceous Existing Vegetation Height (mean value per catchment)
herb_hgt_evh_MIN	LANDFIRE - Herbaceous Existing Vegetation Height (minimum value per catchment)
herb_hgt_evh_STD	LANDFIRE - Herbaceous Existing Vegetation Height (standard deviation per catchment)
MCD15A3H_FPAR_1_MAX	MODIS - January Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_1_MEAN	MODIS - January Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_1_MIN	MODIS - January Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_1_STD	MODIS - January Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_10_MAX	MODIS - October Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_10_MEAN	MODIS - October Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_10_MIN	MODIS - October Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_10_STD	MODIS - October Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_11_MAX	MODIS - November Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_11_MEAN	MODIS - November Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_11_MIN	MODIS - November Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_11_STD	MODIS - November Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_12_MAX	MODIS - December Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_12_MEAN	MODIS - December Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_12_MIN	MODIS - December Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_12_STD	MODIS - December Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_2_MAX	MODIS - February Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_2_MEAN	MODIS - February Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_2_MIN	MODIS - February Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_2_STD	MODIS - February Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_2009_2019_median_MAX	MODIS - Long-Term Median Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_2009_2019_median_MEAN	MODIS - Long-Term Median Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_2009_2019_median_MIN	MODIS - Long-Term Median Fraction of Photosynthetically Active Radiation (minimum value per catchment)

Variable Name	Description
MCD15A3H_FPAR_2009_2019_median_STD	MODIS - Long-Term Median Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_3_MAX	MODIS - March Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_3_MEAN	MODIS - March Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_3_MIN	MODIS - March Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_3_STD	MODIS - March Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_4_MAX	MODIS - April Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_4_MEAN	MODIS - April Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_4_MIN	MODIS - April Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_4_STD	MODIS - April Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_5_MAX	MODIS - May Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_5_MEAN	MODIS - May Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_5_MIN	MODIS - May Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_5_STD	MODIS - May Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_6_MAX	MODIS - June Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_6_MEAN	MODIS - June Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_6_MIN	MODIS - June Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_6_STD	MODIS - June Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_7_MAX	MODIS - July Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_7_MEAN	MODIS - July Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_7_MIN	MODIS - July Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_7_STD	MODIS - July Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_8_MAX	MODIS - August Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_8_MEAN	MODIS - August Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_8_MIN	MODIS - August Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_8_STD	MODIS - August Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_FPAR_9_MAX	MODIS - September Fraction of Photosynthetically Active Radiation (maximum value per catchment)
MCD15A3H_FPAR_9_MEAN	MODIS - September Fraction of Photosynthetically Active Radiation (mean value per catchment)
MCD15A3H_FPAR_9_MIN	MODIS - September Fraction of Photosynthetically Active Radiation (minimum value per catchment)
MCD15A3H_FPAR_9_STD	MODIS - September Fraction of Photosynthetically Active Radiation (standard deviation per catchment)
MCD15A3H_LAI_1_MAX	MODIS - January Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_1_MEAN	MODIS - January Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_1_MIN	MODIS - January Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_1_STD	MODIS - January Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_10_MAX	MODIS - October Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_10_MEAN	MODIS - October Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_10_MIN	MODIS - October Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_10_STD	MODIS - October Leaf Area Index (standard deviation per catchment)

Variable Name	Description
MCD15A3H_LAI_11_MAX	MODIS - November Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_11_MEAN	MODIS - November Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_11_MIN	MODIS - November Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_11_STD	MODIS - November Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_12_MAX	MODIS - December Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_12_MEAN	MODIS - December Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_12_MIN	MODIS - December Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_12_STD	MODIS - December Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_2_MAX	MODIS - February Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_2_MEAN	MODIS - February Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_2_MIN	MODIS - February Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_2_STD	MODIS - February Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_2009_2019_median_MAX	MODIS - Long-Term Median Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_2009_2019_median_MEAN	MODIS - Long-Term Median Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_2009_2019_median_MIN	MODIS - Long-Term Median Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_2009_2019_median_STD	MODIS - Long-Term Median Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_3_MAX	MODIS - March Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_3_MEAN	MODIS - March Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_3_MIN	MODIS - March Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_3_STD	MODIS - March Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_4_MAX	MODIS - April Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_4_MEAN	MODIS - April Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_4_MIN	MODIS - April Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_4_STD	MODIS - April Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_5_MAX	MODIS - May Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_5_MEAN	MODIS - May Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_5_MIN	MODIS - May Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_5_STD	MODIS - May Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_6_MAX	MODIS - June Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_6_MEAN	MODIS - June Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_6_MIN	MODIS - June Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_6_STD	MODIS - June Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_7_MAX	MODIS - July Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_7_MEAN	MODIS - July Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_7_MIN	MODIS - July Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_7_STD	MODIS - July Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_8_MAX	MODIS - August Leaf Area Index (maximum value per catchment)

