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Hillslope Ecohydrology: Vegetation influences on hillslope-stream connectivity in the northern Rocky Mountains, USA

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Little is known about the combined effects of vegetation and topography on hillslope water table dynamics. These interactions are especially important in forested headwater catchments, where complex terrain and occasionally dense vegetation can result in large spatial and temporal variability in fluxes of water from hillslopes to streams. We use empirical evidence from a forested, sub-alpine watershed in the northern Rocky Mountains (Stringer Creek, MT, part of Tenderfoot Creek Experimental Forest) to understand how vegetation interacts with topography to influence patterns of hydrologic connectivity between hillslopes and streams. We combined field measurements, including time series of shallow groundwater levels, with remotely sensed terrain and vegetation variables to identify vegetation-related patterns in hillslope-riparian-stream (HRS) connectivity during a growing season for twenty-three hillslopes within the Stringer Creek watershed covering a range of upslope accumulated areas (UAAs) and vegetation densities. Two regimes emerge when vegetation and topographic variables are combined using regression analysis. Where transects were connected more often than predicted by UAA alone, water table dynamics are likely controlled by a surplus of water relative to vegetation requirements of the hillslope. Conversely, where transects were connected less often than predicted by UAA alone, water table dynamics are likely controlled by a deficit of water relative to hillslope vegetation requirements. We discuss the emergence of these two regimes from the perspective of the hillslope water balance, and we identify the roles of groundwater and evapotranspiration in generating these patterns.