Am. Midl. Nat. 149:1–20

Natural Presettlement Features of the Ashley County, Arkansas Area

DON C. BRAGG[1]

USDA Forest Service, Southern Research Station, P.O. Box 3516 UAM, Monticello, Arkansas 71656

ABSTRACT.—The General Land Office (GLO) survey records of the Ashley County, Arkansas, area were analyzed for natural attributes including forest composition and structure, prairie communities and aquatic and geomorphological features. Almost 13,000 witness trees from at least 23 families were extracted from the surveys. Most (68% of the total) witness trees were black oak (*Quercus velutina*), pine (*Pinus* spp.), post oak (*Q. stellata*), white oak (*Q. alba*), hickory (*Carya* spp.) and sweetgum (*Liquidambar styraciflua*), with 60% of the taxa having fewer than 20 individuals and 26% represented by a single tree. Witness trees were usually moderate sized with very few small or large individuals noted. The distribution of presettlement grasslands, bottomland forests and upland mixed pine/hardwood forests was approximately mapped across the study area. Catastrophic disturbances mentioned in the GLO records included windthrow, floods, fire, timber harvest and earthquakes. Even during this early period, European settlers were altering the Ashley County landscape with trails, homes, farms, cotton gins and small-scale land clearing. Other notable ecological features in these survey records included large woody debris, wetlands, unique terrain conditions and wild game.

INTRODUCTION

Reconstruction of presettlement conditions has become an increasingly important component of the management of public lands. Although some have questioned the value of restoring forests to resemble a fixed point in time (Noss, 1985), public expectations and statutory requirements for the recovery of threatened and endangered species have encouraged the expansion of this type of restoration ecology. Furthermore, even if the decision is made to maintain altered conditions, knowledge of the early vegetation provides a valuable perspective on the long-term effects of management. One of the biggest challenges to the successful reconstruction of functional ecosystems is the absence of reliable reference conditions. While different methods to determine these conditions exist (*see* Egan and Howell, 2001), many are not universally available and, thus, have limited applicability.

The potential of the original General Land Office (GLO) surveys was recognized long ago by ecologists who have used these records to describe vegetation patterns (*e.g.*, Lutz, 1930; Spurr, 1951; Delcourt, 1976; Nelson, 1997). Many have quantitatively interpreted forest conditions from the GLO surveys, although this approach has some theoretical, statistical and scale-related problems (Bourdo, 1956; Noss, 1985; Schulte and Mladenoff, 2001; Whitney and DeCant, 2001). Perhaps the most valuable information in the GLO records are the narratives left by the surveyors. Their colloquial observations on the lands they traversed can appreciably supplement the information available to modern researchers.

This study summarizes a detailed examination of the GLO records and other early accounts for the Ashley County, Arkansas, area and expands on the limited knowledge of regional reference conditions. A complementary effort has examined scores of documents,

[1] Research Forester; Telephone: (870) 367-3464; FAX: (870) 367-1164; e-mail: dbragg@fs.fed.us

photographs and other historical records from the 19th and early 20th Centuries for any useful information on composition, structure and stand dynamics in the Upper West Gulf Coastal Plain (Bragg, *in press*). When combined, these studies will assist in the restoration of communities resembling the virgin forests of this portion of the southern United States.

METHODS AND MATERIALS

Data source.—Most of the information in this study was drawn from the 1818 to 1855 GLO surveys of Ashley County and adjacent portions of Bradley, Drew and Union counties (Fig. 1). The original survey notes were transcribed by the deputy surveyors into field notebooks and later transferred to GLO offices for archiving (the handwritten notes for Arkansas were typed during the 1930s). Recently, the Arkansas Commissioner of State Lands Office scanned the typewritten records and made them available to the public as a digital archive (Daniels, 2000). Original copy quality varied, however, limiting the interpretation of some sheets.

Three types of "corners" were permanently established by the GLO surveyors (Fig. 2). Section corners were placed at the intersection of section lines, whereas quarter-section corners were located at the midpoint of each side of the section. Meander (called "fractional" by the surveyors) corners were set at every intersection of a section line with a navigable body of water. Each corner was marked, usually with a wooden stake, and then located relative to one to four "witness" trees for which species was identified, diameter was estimated and direction and distance to the corner were measured to the nearest link (1 link = 7.92 in = 20.1 cm). Two to four "line" trees along section boundaries were also established to help delineate sections (*see* Stewart (1935) and Bureau of Land Management (1947) for details on the implementation of the survey protocols). Data in the GLO records also include plat maps (which often identified significant attributes like water bodies, prairie or wetland locations, windfalls, geology, agricultural fields, etc.) and occasional commentary on other natural features.

Analysis procedures and challenges.—At least 16 deputy surveyors worked in the study area from 1818 to 1855. Due to the duration of this effort, surveyors operated under an evolving set of instructions (Stewart, 1935). The large number of observers and different performance standards has undoubtedly affected the consistency of the information drawn from the GLO records. Uneven observations constrain the ecological assessment of the survey records because one cannot attribute variation in the notes to the observer, environmental change or pre-existing conditions. For instance, no specific directions for where and how to estimate tree diameter were provided, although this may have been standardized and taught to surveyors during their professional development. It cannot be presumed, however, that diameter used by the surveyors was taken at the current standard of 1.37 m above mineral soil, nor can it be assumed that the same rules for measuring diameter in special cases (*e.g.*, on a slope, leaning trees or for a buttressed base) were applied.

The contractual requirements of surveyors also limited their ability to observe natural features. As an example, the trees selected to witness corners or lines were not randomly or systematically selected from the available population of stems. Rather, as stated in the 1843 instructions issued by the GLO office in Little Rock, Arkansas, the surveyors were to:

> . . . select for bearing trees those which are the *soundest and most thrifty* in appearance, and of the size and kinds of trees which *experience* teaches will be the *most permanent and lasting.* (Reported in Stewart (1935, p. 165), emphasis added)

This instruction permitted considerable latitude in how witness trees were chosen and probably resulted in a level of bias to each surveyor that cannot be quantified. For instance,

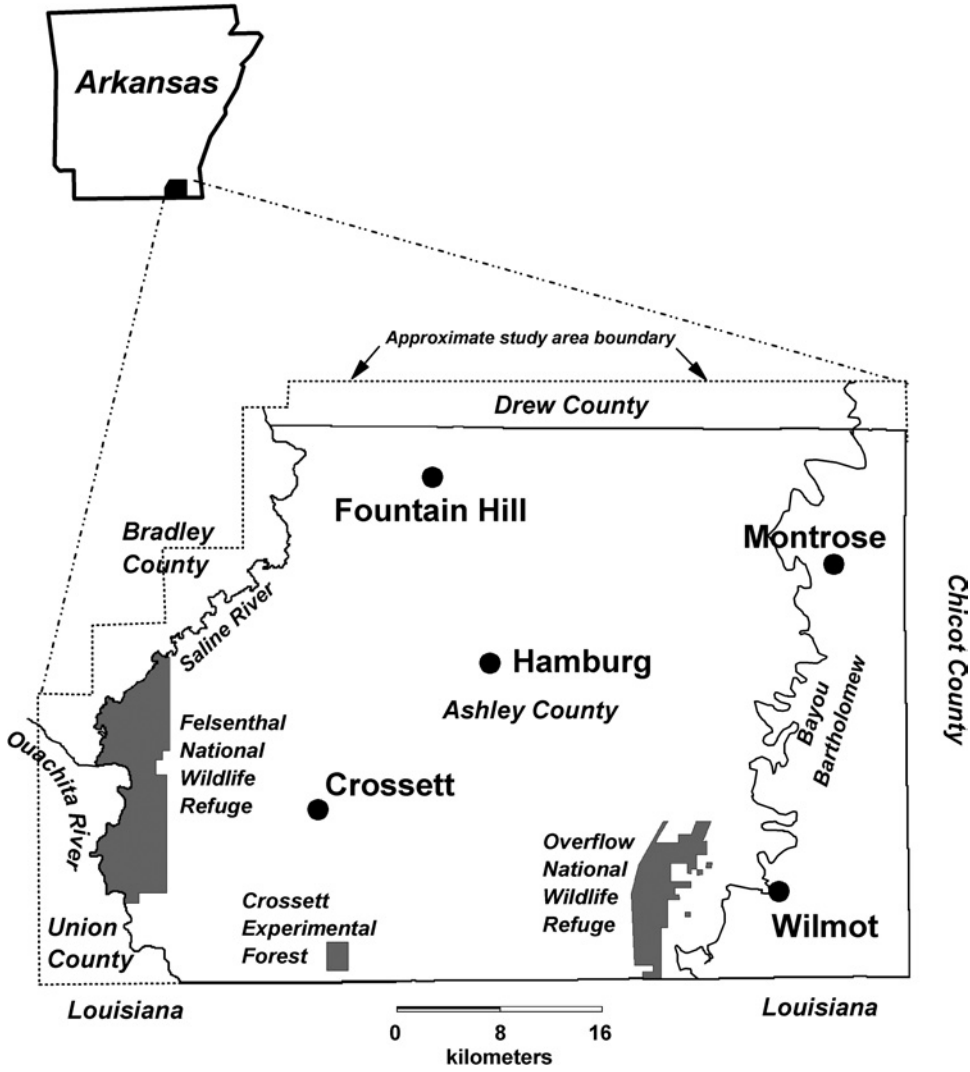

FIG. 1.—Location of the Ashley County, Arkansas study area (dotted line) and contemporary major geopolitical features, including streams, public lands and municipalities

the requirement for "thrifty" witness trees almost certainly prompted them to avoid damaged individuals. Only rarely were leaning or broken-topped trees or multiple stems (called "forked," "doubles" or "triples") mentioned in the surveyor notes, even though these commonly occur in forests.

