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The purpose of ONPS is to encourage the study, protection, propagation, appreciation and use of the native plants of Oklahoma. Membership in ONPS shall be open to any person who supports the aims of the Society. ONPS offers individual, student, family, and life memberships.

Cover: *Phoradendron serotinum*, Mistletoe in flower, by Charles Lewallen.

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Oklahoma Native Plant Record

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Foreword

Over the years our state's ecology has been affected by many changes. New dams, turnpikes, urban sprawl, forestry practices, highway right of away mowing, and excessive use of herbicides are just a few of the activities that have had a profound impact upon our state's native vegetation, many within my lifetime. Concerned Oklahomans founded the Oklahoma Native Plant Society (ONPS) in 1987 with the goal of encouraging the study, protection, use, and appreciation of our native plants.

Many of our citizens are unaware of the unique geographic and biological characteristics of Oklahoma. Botanists and ecologists have debated where Oklahoma should be placed on the biodiversity scale. States such as California, Texas, North Carolina, and Florida have more species. California and Texas have more bioregions. When you consider our geographic location, numbers of species, and bioregions, Oklahoma is considered by many to be number three in terms of biodiversity. Many Western and Eastern, as well as Northern and Southern species intermingle here. Our extensive river system, moving primarily from the Northwest to the Southeast, further divides the state into unique regions.

The sand dunes and the Great Salt Plains are classic examples. Early explorers and botanists made extensive use of these waterways, Washington Irving and Thomas Nuttall are two of the most prominent. The state's elevation and annual rainfall amounts change as you move from west to east, resulting in different bioregions across our state.

As a youngster growing up in Oklahoma City, I would often spend time with a map of Oklahoma and wonder about the regions in our state. Black Mesa, the high plains prairies, the forests of eastern Oklahoma, and the Ozark, Quachita, Wichita, Quartz, and Arbuckle Mountain regions were some of the areas I would dream of someday visiting. Eventually, through family vacations, ecology field trips in college, and my association with ONPS, I was able to visit many of these places. Our state is truly diverse. Much of my appreciation of this is due to my associations with ONPS and as a student in Harriet Barclay's ecology class.

The new *Field Guide to Oklahoma Plants*, by Ron Tyrl, Terrence Bidwell, and Ronald Masters has an excellent introductory section covering the ecogeography and vegetation of Oklahoma. This guide has fine maps and explanations on the geography, soils, and vegetation types. Rolling hills, plains, and unique mountain regions characterize the state. Six forest types are recognized: Oak-Hickory, Oak-Pine, Post Oak-Blackjack Oak, Loblolly Pine, Cypress Bottoms, and Bottom land (Flood Plain). Dr. David Stahle, from the Tree-Ring Laboratory at University of Arkansas, states that the Cross-timbers region (Post Oak-BlackJack Oak) in Oklahoma is one of the largest remaining old growth forests in North America. Our state also consists of Tallgrass, Shortgrass, and Mixed grass prairie regions. The field guide recognizes five different Shrub-Grassland types; Sandsage Grassland, Mesquite Grassland, Shinnery Oak–Grassland, Stabilized Dunes, and Pinon-Juniper Mesa.

The *Oklahoma Native Plant Record* has covered some of these areas in past issues. It is becoming an excellent forum for discussing our state's unique diversity. Much of the Journal's success goes to those original ONPS founding members, whose foresight and concerns about our state have been an inspiration to us all. This Journal is a monument to their efforts. I encourage everyone to support and contribute to its success.

James Elder
ONPS President
June 2003

Oklahoma Native Plant Record
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Black Mesa Flora Study

James K. McPherson, Ph.D.

Department of Botany
Oklahoma State University
22 February 1993

Summary of season's work

The following constitutes a report on field, laboratory, and library work done in 1992 on the flora of the State Parks-The Nature Conservancy preserve property at Black Mesa. This property is north of the town of Kenton; R1E, T6N, sections 28-33 (portions), and R1E, T5N, S6 (portion), Cimarron County, Oklahoma.

I spent 14 full days collecting plants on the preserve, each time camping at the state park a few miles away the nights before and after, so very little travel time was used on collecting days. Collecting dates in the 1992 growing season were 2-3 March, 6-7 April, 30 April-1 May, 14-16 May, 26 June, 2-3 September, and 21-22 September. During each trip an effort was made to visit and collect in as many different types of sites as possible.

Collections of 199 species were made. These were handled in the conventional way, with duplicate specimens being made. One set is deposited in the Oklahoma State University Herbarium, and the other in the Bebb herbarium at the University of Oklahoma.

Interpretation of findings

Flora. The families Compositae, Leguminosae, and Gramineae are represented by the largest numbers of species. However, 47 other families are present. Members of the Gramineae (grass) family clearly dominate most of the landscape. The Pinaceae (in the inclusive sense) is the other dominant family, due to the numerous members of the genus *Juniperus* in some areas.

Two species that are endemic were collected. The shrub *Glossopetalon planitierum* (=*Forsellesia p.*), Celastraceae, which is known only from a few adjacent counties in the Texas panhandle, one nearby county in New Mexico and the Black Mesa area of Cimarron County, OK. The type locality is "near the top of Black Mesa, Cimarron Co." It is possible that the type locality is now on the preserve, though it probably is not possible to know with certainty. The other endemic collected was the perennial herb *Astragalus puniceus*, Leguminosae. It is known only from the Mesa de Maya area (Las Animas County, Colorado; Union County, New Mexico; and Cimarron County, Oklahoma) and Deaf Smith County, Texas. Both species are fairly common locally, but can be considered rare in a general sense.

Four other species are worth mentioning in this context. I did not collect them, but know about them from the literature (Rogers, 1953; Harrington 1964; Waterfall 1969; McGregor et al. 1977; McGregor et al. 1986, Correll and Johnston 1970). *Sarcostemma lobata*, Asclepiadaceae, is apparently known only from Black Mesa. It is likely that this species will be found on the preserve, and

McPherson, J.K.
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seems to be a legitimate rare species. *Lesquerella calcicola*, Cruciferae, *Palafoxia macrolepis*, Compositae, and *Swertia coloradensis*, Gentianaceae, are all endemic in southeastern Colorado, but are at higher elevations and/or on soil types that are not found in Oklahoma, so probably are not on the preserve.

Finally, *Pericome glandulosa*, Compositae, was collected and is described by Rogers (1953) as being an endemic, but has been reduced to varietal status by Harrington. Thus it is now *Pericome caudata* var. *glandulosa*. The reduction appears legitimate. The type locality for it is also Black Mesa. In my opinion, var. *glandulosa* is only a local variant of a widespread species. It occurs on sandstone hills which are common in the region and there does not seem to be any substantial distinct feature about it. Concern about it is probably not justified.

I collected 199 species. Rogers' (1953) list contains 578 species and 11 varieties, a total of 589 taxa. There are some caveats to be mentioned about the comparison of numbers, however. First, Rogers collected from a much larger area. Second, he included types of sites that are not on the preserve (elevations up to 6850 ft., Cimarron River bed and floodplain, sand dunes, and a salt-pan). Finally, some of his species seem questionable in view of present knowledge.

The following is a list of species I collected that Rogers (1953) did not. Identifications will be rechecked.

Selaginellaceae
Selaginella underwoodii [1]
Polypodiacae
Cheilanthes lanosa
Asplenium serpentrionale[1]
Gramineae
Bromus unioloides
Eragrostis trichodes var. *trichodes* [1]
Cyperaceae
Scirpus validus (*S. lacustris* in Waterfall 1969)
Lemnaceae
Lemna minor
Liliaceae
Allium canadense var. *fraseri*
Salicaceae
Salix interior forma *wheeleri*
S. nigra (possibly Rogers' "*Salix* species")
Moraceae
Morus alba[1]
Chenopodiaceae
Suckleya suckleyana
Ranunculaceae
Clematis hirsutissima var. *scottii*[1]
Cruciferae
Arabis fendleri
Saxifragaceae
Ribes odoratum [1]
Leguminosae
Petalostemon tenuifolium
Linaceae
Linum rigidum var. *rigidum*
Vitaceae
Parthenocissus quinquefolia (ident. should be checked)
Vitis vulpina
Onagraceae
Oenothera triloba
Asclepiadaceae
Asclepias arenaria[1]
Sarcostemma crispum[1]
Boraginaceae
Cryptantha minima
Labiatae
Salvia azurea var. *grandiflora*
Rubiaceae
Galium texense
Compositae
Ambrosia linearis[1] (tentative)
Aster fendleri
A. leucelene
Hymenoxys acaulis
Kuhnia chlorolepis
Solidago mollis

Most of these species are permanent resident, "climax" types. They probably would not have immigrated into the area since Rogers made his collections in the late 1940's. The most likely explanation is that Rogers simply missed seeing them.

Vegetation. This is not a formal study of the vegetation or plant communities of the preserve, but I made observations on these attributes of the site on which I can report. Two vegetation types, in the conventional sense of Barbour and Billings, 1988, are present on the preserve. These are Juniper-Pinyon Woodland, which is on the steeper slopes of the mesa and rock outcrops, and Shortgrass Prairie, on level to gently sloping sites with deeper soil.

Within this general picture are some smaller-scale patterns. The most obvious is the presence of Cooper's Arroyo, a stream with rare-intermittent flow. It does have a pool that contains water most of the time, and its bed provides conditions that support typical moist-soil plant species such as *Salix* spp., *Tamarix gallica*, and *Carex gravida*. This can be termed a riparian community.

Two variants of shortgrass prairie are present. On the Berthoud loam and portions of the Travessilla stony loam (USDA, 1960) in the low-lying parts of the preserve is a prairie with many weeds, especially *Erioneuron pilosum*, *Bothriochloa saccharioides*, and *Ambrosia psilostachya*. There is also a substantial amount of the cactus *Opuntia imbricata* which here is associated with disturbance. This portion of the preserve was the most accessible to cattle when the land was ranched, and was where most of the water was provided. It appears that overgrazing is the main cause of the abundance of weedy species and partial loss of the dominants, *Buchloe dactyloides* and *Bouteloua gracilis*.

On the Apache stony clay loam (USDA, 1960), which is found only on the basalt rock forming the top of the mesa, is a slightly different version of shortgrass prairie. The dominant grasses, *Buchloe dactyloides* and *Bouteloua gracilis*, are the same, but they are more dominant and there are fewer weeds. More of the native forbs such as *Castilleja sessiliflora*, *Oenothera lavendulaeflora*, and several Compositae are present. In my judgment, the difference is caused by a history of less disturbance, and by the soil's higher clay content. The contrast between the two variants of short grass prairie will probably diminish with time and the cessation of grazing, but differences due to the contrasting soils are likely to remain. The mesa-top community probably will have a higher diversity of climax species.

On the sides of the mesa the soils are mapped as Rough stony land and the higher parts of the Travessilla stony loam (USDA, 1960). This is where the Juniper-Pinyon woodland is found. *Juniperus monosperma* is the strong dominant here, with only a few *Pinus edulis* trees, despite the traditional name of the vegetation type. There are differing communities within this area, but they are not as clearly separated as is the case with the prairie communities. The most noteworthy group of species here, after *J. monosperma*, is the shrubs. On the drier, open slopes are *Rhus aromatica*, *Cercocarpus montanus*, *Brickellia brachyphylla*, and *B. californica*. Also, *Opuntia imbricata* is here, appearing less weedy than it does in the prairies. In one area near the east end of the preserve the endemic *Glossopetalon planitierrum* is a component of the shrub flora. All are fairly widely spaced so that walking among them is easy.

In the canyons where more moisture accumulates and there is some shelter from the wind is a denser shrub community. Near the bottoms of the deeper canyons it is dense indeed, becoming impenetrable in places. Most of the species just listed are present, and they are joined by *Prunus americana*, *P. virginiana*, *Rubus deliciosus*, *Ptelea trifoliata*, and *Celtis reticulata*. Here also is *Juniperus scopulorum*, a Rocky Mountain species, which is quite uncommon and is very close to the extreme edge of its range.

Throughout the Juniper-Pinyon vegetation is an array of grasses, mostly of different species from the prairie. Very common are *Poa fendleriana* and *Eragrostis cilianensis*. In pockets of deep soil, often only a meter or two across, are *Andropogon gerardii*, *Sorghastrum nutans*, and *Schizachyrium scoparium*. These are dominants of the tallgrass prairie 150 and more miles east, but grow well here in small, favorable sites. The Juniper-Pinyon woodlands are the least disturbed communities on the preserve.

The only other local community that should be noted is the very weedy one that develops in and around the usually-dry, man-made "tanks" or stock-watering ponds. These ponds contain water so seldom that its main effect is to drown any climax species that invade the bed. The original construction work left a massive scar, and trampling by cattle has perpetuated the disturbance. Species commonly found in and around the ponds include *Proboscidea louisianica*, *Xanthium strumarium*, *Cenchrus pauciflorus*, and *Suckleya suckleyana*. If left alone, without cattle trampling, the dams and margins of these ponds will slowly revert to shortgrass prairie. The beds will be weedy as long as the dams occasionally retain water.

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BLACK MESA FLORA STUDY

Year Two Supplement

James K. McPherson

20 January 1994

INTRODUCTION

This is a supplement to my report on the same subject of last year. It is assumed that the present readers have that report and can refer to it. This paper is organized the same way and is in the same sequence as last year's.

SUMMARY OF 1993 WORK

I spent seven full days collecting, using the same plans & format as in 1992. The dates were; 25-26 April, 9-10 May, 31 May, and 6-7 October.

Collections of 30 species new for this project were made, bringing the total to date to 229. They were handled and distributed as before.

INTERPRETATION OF FINDINGS

The count of families has risen to 53 from 50, because of collection of single members of the Selaginellaceae, Sapindaceae, and Polemoniaceae.

Two species should be mentioned. (1) The *Parthenocissus* at the Mesa may be *P. vitacea*, the "western" species. It is known from a few places in the state, but on most herbarium specimens it cannot be distinguished from *P. quinquefolia* so it is hard to know how common it is. Waterfall did not realize *P. vitacea* was in Okla. (or did not accept it), so most people have assumed that it was all *P. quinquefolia*. It will be next season before I will know which we have at the Mesa. (2) There is an *Ambrosia* there that keys to *A. linearis*, which is "Apparently restricted to a few localities in the open high plains of eastern Colorado; rarely collected." There are no specimens in OU's or our herbaria, so Ron Tyrl and I sent it off to University of Colorado for identification. We haven't heard back from them yet. It looks very much like *A. psilostachya*, which is abundant that area; this may be why it is overlooked.

My 1993 estimate of 250-260 species being present on the Preserve still seems reasonable. Since 229 have been collected, about 20-30 remain to be found.

itors otes

This paper is published with the courteous agreement of The Nature Conservancy for whom it was prepared. The approximate PS location of lack Mesa State Park is between latitudes 36.833 and 36.861 and longitudes 102.862 and 102.900. The elevation of the mesa ranges from 960 ft (1512 m) to 973 ft (1516 m). It is now contained within lack Mesa State Park which contains approximately 3 9 acres of land.

The original species list has been updated as follows

[1] On July 1, 199 , ten days before his death, Jim McPherson generated plant labels for 15 additional specimens he had collected on June 7 at lack Mesa on his way to California. With the generous assistance of Iris McPherson, his wife, they are included in the flora and the taxa summary table below.

amilies	55
enera	172
Species	2
Infraspecific taxa	1
xotic species	16

olley's "Additions to lack Mesa lora Study", which follows McPherson's flora in this volume, includes areas of lack Mesa State Park not included in his study and lists only species that are not included here.

[2] The International Code of otanical Nomenclature "conserved" several traditional family names when they standardized the family nomenclature. McPherson used some of these traditional names in the lack Mesa report, but since they are falling into disuse standardized names are provided here. Current species' names have also been provided. Name changes are updates only. No specimens were reexamined for this publication.

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[3] Introduced species are indicated in this list.

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SPECIES BY FAMILY OF THE BLACK MESA RESERVE, CIMARRON COUNTY

James K. McPherson, 1992

(93) = species added in 1993 (94) = species added in 1994[1])

Division/Class/Family	Common Family Name	Standardized Name [2]
Selaginellaceae	**spikemoss family**	
Selaginella underwoodii (93)	spikemoss	
Polypodiaceae	**true fern family**	**Pteridaceae**
Cheilanthes eatoni	Eaton's lip fern	
Cheilanthes feei (93)	slender lip fern	
Cheilanthes lanosa	hairy lip fern	
Notholena standleyi	star cloak-fern	
Pellaea atropurpurea var. p*urpurea* (93)	cliff-brake	
Woodsia oregan (94)	Oregon woodsia	**Dryopteridaceae**
Asplenium septentrionale (94)	forked spleenwort	**Aspleniaceae**
Pinaceae	**pine family**	
Juniperus monosperma	one-seed juniper	
Juniperus scopulorum	Rocky Mtn. Juniper	
Pinus edulis	pinyon pine	
Gramineae	**grass family**	**Poaceae**
Agropyron smithii var. *smithii*	western wheatgrass[3]	
Andropogon gerardii	big bluestem	
Aristida longiseta	Fendler three-awn	
Aristida purpurea	purple three-awn	
Aristida wrightii	Wright three-awn	
Bothriochloa saccharoides	silver bluestem	
Bouteloua curtipendula	side-oats grama	
Bouteloua eriopoda	black grama	
Bouteloua gracilis	blue grama	
Bouteloua hirsuta var. *hirsutea*	hairy grama	
Bromus anomalus var. *lanatipes*	nodding brome	
Bromus tectorum	cheat[3]	
Bromus unioloides	rescue grass[3]	
Buchloe dactyloides	buffalo grass	
Cenchrus carolinianus	sandbur	
Chloris verticillata	windmill grass	
Echinochloa cruzgalli	barnyard grass[3]	
Elymus virginicus var. *jejunus*	Virginia wildrye	
Elymus canadensis (94)	Canadian wild rye	
Eragrostis cilianensis	stinkgrass[3]	

Eragrostis trichodes var. var. *trichodes* (94)	sand love grass	
Erioneuron pilosum	fluffgrass[3]	
Hilaria jamesii	galleta	
Hordeum pusillum	little barley	
Lycurus phleoides Muhlenbergia torreyi Oryzopsis hymenoides	wolftail ring muhly Indian ricegrass	
Oryzopsis micrantha	little-seed ricegrass	
Panicum capillare var. *capillare*	common witchgrass	
Panicum hallii (93)	Hall panic grass	
Panicum obtusum	vine-mesquite	
Poa fendleriana Schedonnardus paniculatus Schizachyrium scoparium Setaria leucopila Sitanion hystrix	muttongrass tumblegrass little bluestem plains bristlegrass	
Sorghastrum nutans Sporobolus cryptandrus	squirreltail Indian grass sand dropseed	*Elymus elymoides*
Stipa comata	thread-and-needle	
Stipa scribneri	Scribner needlegrass	
Vulpia octoflora	six-weeks fescue	
Cyperaceae	**sedge family**	
Carex gravida	sedge	
Cyperus schweinitzii (93)	umbrella sedge	
Scirpus americanus var. polphyllus	bulrush	
Scirpus validus	bulrush	*Scirpus tabernaemontanus*
Commelinaceae	**spiderwort family**	
Commelina erecta var. *angustifolia* (94)	erect dayflower	
Tradescantia occidentalis	western spiderwort	
Lemnaceae	**duckweed family**	
Lemna minor	duckweed	
Liliaceae	**lily family**	
Allium canadense var. *fraseri*	wild onion	
Yucca glauca	plains yucca	
Salicaceae	**willow family**	
Populus deltoids	cottonwood	
Salix amygdaloides	peach-leaf willow	
Salix interior forma wheeleri	sandbar willow	*Salix exigua*
Salix nigra	black willow	

