RESEARCH ARTICLE

Species Composition, Size Structure, and Disturbance History of an Old-Growth Bottomland Hardwood-Loblolly Pine (*Pinus taeda* L.) Forest in Arkansas, USA

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ABSTRACT: The Lost Forty is a 16-ha old-growth bottomland hardwood-loblolly pine (*Pinus taeda* L.) forest located in south-central Arkansas that has had little human disturbance. We established plots in the Lost Forty and collected data on species composition, tree size, age structure, and radial stem growth patterns. The overstory was dominated by species that were shade intolerant or intermediate in tolerance such as sweetgum (*Liquidambar styraciflua* L.), oak/hickory (*Quercus/Carya* spp.), and loblolly pine. Some pines were 46 m tall and 1.2 m in diameter. Trees in the midstory and understory were primarily shade tolerant species including eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), American holly (*Ilex opaca* Ait.), hornbeam (*Carpinus caroliniana* Walt.), and blackgum (*Nyssa sylvatica* Marsh.). Tree ring analysis indicated that the oldest cohort of oak/hickory and pine were recruited during the 1860s and 1870s. This period was characterized by a pulse of tree recruitment and rapid radial stem growth rates, suggesting the occurrence of a major, stand-level disturbance in the study area. Additional disturbance(s) will be needed for the successful regeneration of shade-intolerant species.

Index terms: bottomland hardwoods, disturbance, loblolly pine, old-growth, tree ring analysis

INTRODUCTION

Prior to European settlement, large contiguous areas of bottomland hardwood forests were important landscape features of major and minor floodplains in the southern United States. However, over the last 150 years, conversion to agriculture, urbanization, and pine plantation silviculture have dramatically reduced the extent of these forests. For example, the original bottomland hardwood forest in the Lower Mississippi Alluvial Valley has declined from about 10 million ha to 2 million ha (Stanturf et al. 2000). Throughout the South, many floodplain forests have become relatively small, isolated fragments. This has raised concerns that southern bottomland forests are endangered ecosystems (Noss et al. 1995).

Concurrent with this reduction has been the virtual elimination of old-growth bottomland forests. Smith and Zollner (2001) estimated that 99.99% of old-growth bottomland forests have experienced significant anthropogenic disturbance. Despite – or perhaps because of – the scarcity of these forests, they have received considerable attention from forest researchers. A number of studies have been established in the Congaree Swamp National Monument, a 9000-ha forested floodplain in South Carolina that is the largest fragment of old-growth bottomland hardwood forest in the southern United States (Putz and Sharitz 1991, Allen et al. 1997, Pederson et al. 1997, Battaglia et al. 1999). Most studies, however, have been located in small (4 to 35 ha) old-growth remnants scattered throughout the South (Nixon et al. 1977, Robertson et al. 1978, Jones et al. 1981, White 1987, Devall and Ramp 1992).

In Arkansas, bottomland hardwood forests are widespread in the floodplains of several major rivers (e.g., the Mississippi, Arkansas, White, Ouachita, and Red) and along thousands of km of smaller rivers and bayous. Despite this statewide abundance of bottomland sites, only one old-growth area – Moro Bottoms, a 40-ha forest in south-central Arkansas – has been identified and studied (Devall et al. 2001, Smith and Zollner 2001, Smith et al. 2001). In 1999, we became aware of a second, previously unexamined old-growth bottomland forest located 45 km south of Moro Bottoms. Preliminary examination of the tract – called "the Lost Forty" by local residents and foresters – revealed an old forest dominated by bottomland hardwoods and scattered loblolly pine (*Pinus taeda* L.).

This stand represents a rare opportunity to learn more about the origin, development, and dynamics of older southern bottomland forests. We have established a long-term, plot-based study in the Lost Forty to: (1) describe the existing species composition and size structure, and (2) reconstruct the disturbance history through analysis of tree age and radial stem growth.

METHODS

Study Area

The Lost Forty is located at 33° 23' N and

92° 23' W in Calhoun County, Arkansas (Figure 1). The stand is both drained and flooded by Wolf Creek, a small stream that meanders along the eastern boundary of the forest and flows into Moro Creek about 0.5 km to the east. Generally, Wolf Creek is completely dry in the summer and autumn and periodically floods during the winter and spring. Typical of minor bottomlands, the Lost Forty has a variety of subtle topographical features, including ridges, flats, and sloughs (Hodges 1997). Elevations range from 27-29 m above sea level; slopes are 0-3%. Soils in level, poorly drained areas are Amy silt loam (Typic Ochraquults) and Guyton silt loam (Typic Glossaqualfs), while Ruston fine sandy loam (Typic Paleudults) occurs on ridges (Gill et al. 1980). The growing season in the study area is about 220 days. The mean annual temperature is 17 °C and the average annual precipitation is 130 cm, with generally wet winters and dry autumns.

Potlatch Corporation and the Arkansas Natural Heritage Commission cooperatively manage the Lost Forty. The tract is currently bordered by stands being managed for pine and hardwood sawtimber and pulpwood production. Other than about 5-10 large pine trees that were salvaged in the last decade, no evidence exists of harvesting in the tract. Given the long history of logging in southern Arkansas, it is unclear why the area has never been extensively harvested. Possibilities include uncertainty surrounding the ownership, its inaccessibility, and more recently, its recognition as an ecologically unique area. We know of no large-scale natural disturbances that have recently occurred in the stand. However, a small area (< 0.2 ha) in the northwest corner of the tract was damaged by a tornado in the mid-1980s.