Another difficulty with GLO survey notes is the uncertainty associated with their species identifications. Since the surveyors did not have formal taxonomic training and most of the study area was traversed in the dormant (leaf-off) season (November to March), it is probable that misidentifications occurred. Further complicating matters is that surveyors

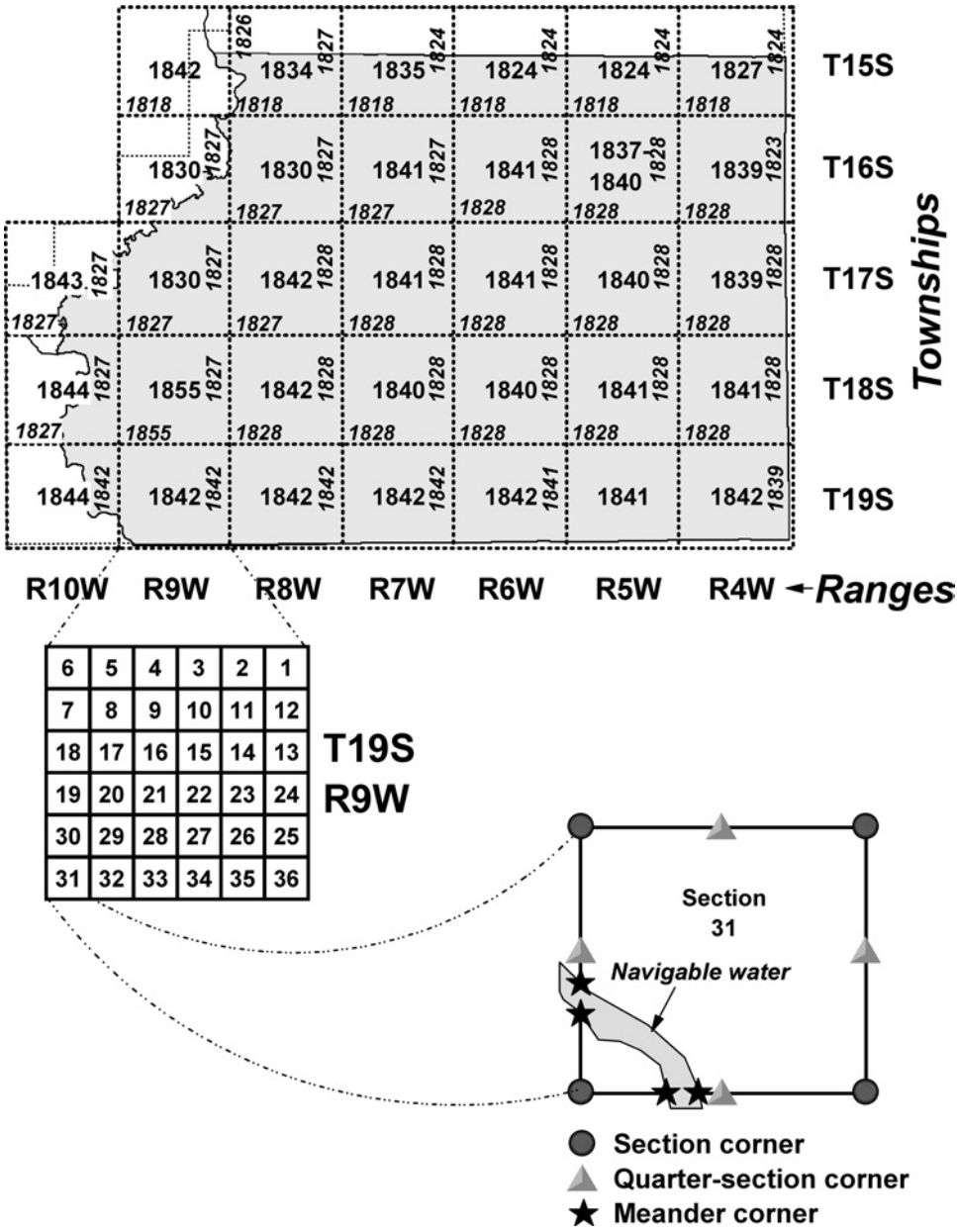

FIG. 2.—Completion dates of GLO survey in townships in the study area (Ashley County has been shaded for context). Dashed lines are approximate township locations, with the year(s) of boundary completion indicated by smaller, italicized font along the township margins and the year(s) of interior completion printed in large font in the center of each square. Insets indicate the layout of the 36 sections within a township (T19S R9W) and the corner types established for section 31 (meander corners were unique to sections lines crossing navigable bodies of water)

always used common names, some of which are now applied differently or no longer used. To address this concern, a list of the surveyor species names and the most probable contemporary taxonomic identifications was created after consulting botanists, foresters, dendrology and silviculture texts and old research papers (multiple possibilities remain for some species). When referring directly to species in this article, the surveyor's identifications are provided.

These influences, coupled with the small sample size at any given point, make it unwise to quantify stand structure solely based on GLO notes (Schulte and Mladenoff, 2001; Whitney and DeCant, 2001). After all, the GLO surveyors were not trained in nor expected to perform the duties of a botanist, ecologist or forester. Since it is virtually impossible to account for surveyor bias, only the most basic statistics of the GLO records were considered. A table of witness trees and their abundances and diameter range was developed. Additionally, a separate list of the largest (>130 cm diam) trees was compiled. The remainder of this paper consists of the narratives provided by the surveyors as they traversed the Ashley County study area.

RESULTS

FOREST ATTRIBUTES

Witness tree characteristics.—Not counting spelling differences or interchangeable common names, GLO surveyors recorded at least 70 tree species in the Ashley County area (Table 1). Some of their taxonomic distinctions were imprecise (*e.g.*, "gum," rather than "sweetgum") and species of small stature or poor form were largely absent. Thus, the true number of presettlement tree species in the study area was almost certainly greater than reported. The six most abundant species groups accounted for more than two-thirds of all witness trees (Table 2, Fig. 3). Black oak (primarily *Quercus velutina* Lam.) was the most common witness tree (18% of total), followed by pine (*Pinus* spp.) (17%), post oak (*Quercus stellata* Wang.) (11%), white oak (*Quercus alba* L.) (9%), hickory (*Carya* spp.) (7%) and sweetgum (*Liquidambar styraciflua* L.) (7%). Over 60% of the taxa had fewer than 20 individuals and 26% were represented by only one individual.

Ashley County area GLO surveyors usually selected moderate-sized witness trees, as 59.2% of all trees ranged from 10 to 20 in (25 to 50 cm)[2] in diameter (Table 2, Fig. 3). Few stems smaller than 5 inches (12 cm) in diameter were taken as witness trees and no individuals less than 3 inches (8 cm) were used. Across the entire 283,000+ ha study area, the GLO surveyors included 737 trees (5.7% of the total) over 30 in (75 cm) in diameter, with only 122 (0.94%) individuals exceeding 40 inches (100 cm) (Table 3, Fig. 3). Trees of either size extreme were poorly suited for witnessing corners. Small stems were too diminutive to adequately scribe with the required markings and surveyors avoided large trees because of their thick, often scaly or platy, difficult-to-remove bark.

