# VASCULAR FLORA OF THE REMNANT BLACKLAND PRAIRIES AND ASSOCIATED VEGETATION OF GEORGIA

by

STEPHEN LEE ECHOLS, JR.

(Under the Direction of Wendy B. Zomlefer)

## ABSTRACT

Blackland prairies are a globally imperiled, rare plant community only recently discovered in central Georgia. A floristic inventory was conducted on six remnant blackland prairie sites within Oaky Woods Wildlife Management Area. The 43 ha site complex yielded 354 taxa in 220 genera and 84 families. Four species new to the state of Georgia were documented. Eight rare species, one candidate for federal listing, and one federally endangered species are reported here as new records for the Oaky Woods WMA vicinity. Twelve plant communities are described. A literature review was performed for six states containing blackland prairie within the Gulf and South Atlantic Coastal Plains of the United States. Geology, soils, and vegetation were compared, and cluster analysis was performed using floristic data to assess similarities.

INDEX WORDS: Black Belt region, Blackland prairies, cluster analysis, floristics, grassland, Georgia, Oaky Woods Wildlife Management Area, prairie, rare species

# VASCULAR FLORA OF THE REMNANT BLACKLAND PRAIRIES AND ASSOCIATED VEGETATION OF GEORGIA

by

STEPHEN LEE ECHOLS, JR.

B.S., Appalachian State University, 2002

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2007

# VASCULAR FLORA OF THE REMNANT BLACKLAND PRAIRIES AND ASSOCIATED VEGETATION OF GEORGIA

by

STEPHEN LEE ECHOLS, JR.

Major Professor: Wendy B. Zomlefer

Committee: Jim Affolter
Rebecca Sharitz

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2007

# DEDICATION

I dedicate this thesis to my girlfriend Lisa Keong, who despite my absence, has stood by me with patience and support throughout the final stages of this project.

I also dedicate this thesis to Galen Danger Burke. Without his friendship, patience, humor, and hard work, this thesis would have never been completed. I'm serious. Hey, hey, hey.

I dedicate this thesis to Will Rogers. Our wonderful friendship and his support have been instrumental in the completion of this chapter of my life.

I also dedicate this thesis to my late mother, Mary Echols.

# ACKNOWLEDGEMENTS

Without the help of the following individuals and institutions, I could not have completed this thesis.

First and foremost, I thank my major advisor, Wendy B. Zomlefer, whose patience, expertise, and focus allowed me to finish this degree in a timely manner. I also thank my committee members, Rebecca Sharitz and Jim Affolter, for their time, patience, and valuable input.

I acknowledge the following Georgia Natural Heritage Program staff: Tom Patrick introduced me to the blackland prairies of Georgia; his time and continued support of this project is highly appreciated. Nathan Klaus has repeatedly lent his expertise regarding prairies. I also thank Mincy Moffett and Lisa Kruse for their contributions in the field and otherwise.

Al Schotz's time, input, and expertise regarding Alabama blackland prairies has been invaluable. Tom Foti has shared his knowledge regarding Arkansas blackland prairies. I also thank Michael MacRoberts, Timothy Schauwecker, John Barone, and Jim Allison for sharing their knowledge regarding blackland prairies. Pete Pattavina contributed valuable fieldwork and knowledge regarding Georgia populations of *Silene polypetala*.

I thank Nicole Lorenz (Louisiana Natural Heritage Program), Matt Hicks (Mississippi Natural Heritage Program), and Cindy Osborne (Arkansas Natural Heritage Commission) for providing data.

I thank Kelly Bettinger for innumerable kind acts, wonderful food, for tolerating my overbearing presence in the herbarium, and proofing labels. David Giannasi has given sage advice and support throughout this project. Leigh Griggs, Galen Burke, and Erin Rasmussen all contributed valuable fieldwork assistance.

The Georgia Botanical Society, The Georgia Native Plant Society, The Georgia Museum of Natural History, and the University of Georgia Department of Plant Biology have all provided critical funding for this project. Their support is greatly acknowledged and appreciated. I also thank the National Science Foundation for herbarium research assistantship funding, and the National Park Service for botanical contract work.

I thank Elaine Nash, whose enthusiasm for native grasses and prairies has inspired me; her encouragement and support has been tremendous. Linda Chafin provided me with valuable advice and encouragement.

Acknowledgements are in order for the following Department of Plant Biology personnel. Susan Watkins has been indispensable in helping me navigate the vagaries of graduate school. Thanks go to Elaine Dunbar for her hours of paperwork and account management that kept my project moving forward. I thank Brenda Maddox, whose payroll expertise ensured I was able to sustain myself. I also thank Gregory Schmidt, graduate coordinator, for his support of my project, and my progess as a graduate student in general.

Many thanks to Larry West (UGA Crop and Soil Sciences), whose time and soil expertise was truly integral to this project. I thank the University of Georgia Soil, Plant, and Water Testing Laboratory for their assistance in soil sample analyses. I also thank David Kissel (UGA Crop and Soil Sciences) for his help in soil data interpretation.

TABLE OF CONTENTS

Page

# LIST OF TABLES

Page

# LIST OF FIGURES

Page

# CHAPTER 1

## INTRODUCTION & LITERATURE REVIEW

We are entering a period of time where large, ecologically significant areas are becoming out of reach for conservation purposes. These tracts have already been subdivided into smaller parcels for development or are too expensive for anyone but land speculators and developers to purchase. Oaky Woods Wildlife Management Area in central Georgia is an example.

State officials have long considered Oaky Woods a high priority "legacy tract" for its diversity of flora and fauna and popularity as a hunting preserve (Foskett 2006). In 2004, the state of Georgia lost the chance to purchase this tract. Weyerhauser Corporation, an international timber firm, was willing to sell the property for 30 million dollars, but the state refused. It is reported that Governor Sonny Perdue's private land interests adjacent to the tract were one of the reasons (Foskett and Salzer 2006). Oaky Woods now rests in the hands of private land speculators who plan to build thousands of houses on the property.

Oaky Woods contains a collection of unique, ecologically valuable habitats comprising the blackland prairies. These prairies and their associated rare forest, woodland, and shrubland habitats have many rare species and form the eastern edge of the blackland prairies' range. Although never widespread in Georgia, they are now exceptionally rare as a result of anthropogenic impacts, such as logging, mining, and development.

This rare habitat is the focus of this study. The thesis is divided into two sections: Chapter 1 is a floristic inventory of Oaky Woods blackland prairies and their associated vegetation; the geology, soils, vegetation, and vascular flora are described in detail. Chapter 2 is

a review of blackland prairie ecosystems throughout their range including a state-by-state summary and comparisons. Chapter 2, thus, places Georgia's blackland prairies within a regional ecological framework to better understand their importance.

This thesis provides valuable information to help guide and bolster these preservation efforts, as well as range wide summary of blackland prairies for land managers, ecologists, and conservation practitioners. It is the hope of this author, and many naturalists and sportsmen throughout the state, that some portion of Oaky Woods may still be preserved.

# CHAPTER 2

# FLORISTIC INVENTORY OF REMNANT BLACKLAND PRAIRIES AND ASSOCIATED VEGETATION OF CENTRAL GEORGIA[*]

[*]Echols, S. L. and W. B. Zomlefer. To be submitted to *Castanea*

**Abstract**

Blackland prairies are a globally imperiled, rare plant community only recently discovered in central Georgia. A floristic inventory was conducted on six remnant blackland prairie sites within Oaky Woods Wildlife Management Area. The 43 ha site complex yielded 352 taxa in 220 genera and 84 families. Four species new to the state of Georgia were documented. Eight rare species, one candidate for federal listing, and one federally endangered species are reported here as new records for the Oaky Woods WMA vicinity. Twelve plant communities are described.

INDEX WORDS: Blackland prairies, floristics, Georgia, Oaky Woods Wildlife Management Area, rare species

## Introduction

The blackland prairie relics of central Georgia, the easternmost examples of blackland prairie in the nation, comprise one of the least known plant communities within the state. Blackland prairie and its associated vegetation are characterized by a mosaic of grassland, savannah, woodland, and mixed southeastern forest types (NatureServe 2007). Related vegetation occurs scattered across Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas (Peacock and Schauwecker 2003; NatureServe 2007; Fig. 1.1). Blackland prairie is associated with limestone and calcareous clay formations originating during the Upper Cretaceous and Lower Tertiary (ca. 65-30 mya) when much of the southeast was covered by a shallow sea (Huddlestun and Hetrick 1986; Peacock and Schauwecker 2003). The unique associated soil outcrops harbor a number of rare and/or disjunct taxa (Liedolf and McDaniel 1998). Blackland prairie communities possess a G2 rarity ranking, i.e., they are "globally imperiled due to range restriction, habitat degradation and destruction" (NatureServe 2007).

### *Location*

The study area is located within Oaky Woods Wildlife Management Area (WMA), 18,925 acres (7,659 ha) in central Georgia approximately 12 km southeast of Warner Robins, Houston County (Fig. 1.2). It is bounded by the Ocmulgee River to the east, GA Highway 247 and Kathleen to the west, GA Hwy 56 and Bonaire to the north, and Big Indian Creek to the south. Six study sites are scattered across the northern, central-west, and southeastern portions of the WMA (Fig. 1.3). The WMA is within the Upper Coastal Plain physiographic province.

### *Edaphic and Climatic Factors*

Underlying geologic formations originated in the Cretaceous and Tertiary periods, when sea level fluctuations intermittently submerged large expanses of the southeastern coastal plain,

creating a wedge of coastal plain sediments (Eversull 2005). In the area of central Georgia between the Flint and Ocmulgee Rivers, these marine sediments interlayer in a complex mosaic of differing series (Huddlestun and Hetrick 1986). Huddelstun and Hetrick (1986) correlated the central Georgia deposits with Upper Eocene Jacksonian sediments of Mississippi and Alabama, two states that once contained extensive areas of blackland prairie (Frost et al. 1986). The study area is underlain by a portion of this mosaic that includes the Dry Branch, Tobacco Road Sand, Tivola and Ocmulgee Formations of late Eocene origin (Huddlestun and Hetrick 1986). The Twiggs Clay member represents the Dry Branch Formation within the study area. This silty clay, known as “Fuller’s Earth”, occurs in discontinuous lenses across the landscape and has been mined within central Georgia for the last 100 years for its absorbent capacities used in household and industrial applications (Eversull 2005). The Tobacco Road Sand Formation, consisting of predominantly weathered sand, is found in its westernmost known locality within Oaky Woods WMA. The Tivola Limestone Formation consists of textured limestone rich in fossil bryozoans and is a northward extension of the Ocala Limestone Group. The Ocmulgee Formation, previously known as Cooper Marl in Georgia, is a combination of indurated and argillaceous limestone that also falls within the Ocala Group (Huddlestun and Hetrick 1986).

Calcareous soils are the main abiotic factor driving the occurrence of blackland prairie vegetation within Georgia. The shrink-swell clays and alkaline pH of these soils account for a distinctive suite of vegetation not found elsewhere in the state. Table 1.1 summarizes the soil series. The Sumter Series most commonly underlies the study area and consists of shallow, alkaline, moderately well-drained silty clays underlain by marl, chalk, or limestone (Woods 1967). In many of the surveyed areas, erosion has revealed the distinctive light grey, marly subsurface. The Oktibbeha, Boswell, and Susquehanna Series are also present to a lesser extent

and occur together in intricate patterns. The Oktibbeha series consists of moderately drained soils developed in beds of clay less than 1.5 m deep. The upper horizons are acidic sandy loams or sandy clay loams underlain by plastic clays. The lower horizons contain calcareous parent material similar to the Sumter Series at a depth of 50-100 cm. The Boswell series consists of strongly acidic, moderately well drained soils over noncalcareous and sandy clays. The Susquehanna series consists of somewhat poorly drained sandy clay soils over thick beds of acid clay (Woods 1967). A potentially undescribed series occurs at site 5 associated with mesic forest, consisting of very deep, dark, slowly permeable soils over limestone. The upper horizons consist of dark brown silty clays, while the lower consist of dark grey, strongly alkaline, silty clays (L. West, pers. comm.).

The North American grassland biome originated during the Miocene-Pliocene transition (7-5 mya) in a time of aridity (Axelrod 1985). The uplifting of the Rocky Mountains was critical in creating drier conditions conducive for prairie genesis in the west. As the Rockies' climatic influence diminishes further east, fire and grazing become more important factors in the evolution and maintenance of prairie vegetation (Peacock and Schauwecker 2003). Higher annual precipitation, lower evaporation rates, and increased soil moisture differentiate the climate of eastern prairies from their western counterparts (Moran 1995).

The climate of the study area is characterized by long, hot summers and short, mild winters (Southeastern Regional Climate Center 2007). The mean annual temperature is 17.5° C, with January the coldest month at 0.8° C, and July, the warmest at 33.1° C. Mean annual precipitation is 115.0 cm/year. July has the highest precipitation at 13.9 cm, and October the lowest at 6.4 cm. Houston County's annual precipitation averages are among the lowest in the state (Georgia Automated Environmental Monitoring Network 2007; Fig. 1.4).

*Current Land Use Issues: Ownership and Management*

State officials have long considered Oaky Woods a high priority "legacy tract" for its diversity of flora and fuana and popularity as a hunting preserve (Foskett 2006). The Georgia Department of Natural Resources has leased the land for use as a Wildlife Management Area for several decades. Oaky Woods was owned by Weyerhauser Corporation prior to their divestiture of the property in 2004 (Shelton and Seabrook 2004). At that time, The Nature Conservancy offered to purchase Oaky Woods if the state of Georgia would agree to purchase the property at a later date, but the state declined (Shelton 2007). It is reported that Governor Sonny Perdue's private land interests adjacent to the tract were one of the reasons (Foskett and Salzer 2006). The Southern Timber Consultants of Perry, Georgia then acquired the property, and Oaky Woods was sold again in 2005 to a smaller consortium of individual investors (J. Skvarla, pers. comm.). Current plans include building as many as 35,000 houses in the area (McCaffrey 2007). However, the state, local residents, and numerous conservation groups remain interested in purchasing the property. The current owners are willing to negotiate with the state if their asking price is met (Foskett 2006).

This study was undertaken in an effort to support conservation initiatives with critical floristic data. The Georgia Natural Heritage Program (GANHP) has identified blackland prairies as a high priority system for conservation (T. Patrick, pers. comm.). Their location within central Georgia also makes them a priority for inventory because these counties are under-represented in University of Georgia Herbarium collections.

**Materials and Methods**

Reconnaissance of Oaky Woods WMA was performed in autumn 2004. Six sites totaling approximately 106 acre (43 hectares) were chosen for survey (Table 1.2). The floristic inventory

was conducted from February-November, 2005-2006. Sites were visited monthly over two entire growing seasons, totaling 42 trips. Specimens were collected in duplicate whenever possible using standard field and herbarium techniques with permission of Georgia Department of Natural Resources and the property owners. A complete set of vouchers are deposited at GA, and the duplicate set, at VSC. Plants were primarily identified using Weakley (2007), supplemented by Diggs et al. (1999) and *Flora of North America* (FNA 2002, 2003, 2006). Nomenclature follows Weakley (2007). Rare plant data were submitted to the Georgia Natural Heritage Program (GANHP 2007a, b, c). Plant communities were described via field observations and plot data. Plots were constructed and sampled using the North Carolina Vegetation Survey methodology (Peet et al. 1998). Three 100 $m^2$ plots were sampled from open prairie vegetation in site 3, and one 400 $m^2$ plot consisting of four 100 $m^2$ subplots were sampled from mesic forest vegetation in site 5. Vascular plant percent cover data from plots were utilized to determine dominant species for some habitat types. One soil sample was collected from sites 1-5. Each soil sample consisted of eight composite subsamples collected from the first 15 cm of representative soil profiles. Soil samples were collected from open prairie habitats in sites 1, 2, 3, and 4. Samples were taken from mesic forest habitat in site 5. Samples were submitted to the UGA Soil, Plant and Water Laboratory for chemical and textural analyses.

**Results and Discussion**

*Floristic Summary*

A total of 354 species in 220 genera and 84 families were documented (Appendix), including 94 woody and 260 herbaceous species. Poaceae (53 spp., 15.1%) and Asteraceae (49 spp., 13.9%) dominate in species richness. Other important families include Fabaceae (25 spp., 7.1%), Rosaceae (22 spp., 6.3%), and Cyperaceae (16 spp., 4.5%).

*Non-native Species*

Thirty-seven species (10.2% of the flora) are exotic, and 11 are listed as non-native invasive plants in Georgia (Georgia Exotic Pest Plant Council 2007; Table 1.3). Of these, six are considered Category 1 species: *Eleagnus umbellata*, *Lespedeza cuneata*, *Ligustrum sinense*, *Lonicera japonica*, *Melia azedarach*, and *Pueraria lobata*. Category 1, or "serious problem" species, invade native plant communities, and displace native species. *Eleagnus umbellata* occurs in low numbers at sites 4 and 5. Small but well established populations of *Lespedeza cuneata* are present along the roadside adjacent to prairie vegetation at sites 4 and 6. Sites 3 and 4 contain small amounts of *Ligustrum sinense*. *Lonicera japonica* sporadically occurs within sites 1 and 5. This species was noted in close proximity to the Federally Endangered *Silene polypetala* and should be a high priority for exotic control. A single individual of *Melia azedarach* was noted on the roadside adjacent to the chalk outcrop in site 5. Of the eleven species listed in Table 1.3, *Melilotus alba*, *Pueraria lobata*, and *Sorghum halapense* are the most established invasives and thus, potentially pose the greatest immediate threat. These three species are discussed in further detail below.

***Sorghum halepense*** (Johnson Grass). *Sorghum halepense* is a well established weed on the edges of site 1. Johnson Grass may have originated in the Mediterranean Region. The rapidly growing, extensive rhizome system and copious seed set make this species extremely difficult to eradicate (Newman 1990). There are numerous control methods. Avoidance of ground disturbance is necessary. Removal of aerial shoots via mowing effectively reduces nutrient stores and reduces rhizome growth. However, chemical control using glyphosate is recommended in wildland settings. Repeated applications over the course of several years are necessary. Positive results have been achieved by spraying actively growing plants greater than 45 cm tall after they

have reached the bloom-to-head stage. Mature inflorescences should be clipped and removed from the site to prevent further infestation.

***Melilotus alba*** (White Sweetclover). *Melilotus alba* establishes large, sometimes monotypic stands within portions of site 1 in early spring. Sweetclover, native to Eurasia, is an annual or biennial with a long taproot. It is especially problematic within prairie communities, where it readily invades open areas (Eckhardt 1987). Controlled burning may be used for eradication. A late fall or early spring burn followed by a late spring burn has achieved elimination in experimental plots. However, for smaller prairies only a few acres in size, frequent burning may eliminate rare native forbs at the expense of prairie grasses. Hand-clipping close to the ground or hand-pulling of young green plants is then the preferred method.

***Pueraria lobata*** (Kudzu). *Pueraria lobata* occurs within sites 3 and 5. Originally introduced to the United States from Japan in the early 1900's, this leguminous vine is one of the most aggressive exotics in the Southeast. It readily colonizes by rooting at the nodes, and seeds are wind, water, and animal-dispersed (Miller 2003). The tuberous fleshy roots also make eradication especially difficult (Georgia Exotic Pest Plant Council 2007). Management of kudzu in natural areas is usually accomplished with chemical applications, with repeated glyphosate or triclopyr applications over several years. These herbicides may be applied to root crowns, cut stumps, or via foliar spraying.

*Rare Species*

Twenty-four rare plant species occur within the study area (Table 1.4), including four state records (*Cyperus acuminatus*, *Draba cuneifolia*, *Galium virgatum*, and *Scutellaria drummondi*); one federally endangered species (*Silene polypetala*); and one candidate for federal listing (*Symphyotrichum georgianum*). Eleven special concern species (rare or imperiled plants

in Georgia) and seven watch list species (plants of lesser conservation concern in Georgia) complete the list (GANHPa,b,c). Of the eleven special concern species documented, *Crataegus triflora*, *Ophioglossum engelmannii*, *Sida elliottii* and *Smilax lasioneuron* are new records for Oaky Woods. Of the seven watch list species documented, *Hexalectris spicata*, *Matelea flavidula*, *Trillium underwoodii*, and *Sympyotrichum laeve* var. *concinnum* are new records for Oaky Woods. Forty-six rare species occurrence records were supplied to the GANHP.

The four state records, *Cyperus acuminatus, Draba cuneifolia, Galium virgatum*, and *Scutellaria drummondii,* occur in association with calcareous substrates west of Georgia (Diggs et al. 1999). They likely represent disjunct populations of more westerly distributed species (USDA 2007). All four were recently added to Georgia's list of special concern plants (GANHP 2007b). *Silene polypetala* and *Symphyotrichum georgianum* are new records for the Oaky Woods flora, and each represent the second documented population for those species in Houston County (GANHP 2007d). These are discussed in further detail below.

***Cyperus acuminatus*** (Flatsedge**)**. *Cyperus acuminatus* is an annual sedge with distinctly hemispheric inflorescence heads; trigonous, broadly ellipsoid achenes; spikelets with mucronate apices; and longest inflorescence bract erect or ascending. Habitats include moist disturbed soils, wetlands, and wet shores, often over limestone (FNA 2002; Weakley 2007). This flatsedge is widely distributed throughout the contiguous United States, although localities from both east and west coast states are considered disjunct. *Cyperus acuminatus* becomes more frequent west of Georgia and has not been recorded in either South Carolina or Florida (USDA 2007). Within the study area, a single population of *C. acuminatus* inhabits saturated blackland prairie soils within a roadbed that dissects site 3.

***Draba cuneifolia*** (Wedgeleaf Whitlow Grass**)**. Wedgeleaf Whitlow Grass is recognized by the loose inflorescence, cauline leaves restricted to the lower stem, and silique pubescence of branched and unbranched hairs (Weakley 2007). Habitats include bluffs, glades, prairies, ledges, and forest openings, often over calcareous substrates (Schotz, pers. comm; Yatskievych 2006). This species is primarily distributed in the southwest (Weakley 2007). It extends east to Georgia and Florida, west to California, north to South Dakota and south to Texas (USDA 2007). North and South Carolina records potentially represent waif populations from old wool-combing mills (Weakley 2007). Within surrounding states, it is recorded from six counties in Alabama, where it is a state-listed rare species found in blackland prairies (Alabama Natural Heritage Program 2006; USDA 2007), and two counties from northern Florida (Wunderlin and Hansen 2007). Within the study area, *D. cuneifolia* was observed on a chalk outcrop with cedar woodland in site 5, as well as bare rocky soil in prairie vegetation in sites 2 and 6.

***Galium virgatum*** (Limestone Bedstraw). Limestone bedstraw is distinguished from other southeastern *Galium* species by subsessile axillary flowers, borne singly or in small clusters, which quickly become deflexed in fruit. It prefers disturbed or eroded ground and is frequently associated with calcareous clays (Diggs et al. 1999). Limestone Bedstraw extends east to Georgia, west to Oklahoma and Texas, north to Illinois, and south to Louisiana (USDA 2007). Like *D. cuneifolia*, South Carolina records were collected around old wool-combing mills and potentially represent waif populations (Weakley 2007). Within surrounding states, it is restricted to four counties in central Tennessee and two counties in west central Alabama (USDA 2007). Within the study area, it is restricted to sites 1 and 4 on bare or eroded soils in open blackland prairie vegetation, often where erosion has exposed beds of marl.

***Scutellaria drummondii*** (Drummond's Skullcap**)**. Habitats include sandy, sandy-loam, or clay soils, often over limestone (Diggs et al. 1999). *Scutellaria drummondii* ranges east to Georgia and Florida, west to New Mexico, north to Oklahoma and south to Texas (USDA 2007). Drummond's Skullcap is absent from all adjacent states except Florida, where it is considered an introduction in two northern panhandle counties (Wunderlin and Hansen 2007; USDA 2007). Georgia's populations are probably native, occurring within typical habitat in association with a suite of other disjunct species. The documented habitat preference for the study area is similar to that of *Galium virgatum*, found in bare soils in open prairie vegetation. A single large population was documented within site 4.

***Silene polypetala*** (Fringed Campion**)**. Fringed Campion's flowers are distinct: pink or white lacerate petals to 3 cm long with a distinctly fringed appearance (Patrick et al. 1995). Other features include villous-pubescent stems and a 2-3 cm long calyx tube. Fringed Campion occurs in mature hardwood or mixed hardwood-pine forests, associated with various microhabitats. *Silene polypetala* is a strict southeastern endemic, restricted to a small cluster of counties in west central and southwest Georgia and adjacent panhandle Florida (P. Pattavina, pers. comm.; T. Patrick et al. 1995). A small population of less than ten plants occurs along a moist stream bank and adjacent floodplain within mesic oak forest at site 5. The site's heavy clay soils may explain why Fringed Campion persists in such low numbers within otherwise suitable mesic forest habitat (P. Pattavina, pers. comm.). This species is known from six counties in Georgia, and the Oaky Woods population represents the second record for Houston County (GANHP 2007d).