Variable Name	Description
MCD15A3H_LAI_8_MEAN	MODIS - August Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_8_MIN	MODIS - August Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_8_STD	MODIS - August Leaf Area Index (standard deviation per catchment)
MCD15A3H_LAI_9_MAX	MODIS - September Leaf Area Index (maximum value per catchment)
MCD15A3H_LAI_9_MEAN	MODIS - September Leaf Area Index (mean value per catchment)
MCD15A3H_LAI_9_MIN	MODIS - September Leaf Area Index (minimum value per catchment)
MCD15A3H_LAI_9_STD	MODIS - September Leaf Area Index (standard deviation per catchment)
MOD16A2_ET_10_MAX	MODIS - October Evapotranspiration (maximum value per catchment)
MOD16A2_ET_10_MEAN	MODIS - October Evapotranspiration (mean value per catchment)
MOD16A2_ET_10_MIN	MODIS - October Evapotranspiration (minimum value per catchment)
MOD16A2_ET_10_STD	MODIS - October Evapotranspiration (standard deviation per catchment)
MOD16A2_ET_11_MAX	MODIS - November Evapotranspiration (maximum value per catchment)
MOD16A2_ET_11_MEAN	MODIS - November Evapotranspiration (mean value per catchment)
MOD16A2_ET_11_MIN	MODIS - November Evapotranspiration (minimum value per catchment)
MOD16A2_ET_11_STD	MODIS - November Evapotranspiration (standard deviation per catchment)
MOD16A2_ET_12_MAX	MODIS - December Evapotranspiration (maximum value per catchment)
MOD16A2_ET_12_MEAN	MODIS - December Evapotranspiration (mean value per catchment)
MOD16A2_ET_12_MIN	MODIS - December Evapotranspiration (minimum value per catchment)
MOD16A2_ET_12_STD	MODIS - December Evapotranspiration (standard deviation per catchment)
MOD16A2_ET_2009_2019_median_MAX	MODIS - Long-Term Median Evapotranspiration (maximum value per catchment)
MOD16A2_ET_2009_2019_median_MEAN	MODIS - Long-Term Median Evapotranspiration (mean value per catchment)
MOD16A2_ET_2009_2019_median_MIN	MODIS - Long-Term Median Evapotranspiration (minimum value per catchment)
MOD16A2_ET_2009_2019_median_STD	MODIS - Long-Term Median Evapotranspiration (standard deviation per catchment)
MOD16A2ET_1_MAX	MODIS - January Evapotranspiration (maximum value per catchment)
MOD16A2ET_1_MEAN	MODIS - January Evapotranspiration (mean value per catchment)
MOD16A2ET_1_MIN	MODIS - January Evapotranspiration (minimum value per catchment)
MOD16A2ET_1_STD	MODIS - January Evapotranspiration (standard deviation per catchment)
MOD16A2ET_2_MAX	MODIS - February Evapotranspiration (maximum value per catchment)
MOD16A2ET_2_MEAN	MODIS - February Evapotranspiration (mean value per catchment)
MOD16A2ET_2_MIN	MODIS - February Evapotranspiration (minimum value per catchment)
MOD16A2ET_2_STD	MODIS - February Evapotranspiration (standard deviation per catchment)
MOD16A2ET_3_MAX	MODIS - March Evapotranspiration (maximum value per catchment)
MOD16A2ET_3_MEAN	MODIS - March Evapotranspiration (mean value per catchment)
MOD16A2ET_3_MIN	MODIS - March Evapotranspiration (minimum value per catchment)
MOD16A2ET_3_STD	MODIS - March Evapotranspiration (standard deviation per catchment)
MOD16A2ET_4_MAX	MODIS - April Evapotranspiration (maximum value per catchment)
MOD16A2ET_4_MEAN	MODIS - April Evapotranspiration (mean value per catchment)

Variable Name	Description
MOD16A2ET_4_MIN	MODIS - April Evapotranspiration (minimum value per catchment)
MOD16A2ET_4_STD	MODIS - April Evapotranspiration (standard deviation per catchment)
MOD16A2ET_5_MAX	MODIS - May Evapotranspiration (maximum value per catchment)
MOD16A2ET_5_MEAN	MODIS - May Evapotranspiration (mean value per catchment)
MOD16A2ET_5_MIN	MODIS - May Evapotranspiration (minimum value per catchment)
MOD16A2ET_5_STD	MODIS - May Evapotranspiration (standard deviation per catchment)
MOD16A2ET_6_MAX	MODIS - June Evapotranspiration (maximum value per catchment)
MOD16A2ET_6_MEAN	MODIS - June Evapotranspiration (mean value per catchment)
MOD16A2ET_6_MIN	MODIS - June Evapotranspiration (minimum value per catchment)
MOD16A2ET_6_STD	MODIS - June Evapotranspiration (standard deviation per catchment)
MOD16A2ET_7_MAX	MODIS - July Evapotranspiration (maximum value per catchment)
MOD16A2ET_7_MEAN	MODIS - July Evapotranspiration (mean value per catchment)
MOD16A2ET_7_MIN	MODIS - July Evapotranspiration (minimum value per catchment)
MOD16A2ET_7_STD	MODIS - July Evapotranspiration (standard deviation per catchment)
MOD16A2ET_8_MAX	MODIS - August Evapotranspiration (maximum value per catchment)
MOD16A2ET_8_MEAN	MODIS - August Evapotranspiration (mean value per catchment)
MOD16A2ET_8_MIN	MODIS - August Evapotranspiration (minimum value per catchment)
MOD16A2ET_8_STD	MODIS - August Evapotranspiration (standard deviation per catchment)
MOD16A2ET_9_MAX	MODIS - September Evapotranspiration (maximum value per catchment)
MOD16A2ET_9_MEAN	MODIS - September Evapotranspiration (mean value per catchment)
MOD16A2ET_9_MIN	MODIS - September Evapotranspiration (minimum value per catchment)
MOD16A2ET_9_STD	MODIS - September Evapotranspiration (standard deviation per catchment)
MOD17A3H_NPP_2004_2014_median_MAX	MODIS - Net Primary Productivity Long-Term Median (maximum value per catchment)
MOD17A3H_NPP_2004_2014_median_MEAN	MODIS - Net Primary Productivity Long-Term Median (mean value per catchment)
MOD17A3H_NPP_2004_2014_median_MIN	MODIS - Net Primary Productivity Long-Term Median (minimum value per catchment)
MOD17A3H_NPP_2004_2014_median_STD	MODIS - Net Primary Productivity Long-Term Median (standard deviation per catchment)
ned17_MAX	NHDPlus - National Elevation Dataset (maximum value per catchment)
ned17_MEAN	NHDPlus - National Elevation Dataset (mean value per catchment)
ned17_MIN	NHDPlus - National Elevation Dataset (minimum value per catchment)
ned17_STD	NHDPlus - National Elevation Dataset (standard deviation per catchment)
ned17shadedrelief_MAX	NHDPlus - National Elevation Dataset, Shaded Relief (maximum value per catchment)
ned17shadedrelief_MEAN	NHDPlus - National Elevation Dataset, Shaded Relief (mean value per catchment)
ned17shadedrelief_MIN	NHDPlus - National Elevation Dataset, Shaded Relief (minimum value per catchment)
ned17shadedrelief_STD	NHDPlus - National Elevation Dataset, Shaded Relief (standard deviation per catchment)
pheno_AMP_ltlean_MAX	MODIS Phenology - Amplitude (maximum value per catchment)
pheno_AMP_ltlean_MEAN	MODIS Phenology - Amplitude (mean value per catchment)
pheno_AMP_ltlean_MIN	MODIS Phenology - Amplitude (minimum value per catchment)