Bottomland forests.—According to the GLO records, the bottoms of the Ouachita and Saline Rivers in western Ashley County and Bayou Bartholomew in the eastern portions of the study area (Fig. 4) contained many baldcypress (*Taxodium distichum* (L.) Rich.), oaks (*Quercus* spp.), gums (mostly *Nyssa* spp.) and other hardwoods 36 to 50 inches (91 to 127 cm) in diameter, with some individuals exceeding 70 inches (178 cm). Baldcypress reached immense size in southern Arkansas, considerably surpassing all other species in maximum girth (Table 3). For example, deputy surveyor L.M. Eiler noted a baldcypress 144 inches

[2] English (and metric, parenthetically) units are used when specific numbers are referred to in quotes or otherwise directly referenced (metric units are provided in all other cases)

TABLE 1.—GLO surveyors' identifications, probable taxonomic interpretations and scientific names (in italics) of the witness tree species identified in the Ashley County, Arkansas area

Surveyors' identification[a]	Probable species[b]
Ash	*Fraxinus* spp.
Bull bay	*Magnolia virginiana*
Beech	*Fagus grandifolia*
Black cherry	*Prunus serotina*
Black elder	*Ilex decidua* var. *decidua*, *Sambucus canadensis*
Black gum	*Nyssa sylvatica* var. *sylvatica*
Black hickory	*Carya texana*
Black oak (b. oak)	*Quercus velutina*, *Quercus schumardii*, *Quercus pagoda*, *Quercus falcata*
Black walnut (walnut)	*Juglans nigra*
Blackjack oak (blackjack)	*Quercus marilandica*
Box elder	*Acer negundo*
Catalpa (catalpia)	*Catalpa bignonioides*, *Catalpa speciosa*
Chinkapin (chinquapin)	*Castanea pumila* var. *pumila*
Chinkpin oak	*Quercus muehlenbergii*, *Castanea pumila* var. *pumila*
Cottonwood	*Populus deltoides*, *Populus heterophylla*
Cypress	*Taxodium distichum*
Dogwood	*Cornus florida*
Elm	*Ulmus* spp.
Gum	*Nyssa* spp., *Liquidambar styraciflua*
Hackberry (hack)	*Celtis laevigata*, *Celtis occidentalis*
Hickory (hick)	*Carya* spp.
Holly	*Ilex opaca*
Honey locust	*Gleditsia triacanthos*, *Gleditsia aquatica*
Hornbeam (horn beme)	*Carpinus caroliniana*, *Ostrya virginiana*
Ironwood	*Ostrya virginiana*, *Carpinus caroliniana*
Laurel	*Symplocos tinctoria*, *Magnolia virginiana*
Locust	*Gleditsia triacanthos*, *Gleditsia aquatica*, *Robinia pseudoacacia*
Lynn (lin)	*Tilia americana*
Maple	*Acer rubrum*, *Acer saccharinum*, *Acer saccharum* var. *floridanum*
Mulberry	*Morus rubra*
Oak	*Quercus* spp.
Overcup oak	*Quercus lyrata*
P. oak	*Quercus phellos*, *Quercus stellata*, *Quercus nigra*, *Quercus laurifolia*, *Quercus texana*
Pawpaw	*Asimina triloba*
Pecan	*Carya illinoensis*
Persimmon	*Diospyros virginiana*
Pignut hickory	*Carya cordiformis*
Pine	*Pinus echinata*, *Pinus taeda*
Pin oak	*Quercus phellos*, *Quercus nigra*, *Quercus laurifolia*, *Quercus texana*
Post oak	*Quercus stellata*
Privy (privey, prevey)	*Forestiera acuminata*
Red elm	*Ulmus rubra*
Red haw	*Crataegus berberifolia*, *Crataegus crus-galli*, *Crataegus mollis*
Red oak	*Quercus falcata*, *Quercus pagoda*, *Quercus shumardii*, *Quercus texana*, *Quercus velutina*
Red privy	*Forestiera acuminata*
Sassafras	*Sassafras albidum*
Scalebark hickory	*Carya ovata*

TABLE 1.—Continued

Surveyors' identification[a]	Probable species[b]
Shellbark hickory	*Carya ovata*
Slippery elm	*Ulmus rubra, Ulmus americana*
Spanish oak	*Quercus falcata, Quercus pagoda*
Sugar	*Acer saccharum* var. *floridanum, Celtis laevigata*
Sugar maple	*Acer saccharum* var. *floridanum*
Swamp oak	*Quercus michauxii*
Swamp white oak	*Quercus michauxii, Quercus lyrata*
Sweet bay (bay)	*Magnolia virginiana*
Sweet elm	*Ulmus americana*
Sweet gum	*Liquidambar styraciflua*
Swamp elm	*Planera aquatica, Ulmus rubra*
Sycamore	*Platanus occidentalis*
Tupelo gum	*Nyssa aquatica*
Water beech	*Carpinus caroliniana*
Water birch (birch)	*Betula nigra*
Water elm	*Planera aquatica*
Water oak	*Quercus nigra, Quercus phellos, Quercus laurifolia*
White ash	*Fraxinus americana*
White oak (w. oak)	*Quercus alba, Quercus michauxii*
White privy	*Forestiera acuminata*
Wild peach	*Prunus persica, Prunus umbellata*
Willow	*Salix nigra*
Willow oak	*Quercus phellos, Quercus nigra, Quercus laurifolia*

[a] Sometimes the surveyors used multiple spellings for the same species—these names represent the most probable intended common names

[b] Species nomenclature and interpretations from Putnam and Bull (1932), Delcourt (1976), Smith (1988), Moore (1999) and Dr. Eric Sundell (pers. comm.)

(366 cm) in diameter in Township 17 South (T17S), Range 9 West (R9W) and deputy surveyor Charles Moore reported a 140-inch (356 cm) diameter baldcypress along the Ouachita River in Union County. Along Bayou Bartholomew, deputy surveyor Nicholas Rightor described the "... excellent Cypress timber ..." and "... the best and largest of Cypress timber ..," although the biggest tree mentioned in these stands was only 60 inches (152 cm) in diameter.

Scattered pockets of water tupelo (*Nyssa aquatica* L.) accompanied baldcypress in the wettest of the large bottomlands. Other bottomland hardwoods frequently encountered included overcup oak (*Quercus lyrata* Walt.), pin oak (probably *Q. phellos* L. and *Q. nigra* L.), pecan (*Carya illinoensis* (Wang.) K. Koch) and various ash (*Fraxinus* spp.) species. Narrow bottomland forests bracketed many of the smaller drainages in the study area, including Chemin-A-Haut Creek in southcentral Ashley County (Fig. 4). River birch (*Betula nigra* L.), "privy" (*Forestiera acuminata* (Michx.) Poir.), American hornbeam (*Carpinus caroliniana* Walt.), planer tree (*Planera aquatica* (Walk.) Gmelin) and black willow (*Salix nigra* Marsh.) were also noted in Ashley County bottomlands by the early GLO surveyors. Several taxa, including sweetgum, blackgum (*Nyssa sylvatica* Marsh.), maple (primarily *Acer rubrum* L.) and elm (*Ulmus* spp.) were common on both bottom and upland sites, frequently intermixed with oak and pine.

Upland forests.—Much of the study area located above overflow was dominated by

TABLE 2.—Proportions and dimensions of witness tree species by surveyor name (in declining order of abundance) in the Ashley County area GLO records

Surveyor name[a]	Number of witness trees	Percent of total	Minimum diameter (inches)[b]	Average diameter (inches)	Standard deviation of avg. dia. (inches)[b]	Maximum diameter (inches)
Black oak	2331	17.98	3	19	6.2	80
Pine	2200	16.97	3	20	9.0	72
Post oak	1364	10.52	3	16	4.8	40
White oak	1167	9.00	4	19	8.7	80
Hickory	879	6.78	4	13	5.1	40
Sweet gum	872	6.73	4	20	9.9	70
Pin oak	675	5.21	4	16	6.2	78
Overcup oak	588	4.54	4	17	8.1	54
Black gum	408	3.15	5	14	4.9	40
Red oak	344	2.65	4	23	10.6	60
Elm	295	2.28	4	12	4.1	30
Pecan	206	1.59	3	13	5.1	40
Maple	203	1.57	4	13	4.7	36
Ash	179	1.38	4	13	5.6	40
Cypress	173	1.33	6	30	19.5	144
Persimmon	127	0.98	4	11	3.4	24
Gum	111	0.86	4	18	8.2	40
Willow oak	85	0.66	7	16	4.8	44
P. oak	71	0.55	6	15	4.8	40
Holly	65	0.50	3	9	3.0	16
Dogwood	61	0.47	3	7	2.0	12
Sassafras	58	0.45	4	12	4.8	30
Hackberry	47	0.36	3	10	4.4	30
Ironwood	47	0.36	5	8	1.8	12
Blackjack oak	39	0.30	5	10	2.9	18
Chinkapin	34	0.26	4	11	3.5	20
Hornbeam	30	0.23	5	8	1.8	11
Honey locust	29	0.22	6	13	4.2	20
Swamp elm	23	0.18	6	9	2.7	14
Spanish oak	22	0.17	4	16	8.4	40
Red privy	19	0.15	5	10	4.5	20
Tupelo gum	18	0.14	5	24	16.6	72
Lynn	17	0.13	6	13	5.0	20
Privy	16	0.12	4	8	2.4	14
Water beech	14	0.11	8	11	3.5	18
Red elm	13	0.10	7	10	2.4	14
Water oak	13	0.10	8	15	6.6	30
Water birch	11	0.08	9	20	7.8	36
Willow	11	0.08	6	15	5.2	24
Mulberry	10	0.08	4	10	2.7	12
Sycamore	9	0.07	12	23	10.2	40
Oak	8	0.06	10	15	6.8	30
Shellbark hickory	8	0.06	10	18	5.0	24
Water elm	7	0.05	8	9	1.5	12
White privy	7	0.05	5	7	1.6	9
Beech	5	0.04	12	23	11.7	40
Swamp white oak	5	0.04	6	16	11.6	34

