RESTORING STRUCTURE AND COMPOSITION OF LONGLEAF PINE ECOSYSTEMS OF THE GULF COASTAL PLAINS

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Abstract: Longleaf communities of the middle and upper Gulf Coastal Plains historically had an overstory dominated by longleaf pine (*Pinus palustris*) with pockets of other southern pines and occasional hardwoods, while the understory was grass dominated with lesser amounts of woody shrubs. The open grassy understory was maintained by frequent, every 2 to 5 years, low intensity fires. The objective of this research project is to develop realistic management options that can be used to manage fuels and restore this ecosystem. Research is being conducted in cooperation with Auburn University at the Solon Dixon Forestry and Education Center near Andalusia, Alabama. Treatments include an untreated control (no fire or other disturbance), prescribed fire only, mechanical removal of selected trees, and a combination mechanical removal of trees and prescribed fire. Although there was not a large change in either relative composition or diameter distributions, thinning created more open stands with fewer small hardwoods. The redistribution of logging slash facilitated prescribed burning just 2 months after the thinning operation. Cover of understory shrubs was reduced by both thinning and burning with the combination treatment the most effective. Burning caused the greatest reduction in small understory hardwoods while thinning alone had no effect. For larger midstory hardwoods, however, burning alone resulted in no change while thinning reduced their density significantly. Thus, fire is needed to control understory hardwoods while thinning is needed to reduce larger midstory hardwoods. Therefore, the combination treatment may be the quickest treatment for restoring structure and composition to this ecosystem.

INTRODUCTION

Historically, prior to fragmentation of the landscape, lightning ignited fire was a frequent natural occurrence (every two to eight years) across much of the South (Abrahamson & Hartnett 1990, Ware and others 1993). These fires regulated plant composition and favored those species that survived frequent burning. Native American burning augmented these natural fires. This burning kept fuel loads low, thereby reducing the probability of more severe wildfires. The South was one of the first areas where land managers recognized the usefulness and need for frequent prescribed burning to control fuel levels. A large influx of people from other regions of the country where fire is not as prevalent has occurred over recent decades. They do not understand the need for burning and only see the temporary negative aspects of smoke and ash and a blacked area. Increasingly this population growth has occurred on the edge or within forested areas creating a significant amount of wildland to urban interface. This has made prescribed burning much more difficult. Litigation from smoke on highways and an increase in rural highway traffic has also reduced the amount of prescribed burning, especially on private lands.

Reduced burning has resulted in significant changes that are undermining the health and long-term sustainability of many southern communities. Longleaf pine ecosystems for example were once the most prevalent type in the Southeast occupying as much as 23 million hectares, stretching from southeastern Virginia south to central Florida and west into eastern Texas (Stout and Marion 1993). This longleaf pine-grass ecosystem was maintained by frequent fires that inhibited the establishment and growth of competitive but less fire-tolerant species (Clewell 1989). Today longleaf occupies less than 5 percent of its original extent (Outcalt and Sheffield 1996). The continuing reduction of this important forest type threatens a myriad of life forms characteristic of, and largely dependent on, longleaf pine habitat.

Widespread treatments are needed to restore ecological integrity and reduce the high risk of uncharacteristically severe and destructive wildfires in these forests. Among possible treatments, however, the appropriate balance among cutting, mechanical fuel treatments and prescribed fire is often unclear. For improved decision making, resource managers need better information about the consequences of alternative management practices involving fire and mechanical, i.e. fire surrogate treatments. The objective of this study is to develop realistic management options that can be used to treat fuels and restore ecosystems. Reported here are the initial effects of these fire and fire surrogate treatments on stand structure and composition in typical gulf coastal plains longleaf stands.

METHODS

This study is part of the national Fire and Fire Surrogate study funded by the Joint Fire Science Program. However, this location received much of its funding from the National Fire Plan to include an ecosystem not in the original nationwide study. It is located about 35 km southwest of Andalusia, Alabama on the Solon Dixon Forestry

Education Center, which is owned and operated by Auburn University School of Forestry. Much of the 2150 ha forest is dominated by longleaf pine but other southern pines are also abundant including loblolly (*P. taeda*), shortleaf (*P. echinata*), slash (*P. elliottii*), and spruce pine (*P. glabra*). In many areas, especially the numerous lower bottoms, there is a substantial hardwood component dominated by oaks (*Quercus* spp.). The understory is dominated by woody shrubs with yaupon holly (*Ilex vomitoria*) the most abundant and lesser amounts of blueberries (*Vaccinium* spp.) and gallberry (*I. glabra*).

