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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 is open to any person who supports the aims of the Society. ONPS offers individual, student, family, and life memberships.

Cover photo: Courtesy of Patricia Folley
Helianthus maximilianii Schrad.
Maximilian's Sunflower

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Foreword

This has been a very busy year for our authors, reviewers, and editors. Thank you for waiting patiently for Volume 8. I think you will agree that it was worth the wait.

Susan Barber has provided our historic article for 2008. Her thesis, "A Floristic Study of the Vascular Plants of the Gypsum Hills and Redbed Plains Area of Southwestern Oklahoma", is long overdue to be published . She researched the relationships between soil and vegetation types, just one of the underlying causes for the great biodiversity in Oklahoma. Her thorough work provides much more to the reader than the title reveals. It is a data-rich source for future botany research, and we know you'll enjoy it.

"Updated Flora of the Wichita Mountains Wildlife Refuge" by Keith Carter, Pablo Rodriguez, and Michael Dunn marks a new step in botanical research in Oklahoma. The Herbarium at Cameron University [CAMU] is now housing the Refuge's plant specimens, thanks to a grant and a lot of work by students, faculty, and staff at Cameron University. This is the first effort to update information regarding species at the Refuge since we published the late Paul Buck's 1977 checklist of the flora in 2002. Hopefully, it will spur interest in keeping the Refuge list up-to-date and bring recognition to a very deserving state institution's herbarium. We also hope that this will mark the beginning of a cooperative relationship between the Society and our state institutions' herbaria. One of the main goals of the *Record* is the initiation of new sources of data for biodiversity research in Oklahoma, and this paper is evidence that we are reaching that goal.

It's been several years since we've published Clark Ovrebo's popular paper about lawn mushrooms. "Spring Mushrooms of Oklahoma" by Ovrebo and Nancy Weber is a new, enlightening and enjoyable article with colorful photos from which we can learn a great deal more about the intriguing kingdom of Fungi. We've also been waiting several years for "Ferns and Rare Ferns in Oklahoma" by Bruce Smith. It's finally here with photos to help identify them. Hopefully, a checklist of Oklahoma ferns will be forthcoming.

Finally, we have a Memorial to Paul Buck, long-time board member and promoter of the Society. Constance Murray has provided us with a look at what it was like to have a professional, as well as a personal relationship, with someone so many of us have known and respected, someone who had a tremendous impact on the study of botany and ecology in Oklahoma.

Sheila Strawn, Editor

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A Floristic Study of the Vascular Plants of the Gypsum Hills and Redbed Plains Area of Southwestern Oklahoma

Submitted to the Faculty of the Graduate College of Oklahoma State University in partial fulfillment of the requirements for the Degree of Master of Science, December 1975

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ABSTRACT

The vascular floras of gypsum and redbed soils in southwestern Oklahoma were collected and studied during the growing season (April-October) of 1975. A total of 359 taxa and 230 genera and 63 families were included in the study. Thirteen taxa are considered to be gypsophiles and indicators of gypsum soils in Oklahoma. Nine taxa are considered calicoles occurring only on gypsum and limestone derived soils. Two introduced species, *Bromus catharticus* Vahl *(syn. = Bromus willdenowii)* and *Caesalpinia gilliesii*, are believed to be new additions to Oklahoma's flora.

Editor's note: The abstract and a brief summary of this thesis was published as "Floristic Components of the Gypsum Hills and Redbed Plains Area of Southwestern Oklahoma" in *The Southwestern Naturalist* 24(3):431-437 September 15, 1979 and is included here by permission (SS)

INTRODUCTION

Gypsum outcrops and soils often support a distinctive flora. These endemic species presumably evolved in response to the rigorous conditions of high calcium sulfate content, drought, etc. Turner (1973) reports numerous new gypsophilous species from Mexico. In southwestern Oklahoma gypsum deposits are quite extensive and Waterfall (1950) listed new additions to the Oklahoma flora from Harmon and Jackson counties. This situation may parallel the well studied endemism on serpentine soils of California (Kruckeberg, 1951). Since gypsum often supports a distinctive group of plants and the southwestern part of the state has been seldom collected, it seems that the floristic components of the gypsum and redbed areas could prove to be very interesting; therefore a study of the flora of the region was undertaken. The objectives of the study were (1) to describe the floras of gypsum and redbed plains geomorphic provinces in southwestern Oklahoma, (2) to determine similarities and differences in plant taxa of the two provinces, (3) to determine if the gypsite region taxa are unique to it or are characteristic of the redbed plains and/or gypsum floras, and (4) to determine if there are differences in the floras of edaphic areas within the gypsum province.

The study area is located within Harmon, Jackson, and Greer

Barber, S.C.
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counties which are located in the southwestern corner of Oklahoma, the county seats being Hollis, Altus, and Mangum, respectively. The area is located approximately 55 miles northwest of Wichita Falls, Texas. The total land area is 1,272,256 acres or 1.988 square miles. Oklahoma Highway 9 near the Salt Fork of the Red River constitutes the northern boundary for the collection area; the Red River, the southern boundary; the North Fork of the Red River, the eastern boundary; and the Oklahoma-Texas state line, the western boundary (Figure 1).

Three east-west transects were established in order to include major soil types and the distinct geomorphic provinces. Locations of the collection sites established along the transects are listed below and are indicated by the circles on the map of Figure 1. Collections were also made at other sites.

REDBEDS

R19W, T2N, Sec. 15
R19W, T2N, Sec. 17
R20W, T1S, Sec. 19
R20W, T1S, Sec. 20
R21W, T2N, Sec. 13
R22W, T2N, Sec. 13
R22W, T2N, Sec. 15
R23W, T2N, Sec. 3
R23W, T2N, Sec. 6
R23W, T5N, Sec. 18
R24W, T1S, Sec. 12
R26W, T4N, Sec. 3

GYPSUM

R22W, T1N, Sec. 33
R22W, T2N, Sec. 13
R23W, T1S, Sec. 21
R24W, T2N, Sec. 2
R24W, T2N, Sec. 6
R24W, T5N, Sec. 21
R25W, T1N, Sec. 7

SAND AREAS AND RIVER FLOODPLAINS

R20W, T2S, Sec. 11
R21W, T2N, Sec. 16
R22W, T4N, Sec. 1
R26W, T5N, Sec. 24

Specimens of the vascular flora of flora of the area were collected and identified. Collecting trips were made during the growing season starting April, 1975 and ending October, 1975. An attempt was made to collect the plants in different stages of flowering and fruiting. Voucher specimens were deposited in the Oklahoma State Herbarium (OKLA) and the Bebb Herbarium of the University of Oklahoma (OKL).

Geological and ecological considerations as well as a list of the 359 taxa are presented in subsequent chapters of this study.

GEOLOGY AND TOPOGRAPHY

Curtis and Ham (1972) describe twenty-six geomorphic provinces for Oklahoma. Of these twenty-six regions, three are found in the area of study: (1) the Mangum Gypsum Hills, (2) the Central Redbed Plains, and (3) the Western Sandstone Hills. The latter region is essentially composed of the same materials as the redbeds and is not discussed as a separate entity (Figure 2).

The most extensive of the geomorphic regions is the Central Redbed Plains area. These deposits were made during a time of sea withdrawal and extremely arid climates. The term redbeds applies to a series of brick-red shales and clays containing strata of other rock, occupying an area of approximately 50,000 square miles in southwestern Kansas, western Oklahoma, northern Texas, and extending westward to the Rocky Mountains. They are of Permian or Upper Carboniferous age, and rest directly above Pennsylvanian rocks to the east. In western Oklahoma the redbeds have been covered by other formations of a later geologic age. West of the Salt Fork of the Red River are bluffs, mesas, and uplands of gypsum and sandstone that are intermingled with the redbeds. This area consists of red Permian clays

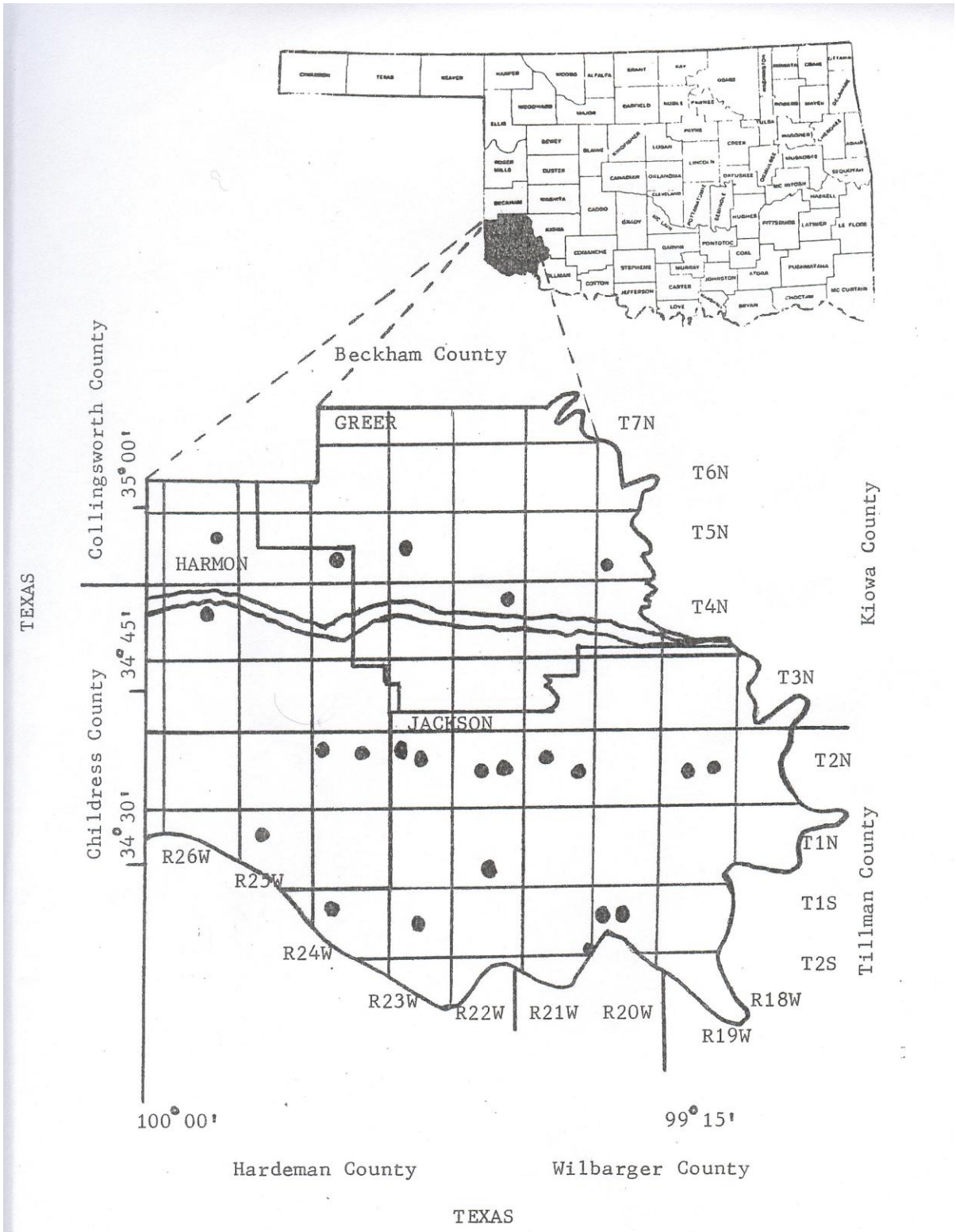

Figure 1. Location Map, Collection Sites Indicated by Solid Circles.

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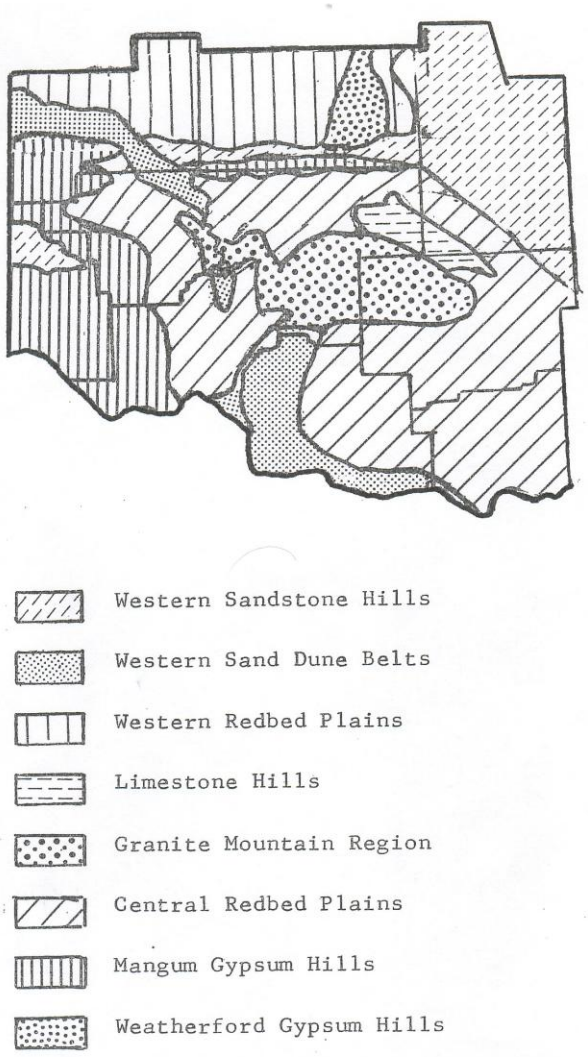

Figure 2. Geomorphic Provinces for Southwestern Oklahoma (Curtis and Ham, 1972).

and shales and has weathered into a gently rolling plain in which the hills seldom exceed 100 feet in height (Bruner, 1931). The area is well suited to the growth of grasses. The most extensive gypsum deposits in the United States, including the Oklahoma gypsum region, were laid in the Permian. The area extends almost uninterruptedly from central Iowa across Kansas, Oklahoma, and Texas. The most extensive gypsum deposits of this area are found in Oklahoma. The total amount of gypsum in the three counties is approximately 42,000,000,000 tons (Gould, 1910). There are three gypsum geomorphic provinces in Oklahoma: (1) the Cimarron Gypsum Hills (the Blaine Region of Gould, 1910), (2) the Weatherford Gypsum Hills, and (3) the Mangum Gypsum Hills (the Greer County Region of Gould, 1910). The Mangum Gypsum Hills are included within the study area. Stratification of the gypsum is erratic and the thickness of the formation varies a great deal. The gypsum does not form conspicuous hills, but appears on the surface in broken, not continuous ledges. The area is delimited from the redbeds by escarpments which are especially steep in southwestern Oklahoma. Snider (1913) described intermediates of the gypsum and the redbed plains which are deposits of gypsiferous clay known as gypsite. These deposits usually lie in valleys or flats below the gypsum ledges. These are probably formed by water which percolates through gypsum to the valley floor and evaporates from the surface leaving gypsum in a fine crystalline form mixed with the clay of the valley floors. In the field it was impossible to distinguish these soils from mixed redbed, gypsum soils.

The occurrence of copper minerals in Permian strata of western Oklahoma has been known from the time of Marcy's exploration in 1850. The copper is generally found in flowerpot shales which are low relief areas. The shales are overlain by Duncan sandstone and underlain by thin dolomites. These areas make up a relatively small part of the study area.

Clifton (1928) made a study of the geology of Harmon, Greer, Jackson, and Tillman counties. The surface exposures within the limits of the three counties belong, for the most part, to the Permian system. Along the northeastern limits of the area

there is a line of pre—Cambrian exposures consisting of granite peaks and knobs. The Cimarron series is divided into three groups consisting of sandstone, shale, gypsum, and dolomite(Table I).

TABLE I

GEOLOGIC FORMATIONS EXPOSED AT THE SURFACE IN HARMON, GREER, AND JACKSON COUNTIES*

Series	Group	Formation
Cimarron	Woodward	Whitehorse Sandstone Dog Creek Shale
	Blaine	Blaine Gypsums
	Enid	Chickasha Duncan Hennessey Garber

*From Clifton, 1928

The Woodward group, exposed only at the surface in Harmon County, consists of two formations, the Whitehorse sandstone and the Dog Creek shale formation. The Dog Creek shale formation appears as a surface outcrop in T5N and extends as far east as R24W. The Whitehorse sandstone overlies the Dog Creek shales in some areas. Approximately the lower half of the formation is represented in the county.

The Blaine group, consisting only of the Blaine formation, is found in all three counties. The formation presents four or more series of discontinuous beds of gypsum and magnesium-calcium carbonate beds, with interbedded red clays and shales throughout the area it outcrops. Occasionally the gypsum beds have a tendency to erode locally in a series of outcrops. This formation covers the eastern portion of Harmon County, and the western portions of Jackson and Greer counties.

Three of the four formations of the Enid group are found in Jackson and Greer counties. None of the rocks of these formations are exposed at the surface in Harmon County. The Hennessey, Duncan, and Chickasha are the formations. The Hennessey formation outcrops in the eastern part of Greer County and in the eastern and extreme southeastern sections of Jackson County. The Duncan and Chickasha formations appear as surface beds in the northern part of Greer County. In Jackson County the formation can be traced in an almost continuous line across the center of the county beginning near the town of Elmer.

Recent deposits consisting of sands, gravels, and alluvia border the streams in the area.

Harmon County is drained by the Red River and its tributaries, the principal of which are Lebos Creek, Salt Fork, and Elm Fork. Jackson County is also drained by the Red River and its tributaries, the North Fork, Salt Fork, and Gypsum Creek. Greer County is drained by Elm Fork, Salt Fork, and North Fork of the Red River. The drainage plain for all three counties slopes in a general southeast direction.

The intermingling of the gypsum and redbeds gives the area its characteristic topography. There is a considerable area having a relief dominated by low gypsum hills and escarpments. Otherwise, the topography is that of a level plain dissected by stream and erosion channels. The lowest elevation for the area is 1300 feet along the Red River in Jackson County, and the highest elevation is 1900 feet in northeastern Harmon County.

SOILS

The soils of the three counties range from shallow to deep and are nearly level to steep. In general, however, the soils are moderately sloping. Soil series are described

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for only Jackson and Greer counties, while soil associations are described for all three counties. A series consists of all soils having like profiles and is named for a geographic feature near the area where the soils were first mapped. In contrast, soil associations consist of one or more major series and at least one minor series and are named for the major soils. These are much more useful to botanists because they cover large areas which are more readily compared and they often support distinctive vegetation types.

Table II enumerates the major soil series common to both Jackson and Greer counties. Tables III and IV list the other major soil series of Jackson and Greer counties, respectively. Since soil associations are more important to floristic botany, and the soil associations for each county are slightly different, each county will be dealt with separately.

Bailey and Graft (1961) described eight soil associations for Jackson County. A brief description for each one is given in Figure 3.

1. **The Tillman-Hollister** association covers about 40 percent of the county. This association is found on a large, broad plain that is nearly level to gently sloping. It is broken occasionally by small areas of rough and broken land. In the level areas are the Tillman, Hollister, and Abilene soils. The steep areas are also composed of rough broken land. Most of these soils are cultivated and a great portion of the irrigated land in the county is in this association. Cotton, sorghum, and alfalfa are the principal irrigated crops of the association, and these crops and wheat are grown under dryland farming on this association.
2. **The Miles-Nobscot** association covers about 13 percent of the county. The chief soils in this association are moderately sandy to sandy, and the slope ranges from nearly level to steep. The Miles soils, the most extensive of the series, have a surface soil that is a fine sandy loam. They are nearly level to moderately sloping. The Nobscot soils are sandier and more rolling than the Miles soils. The Miles soils of the association are best suited for cotton, grain sorghum, wheat, rye, and alfalfa. About two-thirds of the Nobscot soils are cultivated, and rye and grain sorghum are the crops grown. The rest of the association is used for rangeland.
3. **The LaCasa-Weymouth** association makes up about 10 percent of the land area of the county. The soils are gently to stony soils or rock outcrops. The LaCasa and Weymouth soils are gently sloping, and the steep soils are members of the Harmon and Vernon series. Most of these soils are cultivated with wheat being the major crop. Moisture conservation and erosion control are major problems of dryland agriculture on this association.
4. **The Tipton-Enterprise-Tivoli** association lies along the rivers and occupies 15 percent of the county. The soils are mostly level to gently sloping. The Enterprise and Tivoli soils are near the rivers and the Tipton soils occupy the terrace areas. The Tipton

and Enterprise soils are similar and are formed in very fine sands and silts that are blown in from river channels. Tivoli soils consist of wind-drifted sands and are billowy or dune-like. The Tipton and Enterprise soils are fertile and crops are grown on them. Tivoli soil is used for range and is only fair to poor for grazing.

5. **The Vernon-Rough Broken Land** association covers about 10 percent of the county. The Vernon soils are the smoother areas. Rough Broken Land consists of steep escarpments, canyons, and gullied areas. Included in these areas are beds of gypsum mixed with the clays of the redbeds. Harmon soils are shallow soils of this association. This association is not suitable for cultivation, but with proper management this land is often used for pasture.

6. **The Spur-Port** association covers about 6 percent of the county. This association lies along the major creeks. The Port soils are dark and occupy higher positions than the Spur soils. About three-fourths of this association are in cultivation and are used mainly for cotton, alfalfa, small grain, and sorghum.