TABLE 2.—Continued

Surveyor name[a]	Number of witness trees	Percent of total	Minimum diameter (inches)[b]	Average diameter (inches)	Standard deviation of avg. dia. (inches)[b]	Maximum diameter (inches)
Black walnut	4	0.03	16	25	6.6	30
Laurel	4	0.03	4	6	1.7	8
Locust	4	0.03	10	12	2.8	16
Sweet bay	4	0.03	3	6	2.9	10
Catalpa	3	0.02	6	10	4.5	15
Slippery elm	3	0.02	6	9	3.1	12
Black cherry	1	0.01	14	14	0.0	14
Black elder	1	0.01	6	6	0.0	6
Black hickory	1	0.01	16	16	0.0	16
Box elder	1	0.01	10	10	0.0	10
Bull bay	1	0.01	8	8	0.0	8
Chinkpin oak	1	0.01	11	11	0.0	11
Cottonwood	1	0.01	20	20	0.0	20
Pawpaw	1	0.01	6	6	0.0	6
Pignut hickory	1	0.01	18	18	0.0	18
Red haw	1	0.01	6	6	0.0	6
Scalebark hickory	1	0.01	16	16	0.0	16
Sugar maple	1	0.01	18	18	0.0	18
Sugar tree	1	0.01	12	12	0.0	12
Swamp oak	1	0.01	14	14	0.0	14
Sweet elm	1	0.01	10	10	0.0	10
White ash	1	0.01	36	36	0.0	36
Wild peach	1	0.01	4	4	0.0	4
Total trees:	12,963	100.00				

[a] Common species names as designated by the early surveyors

[b] Diameter information from the GLO surveys are ocular estimates based at an unknown height above the ground. Values are in inches to show the precision of the diameter estimates (1 inch = 2.54 cm)

hardwoods, often interspersed with loblolly (*Pinus taeda* L.) and shortleaf (*Pinus echinata* Mill.) pine. Hickories were ubiquitous across the uplands, reflecting little apparent topoedaphic pattern. However, the pooling of multiple hickory species under one name probably masked any obvious pattern related to site quality. Black oak, white oak, sweetgum, blackgum, southern red oaks (*Quercus falcata* Michx. and *Quercus pagoda* Raf.), flowering dogwood (*Cornus florida* L.) and American holly (*Ilex opaca* Ait.) prevailed on mesic sites. Good hardwood sites, especially those close to bottomlands, often yielded very large (>100 cm diam) oak, gum, hickory, pine and ash witness trees. Drier environments were dominated by post oak and scattered blackjack oaks (*Quercus marilandica* Muench.) with a considerable pine component. Intergrades between upland hardwood- and pine-dominated stands were common, making it difficult to delineate forest communities using GLO data. Because of this, upland virgin forests have been mapped in Figure 4 as "mixed pine/hardwood."

Loblolly and shortleaf pine comprised 17% of the witness trees from the Ashley County area (Table 2), a relatively low number given the prominence of pine in the development of this region. Pine may have been underused because surveyors avoided large trees if small

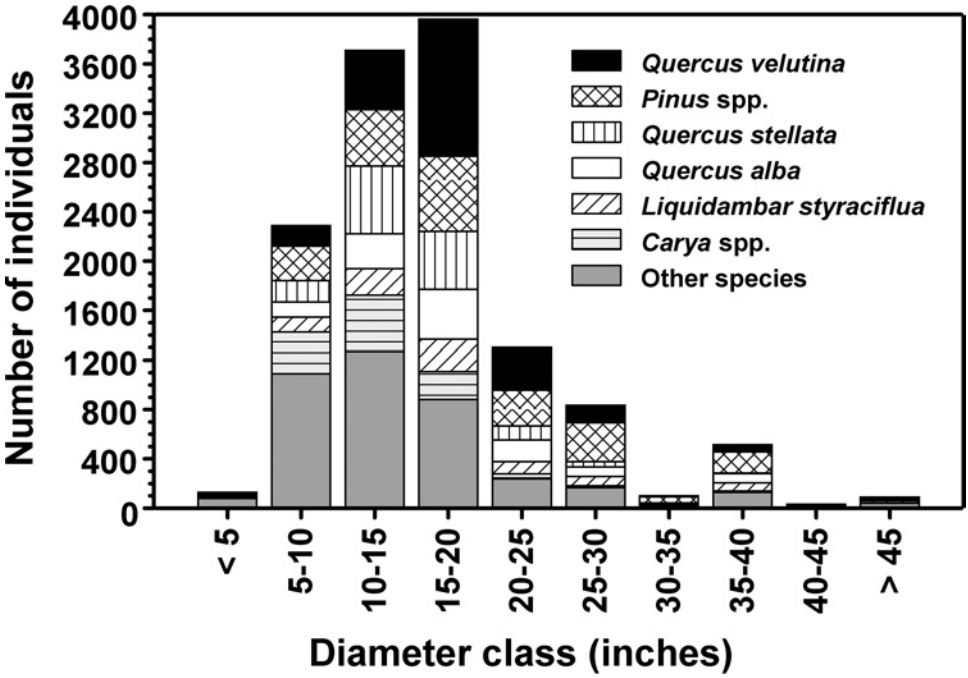

FIG. 3.—Diameter class (1 in = 2.54 cm) by species or species group of trees used by the GLO surveyors in the Ashley County study area

vigorous individuals were available or may have wanted to avoid damaging the valuable pine timber or perhaps even deliberately selected hardwoods in predominantly pine stands (*see* Bourdo, 1956; Mendelson, 2002). The GLO surveyors did not distinguish between loblolly and shortleaf pine (referring instead simply to "pine"), but differences in their life history and response to disturbance suggests their likely presettlement distributions. Since young shortleaf pine can sprout following a top-killing fire and this species does better on poorer sites (Mohr, 1897; Mattoon, 1915), the pinelands adjacent to upland prairies (especially those that burned frequently) were likely dominated by shortleaf (Olmsted, 1902; Record, 1907). Loblolly was most abundant on wetter sites (Olmsted, 1902; Record, 1907; Forbes and Stuart, 1930). The loblolly pine flatwoods bordering the Ouachita River were extensive and contained the largest pine recorded in the Ashley County area GLO notes (72 inches (183 cm) in diameter, Table 3).

Understory conditions.—Reports of understory conditions in the Ashley County area GLO surveys were not as consistent or detailed as for the overstory. In many instances, the only reference to the understory involves mention of grass, brush, cane (*Arundinaria gigantea* (Walt.) Muhl.), briars or vines. Dense cane thickets and dwarf palmetto (*Sabal minor* (Jacq.) Pers.) were common in small bottomlands. Deputy surveyor Nicholas Rightor, when looking over the Bayou Bartholomew bottoms from a hill along the east boundary of section 25, T18S R6W, spotted an abundance of Spanish moss (*Tillandsia usneoides* L.), an epiphyte that reaches its northern extent in extreme southern Arkansas (Smith, 1988). *Rubus* spp. and *Smilax* spp. comprised most of the briars. Vines consisted of *Vitis* spp., *Berchemia scandens*

TABLE 3.—Surveyor name, diameter, legal description and measurement year of the largest (>132 cm diameter) trees noted in the GLO surveys of Ashley County, Arkansas area