Ulmaceae	**elm family**	
Celtis reticulate	hackberry	
Santalaceae	**sandalwood family**	
Commandra pallida	bastard toad-flax	*Commandra umbellata* ssp. *pallida*
Urticaceae	**nettle family**	
Parietaria pennsylvanica	Pennsylvania pellitory	
Polygonaceae	**buckwheat family**	
Eriogonum jamesii	James wild buckwheat	
Eriogonum lachnogynum	wild buckwheat	
Polygonum lapathifolium	pale smartweed	
Polygonum ramosissimum	knotweed	
Rumex crispus	curly dock	
Chenopodiaceae	**goosefoot family**	
Ceratoides lanata	winterfat	
Chenopodium album (93)	lamb's quarters	
Chenopodium incanum (93)	goosefoot	
Kochia scoparia	kochia	
Salsola kali var. *tenuifolia*	Russian thistle	*Salsola kali* var. *tragus*
Suckleyla suckleana	poison suckleya	
Amaranthaceae	**pigweed family**	
Amaranthus retroflexus	rough pigweed[3]	
Nyctaginaccae	**four-o'clock family**	
Mirabilis carletonii (93)	Carleton’s four-o'clock	
Mirabilis linearis var. *subhispida*	narrowleaf four-o'clock	
Portulacaceae	**purslane family**	
Portulaca retusa	purslane	*Portulaca oleracea* ssp. *oleracea*
Ranunculanceae	**buttercup family**	
Clematis hirsutissima var. *scottii*(93)	virgin's bower	
Delphinium virescens var. *penardi*	prairie larkspur	*Delphinium carolinianum* var. *virscens* (93)
Ranunculus sceleratus	cursed crowfoot	
Fumariaceae	**fumitory family**	
Corydalis aurea	golden corydalis	
Capparidaceae	**caper family**	
Polanisia dodecandra	clammy-weed	

Cruciferae	**mustard family**	**Brassicaceae**
Arabis fendleri	rock cress	
Descurania pinnata var. *intermedia*	tansy mustard	
Erysimum capitatum	wallflower	
Lepidium densiflorum	peppergrass[3]	
Lesquerella ovalifolia	bladderpod	
Saxifragaceae	**saxifrage family**	**Grossulariaceae**
Ribes cereum	western red currant	
Ribes odoratum	buffalo currant	*Ribes aureum* var. *villosum* (93)
Rosaceae	**rose family**	
Cercocarpus montanus var. *argenteus*	mountain mahogany	
Physocarpus monogynus (93)	mountain ninebark	
Prunus americana var. *americana*	wild plum	
Prunus virginiana	choke cherry	
Rubus deliciosus	boulder raspberry	
Leguminosae	**pea family**	**Fabaceae**
Amorpha canescens forma *canescens* (94)	lead plant	
Astragalus crassicarpus var. *paysoni* (93)	ground-plum	
Astragalus gracilis	slender milk-vetch	
Astragalus lotiflorus	lotus milk-vetch	
Astragalus missouriensis	Missouri milk-vetch	
Astragalus mollissimus	wooly locoweed	
Astragalus puniceus	Trinidad milk-vetch	
Dalea aurea	golden prairie-clover	
Dalea candida var. *oligophylla*	white prairie-clover	
Dalea enneandra	nine-anther prairie-clover	
Dalea formosa (93)	feather plume	
Dalea jamesii	James dalea	
Glycyrrhiza lepidota (93)	wild licorice[3]	
Hoffmannseggia drepanocarpa (93)	sicklepod rush-pea	*Caesalpinia drepanocarpa*
Hoffmannseggia jamesii	James rush-pea	*Caesalpinia jamesii*
Krameria lanceolata	ratany	**Krameriaceae**
Melilotus officinalis	yellow sweet clover[3]	
Mimosa borealis	pink mimosa	
Petalostemum tenuifolia	slimleaf prairie-clover	*Dalea tenuifolia*
Psoralea argophylla (93)	silver-leaf scurf pea	*Pediomelum argophylla*
Psoralea tenuiflorum	scurf pea	*Psoralidium tenuiflorum*
Vicia americana	American vetch	

Linaceae	**flax family**	
Linum lewisii	blue flax	
Linum rigidum var. rigidum	stiff flax	
Zygophyllaceae	**caltrop family**	
Tribulus terrestris	goat head[3]	
Rutaceae	**citrus family**	
Ptelea trifoliata	wafer-ash	
Polygalaceae	**milkwort family**	
Polygala alba	milkwort	
Euphorbiaceae	**spurge family**	
Argythamnia humilis	wild mercury	
Argythamnia mercurialina	wild mercury	
Croton texensis	Texas croton	
Euphorbia fendleri	Fendler spurge	*Chamaesyce fendleri*
Euphorbia lata	hoary spurge	*Chamaesyce lata*
Euphorbia dentata forma *cuphosperma*	toothed spurge	
Euphorbia marginata	snow-on-the-mountain	
Tragia ramosa	noseburn	
Anacardiaceae	**sumac family**	
Rhus aromatica var. *pilosissima*	lemon sumac	
Toxicodendron radicans	poison ivy	
Celastraceae	**staff-tree family**	**Crossosomataceae**
Glossopetalon planitierum	grease-bush	
Sapindaceae	**soap-berry family**	
Sapindus drummondii (93)	soap-berry	*Sapindus saponaria* var. *drummondii*
Vitaceae	**grape family**	
Parthenocissus quinquefolia	Virginia creeper	
Vitis vulpina	fox grape	*Vitis riparia*
Malvaceae	**mallow family**	
Sphaeralcea angustifolia	globe mallow	
Sphaeralcea coccinea	scarlet globe mallow	
Tamaricaceae	**tamarisk family**	
Tamarix gallica	salt cedar[3]	
Violaceae	**violet family**	
Hybanthus verticillatus	green violet	

Loasaceae	**stick-leaf family**	
Mentzelia decapetala	blazing star	
Cactaceae	**cactus family**	
Echinocereus viridiflorus	green-flowered hedgehog	
Mammillaria vivipara (93)	pincushion cactus	*Escobaria vivipara* var. *vivipara*
Opuntia imbricata	cholla	
Opuntia phaeacantha var. *major*	prickly pear	
Opuntia trichophora (93)	prickly pear	*Opuntia polyacantha* var. *trichophora*
Onagraceae	**evening primrose family**	
Gaura coccinea var. *coccinea*	scarlet butterfly flower	
Oenothera serrulata	evening primrose	*Calyophus serrulatus*
Oenothera albicaulis (93)	evening primrose	
Oenothera lavendulaefolia	evening primrose	*Calyophus lavandulifolius*
Oenothera triloba	stemless evening primrose	
Umbelliferae	**parsley family**	**Apiaceae**
Cymopteris acaulis (93)	(no common name)	
Cymopteris montanus	(no common name)	
Asclepiadaceae	**milkweed family**	
Asclepias arenaria (94)	sand milkweed	
Asclepias asperula var. *decumbens*	low milkweed	
Asclepias macrotis (94)	longhood milkweed	
Asclepias pumila	threadleaf milkweed	
Asclepias uncialis (93)	dwarf milkweed	
Sarcostemma crispum (94)		
Convolvulaceae	**morning glory family**	
Convolvulus incanus	field bindweed[3]	*Convolvulus arvensis*
Evolvulus nuttallianus	Nuttall evolvulus	
Ipomoea leptophylla (94)	bush morning-glory	
Polemoniaceae	**phlox family**	
Gilia laxiflora (93)	gilia	*Ipomopis laxiflora*
Boraginaceae	**borage family**	
Cryptantha jamesii	popcorn flower	*Cryptantha cineria* var. *jamesii*
Cryptantha minima	small popcorn flower	
Cryptantha thyrsiflora	popcorn flower	

Lappula redowskii var. *occidentalis*	stickseed	*Lappula occidentalis* var. *occidentalis*
Lithospermum incisum	cutleaf puccoon	
Onosmodium molle var. *occidentale*	false gromwell	
Verbenaceae	**vervain family**	
Verbena canadensis	rose vervain	*Glandularia canadensis*
Verbena bracteata	prostrate vervain	
Labiatae	**mint family**	**Lamiaceae**
Monarda pectinata	spotted beebalm	
Salvia azurea var. *grandiflora*	pitcher sage	
Solanaceae	**nightshade family**	
Chamaesaracha conioides	false nightshade	
Physalis virginiana var. *sonorae* (94)	Virginia ground cherry	
Physalis lobata	ground cherry	*Quincula lobata*
Solanum elaeagnifolium	silverleaf nightshade	
Solanum rostratum (93)	buffalo bur	
Scrophulariaceae	**figwort family**	
Castilleja sessiliflora	downy indianpaintbrush	
Penstemon albidus	white beardtongue	
Penstemon ambiguous (94)		
Veronica anagallis-aquatica	water speedwell[3]	
Martyniaceae	**unicorn-plant family**	
Proboscidea louisianica	devil's claw	
Plantaginaceae	**plantain family**	
Plantago purshii var. *purshii*	wooly plantain	
Plantago purshii var. *spinulosa* (93)	wooly plantain	
Rubiaceae	**madder family**	
Galium texense	Texas bedstraw	
Cucurbitacaeae	**cucumber family**	
Cucurbita foetidissima	buffalo gourd	
Compositae	**sunflower family**	**Asteraceae**
Agoseris cuspidate	false dandelion	*Nothocalais cuspidata*
Ambrosia sp. (93)	ragweed	
Ambrosia psilostachya	western ragweed	
Artemisia filifolia	sandsage	
Artemisia glauca	silky wormwood	*Artemisia dracunculus*

		ssp. *glauca*
Artemisia ludoviciana	Louisiana sagewort	
Aster ericoides	heather aster	
Aster fendleri	Fendler's aster	
Aster leucelene	white aster	*Chaetoppa ericoides*
Aster oblongifolius	aromatic aster	
Berlandiera lyrata	green eyes	
Brickellia brachyphylla	(no common name)	
Brickellia californica	(no common name)	
Chrysopsis villosa var. *villosa*	golden aster	*Heterotheca villosa* var. *villosa*
Chrysothamnus nauseosus	rabbit brush	
Cirsium undulatum	wavy-leaf thistle	
Conyza canadensis var. *canadensis*	horseweed	
Dyssodia papposa	fetid marigold	
Engelmannia pinnatifida	Engelmann's daisy	
Erigeron divergens var. *cinereus*	fleabane	*Erigeron colomexicanus*
Evax prolifera	rabbit-tobacco	
Gaillardia pinnatifida	blanket flower	
Grindelia squarrosa var. *nuda*	curly-top gumweed	
Gutierrezia sarothrae	snakeweed	
Haplopappus spinulosus	cutleaf ironplant	*Machaeranthera pinnatifida*
Helianthus annuus	annual sunflower	
Hymenopappus flavescens	yellow plainsman	
Hymenopappus tenuifolius	white plainsman	
Hymenoxys acaulis	stemless bitterweed	*Tetraneuris acaulis*
Hymenoxys scaposa var. *linearis*	bitterweed	*Tetraneuris scaposa*
Kuhnia chlorolepis	false boneset	*Brickellia eupatorioides* var. *chlorolepis*
Liatris punctata var. *punctata*	dotted gayfeather	
Lygodesmia juncea (94)	skeleton plant	
Lygodesmia pauciflora	skeletonweed	*Stephanomeria pauciflora*
Machaeranthera tanacetifolia (93)	tansy aster	
Melampodium leucanthemum	black-foot daisy	
Pericome caudate	(no common name)	
Ratibida columnifera	Mexican hat	
Ratibida tagetes (94)	prairie coneflower	
Senecio douglasii var. *longilobus*	shrub groundsel	*Senecio flaccidus*
Senecio plattensis	prairie ragwort	
Senecio tridenticulatus	ragwort	
Solidago mollis	soft goldenrod	
Solidago petiolaris (93)	downy goldenrod	
Thelesperma megapotamicum	greenthread	
Townsendia exscapa	Easter daisy	

Tragopogon major (93)	goatbeard[3]	*Tragopogon dubius*
Verbesina encelioides	golden crownbeard	
Xanthium strumarium	cocklebur	
Zinnia grandiflora	wild zinnia	

Moraceae

Morus alba (94)	white mulberry[3]	

Additions to Black Mesa Flora Study

Patricia Folley
Bebb Herbarium
University of Oklahoma

Many changes have taken place in far western Oklahoma since Jim McPherson's untimely death in 1994. Then the mesa lobe containing the highest point in Oklahoma and its surrounding slopes was owned and managed by the Oklahoma Chapter of the Nature Conservancy, but it soon became part of Black Mesa State Park. Private lands still separate the two portions of the Park, but they are now connected by a public road.

Since that time and during the course of several weekend outings with the Oklahoma Academy of Science and the Oklahoma Native Plant Society, I have been adding to McPherson's list, as many plant species as could be found in bloom or fruit. These species are not already listed by McPherson as present in the mesa area. Voucher specimens are housed in the Robert Bebb Herbarium (OKL) at the University of Oklahoma.

Most visitors to Black Mesa camp in the original park area near Lake Etling. In this list plants collected at that site are noted as "park". Plants found along the roads leading to the Mesa or to the outlying canyons are noted as "roadside". A few plants were found only at privately owned, Tessequite Canyon, one of the many side canyons leading down from the Mesa. Those are identified with the name "Tessequite". "Mesa" denotes plants from Black Mesa or its slopes. McPherson's collections were solely from the Mesa.

Through the years Black Mesa State Park has been studied by several botanists, including C.M. Rogers and U.T. Waterfall, as well as McPherson. It is hoped that their work, along with this list will serve as a basis for the initiation of future explorations in that geographic region.

The approximate GPS location of Black Mesa State Park is between latitudes 36.833 and 36.861 and longitudes 102.862 and 102.900 The elevation of the mesa ranges from 4960 ft (1512 m) to 4973 ft (1516 m). It is now contained within Black Mesa State Park which contains approximately 349 acres of land.

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Additional Plant List for Black Mesa 2003

FAMILY/SPECIES	COMMON NAME	SITE	STATUS
Family Asclepiadaceae			
Asclepias macrotis	longhorn milkweed	park	native
Family Asteraceae			
Bidens cernua	nodding tickseed	park	introduced
Dyssodia papposa	fetid marigold	park	native
Gnaphalium wrightii	Wright's cudweed	park	native
Palafoxia sphacelata	rayed palafoxia	roadside	native
Psilostrophe villosa	paperflower	park	native
Senecio flaccidus	groundsel	mesa	native
Vernonia fasciculata	prairie ironweed	park	native
Family Boraginaceae			
Heliotropium convolvulaceum	bindweed heliotrope	park	native
Lithospermum multiflorum	many-flowered puccoon	park	native
Family Brassicaceae			
Erysimum asperum	wallflower	park	native
Family Cactaceae			
Echinocereus viridiflora	hedgehog cactus	mesa	native
Opuntia fragilis	brittle prickly pear	park	native
Opuntia macrorhiza	white-spine prickly pear	park	native
Opuntia phaeacantha	brownspine prickly pear	park	native
Family Campanulaceae			
Lobelia cardinalis	cardinal flower	park	native
Family Capparidaceae			
Cleome serrulata	Rocky Mountain beeplant	park	native
Polanisia jamesii	James' clammyweed	park	native
Family Caryophyllaceae			
Paronychia sessiliflora	nailwort	roadside	native
Family Chenopodiaceae			
Atriplex canescens	4-wing saltbush	park	native
Chenopodium leptophyllum	narrowleaf goosefoot	park	native

Kochia scoparia	tumbleweed	roadside	introduced
Family Cyperaceae			
Carex brevior	sedge	park	native
Cyperus globulosus		park	native
Scirpus acutus	hardstem bulrush	park	native
Scirpus atrovirens	darkgreen bulrush	park	native
Family Dryopteridaceae			
Cystopteris fragilis	brittle fern	park	native
Family Fabaceae			
Astragalus ceramicus	painted milkvetch	park	native
Colutea arborescens		roadside	introduced
Dalea tenuifolia	slimleaf prairie clover	park	native
Family Fagaceae			
Quercus mohriana	shin oak	Tessequite	native
Family Lamiaceae			
Teucrium laciniatum	cutleaf germander	park	native
Family Liliaceae			
Nolina texana	beargrass	Tessequite	native
Yucca harrimaniae	New Mexico yucca	park	native
Family Loasaceae			
Mentzelia oligosperma	stickleaf	park	native
Family Nyctaginaceae			
Mirabilis albida	white 4 o'clock	park	native
Mirabilis nyctaginea	wild 4 o'clock	park	native
Family Onagraceae			
Gaura villosa	wooly gaura	roadside	native
Oenothera engelmannii	Engelmann's eve. primrose	roadside	native
Oenothera latifolia	mountain eve. primrose	park	native
Family Poaceae			
Andropogon virginicus	sand sedge	park	native
Chloris virgata		park	native
Distichlis spicata	saltgrass	park	native

Muhlenbergia racemosa	marsh muhly	park	native
Panicum virgatum	Switchgrass	park	native
Polypogon monspeliensis	rabbit-foot grass	park	native
Family Polemoniaceae			
Gilia rigidula	prickleaf gilia	base of mesa	native
Family Polygonaceae			
Eriogonum tenellum	no common name	park & mesa	native
Polygonum amphibium	water knotweed	park	native
Rumex altissimus	tall dock	park	native
Family Ranunculaceae			
Ranunculus abortivus	small-flowered buttercup	lake	native
Family Rosaceae			
Rosa woodsii	western wood-rose	park	native
Family Rutaceae			
Ptelia trifoliata	wafer ash	mesa	native
Family Scrophulariaceae			
Veronica anagalis-aquatica	water speedwell	park	introduced
Family Verbenaceae			
Glandularia bipinnatifida	cutleaf verbena	park	native
Family Vitaceae			
Vitis acerifolia	no common name	park	native

Vascular Flora of the Keystone Wildlife Management Area, Creek, Pawnee, and Osage Counties, Oklahoma

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This paper reports the results of an inventory of the vascular plants at the Keystone Wildlife Management Area in northeastern Oklahoma. A total of 380 taxa of vascular plants in 254 genera and 79 families were collected. The most species were collected from the families Poaceae (58), Asteraceae (57), and Fabaceae (30). There were 160 annual and 220 perennial species. Fifty-six species of woody plants were present. A total of 59 exotic species were collected representing 15% of the flora. No species tracked by the Oklahoma Natural Heritage Inventory for rarity were found.

INTRODUCTION

Floristic inventories can be undertaken to address a number of research or management objectives. For example, florisitic inventories are often necessary when analyzing species distributions. Often there are gaps in the known geographic distribution of species and groups of species, so an inventory maybe required in order to complete distribution maps. Inventories are also crucial in plant conservation in order to locate populations of rare or threatened species. Finally, inventories aid land managers in both the protection of sensitive species and the location of nuisance species. Floristic inventories can be conducted at either the regional or local scale. The objective of this study was to provide a floristic inventory to aid Oklahoma Department of Wildlife Conservation personnel in management of the Keystone Wildlife Management Area (KWMA).

