Just Around the Riverbend: Seasonal Hydrologic Controls on Hyporheic Microbial Community Function

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Terrestrial and aquatic elemental cycles are tightly linked in upland fluvial networks. In these systems, mineral weathering, degradation of organic matter, and anthropogenic influences result in the export of solutes (e.g. carbon, metals, and nutrients) often decreasing downstream water quality. Within these fluvial networks, the region of groundwater (GW) and river water (RW) mixing represents a hotspot of microbial activity, exerting significant control over solute export and cycling. To investigate how the deeper exchange of oxic RW into the riverbed during snowmelt-driven peak discharge affects microbial degradation (oxidation) of carbon pools, depth-resolved pore water samples were recovered from multiple locations around a representative meander on the East River near Crested Butte, CO for a suite of microbiological and geochemical analyses. To complement our discrete sampling efforts, we installed a series of temperature and redox probes in the riverbed at each location to continuously monitor the hydrologic mixing and the impact of this process on riverbed microbial activity. Results revealed elevated microbial community diversity, aerobic respiration rates, and lower dissolved metal concentrations when downwelling oxic RW dominated the zone of mixing. Conversely, under reducing conditions induced by base flow, results revealed elevated pore fluid concentrations of dissolved metals and recalcitrant dissolved organic carbon species. Additionally, preliminary microbial analyses have revealed increased vertical stratification in the riverbed during decreased flow. Overall, our results indicate that microbial community composition, functionality, and dynamic structure exert a strong control on biogeochemical processing in riverbeds, with implications for downstream water quality and solute export from watersheds.