***Symphyotrichum georgianum*** (Georgia Aster). Georgia Aster is a colonial, rhizomatous plant with revolute leaf margins and large flower heads. Ray flowers reach 24 mm in length (FNA 2006). Habitats include sandy and clayey soils in oak and oak-pine woodlands, road

embankments, and edges of granite outcrops (FNA 2006; Weakley 2007). *Symphyotrichum georgianum* is a broad southeastern endemic, found in Alabama, Florida, Georgia, North Carolina, and South Carolina (FNA 2006). It is listed as Threatened in North Carolina (Franklin and Finnegan 2006) and considered rare and disjunct in Leon County, Florida (FNA 2006). Georgia Aster is documented from 18 counties in northern, west-central, and southwestern Georgia (GANHP 2007d). Records from southwestern Georgia are considered disjunct populations (FNA 2006). Georgia Aster was documented in site 1 along the edge of open prairie vegetation burned in 2003 by Georgia Department of Natural Resources (N. Klaus, pers. comm.). This coincides with Georgia Aster's presumed affinity for fire-dependant habitats (NatureServe 2007). The Oaky Woods population represents the second record for Houston County.

Several other rare species of note were discovered. *Vicia minutiflora* occurs in the mesic forest riparian area and calcareous woodland of site 5. This species is rare or overlooked within the state: GA Herbarium has records for only Houston and Clay counties. An additional population was recently discovered in Twiggs County (Pete Pattavina, pers. comm.). Weakley (2007) considers the species rare within Georgia and surrounding states. *Dichanthelium boreale* occurs in open prairie and ruderal habitats of sites 3 and 4. This more northerly distributed species is considered rare in the southeast (Weakley 2007). Georgia Herbarium has vouchers for Harris County. Both species should be placed on the Georgia watch list.

*Plant Communities*

Twelve community types were recognized within the study area. Some community types were documented from a single site, and some communities (e.g., grassland descriptions) may occur over areas only 100 $m^2$. Additionally, the study area has been significantly altered by human impacts: roads dissect every site, and repeated logging has taken place. The descriptions

below provide a baseline to compare communities across the range of the blackland prairies and serve as a preliminary template when searching for and documenting new blackland prairies within Georgia. Table 1.5 lists characteristic species of the study area.

*Woodland types*

Although two calcareous woodland types are recognized here, there are additional marginal woodland areas bordering open prairie and small, isolated prairie openings recently invaded by woody species such as *Acer rubrum, Diospyros virginiana, Fraxinus americana,* and *Pinus taeda* that do not warrant classification. Prolonged fire suppression probably plays a role in the occurrence of these communities.

*Juniperus virgininia/Fraxinus americana/Ratibida pinnata-Agalinis tenuifolia* community type. This community resembles the Prairie Cedar Woodland in Mississippi (Leidolf and McDaniel 1998). It is found along a ridgeline chalk outcrop and the adjacent side slope in site 5. *Juniperus virginiana* dominates the open sparse overstory. Common shrub layer species include *Celtis tenuifolia, Fraxinus americana,* and *Ptelea trifoliata. Agalinis tenuifolia, Ratibida pinnata,* and *Salvia lyrata* are frequent within the herbaceous layer. Rare species include *Crataegus triflora, Draba cuneifolia, Glandularia bipinnatifida*, *Sida elliottii,* and *Tragia cordata*.

*Quercus muehlenbergii*/*Cercis canadensis-Quercus sinuata*/*Viburnum rufidulum*/*Scleria oligantha* community type. This community resembles the Upper West Gulf Dry Chalk Savanna in Arkansas (NatureServe 2007) in terms of overstory height and species composition. It is restricted to the Sumter soil series on shoulder slopes of site 3 and is characterized by a stunted overstory dominated by *Quercus muehlenbergii* with *Q. velutina*. The closed overstory in many areas is probably the result of fire suppression. Common understory species include *Cercis*

*canadensis, Quercus sinuata, and Sideroxylon lycioides*. *Viburnum rufidulum* is present within the shrub layer. Common herbaceous components include *Carex abscondita, Scleria oligantha,* and *Zizia aurea*. Other species include *Dioscorea quaternata* and *Phlox pilosa*. Rare species include *Glandularia bipinnatifida* and *Tragia cordata*.

*Shrubland community types*

Two shrub dominated communities were documented. Like the woodland types, prolonged fire suppression probably plays a role in the genesis and proliferation of these communities.

*Fraxinus americana-Quercus muehlenbergii*/*Crataegus* sp.-*Cercis canadensis* community type. This community is restricted to Sumter soils on gentle shoulder slopes of site 3. The sparse overstory is dominated by *Fraxinus americana* and *Quercus muehlenbergii* with lesser amounts of *Pinus taeda*. The dense shrub layer is dominated by an undescribed *Crataegus* species of potential hybrid origin (R. Lance, pers. comm.). *Cercis canadensis* is also a dominant within the shrub stratum. Other components of the shrub layer include *Crataegus aprica, C. crus-galli, C. pruinosa, Ptelea trifoliata, Sideroxylon lycioides,* and *Viburnum rufidulum*. Herb layer associates include *Ratibida pinnata, Silphium asteriscus* var. *dentatum, Sorghastrum nutans,* and *Sporobolus clandestinus*.

*Crataegus spathulata-Cercis canadensis-Celtis tenuifolia* community type. This community consists of dense shrub thickets in linear transition zones bordering open prairie communities. It occurs at every site and is best developed at sites 3 and 6. The composition of this community is highly variable. *Crataegus spathulata* usually dominates, with *Celtis tenuifolia* and *Cercis canadensis* important components as well. Depending on the site, *Cornus asperifolia, Fraxinus americana, Quercus muehlenburgii,* and *Viburnum rufidulum* are important

species. *Cornus florida*, *Crataegus aprica*, and *C. crus-galli* are also common. Rare species include *Smilax lasioneuron*.

*Pine-Hardwood Forest*

One pine-hardwood forest type was documented at site 6. Sites 2 and 5 also contain small, degraded remnants of pine-hardwood dominated communities, typically containing *Quercus muehlenbergii* and *Pinus taeda*, existing as linear transitions or small patches between open prairie and planted loblolly stands.

*Pinus taeda-Quercus velutina-Quercus coccinea-Acer floridanum-Quercus muehlenbergii/Cercis canadensis-Ptelea trifoliata* community type. This dry-mesic forest type occurs over sandy clay loams on side slopes. Canopy dominants include *Pinus taeda*, *Quercus coccinea*, and *Q. velutina*. Important understory species include *Acer floridanum* and *Quercus muehlenburgii*; other understory components include *Juniperus virginiana*, *Liriodendron tulipifera*, and *Robinia pseudoacacia*. The shrub layer consists mainly of *Cercis canadensis*, *Cornus asperifolia*, and *Ptelea trifoliata*. *Arundinaria gigantea*, *Callicarpa americana*, *Frangula caroliniana*, and *Viburnum prunifolium* are also present within this stratum. The sparse herb layer contains *Dichanthelium boscii*, *Elymus hystrix*, *Euphorbia pubentissima*, *Phaseolus polystachios*, and *Toxicodendron radicans*. *Pueraria lobata* is a problematic invasive in this community.

*Mesic Forest Types*

Two mesic forest types were documented within different landscape positions: *Quercus shumardii-Quercus nigra-Ulmus rubra*/*Acer floridanum-Fraxinus americana*/*Ulmus alata-Asimina triloba*/*Vitis rotundifolia* community type occupies back slopes and lower slopes while

the *Quercus nigra-Quercus pagoda*/*Acer floridanum*/*Cercis canadensis* community type occupies bottomlands.

*Quercus shumardii-Quercus nigra-Ulmus rubra*/*Acer floridanum-Fraxinus americana*/*Ulmus alata-Asimina triloba*/*Vitis rotundifolia* community type. Plot data from site 5 were used to determine dominant species within each stratum for this community. Mesic forest occurs over deep, dark, silty clay soils along back slopes and lower slopes within site 5. *Quercus shumardii* dominates the canopy, with *Q. nigra* and *Ulmus rubra* as important components. Common understory species include *Acer floridanum, Carpinus caroliniana, Fraxinus americana* and *Morus rubra*. *Acer floridanum*, *Asimina parviflora, Morus rubra* and *Ulmus alata* are frequent within the shrub layer. The sparse herbaceous layer is dominated by *Vitis rotundifolia*. Other species include *Aesculus pavia, Agrimonia gryposepala, Arundinaria gigantea, Hexastylis arifolia*, *Polystichum acrostichoides*, and *Quercus alba*. Rare species include *Crataegus triflora, Silene polypetala,* and *Smilax lasioneuron*.

*Quercus nigra-Quercus pagoda/Acer floridanum/Cercis canadensis* community type. This community is restricted to sandy loams along ephemeral stream bottoms at site 6. *Quercus nigra* and *Q. pagoda* dominate the canopy, with lesser amounts of *Q. alba*. The understory is dominated by *Acer floridanum* with lesser amounts of *Liquidambar styraciflua*. Dominant shrub layer components include *Acer floridanum* and *Cercis canadensis*. Other species within the shrub stratum include *Callicarpa americana, Morus rubra, Prunus caroliniana, Sideroxylon lycioides*, and *Ulmus alata*. *Toxicodendron radicans* and *Vitis rotundifolia* are common herb layer components. *Chasmanthium latifolium, C. laxum, Euphorbia pubentissima,* and *Zizia aurea* are also present within the herb layer. Rare species include *Trillium underwoodii*.

*Open Prairie Types*

Five open prairie community types were documented. There is significant intergradation between these herbaceous communities. The *Houstonia nigricans-Sporobolus vaginiflorus* and *Sorghastrum nutans-Ratibida pinnata-Houstonia nigricans* community types are the most commonly occurring open prairie habitats within the study area.

*Houstonia nigricans-Sporobolus vaginiflorus* community type. Plot data from site 2 were used to determine dominant species within this community. Anthropogenic disturbance may play a role in the occurrence of this vegetation type, given the sparse vegetative cover relative to other observed open prairie habitats in the study area (J. Allison, pers. comm.). Sites 2, 3, and 4 contain sparsely vegetated shoulder slopes over Sumter soils dominated by *Houstonia nigricans* and/or *Sporobolus vaginiflorus*. Other common species include *Carex cherokeensis, Erigeron strigosus, Ratibida pinnata, Salvia lyrata, Silphium asteriscus, Solidago nemoralis,* and *Sorghastrum nutans.* Rare species include *Draba cuneifolia, Galium virgatum, Glandularia bipinnatifida,* and *Scutellaria drummondii.*

*Sporobolus clandestinus-Aristida purpurascens* community type. Short-stature grassland dominated by *Sporobolus clandestinus* occurs over Sumter soils on level to gently sloping shoulder slopes of site 3. This type occurs as small patch inclusions within calcareous woodland communities; it may not warrant association-level status. Other common species include *Aristida purpurascens, Asclepias tuberosa, Diodia teres,* and *Ratibida pinnata*. Woody encroachment (*Crataegus* spp., *Fraxinus americana, Pinus taeda*) is evident within this vegetation type.

*Muhlenbergia capillaris* community type. Sites 2 and 3 contain shoulder and back slopes where *Muhlenbergia capillaris* is the dominant cover. This type occurs as small patch inclusions within other open prairie communities; it may not warrant association-level status. Other

common species include *Erigeron strigosus*, *Salvia lyrata*, S*ilphium asteriscus*, *Solidago nemoralis*, *Sorghastrum nutans*, and *Sporobolus clandestinus*. *Muhlenbergia capillaris* dominates in some areas where past anthropogenic disturbance is evident, including eroded flats and roadsides. However, other areas with this community show negligible signs of disturbance.

*Sorghastrum nutans-Ratibida pinnata-Houstonia nigricans* community type. Plot data from site 2 was used to determine dominant species within this community. These three dominant species are found over Sumter soils along shoulder and back slopes of sites 1, 2 and 4. The lack of a dominant perennial grass and a diversity of forbs differentiate this vegetation from the *Andropogon gerardii-Sorghastrum nutans* grassland. Common species include *Agalinis tenuifolia, Andropogon virginicus, Polygala boykinii, Rudbeckia fulgida, Solidago nemoralis, Sporobolus clandestinus* and *Symphyotrichum dumosum.*

*Andropogon gerardii-Sorghastrum nutans* community type. This community has become more prevalent after controlled burning and probably represents the burned phase of *Sorghastrum nutans-Ratibida pinnata-Houstonia nigricans* community type. *Andropogon gerardii* and *Sorghastum nutans* are the main components of this community, found over Sumter soils on shoulder slopes of site 1. *Agalinis tenuifolia, Andropogon virginicus, Polygala boykinii, Ratibida pinnata, Rudbeckia fulgida, Symphyotrichum novae-angliae* are also common species.

The communities likely represent marginal examples of previously more prevalent vegetation in central Georgia. Oaky Woods' most productive lands were converted to pine plantations decades ago; the WMA probably contained more extensive areas of blackland plant communities before human intervention. For example, the presence of substantial upland topography and prairie soils in site 1 suggests that this area could have once supported a mosaic of prairie vegetation over 200 acres (80 ha) in size (N. Klaus, pers. comm.).

*Soils*

Soil sample results have significantly higher pH and Ca values, but lower P values, across both forest and prairie community types when compared to more typical Georgia Coastal Plain soils (Soil, Plant and Water Analysis Laboratory 2006; Table 1.6). Open prairie habitats exhibit slightly lower K and significantly lower Mg when average values are compared to those from wildlife plots. Forest samples exhibit higher K and Mg when compared to wildlife plots. Table 1.7 lists soil sample characteristics of study sites 1-5.

*Fire*

Several of the study sites have been burned in recent years by the Georgia Department of Natural Resources. Site 1 was burned in late January/early February 2003 followed by another winter burn in 2004. Site 5 also received a winter burn on a portion of the site in 2003. Sites 3, 4 and 5 were burned in April 2006 (N. Klaus, pers. comm.). Sites 2 and 6 have not been burned. Casual observations indicate that post-burn native grass cover has increased considerably in site 1. Additionally, two rare species, Georgia Aster (*Symphyotrichum georgianum*) and Yellow Milkvine (*Matelea flavidula*) were observed in sites 1 and 5, respectively, after burning.

**Conclusion**

The high species diversity from a relatively small area (315 native spp./106 acres, 49 ha) suggests that Oaky Woods WMA (and perhaps Central Georgia) is an understudied area of vascular plant diversity, due to central Georgia's complex geologic history and associated mosaic of soil types (Woods 1967; Huddlestun and Hetrick 1986). Oaky Woods needs additional floristic documentation before other areas of potential ecological significance are developed. The forested lands adjacent to Little Grocery Creek and Big Grocery Creek (see Fig. 1.3) need further investigation.

It is critical to locate and document additional blackland prairie remnants in central Georgia. Regional geologic maps, soil surveys from surrounding counties, and personal correspondence with local central Georgia citizens suggest that surrounding areas have underlying geologic formations and/or soil series that could support prairie vegetation (Woods 1967; Huddlestun and Hetrick 1986). A comparison of past and present aerial photographs from Houston County and surrounding areas would be the first step. Prairie openings are difficult to distinguish from log landings on aerial photos; however, prairie communities may remain open and recognizable over time while woody vegetation usually recolonizes (or is planted within) log landings (N. Klaus, pers. comm.). An investigation of areas where the Sumter Soil Series is mapped would be beneficial since the presence of this soil type appears to be the most important abiotic indicator for blackland prairies in Oaky Woods.

Georgia is located at the edge of numerous physiographic provinces and/or ecoregions, accounting for its ranking as the sixth most biologically diverse state in the country (Schneier and Reittinger 2005). The blackland prairies in central Georgia significantly contribute to the state's overall biodiversity. This project has documented a noteworthy combination of state records, rare species, and rare communities, many of which possess more westerly affinities. Some species, and the blackland prairie communities as a whole, are at the extreme eastern edge of their known ranges.

The fate of the Georgia blackland prairies remains tenuous, with extensive development plans slated for Oaky Woods WMA (Foskett 2007). It is the hope of this author, and many naturalists and sportsmen throughout the state, that some portion of Oaky Woods may still be preserved.

## Literature Cited

Alabama Natural Heritage Program. 2006. Alabama inventory list: the rare, threatened, & endangered plants & animals of Alabama. Alabama Natural Heritage Program, Montgomery, Alabama.

Axelrod, D. I. 1985. Rise of the grassland biome, central North America. Bot. Rev. 54: 163-201.

Diggs, G. M., Lipscomb, B. L., and R. J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Botanical Research Institute of Texas, Fort Worth, Texas.

Diggs, G. M., B. L. Lipscomb, M. D. Reed, and R. J. O'Kenan. 2006. Illustrated flora of east Texas, Vol. 1. Botanical Research Institute of Texas and Austin College, Austin, Texas.

Eckhardt, N. 1987. Elemental stewardship abstract for *Melilotus alba*. The Nature Conservancy Global Invasive Species Initiative. (http://tncweeds.ucdavis.edu/esadocs.html. Cited 18 May 2007.)

Eversull, L. G. 2005. The twiggs clay: mineralogy, origin, and industrial properties of an Upper Eocene opaline claystone in the Coastal Plain Province of Georgia, U.S. Ph.D. Dissertation. Louisiana State University, Baton Rouge, Louisiana.

Flora of North American Editorial Committee (eds.). 2002. Flora of North America north of Mexico. Volume 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York, New York.

Flora of North American Editorial Committee (eds.). 2003. Flora of North America north of Mexico. Volume 20. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Oxford University Press, New York, New York.

Flora of North American Editorial Committee (eds.). 2006. Flora of North America north of Mexico. Volume 25. Magnoliophyta: Asteridae (in part): Asteraceae, part 2. Oxford University Press, New York, New York.

Foskett, K. 2006. Plans endanger bears' habitat, developer wants homes on forestland. Atlanta Journal Constitution. 19 November (Main Edition): E1. (http://www.ajc.com/. Cited 18 May 2007.)

Foskett, K. and J. Salzer 2006. Preserve purchase was possible; state passed on habitat; funds go to other priorities. Atlanta Journal Constitution. 1 November 2006 (Main Edition): C1.

Franklin, M. A. and J. T. Finnegan (eds.). 2006. Natural Heritage Program list of rare plant species of North Carolina. Division of Parks and Recreation, Department of Environment and Natural Resources, Raleigh, North Carolina.

Frost, C. C., J. Walker, and R. K. Peet. 1986. Fire-dependent savannas and prairies of the southeast: original extent, preservation status and management problems. p. 348-357. *In*: Kulhavey, D. L and R. N. Conner (eds.). Wilderness and natural areas in the eastern United States: a management challenge. Stephen F. Austin State University, Center for Applied Studies, School of Forestry, Nacogdoches, Texas.

Georgia Automated Environmental Monitoring Network. 2007. Map of Georgia annual precipitation, 1961-1990. (http://www.griffin.uga.edu/aemn/cgi-bin/CLIMATE.pl?map=p&b=01&e=12. Cited 18 May 2007.)

Georgia Exotic Pest Plant Council. 2007. List of non-native invasive plants in Georgia. (http://www.gaeppc.org/list.cfm. Cited 18 May 2007.)

Georgia Natural Heritage Program. 2007a. Protected plant species of Georgia. (http://georgiawildlife.dnr.state.ga.us/content/protectedplants.asp. Cited 18 May 2007.)

Georgia Natural Heritage Program. 2007b. Special concern plant species in Georgia. (http://georgiawildlife.dnr.state.ga.us/content/specialconcernplants.asp. Cited 18 May 2007.)

Georgia Natural Heritage Program. 2007c. Watched plant species of Georgia. (http://georgiawildlife.dnr.state.ga.us/content/watchedplants.asp. Cited 18 May 2007.)

Georgia Natural Heritage Program. 2007d. Georgia Rare Species Locations. (http://www.georgiawildlife.com/assets/documents/gnhp/gnhpds.zip. Cited 18 May 2007).

Georgia Wildlife Resources Division. 1991. Map of Oaky Woods Wildlife Management Area. Georgia Department of Natural Resources, Wildlife Resources Division, Atlanta, Georgia.

Huddlestun, P. F. and J. H. Hetrick. 1986. Upper Eocene stratigraphy of central and eastern Georgia. Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, Atlanta, Georgia.

Leidolf, A. and S. McDaniel. 1998. A floristic study of black prairie plant communities at Sixteen Section Prairie, Oktibbeha County, Mississippi. Castanea 63: 51-62.

MacRoberts, M. H. and B. R. MacRoberts. 2002. West Gulf Coastal Plain prairies: A first approximation at a synthesis. *In*: Randall, J. and J.C. Burns (eds.). Proceedings of the third eastern native grass symposium. Omnipress, Madison, Wisconsin.

McCaffrey, S. 2007. State's Oaky Woods purchase remains up in the air. Athens Banner-Herald 28 Jan. (Weekend Edition): D4.

Miller, J. H. 2003. Nonnative invasive plants of southern forests: a field guide for identification and control. USDA Forest Service, Southern Research Station, Asheville, North Carolina.

Moran, L. P. 1995. Soil and ecology remnants in the Jackson Prairie Region of Mississippi. M.S. thesis. Mississippi State University, Starkville, MS.

NatureServe. 2007. An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, VA. (http://www.NatureServe.org/. Cited 18 May 2007.)

Newman, D. 1990. Elemental stewardship abstract for *Sorghum halepense*. The Nature Conservancy Global Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs.html. Cited 18 May 2007.

Patrick, T., J . R. Allison, and G. A. Krakow. 1995. Protected plants of Georgia. Georgia Natural Heritage Program, Wildlife Resources Division, Georgia Department of Natural Resources, Social Circle, Georgia.

Peacock, E. and T. Schauwecker. 2003. Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. University of Alabama Press, Tuscaloosa, Alabama.

Peet, R. K., T. R. Wentworth, and P. S. White. 1998. A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63: 262-274.

Schneier, C. and C. Reittinger. 2005. Georgia state parks' plants of concern. Tipularia 20: 5-9.

Shelton, S. 2007. Missed land opportunity bugs state's nature lovers. Atlanta Journal-Constitution. 10 January (Main Edition): B1

Shelton, S. and C. Seabrook. 2004. Timber giant agrees to sell 304,000 acres in Georgia, Weyerhauser to trim its debt. Atlanta Journal Constitution. 1 July (Home Edition): E3. (http://www.ajc.com/. Cited 18 May 2007.)

Soil, Plant, and Water Analysis Laboratory. 2006. Soil test summaries, 2006. University of Georgia, Agricultural and Environmental Services Laboratories, Soil, Plant, and Water Analysis Laboratory, Athens, GA.

Southeastern Regional Climate Center. 2007. Station climate summaries-Byron Experiment Station, GA (091448). (http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ga1448. Cited 18 May 2007.)

USDA. 2007. The PLANTS Database. National Plant Data Center, Baton Rouge, Louisiana. (http://plants.usda.gov. Cited 18 May 2007.)

Weakley, A. 2007. Flora of the Carolinas, Virginia, and Georgia, and surrounding areas. (http://www.herbarium.unc.edu/flora.htm. Cited 18 May 2007.)

Woods, J. C. 1967. Soil survey of Houston and Peach Counties, Georgia. United States Department of Agriculture, Soil Conservation Service, Washington, D.C.

Wunderlin, R. P. and B. F. Hansen. 2007. Atlas of Florida vascular plants. [S. M. Landry and K. N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa. (http://www.plantatlas.usf.edu/. Cited 18 May 2007.)

Yatskievych, G. 2006. Steyermark's flora of Missouri, revised edition. Volume 2. Missouri Botanical Garden Press, St. Louis, Missouri.

