PRESETTLEMENT FORESTS OF THE BLACK SWAMP AREA, CACHE RIVER, WOODRUFF COUNTY, ARKANSAS, FROM NOTES OF THE FIRST LAND SURVEY

Thomas L. Foti[1]

Abstract—Relationships between forest vegetation and soil were reconstructed from field notes of the 1846 Public Land Survey (PLS) along a portion of the Cache River including Black Swamp. Locations of corners were digitized along with species, diameter, and distance from section or quarter-section corners. Trees were grouped for analysis according to occurrence on groups of ecologically meaningful soil units (similar texture, flood frequency and saturation) using a digitized county soil map. Trees occurring at corners were treated as point-quarter samples to calculate density and dominance; these and relative abundance were used to calculate importance value (IV). Five bottomland and two upland types were defined, based on ecological distinctions in site characteristics. Based on ordination by Detrended Correspondence Analysis, these were shown to occupy a moisture gradient from frequently flooded bottomlands, through less flooded and better-drained bottomlands to well-drained uplands and dry uplands. These types are analyzed to allow restoration biologists maximum flexibility in using them in setting or analyzing restoration goals. One bottomland type occurred on sites where hydrologic regime has been altered by flood control levees to the extent that restoration to the presettlement forest is no longer possible. One of the upland types has not been previously documented and may have been primary habitat for a now-rare plant species, *Cyperus grayoides* Mohlenbrock.

INTRODUCTION

Clearing, drainage and other forms of ecosystem alteration have been and continue to be extensive in the Mississippi Alluvial Plain. Currently, national and international attention is being given to restoration and management needs within this region, such as the North American Waterfowl Management Plan (Arkansas Game and Fish Commission 1988). A number of programs exist that encourage reforestation within the region, perhaps most significantly the USDA Wetland Reserve Program and Conservation Reserve Program. In the Arkansas portion of the region ("the Arkansas Delta") State and Federal agencies as well as private organizations are actively acquiring land, most extensively for addition to the Cache River National Wildlife Refuge and White River National Wildlife Refuge.

On these newly acquired public lands, reforestation is occurring as needed. On Federal lands, ecosystem management is emphasized, that attempts to ". . . restore and sustain ecosystem integrity (composition, structure and function) and produce ecologically acceptable levels of sustainable multiple uses (U.S. Fish & Wildlife Service 1994). Such a management strategy implicitly requires knowledge of baseline ecological conditions against which to compare management alternatives.

Surveyors' notes compiled during the Public Land Survey (PLS) conducted by the General Land Office (GLO) in the 19th Century provide the only systematic survey of the vegetation of the mid-continent during that time, prior to massive timber cutting and settlement. When correlated with physical site characteristics, 19th century vegetation data can be used to develop understanding of and models of plant community composition and structure, as well as distribution on the landscape (Bourdo 1956).

A model of early vegetation of an area does not define a restoration or management goal; it is necessarily incomplete and uncertain. Conditions controlling vegetation may have changed or current needs may preclude restoration to this vegetation. However, even under these circumstances the model is useful in providing one baseline to be used in evaluating the feasibility of and progress toward such a goal.

The primary purpose of this study was to use existing surveyor's notes to develop a model of early vegetation of Black Swamp. A secondary objective was to undertake an initial assessment of the utility of the model to assist in development of reasonable goals for ecosystem restoration in the Lower Mississippi Alluvial Valley in eastern Arkansas.

METHODS

Study Area

The study area selected was Township 6 North, Range 3 West (T6NR3W or The Township) along the Cache River (fig. 1). Acquisition is actively underway in this area for the Cache River National Wildlife Refuge. The study area includes a portion of the Arkansas Game and Fish Commission Black Swamp/Rex Hancock Wildlife Management Area, designated under the Ramsar Convention as Wetlands of International Importance. The Arkansas Natural Heritage Commission (ANHC) holds a conservation easement on a part of the Wildlife Management Area. The study area includes naturally forested wetlands as well as cleared and farmed bottomlands and uplands. This area was chosen partly because of the availability of Geographic Information System (GIS) data layers and other digital data that facilitate the spatial analysis of GLO data.

[1] Chief of Research, Arkansas Natural Heritage Commission, Little Rock, AR.