TABLE II
MAJOR SOIL SERIES COMMON TO JACKSON AND GREER COUNTIES

		Factors of Formation		
Series	**Surface Layer**	**Parent Material**	**Vegetation**	**Slope**
Enterprise	Very Fine Sandy Loam	Very fine sand and silt; Quaternary	Shortgrass Prairie	Nearly level to gently sloping
Hollister	Clay to Clay Loam	Clayey Permian redbeds	Shortgrass Prairie	Nearly level
LaCasa	Clay loam	Clayey Permain redbeds	Short Grass Prairie	Nearly sloping
Miles	Fine Sandy Loam	Sandy earths of Quaternary deposits	Sandsage Grassland & Shortgrass Prairie	Nearly level to undulating
Spur	Clay Loam	Loamy alluvium from Permian redbeds	Mixed-Grass Prairie	Nearly level
Tillman	Clay Loam	Clayey Permian redbeds	Shortgrass Prairie	Nearly level to gently sloping
Vernon	Clay Loam or Clay	Clayey Permian redbeds	Shortgrass Prairie	Gently sloping to steep
Weymouth	Clay Loam	Calcareous Permian redbeds	Shortgrass Prairie	Gently to moderately sloping
Yahola	Loamy Fine Sand	Loamy to moderately sandy alluvium	Floodplain Woodland	Nearly level

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TABLE III
MAJOR SOIL SERIES OF JACKSON COUNTY

		Factors of Formation		
Series	**Surface Layer**	**Parent Material**	**Vegetation**	**Slope**
Abilene	Clay Loam	Calcareous clayey sediments	Shortgrass Prairie	Nearly level to gently sloping
Nobscot	Fine Sand	Sandy earths of Quaternary deposits	Sandsage Grassland	Gently to strongly sloping
Tipton	Loam	Loamy & silty alluvial Quaternary deposits	Shortgrass Prairie	Nearly level and gently sloping
Tivoli	Fine Sand	Siliceous sands of Quaternary deposits	Sandsage Grassland	Billowy and duney

TABLE IV
MAJOR SOIL SERIES OF GREER COUNTY

		Factors of Formation		
Series	**Surface Layer**	**Parent Material**	**Vegetation**	**Slope**
Lawton	Clay Loam	Granitic outwash	Mixed-Grass Prairie	Nearly level to strongly sloping
Springer	Loamy Fine Sand	Old alluvium reworked by wind	Tallgrass Prairie	Nearly level to strongly sloping

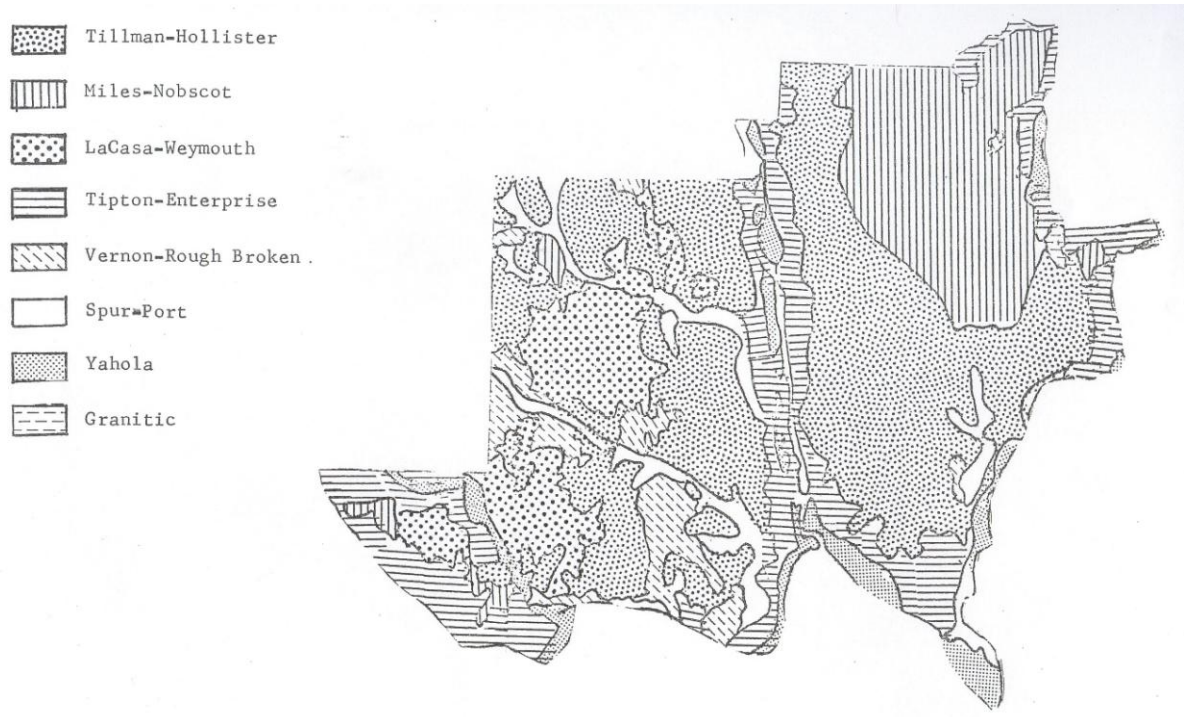

Figure 3. Soil Associations for Jackson County (Bailey and Graft, 1961).

7. **The Alluvial Land-Yahola** association is on the flood plains of the rivers and covers about 6 percent of the county. The alluvial land is made up of sandy soils on the lower part of the flood plain. The Yahola soils are farther from the river channel and are less sandy. This association is used mainly for range. Some crops are grown on them.

8. **The Granitic Mountains** association consists of stony granitic hills in the eastern part of the county and was not considered in this survey.

Frie, Brinlee, and Graft (1967) describe nine soil associations for Greer County. A brief description for each association is given in Figure 4.

1. **The Miles-Springer-Tivoli** association comprises 24 percent of the county. This soil association is on nearly level to strongly sloping uplands with a few dunes. The Miles soils make up most of the association and are nearly level to sloping. The Springer soils are gently to strongly sloping and the Tivoli soils are on stabilized dunes. Much of the acreage of this association is cultivated. Cotton is the main crop, but wheat, rye and grain sorghum are also grown. The land has to be well managed due to the high erosion rate and the rapid loss of fertility.

2. **The St. Paul-Woodward-Quinlan** association occurs in the north-central and northwestern parts of the county and is therefore outside the scope of this study area.

3. **The Hollister-Tillman** association makes up 10 percent of the county. The

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soils are of broad uplands that are formed in old alluvium and/or in material from clay and shale. The Hollister and Abilene soils are formed in calcareous old alluvium and the Tillman soils are nearly level and are formed in calcareous material. Nearly all of this association is cultivated. Wheat is the main crop, but other crops are also grown. These soils are also often irrigated.

4. **The Lawton** association makes up about 8 percent of the county. This association occupies nearly level or gently sloping uplands, broken by steep, stony hills. Much of this association is cultivated. Wheat and cotton are the main crops. Fields sown to winter wheat provide excellent pasture for beef cattle. The soils are also suitable for irrigation.

5. **The LaCasa-Weymouth** association consists of gently sloping and sloping soils of the uplands. The LaCasa and Weymouth soils are formed in material from calcareous clay or shale. The Tarrant soils often intermingle with the Weymouth soils. Much of the land of this association is cultivated, mainly to wheat. The rest of the land is used for rangeland, but the ranges are difficult to manage.

6. **The Badland-Rough Broken Land** association makes up about 21 percent of the county. This association is rugged and is characterized by steep escarpments. Rocks of the Permian redbeds are exposed in a few areas. Much of this association is in native range and is used for grazing. Management is very difficult and forage production ranges from very poor to good. Where the soils contain gypsum care must be taken when selecting ponds.

7. **The Sandy Alluvial Land-Yahola** association covers 5 percent of the county. This association is made up of calcareous, nearly level soils on the flood plains of the rivers. The Yahola soils are, in general, found on higher areas. About 65 percent of the Yahola soils are cultivated, mainly to cotton, wheat, and alfalfa. Good range management is needed in this area.

8. **The Spur-Mangum** association makes up about 6 percent of the county. These are soils of the flood plains that formed in loamy and clayey alluvium. The Spur soils are mainly nearly level. The Mangum soils are dominant in nearly level areas that are occasionally overflowed. Nearly all of the Spur soils are cultivated. Wheat, cotton, and alfalfa are the main crops. The Mangum soils are mainly used for range rather than cultivation.

9. **The Tipton-Enterprise** association covers about 3 percent of the county. These are nearly level to strongly sloping soils. These soils make up the terraces along the Red River. Wheat, cotton, and alfalfa are grown on nearly all the land. The soils of this association are fertile to highly fertile. A large acreage of the area is irrigated.

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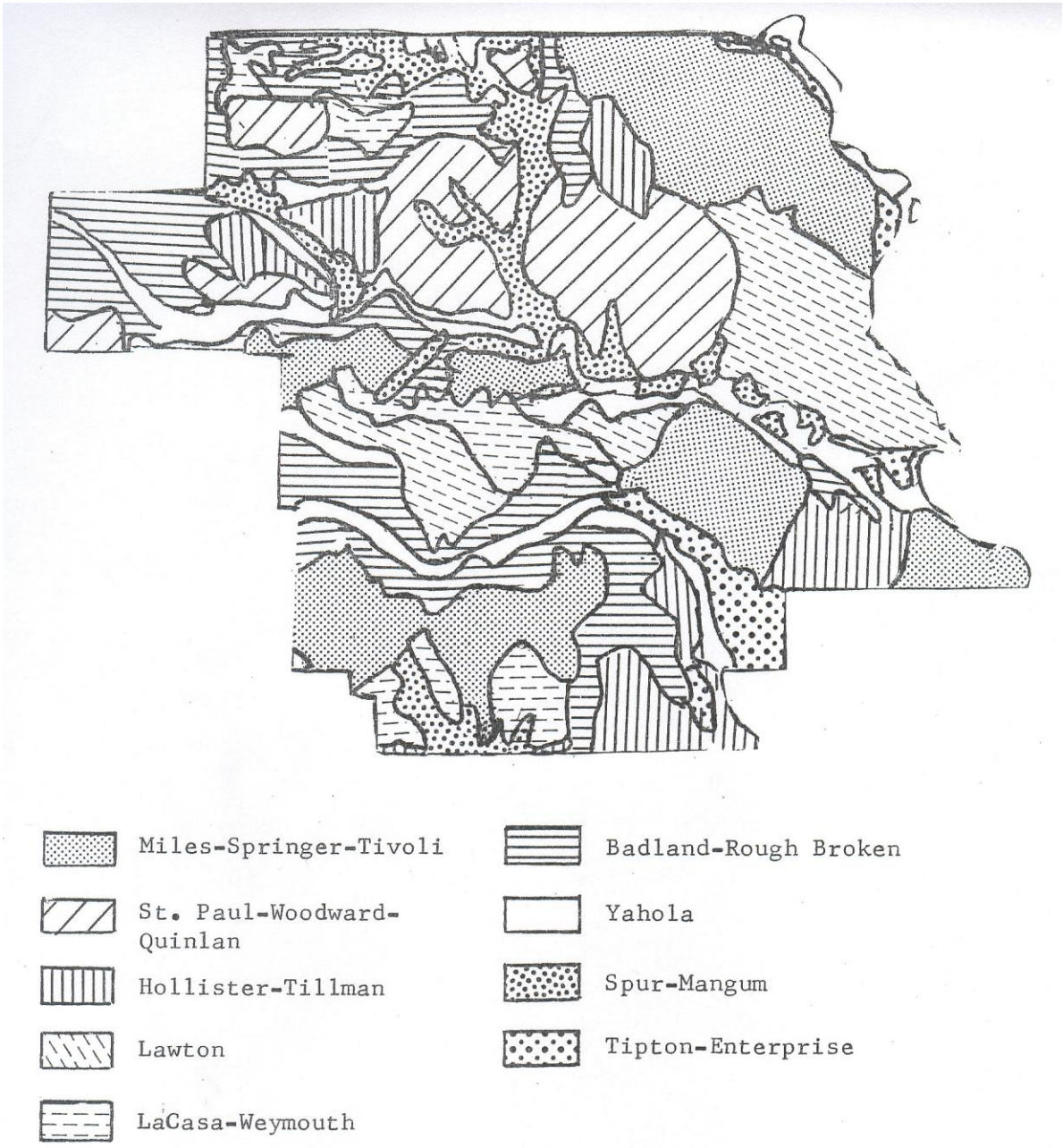

Figure 4. Soil Associations for Greer County (Frie, Brinlee, and Graft, 1967).

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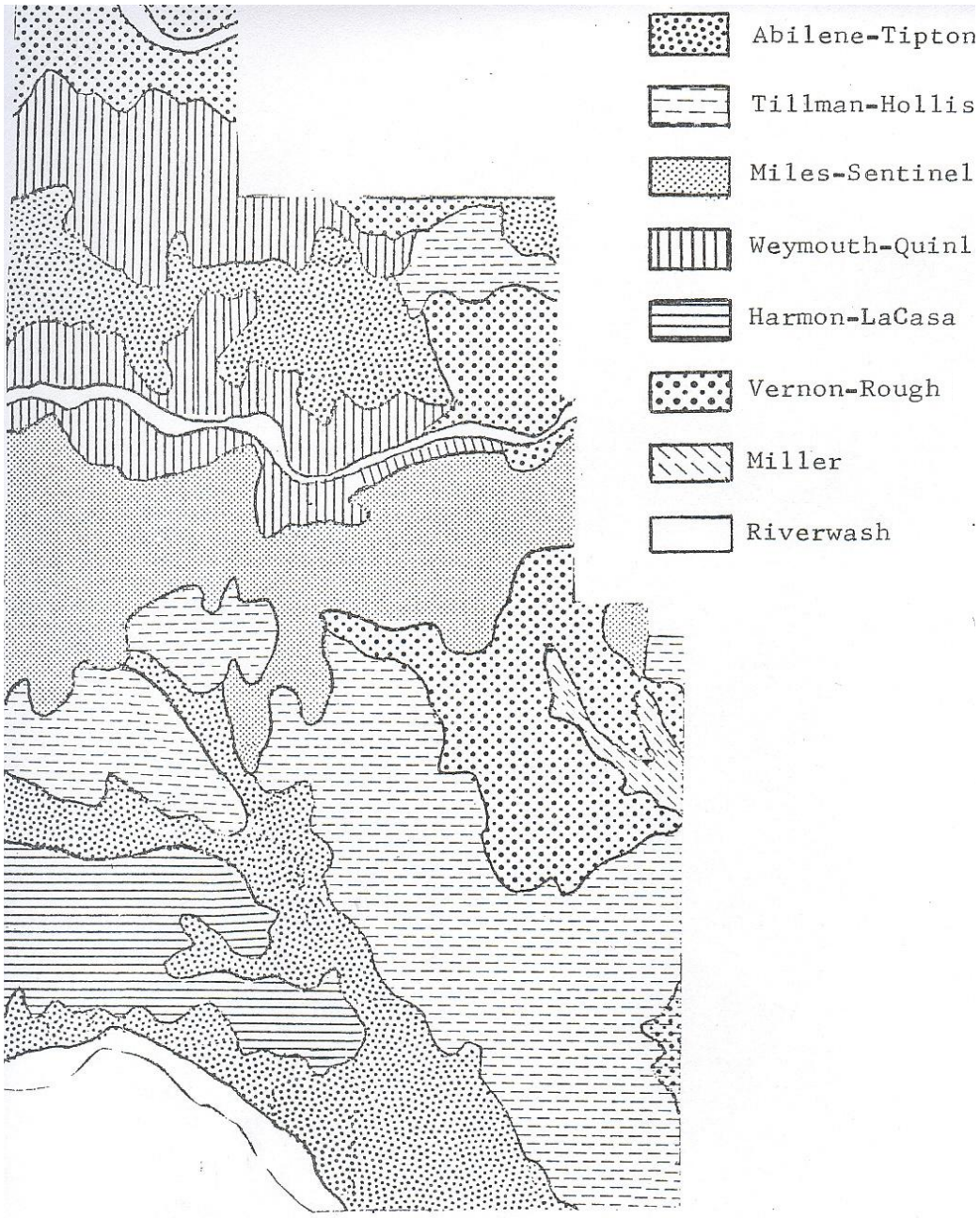

Figure 5. Soil Associations for Harmon County (SCS, 1973).

No complete soil survey report for Harmon County has been published, but the Soil Conservation Service (1973) has mapped the major soil associations for the county (Figure 5). A brief description for each of the eight associations is given below.

1. **The Abilene-Tipton** association is composed of deep upland soils with silty surfaces and permeable subsoils on nearly level to gently sloping topography. The main crops are cotton, wheat, milo, and alfalfa. The rangeland on this association is mostly on droughty soils. Mesquite is a problem on the rangeland of this association.
2. **The Tillman-Hollister** association consists of deep upland soils with silty surfaces. They are nearly level to very gently sloping Cotton is the main irrigated crop.
3. **The Miles-Sentinel** association is composed of deep upland soils with sandy surfaces. The principal crops are sorghum and cotton. The major soil problem of the area is wind erosion.
4. **The Weymouth-Quinlan** association consists of shallow to deep soils, loamy throughout. The soils are gently sloping to steeply sloping. Most of this association is used for rangeland.
5. **The Harmon-LaCasa** association consists of shallow to shallow upland soils with loamy surfaces. The land is mainly used for rangeland, but mesquite is a problem on the ranges.
6. **The Vernon-Rough Broken Land** association is made up of very shallow to shallow upland soils with clayey surfaces. The slopes are gentle to steep. The soils are used primarily for rangeland. The shallow clayed soils cause drouthiness; therefore, maintaining an adequate vegetation cover is a problem.
7. **The Miller** association is composed of deep, clayey, bottomland soils used principally as cropland. Wheat has been almost exclusively the only crop grown on this soil.
8. **The Riverwash** association consists of deep sandy, bottomland soils used principally as rangeland. These soils produce a fair amount of forage, but the fertility is very low.

CLIMATE

The climate of the three county area is continental, warm-temperate, and subhumid. The major climatic variations are caused by the alternating movement of warm, moist air from the Gulf of Mexico and cool, dry air from the north. Daily and seasonal variations in the climate are often sudden and extreme. The months of greatest rainfall are April, May, and June and then the fall months of September and October. Most of the rains are of short duration and high intensity. The soils are driest in July and August when high temperatures and hot, dry winds remove moisture rapidly. Moisture is often removed from leaves faster than it can be supplied and the plants are unable to recover.

The average rainfall for Jackson County is 25 inches. The lowest amount ever recorded was 13.92 inches in 1917 and the

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wettest year was 1941 with 49.30 inches. The average snowfall is 6.7 inches with snow rarely covering the ground for more than 2 weeks, generally only 2-4 days. The average growing season is 224 days. The average last frost in the spring is March 28 and the average first fall frost is November 7th (Bailey and Graft, 1961).

The average rainfall for Greer County is 23.68 inches. Annual amounts have ranged from a low of 10.86 inches in 1910 to as much as 45.13 inches in 1923. The average snowfall ranges from 6.5 inches in the southeastern part of the county to 8.5 inches in the northwestern part of the county. The growing season ranges from 209 days in the northwest to 225 days in the southeast. The average last spring freeze is November 4th (Frie, Brinlee, and Graft, 1967).

The average rainfall for Harmon County is 23.2 inches. The amounts have ranged from a low of 9.79 inches in 1933 and a high of 45.15 inches in 1941. The average growing season is 225 days. The average last killing frost is March 30th and the average first killing frost is November 10th (U.S.D.A. Soil Conservation Service, 1973).

Temperature and rainfall records were recorded at the Altus Irrigation Research Station, which is located in the south-central portion of the collection area in Jackson County. Evaporation data was taken from Altus Dam at Lake Altus in Greer County. Temperature is recorded in degrees Fahrenheit; precipitation and evaporation are recorded in inches.

Climatically, this year was an unusual year for the study area, as indicated in Tables V-VII. Temperatures were generally below average for the year. Precipitation, on the average, was higher in the summer months, but evaporation for the early part of the summer was greater than usual. In July 6.94 inches of the 7.13 inches of rain came in a three day period, the 24th through the 26th. Therefore, most of July was dry and the soil was baked. With the end of July and the first part of August came more rain. September and October, usually wet months, were exceptionally dry.

TABLE V

AVERAGE TEMPERATURES AND DEPARTURE FROM AVERAGE (°F) FOR THE MONTHS JANUARY THROUGH OCTOBER 1975[a]

Month	Average	Departure
January	42.2	+2.2
February	39.4	-5.2
March	50.1	-1.3
April	60.7	-2.6
May	70.2	-1.3
June	78.7	-1.6
July	8.0	-4.3
August	81.0	-1.6
September	70.5	-5.1
October	65.4	+0.6

[a]From Oklahoma Climatological Data, Monthly Summaries, 1975.

TABLE VI

PRECIPITATION AND DEPARTURE FROM AVERAGE FOR THE MONTHS JANUARY THROUGH OCTOBER 1975[a]

Month	Evaporation	Departure
January	1.58	+0.74
February	2.06	+1.04
March	0.90	-0.36
April	0.89	-1.20
May	4.61	+0.31
June	5.18	+1.70
July	7.13	+5.06
August	1.96	-0.10
September	2.22	-0.23
October	0.74	-2.05

[a]From Oklahoma Climatological Data, Monthly Summaries, 1975.

TABLE VII

EVAPORATION AND DEPARTURE FROM AVERAGE FOR THE MONTHS JANUARY THROUGH OCTOBER 1975[a]

Month	Evaporation[b]	Departure
January	-	-
February	-	-
March	5.05	+1.12
April	7.03	+1.37
May	9.58	+1.49
June	11.63	+1.38
July	-	-
August	10.13	-2.18
September	-	-
October	-	-

[a]From Oklahoma Climatological Data, Monthly Summaries, 1975 for the Altus Dam Station.

[b]Evaporation is measured in inches from a standard weather service-type pan with a four foot diameter.

The prolonged winter retarded spring plants flowering, however, high amounts of rainfall in May and June allowed many of these plants to persist into the summer. The largest number of plants was collected in these two months when the climate was most favorable for plant growth. The relatively low amount of rainfall in July, excluding the wet three-day period at the end of the month, and the high evaporation rate created poor growing conditions for the plants, with many plants being smaller than normal. With the rains in late July and early August, conditions once again improved for the plants. The number of plants flowering again decreased with the dryness of September and October.