Table 1.1. Soil characteristics of the study sites (Woods 1967).

| Soil Series | Landscape | Drainage | Slope (%) | Surface Texture | Subsoil Texture | Parent Material |
|---|---|---|---|---|---|---|
| Sumter | Uplands | Moderately well drained | 2-8 | Clay loam to clay | Clay | Marl, chalk, or limestone |
| Oktibbeha | Uplands | Moderately well drained | 2-12 | Fine sandy loam, sandy clay loam | Clay | Marl, chalk, or limestone |
| Boswell | Uplands | Moderately well drained | 2-12 | Fine sandy loam, sandy clay loam | Clay | Noncalcareous clay and sandy clay sediments |
| Susquehanna | Uplands | Somewhat poorly drained | 2-12 | Sandy loam, sandy clay loam | Dense clay | Thick beds of acid clay |

Table 1.2. Site characteristics. Community types: OP1 = *Houstonia nigricans-Sporobolus vaginiflorus*; OP2 = *Sporobolus clandestinus-Aristida purpurascens*; OP3 = *Muhlenbergia capillaris*; OP4 = *Sorghastrum nutans-Ratibida pinnata-Houstonia nigricans*; OP5 = *Andropogon gerardii-Sorghastrum nutans*; ST1 = *Crataegus spathulata-Cercis canadensis-Celtis tenuifolia*; ST2 = *Fraxinus americana-Quercus muehlenbergii*/*Crataegus* sp.-*Cercis canadensis*; W1 = *Juniperus virginiana-Fraxinus americana*/*Ratibida pinnata-Agalinis tenuifolia*; W2 = *Quercus muehlenbergii*/*Cercis canadensis-Quercus sinuata*/*Viburnum rufidulum*/*Scleria oligantha*; PO = *Pinus taeda-Quercus velutina-Quercus coccinea*/*Acer floridanum-Quercus muehlenbergii*/*Cercis canadensis-Ptelea trifoliata*; MF1 = *Quercus shumardii-Quercus nigra-Ulmus rubra*/*Acer floridanum-Fraxinus americana*/*Vitis rotundifolia*; MF2 = *Quercus nigra-Quercus pagoda*/*Acer floridanum*/*Cercis canadensis*.

| **Site #** | **Area (ha)** | **Latitude (decimal degrees)** | **Longitude (decimal degrees)** | **Elevation (m)** | **Community Types** |
|---|---|---|---|---|---|
| 1 | 12.70 | 32.47340 | 83.56150 | 106 | OP4, OP5, ST1 |
| 2 | 3.64 | 32.45122 | 83.52298 | 90 | OP1, OP3, OP4, ST1 |
| 3 | 11.13 | 32.50147 | 83.54335 | 90 | OP1, OP2, OP3, ST2, W2 |
| 4 | 3.63 | 32.48354 | 83.56323 | 120 | OP1, OP4, ST1 |
| 5 | 10.11 | 32.49491 | 83.54343 | 120 | MF1, PO, W1 |
| 6 | 2.02 | 32.50049 | 83.55714 | 90 | OP4, ST1, W2 |

Table 1.3. Invasive species within the study area. Category 1 = serious problem in Georgia natural areas; Category 3 = minor problem in Georgia natural areas; Category 4 = naturalized in Georgia but generally not a problem in Georgia natural areas or potential invasive needing more research (Georgia Exotic Pest Plant Council 2007).

| **Species** | **Category** | **Site(s)** |
|---|---|---|
| *Dioscorea alata* | 3 | 3 |
| *Eleagnus umbellata* | 1 | 4, 5 |
| *Kummerowia striata* | 4 | 2, 5 |
| *Lespedeza cuneata* | 1 | 4, 6 |
| *Ligustrum sinense* | 1 | 3, 4 |
| *Lonicera japonica* | 1 | 1, 5 |
| *Melia azedarach* | 1 | 5 |
| *Melilotus alba* | 3 | 1, 5 |
| *Morus alba* | 3 | 5 |
| *Pueraria lobata* | 1 | 3, 5 |
| *Sorghum halapense* | 3 | 1 |

Table 1.4. Rare species within the study area. [1] = Protected Plant of Georgia, [2] = Georgia Special Concern, [3] = Georgia Watch List (further documentation needed). * = state record (based on collections at GA and VSC). E = endangered, C = candidate for federal listing. State rank definitions: S1 = critically imperiled, five or fewer occurrences, S2 = imperiled, 6-20 occurrences, S3 = rare or uncommon, 21-100 occurrences. Global Rank definitions: G1 = critically imperiled, 5 or fewer occurrences, G2 = imperiled, 6-20 occurrences, G3 = rare or local throughout range; in special habitat; narrowly endemic, 21-100 occurrences, G4 = secure, G5 = demonstrably secure, T = taxonomic subdivision used in global rank, ? = questionable rank (GANHP 2007a, b, c).

| Species | State Status | Federal Status | State Rank | Global Rank |
|---|---|---|---|---|
| *Crataegus triflora*[2] | | | S1 | G2 |
| *Cyperus acuminatus*[2]* | | | S1 | |
| *Delphinium carolinianum* ssp. *carolinianum*[3] | | | S3 | G5T5 |
| *Draba cuneifolia*[2]* | | | S1 | |
| *Galium virgatum*[2]* | | | S1 | |
| *Glandularia bipinnatifida*[2] | | | S1 | G5 |
| *Hexalectris spicata*[3] | | | S3? | G5 |
| *Houstonia nigricans*[3] | | | S3? | G5 |
| *Matelea flavidula*[3] | | | S3? | G4? |
| *Ophioglossum engelmanii*[2] | | | S2S3 | G5 |

| | | | | |
|---|---|---|---|---|
| *Polygala boykinii*[3] | | | S3 | G4 |
| *Quercus sinuata*[2] | | | S1S2 | G4G5 |
| *Scutellaria drummondii*[2]* | | | S1 | |
| *Sida elliottii*[2] | | | S2? | G4G5 |
| *Silene polypetala*[1] | E | E | S2 | G2 |
| *Smilax lasioneura*[2] | | | S2? | G5 |
| *Spermolepis inermis*[2] | | | S1 | G5 |
| *Symphyotrichum georgianum*[2] | T | C | S2 | G2G3 |
| *Symphyotrichum novae-angliae*[2] | | | S1 | G5 |
| *Thaspium chapmanii*[2] | | | S3 | |
| *Tragia cordata*[2] | | | S2? | G4 |
| *Trillium lancifolium*[2] | | | S3? | G3 |
| *Trillium underwoodii*[3] | | | S3? | G4? |
| *Symphyotrichum laeve var. concinnum*[3] | | | S3 | G5T4 |

Table 1.5. Characteristic species of Georgia blackland prairies.

| **Species** |
|---|
| *Agalinis tenuifolia* |
| *Andropogon gerardii* |
| *Andropogon virginicus* |
| *Aristida purpurascens* |
| *Asclepias tuberosa* |
| *Asclepias viridiflora* |
| *Berchemia scandens* |
| *Carex cherokeensis* |
| *Celtis tenuifolia* |
| *Cercis canadensis* |
| *Cocculus carolinus* |
| *Cornus asperifolia* |
| *Crataegus aprica* |
| *Crataegus crus-galli* |
| *Crataegus spathulata* |
| *Diospyros virginiana* |
| *Erigeron strigosus* |
| *Frangula caroliniana* |
| *Fraxinus americana* |
| *Galactia regularis* |
| *Glandularia bipinnatifida* |
| *Houstonia nigricans* |
| *Juniperus virginiana* |
| *Muhlenbergia capillaris* |
| *Panicum anceps* |
| *Pinus taeda* |
| *Polygala boykinii* |
| *Quercus muehlenbergii* |
| *Quercus sinuata* |
| *Salvia azurea* |
| *Salvia lyrata* |

| |
|---|
| *Solidago nemoralis* |
| *Sorghastrum nutans* |
| *Sporobolus clandestinus* |
| *Sporobolus vaginiflorus* |
| *Symphyotrichum novae-angliae* |
| *Thaspium chapmanii* |
| *Ulmus alata* |
| *Viburnum rufidulum* |

Table 1.6. Comparison of soil samples from study sites to Georgia Coastal Plain wildlife plot soil samples. Open prairie soil values are averages of sites 1, 2, and 4; forest soil values are taken from site 5. Wildlife soil values are averages of 1,279 samples collected between January-December 2006 (Soil, Plant and Water Analyis Laboratory 2006).

| **Community Type** | **pH** | **Ca (ppm)** | **K (ppm)** | **Mg (ppm)** | **P (ppm)** |
|---|---|---|---|---|---|
| Open prairie | 7.26 | 5462.50 | 31.11 | 23.98 | 1.87 |
| Forest | 7.03 | 4175.00 | 58.30 | 93.15 | 7.09 |
| Wildlife plots | 5.60 | 356.30 | 39.50 | 64.15 | 19.00 |

Table 1.7. Soil sample characteristics of the study sites (analyses by University of Georgia Soil, Plant, and Water Analysis Laboratory personnel).

| Site | Soil Type | % Sand | % Silt | % Clay | pH | OM[1] | Ca (ppm) | K (ppm) | Mg (ppm) | P (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Clay Loam | 30.00 | 30.00 | 40.00 | 7.21 | 1.82 | 5545.00 | 21.91 | 16.12 | 1.71 |
| 2 | Clay Loam | 32.00 | 30.00 | 38.00 | 7.21 | 2.26 | 5660.00 | 34.08 | 24.42 | 1.76 |
| 3 | Clay | 32.00 | 22.00 | 46.00 | 7.35 | 2.52 | 5575.00 | 38.42 | 33.29 | 2.92 |
| 4 | Clay | 28.00 | 30.00 | 42.00 | 7.37 | 2.16 | 5790.00 | 30.02 | 22.10 | 1.08 |
| 5 | Sandy Clay Loam | 52.00 | 14.00 | 34.00 | 7.03 | 1.94 | 4175.00 | 58.30 | 93.15 | 7.09 |

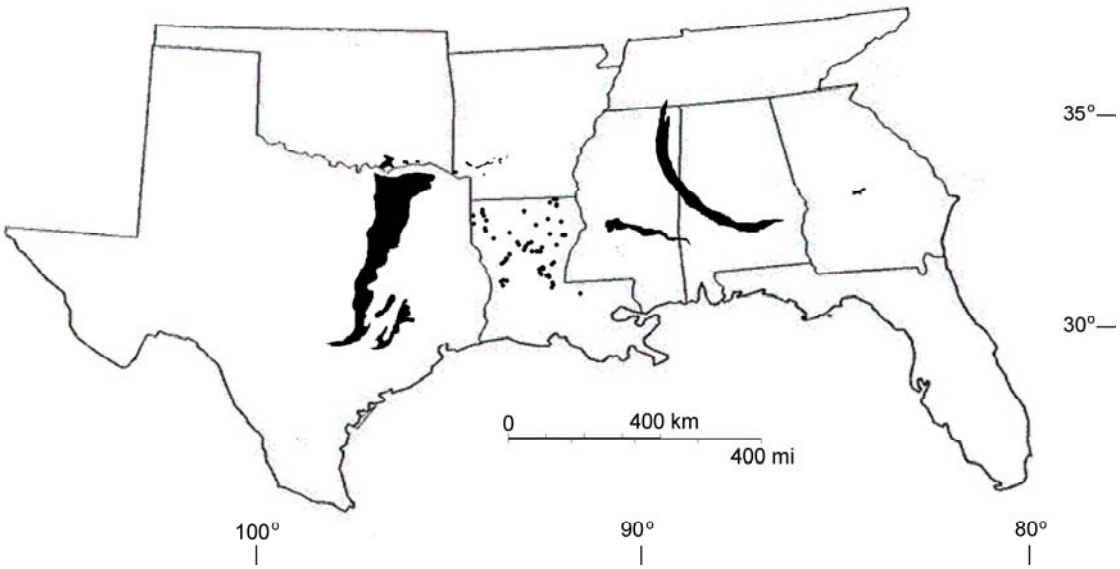


Figure 1.1. Location of blackland prairies in the southeastern United States. Louisiana and Tennessee prairies are not to scale. The northern blackland prairie boundary for Oklahoma is approximate. Modified from MacRoberts and MacRoberts (2002), Peacock and Schauwecker (2003), and Diggs et al. (2006).

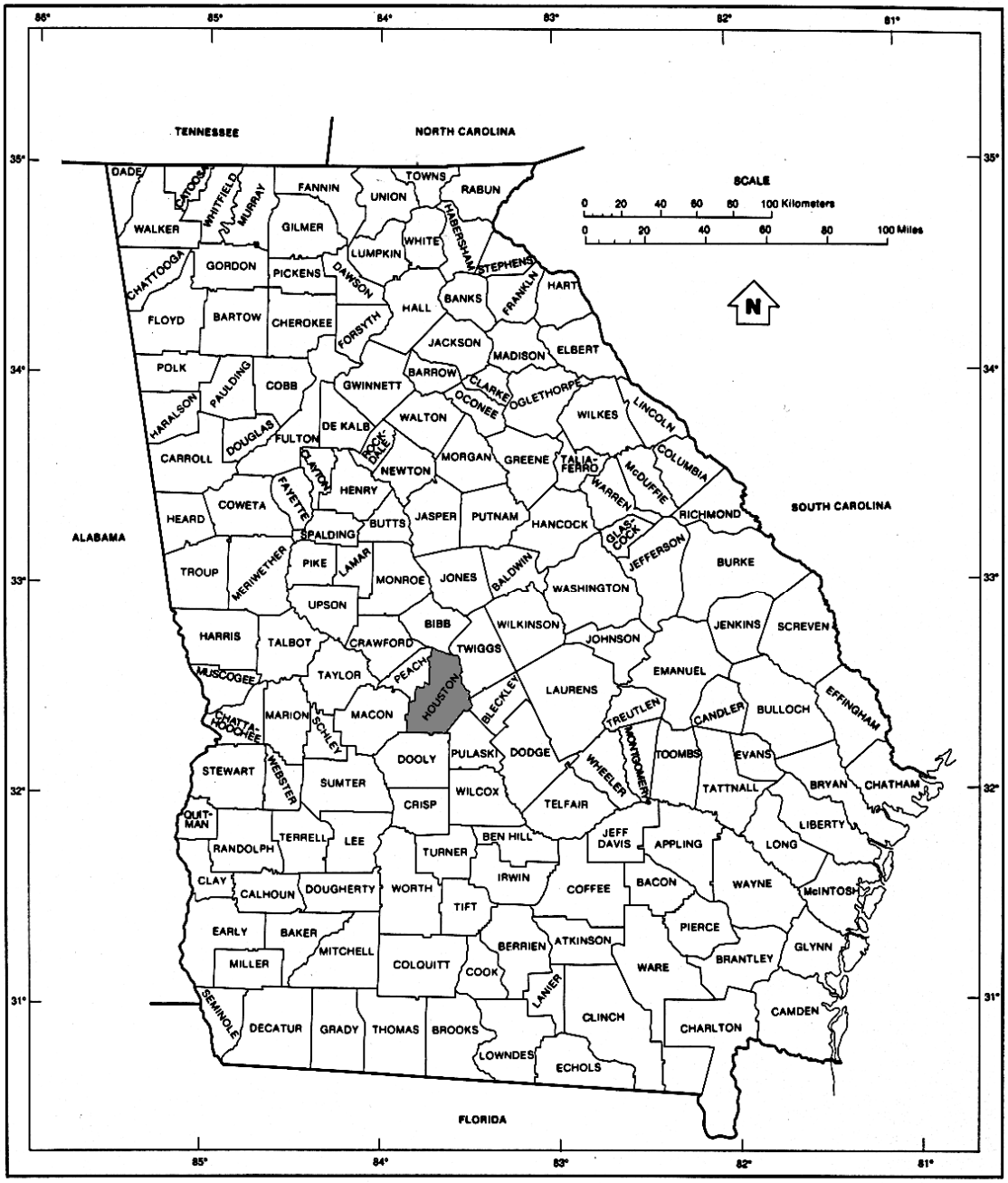


Figure 1.2. Location of Houston County, central Georgia.

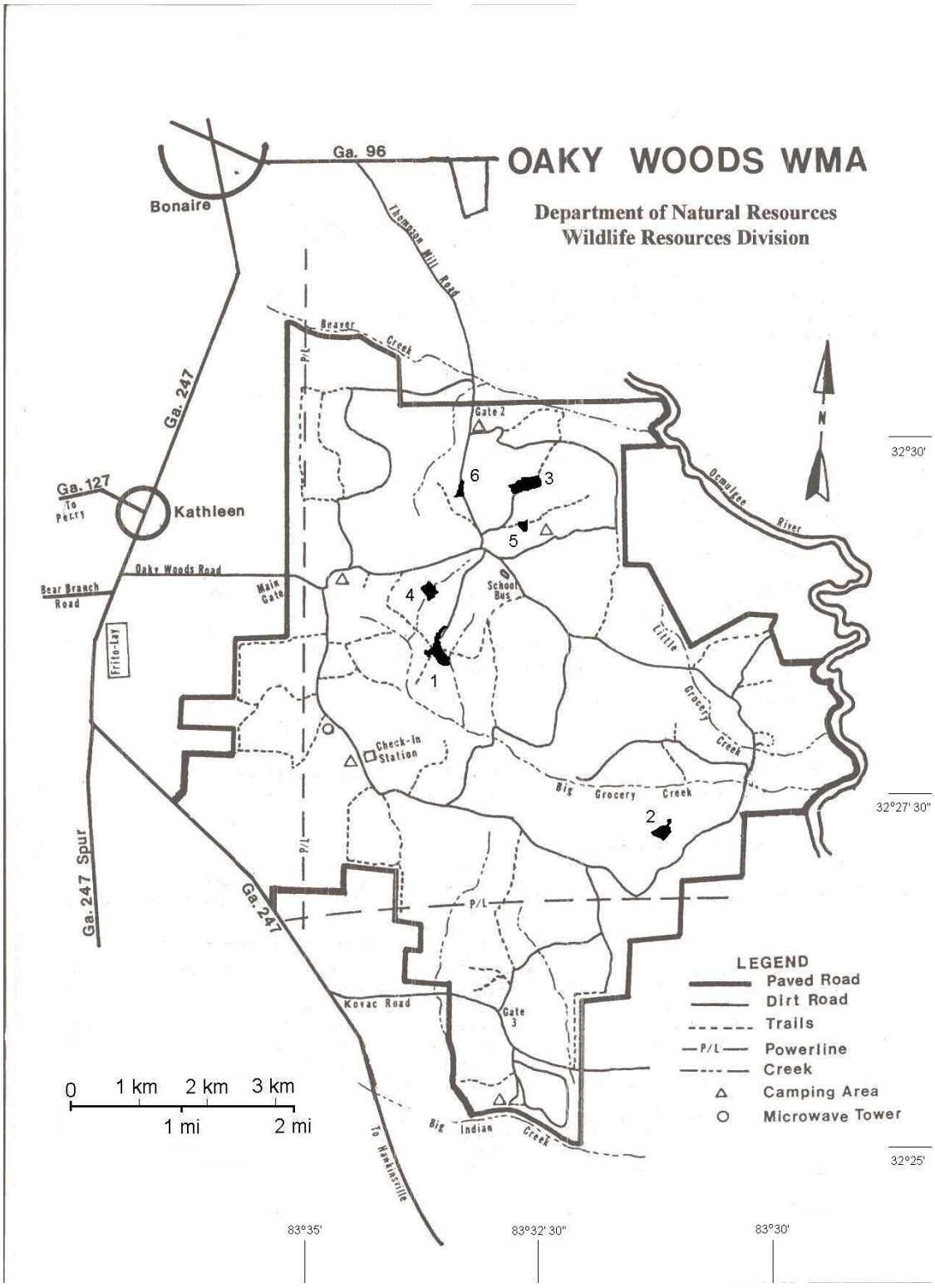


Figure 1.3. Location of the study sites within Oaky Woods WMA. Modified from Georgia Wildlife Resources Division (1991).

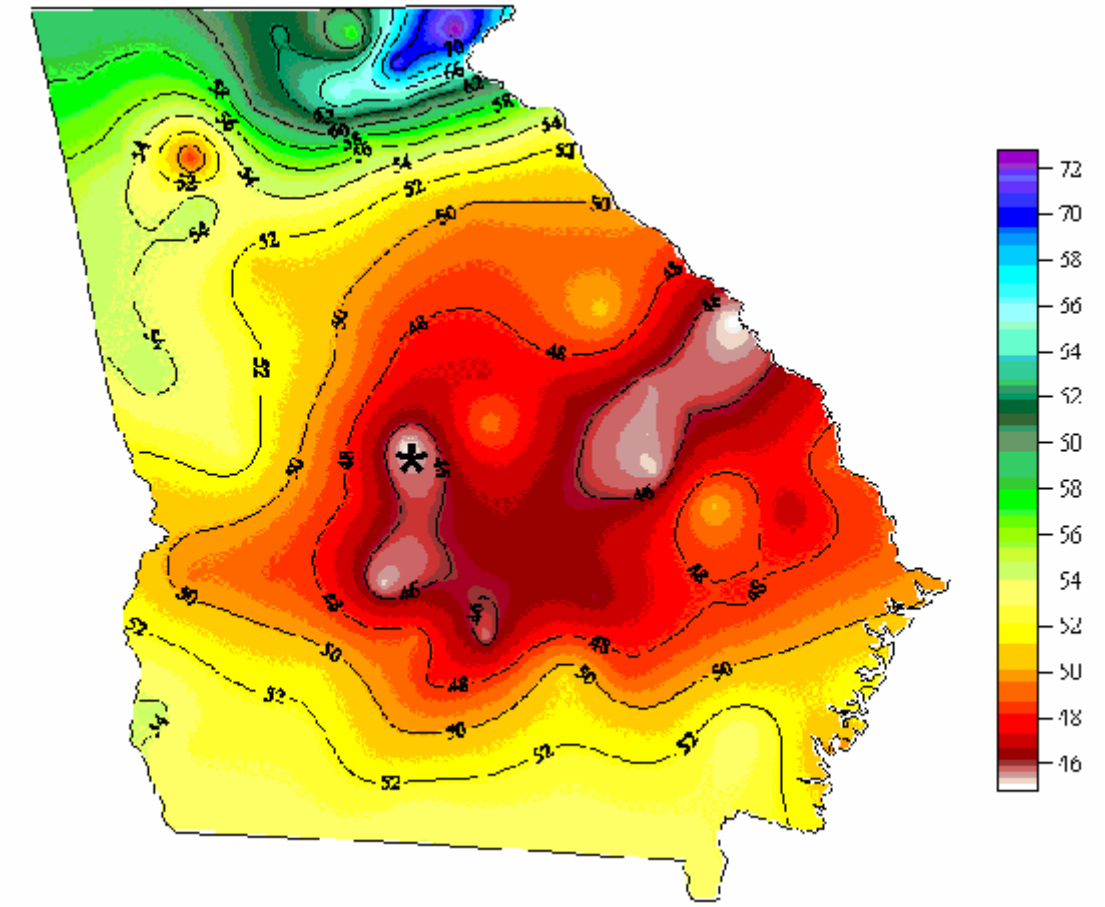


Figure 1.4. Annual precipitation map of Georgia, 1961-1990 (inches). The south-central area (location of study sites; indicated by *) has the lowest rainfall levels (Georgia Automated Environmental Monitoring Network 2007, used with permission).

## Annotated List of Vascular Plant Taxa

A list of 354 vascular plant species representing 220 genera in 84 families is reported here, in alphabetical order by family within ferns, gymnosperms, and angiosperms. Genera, species, and infraspecific taxa are organized alphabetically within each family. Scientific nomenclature and common names follow Weakley (2007), with the exception of a few common names that follow USDA (2007). Family circumscriptions for ferns and gymnosperms follow Weakley (2007), and for angiosperms, APG (2007).

(Site number) = sites 1-6 (see Fig. 1.3); *italic number* = S. Lee Echols collection number; underlined taxa = new Georgia state records; [1] = Protected Plant of Georgia, [2]= Georgia Special Concern species, [3]= Georgia Watch List species (further documentation needed); E = endangered, C = candidate for Federal listing. * = exotic (Weakley 2007); [CAT I] = serious invasive species in Georgia (Georgia Exotic Pest Plant Council 2007). Habitat data: MF = mesic forest; OP = open prairie; PH = pine/hardwoods; ST = shrub thicket; R = ruderal area; W = woodland. Relative abundance: c = common (generally abundant throughout a particular habitat); o = occasional (locally common and/or several individuals distributed within a habitat); i = infrequent (sporadic occurrence of a small number of individuals); r = rare (very few individuals encountered).