	Diameter		Legal description		
Surveyor name[a]	(inches)	(cm)	Township	Range	Year
Cypress	144	366	17S	9W	1830
Cypress	140	356	18S	10W	1844
Cypress	96	244	17S	10W	1843
Black oak	80	203	16S	4W	1839
White oak	80	203	16S	4W	1839
White oak	80	203	17S	4W	1839
Cypress	80	203	17S	5W	1828
Cypress	80	203	18S	10W	1844
Pin oak	78	198	18S	5W	1841
Tupelo gum	72	183	19S	10W	1842
Pine	72	183	19S	10W	1844
Sweet gum	70	178	16S	4W	1839
Sweet gum	70	178	19S	7W	1842
Cypress	65	165	19S	5W	1841
White oak	60	152	15S	4W	1827
Sweet gum	60	152	15S	4W	1827
Red oak	60	152	16S	4W	1839
Cypress	60	152	16S	4W	1828
Pine	60	152	16S	9W	1830
Cypress	60	152	17S	10W	1827
Sweet gum	60	152	17S	10W	1843
White oak	60	152	17S	4W	1839
Sweet gum	60	152	18S	10W	1844
Pin oak	60	152	18S	10W	1844
Cypress	60	152	19S	10W	1844
Cypress	60	152	19S	10W	1844
Cypress	60	152	19S	4W	1842
Cypress	60	152	19S	5W	1841
Cypress	55	140	17S	5W	1840
Sweet gum	55	140	19S	5W	1841
Black oak	55	140	19S	5W	1841
Overcup oak	54	137	19S	10W	1844
Pine	52	132	15S	8W	1834

[a] Common species names as designated by the early surveyors

(Hill) K. Koch, *Smilax* spp., *Lonicera* spp. and *Toxicodendron radicans* (L.) Kuntze, among other less common taxa. Shrubs reported in the Ashley County area included dogwood (*Cornus* spp.), holly (*Ilex* spp.), haw (*Crataegus* spp.), huckleberry (*Vaccinium* spp.), tear-blanket (*Aralia spinosa* L.), spicewood (*Lindera benzoin* (L.) Blume), *Prunus* spp. and witch hazel (*Hamamelis virginiana* L.).

Surveyors rarely mentioned abundant tree seedlings and saplings, but these size classes were probably locally common. Oak, hickory, pine, maple (*Acer* spp.), blackgum, sweetgum, dogwood (*Cornus* spp.), holly (*Ilex* spp.), chinkapin (*Castanea pumila* (L.) Mill.), hornbeam (*Ostrya virginiana* (Mill.) Koch.) and sassafras (*Sassafras albidum* (Nutt.) Nees.) were the primary understory trees reported by the surveyors.

One unexpected species identified by a deputy surveyor was the "wild peach." This may

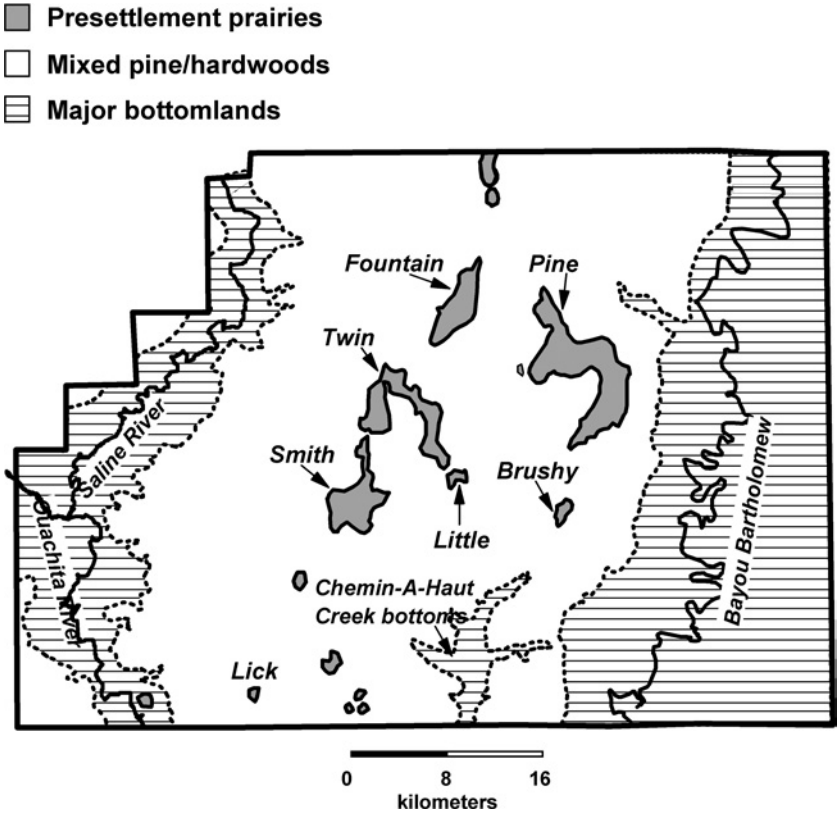

FIG. 4.—Approximate distribution of bottomlands, upland mixed pine-hardwood stands and prairies during the GLO survey period of 1818–1855 (prairie distribution and traditional names as provided by the surveyors, Anonymous (1890) and Wackerman (1929))

have been the peach "of Persia" (*Prunus persica* (L.) Batsch), an exotic to North America (Harrar and Harrar, 1962). The remote forests of southeastern Arkansas circa 1826 may seem a strange place to find this cultivated species. However, other GLO surveyors working near Crowley's Ridge in east-central Arkansas in 1817 reported peach and apple (*Malus pumila* Mill.) trees associated with former Native American settlements. Peach was also said by Thomas Nuttall to have been "... naturalized through the forests of Arkansa [sic] ..." by the time of his 1819 journey across the state (Nuttall, 1980, p. 112), suggesting that the surveyor may have indeed encountered this species.

GRASSLAND COMMUNITIES

The once widespread, but now rare, grasslands of eastern and southern Arkansas are a poorly understood presettlement feature. At one time, the state had an estimated 233,000 to >400,000 ha of prairie, mostly in Prairie and Arkansas counties (Harvey, 1883; Irving *et al.*, 1980). As per their instructions, GLO surveyors demarcated prairie lands and, thus, recorded their original location and extent in the Ashley County area (Fig. 4). Anonymous (1890)

named the six major prairies in Ashley County: Pine (3432 ha), Brushy (243 ha), Fountain (1004 ha), Little (146 ha), Twin (1149 ha) and Smith (1635 ha). Other small areas of prairie were noted in the GLO survey records and by Wackerman (1929) and Etheridge (1959).

Four types of grass-dominated communities can be distinguished. Upland prairies formed on old Pleistocene river terraces and were probably maintained by fire and grazing (T. Foti, pers. comm.). Bottomland prairies arose from a combination of hydrology, frequent fire, soil texture and mineralogy (T. Foti, pers. comm.) and lacked the natural mounds common to terrace grasslands. Alkaline or "lick" prairies (so named because of their animal-attracting mineral deposits) have severely impeded drainage and few runoff channels, forcing most surface water to depart through evaporation. Hence, salts accumulate and, coupled with the seasonal inundation of these areas, inhibit tree establishment (Wackerman, 1929). Often associated with the prairies in Ashley County were communities described as "oak openings" or "barrens" (Owen, 1860). Descriptions like "grassy woods" or "prairie woods" helped distinguish them from the closed canopy forests and grasslands that dominated the landscape. Shortleaf pine and post oak were common associates of most woodlands, with other oaks, gums and hickories present. Deputy surveyor Caleb Langtree also identified small areas in T19S R9W as "hickory barrens" or "hickory & dogwood barrens," presumably hickory-dominated woodlands.

The grasslands of eastern Arkansas were remarkably diverse, with numerous endemic species (Harper, 1914; Irving *et al.*, 1980). Harper (1914, p. 43) was amazed by the taxonomic richness of the Grand Prairie near Hazen, Arkansas, recognizing "... more species of plants in this prairie in one day than I have in the prairies of Long Island [New York] in three summers." Few herbaceous or woody species were specifically identified by the surveyors in the Ashley County grasslands although they can be found. For example, deputy surveyor Andrew Bowman repeatedly mentioned Spanish needles (*Bidens bipinnata* var. *bipinnata* L.) in Pine Prairie.

Perturbations were a major factor in the dynamics of the prairies and woodlands of southern Arkansas, encouraging grass and reducing the abundance of woody undergrowth (including trees) that otherwise dominated (Olmsted, 1902). Deputy surveyor Caleb Langtree witnessed the role of disturbance along the Ouachita and Saline Rivers in western Ashley County:

> ... an open grassy plain small pine timber here & there...[there are] islands surrounded by deep overflow, the surface of the country presents a beautiful and parklike [sic] appearance, but the frequent occurrence of the water mark upon the trees, dispels the illusions of beauty in a moment.

and later "[l]and all in overflow where the timber has fallen & burned up, looks like a prairie, but the fatal water mark soon deceives one as to the true character of the Land. . . ."

DISTURBANCES

GLO surveyors were instructed to record lands disturbed by windthrow, fire, flood and human "improvements" (Bourdo, 1954; Noss, 1985; Hutchison, 1988). Since the surveyors traversed along limited and predetermined routes to complete their tasks, they almost certainly missed smaller disturbances within the interiors of the sections they established. It is also possible that some surveyors ignored disturbed areas, especially if obscured by time. Hence, extrapolation of disturbance regimes using the GLO notes underestimates the extent of the area affected and the frequency of the events.

