OCCURRENCE OF FIRE IN LONGLEAF PINE STANDS IN THE SOUTHEASTERN UNITED STATES

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ABSTRACT

A healthy understory community is a key factor in maintaining the biodiversity of longleaf pine (*Pinus palustris*) Stands, and there appears to be a strong relationship between the occurrence of fire and the condition of the understory vegetation. Generally, the understory is healthier in burned areas than in those not burned. To assess the use of prescribed fire in restoring and maintaining the health of longleaf ecosystems, we looked at a subsample of Forest Inventory and Analysis plot data for longleaf pine maintained by the U.S. Department of Agriculture, Forest Service. The subsample consisted of longleaf pine plots in Florida, Georgia, South Carolina, and North Carolina.

About half of all longleaf pine stands in the Soutbeast had been burned within the last 5 years. Florida had the highest proportion of burned area (58%) and South Carolina the lowest (43%). Although there was some variation among states, fire had been used on most public land (83%) but on a relatively small proportion (37%) of privately owned land. In Georgia, where large hunting reserves constitute much of' the private holdings, fire was used on 48% of the privately owned longleaf areas. The use of fire varied by site type and state; lowland areas were burned more in South Carolina, and uplands more in Georgia and North Carolina. There was a strong relationship between burning and understory condition with most of the unburned areas in poor condition. The use of prescribed fire by private owners is not likely to increase as many holdings are small parcels where burning is expensive and difficult.

keywords: fire, *Florida*, Georgia, longleaf pine, *North* Carolina, *Pinus palustris*, prescribed burning, restoration, South Carolina, understory.

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INTRODUCTION

Longleaf pine ecosystems once occupied as much as 25 million hectares in the southeastern United States, extending south from southeast Virginia to central Florida and west into eastern Texas (Stout and Marion 1993). Use of this valuable resource began in colonial times, and intensive logging of old-growth longleaf forest reached its peak shortly after the turn of the century (Ware et al. 1993). By 1935, only about 8 million hectares of longleaf pine remained. Once logged, much of the land was converted to agricultural and urban uses-or regenerated with slash (*Pinus elliottii*) or loblolly pine (*P. taeda*). Together, these uses contributed to a continual decline in the area of longleaf plant communities. Between 1955 and 1985, longleaf forest area declined from 4.9 million to 1.5 million hectares (Kelly and Bechtold 1990). By 1995, only 1.2 million hectares remained (Outcalt and Sheffield 1996), less than 4,000 hectares of which were old growth (Means 1996).

The amount of longleaf ecosystem with an intact understory is not known but is estimated to be 0.5–0.8 million hectares (Noss 1989, Stolzenburg 1991). Longleaf understory is important because it contains most of the ecosystem's diversity. Not only is the understory plant community very diverse, it also has many endemics that depend on it for survival (Hardin and White 1989). Relatively large, contiguous areas of longleaf community are needed to maintain viable populations of such species as red-cockaded woodpecker (*Picoides borealis*). Therefore, resource managers are striving to perpetuate existing understory and restore it on sites where it has been eliminated or severely damaged.

prescribed fire is a major tool in ecosystem restoration efforts. Prior to landscape fragmentation brought by human habitation, fire was a frequent, natural occurrence across much of the Southeast and maintained once-extensive longleaf pine and grass communities (Christensen 1981). Dead needles and grass furnished fuel that carried fire and maintained healthy stands (Landers 1991). Without fire, plant community composition and structure changed. Woody species increased, and grasses and forbs declined (Lewis and Harshbarger 1976, Myers 1985). Fire is also known to control brown-spot needle blight (*Scirrhia acicola*), which can severely limit the growth and survival of longleaf seedlings (Boyer 1975). Burning encourages the production of flowers and seeds by native grasses and forbs (Christensen 1981, Platt et al. 1988, Clewell 1989, Outcalt 1994). It is therefore necessary that resource managers, conservation groups, and others promote the use of fire to maintain longleaf community health (Landers et al. 1995). Our study objective Was to quantify the occurrence of fire in the longleaf ecosystem by site type, location, and ownership. Such information should help managers concentrate their efforts where they are needed most.