STUDY AREA

The KWMA is located along the upper reaches of Keystone Lake, which was flooded in 1964 (Oklahoma Water Resources Board 1990). Keystone Dam is situated just below the confluence of the Cimarron and Arkansas Rivers, both of which flow through KWMA. The KWMA was established in 1973 by the Oklahoma Department of Wildlife Conservation and is comprised of over 16,000 acres in Creek, Osage, and Pawnee Counties (Pennington 2003).

The KWMA is located within the Subtropical Humid (Cf) climate zone

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(Trewartha 1968). Summers are warm (mean July temperature = 27.3° C) and humid, and winters are relatively short and mild (mean January temperature = 2.6° C). Mean annual precipitation is 98 cm with periodic severe droughts (Oklahoma Climatological Survey 2003). Physiographically, the study area is located in the Osage Plains section of the Central Lowlands province (Hunt 1974) and within the Eastern Sandstone Cuesta plains of Oklahoma (Curtis and Ham 1979). The surface geology consists primarily of Pennsylvanian sandstone and shale (Branson and Johnson 1979). Outcroppings of silty sandstones occur in the eastern portion of KWMA with sandy, silty shales and limestone outcrops in the west (Grieg 1959, Oakes and Jordan 1959). The soils at KWMA are sandy loams and silt loams. Bottomland soils include Yahola very fine sandy loam and Reinach very sandy loam. Uplands soils are steep to gently rolling and consist primarily of the Eufaula loamy fine sand (Oakes 1959). The predominant potential vegetation types are post oak-blackjack and bottomland forests (Duck and Fletcher 1943). However, much of the bottomland forest area has been converted to agriculture and is now actively cultivated or in old-fields. Upland forests have been heavily modified as well.

METHODS

Collections were also made randomly throughout the KWMA from March through October 2002. Sixteen collection sites were established to represent the greatest variety of habitats for intensive floristic sampling. Sites were selected following a review of U. S. Geological Survey 1:24,000 topographic maps and field reconnaissance. Vouchers for exotic species were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed and a voucher set was deposited at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard curatorial procedures (Bridson 1992). Manuals used for specimen identification included Keys to the Flora of Oklahoma (Waterfall 1969), Flora of the Great Plains (Barkley 1986), Shinners & Mahler's Illustrated Flora of North Central Texas (Diggs et al 1999), and Steyermark's Flora of Missouri (Yatsievych 1999). Origin and nativity for species was determined by reference to Taylor and Taylor (1991) and the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2003). Nomenclature follows USDA-NRCS (2003).

RESULTS AND DISCUSSION

A total of 380 taxa of vascular plants in 254 genera and 79 families were collected. Among the angiosperms, 294 were dicots and 83 were monocots. In addition, there were two ferns, and one gymnosperm. The Poaceae (58), Asteraceae (57), and Fabaceae (30) had the greatest numbers of species. The genera *Polygonum* (8), *Quercus* (7), *Carex* (6), *Desmodium* (6), and *Eragrostis* (6) contained the greatest numbers of species. There were 160 annual and 220 perennial species. Fifty-six species were woody plants, 30 of which were trees, 11 shrubs, and 15 vines.

Fifteen percent of the flora was exotic. A total of 59 exotic species were collected in 20 families. The greatest numbers of exotic species were in the

Poaceae (12) and Fabaceae (8). These families also had the greatest number of exotic species at the Chickasaw National Recreation Area (Hoagland and Johnson 2001). In that study, 12% of the flora was composed of exotic species. Six of the eight species reported in the Caryophyllaceae were exotic, the highest ratio for any family. The greatest number of introduced species was in the genus *Bromus* (4). No species tracked by the Oklahoma Natural Heritage Inventory for rarity were encountered.

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Keystone Wildlife Management Area
Annotated Species List

Growth habit is designated as F; forb, G; graminoid, H; herb, S; shrub, T; tree, and V; woody vine. Life history is designated as A; annual/biennial or P; perennial. Origin is noted as N; native or I; introduced.

Pteridophyta (Ferns and allies)

Aspleniaceae
Asplenium platyneuron (L.) B.S.P.
ebony spleenwort; F or H, P, N
Dryopteridaceae
Woodsida obtusa (Spreng.) Torr.
bluntlobe cliff fern; F or H, P, N

Coniferophyta (Gymnosperms)

Cupressaceae
Juniperus virginiana L.
eastern redcedar; T, P, N

Magnoliophyta (Angiosperms)

Monocotyledonae

Araceae
Arisaema dracontium (L.) Schott
green dragon; F or H, P, N
Alistmataceae
Sagittaria montevidensis Cham. & Schlect.
giant arrowhead; F or H, P, I
Commelinaceae
Tradescantia ohiensis Raf.
bluejacket; F or H, P, N
Cyperaceae
Carex albicans Willd. Ex Spreng.
whitetinge sedge; G, P, N
Carex amphibola Steud.
eastern narrowleaf sedge; G, P, N
Carex brevior (Dewey) Mackenzie
shortbeak sedge; G, P, N
Carex bushii Mackenzie
Bush's sedge; G, P, N
Carex caroliniana Schwein.
Carolina sedge; G, P, N
Carex leavenworthii Dewey
Leavenworth's sedge; G, P, N
Cyperus croceus Vahl
Baldwin's flatsedge; G, P, N
Cyperus echinatus (L.) Wood
Globe flatsedge; G, P, N
Cyperus erythrorhizos Muhl.
redroot flatsedge; G, P, N
Cyperus lupulinus (Spreng.) Marcks
Great Plains flatsedge; G, P, N
Cyperus setigerus Torr. & Hook.
lean flatsedge; G, P, N
Eleocharis engelmannii Steud.
Engelmann's spikerush; G, P, N
Fimbristylis puberula (Michx.) Vahl
hairy fimbry; G, P, N
Iridaceae
Sisyrinchium angustifolium P. Mill.
narrowleaf blue-eyed grass;
F or H, P, N
Juncaceae
Juncus brachyphyllus Wieg.
tuftedstem rush; G, P, N
Juncus dudleyi Wieg.
Dudley's rush; G, P, N
Juncus marginatus Rostk.
grassleaf rush; G, P, N
Liliaceae
Allium perdulce S.V. Fraser
plains onion; F or H, P, N
Erythronium sp. L.

troutlily; F or H, P, N

Nothoscordum bivalve (L.) Britt.
crowpoison; F or H, P, N

Poaceae

Agrostis hyemalis (Walt.) B.S.P.
winter bentgrass; G, P, N

Alopecurus carolinianus Walt.
Carolina foxtail; G, A, N

Andropogon gerardii Vitman
big bluestem; G, P, N

Andropogon ternarius Michx.
splitbeard bluestem; G, P, N

Bouteloua rigidiseta (Steud.) A.S. Hitchc.
Texas grama; G, P, N

Bromus catharticus Vahl
rescuegrass; G, A, I

Bromus hordeaceus L.
soft brome; G, P, I

Bromus japonicus Thunb. ex Murr.
Japanese brome; G, A, I

Bromus tectorum L.
cheatgrass; G, A, I

Buchloe dactyloides (Nutt.) Engelm.
buffalograss; G, P, N

Cenchrus spinifex Cav.
coastal sandbur; G, P, N

Chasmanthium latifolium (Michx.) Yates
Indian woodoats; G, P, N

Chloris verticillata Nutt.
tumble windmill grass; G, P, N

Coelorachis cylindrica (Michx.) Nash
cylinder jointtail grass; G, P, N

Cynodon dactylon (L.) Pers.
Bermudagrass; G, P, I

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark
needleleaf rosette grass; G, P, N

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann western panicgrass; G, P, N

Dichanthelium malacophyllum Nash (Gould)
softleaf rosette grass; G, P, N

*Dichanthelium oligosanthes (*J. A. Schultes) Gould var. *oligosanthes*
Heller's rosette grass; G, P, N

Dichanthelium scoparium Lam. (Gould)
velvet panicum; G, P, N

Digitaria sanguinalis (L.) Scop.
hairy crabgrass; G, A, N

Echinochloa crus-galli (L.) Beauv.
barnyardgrass; G, A, I

Eleusine indica (L.) Gaertn.
Indian goosegrass; G, A, I

Elymus virginicus L.
Virginia wildrye; G, P, N

Eragrostis barrelieri Daveau
Mediterranean lovegrass; G, A, I

Eragrostis hirsuta (Michx.) Nees
bigtop lovegrass; G, P, N

Eragrostis pilosa (L.) Beauv.
Indian lovegrass; G, A, N

Eragrostis secundiflora J. Pesl
red lovegrass; G, P, N

Eragrostis spectabilis (Pursh) Steud.
purple lovegrass; G, P, N

Eragrostis trichodes (Nutt.) Wood
sand lovegrass; G, P, N

Eriochloa contracta A.S. Hitchc.
prairie cupgrass; G, A, N

Gymnopogon ambiguous (Michx.) B.S.P.
bearded skeletongrass; G, P, N

Hordeum pusillum Nutt.
little barley; G, A, N

Leersia virginica Willd.
whitegrass; G, P, N

Leptochloa fusca (L.) Kunth
Malabar sprangletop; G, P, N

Leptochloa panacea (Retz.) Ohwi ssp. *mucronata* (Michx.) Nowack
mucronate sprangletop; G, A, N

Lolium arundinaceum (Schreb.) S.J. Darbyshire
tall fescue; G, P, I

Lolium perenne L.

perennial ryegrass; G, P, I
Muhlenbergia frondosa (Poir.) Fern.
wirestem muhly; G, P, N
Muhlenbergia sobolifera
(Muhl. ex Willd.) Trin.
rock muhly; G, P, N
Neeragrostis reptans (Michx.) Nicora
creeping lovegrass; G, A, N
Panicum anceps Michx.
beaked panicgrass; G, P, N
Panicum philadelphicum Bernh. ex Trin.
Philadelphia panicgrass; G, A, N
Panicum virgatum L.
switchgrass; G, P, N
Paspalum pubiflorum Rupr. ex Fourn.
hairyseed paspalum; G, P, N
Paspalum setaceum Michx.
thin paspalum; G, P, N
Poa annua L.
annual bluegrass; G, A, I
Poa arachnifera Torr.
Texas bluegrass; G, P, N
Poa pratensis L.
Kentucky bluegrass; G, P, I
Schedonnardus paniculatus (Nutt.) Trel.
Tumblegrass; G, P, N
Schizachyrium scoparium (Michx.) Nash
little bluestem; G, P, N
Setaria pumila (Poir.) Roemer & J.A. Schultes
yellow bristlegrass; G, A, I
Sorghastrum nutans (L.) Nash
Indiangrass; G, P, N
Sorghum halepense (L.) Pers.
Johnsongrass; G, P, I
Sphenopholis obtusata (Michx.) Scribn.
prairie wedgescale; G, P, N
Tridens flavus (L.) A.S. Hitchc.
purpletop tridens; G, P, N
Tripsacum dactyloides (L.) L.
eastern gamagrass; G, P, N
Vulpia sciurea (Nutt.) Henr.
squirreltail fescue; G, A, N

Smilacaceae
Smilax bona-nox L.
saw greenbriar; S, SS, V, P, N
Smilax rotundifolia L.
roundleaf greenbriar; S, SS, V, P, N

Dicotyledonae

Acanthaceae
Dicliptera brachiata (Pursh) Spreng.
branched foldwing; F or H, A, N
Ruellia humilis Nutt.
fringeleaf wild petunia; F or H, P, N
Ruellia strepens L.
limestone wild petunia; F or H, P, N
Aceraceae
Acer negundo L.
boxelder; T, P, N
Acer saccharinum L.
silvermaple; T, P, N

Amaranthaceae
Amaranthus rudis Sauer
tall amaranth; F or H, A, N
Froelichia floridana (Nutt.) Moq.
plains snakecotton; F or H, A, N
Froelichia gracilis (Hook.) Moq.
slender snakecotton; F or H, A, N
Iresine rhizomatosa Standl.
Juda's bush; F or H, P, N
Anacardiaceae
Rhus aromatica Ait.
fragrant sumac; S, P, N
Rhus copallinum L.
flameleaf sumac; T, S, P, N
Toxicodendron radicans (L.) Kuntze
eastern poison ivy; S, SS, V, P, N
Apiaceae
Ammoselinum popei Torr. & Gray
plains sandparsley; F or H, A, N
Chaerophyllum tainturieri Hook.

hairyfruit chervil; F or H, A, N
Cicuta maculata L.
spotted water hemlock; F or H, P, N
Daucus pusillus Michx.
American wild carrot; F or H, A, N
Eryngium leavenworthii Torr. & Gray
Leavenworth's eryngo; F or H, A, N
Polytaenia nuttallii DC.
Nuttall's prairie parsley; F or H, P, N
Ptilimnium nuttallii (DC.) Britt.
laceflower; F or H, A, N
Sanicula canadensis L.
Canadian blacksnakeroot;
F or H, P, N
Spermolepis divaricata (Walt). Raf. ex Ser.
roughfruit scaleseed; F or H, A, N
Trepocarpus aethusae Nutt. ex DC.
whitenymph; F or H, A, N
Torilis arvensis (Huds.) Link
spreading hedgeparsley; F or, H, A, I

Apocynaceae

Apocynum cannabinum L.
Indianhemp; F or H, P, N

Aristolochiaceae

Aristolochia tomentosa Sims
wooly dutchman's pipe; V, P, N

Asclepiadaceae

Asclepias amplexicaulis Sm.
clasping milkweed; F or H, P, N
Asclepias tuberosa L.
butterfly milkweed; F or H, P, N
Asclepias viridis Walt.
green antelope horn; F or H, P, N

Asteraceae

Achillea millefolium L.
common yarrow; F or H, P, N
Ambrosia artemisiifolia L.
annual ragweed; F or H, A, N
Ambrosia trifida L.
great ragweed; F or H, A, N
Amphiachyris dracunculoides (DC.) Nutt.
prairie broomweed; F or H, A, N
Artemisia ludoviciana Nutt.
white sagebrush; F or H, P, N
Ageratina altissima (L.) King & H.E. Robins.
white snakeroot; F or H, P, N
Antennaria parlinii Fern.
Parlin's pussytoes; F or H, P, N
Bidens bipinnata L.
Spanish needles;F OR H, A, N
Brickellia eupatorioides (L.) Shinners
false boneset; F or H, P, N
Chrysopsis pilosa Nutt.
soft goldenaster; F or H, A, N
Cirsium altissimum (L.) Hill
tall thistle; F or H, P, N
Conyza canadensis (L.) Cronq.
Canadian horseweed; F or H, A, N
Coreposis grandiflora Hogg ex Sweet
largeflower tickseed; F or H, P, N
Coreopsis tinctoria Nutt.
golden tickseed; F or H, A, N
Dracopis amplexicaulis (Vahl) Cass.
clasping coneflower; F or H, A, N
Eclipta prostrata (L.) L.
false daisy; F or H, A, N
Elephantopus carolinianus
Raeusch.Carolina elephantsfoot;
F or H, P, N
Erigeron tenuis Torr. & Gray
slenderleaf fleabane; F or H, P, N
Eupatorium altissimum L.
tall thoroughwort; F or H, P, N
Eupatorium serotinum Michx.
lateflowering thoroughwort;
F or H, P, N
Gaillardia pulchella Foug.
firewheel; F or H, A, N
Gamochaeta purpurea (L.) Cabrera
spoonleaf purple everlasting;
F or H, P, N
Grindelia papposa Nesom & Suh
Spanish gold; F or H, A, N
Helenium amarum (Raf.) H. Rock

Yellowdicks; F or H, A, N
Helianthus annuus L.
common sunflower; F or H, A, N
Helianthus hirsutus Raf.
hairy sunflower; F or H, P, N
Helianthus maximiliani Schrad.
Maximilian sunflower; F or H, P, N
Helianthus petiolaris Nutt.
prairie sunflower; F or H, A, N
Helianthus tuberosus L.
Jerusalem artichoke; F or H, P, N
Heterotheca subaxillaris (Lam.) Britt. & Rusby
camphorweed; F or H, A, N
Hieracium longipilum Torr.
hairy hawkweed; F or H, P, N
Krigia caespitosa (Raf.) Chambers
weedy dwarfdandelion; F or H, A, N
Lactuca canadensis L.
Canada lettuce; F or H, A, N
Lactuca floridana (L.) Gaertn.
woodland lettuce; F or H, A, N
Liatris aspera Michx.
tall blazingstar; F or H, P, N
Liatris punctata Hook.
dotted blazingstar; F or H, P, N
Oligoneuron rigidum (L.) Small
stiff goldenrod; F or H, P, N
Parthenium hysterophorus L.
Santia Maria feverfew; F or H, A, I
Plucea odorata (L.) Cass.
sweetscent; F or H, A, N
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt
rabbittobacco; F or H, A, N
Pyrrhopappus carolinianus (Walt.) DC.
Carolina desert-chicory; F or H, A, N
Ratibida columnifera (Nutt.) Woot. & Standl.
upright prairie coneflower; F or H, P, N
Rudbeckia hirta L.
blackeyed Susan; F or H, P, N
Solidago gigantea Ait.
giant goldenrod; F or H, P, N
Sonchus asper (L.) Hill
spiny sowthistle; F or H, A, I
Symphyotrichum drummondii (Lindl.) Nesom
Drummond's aster; F or H, P, N
Symphyotrichum ericoides (L.) Nesom
white heath aster; F or H, P, N
Symphyotrichum oolentangiense (Riddell) Nesom
skyblue aster; F or H, P, N
Symphyotrichum patens (Ait.) Nesom
late purple aster; F or H, P, N
Symphyotrichum subulatum (Michx.) Nesom
eastern annual saltmarsh aster; F or H, A, N
Taraxacum officinale G.H. Weber ex Wiggers
common dandelion; F or H, P, I
Thelesperma ambiguum Gray
Colorado greenthread; F or H, P, N
Thelesperma filifolium (Hook.) Gray
stiff greenthread; F or H, P, N
Tragopogon dubius Scop.
yellow salsify; F or H, A, I
Verbesina virginica L.
white crownbeard; F or H, P, N
Vernonia baldwinii Torr.
Baldwin's ironweed; F or H, P, N
Xanthium strumarium L.
rough cocklebur; F or H, A, N

Bignoniaceae

Campsis radicans (L.) Seem. ex Bureau
trumpet creeper; V, P, N

Boraginaceae

Buglossoides arvensis (L.) I.M. Johnston
corn gromwell; F or H, A, I
Heliotropium curassavicum L.

salt heliotrope; F or H, A, N
Heliotropium indicum L.
Indian heliotrope; F or H, A, I

Brassicaceae

Arabis canadensis L.
sicklepod; F or H, B, N
Capsella bursa-pastoris (L.) Medik.
shepherd's purse; F or H, A, I
Cardamine parviflora L.
sand bittercress; F or H, A, N
Draba brachycarpa Nutt. ex Torr. & Gray
shortpod draba; F or H, A, N
Draba reptans (Lam.) Fern.
Carolina draba; F or H, A, N
Erysimum repandum L.
spreading wallflower; F or H, A, I
Lepidium densiflorum Schrad.
common pepperweed; F or H, A, N
Lepidium virginicum L.
Virginia pepperwood; F or H, A, N
Rorippa palustris (L.)
bog yellowcress; F or H, A, N
Selenia aurea Nutt.
golden selenia; F or H, A, N

Cactaceae

Opuntia macrorhiza Engelm.
twistspine pricklypear; S, P, N

Campanulaceae

Triodanis perfoliata (L.) Nieuwl.
clasping Venus' looking-glass; F or H, A, N

Caprifoliaceae

Lonicera japonica Thunb.
Japanese honeysuckle; V, P, I
Symphoricarpos orbiculatus Moench
coralberry; S, P, N
Viburnum rufidulum Raf.
rusty blackhaw; T, S, P, N

Caryophyllaceae

Arenaria serpyllifolia L.
thymeleaf sandwort; ; F or H, A, I
Cerastium glomeratum Thuill.
sticky chickweed; F or H, A, I
Dianthus armeria L.
Deptford pink; F or H, A, I
Holosteum umbellatum L.
jagged chickweed; F or H, A, I
Sagina decumbens (Ell.) Torr. & Gray
trailing pearlwort; F or H, A, N
Scleranthus annuus L.
German knotgrass; F or H, A, I
Silene antirrhina L.
sleepy silene; F or H, A, N
Stellaria media (L.) Vill.
common chickweed; F or H, A, I

Celastraceae

Celastrus scandens L.
American bittersweet; V, P, N

Chenopodiaceae

Chenopodium ambrosioides L.
Mexican tea; F or H, A, I
Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats. narrowleaf goosefoot; F or H, A, N

Cistaceae

Lechea mucronata Raf.
hairy pinweed; F or H, P, N
Lechea tenuifolia Michx.
narrowleaf pinweed; F or H, P, N

Clusiaceae

Hypericum punctatum Lam.
spotted St. Johnswort; F or H, P, N

Convolvulaceae

Convolvulus arvensis L.
field bindweed; F or H, P, I
Ipomoea hederacea Jacq.
ivyleaf morning-glory; F or H, A, I
Ipomoea lacunosa L.
whitestar; F or H, A, N

Cornaceae

Cornus drummondii C.A. Mey.
roughleaf dogwood; T, S, P, N

Cucurbitaceae

Melothria pendula L.