Field Sampling

In spring and summer 2000, twenty 0.1-

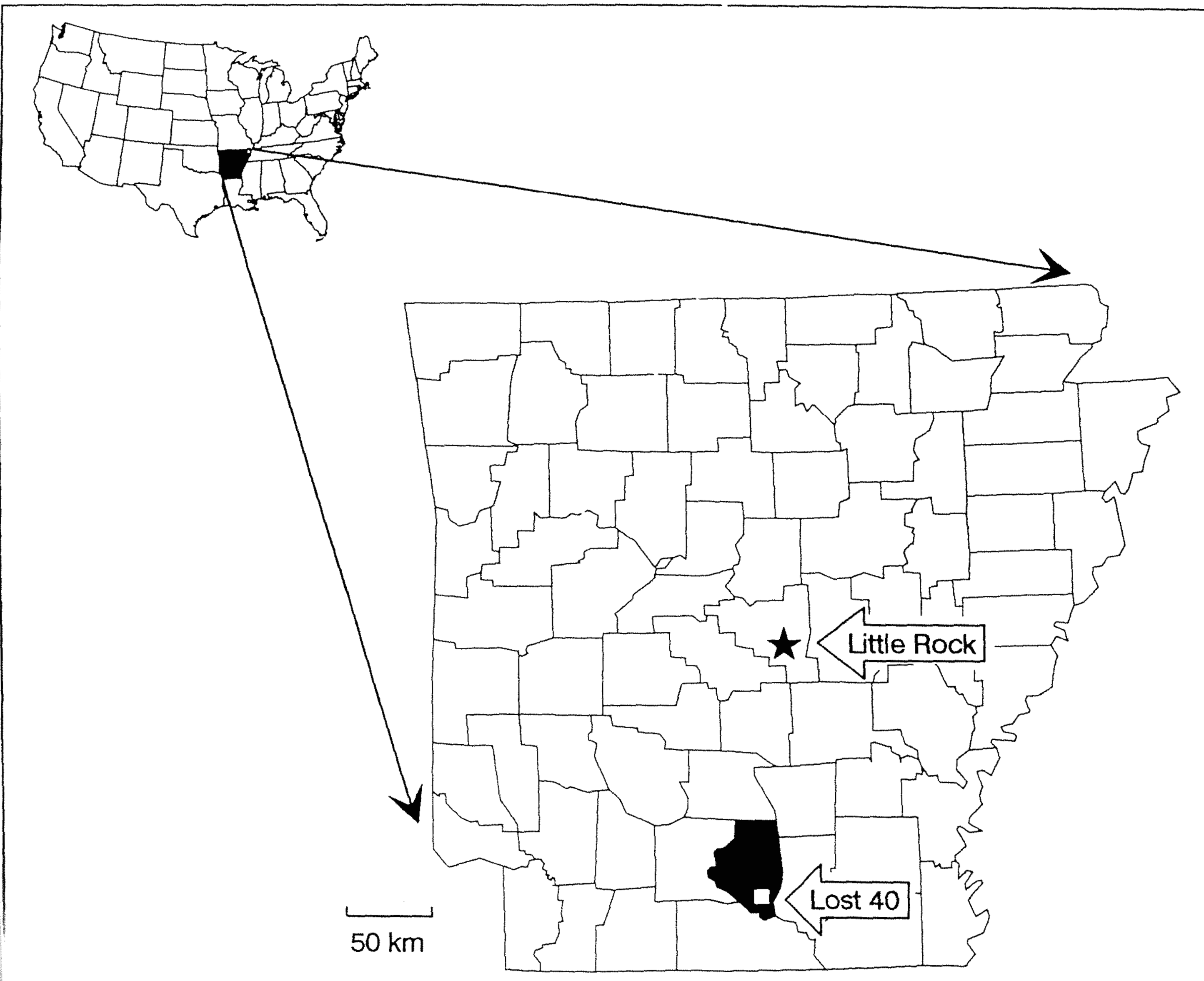

Figure 1. Location of the Lost Forty in south-central Arkansas.

ha square overstory/midstory plots were established systematically throughout the Lost Forty. Plot centers and corners were permanently marked with a metal pin and a descriptive aluminum tag. In each plot, all living trees greater than 9.0 cm in diameter at breast height (dbh) were identified by a numbered aluminum tag on a wire pin at the tree's base. Data collected from these trees included species, dbh, and their distance and azimuth from plot center.

In summer 2000, one hundred and twenty 0.004-ha circular understory plots and one hundred and twenty 0.0004-ha circular regeneration plots were established at the Lost Forty. These plots were nested within the overstory/midstory plots at the four corners and at 7.6 m due north and due south of plot center. In each understory plot, all living trees and shrubs from 1.5 to 9.0 cm dbh were tallied by species and dbh. In the regeneration plots, all living trees and shrubs less than 1.5 cm dbh were tallied by species and height class.

In December 2000 and January 2001, a subsample of overstory/midstory plot trees was selected for additional measurement. Total tree height, height to the base of the live crown, and crown width were determined for 120 trees of common taxa. This included 30 loblolly pine, 41 sweetgum (*Liquidambar styraciflua* L.), 60 oaks (*Quercus* spp.) or hickories (*Carya* spp.), and 29 trees of other species (including American holly (*Ilex opaca* Ait.), blackgum (*Nyssa sylvatica* Marsh.), hornbeam (*Carpinus caroliniana* Walt.), or eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch). Total tree height and height to the base of the live crown were measured with a clinometer or hypsometer. Crown width was measured using a tape along the north-south and east-west crown axes projected to ground level. In addition, increment borers were used to extract one or two cores at dbh from each pine and oak/hickory for age and radial growth determination.