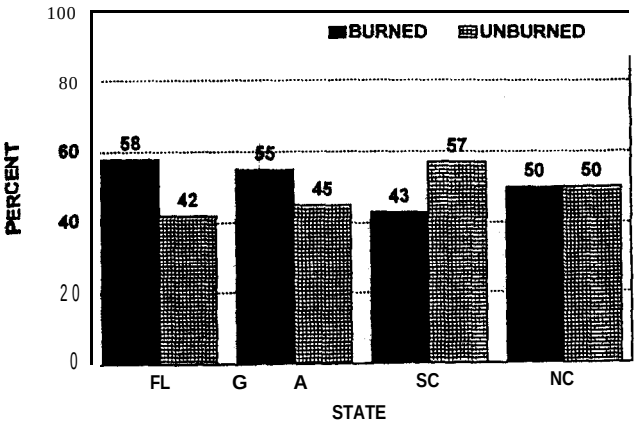

Fig. 1. Percent of area recently burned, i. e., in last 5 years, or unburned in natural longleaf stands in the southeastern United States-

Table 1. Area of natural longleaf pine stands recently burned, i.e., in last 5 years, or unburned in the southeastern United States.

State	Owner			
	Public		Private	
	Burned	Unburned	Burned	Unburned
	hectares (percent)			
Florida	133,245 (82)	29,160 (18)	37,665 (35)	70,065 (65)
Georgia	23,895 (100)	0 (0)	81,065 (48)	87,820 (52)
South Carolina	40,095 (86)	6,480 (14)	29,160 (30)	67,635 (70)
North Carolina	33,615 (77)	10,125 (23)	10,935 (21)	40,500 (79)
Total	230,850 (83)	45,765 (17)	158,825 (37)	266,020 (63)

METHODS

All sampling was based on the network of Forest Inventory and Analysis (FIA) plots in Florida, Georgia, South Carolina, and North Carolina, which have been established by the U.S. Department of Agriculture, Forest Service (USFS), Southern Research Station. To obtain a proportionate sample of all major forest types, sites, and ownership classes in each state, USFS scientists systematically distributed permanent plots across all ownerships. For this study, and for each of the states, all plots with a longleaf-dominated overstory that resulted from natural regeneration were sorted into 5 age groups: l-10, 11–20, 21–40, 41–60, and 60-t years. Age groups were classified by soils and topography into site types, which varied from state to state but were grouped into wet lowlands, dry sandhills, and rolling uplands.

Within each age class and site type, 3 plots were randomly selected for sampling. In Florida and South Carolina, plots were sampled during summer 1995; in Georgia and North Carolina, they were sampled the following summer. We recorded any evidence of past disturbance or recent fire history in each sample stand. The condition of the understory community was determined by general appearance, dominance of typical native species, and amount of human disturbance. We verified site types and changed them, where appropriate.

Data were summarized and the percentage of burned and unburned land calculated for each state by ownership class, i.e., public or private. Because the industrial sector owns very few hectares of natural longleaf, forest industry land was not included. We used these percentages to calculate the area of burned and unburned longleaf as a proportion of the total longleaf area identified in Outcalt and Sheffield (1996). Longleaf stand size was taken from the FIA database.

The relationship between understory condition and burning was tested in each state using 2-way contingency tables and the chi-square statistic.

RESULTS

About half of all sampled longleaf stands in the Southeast had been burned in the last 5 years. Florida had the highest and South Carolina the lowest burning rates (Figure 1). Burning in longleaf stands on public lands ranged from 100% in Georgia to 77% in North Carolina (Table 1). Because Florida had the most publicly owned area of longleaf, it had both the most area burned, and the most area not burned. The incidence of burning in longleaf stands was much lower on private lands. Again, though, Georgia had the highest and North Carolina the lowest, at 48% and 21%, respectively. Combined, the 4 states had ~260,000 unburned hectares of longleaf forest in private ownership. Although Georgia had the highest rate of burning in that sector, it also had the most unburned area.

