Shaded fuel breaks boost wildfire resilience in the Sierra Nevada, CA, USA

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MANAGEMENT IMPLICATIONS

- Shaded fuel breaks can create forest structural conditions (less dense stands dominated by larger trees) that are resilient to wildfire up to 20 years after initial entries.
- Under capacity or logistical constraints that limit follow-up mechanical treatments, low to moderate severity fire can be used to maintain lower torching probabilities and surface and ground fuel loads in dry, pine-dominated forests for at least up to 20 years. In other words, treatment lifespans can be extended by managed wildfire or prescribed fire.
- Torching or crown fire probability is consistently lower in stands subjected to shaded fuel break treatments after 20 years, despite differences in initial treatment intensity.

The ability of fuel reduction treatments to create fire-resilient forest structures with reduced stand densities, larger-diameter trees, and decreased surface and ladder fuel loads is well-documented in California. However, the longevity of treatment effects, as well as treatment interactions with wildfires, have been more difficult to characterize due to the sparse availability of long-term datasets with detailed treatment records. Scientists at the University of California Berkeley, The UC Cooperative Extension, and the US Forest Service Pacific Northwest Research Station leveraged a 20-year old plot network in the Plumas National Forest to track pre-treatment stand conditions, conditions one year after initial thinning treatments in 2001 and 2002, and conditions following varying exposure to low to moderate severity wildfire (2006 Boulder Complex Fire, 2007 Antelope Complex Fire, and 2019 Walker Fire). Shaded fuel breaks are a type of treatment between 0.25 and 0.5 miles in width aiming to reduce the probability of crown fires through mechanical thinning from below and prescribed fire treatments that remove ladder fuels. In the studied plot network, logistical and capacity constraints led to a gradient of initial treatment intensities. These data provide insight into the longevity of treatment-driven changes to forest structure and the interaction between fuel treatments and wildfire in shaping long-term forest structural trajectories.

A nested plot design was used to record live trees of four size classes (DBH 1-5 in, 5-16 in, 16-30 in, >30 in) and snags (dead trees >3.2 yd tall). Within the nested plots, photo series and line-intercept sampling methods were used to characterize woody surface fuels of different size classes (1-hr, 10-hr, 100-hr, and 1000-hr) and litter and duff depths. Formulas were used to calculate live basal area (LBA; a surrogate for tree biomass), live quadratic mean diameter (QMD; a metric of mean tree size), and fuel load estimates of fine woody debris, coarse woody fuel, and duff. The probability of torching in each plot at each measurement time (pre-, one year post- and 20 years post-treatment) was calculated using field measurements and the Western Sierra Variant of the Forest Vegetation Simulator-Fire and Fuels Extension. Finally, fire severity in each wildfire occurrence was quantified using RdNBR (Relative Differenced Normalized Burn Ratio), a common metric of burn severity derived from remotely sensed imagery of pre- to post-fire changes in vegetation greenness and soil ash content.

Time after initial treatment and wildfire occurrences jointly influenced LBA and QMD estimates in the plots over time. LBA initially decreased by an average of 35% across plots following the implementation of shaded fuel breaks, and increased by only 24% over the following 20 years, demonstrating a sustained reduction in stand density as a result of the initial treatments. Initial thinning treatments increased QMD by an average of 32%, followed by an average increase of 10% over the 20-year time period. QMD was higher in burned than unburned plots after 20 years, indicating the role of low to moderate severity wildfire in increasing the relative proportion of large trees