Laboratory Procedures

From January to March 2001, tree cores were carefully glued on wooden boards and sanded with progressively finer sandpaper to facilitate the counting of tree rings. Using a dissecting microscope, tree ring analysis consisted of counting tree rings to determine total tree age for each core and measuring 10-year radial increments from bark to pith for each core. Because some cores were broken or were otherwise impossible to count accurately, our final sample of cores included 29 loblolly pine and 40 oaks or hickories.

Table 1. Regression coefficients and associated statistics for predicting the total height and crown dimensions from dbh in the Lost Forty.

Species or group	Regression coefficients b_0	b_1	Root mean square error	R^2
Total height[a]				
Pinus taeda	3.876	-16.19	3.15	0.95
Liquidambar styraciflua	3.817	-17.46	3.74	0.73
Quercus /Carya	3.815	-19.25	3.73	0.85
Other Species	3.291	-11.71	4.16	0.51
Crown Diameter[b]				
Pinus taeda	1.393	0.01585	2.80	0.87
Liquidambar styraciflua	1.510	0.01824	1.67	0.74
Quercus /Carya	1.951	0.01413	2.58	0.76
Other Species	1.668	0.01574	1.67	0.42
Live Crown Ratio[a]				
Pinus taeda	ns[c]	ns	-	-
Liquidambar styraciflua	ns	ns	-	-
Quercus /Carya	4.315	-3.855	10.25	0.26
Other Species	ns	ns	-	-

[a] The equation for height and live crown ratio is:

$$H \text{ or } P = exp(b_0 + b_1 DBH^{-1})$$

where H is total height in m, P is live crown cover percent in percent, and DBH is in cm.

[b] The equation for crown diameter is:

$$CD = exp(b_0 + b_1 DBH)$$

where CD is crown diameter in m and DBH is in cm.

[c] Not significant at $P \leq 0.05$. Means for live crown ratio were 46, 58, and 65% for *Pinus taeda*, *Liquidambar styraciflua*, and other species, respectively.

Calculations and Statistical Analysis

For the overstory/midstory and understory, basal area (m^2/ha) and density (stems/ha) were calculated by species or species groups for each of the twenty 0.1-ha plots, and then values were averaged across all plots. Mean density of seedlings was calculated for each 0.1-ha plot and then averaged across all plots. Frequency of occurrence for overstory/midstory trees was the percentage of the plots containing at least one individual of the specified species or group. For the understory and seedlings, frequency of occurrence was the percentage of subplots within each 0.1-ha plot containing at least one individual for the specified species or group, and these values were averaged across all 20 plots. The age structure of the forest was summarized by grouping trees into10-year age classes (e.g., the 75-year age class included trees from 71 to 80 years old). The dbh structure was summarized by grouping

Table 2. Species composition of overstory/midstory trees (> 9.0 cm dbh) and understory trees and shrubs (1.5 - 9.0 cm dbh) at the Lost Forty.

	Overstory/midstory trees			Understory trees and shrubs		
Species	Basal area (m^2/ha)	Density (trees/ha)	Frequency (%)	Basal area (m^2/ha)	Density (trees/ha)	Frequency (%)
Pinus taeda	7.13	18.3	75	0.02	8.2	0.8
Liquidambar styraciflua	6.11	49.9	95	0.01	14.4	4.2
Quercus/Carya						
Quercus michauxii	2.93	19.8	70	<0.01	2.1	0.8
Quercus pagoda	2.42	7.4	40	0.01	4.1	0.8
Quercus lyrata	1.09	4.9	30	0.00	0.0	0.0
Quercus nigra	1.00	4.5	35	0.01	8.2	1.7
Quercus phellos	0.91	2.5	15	0.00	0.0	0.0
Quercus alba	0.79	4.9	25	0.00	0.0	0.0
Quercus laurifolia	0.10	0.5	5	0.00	0.0	0.0
Carya glabra	1.01	11.9	70	0.02	8.2	3.3
Carya aquatica	0.69	4.5	10	<0.01	2.1	0.8
Carya tomentosa	0.05	2.5	15	<0.01	2.1	0.8
Group total	10.99	63.4	100	0.04	26.8	6.7
Other species						
Ilex opaca	2.83	110.2	85	0.27	193.6	32.5
Carpinus caroliniana	1.14	93.4	90	0.85	638.4	60.8
Nyssa sylvatica	1.07	31.6	80	0.06	39.1	14.2
Ostrya virginiana	0.50	28.7	55	0.13	55.6	15.8
Ulmus alata	0.30	10.9	50	0.02	8.2	3.3
Sassafras albidum	0.25	1.5	10	0.00	0.0	0.0
Acer rubrum	0.21	7.4	45	0.02	8.2	3.3
Tilia americana	0.19	4.5	15	0.00	0.0	0.0
Fagus grandifolia	0.17	1.0	10	0.00	0.0	0.0
Taxodium distichum	0.16	3.5	10	0.00	0.0	0.0
Planera aquatica	0.13	3.5	5	<0.01	8.2	1.7
Fraxinus pennsylvanica	0.08	1.0	10	0.01	2.1	0.8
Cratagus opaca	0.03	1.5	10	0.02	6.2	0.8
Diospyros virginiana	0.03	2.0	15	0.01	6.2	2.5
Morus rubra	0.01	0.5	5	0.00	0.0	0.0
Symplocos tinctoria	<0.01	0.5	5	0.01	10.3	2.5
Callicarpa americana	0.00	0.0	0	0.02	37.1	2.5
Vaccinium elliotii	0.00	0.0	0	0.01	16.5	0.8
Asimina triloba	0.00	0.0	0	0.06	70.0	2.5
Hamamelis virginiana	0.00	0.0	0	0.04	74.1	7.5
Group total	7.10	301.7	100	1.53	1173.8	90.8
Overall total	31.33	433.3	100	1.60	1223.2	91.7

