CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Fire behavior in masticated fuels

Kreye, J., Brewer, N., Morgan, P., Varner, J., Smith, A., Hoffman, C., and R. Ottmar. 2014. Fire behavior in masticated fuels: a review. Forest Ecology and Management. 314: 193-207.
http://gallery.mailchimp.com/2263fe298f4df255d22b80097/files/Kreye_etal2014_FEM_MasticationFireBx.pdf

Management Implications

- Masticated fuels vary greatly by forest type, but they typically consist of small, fractured particles, and are arranged in shallow, compact, heterogeneous fuel beds. These fuel beds are unique, and the current understanding of them is limited.
- Mastication does not remove fuels; rather, it relocates material from one fuel strata (ladder fuels) to another (surface fuels).
- The sprouting ability of plants is a major determinant of the longevity of treatments. In places with resprouting vegetation, post-treatment fuel loads can rise above pre-treatment levels if new vegetation grows above a layer of masticated particles.
- Long-duration heating during burning can be a problem in masticated fuels, which are very compact and prone to residual flaming and smoldering.
- Modeling challenges are unlikely to be solved through the creation of a generalized masticated fuel model because of variability in the size and composition of masticated particles, and the heterogeneous arrangement of fuels.

Mastication is an increasingly popular fuels treatment, particularly in densely populated or otherwise complex areas where prescribed fire would be difficult or impossible to implement.

Mastication involves the shredding of small trees and shrubs into irregularly shaped particles, which are then deposited onto the forest floor. Visually, these treatments can appear strikingly effective, because they target the ladder fuels that typically carry fire into the canopy. However, rather than removing ladder fuels, mastication effectively repositions them onto the ground, creating a novel fuelbed that is not easily understood with existing models, and does not necessarily result in less severe fire effects. This paper summarizes the state of knowledge around fire behavior in masticated fuels, and identifies areas where more research is needed.

Characteristics of masticated fuels
Masticated fuels are different from naturally occurring woody fuels and other activity fuels; although they vary by forest type, masticated fuels tend to be small and fractured, and arranged in shallow, compact fuel beds. These characteristics complicate fire behavior predictions. For example, masticated particles may have high surface area:volume ratios because of their size, but the compactness of their fuel beds can greatly affect fuel drying and combustion.

The irregular shapes of masticated fuels can also make it difficult to quantify fuel loads. Studies have shown that different quantification methods can produce variable estimates of fuel loading; distorting the understanding of total fuel amounts as well as the relative amounts of various size classes. Likewise, vegetation species composition can have major implications for the quantity and character of fuels in a particular site, further complicating efforts to model fire behavior across forest types.

Temporal changes in masticated sites are also important; in sites with resprouting vegetation, post-treatment fuel loads can rise above pre-treatment levels, with new vegetation growing above a dense layer of masticated fuels. In other areas, masticated fuels can have a mulching effect, suppressing vegetative growth. Managers should consider vegetation response when planning mastication treatments.

Fire behavior in masticated fuels

Current fuel models do not adequately describe the unnatural arrangement and size of masticated fuels, which tend to have a high bulk density and a high proportion of small diameter particles. These unique characteristics are important factors for fire behavior in these fuels.

Across different forest types, greater masticated fuel depths have been shown to result in greater flame lengths. When fuel depths are held constant, fuel moisture is the primary driver of flame lengths. Flame lengths in laboratory studies ranged from just under 0.5 ft. to 5.5 ft., and they were observed to be slightly higher during prescribed burns (~0.8 ft. to 6.0 ft.).

Fuel moisture is also the primary driver of rates of spread and flame residence times in laboratory studies. (In field studies, fire type [heading vs. backing], season of burn, and within-site variability also influenced rates of spread). Higher moisture results in slower rates of spread, and in shorter flames with longer flaming periods—patterns familiar in other types of fuels. However, it is important to understand that long-duration heating can be a problem in masticated fuel beds, which are very compact and prone to residual flaming and smoldering. For example, studies have attributed higher-than-predicted crown scorch to residual flames in masticated fuels, and other studies have warned of potential soil heating, duff consumption, and root injury in masticated sites.

Models of fire behavior in masticated fuels have highly variable results, often greatly over- or under-predicting flame lengths, fireline intensity, and rates of spread. Fuel heterogeneity is one of the major challenges in modeling fire behavior, and these novel fuel beds are no exception; not only are masticated fuels unevenly distributed across the forest floor, affecting fire spread and ignition patterns, but the vertical arrangement of fuels in masticated sites can also be variable. In some sites, there is simply a layer of masticated particles; in other sites, masticated particles are overgrown with recovering vegetation, which complicates estimates of bulk density and fuel bed depth, as well as fire behavior. For these reasons, modeling challenges are unlikely to be solved through the creation of a generalized masticated fuel model.

Conclusion

Masticated fuels are variable! Some are full of leaf litter, and others are more woody; some may decompose quickly, and others may remain intact for long periods; some are scattered evenly across the forest floor, and others are deposited in random patches across a site. This variability complicates understanding of fire behavior in masticated fuels, and precludes development of a single masticated fuel model or a generalized set of management recommendations for masticated sites. However, the management implications section on the front page provides a list of considerations that are critical in any setting where mastication may be used.

Suggestions for further reading

Kane et al. 2009. Novel fuel bed characteristics associated with mechanical mastication treatments in northern CA and SW Oregon. Int. J. of Wildland Fire. 18 (6): 686-697.

Knapp et al. 2011. Behaviour and effects of prescribed fire in masticated fuel beds. Int. J. of Wildland Fire. 20(8): 932-945.

Kreye et al. 2011. Effects of particle fracturing and moisture content on fire behaviour in masticated fuel beds burned in a laboratory. Int. J. of Wildland Fire. 20(2): 308-317.