Why Do We Continually Do the Things We Do? Help Wanted in Changing a Mindset About Prescribed Fire in the South

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Abstract—Prescribed fire is a commonly used land management tool in the southeastern United States. Despite its use, there are several issues that are making land management difficult for private forest landowners. We focus on three of the issues. The first is the increased planting of longleaf pine when prescribed fire is withheld from these plantations for too long, allowing stands to fill in with other species. A second major issue is landowners with upland hardwood stands dominated by oaks. They want oaks but refuse to use fire that would aid in oak regeneration. The third issue is the use of fire in the dormant season in pine stands, allowing for the development of a heavy woody component. Private landowners need help to change these practices. How do we in the science world get information to landowners to help change their perspective?

Keywords: prescribed fire, fire return interval, longleaf pine, season of burn, oak management, private landowners, southern United States

INTRODUCTION

Prescribed fire has been a part of land management across most of the South for probably as long as people have been living here. Fire historian Stephen Pyne (1982) noted:

> The South has long dominated national fire statistics, leading in both frequency and acreage burned (page 143)… The fire history of the South is in good part a history of its fuels. … It is the forest understory—the rough, with its tall grass, hardwood saplings, reproduction and vines…—that is the typical fire hazard (page 145)… The regular firing of the woods prevented the fuel buildups that encouraged episodic fires elsewhere, and the fire history of the South is remarkable for the absence of conflagrations until the advent of industrial forestry in the 1930s (page 146).

Industrial forestry changed the use of prescribed fire in the southeastern United States. The tool was removed from the toolbox because fire was viewed as destructive. Today, university people doing forestry extension work face a variety of concerns from landowners when discussing prescribed fire. This paper presents an Alabama landowner's perspective about forest management and the use of prescribed

In: Hood, Sharon; Drury, Stacy; Steelman, Toddi; Steffens, Ron, tech. eds. The fire continuum—preparing for the future of wildland fire: Proceedings of the Fire Continuum Conference. 21-24 May 2018, Missoula, MT. Proc. RMRS-P-78. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 358 p.

fire. This is important because 67 percent of Alabama is forested and 94 percent of the forests are privately owned (Alabama Forestry Commission 2017).

A major goal is extension work is to help landowners with management issues. The Auburn University School of Forestry and Wildlife Sciences has a demonstration forest to aid landowners in making management decisions. The Mary Olive Thomas Demonstration Forest (MOT) is a 162-ha (400-acre) tract of land just 8 km (5 miles) from the Auburn University main campus. It was bequeathed to the Alabama Cooperative Extension System in 1977 with the stipulation that it be used for the purpose of forest demonstration. Management has been delegated to the School of Forestry and Wildlife Sciences. The overall management objective for MOT is to develop and maintain the property to meet the needs of extension, teaching, and research so as to maximize the benefit to Auburn University and the people of the State of Alabama. There are several ongoing demonstrations on MOT and we focus on three: lack of fire in young longleaf pine (*Pinus palustris* Mill.) plantations; the fear of damaging hardwoods with the use of prescribed fire; and the effects of dormant-season fire on the hardwoods underneath a pine overstory.

PRIVATE LANDOWNER ISSUES

Mr. Franklin Randle is a native-born Southerner. He has been exposed to and has been aware of prescribed fire and its effects, both positive and negative, for most of his life. He has been intrigued by the use of fire to manage a property, but for whatever reason thought that large acreages were needed to employ this powerful tool. He thought one had to a have a pine plantation to utilize prescribed fire. Since he had neither large acreage, nor a pine plantation, he thought prescribed fire had no place on his farm.

Mr. Randle's first experience with prescribed fire issues began with the decision to plant longleaf pine on a highly eroded site after several failed attempts to establish improved pasture. He realized fire was integral to the establishment and maintenance of longleaf pine and associated species. A site prep burn was conducted in late fall, followed by planting. He quickly saw that fire was a valuable tool for reducing fuel loads and putting control pressure on undesirable species. However, a limited knowledge of technique and a couple of inadequacies in preparations nearly resulted in a couple of fire escapes. This left him vexed and, as a result, he did not follow up with prescribed fire for several years. Subsequently, he saw how much more quickly an area could grow up in undesirable species after only one fire.

He decided he needed to learn all he could to most effectively employ fire as a management tool on his farm. Extensive reading on the role of fire in forest/grassland ecology led him to realize that not only should he be regularly burning his longleaf stand to maintain and proliferate its grass/herbaceous groundcover, but that also his mesic hardwood timberland, hitherto unutilized, should have a fire regime reintroduced to promote a similar ground cover. As a grazer of sheep, Mr. Randle found the prospect of periodically grazing the flock through the wooded acreage of the farm appealing.