Windthrow.—A number of windthrow events are described in the Ashley County area GLO notes. For instance, near the Ouachita River in 1827 one deputy surveyor observed:

> [h]ere the Hurricane makes quite a grand appearance; in looking down the long reach of the [Ouachita] river to the South & S W no green Timber to be Seen, nothing but a few trunks of trees and they trimed [sic] of all their branches . . . .

Although windthrown areas were usually called "hurricanes," the likelihood of tropical storms damaging southern Arkansas forests is slight (Turner, 1935; Hutchison, 1988). Tornadoes and straight-line winds are much more likely to have produced the damage found by the GLO surveyors. Tornadoes, for instance, are common in Arkansas, with over 200 twisters reported statewide from 1879 to 1926 (Cole, 1927). It is also possible that some disturbed areas attributed to windfall resulted from heavy ice or snow accumulation, which can similarly injure trees.

Windfall sometimes impeded surveyor progress with downed debris and dense understories. One surveyor noted "[t]imber where there is any standing overcup Oak Pecan . . . but generally down and rotton [sic] by Hurricane with an immense growth of bushes vines briers . . . ." A different surveyor remarked ". . . the line runs thro [sic] an old windfall and the worst thicket of bushes, vines, and briers I ever saw . . ." and finally "[i]t is as bad a country of Cane vines and briers, as any, and I feel myself compelled to give over the pursuit, for I cannot do the work as it should be done. . . ." Even with the rapid decomposition of fallen timber in Arkansas (Long, 1917) and the quick response of understory vegetation to openings in the canopy, it probably took at least a decade for most evidence of windthrow to completely disappear (*see also* Canham and Loucks, 1984). For example, the GLO plat of the north half of sections 3 and 4 in T15S R4W (drawn in 1837) included an area of windthrow that was still apparent when the American Land Company listed some of these properties for sale in 1844 (American Land Company, 1844).

At least 22 discrete windthrow events in the Ashley County area were notable enough for the surveyors to have mapped them (Fig. 5). Three areas covering approximately 1120 ha, 850 ha and 200 ha are obvious (arrows in Fig. 5) and their long, relatively narrow tracks suggest tornadic origins. These events account for over 90% of the roughly 2400 ha of windfall recorded by the surveyors. Most wind damaged areas were small, however, covering less than 10 ha (median = 8 ha, mean = 108 ha, standard deviation = 290.2 ha, range = 3 to 1118 ha). Even though the minimum size of windthrow included in the GLO records is unknown, judging from the smallest areas reported in Ashley County, surveyors disregarded those less than 3 ha. The true extent affected by catastrophic windthrow was further underestimated by the sometimes disjunct timing of the different survey crews. Adjacent townships were periodically not traversed until many years later, often resulting in the abrupt cessation of a windthrow event at their boundary.

Hydrological extremes.—Flooding is mentioned throughout the GLO records of Ashley County. Most references are limited to brief comments made of the depth of "overflow" (obvious markings left on trees from high water). Overflow ranged from 1 to 6 m along large streams to as much as 9 m deep along the Ouachita River. The impact of the hydrological events on the GLO effort depended on the size of the affected drainage, the season of the survey and the weather during the measurement period. Water was sometimes scarce and often too abundant, drowning horses or ending fieldwork prematurely. Improved stream crossings in Arkansas were rare at this time, so traveling across flooded areas could prove hazardous for surveyors and ordinary citizens alike. For example, the adventurer Albert Pike nearly drowned when crossing the flood-swollen Garrison's Creek in western Arkansas in which "[a]t low water, the banks are twenty-five feet [7.6 m] above water; now, the water was level with them. . .." (Pike, 1835, p. 269).

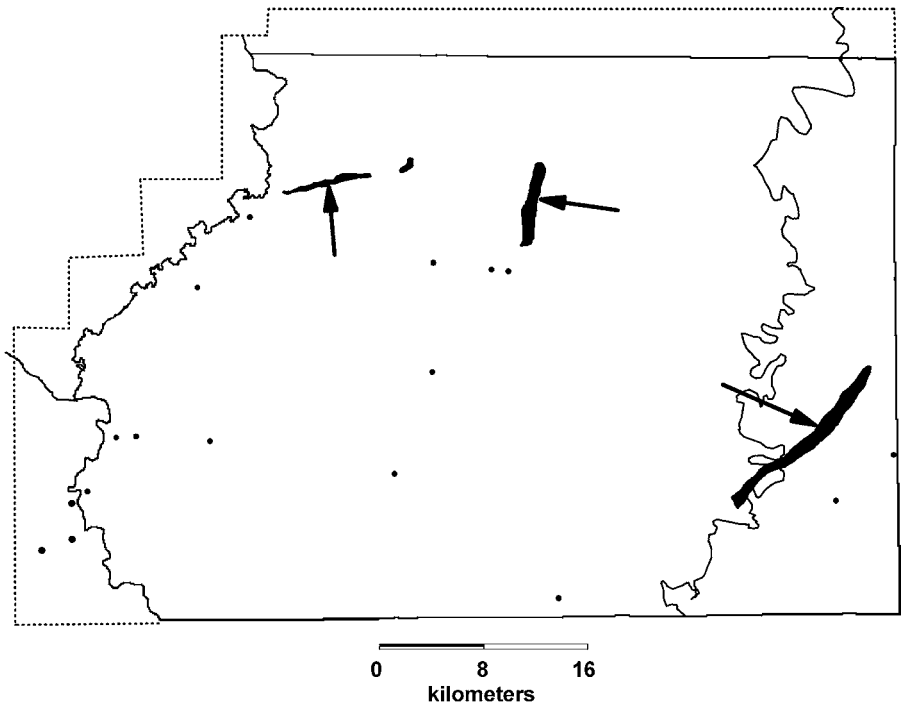

FIG. 5.—Areas of windthrow (black dots and linear tracks) demarcated on GLO plat maps from the Ashley County study area. The long, linear windthrow features (arrows) are almost certainly tornado paths, while smaller point locations could be from downbursts, straight line frontal winds, tornadoes or other types of catastrophic disturbance that appear similar to windthrow

Specific storm and flooding events were occasionally described by surveyors who usually worked during the wet winter and spring seasons. In January of 1828 one saturated surveyor bemoaned the "... desperate heavy rain all day ..." and a couple days later "... from 5 to 6 inches [12 to 15 cm] ... water fall accompanied with heavy thunder & sharp lightning and this day still raining and no prospect of clearing off ... ." This rainy period limited his ability to work as "... the whole face of the country [was] now covered and overflowing with water ..." and "[t]he waters of the small streams are beyond all description high, and the hills very bogy [sic]... ." Occasionally, dry spells were encountered. Deputy surveyor Caleb Langtree once remarked in the notes "... not one drop of Water have we Seen in these 2 days, except what we have drunk at Camp."

Fire.—Fire is thought to have been an important component of the pre-European forests of the southern United States (Delcourt, 1976; Schafale and Harcombe, 1983), but was infrequently mentioned in the Ashley County GLO notes. Lutz (1930) suggested that some burned forests may have been recorded as windthrow, although it would seem hard to confuse charred with wind-toppled trees. It does not appear possible to reconstruct fire regimes from the descriptions in the Ashley County GLO records because of indefinite fire boundary descriptions and the lack of a reliable method to estimate time since burn. However, the surveyor's narratives about fire damage provide some insight into the role of fire in the presettlement forests of the Ashley County area. During his 1855 resurvey of the

boundaries of T18S R9W, Caleb Langtree found "[h]uge trunks of trees...on the ground blackened by the fire & broken into fragments by their fall ...." Others reported an undergrowth of "... [d]ogwood prickle shoemake [sic] and cane on the highest ground but dead by the burning of the woods ..." and "... the hurricane [an area of windthrow near Ouachita River] So burnt that it makes the appearance of Prairie fit for cult[ivation]." Fire also complicated the surveyors' work, with some noting that they could "... find no Bearing trees by which to identify this Corner Every thing around burned down ..." or that "... the [witness] trees all down & burned up ...."

In southern Arkansas, sun-loving graminoids achieved dominance naturally through extreme site conditions or frequent burning, otherwise woody shrubs, vines and tree seedlings quickly occupied the understory. Deputy surveyor Nicholas Rightor found the "... woods has been burnt of[f] clean the whole Six miles [of T16S R8W], but is naturally open and handsome...." Likewise, Langtree mentioned "... an open grassy plain or table land in overflow ... the frequent fires having burned everything down ..." but also noted "... several little [pine] islands above the overflow ... [had] fallen timber in desperate confusion—fire and water hold the mastery here ...."