Variable Name	Description
pheno_AMP_ltmean_STD	MODIS Phenology - Amplitude (standard deviation per catchment)
pheno_DUR_ltmean_MAX	MODIS Phenology - Duration (maximum value per catchment)
pheno_DUR_ltmean_MEAN	MODIS Phenology - Duration (mean value per catchment)
pheno_DUR_ltmean_MIN	MODIS Phenology - Duration (minimum value per catchment)
pheno_DUR_ltmean_STD	MODIS Phenology - Duration (standard deviation per catchment)
pheno_EOSN_ltmean_MAX	MODIS Phenology - End of Season Normalized Difference Vegetation Index (maximum value per catchment)
pheno_EOSN_ltmean_MEAN	MODIS Phenology - End of Season Normalized Difference Vegetation Index (mean value per catchment)
pheno_EOSN_ltmean_MIN	MODIS Phenology - End of Season Normalized Difference Vegetation Index (minimum value per catchment)
pheno_EOSN_ltmean_STD	MODIS Phenology - End of Season Normalized Difference Vegetation Index (standard deviation per catchment)
pheno_EOST_ltmean_MAX	MODIS Phenology - End of Season Time (maximum value per catchment)
pheno_EOST_ltmean_MEAN	MODIS Phenology - End of Season Time (mean value per catchment)
pheno_EOST_ltmean_MIN	MODIS Phenology - End of Season Time (minimum value per catchment)
pheno_EOST_ltmean_STD	MODIS Phenology - End of Season Time (standard deviation per catchment)
pheno_MAXN_ltmean_MAX	MODIS Phenology - Maximum Normalized Difference Vegetation Index (maximum value per catchment)
pheno_MAXN_ltmean_MEAN	MODIS Phenology - Maximum Normalized Difference Vegetation Index (maximum value per catchment)
pheno_MAXN_ltmean_MIN	MODIS Phenology - Maximum Normalized Difference Vegetation Index (maximum value per catchment)
pheno_MAXN_ltmean_STD	MODIS Phenology - Maximum Normalized Difference Vegetation Index (maximum value per catchment)
pheno_SOSN_ltmean_MAX	MODIS Phenology - Start of Season Normalized Difference Vegetation Index (maximum value per catchment)
pheno_SOSN_ltmean_MEAN	MODIS Phenology - Start of Season Normalized Difference Vegetation Index (mean value per catchment)
pheno_SOSN_ltmean_MIN	MODIS Phenology - Start of Season Normalized Difference Vegetation Index (minimum value per catchment)
pheno_SOSN_ltmean_STD	MODIS Phenology - Start of Season Normalized Difference Vegetation Index (standard deviation per catchment)
pheno_SOST_ltmean_MAX	MODIS Phenology - Start of Season Time (maximum value per catchment)
pheno_SOST_ltmean_MEAN	MODIS Phenology - Start of Season Time (mean value per catchment)
pheno_SOST_ltmean_MIN	MODIS Phenology - Start of Season Time (minimum value per catchment)
pheno_SOST_ltmean_STD	MODIS Phenology - Start of Season Time (standard deviation per catchment)
pheno_TIN_ltmean_MAX	MODIS Phenology - Time Integrated Normalized Difference Vegetation Index (maximum value per catchment)
pheno_TIN_ltmean_MEAN	MODIS Phenology - Time Integrated Normalized Difference Vegetation Index (mean value per catchment)
pheno_TIN_ltmean_MIN	MODIS Phenology - Time Integrated Normalized Difference Vegetation Index (minimum value per catchment)
pheno_TIN_ltmean_STD	MODIS Phenology - Time Integrated Normalized Difference Vegetation Index (standard deviation per catchment)
ppt_30yr_norm_01_MAX	PRISM - Normalized 30-Year Precipitation for January (maximum value per catchment)
ppt_30yr_norm_01_MEAN	PRISM - Normalized 30-Year Precipitation for January (mean value per catchment)
ppt_30yr_norm_01_MIN	PRISM - Normalized 30-Year Precipitation for January (minimum value per catchment)
ppt_30yr_norm_01_STD	PRISM - Normalized 30-Year Precipitation for January (standard deviation per catchment)
ppt_30yr_norm_02_MAX	PRISM - Normalized 30-Year Precipitation for February (maximum value per catchment)
ppt_30yr_norm_02_MEAN	PRISM - Normalized 30-Year Precipitation for February (mean value per catchment)
ppt_30yr_norm_02_MIN	PRISM - Normalized 30-Year Precipitation for February (minimum value per catchment)
ppt_30yr_norm_02_STD	PRISM - Normalized 30-Year Precipitation for February (standard deviation per catchment)