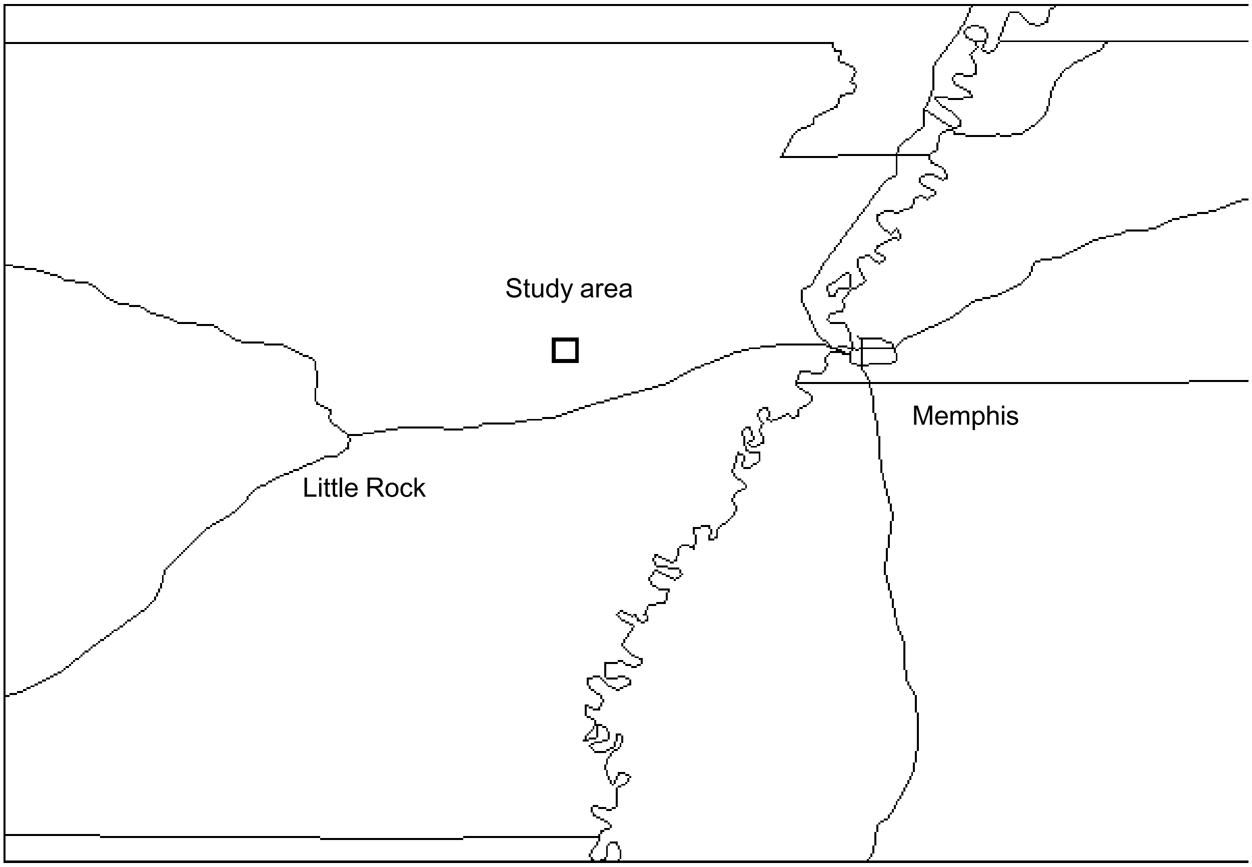

Figure 1—Location of the study area.

The Cache River is the longest tributary of the White River that lies entirely within the Mississippi Alluvial Plain. In the study area, it and its floodplain are usually distinctively incised below the level of the surrounding uplands, but natural levees and terraces within and above the floodplain create variations in flood depth, duration and frequency. Soils and geological substrate of the uplands vary from poorly drained clay flats to productive loamy and sandy upland soils to excessively drained sandy hills. A variety of upland and bottomland vegetation types occur in relationship to flood regime, soil characteristics and other physical features. On lowest, semi-permanently flooded sites is black swamp itself, dominated by water tupelo (*Nyssa aquatica* L.), with baldcypress (*Taxodium distichum* (L.) Rich.) common along watercourses. Buttonbush (*Cephalanthus occidentalis* L.) is a common shrub species. On higher bottoms are areas dominated by overcup oak (*Quercus lyrata* Walt.), Nuttall oak (*Q. texana* Buckl.), willow oak (*Q. phellos* L.) and others. Upland forests have generally been cleared for row-crop agriculture, principally soybeans and rice.

VEGETATION SAMPLING

I obtained survey notes on T6NR3W from the office of the Arkansas State Land Commissioner. David Garretson surveyed The Township in 1846.

Surveyors of the PLS traversed the western and northern sides of each section of 1 mile (1.6 km) square, which were organized into townships of 6 by 6 sections. They monumented corners of each section and gave the distance and direction to a tree in each quadrant of the compass (four trees). Species and sizes of these witness or bearing trees were noted. At the halfway point of each side of each section the surveyor marked the "quarter corner" and noted distance and direction to a witness tree of stated species and size north and south of the monument (two trees). The surveyor also noted two additional "line trees" along each side and recorded species and size. Crossing points of major features, such as rivers, canebrakes, etc. were located. At the end of the traverse of each side (1 mi or 1.6 km) the quality of the land, the kind of "timber" and the "undergrowth" characteristic of the mile were noted.

