THE VASCULAR FLORA OF THE NORTH CENTRAL TEXAS WALNUT FORMATION

By

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INTRODUCTION

In Texas, few floras of significant geographical area have been published, and these traditionally have been floras with political boundaries such as Neill's flora of Madison County, Texas (Neill and Wilson 2000). Correll and Johnstons' *Manual of the Vascular Plants of Texas* (1970) is the only statewide flora, published 41 years ago. Floras are seldom published in peer-reviewed journals, and most languish as theses hidden in university libraries. These floristic evaluations are often merely checklists of plant species found in the area surveyed and lack detailed ecological data, rendering them less valuable for ecological studies.

Tharp (1939) and Cuyler (1931) both stated that geology is often a very strong determinant for vegetation; and thus this thesis has a geological context inspired by the plant *Dalea reverchonii* or Comanche Peak prairie clover. *Dalea reverchonii* (in the Fabaceae, or Bean Family) is endemic to North Central Texas, and was first collected on Comanche Peak in Hood County 1876 by Julien Reverchon. Originally described as *Petalostemum reverchonii*, it was not found again until the early 1980s (Mahler 1984). Since that time, this species has been found in other sites in North Central Texas and botanists have noticed patterns in its distribution. *Dalea reverchonii* is restricted to rocky glades and barrens of the Walnut Formation. While much of North Central Texas is limestone or chalk, the extensive glades of the Walnut Formation host a unique flora.

Floras and herbarium specimens rarely include geological data – information often valuable for understanding rare and endemic species such as *Dalea reverchonii*. Contrary to Poole et al. (2007), who states that *D. reverchonii* was observed only on

Goodland Limestone, with one exception *D. reverchonii* is found only on the Walnut Formation. In May 2011, the author observed *D. reverchonii* growing on exposed Edwards Limestone on the butte of Comanche Peak, but not on nearby Walnut Limestone. This, the only known population south of the Brazos River, confirmed that *D. reverchonii* is not explicitly endemic to the Walnut Formation.

Over 100 years ago William Bray, an early Texas plant ecologist, stated, "before the flora of Texas suffers further radical changes, the schools of the state ought to cooperate in securing a complete and authentic list of species represented by carefully collected and well-preserved specimens" (Bray 1906). Since then, Texas has witnessed accelerated urban development and yet we still lack basic knowledge of the state's natural history. This thesis, a vascular flora of the North Central Texas Walnut Formation, combines the goals of securing a vouchered species within an ecologically relevant circumscription of a floristic area.

The objectives of this geological flora are to:

1. Collect, identify, and archive specimens of the vascular plants found on the northern portion of the Walnut Formation as outlined on the Geologic Atlas of Texas (McGowen et al. 1987; 1991)
2. Create a list of all species and delineate their preferred habitats, including major plant associations
3. Analyze the flora for rare, endemic, invading, and disjunct taxa.
4. Compare the flora with select Walnut Formation locations south of the Brazos River

5. Upload the herbarium specimen images, live plant images, specimen label data, and corresponding maps to Atrium®, an open-source biodiversity information system that will allow the data to be viewed online at http://atrium.brit.org

THE NORTH AMERICAN AND NORTH CENTRAL TEXAS PRAIRIE

Grasslands are the largest of the world's four major natural areas, covering a quarter of the earths' land surface (Sims and Risser 2000; Shantz 1954). Grasslands are also the largest biome in the United States, with a gradation based on precipitation from tall grasses in the eastern and central great plains (highest precipitation), to mixed grasses, short grasses, and then desert grasslands in the southwest (least precipitation) (Sims and Risser 2000). The North American Great Plains vegetation zone runs north and south, and is the median zone between arid western desert scrub and mesic eastern deciduous forest (Savage 2004). Asteraceae, Fabaceae, and Poaceae are the dominant plant families in order of diversity; however, grasses contain the most biomass. Grasslands receive seasonal rains and strong summer droughts that create an environment with intense drought and rainfall. Grasses have developed adaptations in their leaves and roots to maximize water uptake and retention such as carbohydrate production during high moisture for storage in droughts, and leaf adaptations that allow them to close stomata and curl their leaves to reduce transpiration. C4 grasses dominate drier, warmer climates, while C3 grasses dominate cooler climates (Sims and Risser 2000). The specialized adaptations have made the prairie one of the most resilient ecosystems (Savage 2004). Ideal for grazing, with deep fertile soils, former prairies have become dominated by agriculture in the United States (Savage 2004). Mollisols, which dominate the Great Plains, are the most suitable agricultural soil due to their high organic matter content. Alfisols are relatively fertile, and exist in a band from Kansas to the Cross Timbers of Texas (Sims and Risser 2000) in a mosaic of forests and prairies (Francaviglia 2000). Both of these soils, along with entisols and inceptisols, are common on the Walnut Formation. Destruction of the prairie for agricultural purposes seems to have resulted in a loss of knowledge of the ecosystem and its importance to life on earth.

In North Central Texas, the Fort Worth Prairie, the westernmost division of the Grand Prairie, is a grassland that is largely devoid of trees except in waterways (Diggs, Lipscomb, and O'Kennon 1999). Tharp (1926) does not distinguish the better-known Blackland Prairie from the Grand Prairie in his monograph describing the Texas vegetation east of the 98^{th} parallel; however, Hill (1901) described key differences between the two prairies that are crucial for this study. The Grand Prairie is much flatter and more angular, with shallower soils, with the limestone bedrock as the principle difference. Hill describes the Fort Worth Prairie, where the Walnut is located, as the most representative and extensive portion of the Grand Prairie. The soils of the Fort Worth Prairie differ from typical prairie soils. Immature soils overlay the limestone and shale parent material giving weak soil profiles with high concentrations of calcium carbonate, clay, and organic matter (Dyksterhuis 1946). The "barren" properties of the Fort Worth Prairie are due to the structure of shallow calcareous soils over limestone that are incapable of preserving enough moisture and have too much lime to support tree growth (Hill 1887).

In Parker and Johnson counties, south of the Trinity River, Hill (1901) described the southern boundary of the Fort Worth Prairie and the beginning of the Lampasas Cut Plain. The Lampasas Cut Plain is currently described with its northernmost boundaries immediately south of the Brazos River as the Grand Prairie begins to thin (Griffith et al. 2004) (Figure 1). The location of the Lampasas Cut Plain differs greatly in maps over the last century. More often than not, the Cross Timbers and Grand Prairie and Lampasas Cut Plain and are lumped into one vegetational area called "Cross Timbers and Prairies" (Gould 1960; Diggs, Lipscomb, and O'Kennon 1999), which is not very indicative of the landscape. For this study, the Grand Prairie (as described by Hill and Griffith et al.) is recognized as a separate entity from the Walnut Formation, and certainly the Cross Timbers, which will be discussed later.

GEOGRAPHY OF THE WALNUT FORMATION

The Walnut Formation underlies the westernmost part of the Fort Worth Prairie, parts of the Lampasas Cut Plain, and is exposed in at least 18 counties in Texas, most of them south of the Brazos River (United States Geological Survey 2010); in other counties, the Goodland, Edwards, and Comanche Peak formations remain undivided from the Walnut Formation on geologic maps (McGowen et al. 1991; Eifler 1993) making it difficult to locate outcrops. The Walnut Formation is known in Oklahoma, where it is associated with Goodland Limestone (Hill 1901), and in west Texas where it is largely associated with the Edwards and Comanche Peak formations, such as on Double Mountain in Stonewall County (Eifler 1993).

It is in the Lampasas Cut Plain where Hill describes the most representative portion of the Walnut Formation, the Walnut Prairie; here the Walnut is much better exposed (Griffith et al. 2004; Hill 1901). Kendall's (1845) expedition across the southwestern prairies implies that there is a change in the ecology of the Grand Prairie, making the Brazos River an ideal southern boundary due to the vast size of the formation. McGowen et al. (1987) also show the Walnut Formation to be much more exposed south of the Brazos River in the Lampasas Cut Plain. Unfortunately, the scope of this project does not allow for a detailed analysis of what Hill described as the most representative portion of the Walnut Formation, as the southern boundary for this project is the Brazos River. For the purposes of this research, the targeted area of the Walnut Formation lies between approximately -97° 15' and -98° West and within 32° 15' and 34° North within the study area. The Walnut Formation extends much further west and south beyond the borders of the study site (Figure 1).

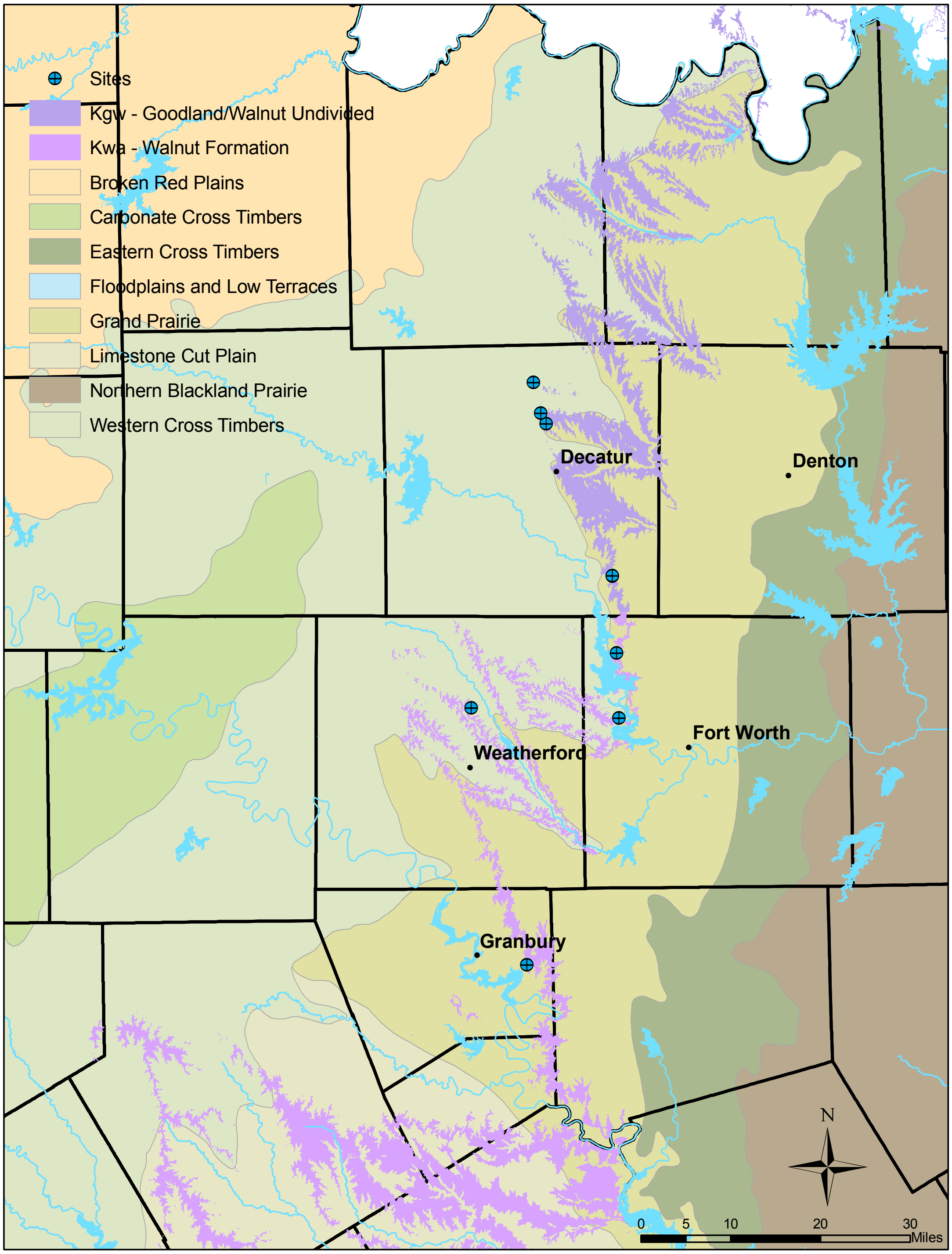

Figure 1. The Walnut Formation in relation to the Level IV Ecoregions of Texas as described by Griffith et al. 2004. Data from TNRIS and the EPA.

The Grand Prairie lies directly in between the Eastern and Western Cross Timbers. The Walnut Formation is primarily a part of the Grand Prairie and its outlying edges to the west appear to intersect the Western Cross Timbers (Griffith et al. 2004). When studied on a smaller scale, the vegetational structure of the Walnut flora aligns more with the Fort Worth Prairie, and the underlying, deeper-soiled, Paluxy and Antlers sandstones support the woodland vegetation of the Western Cross Timbers. The better-known Blackland Prairie begins just east of the Eastern Cross Timbers near Dallas, Texas.

The Cross Timbers lay both east and west of the Grand Prairie in North Central Texas. The Western Cross Timbers are immediately adjacent to the Fort Worth Prairie to the west, and thus the Walnut Formation. The Western Cross Timbers are strips of woodlands over fine red sand intermixed with occasional prairie or glade openings (Tharp 1939; Kendall 1845; Francaviglia 2000; Harris 2008). The arenaceous and siliceous mildly acidic alfisols of the Western Cross Timbers create a matrix that tree roots can penetrate with adequate water storage (Hill 1887; Sims and Risser 2000; Dyksterhuis 1948; Harris 2008). *Quercus stellata* (post oak) and *Quercus marilandica* (blackjack oak) are the dominant trees (Tharp 1939; Dyksterhuis 1948) interspersed with elms, hackberries, and greenbriars (Kendall 1845; Hill 1887; Harris 2008). Author Washington Irving described these woodlands as “forests of cast iron” due their hardiness and density (Francaviglia 2000). The adaptations of post and blackjack oaks to moderate drought allows them to expand further westward than most other trees of the Eastern deciduous forest (Tharp 1939).