In reading various historical accounts of the region, it became apparent that the landscape upon which his farm lies consisted of wooded grasslands with a fire return interval of 1-5 years. This challenged his preconceived notion that the hardwood area was natural or healthy or how it should be. From his reading, it certainly seemed that it would not have the structure it now has—one of an almost completely closed canopy allowing almost no sunlight through thus eliminating the possibility of a grass-based ground cover to develop or thrive. Additionally, we determined that for the desired oak species (white, southern red, northern red, post), as well as hickories and yellow poplar to proliferate themselves for future generations, regeneration would be necessary. Upon walking through the stand, we observed that the only desirable hardwood regeneration taking place was also where remnant ground cover existed. These areas coincided with openings in the canopy allowing adequate sunlight to reach the ground to support this expression.

The first hurdle in achieving his management goals was to convince family members to allow the use of fire on the farm. In general, they had three major concerns. First, they did not want to use fire in the hardwood stand. The belief that fire does not belong in hardwoods, as it will kill the trees, is common in this

region of Alabama. However, with a couple of walks through the stand Mr. Randle was able to show the lack of regeneration of the preferred species, as well as bring awareness to the substantial increase in highly undesirable species such as Chinese privet, autumn olive, kudzu, sweetgum, and red maple.

Mr. Randle has realized the importance of prescribed fire for what he wants to accomplish with his property through reading and through observation. His issues and concerns are those we have dealt with for years from an education, research, and extension perspective in a university setting. The following information from three demonstrations at MOT helped Mr. Randle in making management decisions.

LACK OF FIRE IN YOUNG LONGLEAF PINE PLANTATIONS

At the turn of the 20th century, longleaf pine forests dominated the southeastern United States, covering an estimated 24-36 million ha (59-89 million acres) (Frost 1993). These forests were very open, the result of frequent fires due to lightning strikes (Chapman 1932) and possibly aided by Native Americans. By the 1990s, around 1.2 million ha (4 million acres) remained (Outcalt and Sheffield 1996). Longleaf pine has been reduced to 3 percent of its former range and has been labeled as one of the most endangered ecosystems in the country (Noss et al. 1995). Several causes have been noted for the demise, including over-logging, fire suppression, industrial forestry, and urbanization (Frost 1993; Ware et al. 1993). The decline in longleaf pine acreage and a policy of fire suppression have put hundreds of plants and animal species in peril, with over 30 species listed as federally endangered or threatened (Van Lear et al. 2005).

Since the late 1990s, there has been a renewed interest in longleaf pine management, conservation, and restoration. One of the major efforts is "America's Longleaf Initiative," a collaborative effort of public and private-sector partners. Launched in 2009, this Initiative has a 15-year goal to increase the longleaf acreage from 1.4 to 3.2 million ha (3.4 to 7.7 million acres) by 2024 (Regional Working Group for America's Longleaf 2009). This is a worthy goal, but the important question for longleaf pine is its future management. Planting longleaf pine seedlings is not enough for successful restoration; active management is key.

In 1995, Hurricane Opal passed to the west of Auburn, resulting in the loss of mature loblolly pine (*Pinus taeda*) across 50 ha (123.6 acres) of MOT. As part of a reforestation effort, the decision was made to replant a 7.7-ha (19-acre) area in longleaf pine at a density of 1,648 seedlings ha^{-1} (680 seedlings $acre^{-1}$). To prepare the site, the area was site-prepped and herbicide applied to control competing vegetation. The cost in 1996 of this restoration was \$776 ha^{-1} (\$320 $acre^{-1}$). First-year survival was less than 50 percent. The following year more longleaf was planted in areas where there had been mortality. Unfortunately, prescribed fire was not used as a management tool and the stand began to seed in with loblolly pine, water oak (*Quercus nigra*), and sweetgum from adjacent stands.

As part of two School of Forestry classes, field laboratory exercises were conducted to estimate the density and basal area of overstory trees, defined as trees whose crowns were getting light from above and some from the side, and density of shrub species. The density and basal area of longleaf pine averaged 180 trees ha^{-1} (436 trees $acre^{-1}$) and 2.3 m^2 ha^{-1} (10 ft^2 $acre^{-1}$), respectively. For loblolly pine, the density and basal area averaged 1,310 trees ha^{-1} (3,170 trees $acre^{-1}$) and 16.5 m^2 ha^{-1} (69.3 ft^2 $acre^{-1}$), respectively. Hardwood stems, dominated by water oak and sweetgum, averaged 1,295 stems ha^{-1} (3,134 trees $acre^{-1}$) and 13.3 m^2 ha^{-1} (55.9 ft^2 $acre^{-1}$). Despite planting, longleaf pine was not a dominant component of the forest vegetation.