Plant identification by the surveyors was in some cases problematical. The identity of "cucumber" is unknown. Although cucumber magnolia (*Magnolia acuminata* L.) occurs in Arkansas, it does not occur on sites similar to those in the study area. The identity of "black oak" in the survey notes is an important question of identification. This name is recorded in most of the communities identified here, in both bottomlands and uplands. Black oak (*Quercus velutina* Lam.) does occur on upland sites in the vicinity of the study area, but not in bottomlands. It is likely that in bottomlands the term black oak in the notes refers to Nuttall oak (*Q. texana* Buckl.), which was not described for more than 85 years after this survey; to cherrybark oak (*Q. pagoda* Ell.), or possibly even to water oak (*Q. nigra* L.). In the uplands the term may apply either to black oak or to southern red oak (*Q. falcata* Michx.); in 19th-century contemporary surveys the latter was usually referred to as "Spanish Oak." I take "white oak" to mean *Q. alba* L., but the name occurs in the notes not only in upland forests, but also on bottomland forests, where *Q. alba* should not occur. This is particularly problematic to interpret; both swamp white oak (*Q. michauxii* Nutt., not *Q. bicolor* Willd., which does not occur in Arkansas) and overcup oak (*Q. lyrata* Walt.) are recognized by the surveyor. However, the name "swamp white oak" occurred only one time (in MCCROR, one of the wettest community types). Therefore, my assumption is that the term "white oak" means *Q. michauxii* Nutt. in the bottoms and *Q. alba* L. in the uplands. "Pin oak" in the lists may refer to *Q. palustris*, or perhaps to another of the red oaks, such as Nuttall oak. Although willow oak (*Q. phellos* L.) is often called pin oak locally, willow oak was recognized separately by the surveyor. These uncertainties will be discussed further in community descriptions. Spelling of common names in the descriptions that follow will be that of the surveyor, rather than an assumed accepted common name or scientific name.

Further difficulties occur in interpreting the importance of cypress and tupelo. Instructions to surveyors were unclear as to where the diameter of trees was to be measured, but there is a mention of diameter at the base (White 1983). Even if diameter were measured at breast height, the diameter and consequently basal area and IV of species with buttressed or swollen bases, such as cypress and tupelo, would have been exaggerated.

ANALYSIS PROCEDURES

Universal Transverse Mercatur (UTM) positions of 49 section corners were determined from USGS topographic maps. The UTM coordinates of the quarter-corners, line trees and distinctive features were calculated from the surveyor's noted direction and distance from each section corner. Locations of 455 trees were digitized. For one location, a cypress knee was used as a line marker, but since it was not a "tree" and no diameter or distance was noted, it was not included in the data set for analysis. The locations were read into a sites file in GRASS geographic information system.

Recorded distances and directions from points to trees of recorded species and size allowed use of the point-quarter sample method (Cottam and Curtis 1956) to estimate species composition, density and basal area.

In this study area a digitized map of soil series (map units) produced by the University of Arkansas in cooperation with the USDA Natural Resources Conservation Service served as the primary physical basis for sorting trees into potentially distinguishable communities. A digital map of the floodplains of the 1-, 3- and 100-year frequency floods developed by the U.S. Army Corps of Engineers provided an additional physical basis for grouping GLO trees. To simplify analysis, I aggregated the 39 soil map units into a smaller set of ecologically meaningful and distinct groups. The bottomland groups were distinguished based on duration of inundation or saturation of the soil series, based on descriptions in the county soil survey. Upland soil groups included a group of sandy loam soils along with soils of well drained natural levees and soils with sodium or magnesium salts (termed in the analyses "natric" soils), all of which have dry-mesic character. A separate upland group consisted of soil of loamy fine sand (one soil only—Bulltown) that is xeric.

I sorted trees into groups based on physical features (soil series or groups of series) important in plant community distribution. I used all trees from each data source (corner, quarter-corner and line) to calculate relative abundance and relative basal area (relative dominance). In the case of section corners and quarter corners where distance data were recorded, I calculated additional quantitative measures of forest structure, including absolute and relative density, absolute and relative basal area and geometric mean diameter, the diameter at which mean basal area occurs. I calculated importance value for each species within each group as the averaged sum of relative abundance and relative basal area calculated from all trees, and relative density based only on corner trees (IV = [RA + RBA + RD]/3).

I used relationships among the groups analyzed by multivariate statistical analysis: Detrended Correspondence Analysis (DCA or DECORANA; Hill and Gauch 1980) placed the communities along a continuum based on species composition.

In the discussions that follow, density and diameter are sometimes given. These are not included in the tables that follow, but are available from the author.

RESULTS

The Township includes 12,597 ha (31,131 ac), of which 15 percent lies within the 1-year floodplain, 28 percent within the 3-year floodplain and 70 percent within the 100-year floodplain of the Cache River and tributaries.

Forest Over the Entire Study Area

The surveyor recorded 31 genera or species in The Township (table 1 includes scientific names). Most of these are common taxa in the area today, but a few are uncertain.

Over the whole study area (table 2), cypress was the most important species with an IV of 16.6 percent, followed by white oak at 12.6 and tupelo gum at 11.2, the only other species with IV > 10. Sweet gum, ash, black oak, elm and hickory had IV's between 5 and 10. White oak was the most numerous species with 64 individuals recorded, followed by ash, sweet gum, tupelo gum, black oak, elm, cypress, and hickory. On corners with measured distances to witness trees, ash and white oak had the greatest density of 12.7 per ha (5.1 per ac) each, followed by sweet gum and tupelo gum; average density computed from all corner and quarter corner trees was 114/ha (45.6 per ac). Cypress had the largest mean diameter at 75 cm (30"), followed by white oak, sweet gum, black walnut (one tree only) and tupelo gum. While only white oak compares in importance with cypress and tupelo, and only these three have IV > 10, it is important to note that the combined IV of all oaks is virtually identical to that of cypress and tupelo combined. Thus, the forest of The Township may be described as cypress-tupelo-oak on wetter sites and oak-mixed hardwoods on drier sites.