Guadeloupe cucumber; F or H, P, N
Sicyos angulatus L.
oneseed burr cucumber;
F or H, A, N

Ebenaceae

Diospyros virginiana L.
common persimmon; T, P, N

Euphorbiaceae

Acalypha monococca (Engelm. ex Gray) L. Mill. & Gandhi
slender threeseed mercury;
F or H, A, N
Acalypha ostryifolia Riddell
pineland threeseed mercury;
F or H, A, N
Acalypha rhomboidea Raf.
Virginia threeseed mercury;
F or H, A, N
Chamaesyce maculata (L.) Small
spotted sandmat; F or H, A, N
Chamaesyce nutans (Lag.) Small
eyebane; F or H, A, N
Chamaesyce serpens (Kunth) Small
matted sandmat; F or H, A, N
Cnidoscolus texanus (Muell.-Arg.) Small
Texas bullnettle; F or H, P, N
Croton glandulosus L.
vente conmigo; F or H, A, N
Croton monanthogynus Michx.
prairie tea; F or H, A, N
Croton texensis (Klotzsch) Muell.-Arg.
Texas croton; F or H, A, N
Euphorbia cyathophora Murr.
fire on the mountain; F or H, A, N
Euphorbia dentata Michx.
toothed spurge; F or H, A, N,
Euphorbia hexagona Nutt. ex Spreng.
sixangle spurge; F or H, A, N
Euphorbia marginata Pursh
snow on the mountain; F or H, A, N
Stillingia sylvatica Garden ex L.
queen's-delight; F or H, P, N
Tragia betonicifolia Nutt.
betonyleaf noseburn; F or H, P, N

Fabaceae

Albizia julibrissin Durazz.
silktree; T, S, P, I
Amorpha canescens Pursh
leadplant; SS, S, P, N
Amorpha fruticosa L.
desert false indigo; S, P, N
Chamaecrista fasciculata (Michx.) Greene
sleeping plant; F or H, A, N
Dalea candida Michx. ex Willd.
white prairie clover; F or H, P, N
Desmanthus illinoensis (Michx.) MacM. ex B.L. Robins. & Fern.
prairie bundleflower; F or H, P, N
Desmodium ciliare (Muhl. ex Willd.) DC.
hairy smallleaf ticktrefoil;
F or H, P, N
Desmodium laevigatum (Nutt.) DC.
smooth ticktrefoil; F or H, P, N
Desmodium nudiflorum (L.) DC.
nakedflower ticktrefoil; F or H, P, N
Desmodium obtusum (Muhl. ex Willd.) DC.
stiff ticktrefoil; F or H, P, N
Desmodium paniculatum (L.) DC.
panicledleaf ticktrefoil; F or H, P, N
Desmodium sessilifolium (Torr.) Torr. & Gray
sessileleaf ticktrefoil; F or H, P, N
Galactia volubilis (L.) Britt.
downy milkpea; F or H, P, N
Gleditsia triacanthos L.
honeylocust; T, S, P, N
Gymnocladus dioicus (L.) K. Koch
Kentucky coffeetree; T, P, N
Lathyrus hirsutus L.
Caley pea; F or H, A, I
Lathyrus pusilllus Ell.
tiny pea; F or H, A, N
Lespedeza capitata Michx.
roundhead lespedeza; F or H, P, N

Lespedeza stuevei Nutt.
tall lespedeza; F or H, P, N
Medicago lupulina L.
black medick; F or H, P, I
Medicago sativa L.
alfalfa; F or H, P, I
Melilotus officinalis (L.) Lam.
yellow sweetclover; F or H, A, I
Psoralidium tenuiflorum (Pursh) Rydb.
slimflower scurfpea; F or H, P, N
Robinia pseudoacacia L.
black locust; T, P, N
Strophostyles helvula (L.) Ell.
trailing fuzzybean; F or H, A, N
Trifolium arvense L.
rabbitfoot clover; F or H, A, I
Trifolium campestre Schreb.
field clover; F or H, A, I
Trifolium vesiculosum Savi
arrowleaf clover; F or H, A, I
Vicia sativa L.
golden vetch; V, F or H, A, I
Vicia villosa Roth
winter vetch: V, F or H, A, I

Fagaceae

Quercus falcata Michx.
southern red oak; T, P, N
Quercus macrocarpa Michx.
bur oak; T, S, P, N
Quercus marilandica Muench.
blackjack oak; T, S, P, N
Quercus muehlenbergii Engelm.
chinkapin oak; T, P, N
Quercus shumardii Buckl.
Shumard's oak; T, S, P, N
Quercus stellata Wangenh.
post oak; T, P, N
Quercus velutina Lam.
black oak; T, P, N

Fumariaceae

Corydalis micrantha
(Engelm. Ex Gray) Gray
smallflower fumewort; F or H, A, N

Gentianaceae

Sabatia campestris Nutt.
Texas star; F or H, A, N

Geraniaceae

Geranium carolinianum L.
Carolina geranium; F or H, A, B, N
Geranium molle L.
dovefoot geranium; F or H, A, I

Hydrophyllaceae

Phacelia strictiflora (Engelm. & Gray) Gray
prairie phacelia; F or H, A, N

Juglandaceae

Carya alba (L.) Nutt. ex Ell.
mockerknut hickory; T, P, N
Carya illinoinensis (Wangenh.) K. Koch
pecan; T, P, N
Carya texana Buckl.
black hickory; T, P, N
Juglans nigra L.
black walnut; T, P, N

Lamiaceae

Hedeoma hispida Pursh
rough false pennyroyal; F or H, A, N
Lamium amplexicaule L.
henbit deadnettle; F or H, A, I
Lamium purpureum L.
purple deadnettle; F or H, A, I
Monarda fistulosa L.
wild bergamot; F or H, P, N
Monarda punctata L.
spotted beebalm; F or H, A, N
Salvia azurea Michx. ex Lam.
azure blue sage; F or H, P, N
Teucrium canadense L.
Canada germander; F or H, P, N

Lythraceae

Ammannia coccinea Rottb.
valley redstem; F or H, A, N
Lythrum alatum Pursh
winged lythrum; F or H, P, N

Malvaceae

Abutilon theophrasti Medik.

velvetleaf; F or H, A, I
Callirhoe alcaeoides (Michx.) Gray
light poppymallow; F or H, P, N
Callirhoe involucrata (Torr. & Gray) Gray
purple poppymallow; F or H, P, N
Sida spinosa L.
prickly fanpetals; F or H, A, N

Menipsermaceae
Cocculus carolinus (L.) DC.
Carolina coralbead; V, S, P, N
Molluginaceae
Mollugo verticillata L.
green carpetweed; F or H, A, N
Moraceae
Maclura pomifera (Raf.) Schneid.
osage orange; T, S, P, N
Morus alba L.
white mulberry; T, S, P, I
Nyctaginaceae
Mirabilis nyctaginea (Michx.) MacM.
heartleaf four o'clock; F or H, P, N
Oleaceae
Fraxinus americana L.
white ash; T, P, N
Onagraceae
Gaura longiflora Spach
longflower beeblossom; F or H, A, N
Gaura mollis James
velvetweed; F or H, A, N
Ludwigia peploides (Kunth) Raven
floating primrosewillow; F or H, P, N
Oenothera jamesii Torr. & Gray
trumpet evening primrose; F or H, P, N
Oenothera rhombipetala Nutt. ex Torr. & Gray
fourpoint evening primrose; F or H, P, N
Oxalidaceae
Oxalis stricta L.
common yellow oxalis; F or H, P, N
Oxalis violacea L.
violet wood sorrel; F or H, P, N
Passifloraceae
Passiflora incarnata L.
purple passionflower; F or H, P, N
Passiflora lutea L.
yellow passionflower; F or H, P, N

Phytolaccaceae
Phytolacca americana L.
American pokeweed; F or H, P, N
Plantaginaceae
Plantago aristata Michx.
largebracted plantain; F or H, A, N
Plantago patagonica Jacq.
woolly plantain; F or H, A, N
Plantago rhodosperma Dcne.
redseed plantain; F or H, A, N
Plantago rugelii Dcne.
blackseed plantain; F or H, P, N
Platanaceae
Platanus occidentalis L.
American sycamore; T, P, N
Polemoniaceae
Phlox pilosa L.
downy phlox; F or H, P, N
Polygalaceae
Polygala incarnata L.
procession flower; F or H, A, N
Polygonaceae
Polygonum amphibium L.
water knotweed; F or H, P, N
Polygonum aviculare L.
prostrate knotweed; F or H, A, I
Polygonum lapathifolium L.
curlytop knotweed; F or H, A, N
Polygonum persicaria L.
spotted ladysthumb; F or H, A, N
Polygonum punctatum Ell.
dotted smartweed; F or H, A, N
Polygonum ramosissimum Michx.

bushy knotweed; F or H, A, N
Polygonum scandens L.
climbing false buckwheat; F or H, P, N
Polygonum virginianum L.
jumpseed; F or H, P, N
Rumex crispus L.
curly dock; F or H, P, I

Rumex hastatulus Baldw.
heartwing sorrel; F or H, P, N
Rumex pulcher L.
fiddle dock; F or H, P, I

Portulacaceae
Claytonia virginica L.
Virginia springbeauty; F or H, P, N
Portulaca oleracea L.
little hogweed; F or H, A, N

Primulaceae
Androsace occidentalis Pursh
western rockjasmine; F or H, A, N

Ranunculuaceae
Delphinium carolinianum Walt.
Carolina larkspur; F or H, P, N
Myosurus minimus L.
tiny mousetail; F or H, A, N
Ranunculus abortivus L.
littleaf buttercup; F or H, P, N
Ranunculus sceleratus L.
cursed buttercup; F or H, A, N

Rosaceae
Geum canadense Jacq.
white avens; F or H, P, N
Prunus angustifolia Marsh.
Chickasaw plum; T, S, P, N
Prunus mexicana S. Wats.
Mexican plum; T, S, P, N
Prunus serotina Ehrh.
black cherry; T, S, P, N
Rubus trivialis Michx.
southern dewberry; S, V, P, N

Rubiaceae
Cephalanthus occidentalis L.
common buttonbush; T, S, P, N
Diodia teres Walt.
poorjoe; F or H, A, P, N
Diodia virginiana L.
Virginia buttonweed; F or H, A, N
Galium aparine L.
stickywilly; F or H, A, N
Galium pilosum Ait.
hairy bedstraw; F or H, P, N
Galium virgatum Nutt.
southwestern bedstraw; F or H, A, N
Houstonia pusilla Schoepf
tiny bluet; F or H, A, N

Saliaceae
Populus deltoides Bartr. ex Marsh.
eastern cottonwood; T, P, N
Salix nigra Marsh.
black willow; T, P, N

Sapindaceae
Cardiospermum halicacabum L.
love in a puff; F or H, A, N
Sapindus saponaria L. var. *drummondii*
(Hook. & Arn.) L. Benson
western soapberry; T, S, P, N

Sapotaceae
Sideroxylon lanuginosum Michx.
gumbully; T, S, P, N

Scrophulariaceae
Castilleja indivisa Engelm.
entireleaf Indian paintbrush; F or H, A, N
Leucospora multifida (Michx.) Nutt.
narrowleaf paleseed; F or H, A, N
Lindernia dubia (L.) Pennell
yellowseed false pimpernel; F or H, A, N
Nuttallanthus texanus (Scheele) D.A. Sutton
Texas toadflax; F or H, A, N
Scrophularia marilandica L.
carpenter's square; F or H, P, N

Verbascum thapsus L.
common mullein; F or H, B, I
Veronica polita Fries
gray field speedwell; F or H, A, I

Solanaceae

Physalis angulata L.
cutleaf groundcherry; F or H, A, N
Physalis heterophylla Nees
clammy groundcherry; F or H, P, N
Solanum carolinense L.
Carolina horsenettle; F or H, P, N
Solanum dimidiatum Raf.
western horsenettle; F or H, P, N
Solanum elaegnifolium Cav.
silverleaf nightshade; F or H, P, N
Solanum ptychanthum Dunal
West Indian nightshade; F or H,A,N
Solanum rostratum Dunal
buffalobur nightshade; F or H, A, N

Tamaricaceae

Tamarix chinensis Lour.
fivestamen tamarisk; T, S, P, I

Ulmaceae

Celtis laevigata Willd.
sugarberry; T, S, P, N
Ulmus americana L.
American elm; T, P, N
Ulmus rubra Muhl.
slippery elm; T, P, N

Urticaceae

Laportea canadensis (L.) Weddell
Canadian woodnettle; F or H, P, N
Parietaria pensylvanica Muhl. ex Willd.
Pennyslvania pellitory; F or H, A, N

Valerianaceae

Valerianella radiata (L.) Dufr.
beaked cornsalad; F or H, A, N

Verbenaceae

Glandularia canadensis (L.) Nutt.
rose mock vervain; F or H, P, N
Glandularia pumila (Rydb.) Umber
pink mock vervain; F or H, A, N
Phyla nodiflora (L.) Greene
turkey tangle fogfruit; F or H, P, N
Verbena stricta Vent.
hoary verbena; F or H, P, N
Verbena urticifolia L.
white vervain; F or H, P, N

Violaceae

Viola affinis Le Conte
sand violet; F or H, P, N
Viola bicolor Pursh
field pansy; F or H, A, N

Vitaceae

Ampelopsis cordata Michx.
heartleaf peppervine; V, P, N
Cissus trifoliata (L.) L.
sorrelvine: V, SS, P, N
Parthenocissus quinquefolia (L.) Planch.
Virginia creeper; V, P, N
Vitis cinera (Engelm.) Millard
graybark grape; V, P, N
Vitis riparia Michx.
riverbank grape; V, P, N
Vitis vulpina L.
frost grape; V, P, N

Zygophyllaceae

Tribulus terrestris L.
puncturevine; F or H, A, I

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Floristic survey of The Nature Conservancy's Pennington Creek preserve in Johnston County, Oklahoma 1997

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This study was conducted as one part of an overall biological assessment of The Nature Conservancy's Pennington Creek site. A 9.6 hectare area was surveyed during the 1995 and 1996 growing seasons for plants in fertile condition. They were collected, identified and voucher specimens were deposited in the OSU Herbarium (OKLA). Physiographic and ecological aspects of the site were described using Geographic Information System (GIS) techniques. Two hundred-three species representing 157 genera and 63 families were collected. Four plant communities are present: forest, grassland, granitic outcrop, and riparian. Characteristic taxa of the forest community include *Quercus stellata, Q. marilandica, Carya texana, C. cordiformis, Symphoricarpos orbiculatus, and Elymus canadensis. Tridens flavus, Setaria lutescens, Sorghastrum nutans* and *Gaillardia pulchella* are dominants found in the grasslands. The granitic outcrop areas provide habitat for: *Sedum pulchellum, S. nuttallianum, Krigia virginica, Chaetopappa asteroides,* and *Polypodium polypodioides.* Characteristic species of the riparian community include *Carex* spp., *Cyperus* spp., *Chasmanthium latifolium, Platanus occidentalis,* and *Alnus maritima.*

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INTRODUCTION

Floristic studies have long been an important means of understanding the plants, vegetation, and ecosystems that surround us. Traditionally floristic surveys have covered relatively large areas, but much can be learned from the survey of small ones as well. One such area is a preserve of The Nature Conservancy located in Johnston County in south-central Oklahoma. Situated on an outcrop of Precambrian granite, it is a 3.2 hectare site that has a number of plant communities; deciduous forest, grasslands, riparian, and granitic outcrop, each with a characteristic assemblage of species. The significance of this site is that exposed Precambrian granite is relatively infrequent in Oklahoma, composing less than 1 percent of the rock outcrop cover of the state and restricted primarily to a small portion in the south-central part (1). These Precambrian outcrop areas typically have an interesting variety of plants and plant communities (2, 3).

In late 1994 the Oklahoma Chapter of The Conservancy acquired the site via donation by the landowner. In order to determine whether it was biologically significant and worthy of protection in accordance with its goals, The Conservancy required a floristic survey of the vascular plants present. This survey was to be one part of an overall biological assessment of the property. During the

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1995 and 1996 growing seasons, such a survey was conducted of both the site and the surrounding area of approximately 6.4 hectares. In addition to documenting the plants present, mapping of the site's different communities and physiographic features using Geographic Information Systems (GIS) techniques was completed. The objectives of this work were: 1) to compile a list of the vascular plant species present, 2) to document the taxa present via herbarium specimens, 3) to compile basic ecological and physiographic data and 4) to produce a site-specific vegetation map using GIS techniques.

SITE DESCRIPTION

The site of the Conservancy's Pennington Creek Nature Sanctuary and surrounding area is approximately 9.6 hectares, located in central Johnston County, (T3S, R6E, Sec.5, SW ¼ SW ¼ and Sec. 6 SE ¼). Located 8.0 km (5 mi) north and 3.2 km (2 mi) west of Tishomingo, it is bordered by Pennington Creek and a graveled county road on the northeast side. The site is located within the Arbuckle Uplift geomorphic province and the Grand Praire land resources area. The topography consists of gently rolling hills and plains. Ordovician and Cretaceous limestones and Precambrian granites are the parent rock in the area. These granites and rhyolites are the oldest strata in Oklahoma, dating from 1.05 to 1.35 billion years ago, and contribute to this site's uniqueness. They were exposed as sedimentary cover eroded from above them.

Soil types present are the Chigley-Granite outcrop complex with 1 to 8 percent slope and Gracemont soils. The Chigley-Granite outcrop complex consists of a mixture of soils and outcrops of granite. The Chigley soil is a gently sloping, moderately well drained soil on uplands. Its water table is below a depth of 1 m from February to May and the rate of water intake is moderately slow.

The Gracemont soils are characterized as nearly level to gently sloping, somewhat poorly drained soils in flood plains. Their pattern of soils is intricate; about 35% of an area has a surface layer of loamy fine sand, and 50% has a surface layer of fine sandy loam. These soils are next to the stream channels; the water table is below a depth of 0.1-1.0 m (4-40 in) for most of the year; rate of water intake is rapid.

