PATTERNS OF OAK DOMINANCE IN THE EASTERN OUACHITA MOUNTAINS SUGGESTED BY EARLY RECORDS

Don C. Bragg[1]

Abstract—Many years of human influence across the Interior Highlands have caused profound changes in forest composition, disturbance regimes, and understory dynamics. However, information on the historical condition of these forests is limited. General Land Office (GLO) records, old documents, and contemporary studies provided data on the township encompassing the Lake Winona Research Natural Area (LWRNA). The study area was first surveyed between 1821 and 1838, and few settlers had settled this mountainous region by the 1930s. A 1987 ecological assessment of the LWRNA, coupled with other reports, supplemented the GLO descriptions. The original surveys tallied at least 15 species of witness trees, primarily white oak (*Quercus alba* L.), black oak (*Q. velutina* Lam.), shortleaf pine (*Pinus echinata* Mill.), blackgum (*Nyssa sylvatica* Marsh.), and post oak (*Q. stellata* Wang.). A 1931 resurvey identified at least 14 taxa, but by then the witness trees had become overwhelmingly shortleaf pine, with much less oak. Forest composition in the LWRNA is shifting once again toward oak dominance, with a prominent pine supercanopy.

INTRODUCTION

Humans have dramatically changed forest composition, disturbance regimes, and understory dynamics across most of North America. Very few stands remain that retain sufficient ecological integrity to use as standards for restoration, and new perturbations continually alter these remnants. This challenges stewards and researchers who desire to maintain certain features of the natural environment, especially when the management objects are isolated parcels in a matrix of unprotected forests.

To describe how the forests of Arkansas have changed, researchers have examined narratives of early explorers (Strausberg and Hough 1997), historical documents and photographs (Smith 1986), and General Land Office (GLO) survey notes (Bragg 2003, Foti and Glenn 1991). All of these sources can contribute to our understanding of forest composition and structure. However, the quality of any historical information must be thoroughly evaluated before inferring definitive ecological conclusions (Forman and Russell 1983, Noss 1985). Reliable information is critical when assessing long-term change in remnant stands of old-growth forest.

The 113-ha Lake Winona Research Natural Area (LWRNA) has been preserved as a relic old forest in the Ouachita Mountains of central Arkansas (Fountain and Sweeney 1987). Little is known about the developmental history of the LWRNA, limiting its utility as a case study of forest change. This study is intended to supplement existing ecological research on the eastern Ouachita Mountains including the LWRNA, with special emphasis on long-term patterns of overstory oak dynamics.

METHODS AND MATERIALS

Study Area

Located in the Ouachita Mountains of western Saline County, the study area lies approximately 50 km west of Little Rock and encompasses the whole GLO-surveyed area of Township 2 North, Range 18 West (T2N R18W). The LWRNA (fig. 1) falls entirely within T2N R18W. Since the whole township is relatively uniform in landform and vegetation, and rather than abbreviating the already limited GLO data to the small area encompassed by the LWRNA, the data for the LWRNA will be considered detailed enough for comparison with the larger GLO results. In terms of relative species composition and stand development patterns, this assumption should not be too problematic.

Fountain and Sweeney (1987) described the environment of the LWRNA, which is typical of the region as a whole. The landscapes are predominately steep hills and low mountains, with slopes ranging from gentle (5 to 10 percent) to very steep (> 50 percent). Sandstones and shales dominate the bedrock of the region, and the colluvial-origin soils are primarily Typic Hapludults. Alum Fork, a major tributary of the upper Saline River, and many small creeks drain the township.

Data Sources

This comparison was taken from three main sources: the original land survey (GLO) notes (Daniels 2000), an ecological assessment of the LWRNA (Fountain and Sweeney 1987), and a trade journal report on the lumbering potential of the region (Anonymous 1904). These reports, coupled with other historical and modern references, describe the forest conditions of the LWRNA region from the early 1800s to the present.

For many years researchers have used GLO survey notes to describe presettlement vegetation patterns, e.g., Bourdo 1956, Delcourt 1976, and Lutz 1930, although there are some challenges with their interpretation related to surveyor bias, scale incompatibility, and species clarity (Bragg 2003, Schulte and Mladenoff 2001, Whitney and DeCant 2001). For example, Bragg (2003) reported on the uncertainties related to surveyor species delineations, including the timing of most survey work (November to March, during the dormant season), the surveyors' lack of formal taxonomic

[1] Research Forester, USDA Forest Service, Southern Research Station, Monticello, AR 71656.

