Novel Insights into Reaction-Scale Biogeochemistry in River Corridors and its Response to Wildfire

Allison Myers-Pigg[1,2*], Vanessa Garayburu-Caruso[1], Swatantar Kumar[1], Bob Danczak[1], Kevin Bladon[3], James Stegen[1], and Emily Graham[1,4]

[1]Pacific Northwest National Laboratory, Richland, WA; [2]Marine Sciences Laboratory, Pacific Northwest National Laboratory, Sequim, WA; [3]Oregon State University, Corvallis, OR; [4]Washington State University, Richland, WA

Contact: (allison.myers-pigg@pnnl.gov)
Project Lead Principal Investigator (PI): Tim Scheibe
BER Program: SBR
Project: PNNL SBR SFA
Project Website: https://sbrsfa.pnnl.gov/

This element of the PNNL SFA seeks to explicate universal indicators of pyrogenic organic matter (PyOM) and to identify the effects of burn severity on relationships between pyrogenic material (e.g., PyOM and inorganic nutrients) and river corridor biogeochemistry. The investigation of wildfires is a critical consideration given increases in wildfire prevalence in the Columbia River Basin (CRB) and is a new aspect of the PNNL SFA—however, we will leverage our previous work in river corridor biogeochemistry, and in particular, the significant role that organic matter chemistry plays in river corridor biogeochemistry. In the new triennial period, we will leverage this expertise, as well as our experience in disturbance ecology, to investigate the impacts of chemical changes associated with varying levels of burn severity. Generally, wildfire- impacted river corridors have elevated concentrations of phosphorus, nitrogen, PyOM, and contaminants. PyOM, in particular, is chemically diverse and has poorly understood biogeochemical implications. Additionally, the effects of combustion temperature on PyOM chemistry and inorganic nutrient concentrations can vary considerably with source material.

To evaluate the impacts of pyrogenic materials across burn severities in the CRB, we will first use laboratory experiments to define typical features of PyOM across burn severities and source materials. Natural substrates from the CRB (e.g., plant materials, upland soils) will be combusted in oxic conditions for two hours across a range of temperatures representative of different burn severities. We will use machine learning to associate known (e.g., polycyclic aromatic hydrocarbons (PAHs), anhydrosugars) and new (e.g., FTICR-MS, GC-MS, NMR-derived) chemical markers of PyOM. Then, we will use laboratory-burned PyOM in controlled experiments to evaluate how inorganic nutrient concentration and PyOM concentration and composition are impacted by different burn severities and how these factors, in turn, influence river corridor biogeochemical rates. Finally, we will conduct sampling across recent fires spanning different burn severities at four locations in the CRB to characterize the natural distribution of PyOM indicators, their impact on biogeochemical processes, and their relationship to watershed features. For site selection, we will leverage 363 wildfires (23,909 km^2) between 2015 and 2017, which span low to high burn severities. At all sites, we will analyze variation in biogeochemical process rates across burn severities and their association with PyOM indicators, inorganic nutrient concentrations, microbial information, and watershed features.
Collectively, these activities will allow us to determine biochemical indicators of PyOM and to identify the impacts of burn severity on river corridor biogeochemistry.