Precipitation for the area of the site averages about 101.8 cm (40 in) while the average temperature is 16.7 ^{o}C (62^{o}F). Of the total annual precipitation, 59% usually falls between the months of April and September. The range of precipitation effectiveness values is from 65 to to 50. The growing season for Johnston County ranges from 189 to 230 days. The dominant vegetation type for the area is Post Oak-Blackjack Forest.

METHOD OF STUDY

The major component of this research was the collection and identification of the vascular plants found at the site. During 13 trips from March 1995 to October 1996, vascular plants in fertile condition were collection while the site was systematically traversed on foot. Traditional taxonomic procedures of collecting, pressing, drying, and preservation were employed. Unknown species were identified using the resources of the OSU Herbarium (OKLA). Some plants were identified only to genus because they were not in flower or fruit. Nomenclature was based primarily on that of Waterfall (8) and Gleason and Conquist (9). Common names were taken from Taylor and Taylor (10). Voucher

specimens were deposited in the OSU Herbarium.

The GIS comprised spatial data layers collected in either digital or analog form from a U.S.G.S. aerial photograph, topographic quadrangle map, and the soil survey map of Johnston County. Elevation and soils coverages were digitized from USGS quad map and the soil survey map of Johnston County, respectively. Coverages of plant communities, road, and creek were derived directly from the digitized aerial photograph. Each spatial data layer was accompanied by a table of attribute or non-spatial data. The plant species coverage included attribute data for a representative group of species from each plant community. Each record in the table comprised scientific name, common name, plant community, habit, collection date, collection number and relative abundance. Spatial relationships between distribution of plant species and parameters of plant communities were compared.

COLLECTION OF SPECIMENS

Field notes were compiled as each plant was collected and included: a description of the plant's habitat, morphology, topography, associated species; the date; collection number, and any additional comments. These notes were made with a microcassette recorder and later transcribed onto individual data collection sheets for each specimen. A small site map in the lower-right corner of each sheet allowed the general position of each plant collected to be recorded.

Specimens were pressed and dried at approximately 43^{o}C for 2-3 days. The specimens were then placed in a freezer at 0^{o}C for a minimum of 1 week. Freezing ensured that all insects and other potential pests were dead before being placed in the herbarium.

Most specimens were identified using *Key of the Vascular Plant Families of Oklahoma* (17) along with U.T. Waterfall's *Keys to the Flora of Oklahoma* (8). Keys in the *Flora of the Great Plains,* Correll and Johnston's *Flora of Texas*, *Gray's Manual of Botany,* and Hampton's treatment of the Amaranthaceae (21) were also used to identify plant specimens and herbarium sheets from the OSU herbarium were used to verify identifications. Nomenclature was based primarily on that of Waterfall (8) and Gleason and Cronquist (9).

After the specimens were identified, pressed, and dried they were mounted on herbarium paper. Labels on each specimen provide the scientific name, common name, topography, associated species, collection number, date collected, and relative location of the plant. Each specimen was glued to acid-free herbarium paper with Elmer's Wood Glue®, allowed to dry and then refrozen to kill insects before being accessioned to the OSU herbarium.

GIS DATA

Multiple layers of data were used for this project which was created using the Arcview 3.0 ® program developed by the Environmental Systems Research Institute (ESRI). The first steps of the project included scanning, registering, and referencing a U.S.G.S. aerial photograph of the preserve. This data layer was assigned real-world coordinates using U.T.M. coordinates. Four derived coverages including property boundaries, road, creek, and plant communities were created on-screen from the digitized aerial photo. The road, creek, and plant community themes were created as polygon coverages and the property boundary, elevation, and soils themes are line coverages. The elevation and soils

coverages were digitized directly from a U.S.G.S. quad map (Reagan series) and the Johnston County Soil Survey, respectively. The plant species coverage was added as points within the boundaries of the plant community coverages.

Most of the attribute data came from the derived coverage plant communities. The soil attribute data supplied important information for each plant community. Along with actual soil types, information regarding their depths and drainage properties was included. The point attribute data of the plant species coverage were added from data collected during the 1995-1996 field research seasons.

Analysis of the data represented within each coverage was done as a point-in-polygon analysis. To gain an understanding of the relationships between each species's distribution and the physical features of the site, the plant community layers and the soils layer were linked to each taxon.

Ten coverages were generated in the GIS study: they were study area, species, elevation, soils, penncreek, riparian community, granite community, grassland community, forest community, and road. For each coverage two files, shape and text, were created. The shape file depicts coverages as either polygon, line, or point. The text files describe the shape files by means of tabular attribute or aspatial data. For each coverage, an attribute table comprising three to seven fields and one to 100 records was created. The attribute data below allows coverages to be linked or joined via matching fields.

GIS ATTRIBUTE TABLES

Study Area:

Shape	ID#	Boundary Line
Line	1	Study Area Boundary

Elevation:

Shape	ID#	Elevation Line
line	1	820 feet
line	2	830 feet
line	3	840 feet
line	4	850 feet

Soils:

Shape	ID#	Soil Type	Soil Name	Depth	High Water Table Depth
line	1	6	Chigley Granite Outcrop	0-72 in.	3.0 - 4.0 ft.
line	2	27	Gracemont	0-74 in.	0.5 – 3.0 ft.

Riparian Community

Shape	ID#	Community	
polygon	1	RP	Riparian
polygon	2	RP	Riparian

Forest Community

Shape	ID#	Community	
polygon	1	FO	Forest

polygon	2	FO	Forest

Grassland Community

Shape	ID#	Community	
polygon	1	GR	Grassland
polygon	2	GR	Grassland

Granite Community

Shape	ID#	Community	
polygon	1	GO	Granite outcrop-boulder
polygon	2	GO	Granite outcrop-ground level

Road:

Shape	ID#	Road Type
polygon	1	County Road

RESULTS AND DISCUSSION

Two hundred-three species in 157 genera and 64 families were encountered in this survey (Appendices C-E). The four largest families were the Asteraceae, Poaceae, Fabaceae, and the Cyperaceae (Table 1).These taxa were representative of riparian habitats, post oak-blackjack woods, and prairies.

Table: Number of Genera and Species for the largest Families Present at The Nature Conserancy's Pennington Creek Site.

Family	Genera	Species
Asteraceae	24	32
Poaceae	21	28
Fabaceae	11	14
Cyperaceae	4	10

Species designated by the U.S. Fish and Wildlife Service (11) as endangered, threatened, or Category 1 were not encountered. Although cited as present in the county, *Carex fissa* (S2-imperiled in the state) and *Penstemon oklahomensis* (S3-very rare in the state) were not discovered. The only species presently ranked by the Oklahoma Natural Heritage Inventory (12) as S1, critically imperiled in the state or S2 was *Alnus maritima*. A species of interest because of its unusual distribution is *Alnus maritima,* seaside alder. It is found only in Johnston and Pontotoc Counties along the Blue River, its tributaries, and Pennington Creek (13). This shrub or small tree comprises large populations on the Delmarva Peninsula of southern Delaware and eastern Maryland. The seaside alder's presence in south-central Oklahoma is unexplained. Documentation of the species' existence in the area dates from 1872 (14). Another riparian plant of interest is *Lobelia cardinalis*. It is an example of a taxon encountered less frequently in its natural setting due to extensive collecting by plant collectors and gardeners.

Present at the preserve are four distinct plant communities: forest, grassland, granitic outcrop, and riparian. The forest community is the largest. It is composed of characteristic crosstimbers taxa. The trees are oak-hickory dominants (15) and include: *Quercus stellata, Q. marilandica, Carya texana, C. cordiformis, C. illinoensis, Ulmus alata, and U. rubra.* Dominant shrubby taxa include *Symphoricarpos orbiculatus* and

Rhus copallina. Common herbaceous species present include *Elymus canadensis, Geum canadense, Antennaria plantaginifolia,* and *Carex caroliniana.*

Small grassland communities are present in openings of the forest community and consist of a mixture of grasses and forbs. Typical species include *Tridens flavus, Gaillardia pulchella, Sorghastrum nutans, Coreopsis tinctoria, Castilleja indivisa, Setaria lutescens,* and *Bouteloua curtipendula*. The granitic outcrop community is the most unique community of the site. It occurs on the shallow, loose soils surrounding the ground-level granite domes. These shallow soils support species such as *Sedum pulchellum, S. nuttallianum, Chaetopappa asteroides* and *Krigia virginica.* Many of these species are typical of early successional stages in granite outcrop communities (16). There are also large granite boulders throughout the site, some of which provide habitat on their surfaces or in crevices for taxa such as *Polypodium polypodioides*, *Eragrostis capillaris,* and *Woodsia obtusa.*

The riparian community is characterized by herbaceous species such as *Chasmanthium latifolium, Justicia americana, Equisetum hyemale, Ranunculus hispidus,* and *Lobelia cardinalis*. Woody species present include *Platanus occidentalis* and *Alnus maritima.* Aquatic macrophytes were not observed in the creek.

The GIS permitted comparison of plant distribution and community parameters by creating multiple layers of spatial data and accompanying attribute data. For example, the distribution of *Sedum nuttallianum* and *S. pulchellum* correlated with the occurrence of the Precambrian granite outcrops and the distribution of *Lobelia cardinalis* with the occurrence of riparian habitat.

ADDENDUM

Isoetes butleri
September 14, 1997

On two separate dates (May 15 and 31, 1997, *Isoetes butleri*, Butler's Quillwort, was found on the Nature Conservancy's property at Pennington Creek. This is an important plant species due to its S1 ranking by the Oklahoma Natural Heritage Program. This ranking states that this particular species is critically imperiled in Oklahoma because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor of its biology making it especially vulnerable to extinction (12).

This perennial aquatic or amphibious plant is found usually from March to June and is most often associated with limestone or calcareous soils (18) but seems to be at home among the granitic outcrops characteristic of central Johnston County. This species was not found or documented before May 1997 due to the extremely dry conditions during the 1996 collecting season. Steady amounts of precipitation during the spring of 1997 helped create conditions required by *Isoetes butleri*. The presence of *Isoetes butleri* warrants some degree of protection for this site.

Author's Note:

This site is no longer owned by The Nature Conservency.

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Flora of Pennington Creek Preserve

FAMILY	SPECIES	COMMON NAME
Acanthaceae	**Juss.**	**Acanthus family**
	Justicia Americana (L.) Vahl	
	Ruellia Strepens L.	
Amaranthaceae	**Juss.**	**Pigweed family**
	Amaranthus rudis Sauer	
Anacardiaceae	**Lindl.**	**Cashew family**
	Rhus copallina L.	
	Toxicodendron radicans	Poison Ivy
Apiaceae	**Lindl.**	
	Chaerophyllum procumbens L.	
	C. tainturieri Hook.	
	Cicuta maculata L.	
	Limnosciadium pinnatum (DC.) Math. & Const.	
	Ptilimnium nuttallii (DC.) Britt.	
	Sanicula canadensis L.	
	Zizia aurea (L.) Koch	
Apocynaceae	**Juss.**	**Dogbane family**
	Amsonia ciliata Walt.	
Aquifoliaceae	**Bartl.**	**Holly family**
	Ilex decidua Walt.	
Aristolochiaceae	**Juss.**	**Birthwort family**
	Aristolochia tomentosa Sims	
Asclepiadaceae	**R. Br.**	**Milkweed family**
	Asclepias asperula(Dcne.) Woods	
	A. viridis Walt.	
	Matelea sp.	
Aspleniaceae	**Mett. Ex A.B. Frank**	**Spleenwort family**
	Asplenium platyneuron (L.) D.C. Eat.	
Asteraceae	**Dum.**	**Sunflower family**
	Achillea millefolium L.	
	Actinomeris alternifolia (L.) DC.	
	Antennaria plantaginifolia (L.) DC.	
	Aster azureus Lindl.	
	A. sagittifolius Willd.	
	Bidens polylepis Blake	
	Chaetopappa asteroides DC.	
	Chrysopsis pilosa Nutt.	
	Coreopsis tinctoria Forma *tinctoria* Nutt.	
	Elephantopus carolinianus Raeusch.	

Erigeron philadelphicus L.
E. pulchellus Michx.
Eupatorium incarnatum Walt.
E. rugosum Houtt.
E. serotinum Michx.
Gaillardia pulchella Foug.
Gnaphalium purpureum L.
Helenium amarum var. *amarum* (Raf.) Rock
Helianthus laetiflorus Pers.
Hymenopappus tenuifolius Pursh.
Krigia oppositifolia Raf.
K. virginica (L.) Willd.
Lactuca canadensis L.
Pyrrhopappus carolinianus (Walt.) DC.
P. scaposus DC.
Rudbeckia hirta L.
R. subtomentosa Pursh.
R. triloba L.
Senecio aureus L.
Solidago delicatula Small
Verbesina virginica L.
Vernonia baldwinii Torr.

Betulaceae S.F. Gray **Birch family**

Almus maritima Muhl. Ex Nutt.

Brassicaceae Burnett **Mustard family**

Cardamine parviflora var. *arenicola* (Britt). O.E. Schul
C. pensylvanica Muhl.
Lepidium virginicum L.

Cactaceae Juss. **Cactus family**

Opuntia macrorhiza Engelm.

Campanulaceae Juss.

Lobelia appendiculata DC.
L. cardinalis L.
Specularia leptocarpa (Nuttali) Gray
S. perfoliata (L.) A. DC.

Caprifoliaceae Juss. **Honeysuckle family**

Symphoricarpos orbiculatus Moench.
Viburnum prunifolium L.

Caryophyllaceae Juss. **Pink family**

Arenaria serpyllifolia L.
Stellaria media L.

Clusiaceae Lindl. **St. John's-wort family**

Hypericum drummondii (Grev. & Hook) T & G
H. punctatum Lam.

Commelinaceae R. Br. **Spiderwort family**

Commelina communis L.

Cornaceae Dum. **Dogwood family**
Cornus drummondii Meyer
Crassulaceae DC. **Stonecrop family**
Sedum nutallianum Raf.
S. pulchellum Michx.
Cucurbitaceae Juss. **Cucumber family**
Melothria pendula L.
Cupressaceae Rich. Ex Bartl. **Cypress family**
Juniperus virginiana L.
Cyperaceae Juss. **Sedge family**
Carex blanda Dewey
C. caroliniana Schwein
C. microdonta Torr. & Hook
C. planostachys Mack.
C. shortiana Dew.
C. stricta Lam.
Cyperus ovularis (Michx.) Torr.
C. strigosus L.
Eleocharis sp.
Scirpus sp.
Dryopteridaceae Ching **Woodfern family**
Woodsia obtusa (Spreng.) Torr.
Equisitaceae Rich. **Horsetail family**
Equisetum hyemale L.
Euphorbiaceae Juss.
Croton lindheimerianus Scheele.
Euphorbia dentata Michx.
E. maculata L.
E. nutans Lag.
Tragia ramosa Torr.
Fabaceae Lindl. **Bean family**
Amorpha fruticosa L.
Baptisia leucophaea Nutt.
Cassia fasiculata Michx.
Cercis canadensis L.
Desmodium canescens (L.) DC.
D. glutinosum (Muhl. Ex Willd.) Wood
D. nudiflorum (L.) DC.
Lespedeza cuneata (Dumont) G. Don
L. virginica (L.) Britt.
Neptunea lutea (Leavenw.) Benth.
Psoralea tenuiflora Pursh
Strophostyles helvola (L.) Ell.
Trifolium dubium Sibth.
Vicia villosa Roth.
Fagaceae Dum. **Oak family**

Quercus macrocarpa Michx.
Q. marilandica Muench.
Q. muehlenbergii Engelm.
Q. shumardii Buckl.
Q. stellata Wang.

Fumariaceae DC. Fumitory family
Corydalis micrantha (Engelm.) Gray

Gentianaceae Juss. Gentian family
Sabatia campestris Nutt.

Hydrophyllaceae R. Br.
Phacelia strictiflora (Engelm. & Gray) Gray

Iridaceae Juss.
Sisyrinchium angustifolium P. Mill.

Juglandaceae A. Rich. Ex Kunth. Walnut family
Carya cordiformis (Wang.) K. Koch
C. illinoensis (Wang.) K. Koch
C. texana Buckl.
Juglans nigra L.

Juncaceae Juss. Rush family
Juncus marginatus Rostk.
Juncus sp.

Lamiaceae Lindl. Mint family
Hedeoma hispida Pursh.
Monarda fistulosa L.
Prunella vulgaris L.
Satureja arkansana (Nutt) Briq.
Scutellaria parvula Michx.

Lilaceae Juss. Lily family
Allium canadense L.
Hypoxis hirsuta (L.) Coville
Nothoscordum bivalve (L.) Britton
Polygonatum canaliculatum (Muhl.) Pursh.

Lythraceae J. St.-Hil. Loosestrife family
Lythrum alatum Pursh

Malvaceae Juss. Mallow family
Callirhoe involucrata (T. & G.) A.

Menispermaceae Juss. Moonseed family
Cocculus carolinus (L.) DC.

Moraceae Link Mulberry family
Maclura pomifera (Raf.) Schneid.
Morus rubra L.

Nyctaginaceae Juss. Four O'clock Family
Mirabilis linearis (Pursh.) Heimerl.

Oleaceae Hoffmsg. & Link Olive family
Fraxinus americana L.

Onagraceae Juss. Evening Primrose family

Gaura biennis L. var. *pitcheri* Pickering
Ludwigia alternifolia L.
Oenothera linifolia Nutt.

Oxalidaceae R. Br. Wood Sorrel family
Oxalis corniculata L.
Plantaginaceae Juss. Plantain family
Plantago purshii R. & S.
P. virginica L.
P. wrightiana Dcne.
Plantanaeae Dum. Sycamore family
Platanus occidentalis L.
Poaceae Barnh. Grass family
Agrostis scabra Willd.
Aira elegans Willd. Ex Gaudin
Bothriochloa saccharoides (Sw.) Rydb.
Bouteloua curtipendula (Michs.) Torr.
Bromus japonicus Thunb. Ex Murr.
B. pubescens Muhl. Ex Willd.
B. purgans L.
Chasmanthium latifolium (Michx.) Yates
Cinna arundinacea L.
Echinochloa crus-galli (L.) Beauv.
Elymus virginicus L.
Eragrostis capillaris (L.) Nees
E. spectabilis (Pursh.) Steud.
Festuca arundinacea Schreb.
Lolium multiflorum Lam.
Muhlenbergia sobolifera (Muhl.) Trin.
Panicum acuminatum Swartz.
P. anceps Michx.
P. clandestinus L.
P. laxiflorum Lam.
Paspalum dilatatum Poir.
Setaria lutescens (Weigel) Hubb.
Sorghastrum nutans (L.) Nash
Sorghum halepense (L.) Pers.
Sphenopholis obtusata (Michx.) Scribn.
Sporobolus clandestinus (Biehler) Hitchc.
Tridens flavus (L.) Hitchc.
Polemoniaceae Juss. Polemonium family
Gilia rubra (L.) Wherry
Polygonaceae Juss. Buckwheat family
Polygonum punctatum Ell.
Rumex hastatulus Baldw.
Polypodiaceae S. F. Gray True Fern family

Polypodium polypodioides (L.) Watt

Primulaceae Vent. **Primrose family**

Samolus parviflorus Raf.