Variable Name	Description
ppt_30yr_norm_03_MAX	PRISM - Normalized 30-Year Precipitation for March (maximum value per catchment)
ppt_30yr_norm_03_MEAN	PRISM - Normalized 30-Year Precipitation for March (mean value per catchment)
ppt_30yr_norm_03_MIN	PRISM - Normalized 30-Year Precipitation for March (minimum value per catchment)
ppt_30yr_norm_03_STD	PRISM - Normalized 30-Year Precipitation for March (standard deviation per catchment)
ppt_30yr_norm_04_MAX	PRISM - Normalized 30-Year Precipitation for April (maximum value per catchment)
ppt_30yr_norm_04_MEAN	PRISM - Normalized 30-Year Precipitation for April (mean value per catchment)
ppt_30yr_norm_04_MIN	PRISM - Normalized 30-Year Precipitation for April (minimum value per catchment)
ppt_30yr_norm_04_STD	PRISM - Normalized 30-Year Precipitation for April (standard deviation per catchment)
ppt_30yr_norm_05_MAX	PRISM - Normalized 30-Year Precipitation for May (maximum value per catchment)
ppt_30yr_norm_05_MEAN	PRISM - Normalized 30-Year Precipitation for May (mean value per catchment)
ppt_30yr_norm_05_MIN	PRISM - Normalized 30-Year Precipitation for May (minimum value per catchment)
ppt_30yr_norm_05_STD	PRISM - Normalized 30-Year Precipitation for May (standard deviation per catchment)
ppt_30yr_norm_06_MAX	PRISM - Normalized 30-Year Precipitation for June (maximum value per catchment)
ppt_30yr_norm_06_MEAN	PRISM - Normalized 30-Year Precipitation for June (mean value per catchment)
ppt_30yr_norm_06_MIN	PRISM - Normalized 30-Year Precipitation for June (minimum value per catchment)
ppt_30yr_norm_06_STD	PRISM - Normalized 30-Year Precipitation for June (standard deviation per catchment)
ppt_30yr_norm_07_MAX	PRISM - Normalized 30-Year Precipitation for July (maximum value per catchment)
ppt_30yr_norm_07_MEAN	PRISM - Normalized 30-Year Precipitation for July (mean value per catchment)
ppt_30yr_norm_07_MIN	PRISM - Normalized 30-Year Precipitation for July (minimum value per catchment)
ppt_30yr_norm_07_STD	PRISM - Normalized 30-Year Precipitation for July (standard deviation per catchment)
ppt_30yr_norm_08_MAX	PRISM - Normalized 30-Year Precipitation for August (maximum value per catchment)
ppt_30yr_norm_08_MEAN	PRISM - Normalized 30-Year Precipitation for August (mean value per catchment)
ppt_30yr_norm_08_MIN	PRISM - Normalized 30-Year Precipitation for August (minimum value per catchment)
ppt_30yr_norm_08_STD	PRISM - Normalized 30-Year Precipitation for August (standard deviation per catchment)
ppt_30yr_norm_09_MAX	PRISM - Normalized 30-Year Precipitation for September (maximum value per catchment)
ppt_30yr_norm_09_MEAN	PRISM - Normalized 30-Year Precipitation for September (mean value per catchment)
ppt_30yr_norm_09_MIN	PRISM - Normalized 30-Year Precipitation for September (minimum value per catchment)
ppt_30yr_norm_09_STD	PRISM - Normalized 30-Year Precipitation for September (standard deviation per catchment)
ppt_30yr_norm_10_MAX	PRISM - Normalized 30-Year Precipitation for October (maximum value per catchment)
ppt_30yr_norm_10_MEAN	PRISM - Normalized 30-Year Precipitation for October (mean value per catchment)
ppt_30yr_norm_10_MIN	PRISM - Normalized 30-Year Precipitation for October (minimum value per catchment)
ppt_30yr_norm_10_STD	PRISM - Normalized 30-Year Precipitation for October (standard deviation per catchment)
ppt_30yr_norm_11_MAX	PRISM - Normalized 30-Year Precipitation for November (maximum value per catchment)
ppt_30yr_norm_11_MEAN	PRISM - Normalized 30-Year Precipitation for November (mean value per catchment)
ppt_30yr_norm_11_MIN	PRISM - Normalized 30-Year Precipitation for November (minimum value per catchment)
ppt_30yr_norm_11_STD	PRISM - Normalized 30-Year Precipitation for November (standard deviation per catchment)
ppt_30yr_norm_12_MAX	PRISM - Normalized 30-Year Precipitation for December (maximum value per catchment)

Variable Name	Description
ppt_30yr_norm_12_MEAN	PRISM - Normalized 30-Year Precipitation for December (mean value per catchment)
ppt_30yr_norm_12_MIN	PRISM - Normalized 30-Year Precipitation for December (minimum value per catchment)
ppt_30yr_norm_12_STD	PRISM - Normalized 30-Year Precipitation for December (standard deviation per catchment)
ppt_30yr_norm_annual_MAX	PRISM - Normalized, Annual 30-Year Precipitation (maximum value per catchment)
ppt_30yr_norm_annual_MEAN	PRISM - Normalized, Annual 30-Year Precipitation (mean value per catchment)
ppt_30yr_norm_annual_MIN	PRISM - Normalized, Annual 30-Year Precipitation (minimum value per catchment)
ppt_30yr_norm_annual_STD	PRISM - Normalized, Annual 30-Year Precipitation (standard deviation per catchment)
shrub_cov_evc_MAX	LANDFIRE - Shrub Existing Vegetation Cover (maximum value per catchment)
shrub_cov_evc_MEAN	LANDFIRE - Shrub Existing Vegetation Cover (mean value per catchment)
shrub_cov_evc_MIN	LANDFIRE - Shrub Existing Vegetation Cover (minimum value per catchment)
shrub_cov_evc_STD	LANDFIRE - Shrub Existing Vegetation Cover (standard deviation per catchment)
shrub_hgt_evh_MAX	LANDFIRE - Shrub Existing Vegetation Height (maximum value per catchment)
shrub_hgt_evh_MEAN	LANDFIRE - Shrub Existing Vegetation Height (mean value per catchment)
shrub_hgt_evh_MIN	LANDFIRE - Shrub Existing Vegetation Height (minimum value per catchment)
shrub_hgt_evh_STD	LANDFIRE - Shrub Existing Vegetation Height (standard deviation per catchment)
tree_cov_evc_MAX	LANDFIRE - Tree Existing Vegetation Cover (maximum value per catchment)
tree_cov_evc_MEAN	LANDFIRE - Tree Existing Vegetation Cover (mean value per catchment)
tree_cov_evc_MIN	LANDFIRE - Tree Existing Vegetation Cover (minimum value per catchment)
tree_cov_evc_STD	LANDFIRE - Tree Existing Vegetation Cover (standard deviation per catchment)
tree_hgt_evh_MAX	LANDFIRE - Tree Existing Vegetation Height (maximum value per catchment)
tree_hgt_evh_MEAN	LANDFIRE - Tree Existing Vegetation Height (mean value per catchment)
tree_hgt_evh_MIN	LANDFIRE - Tree Existing Vegetation Height (minimum value per catchment)
tree_hgt_evh_STD	LANDFIRE - Tree Existing Vegetation Height (standard deviation per catchment)
WHP_MAX	USFS - Wildfire Hazard Potential (maximum value per catchment)
WHP_MEAN	USFS - Wildfire Hazard Potential (mean value per catchment)
WHP_MIN	USFS - Wildfire Hazard Potential (minimum value per catchment)
WHP_STD	USFS - Wildfire Hazard Potential (standard deviation per catchment)

