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Field evidence of recent bark beetle outbreaks affecting fire severity in subalpine forests: the importance of time since outbreak and burning conditions

Brian J. Harvey, Zoology, University of Wisconsin, Madison, WI
Monica G. Turner, Zoology, University of Wisconsin, Madison, WI
William H. Romme, NREL, Colorado State University, Fort Collins, CO
Daniel C. Donato, Zoology, University of Wisconsin, Madison, WI

Background/Question/Methods:
Extensive bark beetle outbreaks have increased in recent years in subalpine forests of the western US. Outbreaks can alter fire potentials by increasing foliar flammability in canopy fuels as trees die in early outbreak stages, then decreasing canopy fuels and increasing surface fuels as needles/branches/boles from beetle-killed trees fall in later outbreak stages. Although these changes are expected to affect subsequent fire, field studies following actual fires in post-outbreak forests have not yet tested these hypotheses. To address this knowledge gap, we asked whether fire severity was affected by pre-fire beetle outbreak severity in two recent fires (*n*=143 plots) that burned in *Pinus contorta*-dominated forests of Greater Yellowstone through a range of outbreak stages. Outbreaks occurred the year of fire (green attack), 1-2 years before fire (red stage), and ~5 years before fire (gray stage), allowing us to test for effects over different intervals between disturbances. Pre-fire stand structure and beetle outbreak severity were reconstructed using field measures and corroborated with regional maps of beetle outbreaks. Fire severity was measured using integrative, canopy, and forest floor measures and was evaluated against pre-fire outbreak severity while accounting for burning conditions (moderate vs. extreme) and topography.

Results/Conclusions:
The effects of beetle outbreaks on subsequent fire severity differed with outbreak stage and burning conditions (reflective of weather at the time of fire). Fire severity was unrelated to red-stage outbreak severity, but increased with total early-stage (green attack + red stage) outbreak severity under moderate burning conditions. In gray post-outbreak stages, fire severity decreased with higher outbreak severity under moderate burning conditions, but was unrelated to beetle-killed basal area under extreme conditions. Collectively, these results suggest that fire severity is affected by beetle outbreak severity in complex ways that change through time after an outbreak. Changes to fine fuels caused by beetle outbreaks can increase (green attack + red stage) and decrease (gray stage) fire severity under moderate burning conditions, but these effects are overridden by extreme burning conditions. These findings highlight the importance of understanding beetle outbreak effects on wildfire in the context of multiple drivers (e.g., topography and burning conditions), and illustrate that effects change with time since outbreak.

Oral presentation