PINE

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Composition of a Virgin Stand of Longleaf Pine in South Alabama

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ABSTRACT

The Flomaton Natural Area is a virgin stand of longleaf pine located in Escambia County, Alabama. Fire has been absent for at least the past 45 years from the stand. Efforts are underway to restore this fire-dependent ecosystem through the re-introduction of fire. This paper presents data collected in advance of the re-introduction of fire. A substantial hardwood understory and midstory have developed and a thick litter layer has accumulated in the absence of fire. Longleaf pine (*Pinus palustris*) regeneration and herbaceous vegetation are almost nonexistent. Considering all trees >1.25 cm DBH, longleaf pine averages 309 stems/ha and 19 m^2/ha, or 65% of total stand basal area. The predominant hardwood species are water oak (*Quercus nigra*), laurel oak (*Q. laurifolia*), southern red oak (*Q. falcata*), and black cherry (*Prunus serotina*). Together these hardwoods average 929 stems/ha and 6.5 m^2/ha, or 22% of the total stand basal area. Other pines and hardwoods comprise 8% and 5% of total stand basal area, respectively. Considering only saplings (1.25 to 12.7 cm DBH), longleaf accounts for only 11% and the four major hardwoods 64% of total sapling basal area.

INTRODUCTION

Prior to the arrival of European settlers to the United States, natural communities dominated by longleaf pine (*Pinus palustris* Mill.) and maintained by periodic fire occurred throughout most of the southern Atlantic and Gulf Coastal Plains (Frost 1993). Bartram (1791), an early traveler through the Southeast, described these communities this way *"This plain is mostly a forest of the great long-leaved pine (*P. palustris *Linn.), the earth covered with grass, interspersed with an infinite variety of herbaceous plants, and embellished with extensive savannahs, always green, sparkling with ponds of water . . ."*

The landscape that Bartram and early settlers encountered was largely the result of frequent fire. Low intensity, non-lethal fires swept through the presettlement longleaf savannas at intervals ranging from 1 to 10 years (Mattoon 1922, Chapman 1932, Christensen 1981). These fires were ignited by a combination of lightning strikes (Komarek 1974) and aboriginal burning (Robbins and Myers 1992).

Longleaf pine is noted for its thick bark and a juvenile growth form known as the "grass stage." In this grass stage, longleaf concentrates its first few years' growth on root development, meanwhile ignoring vertical ascension. During this stage, the seedling is extremely resistant to fire. Without fire the seedling may become infected with brown spot needle blight (caused by *Scirrhia acicola*) or become shaded out by faster growing, though more fire-susceptible, *Quercus* spp. (Chapman 1932).

Frequent fire had an incredible impact on the flora and fauna of the longleaf landscape. In the absence of fire, longleaf stands develop a thick undergrowth of broad-leaved species under which longleaf pine regeneration is impossible, and herbaceous vegetation declines in species diversity due to decreased light and increased litter depth (Peet and Allard 1993). Much of the herbaceous understory is dependent on fire for successful scarification and germination (Stoddard 1935, Platt et al. 1988). Avian and mammalian diversity in the longleaf-grassland ecosystem is dependent upon the structure created by frequent fires (Engstrom 1993). Failing

to re-introduce fire into the longleaf pine grassland ecosystems spells doom for not only longleaf pine, but also for the varied flora and fauna that constitutes this diverse ecosystem.

These communities once covered an estimated 33–37 million ha in the Southeast (Vance 1895). Chapman (1932) commented that longleaf pine covered more acreage than any other North American ecosystem dominated by a single tree species. The range of longleaf pine covers a broad arc along the coastal plain and Piedmont from southeastern Virginia, south through central Florida and west to east Texas, extending further inland in the Cumberland Plateau and Ridge and Valley physiographic provinces in Alabama.