ECONOMY

The economy of Harmon, Jackson, and Greer counties is almost entirely dependent upon agriculture. Cattle, cotton, and wheat are the main revenue sources for the three counties. The total land area of the three counties is 1,272,256 acres with 1,202,800 acres or 94.5% of the land in farms (Census of Agriculture, 1969). These farms support the majority of the 44,017 people living in the three county area (Census of Population, 1970). Jackson County, population 30,902 is the only county of the three counties with an urban population. The largest city is Altus, population 23,302. The primary employer for the city is Altus Air Force Base located on the northeastern edge of the city. Other towns of the county are rural farm communities. In order of size they are Blair, population 1,114; Olustee, population 897; Eldorado, population 737; Duke, population 486; and Martha, population 268. Republic Gypsum, a relatively new gypsum plant is housed at Duke. Eagle-Picher Industries owns a copper mine near Creata in the county.

Greer County has a population of 7,979. Mangum is the only town of any significant size with a population of 4,066. The other rural communities in order of size are Granite, population 1,808; Willow, population 188; and Brinkman, population 7.

The least populated of the three counties is Harmon County, population 5,135. Hollis, the county seat, is the largest town with a population of 3,150. The other communities are quite small with Gould being the second largest town with 368 people (Figure 6).

The agricultural use of the land of the three counties is divided equally between crop production and cattle production. The total agricultural market value for the three counties was $34,698,769 in 1969 with $19,665,325 being from livestock and their products and $15,033,445 from crops. The total acreage is 503,164 in pastureland including cropland and woodland used for pasture. There are 9,189 acres of

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woodland in the three counties with 6,421 acres being used for crop production. The total crop acreage includes 25,382 with cover crops being used only to improve the land.

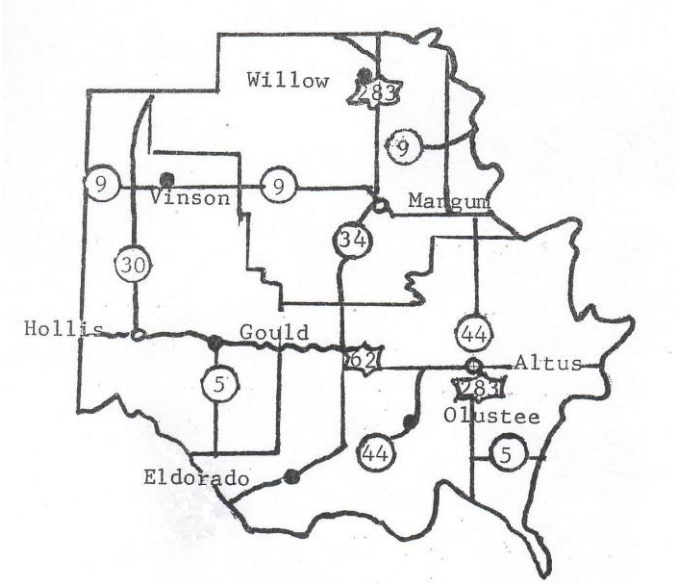

Figure 6. Towns and Major Highways (Modified from Official State Highway Map, 1973).

TABLE VIII

SUMMARY OF ACREAGE USED FOR CROP PRODUCTION

Industry	Jackson	Harmon	Greer	Total
Wheat	128,595	47,617	68,714	244,926
Cotton	40,722	30,634	24,239	95,595
Hay	13,147	11,799	6,289	31,235
Sorghum	13,111	10,709	6,109	29,929
Peanuts Soybeans Corn	1,537	268	526	2,311
Total Crops	197,112	101,027	105,877	404,016

The extensive use of the land for agricultural purposes has had a pronounced effect upon the vegetation. Indicators of overgrazing, such as *Gutierrezia dracunculoides* (DC.) Blake, are often quite abundant in the fields. Extensive cultivation of the land for crop plants has destroyed many of the habitats for the native plants.

Two industries of the area which have had an effect upon the vegetation are those of gypsum and copper mining. Between Elmer and Eldorado there is an extensive area of copper mining near Creta. Republic Gypsum, located in Duke, has a mine near the plant (Johnson, 1954). The mining has also destroyed many of the habitats for the plants, but along the edges of the mining area, the native plants can still be found.

The three county area has not been very profitable for the oil and gas industry. Clifton (1928) did an extensive geological survey of the area with respect to oil and gas and predicted that the area probably would not produce much gas and oil. In 1963 there were thirty-one oil and gas industries in the three county area (Census of Mineral Industries, 1963). In 1967 the number had been reduced to fourteen (Census of Mineral Industries, 1967). The industry has undoubtedly had a small impact upon the vegetation of the area, but the effect is not as pronounced as the effect of the agricultural industry.

HISTORY

The first European to set foot in what is now western Oklahoma was Vasquez de Coronado in 1541. There were no botanists in the group, but in a report to the "Holy Catholic Caesarian Majesty" he noted (Featherly, p. 10), "We found no kind of wood in all these plains away from the gullies and rivers, which were very few". His description is an accurate one for the western part of Oklahoma (Featherly, 1943).

In the year 1601 Juan de Onate of Santa Fe crossed a part of what is now Oklahoma. He stated that the ground was useless for agriculture and suitable only for a hunting ground for savage tribes (Featherly, 1943).

In 1820 Stephen Harriman Long was commissioned to command the "Yellowstone Expedition" from St. Louis to Wyoming (McKelvey, 1955). Dr. Edwin James was appointed to serve as botanist and geologist for the expedition. Traveling on horseback the group departed April 24, 1820. As they entered the Great Plains of Iowa and Missouri, James commented:

> These vast plains in which the eye funds no object to rest upon are at first seen with surprise and please sure, but their uniformity at length becomes tiresome.... Nothing is more difficult than to estimate, by the eye, the distance of objects seen in these plains.... A small animal, as a wolf or turkey appears the magnitude of a horse. (McKelvey, p. 212)

As they crossed Nebraska, James noted changes of the vegetation. Prickly poppy *(Argemone alba)* and Adam's needles *(Yucca angustifolia)* were noted. As the expedition traveled farther west, desert plants, cacti, and sagebrush become more abundant. On June 26th the group entered Colorado and explored the Rocky Mountains approximately one month. On July 24th Long, James, and another member of the party went southward from Colorado to search for sources of the Red River. On August 17th the three men crossed from Hemphill County, Texas into the Antelope Hills area of Roger Mills County, Oklahoma. They were to travel in Oklahoma until September 13th. James, compiler of records for the expedition, was impressed by the elevated plain and stated:

> The luxuriance and fineness of grasses, as well as the astonishing number and good condition of the herbivorous animals of this region clearly indicate its value for purposes of pasturage.(McKelvey, p. 232)

The three men went eastward from there into the Ozarks and on September 19th crossed into Arkansas.

James W. Abert was commissioned by congress in 1845 to survey the Canadian River in western Oklahoma (Abert, 1846). The expedition left on August 9th from Bent's Fort on the Arkansas River. Very little was recorded concerning the vegetation, but the following is his brief description of the area:

> We noticed a profusion of prairie sage, *Artemisia tridentate*, being about the only shrub that grows in these sandy regions. This plant seems to love a dry and arid soil.... In some places it grew so luxuriantly that the stalks might be used for fuel. We were disappointed in not seeing even one specimen of the sage cock, *Tetrao upophrasianus*, which is so extravagantly fond of feeding on this plant that its flesh becomes so embittered as to render it perfectly uneatable. Not withstanding the abundance of the plant, we did not see a single specimen of this bird during the trip. Cacti were numerous, and a species of Cucurbitaceae, *Cucurbita aurantia*, bearing a small spherical gourd, orange-colored. These plants are characteristic of the dry sandy plains. (Abert, p. 14)

On September 20th the group encountered the gypsum and Abert commented:

> We continued to follow the river, and became involved in difficult ground, which was high and rough, composed of red clay filled with gypsum, which is found so generally to pervade this country. The waters percolating the immense masses of this mineral, separate the sulphuric acid from the lime, and acquire an extremely nauseous taste,

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> anything but agreeable to wayworn travelers, although our animals appear to relish it much. (Abert, p. 93)

They were forced to follow a serpentine course of travel on account of deep ravines of red clay and gypsum buttes. On September 23rd the group was 20 miles west of the Antelope buttes.

In 1852 Captain R. B. Marcy led an expedition to explore the Red River boundary between Texas and Oklahoma (March, 1854). The expedition went from Fort Arbuckle through the Wichita Mountains to the source of the North Fork of the Red River. Dr. G. G. Shumard, surgeon of the expedition, collected about 200 species of plants. Determinations of the plants were done by Dr. John Torrey, who reported that many of the plants were rare and that the flora resembled that of the upper portion of the Canadian River. Most of the plants on the list were from the Wichita Mountains. As the party rode through the Wichitas toward the Red River, Marcy (p. 12) noted:

> As we advance, the country away from the borders of the water-courses becomes more barren and woodlands are less frequently met with; indeed, upon the river there is no other timber but cottonwood *(Populus angulata)* and elm *(Ulmus americana)*, and these in very small quantities; for the most part the valley of the river along where we passed today is entirely destitute of trees.

He described the sand-hills to be ten to thirty feet high and the vegetation sparse with weeds, grapevines, and plum bushes. They met Chief CanajeHexie of the Wichita tribe as they were leaving the mountains. He told them (Marcy, p. 17-18), "When you should leave the mountains to go down to the river, the country will be flat prairie country, totally destitute of water, wood or grass and the only substitute for fuel would be buffalo 'chips'."

As the party moved out of the mountains onto the prairie, March described the area as having the appearance of a meadow that has been recently mowed close to the earth due to the buffalo grass. He described the river banks as having mesquite trees and grama grasses and the sandstone hills with weeds and dwarf oaks. The group had hopes that the descriptions of the area that the Indians had given were erroneous. They soon discovered, however, that they were not. The water in the Salt Fork was bitter and unpalatable and caused nausea. The group encountered gypsum forming an immense belt. He described it as being much elevated above the surrounding country, very smooth, and level, spreading out in every direction without trees or shrubs --- "a barren solitude".

Captain Whipple headed a survey party to explore a route for a railroad from the Mississippi River to the Pacific Coast in 1853. Dr. J. M. Bigelow was the botanist of the expedition and collected 125 species. Drs. John Torrey and Asa Gray wrote the botanical descriptions for the plants collected on the expedition (Bigelow, 1855).

As the group entered the western part of Oklahoma they noted gypsum in every variety of form and that there was a lack of trees and scarcity of grass.

They crossed Elm and Gypsum creeks and passed through a new sandstone that the geologist named "new red". Gypsum beds outcrop in these sandstones. The party camped in the Antelope Hills area of scanty grass relieved only by red gullies and occasional ravines.

Bigelow (1855) noted the first appearance of grama grass on the north side of the Canadian River at longitude 96° west. He noted the fact that grama grass and

buffalo grass are important because they retain nutritive quality all year round and that they are only well adapted to arid climates in their native states. Apart from the grasses, the most notable plants were evening primrose, *Ambrosia*, and golden rods on the plains; and prairie plums on the streams. The entire area was described by Bigelow as having a considerable number of Cactaceae, especially *Opuntia macrorhiza*. From Oklahoma the party went to the Pecos and Rio Grande river valleys.

From 1875-1877 Dr. T. E. Wilcox collected plants in what is now western Oklahoma and the determinations were done by Alphonso Wood. No further details of the excursions were given (Henson, 1941).

More recent studies of the area are very few. In 1932 a student at the University of Oklahoma, Rotha Zelma Bull, compiled a list of plants of Greer County as part of her master's program. The study area included the extension of the Wichita system into the southwestern corner of the state.

ECOLOGICAL CONSIDERATIONS

Blair and Hubbell (1938) list two biotic districts within the boundaries of the study area, the Mesquite Plains and Mixed-grass Plains districts.

The Mesquite Plains district is included to a greater extent in the gypsum hills region and only to a lesser degree in the redbed plains district. This province takes in approximately one-half of the land area included in the study. It includes vegetation mostly of the Mangum Gypsum Hills geomorphic province and soils of the Tillman-Hollister, LaCasa-Weymouth, and Vernon-Rough Broken land associations. The principal vegetation is a mesquite grassland type with mesquite *(Prosopis glandulosa)* being the dominant woody vegetation and buffalo grass (*Bouteloua dactyloides*) as the dominant herbaceous species. Desert cactus (*Cylindropuntia leptocaulis*) is also abundant. *Scirpus* marshes are quite often observed around the mouths of the creeks in this district.

The Mixed-grass Plains district comprises all of western Oklahoma except the Panhandle and the Wichita Mountains district. The district includes vegetation both of the Central Redbed Plains and the Mangum Gypsum Hills geomorphic provinces. The soils are basically of the Tillman-Hollister and Miles-Sentinel soil associations. The principal plants of the district are the grama grasses, blue grama (*Bouteloua gracilis)*, hairy grama *(B.* hirsuta*)*, side-oats grama *(B. curtipendula)*, buffalograss, and little bluestem *Schizachyrium scoparium)*. On the deeper soils western wheatgrass *(Pascopyrum smithii)* and silver bluestem *(Bothriochloa saccharoides)* are abundant.

Within each biotic district distinctive plant associations and communities can be seen. Six plant associations are included in the study area, mixed grass eroded plains, mesquite grassland, sandsage grassland, shinnery oak grassland, woodland of creek and river floodplains, and aquatic communities (Figure 7).

The most extensive plant association is that of the mixed-grass prairie type which includes two distinct grassland communities. The first community is that of shallow soils mostly of the Vernon-Rough Broken land association and generally includes the grassland of the gypsum hills(Figures 8 & 9).

In early spring very few grasses are in flower, but various forbs dominate the landscape which includes the following:

false nightshade (*Chamaesaracha coniodes*), (*Cymopterus macrorhizus*), puccon (*Lithospermum incisum*, Indian

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paintbrush (*Castilleja purpurea* var. *citrine*) rose vervain (*Glandularia canadensis*), Texas yellow star (*Lindheimera texana)*, flax (*Linum rigidum*), and prairie flax *(Linum pratense*).

In late spring, late April through May still another set of forbs dominates the scene:

loco weeds (*Astragalus racemosus* and other *Astragalus* species), evening primrose (*Calylophus hartweggii*, var. *pubescens*), paper flower (*Psilostrophe villosa*), aster (*Aster leucelene*), skull cap (*Scutellaria drummondii*), bladder-pod (*Lesquerella gordonii*), (*Nama stevensii*), lazy daisy (*Aphanostephus ramosisimus*), beard tongue (*Penstemon fenderli*), scarlet globe mallow *(Sphaeralcea coccinea*), (*Happlopappus spinulosis*), lemon beebalm *(Monarda citridora*), and (*Phacelia integrifolia*).

By June the grasses have started flowering and the forbs are still abundant. The forbs include:

(*Dalea enneandra*), mock pennyroyal (*Hedeoma drummondii*), prairie clover (*Dalea candida var. oligophylla,* basket flower (*Centaurea americana*), stick leaf (*Mentzelia nuda* and other *Mentzelia* species), *(Haploesthes greggii*), and evening primrose (*Calylophus serrulatus*).

The grasses include:

tumblegrass (*Schedonnardus paniculatus*), white tridens (*Tridens albescens*), tobosa (*Hilaria mutica*), (*Erioneuron pilosum*), and Canada wild rye (*Elymus canadensis*).

From July until October the dominant grasses are flowering and dominate the landscape:

blue grama, hairy grama, side-oats grama, sand dropseed (*Sporobolus cryptandrus*), (*Tridens muticus* var. *elongatus*), little bluestem, and tall dropseed *(Sporobolus asper*).

Numerous forbs are also abundant until frost. These include:

scurfy pea (*Psoralidium tenuiflora*), Missouri goldenrod *(Solidago missourensis*), and bluet (*Stenaria nigricans*).

The second grassland community of mixed grass eroded plains consists mostly of Tillman-Hollister and Miles-Sentinel soil associations which are deep upland soils. In early spring forbs and winter annuals dominate the scene (Figures 10 & 11). They include:

common speedwell (*Veronica arvensis*), purslane speedwell (*Veronica peregrina*), creeping lady's sorrel (*Oxalis corniculata*), tansy mustards (*Descurainia pinnata* and *D. sophia*), shepherd's purse (*Capsella bursa-pastoris*), mousetail (*Myosurus minimus*), plaintain (*Plantago purshii*), loco weed, bladder pod, prairie flax, windflower (*Anemone caroliniana*), Indian paintbrush, false dandelion (*Pyrrhopappus pauciflorus)*, Englemann daisy (*Engelmannia peristenia*) spiderwort (*Tradescantia ohiensis*), wine cup (*Callirhoe involucrata*), rabbit-tobacco (*Evax verna*), oats (*Avena sativa*), Japanese brome (*Bromus japonicus*), thistle (*Cirsium texanum*), canary grass (*Phalaris caroliniana)*, (*Pediomelum cuspidatum*), zinnia (*Zinnia grandiflora*), skull-cap (*Scutellaria wrightii*), and prickly pear (*Opuntia*

humifusa).

By the summer another set of forbs is in full flower. They include:

*widow's tears (*Commelina erecta*), prickly poppy* (*Argemone polyanthemos*), sensitive briar (*Mimosa microphylla*), fern acacia (*Acacia angustissima* var. *hirta*), (*Nama hispidum*), and golden aster (*Heterotheca canescens*).

A few grasses have started to flower by June. These include:

rabbitfoot grass (*Polypogon monspeliensis*), side-oats grama, western wheatgrass, and prairie three-awn (*Aristida purpeurea* and other *Aristida* species).

From August through October, the dominant grasses are in full flower. These include:

blue grama, hairy grama, bristle grass (*Setaria viridis*), silver bluestem, tall dropseed, big bluestem (*Andropogon gerardii*), little bluestem, purple top (*Tridens flavus*), and annual three-awn (*Aristida oligantha*).

Forbs that are present in the fall include:

(*Palafoxia sphacelata*), whitlow-wort (*Paronychia jamesii*), ironweed (*Vernonia baldwinii*), dotted gay-feather (*Liatris* punctata), matchweed *Gutierrezia sarothae*), annual buckwheat (*Eriogonum annum*), and blue sage (*Salvia azurea*).

The mesquite grassland association can also be divided into two grassland types. The two communities vary little from the grassland communities of the mixed eroded plain association. In aspect they are the same with the exception of mesquite, and abrojo (*Cylindropuntia davisii*), which are dominant life forms on the deeper soils and Mormon's tea (*Ephedra antisyphilitica*), and buckthorn (*Ziziphus obtusifolia*), are dominant life forms on the typically Rough Broken land or gypsum soils.

One of the most distinctive associations of the mixed grass eroded plains district is that of the Sandsage grassland which predominates on sand dunes on the north side of most streams (Figure 12). Sandsage (*Artemisia filifoliai), sand plum (*Prunus angustifolia), lemon sumac (*Rhus aromatica*), and sand bluestem (*Andropogon halii*) are the most distinctive indicators of the stabilized dune areas. The vegetation of the sand area appears much more distinct than that of the other associations.

In the spring mostly forbs are blooming, with a few grasses intermingled. The list includes:

false nightshade, bluet (*Hustonia humifusa*), *Cryptantha minima*), bladder-pod, vetch (*Vicia ludoviciana*), Texas bluegrass (*Poa arachnifera*), rescue grass (*Bromus unioloides*), pepper grass (*Lepidium virginicum*), evening primrose (*Calylophus serrulatus*), bullnettle (*Cnidoscolus texanus*), Venus looking-glass (*Triodanis holzingeri*), three-awn (*Aristida longieseta*), Indian blanket (*Gaillardia pulchella*), catch-fly (*Silene antirrhina*), skeleton-plant (*Lygodesmia texana*), queen's delight (*Stillingia sylvatia*), plaintains (*Plantago* spp.), and cut leaved evening primrose (*Oenothera laciniata*).

By the beginning of the summer the area is still dominated by forbs, but the grasses are beginning to flower also. The forbs include:

widow's tears, thistle, scarlet

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pea (*Indigofera miniata*), milkweed (*Asclepias arenaria*), (*Dalea villosa*), cowpen daisy (*Verbesina encelioides*), and (*Oenothera rhombipetala*).

The grasses include:

rabbitfoot grass, hooded fingergrass (*Chloris cucullata*), sand dropseed, and silver bluestem.

With the coming of fall, still mostly forbs are dominant. Unlike the other associations where grasses are the main plants in the fall, forbs still dominate in this vegetation type. The grasses include:

bristlegrass (*Setaria leucophila*), sand bluestem, and sand lovegrass (*Eragrostis trichodes*), giant sandreed (*Calamovilfa gigantean*), and red lovegrass (*Eragrostis oxylepis*).

The fall forbs are mostly members of the Compositae. The list includes:

scratch-daisy (*Haplopappus divaricatus*), aster (*Aster subulatus*), western ragweed (*Ambrosia psilostachya*), golden aster (*Heterotheca latifolia*), and sand groundsel (*Senecio riddellii*).

The shinnery oak association is also a sand association and has essentially the same dominant species as the sandsage grassland area except that shinnery oak (*Quercus harvardii*) is the dominant species. Other dominants such as sand plum and sand lovegrass, etc. are present.

Another plant association of the study area is that of the woodland of the creeks and river flood plains (Figure 13). The woody vegetation includes:

cottonwood (*Populus deltoides*), black willow (*Salix nigra*), American elm (*Ulmus americana*), hackberry (*Celtis* spp.), soapberry (*Sapindus saponaria* var. *drummondii*), and salt cedar (*Tamarix gallica*).

The understory includes:

rush (*Schoenoplectus americanus*), switchgrass (*Panicum virgatum*), Johnson grass (*Sorghum halepense*), barnyard grass (*Echinochloa crusgalli*), nutgrass (*Cyperus uniflorus*), saltgrass (*Distichlis spicata* var. *stricta*), canela (*Pluchea odorata* var. *odorata*), water pimpernel (*Samolus ebracteatus*), smartweed (*Polygonum lapthifolium*), and cockle bur (*Xanthium strumarium*).

