Extended abstract for: Summer Temperature Extremes as a Driver in MPB outbreaks

Abstract ID: 20

Author Elaine Oneil

Affiliation College of Forest Resources, University of Washington, Seattle WA

Abstract

Mountain pine beetle (MPB) epidemics are emerging as a significant disturbance factor in western forests from British Columbia to the Southwest. Warmer winters attributed to climate change have been implicated in the massive MPB outbreaks in British Columbia and Alberta Canada. In more southerly environments, low winter temperatures have not historically played a role in controlling MPB epidemics. Research on the MPB epidemic in eastern Washington indicates that increasing summer temperature and its effect on vapor pressure deficit is the primary driver of host susceptibility to MPB. Linking climate variability to site, stand, and tree characteristics is necessary in order to develop a blueprint for management action that can reduce the incidence of widespread MPB attacks. While increasing insect activity under warmer climate conditions is certainly implicated in the increase in MPB attack levels in the recent past, actions that address increasing host susceptibility are necessary to control the magnitude of this disturbance vector under a changing climatic regime.

Keywords forest disturbance, climate change, tree physiology, mountain pine beetle, lodgepole pine

Discussion

Climate change has been implicated in the massive Mountain pine beetle (*Dendroctonus ponderosae*) (MPB) outbreaks in British Columbia. A northerly shift in the -40 □C mean annual minimum winter temperature isotherm has resulted in MPB outbreaks in areas that had previously been spared because of high winter mortality in MPB brood. Effectively these warmer winters have resulted in a climate change induced range shift for the MPB (Carroll et al, 2003).

A combination of generalized linear models with a Poisson link function (GLM-P) and zero inflated negative binomial (ZINB) models were used to evaluate weather and climate related parameters for lodgepole pine forests of eastern Washington where MPB outbreaks have been increasing dramatically since 1999 (Figure 1). This study found that the climate record does not support the hypothesis that the Eastern Washington outbreaks are coincident with a MPB range shift caused by increasing minimum winter temperatures, even at higher elevations where a greater percentage of the outbreaks are now occurring. The study found that increasing MPB mortality in eastern Washington is correlated with increasing summer temperature and specifically its effect on vapor pressure deficit (VPD). Relative trends in MPB mortality are the

same for eastern Washington and central British Columbia, but the driving variables in the MPB epidemics are different.

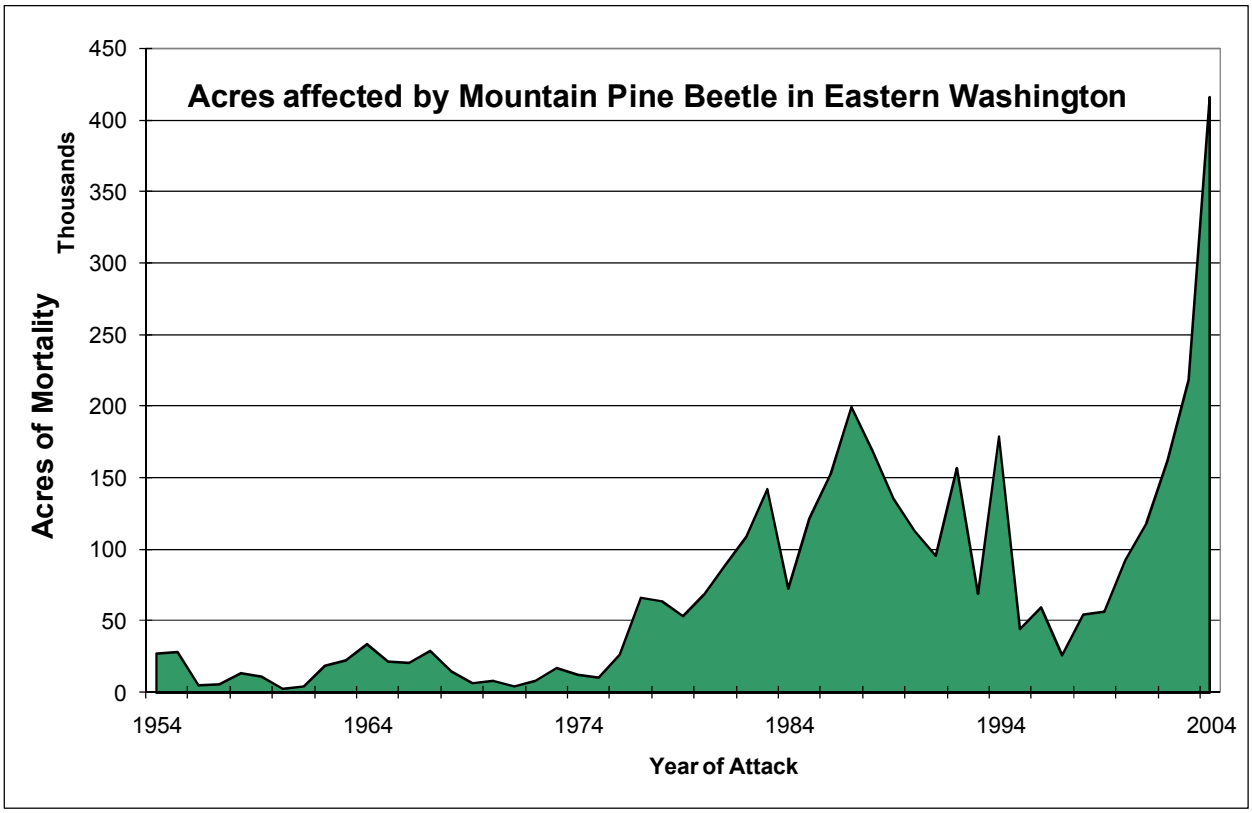

Figure 1: Mountain pine beetle impacts in eastern Washington 1954-2004

Warmer, drier summers can have a substantial impact on MPB's host species. Summer VPD drives tree stress because VPD influences stomatal closure (Waring and Running 1998) and tree physiology (Delucia et al. 2000) both of which affect tree resistance to MPB. The strong relationship between increasing summer VPD and very large MPB epidemics in eastern Washington suggests that increasing host susceptibility plays the dominant role in outbreaks for this region.

Because host susceptibility is the dominant factor in eastern Washington MPB outbreaks, it suggests that silvicultural intervention could be used to manage MPB impacts. For maximum effectiveness, a blueprint for management action should apply both historical strategies and current research. Reducing host susceptibility by lowering stocking and maintaining trees capable of responding to VPD changes are core principles in any successful treatment strategy. The potential to manipulate physiological conditions, specifically leaf area to sapwood area ratios, has not been explored but research suggests it might be a good option. Managing water (stocking control) and nutrients (fertilization) in the short term, and managing soil resources to increase water and nutrient holding capacity over the very long term are important tools that should be given consideration.

References

Carroll, A. L., S. W. Taylor, et al. (2003). Effects of Climate Change on Range Expansion by the Mountain Pine Beetle in British Columbia. Mountain Pine Beetle Symposium: Challenges and Solutions. J. B. TL Shore, and JE Stone. Kelowna, BC, Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre. Information Report BC-X-399: 298 p.

DeLucia, E. H., H. Maherali, et al. (2000). "Climate-driven changes in biomass allocation in pines." Global Change Biology **6**(5): 587-593.

Waring, R. H. and S. W. Running (1998). Forest ecosystems: analysis at multiple scales. San Diego, CA, Academic Press Inc.