The Red, Trinity, and Brazos Rivers are the principle waterways, excluding lakes, which cross through the Walnut Formation, the Brazos being the southern boundary for the study site and the Red River the northern boundary. Several tributaries of the Trinity River run through the northern part of the Walnut exposures within the study area.

Tarrant County receives an average of 34.01 inches of rainfall per year decreasing to the West. The first freeze occurs around November 17th each year and the last freeze around March 15 (Alvarez and Plocheck 2011).

GEOLOGY OF THE WALNUT FORMATION

The Walnut Formation, mapped as Walnut Clay, is part of the Lower Cretaceous Fredericksburg Group that formed during the Comanchean period 103 million years ago. It is largely composed of limestone and shale and is about 23 meters thick in Parker and Tarrant counties (Scott et al. 2003). It thins inland, north, and west, merging with the Paluxy and Antlers formations (Hill 1901). The Walnut Formation overlays the Paluxy Sandstone south of Decatur, Texas; north of Decatur the Antlers Formation is beneath it. The Glen Rose Formation defines the Paluxy Formation; however, it is absent north of Decatur. This forces the recognition of the Antlers Sands underlain by the Twin Mountains Formation (McGowan et al. 1987; McGowen et al. 1991). The Goodland Limestone overlies the Walnut in Parker and Tarrant counties and is undifferentiated from the Walnut on geologic maps in Wise and Montague counties. In Hood, Johnson, and Somervell counties, nearer the Brazos, the Goodland thins, the Walnut expands, and Comanche Peak and Edwards limestones are exposed as the overlying formations. In the rest of Texas, the Glen Rose Limestone is the underlying formation instead of the Paluxy and Antlers sandstones (Figure 2). This has been described as an unconformity because “the Paluxy was deposited in a regressive sea, which readvanced over the land, depositing the Walnut Formation” (Sellards, Adkins, and Plummer 1932).

The Goodland, Comanche Peak, and Edwards formations are less eroded and chalkier than the heavily eroded yellows and browns of the Walnut Formation, helping distinguish them visually (Hill 1901). Quaternary, alluvial, and fluvial deposits above the

Paluxy Sandstone make up the bulk of geology in lake and river valleys adjacent to upland Walnut exposures (Eifler 1993; McGowen et al. 1987; McGowen et al. 1991).

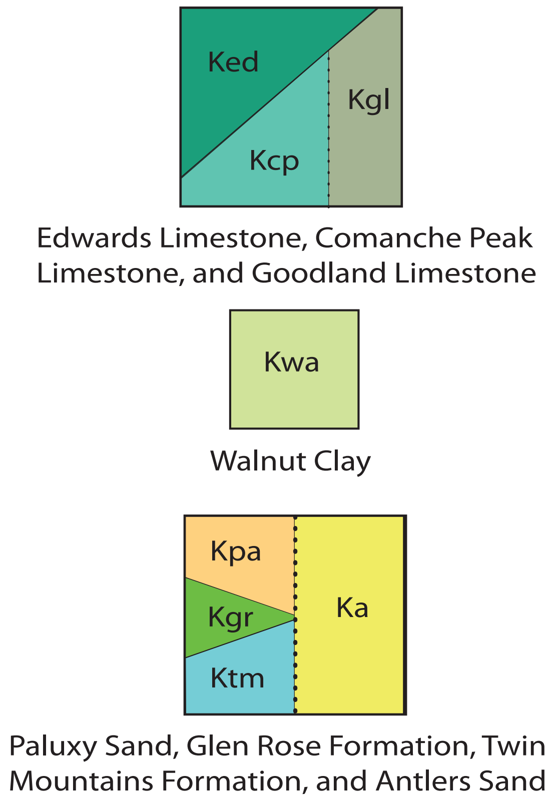

Figure 2. The stratigraphy of the North Central Texas Walnut Formation showing the Edwards, Comanche Peak, and Goodland limestones overlaying the Walnut Clay. The Paluxy and Antlers sands and the Glen Rose limestone underlie the Walnut Formation. The stratigraphic context of the Walnut Formation in North Central Texas differs by location. In Fort Worth and Weatherford, the Walnut Formation is underlain by Paluxy Sand and overlain by Goodland Limestone. As one travels north towards Decatur, Texas, the Walnut Formation is underlain by Antlers Sand and overlain by Goodland Limestone. South towards Granbury, Texas, the Walnut is underlain by Paluxy Sand and overlain by Comanche Peak Limestone. South towards Austin, Texas, the Walnut Formation is underlain by Glen Rose Limestone and overlain by Edwards Limestone. This diagram serves to give a broad overview of the Walnut Stratigraphy on a regional scale. This diagram does not include a small enough scale to denote the interbedded limestone and marl (shale) layers of the Walnut Formation.

Hill (1901) described the Walnut Formation as clay and nonchalky limestones making up the base of the Fredericksburg Division consisting of “alternations of calcareous laminated clays, weathering yellow on oxidation, semicrystalline limestone flags, and shell agglomerate… In places they weather into rich black soils and make extensive agricultural belts" (Hill 1901), which are likely mollisols. Fossilized oyster shells (*Texigryphaea)* are found cemented in the formation. Outcrops appearing to contain only *Texigryphaea* are reminiscent coquina storm beds. Fresh exposures are blue in color and weather cream to yellow and olive in flaggy layers. Marls between limestone layers are deep, calcareous, and suited for agriculture. The limestone beds of the Walnut are easily recognizable as coquinas dominated by *Texigryphaea*. The base of the Walnut consists of calcareous clays intercalated with cemented limestone (Hill 1901).

The nature of the Walnut Formation developed through the influence of marine sedimentation in the Lower Cretaceous when the Gulf of Mexico spread inland covering Texas. The Lower Cretaceous formations tend to be some of the largest regional formations where they extend from mountainous boundaries in Oklahoma and Mexico. Deposited along belts through marine influence, the harder limestones of the Lower Cretaceous formations, such as the Walnut Formation, alternate with clay and overlie sands creating dip and cut plains as well as low escarpments carved by erosion (Hill 1901).

The Walnut Formation is unique in its diversity of exposed geology and the diversity of modern habitats this creates. There are layers of deep clays, hard limestone glades, and shallow barrens soils derived from marls and shell fragments. Seeps are also abundant in the formation on barrens and on slopes, where they often interact with the underlying sands. Slope seeps frequently occur where water flows through fractured limestone and meets less permeable shale or marl layers (Burgess 2010). The perched water table flows laterally over the shale, emerging as a seep where the stratum is exposed (Llado 2011) (Figure 3).

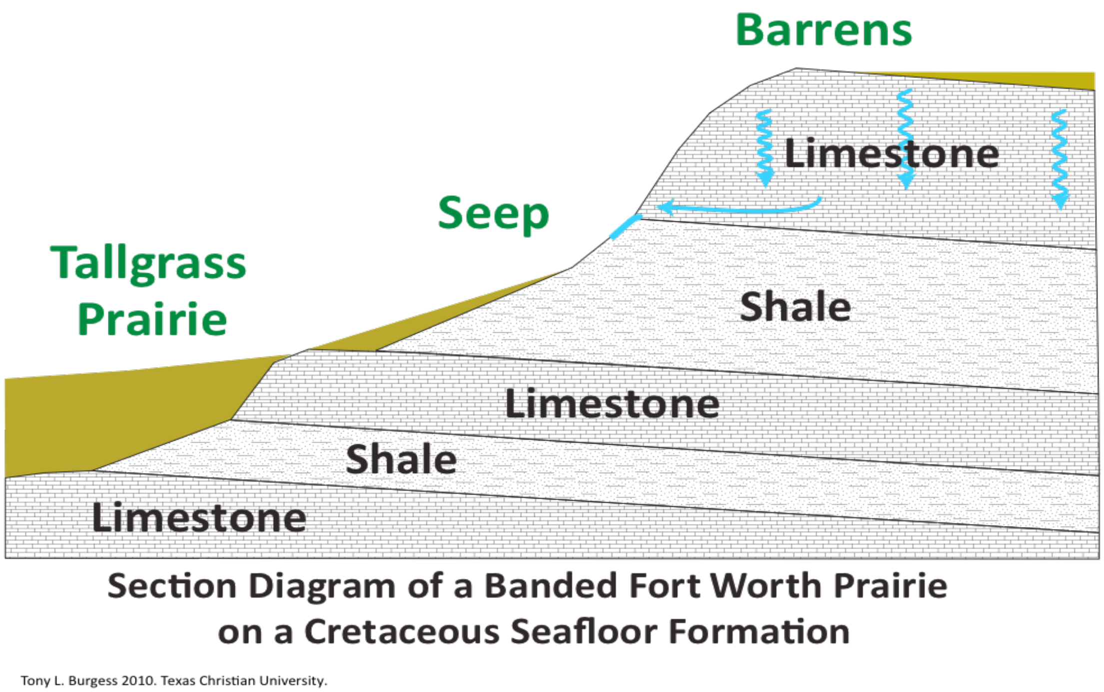

Figure 3. Cross section diagram of the Fort Worth Prairie, from Burgess 2010.

METHODS

Vascular plants were collected on the Walnut Formation north of the Brazos River for two growing seasons. Special attention was paid to the adjacent geological formations. The contacts with the overlying Goodland Limestone were collected, as were the Paluxy and Antlers sandstones. Interesting plant associations occur on slopes below Walnut outcrops, where colluvial deposits of marl and shell hash cover Paluxy and Antlers sands. Here the alkaline soils interact with the sand, extending the range of the prairie limestone flora downslope into the Western Cross Timbers

Geologic maps printed by the Texas Bureau of Economic Geology were used to identify approximate boundaries of the Walnut Formation. The Dallas sheet (McGowen et al. 1987) covers the area just north and south of the Brazos River that contains Parker, Tarrant, Johnson, and Hood counties. The Sherman sheet (McGowen et al. 1991) covers Wise and Montague counties directly north from the Dallas Sheet; however, the Goodland Limestone and Walnut Formation are undivided on this map. Select sites located primarily on the basis of a vouchered collection of *Dalea reverchonii* where the map showed the Goodland/Walnut undivided overlying the Antlers Sandstone were visited to determine the presence or absence of the Walnut Formation in Wise and Montague counties. Tarrant, Parker, Wise, Johnson, and Hood counties contained the study sites for the purposes of this thesis. The presence of Walnut was determined by outcrops and the presence of *Texigryphaea* in the surface rocks.

The Walnut Formation was identified using geologic maps and by locating outcrops. First, sites of interest were located by using geologic maps and then public areas were sought out containing the Walnut Formation. As public parks spanned a broad north-south gradient, fewer private lands were required. GIS maps were created showing the Walnut Formation overlaid with county streets. From there, stretches of road were sought out with high percentages of Walnut Outcrops. Properties of friends and colleagues living near areas containing Walnut Formation were examined for potential sites.

Voucher specimens were collected in triplicate, when possible, pressed in a plant press and dried for preservation. The specimens were identified primarily using *Shinners and Mahler's Illustrated Flora of North Central Texas* (Diggs, Lipscomb, and O'Kennon 1999) and identifications confirmed with existing herbarium specimens at the Botanical Research Institute of Texas (BRIT). Most taxonomic nomenclature follows that of Diggs, Lipscomb, and O'Kennon (1999). For taxa found to occur in North Central Texas after 1999, *Flora of North America* and various other publications (Kiger 2004; Nesom 2006; Smith et al. 2003; Estes and Small 2007) were consulted. Experts consulted include Tony Burgess (TCU), Bob O'Kennon, Barney Lipscomb and Amanda Neill (BRIT) and Dwayne Estes (APSC). Data collected with each specimen include the date, soil type, habitat description, associated plants, species abundance, images of the plant and its habitat, locality, and GPS coordinates. References to protocol include Neill and Wilson (2000), Diggs et al. (1999), Jennings et al. (2009), and Davis (1961). The data and images were imported into Atrium (BRIT Digital Herbarium 2011), an online biodiversity information system. GIS maps were developed for the study sites and visible in Atrium as accessible archives. Specimens will be mounted on archival quality paper and housed in the

Botanical Research Institute of Texas Herbarium. Duplicates will be shared with other institutions.

A full checklist of the flora was created, the data analyzed, habitat types were defined, and dominant species were determined. The flora was analyzed for rare or endemic taxa, invasive or potentially invasive species, and disjunct taxa.

RESULTS AND DISCUSSION

Plant collections from the North Central Texas Walnut Formation resulted in 616 collections. The flora consists of 437 taxa with 423 species in 268 genera and 79 families. The largest three plant families being Poaceae, Asteraceae, and Fabaceae. A further breakdown of the flora is provided in Table 1.

Fourteen habitat types were recognized on the Walnut Formation: aquatic – emergent, floating, submerged (AQ), barren (B), dry glade (DG), eroding hillslope (EH), limestone glade seep (SG), hill slope seep (HS), lawn (L), limestone scrub woodland (LSW), mixed grass hillslope (HS), pond edge (P), roadside (R), Walnut-sand contact (SW), woodland (W), and xeroriparian woodland (XR). Few species are ubiquitous across multiple habitats; most species are very locally adapted to one particular habitat within the Walnut Formation.

