



## Research Brief for Resource Managers

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**Contact:**

Lenya Quinn-Davidson  
Eric Knapp

**Phone:**

(707) 441-5284  
(530) 226-2530

**Email:**

lquinndavidson@ucdavis.edu  
eknapp@fs.fed.us

Northern California Fire Science Consortium, 5630 South Broadway, Eureka, CA 95503-6999

# Behavior and effects of prescribed fire in masticated fuelbeds

*Knapp, EE, JM Varner, MD Busse, CN Skinner, and CJ Shestak. 2011. Behaviour and effects of prescribed fire in masticated fuelbeds. International Journal of Wildland Fire. 20: 932-945.*

[http://www.publish.csiro.au/?act=view\\_file&file\\_id=WF10110.pdf](http://www.publish.csiro.au/?act=view_file&file_id=WF10110.pdf)

Mechanical mastication – a relatively new fuels treatment that converts shrubs and small trees into surface fuels – has gained widespread attention in recent years and is increasingly used in fire hazard reduction efforts. Mastication reduces ladder fuels, increases average height to live crown, and results in a more compact fuel bed, which is thought to moderate fire behavior in treated stands.

However, the novelty of mastication is reflected in the relatively limited understanding of its effects on fire behavior and stand resilience, and in uncertainty regarding the ability of standard fuel models to accurately predict fire effects in masticated stands.

The authors conducted prescribed burns in two masticated areas in northern California to assess fire effects in treated stands, compare fire behavior and effects with outputs from commonly used models, and evaluate the ability of mastication to increase stand resilience under a range of hypothetical wildfire scenarios.

In addition to standard fuel models, the authors developed custom models to reflect the unique characteristics of masticated fuelbeds, which include high surface area to volume ratios and high fuelbed bulk densities.

### Management Implications

- The compactness of masticated fuels can mitigate wildfire behavior, but the mortality risk to surrounding trees may not be alleviated due to high surface fuel loads.
- Custom fuel models provided for masticated shrub fuels resulted in better predictions of rate of spread and flame length in prescribed burns than existing fuel models.
- Prescribed fire may be used to reduce fuel loading in masticated stands. However, burns in these areas should be planned with care; areas with high fuel loading or dense stands of small trees maintain higher risk of mortality from crown scorch, and burning at times of low soil moisture could lead to lethal heating of soil and roots.

### Observed fire behavior and effects

The fire behavior observed in this study was very similar to that documented in other studies in masticated and burned stands in the western US.

Temperatures at the mineral soil-duff boundary ranged from ambient (<68°F) to over 1112°F. However, heat did not penetrate deeply; only 3% of thermocouples registered temperatures lethal to roots at a depth of 2 inches in the soil, and no thermocouples registered lethal temperatures at

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4 inches. These relatively low levels of soil heating are likely due to high duff and soil moistures at the time of the fires; soil moisture has previously been shown to be an important predictor of heat penetration and root injury.

In young (approx. 40 year old) plantation-like ponderosa pine stands, tree mortality 3 years after masticated fuels were burned in prescribed fires was 34.8% at one site and only 7% at the other. At both sites, percentage of crown volume scorched and DBH were the best predictors of mortality, with small trees and trees with a high percentage of crown scorch at highest risk. Raking fuels from around tree bases did not significantly reduce crown scorch or increase survival.



### ***Predicted fire behavior and effects***

Several standard fuel models, most notably fuel models 9 (long needle litter), 10 (timber litter and understory), and sb2 (moderate load activity fuel), offered reasonable predictions of some elements of fire behavior in masticated fuels. However, standard fuel models with fuel loading inputs similar to northern California masticated sites tended to over-predict rates of spread and under-predict flame length; custom models developed by the authors generated more realistic fire behavior, predicting the slower rates of spread and higher flame lengths typically documented in masticated fuelbeds.

Custom fuel models were also tested for predicting tree mortality, using data from the prescribed burns with BehavePlus and FOFEM. Mortality was somewhat under-predicted at one

site but within the range of modeled outcomes at another. Extending the results to wildfire scenarios, models predicted that mastication would not improve survival of residual, often small trees at ten masticated sites across northern California, even under a range of weather conditions. With weather conditions at or above the 80<sup>th</sup> percentile, models predicted substantial to complete mortality at all 10 sites, whether the stand was masticated or not. While all modeling exercises need to be treated cautiously, these findings are similar to anecdotal observations made by the authors of tree survival in masticated sites burned over in wildfires.

### ***Conclusions***

This research suggests that although mastication may alter fire behavior – reducing rates of spread, moderating flame lengths, and potentially facilitating firefighting efforts – it may not necessarily increase stand resilience or improve overstory tree survival during wildfire.

Prescribed burns may be used to reduce fuel loading in masticated sites, mitigating future wildfire behavior and effects. However, prescribed fire in masticated stands may be subject to special considerations, given the unique characteristics of masticated fuelbeds. Burns should be conducted when soils are moist, to avoid heat penetration and subsequent damage to soil and roots. Prescriptions should also attempt to mitigate crown scorch through altered weather windows and firing techniques.

### ***Suggestions for further reading***

*Kreye, JK, JM Varner, and EE Knapp. 2011. Effects of particle fracturing and moisture content on fire behavior in masticated fuelbeds burned in a laboratory. International Journal of Wildland Fire, 20: 308-317.*

*Busse, MD, CJ Shestak, KR Hubbert, and EE Knapp. 2010. Soil physical properties regulate lethal heating during burning of masticated fuels. Soil Science Society of America Journal, 74: 947-955.*

*Kane, JM, JM Varner, & EE Knapp. 2009. Novel fuelbed characteristics associated with mechanical mastication treatments in northern California and southwestern Oregon, USA. International Journal of Wildland Fire, 18: 686-697.*