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Numerical Simulation of Crown Fire Hazard Following Bark Beetle-caused Mortality in Lodgepole Pine Forests

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Abstract
The purpose of this study is to investigate how varying amounts of MPB-induced tree mortality affects the amount of crown fuels consumed and the fire intensity across a range of lodgepole pine stands of different tree density and spatial arrangements during the early stages of a bark beetle outbreak. Unlike past studies which have relied on semi-empirical or empirical mathematical prediction models to predict surface fire behavior and crown fire hazard this study utilizes the Wildland Urban Interface Dynamics Simulator which is a spatially dependent physics based model that does not assume fuel homogeneity within or across a stand and accounts for both fire and atmospheric and fuel and atmosphere interactions. Based on preliminary results, we conclude that the level of crown fuel consumption, the average fireline intensity, the maximum fireline intensity and the total heat release are all positively related to increases in the amount of standing dead trees for times when red-dead needles are still present in the overstory. We also found that for a given set of stand level properties clumpy spatial arrangements resulted in increased fuel consumption, and fire intensities. Our results also show that as surface fire intensities increase the relationship between crown fuels consumed and the level of mortality decreases. Crown consumption and fire intensities for time periods which represent the loss of dead needles from the overstory are currently being conducted and early results from these simulations suggest that there is still a significant increase in crown consumption and fireline intensity at high levels of mortality. The results from this study indicate that both spatial arrangement and the level of mortality have significant influences on the intensity and consumption of crown fuels in the early stages of a bark beetle outbreak and should be considered in assessing crown fire hazard.