### FERNS

### ASPLENIACEAE

*Asplenium platyneuron* (L.) B. S. P, Ebony Spleenwort—(4); MF; o; *175*

*Pleopeltis polypodioides* (L.) Britton, Sterns, & Poggenburg, Resurrection Fern—(4); MF; i; *238*

### DRYOPTERIDACEAE

*Polystichum acrostichoides* (Michaux) Schott, Christmas Fern—(5); MF; o; *155*

**OPHIOGLOSSACEAE**

*Ophioglossum engelmanii*[2] Prantl, Limestone Adder's Tongue—(2), (6); OP; i; *485*, *535*

**GYMNOSPERMS**

**CUPRESSACEAE**

*Juniperus virginianus* L., Eastern Red Cedar—(5), (6); OP, W; c–o; *189*, *32*

**PINACEAE**

*Pinus taeda* L., Loblolly Pine—6); OP, PH, ST, W, R; c; *25b*

**ANGIOSPERMS**

**ACANTHACEAE**

*Ruellia carolinensis* (J. F. Gmelin) Steudel, Carolina Wild-petunia—(1), (2), (5), (6); OP, R, W; o; *123*, *298*, *505*, *575*, *209*

**ADOXACEAE**

*Viburnum prunifolium* L., Black Haw—(5); MF; i; *561*

*Viburnum rufidulum* Rafinesque, Southern Black Haw—(2), (6), (5); PH, W; c-o; *6*, *84*, *152*, *481*

**AGAVACEAE**

*Manfreda virginica* (L.) Salisbury ex Rose, Rattlesnake-master—(4), (6); OP; o-i; *322*, *409*

**ALLIACEAE**

*Allium canadense* L., Wild Onion—(3), (4); OP; R; i; *168*, *278*

*Nothoscordum bivalve* (L.) Britton, Grace Garlic—(1), (4); R; i; *33*, *42*

## ALTINGACEAE

*Liquidambar styraciflua* L., Sweetgum—(1), (4); PH; i; *85, 134*

## AMARYLLIDACEAE

*Zephyranthes atamasca* (L.) Herbert, Atamasco Lily—(5); MF; c; *484*

## ANACARDIACEAE

*Rhus aromatica* Aiton, Fragrant Sumac—(1), (2); OP; R; o–i; *47, 59, 63, 174*

*Rhus copallinum* L. var. *latifolia* Engler, Eastern Winged Sumac—(1); R; c; *217*

*Rhus glabra* L., Smooth Sumac—(3), (4); R, ST; o-i; *183, 254*

*Toxicodendron radicans* (L.) Kuntz, Poison Ivy—(5); MF; o; *406*

## ANNONACEAE

*Asimina triloba* (L.) Dunal, Common Pawpaw—(5); MF; c; *291*

## APIACEAE

*Chaerophyllum tainturei* Hooker, Southern Chervil—(2), (3), (4), (5); MF, ST; R; c–i; *77, 160, 497, 504*

*Cyclospermum leptophyllum* (Persoon) Sprague ex Britton & Wilson, Marsh-parsley—(1), (3), (5), (6); R; c–r; *145, 191, 506, 548*

*Cryptotaenia canadensis* (L.) Augustin de Candolle, Canadian honewort—(5); MF; r; *566*

*Daucus pusillus* Michaux, American Queen-Anne's Lace—(4); OP; i; *251*

*Sanicula canadensis* (L.) var. *floridana*, Florida Snakeroot—(5); MF; o; 198, 242

*Sanicula odorata* (Rafinesque) K. M. Pryor & R. L. Phillippe, Clustered Snakeroot—(5); MF; i; 197, *243*

*Spermolepis inermis*[2] (Nuttall ex Augustin de Candolle) Mathias & Constance, Western Spermolepis—(1); OP, R; i; *120, 547*

*Thaspium chapmanii*[2] (Coulter & Rose) Small, Meadow-parsnip—(1), (2), (5), (6); OP, R; c–o; *116, 203, 260, 521, 539*

*Zizia aptera* (A. Gray) Fernald, Heartleaf Golden-Alexanders—(4); OP, R; c–o; *102, 163, 500*

*Zizia aurea* (L.) W. D. J. Koch, Common Golden-Alexanders—(3); W; o; *92, 273*

**APOCYNACEAE**

*Apocynum cannabinum* L., Hemp-Dogbane—(6); PH; r; *544*

*Asclepias tuberosa* L., Common Butterfly-weed—(1); (3); OP, R; o; *184, 348*

*Asclepias verticillata* L., Whorled Milkweed—(3), (4); OP, ST; o; *332, 595*

*Asclepias viridiflora* Rafinesque, Green Milkweed—(1), (5), (6); OP, W, R; o–i; *282, 345, 569, 578, 587*

*Gonolobus suberosus* (L.) R. Brown, Eastern Anglepod—(3), (5), (6); MF, W; r–i; *236, 292, 552, 570* [=*Matelea gonocarpa* (Walter) Shinners]

*Matelea carolinensis* (Jacquin) Woodson, Carolina Spinypod—(5); PH; o; *531*

*Matelea decipiens*, (Alexander) Woodson, Deceptive Spinypod—(5); PH; o; *560*

*Matelea flavidula*[3] (Chapman) Woodson, Yellow Milkvine—(5); PH; o; *530*

**AQUIFOLIACEAE**

*Ilex decidua* Walter, Possum-haw—(1); ST; r; *573*

*Ilex opaca* Aiton, American Holly—(5); MF; o; *39*

**ARACEAE**

*Arisaema triphyllum* (L.) Schott ssp. *quinatum* (Nuttall) Huttleston, Southern Jack-in-the-pulpit—(5); MF; r; *510*

## ARALIACEAE

*Aralia spinosa* L., Hercules' Club—(3); PH; r; *180*

## ARECACEAE

*Rhapidophyllum hystrix* (Pursh) H. Wendl. & Drude ex Drude, Needle Palm—(5); MF; r; *402*

*Sabal minor* (Jacquin) Persoon, Dwarf Palmetto—(2); OP; r; *285*

## ARISTOLOCHIACEAE

*Endodeca serpentaria* (L.) Rafinesque, Turpentine-root—(5); MF; i; *234* [= *Aristolochia serpentaria* L.]

*Hexastylis arifolia* Small, Little Brown Jugs—(5); MF; o; *51*, *473*

## ASTERACEAE

*Ambrosia artemisiifolia* L., Ragweed—(3), (5); R; o; *392*, *610*

*Brickellia eupatorioides* (L.) Shinners, Eastern False-boneset—(1), (2); ST, R; o–r; *2*, *617*

**Chrysopsis pilosa* Nuttall, Golden-Aster—(4); ST; i; *329*, *468*

*Cirsium altissimum* (L.) Hill, Tall Thistle—(5), (6); PH, OP, R, W; o; *5*, *311*, *356*, *385*, *591*

*Cirsium horridulum* Michaux, Common Yellow Thistle—(6); OP; o; *119*

*Conoclinium coelestinum* (L.) Augustin de Candolle, Mistflower—(3); W; o; *427*

*Coreopsis tripteris* L., Tall Coreopsis—(2); OP; r; *363*

*Elephantopus carolinianus* Raeuschel, Leafy Elephant's Foot—(5); MF; i; *410*

*Elephantopus tomentosus* L., Elephant's Foot—(5); MF; i, *314*

*Erigeron strigosus* Muhlenberg ex Willdenow, Prairie Fleabane—(3), (5); OP, ST, R; W; c; 21, *94*, *95*

*Eupatorium hyssopifolium* L., Hyssopleaf Eupatorium—(2); OP; r; *378*

*Eupatorium serotinum* Michaux, Late Eupatorium—(5); R; r; *393*

*Fleischmannia incarnata* (Walter) King & H. E. Robinson, Pink Thoroughwort—(5); R; r; *629*

*Gamochaeta antillana* (Urban) Anderberg, Cudweed—(6); R; r; *133* [= *Gamochaeta falcata* (Lamarck) Cabrera]

*Gamochaeta purpurea* (L.) Cabrera, Spoonleaf Purple Everlasting—(6); R; r; *131*

**Helenium amarum* (Rafinesque) H. Rock, Bitterweed—(1), (3); R; r; *338, 344*

*Helenium autumnale* L., Common Sneezeweed—(1); OP; r; *448*

*Helianthus divaricatus* L., Spreading Sunflower—(5); R; i; *598*

*Helianthus decapetalus* L., Forest Sunflower—(3); ST; o; *319*,

*Helianthus hirsutus* Rafinesque, Hairy Sunflower— (4); R, W; o; *258*, *325*

*Helianthus strumosus* L., Roughleaf Sunflower—(5); R; i; *597*

*Heliopsis helianthoides* (L.) Sweet var. *gracilis* (Nuttall) Gandhi & Thomas, Smooth Oxeye— (5); W; r; *351*, *423*, *601*

*Heterotheca latifolia* Buckley, Common Camphorweed—(5); R; i; *625*

*Krigia cespitosa* Rafinesque, Opposite-leaf Dwarf-dandelion—(6); OP; r; *525*

*Liatris elegantula* (Greene) K. Schumann, Blazing-star—(2), (6); OP, R; r; *377, 616*

*Liatris spicata* (L.) Willdenow, Florist's Gayfeather— (1); OP; r; *301*

*Packera anonyma* (Wood) W. A. Weber & A. Love, Small's Ragwort—(6); OP, R; c; *115*

*Pityopsis aspera* (Shutteworth ex Small) Small var. *adenolepis* Fernald, Semple & Bowers, Grass-leaved Golden-aster—(2); OP; r; *361*

*Pseudognaphalium obtusifolium* Hillard & Burtt, Fragrant Rabbit Tobacco—(5); R; o; *624*

*Ratibida pinnata* (Ventenat) Barnhart, Globular Prairie Coneflower—(1), (2), (5), (6); OP, R, W; c; *204, 259, 588, 590*

*Rudbeckia fulgida* Aiton, Eastern Coneflower—(1), (3), (5), (6); OP, W; c–o; *283, 307, 350, 414, 446, 609*

*Silphium asteriscus* L. var. *dentatum* (Elliot) Chapman, Rosinweed—(1), (3), (6); OP, W; c–o; *177, 205, 214*

*Smallanthus uvedalius* (L.) Mackenzie ex Small, Bearfoot—(4), (5); MF, R; r; *331, 559*

*Solidago arguta* Aiton var. *bootii* Hooker, Palmer & Steyermark, Boot's Goldenrod—(3); ST; i; *408*

*Solidago canadensis* L., Northern Common Goldenrod—(5); R; o; *622*

*Solidago nemoralis* Aiton, Old Field Goldenrod—(5), (6); OP, W, R, c; *411, 418*

*Solidago rugosa* P. Miller var. *aspera* (Aiton) Fernald, Roughleaf Goldenrod—(3); R; o; *407*

*Solidago ulmifolia* Muhlenberg ex Willdenow, Elmleaf Goldenrod—(5); PH; i; *618*

*Symphyotrichum laeve* (L.) Löve & Löve var. *concinnum*[3] (Willdenow) Nesom, Narrow-leaved Smooth Aster—(4); R; i ;*25, 461*

*Symphyotrichum georgianum*[2] *(*Alexander) Nesom, Georgia Aster—(1); OP; r; c; *1*

*Symphyotrichum lateriflorum* (L.) Löve & Löve, Starved Aster—(1); OP, W; r; *11*

*Symphyotrichum novae-angliae*[2] (L.) Nesom, New England Aster—(1), (6); OP; c; *8, 443*

*Symphyotrichum pilosum* (Willdenow) Nesom, American Aster—(5); R; o; *395, 430*

*Symphyotrichum undulatum* (L.) Nesom, American Aster—(5); MF; r; *412, 462*

*Symphyotrichum dumosum* (L.) Nesom, Long-stalked Aster—(2), (4); R; i; *25a, 469*

**Taraxacum officinale* G. H. Weber ex Wiggers, Dandelion—(5); R; r; *474*

*Verbesina virginica* L., Common Frostweed—(5); PH; o; *22, 387, 619*

*Vernonia angustifolia* Michaux, Ironweed—(2); R; r; *365*

*Vernonia gigantea* (Walter) Trelease, Ironweed—(1), (3), (5), (6); OP, PH, R; o; *343*, *386*, *400*, *605*

**BETULCEAE**

*Ostrya virginiana* (P. Miller) K. Koch, American Hop Hornbeam—(5); MF; o; *310*

**BIGNONIACEAE**

*Bignonia capreolata* L., Cross-vine—(5); PH; r; *76*

*Campsis radicans* (L.) Seemann ex Bureau, Trumpet-creeper—(4); OP, ST; o; *252*

**BORAGINACEAE**

*Cynoglossum virginianum* L., Wild Comfrey—(5); MF; o; *78*, *144*, *244*

*Lithospermum tuberosum* Rugel ex Austin de Candolle, Southern Stoneseed—(3), (5), (6); MF, ST; o–r; *29*, *60*, *62*,*101*

**BRASSICACEAE**

*Draba cuneifolia*[2] Nuttall ex Torrey & A. Gray, Wedgeleaf Draba—(2), (4), (5); OP, W; *36*, *37*, *477*, *486*

**BROMELIACEAE**

*Tillandsia usneoides* (L.) L., Spanish moss—(4); MF; i; *91*

**CAMPANULACEAE**

*Lobelia puberula* Michaux, Lobelia—(2); R; r; *373*

*Triodanis perfoliata* (L.) Nieuwland, Venus's Looking Glass—(6); R; o; *118*

**CANNABACEAE**

*Celtis occidentalis* L., Northern Hackberry—(2); *607*

*Celtis tenuifolia* Nuttall, Georgia Hackberry—(4), (5), (6); MF, OP, ST, W; c; *83*, *89*, *165*, *594*

**CAPRIFOLIACEAE**

**Lonicera japonica* Thunberg, Japanese Honeysuckle—(5); MF; o; [CAT I]; *114*

*Lonicera sempervirens* L., Coral Honeysuckle—(1), (2); OP, ST; o–i; *68*, *495*

**CARYOPHYLLACEAE**

*Silene polypetala*[1] (Walter) Fernald & Schubert, Fringed Campion—(5); MF; r; E; *122*

**CELASTRACEAE**

*Euonymous americanus* L., Strawberry-bush—(4); MF; r; *157*

**COMMELINACEAE**

*Commelina erecta* L. var. *angustifolia* (Michaux) Fernald, Sand Dayflower—(4); ST; r; *327*

**CONVOLVULACEAE**

*Cuscuta pentagona* Engelmann, Dodder—(4); OP; o; *230*

*Ipomoea pandurata* (L.) G. F. W. Meyer, Manroot— (1); OP; i; *207*.

**CORNACEAE**

*Cornus asperifolia* Michaux, Eastern Roughleaf Dogwood—(1), (2), (3), (5), (6); OP, ST, W; c–o; *81*, *212*, *215*, *364*, *437*

*Cornus florida* L., Flowering Dogwood—(2), (6); PH, ST; c–o; *54*, *493*

**CYPERACEAE**

*Carex abscondita* Mackenzie, Thicket Sedge—(3); ST; i; *511*

*Carex blanda* Dewey, Sedge— (1), (3); OP, ST; i; *126*, *514*

*Carex cherokeensis* Schwein., Cherokee Sedge— (1), (3), (5); MF, OP; c–o; *65*, *71*, *149*, *483*

*Carex granularis* Muhlenberg ex Willdenow, Limestone Meadow Sedge—(1), (6); OP; i; *127*, *223*, *550*, *567*

*Carex hirsutella* Mackenzie, Fuzzy Wuzzy Sedge—(4); R; r; *245*

*Carex laxiflora* Lamarck, Sedge—(5); W; i; *80*

*Carex lurida* Wahlenberg, Shallow Sedge—(3), (5); MF, R; i; *185*, *515*, *540*

*Carex nigromarginata* Schwein., Black Edge Sedge—(5); MF; i; *482*

*Carex oxylepis* Torrey & Hooker, Sharpscale Sedge—(3), (5); MF, ST; i; *154*, *513*

*Carex pigra* Naczi, Tarheel Sedge—(3), (5); MF, ST; o–i; *508*, *512*

*Carex planispicata* Naczi, Flat-spiked sedge—(5); MF, PH; i; *532*, *534*

*Cyperus acuminatus*[2] Torrey & Hooker ex Torrey, Flatsedge—(5); R; i; *584*

*Cyperus echinatus* (L.) Wood, Flatsedge—(3); R; i; *579*

*Eleocharis obtusa* (Willdenow) J. A. Schultes, Spikerush—(3), (4); R; o–i; *320*, *583*

*Rhynchospora caduca* Elliott, Angle-stem Beaksedge—(1), (6); OP, o; *225*, *270*, *568*

*Scleria oligantha* Michaux, Few-flowered Nutsedge—(5); MF, ST; W, R; o–i; *188*, *195*

**DIOSCOREACEAE**

**Dioscorea alata* L., Great Yam—(3); ST, W; *182*, *564*, *592*, *611*

*Dioscorea quaternata* J. F. Gmelin, Whorled Wild Yam—(3), (5); MF, W; r; *186*, *612*

**EBENACEAE**

*Diospyros virginiana* L., Persimmon—(1), (6); OP, ST, R, W; c; *187*, *221*

**ELEAGNACEAE**

**Eleagnus umbellata* Thunberg var. *parviflora* (Royle) Scheider, Spring Silverberry—(3), (4); OP; R; i–r; [CAT I]; *257*, *488*

**ERICACEAE**

*Chimaphila maculata* (L.) Pursh, Striped Wintergreen—(5); MF; r; *340*

*Vaccinium stamineum* L., Southern Deerberry—(2); R; r; *286*

## EUPHORBIACEAE

*Chamaesyce maculata* (L.) Small, Spotted Spurge—(5); PH; r; *558*

*Chamaesyce nutans* (Legasca y Segura) Small, Eyebane—(5), (6); OP, R; c–i; *226*, *269*, *359*

*Croton monanthogynus* Michaux, Prairie-tea—(3); OP, R, W; o; *263*, *271*

*Euphorbia pubentissima* Michaux, Flowering Spurge—(4), (6); OP; r; *161*, *211*

*Tragia cordata*[2] Michaux, Heartleaf Noseburn—(2), (3), (5); OP, W; o–r; *279*, *312*, *565*, *615*

*Tragia urticifolia* Michaux, Nettleleaf Noseburn—(4); OP; c; *231*

## FABACEAE

*Amorpha fruticosa* L., Tall Indigo Bush—(3); R; r; *520*

*Baptisia alba* (L.) Ventenat, Thick-pod White Indigo—(2); R; r; *113*

*Centrosema virginianum* (L.) Bentham, Spurred Butterfly Pea—(3); OP; c; *277*

*Cercis canadensis* L., Redbud—(1), (4), (5); MF, OP, PH, ST, R; c; *46*, *86*, *138*, *480*

*Chamaecrista fasciculata* (Michaux) Greene, Common Partridge-pea—(2), (6); PH, R; c; *357*, *379*

*Desmodium cuspidatum* (Muhlenberg ex Willdenow) Augustin de Candolle ex Louden, Toothed Tick-trefoil—(5); PH; i; *383*

*Desmodium glutinosum* Muhlenberg ex Willdenow, Clusterleaf Tick-Trefoil—(5); MF; r; *228*

*Desmodium rotundifolium* Augustin de Candolle, Roundleaf Tick-trefoil—(3), W; r; *582*

*Desmodium canescens* (L.) Augustin de Candolle, Hoary Tick-trefoil—(5); R; r; *623*

*Galactia regularis* (L.) Britton Sterns & Poggenburg, Milkpea—(1), (5); OP, W; o–i; *276*, *339*

*Galactia volubilis* (L.) Britton, Milkpea—(4) OP; o; *256*

**Kummerowia striata* (Thundberg) Schindler, Japanese-clover—(2); R; o; *371*

**Lespedeza cuneata* (Dumont-Cours.) G. Don, Chinese Lespedeza—(3), (4); R; c–o; [CAT I]; *352*, *614*

*Lespedeza procumbens* Michaux, Downy Trailing Lespedeza—(2); W; i; *370*

*Lespedeza repens* (L.) W. Barton, Smooth Trailing Lespedeza—(1); R; i; *341*

*Lespedeza virginica* (L.) Britton, Virginia Lespedeza—(2), (3), (5); PH, W, R; o–c; *362*, *421*, *613*, *626*

**Medicago lupulina* L., Black Medick—(4), (5); OP, R; o–i; *52*, *56*, *501*

**Melilotus albus* Medikus, White Sweetclover—(1); OP, R; c; [CAT I]; *141*

*Phaseolus polystachyos* (L.) Britton Sterns & Poggenburg, Wild Bean—(5); W; i; *562*

**Pueraria montana* (Loureiro) Merritt var. *lobata* (Willdenow) Van der Maeson, Kudzu—(5); W; o; [CAT I]; *313*

**Senna obtusifolia* (L.) Irwin & Barneby, Sicklepod—(5); OP, R; c–o; *388*

*Strophostyles umbellata* (Muhlenberg ex Willdenow) Britton, Perennial Sand Bean—(1), (5), OP, PH; i; *342*, *557*

**Trifolium campestre* Schreber, Hop Clover—(6); R; o; *100*

*Vicia minutiflora* F.G. Dietrich, Smallflower Vetch—(5); MF, W; o; *49*, *478*

**Vicia sativa* L. ssp. *nigra* (L.) Ehrhart, Narrowleaf Vetch—(6); R; o; *97*

**FAGACEAE**

*Fagus grandifolia* Ehrhart, American Beech—(4); MF; i; *334*

*Quercus muehlenbergii* Engelmann, Chinquapin Oak—(2); MF, PH, W; c; *172*

*Quercus sinuata*[2] Walter, Bastard Oak—(1), (3), (4), (5); MF, OP, PH, W; o–i; *28*, *167*, *213*, *306*, *528*, *600*, *603*

*Quercus stellata* Wangenheim, Post Oak—(2), (3), PH; r; *366*, *527*

*Quercus velutina* Lamarck, Black Oak—(3); PH, W; o; *194*

**GELSEMIACEAE**

*Gelsemium sempervirens* St. Hilaire, Yellow Jessamine—(6); R; r; *53*

**GENTIANACEAE**

*Sabatia angularis* (L.) Pursh, Common Marsh-pink—(2), (4); OP; c; *297*, *593*

**GERANIACEAE**

*Geranium carolinianum* L., Southern Carolina Crane's Bill—(4), (5); R; c–o; *73*, *96*

*Geranium maculatum* L.,Wild Geranium—(5); MF; o; *72*

**HYDRANGACEAE**

*Decumaria barbara* (L.), Woodvamp—(5); MF; r; *391*

**HYPERICACEAE**

*Hypericum gentianoides* (L.) Britton Sterns & Poggenburg, Pineweed—(2); R; r; *369*

*Hypericum hypericoides* (L.) Crantz, St. Andrew's Cross—(2); R; r; *374*

**IRIDACEAE**

*Sisyrinchium mucronatum* Michaux, Blue-eyed Grass—(1), (2), (3), (6); OP, ST, W, R; c-o; *66*, *491*, *499*, *519*, *563*

**JUGLANDACEAE**

*Carya alba* (L.) Nuttall ex Elliott, Mockernut Hickory—(4); MF; r; *551*

*Carya carolinae-septentrionalis* (Ashe) Engler & Graebner, Carolina Shagbark Hickory—(4), (5); MF, PH; o; 397, 542, *546*,

*Carya cordiformis* (Wangenheim) K. Koch, Bitternut Hickory—(5); MF; r; *396*

*Juglans nigra* L., Black Walnut—(1); W; i; *358*

## JUNCACEAE

*Juncus biflorus* Elliott, Rush—(1), (4); OP, R; i–r; *227*, *246*

*Juncus scirpioides* Lamarck, Rush—(1); OP; o; *125*, *224*

*Juncus tenuis* Willdenow, Path Rush—(1), (5); R; r; *124*, *192*

*Juncus validus* Coville, Vigorous Rush—(4); R; i; *336*

## LAMIACEAE

*Callicarpa americana* L., Beautyberry—(1); W; i; *274*

*Collinsonia canadensis* L., Richweed—(5); MF; r; *413*

**Lamium amplexicaule* L., Henbit—(5); W; r; *476*

*Monarda punctata* L., Eastern Horse-mint—(6); R; r; *353*

**Prunella vulgaris* L., Eurasian Self-heal—(3); OP; i; *272*

*Salvia azurea* Michaux ex Lamarck, Azure Sage—(3), (5), (6); OP, W; c–o; *3*, *417*, *425*

*Salvia lyrata* L., Lyre-leaved Sage—(1); OP, W; c; *67*

*Scutellaria australis* (Fasset) Epling, Southern Skullcap—(1), (2); OP; i; *64*, *69*

*Scutellaria drummondii*[2] Bentham, Drummond's Skullcap—(6); OP; o; *82*, *108*

*Scutellaria integrifolia* L., Skullcap—(1), (4); OP, R; *105*, *169*, *255*

*Trichostema dichotomum* L., Common Blue Curls—(2); OP; r; *621*

*Spigelia marilandica* L., Pinkroot—(4); PH; r; *170*

## LYTHRACEAE

*Lythrum lanceolatum* Elliott, Southern Winged Loosestrife—(1); OP, R; o; *275*, *281*

## MALVACEAE

*Sida elliottii*[2] Torrey & A. Gray, Elliott's Fanpetal—(5); W; i; *23*, *424*

*Tilia americana* L. var. *heterophylla* (Ventenat) Loudon, White Basswood—(5); MF; r; *235*

**MELIACEAE**

**Melia azedarach* L., Chinaberry—(5); R; r; [CAT I]; *589*

**MENISPERMACEAE**

*Cocculus carolinus* (L.) A.P. deCandolle, Coralbeads—(3), (4), (6); OP, R, W; o–i; *253*, *337*, *416*

**MORACEAE**

*Morus alba* L., White Mulberry—(5); PH; r; *317*

*Morus rubra* L., Red Mulberry—(5); MF; o; *143*

**MYRICACEAE**

*Morella cerifera* (L.) Small, Common Wax Myrtle—(4), (6); PH; c–o; *31*, *55*

[= *Myrica cerifera* L.]

