Mechanical Mastication as a Fuels Treatment Method in Pine Flatwoods

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ABSTRACT

As the wildland urban interface area in the southeast grows, the threat to communities from wildfire becomes more widespread, while the use of prescribed fire to reduce this threat becomes more challenging. Mechanical treatments may be employed to alter fuel complexes prior to or as an alternative to prescribed burning. We are currently studying the effectiveness as well as the potential consequences of mechanically masticating understory shrubs and small trees in pine flatwoods of the Osceola National Forest, Florida, USA.

Fig. 1- Pre and post-treatment from mechanical mastication in pine flatwoods (repeat photos taken in 2 plot locations)

BACKGROUND

Fire is an important ecological process in many forest ecosystems of the southeastern United States and the maintenance of these ecosystems is often conducted with the use of prescribed fire. But as the spatial area occurring within the wildland-urban interface (WUI) increases it will become more difficult to use prescribed fire not only to maintain fire-dependant ecosystems, but also to mitigate threats associated with wildfire through the manipulation of fuel complexes. As prescribed burning becomes more difficult to employ, the mechanical treatment of fuels is likely to increase as an alternative to prescribed burning or as a pre-treatment option in conjunction with prescribed burning. While mechanical fuels treatments increase as a fuels management option several questions will need to be addressed to fully understand their applicability.

Mechanical mastication is a fuels treatment method that converts standing live shrubs and small trees (Fig. 1) into a dense fuelbed composed of horizontally oriented dead fragments of vegetation. Live fuels are chopped or cut using front end (Fig. 2) or boom mounted rotating equipment containing flailing cutters that sever branches, limbs, and stems. The resulting activity fuels created from the mastication process are not turned into the soil, but rather scattered on top of the soil surface. Important questions regarding mechanical fuels treatments are their effectiveness in reducing the threat of wildfire to communities within the WUI as well as the longevity of such effectiveness. It is also important to understand what potential ecological effects may result from the implementation of these types of treatments across a landscape scale. Fully understanding the benefits as well as the consequences of using mechanical treatments as an alternative to or in conjunction with prescribed burning will be required to make sound management decisions.

Fig. 2- Example of mastication equipment.

OBJECTIVES

Our primary objectives are to:

1) Characterize the resulting fuel complex created from the mastication of southern pine flatwoods.

2) Assess vegetation dynamics following mastication treatments.

3) Quantify fire behavior and potential fire effects in these unique fuelbeds.

METHODS

Mechanical mastication of understory shrubs and small trees (<20 cm diameter) is being conducted as a fuels treatment method in Osceola National Forest in northern peninsular Florida, USA. The sites being masticated are primarily in pine flatwoods ecosystems dominated by slash (*Pinus elliottii*) and longleaf pines (*P. palustris*) in the overstory, and by gallberry (*Ilex glabra*) and saw palmetto (*Serenoa repens*) in the understory. Most sites have not burned in over 10 years and this fuels treatment method is being implemented to alter the fuel complex prior to prescribed burning with the intent to reduce fire behavior.

Sixty three plots were systematically established within a 100 hectare fire buffer (~100 m wide) implemented along approximately 10 km of the boundary of the Osceola National Forest adjacent to multiple private properties in the vicinity of Lake City, Fl, USA. Plots were established prior to mastication and both vegetation and surface fuels were measured prior to and following the 2009 treatment. We are continuing to monitor vegetation recovery and fuel dynamics to assess the recovery and life cycle within this fuel complex to better understand its effectiveness and longevity.

In addition to the 100 m wide buffer, the Osceola National Forest is using mastication to treat fuels within larger compartments prior to prescribed burning. Within these larger compartments we are establishing blocks to compare fire behavior, fire effects, vegetation recovery, and fuel dynamics across the following treatments: mastication only, mastication + burn, burn only, and control (no treatment). Plots will be established within all blocks to measure vegetation and fuels prior to and following mastication, immediately following burning, and every six months thereafter.

To fully understand the effectiveness and/or potential consequences of this treatment we need to understand how the resulting fuel complex burns. To do so we are quantifying fire behavior within these novel fuels both in the field (Fig. 3) and within constructed fuelbeds (Fig. 4). Following mechanical treatments we propose to monitor fire behavior (rate of spread and flame heights) during prescribed burning operations and to monitor the resulting effects (fuel consumption and tree mortality). To better predict fire behavior in these fuels we are developing and burning fuelbeds constructed from material collected from treated sites. We have conducted controlled burns in 18 constructed fuelbeds across 3 fuel loading treatments (10, 20, and 30 Mg/ha) at 2 fuel moisture content (FMC) treatments (9±2 and 14±5 %). Flame heights and rate of spread were observed during burning and temperatures above the fuelbeds and within the soil were measured throughout the burns using type K thermocouples. We intend to burn additional fuelbeds at an even higher FMC treatment. We have analyzed preliminary results here just for discussion.

Fig. 3- Fire behavior in pine flatwoods following mechanical mastication of understory shrubs and small trees. The photo on the right shows a pocket of un-masticated shrubs burning beneath a residual pine tree

Fig. 4- Burning constructed fuelbeds using material collected material from treated field sites.