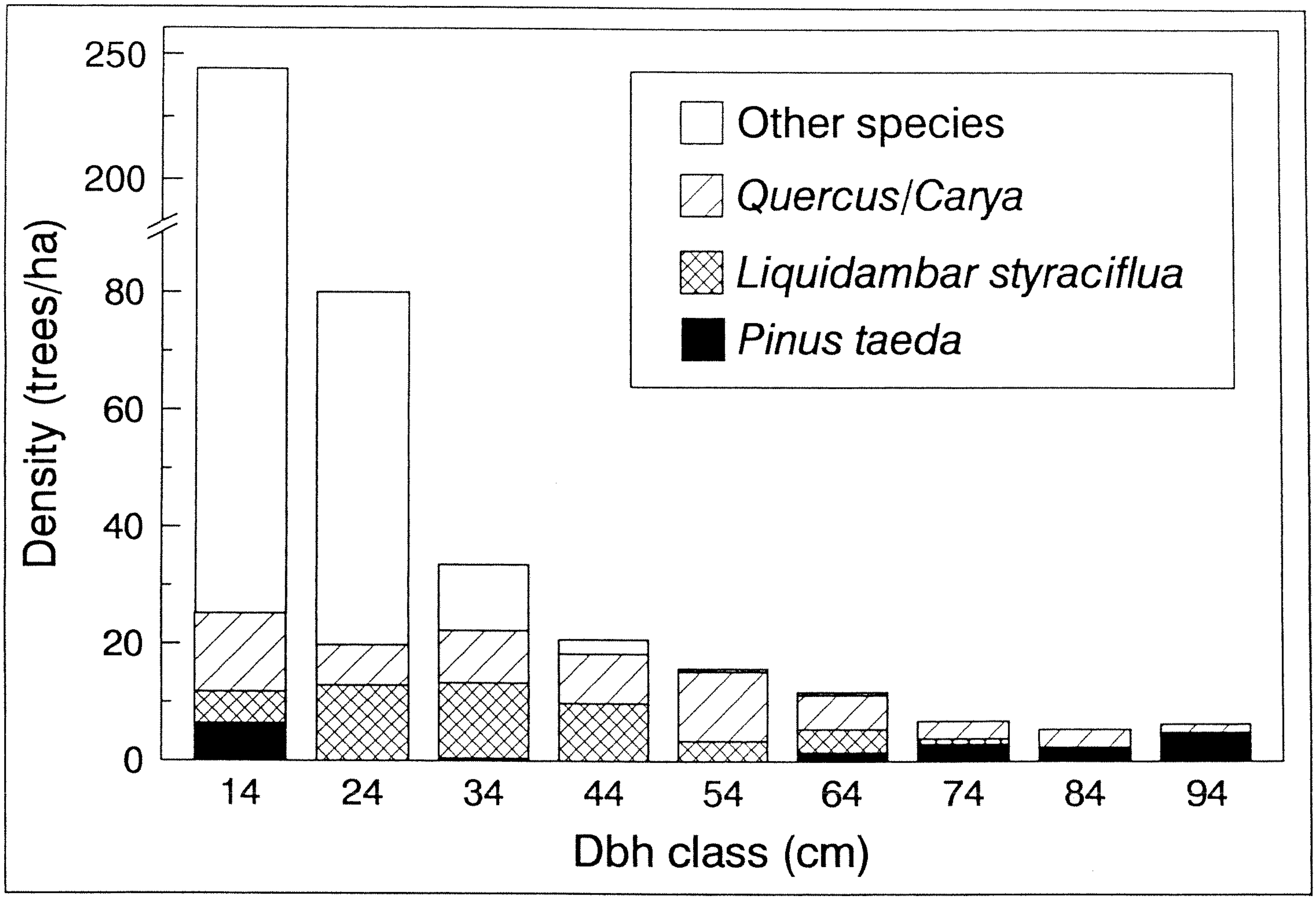

Figure 2. Diameter-class distribution for overstory/midstory trees > 9.0 cm dbh at the Lost Forty.

