# Regeneration of high-elevation five-needle pines limited by microclimate conditions across disturbance gradients

**Presenter's Name:** Lacey Hankin
**Presenter's Company/Employer:** University of Nevada, Reno
**Presenter's Title:** PhD Student
**Topic:** Natural areas management in light of climate change
**Proposal Type:** Symposium - select this if you are part of an organized session

**Abstract:**
Co-authors Sarah Bisbing, sbisbing@unr.edu Alexandra Urza, alexandra.urza@usda.gov Background/Methods High-elevation forests occupy environments near the physiological tolerances of tree species, and their extreme longevity have allowed for their persistence through significant climatic changes. Unprecedented climate change coupled with threats from mountain pine beetle, white pine blister rust, and changes in fire activity now threaten the resilience of these endemic forests. To improve our understanding of climate and disturbance effects on high-elevation forests dominated by limber pine (Pinus flexilis), bristlecone pine (Pinus longaeva), and whitebark pine (Pinus albicaulis), we asked: a) how does disturbance interact with water availability to influence the regenerating community?, b) to what extent is the regenerating community dominated by surviving advanced regeneration versus post-disturbance recruitment?, and c) what are the implications of species-specific responses to disturbance across climatic gradients? We evaluated natural regeneration in 70 sites varying in climatic and disturbance characteristics across eastern California and the Great Basin. Sites were either undisturbed or affected by one or more disturbance agent. We sampled community composition in addition to quantifying disturbance history and potential seed availability. We used structural equation models to evaluate direct and indirect effects of abiotic and biotic drivers on the regenerating community. Results/Conclusions Extensive recent mortality occurred across the study area. Natural regeneration was highly variable, with abundant regeneration of whitebark pine across varying disturbance and climatic conditions but significantly lower limber and bristlecone pine regeneration. All species showed reduced regeneration with increasing understory cover. Coarse acidic soils and decreased water deficit favored whitebark pine regeneration, while limber pine regeneration increased with increasing water deficit and tree density, suggesting potential buffering effects of tree canopy for microclimate. While increased spring snowpack and summer temperature favored bristlecone pine regeneration in undisturbed sites, these drivers had strong negative effects in burned sites.  Our findings highlight the complex drivers of regeneration in arid high-elevation pine forests. Water availability, through increased snowpack, canopy buffering, or soils, is an important driver of regeneration, and water stress is expected to increase under projected future conditions. Bird dispersal may buffer the effects of disturbance by overcoming seed limitations, however forest mortality may exacerbate microclimate conditions, leading to increasingly rare opportunities for establishment. Widespread mortality necessitates continued monitoring of natural regeneration and implications for forest persistence. This work will help managers target areas for restoration to facilitate persistence of these species under current and future climate scenarios.