Table 1. Distributional summary of the North Central Texas Walnut Formation

Taxa	Families	Genera	Species
Ferns & Allies	2	2	2
Gymnosperms	1	1	3
Dicots	66	204	312
Monocots	10	61	106
Total	79	268	423

Major Vegetational Habitats

The vegetation aligned almost perfectly with geological and pedological boundaries within the Walnut Formation. Soil depth and type was best indicated by vegetation structure and albedo. As soil depth decreased, there was a strong correlation with light intensity as the canopy cover decreased (Figure 8). There is one exception; a limestone scrub woodland found on north-facing slopes. Glades, barrens, woodlands, mixed grass prairies, and seeps are the dominant habitats and species dominance and composition strongly aligns with habitat structure. While these may not be mappable units as defined by the Ecological Society of America Vegetation Classification Panel (2011), these associations are certainly patterns that were consistently encountered throughout the North Central Texas Walnut Formation.

Dry Glade:

Slim Tridens – Purple Threeawn – Woolly Fluff Grass – Prairie Clover Association/ *Tridens muticus – Aristida purpurea* var. *nealleyi – Erioneuron pilosum – Dalea* spp. Association

Glades are open areas of exposed limestone outcrops and rocky areas with soils less than 2-4 inches deep. *Texigryphaea* fossil shell fragments usually dominate rocky areas over very thin soils. The most common soils are clayey upland paralithic entisols in the Maloterre Series (Ressell 1981). Frequently found on ridge tops and next to incised stream channels, glades are quite extensive and are characteristic landscape features on the Walnut Formation. Glades are open areas free of trees, except for occasional mottes, with shallow soils incapable of retaining much water. Plants typically establish their roots in limestone cracks or are extremely shallow-rooted. The glades are a distinct habitat of specialized, frequently endemic plants. Few plants are weedy or characteristic of ruderal habitats. Glades traditionally are considered climax communities (Jones 2004; Baskin and Baskin 2003) because they do not burn easily. Walnut Glades are dominated by perennial bunch grasses in limestone cracks such as *Schizachyrium scoparium, Tridens muticus*, *Aristida purpurea*, and *Erioneuron pilosum;* annual grasses such as *Sporobolus ozarkanus*, herbaceous dicots such as *Dalea reverchonii, D. tenuis*, *Lesquerella engelmannii,* scattered succulents including *Opuntia phaeacantha, Coryphantha sulcata, Escobaria missouriensis,* and various non-vascular plants, the most notable being *Nostoc commune* (Figure 4). *Muhlenbergia reverchonii* is a dominant bunch grass on wet glades.

Figure 4. Dry glade on ridgetop mesa at LBJ Grasslands Unit 32. Taller bunchgrasses dominate the limestone cracks where soil has formed and perennial herbs, small bunchgrasses, and succulents dominate the shallow soiled glades.

Dry glades tend to be present on ridgetops or upslope of glade seeps where the soil is well drained. Water pools on glade seeps, and soil is deeper downslope of glade seeps where water picks up speed as it flows down the glade, especially with an absence of vegetation and soil to allow water to infiltrate.

Comanche Peak Prairie Clover – Rock-Pink – Rock Sandwort Association

***Dalea reverchonii – Phemeranthus calycinus – Minuartia michauxii* Association**

In less disturbed sites, this association occurs where soil has been thinned by erosion on the upslope side of a limestone expanse, and where shallow soil has started to accumulate on the downslope side of a glade. This interesting glade association is not locally extensive, but is widespread among glades and may be more appropriately called a sub-association; however, when present the association is distinctive and recognizable on extremely shallow, clayey soils bordering expanses of bare limestone. *Nostoc commune* and *Sedum nuttallianum* are very common in these associations. This community of the characteristic species *Dalea reverchonii, Phemeranthus calycinus, and Minuartia michauxii* var. *texana* appears to be more of a seral community, sometimes occurring where topsoil has been scraped from the limestone bedrock (Figure 5). Topsoil scraping has occurred at both the Utley Prairie and the New Highland Road sites.

Figure 5. *Phemeranthus calycinus* (left)*, and Minuartia michauxii* var. *texana* (right) glade community. These species inhabit shallow-soiled glades with *Nostoc commune* and *Sedum nuttallianum. Dalea reverchonii* is not present in this photo.

Barrens:

Little Bluestem – Prickly Pear – Pale Yucca Association

***Schizachyrium scoparium – Opuntia phaeacantha – Yucca pallida* Association**

Glades are often surrounded by barrens or areas of locally thin soils, at least 5-25 cm deep with small patches of exposed bedrock and cryptogamic crusts. Dominated by bunch grasses, *Schizachyrium scoparium, Muhlenbergia reverchonii* (on wetter sites), *Aristida purpurea, Bouteloua pectinata, B. hirsuta*, *Opuntia phaeacantha,* and *Yucca pallida* are the typical species in this habitat; various herbaceous perennials, winter and summer annuals are also present. Barrens have deeper soils incapable of supporting larger woody species; trees are very uncommon, but mottes of *Quercus fusiformis*, *Rhus* spp., *Juniperus* spp., *Ulmus crassifolia*, and *Forestiera pubescens* are common and provide a habitat for vines and sciophytes, thus supporting a unique microhabitat. *Schizachyrium scoparium* and *Yucca pallida* tend to occur on sloping sites with good drainage where the limestone is more deeply weathered.

Prickly Pear – Indian Blanket – Gayfeather – Slim Tridens Association

***Opuntia phaeacantha – Gaillardia pulchella – Liatris mucronata – Tridens muticus* Association**

Found on upland barrens, the association is quite common in shallow soil over limestone. It occurs on more level sites where limestone is less deeply weathered than sites with *Schizachyrium scoparium. Opuntia phaeacantha* and *Gaillardia pulchella* are common indicators occurring with various dominant bunch grasses (Figure 6). *Liatris mucronata* and *Tridens muticus* are also both common; one usually is more common than the other depending on the site. Other typical species include *Nassella leucotricha, Panicum hallii, Thelesperma filifolium, Monarda citriodora,* and *Panicum oligosanthes.* Down slope from this association *Muhlenbergia reverchonii* dominates where water accumulates.

Figure 6. *Gaillardia pulchella, Opuntia phaeacantha* barrens with *Monarda citriodora.* Barren adjacent to a glade (right background) and a motte (left background)

Little Bluestem – Pale Yucca – Hairy Grama – Three-Awn Association

***Schizachyrium scoparium – Yucca pallida – Bouteloua hirsuta – Aristida purpurea* Association**

Found on mid to low slopes typically in marls, where the soil appears to be more clayey than typical Walnut loams, *Schizachyrium scoparium, Yucca pallida, Aristida purpurea* var. *nealleyi,* and *Bouteloua hirsuta* dominate (Figure 7). *Liatris mucronata, Aristida purpurea, Hedyotis nigricans, Glandularia bipinnatifida, Asclepias asperula,* and *Marshallia caespitosa* are common plants found in this association. While still considered barrens, these communities frequently border seepy areas or woodlands dominated by *Quercus buckleyi*.

Figure 7. *Yucca pallida* with *Schizachyrium scoparium* and *Hedyotis nigricans* in barren in Rhome, Texas

Seep (Hillslope and Limestone Glade Seeps):

Seep Muhly – Spikerush – Small-Tooth Caric Sedge Association

***Muhlenbergia reverchonii* – *Eleocharis* spp. – *Carex microdonta* Association**

Seeps are frequently found on hillslopes where water flows through fractured limestone, hits an impervious shale layer, begins flowing horizontally, and seeps out on hillsides. Frequently dominated by *Muhlenbergia reverchonii*, Dyksterhuis (1926) called them Muhly Benches. Limestone Glade Seeps are also found on limestone glades below Goodland Limestone where water percolates down and hits impervious Walnut

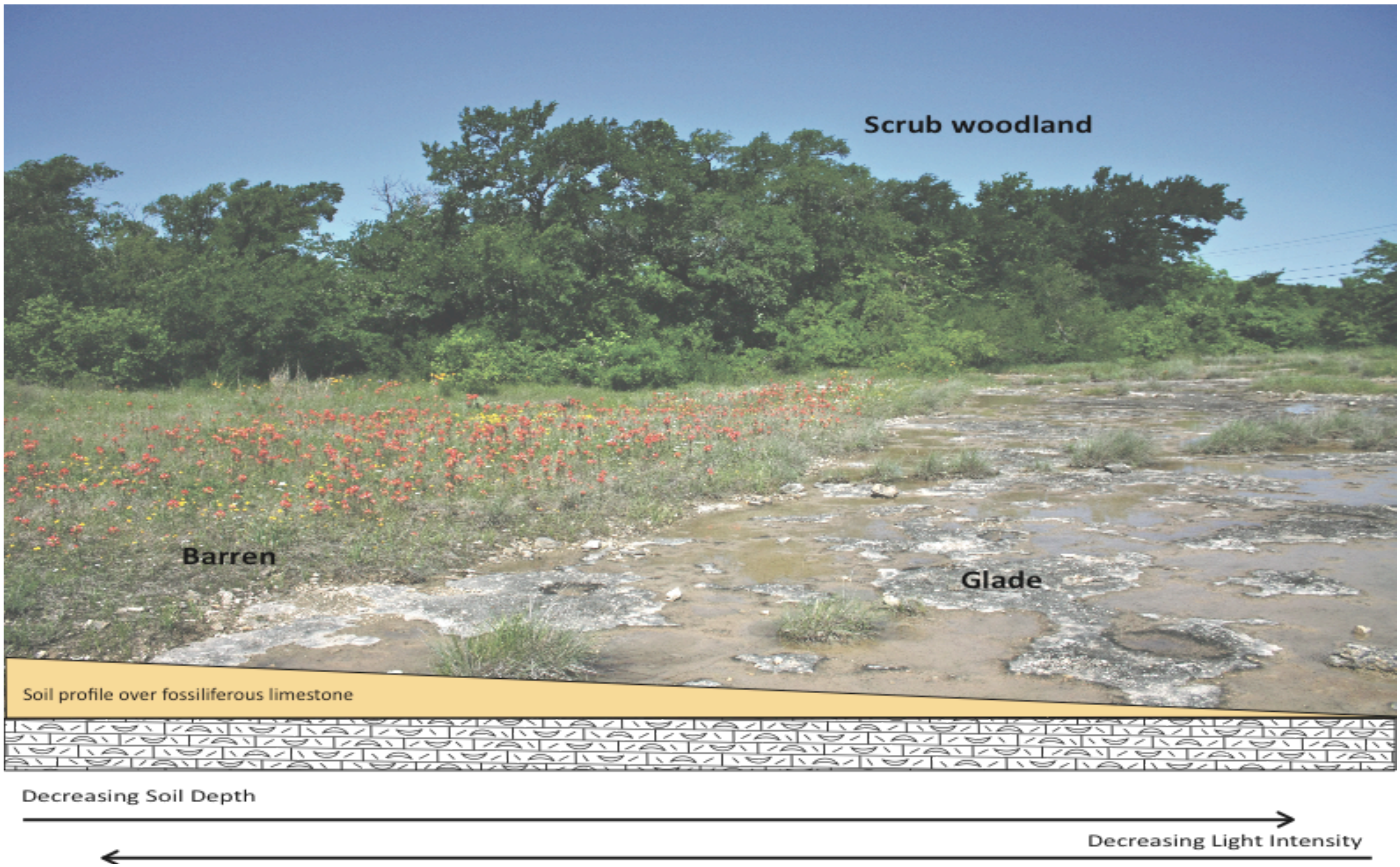

Figure 8. Rhome, Texas site south of Highway 114, west of Highway 287: soil depth as it relates to light intensity in a typical Walnut Formation landscape.

Limestone and begins flowing horizontally until it seeps. Glades also have much slower infiltration rates because of the virtually impermeable limestone and so water collects on top of glades in the Spring.

Seeps are the primary location for riparian vegetation on the Walnut Formation. most large rivers and significant creeks cut through sand formations and deposit alluvium, therefore typical riparian vegetation was not found on the Walnut. While the species composition is somewhat different when comparing hill slope seeps to limestone glade seeps, some dominant species are shared. Sedges such as *Eleocharis occulta*, *E. montevidensis*, and *Carex microdonta* may be co-dominant. *Carex microdonta* is usually on hillslope seeps, but not on Limestone Glade Seeps. *Allium* spp., *Muhlenbergia reverchonii,* and *Tridens albescens* are also quite common. *Tridens albescens* can be found on Limestone Glade Seeps where water pools long enough to grow algal mats. When it occurs with *Muhlenbergia reverchonii*, it grows on wetter sites and seems to tolerate prolonged flooding better than *M. reverchonii.* The presence of *Muhlenbergia reverchonii* is often quite dependent on the amount of disturbance to the seep. Jue (2011) also noticed this on Duck Creek Limestone where *M. reverchonii* was absent from seeps near social trails, where footpaths had removed vegetation. *Rhynchospora nivea* may be locally dominant on hillslope seeps in the Paluxy or Antlers sandstones just beneath the contact with the Walnut Formation, in calcareous sandy clay loam.

