CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Thinning + burning treatments effectively reduce Dixie Fire severity

Shive, K.L, M. Coppoletta, R.B Wayman, A.K. Paulson, K. Wilson, J.T. Abatzoglou, S.J. Saberi, B.L. Estes, H.D. Safford. 2024. "Thinning with follow-up burning treatments have increased effectiveness at reducing severity in California's largest wildfire." Forest Ecology and Management 572.
https://www.sciencedirect.com/science/article/pii/S0378112724004833

Management Implications

- Mechanical thinning + prescribed fire or pile burning reduced the probability of stand replacing fire (100% mortality).
- Plots with thinning + fire treatments were most likely to remain within target conditions for tree density post-wildfire.
- Outside of stand replacement, thin-only treatments also reduced fire severity.

Introduction

Although fuels treatments are generally shown to be effective at reducing fire severity, there is widespread interest in monitoring that efficacy as the climate continues to warm and the incidence of extreme fire weather increases.

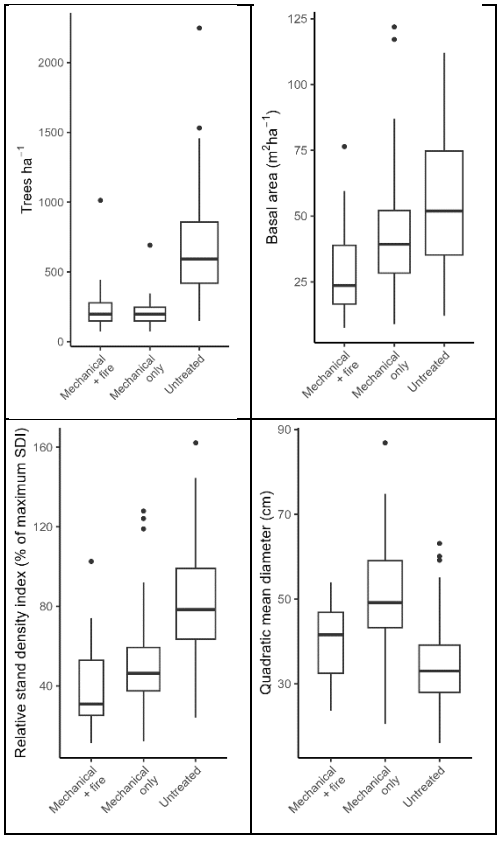
We compared basal area mortality across adjacent treated and untreated sites in the 2021 Dixie Fire of California's Sierra Nevada. We sampled mixed conifer and yellow pine forests in the Plumas and Lassen National Forests one year after the wildfire. We focused on sites that were treated with mechanical thinning followed by either prescribed fire or pile burning, with thinning only, as well as untreated areas. Most mechanical treatments included a commercial thinning component. We also explored how both pre- and postfire conditions compare to target conditions.

Treatment effects on fire severity

The treated plots had generally lower basal area, tree density and Stand Density Index (SDI) and higher Quadratic Mean Diameter (QMD; Figure 1). Low SDI and high QMD values are generally indicative of lower density stands with larger trees.

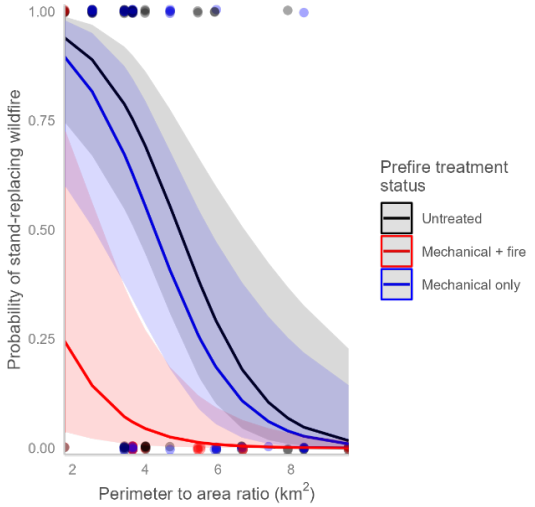
The probability of stand replacing wildfire (100% mortality) increased on large fire growth

Figure 1. Tree density, basal area, SDI and QMD for sampled sites.



days, but was reduced in areas that had been thinned and burned before the fire. Thin-only treatments did not differ from untreated areas (Figure 2). Time since treatment and other topographic variables were not important predictors of stand replacing wildfire. Weather variables were also not significant, but we suspect that the large growth days are themselves driven by a complex interaction between site-level variations in weather and landscape-level patterns of fuels.