Table 1—Common names of tree species as recorded by surveyor with scientific names of presumed actual taxa

Common name (scientific names)
Ash (*Fraxinus* L. sp. - F. *pennsylvanica* Marsh, *F. americana* L.)
Black gum (*Nyssa sylvatica* Marsh)
Black oak (*Quercus velutina* Lam., *Q. falcata* Michx., *Q. texana* Buckley, *Q. pagoda* Ell.; see text)
Black walnut (*Juglans nigra* L.)
Box elder (*Acer negundo* L.)
Cherry (*Prunus serotina* Ehrh.)
Cucumber (identification uncertain, see text)
Cypress (*Taxodium distichum* (L.) Rich.)
Dogwood (*Cornus florida* L.)
Elm (*Ulmus* L.sp. - *U. americana* L.)
Hackberry (*Celtis laevigata* Willd.)
Hickory (*Carya* Nuttall sp.)
Horn beam (*Carpinus caroliniana* Walt.)
Locust (*Gleditsia* L. sp. or *Robinia* L. sp.)
Maple (*Acer* L. sp. - *A. rubrum* L., *A. saccharinum* L.)
Mulberry (*Morus rubra* L.)
Overcup oak (*Quercus lyrata* Walt.)
Pawpaw (*Asimina triloba* (L.) Dunal)
Pecan (*Carya illinoensis* (Wang) K. Koch)
Persimmon (*Diospyros virginiana* L.)
Pin oak (*Quercus palustris* Muench, *Q. texana* Buckley)
Post oak (*Quercus stellata* Wang.)
Red bud (*Cercis canadensis* L.)
Sassafras (*Sassafras albidum* (Nutt.) Nees)
Slippery elm (*Ulmus rubra* Muhl.)
Swamp elm (*Planera aquatica* (Walt.) Gmelin)
Swamp white oak (*Quercus michauxii?* Nutt.)
Sweet gum (*Liquidambar styraciflua* L.)
Tupelo gum (*Nyssa aquatica* L.)
White oak (*Quercus alba* L., *Q. michauxii* Nutt., see text)
Willow oak (*Quercus phellos* L.)

DEFINITION OF SOIL GROUPS FOR VEGETATION ANALYSIS

Thirty-nine soil map units (plus water) occur in the township and GLO survey trees occurred on 27 of these. These 27 soil map units were aggregated into 7 soil groups (see table 3 for the codes by which the groups are referred to elsewhere). No GLO trees occurred on 12 soil series (table 4). These are not included in the analysis, but have been aggregated in mapping. In aggregate they cover about 7 percent of the study area.

Analysis of Soil/Vegetation Groups

The distribution in the study area of the following soil/vegetation types, even in generalized form, is a complex one (fig. 2). Tree species listed as “most important” below are the ones with IV > 10 percent.

TUCKER Forest (Tupelo-Cypress)—Tuckerman silty clay loam occurs in the lowest bottoms, immediately adjacent to the Cache River within the floodplain (fig. 2). The group includes a few trees on small watercourses outside the floodplain of the Cache River. A total of 91 trees of 16 species were recorded on this soil. The most important trees were tupelo gum and cypress (table 2). Tupelo gum was the most numerous species followed by cypress and overcup oak. Total density was 120 per ha (48 per ac), with tupelo gum having the highest density followed by persimmon and overcup oak. Cypress had largest mean diameter, followed by tupelo gum and white oak (2 trees only).

KOBFRQ Forest (Cypress-Oak-Tupelo-Maple)—This group is primarily comprised of Kobel frequently flooded soils that occur primarily below Black Swamp in the floodplain of the Cache River (fig. 2). A total of 21 trees of 13 species were recorded. The most important trees were cypress followed by white oak (presumed *Q. michauxii* Nutt.), tupelo gum and maple. No species were particularly abundant, with all species having from one to three occurrences in the data set. White oak, tupelo gum and maple had higher density than other species, and the total density was 175 per ha (70 per ac), the second-highest of the site types. Cypress had the greatest mean diameter, followed by swamp white oak (one tree only) and tupelo gum.

MCCROR Forest (Cypress-Sweetgum-Ash-Oak)—McCrory fine sandy loam soil occurs primarily east of and within the floodplain of the Cache River (fig. 2), on terraces slightly elevated above the adjacent Tuckerman soil. A total of 59 trees of 13 species were recorded on this site type. The most important were cypress, followed by sweet gum, ash, white oak (presumed *Q. michauxii* Nutt.) and overcup oak. Cypress was the most abundant species, followed by sweet gum, white oak, overcup oak and ash. Ash and sweet gum had the highest density, and the total density of 122 per ha (49 per ac) was moderate in comparison to other types. Cypress had the greatest mean diameter, followed by white oak and sweet gum.

KOBLEV Forest (Oak-Sweetgum-Ash-Cypress)—The principal soil of this group is Kobel silty clay loam, ponded. It occurs primarily west of the Cache River. The several other soil mapping units that are found on poorly drained natural levees are distributed primarily as linear bands within larger areas of Kobel frequently flooded soil and Kobel ponded soil. They occur elsewhere in the Cache floodplain and in the uplands along watercourses as well. A total of 117 trees occurred on these sites. The most important tree species was white oak (presumed *Q. michauxii* Nutt.), followed by sweetgum, ash and cypress. The most abundant species was white oak, followed by ash, sweet gum and elm. Ash had the highest density followed by white oak and sweetgum. Cypress had the greatest mean diameter, followed by sweet gum and tupelo gum. “Black oak” in this type was probably *Q. pagoda* Ell. or *Q. texana* Buckl.