Exploitation of longleaf pine-dominated forests led to a steady decline in the area occupied by this species (Frost 1993). By 1935, 8.3 million ha were left, declining to 5 million ha by 1955 and further to about 2 million ha in 1975. Today, estimates indicate that less than 1.2 million ha of longleaf pine forest remain (Outcalt and Sheffield 1996). Noss (1989) noted that longleaf pine comprised 40% of the southern coastal plain in pre-settlement time while today that percentage has declined to 0.7%.

A few fragments of remnant virgin, old-growth longleaf pine stands remain (Means 1995). One of these is the Flomaton Natural Area, a 25 ha stand currently owned by Champion International Corporation. The stand is located in Escambia County, Alabama, within the city limits of Flomaton. The Alger-Sullivan Lumber Company, one-time owner, preserved this stand through the first half of the century (the company was sold in 1958). As part of the preservation effort, the stand was regularly control burned until about 1950, after which the stand has remained unburned.

The importance of the stand was recognized by the Society of American Foresters (SAF) in 1963 when they designated the area, then owned by the St. Regis Paper Company, as the E. A. Hauss Old Growth Longleaf Natural Area (Walker 1963). The SAF's definition of a natural area is "a tract of land set aside to preserve permanently in unmodified condition a representative unit of virgin growth of a major forest type, with the preservation primarily for scientific and educational purposes."

An agreement has been signed among Champion International Corporation, Auburn University School of Forestry, the Southern Research Station of the U.S. Forest Service, The Nature Conservancy, the Alabama Forestry Commission, and the Alabama Natural Heritage Trust of the Alabama Department of Conservation and Natural Resources for cooperative work (Meldahl et al. 1994). Efforts are underway to restore, monitor and manage the stand as an old-growth longleaf pine habitat.

The purpose of this study is to describe Flomaton Natural Area, a virgin stand of longleaf pine in south Alabama. The objectives are (1) to document the composition and structure of Flomaton Natural Area prior to the re-introduction of fire (2) establish research plots to monitor changes in the stand after the re-introduction of fire and (3) to provide information on old-growth stand dynamics and assist future ecological restoration work.

METHODS

Description of the Study Area

The Flomaton Natural Area is located within the city limits of Flomaton, Alabama in the south-central part of Escambia County, Alabama at 31°01'N mean latitude and 87°15'W mean longitude. The climate is humid and mild with plentiful rainfall well distributed throughout the year. The warmest months are July and August with average daily maximum and minimum temperatures of 33° and 20°C, respectively. The coldest months are December and January with average daily temperatures of 18° and 3°C, respectively. The growing season is 250 days. Annual precipitation averages 156 cm with October being the driest month.

The stand is relatively level at 63 m above sea level. The predominant soil belongs to the Orangeburg series, which are formed in marine sediments of sandy loams and sandy clay loams. They are low in natural fertility and organic-matter content with a site index for longleaf pine of 22 m at 50 years.

Inventory Procedures

Plot centers have been established throughout the entire tract on a 60 m by 80 m grid with plot centers located at least 30 m from the edge of the old-growth tract. Each plot is circular, enclosing an area of 0.08 ha (radius = 16.05 m). Data recorded for every tree or shrub (>1.25 cm DBH) on each plot includes: tree number, azimuth and distance from plot center, diameter at breast height (DBH) of live trees and standing snags, crown position in the tree canopy, crown height, total height, and litter depth at the base of each tree. Small woody tree seedlings, less than 1.25 cm DBH but taller than 0.3 m, and shrubs have been tallied by 0.3 m height classes. Four, 1.42 m^2 quadrats per plot have been staked off and ground cover vegetation is being surveyed quarterly for presence and relative abundance. Ground cover vegetation was separated into three categories, small woody seedlings, vines, and herbaceous vegetation. Woody taxonomic determinations and nomenclature follow Godfrey (1988) and herbaceous follow Clewell (1985).

For the purposes of discussion, tree species were separated into two categories based on their crown position in the canopy and DBH. Species occurring in the midstory and overstory made up the tree layer. The midstory was made up of trees located in the sub-canopy and had DBH's between 12.7 and 25.4 cm. The overstory consisted of trees that were dominant or co-dominant in the canopy. Their DBH's were greater than 25.4 cm. The third layer was considered saplings, which were overtopped, suppressed trees with a DBH between 1.25 and 12.7 cm. The differentiation between calling a species a tree or a shrub was based on Godfrey (1988).

