CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Longer-term impacts of fuels reduction treatments in the Lake Tahoe Basin

Low, K.E., B.M. Collins, A. Bernal, J.E. Sanders, D. Pastor, P. Manley, A.M. White, S.L. Stephens. 2021. Longer-term impacts of fuels reduction treatments on forest structure, fuels, and drought resistance in the Lake Tahoe Basin. Forest Ecology and Management 497: 118609. https://doi.org/10.1016/j.foreco.2020.118609

Management Implications

- Impacts of thinning treatments can persist long after treatment implementation.
- Thinning treatments effectively met and maintained overstory structural objectives and reduced downed woody fuels and snag basal area.
- Thinning treatments, especially those leaving lower residual basal area, improve drought resistance.

Long fire-excluded forests that historically experienced frequent-fire are associated with reductions in tree vigor due to increased competition. Extensive tree mortality from California's 2012–2015 drought made this reduction in vigor abundantly clear. Rising temperatures attributed to climate change have increased the likelihood of drought events in California. It is well documented that fuels reduction treatments can reduce wildfire hazard and alleviate individual tree stress. However, direct observations that quantify the longer-term effects on forest structure and individual tree vigor are lacking.

Forests in the study area were impacted by long-established fire exclusion and early timber harvesting. Employing a robust before-after-control-impact (BACI) study design, researchers assessed how thinning in forests altered forest structural conditions in the short- and longer-term (~10 yr). The study aimed to 1) describe and analyze changes in forest structure and composition 2) compare downed woody fuel loads across treated and untreated controls and characterize temporal changes in fuel loads as an element of forest structure 3) understand how thinning treatments impacted overstory tree resistance to California's 2012–2015 severe drought.

Data was collected from six study sites in West Lake Tahoe, CA. From 2007–2009, half of the study units were thinned, which varied in terms of desired conditions and fuels treatment prescriptions. Researchers gathered plot-level information about overstory trees, downed

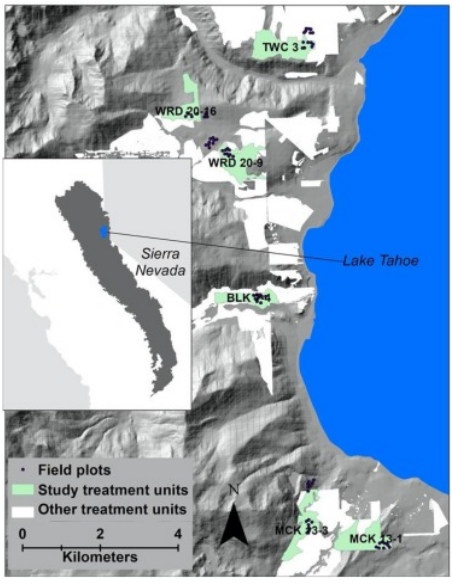

Figure 1: Study locations in West Lake Tahoe, CA

woody fuels, and snags in 2006 (pre-treatment), 2007–2009 (1 yr post-treatment), and in 2018 (10 yr post-treatment). In 2018 tree cores were collected from dominant and co-dominant trees. Resistance values were calculated by dividing the average basal area increment (BAI) during the drought (2012-2015) by the average BAI of the four years prior to the drought (2008-2011).

Linear mixed-effects models were constructed to assess the effects of treatment and time on several forest structure metrics: tree density, residual live basal area, live quadratic mean diameter (QMD), cumulative snag basal area, and basal area of shade-tolerant species. Additionally, authors used generalized linear mixed-effects models to 1) evaluate the influence of overstory characteristics on woody fuel loads and 2) assess treatment impacts on individual tree resistance to the 2012–2015 drought.

Results indicate that treatments effectively achieved desired structural conditions with effects persisting in the longer-term. Lower tree density was maintained 10 years post treatment, with treated units exhibiting 61% lower density than controls. Although treated units maintained 40% lower basal area than untreated stands, treated stands experienced a 57% increase in live basal area between 1 yr and 10 yr post-treatment, relative to untreated stands. Treated stands still exhibited 19% higher QMD and 53% lower snag basal area than controls 10 yr post-treatment. Preferential retention of pine species reduced basal area of shade-tolerant species, however, 10 years later, treated units still exhibited 48% lower shade-tolerant basal area than controls.

Coarse woody fuels were the only fuel class to be effectively reduced following thinning (relative to untreated controls) in both the short and long term. Thinned stands exhibited an immediate reduction (44–63%) in coarse woody fuels 1 yr post-treatment and maintained lower loads (15–29%) 10 yr post-treatment relative to pretreatment levels. Snags were the most important overstory characteristic driving accumulation of fine and coarse woody fuels. Time was the only variable to show an effect on woody fuel dynamics with 1 and 10 yr post-treatment associated with higher fuel loads relative to pre-treatment levels. Although there was no significant relationship between overstory metrics and observed surface fuels, litter and duff may be related to unmeasured characteristics, such as canopy cover.

Thinning treatments effectively increased individual tree drought resistance despite being implemented 4-6- years prior to the 2012-2015 drought (Figure 2). Greater and more variable resistance values were detected in individual trees sampled in units subject to treatments of greater intensities. Average resistance for trees in treated units (1.33) was 28% greater than those in untreated units (1.04). Average drought resistance values for treated and untreated units remained above 1, indicating radial growth was not severely impacted by the record-breaking drought severity. Due to study location, precipitation may still have been sufficient to maintain growth regardless of record high temperatures and other environmental stressors.

Results suggest future treatment applications can be more extensive and intense to meet structural objectives and enhance resistance to projected stressors.

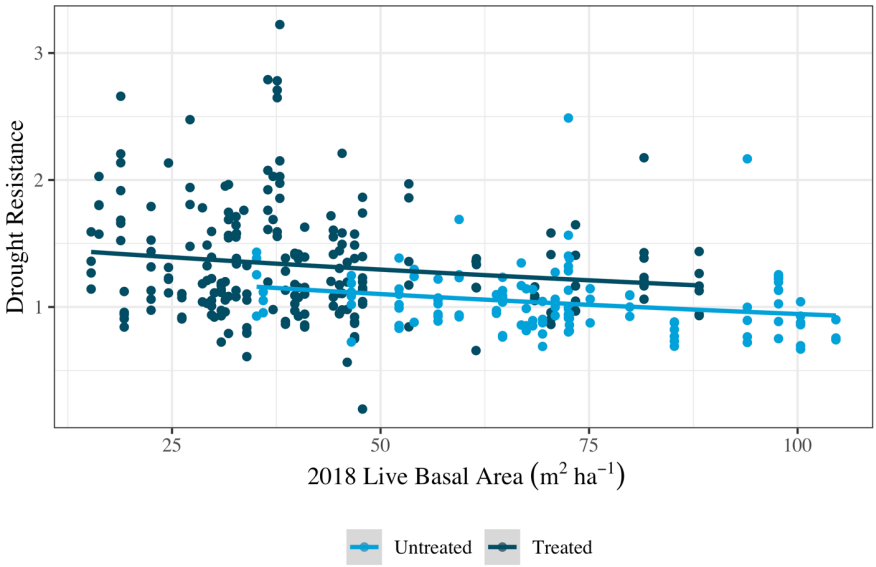

Figure 2: Response curves showing the relationship between 2018 live basal area (BA) and drought resistance. Model response curves are back-transformed from a log transformation and points represent actual individual tree resistance values. Points are colored based on treatment status. There were 334 analyzed cores, 216 from treated units and 118 from untreated units.