Ranunculaceae Juss. **Buttercup family**

Delphinium tricorne Michx.
Ranunculus sp.
Ranunculus fascicularis Muhl.
R. hispidus Michx.

Rhamnaceae Juss. **Buckthorn family**

Berchemia scandens (Hill) K. Koch
Rhamnus caroliniana Walt.

Rosaceae Juss. **Rose family**

Geum canadense Jacq. var. *camporum* (Rydb.) Fern.
Prunus mexicana S. Wats.
Rosa setigera var. *setigera* Michx.
Rubus sp.

Rubiaceae Juss. **Madder family**

Cephalanthus occidentalis L.
Diodia teres Walt.
Galium aparine L.
G. pilosum Ait.
Hedyotis crassifolia Raf.

Rutaceae Juss. **Citrus family**

Zanthoxylum americanum Mill.

Sapotaceae Juss. **Sapodilla family**

Bumelia lanuginosa (Michx.) Pers.

Scrophulariaceae **Figwort family**

Castilleja indivisa Engelm.
Collinsia violacea Nutt.
Linaria canadensis (L.) Dumont]

Smilaceae Vent. **Greenbrier family**

Smilax bona-nox L.

Ulmaceae Mirb. **Elm family**

Ulmus alata Michx.
U. rubra Muhl.

Valerianaceae Batsch **Valerian family**

Valerianella radiata (L.) Dufr.

Verbenaceae St.-Hil. **Vervain family**

Phryma leptostachya L.
Verbena urticifolia L.

Violaceae Batsch **Violet family**

Viola langloisii Greene
V. rafinesquii Greene
V. sororia Willd.

Vitaceae Juss. **Grape family**

Vitis acerifolia Raf.

Historical accounts of the transformation of a prairie town

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Abstract

Prior to European settlement, the area that would later become Norman, Oklahoma was dominated by prairie vegetation. Woody vegetation was limited to riparian zones and isolated groves presumably protected from the effects of fire. The contemporary landscape of Norman, stands in stark contrast to this "treeless" prairie, and is now characterized by a so-called urban forest. In this paper, we analyze a number of archival sources, ranging from early expedition and traveler accounts to post-settlement photography in order to qualitatively assess the nature of the landscape in and around the present-day city of Norman prior to and immediately following European settlement. We also utilize repeat photography to document the floristic and vegetation changes that have occurred. We found that the pre-European settlement landscape was characterized by rolling prairies heavily influenced by the grazing of black-tailed prairie dogs (*Cynomys ludovicianus*), bison (*Bison bison*), and pronghorn antelope (*Antilocapra americana*). Forbs were limited and herbaceous vegetation was dominated primarily by closely grazed grasses. Woody vegetation was limited primarily to watercourses and ravines, though numerous accounts cite thickets of oaks (*Quercus* spp.) occurring in the adjacent cross timbers. Today, the vegetation of Norman is characterized by the dominance of woody vegetation. Within Norman's historical residential areas, commonly occurring species include hackberry (*Celtis occidentalis*), Shumard's oak (*Q. shumardii*), silver maple (*Acer saccharinum*), and sycamore (*Platanus occidentalis*).

INTRODUCTION

A contemporary aerial view of Norman, Oklahoma, (Table; Figure 1) shows a landscape replete with trees and sloping gently from northwest to southeast. Below the seemingly dense canopy lies Norman's residential and commercial areas, all but obscured by the towering sycamore (*Platanus occidentalis* L.), hackberry (*Celtis occidentalis* L.), pecan (*Carya illinoensis* (Wangenh.) K. Koch, elm (*Ulmus spp*.), and numerous other species, native and non-native alike. Unknown to many, this urban forest is an anomaly, standing in stark contrast to what once was the standard throughout much of the southern Great Plains. While the North American prairies that covered more than 350 million ha in the Central Lowlands prior to European settlement (Clements 1920; Gleason 1922;

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Axelrod 1985) have succumbed largely to the plow and urban sprawl, Norman's vegetative fate resided in earlier settlers' conception of an ideal environment (Gumprecht 2001). Aggressive tree planting fueled by these notions and widespread fire suppression followed a half-century of belligerent extirpation of native flora and fauna. The result has been an environment quite unlike the surrounding matrix of monoculture agriculture, remnant grasslands, and post oak-black jack oak (*Quercus stellata* Wang.-*Q. marilandica* Muench.) woodlands.

In this paper, we use a number of archival sources, ranging from early traveler accounts to historical photographs to qualitatively assess the pre-European settlement vegetation of the area that would later become Norman. We also utilize repeat photography, the practice of finding the original location of a historic photograph of a landscape, determining and re-occupying the original camera position, and taking a repeat photograph of the same scene (Bahre 1991; Veblen and Lorenz 1991), as a means to document the rapid transformation of one of the last vestiges of the North American prairies. The results presented here are preliminary, and will later be incorporated into a larger study that seeks to determine the biogeographic and ecological implications of afforestation of former prairie environments.

MATERIALS AND METHODS

Study Area

The city of Norman is the county seat of Cleveland County and located in central Oklahoma approximately 28 kilometers south of the state capital in Oklahoma City. Norman currently covers an area of 49,083 ha, of which approximately 3,519 ha are urban. The area primarily under consideration for this study, though, encompasses the original Norman townsite, as well as the adjacent areas that were developed within forty years of the initial European settlement (core area; Figure 2). Norman has the third largest population in the state (USCB 2000). European settlement began in 1889 (Womack 1976; Gumprecht 2001) and has increased at a steady rate since. The first census enumeration occurred in June 1890 and placed Norman's population at 817 (Womack 1976). The most recent census enumeration places the population of Norman at 95,694 (USCB 2000).

The topography is generally flat to rolling and slopes from an elevation of 349 m to 313 m. Mean annual precipitation is 148 mm (37.6 in.) with the precipitation maxima during the months of March through June. Mean annual temperature is 15.6º C (60.1º F). Summers are typically humid and hot, with an average temperature of 26.7º C (80º F), while the average winter temperature is 4º C (39.2º F) (Oklahoma Climatological Survey 2002).

The potential natural vegetation (PNV) of Norman is a matrix of tallgrass prairie, post oak-black jack oak forests, and bottomland forest (Duck and Fletcher 1945; Figure 3), though the PNV of the core area is solely tallgrass prairie. According to this schema, the pre-settlement PNV of the core area would have been dominated by big bluestem (*Andropogon gerardii* Vitman), little bluestem (*Schizachyrium scoparium* (Nash) Bickn.), Indian grass (*Sorghastrum nutans* (L.) Nash), and switch grass (*Panicum virgatum* L.), and may have also consisted of buffalo grass (*Buchloë dactyloides* (Nutt.) Engelm.), blue grama (*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths) and side oats grama (*Bouteloua curtipendula* (Michx.) Torr.) (Duck and Fletcher 1943).

Historical Documentation

In order to qualitatively assess the nature of the Norman landscape prior to and shortly after European settlement, we

analyzed a number of historical documents, ranging from expedition and travel accounts to descriptions of the landscape by earlier settlers. Of particular note are the accounts of military expeditions commissioned by the U.S. government to survey Indian lands and the western frontier (Womack 1976). Moreover, we analyzed mid-nineteenth century travel accounts by the likes of Washington Irving (1956) and Josiah Gregg (1954) in order to glean useful information about the pre-European settlement landscape in and around the future Norman townsite. Finally, we analyzed early settler accounts, primarily in the form of newspaper articles appearing in the territorial newspaper, *The Norman Transcript* (Womack 1976).

Photographic Documentation

The Western History Collections at the University of Oklahoma houses a rich collection of photographs of the Norman landscape immediately following European settlement through its historical development. We acquired a set of those photographs that were apropos to our study. We then used basic photographic interpretation to analyze the vegetation and flora (when applicable) of the core area of Norman at intervals corresponding to the availability of photographs. We also returned to those areas that could be precisely relocated and re-photographed the landscape as a means to document vegetation changes.

RESULTS AND DISCUSSION

Military Expeditions and Travel Accounts

In the period between 1740 and 1889, there were at least ten known reconnoissances of the area that would become Norman (Table; Figure 4). The earliest of these was carried out by the French explorers Pierre and Paul Mallet, who descended on the Canadian River upon their return trip from Santa Fe, New Mexico to the French settlements in Illinois (Hoig 1998). The original journal of the Mallet expedition has been lost, and all that remains is a summary of the journal sent to Paris by Governor Bienville of the French colony of Louisiana (Blakeslee 1995). Based on a recreation of the trail followed by the expedition (Blakeslee 1995), Mallet would have passed south of the present-day location of Norman on or around the 13th or 14th of June, 1740. However, the journal summary does not contain an adequate description of the landscape encountered in route to the French territories.

The first landscape descriptions of present-day Norman came some eighty years later when Major Stephen H. Long's party traversed the area in 1820 (Womack 1976; Goodman and Lawson 1995). In late August 1820, Long's scientific expedition to find the headwaters of the Platte, Arkansas, and Red Rivers crossed the 98th meridian heading east towards the future site of Norman. Long's map of his expedition placed the future townsite of Norman on the periphery of the so-called "Great Desert" and south of the region he described as "Extensive Plains with broad swells" (James 1823). Long did not otherwise describe the area in which present-day Norman occurs.

Among the scientific staff of the Long expedition was Edwin James whose careful chronicling and extensive plant collection provides one of the clearest pictures of the pre-settlement flora and fauna of the Southern Great Plains (Goodman and Lawson 1995). Though there is uncertainty as to when exactly the Long expedition crossed the area to become Norman (Womack 1976; Goodman and Lawson 1995), James' (1823) accounts of the vicinity are nonetheless quite useful in establishing an idea of the pre-settlement landscape.

James and the Long expedition arrived in or around present-day Norman on August 28th and 29th (Goodman and Lawson (1995). A journal entry from that time describes "extensive forests (that) appeared in the distant horizon, and prairies in every direction intersected by creeks and ravines, distinguished by lines of forest." Long's entourage traveled "a few miles across the open plains," which were covered by a "large and uncommonly beautiful village of the prairie marmots (sic), covering an area of about a mile square, having a smooth surface, and sloping almost imperceptibly to the east" (James 1823). The grasses here were "fine, thick, and close fed" (James 1823), as one would expect in a prairie dog (*Cynomys ludovicianus* Ord) town (Hoogland 1995). James (1823, Pp. 148) also reported that the plains of the area were "covered with a herd of some thousands of bisons (sic); on the left a number of wild horses, and before us 20 or 30 antelopes, and about half as many deer."

Of particular note was James' (1823) tendency to identify number of plants he encountered to species level. As a trained botanist, James (1823) reported encountering a number of forbs, including cardinal flower (*Lobelia cardinalis* L.), copperleaf (*Acalypha* spp.), sunflowers (*Helianthus* spp.), ragweed (*Ambrosia* spp.), and "other heavy weeds" during the Long expedition's reconnaissance of the Norman area, and amongst the woody plants reported in the area were honey locust (*Gleditsia triacanthos* L.), eastern cottonwood (*Populus deltoides* Bartr. ex Marsh.), sycamore, and "thickets of" oak (*Quercus* spp.) and elm (*Ulmus* spp.). However, James' (1823) descriptions of the habitats in which each of the species encountered and collected occurred were often limited.

Henry L. Ellsworth, the newly appointed commissioner to treat with western Indians, led the next known expedition to reconnoiter the area in the vicinity of present-day Norman (Womack 1976). The famous writer Washington Irving and his entourage (Ellsworth 1937; Latrobe 1955; de Pourtalès 1968) were invited to travel with the Ellsworth expedition, and passed through the future townsite of Norman on August 29, 1832. Irving's (1956) account of the "great Prairie" is perhaps the most vivid of Norman's pre-settlement landscape. After emerging from the "dreary belt of the Cross Timbers" (post oak-black jack oak forest), Irving wrote of the "infinite delight" he felt as he "beheld the 'great Prairie' stretching to the right and left before us." According to Irving, the "landscape was vast and beautiful" consisting of "boundless and fertile wastes." The only mention of woody vegetation upon the prairie was the "strips of green forest" that bordered the Canadian River and its tributaries.

The Irving party's venture into present day Norman was marked by a buffalo hunt. Like James' (1823) account of the area, Irving (1956, Pp. 139) commented, "the prairies of the hunting ground are not so much entangled with flowering plants and long herbage as the lower prairies and are principally covered with short buffalo grass." Such descriptions are echoed in accounts of the area by Hildreth (1836), Boone (1929); Hurt (1998), and Gregg (1954). Hildreth (1836) described "an immense herd of buffalo", while Boone described a "beautiful plain" replete with "countless numbers of buffalo" (Hurt 1998). Gregg (1954, p. 235) echoed these sentiments, recounting the "little herds of buffalo" amongst a "beautifully variegated" landscape "with stripes and fringes of timber."

Captain Nathan Boone returned to the area in July 1843 and commented that the "rolling prairies [were] intersected by numerous wooded creeks rendering the scenery very pleasing to the eye. The "flat prairie country" was "very much parched by the summer heat" and "vegetation was very scant." He noted that the "buffalo grass" was "eaten down very close by the buffalo." (Boone 1929). Likewise, Captain R.B. Marcy (Foreman 1939), reflecting on the area on the eastern edge of the cross timbers, wrote, "the country…has been entirely prairie, with the exception of a few scattering trees." Sherburne (1988), the diarist for the Whipple expedition, noted that the area presumably between present day Lexington and Norman was "still a vast prairie with a few scattering trees." Among the trees encountered was a tree "with a peculiar appearance …[t]he bark had peeled off leaving the wood perfectly white, & it looked precisely as though it had been whitewashed." Sherburne (1988, p. 65) identified the tree as a "Cotton wood", though it most likely was a sycamore.

These accounts offer perhaps the best insight to Norman's pre-settlement vegetation structure and composition. The current city of Norman has a PNV dominated by tallgrass prairies (Duck and Fletcher 1943). However, the presence of numerous grazers, such as the American bison (*Bison bison* L.), North American elk (*Cervus canadensis* Ord), pronghorn antelope (*Antilocapra americana* Ord), and black-tailed prairie dog, all of which were recorded to have occurred in the area prior to settlement (James 1823; Gregg 1954; Irving 1956) resulted in grasses of a diminutive structure. Within prairie dog colonies, for instance, vegetation is conspicuously lower than surrounding vegetation, and the plant community composition thereof is also markedly different from surrounding plant communities (Hoogland 1995). Similarly, generalist grazers, such as bison, have been shown to have a tremendous effect on the physiognomy of grassland communities (Milchunas et al. 1988).

The half century leading to settlement of present-day Norman, though, was characterized by a rapid and belligerent campaign of faunal extirpation throughout the southern Great Plains (Flores 2001). The effects of this faunal extirpation on the vegetation of present day Norman at the time of settlement are unknown. However, earlier settler accounts, documented primarily in the city's first territorial paper, *The Norman Transcript,* offer some insight. From the first year of publication alone, we found thirteen accounts of the wildlife in the area, as well as numerous accounts describing the landscape of the area. For instance, a July 13, 1889 press notice described "prairies…covered with beautifully blossoming" and varied wildflowers. Moreover, much of the game cited in the area, such as the lesser prairie chicken (*Tympanuchus pallidicinctus* Ridgway), are often associated with short and mixed grass prairies interspersed with some tall grasses (Woodward et al. 2001).

Photographic Documentation: 1889-Present

In the months following the opening of the unassigned lands of Oklahoma to European settlers, an aggressive campaign of afforestation began in the Norman townsite (Gumprecht 2001). This often belligerent campaign has continued more or less unabated into the present and has led to the designation of Norman as a 'Tree City U.S.A.' (Blakey 2002), a title bestowed by the National Arbor Day Foundation upon cities that take an active role in urban forestry. This afforestation, coupled with fire suppression, has resulted in a contemporary landscape that differs

markedly from the landscape described by James (1823), Irving (1956), and others.

Much of the transformation that has occurred over the past 114 years has been photographically documented. Currently, many historical photographs related to Norman's growth are available in the Western History Collections at the University of Oklahoma. We acquired sixteen historical photographs from the Western History Collections that were apropos to our study. Of these, the earliest photographs were dated to June 1889, two months after the unassigned lands (which included Norman) were opened to European settlement. The most recent photographs from these collections date to 1939. Of these sixteen photographs, we were able to accurately relocate thirteen vantage points in order to re-photograph the scenes.

Among the earliest photographs taken of the Norman townsite is a view looking east on Main St. from the railroad tracks (Figure 5a). The landscape is austere, punctuated by two rows of makeshift wooden buildings. No woody vegetation is present in the photograph. Rather closely shorn grasses dominate the landscape, while a lone wavyleaf thistle (*Cirsium undulatum* Nutt.) stands in the foreground of the photograph. The area was re-photographed in 1939 (Figure 5b). Though more permanent structures have replaced the temporary wooden buildings and asphalt now dominates the erstwhile prairie, the only woody vegetation visible in the photograph dots the distant residential area (far eastern end of Main St.). A contemporary view of Main St. (Figure 5c) stands in contrast to the two historic photographs. While many of the same structures present in the 1939 photograph remain, the sidewalks are lined with several species of woody plants, most notably live oak (*Quercus virginiana* Mill.), eastern redbud (*Cercis canadensis* L.) and Bradford pear (*Pyrus calleryana* Dcne.).

Another photograph taken in newly established Norman townsite depicts the view south from Main St. along the railroad tracks (Figure 6a). Much like the photograph looking east on Main St. from the railroad tracks, the landscape in this photograph is austere, marked by low-growing grasses. A contemporary view looking south from Main St. along the railroad tracks (Figure 6b) indicates that the area immediately adjacent to the railroad tracks remains largely depauperate of woody vegetation. However, the parallel road, marking the beginning of one of Norman's historical neighborhoods, as well as parkland, are lined with numerous species of woody plants, including species of pine (*Pinus* spp.), bald cypress (*Taxodium distichum* (L.) Rich.), Chinese pistachio (*Pistacia chinensis* Bunge), American elm (*Ulmus americana* L.), lacebark elm (*U. parvifolia* Jacq.), pecan, hackberry, mimosa (*Albizia julibrissin* Durazzini), eastern redcedar (*Juniperus virginiana* L.), and cottonwood (*Populus deltoids* Marsh.).

The rapid afforestation of the Norman townsite is perhaps best illustrated by two early views of David Ross Boyd's, the first president of the University of Oklahoma, house (Figure 7a). The first photograph, taken in 1895, shows a row of American elm saplings. Within a year, the saplings around the Boyd House had experienced vigorous growth. Today, a row of lacebark elm flank the eastern side of the Boyd House, while numerous other species, native and nonnative alike, such as tulip poplar (*Liriodendron tulipifera* L.), paper birch (*Betula papyrifera* Marsh.), swamp white oak (*Quercus bicolor* Wild.), and eastern redbud (*Cercis canadensis* L.) (Figure 7b) decorate the landscape.

By the 1930s, much of Norman's residential areas had been adorned with trees, as is evident in an undated photograph depicting rows of evenly aged elms and maples lining a city street (Figure 8a). A contemporary view of a similar residential street (Figure 8b) is indicative of many streets throughout Norman, especially within the core settlement area after 40 years of initial settlement. American elms, sycamores, hackberries, and cottonwoods tower above residential homes and smaller woody species, such as eastern redbud and various maples (*Acer* spp.).