The ecology of longleaf pine indicates it evolved with a frequent fire return interval (FRI). Over most of its range, this interval may have been every 1-5 years (Chapman 1932). In the early 1900s, it was realized that fire was a necessary management technique for regeneration of longleaf pine. One of the major reasons for the decline in longleaf pine in the early 1900s was fire suppression. Fire is critical in the early stages of longleaf pine's life (Chapman 1932). Gifford Pinchot (1899) wrote in a National Geographic article that longleaf pine was the rare exception among trees in that it could survive fire when it was less than

10 years old because of its grass-stage. Failing to burn young longleaf stands goes against its nature. Heyward (1939) studied several stands across the South and provided information on the composition of burned and unburned longleaf forests. His research showed that hardwoods were a problem in longleaf pine stands that had experienced 10 or more years of fire suppression, especially if the hardwoods were larger than 5 cm (2 inch) d.b.h.

As the data gathered by the two courses showed, planting by itself does not lead to the successful establishment of longleaf pine. The situation where a longleaf pine plantation seeds in with other species is not unique; it is happening all across the southeastern United States where longleaf is being planted. Longleaf pine stands need to be burned early in their life and often, approximately every 1-3 years. If young plantations of longleaf pine are not burned early, then the longleaf pine will be few and far between.

FEAR OF USING FIRE IN UPLAND HARDWOOD MANAGEMENT

The second issue we often hear from landowners is that "we want oaks but we do want to use fire in these stands." Successful oak regeneration and management has two main requirements: the presence of competitive oak regeneration and timely release of this oak regeneration (Loftis 2004). In xeric forests, regeneration of oak is dependent on the accumulation of advance reproduction and the creation and maintenance of the conditions that favor such accumulation (Smith and Miller 1993). Another issue is the poor retention and growth of oak seedlings already present (Lorimer et al. 1994). Many landowners are not aware of the need for proper conditions to facilitate oak regeneration through natural means. To achieve the conditions needed, prescribed fire can be the most important and cost-effective tool to use. However, this is the last thing that comes to mind when landowners think about hardwood management.

An extensive review of the literature determined that larger diameter oaks and yellow poplar should not be adversely impacted by properly conducted prescribed fires. Frequent, low-intensity fires are a natural part of upland southern hardwood systems. Oak seedlings are naturally adapted to fire. They develop strong root bases before they begin growing upwards, which initially is quite slow. As a result, fire will only topkill oak seedlings, and the powerful oak root base will resprout growing stronger each time so that it is eventually able to outcompete other faster-growing species. With lack of fire, upland oaks are often outcompeted by faster-growing species and will eventually die due to lack of sunlight. The proper use of fire will kill and reduce oak competition, allowing them to develop.

In 2014, we initiated a project at MOT to demonstrate how prescribed fire can be used in southern upland hardwood management. Approximately 4 ha (10 acre) on MOT was selected because of its high proportion of oaks and hickories in the overstory. No management activities had been conducted in over 30 years other than a firewood salvage in 1996 after Hurricane Opal caused many overstory trees to topple.

The results of this inventory showed that the stand averaged 33 trees ha^{-1} (138 trees $acre^{-1}$) and 22.9 m^2 ha^{-1} (96 ft^2 $acre^{-1}$). Basal area/acre per species group were 5.3 (22.3), 4.2 (17.5), 4.1 (17.3), and 5.0 (21.2) m^2 ha^{-1} (ft^2 $acre^{-1}$) for white oaks (*Quercus* spp.), red oaks (*Quercus* spp.), yellow-poplars, and hickories respectively. Notable species found in the overstory consist of white oak, northern red oak, post oak, yellow poplar, pignut hickory (*Carya glabra*), and American beech (*Fagus grandifolia*). The midstory is comprised mostly of American beech of both small and large diameters. American beech accounted for 1.9 m^2 ha^{-1} (8 ft^2 $acre^{-1}$). The understory is relatively open, lacking much in the way of advance regeneration of desirable species and had a developed leaf litter layer.

In mid-March 2015, we conducted a prescribed fire in the hardwood stand. We had four people run lines, each about 36 m (120 ft) apart, to avoid a large flaming front. The winds were less than forecasted and, in some areas, there was little fire movement. It was estimated that about 65 percent of the stand burned, removing about the same percentage of leaf litter. During the following summer and fall, we did visual checks of trees to assess basal stem damage to overstory trees. Oaks, yellow poplar, and hickories

sustained no damage. However, there was some damage to smaller stems of American beech but no mortality was seen.

