INITIAL EFFECTS FROM RE-INTRODUCING FIRE IN ALABAMA MONTANE LONGLEAF STANDS: FIFTY YEARS SINCE LAST BURN

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Abstract—In 2006, after more than fifty years with no burns, the National Park Service reintroduced fire in montane longleaf pine stands at Horseshoe Bend National Military Park in central AL. Residual longleaf pine stands indicates that this tree once dominated many slopes. The prolonged period of fire exclusion resulted in accumulation of duff and litter that exceeds 4 to 5 inches in places; especially heavy loads were found at bases of residual longleaf pine (50-80 year old). In an effort to minimize injury to adult longleaf from smoldering fire, heading and flanking ignition patterns were recommended. In addition, selected tree bases were soaked with approximately 50 gallon of water a day prior to the burn. Preliminary evaluation indicates that this treatment was effective but costly. Recent observations suggest that, even under moderate weather conditions and moist duff, backing fires have high potential for smoldering near large trees.

INTRODUCTION

It is widely accepted that the current acreage of longleaf pine (*Pinus palustris* Mill.) forest represents a small percentage (about 3 percent) of its extent 200 years ago (Frost 1993). Although there is increasing awareness of the importance of frequent fire to this ecosystem, a recent review by Outcalt (2000) revealed that almost 50 percent of existing longleaf stands had not been burned in the previous five years. When fire is excluded many changes occur. Factors that are expected to increase are litter depth and number of woody stems, especially of hardwoods and non-longleaf pines. In addition, longleaf recruitment is likely to decrease and, if fire is excluded long enough, duff may form. The more years that fire is excluded from a site, the greater the challenge will be to reintroduce it and restore the stand.

For efforts to reintroduce fire to be worthwhile, they must be offset by expected enhanced economic and/or ecological value of the restored stand. To make this assessment, it is necessary to compare current degraded stand conditions to a reference site. There is a basic understanding of desired conditions for longleaf ecosystems in the coastal plain, based on existing old-growth stands (cf. Platt and others 1988) coupled with descriptions from the eighteenth and nineteenth centuries (Bartram 1791, Sargent 1884, Mohr 1896). Old-growth characteristics of montane longleaf forest, north of the Fall Line, are less well known (but see Varner and others 2003).

In this paper, we describe upland stands in Horseshoe Bend National Military Park (HOBE), owned and managed by the National Park Service (NPS) in Tallapoosa County in central AL. NPS records indicate that fire has been excluded from the 2,100 acre site for more than 50 years and regional accounts suggest that the area was logged in the early 1900s. We summarize early descriptions of nearby uplands and make comparisons between 100 year old timber cruise information provided by Reed (1905) from Coosa County, approximately 50 miles west of Tallapoosa County, and the modern upland landscape of HOBE to provide an estimation of degradation of the ecosystem. In addition we present information on the 2005–2006 fuel load, describe the first reintroduction of fire, evaluate pre- and post-burn levels of fine fuel (litter and duff), and suggest future activities to reclaim and enhance longleaf pine stands at HOBE.

EARLY DESCRIPTIONS OF REGIONAL UPLANDS

There are many fewer descriptions of longleaf forest above the Fall Line compared to Coastal Plain regions. There are two general descriptions that are relevant to HOBE. In 1775, Bartram viewed a “vast open forest” with longleaf, loblolly (*Pinus taeda*) and hardwoods on hills approximately 40 miles south of HOBE (Bartram 1791). In 1814, at the beginning of the battle of Horseshoe Bend in the Creek Indian War, Brig. General John Coffee wrote a letter to Major General Andrew Jackson to report that he had established a battle line “in an open hilly woodland” (Coffee 1814). Although neither narrative is explicit, both indicated the presence of open canopied forest; in addition Bartram (1791) confirmed that longleaf pine grew nearby.

Reed (1905) provided detailed information for a large forested area in Coosa County, AL, approximately 50 miles west of HOBE. Although this work was done a century after the earlier reports, large-scale logging and fire suppression were only beginning in the region. Reed (1905) provided a photograph of a recently burned longleaf stand. He noted that longleaf pine was present in a variety of upland areas and dominated the forest on ridges plus on south and west facing slopes.