Contemporary Vegetation

The contemporary Norman landscape leaves few traces of the erstwhile prairie that so awed Irving (1956) and others. Indeed, in 1999, the Norman Park Foundation received a grant to inventory woody vegetation located on public property, the purpose thereof to create a database for the management of a portion of the urban forest resource (Hennessey 2000). During May-June 2000, Hennessey (2000) inventoried and mapped every tree growing on City of Norman right-of ways within an approximate 1.3 km^2 (0.5 mi^2) area in the core area. Trees located on private property, which represents the bulk of the trees in this area, were not inventoried.

A total of 1,141 trees representing 48 species were documented by Hennessey (2000). Of the 48 species, 15 species comprising 590 (52%) individuals are within their historic range, 13 species comprising 383 (33%) individuals are native to Oklahoma but outside their historic range, and 20 species comprising 168 (15%) individuals are not native to Oklahoma. The most frequently occuring species include hackberry, Shumard's oak (*Q. shumardii* Buckl.), silver maple (*Acer saccharinum* L.), and sycamore. Data are provided by Hennessey (2000).

CONCLUSIONS

During the past several decades, ecologists, biogeographers, and others have begun to pay increasing attention to anthropogenic environments, in general, and urban environments specifically (Gilbert 1989; Pyšek 1993 ; Kent et al. 1999). As the last vestiges of the North American prairies are swept away by wheat and concrete, it becomes increasingly imperative to document the specific nature of the change, as well as the possible biological and ecological consequences. Within the span of a little more than a century, the entire vegetation and flora of the area comprising the city of Norman has been radically transformed. Documenting these changes has been relatively easy. Understanding this transformation in terms of the broader ecology of the region is the real challenge.

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TABLE

Expedition	Year	Date	General Description of Area	Sources
Mallet	1740	June 13-14	Original notes lost; description unavailable.	Morris et al. (1986); Blakeslee (1995); Hoig (1998)
Long	1820	Aug 26, 27, or 28-29	Prairies in every direction intersected by wooded creeks and ravines.	Womack (1976); Morris et al.(1986); Goodman and Lawson (1995); Hoig (1998)
Irving et al.	1832	Oct. 29	Great prairie; boundless fertile wastes.	Womack (1976); Morris et al. (1986); Hoig (1998)
Levenworth	1834	Aug. 1-2	Deer and buffalo abundant upon the prairie.	Hildreth (1836); Womack (1976); Morris et al. (1986)
Gregg	1839	May 18; Apr 3, 1940	Beautiful plains with countless numbers of bison.	Womack (1976); Morris et al. (1986); Hoig (1998)
Boone	1843	July 19-20	Rolling prairies interesected by numerous wooded creeks.	Womack (1976); Morris et al. (1986)
Abert	1845	Oct. 8	Lowlands covered w/tall grass. Oaks forests in distance.	Hoig (1988); Abert (1999)
Marcy	1849	May 9-10	Entirely prairie, with the exception of a few scattering trees.	Marcy (1939); Hollan (1955); Hoig (1998)
Whipple	1853	Aug. 22-23	Vast prairie with a few scattering trees.	Sherburne (1988); Hoig (1998)
Beale	1858	Nov. 27-28	Exclusively prairie; gently rolling and firm.	Beale 1860; Hoig (1998)

Figure 1. A contemporary aerial view of Norman, Oklahoma. Below this seemingly dense canopy of trees lies one of Norman's residential areas.

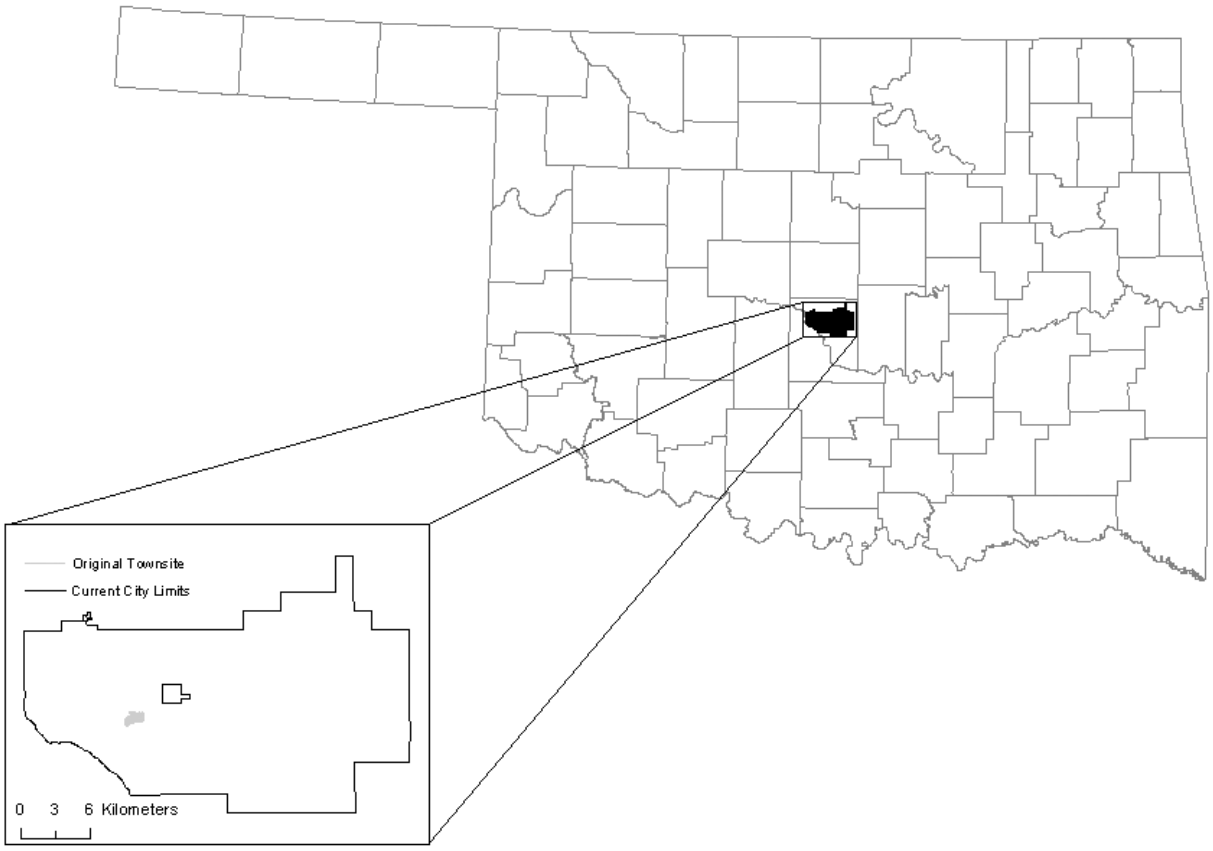

Figure 2. The study area; the present City of Norman boundary, in relationship to the state of Oklahoma and the original Norman townsite, settled in 1889.

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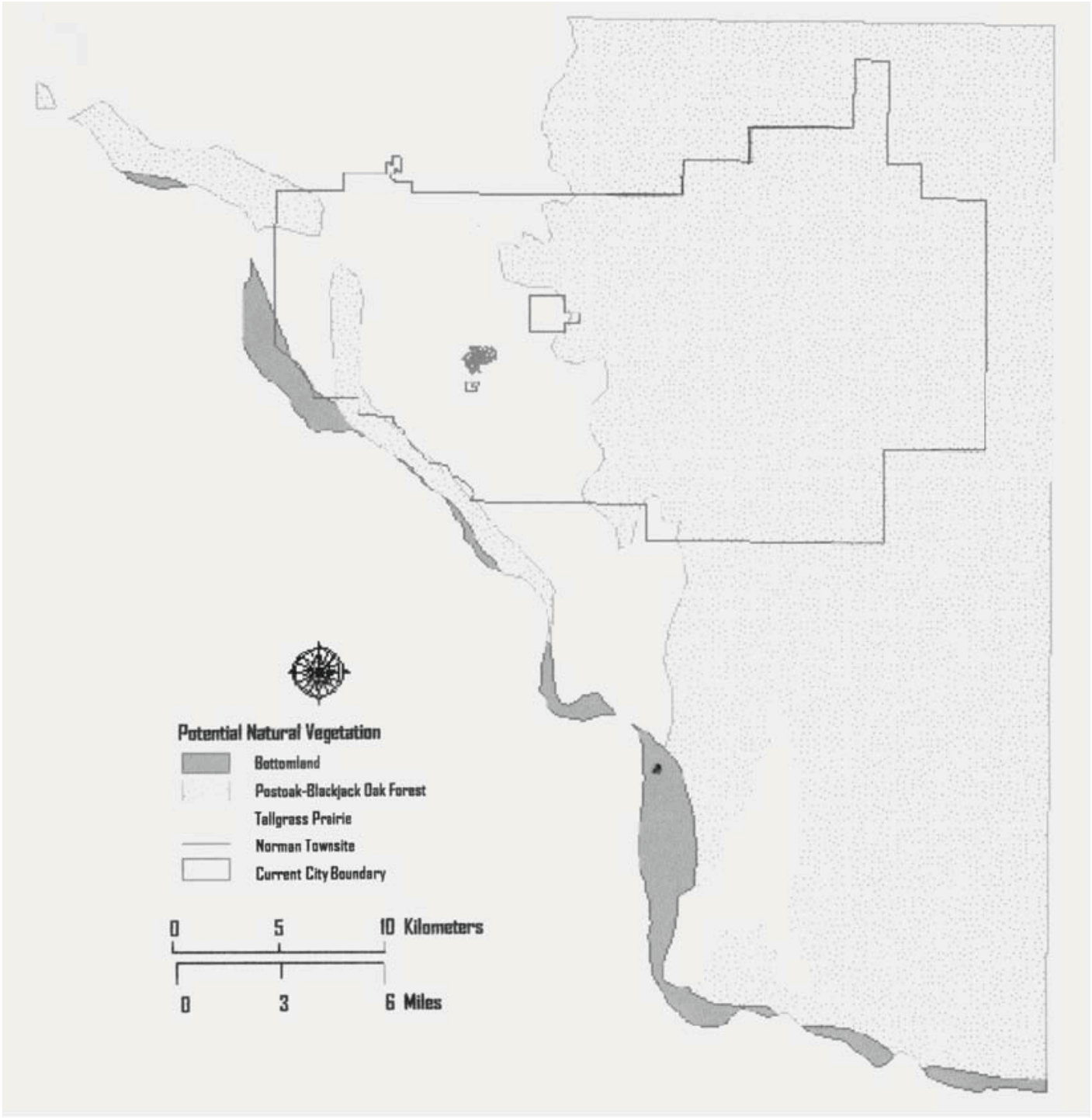

Figure 3. Potential Natural Vegetation (PNV) of Norman indicates that the area encompassing the townsite was once dominated by tallgrass prairie vegetation. After Duck and Fletcher (1943).

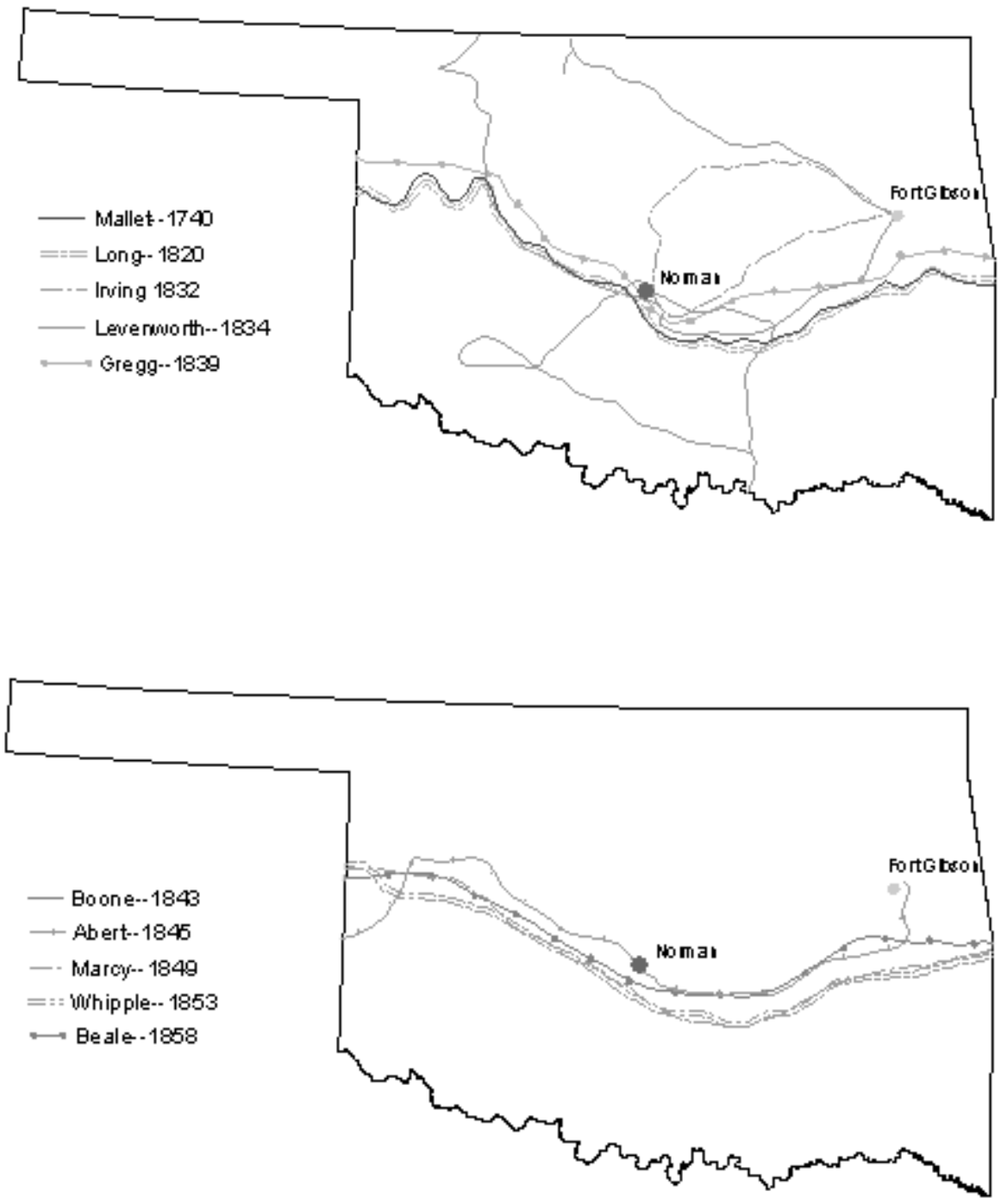

Figure 4. Routes of expeditions known to pass through present-day Norman and the vicinity, 1740-1858. After Morris et al. (1986) and Hoig (1998).

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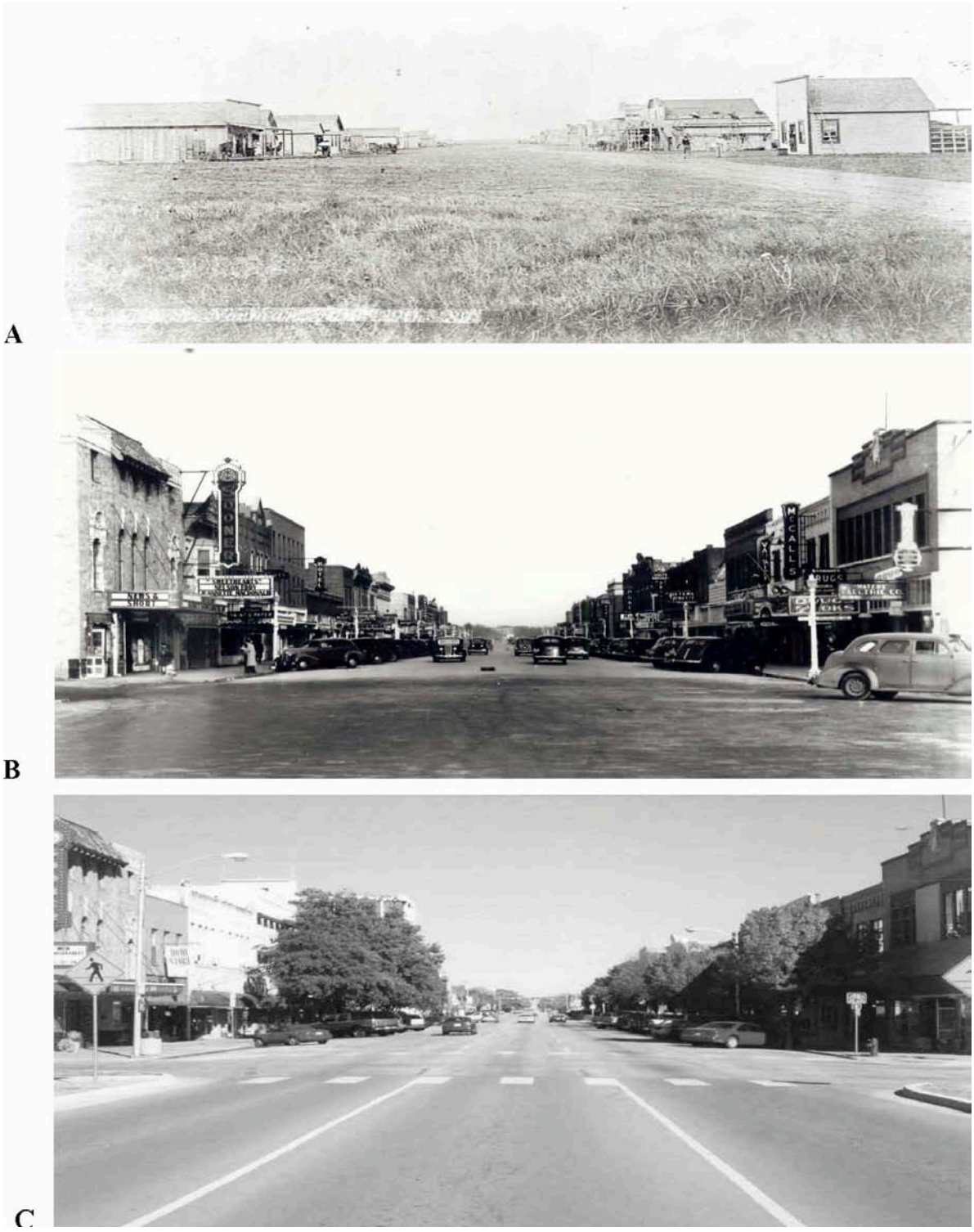

Figure 5. Main Street, looking east from the present site of the railroad tracks. A) June 1889; area dominated by short grasses, no woody vegetation visible. Lone thistle, *Cirsium undulatum* in foreground. B) 1939; Permanent structures replaced wooden buildings, asphalt replaced grasses. Woody vegetation only in residential area. C) Present; buildings flanked by woody plants, including *Quercus virginiana, Cercis canadensis,* and *Pyrus calleryana.* Historical photographs courtesy of the Western History Collections. Contemporary photograph by the authors.

