CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief

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Do fuel reduction treatments cause beetle mortality or resilience?

Stark, DT, DL Wood, AJ Storer, and SL Stephens. 2013. Prescribed fire and mechanical thinning effects on bark beetle caused tree mortality in a mid-elevation Sierran mixed-conifer forest. Forest Ecology and Management 306:61-67. doi.org/10.1016/j.foreco.2013.06.018

Management Implications

- Some tree mortality is an expected and often desirable outcome of fuel reduction treatments.
- Mastication does not cause delayed bark beetle mortality in the short term. Prescribed fire and mastication with prescribed fire both slightly increase beetle mortality.
- When planning fuel reduction treatments, managers can expect some delayed white fir and sugar pine mortality due to beetles in their treatment plans for small and medium trees.
- Managers can reduce beetle threat to sugar pine by mechanically treating around the tree before fire.

Fuel reduction treatments reduce tree deaths during wildfires, but may also stress trees and make them vulnerable to insect and disease. At the same time, treatments may reduce competition between trees, make them healthier, and build resilience against beetles. Stark et al. (2013) is one of the few studies that experimentally tests these competing ideas.

Stark et al. (2013) examined bark beetle mortality for two-years after fuel reduction treatment in mid-elevation mixed conifer forests at the University of California Blodgett Research Forest. As part of the National Fire and Fire Surrogate Study, the experimental treatments included prescribed fire (fire), mastication, the combination of the two, and a control. Each treatment had three replicates ranging from 14 to 29 hectares in size (or ~ 35-72 acres). This study occurred from 2001 to 2003 during endemic levels of beetle activity in the region. Monitoring occurred before treatment, one-year after treatment, and two-years after treatment. Monitoring consisted of 20 0.04-hectare (.1 acre) plots per replicate, which was 240 total plots per year.

Some of the treatments influenced beetle mortality, but not all. Mastication either slightly decreased beetle mortality or had no effect. Both fire and fire in combination with mastication caused up to 7% increases in beetle mortality. However, managers may want some of this mortality, and beetle mortality did not exceed the goals for the fuel reduction treatment. For example, beetles killed small and medium white firs (11.5-46 cm DBH) after treatments. The white-fir mortality reinforces fuel reduction goals of making trees discontinuous both horizontally and vertically. It also reinforces forest restoration goals of thinning understory dominated by shade-tolerant white fir from dense mixed conifer forest.

Figure 1. Post-treatment beetle mortality was restricted to small and medium sized white fir and medium sized sugar pines.

In fire treatments, medium-sized (25-46 cm DBH) sugar pines had increased mortality, which may also be beneficial to thin overly dense forests. However, some people may be concerned by sugar pine mortality because white pine blister rust has already increased their mortality. If you are concerned, you can complete mastication in coordination with fire or in lieu of it.

This study was conducted during endemic levels of bark beetle populations, and results do not directly apply to treatments done during or before bark beetle epidemics. During epidemics, others found that long after fuel reduction treatments, the treatments reduced bark beetle mortality likely because the remaining trees are healthier (van Magtem et al., 2016). While Cal Fire and others suggest mechanical thinning when beetles are dormant to protect your trees, there is a research gap about how fuel reduction treatments influence tree mortality during a beetle epidemic in California's mixed conifer forest.

Suggestions for further reading:

Van Mantgem, PJ, AC Caprio, NL Stephenson, and AJ Das. 2016. Does prescribed fire promote resistance to drought in low elevation forests of the Sierra Nevada, California, USA. Fire Ecology 12:13-25.
http://fireecologyjournal.org/docs/Journal/pdf/Volume12/Issue01/013.pdf

Young, DJN, JT Stevens, JM Earles, J Moore, A Ellis, AL Jirka, and AM Latimer. 2017. Long-term climate and competition explain forest mortality patterns under extreme drought. Ecology Letters 20:78-86.
http://onlinelibrary.wiley.com/doi/10.1111/ele.12711/full

USDA Joint Fire Science Program. May 2009. Masticating Fuels: Effects on Prescribed Fire Behavior and Subsequent Vegetation Effects. Fire Science Brief 47: 1-6.
https://www.firescience.gov/projects/briefs/03-3-2-06_FSBrief47.pdf