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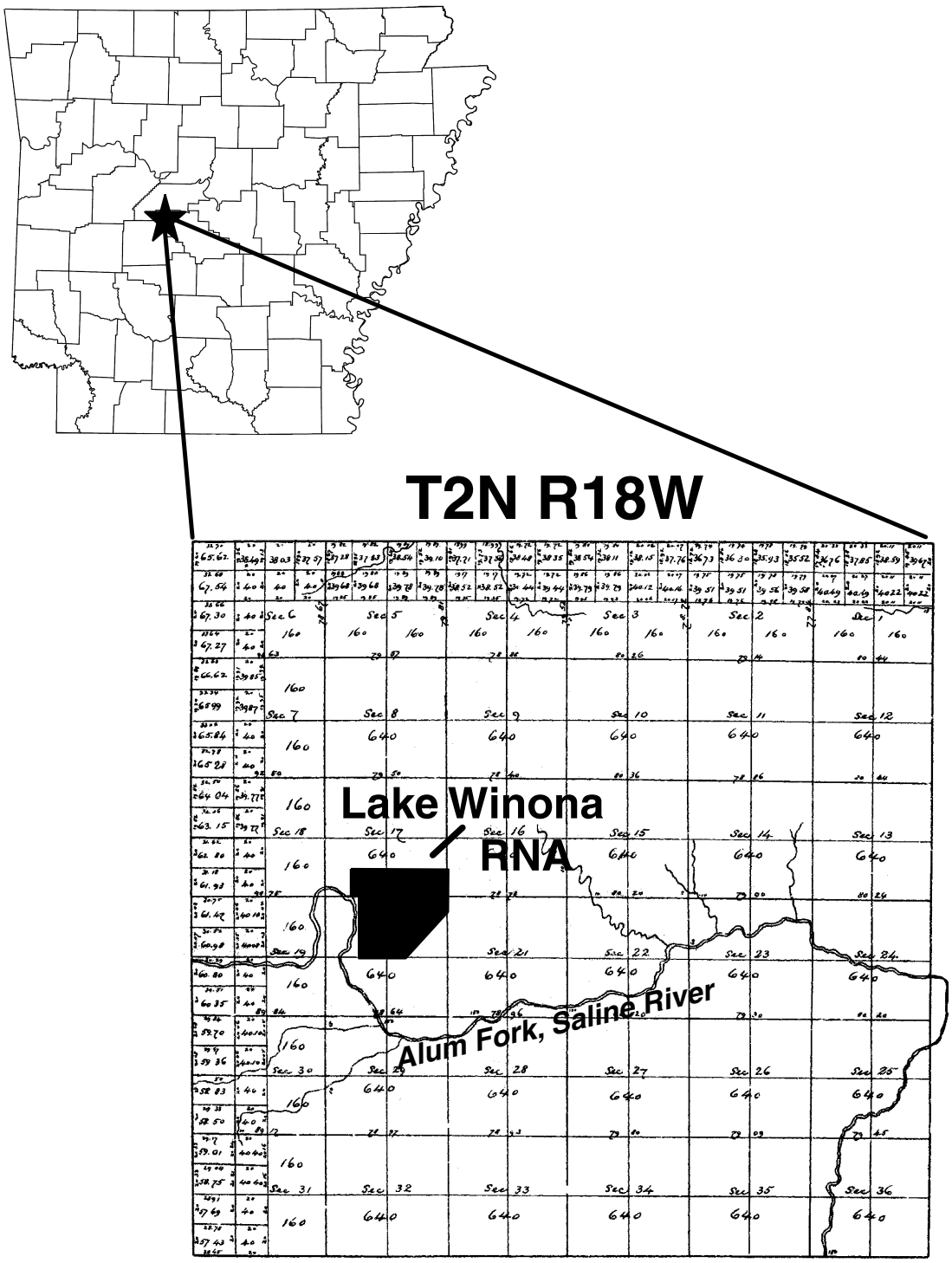

Figure 1—The 1840 plat map of T2N R18W, showing the approximate location of major drainages and the LWRNA.

training, and their use of nonspecific or obscure common names. Though these concerns may limit interpretation of GLO records, the survey notes still represent the best available quasi-quantitative information on presettlement vegetation conditions.