METHODS

Forest Inventories 2005 and 2006

We extracted data from tables provided by Reed (1905) and pooled timber information for west and south facing upland slopes. Unfortunately the data in Reed (1905) does not permit estimation of variation.

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In 2005, all upland areas of HOBE were systematically searched for large longleaf pine trees by selecting a compass bearing and walking lines. The three densest stands of longleaf pine were identified and 100 percent cruises were done in each stand of 5 to 6 acres. All longleaf encountered were stem mapped and diameter at breast height (d.b.h.) measured, regardless of size. In addition, in each of the three longleaf stands, all non-longleaf pines and hardwood stems ≥ 4 inches d.b.h. were identified, stem mapped and d.b.h. measured. Information on number of hardwood stems is summarized in Hermann and Kush (2006).

Evaluation of Fuel after 50+ Years of Fire Exclusion

At HOBE, categories of fuel monitored were litter, duff, 10 hour, 100 hour, and 1000 hour fuels. The Fire Monitoring Handbook (FMH) (USDI National Park Service 2003) provides definitions of fuel categories. Fuel is any organic matter (living or dead) that will burn. Litter is dead leaves, needles, pine cones, etc. that remain identifiable. Duff is decomposed vegetation that includes fermentation and humus layers. Larger woody debris is divided into categories based on the estimated time lag for fuel to gain or lose moisture with changes in the environment. Larger diameter stems are associated with longer time lags. Fuel was assessed at different micro-sites and scales.

In order to gain experience in burning fire-excluded areas before tackling units with the highest ecological value, none of the dense stands of longleaf were burned in 2006. However, in the three stands with dense longleaf, litter and duff were assessed near the base of large longleaf trees and in gaps away from large longleaf. In each stand, four gap areas were selected based on maps created from the GIS data. In each of the four gaps, three, 130-feet long transects were spaced with at least 50 feet between transects. Every 18 feet, depths of litter and duff were measured to the nearest half-inch for a total of 96 sample points per stand.

To initiate fire effects monitoring, a standard 66 by 164 feet FMH plot was installed in a 2 to 3 acres stand of sparse longleaf pine embedded in a compartment burned in 2006. Pre- and post-burn information was collected on litter, duff, and woody debris. Details of the FMH plot methods are described by USDI National Park Service (2003).

Prescribed Fire Weather, Ignition, and Behavior

On April 6, 2006, the first burns in more than 50 years were conducted at HOBE. Information on weather, ignition pattern, and fire behavior were recorded by NPS staff using methods described in USDI National Park Service (2003).

RESULTS AND DISCUSSION

Forest Inventories 1905 and 2005

Information presented in Reed (1905) indicates that on south and west facing slopes adult longleaf ≥ 6 inches d.b.h. were common in Coosa County AL in 1905 (table 1). Non-longleaf pines (loblolly and/or shortleaf) were present but accounted for only 16 percent of the trees. In addition, Reed (1905) noted that there were sparse, scattered hardwoods in Coosa County uplands. However the low density of these trees created little or economic value and they were not included in cruise data. Data collected a century later in the three extant stands at HOBE reveals relatively similar densities of adult longleaf compared to the 1905 forest. There appears to be an increase in the density of non-longleaf pines, and there has certainly been a substantial increase in density of hardwood stems compared to one hundred years earlier (table 1). Changes in forest composition at HOBE are related, in large part, to the lack of fire in over fifty years coupled with past logging activities.