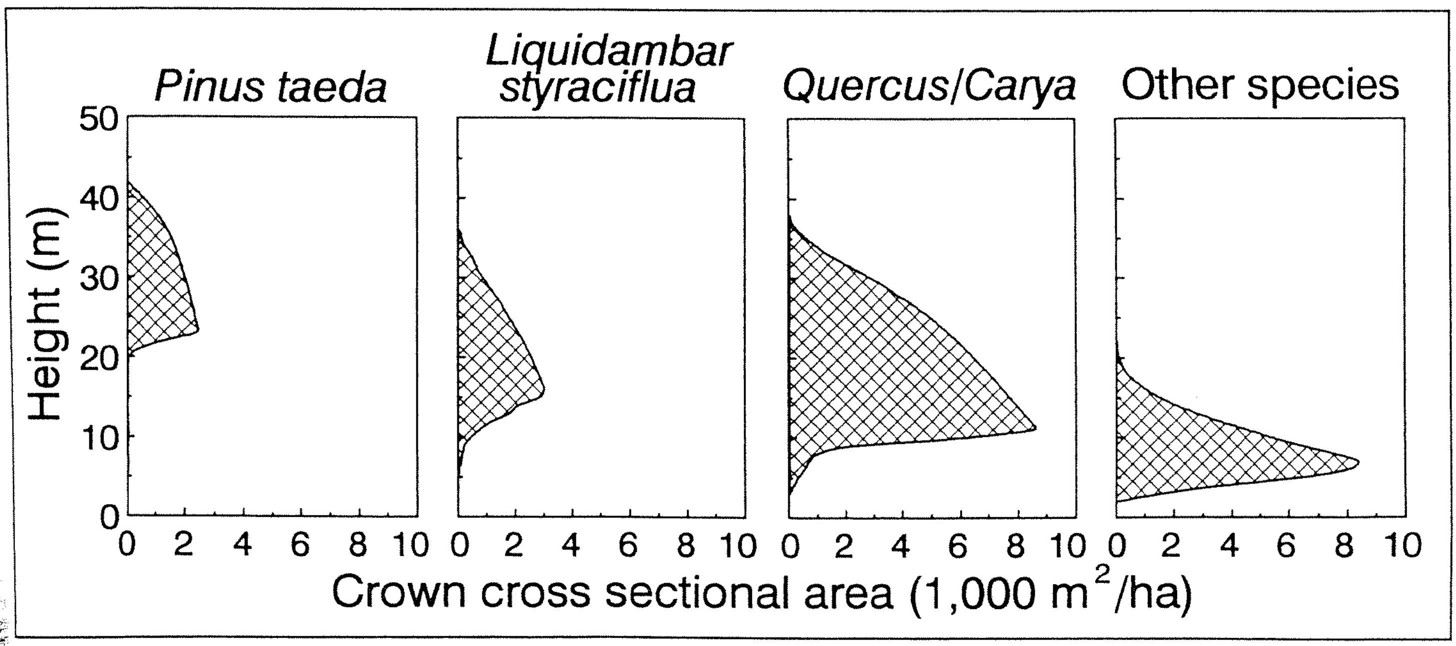

Figure 3. Vertical canopy structure by species or species group at the Lost Forty.

trees into10-cm dbh classes (e.g., the 14-cm dbh class included trees ranging from 9.1 to 19.0 cm in dbh).

Live crown ratio was calculated as the percentage of total height that was above the crown base. Regression equations for sample trees were developed using nonlinear regression (SAS 1988). All reported coefficients were significantly different from zero at P ≤ 0.05. Regression equations were developed for the relationships between total height, crown diameter, and live crown ratio to dbh for the sample trees measured for these parameters (Table 1). Canopy structure was calculated by applying regression equations for predicting height and crown dimensions from dbh. The width of each crown was calculated at 1-m intervals by assuming a parabolic shape. Crown cross-sectional area was then calculated from the crown width for the 1-m intervals and summed for each species or group.

RESULTS

The most conspicuous trees at the Lost Forty were loblolly pine, sweetgum, oak (including swamp chestnut oak (*Quercus michauxii* Nutt.), cherrybark oak (*Q. pagoda* Raf.), overcup oak (*Q. lyrata* Walt.), water oak (*Q. nigra* L.), willow oak (*Q. phellos* L.), and white oak (*Q. alba* L.), and hickory (including pignut hickory (*Carya glabra* (Mill.) Sweet var. *glabra*) and water hickory (*C. aquatica* (Michx. f.) Nutt.)). These species comprised 77%

Table 3. Species composition of woody seedlings (< 1.5 cm dbh) at the Lost Forty.

Species	Density (trees/ha) by height class (m) < 0.79	0.79-1.37	> 1.37	Total	Frequency (%)
Pinus taeda	21	0	0	21	0.8
Liquidambar styraciflua	144	41	0	185	5.8
Quercus / Carya					
Quercus nigra	2100	0	0	2100	21.7
Quercus phellos	1235	21	21	1277	15.8
Quercus michauxii	659	21	21	701	18.3
Quercus pagoda	144	0	0	144	5.0
Quercus alba	124	0	0	124	3.3
Quercus laurifolia	41	0	0	41	0.8
Quercus lyrata	41	0	0	41	0.8
Carya glabra	638	0	0	638	19.2
Carya aquatica	62	0	0	62	1.7
Group total	5044	42	42	5128	55.0
Other species					
Callicarpa americana	1359	309	103	1771	20.0
Carpinus caroliniana	967	185	453	1605	23.3
Symplocos tinctoria	700	21	41	762	5.0
Ilex opaca	638	103	41	782	13.3
Asimina triloba	535	0	21	556	8.3
Vaccinium spp.	371	82	165	618	8.3
Diospyros virginiana	309	0	0	309	3.3
Acer rubrum	206	0	0	206	5.0
Ulmus alata	144	0	21	165	4.2
Ostrya virginiana	124	0	0	124	2.5
Hamamelis virginiana	124	41	41	206	5.8
Planera aquatica	103	0	0	103	1.7
Cephalanthus occidentalis	62	0	0	62	1.7
Nyssa sylvatica	41	0	0	41	1.7
Taxodium distichum	41	21	0	62	1.7
Sassafras albidum	41	0	0	41	1.7
Crataegus marshallii	21	21	0	41	1.7
Group total	5786	783	886	7455	62.5
Overall total	10995	866	928	12789	78.3

of the total basal area (31.33 m^2/ha) and 30% of the total tree density (433/ha) in the overstory/midstory (Table 2). They were most prevalent in larger diameter classes (Figure 2) and upper canopy positions (Figure 3). Indeed, a striking feature of the Lost Forty was the presence of large trees. All 20 of the overstory/midstory plots had a tree at least 53 cm dbh, and 15 of the 20 plots had a tree at least 76 cm dbh. Some specimens of loblolly pine were especially impressive in size. There were only 18 pines/ha, but they comprised a basal area of 7 m^2/ha. The tallest pine we measured was 46 m tall, and the largest pine dbh was 122 cm.