**OLEACEAE**

*Fraxinus americana* L., White Ash—(1), (5); (6); MF OP, PH, ST, R, W; c; *210*, *240*, *599*

**Ligustrum sinense* Loureiro, Chinese Privet—(6); R, W; [CAT I]; *354*, *522*

**ONAGRACEAE**

*Oenothera biennis* L., Common Evening-primrose—(1); R; r; *107*

*Oenothera laciniata* Hill, Cutleaf Evening-primrose—(1); R; r; *106*

**Oenothera speciosa* Nuttall, White Evening-primrose—(2), (6); OP; o; *110*, *494*

**ORCHIDACEAE**

*Hexalectris spicata*[3] (Walter) Barnhart, Crested Coralroot—(4); R; r; *586*

**OROBANCHACEAE**

*Agalinis fasciculata* (Elliott) Rafinesque, Purple-foxglove—(1); OP; r; *439*

*Agalinis tenella* Pennell, Purple-foxglove—(2); R; r; *372*

*Agalinis tenuifolia* (Vahl) Rafinesque, Purple-foxglove—(1), (2), (5), (6); OP, ST, W; c–o; *15, 30, 431,442*

**Verbascum thapsus* L., Wooly Mullein—(5); R; r; (*577*)

**OXALIDACEAE**

**Oxalis corniculata* L., Creeping Lady's Sorrel—(4), (6); OP; R; o; *58, 502*

**PASSIFLORACEAE**

*Passiflora incarnata* L., Maypops—(5); R; r; *585*

*Passiflora lutea* L., Yellow Passionflower—(5); MF; r; *422*

**PHRYMACEAE**

*Mimulus alatus* Aiton, Monkeyflower—(5); MF; r; *316*

*Phryma leptostachya* L., American Lopseed—(5); MF; r; *267, 576*

**PHYTOLACCACEAE**

*Phytolacca americana* L., American Pokeweed—(2); OP; r; *463*

**PLANTAGINACEAE**

*Mecardonia acuminata* (Walter) Small, Mecardonia—(2), (4); OP; i–r; *426, 460*

*Nuttallanthus canadensis* (L.) D. A. Sutton, Common Toadflax—(1); R; i; *117*

*Penstemon laevigatus* Aiton, Eastern Beardtounge—(2); OP; W; o; *173*

**Plantago aristata* Michaux, Buckhorn Plantain—(3); R; o; *200, 529*

*Plantago virginica* L., Virginia Plantain—(3); R; o; *516*

**Veronica arvensis* L., Corn Speedwell—(6); R; o; *35*

*Veronica peregrina* L., Common Purslane Speedwell—(1); R; o; *130*

**POACEAE**

*Agrostis hyemalis* (Walter) Britton Sterns & Poggenburg, Ticklegrass—(1); R; o; *132*

*Andropogon gerardii* Vitman, Turkeyfoot—(1), (6); OP; c–r; *9*, *450*

*Andropogon glomeratus* (Walter) Britton, Sterns & Poggenburg, Bluestem—(2); OP; r; *466*

*Andropogon perangustatus* Nash., Narrow-leaf Bluestem—(4); OP; o; *451*

*Andropogon virginicus* L., Old Field Broomstraw—(3); (6); OP, W, R; c–o; *435*, *628*

*Aristida longespica* Poiret, Eastern Slim-spike Three-awn—(4); OP; o; *457*, *471*

*Aristida purpurascens* Poiret, Arrowfeather—(2), (3), (4), (6); OP; c–o; *12*, *438*, *458*, *472*

*Arundinaria gigantea* (Walter) Walter, Giant Cane—(5); MF; o; *390*

*Brachyeletrum erectum* (Schreber ex Sprengel) Palisot de Beauvois, Common Shorthusk—(5); MF; o; *318i*

**Bromus japonicus* Thunberg ex Murray, Japanese Chess—(5); R; c; *541*

*Bromus pubescens* Muhlenberg ex Willdenow, Common Eastern Brome—(4), (6); MF, R; i–r; *164*, *241*

*Chasmanthium latifolium* (Michaux) Yates, Fish-on-a-pole—(4); MF; i; *330*

*Chasmanthium sessiliflorum* (Poiret) Yates, Longleaf Woodoats—(4), (5); o; *405*, *328*

*Dichanthelium aciculare* (Desvaux) ex Poiret, Needle Witch Grass—(2); R; r; *375*

*Dichanthelium acuminatum* (Swartz) Gould & Clark var. *lindheimeri* (Nash) Gould & Clark, Lindheimer's Witch Grass—(3); W; r; *555*

*Dichanthelium boreale* (Nash) Freckmann, Northern Witch Grass—(3), (4); OP; r; *104*, *151*

*Dichanthelium boscii* (Poiret) Gould & Clark, Bosc's Witch Grass—(2), (4), (5); MF, PH; o–i; *150*, *266*, *300*, *326*

*Dichanthelium commutatum* (Schultes) Gould, Variable Witch Grass—(3), (4), (5); MF, W; o–i; *79*, *265*, *324*, *403*, *556*

*Dichanthelium depauperatum* (Muhlenberg) Gould, Starved Witch Grass—(2), (6); OP, ST; o–i; *121*, *496*

*Dichanthelium laxiflorum* (Lamarck) Gould, Open-flower Witch Grass—(2), (5); MF, ST; i; *404*, *498*

*Dichanthelium sphaerocarpon* (Elliott) Gould, Round-fruited Witch Grass—(2); OP; o; *549*

**Echinochloa colona* (L.) Link, Jungle Rice—(3); R; r; *581*

*Elymus hystrix* L., Common Bottlebrush Grass—(3), (5); OP, PH; *201*, *538*, *620*

*Elymus magregorii* R. Brooks & J. J. N. Campb., Early Wild-rye—(6); OP; r; *571*

*Elymus virginicus* L. Wild-rye—(1); W; r; *295*

*Eragrostis hirsuta* (Michaux) Nees, Bigtop Lovegrass—(4), (5); o–i; *394*, *453*, *470*

*Eragrostis refracta* (Muehlenberg) Scribner, Coastal Lovegrass—(5); OP; r; *449*

*Eragrostis spectabilis* (Pursh) Steudel, Purple Lovegrass—(3); R, ST; i; *436*

*Glyceria striata* (Lamarck) A.S. Hitchcock, Fowl Mannagrass—(5); MF; i; *268*

**Hordeum pusillum* Nuttall, Little Barley—(1); R; r; *129*

**Lolium perenne* L. var. *aristatum* Willdenow, Italian Rye-Grass—(3), (5); R; r; *193*, *553*

*Melica mutica* Walter, Two-flowered Melic—(1), (4); OP, W; o; *103*, *128*

*Muhlenbergia capillaris* (Lamarck) Trinius, Hairgrass—(1), (2), (4), (6); OP; c–o; *14*, *441*, *452*, *467*

*Panicum anceps* Michaux, Beaked Panic-Grass—(1), (3), (4); OP, R; o–i; *323*, *347*, *459*, *608*

*Panicum capillare* L., Old-witch Grass—(1); W; r; *602*

*Panicum virgatum* L., Switchgrass—(5); W; r; 384

**Paspalum dilatatum* Poiret, Dallis Grass—(5); R; c; *190*

*Paspalum floridanum* Michaux, Florida Paspalum—(1), (3); OP; r; *447*, *631*

**Paspalum notatum* Flugge, Bahia Grass—(2); OP, R; o; *380*

*Poa autumnalis* Muhlenberg ex Elliott, Bluegrass—(5); MF; i; *517*

**Schedonurus arundinaceus* (Schreber) Dumortier, Tall Fescue—(6); R; r; *523*

*Setaria parviflora* (Poiret) Kerguelen, Knotroot Bristlegrass—(1); OP; o; *303*, *604*

**Setaria pumila* (Poiret) Roemer & Schultes, Yellow Foxtail—(3); R; r; *580*, *596*

*Sorghastrum elliottii* (C. Mohr) Nash, Slender Indiangrass—(4); OP, ST; r; *455*

*Sorghastrum nutans* (L.) Nash, Indian Grass—(1), (6); OP, R, W; c; *415*, *444*

**Sorghum halepense* Persoon, Johnson Grass—(1); OP, R; c; *222*

*Sphenopholis nitida* (Biehler) Scribner, Shiny Wedgescale—(5); W; o; *81*

*Sphenopholis obtusata* (Michaux) Scribner, Prairie Wedgegrass—(4); MF; i; *159*

*Sporobolus clandestinus* (Biehler) A.S. Hitchcock, Rough Dropseed—(1), (2), (3), (4); OP; c; *19*, *432*, *440*, *465*

**Sporobolus indicus* (L.) R. Brown, Smut Grass—(6); R; r; *627*

*Sporobolus vaginiflorus* (Torrey ex A. Gray) Wood, Poverty Dropseed—(1), (2), (3), (4), (6); OP; c; *419*, *434*, *445*, *456*, *464* [Individuals resembling *S. ozarkanus* with lemmas and paleas shorter than glumes are commonly intermixed with typical *S. vaginiflorus* (Weakley 2007).]

*Tridens flavus* (L.) A. S. Hitchcock, Red Top—(2), (3); OP, R; o–i; *381*, *433*

*Tripsacum dactyloides* L., Gamma Grass—(3); OP, W; i; *304*, *606*

**POLEMONIACEAE**

*Phlox divaricata* L., Eastern Blue Phlox—(3); W; o; *507*

**POLYGALACEAE**

*Polygala boykinii*[3] Nuttall, Boykin's Milkwort—(2), (4), (5), (6); OP, R, W; c, *10*, *20*, *176*, *296*, *533*, *545*

*Polygala polygama* Walter, Southern Bitter Milkwort—(2), (5), (6); PH, R; i–r; 1*71*, *536*

*Rumex verticillatus* L., Swamp Dock—(3); R; r; *554*

**PRIMULACEAE**

*Lysimachia ciliata* L., Fringed Loosestrife—(5); MF; o; *232*

*Samolus floribundus* Humboldt, Bonpland & Kunth, Water-pimpernel—(5); MF; r; *178*

**RANUNCULACEAE**

*Anemone virginiana* L., Thimbleweed—(2), (4); OP, PH, W; o–i; *249*, *289*

*Delphinium carolinianum*[3] Walter, Prairie Larkspur—(2), (4); OP; c–o; *229*, *261*

*Ranunculus recurvatus* Poiret, Hooked Crowfoot—(5); MF; r; *147*, *199*

**RHAMNACEAE**

*Berchemia scandens* (Hill) K. Koch, Supplejack—(6); OP, PH, ST; W; c; *13*

*Ceanothus americanus* L. var. *intermedius* (Pursh) Torrey & A. Gray, Southern New Jersey Tea—(2); PH; i; *287*

*Frangula caroliniana* (Walter) A. Gray, Carolina Buckthorn—(1), (4); OP, ST, W, c–o; *90*, *216* [= *Rhamnus caroliniana* (Walter)]

**ROSACEAE**

*Agrimonia gryposepala* Wallroth, Common Agrimony—(5); MF; c; *389*

*Crataegus aprica* Beadle, Sunny Hawthorne—(4); OP, ST, W, c; *247*, *335*

*Crataegus crus-galli* L., Cockspur Hawthorn—(1), (6); OP, PH, ST; c–o; *308*, *349*

*Crataegus iracunda* Beadle, Red Hawthorn—(3); W; i; *429*

*Crataegus lassa* Beadle, Sandhill Hawthorn—(1); ST; r; *632*

*Crataegus marshallii* Eggleston, Parsley Hawthorn—(2); ST, W; o; *376*, *290*

*Crataegus pruinosa* (Wendl.) K. Koch, Frosted Hawthorn—(2); PH, OP; r; *368*

*Crataegus spathulata* Michaux, Littleship Hawthorn—(2); PH, OP, ST, W; o; *248*, *299*, *367*

*Crataegus triflora*[2] Chapman, Threeflower Hawthorn—(3), (5); MF, PH, W; o; *315*, *398*, *428*

*Crataegus uniflora* Muenchhausen, Oneflower Hawthorn—(2), (4); OP, PH; o–c; *166*, *284*, *382*, *454*

*Fragaria virginiana* P. Miller, Wild Strawberry—(6); R; o; *44*, *57*

*Gillenia stipulata* (Muhlenberg ex Willdenow) Nuttall, Midwestern Indian-physic—(5); PH; o; *537*

*Malus angustifolia* (Aiton) Michaux, Wild Crab Apple—(2), (5); ST; r; *288*, *630*

**Potentilla indica* (Andrews) T. Wolf, Indian-Strawberry—(5); MF; r; *420*

*Prunus americana* Marshall, Wild Plum—(1), (5); W; r; *302*, *309*, *509*

*Prunus angustifolia* Marshall, Chickasaw Plum—(6); OP, W; r; *219*

*Prunus caroliniana* (P. Miller) Aiton, Carolina Laurel Cherry—(6); PH; i; *355*

*Prunus umbellata* Elliott, Hog Plum—(3); PH; r; *489*

**Rosa bracteata* J.C. Wendland, Chickasaw Rose—(1); OP; R; o–i; *202*

*Rosa carolina* L., Carolina Rose—(1), (2), (4), (6); OP, R, W; o–i; *17*, *162*, *239*, *346*

*Rubus argutus* Link, Southern Blackberry—(1); ST; r; *574*

*Rubus trivialis* Michaux, Southern Dewberry—(6); R; i; *112*

**RUBIACEAE**

*Diodia teres* (Walter), Poorjoe—(3); OP; o; *399*

**Galium aparine* L., Cleavers—(5); W; o; *74*

*Galium circaezans* Michaux, Southern Forest Bedstraw—(3), (4), (5); MF, PH; o; *142*, *158*, *196*

*Galium pilosum* Aiton var. *puncticulosum* (Michaux) Torrey & A. Gray, Hairy Bedstraw—(2); *264*

*Galium virgatum*[2] Nuttall, Limestone Bedstraw—(1), (6); OP; r; *98*, *109 136*

*Houstonia nigricans*[3] (Lamarck) Fernald, Diamond-flower—(1), (2), (6); OP; c; *18*, *208*, *262*, *360*, *401*

**RUTACEAE**

*Ptelea trifoliata* L., Smooth Wafer-Ash—(5); PH, W; o; *26*, *75*, *153*

**SAPINDACEAE**

*Acer floridanum* (Chapman) Pax, Southern Sugar Maple—(4); MF; o; *87*

*Acer rubrum* L., Red Maple—(6); W; i; *524*

*Aesculus pavia* L., Red Buckeye—(5); MF; o; *48*

**SAPOTACEAE**

*Sideroxlyon lycioides* L., Buckthorn Bumelia—(3), (6); W; o–i; *7*, *220*, *526*

**SMILACEAE**

*Smilax bona-nox* L., Tramp's Trouble—(1), (4); W; i–r; *156*, *294*

*Smilax glauca* Walter, Whiteleaf Greenbrier—(1); R; r; *293*

*Smilax hispida* Rafinesque, Hellfetter—(5); PH; r; *140*

*Smilax hugeri* (Small) J. B. S. Norton ex Pennell, Huger's Carrionflower—(4); MF; r; *93*

*Smilax lasioneura*[2] Hooker, Midwestern Carrionflower—(2), (5); MF, ST; *146*, *233*, *492*

*Smilax rotundifolia* L., Common Greenbrier—(5); PH; i; *139*

*Smilax smallii* Morong, Jackson-brier—(1), (3), (4); OP, MF, W; i–r; *41*, *305*, *518*

**TRILLIACEAE**

*Trillium lancifolium*[2] Rafinesque, Lanceleaf Trillium—(5); MF; r; *237*

*Trillium underwoodii*[3] Small, Underwood's Trillium—(4); MF; r; *487*

**ULMACEAE**

*Ulmus alata* Michaux, Winged Elm—(1); PH, OP, ST, R, W; c *135, 218*

*Ulmus rubra* Muhlenberg, Slippery Elm—(5); MF; o; *88*

**VALERIANACEAE**

*Valerianella radiata* (L.) Dufr., Corn Salad—(1), (4); OP, W, R,; c–o; *70, 99*

**VERBENACEAE**

*Glandularia bipinnatifida*[2] (Nuttall) Nuttall, Dakota Mock Vervain—(3), (4), (5), (6); OP, ST, W; o–i; *16, 27, 40, 479, 490, 503*

**Verbena brasiliensis* Vellozo, Brasilian Vervain—(5); R; c; *179*

*Verbena simplex* Lehmann, Narrowleaf Vervain—(1); OP, R, o; *206, 572*

**VIOLACEAE**

*Viola bicolor* Pursh, White Pansy—(6); R; o; *34, 43*

*Viola sororia* Willdenow, Dooryard Violet—(3), (5); OP, R, W; c–o; *5, 50*

*Viola walteri* House, Walter's Violet—(3); OP; o; *61, 475*

**VITACEAE**

*Ampelopsis arborea* (L.) Koehne, Peppervine—(5); W; i; *280*

*Parthenocissus quinquefolia* (L.) Planchon, Virginia Creeper—(4); MF; i; *321*

*Vitis aestivalis* Michaux, Summer Grape—(4), (6); PH, ST; i; *137 333, 543*

*Vitis rotundifolia* Michaux, Muscadine—(6); MF, PH; c–o; *148*

*Vitis vulpina* L., Chicken Grape—(4); R; r; *250*

# CHAPTER 3

# A COMPARISON OF BLACKLAND PRAIRIE ECOSYSTEMS ACROSS THEIR RANGE*

*Echols, S. L. and W.B. Zomlefer. To be submitted to *Sida* or *Natural Areas Journal*

**Abstract**

A literature review was performed for six states containing blackland prairie within the Gulf and South Atlantic Coastal Plains of the United States. Geology, soils, and vegetation were compared, and a cluster analysis was performed using floristic data to assess similarities. Despite geologic, pedologic, and floristic similarities between groups of states, the diversity of plant communities (ca. 67 associations) suggest blackland prairies differ markedly across their range.

INDEX WORDS: Black Belt region, cluster analysis, grassland, prairie

## Introduction

Blackland prairie ecosystems are characterized by a mosaic of grassland, savanna, shrubland, woodland, and mixed southeastern forest types (NatureServe 2007). Related vegetation occurs scattered across the Gulf and Atlantic Coastal Plains: Blackland prairies are documented from Alabama, Arkansas, Georgia, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas (Peacock and Schauwecker 2003; NatureServe 2007; Fig. 2.1). Blackland prairie is predominantly associated with limestone and calcareous clay formations originating during the Upper Cretaceous and Lower Tertiary (ca. 65-30 mya) when much of the southeastern United States was covered by a shallow sea (Huddlestun and Hetrick 1986; Peacock and Schauwecker 2003). The term “blackland prairie” is best considered as a vernacular vegetation type, indicative of southeastern plant communities dominated by grasses and forbs, associated with alkaline clay soils with high shrink/swell potential underlain by calcareous parent material.

Calcareous soils are a contributing factor to blackland prairie vegetation. Shrink-swell clays, alkaline pH, and shallow rooting depth of soil profiles likely decrease invasion of woody species (Larry West, pers. comm., Schauwecker 1996; Klaus and Patrick 2002). Large quantities of organic matter in the soil are an important to pedogenic processes in blackland prairies. Decay of dense root systems from prairie grasses and forbs creates dark organic compounds that persist in the soil and coat mineral particles, creating the coloration responsible for the prairies’ namesake (Diggs et al. 2006).

Fire is probably the most important factor in maintaining blackland prairie vegetation (Anderson 1990; Diggs et al. 2006). Benefits to prairie vegetation include decreasing woody plant competition, increased nutrient availability, and altering microclimatic conditions to favor above-ground plant growth (Moran et al. 2003). Vegetation response to fire depends on a number

of factors, including precipitation patterns before and after burning, topography, vegetation structure, depth to water table, frequency, and seasonality (Anderson 1990). Although Diggs and Schulze (2003) recognized the importance of the physical characteristics of clay soils in maintaining prairie vegetation, they proposed a soil-dependant fire frequency hypothesis: larger quantities of high quality fuel (prairie grasses) on clay soils increase the frequency and intensity of fires, creating a positive feedback loop for fire-adapted grasses and subsequently suppressing woody plant growth.

Rostlund (1957) contended that there was no natural prairie belt in the Black Belt region of Mississippi and Alabama. However, Jones and Patton (1966) provided historical evidence that prairie vegetation coincided with calcareous clay soils. Recently, Barone (2005b) provided further historical evidence that the Mississippi/Alabama blackland prairies formed a cohesive ecosystem. He emphasized that these prairies were not large expanses of open grassland as in Midwestern tallgrass prairies, but "…a dense archipelago of prairie 'islands' surrounded by an ocean of forest." With the exception of historical Texas blackland prairies, this description applies to blackland prairies across their range: they existed as patches in a mosaic of other predominantly woody vegetation types.

Grasslands, including blackland prairies, are the most endangered biome in North America (Noss et al. 1994). Blackland prairies are considered critically imperiled or imperiled throughout their range (NatureServe 2007). For example in Texas, where the blackland prairie region covers 6.1 million acres, less than 1% of the original vegetation cover remains. Numerous factors have lead to the prairies' range-wide decline. The fertility of blackland prairie soils has been long been exploited (Peacock and Schauwecker 2003). Extensive cotton farming within the Black Belt of Mississippi and Alabama has been a major factor in prairie destruction over the

past 200 years (Frost et al.1986). Overgrazing and deep plowing have resulted in significant erosion, further exacerbated by the inherent properties of blackland soils: in the absence of vegetation, Texas blackland prairies erode at rates many times higher than any other region in the state (Schauwecker 1996; Diggs et al. 2006). Other anthropogenic impacts, including urbanization, fire suppression and subsequent invasion of woody species and invasives, landfill placement, and the construction of catfish ponds, have resulted in further range-wide decimation (MacRoberts et al. 2003; Peacock and Schauwecker 2003; Zollner et al. 2003).

Endangered systems such as blackland prairies require a systematic approach for effective conservation. The concept of representation, or capturing the variation of a system or taxon across its range, is integral to the field of conservation biology (Noss et al. 1994). This chapter is a preliminary step in assessing variation within the blackland ecosystem.

**Materials and Methods**

A literature review was performed for all states containing blackland prairie except for Oklahoma, with a small extension of Texas blackland prairie, and Tennessee, reported to have degraded remnants of Black Belt prairie in McNairy County (NatureServe 2007). Geology, soils, and vegetation were compared. Blackland prairies – the open, herbaceous, grass and forb-dominated vegetation types – are the focus of this chapter, but forest, woodland, savanna, and shrubland types associated with prairie habitats are also included (Table 2.1).

Data were collected from open vegetation types covering seven studies and 22 sites to compare floristic composition among six states (Fig. 2.2). Only open prairie and associated open chalk outcrop communities lacking woody dominant species were included. Presence/absence data were utilized, since studies consisted of floristic inventories and vascular plant checklists mostly lacking abundance data. Vascular plant nomenclature was standardized using the

Integrated Taxonomic Information System (2007). A hierarchical agglomerative cluster analysis was performed using a complete linkage algorithm with Sorenson's index as the distance measure, using PC-ORD (McCune and Mefford 1996).

## Results & Discussion

### *Arkansas*

Blackland Prairies occur in seven counties in southwest Arkansas (Foti 1989). The state has the largest relatively intact holding in the United States with ca. 6,000 ha of blackland prairie and related communities in natural (or near natural) condition (Foti et al. 2003). Approximately 2,700 ha are protected and managed for ecological value. The Arkansas Natural Heritage Commission has identified 118 prairies, and of these, 60 retain natural blackland prairie ecological characteristics but all remnants show some level of degradation (Foti et al. 2003). Many prairies were abandoned pastures; the impacts of grazing are still evident, including the presence of exotic *Melilotus* species and numerous bald spots on the landscape (Foti 1989).

#### *Geology*

Blackland prairies in Arkansas primarily occur over Cretaceous calcareous substrates but a narrow strip is underlain by the Midway Group of the Tertiary. Cretaceous formations known to underlie prairie and associated vegetation types include Annona Chalk, Arkadelphia Marl, Brownstone Marl, Dierks, DeQeen, Ozan, Nacatoch Sands, and Saratoga Chalk (Foti 1989; Zollner et al. 2003). Most prairie vegetation types occur on shallow beds of soil over chalk, and increasing soil depths allow woodland and forest types to flourish.

#### *Soils*

The most prevalent prairie soil types are the Sumter and Demopolis Series. These alkaline, clay, or silty clay soils have a high shrink-swell potential and are usually underlain by

chalk. The Houston Series is another common, typically deeper, alkaline clay soil underlying herbaceous prairie and savanna vegetation types. The Terouge and Tuscumbia Series are less commonly occurring silty clays. Some associated woodland and forest types are found on the more acidic, loamy Oktibbeha, Kirvin, Kipling, and Sacul Series (Foti 1989; Zollner et al. 2003).

*Vegetation*

Eighteen association-level plant communities have been classified within the blackland prairie landscapes of Arkansas (Zollner et al. 2003; NatureServe 2007; Table 2.1). Of the six described open prairie communities, Zollner et al. (2003) found *Sorghastrum nutans-Schizachyrium scoparium-Echinacea pallida-Dalea purpurea* var. *purpurea* Dry-mesic Blackland Prairie Herbaceous Vegetation as the matrix type for the state. Foti (1989) documented *Schizachyrium scoparium* as the dominant in 113 prairie plots. Schauwecker (1996) also found *S. scoparium* with highest frequency in Arkansas prairie plots; other frequently occurring species include *Berchemia scandens*, *Chamaecrista fasciculata*, *Dalea purpurea*, *Galactia volubilis*, *Houstonia* spp. and *Rudbeckia hirta* (Table 2.2). *Dalea purpurea* was the most abundant species in an analysis of plant biomass from post-burn prairie plots, accounting for ca. 60% of the biomass (Foti 1990).

***Mississippi***

Mississippi contains two distinct areas of blackland prairie, the Jackson and Blackbelt Prairie regions. These have similar vegetation and soils and differ more markedly in their underlying geologic formations, detailed below.

*Jackson Prairie*

The Jackson Prairie belt occurs in seven counties in central and eastern Mississippi, and consists of gently rolling topography approximately 15 to 50 km wide, extending from the

eastern edge of the Loess Bluff Region to just across the border of Mississippi and Alabama (Moran 1995; Moran et al. 1997). Barone (2005a) estimated the Jackson Prairie region to cover 19,555 ha in the early nineteenth century. Currently, 54 prairie remnants are known from the Jackson region, and prairie openings range in size from less than one to 65 ha, totaling ca. 325 ha (Moran et al. 2003).

*Jackson Prairie-Geology*

The Jackson Prairie region is underlain by two formations of the Jackson Group: Yazoo Clay and Moody's Branch, both deposited during the Eocene. The Yazoo Clay formation is calcareous, contains a high percentage of montmorillonite, and ranges in color from green to grey. The Moody's Branch formation, the basal formation in the Jackson Group, consists of fossiliferous marls with quartz, sand, and clay (Cooke 1939; Moran 1995; Moran et al. 2003).