A total of 280 variables (i.e., variable-statistical moment combinations) were created as input data to cluster analysis by calculating the four statistical moments (mean, minimum, maximum, and standard deviation values) for each of 16 key biophysical and hydrological attributes. The cluster analysis was performed to group Columbia River basin NHDPlusV2.1 catchments into six classes sharing similar characteristics. The 16 key biophysical and hydrological variables include: 1) MODIS-derived existing vegetation cover, percent (shrub, tree, and herbaceous vegetation; %); 2) MODIS-derived existing vegetation cover (shrub, tree, and herbaceous vegetation), height (m); 3) eMODIS Phenology-derived net primary productivity (NPP), long-term median ($\text{kg C m}^{-2} \text{ y}^{-1}$); 4) eMODIS Phenology-derived net ecosystem productivity (NEP), long-term median ($\text{kg C m}^{-2} \text{ y}^{-1}$); 5) eMODIS Phenology-derived amplitude (day of the year); 6) eMODIS Phenology-derived length of growing season (number of days); 7) eMODIS Phenology-derived time of growing season, start-of-season and end-of-season (day of year); 8) eMODIS Phenology-derived normalized difference vegetation index (NDVI), start-of-season, end-of-season, maximum, and time-integrated NDVI values; 9) MODIS-derived leaf area index (LAI; m^2 green leaf area per m^{-2} land area); 10) MODIS-derived fraction of photosynthetically active radiation (FPAR), monthly and long-term median (%); 11) MODIS-derived total evapotranspiration (ET), monthly and long-term median ($\text{kg H}_2\text{O m}^{-2} \text{ land area d}^{-1}$); 12) PRISM-derived 30-year precipitation (PPT), normalized monthly and normalized annual (mm); 13) National Elevation Dataset (NED)-derived elevation (m); 14) National Elevation Dataset (NED)-derived slope (%); 15) National Elevation Dataset (NED)-derived aspect; and 16) LANDFIRE-derived USFS Wildfire Hazard Potential (WHP). See the Code and Data Availability section for more information on the source of these data and how these data were processed and analyzed for use in this study

Table S2. Key biophysical and hydrological variable-statistical moment combinations evaluated for use in the Columbia River catchment cluster analysis.

Variable Set ^a	Description ^b	Variables ^c	Moments ^d	Months	<i>n</i> ^e	Notes
0	All zonal and tabulation statistical moments for all variables	All	All	January–December	280	
1	All variables using zonal mean only	All	zonal mean	January–December	70	
2	Set 1 AND only months 3, 7, and 11 for FPAR, LAI, ET, and PPT	FPAR, LAI, ET, PPT	zonal mean	March, July, November	30	
3	Set 1 AND only long-term median for FPAR, LAI, ET, and PPT	FPAR, LAI, ET, PPT	long-term median	March, July, November	22	
4	Set 3 with FPAR and PPT	FPAR, PPT	long-term median	March, July, November	20	Dropped LAI, ET
5	Set 3 with LAI and PPT	LAI, PPT	long-term median	March, July, November	20	Dropped FPAR, ET
6	Set 3 with ET and PPT	ET, PPT	long-term median	March, July, November	20	Dropped FPAR, LAI
7	All variables using zonal SD only	All	zonal SD	January–December	70	
8 ^a	All variables using zonal mean and SD	All	zonal mean, zonal SD	January–December	140	
9	Set 2 with only FPAR and PPT	FPAR, PPT	zonal mean	March, July, November	24	
10	Set 2 with only LAI and PPT	LAI, PPT	zonal mean	March, July, November	24	
11	Set 2 with only ET and PPT	ET, PPT	zonal mean	March, July, November	24	
12	PCA derived from means of all variables	All	mean	January - December	30	Used top 30 PCA components (PC1–PC30)

^a Variable set 8 was used in the final Columbia River basin catchment cluster analysis. The data set includes two statistical moments (zonal mean and zonal standard deviation (SD)) for the key biophysical and hydrological variables shown in Table S1.

^b The description for the 13 variable sets analyzed using cluster analysis lists the key biophysical and hydrological variables and the statistical moments for each key variable included in a specific variable set. FPAR (%) is the MODIS-derived fraction of photosynthetically active radiation for the month(s) indicated. LAI (m² green leaf area per m⁻² land area) is the MODIS-derived Leaf Area Index for the month(s) indicated. ET (kg H₂O m⁻² d⁻¹) is the MODIS-derived total evapotranspiration for the month(s) indicated. PPT (mm) is the PRISM-derived, normalized 30-year precipitation for the month(s) indicated.

^c Key biophysical and hydrological variables in each variable includes either 1) all the key variables shown in Table S1 or 2) a subset of the key variables shown in Table S1.

