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Fire in the southern Appalachians: restoration of pine-hardwood ecosystems

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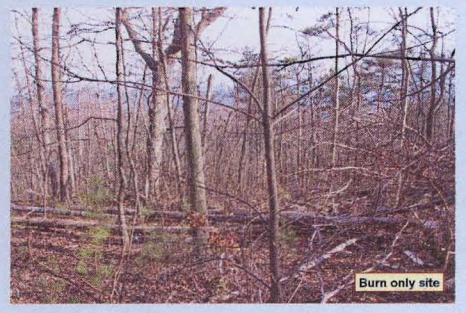
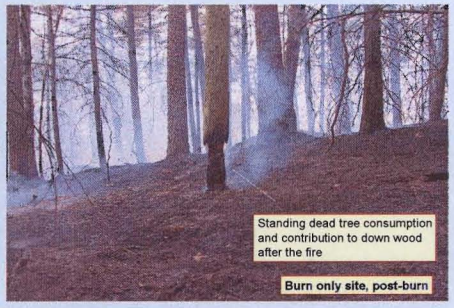
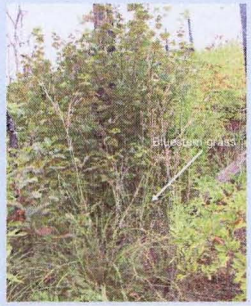
Abstract: Vast acreage across the southern Appalachians has been severely impacted by the recent southern pine beetle (SPB) epidemic (1999-2003). As a result of this most recent SPB outbreak, thousands of hectares of dead pine trees have created wildfire-hazard conditions. One of the challenges for land managers is how to return fire to these ecosystems after (1) nearly a decade of exclusion, and (2) the more recent SPB mortality enhanced fuel loads. Higher fuel loads have the potential to increase fire intensity and severity. At the extremes, fires of high intensity and severity can have a large effect on ecosystem structure and function. The objectives of our research were: (1) to quantify fuel load reduction methods (pine overstory felling, material left on site followed by prescribed fire; prescribed fire only; and no treatment) in pine/hardwood forests heavily impacted by southern pine beetle induced tree mortality, and (2) to evaluate the effects of further restoration treatments including planting shortleaf (*Pinus echinata*) pine and seeding native bluestem grasses on ecosystem structure and function in these pine-hardwood forests in the ...thern Appalachian region. Eight sites on the Cherokee ...onal Forest, eastern Tennessee were chosen to ...luate restoration of shortleaf pine ecosystems. Four sites were cut+burn (2-dry, 2-submesic), two sites were burn only, and two sites were used as references. Sites were cut in summer 2005 and burned in March 2006. We measured vegetation; soil and soil solution chemistry; forest floor mass, carbon and nitrogen; and fuel load before and after the burn treatments. The prescriptions resulted in high intensity, moderate severity fires. Fuel consumption was greatest on the cut+burn sites. Mortality of planted pine averaged 25% by the end of the first growing season; whereas, success of seeded bluestem grass was not apparent until the second growing season after the fire.







Seeded bluestem grasses (*Schizachyrium scoparium* and *Andropogon gerardii*) emerged the first growing season after the prescribed fire. Not until the second growing season (2007) did they become a significant component of the herbaceous layer.

In addition, the nonnative invasive grass, *Microstegium vimineum*, colonized some of the burned sites.

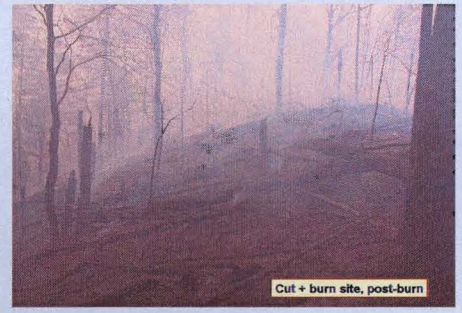
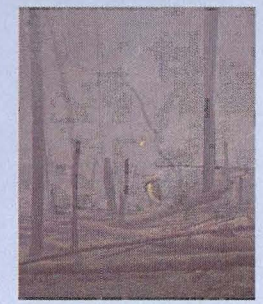


Table 1. Understory woody species richness (number of species per plot), density (stems ha^{-1}), and basal area (m^2 ha^{-1}) for the prescribed burn treatments

Treatment	Richness		Density		Basal area	
	Pre	Post	Pre	Post	Pre	Post
Burn	6.4 (0.9)	6.5 (0.7)	16,500 (3466)	32,250 a (5870)	2.78 (0.65)	1.87 (0.43)
Cut + burn	8.6 (1.0)	7.4 (0.7)	27,375 (4160)	33,875 ab (4480)	4.99 (0.79)	2.04 (0.30)
Reference	7.6 (0.9)	8.5 (0.7)	12,450 (2330)	14,550 b (2757)	1.94 (0.42)	2.56 (0.64)

Woody stems < 5.0 cm dbh, >0.5 m height. Standard errors are in parentheses.

