CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

Release:	Contact:	Phone:	Email:
November 2019	Rebecca Wayman	(530) 401-0471	rbwayman@ucdavis.edu

Sierra Nevada Fire Science Delivery Consortium | One Shields Avenue, Davis, CA 95616

Wildfire Following Severe Tree Mortality in Frequent Fire Forests: A Research Summary and Call for Proactive Management

Stephens SL, Collins BM, Fettig CJ, Finney MA, Hoffman CM, Knapp EE, North MP, Safford H, Wayman RB. 2018. Drought, Tree Mortality, and Wildfire in Forests Adapted to Frequent Fire. Bioscience 68:77-88.
https://doi.org/10.1093/biosci/bix146

Over 100 million trees recently died in California due to the combined effects of acute drought and forest management, especially the removal of fire from fire-adapted forest ecosystems. Forest densification has increased competition among trees for water and other resources, leaving them more susceptible to mortality from drought and bark beetles. California's recent prolonged drought triggered widespread tree mortality and left forest managers concerned about the effects of these altered forest fuels on future wildfires.

This Overview Article summarizes research relevant to understanding short- and longer-term effects of massive tree mortality in what were historically frequent fire forests of California, presents results on fire severity from a recent wildfire that burned through severe tree mortality, and makes management recommendations for reducing future tree mortality and increasing forest resilience and adaptation to climate change.

Management Implications

- Forest composition and fuels profiles have been drastically altered by the recent severe bark beetle epidemic.
- Applying prescribed or managed fire to post-mortality forests may be the most cost-effective means of reducing fuels.
- Managing for heterogeneity in forest structure will be essential as climate variability and the threat of transformational disturbances increases.
- Managers should proactively increase forest resistance and resilience to disturbance before drought or wildfire occurs through a combination of thinning and prescribed or managed fire.

In the early years of a mortality event (red phase), especially when the onset of mortality is rapid, increased canopy fuel flammability appears to lead to increased rate of fire spread and fire line intensity. Where the onset of mortality is gradual, a decrease in these metrics may occur due to reduced canopy fuel loads. As fine and then large-diameter fuels fall to the forest floor during the gray and old phases, a decrease in crown fire potential and increase in surface fire intensity is expected due to an increase in the amount and continuity of dry, combustible small and large woody material.

New results from an empirical field-based study in the southern Sierra Nevada and first reported in this publication indicate that pre-fire tree mortality is associated with increased fire-caused tree mortality at the plot level, but only up to pre-fire mortality rates of about 30%.

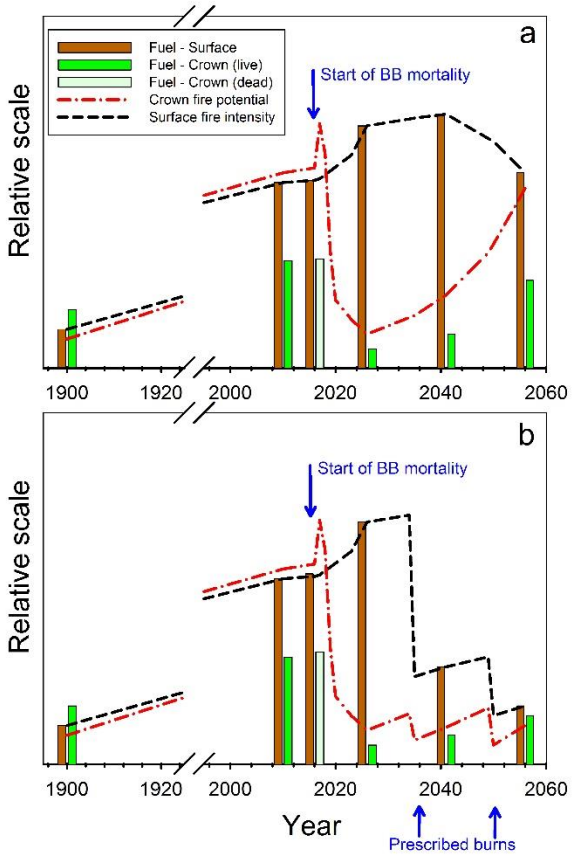

Figure 1. A conceptual diagram showing fuel load and expected fire behavior in a mixed-conifer forest prior to and following a major bark-beetle-caused tree-mortality episode, with either (a) no follow-up-fuels treatment or (b) periodic prescribed fire to consume fuels. Surface-fire intensity is expected to roughly follow surface fuel load, whereas crown-fire potential is regulated by the amount of surface fuel (necessary to heat and dry live fuels to the point of combustion), as well as crown bulk density.

On the landscape level, the increased connectivity of heavy dead fuels over thousands of hectares will likely increase future fire spread rates in frequent fire forests affected by severe tree mortality. The presence of long-burning high fuel loads over extensive areas could lead to increased incidence of mass fire behavior with unpredictable spread and behavior. However, today's operational fire behavior models are not equipped to predict the consequences of these large, long-burning downed fuels.

After drought and bark-beetle induced tree mortality, forest managers will need to consider effects of altered forest overstory composition on future forests. Unlike historic low-severity fires which tended to kill shade tolerant and small diameter trees, the recent bark beetle epidemic caused major mortality of large diameter pines.

Applying prescribed fire or managed wildfire to post-mortality forests may be the most cost-effective means of reducing fuels. Commercial salvage harvest will likely be limited due to low wood prices and lack of mill capacity during mortality events. Therefore, the authors recommend an initial burn to clear up small surface fuels, followed in 10-15 years by a subsequent burn to consume some fallen large logs and branches. The patchy nature of burns conducted during relatively high fuel moistures would break up fuel continuity while allowing patches of regenerating trees to survive. Managing for heterogeneity in forest structure will be essential as climate variability and the threat of transformational disturbances increases.

The authors contend that the most important management change needed in a time of increased incidence and severity of these disturbances is to proactively increase forest resistance and resilience to disturbance before drought or wildfire occurs. They recommend manipulating stand densities, age classes, composition, and spatial arrangement through a combination of thinning and prescribed or managed fire.

Further reading:

Fettig, C. J., L. A. Mortenson, B. M. Bulaon, and P. B. Foulk. 2019. Tree mortality following drought in the central and southern Sierra Nevada, California, U.S. Forest Ecology and Management 432:164–178.

Restaino, C., D. J. N. Young, B. Estes, S. Gross, A. Wuenschel, M. Meyer, and H. Safford. 2019. Forest structure and climate mediate drought-induced tree mortality in forests of the Sierra Nevada, USA. Ecological Applications 29:e01902.

Young, D. J., J. T. Stevens, J. M. Earles, J. Moore, A. Ellis, A. L. Jirka, and A. M. Latimer. 2017. Long-term climate and competition explain forest mortality patterns under extreme drought. Ecol Lett 20:78–86.