Mechanisms Governing Spatial Variability in River Corridor Hydrobiogeochemistry

Stephanie Fulton,[1]* Morgan Barnes,[1] Xingyuan Chen,[1] Robert Danczak,[1] Bob Hall,[2] Matthew Kaufman,[1] Vanessa Garayburu-Caruso,[1] Amy Goldman,[1] Jesus Gomez-Velez,[3] Samantha Grieger,[1] Xinming Lin,[1] Sophia McKever,[1] Allison Myers-Pigg,[1,4] Opal Otenburg,[1] Huiying Ren,[1] Lupita Renteria,[1] Alan Roebuck,[1] Kyongho Son,[1] and James Stegen[1]

[1]Pacific Northwest National Laboratory, Richland, WA; [2]University of Montana, Polson, MT; [3]Vanderbilt University, Nashville, TN; [4]University of Toledo, Toledo, OH

Contact: Stephanie.Fulton@pnnl.gov
Project Lead Principal Investigator (PI): Tim Scheibe
BER Program: ESS
Project: PNNL River Corridor SFA (RCSFA)
Project Website: https://www.pnnl.gov/projects/river-corridor

Project Abstract: *This element of the PNNL River Corridor SFA seeks to understand spatial variability in hydrobiogeochemistry across the Yakima River Basin (YRB).* To represent processes governing river corridor hydrobiogeochemistry in models, we need to understand hydrobiogeochemistry across broad environmental gradients that include natural (e.g., fire) and anthropogenic (e.g., urban) disturbances. To help fill this need we are studying spatial variation in river corridor chemistry, microbiology, and aerobic respiration across 47 sites in the YRB. Sites were selected using an iterative ModEx approach. Integrated teams selected model-relevant variables for both standard (e.g., dissolved organic C concentration, major ion chemistry) and less standard measurements (e.g., organic matter chemistry via FTICR). Numerical simulations were coupled with AI methods to identify system features most strongly associated with predicted variation in river corridor hydrobiogeochemistry. These key features were used to cluster YRB rivers into classes. Field sites were selected across all classes while accounting for logistical constraints of field work. Resulting sites were distributed across stream orders, biomes, and land cover/land use from low order mountain settings to high order lowlands adjacent to urban and agricultural settings. One key measurement was water column respiration, assayed using *in situ* dark bottle incubations. We found that water column respiration increased with stream order. This is counter to previous work showing that CO_2 (a product of respiration) evasion from streams decreases with increasing stream order. This also implies that the fraction of ecosystem respiration from sediments may decrease with stream order. If so, that would reject current model predictions; a field campaign in summer 2022 will test this hypothesis and outcomes will guide model refinements and updated model predictions. Further, our work both rejects and supports the River Continuum Concept (RCC). The RCC predicts that organic matter (OM) chemistry will vary down the stream network. Consistent with the RCC, OM diversity increased down the network. In contrast, processes governing OM chemistry were similar at the top and bottom of the network, but distinct in the middle. These results point to a need to revise some of the conceptual and mechanistic foundations of river corridor hydrobiogeochemistry.