Title: **Water sources and resource limitations vary for trees along a hillslope transect in the East River Watershed**

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Project Abstract:

In mountainous headwaters, there is substantial heterogeneity in physical drivers (e.g., soil moisture, depth to groundwater, snowpack and radiation) along hillslope transects that result in strong gradients in ecological properties, species distributions, and plant density. This coupled ecological and physical variability makes it difficult to develop integrated watershed-scale estimates of water (ET) and carbon fluxes using small fetch measurement approaches like eddy covariance. While remote sensing and physical models can provide spatially continuous information, these approaches require temporal and spatial networks of ground-based measurements for validation. Here, we report continuous (since 2019) sap flow measurements distributed across seven sites and three dominant species (aspen, fir and spruce) along a ~500 m elevational gradient in the East River Watershed. We used LiDAR estimates of tree height and density to generate half hourly stand-scale estimates of transpiration for these seven sites. A principal finding of this work is that transpiration near the toe slope converged on a value similar to estimates of energy-limited evapotranspiration from a nearby eddy covariance site situated in the riparian zone. This result suggests that transpiration accounted for almost all of evapotranspiration and that transpiration was not water limited. Moving up the hillslope, transpiration declined by almost an order of magnitude, reflecting both more water limitation as the vadose zone becomes more decoupled from groundwater and a relative increase in evaporation relative to transpiration as tree density declines. The exception to this elevation gradient was found in a convergence zone midway up the hillslope where transpiration reflected the energy-limited values seen at the toe slope and in the riparian zone. This spatial pattern also manifested following a major rainstorm: the energy-limited sites saw declines in transpiration (associated with reduced radiation) while the water-limited sites showed an increase in transpiration associated with the increase in soil moisture. Lastly, we used water isotope measurements of xylem water across the sites to show that the energy-limited sites drew more

heavily on winter precipitation through the summer, indicating their reliance on older water sources whose access does not vary a great deal seasonally, interannually or between species.