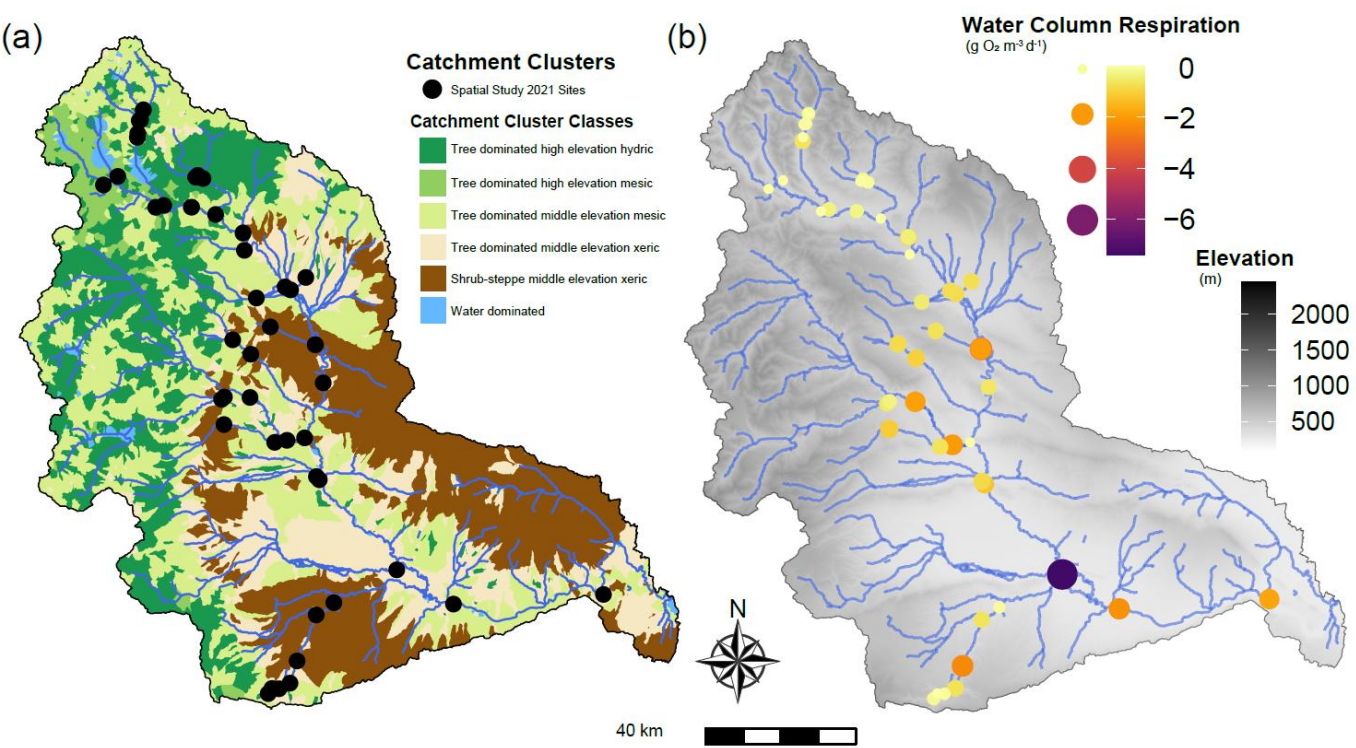
^d “All” includes the following four statistical moments calculated for the key variables in each variable set: 1) mean value, 2) minimum value, 3) maximum value, and 4) standard deviation, and 5) long-term median value calculated for the variables listed.

^e *n* is the total number of key variable-statistical moment combinations in each variable set.

Table S3. Expanded cluster analysis results characterizing NHDPlusV2.1 catchments across the Columbia River basin and Yakima River basin with similar biophysical and hydrologic characteristics and the number and percentage of sites in each.

Cluster	Name	CRB Catchments	CRB Drainage Area	YRB Catchments	YRB Drainage Area	YRB Sites Per Cluster	Percent YRB Sites Per Cluster
1	Tree dominated high elevation mesic	41,153	23%	1,553	27%	9	19%
2	Water dominated	6,188	34%	127	2%	0	0%
3	Tree dominated high elevation hydric	13,223	7%	136	2%	2	4%
4	Shrub-steppe middle elevation xeric	46,028	25%	1,591	28%	10	21%
5	Tree dominated middle elevation mesic	31,549	17%	982	17%	13	28%
6	Tree dominated middle elevation xeric	43,390	24%	1,282	23%	13	28%

“CRB Catchments” is the number of NHDPlusV2.1 catchments within the Columbia River basin classified in each cluster type. “CRB Drainage Area” is the percentage of the total drainage area of the Columbia River basin that was classified in each cluster. “YRB Catchments” is the number of NHDPlusV2.1 catchments within the Yakima River basin classified in each cluster. “YRB Drainage Area” is the percentage of the total drainage area of the Yakima River basin that was classified in each cluster. “YRB Sites Per Cluster” is the total number of field sites in the Yakima River basin located in each cluster. “YRB Sites Per Cluster” is the percentage of field sites located in each cluster.



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63 **Figure S1. Field sites from the 2021 spatial study on maps of the Yakima River basin.** a) Field sites from the 2021 spatial study superimposed
64 on a map of catchment cluster analysis results National Hydrography Dataset Plus Version 2.1 (NHDPlusV2.1). Catchments were grouped into
65 six classes sharing similar landscape characteristics using key biophysical and hydrologic variables and characterized according to tree height,
66 precipitation, and elevation. Field sites located in cluster 1 are characterized as tree dominated high elevation mesic sites. Field sites located in
67 cluster 3 are characterized as tree dominated, high elevation, hydric sites. Field sites located in cluster 4 are characterized as shrub-steppe, middle
68 elevation, xeric sites. Field sites located in cluster 5 are characterized as tree dominated, middle elevation, mesic sites. Field sites located in
69 cluster 6 are characterized as tree dominated, middle elevation, xeric sites. No sites were in cluster 2, which is characterized as water dominated.
70 (b) Yakima River basin water column respiration rates (ER_{wc} , $g\ O_2\ m^{-3}\ d^{-1}$) by site overlaid on a shaded hillslope map of the basin and the Yakima
71 River and its tributaries. Map data from the National Hydrography Dataset Plus (NHDPlusV2.1) includes catchment boundaries from the
72 Watershed Boundary Dataset (WBD) and hydrography data from the National Hydrography Dataset (NHD) (McKay et al., 2012). Elevation data
73 is pulled from various web services using the `get_elev_raster` function in R (Hollister, 2023).