ASKEW Forest (Sweetgum-Ash-Elm-Hackberry)—Askew fine silt loam is found on small, elevated areas within the floodplain of the Cache River, generally surrounded by Kobel or McCrory soil (fig. 2). A total of only 9 trees of 7 species were recorded on these sites (table 2), but they were analyzed separately because of the distinctive differences in site characteristics. The most important tree species was sweet gum, followed by ash, elm, and hackberry. Ash and

Table 2—Importance values of trees of the soil/vegetation groups[a b]

	Soil type / forest group							
Species	TUCKER	KOBFRQ	MCCROR	KOBLEV	ASKEW	UPLAND	UPSAND	ALL
Tupelo gum	35.9	11.3		4.6				11.2
Cypress	25.0	25.0	31.3	10.1				16.7
Overcup oak	8.1	4.5	10.6	4.3		0.8		4.6
Persimmon	8.0	2.3		2.9				2.6
Ash	5.8		12.1	12.9	20.3	5.4		7.9
Pecan	2.7	6.5	2.3	1.0				1.4
Elm	2.7	4.5	6.7	6.4	10.6	9.0		5.8
Maple	2.4	10.0		4.0				2.0
White oak	1.9	11.8	11.9	17.4	4.2	21.0	21.3	12.6
Swamp elm	1.8		3.0	.7				.9
Willow oak	1.3		2.1	.8		1.7		.1
Locust	1.0		.7	1.4				.7
Pin oak	.9	2.3	.7					.4
Hackberry	.9	4.1	1.5	1.8	10.0			1.2
Black gum	.9			2.2		5.1		1.9
Sweet gum	.6	4.9	15.4	13.9	44.5	10.6	8.4	9.4
Swamp white oak		6.6						.3
Hickory		6.1		4.5	6.2	11.9	14.8	5.3
Cucumber			1.6					.4
Black oak				6.3		18.9	26.4	7.4
Sassafras				1.5		.6		.6
Red bud				.7				.2
Horn beam				.6	4.1			.2
Pawpaw				.7		.9		.2
Box elder				.6		2.3		.7
Dogwood						6.1	9.3	2.2
Mulberry						1.7		.5
Black walnut						.9		.2
Post oak						.9	19.7	1.0
Cherry						.6		.2
Slippery elm						1.4		.4
Total trees	91	21	59	117	9	137	21	455
Corner trees	68	14	38	90	6	90	18	324

[a] Detailed data on which the IV's are based are available from the author.
[b] In calculations of IV, relative abundance was based on all trees in the database, while relative basal area and relative density were based on corner trees only.

sweet gum were the only species to have 2 individuals in the data set. The total density was the highest of any of the site types at 407 per ha (163 per ac), but this is based on only 3 corners. Sweet gum had the largest mean diameter among the species.

UPLAND Forest (White Oak-Black Oak-Hickory-Sweetgum)—This group, including well-drained natural levees, upland loamy and natric soils (table 3), occurs outside the floodplain on both sides of the Cache (fig. 2). It contains areas that are poorly drained bottomlands and the following excessively well-drained xeric type. Soils in this group are typically well drained. For this analysis it was not possible to eliminate all the poorly drained areas. A total of 137 trees of 17 species occurred on these sites (table 2). The most important species were white oak (probably *Q. alba* L.) and black oak (probably *Q. velutina* Lam. on these dry sites, or *Q. falcata* Michx.), followed by hickory and sweetgum. Most abundant trees were white oak and black oak, followed by hickory, elm, sweetgum, and dogwood. Black oak, white oak and elm had the highest density; the total density of 116 per ha (47 per ac) was moderate. Black walnut, post oak and willow oak had greatest mean diameter.

UPSAND Forest (Black Oak-White Oak-Post Oak-Hickory Woodland)—This type was comprised of one soil only - Bulltown loamy fine sand. These sites are generally excessively well drained, leading to droughty conditions. A total of 21 trees of 6 species occurred on these sites (table 2). Overall density of the forest (34 per ha or 14 per ac), characterizes it as a woodland or savanna. The most