Figure 2. The probability of stand-replacement by perimeter to area ratio (lower values indicate larger growth days). The lines represent are predicted response by treatment, the dots are data points (1=stand replacement, 0=non-stand replacement).



The difference in response by treatment type is most likely due to the difference in prefire surface fuels. Although we do not have prefire data on surface fuels, other research has shown much lower surface fuels in thin + burn treatments relative to thin-only treatments.

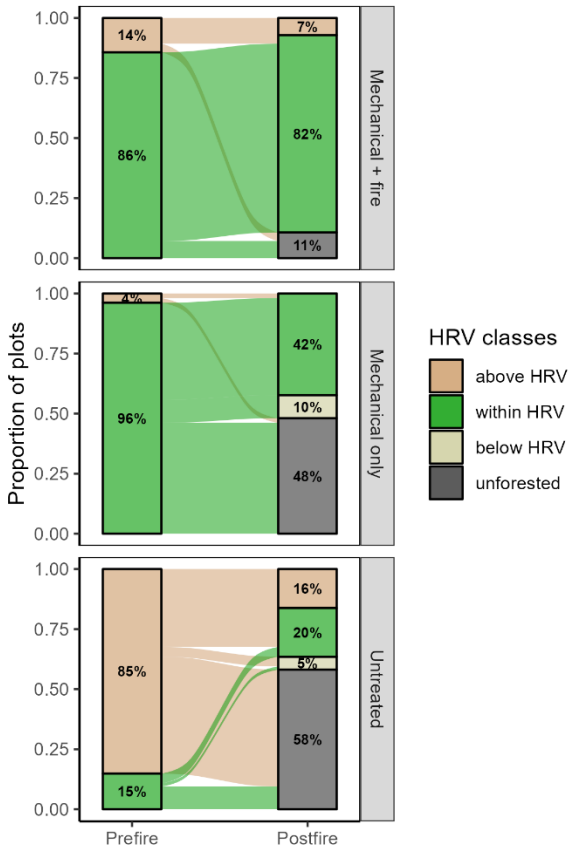
For areas that did not experience stand replacing wildfire (<100% mortality), both the thin + burn treatment and the thin-only treatment had lower fire severity than untreated areas. Treated areas had lower SDIs and higher QMDs, which indicate stands dominated by fewer, larger trees. This suggests that under less extreme burning conditions, thin-only treatments can still be effective.

Prefire treatments and postfire conditions

We also explored how well the treatments met desired conditions, which we defined here as the historical range of variation (HRV). HRV describes the range of tree densities that have been estimated in pre-settlement forests (Safford and Stevens 2017), and are commonly used to define target conditions for forest resilience to sever fire.

We reconstructed prefire tree density by excluding prefire snags, and used HRV to classify the plots as above, within or below HRV prefire. We then classified the plots postfire based on live tree density, additionally adding "unforested" to represent plots that had no live trees remaining. Both treatment types had a majority of plots in HRV for tree density prefire, but only 42% of the thin-only plots remained within HRV postfire, whereas 82% of the thin + burn plots did.

Figure 1. Flow diagram showing pre- to postfire transitions across HRV tree density classes, by treatment type.



Conclusions

Even as wildfire severity continues to rise, thinning and burning treatments remain highly effective at reducing fire severity. Although the thin only treatment was also effective under milder conditions, this research reiterates the importance of reducing surface fuels via prescribed fire or pile burning.

References

Safford, H.D., and J.T. Stevens. 2017. "Natural Range of Variation for Yellow Pine and Mixed-Conifer Forests in the Sierra Nevada, Southern Cascades, and Modoc and Inyo National Forests, California, USA." PSW-GTR-256. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. https://doi.org/10.2737/PSW-GTR-256.