The township and range lines of T2N R18W were surveyed as early as 1821, with most of the interior section lines completed in early 1838. For simplicity, I refer to these data as the “Original 1838 data” since the GLO completed the vast majority of the interior lines during that year. As an aside, John R. Conway surveyed much of the study area. A member of an early regional political dynasty, Conway’s father, John S., was the first governor of Arkansas, his older brother Henry was an Arkansas congressman, brother Frederick was the surveyor-general of Missouri, brother

William was an Arkansas supreme court justice, and brother Elias became governor of Arkansas in 1852 (Herndon 1922).

By 1931, a resurvey of T2N R18W was commissioned. The notes do not give any justification for this effort, although it could be related to an ownership dispute. Arthur W. Brown, a federal surveyor, undertook the resurvey of T2N R18W between August and December of 1931 and relocated approximately half of the original corners. Many of the witness trees had died or been cut since the original GLO survey, so most corners required remonumentation. Another resurvey of a portion of the township was completed in the mid-1970s when the U.S. Department of Agriculture Forest Service requested a survey of the Lake Winona spillway elevation. However, I did not include this traverse because of the very limited area surveyed within T2N R18W.

The Ouachita National Forest established the LWRNA in 1977 to preserve a remnant of the pine-hardwood forest that once dominated much of the Ouachita Mountains. In a baseline ecological assessment, Fountain and Sweeney (1987) reported an overstory of > 100-year-old shortleaf pine (*Pinus echinata* Mill.) and a mid- and understory overwhelmingly dominated by oaks (*Quercus* spp.), hickories (*Carya* spp.), gums (*Liquidambar* sp. and *Nyssa* sp.), and shrubs. They predicted that the lack of fire, coupled with individualistic pine mortality from disease, insects, wind, and lightning, would eventually lead to a hardwood-dominated overstory.

I searched the GLO records for any witness or line trees with the surveyors' assignment of species and an estimated diameter. The common names given by the surveyors (table 1) are probably reliable to species for the most obvious taxa, e.g., white oak (*Q. alba* L.), but are only accurate to genera for others, e.g., hickory. The 1987 assessment of the LWRNA was conducted by trained ecologists and foresters using modern equipment and measurement protocols, and hence better reflects the true distribution of vegetation. The taxonomic assignments by Fountain and Sweeney (1987) were assumed to be accurate to species. For broad discussion, species groups have been used to simplify the naming conventions. Hence, the white oak group includes white oak and post oak (*Q. stellata* Wang.); the red oak group consists of southern red oak (*Q. falcata* Michx.), black oak (*Q. velutina* Lam.), blackjack oak (*Q. marilandica* Muenchh.), and spotted oak (*Q. shumardii* Buckl.); the hickory group probably contains several *Carya*; the gums consist of blackgum (*N. sylvatica* Marsh.) and sweetgum (*L. styraciflua* L.); the conifer group includes eastern redcedar (*Juniperus virginiana* L.) and shortleaf pine; and other hardwoods contain all other minor hardwood taxa.

Table 1—Common names of trees used by the 1821–1838 and 1931 surveyors in T2N R18W, and their probable taxonomic equivalents

Surveyor name	Probable scientific name[a]
Pignut hickory	*Carya cordiformis* (Wang.) K. Koch
Hickory	*C.* spp.
Chinkapin	*Castanea pumila* (L.) Mill. var. *ozarkensis* (Ashe) Tucker
Dogwood	*Cornus florida*
Ash	*Fraxinus* spp.
Holly	*Ilex opaca*
Cedar	*Juniperus virginiana*
Sweetgum	*Liquidambar styraciflua*
Gum	*L. styraciflua*, *Nyssa sylvatica*
Mulberry	*Morus rubra* L.
Blackgum	*N. sylvatica*
Pine	*Pinus echinata*
Cherry	*Prunus serotina* Ehrh.
White oak	*Quercus alba*
Red oak	*Q. falcata*, *Q. rubra*, *Q. velutina*
Blackjack oak	*Q. marilandica*
Spotted oak	*Q. shumardii*
Post oak	*Q. stellata*
Black oak	*Q. velutina*, *Q. rubra* L., *Q. falcata*
Elm	*Ulmus* spp.