The four treatments were prescribed burning only, thinning only and their combination along with an untreated control. These were applied utilizing a randomized block design with three blocks. Stands were selected from all possible areas that were pine dominated with a significant amount of longleaf, were historically longleaf pine dominated, and were at least 12.5 ha. Trees were marked in selected stands at the end of 2001. Selected trees were sold to a commercial logger who began thinning in January of 2002 and finished operations by early April. Limbing was done near the stump with chainsaws. Logging slash was redistributed by hand to move concentrations away from remaining crop trees. Prescribed burning was done during April and May utilizing backing, flank, and spot fires (Outcalt 2003).

Each stand consisted of a core area of 12.25 ha with a surrounding 20m buffer. There were 36 grid points on a 50m by 50m spacing in each stand with ten rectangular 20m by 50m plots established between selected grid points. The overstory tree layer (all trees > 15cm at dbh) was sampled on the entire 20 by 50m plot, while midstory trees (3.1 to 14.9 cm) were sampled on 10 by 50m sub-plots. Diameters and species were recorded for all overstory and midstory stems before treatment application and one growing season post treatment. Cover of understory shrubs greater than 1.37 m tall was determined by ocular estimation before and after treatments on two 10 by 10m sub-plots located at each end of the 20 by 50 plots. Pretreatment data were analyzed with analyses of variance and post treatment data were compared with analyses of covariance using pretreatment levels as the covariate.

RESULTS

Prior to treatments total basal area ranged from 15.4 to 23.4 m^2/ha. Longleaf pine was the most prevalent species on all sites except stand 15, which was dominated by loblolly pine (Figure 1). Most stands also contained a considerable amount of hardwood, especially oaks. Thinning treatments targeted hardwoods and other pines to reduce their prevalence while increasing the dominance of longleaf pine. However, longleaf pine was also harvested where it was deemed appropriate to reduce stocking and remove inferior trees. On average across all stands thinning removed 10 percent of slash pine basal area, 15 percent of longleaf, 18 percent of loblolly, and 49 percent of other pines. The most heavily harvested were the hardwoods with oak basal area reduced by 55 percent and other hardwoods by 58 percent.

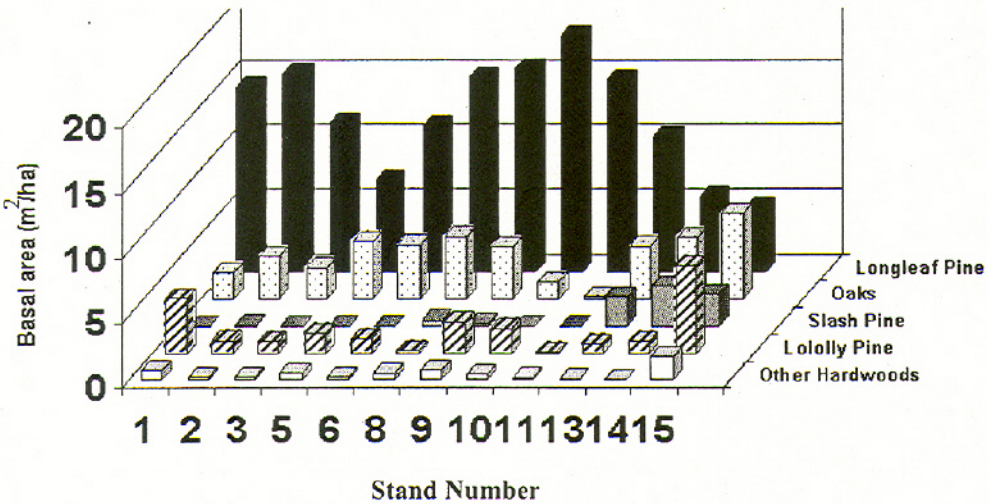

Figure 1.—Pretreatment basal area (m^2/ha) of overstory trees > 15cm diameter by stand and species group.

