

# Whitebark Pine (*Pinus albicaulis*) In Cascadia: A Climate Change Prognosis

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**Abstract**—Species distribution models (SDMs) predict that whitebark pine (*Pinus albicaulis*) will lose much of its current climatic range in Cascadia (the Pacific Northwest in the United States plus British Columbia, Canada) by the 2080s as the climate warms. However, the same models indicate that the species will simultaneously gain a large, climatically-favorable habitat expanse northwest of its current northern range limit. While SDMs are one of the best tools available for predicting range shifts under climate change, their shortcomings, particularly for threatened species like whitebark pine, must be tested and accounted for prior to their use in conservation planning. The potential for whitebark pine to independently migrate northward, and the management option of assisting its migration should natural dispersal not suffice, must also be assessed. I examine these questions using existing literature and new experimental data. Problems associated with whitebark pine distribution modeling include the existence of large differences between the fundamental and realized niche of the species, a lack of knowledge regarding the species distribution at high elevations, and a current lack of accounting for snow accumulation and persistence. These issues must be addressed, but they do not nullify the overall prediction that whitebark pine will lose a substantial portion of its current climatically-suitable range by the 2080s, while gaining new habitat in northwestern British Columbia. Predicting the rate of natural range expansion

into newly habitable areas under climate change is challenging for whitebark pine because of its dependency on Clark's nutcrackers (*Nucifraga columbiana*) for seed dispersal. However, based on past seed-dispersal observations, it seems unlikely that the species will naturally disperse into a significant portion of its future climatic range within the century. Pests, pathogens and warming-induced vegetative competition are predicted to kill the majority of reproductively-viable whitebark pines in current populations by then, potentially leaving assisted migration as the only viable strategy for protecting the species from extinction. Results from an assisted migration common garden trials in western British Columbia confirm whitebark pine's ability to germinate and survive in climatically-favorable areas north of the species range, while growth chamber data confirm that whitebark pine is a poor height competitor at all but the coldest growing-season temperatures. These findings suggest three critical future research needs: 1) further refinement of SDMs, particularly for threatened and high-elevation species, 2) evaluation of Clark's nutcracker and whitebark pine dynamics at the northern edge of the species range to determine the pine's natural migration potential, and 3) continued development of ecological and ethical decision-making frameworks for assisted migration, using whitebark pine as a test case because of its threatened status and favorable life history attributes.

**Keywords:** species distribution model, climate envelope, range expansion, population differentiation

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