PRESCRIBED FIRE EFFECTS IN A LONGLEAF PINE ECOSYSTEM-ARE WINTER FIRES WORKING?

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Abstract--Longleaf pine (*Pinus palustris* Mill.) ecosystems once dominated 60 to 90 million acres and supported one of the most diverse floras in North America. It is well-known that longleaf pine ecosystems must burn frequently to maintain natural structure and function. This vegetation type ranks as one of the most fire-dependent in the country and must burn frequently (multiple times a decade) for natural structure and function to be maintained. Frequent fires maintain relatively low fuel loads, so many burns do not directly affect adult longleaf trees. However all species are immediately affected by each fire that burns through a stand. Because many resident species are perennials that re-sprout after fires, it likely takes multiple burns to change the plant assemblage of the ground layer. There is a need is for better insight into fire effects on small woody stems in the ground layer. In 1984 a long-term study was established on the Escambia Experimental Forest in Brewton, Alabama to study the impact of fire on longleaf pine growth. Spring and winter burns at 2-, 3-, and 5-year return intervals were implemented and have been continued since that time. Hardwood species composition from each of the season of burn and fire frequency treatments will be discussed. Winter burning has not removed what are considered to be fire-intolerant species such as water oak (*Quercus nigra* L.) and sweetgum (*Liquidambar styraciflua* L.), from the landscape. These species will make future fires more difficult to make and eventually make it difficult to regenerate longleaf pine.

INTRODUCTION

Descriptions exist of the southeastern landscape before European settlement (e.g. Bartram 1791) and by all accounts longleaf pine (*Pinus palustris* Mill.) dominated the landscape. At this time, fire was ever-present and the most important ecological process responsible for persistence of longleaf pine forests (Burns and Honkala 1990, Chapman 1932, Croker and Boyer 1975, Wahlenberg 1946, Walker and Wiant 1973). The original longleaf pine ecosystem had a groundcover dominated by perennial grasses and forbs that was maintained by a mosaic of fire, both in time interval and season. Reports at the end of the 1800s suggest that south of the Fall Line, much of the region supported pine-dominated ecosystems (Mohr 1896), most maintained by frequent, low-severity fire. There were accounts of hardwood forests as well, but at such small acreages that they were not reported in timber values (Mohr 1896, Sargent 1884). Fire regimes varied across the landscape depending on topography, soil-type, and biotic factors related to abiotic differences; current estimates suggest burn frequencies of one to five events or more each decade. Open-canopy pine forests served as the landscape matrix with other ecosystems imbedded in them.

In the modern landscape, the acreage of longleaf pine forests has dramatically declined due to conversion to agricultural use, urban development, or plantation forestry. The naturally regenerated stands that remain are often fire suppressed or burned only infrequently. This is especially problematic for longleaf stands (Noss and others 1995). Prescribed fire helps control disease such as brown spot needle blight, eliminates some stems and foliage from woody competition, and promotes seedling establishment and growth by eliminating excessive litter on the forest floor (Chapman 1932, Croker and Boyer 1975, Walker and Wiant 1973). Natural regeneration of longleaf is generally unsuccessful unless seed falls on bare soil; in addition, native ground layer of grasses and forbs declines without fire. Although Outcalt (2000) estimated that slightly more than 80 percent of natural longleaf stands on public property had been burned at least once in the previous 5 years, less than 40 percent of private property stands were burned during the same time period.

Longleaf pine has the potential, if actively managed, to meet modern forestry goals. However, because there was a period of time in U.S. history where fire was not promoted as a management tool, many landowners and land

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managers today are uncomfortable with burning their forestland for fear of killing their crop trees. Longleaf pine is not loblolly (*Pinus taeda* L.) or slash pine (*Pinus elliottii* Engelm.) and evolved under different conditions than the other southern pines. It evolved with fire and regenerated in dense stands that formed in openings created by some disturbance event. Thinning techniques can be used to develop canopy openings to capture regeneration when trees are old enough to produce viable seeds. This in conjunction with an early and active burning regime can promote the development of high-quality sawlogs and understory plant species that are preferred browse and forage for wildlife (Haywood and others 1998, Walker and Wiant 1973). Without fire, hardwood competition will dominate the understory and eliminate or dramatically reduce regeneration opportunities and forage availability in longleaf pine forests.

By considering fire regimes that include season and frequency of burn, modern management goals may be better achieved. This paper examines the results of a long-term study that was established in 1984 on the Escambia Experimental Forest in Brewton, Alabama by Dr. William Boyer to examine 2-, 3- and 5-year fire-return intervals on longleaf pine stands. The objective is to better understand the impact of season and timing of burn on longleaf pine forests, and in particular, the effect it has on hardwood competition in these forests.

MATERIALS AND METHODS

This study was initiated in 1984 on the Escambia Experimental Forest near Brewton, AL to study potential growth losses in frequently burned longleaf pine forests. Specifically, this study examines impact of winter (January/February) and spring (April/May) burns on growth and mortality of longleaf pines. Three study blocks of 9-year-old longleaf pine trees were established on the forest. Efforts were made to locate them in relatively close proximity to each other and on areas of similar site quality. On these blocks, 0.1-acre measurement plots were established, and trees were thinned to 40, fairly uniformly spaced crop trees. Measurements taken at time of study establishment showed no significant differences in species composition or size of trees across all plots.