In South Carolina, most wet lowland areas with longleaf pine had been burned (Table 2). In Georgia, however, the opposite was true. Nearly 67% of all sandhills longleaf sites had been burned in Florida and Georgia, but in South Carolina not much of either the sandhills or the upland sites had been burned. All sampled longleaf stands in North Carolina's upland areas had been burned in the last 5 years. Only in Florida was burning evenly spread across all site types.

Stand size strongly influenced whether longleaf areas were burned (Table 3). Across all states, the average size of unburned stands was 43 hectares, and of burned stands 113 hectares. Mean size of burned areas was larger in South Carolina and North Carolina on private lands than on public lands. However, for the 4 states combined there was no real difference in mean size of burned versus unburned areas between public and private lands. The effect of size was also evident when private lands were subdivided into classes. In both Georgia and South Carolina, many privately owned longleaf sample stands occurred on the larger Parcels that were managed for hunting and as timber plantations. Burning on those lands was 100% in Georgia and 75% in South Carolina; on other private lands in those states it was 38% and 21%, respectively.

The condition of vegetation in sampled longleaf

Table 2. Percent of area recently burned, i.e., in last 5 years, and unburned, by site type in natural longleaf pine stands in the southeastern United States.

State	Site Type					
	Lowlands		Sandhills		Uplands	
	Burned	Unburned	Burned	Unburned	Burned	Unburned
Florida	53	47	67	33	60	40
Georgia	17	63	60	40	75	25
South Carolina	80	20	24	86	30	70
North Carolina	80	20	24	86	100	0

stands was significantly related ($P = 0.001$) to burning (Table 4). Vegetation in most of the recently burned stands was in good to fair condition, and vegetation in most unburned areas was rated as poor to very poor. For the 4 states, 42% of the natural longleaf areas had an understory in good to fair condition and had been recently burned. Conversely, 36% of the sampled longleaf stands showed no evidence of recent burning and vegetation was in poor to very poor condition. The relationship was strongest in South Carolina, where all stands in -good to fair condition had been burned in the last 5 years, whereas 53% were in poor to very poor condition and had not been burned.

DISCUSSION

Ownership

Burning on public lands is higher than on private ownership for many reasons, including the fact that the public sector has access to the resources and personnel necessary to conduct prescribed burning programs. A greater awareness of the need for fire and its benefits to the longleaf pine ecosystem may also significantly influence burning on public lands. Because scientific information supporting the use of fire to restore and maintain ecosystem health has only recently gamed widespread acceptance (Noss 1989, Myers 1990, Stout and Marion 1993), there is still a backlog of unburned longleaf sites on public land. Most organizations are reducing this backlog as quickly as possible, and burning in longleaf plant communities on public lands should soon reach 100% across all 4 of the southeastern states. Georgia has nearly reached this level because most public lands with longleaf in the state are controlled by the military services. Military test ranges are often ignited by live fire during training exercises, and Department of Defense (DOD) resource managers often aggressively burn adjoining areas to prevent wildfires. For these reasons, many bases have begun with a smaller backlog of untreated sites than have other public agencies.

Site Type and Size

Upland sites in North Carolina have a high rate of burning for 2 reasons. Fit, military bases account for a large proportion of public ownership in North Carolina; and the DOD has burned a considerable amount of its upland longleaf sites. Second, because the soil on upland sites is well suited for agricultural uses, longleaf stands were cleared from private lands long ago. In Georgia the burning rate is low on wet lowland sites because <6,000 hectares are in public ownership; and the areas in private ownership are small parcels, which are less likely to be burned. Size is also the reason burning was not prevalent on upland and sandhills longleaf stands in South Carolina, where sampled upland sites had a mean size of just 15 hectares and sandhills a mean of 33 hectares. However, in lowland areas, where recent buming has occurred much more often, the mean size was 150 hectares. Between burned and unburned stands, the overall difference in parcel size was partially due to a higher per-hectare cost for smaller areas. Many small parcel owners also seem to have other priorities. Most small, unburned sample stands showed no evidence of active management.