Eastern hophornbeam, American holly, hornbeam, blackgum, and winged elm (*Ulmus alata* Michx.) accounted for 63% of the overstory/midstory tree density, but only 19% of the overstory/midstory basal area (Table 2). These and other miscellaneous species dominated the smaller diameter classes (Figure 2) and the midstory canopy positions (Figure 3). Eastern hophornbeam, American holly, hornbeam, and blackgum were also abundant in the understory and comprised 76% of the trees (Table 2). Common understory associates included witch-hazel (*Hamamelis virginiana* L.), pawpaw (*Asimina triloba* (L.) Dunal), American beauty berry (*Callicarpa americana* L.), and mayberry (*Vaccinium elliottii* Chapm.). Loblolly pine, sweetgum, and oak/hickory were not important understory trees.

There were almost 13,000 seedlings/ha at the Lost Forty (Table 3). Water oak, American beauty berry, hornbeam, willow oak, American holly, horse sugar (*Symplocos tinctoria* (L.) L'Her), and swamp chestnut oak were the most common species. However, most seedlings were in the shortest (< 0.76 m) height class. In fact, 86% of all seedlings, and 98% of oak seedlings, were less than 0.76 m tall. Of these seedlings, observations suggest that the vast majority were no more than 0.3 m tall.

The diversity of woody species was high, in part because of the varied microtopography throughout the study area. There were 27 tree species in the overstory/midstory plots, 23 tree and shrub species in the understory plots, and 29 tree and shrub species in the regeneration plots (Tables 2 and 3). In all, we tallied 35 tree and shrub species.

Analysis of tree cores extracted from dbh indicated that the Lost Forty is an uneven-aged stand. Beginning in the 1860s, a pulse of oaks and loblolly pine reached 1.37 m in height (Figure 4), suggesting that these trees probably established in the 1850s or early 1860s. We found no trees whose age

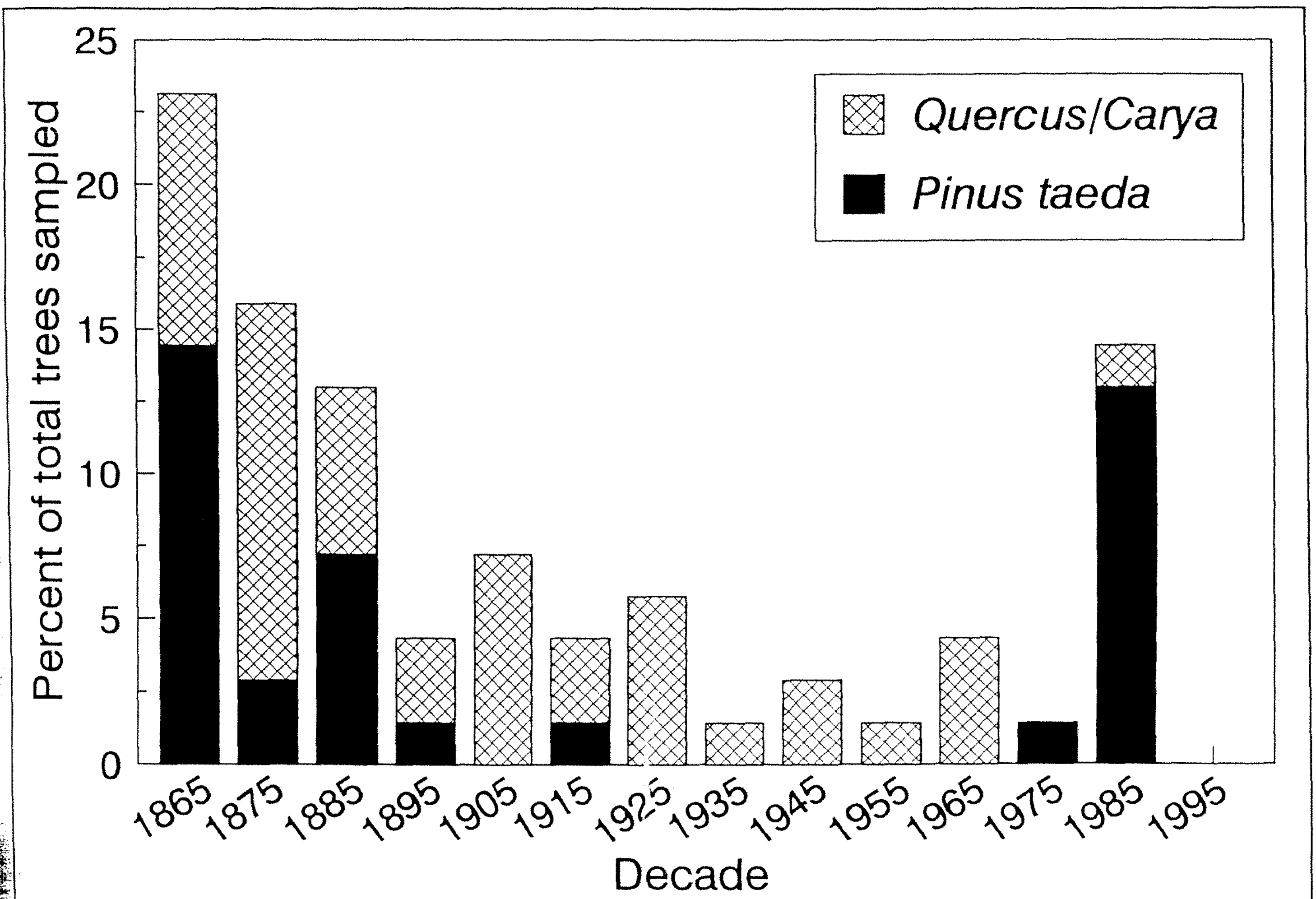

Figure 4. Distribution of age at 1.37 m in height for 69 selected overstory/midstory loblolly pine and oak/hickory at the Lost Forty.

at 1.37 m preceded 1862. For pine, most recruitment occurred from 1861-1890 and 1981-1990, with little to no recruitment between these periods. The pine recruitment in the 1980s resulted from the tornado that destroyed trees in a small portion of the Lost Forty. For oaks, peak recruitment occurred from 1861-1880. Since then, oak recruitment has been more or less continuous, although there has been a noticeable decrease since 1930 (Figure 4).

