DISTURBANCE AND STAND STRUCTURE IN A LONGLEAF PINE WOODLAND

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EXTENDED ABSTRACT

All stands experience disturbance events that impact succession and development. Most mortality in longleaf pine (*Pinus palustris*) ecosystems consists of localized, gap-scale events composed of one to several canopy trees (Mueller and others 2022, Palik and Pederson 1996) that free resources including light, soil nutrients, moisture, and growing space (Hart and Kleinman 2018, Palik and others 1997). Available resources allow for tree establishment and recruitment that may result in a mosaic of age and size classes (Richards and Hart 2011, Varner and others 2003). We quantified the stand structure, composition, canopy disturbance history, and prescribed fire effects in a complex-stage reference longleaf pine stand in the desired future condition as identified by U.S. Department of Agriculture, Forest Service personnel (multiple age classes of canopy longleaf pine, presence of advance reproduction, and desired species composition). Canopy disturbance history data such as these can be used to inform current management of longleaf pine ecosystems, and quantifying prescribed fire mortality can provide insight into potentially undesirable fire effects.

The chosen stand was located in the Alabama Fall Line Hills, within the Oakmulgee Ranger District of the Talladega National Forest, AL. The stand was entered in 1979 for timber stand improvement, 1990 for midstory removal to enhance red-cockaded woodpecker (*Leuconotopicus borealis*) foraging habitat, and 1997 for a thinning. Prescribed fire occurred in 1963, 1976, 1980, 1993, 1997, 2000, 2004, 2015, 2019, and 2021. Within a 1-ha plot in the stand, we recorded location (using a sighting compass and Haglof hypsometer and transponder, Sweden), species, height (using a hypsometer and transponder and measured to the nearest 0.1 m), and diameter at breast height (d.b.h., using a diameter tape and measured to the nearest 0.1 cm) of all trees with d.b.h. ≥5 cm and longleaf pine saplings (height ≥1 m, d.b.h. <5 cm). Additionally, we recorded the species and quadrat for saplings of other species. We extracted a single tree core (from outer bark to pith) from every tree using a Haglof increment borer about 50 cm above the ground and parallel to the slope to avoid reaction wood in the tree cores (Hart and others 2010). Tree-ring samples were processed in accordance with the methods of Stokes and Smiley (1996). Cores were air dried for 48 hours, attached to wooden mounts with cells vertically aligned, and sanded using progressively finer grits. Tree rings

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were then dated to their calendar year of formation. We measured raw ring width for all canopy trees to the nearest 0.001 mm using a Velmex measuring stage (Velmex Inc., 2009, Bloomfield, NY) and Measure J2X software (version 4.2, VoorTech Consulting, 2008, Holderness, NH). We used standard dendroecological techniques to reconstruct canopy disturbance history and age structure within the study area. We applied the 10-year running mean method (Nowacki and Abrams 1997) to detect release events (growth 25 percent greater than the mean of the preceding and succeeding 10 years, sustained for a minimum of 3 years; Hart and Grissino-Mayer 2008). To capture a contemporary disturbance impact, we recorded mortality approximately 6 months after a compartment-wide (401-ha) prescribed burn in the spring of 2021.

We observed 11 different species in the tree layer within the 1-ha plot. Longleaf pine dominated the study area, with loblolly pine (*P. taeda*) and blackjack oak (*Quercus marilandica*) having the second and third greatest basal area, respectively (table 1). Of the 189 overstory individuals analyzed for disturbance history, 163 trees (86 percent) exhibited at least one release event, and 84 trees (52 percent) exhibited multiple release events (fig. 1). Three plot-wide release events were documented. The first two events (1878–1885 and 1908–1913) were based on only five trees, three of which experienced the release events. The third release event occurred during 1967–1978 and included over 60 percent of the 160 trees at that time.