*Jackson Prairie- Soils*

Alkaline clays dominate prairie vegetation and include Catalpa, Griffith, Houston, Leeper, Maytag, Oklona, and Tuscumbia series (Moran 1995). The Maytag series most commonly underlies prairie openings (NatureServe 2007). Acidic clay series more commonly associated with surrounding mixed pine and hardwood forests include Eutaw, Kipling, Louin, Oktibbeha, and Vaiden (Moran 1995). The Siwell series, consisting of silty loams over calcareous clays, occurs in calcareous forest (Wieland 2000; Table 2.1).

*Jackson Prairie-Vegetation*

Vegetation within the Jackson Prairie landscape includes one open prairie, one wooded seep, and six forest types (Wieland 2000; Mississippi Natural Heritage Program 2007; NatureServe 2007; Table 2.1). A post oak acid prairie has been also described from low slopes within the Jackson Prairie, but insufficient information exists for inclusion in Table 2.1 (Moran

et al. 1997). Moran (1995) describes the Jackson Prairies as isolated calcareous islands surrounded by mixed pine and hardwood forests. Common species within prairie openings include *Carex cherokeensis, Helenium autumnale,* and *Schizachyrium scoparium* with species such as *Dalea purpurea, D. candida,* and *Sporobolus compositus* var. *macer* occurring within less disturbed openings (NatureServe 2007; Table 2.3).

*Blackbelt Prairie*

Blackland prairie vegetation also occurs in a region known as the "Black Belt." This crescent-shaped area, approximately 40 km long and 500 km wide, runs from northeast Mississippi into central Alabama (Fig. 2.1). Black Belt prairies are known from 11 counties in Mississippi (Schauwecker 1996). Barone (2005b) estimated black belt prairies to cover ca. 700 $km^2$ or 0.6% of Mississippi's land area in the 1830's.

*Blackbelt Prairie-Geology*

The Mississippi black belt prairie is predominantly underlain by the Demopolis and Mooreville Formations of the Selma Chalk Group. This soft cretaceous chalk produces outcrops dipping to the south and west (Moran 1995). The basal Mooreville formation contains a lower percentage of calcareous constituents than the harder, upper Demopolis Formation. More recent alluvial deposits are present where the Tombigbee River flows through the Black Belt (Barone 2005b). The basal Eutaw formation underlies Selma Chalk. The younger Ripley and Prairie Bluff Chalk formations are present to a lesser extent within the Black Belt region and overlie the Demopolis formation (Gibson 1941).

*Blackbelt Prairie-Soils*

Liedolf and McDaniel (1998) found the alkaline clayey Sumter and Binnsville Series to dominate a 16.8 ha fragment of remnant upland Black Belt prairie vegetation within Oktibbeha

County, Mississippi. The Houston series is found less frequently. Other soils include the more acidic Kipling, Oktibbeha and Vaiden Series, found on old stream terraces, wide ridges and narrow side slopes, and Catalpa, Eutaw, and Leeper Series in Bottomlands (Hajeck and Dane 2007; USDA 2007).

*Blackbelt Prairie-Vegetation*

Current vegetation documented within Mississippi's Blackbelt include one prairie, two chalk outcrop, two woodland, and six forest types (Morris et al. 1993; Liedolf and McDaniel 1998; Mississippi Natural Heritage Program 2007; NatureServe 2007; Table 2.1). Open prairie is mainly represented by *Schizachyrium scoparium-Sorghastrum nutans-Dalea candida-Liatris squarrosa*-(*Silphium terebinthaceum*) Black Belt Herbaceous Vegetation (NatureServe 2007). Schauwecker (1996) found *Schizachyrium scoparium* to have the highest frequency out of 99 prairie plots in the Mississippi Black Belt (Table 2.4). Other high frequency species included *Aristida dichotoma, Carex cherokeensis, Dalea purpurea, Galactia volubilis, Hedyotis* spp., *Salvia lyrata, Solidago nemoralis,* and *Symphyotrichum laeve.* Common woody species frequently invading Mississippi prairie include *Cercis canadensis, Diospyros virginiana, Fraxinus americana, Ilex decidua,* and *Ulmus alata* (Leidolf and McDaniel 1998). Liedolf and McDaniel (1998) listed six forest communities within the Mississippi Blackbelt: xeric post oak ridges, mesic oak-hickory forests, seasonally inundated bottomland hardwood forests, water tupelo swamps, mixed hardwood gallery forests, and prairie cedar woodland.

***Alabama***

Alabama contains the southeastern portion of the Black Belt crescent in 12 counties in west-central and central Alabama, and the historical distribution of prairies approximate that of Mississippi, covering ca. 700 km² (Barone 2005b). Montgomery County contained an estimated

30,000 ha of prairie, more than any other county in the state. Associated geology and soils within Alabama Black Belt are identical to its contiguous Mississippi counterpart. A small portion of the Jackson Prairie region also extends into Alabama (NatureServe 2007; Fig. 2.1).

*Geology*

As in Mississippi, Alabama's Black Belt is predominantly underlain by the Mooreville and Demopolis formations of the Selma Chalk group (Moran 1995). Basal sediments consist of the Eutaw Formation, and younger Ripley, Tuscaloosa and Prairie Bluff Chalk formations to a lesser extent (Gibson 1941).

*Soils*

Alabama Black Belt soils include series found in Mississippi, with Sumter and Binnsville Series frequently found in open prairie vegetation (NatureServe 2007). The Houston series occurs less commonly. Other series include Catalpa, Eutaw, Leeper Kipling, Oktibbeha and Vaiden (Hajeck and Dane 2007).

*Vegetation*

Vegetation within the Alabama Black Belt includes at least two prairie, two woodland, and one forest type (Alabama Natural Heritage Program 2007; NatureServe 2007; Table 2.1). Open prairie is mainly represented by *Schizachyrium scoparium-Sorghastrum nutans-Dalea candida-Liatris squarrosa-*(*Silphium terebinthaceum*) Black Belt Herbaceous Vegetation (NatureServe 2007). Jackson Prairie vegetation occurs in Choctaw, Clarke, and Washington counties in Alabama (NatureServe 2007; Table 2.1). Schuster and McDaniel (1973) performed a floristic inventory and vegetation analysis of a 1.2 ha prairie in Greene County; within sampled plots, *Hypoxis hirsuta* had the highest relative density in early spring, followed by *Schoenolirion croceum* (Table 2.5). They also noted *Schizachyrium scoparium* to dominate upper slopes, with

*Sporobolus vaginiflorus* dominating lower slopes. Jones and Patton (1966) analyzed historical field notes and plats from the Black Belt in Sumter County and found a strong correlation between alkaline clay soils and low tree density. In a similar study of historical Black Belt land-survey data from Montgomery County, Rankin and Davis (1971) reported oaks as the dominant recorded trees, followed by pines.

***Texas***

The Blackland Prairie region spans ca. 6.1 million ha in eastern Texas (Eidison and Smeins 1999). The main belt, 4.3 million ha, is bound by the Red River to the north and the city of San Antonio to the south. It is approximately 70 km at its widest point, narrowing to a 12 km belt at its southern terminus (Collins et al. 1975). The smaller Fayette and San Antonio Prairie regions east of the main belt are 1.7 and 0.7 million ha, respectively. Isolated Fleming Prairies over identical parent material occur east of these smaller belts (Brown et al. 2002; NatureServe 2007). Today, less than 1% of the original blackland prairie vegetation remains intact; most patches are smaller than 16 ha as a result of fragmentation from agricultural and urban expansion (Eidison and Smeins 1999). Approximately 1675 ha are currently protected via formal or voluntary agreements.

*Geology*

The main belt of Texas blackland prairie comprises four, distinct, parallel geomorphic regions, running north to south (corresponding geologic groups given in parentheses): Eagle Ford Prairie (Eagle Ford), White Rock Cuesta (Austin Chalk), Taylor Black Prairie (Taylor Group), and Eastern Marginal Prairie (Navarro and Midway Groups). The Eagle Ford Group is composed of highly laminated shales (Collins et al. 1975). The Austin Group, comprising harder limestone underlying shallow black clay soils, is light in coloration (Hill 1901; Collins et al.

1975). This group forms the most conspicuous landscape within the blackland prairie region, and its resistant chalk forms escarpments (Diggs et al. 2006). The Taylor Group is the largest geomorphic region, consisting of limestone underlying stiff black clay soils with a light-blue marly subsurface (Hill 1901). The Navarro group includes calcareous shaley clays, sandy clays, and sands, while the Midway consists of limestone, gypsum-rich clays, and calcareous sandstone (Collins et. al. 1975). All groups are of Upper Cretaceous origin, except for the Midway, which is Eocene (Hill 1901; Foti 1989). The Fayette and San Antonio Prairies are underlain by Fleming, Oakville Sandstone, and Cook Mountain Formations of Eocene origin (Diggs et al. 2006). The Fleming Formation dominates these outlier prairie belts, composed of calcareous silty clay sediment with lesser amounts of coarse-grained sandstone. The Oakville Sandstone comprises calcareous sandstone and clay, while the Cook Mountain Formation includes fossil-rich marine muds, mudstone, and minor proportions of sand and limestone (Diggs et al. 2006). The San Antonio Prairie is also underlain by the Crockett Formation, consisting of soft clays and unconsolidated sands (Launchbaugh 1955).

*Soils*

Before European settlement, the varied soils of the Texas blackland region fostered a diversity of plant communities greater than that of the northern tallgrass prairie (Eidison and Smeins 1999). Collins et al. (1975) recognized three soil associations within the main blackland prairie belt. The association containing the Houston Black, Heiden, and Ferris series dominates Texas blacklands and is typical for the region. The Houston Black series is underlain by calcareous clays and marls, while the Heiden and Ferris series are underlain by weathered shale (USDA 2007). This group of alkaline clays is associated with the formation of “gilgae” or microrelief consisting of ridges and depressions. As the shrink-swell clays dry and crack, loose

soil particles fall into the resulting crevices. These particles expand upon wetting, creating the topography once a common part of the east Texas landscape (Collins et al. 1975; Diggs et al. 2006). The Austin, Stephen, and Eddy series are brown silty clay and clay loams, developed on chalky limestone and/or marl (Collins et al. 1975). The Austin series is the deepest, the others reaching parent material at shallow depths. The Wilson, Crockett, and Burleson series consist of loams and clays underlain by alkaline clays and shales. The upper horizons of the Wilson and Crockett series are loamy, while that of the Burleson is dark clay (USDA 2007). An unexplained microtopographic phenomenon (mima mounds) is associated with this soil type; these are circular mounds several meters in diameter and up to one meter tall and support distinct zonal vegetation (Collins et al. 1975; Eidison and Smeins 1999).

*Vegetation*

Table 2.1 relates fine-scale, association-level plant communities to the nomenclature of both Collins et al. (1975) and Diamonds and Smeins (1993). Collins et al. (1975) recognized seven different grassland communities within the main belt of Texas blackland prairie. Diamond and Smeins (1993) listed six major types, including the Fayette and San Antonio belts: (1) the *Schizachyrium scoparium*-S*orghastrum nutans-Andropogon gerardii* type, found on Vertisols of the central and southern main belt and Fayette Prairie belt; (2) the *Schizachyrium scoparium-Sorghastrum nutans* type, found over Alfisols of the central and southern main belt and San Antonio belt; (3) the *Schizachyrium scoparium-Andropogon gerardii-Sorghastrum nutans* type, occurring over Mollisols of the Blackland Prairie region; (4) the *Schizachyrium scoparium-Paspalum plicatulum-Sorghastrum nutans* type, found over Alfisols of the Fayette Prairie; (5) the *Tripsacum dactyloides-Panicum virgatum-Sorghastrum nutans* type, found over Vertisols in

the northern main belt; and (6) the *Sporobolus silvaneus-Carex meadii* type, over Alfisols in the northern main belt. Table 2.6 lists characteristic species of these major types.

The *Schizachyrium scoparium-Sorghastrum-nutans* and *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardi* types dominate vegetation cover in the blacklands (Diamond & Smeins 1993). The unique *Sporobolus silvaneus-Carex meadii* type is restricted to the northeastern blackland region (Diamond and Smeins 1985). This community and type (4) are commonly associated with mima mounds (Collins et al. 1975; Diamond and Smeins 1985). Collins et al. (1975) documented a three-part zonation occurring on mima mounds: *Andropogon gerardii* dominated the upper third, followed by *Tridens strictus*, with the lower third of the mound relatively undifferentiated from other matrix species in the sampled area. Two association-level communities are especially common in areas with gilgae topography: the *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardii-Bifora americana* and *Tripsacum dactyloides-Panicum virgatum-Sorghastrum nutans-Helianthus maximiliani* associations (Eidison and Smeins 1999; NatureServe 2007).

A characteristic herbaceous assemblage occurs on thin soils and outcrops of Austin Chalk in northern Blackland Prairie. Common species include *Baptisia austalis, Callirhoe pedata, Eriogonum longifolium, Grindelia lanceolata, Ipomopsis rubra, Marshallia caespitosa, Oenothera macrocarpa, Paronychia jamesii,* and *Thelesperma filifolium* (Diggs et al. 2006).

Woodland and forest types were more common within the Texas Blacklands before European settlement. Important upland woodland species include *Carya texana, Juniperus virginiana, Quercus marilandica,* and *Q. stellata*. Important floodplain species include *Carya illinoensis, Celtis laevigata, C. reticulata, Ulmus americana, U. crassifolia, Salix nigra, Fraxinus* spp., *Platanus occidentalis, Quercus buckleyi, Q. macrocarpa, Q. muhlenbergii,* and *Q.*

*shumardii* (Diamond and Smeins 1993). A distinctive suite of woody species occurs on Austin Chalk escarpments; in Dallas County, dominant trees include *Fraxinus texensis, Quercus sinuata* var. *breviloba,* and *Ulmus crassifolia*. Dominant shrubs include *Symphoricarpos orbiculatus, Rhus americana,* and *Forestiera pubescens* (Kennemer 1987). Further south in the Balcones Scarp area, Gehlbach (1988) described five distinct woody plant vegetation types using DFA ordination: (1) climax successional floodplains & north-facing ravine slopes; (2) climax south-facing ravine slopes & scarpedges; (3) climax scarp slopes, (4) successional scarp slopes & scarp edges; and (5) climax motts (islands of evergreen woody plants bordered by grassland).

***Louisiana***

Louisiana has four types of isolated calcareous prairies: Jackson Prairies (north-central Louisiana), Fleming Prairies (western Louisiana), Cook Mountain (also known as Keiffer) Prairies (west-central Louisiana), and Morse Clay Prairies (northwestern Louisiana). Historical and current estimates of isolated Louisiana prairie habitats vary. Historical estimates range from 800-4,000 (Lester et al. 2005) up to 16,000-20,000 ha (MacRoberts and MacRoberts 1997). MacRoberts and MacRoberts (1997) plotted former distributions of prairie in northern and central Louisiana, concluding less than 1% remains. Higher estimates place remaining prairie habitat at 2-10% (Lester et al. 2005).

The Morse Clay Prairies have calcareous shrink-swell clayey soils but are restricted to terraces of the Red River. The underlying Pleistocene alluvium is considerably younger (ca. 115-130,000 ya) than geologic formations commonly associated with blackland prairies; they are therefore not included here (US Army Corps of Engineers 1992; NatureServe 2007; USDA 2007). The remaining prairie types are discussed below. The Jackson, Fleming, and Cook

Mountain Prairies share some geologic, pedologic, and vegetation characteristics of blackland prairies from surrounding states.

*Geology*

Within Louisiana, the Cook Mountain, Fleming, and Jackson Prairies are associated with the Cook Mountain formation, Fleming formation, and Jackson group, respectively (Lester et al. 2005). The Cook Mountain and Fleming formations also underlie portions of the Fayette and San Antonio blackland prairie belts of Texas (Diggs et al. 2006). The Jackson Group of Louisiana is also associated with the Jackson Prairie belt in Mississippi (Moran 1995).

*Soils*

Louisiana calcareous prairies are associated with several soil series common to blackland prairies of other states, as well as more unique soil types. The Houston Black and Ferris series are associated with the Fleming Prairies (Collins et al. 1975; NatureServe 2007). The Tahoula series, including deep calcareous clays over weathered shale, clay or mudstone, also underlies some Fleming prairie examples (USDA 2007; NatureServe 2007). The Keiffer Series, typically comprising deep calcareous clay loams, is associated with the Cook Mountain prairies (MacRoberts and MacRoberts 1995; USDA 2007). The Oktibbeha and Hollywood Series underlie calcareous forest associated with the Cook Mountain Prairies (NatureServe 2007). The Hollywood Series typically consists of clay loams often found in upland depressions and other habitats where water drains slowly (USDA 2007).

*Vegetation*

Vegetation types associated with isolated Louisiana prairies include one prairie, one woodland, and one forest type associated with the Cook Mountain Formation; one prairie and three forest types associated with the Jackson Formation; and one prairie type associated with the

Fleming Formation (NatureServe 2007; Table 2.1). One shrub thicket type is associated with the Cook Mountain and Fleming Formations. Floristic inventories of four isolated prairies in central Louisiana included characteristic grasses such as *Andropogon gerardii, Panicum virgatum, Schizachyrium scoparium*, and *Sorghastrum nutans*. Ninety-eight percent of the species reported from these four prairies were native. Species richness in central Louisiana prairies is high, averaging ca. 100 species/ha (MacRoberts et al. 2003).

***Georgia***

Georgia blackland prairies are currently restricted to Houston, Bleckley, and Peach Counties in central Georgia (Klaus and Patrick 2002). Georgia blackland prairies are geographically unique: they are located within the Southern Atlantic Coastal Plain ecoregion, whereas all other blackland prairies are restricted to the Gulf Coastal Plain (data provided by G. Krakow, Georgia Natural Heritage Program; Peacock and Schauwecker 2003). There are no historical occurrence estimates for blackland prairies in the state. Less than 60 hectares of prairie and associated blackland vegetation are known (J. Payne, pers. comm.; data provided by N. Klaus, Georgia Natural Heritage Program). Approximately 50 ha are found within the Oaky Woods Wildlife Management Area (WMA) and Ocmulgee WMA in Houston County, adjacent to the Ocmulgee River.

*Geology*

Like the Jackson Prairies of Mississippi and Louisiana, Georgia blackland prairies are associated with Eocene deposits (Moran 1995; NatureServe 2007). Geologic formations include the Dry Branch, Ocmulgee and Tivola formations, consisting of calcareous clay and limestone deposits of the Upper Eocene. The Twiggs Clay member of the Dry Branch formation is silty calcareous clay that has been mined in central Georgia for its various industrial applications for

over 100 years. The Tivola and Ocmulgee limestone formations comprise textured, indurated or argillaceous limestone; both formations fall within the Ocala Group (Huddlestun and Hetrick 1986; Eversull 2005).

*Soils*

Georgia blackland prairies are predominantly underlain by the Sumter series, a common soil of Arkansas, Mississippi, and Alabama prairies (Woods 1967; USDA 2007). The more acidic Oktibbeha, Boswell, and Susquehanna soil series are also present to a lesser extent, associated with surrounding forest vegetation.

*Vegetation*

Three forest, two woodland, two shrubland, and five prairie types are associated with Georgia blackland prairies (Table 2.1). Two prairie types, one dominated by *Muhlenbergia capillaris* and the other by *Sporobolus clandestinus*, are considered small patch inclusions within a matrix of other prairie and calcareous woodland types. *Sorghastrum nutans* is the most common perennial grass; *Andropogon gerardii* attains codominance with this species on one recently burned prairie. Other common and characteristic species of herbaceous prairie vegetation include *Agalinis tenuifolia*, *Andropogon virginicus*, *Aristida purpurescens, Carex cherokeensis*, *Erigeron strigosus*, *Houstonia nigricans*, *Polygala boykinii*, *Ratibida pinnata*, *Rudbeckia hirta*, *Salvia lyrata*, *Solidago nemoralis*, and *Sporobolus vaginiflorus*. Characteristic woody species include *Berchemia scandens, Celtis tenuifolia, Cercis canadensis, Crataegus aprica, C. crus-galli, C. spathulata*, *Diospyros virginiana, Fraxinus americana, Pinus taeda, Quercus muehlenbergii, Rhus copallinum* var. *latifolia,*, *Ulmus alata,* and *Viburnum rufidulum* (Table 2.7). Georgia's blackland prairies also contain four species found nowhere else in the state: *Cyperus acuminatus*, *Draba cuneifolia*, *Galium virgatum*, and *Scutellaria drummondii*.

### *Comparison of Findings Across Six States*

#### *Geology Comparison*

Although a diversity of groups and formations underlie blackland prairies, their overall character is similar: chalks, marls and calcareous clays of marine origin predominate. Shale, sandstone, and mudstone substrates are less common. All geologic units are of Upper Cretaceous or Lower Tertiary origin. Texas has the greatest geologic diversity associated with blackland prairies, while Georgia and Louisiana are restricted to just a few geologic formations. Texas and Arkansas blackland systems share the Midway, Taylor, and Navarro geologic groups.

The outer Fayette and San Antonio blackland prairie belts of Texas and the isolated prairies of Louisiana are underlain by the Fleming and Cook Mountain Formations. Louisiana Jackson Prairies share the Jackson Group with the Jackson Belt of Mississippi. The Black Belt of Mississippi and Alabama forms a relatively contiguous geologic unit, primarily underlain by the Demopolis and Mooreville Formations of the Selma Chalk Group. The unique Georgia blackland prairies are predominantly underlain by the Dry Branch Formation and members of the Ocala Group.

#### *Soil Comparison*

Alkaline clays with high shrink-swell potential within the Vertisol soil order dominate blackland prairies across their range. Texas blackland prairies are also underlain by Mollisols (dark surface color, high organic matter content, alkaline) and Alfisols (light surface color, lower organic matter content, less alkaline, coarser surface texture; Hallmark 1993). The gilgae topography associated with Texas blackland prairie Vertisols is not reported in other states; this phenomenon should be evident in other soil series with high shrink-swell potential. This is probably a result of habitat loss and degradation across the range of the ecosystem.

Blackland prairies share numerous soil series. The Sumter Series is a dominant soil underlying herbaceous prairie vegetation in Alabama, Arkansas, Georgia and Mississippi. Alabama, Arkansas, and Mississippi also share the alkaline Houston series, as well as the more acidic Oktibbeha and Kipling series. The Oktibbeha series is also found associated with Louisiana and Georgia wooded vegetation associated with prairies. Texas and Louisiana prairies share several series, including Houston Black and Ferris.

*Vegetation comparison*

The two most commonly reported species across the entire range of blackland prairies are *Schizachyrium scoparium* and *Sorghastrum nutans*. These common species are frequently dominant or at least a component of herbaceous prairie associations. Foti (1989) and Liedolf and McDaniel (1998) note similarities in species composition among Arkansas, Mississippi, and Alabama such as *Berchemia scandens, Carex cherokeensis, Dalea candida, D. purpurea*, *Desmanthus illinoensis*, *Juniperus virginiana*, and *Houstonia* spp. Georgia shares many of these species, especially those of Alabama. Common elements include *Erigeron strigosus, Houstonia nigricans, Ratibida pinnata*, *Silphium asteriscus, Solidago nemoralis*, *Sporobolus vaginiflorus*, and *Polygala boykinii*. Noticeably absent in Georgia blackland prairies are *Dalea* spp. and the *Schizachyrium scoparium*-dominated herbaceous vegetation types known from Alabama, Arkansas, and Mississippi blackland prairies. *Sporobolus clandestinus* is a conspicuous component of Georgia blackland prairies not reported for other states. This indicates that Georgia blackland prairies are currently floristically unique. Prairies lost to agriculture, mining, and urban expansion may have contained common characteristic dominants of other states, however, and the few remnants may not adequately represent the full variation once present.

The Texas Blackland region historically consisted of much greater expanses of unbroken prairie when compared to other states (Diggs et al. 2006). Ecologists have considered Texas blackland prairie as a southern extension of the "True Prairie" stretching northward to Manitoba (Launchbaugh 1955; Collins et al. 1975; Diamond and Smeins 1993; Diggs et al. 2006). It could also be considered as contiguous with Coastal Prairie within Texas (Collins et al. 1975). The Texas blacklands share many dominants with both areas, and rainfall levels are intermediate (Diggs et al. 2006). Louisiana prairies share vegetation characteristics with both Texas and Mississippi. The Jackson Prairie openings of Louisiana are closely related to those occurring in Mississippi's Jackson Prairie Belt. Similarly, the Fleming Prairies of Louisiana are related to isolated prairie openings of eastern Texas (NatureServe 2007). Similarities in soils, geology, and vegetation indicate the outer blackland prairie belts and isolated prairies of eastern Texas and isolated prairies of Northern Louisiana probably once represented a continuum of variation.

*Cluster Analysis Results*

A total of 491 species were used in the cluster analysis (Fig. 2.2). Georgia clusters with Alabama, and Louisiana and Texas form a cluster; thus, distance between sites appears to play a significant role in dendrogram structure. Mississippi forms a cluster with Arkansas, consistent with the results of Barone (2005b) and observations of Foti (1989). These results support observations of floristic similarities between Georgia and Alabama prairies, as well as geologic and pedologic similarities between Texas and Louisiana prairies. However, due to the use presence/absence data, small number of studies analyzed, and small sample sizes, the results may be somewhat inconclusive. Additionally, isolated Texas and Louisiana prairies were used in the analysis; floristic data from the main belt of Texas blacklands would potentially yield a different dendrogram. Barone's (2005b) cluster analysis and this study place Mississippi and Alabama

Blackbelt vegetation in distant clusters, despite proximity and similarities in geology, soils, and documented prairie types. This may indicate a distinct range of variation in species composition not previously recognized within the Blackbelt prairies.