Earthquakes.—In the winter of 1811–1812 a seismic event involving at least three earthquakes registering a minimum of 8.0 on the Richter Scale struck northeastern Arkansas and southeastern Missouri (Nuttli, 1974), causing extensive regional subsidence, flooding and tree mortality. Early GLO surveyors attributed two aquatic features in Ashley County to this event, which they dubbed "earthquake swamps." For example, an elliptical indentation along the east boundary of section 1 in T17S R4W had "... [t]imber all dead and of highland kind except small Persimmon which appears to have grown since it sunk no brush or briers growing in it ...." Trelease (1897, p. 370) described a similar condition in southeastern Missouri:

> Now and then old Cypress stubs, with gray bark and large branches emerging from the giant trunks close the water level, stand in marked contrast with the tall, clean stems of a later generation, suggesting the doubtful hypothesis that the strip of land on which they grew has sunken locally below the general level of the stream.

Even though Trelease (1897) did not seem to favor the sinking land theory, others (*e.g.*, Shelford, 1954; Nuttli, 1974; King, 1978) have linked similar subsidence to the New Madrid quakes.

Large woody debris.—The original surveyors made little effort to note the presence of large woody debris (LWD) unless challenged by having to cross a "... bottom almost impenetrable with vines briers fallen timber ..." or spending most of a day "... gitting [sic] through, this desperate hurricane...." Snags also hindered the navigability of rivers. In late 1827 deputy surveyor Nicholas Rightor described a portion of the Saline River as "... partly full of timber and a great deal of drift at the head of it, and not attal [sic] traveled by water crafts...." Later, Rightor described sections of Bayou Bartholomew in eastern Ashley County as being "... full of logs ..." and "... here fill'd with trees, or old logs convenient for crossing...."

The presence of LWD was implicit with the occurrence of disturbed areas. Caleb Langtree mentioned large logs he encountered in western Ashley County, fragmented by their fall and blackened by fire and also noted a "... large forked Red Oak S.E. but it is dead, and will Soon be down & decayed...." When corners were relocated, it was not unusual for the surveyors to find the old witness trees dead and decaying, possibly succumbing from the blazing and scribing they received years earlier. If no living trees were found within a convenient distance to the corner (especially in prairies), surveyors

were to construct a suitable monument (Stewart, 1935). Typically, these markers were comprised of cylinders of charcoal, usually collected from a campfire. However, surveyors also gathered charcoal from burned woods, if available. One industrious surveyor left "... charcoal I found in the burnt woods ..." and later used "... a very well charred root about 6 inches [15 cm] long & from 3 to 4 inches [8 to 10 cm] diamr [sic] ...."

OTHER NOTEWORTHY FEATURES

Wildlife.—The GLO surveyors rarely mentioned wildlife, although undoubtedly they found an abundance. Caleb Langtree encountered biting insects, black bears (*Ursus americanus* Pallas) and rattlesnakes (*Crotalus* spp.) and deputy surveyor Abraham Bowman crossed at least one beaver (*Castor canadensis* Kuhl) pond. Many survey crews had a designated hunter to supplement their food stores and some reported on their successes and failures. For example, in late 1827 Nicholas Rightor spent at least a day fruitlessly tracking a black bear wounded by his hunter (the bear apparently entered the Saline River and drowned), and later mentioned the shooting of two white-tailed deer (*Odocoileus virginianus* Zimm.) near a windthrow in T16S R8W.

Natural mounds and other edaphic features.—Relatively small yet pronounced circular mounds were frequently noted in the GLO records. Usually less than 2 m high and 10 m across, the origin of these earthen mounds is unknown, although several theories have been advanced (Cain, 1974). Called "gas," "prairie," "pimple" or "mimas," these natural mounds were commonly reported in both forests and prairies of Ashley County, but are not present in alluvial bottoms. The Smith Prairie in south-central Ashley County, for example, was described by one surveyor as "full of mounds," while Cain (1974, p. 181) provided an aerial photograph of the abundant mounds in the Pine Prairie of northeastern Ashley County. Mound frequency varied, but some locations "... average about 4 mounds to the acre [10 per ha] ..." and "... there is a mound within 2 chains [40 m] (all over the prairie)...." The mounds were at times regarded by the surveyors as particularly productive: "... an occasional mound which is covered with an undergrowth denoting rich soil ... ," possibly because of their improved drainage (*see also* Owen, 1860).

Apart from broad references to landform shape or type (*e.g.*, "rolling," "level," "bottom") and brief soil descriptions (*e.g.*, "first rate," "second rate," "third rate," "swampy"), the surveyors only infrequently described the edaphic conditions of the Ashley County area. Caleb Langtree provided some limited detail on soil conditions for scattered locations in T18S R9W. Langtree once entered "... a dry slash white clay bottom & long sedge grass ..." and later described other locations as sandy. Other surveyors commented on the favorability of an area for agriculture. For example, deputy surveyor John Wilson identified a site near the Saline River in T15S R8W that he believed may be "... flat corn land not rich ..." and noted an area of "[s]andy soil and red clay foundation ... [that] ... would produce well."

Aquatic conditions.—Features like swamps, seeps, rivers, creeks, bayous and lakes are found throughout the survey region. Large rivers often formed diverse landscapes of sloughs, meanders, oxbow lakes, multiple channels, islands and occasional bluffs. A few bodies of water were identified as navigable and surveyed as such, but navigation at this time would have been difficult due to the tangled vegetation and riparian large woody debris. Springs were encountered, including a mention by Langtree of the "famous Sulphur Springs" in section 9 of T19S R9W. Other aquatic features were suggested largely by their associated vegetation. Areas of still water frequently had groves of cypress and water tupelo, whereas small streams often flowed through brush- or cane-filled bottoms. Even though understory plants were rarely identified to the degree needed to classify wetlands, some descriptions suggest special conditions like seeps or mineral springs. In T15S R8W John Wilson

encountered an area of ground that was "... flat and wet and the earth over spread with green moss ..." and other surveyors reported sedges or ferns, which may be associated with seepage wetlands.

Early settlers.—Native Americans first settled southern Arkansas many thousands of years ago, but left only scattered evidence of their occupation. The most visible signs of pre-1500 Mississippian Culture are the large mounds constructed along the major waterways of the Ashley County area (Moore, 1909; DeArmond-Huskey, 2001). Protohistoric (from 1500–1700 AD) Tunican Indians were replaced by a tribe known as the Quapaws, who occupied parts of southeastern Arkansas until their removal in the early 1800s (Schambach and Newell, 1990; Hoffman, 1992). Very little information on the environmental impacts of Native Americans in the Ashley County area is available. They probably used fire to maintain openings and improve conditions for wild game and likely cleared the forest to plant crops, as was done by tribes in other portions of the state (Schambach and Newell, 1990; Key, 2000). The GLO surveyors made no specific mention of evidence of Native American habitation in the Ashley County area as they did in other parts of Arkansas, but it is likely that many of the trails they followed were first tread by Native Americans.

European settlement of the Ashley County area began in earnest during the latter half of the GLO survey period (especially after 1840) and was reported in the survey notes. Several roads and trails crossed the region, usually extending between the scattered settlements of the area. Although a few agricultural ventures had begun along the major waterways in the study area as early as the late 1820s (Etheridge, 1959; DeArmond-Huskey, 2001), settlement of the interior was still years away. Surveyors also reported limited areas of logging along the Ouachita River and the occasional "deadening" of the timber as a prelude to farming. Some township surveys after 1840 mentioned cleared fields (called "improvements"), houses, cotton gins and even slave quarters.

DISCUSSION

Assembling information on the early landscapes of southern Arkansas is difficult because so few records of presettlement ecosystems are available before commercial exploitation started in the mid 1800s. The GLO survey notes appear to be reasonably unbiased (as generous with negative comments about the lands surveyed as favorable ones) and contain descriptions of the study area in much greater detail than available from other traditional sources (*e.g.*, early explorer journals). The GLO records of the Ashley County area could, for example, help locate rare community types like alkaline prairies or hickory barrens that may still contain isolated populations of endangered species [Foti (2001) describes such an application of the original survey notes in the search for a previously unknown woodland type in east-central Arkansas]. Even though there are some problems with quantitatively interpreting the ecological data collected by early surveyors, the GLO notes are an invaluable contribution to restoration projects targeting presettlement conditions because of their unprecedented consistency, coverage, detail and timeliness.