We observed mortality in 9 of the 394 trees (2 percent) and 12 of the 57 longleaf pine saplings (21 percent). Of the nine trees, four were longleaf pine, one was loblolly pine, two were turkey oak (*Quercus laevis*), and two were blackjack oak. The nine trees had an average d.b.h. of 10.4 cm, with

Table 1—Density, dominance, and relative importance (average of relative density and relative dominance) of trees in a longleaf pine woodland in the Oakmulgee Ranger District of the Talladega National Forest, AL

Species	Density	Relative density	Dominance	Relative dominance	Relative importance
	stems/ha	*percent*	*m²/ha*	*percent*	
Pinus palustris	350	88.83	19.5342	93.99	91.41
Quercus marilandica	14	3.55	0.2971	1.43	2.49
Pinus taeda	9	2.28	0.4514	2.17	2.23
Nyssa sylvatic	6	1.52	0.1994	0.96	1.24
Quercus laevis	7	1.78	0.0735	0.35	1.07
Diospyros virginiana	2	0.51	0.1154	0.56	0.53
Pinus echinata	1	0.25	0.0625	0.30	0.28
Liquidambar styraciflua	2	0.51	0.0069	0.03	0.27
Quercus velutina	1	0.25	0.0373	0.18	0.22
Pinus virginiana	1	0.25	0.0029	0.01	0.13
Oxydendrum arboretum	1	0.25	0.0024	0.01	0.13
Total	394	100.00	20.7829	100.00	100.00

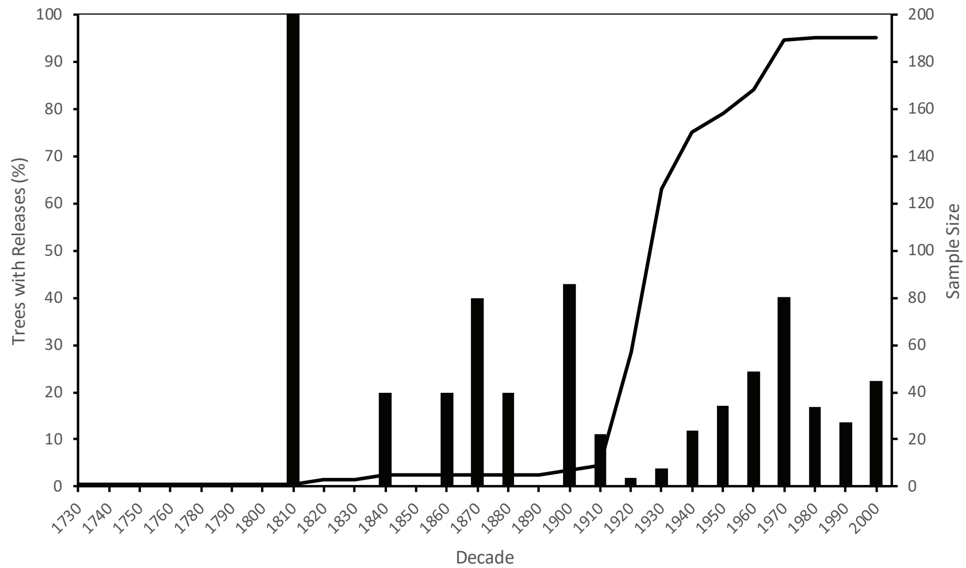

Figure 1—Release events documented in 189 canopy trees in a longleaf pine woodland in the Oakmulgee Ranger District of the Talladega National Forest, AL. Bars represent the percentage of trees in each decade that experienced a release event. The line represents the total sample size in any given decade.

a minimum of 5.2 cm and a maximum of 32.8 cm (both longleaf pine). The 12 saplings had an average d.b.h. of 3.8 cm and an average height of 3.9 m, just below the averages for all longleaf pine saplings (3.9 cm and 4 m, respectively).

In the tree layer, stems other than longleaf pine suffered a greater percentage of mortality (5 out of 44, 11 percent) than longleaf pine (4 out of 350, 1 percent). Although there was a 21-percent mortality rate for longleaf pine saplings, it is likely that other saplings suffered a much greater mortality rate. Further, we did not sample the seedling layer, where additional longleaf pine reside. These findings provide details on the natural patterns of disturbance and may be used to inform silvicultural systems intended to enhance ecosystem resilience of longleaf pine woodlands.

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