**Conclusion**

The variation in geology, soils, and vegetation across the six states covered in this chapter requires explicit clarification for classification and conservation purposes. Close attention to differences in underlying geologic formations, vascular plant associations, and soil series is necessary to properly assess this variation. The diversity of vegetation types (ca. 67 associations), many of which are imperiled or critically imperiled, suggests that blackland prairies differ markedly across their range. There is a critical need to conduct quantitative vegetation sampling and classification of blackland prairie remnants and associated vegetation types (Peacock and Schauwecker 2003). This information would help to further assess the blackland prairies in each state and to properly allocate scant resources for preservation and restoration efforts. It is not only the prairies, but the unique mosaic of associated vegetation that makes the diversity of blackland prairie landscapes exceptional. Further documentation of remaining forest, woodland, shrubland, and savanna vegetation types associated with blackland prairies is of special concern. These communities are unique, as are the prairies themselves, harboring rare and/or disjunct taxa.

## Literature Cited

Alabama Natural Heritage Program. 2007. Alabama blackbelt prairie element occurrence records. Alabama Natural Heritage Program, Montgomery, Alabama.

Anderson, R. C. 1990. The historic role of fire in the North American grasslands. In: S.L. Collins and L. L. Wallace, eds. Fire in North American tallgrass prairies. University of Oklahoma Press, Norman.

Barone, J. A. 2005a. The historical distribution of prairies in the Jackson Prairie Belt and in western Mississippi. J. Mississippi Acad. of Sci. 50: 144-148.

Barone, J. A. 2005b. Historical presence and distribution of prairies in the black belt of Mississippi and Alabama. Castanea 70: 170-183.

Brown, L. E., K. H. Hillhouse, B. R. MacRoberts, and M.H. MacRoberts. 2002. The vascular flora of Windham Prairie, Polk County, Texas. Texas J. Sci. 54: 227-240.

Collins, O. B., F. E. Smeins, and D. H. Riskind. 1975. Plant communities of the blackland prairie of Texas. p. 75-88. In: M. K. Wali, ed. Prairie: a multiple view. University of North Dakota Press, Grand Forks, North Dakota.

Cooke, C. W. 1939. Equivalence of the Gosport Sand to the Moodys Marl. J. Paleont. 13: 337-340.

Diamond, D. D. and F. E. Smeins. 1985. Composition, classification, and species response pattens of remnant tallgrass prairie in Texas. Amer. Midl. Naturalist 113: 294-309.

Diamond, D. D. and F. E. Smeins. 1993. The native plant communities of the blackland prairie. p. 66-81. *In*: M. R. Sharpless and J. C. Yelderman, eds. The Texas blackland prairie, land, history, and culture. Baylor University Program for Regional Studies, Waco, Texas.

Diggs, G. M. and P. C. Schultze. 2003. Soil-dependant fire frequency: a new hypothesis for the distribution of prairies and woodlands in north central and east Texas. Sida 20: 1139-1153.

Diggs, G. M., B. L. Lipscomb, M. D. Reed, and R. J. O'Kenan. 2006. Illustrated flora of east Texas, Vol. 1. Botanical Research Institute of Texas and Austin College, Austin, Texas.

Eidison, J. and F. E. Smeins. 1999. Texas blackland prairies. p. 304-307. *In*: Terrestrial ecoregions of North America: a conservation assessment. Island Press, Washington, D.C.

Eversull, L. G. 2005. The twiggs clay: mineralogy, origin, and industrial properties of an Upper Eocene opaline claystone in the Coastal Plain Province of Georgia, U.S. Ph.D. Dissertation. Louisiana State University, Baton Rouge, Louisiana.

Foti, T. 1989. Blackland prairies of southwestern Arkansas. Proc. Arkansas Acad. Sci. 43: 23-28.

Foti, T. 1990. The vegetation of Saratoga Landing blackland prairie. Proc. Arkansas Acad. Sci. 44: 40-43.

Foti, T., S. Simon, D. Zollner, and M. Hattenbach. 2003. Blackland prairie landscapes of southwestern Arkansas. p. 94-109. *In:* Peacock, E. and T. Schauwecker (eds.). Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. The University of Alabama Press, Tuscaloosa, Alabama.

Frost, C. C., J. Walker, and R. K. Peet. 1986. Fire-dependent savannas and prairies of the southeast: original extent, preservation status and management problems. p. 348-357. *In*: Kulhavey, D. L and R. N. Conner (eds.). Wilderness and natural areas in the eastern United States: a management challenge. Stephen F. Austin State University, Center for Applied Studies, School of Forestry, Nacogdoches, Texas.

Gehlbach, F. R. 1988. Forests and woodlands of the northeastern Balcones escarpment. p. 57-77. *In*: B.B. Amos and F.R. Gehlbach, eds. Edwards Plateau vegetation: plant ecological studies in central Texas. Baylor University Press, Waco, Texas.

Gibson, J. S. 1941. The Alabama Black Belt: its geographic status. Econ. Geogr. 17: 1-23.

Hajeck, B. F. and J. Dane. 2007. Alabama and Mississippi blackland prairie. (http://soilphysics.okstate.edu/S257/book/mlra135/index.html. Cited 20 June 2007).

Hallmark, C. T. 1993. The nature and origin of the blackland soils. p. 41-46. *In*: M. R. Sharpless and J. C. Yelderman, eds. The Texas blackland prairie, land, history, and culture. Baylor University Program for Regional Studies, Waco, Texas.

Hill, R. T. 1901. Geography and geology of the black and grand prairies, Texas. Twenty-first Annual Report of the U.S. Geological Survey, Part VII-Texas. U.S. Government Printing Office, Washington, D.C.

Huddlestun, P. F. and J. H. Hetrick. 1986. Upper Eocene stratigraphy of central and eastern Georgia. Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, Atlanta, Georgia.

Integrated Taxonomic Information System. 2007. Integrated Taxonomic Information System (ITIS) on-line database. (http://www.itis.com. Cited June 20, 2007).

Kennemer, G. W. 1987. A quantitative analysis of the vegetation on the Dallas County White Rock Escarpment. Sida, Bot. Misc. 1:1-10.

Klaus, N. and T. Patrick. 2002. Draft management plan for the blackland prairies, Oaky Woods and Ocmulgee Wildlife Management Areas. Georgia Department of Natural Resources, Nongame Wildlife and Natural Heritage Section, Social Circle, Georgia.

Jones, A. S. and E.G. Patton. 1966. Forest, “prairie,” and soils in the black belt of Sumter County, Alabama, in 1832. Ecology 47: 75-80

Launchbaugh, J. L. 1955. Vegetational changes in the San Antonio prairies associated with grazing, retirement from grazing, and abandonment from cultivation. Ecol. Monogr. 25: 39-57.

Lester, G. D., S. G. Sorenson, P. L. Faulkner, C. S. Reid, and I. E. Maxit. 2005. Louisiana comprehensive wildlife conservation strategy. Louisiana Department of Wildlife and Fisheries. Baton Rouge, LA.

Liedolf, A. and S. McDaniel. 1998. A floristic study of black prairie plant communities at Sixteen Section Prairie, Oktibbeha County, Mississippi. Castanea 63: 51-62.

MacRoberts, B. R. and M. E. MacRoberts. 1995. Vascular flora of two calcareous prairie remnants on the Kisatchie National Forest, Lousiana. Phytologia 78: 18-27.

MacRoberts, B. R. and M. E. MacRoberts. 1996. The floristics of calcareous prairies on the Kisatchie National Forest, Louisiana. Phytologia 81: 35-43.

MacRoberts, B. R. and M. E. MacRoberts. 1997. Former distribution of prairies in northern Louisiana. Phytologia 82:316-325.

MacRoberts, M. H. and B. R. MacRoberts. 2002. West Gulf Coastal Plain prairies: A first approximation at a synthesis. *In*: Randall, J. and J.C. Burns (eds.). Proceedings of the third eastern native grass symposium. Omnipress, Madison, Wisconsin.

MacRoberts, M. H., B. R. MacRoberts, and L. S. Jackson. 2003. Louisiana prairies. p. 80-93. *In:* Peacock, E. and T. Schauwecker (eds.). Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. The University of Alabama Press, Tuscaloosa, Alabama.

McCune, B. and M. J. Mefford. 1996. PC-ORD: Multivariate analysis of ecological data, version 5. MjM Software Design, Gleneden Beach, Oregon.

Mississippi Natural Heritage Program. 2007. Mississippi blackland prairie element occurrence records. Mississippi Department of Wildlife, Fisheries, and Parks, Mississippi Museum of Natural History, Mississippi Natural Heritage Program, Jackson, Mississippi.

Moran, L. P. 1995. Soil and ecology remnants in the Jackson Prairie region of Mississippi. M.S. thesis. Mississippi State University, Starkville, Mississippi.

Moran, L. P., D. E. Pettry, R. E. Switzer, S. T. McDaniel, and R. G. Wieland. 1997. Soils on native prairie remnants in the Jackson Prairie Region of Mississippi. Mississippi State University, Mississippi Agricultural and Forestry Experiment Station, Jackson, Mississippi.

Moran, L. P., D. E. Pettry, and R. E. Switzer. 2003. Plant and soil interactions in prairie remnants of the Jackson Prairie Region, Mississippi. p.146-163. *In:* Peacock, E. and T. Schauwecker (eds.). Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. The University of Alabama Press, Tuscaloosa, Alabama

Morris, M. W., C. T. Bryson, and R. C. Warren. 1993. Rare vascular plants and associate plant communities from the Sand Creek Chalk Bluffs, Oktibbeha County, Mississippi. Castanea 58: 250-259.

NatureServe. 2007. An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, VA. (http://www.NatureServe.org/. Cited 20 June 2007.)

Noss, R. F., A. Cooperrider, and R. S. Schlickeisen. 1994. Saving nature's legacy: protecting and restoring biodiversity. Island Press, Washington, D.C.

Peacock, E. and T. Schauwecker. 2003. Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. University of Alabama Press, Tuscaloosa, Alabama.

Rankin, H. T. and D. E. Davis. 1971. Woody vegetation in the black belt prairie of Montgomery County, Alabama, 1845-46. Ecology 52: 716-719.

Rostlund, E. 1957. The myth of a natural prairie belt in Alabama: an interpretation of historical records. Annals Assoc. Amer. Geogr. 47:392-411.

Schauwecker, T. J. 1996. A comparison of blackland prairie relicts in Arkansas and Mississippi. M.S. thesis. Mississippi State University, Starkville, Mississippi.

Schuster, M. F. and Sidney McDaniel. 1973. A vegetative analysis of a black prairie relict site near Aliceville, Alabama. J. Mississippi Acad. Sci. 173: 153-50.

US Army Corps of Engineers. 1992. Geomorphic investigations: geomorphic chronology. (http://www.clidata.org/Reports/DaingerfieldReach/Geomorphic/part3.pdf. Cited 20 June 2007).

USDA. 2007. Official soil series descriptions. (http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi. Cited 18 May 2007.).

Wieland, R. G. 2000. Ecology and vegetation of LeFleur's Bluff State Park, Jackson, Mississippi. J. Mississippi Acad. Sci. 45: 150-184.

Woods, J. C. 1967. Soil survey of Houston and Peach Counties, Georgia. United States Department of Agriculture, Soil Conservation Service, Washington, D.C.

Zollner, D., S. Simon, and T. Foti. 2003 A plant community classification for Arkansas's blackland prairie ecosystem. p. 110-145. *In*: Peacock, E. and T. Schauwecker (eds.). Blackland prairies of the Gulf Coastal Plain: nature, culture and sustainability. The University of Alabama Press, Tuscaloosa, Alabama.

Table 2.1. Association-level plant communities documented within blackland prairie regions. IVC = International Vegetation Classification; MS NHP = Mississippi Natural Heritage Program; ? = additional information needed. Vegetation types: CO = chalk outcrop, F = forest, P = prairie, SA = savanna, SL = shrubland, W = woodland. Global Rank definitions: G1 = critically imperiled, 5 or fewer occurrences, G2 = imperiled, 6-20 occurrences, G3 = rare or local throughout range, in special habitat, or narrowly endemic, 21-100 occurrences, G4 = apparently secure, G5 = demonstrably secure, T = taxonomic subdivision used in global rank. Data from: J. Allison (pers. comm.); Collins et al. (1975), Diamond and Smeins (1993); Liedolf and McDaniel (1998), Wieland (2000), Zollner et al. (2003), Alabama Natural Heritage Program (2007), Mississippi Natural Heritage Program (2007), and NatureServe (2007).

| State(s) | Vege-tation Type | Common Name | IVC Association Name | Other Designation(s) | Global Rank | Comments |
|---|---|---|---|---|---|---|
| AL | P | Chalk Prairie | ? | *Juniperus virginiana-Schizachyrium scoparium-Sorghastrum nutans-Dalea candida* | G2 | Community may be closely related or potentially analagous to Black Belt Prairie |
| AL, MS | P | Blackbelt Prairie | *Schizachyrium scoparium-Sorghastrum nutans-Dalea candida-Liatris squarrosa-*(*Silphium terebinthinaceum*) Black Belt Herbaceous Vegetation | open prairie | G1 | Over Sumter and Binnsville Soils in the Black Belt of Alabama and Mississippi; remnants known from McNairy County, southern Tennessee |

| | | | | | | |
|---|---|---|---|---|---|---|
| AL, MS | P | Mississippi Jackson Calcareous Clay Prairie | *Schizachyrium scoparium-Sorghastrum nutans-Dalea purpurea-Silphium integrifolium* Jackson Prairie Herbaceous Vegetation | Jackson Prairie | G1 | Mostly associated with Maytag soils; calcareous clay islands of the Jackson Prairie region in Mississippi; also Washington, Choctaw, and Clarke Counties of Alabama |
| AL, MS | W | Blackbelt Prairie Cedar Woodland | *Juniperus virginiana* var. *virginiana*-(*Celtis laevigata*, *Prunus angustifolia*, *Sideroxylon lycioides*) Woodland | Prairie Cedar Woodland | G1 | Thin soils over chalk in Black Belt region of Mississippi and Alabama; develops after long periods of fire exclusion |
| AL, MS | W | Blackbelt Post Oak Woodland | *Quercus stellata-Quercus muehlenbergii*/*Schizachyrium scoparium*-*Sorghastrum nutans* Woodland | | G2G3 | Canopy opens with more frequent burning; *Quercus marilandica* also a canopy dominant |
| AL, MS | F | Upper East Gulf Calcareous Bluff Forest | *Acer barbatum-Aesculus glabra-Carya myristiciformis-Quercus shumardii-Quercus muehlenbergii* Forest | Mesic Calcareous Bluff | G1G2 | Sumter soils in the Pontohoc Ridge-Blackbelt Prairie transition zone of Oktibbeha Counry in NE Mississippi |
| AR | P | Upper West Gulf Coastal Plain Dry Calcareous (Blackland) Prairie | *Schizachyrium scoparium-Sporobolus compositus-Fimbristylis puberula* var. *puberula* Herbaceous Vegetation | | G2 | Dry ridges and chalk outcrops over Sumter and Demopolis soils |
| AR | P | none | *Sorghastrum nutans-Schizachyrium scoparium-Echinacea pallida-Dalea purpurea* var. *purpurea* Dry-mesic Blackland Prairie Herbaceous Vegetation | | G2G3 | Upper and middle slopes, and ridgetops over Sumter and Demopolis clay; matrix type community for AR, responds to Sweetclover and Red Cedar removal |
| AR | P | none | *Sorghastrum nutans-Andropogon glomeratus-Lythrum alatum-Aster prealtus-Tripsacum dactyloides* Mesic Blackland Prairie Herbaceous Vegetation | | G1? | Along lower slopes, flat tabletops, areas of high soil moisture; Houston and Sumter soils |
| AR | P | none | *Lythrum alatum-Panicum anceps-Aster lanceolatus* West-mesic Blackland Prairie Temporarily Flooded Herbaceous Vegetation | | G1? | Shallow draws, depressions, and level areas soils occasionally to seasonally saturated; Houston Clay and Terouge silty clay soils; speculative concept community based on degraded sites |

| | | | | | |
|---|---|---|---|---|---|
| AR | W | Upper West Gulf Dry Chalk Savanna | *Quercus muehlenbergii-Quercus sinuata/Rhus aromatica/Liatris aspera-Allium canadense* var. *mobilense-Schizachyrium scoparium* Woodland | G2 | Ridgetops and knobs; shallow, Demopolis silty clays; chalk outcrops frequent; community has responded dramatically after cedar removal and fire restoration |
| AR | W | Upper West Gulf Coastal Plain Dry Calcareous Woodland | *Quercus sinuata/Solidago auriculata-Zigadenus nuttallii* Mixed Herb Dry-mesic Blackland Ravine Woodland | G1 | Slopes and ravines adjacent to blackland prairie |
| AR | SA | none | *Quercus muehlenbergii/ Andropogon gerardii-Dalea compacta-Seymeria cassioides* Dry-mesic Chalk Savanna | G1? | Flattened ridges; shallow, eroded, well-drained, low-permeability, low-water-holding capacity, Demopolis chalk |
| AR | SA | Upper West Gulf Coastal Plain Mesic Blackland Savanna | *Quercus falcata-Carya illinoinensis/Silphium integrifolium-Panicum anceps-*(*Carex cherokeensis*) Mesic Wooded Herbaceous Vegetation | G1 | Deep, moist, uneroded, Houston clay soils, nearly level or gentle terrain; based on degraded examples |
| AR | W | none | *Quercus shumardii-Carya myristiciformis-*(*Quercus muehlenbergii)/Cercis canadensis/Carex cherokeensis-Scleria oligantha-Sorghastrum nutans* Dry-mesic Calcareous Woodland | G1G2 | Deep, moist soil, nearly level terrain, topographically protected areas; Sumter soils |
| AR | W | none | *Quercus pagoda-*(*Carya illinoensis*)/*Ilex decidua/Carex cherokeensis-Leersia virginica* Mesic Blackland Woodland | ? | Rich, mesic sites bordering ephemeral streams and flats, mildy acidic Kipling soils; very rare |

| | | | | | |
|---|---|---|---|---|---|
| AR | W | none | *Quercus stellata*/*Vaccinium arboreum*/ *Chasmanthium sessiliflorum-Danthonia spicata-Schizachyrium scoparium* Dry Blackland Woodland | G2? | Dry upland situations, Oktibbeha soils in small patches or linear transitions |
| AR | W | none | *Quercus falcata -Quercus stellata*-(*Pinus echinata-Pinus taeda*) *Chasmanthium sessiliflorum-Danthonia spicata* Dry-mesic Woodland | G2? | Higher topographic locations; mixed calcareous blackland and acidic soils (commonly found on Oktibbeha soils) |
| AR | W | none | *Ulmus americana-Fraxinus pennsylvanica-Carya illinoensis*/*Glyceria striata-Elymus canadensis*-(*Carex cherokeensis)* Mesic Riparian Blackland Woodland | G2? | Deep, poorly drained, silty clays of the Terouge and Tuscambia series, sloping hillsides; high water tables influence herbaceous community |
| AR | W | none | *Maclura pomifera-Diospyros virginiana*/*Glyceria striata*-(*Carex cherokeensis*) Mesic Riparian Woodland | G2? | Deep soils on level terrain, typically lining ephemeral streams; community may be an artifact of Native Americans widespread planting of *M. pomifera* |
| AR | F | none | *Quercus alba-Quercus falcata* var. *falcata-Quercus stellata-Nyssa sylvatica*-(*Pinus echinata-Pinus taeda*)/*Chasmanthium sessiliflorum* Dry-mesic Forest | G3G4 | Level terrain in higher topographic positions; Oktibbeha, Sacul, and Kirvin soils |
| AR | F | none | *Quercus muehlenbergii-Liquidambar styraciflua*/(*Arundinaria gigantea*)/*Carex cherokeensis-Chasmanthium latifolium* Mesic Riparian Forest | G3? | Deep, recently deposited blackland alluvium or calcareous sands in relatively level, wide bottoms along ephemeral streams |

| | | | | | | |
|---|---|---|---|---|---|---|
| AR | F | none | *Liquidambar styraciflua-Platanus occidentalis*/A*cer negundo*/*Saururus cernuus-Senecio glabellus-Carex tribuloides* Wet-mesic Ravine Forest | | G3? | Flat, lower ravines and bases of slopes on rich, calcareous, and usually nearly saturated and seepy soils. |
| AR | F | none | *Quercus alba-Quercus rubra-Fraxinus americana*/*Ostrya virginiana*/ *Arundinaria gigantea*/*Cynoglossum virginianum-Arisaema dracontium-Cypripedium kentuckiense* Mesic Calcareous Forest | | G2G3 | Rich, mildly calcareous, mesic slopes and ravines |
| GA | P | None | none | *Houstonia nigricans-Sporobolus vaginiflorus* community type | ? | Sparsely vegetated shoulder slopes; anthropogenic disturbance may play a role in its occurrence |
| GA | P | None | none | *Sporobolus clandestinus-Aristida purpurascens* community type | ? | Sumter soils as small patch inclusions within calcareous woodland, level to gently sloping shoulder slopes; grassland of short stature |
| GA | P | none | none | *Muhlenbergia capillaris* community type | ? | Sumter soils as small patch inclusions within other open prairie types, gently sloping shoulder and back slopes; strongly dominated by *M. capillaris* |
| GA | P | none | none | *Sorghastrum nutans-Ratibida pinnata-Houstonia nigricans* community type | ? | Sumter soils on shoulder and back slopes |
| GA | P | none | none | *Andropogon gerardii-Sorghastrum nutans* community type | ? | Deep soil profiles on shoulder slopes; represents burned phase of the above described association |
| GA | SL | none | none | *Crataegus spathulata-Cercis canadensis-Celtis tenuifolia* community type | ? | Dense thickets in narrow, linear, transition zones bordering open prairie communities; species composition of this community is highly variable |

| | | | | | | |
|---|---|---|---|---|---|---|
| GA | SL | none | none | *Fraxinus americana-Quercus muehlenbergii/Crataegus* sp.-*Cercis canadensis* community type | ? | Sumter soils on gentle shoulder slopes; an undescribed *Crataegus* species, possibly of hybrid origin, dominates the shrub layer; *Melilotus alba* has infested this community after fire reintroduction |
| GA | W | none | none | *Juniperus virginiana/ Fraxinus americana/ Ratibida pinnataAgalinis tenuifolia* community type | ? | Along ridgelines on thin soils over chalk |
| GA | W | none | none | *Quercus muehlenbergii/ Cercis canadensis-Quercus sinuata/ Viburnum rufidulum/ Scleria oligantha* community type | ? | Sumter soils on gentle shoulder slopes |
| GA | F | none | none | *Pinus taeda-Quercus velutina-Quercus coccinea/Acer floridanum-Quercus muehlenbergii/Cercis candensis-Ptelea trifoliata* community type | ? | Sandy clay loams on moderate slopes; *Pueraria lobata* threatens this community |
| GA | F | none | none | *Quercus shumardii-Quercus nigra-Ulmus rubra/Acer floridanum-Fraxinus america/ Ulmus alata-Asimina triloba/Vitis rotundifolia* community type | ? | Very deep soils resembling Houston Black series on mesic lower and toe slopes |
| GA | F | none | none | *Quercus nigra-Quercus pagoda/Acer floridanum/Cercis canadensis* community type | ? | Sandy loams adjacent to blackland prairies along ephemeral stream bottoms; *Acer floridanum* is a characteristic dominant in the shrub layer |

| | | | | | | |
|---|---|---|---|---|---|---|
| LA | P | Jackson Calcareous Prairie (Louisiana) | *Schizachyrium scoparium-Sorghastrum nutans* Jackson Prairie Herbaceous Vegetation | | G1 | Ridgetops and upper slopes; restricted to north-central Louisiana over the Jackson Formation; closely related to Mississippi Jackson Calcareous Clay Prairie |
| LA | P | Cook Mountain Prairie | *Schizachyrium scoparium-Panicum flexile-Carex microdonta* Herbaceous Vegetation | Keiffer Prairie | G1 | Silty loams, clays, and silt loams, ridgetops, and gentle slopes; west-central Louisiana over the Cook Mountain Formation |
| LA | F | Keiffer Prairie Margin Oak-Ash-Hickory Forest | *Quercus shumardii-Fraxinus americana-Carya myristiciformis*/*Viburnum dentatum*/*Carex cherokeensis* Forest | | G1 | Keiffer (Cook Mountain) prairie openings on low ridges and side slopes, Hollywood and Oktibbeha soils |
| LA | F | West Gulf Coastal plain Calcareous Clay Small Stream Bottomland Forest | *Quercus pagoda-Quercus similis-Carya glabra-Quercus sinuata* var. *sinuata*/*Crataegus triflora* Forest | | G1 | Calcareous clay on fire-protected, small stream floodplains, Jackson Formation |
| LA | F | West Gulf Coastal Plain Calcareous Small Stream Bottomland Forest | *Celtis laevigata-Gleditsia triacanthos-Sapindus saponaria* var. *drummondii*/ *Lithospermum tuberosum*/ *Carex willdenowii* Forest | | G1 | Loamy, calcareous substrates along small, infrequently flooded streams, Jackson Formation |
| LA, MS | F | Jackson Formation Calcareous Forest | *Quercus shumardii-Quercus pagoda-Fraxinus americana*/*Ostrya virginiana-Cornus ludovicianum* Forest | | G1 | Fire-protected mesic sites, Jackson Formation in north-central Louisiana and central Mississippi |
| LA, TX | P | West Gulf Coastal Plain Fleming Calcareous Prairie | *Schizachyrium scoparium-Rudbeckia missouriensis-Grindelia lanceolata-*(*Liatris mucronata*) Herbaceous Vegetation | | G1 | Uplands over Ferris and Houston Black Soils; western Louisiana, Fleming Formation; originally described from Polk County, TX; includes isolated Fleming prairies of eastern TX |