Table 3—Soil groups used in analysis, with descriptions of constituent soils

Code – Name Texture, slope, hydrology, location, landform	Hydric?	Ac	Ha
TUCKER – Tuckerman			
Tuckerman SiClLm, 0–1 percent, frqfld, fldpln	Yes	3,753	1519
Tuckerman FnSaLm, 0–1 percent, frqfld, sm drains	Yes	870	352
Tichnor SiLm, 0–1 percent, frqfld, fldpln	Yes	74	30
KOBFRQ – Kobel silty clay loam			
Kobel SiClLm, 0–1 percent, frqfld, Cache backswamp	Yes	2,621	1061
MCCROR – McCrory fine sandy loam			
McCrory FnSaLm, 0–1 percent Cache terraces	Yes	3,663	1482
KOBLEV – Kobel and poorly drained natural levees			
Kobel SiClLm, 0–1 percent, ponded, Cache backswamp	Yes	1,910	773
Arrington SiLm, 0–3 percent, rarely fld	No	198	80
Yankopin (Commerce) SiClLm, <3 percent, rarely fld	No	845	342
Yankopin (Commerce) SiClLm, 0–3 percent, frqfld	No	1,275	516
Dundee SiLm, 0–1 percent	No	271	110
Amagon SiLm, 0–1 percent, terraces	Yes	326	132
Forestdale SiClLm, –1 percent, frqfld, fldpln	Yes	332	134
ASKEW – Askew fine sandy loam			
Askew FnSaLm, 1–3 percent, knolls in bottoms	No	930	376
UPLAND – Various			
Well-drained natural levee			
Dubbs SiLm, 0–1 percent	No	153	62
Bosket FnSaLm, 0–1 percent	No	345	140
Bosket FnSaLm, 1–3 percent	No	1,024	414
Bosket FnSaLm, 3–8 percent	No	412	167
Natric – sodium or magnesium Salt			
Lafe SiLm, 0–1 percent	No	16	6
Hillemann SiLm, 0-1 percent	No	46	19
Foley-Bonn complex, 0–1 percent	No	419	169
Grubbs SiLm,1–3 percent	No	790	320
Grubbs SiLm, 3–8 percent, eroded	No	464	188
Grenada SiLm, 1–3 percent	No	540	218
Upland sandy loam			
Wiville FnSaLm, 0–1 percent, near Bulltown	No	2,493	1009
Wiville FnSaLm, 1–3 percent, on edge of bottoms	No	1,902	770
Wiville FnSaLm, 3–8 percent, on edge of bottoms	No	373	151
UPSAND – loamy fine sand			
Bulltown LmFnSa, 1–8 percent, on dunes	No	2,067	836

Cl = clay(ey); fld = flood(ed); Fn = fine; frq = frequently; Lm = loam(y); pln = plain; Sa = sand(y); Si = silt(y); sm = small.

Table 4—Soils on which no witness trees occurred and the group with which they were combined for mapping purposes

Name, texture, slope, hydrology	Group	Ac	Ha
Kobel SiClLm, 0–1 percent	KOBLEV	56	23
Calhoun SiLm, 0–1 percent	KOBLEV	395	160
Calloway SiLm, 0–1 percent	UPLAND	396	160
Calloway SiLm, 1–3 percent	UPLAND	49	20
Overcup SiLm, 0–1 percent	KOBLEV	664	269
Jackport SiClLm, 0–1 percent	KOBLEV	10	4
Patterson FnSaLm, 0–2 percent	KOBLEV	161	65
Dubbs SiLm, 1–3 percent	UPLAND	152	61
Oaklimeter SiLm, 0–2 percent, occasionally flooded	KOBLEV	1	0
Arrington SiLm, 0–3 percent, freq. flooded	KOBLEV	30	12
Hillemann SiLm, 1–3 percent (natric)	UPLAND	210	85
Grenada SiLm, 3–8 percent (natric)	UPLAND	540	218
Water		355	144

Cl = clay(ey); fld = flood(ed); Fn = fine; frq = frequently; Lm = loam(y); pln = plain; Sa = sand(y); Si = silt(y); sm = small.