The final community is comprised of the plants from the stock ponds, the aquatic community. These ponds are temporary and tend to have a high evaporation rate during the summer months, therefore the aquatics of these communities are temporal. The pond plants include:

cattail (*Typha angustifolia*), smartweed (*Poly*gonum pensylvanicum), water clover (*Marsilea vestita*), tooth-cup (*Ammania coccinea*), sneezeweed (*Helenium microcephalum*), and spikerushes (*Eleocharis macrostachya* and *E. compressa*).

One other area needs to be discussed. Shelter belts are common in the southwestern part of the state. These were probably established in the 1930's during the "Dust bowl" days. This accounts for some unusual range extensions occurring in the area including:

green ash (*Fraxinus pennsylvanica*), honey locust (*Gleditsia triacanthos*), and desert willow (*Chilopsis linearis*).

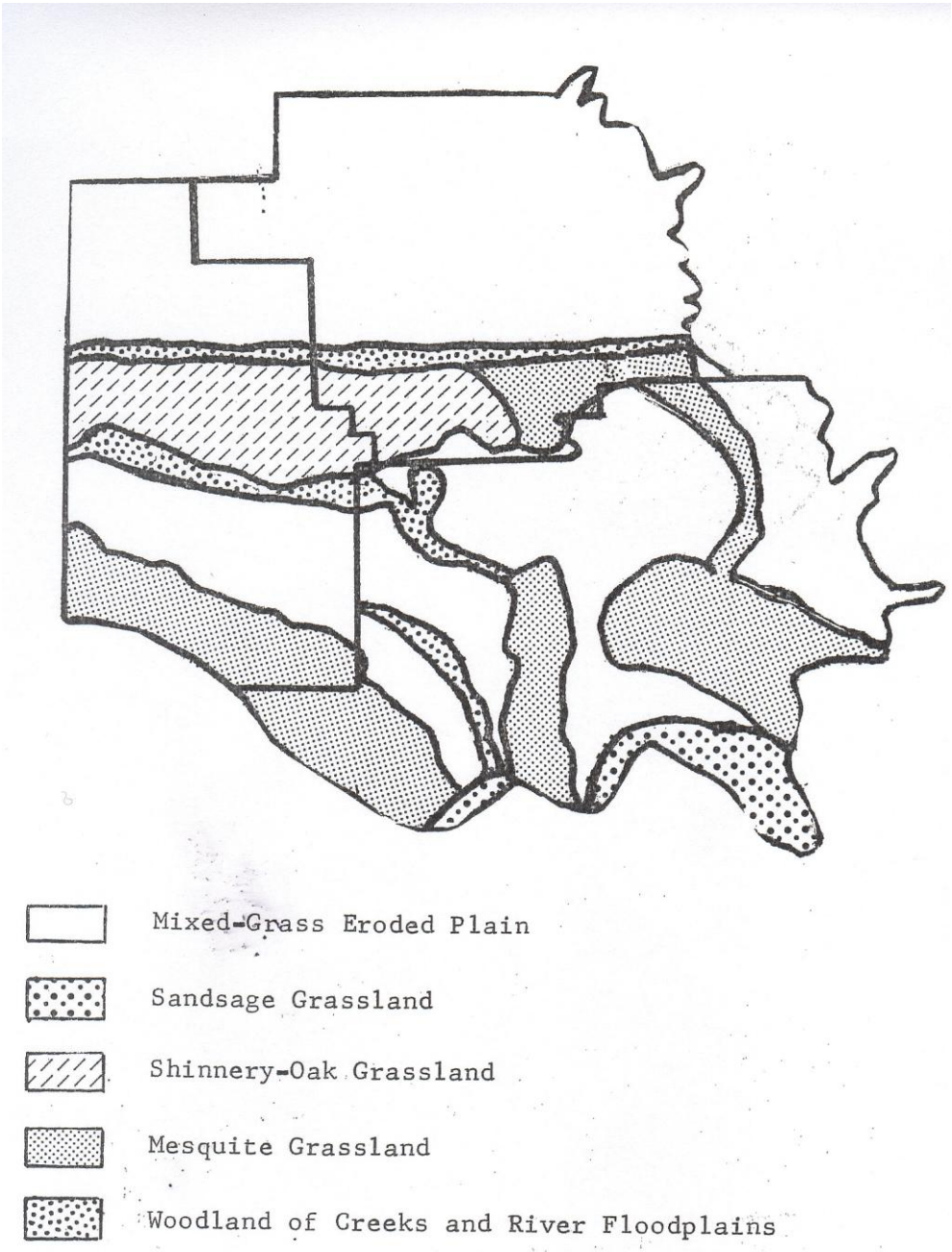

Figure 7. Plant Associations.

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Figure 8 Mixed-grass prairie of rough broken land

Figure 9 Mixed-grass prairie of rough broken land

Figure 10 Mixed-grass and mesquite grassland of Tillman-Hollister

Figure 11 Mixed-grass and mesquite grassland of Tillman-Hollister

Figure 12 Sandsage grassland association

Figure 13 Woodland and *Scirpus* marsh area of river flood plain

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A COMPARISON OF THE GYPSUM AND REDBED TAXA

An important aspect of the study was the comparison of the gypsum and redbed floras. One hundred eighty-seven species were found to occur on the redbed plains soils, excluding the sand areas; whereas 108 species were found on gypsum. Although gypsum soils are very fertile, they are often shallow and very dry, conditions that are not conducive to plant growth. Application of gypsum to soils causes an increase in exchangeable calcium and a decrease in exchangeable sodium, thus improving physical conditions for soil and plant growth. Magnesium, potassium, and nitrogen levels all increase within a plant in the presence of gypsum (Poonia and Bhumbla, 1973). However, soils of 100% gypsum exhibited a marked decrease of the same nutrients.

The aspects of the two areas are certainly distinct as can be seen from the previous discussion of the two grassland communities which coincide quite well with the gypsum and redbed soil types.

A comparison of the floras is given below where G = Gypsum and R = Redbeds. The list excludes sand species.

Taxa	Soils
MARSILEACEAE	
Marsilea vestita	R
POLYPODIACEAE	
Pellaea atropurpurea	G
CURPRESSACEAE	
Juniperus pinchotii	G
J. virginiana	R
GNETACEAE	
Ephedra antisyphilitica	G
GRAMINEAE	
Agropyron gerardii	R
Aristida fenderliana	R
A. longiseta	G
A. oligantha	R
A. purpurea	R
A. wrightii	R
Arundo donax	R
Avena sativa	R
Bothriochloa ischaemum	R
B. saccharoides	R
Bouteloua dactyloides	G&R
B. curtipendula	G&R
B. gracilis	G&R
B. hirsuta	G&R
Elymus canadensis	G&R
E. virginicus	R
Erioneuron pilosum	G&R
Pascopyrum smithii	R
Phalaris caroliniana	R
Pleuraphis mutica	G
Poa arachnifera	R
Polypogon monseliensis	R
Schedonnardus paniculatus	G
Schizachyrium scoparium	G&R
Sorghastrum nutans	R
Sporobolus airoides	G
S. asper	G&R
S. cryptandrus	G
Tridens albescens	G&R
T. flavus	G
T. muticus var. elongatus	G
COMMELINACEAE	
Tradescantia ohiensis	R
LILIACEAE	
Yucca glauca	G&R
IRIDACEAE	
Sisyrinchium angustifolium	R
POLYGONACEAE	
Eriogonum annum	R
E. longifolium	R
CHENOPODIACEAE	
Atriplex canescens	G
AMARANTHACEAE	
Kallstroemia parviflora	R
NYCTAGINACEAE	
Mirabilis linearis	G&R
ILLECEBRACEAE	
Paronychia jamesii	G&R
RANUNCULACEAE	
Anemone caroliniana	R
Delphinium carolinianum ssp. *virescens*	R
Myosurus minimus	R
CRUCIFERAE	
Erysimum repandum	R
Lepidium austrinum	R
L. virginicum	R
Lesquerella gordonii	G&R

LEGUMINOSAE	
Acacia angustissima var. *hirta*	R
Astragalus lindheimeri	G&R
A. lotiflorus	G
A. missouriensis	G&R
A. mollissimus	G
A. nuttallianus	R
A. plattensis	G
A. racemosus	G
Chamaecrista fasciculate	R
Dalea aurea	R
D. candida	G&R
D. enneandra	R
Hoffmanseggia glauca	G&R
Mimosa borealis	G&R
M. microphylla	G&R
Pediomelum cuspidatum	G&R
Prosopis glandulosa	G&R
Psoralidium tenuiflora	G&R
LINACEAE	
Linum pratense	G&R
L. rigidum	G&R
OXALIDACEAE	
Oxalis corniculata	R
O. dillenii	R
GERANIACEAE	
Erodium texanum	G&R
Geranium carolinianum	R
POLYGALACEAE	
Polygala alba	G
RHAMNACEAE	
Ziziphus obtusifolia	G
MALVACEAE	
Sphaeralcea coccinea	G&R
LOASACEAE	
Mentzelia decapetala	G&R
M. nuda	G
M. oligosperma	G
M. stricta	G&R
CACTACEAE	
Cylindropuntia davisii	R
C. leptocaulis	G
Echinocactus texsensis	R
Echinocerreus reichenbachii	G&R
Opuntia humifusa	G&R
ONAGRACEAE	
Calylophus hartwegii ssp. *fendleri*	R
C. hartwegii ssp. *pubescens*	G&R
Gaura longiflora	G
G. parviflora	R
G. sinuata	R
G. suffulta	R
Oenothera triloba	R
Stenosiphon linifolius	G&R
UMBELLIFERAE	
Ammoselinum popei	G&R
Cymopterus macrorhizus	G&R
Lomatium foeniculaceum ssp. *daucifolium*	R
PRIMULACEAE	
Androscace occidentalis	R
Samolus ebracteatus	R
ASCLEPIADACEAE	
Asclepias engelmanniana	G
Matelea biflora	G&R
CONVOLVULACEAE	
Evolvulus nuttalianus	R
HYDROPHYLLACEAE	
Nama hispidum	R
N. stevensii	G
Phacelia integrifolia	G
BORAGINACEAE	
Lappula occidentalis var. *occidentalis*	R
L. occidentalis var. *copulata*	R
VERBENACEAE	
Glandularia canadensis	G&R
Verbena halei	R
LABIATAE	
Hedeoma drummondii	G&R
Monarda citriodora	G&R
Salvia azurea	R
Scutellaria drummondii	G
S. wrightii	R
Teucrium laciniatum	R
SOLANACEAE	
Chamaesaracha coniodes	G&R
Physalis lobata	R
P. viscosa	R
SCROPHULARIACEAE	
Castilleja purpurea var. *citrina*	G&R
Penstemon albidus	R
P. fenderli	G
PLANTAGINACEAE	
Plantago purshii	G&R
RUBIACEAE	
Hustonia humifusa	R
CAMPANULACEAE	
Triodanis holzingeri	R
COMPOSITAE	
Aphanostephus ramosissimus	G&R
Berlandiera lyrata	R
Centauries americana	G&R
Chaetopappa ericoides	G&R
Evax verna	G&R
Gaillardia pinnatifida	G&R
G. pulchella	G&R
G. suavis	R
Grindelia nuda	G

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Haploesthes greggii	G
Heterotheca canescens	R
H. stenophylla	G
Hymenoxys odorata	G&R
Liatris punctata	G&R
Lindheimera texana	G&R
Machaeranthera Pennatifida	G&R
Psilostrophe tagetina var. *cerifera*	G
Pyrrhopappus multicaulis	R
Symphyotrichum ericoides	G&R
S. oblongifolium	R
S. subulatum	R
Tetraneuris scaposa	R
Thelesperma megapotamicum	R
Zinnia grandiflora	G&R

Of the 108 species occurring on the gypsum, the author discovered that only 30 were found exclusively on the gypsum. Seven of the 30 have herbarium records indicating occurrence only on gypsum. They include:

Ephedra antisyphilitica, Haploesthes greggii, Hilaria mutica, Juniperus pinchoti, Nama stevensii, Phacelia integrifolia, and Ziziphus obtusifolia.

Six other species which the author collected and observed only on gypsum appear to be good gyp indicators. These and the previous seven are considered Gypsophiles and indicators of gypsum soils. They are:

Astragalus missouriensis, A. racemosus, A. lotiflorus, Asclepias engelmanniana, Penstemon fendleri, and *Psilostrophe tagetina* var. *cerifera.*

The herbarium records of the above show one or two sheets which were not collected on gypsum. Nine taxa found here only on the gypsum are reported also from limestone soils, especially the Arbuckle Mountains and parts of Cimarron County. Russell (1969) states that calcareous soils free from sodium salts cannot have a pH exceeding 8.4, but the plants do not often do well in the soils because iron, manganese, boron, and perhaps other trace elements are so insoluble in these soils. He also points out that potassium deficiency sometimes induces iron deficiency or chlorosis and that this is a characteristic trouble of calcareous soils. Calcareous soils in excess can be harmful. It seems then that plants common to the limestone and gypsum have adapted to the situation.

The list of plants occurring *almost* exclusively on the gypsum and limestone are the following:

Aristida longiseta, Astragalus mollissimus, A. plattensis, Cylindropuntia leptocaulis (1 sheet from limestone area), Mentezelia nuda, M. oligosperma, Polygala alba (also from prairie sites of deep soils), *Scutellaria drummondii,* and *Tridens muticus* var. *elongatus* (also Wichita Mountains).

The other eight species of the thirty species were collected by the author only on gypsum, but do occur elsewhere. These are the following:

Atriplex canescens, Sporobolus airoides, S. cryptandrus, Heterotheca stenophylla, Gaura parviflora, Grindelia nuda, Pellaea atropurpurea, and Schedonnardus paniculatus.

It should be noted that *Sporobolus cryptandrus* was most often observed on sand in the area, but was collected and observed on the gypsum several times. *Schedonnardus paniculatus* occurs in mostly sandy disturbed areas in the rest of the state. This grass was found in an area disturbed by gypsum mining. *Atriplex canescens* and *Sporobolus airides* occur only in saline sites in other parts of the state.

ADDITIONS TO THE FLORA OF OKLAHOMA AND TAXA OF SPECIAL SIGNIFICANCE

Two introduced species *Bromus willdenowii* and *Caesalpinia gilliesii* are believed to be new additions to the state flora. No specimens are deposited in the two large herbaria of the state, the Bebb Herbarium at the University of Oklahoma and the Oklahoma State Herbarium. *Caesalpinia gilliesii* (Acc. No. 908) is a native of South America and is often found as an escape in central and West Texas. The species was found growing on the floodplain of the Red River, R20W, T2S, Sec. 11, and several individual shrubs were growing in the area. The plant was most likely cultivated for its showy flowers at the old homestead and escaped to the floodplain.

The distinctions between *Bromus willdenowiii* and *Bromus unioloides* have been previously discussed by Raven (1960) and Beetle (1972). The species are very closely related, but the author believes Acc. No. 668 to be *B. willdenowii.* The species is a native of South America and according to Gould (1965) is quite common on the coast of Texas. The species was introduced into the United States as a forage grass and apparently has escaped in many areas. It is distinguished from *B. unioloides* on the basis of spikelet color, lemma length, and arrangement of spikelets.

In addition to the additions to the state flora, 18 other taxa are considered somewhat significant. These specimens are represented by six or less sheets in the Oklahoma State Herbarium.

***Asclepias arenaria* Torr.** (Acc. No. 953). This species is represented by three sheets but is a widespread species in the Plains Country of Texas. The plants seem to occur sporadically, therefore they could have been easily missed by collectors making one trip into the area.

***Asclepias engelmanniana* Woods.** (Acc. No 986). This taxon is represented by five sheets and is very closely related to *A. stenophylla.* The two are quite difficult to delimit, therefore some of the herbarium material may be misidentified. This taxon is interesting in that it was only found on the gypsum soils in the study area.

***Aphanostephus ramosissimus* Buckl.** (Acc. No. 670). This taxon is very similar in aspect to *A. skirrhobasis* and *A. pilosus.* It actually seems quite abundant in the area and has probably been overlooked by collectors due to the similar appearance of its relatives.

***Atriplex canescens* (Pursh) Nutt.** (Acc. No. 841). Although only four sheets are in the herbarium, this species is widespread on alkaline soils in Texas. It was only found on gypsum soils in the study area.

Berlandiera lyrata* Benth. var. *lyrata (Acc. No. 711). Although this species is represented by only six sheets in the OSU herbarium, it is well represented in the Bebb Herbarium. However, this taxon has been previously collected in Cimarron County in Oklahoma. This is quite a range extension for the state, but is not too unlikely in that the species occurs in the Texas Panhandle.

***Chilopsis linearis* (Cav.) Sweet.** (Acc. No. 955). This taxon is represented by one sheet and was collected as a member of a shelter belt in Caddo County. This collection was also made in a shelter belt. The plant is native in the Trans-Pecos of Texas.

***Echinocactus texensis* Hopffer.** (Acc. No. 725). There are no sheets of this species from Oklahoma in the OSU herbarium. Waterfall (1969) lists the species as occurring in the state. Correll and Johnston (1970) give a very

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limited distribution for the species in Texas and Mexico. The species was observed only one time in the study area in a mesquite grassland area near Eldorado. It seems to be a relatively rare species.

***Echinocereus reichenbachii* (Terscheck) Haage** (Acc. No. 1109). This species is represented by three sheets, but is actually quite common in the study area. It probably has not been collected more often due to the difficulty in pressing and preserving cacti.

***Haploethes graggii* Gray** (Acc. No. 984). This taxon is represented by five sheets. It is an apparent gypsum endemic and has probably not been collected more often in the state because the gypsum areas have not been well collected.

***Houstonia humifusa* (A. Gray) A. Gray** (Acc. No. 664). Although there are only two sheets represented of this species, it is quite common in the Plains Country of Texas. Most likely it has been overlooked by plant collectors because it is very inconspicuous.

***Helenium microcephalum* DC.** (Acc. No. 932). Four sheets of this species are represented and are all from the southwestern part of the state. The plant also occurs in seasonally moist areas. Combining these two factors, the species has most likely just been overlooked.

***Pleuraphis mutica* Buckley** (Acc. No. 927). This species was only found on the gypsum soils in the study area and only occurred on two of the collection sites. However, it is locally quite abundant.

***Matelea biflora* (Raf.) Woods.** (Acc. No. 853). There is only one sheet represented in the herbarium. This plant was only observed in two localities and was not abundant either place. It could quite easily be overlooked by a plant collector also because it blends in with the vegetation surrounding it.

***Cylindropuntia davisii* (Engelm. & Bigelow) F.M. Knuth** (Acc. No. 996). There is one collection of this species represented in the herbarium. It was seen only at one location by the author. Also, the spines are approximately four centimeters long and are very painful and make the specimen difficult to press so it has probably been passed by, by many collectors.

***Cylindropuntia leptocaulis* (DC.) F.M. Knuth** (Acc. No. 935). This species is quite often seen in the study area and has probably not been collected more often due to the difficulty in pressing.

***Setaria leucophilia* (Scribn. & Merr.) K. Schum.** (Acc. no. 1022). There is one representative of this species and is reported by Correll and Johnston (1970) to occur on the Rio Grande Plains, Trans-Pecos, and Plains Country of Texas. Most likely the taxon has just extended its range into southwestern Oklahoma.

***Triodanis holzingeri* McVaugh.** (Acc. no. 767). There are no sheets of this species in the herbarium, but it is reported by Waterfall (1969) to occur in the state. Correll and Johnston (1970) report that it occurs in open plains, therefore it is probably not rare, just overlooked by collectors.

***Triodanis perfoliata* (L.) Nieuw.** (Acc. no. 877). There are only three collections of this taxon, but the plant seems quite weedy, therefore it has probably been overlooked as unimportant to collect.

SUMMARY

During the collecting season of 1975, 542 accessions were made by the author and the identified specimens deposited in the Oklahoma State and the Bebb herbaria. From these specimens and 26 others collected by U.T. Waterfall and G.W. Stevens, a list of the vascular plants of the redbed plains and gypsum hills regions of southwestern Oklahoma was compiled. The list contains 63 families, 230 genera, 354 species, and 359 different taxa. Thirty species were found to grow only on gypsum soils. Approximately 60% of the taxa are from seven families: Compositae, 69; Graminae, 65; Leguminosae, 29; Onagraceae, 13; Euphorbiaceae, 12; Cruciferae, 11; and Solanaceae, 10. Two introduced species *Bromus catharticus* Vahl (syn. = *Bromus willdenowii)* and *Caesalpinia gilliesii* are listed as additions to the state flora and eighteen taxa are discussed as being infrequently collected and especially significant.

