

DO BARK BEETLE OUTBREAKS INCREASE FIRE RISK IN THE WESTERN US? A SYNTHESIS OF CURRENT KNOWLEDGE AND FUEL DYNAMICS IN THE GREATER YELLOWSTONE ECOSYSTEM

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In the western US, forest fires and native bark beetle outbreaks have increased in extent and frequency during the recent decades. It is often assumed that widespread bark beetle outbreaks set the stage for catastrophic wildfires because they create great quantities of dead and ladder fuels. Although this idea has dominated since the early 20th century, it is only beginning to receive rigorous testing. We first review the state of the science on beetle-fire interactions across several western forest types, then present surface and canopy fuel data from the Greater Yellowstone Ecosystem (GYE). Fuels were sampled in 2007 in lodgepole pine (*Pinus contorta* var. *latifolia*) stands ($n = 25$) that were attacked by the mountain pine beetle (MPB, *Dendroctonus ponderosae*) at different times in the past (undamaged and 1- to ~35-yr-old attacks). This time-since-beetle chronosequence is compared with another chronosequence sampled in 1981 ($n = 10$ stands, 0 to ~15 yrs post-beetle), allowing a more robust estimate of bark beetle effects on fuel dynamics.

Review of peer-reviewed empirical studies revealed that beetle-fire interactions varied with time since beetle attack and between host-beetle pairs. There is increasing evidence that spruce beetle (*Dendroctonus rufipennis*) outbreaks have no effect on the occurrence and severity of stand-replacing fires in spruce-fir (*Picea engelmannii*-*Abies lasiocarpa*) forests. The effect of MPB infestations on fire occurrence and severity in lodgepole pine forests are variable and influenced by time since beetle outbreak. Effect of bark beetle outbreaks on fire in other forest types are unknown (ponderosa pine [*Pinus ponderosa*], pinyon-juniper [*Pinus edulis*-*Juniperus* spp.]) or need more research (Douglas-fir [*Pseudotsuga menziesii*]). Chronosequence data from

the Yellowstone area showed that immediately after the outbreak (2-4 yrs post-beetle), the most significant changes in fuels were a decrease in canopy bulk density and an increase in needle litter depth. Over longer periods of time (10-30 years post-beetle), biomass of large dead surface fuels and understory vegetation increased. Dead surface woody fuels less than 8 cm in diameter (1-hr to 100-hr fuels) showed high variability throughout the chronosequence. These results illustrate the complex changes in the quantity and distribution of dead and live fuel following bark beetle outbreak, and underscore the need to consider both canopy and surface fuels. Time since beetle outbreak is an important factor to consider in the relationship between bark beetle outbreaks and fire risk because fuels change over time.