Prescribed fires were initiated in the winter (January/February) and spring (April/May) of 1985. Flank or strip-head fires were used to minimize crown scorch. Fires were set in periods following soaking rains, when fine fuel moisture was 7 to 10 percent, relative humidity was 35 to 55 percent, and winds were steady. Following that initial burn, stands were burned under similar conditions on 2-, 3-, or 5-year intervals. There was also a no-burn treatment for comparison.

All pine and hardwood trees that were at least 1 inch in diameter at breast height (d.b.h., where breast height = 4.5 feet above the ground level) were measured for diameter to the nearest 1 inch and total height to the nearest 1 foot at the time of study initiation. Similar measurements continued to be taken at 5-year intervals, measuring both trees that were present at the start of the study as well as ingrowth. Treatments by both season and timing of burn were compared at the 95 percent level for differences in d.b.h., height, and basal area through time.

RESULTS

With regard to longleaf pine growth and mortality, this study found no significant differences between burn and no burn treatments until age 19 when basal area was lower on burn plots regardless of time interval. At age 24, height, longleaf pine d.b.h., and basal area were lower on burn plots. By age 29, only height was comparatively lower on burn treatments. There was no significant loss of longleaf pine trees due to mortality at this time. When comparing different seasons and frequency of burns, there were no significant differences among treatments for d.b.h. and basal area through age 29. Height of the overstory longleaf pine trees, however, was significantly lower on 2-year burn compared to 3- and 5-year burn intervals.

Results are varied, however, for hardwood stems on the plots. By age 12, winter 5-year and no-burn plots had significantly higher numbers of hardwood stems and hardwood basal areas compared to other treatments. The winter 5-year and no-burn treatments were not significantly different from each other at this time in terms of hardwood stems and basal area. By age 24, hardwood density on no-burn plots was significantly higher than the winter 5-year burn and all other treatments.

When comparing the diameter distribution of hardwood stems per acre on the unburned sites, the number of stems has continued to increase since the initial measurement in 1984. At the time of the most recent measurement in 2009, there were not only as many 1-inch stems as there were in 1984, but there were more than two times the number of 2- and 3-inch stems. There were also stems in the 4- through 10-inch classes that were not found on the site at the time of study initiation. Fire-intolerant species such as water oak (*Quercus nigra* L.), and sweetgum (*Liquidambar styraciflua* L.) make up the majority of the hardwood stems found on these plots.

There were more hardwood stems present on winter burns overall. For example, winter 5-year burn plots saw increases in the diameter of understory hardwoods into the 2- to 8-inch diameter classes over the last 24 years, but the number of stems was less than that of the unburned treatment. Measurements taken in 2009 show that winter 2- and 3-year burns had more hardwood stems in larger diameter classes than were present at the time of study initiation. However there are fewer 1-inch d.b.h. stems on these treatments than there were in 1985. Oaks and dogwoods (*Cornus* spp.) comprised the majority of stems > 1.5 inches d.b.h. on these winter burn plots, while mostly water oak and sweetgum were found to make up the smaller diameter classes.

Over the same 24-year period, spring burns were found to control almost all hardwood stems that were on site at the beginning of the study regardless of timing. By 2009 neither the spring 2-year nor the spring 3-year burns had any measurable hardwood stems > 1 inch d.b.h. The spring 5-year treatments had fewer than 50 stems per acre of hardwoods in the 1-inch d.b.h. class. Species composition of hardwoods on the spring burn sites were predominantly oaks and dogwoods.

DISCUSSION

Growth losses in longleaf pine this study did not compare similarly to those found in prior studies (Boyer 1987). After 20+ years the longleaf on unburned plots were growing as well or better than the burn treatments. So, one might wonder, "Why bother burning longleaf?"

Based on the results of this study, conducting prescribed fires in the winter on a 3- to 5-year cycle alone is probably not enough to control hardwood competition. Winter fires did not remove hardwood competition as well as growing season burns, even spring burns on a longer rotation. In addition, winter burning did not remove what are considered to be fire-intolerant species such as water oak and sweetgum. As these hardwoods grow, they produce increasing amounts of leaf litter that does not burn as efficiently as pine litter, thus limiting the effectiveness of prescribed fire. This promotes a cycle in which hardwood stems then multiply in the absence of fire forming thick "islands" of hardwood brush. It is more difficult for fire to travel through these "islands" allowing hardwoods to continue to grow in diameter and height, eventually making their way into the overstory.

Once fire has been excluded from a forested site for long periods of time, it likely takes multiple burns over many years to change the plant assemblage of the established ground layer. Although there was no longleaf pine regeneration on these sites as the overstory density was too high, without fire hardwood competition can eliminate or dramatically reduce longleaf pine regeneration opportunities, resulting in the eventual loss of the system. We must understand forest stand dynamics, impacts on native understory, and forest structure to better manage these forests in the future.

CONCLUSION

How best to promote longleaf pine as a major species in the South can be a bit puzzling with the prevailing diversity of management interests. Based on the information presented above, there are options for prescribing fire at varying intervals and seasons to help landowners meet their objectives.

So in answer to the question, "Why burn longleaf?", as Dr. H.H. Chapman (1932), Yale Professor of Forestry, writes:

> "In the longleaf pine type of the south (and nowhere else in North America to the writer's knowledge) fire at frequent but not necessarily annual intervals is as dependable a factor of site as is climate or soil."

The longleaf pine ecosystem evolved with fire and is adapted to its presence on the landscape.

Fire is needed to promote and maintain both the trees and the system through time.

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