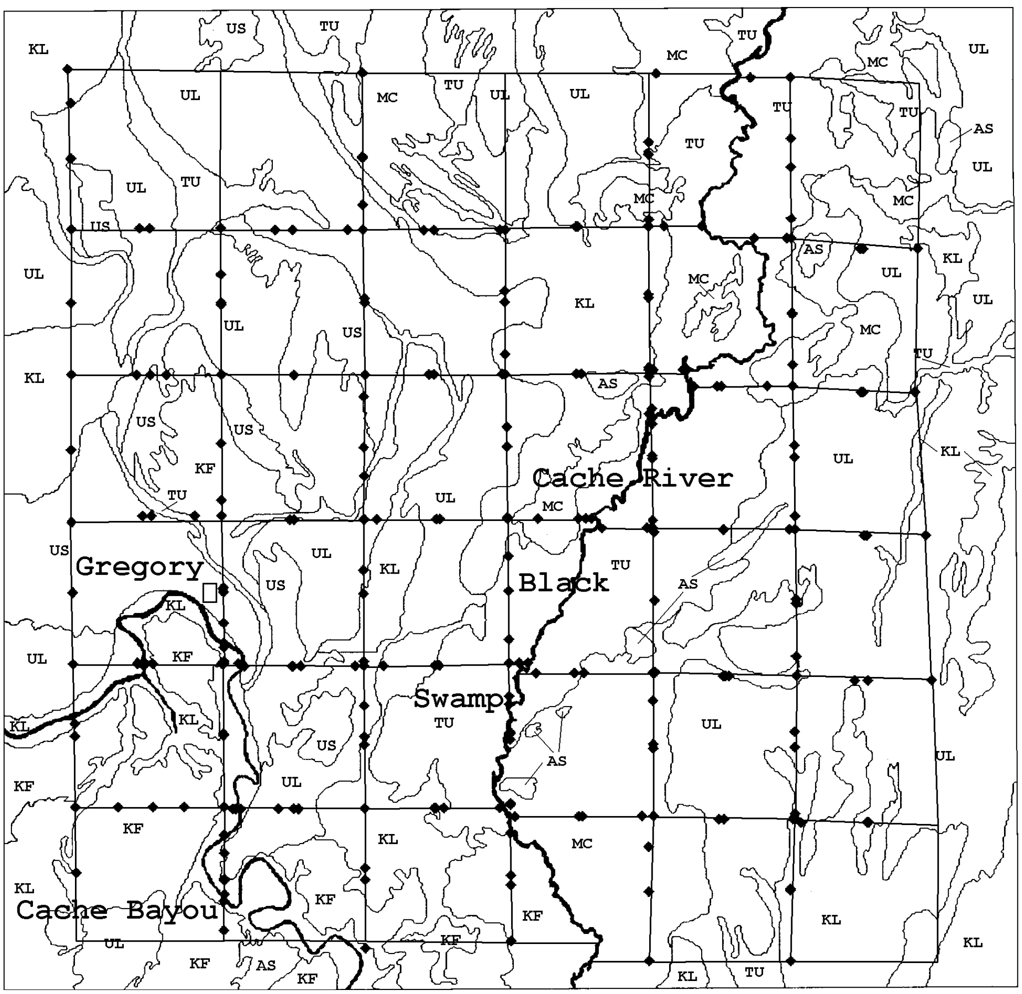

Figure 2—Generalized map of soil groups with General Land Office corners and line trees, approximate section lines and major features shown. Arkansas Highway 33 runs N-S through the western part of the study area but is not shown because it lies on section lines and would obscure witness tree locations. Section lines do not match at Cache River because surveys were conducted separately on each side of the river. The surveyor measured (approximately) and noted the discrepancies. Locations of General Land Office trees are indicated with a ♦. Soil groups are abbreviated: AS = ASKEW, KF = KOBFRQ, KL = KOBLEV, MC = MCCROR, TU = TUCKER, UP = UPLAND, US = UPSAND.

important species was black oak (probably *Q. velutina* Lam.), followed by white oak (probably *Q. alba* L.), post oak and hickory. The most abundant species in the sample was black oak, followed by post oak and hickory. Black oak had the highest density, followed by post oak and hickory. Sweet gum (1 individual) had the highest diameter followed by white oak.

Relationships Among Soil/forest Groups—Detrended Correspondence Analysis placed the soil/vegetation groups along a continuum that apparently represents a moisture gradient, as judged by species composition. From wettest to driest, the order was TUCKER, MCCROR, KOBFRQ, KOBLEV, ASKEW, UPLAND and UPSAND (fig. 3). Scores of the species at positive and negative extremes of Axis 2 indicate that Axis 2 primarily separates the KOBLEV soil/ vegetation group from the ASKEW type. While these are adjacent and in close proximity on Axis 1, they are clearly separated on Axis 2. On this axis, horn beam, hackberry and sweetgum occupy one extreme. They are all high or present in ASKEW and low or absent in KOBLEV. At the other extreme, sassafras, pawpaw and red bud are all present in KOBLEV and absent from ASKEW. These differences separate the vegetation on KOBLEV poorly drained natural levees from that of similar ASKEW high mounds within the floodplain.

DISCUSSION

The seven soil/forest groups categorized here represent adaptations to a moisture gradient, ranging from extremely wet bottomlands through well-drained bottomlands and moist uplands to dry uplands. Because these communities are related to particular soils they should provide useful guidance to restoration efforts within and near the study area. Most of the types are similar to those found on little-disturbed sites of the same soil today, so inspection of the extant sites can provide details on overstory, midstory and understory composition of the communities, propagules for restoration, and the ability to do functional assessments of the types. In such cases, the 1846 community model serves only to provide the perspective that the existing forest is not simply an artifact of human management or mismanagement in the past 150 years, but is in fact a variant of the "natural" forest of the region. However, at least two of the types provide interesting and perhaps unexpected insights:

1. KOBFRQ (Kobel silty clay loam, frequently flooded) occurs in the second most hydric position on the moisture continuum, and consequently in a more hydric location than the related soil group KOBLEV (Kobel silty clay loam, ponded and poorly drained natural levees). Yet today KOBFRQ is virtually all cleared and in agriculture, while large areas of KOBLEV are still forested. This is because most areas of KOBLEV are within the floodplain of Cache River, which at this point is not channelized or leveed. In contrast, most areas of KOBFRQ lie outside the Cache floodplain along Cache Bayou, which was a distributary of the White River at the time of the GLO survey. Flood control levees along the White have since disconnected the source and dramatically reduced flooding in this area, allowing row-crop agriculture. From a restoration standpoint, this is a clear demonstration that the early forest may not be the appropriate goal for current restoration efforts. In the case where hydrologic regime has been dramatically and