[a] Multiple species are listed if several options are possible.

RESULTS

The original GLO survey of the LWRNA region in the early 1800s described a largely untouched wilderness, with oaks and pine dominating the overstory (table 2). The 1838 survey reported at least 15 taxa. Witness trees were mostly white oak, black oak, shortleaf pine, blackgum, and post oak. Blackjack oak, commonly found in open, fire-dominated sites, was used several times as a witness tree. Other minor shade-tolerant species such as flowering dogwood (*Cornus florida* L.) and American holly (*Ilex opaca* Ait.) were mentioned, but their infrequent usage suggests that their presence in the early 1800s was limited.

The intervening century found the region gradually settled, logged, and farmed. Most witness trees in the 1931 resurvey were small-diameter shortleaf pine (fig. 2), followed by white oak, blackgum, and post oak. Surveyor A.W. Brown noted much of mature pine and oak had been removed, although some areas still contained virgin timber. Brown placed the hickory, gum, elm (*Ulmus* spp.), ironwood [*Ostrya virginiana* (Mill.) Koch.], and holly along the creek bottoms implying that their presence in upland areas was limited. Brown's report also stated that "[p]ractically the entire township produces a very good growth of native grasses, but the efforts of the Forest Service to get settlers to launch more extensively into the cattle business have so far proved rather fruitless," and later "timber on the hillsides is quite free of undergrowth" (Brown 1931).

During the next half-century, much of the township experienced timber harvest and fire suppression. The 1987 LWRNA inventory indicated a decline in pine dominance and a resurgence of oak importance. Conifers (mostly shortleaf pine) had decreased from almost 74 percent of surveyed stems to < 35 percent of trees in the LWRNA inventory (fig. 2). White and red oaks, gums, and other hardwoods increased noticeably and dominated the understory (Fountain and Sweeney 1987), which had virtually no shortleaf pine or eastern redcedar. The white oak group comprised nearly one-third of the stems in the LWRNA, and the red oak group increased to almost 11 percent, or over five times their

Table 2—Common names of species (and counts) noted in the GLO surveys of T2N R18W and the LWRNA

1838 GLO[a]	1931 Resurvey[a]	1987 LWRNA inventory[b]
White oak (135)	Pine (299)	Shortleaf pine (456)
Black oak (91)	White oak (58)	White oak (408)
Pine (78)	Blackgum (19)	Blackgum (108)
Blackgum (13)	Post oak (14)	Red maple (75)
Post oak (11)	Black oak (5)	Black oak (71)
Hickory (8)	Sweetgum (3)	Post oak (58)
Sweetgum (5)	Ash (2)	Hickory (48)
Blackjack oak (4)	Cedar (2)	Blackjack oak (37)
Dogwood (3)	Blackjack oak (1)	Dogwood (40)
Elm (3)	Gum (1)	Southern red oak (34)
Gum (3)	Hickory (1)	(many other hardwoods present)
Holly (2)	Holly (1)	
Red oak (2)	Pignut hickory (1)	
Cherry (1)	Red oak (1)	
Chinkapin (1)	Spotted oak (1)	
Mulberry (1)		

[a] Common names as provided by the surveyors; count totals are for the entire T2N R18W.
[b] Trees per hectare for the "dominant" species on the LWRNA.