Midstory hardwoods were present in all stands prior to treatment with an average density from 104 stems/ha in stands that were selected for burning to 240/ha in the thin and burn stands. There were no significant changes in midstory hardwood density in control stands over the first 2 years. Burning alone did not significantly reduce midstory stocking. Some hardwood stems were harvested during thinning and additional individuals were knocked down by logging equipment. This resulted in a significant decline in midstory density on thinned only (216 pre vs. 87/ha post) and thinned and burned stands (240 pre vs. 42/ha post).

Density of the smallest diameter hardwoods stems (0.01 to 1.00 cm) was not affected by the thinning operation (Table 1). Burning, however, significantly reduced this size class of hardwood stems with over a ten fold reduction in both burn only and thin and burn stands. It appears that thinning may have reduced the density of understory hardwood stems in both the 1.01 to 2.00 and 2.01 to 3.00 cm diameter classes, but densities were still not significantly different from stocking in control stands. The effect of burning however, was quite pronounced in these larger size classes of understory hardwoods, where burned stands had very few of these larger hardwood stems one growing season following treatment.

Understory tall shrub cover averaged between 8.5 and 13.6 percent prior to treatment. All treatments significantly reduced tall shrub cover. Thinning reduced shrub cover from 13 to 4 percent and burning reduced it from 8.5 to 6 percent. The combination treatment caused shrub cover to decline from 12 to less than 1 percent.

Table 1. Density of understory hardwood stems before and one growing season after treatment of longleaf pine stands on the Solon Dixon Forestry Center.

	Stem DBH 0.01-1.00 cm		**Stem DBH 1.01-2.00 cm**		**Stem DBH 2.01-3.00 cm**	
Treatment	Before	After	Before	After	Before	After
	-Stems/ha-					
Control	478a*	500b	100a	143b	23a	33b
Burn	806a	68a	220a	13a	44a	10a
Thin	412a	394b	268a	131b	80a	39b
Thin & Burn	500a	42a	86a	3a	30a	4a

*Letters denote significant differences within a column at .05 level.

DISCUSSION

Thinning can be used to readjust structure and composition of the midstory and overstory layers of longleaf communities of the Gulf Coastal Plains region. By selectively targeting species that have increased during the period of reduced fires, a stand can be set on a trajectory to become a more open and fire adapted community where overstory health can be maintained with prescribed burning. These stands can be treated with growing season burns soon after thinning to dispose of slash and reduce wildfire hazard. This requires movement of logging slash away from the base of remaining trees. Because of this additional work and the more careful burning required with these higher fuel loads, treatment cost will be higher than normal. It took an average of 2.5 person hr./ha to redistribute logging slash and 5 person hr./ha to prepare and burn stands. In addition the burns were more spotty but still successful with proper planning and execution. The additional costs for slash moving and burning could be reduced by waiting 18 to 2 months for slash to decay before the site is burned. Once the stand has readjusted to growing season burns, costs will be more typical of prescribed burning in the region.

The cover of understory shrubs can be reduced by both thinning and burning. Burning is also the most effective means of removing small understory hardwood stems. Larger stems however, i.e. those bigger than 3.0 cm in diameter are quite resistant to burning and even those between 2 and 3 cm were more resistant than smaller stems. Thus, burning did not effectively reduce midstory hardwoods with a single burn. Others have also reported that young hardwoods are also quite susceptible to top kill by fire; and frequent fires can keep hardwood sprouts at low stature in longleaf stands (Komarek 1977; Landers and others 1990). Once stems become larger however, they are more resistant to future surface fires (Rebertus and others 1993). Repeated burning at frequent intervals is required to kill larger hardwoods and reduce the density of hardwood rootstock (Waldrop and others 1987). Therefore, although the combination thinning and burning treatment will be more costly, it is also the quickest method for restoring stand structure and overstory composition to these longleaf pine communities of the Gulf Coastal Plain. It will require continued prescribed burning on a regular basis to maintain these stands and further their development into a more open longleaf pine dominated overstory with a diverse herbaceous dominated understory.

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