Since we did not get the coverage we had hoped from the 2015 fire, we burned the stand again in March 2016. We followed the same procedure but this time picked a day with lower humidity, 40-45 percent, and higher winds, 5-8 kph (3-5 mph). This time we got 100 percent coverage of the stand and complete leaf litter layer removal using the same ignition techniques as the 2015 fire. This fire did have an impact on the American beech, causing mortality in the smaller diameter classes, less than 15 cm (6 inch) d.b.h., and basal damage to some of the larger beech trees. We also noticed considerable die-back in the tops of many of the beech trees. The oaks, yellow-poplars, and hickories continued to show no signs of basal stem damage. With this burn, we saw a slight increase in oak regeneration, particularly white oak regeneration for a few months after the fire. By the end of the 2016 growing season, there was no surviving oak regeneration. We cannot say if the mortality was due to the dense shade created by the overstory or the drought experienced by the State—probably a combination of both factors.

A similar approach to burning the stand was followed in 2017. The stand was burned in early March, 2 days after a 2.5 cm (1 inch) rain and again we had complete consumption of the forest floor. There has been no sign of visual damage to the base of the oaks, hickories, and yellow-poplars. However, we are seeing more mortality in the smaller diameter beech trees.

Our take-home message was that you can burn in upland hardwood stands and you will need to if you are interested in getting advanced oak regeneration before any removal of overstory trees happens. You do have to pay attention to conditions on-site and what the day of burn conditions are. We have worked hard at burning on days when there is rapid movement of fire through the stand and not allowing for a longer residence time around the bases of the hardwoods.

USE OF WINTER (DORMANT-SEASON) PRESCRIBED FIRE

The third issue is that most landowners who use prescribed fire in pine plantations conduct burns during the winter (dormant season). Their hope is the fire will bring about a grassy understory to benefit wildlife. Instead, what they often get is an understory dominated by stems of sweetgum and water oak.

Recently developed models suggest that prior to the 1800s, large areas of the United States burned multiple times a decade (Guyette et al. 2012). The southeastern United States experienced the most frequent FRI, possibly as short as every 1.5 to 4.0 years (Frost 2006; Guyette et al. 2012). An important result of these very short FRIs was to create and maintain an open tree canopy with a diverse herbaceous ground layer (Van Lear et al. 2005).

The landscape that early settlers in the southeastern United States encountered was largely the result of frequent, low-intensity, nonlethal fires that swept through presettlement forests every 2 to 10 years (Chapman 1932; Mattoon 1922). These fires were ignited by a combination of lightning strikes (Komarek 1974) and aboriginal burning (Robbins and Myers 1992).

However, across much of the modern landscape, this natural process of frequent fire has functionally been eliminated. In the absence of fire, forested stands develop a thick undergrowth of broad-leaved species and the diversity of herbaceous vegetation declines due to decreased light and increased litter depth (Peet and Allard 1993).

In 1996, a demonstration was established on MOT to assess the impacts of different FRI with fires conducted during the winter (dormant) season. The plots were set up in a loblolly pine stand planted in 1979. There are three replicates: (1) 1-year FRI, (2) 2-year FRI, (3) three-year FRI; and a (4) no-burn treatment. For the most part, these fires have been happening from mid-January to mid-March.

What do the dormant-season fires do? It is all a matter of perspective. Figure 1 was taken during December 2017, just before the area was to be burned, and this 1-year FRI stand has the appearance of being dominated by grasses and herbaceous plants. However, if you look at the area from your knees down (see the dark line in fig. 1), you will see sweetgum stems making up a good portion of the understory. Data have never been collected on the density of these stems but there are easily several hundred to the acre. With the increase in the time between fires, i.e., a longer FRI, there is an associated increase in the number of hardwood stems, especially sweetgum. Figure 2 illustrates a 3-year FRI with the photograph taken

Figure 1—One-year FRI taken in December, 9 months after burning on the Mary Olive Thomas Demonstration Forest near Auburn, Alabama. (Photo by John Kush.)

Figure 2—Three-year FRI taken in April, 33 months after burning on the Mary Olive Thomas Demonstration Forest near Auburn, Alabama. (Photo by John Kush.)

in April 2018 over 2 years since the last burn. There are several thousand sweetgum stems to the acre, a majority of them 1.2-2.1 m (4-7 ft) tall. There are several hundred sweetgum stems that are 7.6 cm (3 inch) d.b.h. and bigger.

Despite sweetgum being a species very sensitive to fire, the winter burns at MOT are not eliminating the stems. In fact, the 2-year and 3-year FRI appear to be increasing the density of sweetgum stems. The fire top-kills the stem and this results in 2-4 stems sprouting from the base of the top-killed sweetgum.

CONCLUDING COMMENTS

Through university classes and extension programs, we try to make future land managers and current landowners aware of the need for prescribed fire in young longleaf pine plantations, its need in the management of upland hardwoods, and its need for use during the growing season if landowners do not want off-site hardwood stems in their pine stands. We have shown that demonstrations exist of what not to do; we are in need of more examples of what to do and we need to figure out a better way to get that message across. The fuels are changing in the South and they are not changing for the better. This is our call to the science world to get information to landowners to help change their perspective on the use of prescribed fire in the South.

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