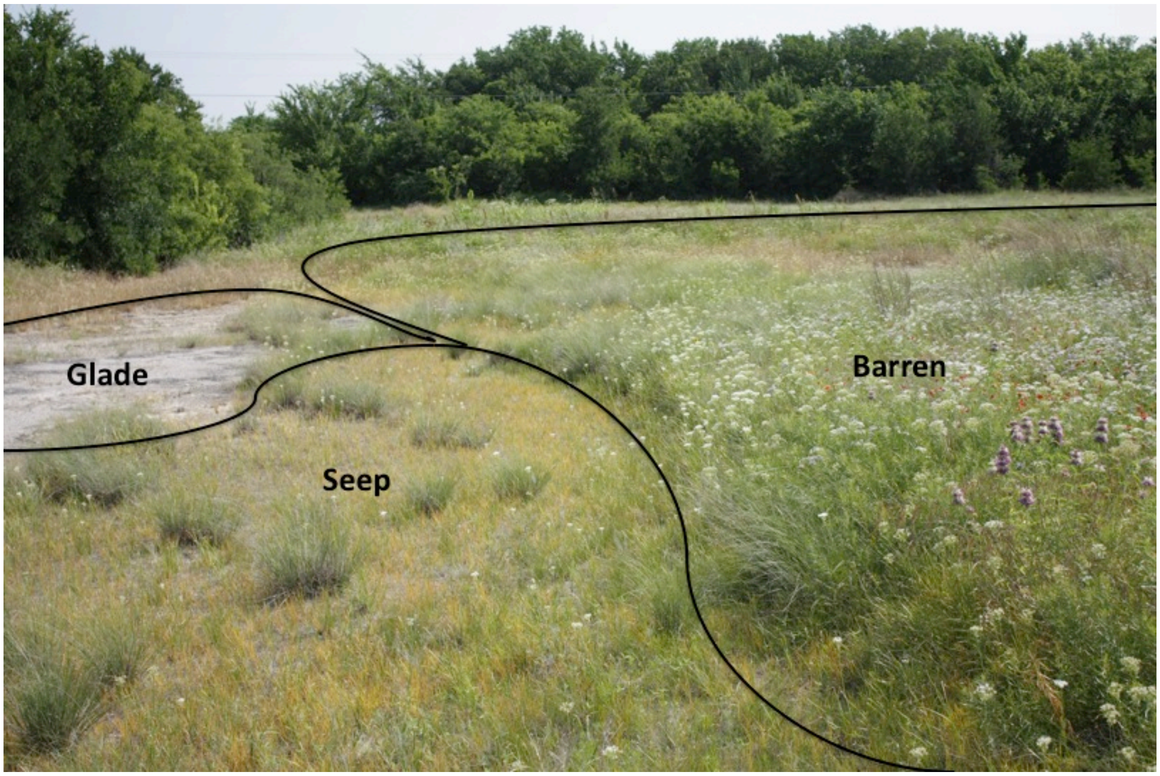

Figure 9. Seep adjacent to a limestone glade with shallow soil. The seep appears flat but comes out at the base of a shallow hillslope below Goodland Limestone. *Carex microdonta* is abundant before flowering (yellow/orange color, pre-anthesis) with *Muhlenbergia reverchonii.*

Mixed Grass Hillslope:

Little & Big Bluestem – Indian Grass – Grama Grass Association

***Schizachyrium scoparium – Andropogon gerardii – Sorghastrum nutans – Bouteloua* spp. Association**

Mixed grass prairies are found on lower on hill slopes and footslopes where the soil is deeper. The "big four" tall grasses (*Schizachyrium scoparium, Andropogon gerardii, Sorghastrum nutans*, and *Panicum virgatum*) are generally present, as well as shorter species of grama grass, small shrubs, and trees. These foot slopes are predominately Sunev Soil footslopes where the soils are mollisols and are deeper because the underlying geology is sand instead of limestone (Ressell 1981).

Limestone Scrub Woodland:

Texas Red Oak – Cedar Elm – Sugar Hackberry – Redbud – Texas Ash Association

***Quercus buckleyi – Ulmus crassifolia – Celtis laevigata – Cercis canadensis – Fraxinus texensis* Association**

Limestone scrub woodlands are generally found near ridge tops of north-facing slopes, often on Walnut Formation outcrops where soil is locally thin with a significant duff layer and tree roots persist in old limestone cracks. Common trees include *Quercus buckleyi, Ulmus crassifolia, Celtis laevigata, Cercis canadensis,* and *Fraxinus texensis. Quercus fusiformis* is also frequently present, though often not dominant. Shrubs include *Ungnadia speciosa, Forestiera pubescens, Rhus trilobata,* and *Cornus drummondii.* Vines such as *Smilax bona-nox*, *Funastrum crispum, Vitis* spp., and *Ibervillea lindheimeri* are typical in these habitats. *Carex planostachys* is commonly the only bit of green mixed in with duff on the forest floor, except around forest edges where *Opuntia phaeacantha, Yucca pallida*, and *Schizachyrium scoparium* border the woodland (Figure 10). The Ecological Society of America Vegetation Classification Panel (2011) has listed many similar associations in the Edwards Plateau Region of Texas and the Arbuckle Mountains of Oklahoma on mesa tops underlain by limestone; though the vegetation panel has not yet accepted many of these associations. With plot data from plant communities on Walnut Formation, more associations could be proposed.

A few habitats are more appropriately described as xeroriparian woodland where water was concentrating and alluvial soils were present in a canyon. Water may seldom flow through the canyon, but more typical riparian or hydrophilic vegetation was found. This was vegetation was found in a small canyon at the Fort Worth Nature Center and Refuge. Xeroriparian vegetation includes *Celtis laevigata, Ulmus crassifolia, Tridens flavus, Frangula caroliniana,* and *Pellaea atropurpurea.*

Roadsides and lawns provided a typical weedy flora. Typical species included *Lamium amplexicaule, Sherardia arvensis, Medicago minima, Bromus catharticus, B. japonicus, Ambrosia trifida, Ipomoea cordatotriloba, Sorghum halepense,* and *Bothriochloa ischaemum* var. *songarica.*

Comparison with the Walnut Formation South of the Brazos River

For the most part, similar habitats were observed north and south of the Brazos River. It was not within the scope of this project to do a full comparison of the different habitats. The most obvious difference in the flora of the southern Walnut Formation was the addition of many species that are more common in the Edwards Plateau region than in North Central Texas. A few trips were made to a Walnut Limestone site outside of Hico, Texas, and vouchers were collected. Plants collected south of the Brazos River that were not collected north of the Brazos River are *Melampodium leucanthum* and *Thelesperma simplicifolium.* Though uncommon, both of these species have been found elsewhere in North Central Texas, but were not collected on the northern Walnut Formation during this study.

Figure 10. Limestone scrub woodland dominated by *Quercus buckleyi* and bordered by *Yucca pallida* and *Sporobolus compositus*.

Lyday's (1989) descriptions of plant associations of the Edwards, Walnut, and Glen Rose formations in Hays County, Texas, on the Edwards Plateau ca. 340 km from Fort Worth, was used for a simple comparison of the northern and southern portions of the Walnut Formation. Hays County appears to have a very different species composition compared to the site outside of Hico, which is 165 miles north of Hays County. Lyday found *Yucca rupicola, Rhus virens, Garrya ovata, Juglans major, Berberis* *trifoliata, Passiflora lutea,* and *Opuntia lindheimeri* on the Walnut Formation in Hays County; these species were not documented on the northern portion of the Walnut Formation during this project, but some species may be present elsewhere locally. Notably, Lyday did not encounter *Quercus fusiformis* or *Ulmus crassifolia,* two dominants on the North Central Texas Walnut Formation, and found *Juniperus ashei* and *Quercus buckleyi* to be the dominant woody species on the Walnut Formation in Hays County.

Unique Sites

The major disturbances on the Walnut Formation are suburban development, cattle grazing, and quarrying. The most development is concentrated near Weatherford and Decatur, Texas, but urban sprawl continues north and west of Fort Worth. Most soils of the Walnut are too shallow to support crops but cattle grazing is common. The endemic *Dalea reverchonii* is not found where cattle graze. It is found mostly on quarry sites or roadsides. These sites often have been scraped to create an anthropogenic seral glade-like habitat that creates a perfect environment for *D. reverchonii* free from cattle (Figure 11). Quarried sites have a unique flora, not fully typical of glades. These anthropogenic glade habitats have the same shallow soil, less than 2 inches deep, except open bare rock is not common. The disturbance is evident by mounds of soil dividing glade habitats, as at the Utley Property in Weatherford, Texas, or a large portion of dug out ground that is about two feet lower than the adjacent landscape, with intermittent pools of water, as at the New Highland Property.


Figure 11. *Dalea reverchonii* in flower on a glade in May 2010 at the Utley Property.

Streams are not common on the Walnut because most rivers have eroded the Walnut and occur at lower elevations with the Paluxy Formation. The only ephemeral stream on the Walnut Formation was found 0.66 km west-northwest of the intersection of Highway 287 and Highway 114 in Rhome, Texas. The stream runs underneath the Highway 114 and provides a unique flora north and south of Highway 114. The site had one of the most diverse glade complexes (Figure 12); however, unfortunately a McDonald's and Loves gas station now sit on Goodland Limestone just upslope of the glade on the south side of the road. This construction has altered the hydrology of the site and it is not clear whether the glade will return to a seep of the same caliber. This site supported *D. reverchonii, Gratiola quartermaniae, Isoëtes butleri,* and *Phemeranthus calycinus* – all rare in North Central Texas. This was the only site with

Justicia americana, Callitriche heterophylla, Helenium elegans, Gratiola quartermaniae, Cardiospermum halicacabum, and *Xanthium strumarium.*

The New Highland Site, west-northwest of the intersection of New Highland and Highland Road near Springtown is a quarry site on Walnut Limestone. Here water has concentrated forming a shallow pool or trough about 18 cm deep (on May 25, 2011) where the Walnut has been quarried about 3 meters deep. The pool supported typical Walnut Seep vegetation, as well as some unique taxa not found at other sites. The dominant species found in the pool were *Eleocharis montevidensis, E. occulta, Iva angustifolia,* and *Tridens albescens.* Found only at this site was *Eleocharis palustris.*

The Walnut Formation Compared to Nearby Ecoregions

As previously mentioned, Griffith et al. (2004) map the Walnut Formation north of the Brazos River in both the Fort Worth Prairie and the Western Cross Timbers. This study has revealed that the Walnut Formation vegetation does not have many structural aspects of the Western Cross Timbers or the Fort Worth Prairie. The Grand Prairie is underlain by limestone and is a true mixed grass prairie with *Schizachyrium scoparium*, *Andropogon gerardii, Sorghastrum nutans, Bouteloua hirsuta, Bouteloua curtipendula,* and *Nassella leucotricha* (Griffith et al. 2004). In contrast, the Walnut Formation contains shorter grasses such as *Tridens muticus, Aristida purpurea* var. *nealleyi*, *Bouteloua hirsuta,* and *Nassella leucotricha* and very patchy areas of tall grass, although

Figure 12. Rhome, Texas on the north-west side of Highway 114, 0.66 km west-northwest of the intersection with Highway 287. Limestone glade with associated seeps, barrens, and woodlands.

Schizachyrium scoparium is very abundant. *Andropogon gerardii* and *Sorghastrum nutans* are in small patches or on Sunev footslopes underlain by sand with limestone at the surface. Although tallgrass prairie is only typical on the Walnut Formation on sand with calcareous topsoil, the Walnut Formation does not appear to strongly align with the vegetation of the Grand Prairie as described by Griffith et al. (2004). Within the Grand Prairie, there are shallow soil barrens on the Goodland, Duck Creek, and Fort Worth formations that have a vegetation structure and flora resembling the Walnut Barrens. Muhly Seep and Limestone Scrub Woodlands are also very similar. Even so, the Walnut Formation hosts habitats and vegetation unlike the rest of the Grand Prairie and appears to be a unique landscape in North Central Texas.

Figure 13. LBJ National Grasslands Unit 71. Walnut Marl slumps downslope onto Antlers Sand. On left is limestone vegetation growing in sand with calcareous topsoil from the Walnut.

The Western Cross Timbers, underlain by sandstone of Paluxy, Twin Mountains, and Antlers formations, is a woodland dominated by post oak and blackjack oak (Griffith et al. 2004; Dyksterhuis 1948; Harris 2008; Hill 1887), whereas the Walnut Formation supports very few post oaks or blackjack oaks. Only three sites containing post oaks were encountered in this study.

Quercus stellata (post oak) is quite widespread in North Central Texas, but seldom found on limestone. *Q. stellata*, a dominant component of the Eastern and Western Cross Timbers in North Central Texas, was found in several sites, predominantly at the Fort Worth Nature Center and Refuge, where the soil is from the

Lindale Soil Series, an alfisol with approximately a 35% calcium carbonate percentage (Ressell 1981). An alfisol over limestone is uncommon because alfisols are generally mildly acidic (Hill 1887; Soil Survey Staff 1999). Their presence on a limestone indicates long-term soil development with leaching of calcareous minerals. The occurrence of post oak on limestone is a perfect illustration of how edaphic factors determine the vegetation of the Walnut Formation.

Floristic Comparisons

Unique floristic connections were found with Apacherian Savannas, formerly called desert grasslands, of Southwestern North America (Burgess 1995) and Cedar Glades of the Southeast United States (Norton 2010). Though not an ecotone, the Walnut Formation contains distinct characteristics of Cedar Glades and Apacherian Savannas, both structurally and floristically. Both the Apacherian Savannas and Cedar Glades contain edaphic communities that are strongly determined by soil and geology (Quarterman 1950a; Baskin and Baskin 2003; McAuliffe 1994).

