Adaptive capacity and climate refugia for interior *Pinus albicaulis*

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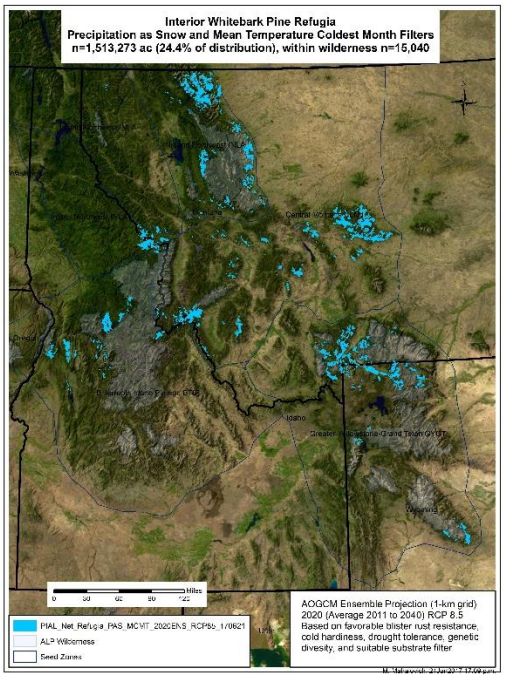
Abstract: Refugia have long been studied from the paleontological record to better understand how populations persist during periods of unfavorable or rapid environmental change. These concepts are now being applied to contemporary plant populations to identify potential areas buffered from climate change. Here we characterize the adaptive capacity of several key traits impacting this species ability to survive in the context of associated physical and climatic parameters favoring the long-term persistence of interior *Pinus albicaulis*. Spatially explicit layers of white pine blister rust (*Cronartium ribicola)* resistance, drought tolerance, late winter cold hardiness, and genetic diversity are integrated to identify buffered locations that possess desirable genetic attributes. A filter for suitable substrates is subsequently applied, as plant populations are known to retract to limestone, ultramafic and podosols during rapid environmental change. Model validation includes future climatic grids and two representative concentration pathways (RCP 4.5 and 8.5) for areas experiencing ≤ 1°C change in mean annual temperature and ≤ 10% change in precipitation in the form of snowpack. Wilderness areas are widely held as germplasm repositories for plant populations. While an average of 85% of present day *P. albicaulis* occurs in designated wilderness, our results indicate less than 1% of the projected refugia are located within the boundaries of these unmanaged areas. These findings have far-reaching implications for prioritizing areas for conservation and active restoration if *P. albicaulis* is expected to provide a valuable food source for dependent wildlife and continue to function as both a foundation and keystone species.



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