Table 1—Tree composition for stems ≥ 6 inches DBH from Reed (1905) for south and west facing slopes in Coosa County and tallied for three residual longleaf stands at HOBE in 2005. According to Reed (1905), hardwoods were present in 1905 but were uncommon on south and west facing slopes in Coosa County, AL

	Estimated number of trees per acre			
Tree type	Coosa Co 1905	HOBE NE 2005	HOBE NW 2005	HOBE SW 2005
Longleaf pine	42	37	27	32
Other pines	8	20	21	30
Hardwoods	uncommon	44	40	39

While density of adult longleaf is relatively similar between Coosa County in 1905 and at HOBE in 2005, the same is not true for juveniles. In 1905 on south and west facing slopes, the size class distribution of longleaf stems depicts a reverse J-shape curve with a relatively large number of small trees (table 2). This is similar to the size-class population structure associated with old-growth conditions for this forest type in the Coastal Plain (Platt and others 1988). This is in contrast to the three 2005 HOBE longleaf stands that supported almost no longleaf < 5 inches d.b.h. (table 2). Almost complete absence of juvenile longleaf at HOBE reflects the lack of fire. Longleaf seedlings need bare mineral soil for successful establishment and HOBE had little exposed substrate for 50+ years. For longleaf pine stands to support a range of size- (age-) classes, fire frequencies of three to five times a decade are required. Because HOBE has missed > 15 burns, longleaf recruitment has been absent.

Although HOBE lacks younger size-classes of longleaf pine, density of adult longleaf in the three surveyed dense stands mirrors the density observed in natural stands of a century earlier. These residual adult longleaf are valuable resources for future forest restoration efforts at HOBE. The existence of cone-producing sized trees could result in natural regeneration decades ahead of a project relying on planting seedlings in the near future. Although invasion of hardwoods into longleaf stands will require aggressive management to reverse, the presence of residual adult longleaf may offset the effort required to reduce the hardwoods.

Fuel Loads

Litter and duff were measured in the dense stands of longleaf because these sites have high ecological value and it is important to know about the level of fuel accumulation prior to reintroduction of fire. Across the stands of dense longleaf,

Table 2—Estimated number of longleaf trees per acre by d.b.h. category summarized from Reed (1905) for south and west facing slopes in Coosa County and tallied for three residual longleaf stands at HOBE in 2005

d.b.h. (inches)	Estimated number of longleaf pine trees per acre			
	Coosa Co 1905	HOBE NE 2005	HOBE NW 2005	HOBE SW 2005
0.1 – 4.9	20	1	0	2
5.0 – 7.9	13	7	5	7
8.0 – 10.9	9	6	10	12
11.0 – 13.9	7	11	11	14
14.0 – 16.9	6	19	7	13
17.0 – 19.9	3	9	4	3
20.0 – 22.9	3	2	0	0
23.0 – 25.9	2	0	0	0
26.0 – 28.9	1	0	0	0
29.0 +	0	0	0	0

depths of litter and duff were similar (table 3). There is no comparable data for Coosa County in 1905 but in frequently burned longleaf stands litter is expected to vary but rarely exceeds the level observed at HOBE. This suggests that current litter depth at HOBE is high but should be able to be burned. On the other hand, duff is rare in frequently burned stands and smoldering in this layer is a threat to adult longleaf (cf. Varner and others 2005). The NPS fire effects monitoring plot was located in longleaf pine but the stand was less dense and this may be reflected in the amount of litter and duff recorded in 2005 prior to burning in 2006 (table 3).

Table 3—Depth of litter and duff for 12 transects in each of three HOBE stands in 2005; each transects had 24 sample points for a total of 96 samples per stand. Transects were in areas away from the crowns of large longleaf trees. Data is also presented for a HOBE FMH plot. All data was collected in 2005; fire had been excluded from all areas for more than fifty years

	HOBE NE	HOBE NW	HOBE SW	HOBE FMH
Average litter depth (inches)	2.3	2.4	2.4	2.2
Average duff depth (inches)	2.6	2.4	2.3	0.8

Table 4 – Fuel estimated in tons per acre based on measurements provided by L. McInnis in the HOBE FMH plot

Fuel category (estimated tons per acre)	FMH 2005 (pre-burn)	FMH 2006 (post-burn)
Litter	10.90	3.62
Duff	13.00	9.50
1 hour	0.01	0.005
10 hour	0.14	0.09
100 hour	0.22	0.29
1000 hour	3.36	3.57

Prescribed Fire Preparation, Weather, Ignition, and Behavior

Fire was first reintroduced at HOBE on April 6, 2006. It must be noted that is later than recommended for re-introducing fire at sites with excessive fuels. The preferred dates would span mid-December through mid-February. However, careful planning and execution by NPS fire crews produced desirable results for the first burn. As a precaution, on April 5, crews used hose-lay to soak the bases of approximately 40 large (≥ 15 inches d.b.h.) longleaf trees. Approximately 50 gallons of water was applied to each tree that could be reached with a hose.