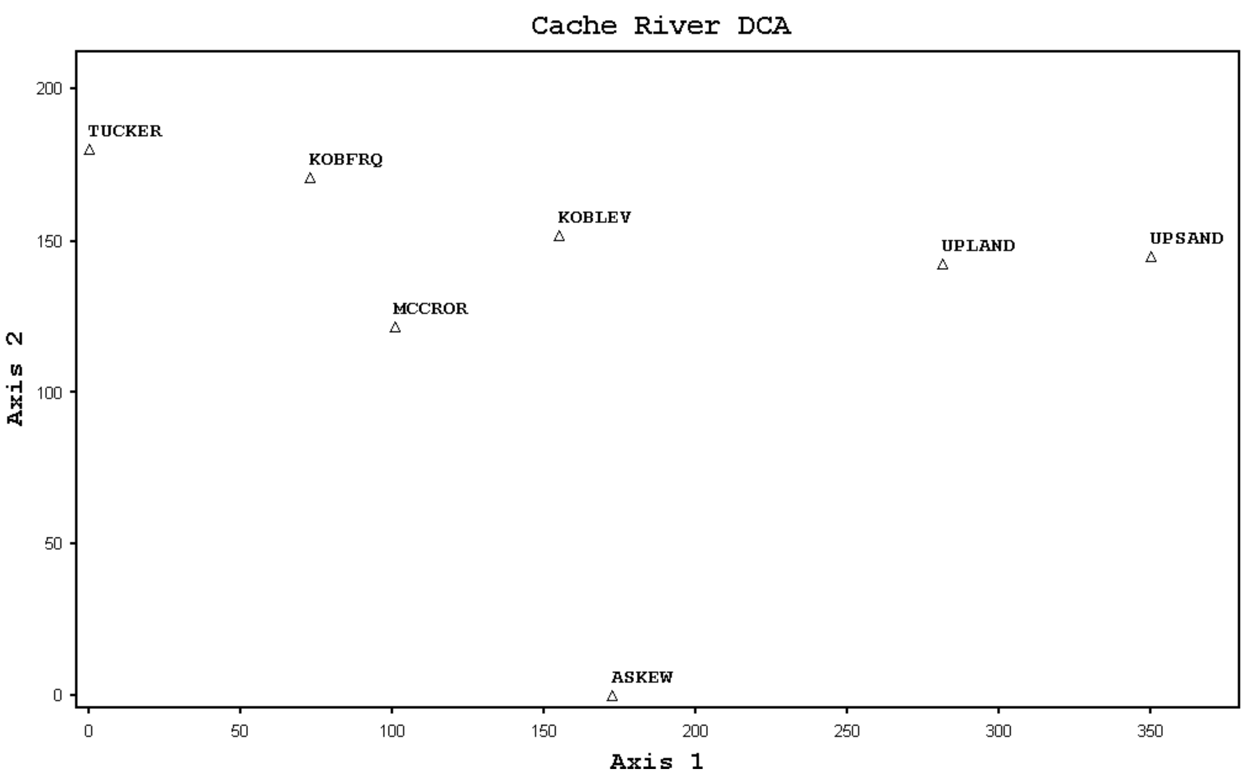

Figure 3—Soil/vegetation groups plotted on Axis 1 vs. Axis 2 of Detrended Correspondence Analysis.

unalterably changed from the “natural”, forest species suited to the new conditions will have to be propagated.

2. True upland forest (white oak-black oak-hickory) occurred in this area, with dogwood as a diagnostic species, limited to the uplands, as it is today. To many, the LMV was synonymous with bottomland hardwood forest. Nevertheless, large areas were covered with upland hardwood forest, pine forest or prairie, depending on site conditions. Many of these less appreciated vegetation types have been decimated even more than the bottomland hardwoods. A perhaps very rare and dramatically impacted community in this study area is represented by UPSAND, the community occurring on Bulltown loamy fine sand. This community, previously undocumented, was dominated by widely spaced trees. This community is typically referred to as savanna, barrens or woodland (a community with 25-60 percent canopy cover of trees). Searches by the ANHC have failed to locate any extant sites occupied by this type, even in degraded form. The presence of enough fine material in this soil, along with ease of removing the few trees, probably led to early clearing of the sites. At this point, little is known about the overall composition and structure of this community, but its importance may be illustrated by the occurrence in Missouri of the sedge *Cyperus grayoides* Mohlenbrock on similar lowland sandy sites. After failing to find suitable habitat in the vicinity of this study site, ANHC botanist John Logan discovered the species in Arkansas by looking in sandhill woodlands in the West Gulf Coastal Plain 300 km to the south (Personal communication. 1996. Logan, J. Arkansas Natural Heritage Commission, Suite 1500, Tower Building, 323 Center St., Little Rock, AR 72201). Restoration of the community on appropriate sites should be a high priority.

ACKNOWLEDGMENT
This paper was improved by the important suggestions of an anonymous reviewer.

REFERENCES
Arkansas Game and Fish Commission. 1988. A proposal for the Cache/Lower White Rivers Joint Venture Project, a component of the North American Waterfowl Management Plan’s Lower Mississippi Valley Joint Venture. Little Rock, AR: Arkansas Game and Fish Commission, in cooperation with U.S. Fish and Wildlife Service and other supporting agencies.

Bourdo, E.A., Jr. 1956. A review of the General Land Office Survey and of its use in quantitative studies of former forests. Ecology. 37: 754-768.

Cottam, G.; Curtis, J.T. 1956. The use of distance measures in phytosociological sampling. Ecology. 37: 451-460.

Hill, M.O.; Gauch, H.C. 1980. Detrended correspondence analysis: an improved ordination technique. Vegetatio. 42: 47-50.

U.S. Fish & Wildlife Service. 1994. Comprehensive management plan for the Cache River and White River National Wildlife Refuges within the Cache/Lower White Rivers Ecosystem. Unpublished master plan. St. Charles, AR: U.S. Fish and Wildlife Service.

White, C.A. 1983. A history of the rectangular survey system. Washington, DC: Government Printing Office.