Recent bark beetle outbreaks influence wildfire severity in mixed-conifer forests of the Sierra Nevada, California, USA

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Topic: Managing fire regimes in a changing world (good fire/bad fire)
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Rebecca B. Wayman and Hugh D. Safford. In temperate forests, elevated frequency of drought related disturbances will likely increase the incidence of interactions between disturbances such as bark beetle epidemics and wildfires. Ecosystem management relies on sound information from analogous forest types, yet our understanding of the influence of recent drought and insect-induced tree mortality on wildfire severity has largely lacked information from forests historically experiencing frequent fire. A recent unprecedented tree mortality event in California's Sierra Nevada provides an opportunity to examine this disturbance interaction in historically frequent-fire forests, filling an important gap in a body of evidence drawn largely from forests adapted to severe, infrequent fire. Using field data collected within areas of recent tree mortality that subsequently burned in wildfire, we examined whether and under what conditions wildfire severity relates to severity of pre-fire tree mortality in Sierra Nevada mixed-conifer forests. We collected data on 180 plots within the 2015 Rough Fire and 2016 Cedar Fire footprints. Our analyses identified pre-fire tree mortality as influential to all measures of wildfire severity (basal area killed by fire, RdNBR, and canopy torch) on the Cedar Fire and to two of three measures on the Rough Fire. Factors such as fire weather and topographic position also strongly influenced wildfire severity. On the Cedar Fire, the influence of pre-fire mortality on wildfire severity was greater under milder weather conditions. All measures of fire severity increased as pre-fire mortality increased up to pre-fire mortality levels of approximately 30-40%; further increases did not result in greater fire severity. The interacting disturbances shifted a pine dominated system to a cedar/pine/fir dominated system, while the pre-disturbance fir/cedar system retained its species dominance. Managers of historically frequent-fire forests will benefit from utilizing this information when prioritizing fuels reduction treatments in areas of recent tree mortality, as it is the first empirical study to document a relationship between pre-fire mortality and subsequent wildfire severity in these systems. This study contributes to a growing body of evidence that the influence of pre-fire tree mortality on wildfire severity in temperate coniferous forests may depend on other conditions capable of driving extreme wildfire behavior, such as weather.