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**TABULAR VIEW OF FAMILIES: GENERA (G)
SPECIES (S); SPECIES AND SUBORDINATE TAXA (SS)**

	G	S	SS
AMARANTHACEAE	2	2	2
ANACARDIACEAE	1	3	3
ASCLEPIADACEAE	3	5	5
BIGNONIACEAE	3	3	3
BORAGINACEAE	3	4	4
CACTACEAE	3	5	5
CAMPANULACEAE	1	2	2
CARYOPHYLLACEAE	3	3	3
CHENOPODIACEAE	5	7	7
COMMELINACEAE	2	3	3
COMPOSITAE	45	66	69
CONVOLVULACEAE	4	4	4
CRUCIFERAE	9	11	11
CUCURBITACEAE	2	2	2
CUPRESSACEAE	3	4	4
CYPERACEAE	5	12	12
EUPHORBIACEAE	5	12	12
FAGACEAE	1	1	1
GERANIACEAE	2	3	3
GNETACEAE	1	1	1
GRAMINEAE	35	65	65
HYDROPHYLLACEAE	2	3	3
ILLECEBRACEAE	1	1	1
IRIDACEAE	1	1	1
KRAMERIACEAE	1	1	1
LABIATAE	6	9	9
LEGUMINOSAE	18	29	29
LILIACEAE	4	4	4
LINACEAE	1	2	2
LOASACEAE	1	2	2
LYTHRACEAE	1	1	1
MALVACEAE	3	5	6
MARSILEACEAE	1	1	1
MARTYNIACEAE	1	1	1
MORACEAE	2	2	2
NYCTAGINACEAE	3	3	3
OLEACEAE	1	1	1
ONAGRACEAE	4	12	13
OXALIDACEAE	1	2	2
PAPAVERACEAE	1	1	1
PLANTAGINACEAE	1	4	4
PLUMBAGINACEAE	1	1	1
POLEMONIACEAE	1	1	1
POLYGALACEAE	1	1	1
POLYGONACEAE	3	7	7
POLYPODIACEAE	1	1	1
PORTULACACEAE	1	1	1
PRIMULACEAE	2	2	2
RANUNCULACEAE	3	3	3
RHAMNACEAE	1	1	1
ROSACEAE	1	1	1
RUBIACEAE	1	2	2
SALICACEAE	2	2	2
SAPINDACEAE	1	1	1
SCROPHULARIACEAE	3	6	6
SOLANACEAE	6	10	10
TAMARICACEAE	1	1	1
TYPHACEAE	1	1	1
ULMACEAE	2	4	4
UMBELLIFERAE	6	6	6
VERBENACEAE	1	5	5
VITACEAE	1	1	1
ZYGOPHYLLACEAE	2	2	2

Families	G	S	SS
TOTALS 230	354	359	359

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Updated List of Taxa for Vascular Plants of the Gypsum Hills and Redbed Plains Area of Southwestern Oklahoma

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The following is a list of vascular plants of the redbed plains and gypsum areas of southwestern Oklahoma based on specimens collected by the author and deposited in the Oklahoma State Herbarium and the Bebb Herbarium of the University of Oklahoma. In addition, 26 taxa collected by previous workers and four observed, but not collected, are included and so indicated. Each taxon is listed alphabetically within its family and families are listed in order according to the Engler-Prantl classification scheme. Nomenclature originally followed that of Correll and Johnston (1970) and Waterfall (1969), but has been updated by Bruce Hoagland of the Oklahoma Biological Survey according to the National Plant Data Center, Baton Rouge, LA <http://plants.usda.gov> accessed January 2009.

MARSILEACEAE

Marsilea vestita Hook. & Grev. (syn. = *Marsilea mucronata* A. Braun)

POLYPODIACEAE

Pellaea atropurpurea (L.) Link var. *atropurpurea*

CUPRESSACEAE

Juniperus pinchoti Sudw.; U.T. Waterfall(11261) April 4, 1953.
J. virginiana L.

EPHEDRACEAE (= **GNETACEAE**)

Ephedra antisyphilitica Berl. ex C.A. Mey.

TYPHACEAE

Typha angustifolia L.

GRAMINEAE (POACEAE)

Andropogon gerardii Vitman var. *gerardii*
A. hallii Hack.
Aristida oligantha Michx.
A. purpurea Nutt.
A. purpurea Nutt. var. *fendleriana* (Steud.) Vasey (syn. = *A. fendleriana* Steud.)
A. purpurea Nutt. var. *longiseta* (Steud.) Vasey (syn. = *A. longiseta* Steud.)
Arundo donax L.
Avena sativa L.
Bothriochloa ischaemum (L.) Keng (syn.= *Andropogon ischaemum* L.)
B. saccharoides (Sw.)Rydb. (Syn.= *Andropogon saccharoides* Sw.)
Bouteloua barbata Lag.; U.T. Waterfall (8729) August 26, 1948.
B. curtipendula (Michx.) Torr.
B. dactyloides (Nutt.) J.T. Columbus (syn. = *Buchloe dactyloides* (Nutt.) Engelm.)
B. gracilis (Willd. ex Kunth) Lag. ex Griffiths
B. hirsuta Lag.
Bromus arvensis L. (syn. = *B. japonicus* Thunb.)
B. catharticus Vahl (syn. = *B. unioloides* Kunth, *Bromus willdenowii*)
B. tectorum L.

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Calamovilfa gigantea (Nutt.) Scribn. & Merr.
Cenchrus spinifex Cav.
Chloris cucullata Bisch.
C. verticillata Nutt.
Cynodon dactylon (L.) Pers.
Digitaria sanguinalis (L.) Scop
Distichlis spicata (L.) Greene (syn. = *Distichlis spicata* L. var. *stricta* (Torr.) Scribn.)
Echinochloa crus-galli (L.) P. Beauv.
Elymus canadensis L.
E. elymoides (Raf.) Swezey ssp. *Elymoides* (syn. = *Sitanion hystrix* (Nutt.) J.G. Sm.); J.G. Smith (199) June 8, 1931; U.T. Waterfall (8954) June 14, 1949.
E. virginicus L.
Eragrostis barrelieri Daveau
E. cilianensis (All.) Vign. ex Janchen
E. curvula (Schrad.) Nees (Observed only)
Eragrostis secundiflora J. Presl ssp. *oxylepis* (Torr.) S.D. Koch (syn. = *E. oxylepis* (Torr.) Torr. var. *oxylepis*)
E. trichodes (Nutt.) Alph. Wood (syn. = *E. trichodes* (Nutt.) Alph. Wood var. *pilifera* (Scheele) Fernald)
Erioneuron pilosum (Buckley) Nash
Hordeum pusillum Nutt.
Muhlenbergia arenicola Buckley G.W. Stevens (1111) June 21, 1913.
M. asperifolia (Nees & Meyen ex Trin.) Parodi; U.T. Waterfall August 26, 1948.
Panicum capillare L. var. *capillare*
P. virgatum L.
Pascopyrum smithii (Rydb.) A. Löve (syn. = *Agropyron smithii* (Rydb. var. *smithii*)
Phalaris caroliniana Walter
Pleuraphis mutica Buckley
Poa arachnifera Torr.
Polypogon monspeliensis (L.) Desf.
Schedonnardus paniculatus (Nutt.) Trel.
Schizachyrium scoparium (Michx.) Nash (syn. = *Andropogon scoparius* Michx.)
Setaria leucophila (Schribn. & Merr.) K. Schum.
Setaria pumila (Poir.) Roem. & Schult. ssp. *pumila* (syn. = *Setaria lutescens* (Wiegel) F.T. Hubb.)
Setaria reverchonii (Vasey) Pilg. ssp. *reverchonii* (syn. = *P. reverchonii* Vasey); U.T. Waterfall (7774) June 3, 1948 (7802) June 5, 1948.
S. virdis (L.) P. Beauv.
Sorghastrum nutans (L.) Nash
Sorghum halepense (L.) Pers.
Sporobolus airoides (Torr.) Torr.
S. compositus (Poir.) Merr. var. *compositus* (syn. = *S. asper* (Michx.) Kunth).
S. cryptandrus (Torr.) A. Gray
S. giganteus Nash; R.J. Tyrl (883) & S.C. Barber September 28, 1974.
Tridens albescens (Vasey) Woot. & Standl.
T. flavus (L.) Hitchc.
Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners (syn. = *T. elongatus* (Buckley) Nash)
Urochloa texana (Buckley) R. Webster (syn. = *Panicum texanum* Buckley)

CYPERACEAE

Cyperus retroflexus Buckley (syn. = *C. uniflorus* Torr. & Hook.)
Eleocharis compressa Sull.
E. macrostachya Britton
Schoenoplectus americanus(Pers.) Volkart ex Schinz & R. Keller (syn. = *Scirpus americanus* Pers. var. *americanus*)

COMMELINACEAE

Commelina erecta L. var. *erecta*
Tradescantia occidentalis (Britton) Smyth
T. ohiensis Raf. forma *ohiensis*

LILIACEAE

Allium drummondii Regel
Androstephium coeruleum (Scheele) Greene forma *coeruleum*
Nothoscordum bivalve (L.) Britton
Yucca glauca Nutt. var. *glauca*

IRIDACEAE

Sisyrinchium angustifolium Mill.

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SALICACEAE

Populus deltoides Bartram ex Marsh.
Salix nigra Marsh.

FAGACEAE

Quercus havardii Rydb.

ULMACEAE

Celtis laevigata Willd.

Celtis laevigata Willd. var. *reticulata* (Torr.) L.D. Benson (syn. = *C. reticulata* Torr.)
C. occidentalis L.

MORACEAE

Maclura pomifera (Raf.) C.K. Schneid.
Morus alba L.

POLYGONACEAE

Eriogonum annuum Nutt.
E. longifolium Nutt. var. *longifolium*
Polygonum lapathifolium L.
P. pensylvanicum L. (syn. = *Polygonum bicorne* Raf.)
Rumex altissimus Alph. Wood
R. crispus L.
R. hymenosepalus Torr.

CHENOPODIACEAE

Atriplex argentea Nutt.; U.T. Waterfall (8733) August 25, 1948.
A. canescens (Push) Nutt.
Chenopodium album L.
C. incanum (S. Watson) A. Heller U.T. Waterfall (9084) June 14, 1949.
Kochia scoparia (L.) A.J. Scott
Salsola tragus L. (syn. = *Salsola kali* L. ssp. *tenuifolia* Moq.)
Suaeda calceoliformis (Hook.) Moq. (syn. = *Suaeda depressa* (Pursh) S. Watson)

AMARANTHACEAE

Amaranthus palmeri S. Watson
Tidestromia lanuginosa (Nutt.) Standl.

NYCTAGINACEAE

Abronia fragrans Nutt. ex Hook. R.J. Tyrl (855), C. McDonald & P. Risk May 15, 1974.

PORTULACACEAE

Portulaca pilosa L.

CARYOPHYLLACEAE

Arenaria serpyllifolia L.
Cerastium brachypodum Engelm. ex A. Gray) B.L. Rob.
Paronychia jamesii Torr. & A. Gray (formerly in the Illecebraceae)
Silene antirrhina L. forma *antirrhina*

RANUNCULACEAE

Anemone caroliniana Walter forma *violacea* Clute
Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks (syn. = *Delphinium virescens* Nutt. var. *pernardii* (Hutt.) L.M. Perry)
Myosurus minimus L. (syn. = *M. minimus* L. var. *interior* Boivin)

PAPAVERACEAE

Argemone polyanthemos (Fedde) G.B. Ownbey

CRUCIFERAE (BRASSICACEAE)

Camelina microcarpa Andrz. ex DC.
Capsella bursa-pastoris (L.) Medik.
Descurainia pinnata (Walter) Britton ssp. *halictorum* (Cockerell) Detling (syn. = *D. pinnata* (Walt.) Britt. var. *osmiarum* (Cockerell) Shinners)
D. sophia (L.) Webb ex Prantl
Dimorphocarpa candicans (Raf.) Rollins (syn. = *Dithyrea wislizenii* Engelm. var. *palmeri* Payson)
Draba brachycarpa Nutt. ex Torr. & A. Gray
Erysimum repandum L.
Lepidium austrinum Small
L. virginicum L. var. *medium* (Greene) C.L. Hitchc.
Lesquerella gordonii (A. Gray) Watson
Sibara virginica (L.) Rollins

ROSACEAE

Prunus angustifolia Marsh.

LEGUMINOSAE (FABACEAE)

Acacia angustissima (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob. (syn. = *Acacia hirta* Nutt.)
Astragalus lindheimeri Englem. ex A. Gray
A. lotiflorus Hook.
A. missouriensis Nutt.
A. mollissimus Torr.
A. nuttallianus DC. var. *nuttallianus*
A. plattensis Nutt.
A. racemosus Prush
Caesalpinia gilliesii (Wall. ex Hook.) Wall. ex D. Dietr.
Chamaecrista fasciculata (Michx.) Greene var. *fasciculata* (syn. = *Cassia fasciculata* Michx.)
Dalea aurea Nutt. ex Pursh
D. candida Michx. ex Willd. var. *oligophylla* (Torr.) Shinners (syn. = *Petalostemon candidus* Michx. var. *oligophyllus* (Torr.) F.J. Herm.)
D. enneandra Nutt.
D. villosa (Nutt.) Spreng (syn. = *Petalostemon villosum* Nutt.)
Desmanthus illinoensis(Michx.) MacMill. ex B.L. Rob. & Fernald
Gleditsia triacanthos L.
Hoffmannseggia glauca (Ortega) Eifert (syn. = *Hoffmannseggia densiflora* Benth.)
Indigofera miniata Ortega (*I. miniata* Ortega var. *leptosepala* (Nutt.) Turner)
Medicago minima (L.) L.
Mimosa borealis A. Gray
M. microphylla Dryand. (syn. = *Schrankia uncinata* Willd.)
Pediomelum cuspidatum (Pursh) Rydb. (syn. = *Psoralea cuspidata* Pursh)
Pomaria jamesii (Torr. & A. Gray) Walp. (syn. = *Hoffmannseggia jamesii* Torr. & A. Gray)
Psoralidium tenuiflorum (Pursh) Rydb. (syn. = *Psoralea tenuiflora* Pursh)
Prosopis glandulosa Torr. var. *glandulosa*
Strophostyles leiosperma (Torr. & A. Gray.) Piper
Vicia ludoviciana Nutt.

KRAMERIACEAE

Krameria lanceolata Torr.

LINACEAE

Linum pratense (Norton) Small (syn. = *Linum lewisii* Pursh var. *pratense* Norton)
L. rigidum Pursh var. *rigidum*

OXALIDACEAE

Oxalis corniculata L.
O. dillenii Jacq.

GERANIACEAE

Erodium cicutarium (L.) L'Hér. ex Aiton
E. texanum A. Gray
Geranium carolinianum L.

ZYGOPHYLLACEAE

Kallstroemia parviflora J.B.S. Norton (syn. = *K. intermedia* Rydb.)
Tribulus terrestris L.

POLYGALACEAE

Polygala alba Nutt.

EUPHORBIACEAE

Chamaesyce albomarginata (Torr. & A. Gray) Small (syn.= *Euphorbia albomarginata* Torr. & A. Gray)
C. glyptosperma (Engelm.) Small (syn. = *Euphorbia glyptosperma* Engelm.)
C. lata (Engelm.) Small (syn. = *Euphorbia lata* Engelm.)
C. missurica (Raf.) Shinners (syn. = *Euphorbia missurica* Raf.)
Cnidoscolus texanus (Müll. Arg.) Small
Croton texensis (Klotzsch) Müll. Arg.
Euphorbia cuphosperma (Engelm.) Boiss. (syn. = *E. dentata* Michx. var. *cuphosperma* (Engelm.) Fern.)
E. hexagona Nutt. ex Spreng.
E. marginata Pursh
E. spathulata Lam.
Reverchonia arenaria A. Gray; U.T. Waterfall (8340) July 21, 1948.
Stillingia sylvatica L.

ANACARDIACEAE

Rhus trilobata Nutt. var. *trilobata* (syn. = *R. aromatica*

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Aiton var. *flabelliformis* Shinners)
R. microphylla Engelm. ex A. Gray U.T. Waterfall (8447) May 13, 1950.
Toxicodendron radicans (L.) Kuntze ssp. *radicans* (syn. = *Rhuss radicans* L. var. *radicans*)

SAPINDACEAE

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson (syn. = *Sapindus drummondii* Hook. & Arn.)

RHAMNACEAE

Ziziphus obtusifolia (Hook. ex Torr. & A. Gray) A. Gray (syn. = *Condalia obtusifolia* (Hook. ex Torr. & A. Gray) Weberb.)

VITACEAE

Vitis acerifolia Raf.

MALVACEAE

Callirhoe involucrata (Torr. & A. Gray) A. Gray var. *involucrata*
Malvella leprosa (Ortega) Krapov. (syn. = *Sida leprosa* (Ortega) K. Schum. var. *hederaceae* (Douglas ex Hook.) K. Schum.) U.T. Waterfall (9016) June 16, 1949.
Rhynchosida physocalyx (A. Gray) Fryxell (syn. = *Sida physocalyx* A. Gray); U.T. Waterfall (8996) June 15, 1949.
Sphaeralcea coccinea (Nutt.) Rydb.

TAMARICACEAE

Tamarix gallica L.

LOASACEAE

Mentzelia decapetala (Pursh ex Sims) Urb. & Gilg ex Gilg
M. nuda (Pursh) Torr. & A. Gray
M. nuda (Pursh) Torr. & A. Gray var. *stricta* (Osterh.) Harrington (syn. = *M. stricta* (Osterhout) Greene)
M. oligosperma Nutt. ex Sims

CACTACEAE

Cylindropuntia davisii (Engelm. & Bigelow) F.M. Knuth (syn. = *Opuntia davisii* Engelm. & Bigelow)
C. leptocaulis (DC.) F.M. Knuth (syn. = *O. leptocaulis* DC.)
Echinocactus texensis Hopffer
Echinocereus reichenbachii (Terscheck ex Walp.) hort ex Haage
Opuntia humifusa (Raf.) Raf. (syn. = *Opuntia compressa* auct. non J.F. Macbr.)

LYTHRACEAE

Ammannia coccinea Rottb.

ONAGRACEAE

Calylophus hartwegii (Benth.) P.H. Raven ssp. *fendleri* (A. Gray) Towner & P.H. Raven
C. hartwegii (Benth.) P.H. Raven ssp. *pubescens* (A. Gray) Towner & P.H. Raven (syn. = *C. hartwegii* (Benth.) P.H. Raven var. *pubescens* (A. Gray) Shinners)
C. serrulatus (Nutt.) P.H. Raven
Gaura longiflora Spach (syn. = *Gaura filiformis* Small)
G. mollis James (syn. = *G. parviflora* Douglas ex Lehm.)
G. sinuata Nutt. ex Ser.
G. suffulta Engelm. ex A. Gray
G. villosa Torr. ssp. *villosa*
Oenothera grandis (Britton) Smyth (syn. = *O. laciniata* Hill var. *grandiflora* (S. Watson) B.L. Rob.)
O. rhombipetala Nutt. ex Torr. & A. Gray
O. speciosa Nutt.
O. triloba Nutt.
Stenosiphon linifolius (Nutt. ex James) Heynh.

UMBELLIFERAE (APIACEAE)

Ammoselinum popei Torr. & A. Gray
Cymopterus macrorhizus Buckley
Daucus pusillus Michx.
Eurytaenia texana Torr.& A. Gray Waterfall (11981) June 4, 1954.
Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose ssp. *daucifolium* (Torr. & A. Gray) W.L. Theobald (syn. = *L. daucifolium* (Torr. & A. Gray) J. M. Coult. & Rose)
Torilis arvensis (Huds.) Link

PRIMULACEAE

Androsace occidentalis Pursh
Samolus ebracteatus Kunth

PLUMBAGINACEAE

Limonium limbatum Small; U.T. Waterfall (8319) July 21, 1948.

OLEACEAE

Fraxinus pennsylvanica Marsh.

ASCLEPIADACEAE

Asclepias asperula (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson (syn. = *A. asperula* (Decne.) Woodson var. *decumbens* (Nutt.) Shinners)
A. arenaria Torr.
A. engelmanniana Woodson
Cynanchum laeve (Michx.) Pers.
Matelea biflora (Raf.) Woodson

CONVOLVULACEAE

Convolvulus arvensis L.
Cressa truxillensis Kunth; U.T. Waterfall (9423) May 13, 1950.
Cuscuta sp. Observed only.
Evolvulus nuttallianus Schult.

POLEMONIACEAE

Ipomopsis longiflora (Torr.) V.E. Grant

HYDROPHYLLACEAE

Nama hispidum A. Gray
N. stevensii C.L. Hitchc.
Phacelia integrifolia Torr.

BORAGINACEAE

Cryptantha minima Rydb.
Lappula occidentalis (S. Watson) Greene var. *occidentalis* (syn. = *L. redowskii* (Hornem.) Greene var. *occidentalis* (S. Watson) Rydb.)
L. occidentalis (S. Watson) Greene var. *cupulata* (A. Gray) Higgins (syn. = *L. texana* (Scheele) Britton)
Lithospermum incisum Lehm.

VERBENACEAE

Glandularia canadensis (L.) Nutt. (syn. = *Verbena canadensis* (L.) Britton)
G. pumila (Rydb.) Umber (syn. = *V. pumila* Rydb.)
Verbena bracteata Cav. ex Lag. & Rodr.
V. halei Small
V. plicata Greene

LABIATAE (LAMIACEAE)

Hedeoma drummondii Benth.
Lamium amplexicaule L. forma *amplexicaule*
Monarda citriodora Cerv. ex Lag.
M. punctata L. ssp. *punctata* var. *occidentalis* (Epling) Palmer & Steyerm. (syn. = *M. punctata* L. ssp. *occidentalis* Epling)
Salvia azurea Michx. ex Lam. var. *grandiflora* Benth.
Scutellaria drummondii Benth.
S. wrightii A. Gray forma *wrightii*
Teucrium canadense L. var. *canadense* (syn. = *Teucrium canadense* L. var. *virginicum* (L.) Eaton)
T. laciniatum Torr.

SOLANACEAE

Chamaesaracha coniodes (Moric. ex Dunal) Britton
Datura wrightii Regel (syn. = *D. meteloides* auct. non Dunal. p.p.)
Lycium berlandieri Dunal; U.T. Waterfall (8994) June 15, 1949.
Nicotiana obtusifolia M. Martens & Galeotti var. *obtusifolia* (syn. = *N. trigonophylla* Dunal); U.T. Waterfall (7801) June 5, 1948.
Quincula lobata (Torr.) Raf. (syn. = *Physalis lobata* Torr. var. *lobata*)
Solanum dimidiatum Raf. (syn. = *S. torreyi* A. Gray forma *torreyi)*
S. elaeagnifolium Cav.
S. rostratum Dunal
S. triflorum Nutt.; G.W. Stevens (1096) June 23, 1913.