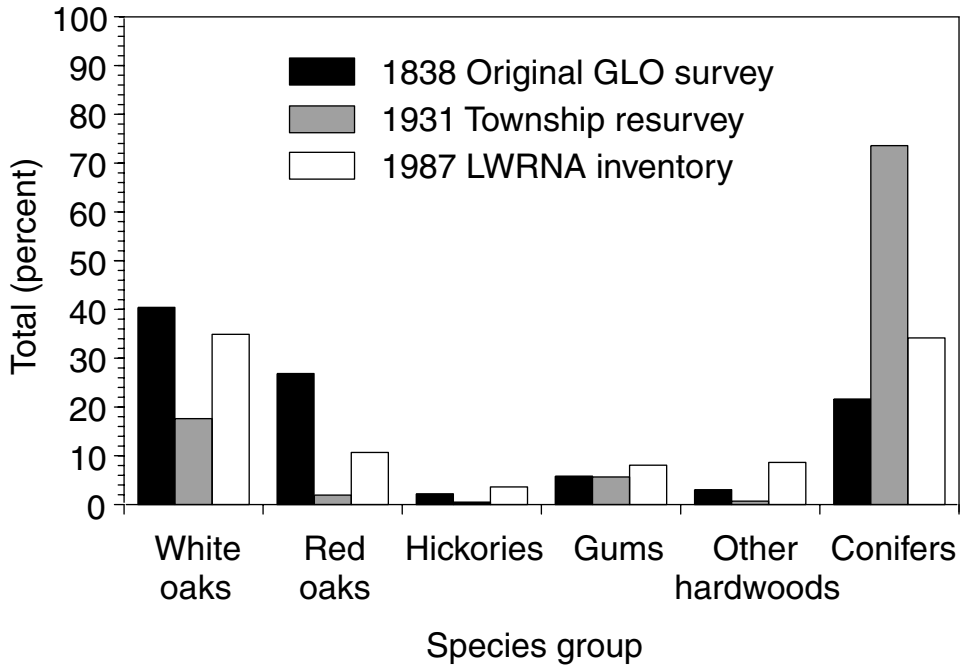

Figure 2—Frequency distribution of major species groups in the original Government Land Office surveys and the 1987 LWRNA inventory (see text for group delineations).

presence just 50 years earlier. Hickories, gums, and other minor hardwood species also increased their stocking, although they still represent a minor component (about 20 percent) of the stand.

DISCUSSION

Comparison of GLO data with Fountain and Sweeney's work suggests that pine gained more prominence between the early 1830s and 1930, with a concurrent decrease in oak. Regional forest dynamics changed markedly during this period, especially after commercial logging began early in the 20th century (Shelton and Murphy 1990, Smith 1986). The frequency of hardwoods in the 1838 GLO notes suggests that these hills had undergone a remarkable transformation by the 1930s. Harvesting and fire, coupled with land clearing, probably improved shortleaf pine establishment, resulting in large numbers of small pine being utilized as witness trees by the 1931 resurvey.

However, because of uncertainty in how surveyors actually selected their witness trees, I did not further quantify oak and pine composition. Even though the oldest GLO notes suggested the prominence of oaks and other hardwoods, the surveyors' preferences may have biased tree selection. For example, it is possible that hardwoods were chosen more frequently than shortleaf pine because they contrasted with a pine overstory (Bourdo 1956, Bragg 2003). If so, the abundance of some hardwood species from the initial GLO surveys may exceed their true historical representation.

Other reports, e.g., Smith 1986, disagree with the relative dominance of hardwoods suggested by the GLO notes. Early (pre-1900) observations on the study region indicated shortleaf pine was the dominant overstory species. For instance, Anonymous (1904) reported pine sawtimber volume five times that of hardwoods in the eastern Ouachita Mountains. However, Anonymous (1904) alone is not definitive proof of an informational discontinuity, because this nonrefereed (and even promotional) source may reflect biases that emphasize the commercial potential of the region. Additionally, merchantable sawtimber does not directly translate into stocking proportions, especially if the hardwoods were predominantly small-diameter, poorly formed stems.

Oaks and other hardwoods have probably long held subordinate positions in the Ouachita Mountains of central Arkansas, especially on exposed sites in fire-prone areas. However, given the absence of large-scale catastrophic disturbances like fire or timber harvesting, it is likely that the mixed pine-hardwood overstory of the LWRNA will gradually revert to a hardwood-dominated stand. In a second-growth pine-oak stand near the LWRNA, Shelton and Murphy (1990) reported a noticeable decline in smaller pine size classes and increased representation by white oak, southern red oak, and other hardwoods. However, if borers, sudden oak decline, drought, or similar destructive agents arise, then the LWRNA may develop a greater prominence of hickory, gum, red maple (*Acer rubrum* L.), and other hardwoods.

CONCLUSIONS

Barring a major disturbance, the dominance of closed-canopy hardwood under- and midstories means the existing supercanopy of shortleaf pine will not replace itself. Unless constrained by decline, oaks (especially white and black oak) are poised to replace shortleaf as the pines succumb to age, insects, lightning, and other causes. The long-term preservation of current conditions, i.e., shortleaf pine dominance, at the LWRNA is highly unlikely, but whether or not oaks will reach and maintain their expected importance is less certain.

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