A dry glade community found on limestone mesatops at LBJ National Grasslands, and occasionally on the upslope side of glade seeps where soil is well drained, consists of short grasses in shallow soil over limestone. This community resembles parts of the Apacherian Savannas in the Southwestern United States and Mexico, and contains *Tridens muticus, Opuntia phaeacantha, Panicum obtusum* (now *Hopia obtusa*), *Escobaria missouriensis, E. vivipara,* and related species in *Bouteloua* and *Erioneuron* (Burgess 2011, pers. comm.).

Cedar Glades of the Southeastern United States also have a great similarity structurally and floristically to the Walnut Glades. Cedar Glades are on limestone or dolomite from the Ordovician, Silurian, or Mississippian eras (Baskin and Baskin 2003). They are in lowland basins often surrounded and separated by rolling hills (Quarterman 1950a; Norton 2010). Soils are lacking to very shallow, and deeper in crevices where the rock has cracked vertically (Quarterman 1950). Glades are dominated by annual grasses, perennial herbaceous dicots, mosses, *Nostoc commune,* and various lichens (Baskin and Baskin 2003). *Juniperus virginiana* (Eastern Red Cedar) is the dominant shrubby vegetation surrounding the glades (Norton 2010; Quarterman 1950b) (Figure 14).

Figure 14. Sunnybell Cedar Glade in the Central Basin of Middle Tennessee in Rutherford County. Photo used with permission from Kimberly R. Norton.

The Walnut Glades and glade-like habitats west of the Mississippi River are not considered true Cedar Glades because they differ floristically (Norton 2010). Both habitats are hyperseasonal, with plants adapted to an extreme wet and extreme dry season (Norton 2010), thus having very different seasonal aspects during the year. In Muhly Seeps on the nearby Duck Creek Formation of North Central Texas, the soil is often saturated for weeks during Spring, in Summer gets so dry that soil moisture is below permanent wilting point (Llado 2011). Dormancy mechanisms allow plants to persist through both saturation and drought (Quarterman 1950a). The clays in the Walnut Formation will amplify the wet and dry seasons, as more water can be stored in clays (Burgess 1995). As with Cedar Glades, Walnut Glades all have a slightly different species composition due to geographical and structural variations (Baskin and Baskin 1996). Many species on Walnut Glades are also found on Cedar Glades, such as *Nostoc commune, Sporobolus vaginiflorus*, *Nothoscordum bivalve, Heliotropium tenellum, Croton monanthogynus, Oenothera macrocarpa, Hedyotis nigricans, Isoëtes butleri, Dichanthelium acuminatum,* and *Gratiola quartermaniae.* Related species include *Manfreda virginica* in Cedar Glades versus *Yucca pallida* on the Walnut Formation, *Opuntia humifusa* versus O. *phaeacantha*, *Dalea gattengeri* versus *D. reverchonii* and *D. tenuis*, *Phemeranthus calcaricus* versus *Phemeranthus calycinus, Eleocharis bifida* versus *E. occulta* and *E. montevidensis, Minuartia patula* versus *M. michauxii,* and *Sedum pulchellum* versus *S. nuttallianum* (Jones 2005; Quarterman 1950; Norton 2010; Baskin and Baskin 2003).

George (1987) did a brief comparison between eastern Cedar Glades and the Weches Formation in East Texas. The Weches is a limestone formation that is very isolated floristically because it is surrounded by sand and arenicolous species. The

Weches Formation receives annual precipitation similar to Cedar Glades. George found shared species between the Weches formation and Cedar Glades, the most notable being *Leavenworthia texana* and *Sedum pulchellum. Leavenworthia texana* is the only species of the genus in Texas and is restricted to deep East Texas. It is endemic to Texas; however, its relatives are dominant on Cedar Glades, mapped by Baskin and Baskin (2003). *Sedum pulchellum* is more widespread but is not found further west than East Texas. It appears that the Weches Formation and the Ozark Glades could serve as a bridging habitat between eastern Limestone Cedar Glades and Walnut Glades.

Soils and plant communities

Soils orders on the Walnut Formation are very indicative of plant communities. Entisols generally make up glades, where soils are very new and not developed and an A horizon is minimal. Inceptisols and mollisols generally make up barrens and mixed grass prairies. Inceptisols have much more sparse vegetation and still very weak profiles. Mollisols are deep well developed soils that are still calcareous over limestone. Mollisols are extremely fertile soils frequently used for agriculture in North America. They have a well developed A horizon, a mollic epipedon and support deeper soiled barrens and mixed grass prairies. Alfisols are mildly acidic clays that are less fertile than mollisols. Their presence over limestone indicates that calcareous topsoil has leached over time resulting in an E horizon instead of a B horizon with an ochric epipedon and an accumulation of clay. Alfisols on the Walnut Formation support actual woodlands with

Quercus stellata, which is generally only found on sand formations in North Central Texas, versus limestone scrub woodlands.

Range Extensions, Invaders, and Endemic Taxa

Exotic invasive species were denoted using the Texas Invasives database (Texas Invasives 2011). Exotic invasive species were sparse on the Walnut Formation. Due to the harsh dry conditions, most species found on the Walnut Formation are adapted to the hyperseasonal conditions and because of this, few invasive species are common. Found in barrens and roadsides, *Bromus catharticus*, *Bromus japonicus*, *Bromus tectorum,* and *Bothriochloa ischaemum* var. *songarica* are common competitors with the native prairie grasses. *Sorghum halepense* was only found at two sites in seeps, at the Utley Prairie, and at intermittent streams near the roadside in Rhome where water was plentiful; however, it was a dominant on roadsides. The seep population was found at the Utley Property and was infected with a fungus. *Arundo donax* was found at one site (New Highland) in a very disturbed quarry near a deer blind. *Carduus nutans* ssp. *macrocephalus* was found as a roadside weed at only one site in Weatherford and has since been removed by the property owner. *Ligustrum quihoui* was common on barrens at the Fort Worth Nature Center and Refuge, but uncommon elsewhere on the Walnut Formation. *Nandina domestica* was found only at the Fort Worth Nature Center and Refuge in a riparian canyon. *Vitex agnus-castus* was only found at the Eagle Mountain Lake Park, with other persisting homestead plants such as *Lantana* sp. and *Jasminum floridanum*.

Two seep dwellers were found new to North Central Texas in this study. *Gratiola quartermaniae* is endemic to rock outcrops in Tennessee, Alabama, and Central Texas (Estes and Small 2007). *Isoëtes* specimens previously collected were thought to be *I. melanopoda,* but scanning electron microscopy revealed that *I. butleri* is actually prevalent in North Central Texas, known previously only from the Edwards Plateau in Texas and elsewhere in the United States.

Phemeranthus calycinus, previously *Talinum* (Kiger 2001) was found quite abundantly in very shallow soil on the edge of glades. The specimens collected on the Walnut were identified using the *Flora of North America* (Kiger 2004), which distinguishes *Phemeranthus calycinus* (sepal length 4 - 6 mm., petal length 10 – 15 mm.) from *Phemeranthus calcaricus* (sepal length 3 – 4 mm., petal length 8 – 10 mm.). The specimens collected (S 387 and 625) both had sepal lengths of 3 mm and petal lengths of closer to 12 mm, though collection S 746 had a petal length of about 9 mm. As *Phemeranthus calcaricus* is endemic to Cedar Glades of Tennessee and Kentucky, the collections were originally identified as *Phemeranthus calycinus*, which is known to grow in North Central Texas and adjacent states. When compared with herbarium specimens from the BRIT collection, which is strongest in North Central Texas, and the Vanderbilt collection, which is strongest in Tennessee and Alabama collections and contains the isotype for *Talinum calcaricum* [Tennessee: Davidson County: 21 August 1966. S. Ware 215 (VDB)] the specimen actually more closely resembles *P. calcaricus*. The author believes that these may actually be varieties of a single species and further studies need to be conducted in order to understand the distribution and variation between these two taxa, especially considering the similarity of their habitats.

Texas and Oklahoma regional endemics found on the Walnut Formation are *Echinacea atrorubens, Silphium albiflorum, Lesquerella densiflora, Ibervillea lindheimeri, Dalea reverchonii, Dalea hallii, Dalea tenuis, Lupinus texensis, Pediomelum cyphocalyx, Pediomelum hypogaeum* var. *scaposa, Pediomelum latestipulatum, Pediomelum reverchonii, Fraxinus texensis, Yucca pallida,* and *Juncus texanus* (Diggs et al. 1999). *Muhlenbergia reverchonii* is not listed in endemic in literature, but is only known from limestone seeps in Texas and Oklahoma (Barkworth et al. 2007); it is not clear whether it is thought the distribution of *M. reverchonii* might be more widespread. *Eleocharis occulta* (Smith 2001) and *Liatris aestivalis* (Nesom and O'Kennon 2001) were also collected on the Walnut Formation and are endemic to the region. A distinction between strict nativity to Texas was ignored, as political boundaries do not correspond with regional vegetation.

While no species on the North Central Texas Walnut Formation falls under special concern from a governing body, *Dalea reverchonii* should probably be federally listed due to its very restricted range and habitat destruction due to urban sprawl. According to NatureServe (2006), *D. reverchonii* has been extirpated from the top of Comanche Peak and it grows in "grasslands or openings in post oak woodlands on shallow calcareous clay to sandy clay soils over limestone. Often among sparse vegetation in barren, exposed sites." This is inaccurate. Multiple status reports (Mahler 1984; McLemore and O'Kennon 2003; O'Kennon 2010), state *D. reverchonii* is alive and well atop Comanche Peak; however, these status reports have not been formally published. Voucher specimens of *D. reverchonii* atop Comanche Peak exist at BRIT (O'Kennon 23370; 18793 Texas: Hood County) and 2 type specimens are at the Missouri Botanical Garden (Reverchon 1273 Texas: Hood County) on "rocks. Top of the Comanche Peak" in June of 1882, and one isotype at BRIT.

As previously stated, *Dalea reverchonii* appears to thrive in sites that have been quarried, leaving behind anthropogenic glades suitable for *D. reverchonii*. Free from cattle grazing, these old quarries are ideal habitat for *D. reverchonii. Dalea reverchonii* is a rare species in North Central Texas due to its restricted range, though existing populations tend to support many individuals. *Dalea reverchonii* thrives under episodic disturbance on Walnut Limestone, even surviving an asphault application, thus inviting an interesting conversation regarding conservation of the species.

ANNOTATED CHECKLIST

Vascular plant families are taxonomically arranged. Angiosperm families are subdivided into Magnoliopsida (Dicots) and Liliopsida (Monocots). Taxa are listed alphabetically within their respective family by genus, species, and subspecific epithet. Authorities are given for all taxa and common names follow the scientific names. Next is the collector name and number, followed by the abbreviation of the major vegetational habitat in which the taxon was collected: aquatic – emergent, floating, submerged (AQ), barren (B), dry glade (DG), eroding hillslope (EH), glade seep (GS), hill slope seep (HS), lawn (L), limestone scrub woodland (LSW), mixed grass hillslope (MGH), pond edge (P), roadside (R), Sand formation – Walnut Formation contact (SW), woodland (W), and xeroriparian woodland (XR). Additional collectors are R.J. O'Kennon (ROK), K.R. Norton (KRN), S.R. Kieschnick (SRK), T.F. Franklin (TFF), Jeff Quayle (JQ), E.L. Bridges (ELB), and Will McClatchey/Valerie McClatchey (WCM/VAM), all of whose specimens are deposited at BRIT. Please, see the appendix for a complete list of taxa.

APPLICATIONS AND FURTHER RESEARCH

Floristic Studies

The Walnut Flora as a landscape is never truly static. Additional collections from different habitat types would be valuable additions. As many of these proposed associations are not mapped, nor based on plot data describing relevés across different habitat types, in conjunction with soil studies, would provide more accuracy and insight into the habitats of the Walnut Formation.

As the southern portion of the Walnut Formation was not thoroughly sampled, a study comparing the northern and southern portions would be very valuable for understanding the Walnut Formation landscape. This would be especially valuable as Hill (1901) described the part of the Walnut Formation found in the Lampasas Cut Plain as the Walnut Prairie, and the most representative portion of the Walnut Formation. This would make sense considering the Walnut Formation is much more extensive in this region of Texas.

As mentioned, the Walnut Formation vegetation does not appear to align with other Grand Prairie or Fort Worth Prairie limestone formations and better understanding of this ecoregion would emerge from an in-depth comparison of these limestone formations (e.g. the Goodland, Duck Creek, Fort Worth, Glen Rose, Comanche Peak, and Edwards limestones).

Muhly Seeps as Wetlands

Jue (2011) and Llado (2011) studied Muhly Seeps on the Fort Worth Prairie on Duck Creek Limestone. Their objective was to see if the vegetation, soils, and hydrology would classify Muhly Seeps as wetlands through 404 Permitting by the United States Army Core of Engineers (USACE). Unfortunately their studies were performed in a drought year, so neither the vegetation nor hydrology aligned closely enough with USACE requirements for wetland status. These requirements state that given a 280-day growing season and 12.5% saturation, 35 days of saturation are required to fill the hydrology criterion (USACE 1987). While Llado and Jue's study site did not yield these results, a few seeps near Rhome, Texas and at the Eidson Property near the Fort Worth Nature Center and Refuge, showed hydric soil properties of gleyed color and a hydrogen sulfide odor through June in dryer years. More Muhly Seep sites should be monitored for possible wetland status of these unique habitats.