SCROPHULARIACEAE

Castilleja purpurea (Nutt.) G. Don var. *citrina (*Pennell) Shinners (syn. = *C. citrina* Pennell)
Penstemon albidus Nutt.
P. cobaea Nutt.
P. fendleri Torr.& A. Gray
Veronica arvensis L.
V. peregrina L. ssp. *xalapensis* (Kunth) Pennell

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BIGNONIACEAE

Catalpa bignonioides Walter
Chilopsis linearis (Cav.) Sweet.

MARTYNIACEAE

Proboscidea louisianica (Mill.) Thell. Observed only.

PLANTAGINACEAE

Plantago patagonica Jacq. (syn. = *P. purshii* Roem. & Schult. var. *spinulosa* (Decne.) Shinners)
P. rhodosperma Decne.
P. virginica L.
P. wrightiana Decne.

RUBIACEAE

Houstonia humifusa (A. Gray) A. Gray (syn. = *Hedyotis humifusa* A. Gray)
Stenaria nigricans (Lam.) Terrell (syn. = *H. nigricans* (Lam.) Fernald)

CUCURBITACEAE

Cucurbita foetidissima Kunth
Ibervillea lindheimeri (A. Gray) Greene; U.T. Waterfall (9406) May 13, 1950.

CAMPANULACEAE

Triodanis holzingeri McVaugh
T. perfoliata (L.) Nieuwl.

COMPOSITAE (ASTERACEAE)

Achillea millefolium L.
Ambrosia psilostachya DC. var. *lindheimeriana* (Scheele) Blankenship
A. trifida L. var. *texana* Scheele
Amphiachyris dracunculoides (DC.) Nutt. (syn. = *Gutierrezia dracunculoides* (DC.) S.F. Blake)
Aphanostephus pilosus Buckley
A. ramosissimus DC.
A. skirrhobasis (DC.) Trel.
Artemisia filifolia Torr.
A. ludoviciana Nutt. ssp. *ludoviciana*
Baccharis salicina Torr. & A. Gray
B. texana (Torr.& A. Gray) A. Gray; U.T. Waterfall (8361) July 23, 1948.
Berlandiera lyrata Benth. var. *lyrata*
Centaurea americana Nutt.
Chaetopappa ericoides (Torr.) G.L. Nesom (syn. = *Aster leucelene* S.F. Blake)
Cirsium texanum Buckley
Conyza canadensis (L.) Conq. var. *glabrata* (A. Gray) Conq.
Croptilon hookerianum (Torr.& A. Gray) House var. *hookerianum* (syn. = *Haplopappus divaricatus* (Nutt.) A. Gray var. *hookerianus* (Torr. & A. Gray) Waterf.)
Engelmannia peristenia (Rafr.) Goodman & C.A. Lawson (syn. = *E. pinnatifida* A. Gray ex Nutt.)
Evax verna Raf.
Flaveria campestris J.R. Johnst. U.T. Waterfall (8735) August 25, 1948.
Gaillardia pinnatifida Torr.
G. pulchella Fouq.
G. suavis (A. Gray & Engelm) Britton & Rusby
Grindelia nuda Alph. Wood var. *nuda* (syn. = *G. squarrosa* (Pursh) Dunal var. *nuda* (Alph. Wood) A. Gray)
G. papposa G.L. Nesom & Suh (syn = *Haplopappus ciliatus* (Nutt.) DC.)
Gutierrezia sarothrae (Pursh) Britton & Rusby
Haploesthes greggii A. Gray var. *texana* (J.M. Coul.) I.M. Johnst.
Helenium microcephalum DC.
Helianthus annuus L.
H. petiolaris Nutt.
Heterotheca canescens (DC.) Shinners (syn. = *Chrysopsis villosa* (Pursh) Nutt. ex DC. var. *canescens* A. Gray)
H. stenophylla (A. Gray) Shinners var. *stenophylla* (syn. = *Chrysopsis villosa* (Pursh) Nutt. ex DC. var. *stenophylla* (A. Gray) A. Gray)
H. subaxillaris (Lam.) Britton & Rusby (syn. = *Heterotheca latifolia* Buckley)
Hymenopappusi scabiosaeus L'Her var. *corymbosus* (Torr. & A. Gray) B.L. Turner
H. tenuifolius Pursh; U.T. Waterfall (7307) June 28, 1947.
Hymenoxys odorata DC.

Iva annua L. var. *annua* (syn. = *Iva ciliata* Willd.)
Liatris punctata Hook. var. *nebraskensis* Gasier
L. punctata Hook. var. *punctata*
Lindheimera texana A. Gray & Engelm.
Lygodesmia texana (Torr. & A. Gray) Greene (syn. = *Lygodesmia aphylla* (Nutt.) DC. var. *texana* Torr & A. Gray.)
Machaeranthera pinnatifida (Hook.) Shinners ssp. *pinnatifida* var. *pinnatifida* (syn. = *Haplopappus spinulosis* (Pursh) DC.)
Palafoxia sphacelata (Nutt. ex Torr.) Cory
Pluchea odorata (L.) Cass. var. *odorata* (syn. = *P. purpurascens* (Sw.) DC.)
Psilostrophe tagetina (Nutt.) Greene var. *cerifera* (A. Nelson) B.L. Turner (syn. = *P. villosa* Rydb.)
Pyrrhopappus grandiflorus (Nutt.) Nutt.
P. pauciflorus (D. Don) DC. (syn. = *P. multicaulis* DC. var. *geiseri* (Shinners) Northington)
Ratibida columnifera (Nutt.) Woot. & Stand. forma *columnifera*
R. tagetes (James) Barnhart; G.W. Stevens (1080) June 21, 1913.
Rudbeckia hirta L. var. *pulcherrima* Farw.
Senecio riddellii Torr. & A. Gray
Silphium laciniatum Torr. var. *laciniatum*
Solidago gigantea Aiton *(syn. = S. gigantea* Aiton var. *leiophylla* Fernald)
S. missouriensis Nutt. var. *faciculata* Holz.
Symphyotrichum divaricatum (Nutt.) G.L. Nesom (syn. = *Aster subulatus* Michx. var. *ligulatus* Shinners)
S. ericoides (L.) G.L. Nesom (syn. = *Aster ericoides* L.)
S. oblongifolium (Nutt.) G.L. Nesom (syn. = *Aster oblongifolius* Nutt.)
Tetraneuris scaposa (DC.) Greene (syn. = *Hymenoxys scaposa* (DC.) K.F. Parker var. *scaposa)*
Thelesperma filifolium (Hook.) A. Gray
T. megapotamicum (Spreng.) Kuntze
Tragopogon dubius Scop. (syn. = *T. major* Jacq.)
Verbesina encelioides (Cav.) Benth. & Hook. F. ex A. Gray
Vernonia baldwinii Torr. var. *interior* (Small) Faust
V. marginata (Torr.) Raf.; Bruce Harkins (91) October 17, 1970.
Xanthisma texanum DC. ssp. *drummondii* (Torr. & A. Gray) Semple (syn. = *X. texanum* DC. var. *drummondii* (Torr. & A. Gray) A. Gray)
Xanthium strumarium L. var. *canadense* (Mill.) Torr.& A. Gray
X. strumarium L. var. *glabratum* (DC.) Cronquist.
Zinnia grandiflora Nutt.

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An Updated Flora of the Wichita Mountains Wildlife Refuge

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The herbarium collections of the Wichita Mountains Wildlife Refuge have been transferred to the Cameron University Herbarium (CAMU) so that they could be safely curated, and electronically databased and still remain accessible to refuge personnel while for the first time becoming readily available to other interested researchers. This paper is a report on the initial inventory of the specimens. The 1784 specimen collection includes 101 families, 339 genera, and 634 species that have been physically repaired and taxonomically updated as needed, accessioned into the CAMU collections, and entered into the Specify Database.

INTRODUCTION

The Wichita Mountains are some of the oldest exposed mountains in the world and because the area was too rocky to plow, they formed a natural refugium that preserved what is arguably the largest remaining intact tract of southern mixed-grass prairie in existence. The mountains were part of the Kiowa-Comanche-Apache Reservation in the late 19th Century. When the reservation was opened to settlement in 1901, the land was set aside by the federal government. Originally administered by the Department of the Interior, jurisdiction was transferred to the Forest Service in 1905, and in 1935 management of the Wichita Mountains Wildlife Refuge (WMWR) was transferred to what is now the Fish and Wildlife Service (Morgan, 1973). In 1907 bison were reintroduced to the Refuge and in 1927 Congress issued a mandate to preserve the bloodline of Texas Longhorn Cattle. Elk, which had been extirpated by 1875 were transplanted from Jackson Hole, Wyoming, and today in addition to the buffalo, longhorn cattle, and elk that get most of the public's attention, the refuge is home to over 50 mammal species including prairie dogs, coyotes, bobcats, and mountain lions (Tyler, 2005). In addition, over 240 bird, 64 reptile and amphibian, and 36 fish species have been identified. Eight hundred and six vascular plants have been identified at the WMWR (Eskew, 1938; Osborn and Allan, 1949; Buck, 1977).

Much of the natural history of the Refuge is recorded in herbarium collections that were housed in the basement of the headquarters building. In 2005, refuge management recognized the need to protect the specimens, and make the data available to the scientific community as well as the general public, but still keep the data accessible to Refuge biologists and technicians. The only facility that met all of the criteria was the Cameron University Herbarium (CAMU), and in 2006 the specimens were transferred to CAMU as a permanent loan. In 2008 The National Science Foundation (NSF) provided funding to procure additional cabinets and equipment and to hire student workers to enter the specimens into the Specify Database. This paper is the first report of the inventory of these specimens and will serve as a benchmark for future studies that will update the complete flora of the Refuge.

The 23,885 hectare Wichita Mountains Wildlife Refuge is located in northwestern Comanche County, Oklahoma (Fig.), ranging from 34°41'N to 34°50'N and 98°48'30"W to 98°30'30"W. Elevation ranges from 404 m (1330 ft) where Cache Creek crosses the WMWR southern boundary to 756 m (2479 ft) at the summit of Mt. Pinchot. The mountains themselves are predominantly Cambrian igneous rock and the surrounding

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plains are predominantly Permian sedimentary rock (Price and Gilbert, 1996). The ecoregion is categorized as Great Plains Steppe Shrub Province (Bailey, 1995) or Central Great Plains (Woods et al., 2005) and receives on average 86.84 cm (34.19 in) of precipitation annually, with May the wettest month (mean 13.03 cm [5.13 in]) and January the driest (mean 3.50 cm [1.38 in]). Mean annual temperature is 22.22^{0}C (72.0^{0}F) (Oklahoma Climatological Survey, 2007).

MATERIALS AND METHODS

A total of 1784 specimens were accepted as a permanent loan from WMWR to CAMU in June 2006. NSF-Biological Research Collections funds were awarded in 2008 and were used to purchase new herbarium cabinets and begin curation during that summer. Specimens were first triaged for damage and physically repaired as necessary. Preliminary identification and taxonomic updating were the responsibility of KAC. Specimens were then entered into the Specify database by KAC and PR. All identifications and taxonomic updates were then verified by MTD before annotations were added and specimens were fumigated and curated into separate color coded genus folders. Because taxonomy for many of the specimens is ambiguous and no completed treatment of the flora of Oklahoma was broadly accepted, a combination of McGregor et al., (1986), Diggs et al (1999) and Judd et al., (2008) was used to update the taxonomy of the specimens (details available upon request).

RESULTS AND DISCUSSION

Three of the 1784 specimens were collected outside the WMWR proper but all three have duplicates collected on the Refuge. The collection includes 101 families, 339 genera, and 634 species (Appendix), including: 1 family of Charophyceans, 6 families of seedless vascular plants, 2 gymnosperm families, 1 basal angiosperm, 16 monocot families and 75 Eudicot families. The largest families are Asteraceae with 88 species and Poaceae with 99 species. The largest monocot genera are *Carex* and *Eragrostis* with 12 species each. The largest herbaceous and woody eudicots are respectively *Polygonum* with nine and *Quercus* with eight species each.

Now that these preliminary data have been compiled, we hope to expand the project by updating the taxonomy of the classic Buck (1977) report on the flora of WMWR to enable direct comparison with this assemblage, quantify the percentage of exotics in the collections, and with the permission of WMWR biologists and administrators, begin surveying the Refuge for some of the rarer plants in the collection to identify those taxa in danger of extirpation.

ACKNOWLEDGEMENTS

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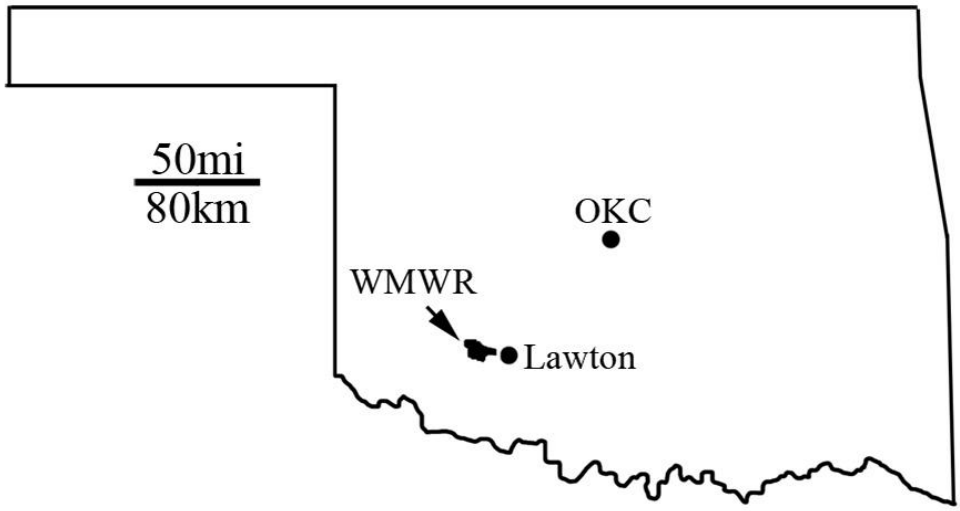

Figure Location of Wichita Mountains Wildlife Refuge, Comanche County, Oklahoma

APPENDIX

GREEN ALGAE

Characeae
Chara vulgaris L.

SEEDLESS VASCULAR PLANTS

Isoetaceae
Isoetes melanopoda Gay & Dur.

Equisetaceae
Equisetum laevigatum A. Braun

Aspleneaceae
Asplenium trichomanes L.

Dryopteridaceae
Dryopteris marginalis (L.) A. Gray
Woodsia obtusa (Spreng.) Torr.

Marsileaceae
Pilularia americana A. Braun
Marsilea vestita Hood. and Grev.

Pteridaceae
Cheilanthes eatoni Baker
Cheilanthes lanosa (Michx.) D.C. Eaton
Cheilanthes tomentosa Link.
Pellaea atropurpurea (L.) Link.
Pellaea wrightiana Hook.

GYMNOSPERMS

Cupressaceae
Juniperus virginiana L.

Pinaceae
Pinus elliottii Englm.

ANGIOSPERMS

MONOCOTS

Agavaceae
Manfreda virginica (L.) Salisb. ex Rose

Alismataceae
Echinodorus berteroi (Spreng.) Fassett
Sagittaria latifolia Willd.
Sagittaria montevidensis Cham. & Schlecht.

Araceae
Arisaema dracontium (L.) Schott

Commelinaceae
Commelina erecta L.
Tradescantia occidentalis (Britt.) Smyth
Tradescantia ohiensis Raf.

Cyperaceae
Bulboschoenus maritimus (L.) Palla
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke
Carex amphibola Steud.
Carex annectens (Bickn.) Bickn.
Carex austrina Mack.
Carex blanda Dewey
Carex emoryi Dewey
Carex festucacea Schkuhr. ex Willd.
Carex frankii Kunth.
Carex gravida Bailey
Carex grisea Wahl.
Carex microrhyncha Mack.
Carex muehlenbergii Schkuhr ex Willd.
Carex vulpinoidea Michx.
Cyperus acuminatus Torr. & Hook. ex Torr.
Cyperus echinatus (L.) Wood
Cyperus erythrorhizos Muhl.
Cyperus esculentus L.
Cyperus lupulinus (Spreng.) Marcks.
Cyperus odoratus L.
Cyperus pseudovegetus Steud.
Cyperus schweinitzii Torr.
Cyperus setigerus Torr. & Hook
Cyperus squarrosus L.
Cyperus strigosus L.
Eleocharis acutisquamata Buckley
Eleocharis compressa Sulliv.
Eleocharis engelmanni Steud.
Eleocharis montevidensis Kunth.
Eleocharis obtusa (Willd.) Schult.
Eleocharis palustris (L.) Roem. & Schult.
Eleocharis parvula (Roemer & J.A. Schutles) Link ex Bluff, Nees & Schaeur
Eleocharis quadrangulata Fern.
Eleocharis tenuis (Willd.) Schult.
Eleocharis wolfii (A.Gray) A.Gray ex Britton
Fimbristylis puberula (Michx.) Vahl.
Fimbristylis vahlii (Lam.) Link.

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Fuirena simplex Vahl.
Lipocarpha micrantha (Vahl.) Tucker
Schoenoplectus acutus (Muhl ex Bigelow) A. Love & D. Love
Schoenoplectus pungens (Vahl.) Palla
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla
Scleria pauciflora Muhl.
Scirpus atrovirens Muhl.
Scirpus pendulus Muhl.

Hydrocharitaceae
Najas guadalupensis (Spreng.) Morong.

Iridaceae
Sisyrinchium angustifolium Mill.

Juncaceae
Juncus acuminatus Michx.
Juncus dudleyi Wiegand.
Juncus interior Wieg.
Juncus marginatus Rostk.
Juncus tenuis Woot. & Standl.
Juncus torreyi Coville

Lemnaceae
Lemna minor L.

Liliaceae
Allium canadense L.
Allium drummondii Regel.
Allium stellatum Ker.
Androstephium coeruleum (Scheele) Greene
Camassia scilloides (Raf.) Cory
Cooperia drummondii Herbert
Erythronium americanum Ker.
Nothoscordum bivalve Greene ex Rydb.

Orchidaceae
Spiranthes magnicamporum Sheviak.

Poaceae
Agrostis hyemalis (Walter) B.S.P.
Agrostis elliottiana Schult.
Alopecurus carolinianus Walt.
Andropogon gerardii Vitman.
Aristida dichotoma Michx
Aristida longespica Poir.
Aristida oligantha Michx.
Aristida purpurea Nutt.
Bothriochloa barbinodes (Lag.) Herter.
Bothriochloa laguroides (D.C.) Herter.
Bouteloua curtipendula (Michx) Torr.
Bouteloua gracilis (Willd ex Kunth) Lag. ex Griffiths
Bouteloua hirsuta Lag.
Bouteloua rigidiseta (Steud.) Hitchc.
Bromus arvensis L.
Bromus catharticus Vahl
Bromus commutatus Schrad.
Bromus japonicus Thunb. ex Murray
Bromus pubescens Muhl. ex Willd.
Buchloe dactyloides (Nutt.) Engelm.
Cenchrus spinifiex Cav.
Chasmanthium latifolium (Mickx.) H.O. Yates
Chloris verticillata Nutt.
Chloris virgata Sw.
Coelorachis cylindrica (Michx.) Nash
Cynodon dactylon (L.) Pers.
Dactylis glomerata L.
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark
Dichanthelium depauperatum (Muhl.) Gould
Dichanthelium linearifolium (Scribn. ex Nash) Gould
Dichanthelium malacophyllum (Nash) Gould
Dichanthelium oligosanthes (J.A. Schultes) Gould
Digitaria californica (Benth.) Henr.
Digitaria cognata (Schultes) Pilger
Digitaria sanguinalis (L.) Scop.
Echinochloa crus-galli (L.) Beauv.
Eleusine indica (L.) Gaertn.
Elymus canadensis L.
Elymus virginicus L.
Eragrostis capillaris (L.) Nees
Eragrostis cilianensis (All.) Vignalo ex Janch
Eragrostis curtipedicellata Buckley
Eragrostis hypnoides (Lam.) B.S.P.
Eragrostis intermedia Hitchc.
Eragrostis pectinacea (Mickx.) Nees ex Steud.
Eragrostis pilosa (L.) Beauv.
Eragrostis reptans (Michx.) Nees
Eragrostis secundiflora J. Presl.
Eragrostis sessilispica Buckley
Eragrostis spectabilis (Pursh.) Steud.
Eragrostis trichodes (Nutt.) A.W. Wood
Eriochloa contracta Hitchc.
Eriochloa sericea (Scheele) Munro ex Vasey
Erioneuron pilosum (Buckley) Nash
Festuca versuta Beal
Hordeum pusillum Nutt.

Leersia oryzoides (L.) Sw.
Leptochloa fascicularis (Lam.) A. Gray
Limnodea arkansana (Nutt.) L.H. Dewey
Lolium pratense (Huds.) S.J.Darbyshire
Melica nitens (Scribn) Nutt. ex Piper
Muhlenbergia capillaris (Lam.) Trin.
Muhlenbergia mexicana (L.) Trin.
Muhlenbergia racemosa (Michx) B.S.P.
Panicum anceps Michx.
Panicum capillare L.
Panicum dichotomiflorum Michx.
Panicum obtusum Kunth.
Panicum philadelphicum Bernh. ex Trin.
Panicum virgatum L.
Pascopyrum smithii (Rydb.) A. Love
Paspalum dilatatum Poir.
Paspalum pubiflorum Rupr.
Paspalum setaceum Michx.
Phalaris caroliniana Walter
Poa annua L.
Poa arachnifera Torr.
Poa compressa L.
Schedonnardus paniculatus (Nutt.) Trel.
Setaria parviflora (Poir) Kerguélen
Setaria viridis (L.) P. Beauv.
Schizachyrium scoparium (Michx.) Nash
Sorghastrum nutans (L.) Nash
Sorghum halepense (L.) Pers.
Spartina pectinata Link
Sphenopholis obtusata (Michx) Scribn.
Sporobolus airoides Torr.
Sporobolus clandestinus (Biehler) Hitchc.
Sporobolus compositus (Poir.) Merr.
Sporobolus cryptandrus (Torr) A. Gray
Sporobolus neglectus Nash
Sporobolus pyramidatus (Lam.) Hitchc.
Sporobolus vaginiflorus (Torr ex A. Gray) A.W. Wood
Tridens albescens (Vasey) Wooton & Standl.
Tridens flavus (L.) Hitchc.
Tridens muticus (Torr) Nash
Tridens strictus (Nutt) Nash
Tripsacum dactyloides (L.) L.
Vulpia octoflora (Walter) Rydb.