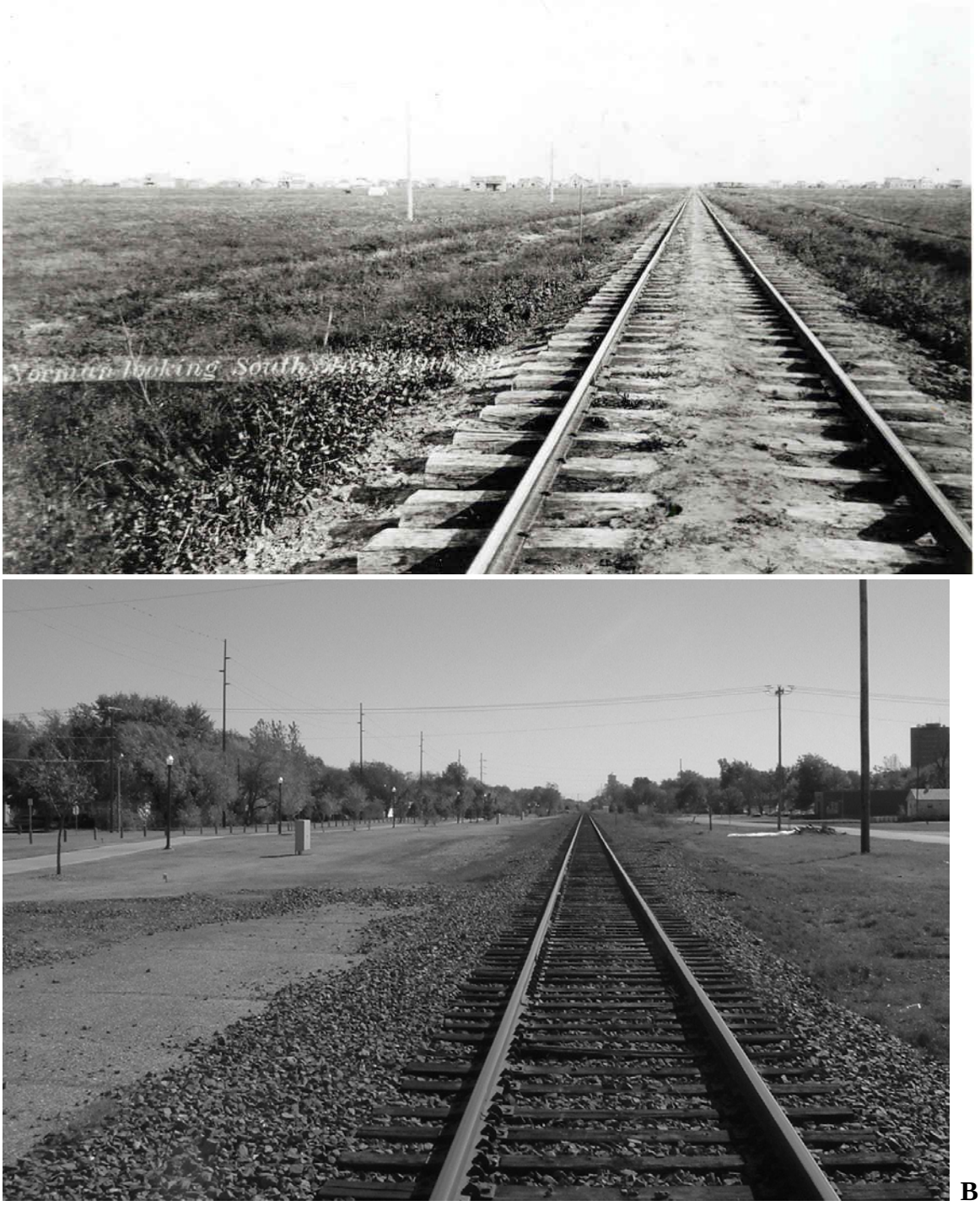

Figure 6. Views looking south on tracks from Main Street. A) June 1889; area dominated by short grasses. No woody vegetation visible. B) Present; railroad right-of-way flanked by numerous species of woody plants, including *Taxodium distichum, Pistacia chinensis, Ulmus americana, U. parvifolia, Carya illinoensis, Celtis occidentalis, Albizia julibrissin, Juniperus virginiana,* and *Populus deltoids.* Historical photograph courtesy of the Western History Collections. Contemporary photograph by the authors.

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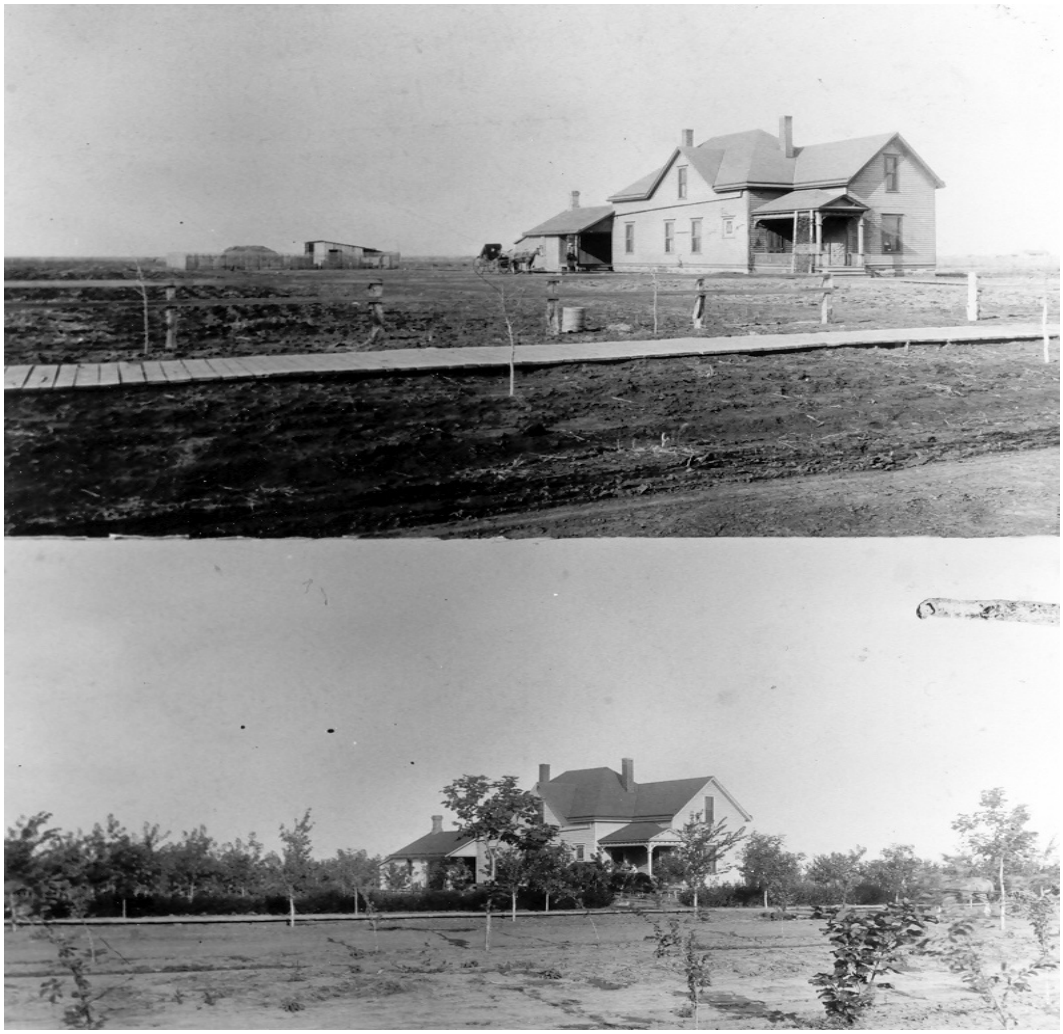

A

B

Figure 7. The Boyd House. A) 1895 and 1896; sequential photographs of the house of the first president of the University of Oklahoma, David Ross Boyd. In the first year the row of elm saplings experienced vigorous growth. B) Present; a row of *Ulmus parvifolia* flank the east side of Boyd House, *Quercus bicolor* stand in the foreground. Other species in the lawn include: *Lirodendron tulipifera, Betula papyrifera,* and *Cercis canadensis.* Historical photographys courtesy of the Western History Collections. Contemporary photograph by the authors.

A

B

Figure 8. Two residential streets in Norman. A) Undated photograph depicting rows of evenly aged elms and maples lining a city street. B) Present view; a typical residential street in one of Norman's historical neighborhoods characterized by towering *Platanus occidentalis, Ulmus Americana,* and *Populus deltoids.* Understory vegetation includes species of *Acer sp.* and *Cercis canadensis*. Historical photograph courtesy of the Western History Collections. Contemporary photograph by the authors.

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Three Birds Orchid and Crane-fly Orchid in Oklahoma

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The Three Birds Orchid or Nodding Pogonia, *Triphora trianthophora* (Sw.) Rydb., is one of the most beautiful jewels of the fall orchid collection in the eastern 1/3 of the country. It occurs from Vermont and Ontario, south to Florida, west to Texas, and north to Michigan. Pridgeon and Urbatsch (1977) cite one collection from West Feliciana Parish in Louisiana.

In Kansas it was long listed as part of the orchid flora, based on a report by Popenoe. However, no one had seen a living specimen until Rufus Thompson, an algae specialist at the University of Kansas, discovered them in Baldwin Woods south of the City of Lawrence (Douglas County) in late August 1971. After his report several botanists from the University of Kansas also found it in Baldwin Woods and later in several other counties. Still later, when working in the herbarium at the Smithsonian Institution in Washington, D.C., I found a specimen collected by Popenoe in Topeka in Shawnee County in 1876.

In Oklahoma it has been known to occur in Cleveland County in central Oklahoma since 1947. A collection from LeFlore County in the southeastern part of the state was made in 1967. Since 1972 it has been found in Choctaw, Caddo, Adair Counties, and most recently in Canadian County by Dr. Paul Buck in 1993. There have been several other unconfirmed reports in Oklahoma. In Arkansas it has been found in several counties in the Ozark Mountains, which cross the border into Oklahoma.

One of the reasons that so few people have reported seeing this delightful little orchid is probably that it blooms in late August and early September. That is a time when few orchid or wildflower enthusiasts are out in the woods because of the ticks, mosquitoes, and miserable hot weather. Nevertheless, it is a flower well worth the trouble endured to find it. It grows in rich mixed deciduous woodlands or deciduous-pine woodlands in the deep humus or leaf mold of moist shaded areas. This species is often associated with other fall flowering orchids such as *Corallorhiza odontorhiza* and *Tipularia discolor.*

It may occur as a single stem, a few scattered stems, or as large colonies up to 3 feet in diameter with hundreds or occasionally thousands of stems, such as are found at the Battiest Site in northern McCurtain County, Oklahoma. The 7-30 cm (3-12 inches) plants produce from one to six (rarely seven) flowers about the size of a nickel at the tip of succulent green stems. Typically the plants are about 10-18 cm (4-7 inches) tall. The flowers open white with a delicate patch formed by three crests or lamellae of emerald green

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in the center of the lip. As the flowers age, they become flushed with pink or lavender. When observed under magnification the flowers appear to be sculpted out of transparent or translucent crystal. They are truly a delight to behold. The plants have underground stolons bearing fleshy tuberoids (Medley 2002). The tuberoids rarely ever penetrate into the soil, but rather appear to be confined to the layer of decaying organic matter. Any attempts to cultivate this plant should take this into account.

Oklahoma Native Plant Society (ONPS) and Southwestern Region Orchid Growers Association (SWROGA) Conservation Committees would appreciate knowing of additional locations for this orchid. It is probably more common than previously believed. However, proof is in the finding!

The Crane-fly Orchid, *Tipularia discolor* (Prush) Nutt., is one of the more interesting and elusive native orchids. Its name is derived from the Latin *tippula* "water-spider" + *discolor* "variegated, of different colors." It is one of the late summer orchids found in Arkansas, southeastern Oklahoma, eastern Texas, and Louisiana. The genus contains three recognized species: *Tipularia josephi* in the Himalayan Mountains, *T. japonica* in Japan and *T. discolor* in the United States. It ranges from Florida west to eastern Texas through Oklahoma, Arkansas, Missouri, southern Illinois, and Indiana east to Pennsylvania, New Jersey, and Massahusetts, as well as along the Atlantic Coast. It may be the most common orchid in Arkansas (Slaughter 1993). In Oklahoma it was first collected in 1968 two miles south of Honobia by Steve Stephens from the University of Kansas. The collection consisted of one flowering plant (Magrath 1973). Since then it has been found throughout the southeastern part of Oklahoma in colonies often numbering in the thousands.

According to Luer (1975) "The plants are characterized by their series of undergournd tubers which are actually corms connected by slender rhizomes." A new corm is produced each year. Each new mature corm produces a solitary ovoid, overwintering leaf which disappears in May or June. The inflorescence is produced in August. The scape is slender and is terminated by a raceme of small, dull flowers. The sepals and petals are free but one petal partially overlaps the dorsal sepal. The lip is three-lobed and has a spur at the base. Homoya (1993) describes the inflorescence as "giving an impression of a swarm of flying gnats, mosquitoes, or small crane-flies."

To find a large colony of these plants in full bloom in a dimly lit woods and to watch the flowers dance with every little bit of breeze is a treat. Then they truly seem like insects in flight. Homoya (1993) notes that, "The flowers of *Tipularia* are unique among North American orchids in that they are not bilaterally symmetrical. Instead, the sepals and petals are positioned so that the flower is lopsided, with an unlike number of petals and sepals to either side of the column. Moreover, the flowers are angled to one side of the main stem, some to the right, others to the left**."** Homoya (1993) further notes that *Tipularia* commonly sets seed capsules. Occasionally, isolated solitary plants may not be pollinated, but wherever there is a population, each plant normally will have between 80 to 100% capsule set.

Tipuolaria like *Aplectrum* (Adam-and-Eve, Putty Root) has a series of corms connected by a slender rhizome. Both produce an over-wintering single leaf, although *Aplectrum* is usually 2-5 times

larger and accordion pleated, both are typically purplish on the underside of the leaf. *Aplectrum* is, however, a late spring to early summer flowering plant, while *Tipulari* is a late summer flowering plant. In Oklahoma its late flowering time overlaps with golden plume, *Platanthera ciliaris*, and three-bird orchid, *Triphora trianthophora*. *Tipularia* tends to grow in decaying leaf litter in relatively well drained areas often over a rocky substrate, and seems to prefer drier locations than does *Aplectrum.* Homoya (1993) notes that *Tipularia* "is clearly advancing its range" in Indiana. I feel that the same is true in Oklahoma.

The orchid can be cultivated in shaded areas where decaying leaf litter that is relatively moist, but well drained. Basically the same type of habitat in which *Triphora trianthophora* and *Malaxis unifolia* (Green Adder's Mouth) would grow. I have also successfully grown it in terrarium culture. Since it produces large numbers of seed capsules, it would seem to be a good candidate for growing in flask from seed and it is to be hoped that at some time in the near future it will be available in the form of nursery propagated plants, as opposed to collected plants.

While it is hoped that this native will soon begin to come into cultivation and that the *Triphora trianthophora* will be found in more locations, as always, we recommend that when in natural settings leave only footprints, being careful not to damage young seedlings, and take only memories and photos.

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Three Birds Orchid, *Triphora trianthophora* (Sw.) Rydb.
Photos courtesy Charles Lewallen.

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Crane-Fly Orchid, *Tipularia discolor* (Prush) Nutt. Photos curtesy of Charles Lewallen.

Critic's Choice Essay

Take time to watch, not just smell the wildflowers!

Gloria M. Caddell

Although plant-pollinator interactions between orchids and bees in the tropics may seem more interesting than those closer to home, Oklahoma is full of fascinating plant-pollinator interactions and mechanisms. The most important pollination agents in Oklahoma are wind and insects. Wind is particularly effective where many plants of the same species grow close together. Prairie grasses, and dominant trees of our forests and woodlands, e.g. post oak and blackjack oak, are wind-pollinated. There are few things more beautiful than anthers dangling from a grass spikelet along with feathery stigmas that trap wind-borne pollen! In spring, male flowers of oaks are borne on pendulous catkins, releasing pollen that catches on stigmas of tiny female flowers held close to the branch.

Insects are major pollinators of our prairie forbs, and their flowers are visited by a variety of insects, including butterflies, moths, beetles, flies, bees, and wasps. Of these, bees are most important. You can observe bumblebees with glistening, saddlebag-shaped pollinia of green milkweed (*Asclepias viridis*) on their legs. You can hear their buzzing as bees clasp the anther cone of western horsenettle (*Solanum dimidiatum*) and use their flight muscles to vibrate pollen out through pores at the top of the anthers.

Flower characters such as color, shape, size, and amount of nectar can sometimes be used to predict major pollinator(s) of a species. But it takes many hours of observing and collecting insect visitors to see if they are carrying pollen, to determine which are actual pollinators. My students and I have observed over 20 families of insect visitors to a single species, but find that only two or three effectively transfer pollen.

Differences in flowers among species are often clearly related to pollination, but differences among flowers within a single species may also be related to pollination and are equally intriguing. Within a population you find sometimes subtle, and at other times obvious, differences between flowers at different stages. For example, when a pink gentian (*Sabatia campestris*) flower opens its anthers are bright yellow and release pollen, but its style branches are green, coiled together, and lay flat against the petals. As the anthers wither the style branches uncoil, become erect, turn bright yellow, and their stigmas become receptive to pollen. In any population and even on the same plant, you can find flowers with style branches in various stages of uncoiling. Difference in timing between pollen release and stigma receptivity is a mechanism to promote cross-pollination. When flowers of fog fruit (*Phyla*) open, they have a yellow spot near the corolla tube opening (the "throat"). Later in the day the spot turns a rosy-lavender color, less visible to bees. Older flowers remain on the inflorescence as new flowers open, but in many cases such as this, newer, more attractive flowers offer a greater reward, e.g. more nectar.

In prairie bluet (*Hedyotis nigricans*) some plants bear flowers with long styles and short stamens. Others bear flowers with short styles and long stamens with clearly visible blue anthers. Insects that contact anthers of long stamens will likely transfer that pollen to a long-styled flower on another plant. So this mechanism also promotes cross-pollination.

Details of flowering stages and plant-pollinator interactions of many Oklahoma plants have not been well-documented. I encourage you to stop, sit, and not only take the time to "smell" the wildflowers, but to watch them as well. You will surely see things that have never been observed before!

O.N.P.S

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Editorial Policies and Practices

Oklahoma Native Plant Record is published annually by Oklahoma Native Plant Society. Submission for publication in the journal is open to all. Manuscripts will be accepted on topics related to Oklahoma's regional botany, including historical research reports, current research articles, site record species lists, and descriptions of new or important species sightings in Oklahoma. Oklahoma's environmental gradients of human impact, climate, and elevation make us a prime target for research on habitat edges, species ranges, and edge species, but articles of other themes may be included as well. Important works overlooked by journals of broader geographic regions will also be considered for publication here.

Papers must not have been published previously or accepted for submission elsewhere and should represent research conducted in accordance with accepted procedures and scientific ethics. Submission of the article implies the granting of copyright permission to Oklahoma Native Plant Society.

Manuscripts will be reviewed for content and appropriateness by at least two reviewers. The title page should state the affiliation and complete addresses of all authors and telephone numbers for the corresponding author. Research and technical papers should include a one-paragraph abstract of not more than 250 words. It should concisely state the goals, principal results, and major conclusions of the paper. All references, figures, and tables should be cited in the text. Site descriptions should include latitude, longitude, total area and elevation. Common names should be referenced to a scientific name. Abbreviations of authorities for scientific names should follow Authors of Plant Names (Brummitt and Powell, 1992). Titles of periodicals should be abbreviated following Botanico-Peridoicum-Huntianum and its supplement - except in historic publications when original format will be used.

Authors with access to IBM-compatible microcomputers are encouraged to send a copy of the manuscript on diskette in rtf (rich text format). If the manuscript is typed, manuscripts should be double-spaced on 8 1/2 x 11 inch paper with minimum one-inch margins and should be submitted in duplicate. Diskette or hardcopy manuscripts should be sent to the managing editor at the ONPS address on the back cover by June 1.

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