Cedar Invasion

The presence of *Juniperus* spp. (cedars) in North Central Texas provides an interesting potential for study. Frequently quite invasive in grasslands, cedars were not mentioned at all in historic North Central Texas literature (Hill 1901, Bray 1906, Dyksterhuis 1946). It is well understood in the region that *Juniperus* spp. have extended their ranges in response to fire suppression, allowing *Juniperus* to overtake many landscapes in under 65 years. Mapping the distribution and predicting habitat expansion of the three species of *Juniperus* in North Central Texas (*J. virginiana, J. ashei,* and *J. pinchotii*) would give an interesting insight as to how the prairie landscape may appear in another 65 years, and more specifically how Walnut Glades would compare to Cedar Glades. Much of the data for this study has already been collected by O'Kennon and McLemore, but needs to be published.

Comparisons with Eastern Limestone Cedar Glades

Cedar Glades and similar outcrops in Texas could be further compared using similar sampling methods as described in Norton (2010) and George (1987). *Nostoc commune,* an important nitrogen fixing cyanobacterium in Cedar Glades, is also quite abundant in Walnut Glades. When comparing these different habitats, the non-vascular flora should also be considered, as it has been a major component of species composition (Quarterman 1950b) and cryptogams are important to soil properties (Dunne 1989).

Landscape Design Applications

This thesis differs from the traditional county flora in that it has more practical and ecological applications. Williams (2008) and Kinder (2009) used the Fort Worth Prairie, including Walnut Barrens, as a model for green roof design in North Central Texas through biomimicry of natural systems. Williams stresses the importance of green roofs for the quality of life in urban areas as the population and urban centers grow. Shallow limestone barrens, like those of the Fort Worth prairie, are ideal study sites for green roof research because of the plants' ability to survive in soils less than 6 inches deep. Soil depth is important when taking into account the amount of weight a roof can hold. Williams' (2008) and Kinder's (2009) research proposes using native plants and soil to construct green spaces in urban areas; thus an improved knowledge of the ecology of the Fort Worth Prairie will be a valuable basis for appropriate designs. The research of Williams and Kinder has been put to the test on the rooftop of the Botanical Research Institute of Texas in Fort Worth, where the intense heat of the 2011 summer will provide more insight to their biomimicry research questions.

Biomimicry has also been proposed for design and implementation of rain gardens or bioswales, and other storm water management and water-purifying features. In Texas, rain gardens need to survive without year-round water; they must be adapted to seasonal rains and very hot, dry summers. When looking again to a native habitat design template, we find seeps. Seeps in North Central Texas are hyperseasonal; wet and “seeping” in the spring and early summer, often so much so that the soil is anaerobic, and then in the absence of rain, becoming dry and cracked in the summer. The plants in seeps are pre-adapted to the intermittent flooding and drought of rain gardens.

Educational Applications

This thesis, integrating geology, soil, and vegetation, ideally could be used for educational purposes in a botanical, geological, or environmental setting. Understanding the roles that abiotic factors (geology, water, and soil) have on the vegetation should enhance a “sense of place” as described by Gruenewald (2003). Place-based education demonstrates that connections to a local environment will help connect people to environmental issues through familiarity; people are already more connected to their home, a place where they are comfortable. Using this familiarity and connection to home and place allows for a comfortable teaching environment about natural processes and environmental issues that can be translated to a global scale. This practice also refers to agriculture; as Wendell Berry (2005) said, “To live as a farmer, one has to come into the local watershed and the local ecosystem and deal well or poorly with them. One must encounter directly and feelingly the topography and the soils of one’s particular farm, and treat them well or poorly. If one wishes to farm well, and agrarianism inclines to that wish above all, then one must submit to the unending effort to change one’s mind and ways to fit one’s farm.”

CONCLUSIONS

The Walnut Formation provides the context for unique vegetation and plant communities in North Central Texas. Floristics in conjunction with topographical, geological, pedological, and hydrological data provides a much more precise overview of the landscape as a whole.

On glades with absent to very shallow soils the *Tridens muticus – Aristida purpurea – Erioneuron pilosum – Dalea* spp. Association and the *Dalea reverchonii – Talinum calycinum – Minuartia michauxii* Association are widespread. On the adjacent barrens with some deeper soils (around 4 inches deep) is the *Schizachyrium scoparium – Opuntia phaeacantha – Yucca pallida* Association. On hillslope or glade seeps, the *Muhlenbergia reverchonii – Eleocharis* spp. – *Carex microdonta* Association is widespread. On footslopes *Schizachyrium scoparium – Andropogon gerardii – Sorghastrum nutans – Bouteloua* spp. Association is quite common, especially over a sandy soil with calcareous topsoil. In limestone scrub woodlands on north-facing slopes with open exposed rock, the *Quercus buckleyi – Ulmus crassifolia – Celtis laevigata – Cercis canadensis – Fraxinus texensis* Association is common.

Several taxa new to North Central Texas were discovered during this project such as *Gratiola quartermaniae* and *Isoëtes butleri,* though none notable enough to publish. The data concerning *Talinum calycinus*; however is most interesting. Several collections found denote *Talinum calcaricus* might be present in North Central Texas, which would be disjunct from other states. Its association in communities with the endemic *Dalea reverchonii* will hopefully encourage further work on Walnut Glades.

Hopefully, the work from this project will inspire further study of the Walnut Formation and the Fort Worth Prairie and plot data will be sampled in order to improve these plant associations for their proposal to the Ecological Society of America Vegetation Classification Panel.

While this thesis is essentially complete, the need to further explore the ecology of North Central Texas is becoming more apparent and necessary. As the metroplex expands and the population grows, and climate change continues, the connection to place and natural history will become more important to life. Integrating novel techniques for landscapes, storm water management systems, and air and water quality improvements will become more vital to the quality and sustainability of human inhabitation in North Central Texas.

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APPENDICES

LYCOPODIOPHYTA

ISOETACEAE *Isoëtes butleri* Engelm. **Butler's Quillwort** (S 201 GS)

POLYPODIOPHYTA

PTERIDACEAE *Pellaea atropurpurea* (L.) Link **Cliff-Break** (S 743 XR; KRN 883)

PINOPHYTA

CUPRESSACEAE *Juniperus ashei* J. Buchholz **Mountain Cedar** (S 706 B; S 788 B; S 347b R 15)
CUPRESSACEAE *Juniperus pinchotii* Sudw. **Red-Berry Juniper** (S 723 B)
CUPRESSACEAE *Juniperus virginiana* L. **Eastern Red-Cedar** (S 236 B; S 527 HS/SW)

MAGNOLIOPHYTA: MAGNOLIOPSIDA

ACANTHACEAE *Dyschoriste linearis* Torr. & A. Gray **Narrow-Leaf Snakeherb** (S 310 DG; S 584 DG/R)
ACANTHACEAE *Justicia americana* (L.) Vahl **American Water-Willow** (S 261 AQ/GS)
ACANTHACEAE *Ruellia humilis* Nutt. **Prairie Petunia** (S 373 B; S 392 HS; S 398 EH; S 744 XR)
AMARANTHACEAE *Amaranthus blitoides* S. Watson **Prostrate Pigweed** (S 780 W)
AMARANTHACEAE *Amaranthus retroflexus* L. **Red-Root Pigweed** (WCM/VAM 261)
AMARANTHACEAE *Amaranthus rudis* J.D. Sauer **Water-Hemp** (S 756 P)
ANACARDIACEAE *Rhus glabra* L. **Smooth Sumac** (S 281 B; S 402 EH)
ANACARDIACEAE *Rhus lanceolata* (A. Gray) Britton **Prairie Sumac** (S 704 B)
ANACARDIACEAE *Rhus trilobata* Nutt. **Skunkbush** (S 227 B; WCM/VAM 28; WCM/VAM 143)
ANACARDIACEAE *Toxicodendron radicans* (L.) Kuntze **Poison-Ivy** (WCM/VAM 134; WCM/VAM 180)
ANACARDIACEAE *Toxicodendron radicans* (L.) Kuntze ssp. *verrucosum* (Scheele) Gillis **Poison-Ivy** (S 630 LSW)
APIACEAE *Ammoselinum butleri* (Engelm. ex S. Watson) J.M. Coult. & Rose **Butler's Sand-Parsley** (S 216 GS)
APIACEAE *Bifora americana* Benth. & Hook. f. ex S.Wats. **Prairie Bishop** (KRN 758 B; KRN 888; S 334 HS; S 269 GS)
APIACEAE *Chaerophyllum tainturieri* Hook. var. . *dasycarpum* Hook. ex S. Watson **Hairy-Fruit Chervil** (S 180 WS)
APIACEAE *Daucus pusillus* Michx. **Rattle-Snake Weed** (S 271 GS)
APIACEAE *Eryngium leavenworthii* Torr. & A. Gray **Leavenworth's Eryngo** (S 430 EH)
APIACEAE *Polytaenia nuttallii* DC. **Prairie Parsley** (S 629 B)
APIACEAE *Spermolepis inermis* (Nutt. ex DC.) Mathias & Constance **Spreading Scaleseed** (S 177 B)
APIACEAE *Torilis arvensis* (Huds.) Link **Beggar's Lice** (S 270 GS; WCM/VAM 57)
APOCYNACEAE *Amsonia ciliata* Walter var. *texana* (A. Gray) J.M. Coult. **Texas Slimpod** (S 152 B; TFR 219 B)
AQUIFOLIACEAE *Ilex decidua* Walter **Possumhaw** (S 119 EH; S 797 P; WCM/VAM 14; WCM/VAM 68; WCM/VAM 69)
ASCLEPIADACEAE *Asclepias asperula* (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson **Antelope-Horns** (S 174 B)
ASCLEPIADACEAE *Asclepias engelmanniana* Woodson **Engelmann's Milkweed** (KRN 924)
ASCLEPIADACEAE *Asclepias linearis* Scheele **Slim Milkweed** (S 713 MGH/SW)
ASCLEPIADACEAE *Asclepias stenophylla* A. Gray **Slim-Leaf Milkweed** (S 411 EH)
ASCLEPIADACEAE *Asclepias verticillata* L. **Whorled Milkweed** (S 415 LSW/SW)

Asclepiadaceae *Asclepias viridiflora* Raf. **Green-Flower Milkweed** (S 413 EH; S 712 MGH/SW)
Asclepiadaceae *Asclepias viridis* Walter **Green Milkweed** (S 331 HS; S 617 R)
Asclepiadaceae *Funastrum crispum* (Benth.) Schltr. **Wavy Leaf Milkweed Vine** (S 633 LSW; S 638 B; TFR 218 LSW)
Asclepiadaceae *Matelea biflora* (Raf.) Woodson **Two-Flower Milkvine** (S 591 B)
Asteraceae *Achillea millefolium* L. **Common Yarrow** (S 763 W)
Asteraceae *Ambrosia artemisifolia* L. **Common Ragweed** (S 480 B)
Asteraceae *Ambrosia confertiflora* DC. (WCM/VAM 276)
Asteraceae *Ambrosia psilostachya* DC. **Western Ragweed** (S 441 R; S 526 HS/SW)
Asteraceae *Ambrosia trifida* L. var. *texana* Scheele **Blood Ragweed** (S 755 P; S 783 R)
Asteraceae *Artemisia ludoviciana* Nutt. ssp. *mexicana* (Willd. ex Spreng) D. D. Keck **Mexican Sagebrush** (S 445 DG; S 514 MGH/SW; S 764 W; S 772 DG)
Asteraceae *Aster ericoides* L. **Heath Aster** (S 482 B; S 487 B; S 519 MGH/SW)
Asteraceae *Aster praealtus* Poir. **Willow-Leaf Aster** (S 759 P)
Asteraceae *Aster pratensis* Raf. **Silky Aster** (ROK 20719 GS)
Asteraceae *Aster subulatus* Michx. var. *ligulatus* Shinners **Wireweed** (S 531 HS)
Asteraceae *Baccharis texana* (Torr. & A. Gray) A. Gray **Prairie Baccharis** (S 509 DG; S 790 B)
Asteraceae *Brickellia eupatorioides* (L.) Shinners (S 775 W; S 778 W; S 787 R; WCM/VAM 270)
Asteraceae *Carduus nutans* L. ssp. *macrocephalus* (Desf.) Nyman **Nodding-Thistle** (S 223 B)
Asteraceae *Carduus tenuiflorus* Curtis **Slender Bristle-Thistle** (WCM/VAM 12)
Asteraceae *Centaurea americana* Nutt. **Basket-Flower** (S 282 B)
Asteraceae *Cirsium texanum* Buckley **Texas Thistle** (S 237 B; S 614 B)
Asteraceae *Conyza canadensis* (L.) Cronquist var. *glabrata* (A. Gray) Cronquist (S 419 GS)
Asteraceae *Dracopis amplexicaulis* (Vahl) Cass **Clasping Coneflower** (S 279 B)
Asteraceae *Dysodiopsis tagetoides* Torr. & A. Gray **Marigold Dogweed** (S 332 HS; S 404 EH; KRN 877)
Asteraceae *Echinacea angustifolia* DC. **Blacksamson** (S 182 EH; S 414 LSW/SW; S 731 EH/SW)
Asteraceae *Echinacea atrorubens* Nutt. (KRN 776)
Asteraceae *Engelmannia peristenia* (Raf.) Goodman & C.A. Lawson **Engelmann's Daisy** (S 287 HS; S 348 R)
Asteraceae *Erigeron strigosus* Muhl. ex Willd var. *strigosus* **Prairie Fleabane** (S 181 EH; S 657 HS; ROK 12153 G; ROK 12154 G; ROK 12157 B)
Asteraceae *Eupatorium serotinum* Michx. **Fall Boneset** (S 720 HS/SW)
Asteraceae *Evax prolifera* Nutt. ex DC. **Rabbit Tobacco** (S 159 B)
Asteraceae *Gaillardia aestivalis* Walter var. *aestivalis* **Yellow Indian Blanket** (S 319 SW; S 729 EH/SW)
Asteraceae *Gaillardia aestivalis* (Walter) H.Rock var. *flavovirens* (C. Mohr) Cronquist **Yellow Indian Blanket** (S 658 HS)
Asteraceae *Gaillardia pulchella* Foug. **Indian-Blanket** (S 192 R/DG)
Asteraceae *Grindelia adenodonta* (Steyerm.) G.L.Nesom **Little-Head Gumweed** (ROK 22675 R)
Asteraceae *Grindelia lanceolata* Nutt. **Gulf Gumweed** (S 378 DG; D 709 DG; S 773 DG; KRN 929)
Asteraceae *Grindelia nuda* A. W. Wood **Rayless Gumweed** (S 496 DG)
Asteraceae *Gutierrezia dracunculoides* (DC.) S. F. Blake **Common Broomweed** (S 431 EH/R; S 454 DG; S 476 B)
Asteraceae *Helenium elegans* DC. **Sneezeweed** (S 420 GS; S 702 GS; KRN 887)
Asteraceae *Helianthus annuus* L. **Common Sunflower** (S 424 B)
Asteraceae *Helianthus maximiliani* Schrad. **Maximilian Sunflower** (S 467 HS/Sw)
Asteraceae *Heterotheca canescens* (DC.) Shinners **Gray-Gold Aster** (SRK 323 R)