Acknowledgments.—I would like to recognize the deputy surveyors whose trials and tribulations over 150 y ago made this work possible: Caleb Langtree, Nicholas Rightor, Abraham Bowman, Charles Moore, Laurentine Eiler, Jonas Smith, Alexander Brookie, James Danley, Thomas Mathers, Charles Drury, Thomas Rector, John Wilson, Will Rector, John Clark, J.E. Graham and J.M. Conway, as well as their many crew members. Anna Zeide and Hope Bragg assisted in data acquisition. Tom Foti (Arkansas Natural Heritage Commission), Eric Sundell (University of Arkansas at Monticello) and several anonymous reviewers provided many valuable comments.

LITERATURE CITED

AMERICAN LAND COMPANY. 1844. Catalogue of 96,046 acres of land belonging to the American Land Company, situate and lying in the State of Arkansas. James Van Norden & Co., New York, New York. 28 p.

ANONYMOUS. 1890. Biographical and historical memoirs of southern Arkansas. The Goodspeed Publ. Co., Chicago, Illinois. 1088 p.

BOURDO, E. A. 1956. A review of the General Land Office survey and of its use in quantitative studies of former forests. *Ecology,* **37**:754–768.

BRAGG, D. C. 2002. Reference conditions for old-growth pine forests in the Upper West Gulf Coastal Plain. *J. Tor. Bot. Soc.* In press.

BUREAU OF LAND MANAGEMENT. 1947. Manual of instructions for the survey of the public lands of the United States 1947. U.S.D.I. Bur. Land Manage., Washington, DC. 613 p.

CAIN, R. H. 1974. Pimple mounds: a new viewpoint. *Ecology,* **55**:178–182.

CANHAM, C. D. AND O. L. LOUCKS. 1984. Catastrophic windthrow in the presettlement forests of Wisconsin. *Ecology,* **65**:803–809.

COLE, H. S. 1927. Tornadoes in Arkansas, 1879–1926. *Mon. Weather Rev.,* **55**:176–182.

DANIELS, C. [commissioner] 2000. Arkansas original General Land Office survey notes and plats. Ark. State Land Office, Little Rock, Arkansas (16 compact disks).

DEARMOND-HUSKEY, R. 2001. Bartholomew's song: a bayou history. Heritage Books, Inc., Bowie, Maryland. 645 p.

DELCOURT, H. R. 1976. Presettlement vegetation of the North of Red River Land District, Louisiana. *Castanea,* **41**:122–139.

EGAN, D. AND E. A. HOWELL [EDS.]. 2001. The historical ecology handbook: a restorationist's guide to reference ecosystems. Island Press, Washington, DC. 457 p.

ETHERIDGE, Y. W. 1959. History of Ashley County, Arkansas. The Press Argus, Van Buren, Arkansas. 173 p.

FORBES, R. D. AND R. Y. STUART. 1930. Timber growing and logging and turpentining practices in the southern pine region. U.S.D.A. Tech. Bull. 204. 114 p.

FOTI, T. L. 2001. Presettlement forests of the Black Swamp area, Cache River, Woodruff County, Arkansas, from notes of the first land survey, p. 7–15. *In*: P. B. Hamel and T. L. Foti (eds.). Proc., Bottomland hardwoods of the Mississippi Alluvial Valley: characteristics and management of natural function, structure, and composition. U.S.D.A. For. Serv. South. Res. Sta. Gen. Tech. Rep. SRS-42.

HARPER, R. M. 1914. Phytogeographical notes on the coastal plain of Arkansas. *Plant World,* **17**:36–48.

HARRAR, E. S. AND J. G. HARRAR. 1962. Guide to southern trees, 2nd ed. Dover Publ., Inc., New York, New York. 709 p.

HARVEY, F. L. 1883. The arboreal flora of Arkansas. *Am. J. For.,* **1**:413–424;451–458.

HOFFMAN, M. P. 1992. Protohistoric Tunican Indians in Arkansas. *Ark. Hist. Quart.,* **51**:30–53.

HUTCHISON, M. 1988. A guide to understanding, interpreting, and using the public land survey field notes in Illinois. *Nat. Areas J.,* **8**:245–255.

IRVING, R. S., S. BRENHOLTS AND T. FOTI. 1980. Composition and net primary production of native prairies in eastern Arkansas. *Am. Midl. Nat.,* **103**:298–309.

KEY, J. P. 2000. Indians and ecological conflict in territorial Arkansas. *Ark. Hist. Quart.,* **59**:127–146.

KING, J. E. 1978. New evidence on the history of the St. Francis Sunk Lands, northeastern Arkansas. *Geol. Soc. Am. Bull.,* **89**:1719–1722.

LONG, W. H. 1917. Investigations of the rotting of slash in Arkansas. U.S.D.A. Bull. 496. 14 p.

LUTZ, H. J. 1930. Original forest composition in northwestern Pennsylvania as indicated by early land survey notes. *J. For.,* **28**:1098–1103.

MATTOON, W. R. 1915. Life history of shortleaf pine. U.S.D.A. Bull. 244. 46 p.

MENDELSON, J. 2002. An additional source of data on northeastern Illinois woodlands around the time of settlement. *Am. Midl. Nat.,* **147**:279–286.

MOHR, C. 1897. Timber pines of the southern United States. U.S.D.A. Div. For. Bull. 13. 176 p.

MOORE, C. B. 1909. Antiquities of the Ouachita Valley, part 1. *J. Acad. Nat. Sci. Philadelphia,* **11**:111.

MOORE, D. M. 1999. Trees of Arkansas, 5th ed. Ark. For. Comm., Little Rock, Arkansas. 142 p.

NELSON, J. C. 1997. Presettlement vegetation patterns along the 5th Principal Meridian, Missouri Territory, 1815. *Am. Midl. Nat.,* **137**:79–94.

NOSS, R. F. 1985. On characterizing presettlement vegetation: how and why. *Nat. Areas J.,* **5**:5–19.

NUTTALL, T. 1980. A journal of travels into the Arkansas Territory during the year 1819. S. Lottinville, editor. Univ. Ok. Press, Norman, Oklahoma. 361 p.

NUTTLI, O. W. 1974. The Mississippi Valley earthquakes of 1811 and 1812. Earthquake Information Bull., vol. 6. 3 p.

OLMSTED, F. E. 1902. A working plan for forest lands near Pine Bluff, Arkansas. U.S.D.A. Bureau of For. Bull. 32. 48 p.

OWEN, D. D. 1860. Second report of a geological reconnoissance [sic] of the middle and southern counties of Arkansas. C. Sherman & Son, Philadelphia, Pennsylvania. 433 p.

PIKE, A. 1835. Letters from Arkansas, no. 1. *New England Mag.,* **9**:263–270.

PUTNAM, J. A. AND H. BULL. 1932. The trees of the bottomlands of the Mississippi River delta region. U.S.D.A. For. Serv. South. For. Exp. Sta. Occ. Pap. 27. 207 p.

RECORD, S. J. 1907. The forests of Arkansas. *For. Quart.,* **5**:296–301.

SCHAFALE, M. P. AND P. A. HARCOMBE. 1983. Presettlement vegetation of Hardin County, Texas. *Am. Midl. Nat.,* **109**:355–366.

SCHAMBACH, F. AND L. NEWELL. 1990. Crossroads of the past: 12,000 years of Indian life in Arkansas. Ark. Arch. Soc. Pop. Series no. 2, Ark. Human. Council, Little Rock, Arkansas. 59 p.

SCHULTE, L. A. AND D. J. MLADENOFF. 2001. The original US public land survey records: their use and limitations in reconstructing presettlement vegetation. *J. For.,* **99**:5–10.

SHELFORD, V. E. 1954. Some lower Mississippi Valley flood plain biotic communities; their age and elevation. *Ecology,* **35**:126–142.

SMITH, E. B. 1988. An atlas and annotated list of the vascular plants of Arkansas. 2nd ed. Dept. Botany and Microbiol., Univ. Ark., Fayetteville, Arkansas. 489 p.

SPURR, S. H. 1951. George Washington, surveyor and ecological observer. *Ecology,* **32**:544–549.

STEWART, L. O. 1935. Public land surveys: history, instructions, and methods. Collegiate Press, Inc., Ames, IA. 202 p.

TURNER, L. M. 1935. Catastrophes and pure stands of southern shortleaf pine. *Ecology,* **16**:213–215.

TRELEASE, W. 1897. The swamps of south-eastern Missouri. *Garden and Forest,* **10**:370–371.

WACKERMAN, A. E. 1929. Why prairies in Arkansas and Louisiana. *J. For.,* **27**:726–734.

WHITNEY, G. G. AND J. DECANT. 2001. Government Land Office survey and other early land surveys, p. 147–172. *In:* D. Egan and E. A. Howell (eds.). The historical ecology handbook. Island Press, Washington, DC.

SUBMITTED 2 JANUARY 2002 ACCEPTED 25 JULY 2002