Day of burn weather conditions were: temperature 65-80 °F, RH 25 to 56 percent, wind 0 to 2 miles per hour with gusts of 4 miles per hour. Backing fire was the primary ignition pattern. Weather conditions coupled with heading and flanking lines of fire produced flame lengths of 0.5 to 2.0 feet and rate of spread of 1 to 3 chains per hour (20 to 60 miles per hour). These conditions likely minimized residence time near large trees and created low fire severity.

Effects of 2006 Burn

Visual post-burn assessment suggested that much of the litter but little of the duff was consumed in the first burn. By 2007, only the single FMH plot had been measured to evaluate fire effects on fuel load. In this plot, there was little change in woody fuels. However the depth of litter and the related estimate of fuel load was decreased (table 4). Although immediate post-burn inspection did not indicate duff consumption in the plot, post-burn measurements suggest a decrease in depth of duff. It is unclear if the depth of duff was actually lowered during the burn or if post-burn exposure and/or drying was involved in the decrease of depth.

Soaking appears to have been effective because there was no smoldering at the base of any treated tree. Although the re-census was not completed at the time of this report, there appears to have been at least some smoldering at the bases of approximately 1/4 of the un-soaked trees. Unfortunately this treatment was costly and required two pumper units and more than 32 person hours to accomplish.

CONCLUSIONS

For longleaf pine stands, maintenance of forest health often requires fire frequencies of 3 to 5 times a decade. HOBE has missed at least 15 burns. This has resulted in a large number of stems of off-site species and has prohibited longleaf regeneration. In addition, litter has accumulated and, perhaps most importantly, duff has formed. Duff at the base of the residual adult longleaf is an important concern because reintroduction of fire may result in smoldering at the base and subsequent mortality. Use of heading and flanking fire may have aided in creating relatively low burn severity. Use of a soaking treatment at the base of many adult longleaf a day prior to the burn appears to have minimized damage to the trees. Unfortunately, this treatment has been deemed too costly and is unlikely to be used at HOBE in the future. Other types of treatments are being considered and may include partial raking a few weeks to months prior to the next burn. It may be appropriate to consider goals that do not include total removal of duff around large trees but rather is focused on creating duff-free gaps suitable for natural regeneration near large trees.

General observations made in the fall of 2006 suggest that although a few hardwood stems were top-killed, many shrubs and understory trees increased their number of basal sprouts over the summer. Preliminary assessment indicates that 8 months after the fire there may be 3 to 8 times the original number of small hardwood stems. In the future, mechanical and/or chemical treatments may be needed until the hardwood sprouts are able to be controlled with fire alone.

Observations from a recently completed burn in 2007 help to emphasis the importance of using heading and flanking lines of fire. The burn was on January 30 and under moderate weather conditions (temperature 45-50 °F, RH 32 to 45 percent, minimal wind with gusts to 5 miles per hour). Cloud cover was high (60 to 100 percent) and the duff was moist. It was a challenge to get the burn to carry across the landscape and over much of the area a backing fire was used. This resulted in a patchy burn. Despite the low intensity fire, severity of the burn may prove to be greater than expected. In the vicinity of the HOBE NE stand of dense longleaf pine, the bases of at least six large trees were smoldering the day after the burn.

There is much work to be done at HOBE. The effects of missing 15 or more burns over 50+ years will not be rectified after one or two fires. This conclusion is shared by Kush and others (1998) and Varner and others (2005). It is likely that habitat restoration will require multiple burns coupled with short-term use of mechanical and/or chemical treatments to restructure the forest, remove litter, and decrease duff. Residual adult longleaf pines are a valuable resource for restoration if they can be protected from damage during the process of reintroducing fire (Kush and others 2004). If some cone bearing trees can survive until gap areas with no duff are created, then natural regeneration may be possible decades before it could be if restoration relied solely on planted trees.

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