ASTERACEAE *Hymenopappus scabiosaeus* L'Hér var. *corymbosus* (Torr. & A. Gray) B.L. Turner **Old Plainsman** (S 186 EH)
ASTERACEAE *Hymenopappus tenuifolius* Pursh **Old Plainsman** (S 175 B; S 622 EH; WCM/VAM 11)
ASTERACEAE *Hymenoxys linearifolia* Hook. (ELB 13633)
ASTERACEAE *Iva angustifolia* Nutt. ex DC. **Marsh-Elder** (S 753 GS; S 792 GS)
ASTERACEAE *Lactuca canadensis* L. **Wild Lettuce** (S 395 R)
ASTERACEAE *Lactuca ludoviciana* (Nutt.) Riddell **Western Wild Lettuce** (S 639 B)
ASTERACEAE *Lactuca serriola* L. **Prickly Lettuce** (WCM/VAM 252)
ASTERACEAE *Liatris aestivalis* G.L. Nesom & O'Kennon **Summer Gayfeather** (S 365 EH; S 405 EH; S 732 EH/SW)
ASTERACEAE *Liatris mucronata* DC **Narrow-Leaf Gayfeather** (S 459 MGH; S 478 B; S 510 EH; S 511 MGH/SW)
ASTERACEAE *Lindheimera texana* Engelm. & A. Gray **Texas-Star** (S 212 B)
ASTERACEAE *Lygodesmia texana* Torr. & A. Gray **Texas Skeleton-Plant** (S 314 B)
ASTERACEAE *Marshallia caespitosa* Nutt. ex DC. var. *caespitosa* **Barbara's Buttons** (S 257 EH; KRN 773 DG)
ASTERACEAE *Palafoxia callosa* (Nutt.) Torr. A. Gray **Small Palafoxia** (S 425 B; S 439 DG; S 483 B; SRK 322 R)
ASTERACEAE *Parthenium hysterophorus* L. **False Ragweed** (S 710 W; S 779 W)
ASTERACEAE *Pyrrhopappus grandiflorus* (Nutt.) Nutt. **Tuber False Dandelion** (S 197 R/DG)
ASTERACEAE *Pyrrhopappus pauciflorus* (D. Don) DC. **Mini-Stem False Dandelion** (S 264 GS; S 579 GS)
ASTERACEAE *Ratibida columnifera* Nutt. **Mexican-Hat** (S 313 B)
ASTERACEAE *Rudbeckia grandiflora* (D. Don) J.F. Gmel. ex DC. var. *alismifolia* (Torr. & A.Gray) Cronquist **Rough Coneflower** (S 391 HS)
ASTERACEAE *Rudbeckia hirta* L. var. *pulcherrima* Farw. **Black-Eyed Susan** (S 349 R/DG)
ASTERACEAE *Silphium albiflorum* A. Gray **White Rosinweed** (S 325 B; S 360 B; KRN 925; KRN 928)
ASTERACEAE *Silphium laciniata* L. **Compass-Plant** (RKN 926)
ASTERACEAE *Silphium radula* Nutt. **Rough-Stem Rosinweed** (S 393 HS)
ASTERACEAE *Solidago nemoralis* Aiton var. *longipetiolata* (Mack. & Bush) E. J. Palmer & Steyerm. (S 463 MGH/SW)
ASTERACEAE *Solidago nitida* Torr. & A. Gray **Shiny Goldenrod** (S 794 GS)
ASTERACEAE *Solidago rigida* L. **Stiff Goldenrod** (S 513 MGH/SW; S 784 R)
ASTERACEAE *Solidago radula* Nutt. **Rough Goldenrod** (S 522 HS/SW)
ASTERACEAE *Sonchus oleraceus* L. **Common Sow-Thistle** (S 253 GS)
ASTERACEAE *Taraxacum officinale* L. **Dandelion** (WCM/VAM 4 L)
ASTERACEAE *Tetraneuris linearifolia* (Hook.) Greene (S 651 B; S 172 HS)
ASTERACEAE *Tetraneuris scaposa* (DC.) Greene **Plains Yellow Daisy** (S 145 GS; S 183 EH; WCM/VAM 8; WCM/VAM 29; KRN 665)
ASTERACEAE *Thelesperma filifolium* (Hook.) A. Gray **Greenthread** (S 157 B)
ASTERACEAE *Vernonia baldwinii* Torr. **Baldwin's Ironweed** (S 418 R)
ASTERACEAE *Xanthisma texana* DC. ssp. *drummondii* (Torr. & A. Gray) Semple **Texas Sleepy Daisy** (S 624 DG)
ASTERACEAE *Xanthium strumarium* L. var. *canadense* (Mill.) Torr. & A. Gray **Cocklebur** (S 758 P)
BERBERIDACEAE *Nandina domestica* Thunb. **Sacred-Bamboo** (S 742 XR; WCM/VAM 47)
BORAGINACEAE *Heliotropium tenellum* (Nutt.) Torr. **Pasture Heliotrope** (S 375 B; S 381 DG; S 474 B)
BORAGINACEAE *Lithospermum incisum* Lehm. **Narrow-Leaf Gromwell** (S 163 EH)

BRASSICACEAE *Capsella bursa-pastoris* (L.) Medik. **Shepard's-Purse** (S 572 L; WCM/VAM 3; WCM/VAM 147)
BRASSICACEAE *Draba cuneifolia* Nutt. ex Torr. & A. Gray **Wedge-Leaf Draba** (S 126 B; WCM/VAM 25; WCM/VAM 24; WCM/VAM 32)
BRASSICACEAE *Lepidium austrinum* Small **Southern Pepperweed** (S 242 B)
BRASSICACEAE *Lesquerella densiflora* (A. Gray) S. Watson **Dense-Flower Bladderpod** (S 559 B)
BRASSICACEAE *Lesquerella engelmannii* (A. Gray) S. Watson **Engelmann's Bladderpod** (S 161 EH; S 162 EH; S 198 R/DG; S 587 DG; S 693 DG)
CACTACEAE *Coryphantha sulcata* (Engelm.) Britton & Rose **Pineapple Cactus** (S 201 R/DG; S 696 DG)
CACTACEAE *Echinocereus reichenbachii* (Terscheck ex Walp.) F. Haage **Hedgehog Cactus** (S 636 LSW; KRN 784 DG)
CACTACEAE *Escobaria missouriensis* (Sweet) D.R. Hunt **Plains Nipple Cactus** (S 207 DG)
CACTACEAE *Escobaria vivipara* (Nutt.) Buxb. **Spiny-Star** (S 434 DG; S 697 DG)
CACTACEAE *Opuntia phaeacantha* Engelm. var. *major* Engelm. **Prickly-Pear** (S 350 DG; S 359 B; S 628 B; S 766 W)
CALLITRICHACEAE *Callitriche heterophylla* Pursh. **Larger Waterwort** (S 293 AQ/GS)
CAMPANULACEAE *Triodanis leptocarpa* (Nutt.) Nieuwl. **Slimpod Venus' Looking-Glass** (S 194 R/DG)
CAPPARACEAE *Polanisia dodecandra* (L.) DC **Clammyweed** (S 426 B/R)
CAPRIFOLIACEAE *Lonicera albiflora* Torr. & A. Gray **White Honeysuckle** (S 160 B; S 403 EH)
CAPRIFOLIACEAE *Symphoricarpos orbicularis* Moench **Coralberry** (S 497 EH; S 517 MGH/SW; S 762 W)
CAPRIFOLIACEAE *Viburnum rufidulum* Raf. **Rusty Blackhaw** (S 140 EH; S 294 HS; S 436 LSW; S 740 XR)
CARYOPHYLLACEAE *Minuartia michauxii* (Fenzl) Farw. var. *texana* (B.L. Rob.) Mattf. **Rock Sandwort** (S 195 R/DG; S 626 DG; KRN 664 DG; ROK 12160 DG; JQ 146 DG)
CARYOPHYLLACEAE *Paronychia virginica* Spreng. **Parks' Nailwort** (S 433 DG; S 484 B)
CARYOPHYLLACEAE *Stellaria media* (L.) Vill. **Common Chickweed** (WCM/VAM 20)
CONVOLVULACEAE *Convolvulus equitans* Benth. **Texas Bindweed** (S 204 R/DG)
CONVOLVULACEAE *Evolvulus nuttallianus* Schult. **Hairy Evolvulus** (S 168 EH; S 322 SW; S 347b R 267)
CONVOLVULACEAE *Ipomoea cordatotriloba* Dennst. var. *cordatotriloba* **Sharp-Pod Morning-Glory** (S 443 R; S 761 R)
CORNACEAE *Cornus drummondii* C.A. Mey. **Rough-Leaf Dogwood** (S 521 EH)
CRASSULACEAE *Sedum nuttallianum* Raf. **Yellow Stonecrop** (S 254 GS; S 146 GS)
CUCURBITACEAE *Ibervillea lindheimeri* (A. Gray) Greene **Balsam Gourd** (S 226 B; S 389a B)
CUSCUTACEAE *Cuscuta exaltata* Engelm. **Tree Doder** (ROK 20687 LSW)
CUSCUTACEAE *Cuscuta gronovii* Willd. ex Schult. (S 464 DG)
CUSCUTACEAE *Cuscuta indecora* Choisy var. *indecora* (S 309 DG; S 358 B; S 502 EH)
CUSCUTACEAE *Cuscuta obtusiflora* Kunth var. *glandulosa* Engelm. **Red-Dodder** (S 384 B)
CUSCUTACEAE *Cuscuta pentagona* Engelm. var. *glabrior* (Engelm.) Gandhi, R.D. Thomas, S.L. Hatch (S 300 DG; S 328 B)
EBENACEAE *Diospyros virginiana* L. **Common Persimmon** (S 294 LSW; S 374 LSW; S 771 MGH/SW)
EUPHORBIACEAE *Acalypha ostryifolia* Riddell **Hop-Hornbeam Copperleaf** (S 421 GS)
EUPHORBIACEAE *Chamaesyce fendleri* (Torr. & A. Gray) Small (S 376 B; KRN 772 DG: ROK 12194 G)
EUPHORBIACEAE *Chamaesyce missurica* (Raf.) Shinners **Prairie Spurge** (S 446 DG; S 498 EH; S 718 DG)
EUPHORBIACEAE *Chamaesyce nutans* (Lag.) Small **Eyebane** (S 785 R; ROK 22674 R)