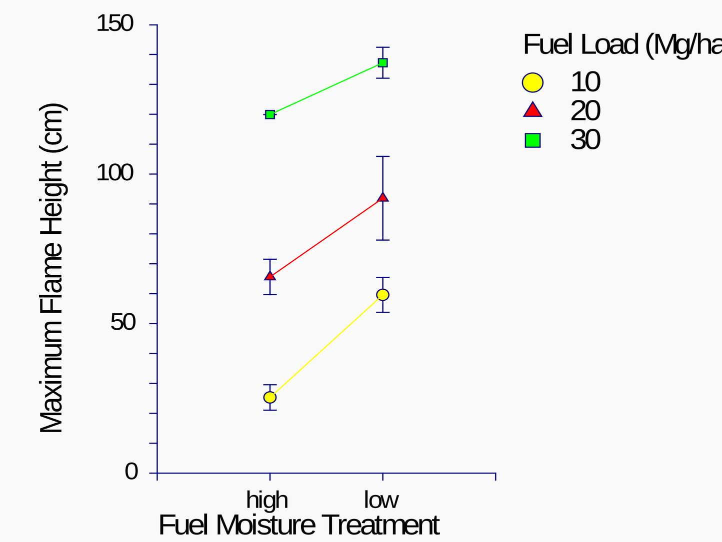

Fig. 5- Maximum flame heights from the burning of constructed fuelbeds across fuel loading treatments (10, 20, and 30 Mg/ha) at high and low fuel moisture.

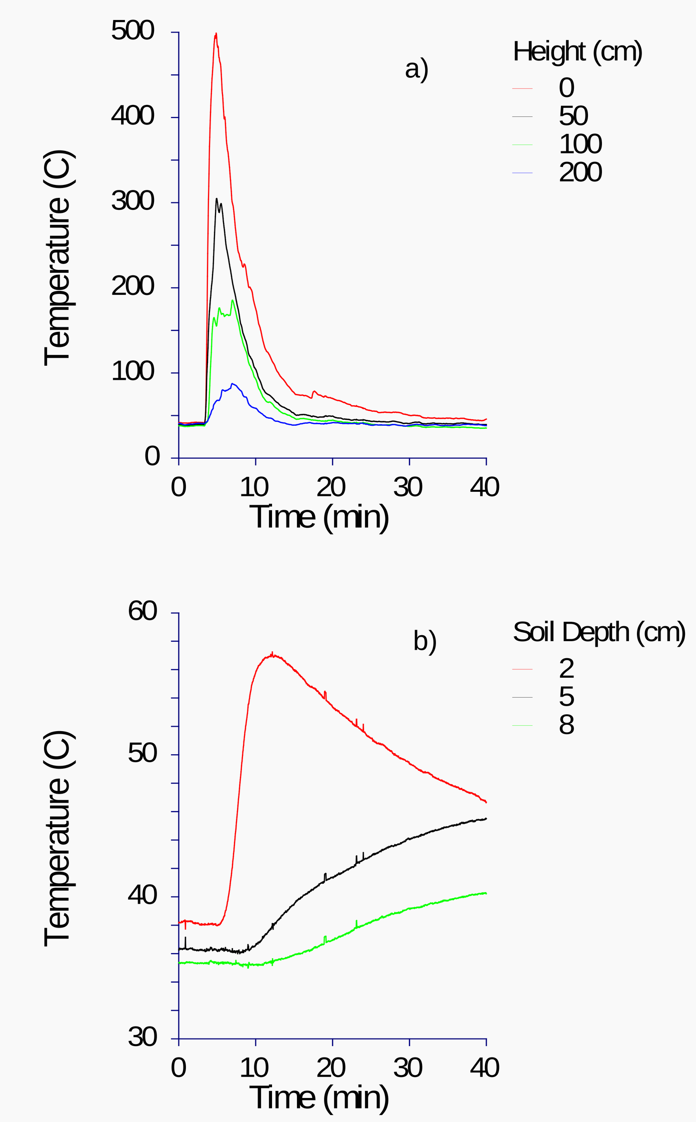

Fig. 6- Temperature profile from the burning of a constructed fuelbed at 30 Mg/ha and low fuel moisture treatment.
a) above the fuelbed
b) within the soil

PRELIMINARY RESULTS AND DISCUSSION

Preliminary results indicate an increase in loading (biomass) of small diameter (<7.6 cm) woody surface fuel, but a reduction in both surface woody fuel height and surface litter depths. While surface litter depths appear reduced we do not have results of the change in biomass of surface litter as we are currently developing equations to quantify biomass from litter depth in post-treatment fuelbeds. While litter depth may be lower following mastication it is visually apparent that litter biomass has increased since heavy accumulation of litter, especially from saw palmetto, has resulted. An increase in surface fuel loading in conjunction with a decrease in fuel depths results in high fuelbed bulk density. Vertically oriented live fuels (shrubs) are being converted into a compact, horizontally oriented fuelbed composed of dead litter and small diameter wood.

Our preliminary data from the burning of constructed fuelbeds are giving us some indication of how these fuelbeds may burn under various post-treatment fuel loadings that may result from the mastication of sites with a range of live biomass prior to mastication. Maximum flame heights, for example (Fig. 5), have been shown to be affected by different fuel loading treatments ($p<0.001$) and at different fuel moisture treatments ($p=0.006$) and ranged from 25 to 140 cm. Temperature profiles appear to all take the general shape of that indicated in the example from a low FMC burn with 30 Mg/ha loading (Fig. 6). Temperatures peak above the fuelbed (Fig. 6 a) for relatively short durations as the flaming front moves across the fuel bed and the magnitude of the heat pulse dissipates with height above the fuelbed. In contrast, soil heating (Fig. 6 b) shows a delayed heating response compared with that above the fuelbed and that the retention of this heat lasts longer as soil takes longer to both heat up and to cool down. With these temperature data we intend to analyze the duration of occurrences of various temperatures to help us understand how energy released from the burning of these fuelbeds may induce heating to residual plant tissues (tree cambium, tree roots, shrub underground storage organs, etc). A better understanding of the effectiveness, longevity, and potential consequences of these treatments will help land managers to better assess the usefulness of mastication as a fuels management tool in these ecosystems.

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