| | | | | | | |
|---|---|---|---|---|---|---|
| LA, TX | SL | West Gulf Coastal Plain Prairie Shrub Thicket | *Crataegus spathulata-Cornus drummondii-Berchemia scandens* Shrubland | | G2 | Ridgetops and gentle slopes over the Cook Mountain Formation of Louisiana and Fleming Formation of Texas; community results in part from fire suppression of calcareous prairies |
| LA, TX | W | West Gulf Coastal Plain Calcareous Pine-Oak Woodland | *Pinus echinata-Pinus taeda-Quercus stellata/Juniperus virginiana var. virginiana/Cornus drummondii* Woodland | | G1G2? | Hill tops and upper slopes associated with prairie openings in north-central Louisiana and Eastern Texas, Cook Mountain and Fleming Formations |
| MS | CO | Blackbelt Prairie (Chalk Bluffs) | ? | Little Bluestem - Yellow Indiangrass-Goldenrod-Rosinweed-Prairie Coneflower; Chalk Outcrops; Chalk Outcrops and Barrens | | Within Blackbelt Prairie region; Additional information needed to clarify relationships between MS NHP records and chalk communities described by Morris et al. (1993) and Liedolf and McDaniel (1998) |
| MS | CO | Cedar Glades/ Barrens (Chalk Bluffs) | ? | Eastern Redcedar-Switchgrass-Yellow Indiangrass; Chalk Outcrops; Chalk Outcrops and Barrens | | Within Blackbelt Prairie region; Additional information needed to clarify relationships between MS NHP records and chalk communities described by Morris et al. (1993) and Liedolf and McDaniel (1998) |
| MS | F | Dry-Upper Slope Pine-Oak Forest | ? | Shortleaf/ Loblolly Pine-other Oaks and Hickories-mixed arborescent | ? | Within Jackson Prairie region; included based on MS NHP Element Occurrence Records |
| MS | F | Dry-Upper Slope Oak Forest | ? | Post Oak-Southern Red/Blackjack/ White Oak-Sand/ Mockernut Hickory-Sweetgum | ? | Within Blackbelt Prairie region; included based on MS NHP Element Occurrence Records |

| | | | | | | |
|---|---|---|---|---|---|---|
| MS | F | Dry-Mesic Mixed Pine-Oak Forest | ? | Loblolly Shortleaf Pine-White/ Southern Red/Water/ Cherrybark Oak-Sweetgum | ? | Within Jackson Prairie region; included based on MS NHP Element Occurrence Records |
| MS | F | Lower Slope Mixed Hardwood-Pine Forest | ? | White/Swamp/ Chestnut Oak/Water Oak-mixed deciduous/ Loblolly/ Spruce Pine | ? | Within Jackson Prairie region; included based on MS NHP Element Occurrence Records |
| MS | F | Lower Slope Mixed Hardwood Forest | ? | White/Water/ Cherrybark-Mixed Deciduous Forest | ? | Within Blackbelt Prairie region; included based on MS NHP Element Occurrence Records |
| MS | F | Oak-Mixed Hardwood Ridge Bottom Forest | ? | Water/ Cherrybark/ White Oak-Bitternut Hickory-Pawpaw Forest | ? | Within Blackbelt Prairie region; included based on MS NHP Element Occurrence Records |
| MS | F | Submesic Mixed Hardwood Calcareous Forest | ? | *Quercus* (*shumardii*, *stellata*)-*Fraxinus* americana-*Carya* (*glabra*, *alba)* Ecological Community | ? | Shallow, Siwell soils on mid and shoulder slopes |
| MS | F | Mesic Calcareous Bluff Forest | ? | *Quercus* (*michauxii*, *shumardii*)-*Liriodendron tulipifera* Ecological Community | ? | Within Jackson Prairie region; rich diversity of understory species; similar to Upper East Gulf Coast Calcareous Bluff Forest |
| MS | F | Mesic Calcareous Bluff Forest | ? | White/Shumard Oak-White Ash-Tuberous Gromwell-Soft Agrimony Forest | ? | Within Blackbelt Prairie region; included based on MS NHP Element Occurrence Records |
| MS | W? | Wooded Seep/Spring Seep/Wet Terrace | ? | Hazel Alder-Sweetspire-Sweetbay/ Bigleaf Magnolia-ferns:Royal/ Cinnamon/ Chainfern | ? | Within Jackson Prairie region; included based on MS NHP Element Occurrence Records |

| | | | | | | |
|---|---|---|---|---|---|---|
| MS | F | Bald Cypress - Hardwood Swamp Forest | ? | Baldcypress - Water Hickory - Overcup Oak-Planertree-Willow | ? | Within Blackbelt Prairie region; included based on MS NHP Element Occurrence Records |
| TX | P | Alfisol Blackland Prairie | *Schizachyrium scoparium-Sorghastrum nutans-Bifora americana* Alfisol Herbaceous Vegetation | *Schizachyrium-Sorghastrum-Andropogon* type; *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardii* type | G1G2 | Alfisol soils in southern and central portions of the main blackland prairie belt and San Antonio Prairie |
| TX | P | Mollisol Blackland Prairie | *Schizachyrium scoparium-Andropogon gerardii-Sorghastrum nutans-Bifora americana* Herbaceous Vegetation | *Schizachyrium-Sorghastrum-Andropogon* type; *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardii* type | G1G2 | Mollisol soils primarily on Whiterock Cuesta; nearly extirpated in TX blacklands; large tracts in TX Fort Worth Prairie region |
| TX | P | Vertisol Blackland Prairie | *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardii-Bifora americana* Vertisol Herbaceous Vegetation | *Schizachyrium-Sorghastrum-Andropogon* type; *Schizachyrium scoparium-Sorghastrum nutans-Andropogon gerardii* type | G1G2 | Vertisol soils in southern and central portions of the main blackland prairie belt and Fayette Prairie |
| TX | P | None | *Sporobolus silveanus- Carex meadii* Herbaceous Vegetation | *Sporobolus-Carex type*; *Sporobolus silveanus-Carex meadii* type | G1 | Alfisol soils in response to high rainfall in northeast blackland Prairie; associated with mima mound topography |
| TX | P | None | *Sporobolus silveanus- Tridens strictus* Herbaceous Vegetation | *Sporobolus-Tridens-Paspalum* type | G2 | Alfisol soils in response to high rainfall in northeast blackland Prairie; associated with mima mound topography |
| TX | P | None | *Tripsacum dactyloides Panicum virgatum-Sorghastrum nutans-Helianthus maximiliani* Herbaceous Vegetation | *Tripsacum dactyloides Panicum virgatum-Sorghastrum nutans* type | G1 | Poorly drained soils in the main blackland prairie belt and Fayette Prairie; gilgae topography common where it occurs on Vertisol soils |
| TX | P | None | *Tripsacum dactyloides-Sporobolus compositus var. compositus* Herbaceous Vegetation | *Tripsacum-Sporobolus-Panicum type*; *Tripsacum dactyloides-Panicum virgatum-Sorghastrum nutans* type | G1 | Main blackland prairie belt and Fayette prairie; may be a phase of the above described association; one of the most endangered grassland types in TX |

| | | | | | | |
|---|---|---|---|---|---|---|
| TX | P | None | *Schizachyrium scoparium-Paspalum plicatulm-Sorghastrum nutans-Dichanthelium oligosanthes-Paspalum setaceum-Symphyotrichum pratense* Alfisol Herbaceous Vegetation | *Schizachyrium scoparium-Paspalum plicatulm-Sorghastrum nutans* type | G1 | Alfisol soils over the Cook Mountain Formation in the Fayette and San Antonio Prairies |

Table 2.2. Frequency of species occurring in greater than 10% of 56 Arkansas blackland prairie plots. Modified from Schauwecker (1996).

| Species | Frequency (%) |
|---|---|
| *Agalinis* sp. | 10.7 |
| *Aster* spp. *(sensu lato)* | 39.5 |
| *Berchemia scandens* | 32.1 |
| *Carex cherokeensis* | 23.2 |
| *Carex* spp. | 33.9 |
| *Chamaecrista fasciculata* | 30.4 |
| *Croton* spp. | 14.3 |
| *Dalea compacta* | 14.3 |
| *Dalea purpurea* | 55.4 |
| *Desmanthus illinoisensis* | 23.2 |
| *Echinacea pallida* | 19.6 |
| *Galactia volubilis* | 39.3 |
| *Galium virgatum* | 17.9 |
| *Hedyotis* spp.. | 35.7 |
| *Ilex decidua* | 10.7 |
| *Juniperus virginiana* | 12.5 |
| *Liatris squarrulosa* | 17.9 |
| *Panicum* spp.. | 17.9 |
| *Quercus* spp.. | 12.5 |
| *Rudbeckia hirta* | 67.9 |
| *Ruellia humilis* | 41.1 |
| *Schizachyrium scoparium* | 73.2 |
| *Sisyrinchium albidum* | 14.3 |
| *Smilax* spp.. | 28.0 |
| *Solidago nemoralis* | 17.9 |
| *Sorghastrum nutans* | 21.4 |

Table 2.3. Common species of Jackson Prairie remnants of Mississippi. Modified from Moran (1995).

| **Species** |
|---|
| *Andropogon gerardii* |
| *Berchemia scandens* |
| *Carex cherokeensis* |
| *Cercis canadensis* |
| *Cornus drummondii* |
| *Crataegus crus-galli* |
| *Crotalaria sagittalis* |
| *Dalea candida* |
| *Dalea purpurea* |
| *Desmanthus illinoisensis* |
| *Erigeron strigosus* |
| *Fraxinus americana* |
| *Helenium autumnale* |
| *Juniperus virginiana* |
| *Liquidambar styraciflua* |
| *Panicum virgatum* |
| *Prunus americana* |
| *Quercus* sp. |
| *Ratibida pinnata* |
| *Rudbeckia hirta* |
| *Schizachyrium scoparium* |
| *Scleria oligantha* |
| *Smilax* sp. |
| *Sorghastrum nutans* |
| *Sporobolus compositus* var. *macer* |
| *Symphyotrichum dumosum* |
| *Ulmus alata* |
| *Vitis* sp. |

Table 2.4. Frequency of species occurring in greater than 10% of 99 prairie plots in the Blackbelt prairie region of Mississippi. Modified from Schauwecker (1996).

| Species | Frequency |
|---|---|
| *Agalinis* sp. | 11.1 |
| *Aristida dichotoma* | 19.2 |
| *Aster ericoides* | 10.1 |
| *Aster laevis* | 19.2 |
| *Berchemia scandens* | 13.1 |
| *Carex cherokeensis* | 19.2 |
| *Chamaecrista fasciculata* | 13.1 |
| *Dalea candida* | 12.1 |
| *Dalea purpurea* | 22.2 |
| *Desmanthus illinoisensis* | 11.1 |
| *Desmodium* spp. | 11.1 |
| *Erigeron* spp. | 11.1 |
| *Galactia volubilis* | 24.2 |
| *Hedyotis* spp. | 42.4 |
| *Juniperus virginiana* | 21.2 |
| *Liatris squarrosa* | 14.1 |
| *Medicago falcata* | 10.1 |
| *Prunella vulgaris* | 12.1 |
| *Quercus* spp. | 10.1 |
| *Ratibida pinnata* | 13.1 |
| *Ruellia humilis* | 14.1 |
| *Schizachyrium scoparium* | 52.5 |
| *Sabatia angularis* | 10.1 |
| *Salvia lyrata* | 20.2 |
| *Sisirhynchium albidum* | 14.1 |
| *Solidago nemoralis* | 24.2 |
| *Solidago rigida* | 13.1 |

Table 2.5. Mean frequency of species documented from three plots in the Blackbelt prairie of Alabama. Modified from Schuster and McDaniel (1973).

| Species | Mean Frequency |
|---|---|
| *Andropogon scoparius* | 0.67 |
| *Andropogon virginicus* | 0.17 |
| *Aristida purpurascens* | 0.67 |
| *Blephilia ciliata* | 0.33 |
| *Echinacea purpurea* | 0.83 |
| *Eragrostis hirsuta* | 0.33 |
| *Erianthus contortus* | 0.17 |
| *Galactia volubilis* | 0.17 |
| *Helenium autumnale* | 0.17 |
| *Houstonia purpurea* | 0.67 |
| *Hypoxis hirsuta* | 0.83 |
| *Panicum anceps* | 0.33 |
| *Polygala boykinii* | 0.17 |
| *Rudbeckia fulgida* | 0.17 |
| *Salvia lyrata* | 0.33 |
| *Schoenolirion croceum* | 1 |
| *Silphium lacinaiatum* | 0.75 |
| *Sisyrinchium albidum* | 0.5 |
| *Sporobolus vaginiflorus* | 0.83 |
| *Symphyotrichum laeve* | 0.17 |
| *Symphyotrichum patens* | 0.33 |
| *Symphyotrichum pilosum* | 0.5 |
| *Tragia urticifolia* | 0.33 |
| *Tridens flavus* | 0.5 |

Table 2.6. Characteristic species of blackland prairies of Texas. Modified from Diamond and Smeins (1993).

| Species |
|---|
| *Acacia hirta* |
| *Andropogon gerardii* |
| *Aristida purpurascens* |
| *Bifora americana* |
| *Bouteloua curtipendula* |
| *Cacalia plantaginea* |
| *Carex meadii* |
| *Carex microdonta* |
| *Cirsium undulatum* |
| *Coelorachis cylindrica* |
| *Dichanthelium oligosanthes* |
| *Elymus canadensis* |
| *Eriochloa sericea* |
| *Eryngium yuccifolium* |
| *Fimbristylis puberula* |
| *Gnaphalium* spp. |
| *Helianthus maximiliani* |
| *Houstonia nigricans* |
| *Hymenopappus scabeosaeus* |
| *Linum medium* |
| *Mimosa microphylla* |
| *Muhlenbergia capillaris* |
| *Nasella leucotricha* |
| *Neptunea lutea* |
| *Panicum virgatum* |
| *Paspalum floridanum* |
| *Paspalum plicatulum* |
| *Paspalum setaceum* |
| *Physostegia intermedia* |

| |
|---|
| *Ratibida columnaris* |
| *Rudbeckia hirta* |
| *Ruellia nudiflora* |
| *Sabatia campestris* |
| *Schizachyrium scoparium* |
| *Scleria ciliata* |
| *Silphium lacinaiatum* |
| *Sorghastrum nutans* |
| *Sporobolus asper* |
| *Sporobolus silvaneus* |
| *Symphyotrichum ericoides* |
| *Symphyotrichum pratense* |
| *Tridens strictus* |
| *Tripsacum dactyloides* |

Table 2.7. Characteristic species of blackland prairies of Georgia.

| **Species** |
|---|
| *Agalinis tenuifolia* |
| *Andropogon gerardii* |
| *Andropogon virginicus* |
| *Aristida purpurascens* |
| *Asclepias tuberosa* |
| *Asclepias viridiflora* |
| *Berchemia scandens* |
| *Carex cherokeensis* |
| *Celtis tenuifolia* |
| *Cercis canadensis* |
| *Cocculus carolinus* |
| *Cornus asperifolia* |
| *Crataegus aprica* |
| *Crataegus crus-galli* |
| *Crataegus spathulata* |
| *Diospyros virginiana* |
| *Erigeron strigosus* |
| *Frangula caroliniana* |
| *Fraxinus americana* |
| *Galactia regularis* |
| *Glandularia bipinnatifida* |
| *Houstonia nigricans* |
| *Juniperus virginiana* |
| *Muhlenbergia capillaris* |
| *Panicum anceps* |
| *Pinus taeda* |
| *Polygala boykinii* |
| *Quercus muehlenbergii* |
| *Quercus sinuata* |
| *Salvia azurea* |
| *Salvia lyrata* |

| |
|---|
| *Solidago nemoralis* |
| *Sorghastrum nutans* |
| *Sporobolus clandestinus* |
| *Sporobolus vaginiflorus* |
| *Symphyotrichum novae-angliae* |
| *Thaspium chapmanii* |
| *Ulmus alata* |
| *Viburnum rufidulum* |

Table 2.8. Geology and soils of blackland prairies by state. Data from Gibson (1941), Launchbaugh (1955), Woods (1967), Collins et al. (1975), Huddlestun and Hetrick (1986), Foti (1989), MacRoberts and MacRoberts (1995), Moran (1995), Moran et al. (2003), Zollner et al. (2003), Eversull (2005), Lester et al. (2005), Diggs et al. (2006), Hajeck and Dane (2007), USDA (2007), and NatureServe (2007).

| **State** | **Geology (formations unless otherwise noted)** | **Soil Series** |
|---|---|---|
| AL | Eutaw, Demopolis, Mooreville, Moody's Branch, Prairie Bluff Chalk, Ripley, Yazoo Clay | Binnsville, Catalpa, Eutaw, Leeper, Kipling, Oktibbeha, Sumter, Vaiden, |
| AR | Annona Chalk, Arkadelphia Marl, Brownstone Marl, Dierks, DeQeen, Ozan, Nacatoch Sands, Midway Group | Demopolis, Houston, Oktibbeha, Kirving, Kipling, Sacul, Sumter, Terouge, Tuscumbia |
| GA | Dry Branch, Ocmulgee, Tivola | Boswell, Oktibbeha, Susquehanna, Sumter |
| LA | Cook Mountain, Fleming, Jackson Group | Ferris, Hollywood, Houston Black, Keiffer, Tahoula |
| MS | Eutaw, Demopolis, Mooreville, Moody's Branch, Prairie Bluff Chalk, Ripley, Yazoo Clay | Binnsville, Catalpa, Eutaw, Griffith, Houston, Kipling, Oktibbeha, Leeper, Maytag, Oklona, Siwell, Sumter, Tuscumbia, Vaiden |
| TX | Austin Chalk Group, Cook Mountain, Crockett, Eagle Ford Group, Fleming, Midway Group, Navarro Group, Oakville Sandstone, Taylor Group | Austin, Burleson, Crockett, Eddy, Ferris, Heiden, Houston Black, Stephen, Wilson |

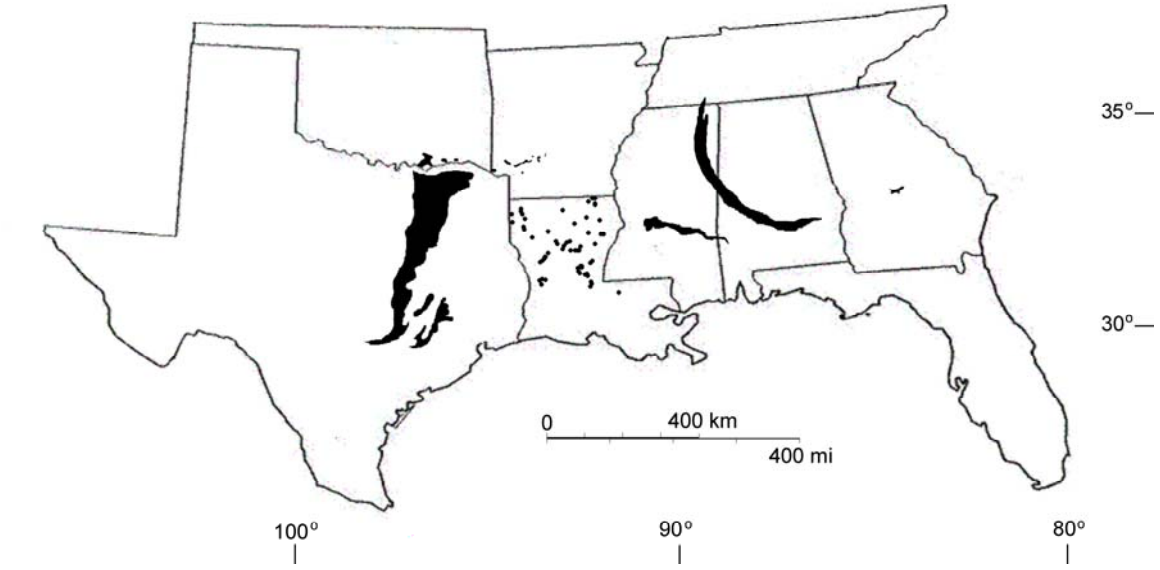


Figure 2.1. Location of blackland prairies in the southeastern United States. Louisiana and Tennessee prairies are not to scale. The northern boundary for Oklahoma blackland prairies is approximate. Modified from MacRoberts and MacRoberts (2002), Peacock and Schauwecker (2003), and Diggs et al. (2006).

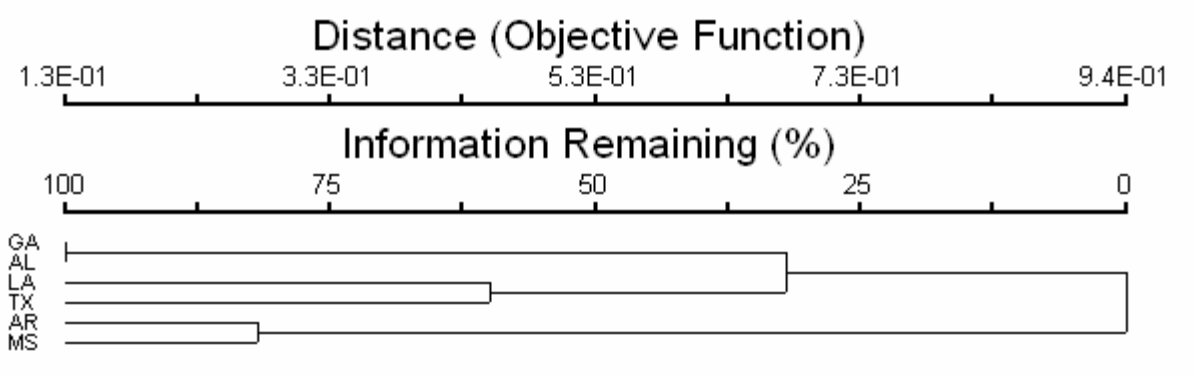


Figure 2.2. Results of cluster analysis of floristic data of open blackland prairie vegetation for six states. Data from 22 sites of seven studies, except AL with observations of blackland prairies throughout the Alabama black belt region. AL = Alabama black belt prairies (AL Schotz, pers. comm.), AR= Arkansas blackland prairies (Foti 1989), GA = Georgia blackland prairies, LA = Isolated central Louisiana prairies (MacRoberts and MacRoberts 1995, 1996), MS = Mississippi Blackbelt prairies and chalk outcrops (Leidolf and McDaniel 1998), TX = Isolated east Texas Fleming Prairie (Brown et al. 2002).

# CHAPTER 4

# CONCLUSION

There is a critical need to conduct quantitative vegetation sampling and classification of blackland prairie remnants and associated vegetation types (Peacock and Schauwecker 2003). This information would help to assess blackland prairies in each state and to properly allocate scant resources for preservation and restoration efforts. It is not only the prairies, but the unique mosaic of associated vegetation that makes the diversity of blackland prairie landscapes exceptional. Further documentation of remaining forest, woodland, shrubland, and savanna vegetation types associated with blackland prairies is of special concern. These communities are unique, as are the prairies themselves, harboring rare and/or disjunct taxa.

The blackland prairies in central Georgia significantly contribute to the state's overall biodiversity. The high species diversity from a relatively small area (315 native spp./106 acres, 49 ha) suggests that Oaky Woods WMA (and perhaps central Georgia) is an understudied area of vascular plant diversity, due to the complex geologic history and associated mosaic of soil types (Woods 1967; Huddlestun and Hetrick 1986). It is critical to locate and document additional blackland prairie remnants in central Georgia. Oaky Woods needs additional floristic documentation before other areas of potential ecological significance are developed: forested lands adjacent to Little Grocery Creek and Big Grocery Creek (see Fig. 1.3) should be targeted for further investigation.

Blackland prairies, in Georgia and across their entire range, are an example of an ecosystem at the brink of extinction. Millions of acres have been lost to anthropogenic causes.

Until the prairies' intrinsic aesthetic and biodiversity values are recognized, we will continue to lose an important part of our southeastern natural heritage. Aggressive conservation efforts, coupled with careful restoration and management of protected sites, are necessary to counter this loss. The fate of the Georgia blackland prairies remains tenuous, with extensive development plans slated for Oaky Woods WMA (Foskett 2007). It is the hope of this author that some portion of Oaky Woods may still be preserved.