Pontederiaceae

Heteranthera limosa (Sw.) Willd

Potamogetonaceae

Potamogeton ampifolius Tuckerm.
Potamogeton diversifolius Raf.
Potamogeton nodosus Poir
Potamogeton pusillus L.

Smilacaceae

Smilax bona-nox L.
Smilax pseudochina L.
Smilax rotundifolia L.
Smilax tamnoides L.

Typhaceae

Typha domengensis L.
Typha latifolia L.

EUDICOTS

Acanthaceae

Justicia americana (L.) Vahl
Ruellia caroliniensis (J.F. Gmel) Steud.
Ruellia humilis Nutt.

Amaranthaceae

Alternanthera caracasana Kunth
Amaranthus albus L.
Amaranthus hybridus L.
Amaranthus retroflexus L.
Amaranthus rudis Sauer
Froelichia floridana (Nutt.) Moq.
Froelichia gracilis (Hook.) Moq.
Gossypianthus lanuginosus (Poir.) Moq
Guilleminea densa (Humb. & Bonpl. ex Willd.) Moq.

Anacardiaceae

Rhus glabra L.
Rhus trilobata Nutt.
Toxicodendron radicans (L.) Kuntze

Apiaceae

Ammoselinum popei Torr. & Gray
Chaerophyllum tainturieri Hook.
Cicuta maculata L.
Daucus pusillus Michx.
Eryngium leavenworthii Torr. & Gray
Lomatium foeniculaceum (Nutt.) Coult. & Rose
Polytaenia nuttallii DC.
Ptilimnium nuttallii (DC.) Britt.
Sanicula canadensis L.
Spermolepis divaricata (Walt.) Raf. ex Ser.
Spermolepis echinata (Nutt. ex DC.) Heller

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Apocynaceae

Apocynum cannabinum L.
Amsonia ciliata Walt.

Asclepiadaceae

Asclepias asperula (Dcne.) Woods.
Asclepias latifolia Engelm. & Gray
Asclepias pumila (Gray) Vail
Asclepias stenophylla Gray
Asclepias tuberosa L.
Asclepias verticillata L.
Asclepias viridis Walt.

Asteraceae

Achillea millefolium L.
Ambrosia artemisiifolia L.
Ambrosia psilostachya DC.
Ambrosia trifida L.
Antennaria parlinii Fern.
Aphanostephus pilosus Buckl.
Aphanostephus ramosissimus DC.
Aphanostephus skirrhobasis (DC.) Trel.
Artemisia dracunculus L.
Artemisia filifolia Torr.
Artemisia longifolia Nutt.
Artemisia ludoviciana Nutt.
Aster ericoides L.
Aster oblongifolius Nutt.
Aster patens Ait.
Aster subulatus Michx.
Baccharis salicina Torr. & Gray
Bidens cernua L.
Bidens frondosa L.
Brickellia eupatorioides (L.) Shinners
Centaurea americana Nutt.
Chaetopappa asteroides Nutt. ex DC.
Cirsium ochrocentrum Gray
Cirsium undulatum (Nutt.) Spreng.
Conyza canadensis (L.) Cronq.
Conyza ramosissima Cronq.
Coreopsis grandiflora Hogg ex Sweet
Coreopsis tinctoria Nutt.
Dysodiopsis tagetoides (Torr. & Gray) Rydb.
Echinacea angustifolia DC.
Eclipta prostrata (L.) L.
Engelmannia peristenia (Raf.) Goodman & C.A. Watson
Erigeron strigosus Muhl. ex Willd.
Eupatorium serotinum Michx.
Evax prolifera Nutt. ex DC.
Evax verna Raf.
Gaillardia aestivalis (Walt.) H. Rock
Gaillardia pulchella Foug.
Gaillardia suavis (Gray & Engelm.) Britt. & Rusby
Gamochaeta purpurea (L.) Cabrera
Grindelia papposa McKelvey
Grindelia squarrosa (Pursh) Dunal
Gutierrezia dracunculoides (DC.) S.F. Blake
Helenium amarum (Raf.) H. Rock
Helenium microcephalum D.C.
Helianthus annuus L.
Helianthus hirsutus Raf.
Helianthus maximiliani Schrad.
Helianthus pauciflorus Nutt.
Helianthus petiolaris Nutt.
Heterotheca canescens (DC.) Shinners
Heterotheca stenophylla (Gray) Shinners
Hieracium longipilum Small
Hymenopappus scabiosaeus L'Hér.
Hymenopappus tenuifolius Pursh
Iva annua L.
Krigia caespitosa (Raf.) K.L. Chambers
Krigia dandelion (L.) Nutt.
Lactuca canadensis L.
Lactuca serriola L.
Lactuca tatarica (L.) C.A. Mey
Liatris aspera Michx.
Liatris punctata Hook.
Liatris scariosa (L.) Willd.
Machaeranthera pinnatifida (Hook.) Shinners
Nothocalais cuspidata (Pursh) Greene
Packera plattensis (Nutt) W.A. Weber & A. Love
Palafoxia sphacelata (Nutt. ex Torr.) Cory
Pluchea camphorata (L.) DC.
Polanisia dodecandra (L.) D.C.
Pseudognaphalium canescens DC.
Pseudognaphalium stramineum (Kunth) W.A. Weber
Pyrrhopappus grandiflorus (Nutt.) Nutt.
Ratibida columnifera (Nutt.) Wooton & Standl.
Rudbeckia hirta L.
Silphium asteriscus L.
Silphium laciniatum L.
Silphium radula Nutt.
Solidago arguta Ait.
Solidago gigantea Ait.
Solidago missouriensis Nutt.
Solidago petiolaris Ait.
Tetraneuris linearifolia (Hook.) Greene
Thelesperma filifolium (Hook.) Gray
Townsendia exscapa (Richards.) Potter
Vernonia baldwinii Torr.

Xanthium strumarium L.
Xanthisma texanum DC.

Boraginaceae
Buglossoides arvensis (L.) I.M. Johnston
Lithospermum incisum Lehm.
Mysotis verna Nutt.

Brassicaceae
Draba brachycarpa Nutt. ex Torr. & A. Gray
Draba cuneifolia Nutt. ex Torr. & A. Gray
Draba reptans (Lam.) Fern.
Descurainia pinnata (Walt.) Britt.
Erysimum capitatum (Dougl. ex Hook.) Greene
Lepidium oblongum Small
Lepidium virginicum L.
Lesquerella auriculata (Engelm & A. Gray) S. Watson
Lesquerella engelmannii (A.Gray) S. Watson
Lesquerella gracilis (Hook.) S. Watson
Lesquerella ovalifolia Rydb. ex Britt.
Rorippa nasturtium-aquaticum (L.) Hayek
Rorippa palustris (L.) Bess.
Rorippa sessiliflora (Nutt.) Hitchc.
Sibara virginica (L.) Rollins

Callitrichaceae
Callitriche heterophylla Pursh.

Campanulaceae
Lobelia appendiculata A. DC.
Lobelia cardinalis L.
Triodanis leptocarpa (Nutt.) Nieuwl.
Triodanis perfoliata (L.) Nieuwl.

Capparaceae
Cleomella angustifolia Torr.

Caprifoliaceae
Viburnum rufidulum Raf.
Symphoricarpos orbiculatus Moench

Caryophyllaceae
Cerastium brachypodum (Engelm. ex Gray) B.L. Robins.
Minuartia michauxii (Fenzl.) Farw.
Minuartia patula (Michx.) Mattf.
Paronychia jamesii Torr. & A. Gray
Paronychia virginica Spreng.
Sagina decumbens (Ell.) Torr & A. Gray
Silene antirrhina L.

Ceratophyllace
Ceratophyllum demersum L.

Chenopodiaceae
Chenopodium album L
Chenopodium leptophyllum (Moq.) Nutt.
Chenopodium simplex (Torr.) Raf.
Chenopodium standleyanum Aell.
Salsola tragus L
Monolepis nuttalliana (Schult.) Greene

Cistaceae
Lechea tenuifolia Michx.

Clusiaceae
Hypericum drummondii (Grev. & Hook) Torr. & A. Gray
Hypericum mutilum L.

Convolvulaceae
Convolvulus arvensis L.
Evolvulus nuttallianus Schult.

Cornaceae
Cornus drummondii C.A. Mey

Cuscutaceae
Cuscuta gronovii Willd.
Cuscuta coryli Engelm.

Crassulaceae
Sedum nuttallianum Raf.

Cucurbitaceae
Cyclanthera dissecta (Torr. & Gray) Arn.
Cucurbita foetidissima Kunth
Ibervillea lindheimeri (Gray) Greene
Melothria pendula L.

Ebenaceae
Diospyros virginiana L.

Euphorbiaceae
Acalypha gracilens A. Gray
Acalypha ostryifolia Riddell
Chamaesyce glyptosperma (Engelm) Small
Chamaesyce maculata (L.) Small
Chamaesyce missurica (Raf.) Shinners
Chamaesyce nutans (Lag.) Small
Chamaesyce prostrata (Aiton) Small
Croton capitatus Michx.
Croton glandulosus L.

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Croton lindheimerianus Scheele.
Croton monanthogynus Michx.
Croton texensis (Klotzch.) Muell. Arg.
Euphorbia commutata Engelm.
Euphorbia corollata L.
Euphorbia dentata Michx.
Euphorbia marginata Pursh.
Euphorbia spathulata Lam.
Phyllanthus caroliniensis Walt.
Phyllanthus polygonoides Nutt. ex Spreng.
Stillingia sylvatica Garden ex L.
Tragia ramosa Torr.

Fabaceae

Acacia angustissima (Mill.) Kuntze
Amorpha canescens Pursh.
Amorpha fruticosa L.
Apios americana Medik.
Astragalus crassicarpus Nutt.
Astragalus plattensis Nutt.
Baptisia australis (L.) R. Br.
Baptisia bracteata Muhl. ex Elliot
Baptisia sphaerocarpa Nutt.
Cercis canadensis L.
Chamaecrista fasciculata (Michx.) Greene
Clitoria mariana L.
Crotalaria sagittalis L.
Dalea aurea Nutt. ex Pursh.
Dalea candida Willd.
Dalea enneandra Nutt.
Dalea multiflora (Nutt.) Shinners
Dalea purpurea Vent.
Dalea tenuis (J.M. Coult) Shinners
Desmanthus illinoensis (Michx.) MacM
Desmanthus leptolobus Torr & A. Gray
Desmodium ciliare DC.
Desmodium nudiflorum (L.) DC.
Desmodium paniculatum (L.) DC.
Desmodium sessilifolium (Torr.) Torr. & A.Gray
Galactia volubilis (L.) Britt.
Glycyrrhiza lepidota (Nutt.) Pursh.
Gymnocladus dioicus (L.) Koch.
Hoffmanseggia glauca (Ortega) Eifert
Indigofera miniata Ortega
Lespedeza capitata Michx.
Lespedeza procumbens Michx.
Lespedeza virginica (L.) Britt.
Lotus unifoliolatus (Hook.) Benth.
Melilotus albus Medik.
Neptunia lutea (Leavenw.) Benth.
Pediomelum esculentum (Pursh.) Rydb.
Pediomelum linearifolium (Torr. & A. Gray) J.W. Grimes
Psoralidium tenuiflorum (Pursh.) Rydb.
Senna marilandica (L.) Link.
Strophostyles helvula (L.) Elliott

Strophostyles leiosperma (Torr. & A.Gray) Piper
Strophostyles umbellatum (Muhl ex Willd.) Britt.
Stylosanthes biflora (L.) Britton, Sterns. & Pogg.
Vicia ludoviciana Nutt.

Fagaceae

Quercus buckleyi Nixon & Dorr.
Quercus macrocarpa Michx.
Quercus marilandica Muench.
Quercus muehlenbergii Engelm.
Quercus shumardii Buckl.
Quercus stellata Wang.
Quercus velutina Lam.
Quercus virginiana Mill.

Fumariaceae

Corydalis aurea Willd.

Gentianaceae

Sabatia campestris Nutt.

Geraniaceae

Geranium carolinianum L.

Grossulariaceae

Ribes aureum Pursh

Haloragaceae

Myriophyllum pinnatum (Walter) Britton, Stens & Poggenb.
Myriophyllum spicatum L.

Hydrophyllaceae

Nama hispidum A. Gray

Juglandaceae

Carya illinoinensis (Wang.) K. Koch
Juglans major (Torr.) Heller
Juglans microcarpa Berland
Juglans nigra L.

Krameriaceae

Krameria lanceolata Torr.

Lamiaceae
Hedeoma hispida Pursh.
Lycopus americanus Muhl.
Monarda citriodora Cerv. ex Lag.
Monarda clinopodioides A. Gray
Monarda fistulosa L.

Monarda pectinata Nutt.
Nepeta cataria L.
Salvia azurea Michx. ex Lam.
Salvia reflexa Hornem.
Scutellaria drummondii Benth.
Scutellaria wrightii A. Gray
Scutellaria resinosa Torr.
Teucrium canadense L.
Teucrium laciniatum Torr.
Trichostema brachiatum L.

Lentibulariaceae
Utricularia gibba L.

Linaceae
Linum berlandieri Hook.
Linum hudsonioides Planch.
Linum imbricatum (Raf.) Shinners
Linum rigidum Pursh
Linum sulcatum Riddell

Loasaceae
Mentzelia oligosperma Nutt.
Mentzelia nuda (Pursh.) Torr & A. Gray

Lythraceae
Ammannia auriculata Willd.
Ammannia coccinea Rottb.
Lythrum alatum Pursh.

Malvaceae
Callirhoe involucrata (Torr. & A. Gray) A. Gray
Sphaeralcea coccinea Nutt.

Menispermaceae
Cocculus carolinus (L.) DC.

Molluginaceae
Mollugo verticillata L.

Moraceae
Morus rubra L.

Nyctaginaceae
Mirabilis nyctaginea (Michx.) MacM.
Mirabilis linearis (Gray) Greene
Mirabilis glabra (S. Wats.) Standl.
Mirabilis hirsuta A. Nels.
Mirabilis albida (Walter) Heimerl.

Oleaceae
Fraxinus pennsylvanica Marsh.

Onagraceae
Calylophus serrulatus (Nutt.) P.H. Raven
Gaura coccinea Nutt. ex Pursh.
Gaura parviflora Douglas ex Lehm.
Gaura sinuate Nutt.
Gaura suffulta Engelm. ex A. Gray
Gaura triangulata Buckley
Ludwigia alternifolia L.
Ludwigia decurrens (Walt.) DC.
Ludwigia peploides (Kunth) Raven
Ludwigia repens J.R. Forst
Oenothera biennis L.
Oenothera brachycarpa A. Gray
Oenothera grandis (Britton) Smith
Oenothera jamesii A. Gray
Oenothera laciniata Hill
Oenothera linifolia Nutt.
Oenothera macrocarpa (A. Gray) W.L. Wagner
Oenothera triloba Nutt.
Stenosiphon linifolius (Nutt. ex E. James) Heynh.

Oxalidaceae
Oxalis violacea Rydb.
Oxalis stricta L.

Papaveraceae
Argemone polyanthemos (Fedde) G.B. Ownbey

Pedaliaceae
Proboscidea louisianica (Mill.) Thell.

Phytolaccaceae
Phytolacca americana L.

Plantaginaceae
Plantago aristata Michx.
Plantago elongata Pursh.
Plantago patagonica Jacq.
Plantago virginica L.
Plantago wrightiana Dcne.

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Polemoniaceae
Ipomopsis rubra Fern.

Polygalaceae
Polygala alba Nutt.

Polygala verticillata L.

Polygonaceae
Eriogonum annum Nutt.
Eriogonum longifolium Nutt.
Polygonum amphibium L.
Polygonum convolvulus L.
Polygonum hydropiperoides Michx.
Polygonum lapathifolium L.
Polygonum pensylvanicum L.
Polygonum punctatum Ell.
Polygonum ramosissimum Michx.
Polygonum scandens L.
Polygonum tenue Michx.
Rumex altissimus Wood
Rumex crispus L

Portulacaceae
Claytonia virginica L.
Portulaca pilosa L.
Portulaca umbraticola Kunth.
Portulaca oleracea L.
Talinum calycinum Engelm.
Talinum parviflorum Nutt.

Primulaceae
Adrosace occidentalis L.
Dodecatheon meadia L.
Samolus valerandi L.

Ranunculaceae
Anemone berlandieri Pritz
Delphinium carolinianum Walt.
Myosurus minimus L.

Rhamnaceae
Ceanothus herbaceus Raf.

Rosaceae
Agrimonia parviflora Aiton
Crataegus reverchonii Sarg.
Crataegus viridis L.
Geum aleppicum Jacq.
Geum canadense Jacq.
Potentilla arguta Pursh
Prunus angustifolia Marsh.
Prunus gracilis Engelm. & A. Gray
Prunus mexicana S. Watson
Prunus virginiana L.
Rubus aboriginum Rydb.

Rubus occidentalis L.

Rubiaceae
Cephalanthus occidentalis L.
Diodia teres Walt.
Galium aparine L.
Galium pilosum Aiton
Galium texense A. Gray
Galium virgatum Nutt.
Hedyotis nigricans (Lam.) Fosberg
Houstonia caerulea L.
Houstonia pusilla Schoepf

Rutaceae
Ptelea trifoliata L.

Salicaceae
Populus alba L.
Populus deltoides Marsh
Salix caroliniana Michx.
Salix nigra Marsh.

Santalacaceae
Comandra umbellata (L.) Nutt.

Sapindaceae
Aesculus glabra Willd.
Acer grandidentatum Nutt.
Acer saccharinum L.
Acer saccharum Marsh.
Sapindus saponaria L.
.

Sapotaceae
Sideroxylon lanuginosum Michx.

Scrophulariaceae
Agalinis fasciculata Pennell
Bacopa rotundifolia (Michx.) Wettst.
Castilleja purpurea (Nutt.) G. Don.
Castilleja sessiliflora Pursh.
Collinsia violacea Nutt.
Gratiola virginiana L.
Leucospora multifida (Michx) Nutt.
Linaria canadensis (L.) Dumont.
Lindernia dubia (L.) Pennell

Penstemon cobaea Nutt
Penstemon oklahomensis Pennell
Scrophularia lanceolata Pursh.
Veronica arvensis L.
Veronica peregrine L.

Simaroubaceae
Ailanthus altissima (P. Mill.) Swingle

Solanaceae
Physalis cinerascens (Dunal) Hitchc.
Physalis longifolia Nutt.
Quincula lobata (Torr.) Raf.
Solanum dimidiatum Raf.
Solanum elaeagnifolium Cav.
Solanum ptycanthum Dunal
Solanum rostratum Dunal

Ulmaceae
Celtis laevigata Willd.
Ulmus americana L.
Ulmus rubra Muhl

Urticaceae
Boehmeria cylindrica (L.) Sw.
Parietaria pensylvanica Muhl. ex Willd.

Valerianaceae
Valerianella radiata (L.) Dufr.

Verbenaceae
Glandularia canadensis (L.) Nutt.
Glandularia pumila (Rydb.) Umber
Lippia cuneifolia (Torr.) Steud
Lippia nodiflora (L.) Michx.
Verbena bracteata Lag. & Rodr.
Verbena stricta Vent.
Verbena urticifolia L.

Violaceae
Hybanthus verticillatus (Ortega) Baill
Viola bicolor Pursh
Viola missouriensis Greene
Viola sororia Willd.

Vitaceae
Ampelopsis cordata Michx.
Cissus incisa Des Moul.
Parthenocissus quinquefolia (Buckley) Britton ex Small
Vitis cinerea (Englm.) Millardet.
Vitis riparia Michx.
Vitis rupestris Scheele

Zygophyllaceae
Kallstroemia californica (S. Wats.) Vail
Tribulus terrestris L.

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Common Spring Mushrooms of Oklahoma

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INTRODUCTION

Springtime brings a resurgence of greenery and wildflowers to the landscape. For those interested in fungi it is time to look for mushrooms as well. In Oklahoma spring mushrooms appear for approximately two to three-weeks from late March to mid-April. The exact time depends on temperature, moisture, and in which corner of the state you hunt mushrooms.

Collectors might encounter a few of the "gilled mushrooms", Basidiomycota, during the spring, but it is the members of the phylum Ascomycota, often referred to as "Ascomycetes", that are the most prominent and popular of the spring fungi. Here, we present a selection of common ascomycetes in the order Pezizales, the morels and related cup-fungi that you may encounter in the spring woods.

The Ascomycota includes a diverse group of fungi ranging from yeasts to devastating plant pathogens, to edible wild mushrooms. Members of this phylum bear their spores in microscopic sac-like structures called asci. Some ascomycetes form fruiting bodies called ascocarps or ascomata. In the order Pezizales, the basic form of the ascocarp is called an apothecium. Apothecia resemble a cup or saucer with the asci lining the cup or covering the upper surface of the saucer; these fungi are often referred to as "cup-fungi." In some species the apothecium has a stalk or stem. In others the apothecium may be recurved or contorted into any of a number of shapes including thimbles and pitted or wrinkled caps.

Below we provide photographs and brief descriptions of the more commonly encountered spring-fruiting members of the Pezizales. More details can be found in most mushroom field guides. Common names, where known, are given in parentheses.

We are hesitant to provide information on edibility. Great care must be taken to be absolutely sure of a mushroom's identity. Only after becoming proficient at identifying mushrooms, and only then, can one determine edibility.