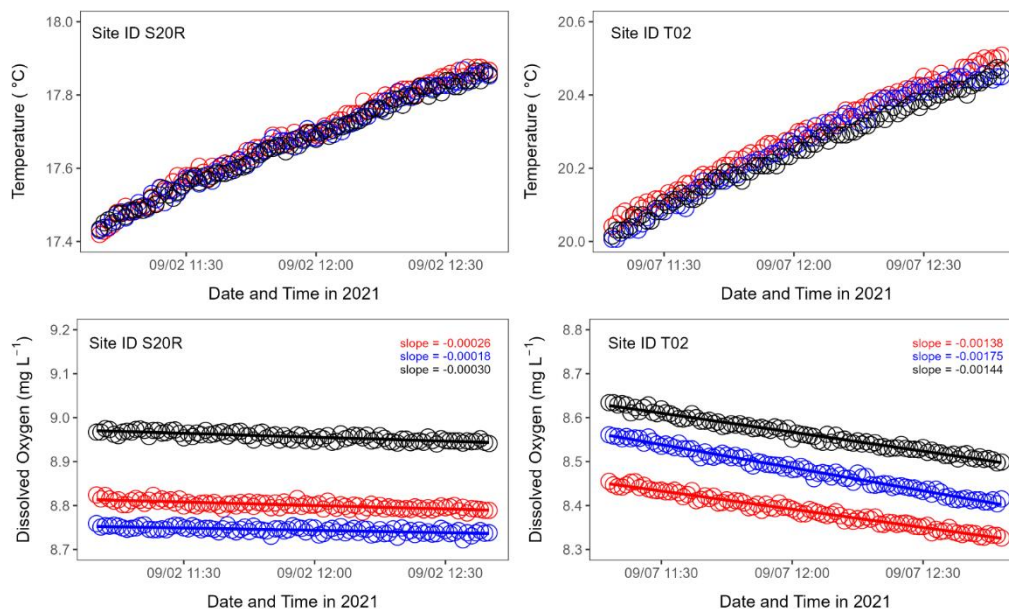
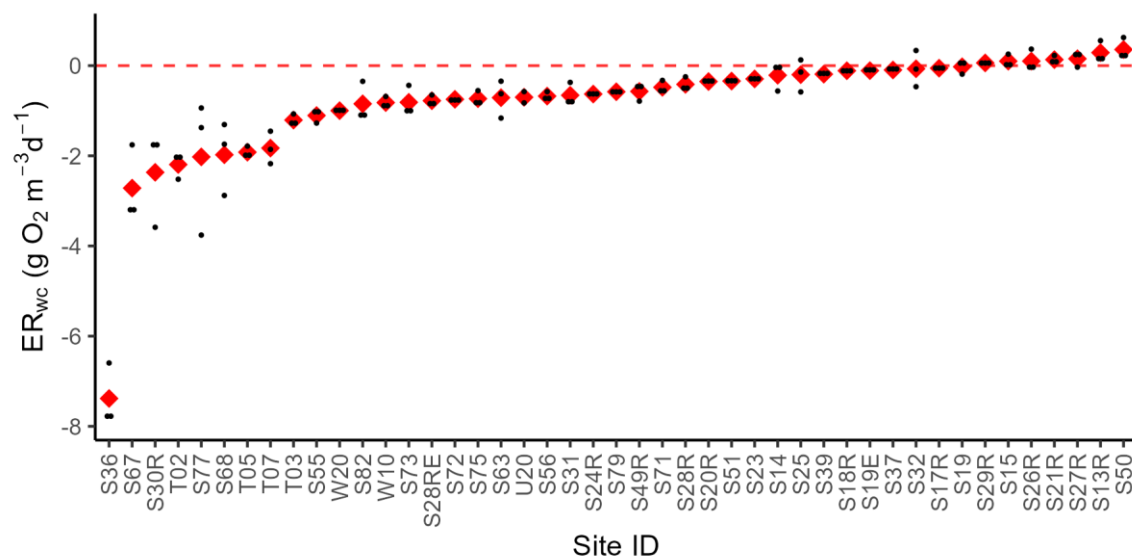


Figure S2. Example triplicate incubation bottle dissolved oxygen (DO) sensor time series data and linear regression models fit to the data for two sites in the Yakima River basin in different environmental settings. Left: West Fork Teanaway River (site S20R), Kittitas County, Washington. Right: Yakima River at Mabton (site T02), Yakima County, Washington. The red, blue, and black circles are raw sensor measurements logged on a 1-min time interval for each replicate bottle. Temperature data (°C) are shown in the top two panels. DO data (mg L⁻¹) are shown in the lower two panels and the red, blue, and black lines are the regression lines fit to each data set. The slope (mg O₂ L⁻¹ min⁻¹) is provided for each regression model. The regression models were well fit to the data with a normalized root mean square error (NRMSE) ≤ 0.01. Water column respiration rates (ER_{wc}) for each site were calculated as the mean slope (converted to daily units; g O₂ m⁻³ d⁻¹) of the three regression models.



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Figure S3. Dot plot comparison of the mean water column respiration rates for the triplicate sample incubations at each site ($n = 141$). Black dots represent water column respiration rates (ER_{wc} , g O₂ m⁻³ d⁻¹) from individual replicates. Red diamonds represent the mean ER_{wc} at each site. More negative ER_{wc} rates indicate greater oxygen consumption. Positive ER_{wc} rates are a biologically unrealistic outcome and likely indicate true oxygen consumption rates were too small to overcome instrument noise. Positive ER_{wc} rates greater than 0.5 g O₂ m⁻³ d⁻¹ are not included on this plot.