Average annual radial growth increments for pine and oaks in 1861-1870 were about 8.4 and 3.6 mm/yr, respectively (Figure 5). This represented the maximum radial growth rates for both species over the past 40 years. That these rapid rates of growth occurred simultaneously with peak recruitment (Figure 4) suggested that a major disturbance occurred at the Lost Forty in the mid-19th century.

DISCUSSION

At the Lost Forty, the largest diameter and tallest trees are species that are shade intolerant or intermediate in tolerance (e.g., sweetgum, oak/hickory, and loblolly pine). Trees in smaller diameter classes and mid- and lower canopy positions are predominantly shade tolerant species (e.g., eastern hophornbeam, American holly, hornbeam, and blackgum) (Burns and Honkala 1990a, 1990b). Also, tree seedlings taller than 0.76 m are generally shade tolerant. A similar stratification pattern based on shade tolerance has been reported in other old-growth and mature bottomland hardwood forests (Hosner and Minckler 1963, Jones et al. 1981, Janzen and Hodges 1985, Streng et al. 1989, Jones et al. 1994, Smith 1996, Battaglia et al.1999).

In many forest types, the death and/or decline of overstory trees allow shade tolerant species to emerge from midstory and understory strata; these tolerant species can eventually attain dominant and codominant canopy positions. This type of succession is common in many forest types, including northern conifers (Sprugel 1977, Seymour 1992), northern hardwoods (Canham 1988, Frelich and Lorimer 1991), central hardwoods (Lorimer et al. 1994, Abrams 1998), and southern pines (Quarterman and Keever 1962). However, such succession is not occurring, and probably cannot occur, at the Lost Forty. With the exception of blackgum, the other common shade tolerant species on the site, American holly, hornbeam, eastern hophornbeam, and winged elm (*Ulmus alata* Michx.) lack