RESULTS AND DISCUSSION

Longleaf pine occupies a majority of the stand overstory with some smaller patches dominated by loblolly (*Pinus taeda* L.), shortleaf (*P. echinata* L.), or slash (*P. elliottii* Engelm.) pine. Several of the largest of these last three pines were cored to determine age. They were all less than 50 years old, suggesting that they came in with the cessation of fire. Table 1 presents data for the density, basal area and importance values (IV) [IV = (percent density + percent basal area)/2] of tree-size species (stems >12.7 cm DBH) for the Flomaton Natural Area. Longleaf pine is the dominant tree species, accounting for 40% of the tree-size density and 70% of the basal area.

Absence of fire has allowed oaks, specifically water oak (*Quercus nigra* L.), laurel oak (*Q. laurifolia* Michx.), and southern red oak (*Q. falcata* Michx.), to become a major component of the stand. These three oaks account for 37% of tree density and 15% of the basal area for species in the overstory. In this midstory, oaks account for 45% of the stems compared to less than 30% for longleaf pine. However, the trees of the midstory (12.7 to 25.4 cm DBH class) have the potential to replace the longleaf pine in the overstory as large tree mortality occurs.

The oaks dominate the sapling-size (stems 1.25 to 12.7 cm DBH) species in the Flomaton Natural Area (Table 1). They account for 56% of the density and basal area of this size class. Longleaf pine has dropped to 5% of the stems and 11% of the basal area. Shade tolerant species like American holly (*Ilex opaca* Ait.), flowering dogwood (*Cornus florida* L.), and southern magnolia (*Magnolia grandiflora* L.) have increased in importance. The other pines, which are part of the overstory, have very few stems in the understory. Competition from hardwoods will keep secondary pines from replacing longleaf pine as mortality occurs.

In addition to the hardwood-dominated understory, there is a substantial shrub component. Yaupon (*Ilex vomitoria* Ait.), mayberry (*Vaccinium elliottii* Chapm.), and sparkleberry (*V. arboreum* Marsh.) account for 79.3% of the total shrub density (3,115 stems/ha) (Table 2). In contrast to the dense shrub cover, there is a paucity of ground cover vegetation. Vines are the most frequently occurring plants in the ground cover quadrats but even their presence is limited to one or two plants/quadrat. Percent occurrence for ground cover vegetation surveyed quarterly over the past year are provided in Table 3. Vines, especially greenbriers (*Smilax* spp.), constitute a majority of the plants recorded.

Table 4 presents litter depth data measured at the base of all longleaf pine. Depth of litter at the base of longleaf pine increased with size class. In addition, the litter layer will play

Table 1. Species composition of the tree layer (first line) and sapling layer (second line) in the Flomaton Natural Area. Percent density (%), percent basal area (%), and importance values[a] (IV) are presented for tree layer (stems >12.7 cm DBH) and sapling layer (stems between 1.25 and 12.7 cm DBH)

