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Evaluating the hydrologic change of montane meadows following the removal of encroached conifers

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Montane meadows provide important ecosystem and economic services and are considered areas with high conservation value. Over the last century montane meadows in the Sierra Nevada and Cascade mountains, USA, have reduced in size and number in part due to conifer encroachment from primarily lodgepole pine (Pinus contorta). Conifer encroachment is a blanket term for movement of conifers into meadow biotic communities. Depending on elevation and geomorphic position, lodgepole pine will colonize meadows opportunistically during times of drought to avoid plant water stress. Climate change, fire suppression, and poor land management practices have and will continue to accelerate lodgepole pine encroachment in montane meadows. Restoration of encroached meadows involves removal of the encroached conifers altering site evapotranspiration (ET) thus increasing the groundwater table and soil moisture. The change in ET is hypothesized to create hydrologic conditions conducive to enable perennial meadow flora to flower and reproduce.

Results at Marian Meadow, southern Cascade mountains, 3 years following removal of encroached lodgepole pine, indicated statistically significant increases in soil moisture and groundwater elevation. Additionally an increase in duration of near surface groundwater conducive for supporting meadow vegetation was measured. The primary mechanism identified was a reduction in precipitation interception from removal of the lodgepole pine canopy. There was little observed change in soil only ET suggesting relatively similar transpiration from newly established meadow vegetation compared to lodgepole pine. A new meadow study, Rock Creek Meadow, is being established to better understand the mechanisms associated with removal of encroached lodgepole pine to restore perennial meadow vegetation. In this study vegetation communities will be mapped and tracked for changes before and after removal of encroached conifers. Analysis of the spatial distribution of soil moisture and groundwater depth will be tested using a network of in-situ instruments and periodic electrical resistivity tomography. Aspen (Populus tremuloides) trees, wet area associated trees, will additionally be evaluated for evapotranspiration changes using sap flow meters and the associated soil moisture and groundwater influences following encroached lodgepole pine removal. The in situ measurements will attempt to provide accurate ET measurements across different vegetation communities, before and after restoration, to fit parameters for an ET model. Climate change scenarios can be investigated using an ET model to assist in understanding resiliency and strategies to maintain montane meadow habitat.