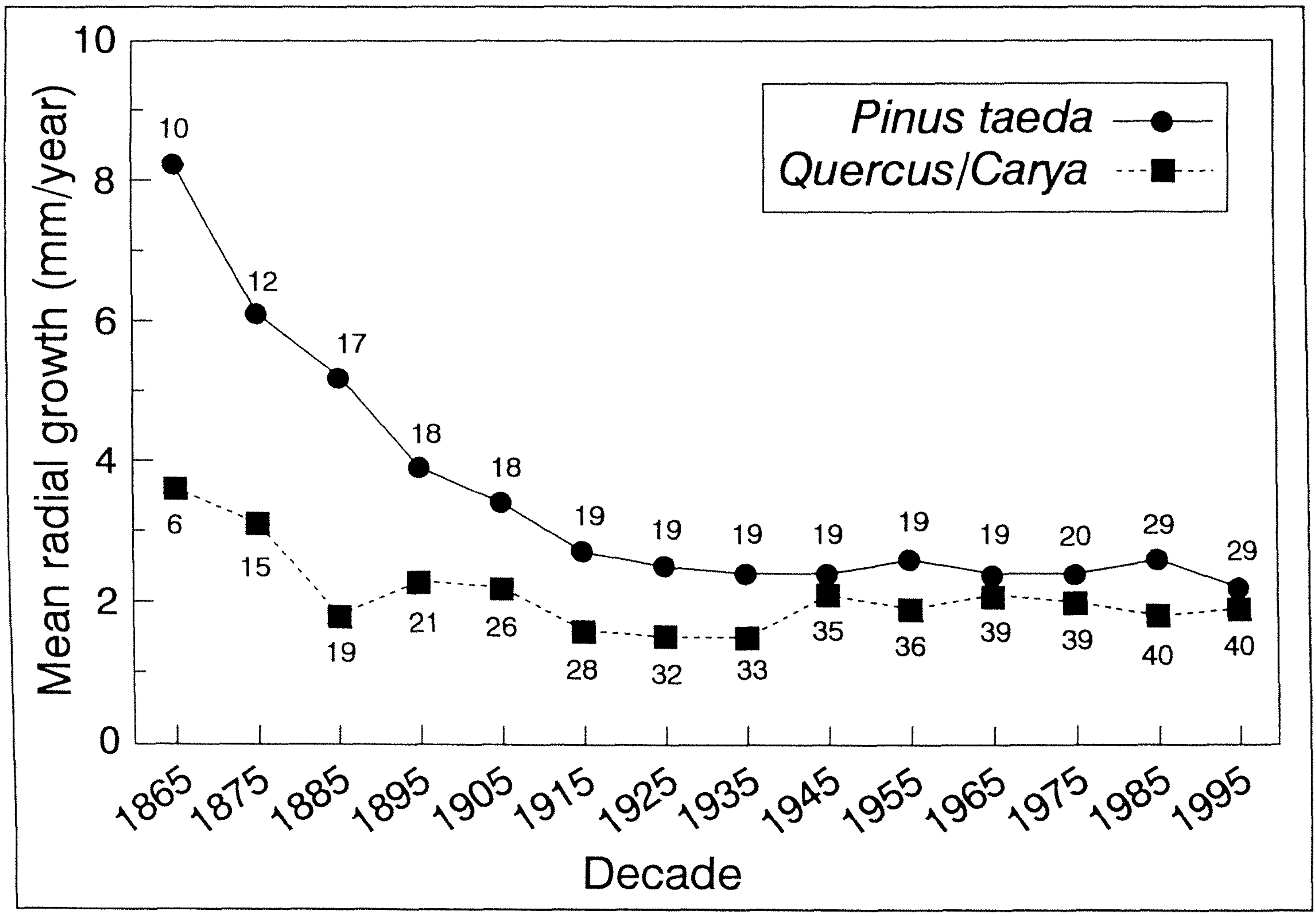

Figure 5. Mean radial growth (mm/yr) by decade for selected overstory/midstory loblolly pine (n=29) and oak/hickory (n=40) at the Lost Forty. Numbers associated with symbols indicate tree sample size during that decade.

the intrinsic growth potential necessary to replace sweetgum, oak/hickory, and pine in the overstory (Burns and Hokela 1990b). McCune and Cottam (1985) reported a similar pattern in an upland oak forest in Wisconsin, where a declining oak overstory was being replaced by a mixture of tree and shrub species that showed little promise of forming a new canopy. In a mature pine-oak stand in Arkansas, Shelton and Cain (1999) also observed that the shade tolerant midstory species lacked overstory potential.

By dominating the midstory and understory, shade tolerant species at the Lost Forty are effectively preventing the establishment and/or recruitment of less tolerant tree species. Indeed, while sweetgum, oak/hickory, and pine dominate the overstory, they are found only occasionally in understory positions. Also, while there are over 5,000 oak seedlings/ha, most of these are less than 0.76 m tall. Studies in upland and bottomland oak forests indicate that oak seedlings of such short stature have a low probability of long-term survival (Sander 1972, Johnson and Deen 1993, Belli et al. 1999).

Successful regeneration of shade intolerant species at the Lost Forty will require some type of disturbance that removes enough of the canopy to provide a suitable environment for seedling establishment and recruitment, stump sprouting, and/or root sprouting. Given the present paucity of large shade intolerant seedlings, release of advance regeneration would probably be of minor importance as a regeneration mechanism (Streng et al. 1989, Jones et al 1994, Jones and Sharitz 1998). Evidently, a disturbance of this magnitude occurred at the Lost Forty in the mid-19th century and created conditions favorable for oak/hickory, sweetgum, and pine throughout the stand. In other old-growth bottomland hardwood forests, infrequent, large-scale disturbances have been offered to explain the preponderance of shade intolerant overstory trees (Jones et al. 1981, Pederson et al. 1997, Battaglia et al. 1999).

We speculate that the disturbance at the Lost Forty may have been a severe windstorm, flood, or fire. Intense wind events such as tornadoes or hurricanes can be very damaging in old-growth bottomland forests (Putz and Sharitz 1991, Battaglia et al. 1999, Smith et al. 2001). Indeed, the tornado at the Lost Forty in the 1980s was clearly responsible for the pulse in pine establishment and recruitment during that decade. While we have no specific evidence of catastrophic flooding in the study area, the natural and human-caused migration of major and minor stream channels in the southern United States can be an important determinant of vegetation patterns (White 1983, Shankman 1993, Hodges 1997). This may be relevant to the Lost Forty. According to the General Land Office surveyors' maps of the region, Moro Creek flowed along the west edge of the Lost Forty in 1844, but now flows about 0.8 km further east. Fire is an important factor in the successional development of upland forests in the southern United States (Quarterman and Keever 1962, Bonnicksen 2000), but is not generally thought to be important in bottomlands. However, it is possible that a severe drought, which periodically occurs in Arkansas forests (Stahle et al. 1985), could have created conditions for a stand-replacing fire at the Lost Forty.

It is unlikely that timber harvesting was the disturbance responsible for the establishment and recruitment of the current overstory trees in the study area. According to Bragg (2002), small-scale logging began in southern Arkansas in the 1830s and 1840s but was restricted to major watercourses. However, extensive harvesting did not begin until a well-developed railroad system was developed in the region in the late 1880s (Morbeck 1915).

In conclusion, the Lost Forty is a rare example of an old-growth bottomland hardwood-pine forest in southern Arkansas. What makes the stand particularly unusual is the abundance of large trees and the extent to which the overstory and midstory have remained relatively intact. Certainly, the death of large, old trees occurs at the Lost Forty. Yet a striking feature of the area is the limited number of regenerating canopy gaps and the ease of walking through the stand. Indeed, the low number of saplings and tall seedlings imparts much of the forest with a rather park-like appearance. The Lost Forty originated following a severe disturbance about 150 years ago, but subsequent major perturbations seem to have been conspicuously absent. This offers an interesting contrast with Moro Bottoms, the old-growth bottomland forest closest (45 km) to the Lost Forty. There, a severe windstorm in 1989 created numerous canopy gaps up 0.3 ha in size throughout the 40-ha stand (Devall et al. 2001, Smith et al. 2001, Smith and Zollner 2001). It is inevitable that natural disturbances of this magnitude or larger will occur again at the Lost Forty, and it seems likely that such disturbances will eventually facilitate the establishment of the shade intolerant species currently dominating the overstory. We plan to re-measure our field plots every five years to describe the dynamic nature of this forest.

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