Species	% Density	% Basal Area	IV
Pinus palustris[b]	40.4	69.7	55.1
	5.2	10.8	8.0
Quercus nigra	16.6	7.5	12.0
	30.8	28.8	29.8
Quercus falcata	11.4	4.9	8.2
	8.5	13.1	10.8
Quercus laurifolia	3.5	3.8	6.2
	16.5	13.2	14.8
Prumus serotina	3.6	3.4	3.5
	0.6	1.2	0.9
Pinus elliottii	1.6	1.5	1.6
	0.4	0.6	0.5
Magnolia grandiflora	1.8	0.8	1.3
	3.5	2.7	3.1
Ilex opaca	1.7	0.7	1.2
	10.3	7.9	9.1
Nyssa sylvatica	1.1	0.7	0.9
	3.2	2.4	2.8
Liquidambar styraciflua	0.7	0.5	0.6
	0.7	1.0	0.9
Cornus florida	0.6	0.2	0.4
	5.2	4.4	4.8
Quercus stellata	0.4	0.1	0.3
	0.6	0.7	0.6
Quercus marilandica	0.2	<0.1	0.1
	0.8	0.8	0.8
Acer rubrum	<0.1	<0.1	<0.1
	0.7	0.4	0.5
Diospyros virginiana	<0.1	<0.1	<0.1
	1.0	0.9	1.0
Quercus laevis	<0.1	<0.1	<0.1
	<0.1	0.1	0.1
Magnolia virginiana	<0.1	<0.1	<0.1
	0.7	0.4	0.6
Crataegus spp.	np[c]	np	np
	1.1	0.6	0.9
Albizia julibrissin	np	np	np
	1.1	0.6	0.9
Persea borbonia	np	np	np
	0.3	0.1	0.2
	stems/ha	(m^2/ha)	
Totals	634.3	26.74	
	1,009.5	2.44	

[a] importance value = (% density + % basal area)/2.
[b] Nomenclature follows that of R.K. Godfrey (1988).
[c] np indicates species was not present.

an important role in the regeneration of longleaf pine in the stand. Longleaf pine is an infrequent seed producer, often going several years between adequate seed crops. The seed is usually shed in the autumn/winter, and it needs to have contact with mineral soil in order to survive. The February 1994 survey had 58% of the quadrats stocked with longleaf pine regeneration.

Table 2. Percent density (%) for shrubs in the Flomaton Natural Area

Species	% Density
Ilex vomitoria[a]	44.4
Vaccinium elliottii	19.4
Vaccinium arboreum	15.5
Ilex glabra	7.3
Osmanthus americanus	4.7
Symplocos tinctoria	3.2
Ilex decidua	3.0
Ligustrum spp.	1.1
Myrica cerifera	0.8
Viburmum rufidulum	0.2
Rhus copallina	0.1
Castanea pumila	0.1
Callicarpa americana	<0.1
Aralia spinosa	<0.1
Amelanchier americana	<0.1
Totals	3,115.3 stems/ha

[a] Nomenclature follows that of R.K. Godfrey (1988).

There was no longleaf pine seedling survival in the subsequent June 1994 survey. The thick litter layer prevented the contact needed with mineral soil for survival.

The 45-year accumulation of litter has an important role in restoration efforts in the stand. The re-introduction of fire poses a problem because any lengthy period of fuel accumulation increases the possibility of burn conditions that can be lethal even to the larger trees. The absence of fire for several years allows feeder roots to colonize the duff layer. Fires that consume this layer will damage root systems and result in the death of overstory trees even if the fire is of low intensity and produces little to no visible crown scorch. In an effort to minimize potential damage with the re-introduction of fire, plans are to apply water around trees where the duff layer is still hot after the prescribed fire is complete.

Longleaf pine remains the dominant species in the Flomaton stand based on the density and the basal area of the overstory trees. Unless restoration efforts are undertaken, the stand will eventually convert into a mixed hardwood stand dominated by oaks. This succession may be a gradual process or it may happen rapidly through some type of catastrophic event, such as an uncontrolled fire or windstorm. Historically, longleaf pine communities that were regularly burned were often described as park-like forests (Wells 1928, 1942; Garren 1943). There was almost no shrub layer and only a sparse understory of small patches of longleaf pine regeneration in existing gaps. The herbaceous layer was species-rich and dominated by grasses. Chapman (1932) argued that the longleaf pine forest type was the climax type for a major portion of the Southeast because fire at frequent intervals was as dependable a factor of site as was soil or climate. Without fire, dense undergrowth of broad-leaved species develops preventing longleaf pine regeneration.

SUMMARY AND CONCLUSIONS

A small remnant of the original longleaf pine forest that once covered approximately ⅔ of the southeastern United States exists on a 25 ha stand in Flomaton, Alabama. Very little is left of this community, which dominated the southeastern Coastal Plain for at least 5,000 years (Ware et al. 1993). Restoration efforts involving the re-introduction of fire after a 45-year absence and a study of longleaf pine dynamics are underway in the Flomaton Natural Area. These efforts are an attempt to restore one of the few remaining truly old-growth longleaf pine stands.