Condition

Fire is often necessary to maintain the health of plant communities in longleaf pine ecosystems; in this

Table 3. Mean size of natural longleaf pine stands recently burned, i. e., in last 5 years, or unburned in the southeastern United States.

State	Owner			
	Public		Private	
	Burned	Unburned	Burned	Unburned
	(hectares)			
Florida	142	72	140	79
Georgia	79	0	68	25
South Carolina	46	26	195	37
North Carolina	84	23	156	20
Mean	106	44	125	39

Table 4. Relationship of recent burning, i.e., last 5 years, to understory condition of longleaf pine stands in the southeastern United States.

State	Condition			
	Good to fair		Poor to very poor	
	Burned	Unburned	Burned	Unburned
	(percent)			
Florida	45	16	13	24
Georgia	41	14	14	31
South Carolina	37	0	10	53
North Carolina	46	11	4	39
Mean	42	11	11	36

study, most sampled longleaf sites that were in good condition had been recently burned. Frost (1993) reported that in North Carolina 26% of longleaf stands in good condition had been maintained with fire. Although this study reports 46%, the difference may be due in part to sample selection. Frost (1993) sampled longleaf remnants regardless of stand composition, whereas we sampled only areas where longleaf is still the dominant tree. Nonetheless, burning appears to have increased since 1993, especially on public lands. The results have been cumulative-more longleaf sites are now in good condition as a result of continued burning. Land managers can expect additional gains, because this study shows that across the Southeast there are sites that have been burned but remain in poor condition. Conversely, there are about as many sites that. have not been burned recently, but that are in good condition. Most such sites probably have been burned in the past but are now only raked for pine straw.

MANAGEMENT IMPLICATIONS

Efforts to restore fire to its proper role in the longleaf ecosystem have been very successful on public lands. The backlog of unburned sites will soon be gone, and periodic regular burning will be occurring on nearly all publicly controlled longleaf sites. The improved condition of understory vegetation that results from periodic fire is becoming apparent on a landscape scale. However, there is growing resistance among public land users to the changes in understory condition, largely due to concerns about the loss of woody shrubs and hardwoods. Managers need to be sensitive to these concerns, but there is little justification for reduced burning.

First, burning of longleaf stands on private lands probably will not increase much because many of the areas not currently maintained with fire are smaller fragments. In most cases, landowners manage those fragments very little because they are difficult and costly to burn. If smoke management restrictions increase, burning may actually decline on privately owned lands. It follows, then, that burning in the Southeast's longleaf plant communities will at best reach only 65% of the total area, leaving roughly 240,000 hectares of abundant woody shrubs and hardwoods. In addition, even on those sites regularly burned, shrubs and hardwoods will be only reduced in stature, not eliminated (Waldrop et al. 1987).

Most importantly, species of concern like gallberry (*Ilex glabra*), saw palmetto (*Serenoa repens*), and turkey oak (*Quercus laevis*) are generalist species found on large areas of pine plantations and hardwood-dominated areas across the Southeast. For example, in Florida alone, there are 147,000 hectares of scrub oak (Outcalt 1998). Burning in longleaf-dominated areas should continue for the benefit of such rare and declining species as the red-cockaded woodpecker and gopher tortoise (*Gopherus polyphemus*), which need the grassy open condition that fire promotes. Paraphrasing Harris and Silva-Lopez (1992:233), what the Southeast needs is not more of what is commonly present but, rather, more of what has become rare. The continued use of fire in forests of the region will help meet this goal.

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