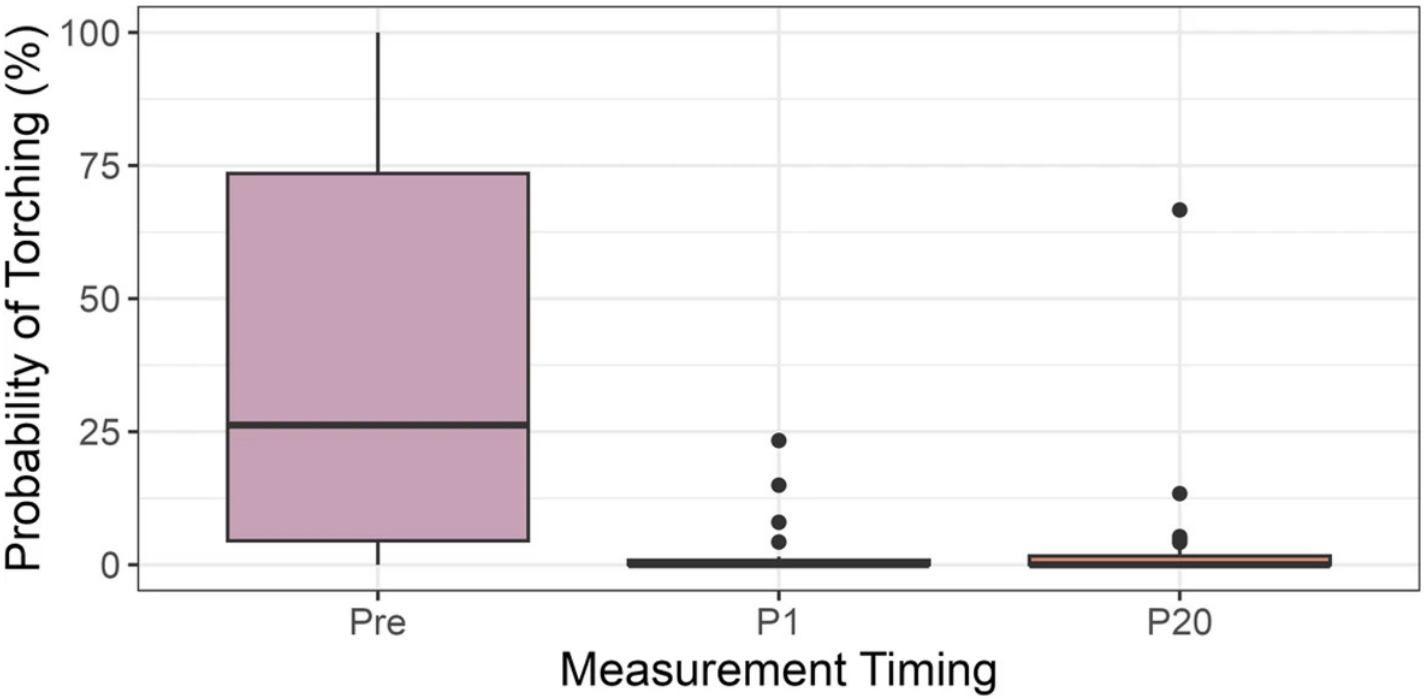

Figure 1. *Figure from Low et al. 2023 shows how initial fuel reduction treatments maintain forest structures with reduced probability of torching at least 20 years post-treatment.*

in the studied stands. While treatments did not substantially influence coarse woody debris loads, wildfires reduced them by 9% after the first wildfire and by 70% after the second wildfire, indicating the potential for successive reburns through either prescribed- or wildfire to keep surface fuels low. Fine fuels and duff showed a similar pattern, where low and moderate severity wildfire reduced fuel loads by 26-47% and 75-77%, respectively. Importantly, regardless of initial treatment intensity, treatments reduced the probability or crown fire or torching by 37% in the first year post-treatment, and maintained a torching probability of only 3.6% in 2021 (Figure 1).

Overall, shaded fuel breaks reduced stand stocking and retained larger-diameter trees immediately after treatments, two structural impacts which in most cases persisted 20 years after initial treatments. Wildfires additionally kept surface and ground fuels low, indicating a promising role for mechanical treatments used jointly with prescribed or low to moderate severity wildfire to maintain fire resilience at multiple forest structural levels. With careful planning, these treatment interventions may increase forest health and allow movement towards the restoration of frequent fire regimes in dry, pine-dominated western ecosystems.

Additional Information

This brief is based on the following article:
Low, Kathryn E., John J. Battles, Ryan E. Tompkins, Colin P. Dillingham, Scott L. Stephens and Brandon M. Collins. 2023. Shaded fuel breaks create wildfire-resilient forest stands: lessons from a long-term study in the Sierra Nevada. Fire Ecology 19:29. https://doi.org/10.1186/s42408-023-00187-2

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