

Climate and Mountain Pine Beetles in Whitebark Pine Forests across the Western US

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Issue

Whitebark pine is a high-elevation tree species that provides critical habitat for wildlife, influences ecosystem processes, and supplies valued ecosystem services. These trees are currently subjected to multiple threats, including attack by mountain pine beetle, which has recently killed whitebark pines over much of the western US. Climate is an important factor in outbreaks of this beetle, and future warming is expected to affect outbreaks. We conducted a study to quantify the influence of climate on outbreaks in whitebark pine stands of the US.

Objectives

The objectives of our study were to assess relationships between climate and beetle outbreaks; evaluate climate influences on recent outbreaks; and project future climate suitability for whitebark pine mortality from beetle attack given future scenarios of climate change. We developed empirical models of mountain pine beetle outbreaks in whitebark pine using observations of beetle-killed trees, climate, and stand conditions for the Greater Yellowstone Ecosystem and for whitebark pine range in the US outside of the Sierra Nevada.

Findings

Statistical models fit the observations well, increasing confidence in the understanding and predictions of the models. We found that climate influenced mountain pine beetle outbreaks most strongly through fall and winter temperatures, which are direct effects on the beetles, as well through summer precipitation, which affects tree defenses. Recent mountain pine beetle outbreaks in the western United States were caused by warming, particularly the recent absence of very cold winters, combined with drought in the early 2000s. We estimated future climate suitability for whitebark pine mortality from mountain pine beetles using climate projections from ten GCMs and three emissions scenarios. These results suggest that given continued levels of greenhouse gas emissions, in most of the western US future climate will likely be as favorable for mountain pine beetle outbreaks in whitebark pine as the climate was during the recent outbreak period in the 2000s. Climate suitability may decline in some regions as a result of increasing fall temperatures that could disrupt beetle life cycle development timing. Variability exists among projections as a result of the amount of warming, which is a function of climate model, emissions scenario, and decade, and differences in precipitation estimated by each GCM.

Conclusions

Because climate in the next thirty years will likely be suitable for beetle outbreaks in whitebark pine, we recommend that land managers and decision makers consider the impacts of expected climate change when planning conservation actions. Future conservation actions should consider geographic areas where winter temperatures are expected to remain cold. The influence of precipitation on climate suitability, and therefore management site selection, requires additional research.

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