The study area is located in eastern Tennessee (35° 5' N latitude, 84° 35' W longitude). Elevations range from 290 to 600 meters. All sites were delineated around patches of high pine mortality due to the SPB outbreak (Fig 1). The Ocoee River and Lake are heavily used recreational areas on the Cherokee National Forest, TN. Fires were ignited by the Ocoee Ranger District (FMO and crew) and smoke management was monitored and addressed by the National Forest.



A site preparation burn was implemented on six sites in March 2006. Ignition was a hand-lit backing fire along ridges, then a head fire was hand-lit from the lower slopes. This prescription resulted in high intensity and short duration fires (Fig. 2), resulting in moderate severity burns.
The fires consumed nearly all fine fuels (litter and small wood [1-100 hr]) and 23-31% of the larger fuels (1000 hr).

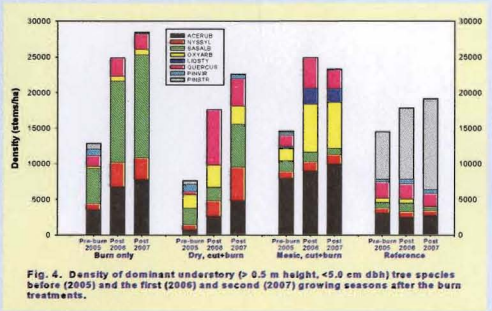


Fig. 4. Density of dominant understory (> 0.5 m height, <5.0 cm dbh) tree species before (2005) and the first (2006) and second (2007) growing seasons after the burn treatments.

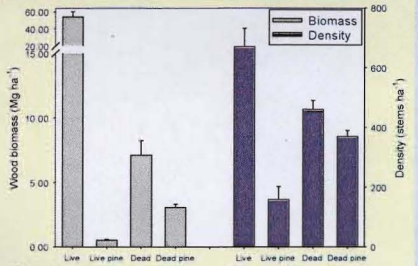


Fig. 1. Pre-treatment (2005) aboveground biomass of live and dead trees (branch + bole). Biomass was estimated from species specific allometric equations.

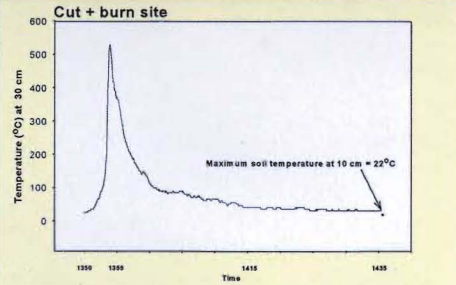


Fig. 2. High intensity, short duration fire

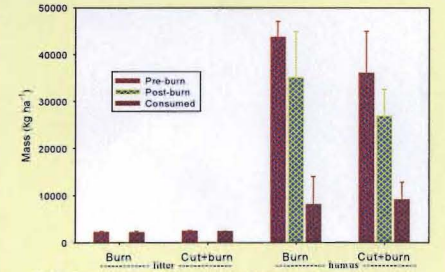


Fig. 3. Forest floor litter (Oi) and humus (Oe+Oa) mass pre- and post-burn.

Summary

- Before the prescribed fires, all sites had a large amount of dead wood (Fig. 1) due to tree mortality from the southern pine beetle.
- In the burn only treatment, the fire burned standing dead trees, which contributed large wood mass to the forest floor. More new wood was contributed than down material consumed. The cut+burn treatment reduced down wood mass.
- On these high intensity burns (Fig. 2), even though the forest floor litter layer was consumed, a large proportion of the humus layer remained intact (Fig. 3).
- Understory density was high before the treatments due to increased number of saplings following the pine mortality. Density increased further after treatments (Table 1).
- Oak (*Quercus*) sapling numbers increased after the burn treatments (Fig. 4). However, other hardwoods that increased by even greater numbers may out compete oaks.
- We are continuing sampling and analyses on this project to evaluate changes in vegetation composition and diversity, carbon and nitrogen pools, soil and soil water chemistry, and success of planted pine and bluestem grasses.

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