After initial fires reduce the fuel load, late spring/early summer fires will be used on a periodic basis to reduce the competing hardwood vegetation and to restore the herbaceous component of the community.

Table 3. Ground cover vegetation percent occurrence (%) in the Flomaton Natural Area for (A) small woody seedlings, (B) vines, and (C) herbaceous vegetation

	Percent Occurrence			
	Dec. 93	**Feb. 94**	**June 94**	**Sep. 94**
(A) small woody seedlings[a]				
Ilex vomitoria	30.2	30.2	31.0	31.0
Quercus nigra	25.4	25.4	25.4	25.4
Vaccinium elliottii	20.6	20.6	21.4	21.4
Prunus serotina	20.6	20.6	23.0	23.0
Quercus laurifolia	8.7	8.7	9.5	9.5
Quercus falcata	7.9	7.9	7.9	7.9
Ilex opaca	7.9	7.9	8.7	8.7
Osmanthus americanus	4.8	4.8	4.8	4.8
Ilex glabra	4.0	4.0	4.0	4.0
Vaccinium arboreum	4.0	4.0	4.0	4.0
Magnolia virginiana	4.0	4.0	4.0	4.0
Magnolia grandiflora	2.4	2.4	2.4	2.4
Ilex decidua	1.6	1.6	2.4	2.4
Ligustrum spp.	1.6	1.6	1.6	1.6
Myrica cerifera	1.6	1.6	1.6	1.6
Rhus copallina	1.6	1.6	4.0	4.0
Cornus florida	0.8	0.8	0.8	0.8
Symplocos tinctoria	0.8	0.8	0.8	0.8
Liquidambar styraciflua	0.8	0.8	0.8	0.8
Persea borbonia	0.8	0.8	0.8	0.8
Pinus palustris	np[b]	58.1	0.8	np
Pinus taeda	np	2.4	0.8	np
Callicarpa americana	np	np	2.4	2.4
Crataegus spp.	np	np	1.6	1.6
Acer rubrum	np	np	0.8	0.8
(B) vines				
Smilax pumila	79.4	79.4	79.4	79.4
Gelsemium sempervirens	43.7	43.7	43.7	43.7
Smilax rotundifolia	40.5	40.5	46.8	46.8
Smilx glauca	31.7	31.7	31.7	31.7
Smilx smallii	17.5	17.5	17.5	17.5
Vitis rotundifolia	11.9	11.9	24.6	24.6
Rubus spp.	9.5	9.5	12.7	12.7
Smilax bona-nox	3.2	3.2	3.2	3.2
Mitchella repens	3.2	3.2	3.2	3.2
Lonicera japonica	3.2	3.2	3.2	3.2
Smilax laurifolia	np	0.8	0.8	0.8
Toxicodendron radicans	np	np	7.1	7.1
Aristolochia tomentosa	np	np	6.3	6.3
Parthenocissus quinquefolia	np	np	2.4	2.4
Berchemia scandens	np	np	0.8	0.8
(C) herbaceous vegetation[c]				
Gramineae	3.2	3.2	3.2	3.2
Elephantopus spp.	np	0.8	0.8	0.8
Euphorbia spp.	np	np	4.0	4.0

[a] Nomenclature for small woody seedlings and vines follows that of R.K. Godfrey (1988).

[b] np indicates species was not present.

[c] Nomenclature for herbaceous vegetation follows that of A.F. Clewell (1985).

Table 4. Litter depth (cm) at the base of longleaf pine trees

DBH Class (cm)	Number	Mean (cm)	Minimum	Maximum
0–12.7	331	12.7	0	30.5
12.8–25.4	237	14.7	0	35.6
25.5–38.1	110	18.3	5.1	40.6
38.2–50.8	88	21.8	12.7	38.1
>50.8	56	24.4	10.2	45.7

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