Vouchers for specimens described here are housed in the mycological collection of the University of Central Oklahoma's herbarium (CSU).

Order Pezizales

Morchella esculenta (common, yellow or tan morel)

This is by far the most popular spring mushroom collected for consumption. It is recognized by its pitted cap with light tan or gray pits separated by creamy-white ribs when young. The ribs do not blacken at maturity. The entire length of the cap is attached to the stalk and both the cap and stalk are hollow. Two slightly different forms of this species are illustrated. One has a more rounded cap (Fig. 1) and the other is more tapered (Fig. 2). The morphological variation within this species needs further investigation, so we cannot be certain whether these variations represent distinct species. Websites such as www.mushroomexpert.com/morchella_yellow.html can offer more information. The common morel is usually found in wooded areas. River bottom forests seem to be good places in Oklahoma for finding morels. We have frequently found morels near eastern red cedar trees as well. Don't count out metropolitan areas. The first author has found them in his own yard and on the University of Central Oklahoma campus.

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Figure 1 ***Morchlla esculenta*** **with rounded cap.**

Figure 2 ***Morchella esculenta*** **with tapered cap.**

Morchella semilibera (half-free morel)

It fruits at about the same time as the common morel and differs from the common morel by the way that the cap is attached to the stalk (Fig. 3). The lower half of the cap is free from the stalk and resembles a skirt. The ribs of the cap turn dark brown to black with age and the caps are often darker and smaller than those of the common morel.

Figure 3 ***Morchella semilibera***

Gyromitra caroliniana

Gyromitra c. is by far the largest spring mushroom found in Oklahoma (Fig. 4). The cap is brownish red and convoluted or brain-like. The stalk is robust with the exterior formed into irregular, rounded ridges separated by irregular grooves. The inside tissue of the cap and stalk appears to be stuffed with folded or convoluted tissue (Fig. 5).

Figure 4 ***Gyromitra caroliniana*** **external view**

Figure 5 ***Gyromitra caroliniana*** **showing internal structure**

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Verpa conica (bell morel)

It is recognized by the brown, smooth to slightly wavy, bell-shaped apothecium that is attached only at the stalk apex (Fig. 6), resembling a thimble sitting on a finger. For that reason it is also called the thimble morel.

Figure 6 ***Verpa conica***

Helvella acetabulum

This differs in outward appearance from the previous because the apothecium is cup-shaped (Fig. 7). The inside of the apothecium is brown to grayish brown. A very short stalk may be present or absent. Its surface has sharp-edged ribs that extend onto the lower surface of the apothecium, sometimes nearly to the margin of the cup.

Figure 7 ***Helvella acetabulum***

Helvella stevensii

This is a relatively small fungus. The spore-bearing surface of its apothecium is ivory to pale tan at maturity. In some views mature apothecia often resemble pies with a missing wedge (Fig. 8) or have three lobes, but in young apothecia the margins are rolled over the spore-bearing surface. The undersurface of the apothecium is covered with short hairs that can be seen with a hand lens. The stalk is round in outline or slightly flattened.

Figure 8 ***Helvella stevensii***

Urnula craterium (devil's urn)

The apothecium of this fungus is shaped more like a water or wine goblet than a drinking cup because of its long stalk (Fig. 9). Apothecia are dark brownish black overall and typically arise in clusters from, or adjacent to, downed logs. *Urnula craterium* is generally the first fungus to appear in the spring, often well in advance of the morels.

Figure 9 ***Urnula craterium***

Sarcoscypha occidentalis (stalked scarlet cup)

This cup fungus makes its first appearance in late spring and fruits throughout the summer and into the early fall. It is a small fungus with the apothecium seldom being larger than one cm across (Fig. 10). The apothecium is bright red and the stipe is white. This fungus appears to fruit on the soil but is actually attached to buried wood.

Figure 10 ***Sarcoscypha occidentalis***

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Fern Habitats and Rare Ferns in Oklahoma

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This paper features some of the more common fern habitats in Oklahoma and provides information on four rare Oklahoma ferns from two fern families: Aspleniaceae and Pteridaceae. Surprisingly, ferns can be found in a variety of habitats across Oklahoma.

INTRODUCTION

With over 2500 species of vascular plants (Taylor and Taylor 1991), Oklahoma is rich in both plant and habitat diversity. The vast majority of Oklahoma's vascular plants are flowering plants. Less than 100 species are ferns and fern allies. Needless to say, ferns and fern allies do not get the same attention as do flowering plants. One obvious reason is that they are not as showy and do not catch our eye as wildflowers do. Secondly, we tend to visit wildflower habitats more often than fern habitats. Ferns live in some of the most interesting places, however. If you are in the Quartz Mountains you may be staring at a western diamondback snake and a star cloak-fern on the same rock. If you are hunting the netted chain fern in southeastern Oklahoma you may be up to your ankles in mud. One of the objectives of this article will be to introduce you to some of the typical habitats and places that you can find ferns. You will also be introduced to some of the rare ferns of Oklahoma.

Habitat information for some of the species is from The Flora of North America (1993). Rare species are those listed in the Oklahoma Natural Heritage Inventory (2005). Collection dates and distribution information are from the Oklahoma Biological Survey Database and from personal encounters with the species. Authority and common names are from Taylor and Taylor (1991) and The Flora of North America (1993). Technical descriptions of each species can also be obtained from The Flora of North America. To distinguish between the different taxa I would encourage readers to use field guides and a good dichotomous key such as Keys and Descriptions for the Vascular Plants of Oklahoma (Tyrl et al. 2007) or the Illustrated Flora of North Central Texas (Diggs et al. 1999).

FERN HABITATS

One of the best places to look for ferns is on rock outcrops with mosses. Rocks are great places to find ferns, no matter what part of the state you are in. Ferns can even be found embedded in mosses on trees. If you can't find them on rocks and trees, look for them in marshes, bogs, mudflats, woodland forests, areas with rocky soils, near waterfalls, and even floating on the water surface. The places you will likely not find them are in lawns or prairies. Often, when someone has brought or described to me the leaf of a "fern" they found in such a habitat, it has been *Achillea millefolium* L., the common yarrow. Common yarrow is a flowering plant in the composite family Asteraceae.

Do not let the rocky outcrop habitats in Quartz Mountain Resort, or other islands of the Wichita Mountains (Fig. 1), discourage you from looking for ferns. Southwestern Oklahoma is a great place to see several families of ferns including the Aspleniaceae, Dryopteridaceae, and especially the maidenhair family, Pteridaceae.

Figure 1 Rock outcrop, Quartz Mountain Resort.

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The overhang of the cave at Robbers Cave State Park and Lodge supports a healthy population of *Asplenium bradleyi* D.C. Eaton, Bradley's spleenwort, one of Oklahoma's rarer ferns (Fig. 2). I have visited this same population many times over the years. The population appears to have grown and is healthier than ever.

Figure 2 Rock outcrop overhang of Robbers Cave.

Limestone crevices can hold lichens as well as *Argyrochosma dealbata* (Pursh) Windham, the powdery cloak-fern (Fig. 3). The Arbuckle Mountains are great places to see several species of ferns, especially the maidenhair ferns.

Figure 3 *Argyrochosma dealbata* in limestone crevice with lichens, Turner Falls in the Arbuckle Mountains.

Cheilanthes lanosa (Michx.) D.C. Eaton, the hairy lipfern, grows on rocky soil with a spike moss on Elk Mountain in the Wichita Mountains (Fig. 4). Other granitic rocks on which to find this fern are in the Great Plains State Park and Quartz Mountain Resort.

Figure 4 *Cheilanthes lanosa* with spike moss.

Cheilanthes lanosa also grows on other rock types such as the limestone at Beavers Bend Resort Park and Robbers Cave State Park and Lodge. This fern is one of the few in Oklahoma that has the ability to take over large patches of hillsides in open areas (Fig. 5).

Figure 5 *Cheilanthes lanosa* in an open area, Beavers Bend Resort Park.

I do not know of any Oklahoma epiphytic ferns other than *Pleopeltis polypodioides* (L.) Andrews & Windham (figs. 6 & 7), the resurrection fern. It is common in eastern forests on both mossy covered rocks and mossy covered trees. It occurs as far west as Johnston County.

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Figure 6 *Pleopeltis polypodiodes* , the resurrection fern, in Idabel City Park.

Figure 7 *P. polypodioides* growing as an epiphyte.

Osmunda cinnamomea L., cinnamon fern, grows under the canopy of a mesic forest in Choctaw County (Fig. 8). Cinnamon ferns can live in acidic soils, vernal seeps, and moist areas. Cinnamon ferns can be seen on public land at Ferndale Bog in McGee Creek State Park. The best time to visit them is in May when you can see their cinnamon colored fertile fronds.

Figure 8 Cinnamon fern in Choctaw County

Woodwardia areolata (L.) T. Moore (Fig. 9) grows in wet forest soils in Choctaw County, but they can also be found in seeps and acidic bogs. Look carefully at the erect fertile frond in the foreground. The elongated sori of each leaflet fit end to end forming a chain, thus the common name, netted chain fern. Growing laterally in the background you can see the sterile fronds that do not produce sori. Both fronds are part of the same rhizome. This is an interesting species to see, especially when both types of fronds are present. It is a southeastern Oklahoma species that can be seen in at least five counties.

Figure 9 *Woodwardia* areolata with fertile frond in foreground.

Onoclea sensibilis L. (Fig. 10) grows in marshy soils on McCurtain County roadsides. Sensitive ferns can be found in open swamps, thickets,

marshes, or lowland woods. Like *Woodwardia areolata*, the sensitive fern has separate fertile (brown) fronds and sterile (green) fronds. This species has a much wider distribution than the netted chain fern. The sensitive fern is seen as far west as Creek County.

Figure 10 *Onoclea sensibilis* with fertile brown fronds.

Mudflats like the one at the University of Oklahoma Biological Station in Marshall County are not the greatest habitat to look for ferns (Fig. 11). However, *Marsilea vestita* Hook. and Grev., water clover, was collected there in 2006.

Figure 11 Mudflat habitat at OU Biological Station.

On the falls and rocks in the creek area at Price Falls in Falls Creek Baptist Assembly (Fig. 12) you can see *Adiantum capillus-veneris* L., the southern maidenhair fern. The tissue thin fronds require moist cool air to survive. Climb fifteen feet above the waterfall on the rock and away from the creek and you will not find it. Falls Creek is a wonderful place to find several species of the Pteridaceae: *Adiantum capillus-veneris, Argyochosma dealbata, Astrolepis integerrima* (Hook.) Benham & Windham, *Cheilanthes tomentosa* L., and *Pellaea atropurpurea* (L.) Link.

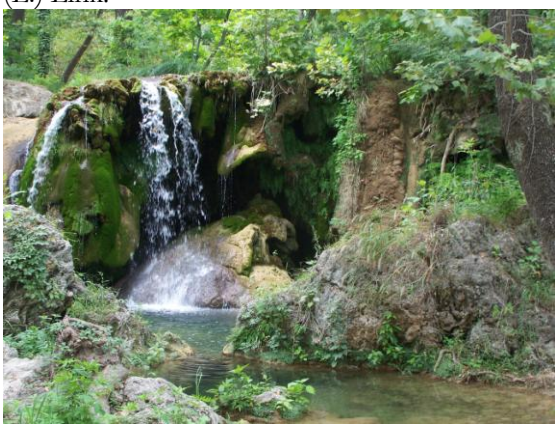

Figure 12 Price Falls at Falls Creek Baptist Assembly.

RARE FERNS

I do not remember when I first became a "Pteridomaniac". The spore must have begun developing in 1977 after enrolling in my first field botany course, Plant Taxonomy, under Dr. Doyle McCoy. Since 1977 I have taken my share of botany field trips all over the state. In fact, I consider every day a botany field trip, always looking for that fern or other plant that I have never seen as well as those "old friends", as Dr Tyrl would call them, like *Asplenium platyneuron* (L.) Britton, Sterns & Poggenb. (Fig. 13) and *Woodsia obtusa* (Spreng.) Torr. (Fig. 14), two ferns that are as common as dandilions.

Figure 13 *Asplenium platyneuron, ebony spleenwort, a very common fern.*

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Figure 14 *Woodsia obtusa*, blunt-lobed cliff fern, another common fern

The following species are relatively rare in Oklahoma and are listed as "s*pecies of concern"* by the Oklahoma Natural Heritage Inventory (2008). The first three are in Aspleniaceae family and the last is in Pteridaceae. I have had the good fortune to see each of them more than once, some in multiple locations, others in only one location.

Asplenium bradleyi D.C. Eaton (Fig. 15)
Common name: Bradley's spleenwort
Distribution: Latimer County, also seen in Atoka County.
Note: This is a difficult species to describe, but it can easily be identified using a field guide or dichotomous key.

Figure 15 *Asplenium bradleyi* growing on sandstone rock, Robbers Cave State Park and Lodge.

Asplenium pinnatifidum Nutt. (Fig. 16)
Common name: lobed spleenwort
Distribution: Latimer County.
Note: this species has only been reported at Robbers Cave State Park and Lodge, but there are several populations throughout the park, including Robbers Cave.

Figure 16 *Asplenium pinnatifidum*, Robbers Cave State Park and Lodge.

Asplenium septentrionale (L.) Hoffm. (Fig. 17)
Common name: forked spleenwort
Distribution: Cimarron County.
Note: This fern does not have the typical fern appearance. The novice might even mistake it for a grass. The fronds have a grass-like appearance with narrow linear blades. The blade apex can be forked, thus its common name.

Figure 17 *Asplenium septentrionale*, north of Black Mesa State Park and Nature Preserve.

Cheilanthes wootonii Maxon (Fig. 18)
Common name: beaded lipfern
Distribution: Cimarron, Greer, and Kiowa counties, but also seen in Canadian County.
Note: *Cheilanthes* species are difficult to identify. *C. wootonii* Hook. can easily be mistaken for *C. eatonii* Baker, *C. tomentosa* Link, or even *C. lindheimeri*. You'll need a good dichotomous key such as *Keys and Descriptions for the Vascular Plants of Oklahoma* (Tyrl et al. 2007) to identify members of this genus.

Figure 18 *Cheilanthes wootonii*, Methodist Canyon Camp.

CONCLUSION

I hope you will visit a fern habitat on a future field trip. You do not need to wait until spring to see ferns because there are several species in our state that are evergreens. You will find ferns to be both fascinating and beautiful. If you are fortunate enough to come across one of these rare ferns, please practice good conservation by not collecting it and by protecting its habitat.

ACKNOWLEDGEMENTS

My thanks to the following individuals: Richard Butler for accompanying me on many field trips the last five years and helping to edit portions of the article: Mickey Cooper for giving me my start in Botany; Doyle McCoy for giving me my start in Oklahoma native plants; Ron Tyrl for training me as a botanist and providing so many great botanical opportunities; Richard Butler, Catherine Eimen, Bruce Hoagland, and Sheila Strawn, for helping to edit portions of this article; and to my wife, Sharon, for helping to edit the article and for allowing me to pursue my passion.

I also give my thanks for access to these properties: Hoby family property; University of Oklahoma Biological Station; Falls Creek Baptist Assembly; Methodist Canyon Camp; Southwest Baptist Assembly; Turner Falls; Idabel City Park; and the following state facilities: Beavers Bend Resort Park, Black Mesa State Park and Nature Preserve, Great Plains State Park, McGee Creek State Park, Quartz Mountain Resort, Red Rock Canyon State Park, and Robbers Cave State Park and Lodge.

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Tribute to Paul Buck

Paul Buck passed away on January 16, 2008. Respected and admired by his colleagues and friends, he left a legacy of lifelong commitment to ecology and botany.

Paul was a founding member of the Board of Directors of the Oklahoma Native Plant Society in 1987, and, after serving on its board for several subsequent terms, he was the second recipient of the ONPS Service Award.

In the early days of ONPS he was an active leader and participant in Society field excursions throughout the state. Paul was at the organizing core of the ONPS Color Oklahoma Committee, serving on its first board from 2003 through 2006.

For more than ten years he wrote a column entitled "Botany Bay" for the ONPS quarterly newsletter, *Gaillardia*. In each issue he presented a puzzling or intriguing botanical problem and then decoded it in colorful terms, accessible to both amateur and professional botanists.

Most knew Paul as Professor of Botany at the University of Tulsa. He was there from 1964 to 1987, teaching and inspiring students, majors and non-majors alike. For decades he transported students all over the state to Oklahoma Academy of Science (OAS) Field Meetings and Technical Meetings, to Southwest Association of Naturalists meetings, and on spring break excursions to Mexico and New Mexico He encouraged students to attend the University of Oklahoma Biological Station, which he had attended as a student, and Rocky Mountain Biological Station, at which he taught during the summer.

Paul was the faculty advisor of the TU student chapter of Zero Population Growth. With his colleague, Estelle Levetin, he established the longest pollen record in the U.S., also one of the longest in the world. After Paul retired from the University of Tulsa he continued to curate the Harriet G. Barclay Herbarium there and to teach and guide students.

In the mid-1980s Paul was a founding member of the Flora of Oklahoma Committee, a group of Oklahoma botanists dedicated to writing the *Flora of Oklahoma*. This has been and continues to be a monumental work to write and update keys and descriptions of all the vascular plant species in Oklahoma, replacing the keys of U.T. Waterfall. Paul actively participated in the Flora of Oklahoma Board of Directors until retiring in the spring of 2006 as its Treasurer.

Paul was elected President of the Oklahoma Academy of Science in 1971 and served as Executive Secretary-Treasurer in the late 1980s and early 1990s. He was recognized by OAS for his meritorious service to Oklahoma scientists with the Tenure Service Award in 1991, the Education Service Award in 1994, and the OAS Lifetime Achievement Award presented at a botanical symposium in his honor in 2006. OAS continues to publish Paul's *Distribution and Identification of Woody Plants of Oklahoma in the Winter Condition* (1983).

Paul was founder of the Mary Kay Oxley Nature Center, a natural area along Bird Creek at the edge of Mohawk Park in Tulsa. Along with Harriet Barclay, he was instrumental in encouraging The Nature Conservancy to purchase both Red Bud Valley Nature Preserve in 1970 and the Tall Grass Prairie Preserve in 1989. He served on the boards of all three of these organizations for many years until they were well established. He also served on the board of The Oklahoma Nature Conservancy.

Many are surprised to learn that Paul Buck was not a native Oklahoman. He was born in Lansing, Michigan, September 9, 1927. At 17 he joined the US Navy and was stationed in Norman, Oklahoma. On leave

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in Tulsa, he met Lou Ann Clark, whom he later married. In Tulsa he served on the Tulsa Police Force as a "beat cop" in Oakhurst in west Tulsa. Working the night shift enabled him to attend classes at the University of Tulsa during the day. There he was inspired by Harriet Barclay and Ralph Kelting to pursue a career in botany. After his BS and MS at UT, he attended the University of Oklahoma where he worked with Elroy Rice. His dissertation, *Relationships of Woody Vegetation of the Wichita Mountains Wildlife Refuge to Geological Formations and Soil Types,* was among the first ecological studies of the Wichita Refuge. In 2002 *Oklahoma Native Plant Record* published "Vascular Plants of the Wichita Mountains", from an informational pamphlet previously used by Refuge biologists, which was based on that work.

Paul's commitment to botany, ecology, and environmental conservation extended beyond formal and academic venues. He involved neighborhood children in observing the natural world. Paul was active in community and student efforts to start recycling programs. He led Boy Scout trips to Philmont in New Mexico and spoke to citizen groups at the Tulsa Library. He rode his bicycle to campus for years, attired in a tuxedo. Paul even rode his bicycle to his daughter's wedding. He lived his commitment to conservation and never lost his joy and wonder at the beauty and complexity of the natural world.

Nothing in this formal description can convey the serene and honorable way in which Paul conducted his life. As he mentored and encouraged students, he persisted in his community activism and cared for his mentor and colleague, Harriet Barclay in her later years. He did so with kindness and good humor. Nor can it convey the remarkable grace with which he accepted the unfairness and disability of Parkinson's disease as it limited his field experiences in his own later years.

Paul was remembered in a memorial service May 3, 2008 at the Harriet G. Barclay Nature Center at Red Bud Valley. It was a glorious spring afternoon, sun shining, gentle breeze – Oklahoma at its best. Family and friends, colleagues and former students, neighbors and community activists were all in attendance, remembering the life of the man who had formed, shared, or changed their lives and left this world a better place for his having been here.

Paul is survived by Lou Ann Clark Buck, his wife of more than fifty years, and by his children, Paul Buck III of Gunnison, Colorado and Dana Buck of Atlanta, Georgia. Intellectually and inspirationally, he is survived by us all. Paul's knowledge of the natural world and his tireless pursuit of its further understanding inspired students, future scientists, and laymen for more than five decades. His gentle manner, his patience, his persistence, and his kindness, even in the face of personal, professional, political, and environmental adversity, make him a model for each of us as we continue his commitment to the botany and ecology of Oklahoma.

Constance Murray, 1 June 2008

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, therefore, articles of other themes may be included as well. Research overlooked by journals of broader geographic regions will be considered for publication in the Record.

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. All authors retain copyright of their articles. Submission of the article implies the granting to Oklahoma Native Plant Society of permission to publish it. We ask only for the right to publish articles. We do not seek to own them. In return, we require our authors to allow that work to be used freely for non-commercial purposes, allowing each individual to make, gratis, a single copy of the published manuscript whether from its print or its Internet version; instructors to make gratis, multiple copies available for non-commercial teaching purposes; and libraries to make copies available, gratis, for interlibrary loan. Authors are responsible for supplying reprints upon request.

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 PC-compatible microcomputers are encouraged to send a copy of the manuscript on CD or 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. Use no headers, footers, nor auto page numbering. Proof-read and verify taxa numbers before submission. Color photos may be submitted on CD or diskette. CDs, diskettes, or hardcopy manuscripts should be sent to the managing editor at the address below by July 1.

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