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91 **Figure S4. Pearson correlation coefficients, histograms, and scatter plots with ordinary least squares linear regressions of cube root**
 92 **transformed, scaled data variables with positive ER_{wc} values greater than $0.5 \text{ g m}^{-3} \text{ d}^{-1}$ removed and positive ER_{wc} values less than 0.5 g**
 93 **$\text{m}^{-3} \text{ d}^{-1}$ turned to 0. *, **, and *** represent significant correlations at p-values of 0.05, 0.01, and 0.001, respectively. Dashed lines represent**
 94 **ordinary least squares regression models.**

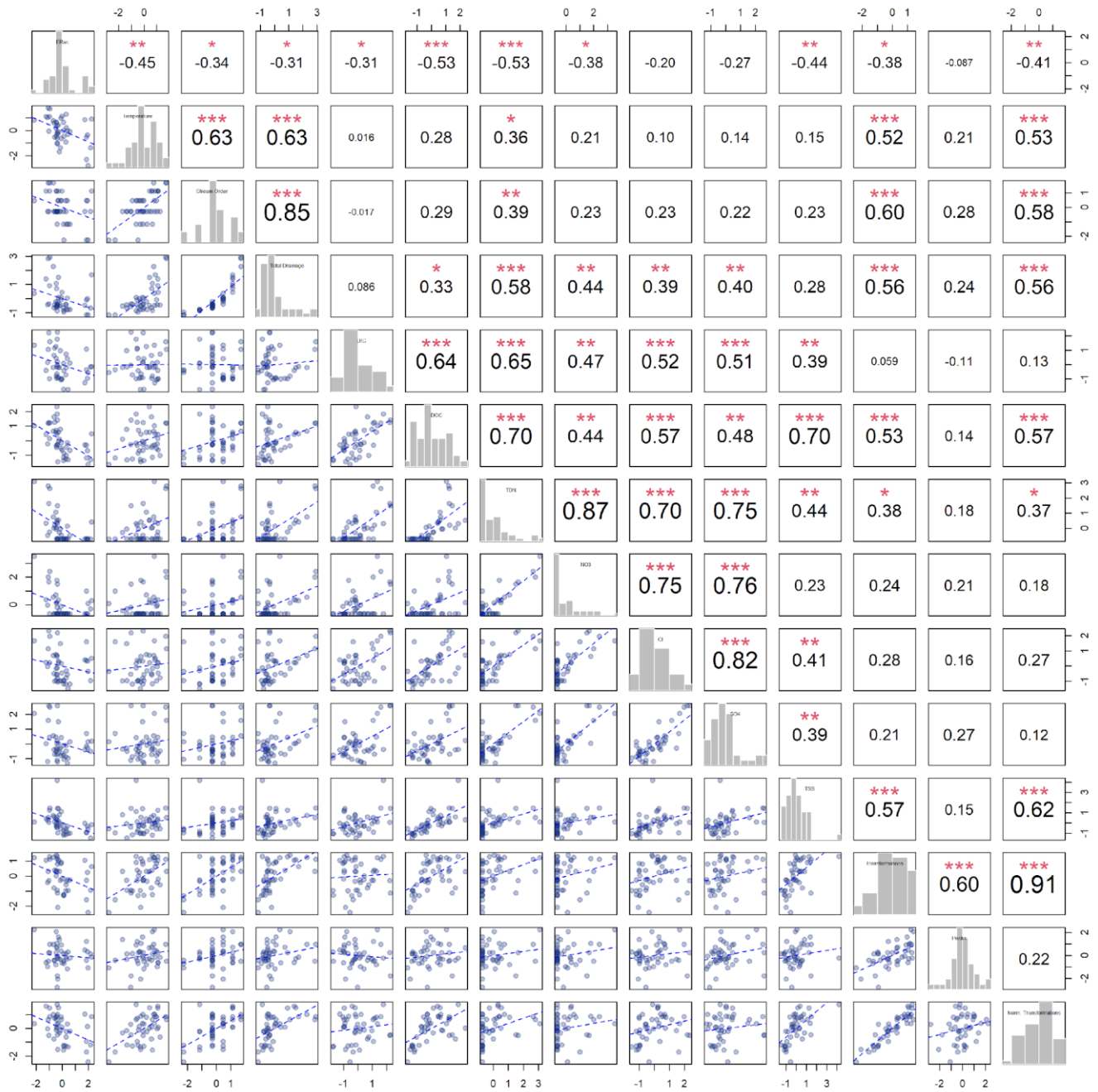


Figure S5. Pearson correlation coefficients, histograms, and scatter plots with ordinary least squares linear regressions of cube root transformed, scaled data variables with positive ER_{wc} values less than $0.5 \text{ g m}^{-3} \text{ d}^{-1}$ retained. *, **, and * represent significant correlations at p-values of 0.05, 0.01, and 0.001, respectively. Dashed lines represent ordinary least squares regression models.**

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101 Table S4. β coefficients from LASSO analyses for explaining ER_{wc} across the Yakima River Basin. Positive values of ER_{wc} less than 0.5 g m⁻³
102 d⁻¹ were retained for analysis. ER_{wc} and all explanatory variables were cube root transformed and standardized as z-scores. LASSO was performed
103 over 100 seeds, and β coefficients for each variable were normalized to the maximum β coefficient in each seed and averaged across all seeds for
104 the reported values. Values of zero indicate that while the variable was included in the model, it was deemed not influential in predicting model
105 outcomes and thus was not assigned a β coefficient.

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Predictor Variable	Mean β Coefficient	Standard Deviation
TDN	--0.98	0.03
Temperature	-0.95	0.08
DOC	-0.74	0.09
TSS	-0.48	0.09
NO3-	-0.04	0.11
SO4-	00	00
Normalized DOM Transformations	00	00
DIC	00	00
DOM Transformations	00	00
DOM Peaks	0.002	0.01
Total drainage area	0.01	0.04
Cl-	0.13	0.25
R2	0.40	

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115 **References for Supplementary Material**

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