Impacts of fire and fuel treatments on tree defenses and resistance to mountain pine beetle

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Main questions or issues that you addressed

Fire frequency in low-elevation coniferous forests in western North America has greatly declined since the late 1800s. In many areas, this has increased tree density and the proportion of shade-tolerant species, reduced resource availability, and increased forest susceptibility to forest insect pests and high-severity wildfire. We investigated how low-intensity fire affects tree defenses and whether fuel treatments impact resistance to a mountain pine beetle outbreak.

Location and ecosystem investigated

Ponderosa pine dominated forests in Montana, Utah, Oregon, and Idaho.

Key Findings of Your Research

- Resin duct-related traits provide resistance against bark beetles and low-severity fire induces resin duct production. When fire ceases resin duct production declines.
- Low-severity fire can trigger a long-lasting induced defense that may increase tree survival from bark beetles
- Mortality from MPB was highest in the denser, untreated control and burn-only treatments, with approximately 50% and 39%, respectively, of ponderosa pine killed during the outbreak, compared to almost no mortality in the thin-only and thin-burn treatments. Thinning treatments, with or without fire, dramatically increased tree growth and resin ducts relative to control and burn-only treatments.
- While ponderosa pine remained dominant in the thin and thin-burn treatments after the outbreak, the high pine mortality in the control and burn-only treatment caused a shift in species dominance to Douglas-fir. The high Douglas-fir component in the control and burn-only treatments due to 20th century fire exclusion, coupled with high pine mortality from MPB, has likely reduced resilience of this forest beyond the ability to return to a ponderosa pine-dominated system in the absence of further fire or mechanical treatment.

How Did You Answer the Main Questions or Inform the Issues?

We used tree ring analysis to answer the questions about fire and tree defense, because resin ducts embedded in tree rings allow us to go back in time to see how growth and defenses have changed with fire frequency. We

This research was presented at the 7th International Fire Ecology and Management Congress, which was held in Orlando, Florida, November 28-December 2, 2017 and was hosted by the Association for Fire Ecology, in cooperation with the Southern Fire Exchange.

also used a long-term experimental fuel treatment study to see how tree-level defenses scaled up to stand-level resistance to a naturally occurring mountain pine beetle outbreak. This project utilized one site of the Inland Empire Tree Improvement Cooperative, which is partially supported by the Forest Service, for tree breeding. It also capitalized on one of the Fire and Fire Study sites originally funded by the Joint Fire Science Program.

How Might/Will It Influence Fire Management Decisions or Practices?

- Forest management that encourages healthy, vigorously growing trees will also favor larger resin ducts, thereby conferring increased resistance to bark beetle attacks.
- Treatments designed to increase resistance to high-severity fire in ponderosa pine-dominated forests in the Northern Rockies can also increase resistance to MPB, even during an outbreak.
- This study suggests that fuel and restoration treatments in fire-dependent ponderosa pine forests that reduce tree density increase ecosystem resilience in the short term, while the reintroduction of fire is important for long-term resilience.

Who Is the Main End-user of Your Research?

Forest managers, fire ecologists.

Congress Session

Bark Beetle and Fire Interactions in Western North America: The Current State of Knowledge and Implications for Forest and Fire Managers, Christopher Fettig.