EUPHORBIACEAE *Cnidoscolus texanus* (Müll. Arg.) Small (WCM/VAM 225)
EUPHORBIACEAE *Croton monanthogynus* Michx. **Doveweed** (S 337 B; S 382 DG; S 455 DG; S 770 W; WCM/VAM 263)
EUPHORBIACEAE *Croton texensis* (Kl.) Muell. **Texas Croton** (ROK 22673 R)
EUPHORBIACEAE *Ditaxis humilis* (Engelm. & Gray) Pax var. *humilis* **Low Wild Mercury** (KRN 750 R; KRN 1044)
EUPHORBIACEAE *Euphorbia bicolor* Engelm. & Gray **Snow-on-the-Prairie** (S 435 B)
EUPHORBIACEAE *Euphorbia davidii* Subils (S 776 W)
EUPHORBIACEAE *Euphorbia dentata* Michx. **Toothed Spurge** (S 389 B; S 655 B)
EUPHORBIACEAE *Euphorbia longicruris* Scheele **Wedge Leaf Euphorbia** (S 327 B)
EUPHORBIACEAE *Euphorbia marginata* Pursh. **Snow-on-the-Mountain** (S 440 R; WCM/VAM 257)
EUPHORBIACEAE *Euphorbia spathulata* Lam. **Warty Euphorbia** (S 232 B; ROK 12145 G)
EUPHORBIACEAE *Phyllanthus polygonoides* Nutt. ex Spreng **Knotweed Leaf-Flower** (S 199 R/DG; S 234 B; S 501 EH; S 574 L; WCM/VAM 35; WCM/VAM 186)
EUPHORBIACEAE *Stillingia texana* I.M. Johnst. **Texas Stillingia** (S 311 DG; S 363 B)
EUPHORBIACEAE *Tragia brevispica* Engelm. & A. Gray **Short-Spike Noseburn** (S 648 B; WCM/VAM 255)
EUPHORBIACEAE *Tragia ramosa* Torr. **Catnip Noseburn** (S 356 B; S 615 B; S 635 LSW)
FABACEAE *Acacia angustissima* (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob. **Fern Acacia** (S 619 EH; S 699 DG; S 774 EH)
FABACEAE *Astragalus lotiflorus* Hook **Lotus Milk-Vetch** (S 139 EH)
FABACEAE *Cercis canadensis* L. var. *canadensis* **Eastern Red Bud** (S 556 LSW)
FABACEAE *Cercis canadensis* L. **Red Bud** (S 132 EH)
FABACEAE *Chamaecrista fasciculata* (Michx.) Greene **Partridge-Pea** (S 367 EH/SW; S 371 B)
FABACEAE *Dalea aurea* Nutt. ex Pursh **Golden Dalea** (S 307 DG; S 372 B; S 698 DG; KRN 882)
FABACEAE *Dalea enneandra* Nutt. **Big-Top Dalea** (S 369 B; KRN 880)
FABACEAE *Dalea frutescens* A. Gray **Black Dalea** (S 747 DG)
FABACEAE *Dalea hallii* A. Gray **Hall's Dalea** (S 460 MGH; S 724 B; KRN 879)
FABACEAE *Dalea multiflora* (Nutt.) Shinners **White-Praire Clover** (S 362 B)
FABACEAE *Dalea purpurea* Vent. **Violet Prairie-Clover** (ROK 19614)
FABACEAE *Dalea reverchonii* (S. Watson) Shinners **Comanche Peak Prairie Clover** (S 255 DG; KRN 790 DG; KRN 875; ROK 12149 DG; SRK 314 R/DG; SRK 321 R/DG)
FABACEAE *Dalea tenuis* (J.M. Coult.) Shinners (S 312 DG; S 429 E;S 366 EH/SW; KRN 878)
FABACEAE *Desmanthus illinoensis* (Michx.) MacMill. ex B.L. Rob. & Fernald (S 284 HS; S 364 B)
FABACEAE *Gleditsia triacanthos* L. **Common Honey-Locust** (S 754 DG)
FABACEAE *Indigofera miniata* Ortega var. *miniata* **Coast Indigo** (S 320 SW; S 733 EH/SW)
FABACEAE *Lupinus texensis* Hook **Texas Bluebonnet** (S 179 B; WCM/VAM 41; WCM/VAM 167)
FABACEAE *Medicago arabica* (L.) Huds. **Spotted Bur-Clover** (S 233A R)
FABACEAE *Medicago minima* (L.) L. **Bur-Clover** (S 563 R; S 571 L; 233B R)
FABACEAE *Medicago sativa* L. **Alfalfa** (S 623 R)
FABACEAE *Mimosa roemeriana* Scheele **Roemer's Sensitive Briar** (S 258 EH)
FABACEAE *Pediomelum cuspidatum* (Pursh) Rydb. **Tall-Bread Scurf-Pea** (S 176 B; S 586 EH; KRN 885)
FABACEAE *Pediomelum cyphocalyx* (A. Gray) Rydb. **Turnip-Root Scurf-Pea** (S 347C B; ROK 12202 G; ROK 12159 G; KRN 886; KRN 762 EH; KRN 783 EH)
FABACEAE *Pediomelum hypogaeum* Nutt. ex Torr. & A. Gray var. *scaposum* **Edible Scurf-Pea** (S 326 B; ROK 12158 G)

FABACEAE *Pediomelum latestipulatum* (Shinners) Mahler var. *latestipulatum* **Texas Plains Indian-Breadroot** (S 213 B)
FABACEAE *Pediomelum latestipulatum* (Shinners) Mahler **Texas Plains Indian-Breadroot** (KRN 659 DG; ROK 20000 GS)
FABACEAE *Pediomelum linearifolium* (Torr. & A. Gray) J.W. Grimes (S 351 EH; S 361 B)
FABACEAE *Pediomelum reverchonii* (S. Watson) Rydb. **Rock Scurf-Pea** (S 354 B; S 705 B)
FABACEAE *Prosopis glandulosa* Torr. **Honey Mesquite** (S 570 B)
FABACEAE *Senna roemeriana* Scheele **Two-leaf Senna** (S 302 R/DG, S 400 DG; S 749 DG; TFR 229 DG)
FABACEAE *Tephrosia virginiana* (L.) Pers. **Goat's Rue** (S 417 LSW/SW)
FABACEAE *Vicia villosa* Roth ssp. *villosa* **Hairy Vetch** (S 554 EH/R)
FAGACEAE *Quercus buckleyi* Nixon & Dorr **Texas Red Oak** (S 129 LSW; S 130 LSW)
FAGACEAE *Quercus fusiformis* Small **Plateau Live Oak** (S 533 B; S 555 LSW; 557 LSW; WCM/VAM 16)
FAGACEAE *Quercus sinuata* Walter var. *brevifolia* (Torr.) C.H. Mull **Bastard Oak** (S 575 L; S 751 LSW)
FAGACEAE *Quercus stellata* Wangenh. **Post Oak** (S 492 B)
GENTIANACEAE *Centaurium texense* (Griseb.) Fernald **Texas Centaury** (S 627 B; TFR 228 B; KRN 923)
GENTIANACEAE *Eustoma russellianum* (Hook.) G. Don **Texas Bluebells** (S 686 B)
GENTIANACEAE *Sabatia campestris* Nutt. **Prairie Rose Gentian** (S 283 B)
GERANIACEAE *Erodium texana* A. Gray **Storks-Bill** (S 567 EH/R)
GERANIACEAE *Erodium cicutarium* (L.) L'Hér ex Aiton **Filaree** (S 120 G; WCM/VAM 2)
GERANIACEAE *Geranium carolinianum* L. **Crane's Bill** (S 239 B; S 581 R)
GERANIACEAE *Geranium texanum* (Trel.) A. Heller **Texas Geranium** (WCM/VAM 6)
JUGLANDACEAE *Carya illinoinensis* (Wangenh.) K. Koch **Pecan** (S 768 W; S 777 W)
KRAMERIACEAE *Krameria lanceolata* Torr. **Trailing Ratany** (S 589 B; TFR 224 B; WCM/VAM 205)
LAMIACEAE *Hedeoma acinoides* Scheele **Slender Hedoma** (S 170 B)
LAMIACEAE *Hedeoma hispida* Pursh **Rough Hedeoma** (S 229 B)
LAMIACEAE *Hedeoma reverchonii* A. Gray **Reverchon's False Pennyroyal** (ROK 12152 G; ROK 20517 G)
LAMIACEAE *Lamium amplexicaule* L. **Henbit** (S 577 L; WCM/VAM 9)
LAMIACEAE *Monarda citriodora* Cerv. ex Lag. **Lemon Beebalm** (S 280 B)
LAMIACEAE *Salvia azurea* Michx. ex Lam var. *grandiflora* Benth. **Blue Sage, Azure Sage** (S 765 W; S 456 B; WCM/VAM 248)
LAMIACEAE *Salvia farinacea* Benth **Mealy-Cup Sage** (S 466 B)
LAMIACEAE *Salvia texana* (Scheele) Torr. **Texas Sage** (S 158 B)
LAMIACEAE *Scutellaria drummondii* Benth. **Drummond's Skullcap** (S 200 R/DG; WCM/VAM 159)
LAMIACEAE *Scutellaria ovata* **Egg-Leaf Skullcap** (WCM/VAM 78)
LAMIACEAE *Scutellaria resinosa* Torr. **Resin-Dot Skullcap** (S 167 EH; S 590 B)
LAMIACEAE *Scutellaria wrightii* A.Gray **Wright's Skullcap** (WCM/VAM 137; WCM/VAM 154; ELB 13641)
LAMIACEAE *Warnockia scutellarioides* (Engelm. & Gray) M.W.Turner **Prairie Brazoria** (KRN 749 GS)
LINACEAE *Linum pratense* (J.B. Norton) Small **Meadow Flax** (S 153 B; KRN 754 GS)
LINACEAE *Linum rigidum* Pursh **Flax** (S 164 EH)
LINACEAE *Linum rupestre* (A. Gray) A. Gray **Rock Flax** (ROK 12204 G)
LINACEAE *Linum sulcatum* Riddell **Grooved Flax** (S 396 B; KRN 881)

Loasaceae *Mentzelia oligosperma* Nutt. ex Sims **Stickleaf** (S 385 B; TFR 227 DG)
Loganaceae *Mitreola petiolata* (J.F. Gmel.) Torr. & A. Gray **Lax Hornpod** (S 721 HS; S 515 MGS/SW)
Lythraceae *Lythrum californicum* Torr. & A. Gray **California Loosestrife** (S 275 B; S 423 B)
Malvaceae *Abutilon fruticosum* Guill. & Perr. **Indian-Mallow** (S 346 B; S 728 LSW; TFR 226 LSW)
Malvaceae *Callirhoe pedata* (Nutt. ex Hook.) A. Gray **Finger Poppy-Mallow** (S 166 EH; WCM/VAM 160)
Malvaceae *Malva neglecta* Wallr. **Common Mallow** (S 576 SLW; WCM/VAM 141)
Malvaceae *Sida abutifolia* Mill. **Spreading Sida** (S 308 DG; S 694 DG)
Malvaceae *Sida spinosa* L. **Prickly Sida** (WCM/VAM 266)
Menispermaceae *Cocculus carolina* (L.) DC. **Carolina Snailseed** (S 745 LSW; WCM/VAM 253)
Moraceae *Maclura pomifera* (Raf.) C.K. Schneid **Bois D'Arc** (S 711 W; S 769 W)
Moraceae *Morus microphylla* Buckley **Mexican Mulberry** (S 752 DG; KRN 661)
Nyctaginaceae *Mirabilis linearis* Pursh. **Linear-Leaf Four-O'Clock** (S 329 B)
Nyctaginaceae *Mirabilis albida* (Walter) Heimerl **White Four-O'Clock** (S 760 R; S 767 W)
Oleaceae *Forestiera pubescens* Nutt **Elbow-Bush** (S 121 G)
Oleaceae *Forestiera pubescens* Nutt. var. *pubescens* **Elbow-Bush** (S 247 B)
Oleaceae *Fraxinus texensis* (A. Gray) Sarg. **Texas White Ash** (S 127 LSW)
Oleaceae *Jasminum floridum* Bunge (S 689 B)
Oleaceae *Ligustrum quihoui* Carriere **Quihoui's Privet** (S 494 B; S 727 LSW)
Onagraceae *Calylophus berlandieri* Spach (S 191 R/DG; WCM/VAM 128)
Onagraceae *Calylophus serrulatus* (Nutt.) P.H. Raven **Yellow Evening-Primrose** (S 695 DG)
Onagraceae *Gaura drummondii* (Spach) Torr. & A. Gray **Sweet Gaura** (WCM/VAM 132)
Onagraceae *Gaura lindheimeri* Engelm. ex A. Gray **White Gaura** (WCM/VAM 129)
Onagraceae *Gaura suffulta* Engelm. ex A. Gray **Roadside Gaura** (S 148 B; S 616 B/R)
Onagraceae *Oenothera coryi* W.L.Wagner (WCM/VAM 31)
Onagraceae *Oenothera glaucifolia* W.L.Wagner & Hoch **Waxy-Leaf Evening-Primrose** (ROK 12150 G)
Onagraceae *Oenothera macrocarpa* Nutt. ssp. *macrocarpa* **Fluttermill Primrose** (S 185 EH; S 585 DG/R)
Onagraceae *Oenothera speciosa* Torr. & A. Gray **Spach's Evening-primrose** (S 289 GS; S 562 R; WCM/VAM 66; WCM/VAM 130; WCM/VAM 133)
Onagraceae *Oenothera triloba* Nutt. **Stemless Evening-Primrose** (S 578 L; S 653 B)
Onagraceae *Stenosiphon linifolius* (Nutt. ex E. James) Heynh. **False Gaura** (S 353 EH/SW; S 369 B; S 450 DG)
Oxalidaceae *Oxalis stricta* L. **Gray-Green Woodsorrel** (S 621 EH; S 632 LSW; WCM/VAM 63)
Plantaginaceae *Plantago aristata* Michx. **Bracted Plantain** (S 298 GS; ROK 12146 DG)
Plantaginaceae *Plantago helleri* Small **Cedar Plantain** (S 147 GS; KRN 660 DG; KRN 662 DG; WCM/VAM 120)
Plantaginaceae *Plantago patagonica* Jacq. **Bristle-Bract Plantain** (S 583 DG/R)
Plantaginaceae *Plantago rhodosperma* Decne. **Red-Seed Plantain** (S 246 B; R 659 B; WCM/VAM 146)
Plantaginaceae *Plantago wrightiana* Decne. **Wright's Plantain** (S 241 B; TFR 223 B; S 297 GS; S 634 LSW)
Polemoniaceae *Ipomopsis rubra* (L.) Wherry **Standing-Cypress** (S 357 B)
Polygalaceae *Polygala alba* Nutt. **White Milkwort** (S 187 EH; S 481 B; RKN 779)
Polygonaceae *Eriogonum longifolium* Nutt. **Long-Leaf Wild Buckwheat** (S 453 DG; S 512 MGH/SW; S 722b B)

Polygonaceae *Rumex crispus* L. **Curly Dock** (S 252 GS; WCM/VAM 127)
Portulacaceae *Claytonia virginica* L. **Virginia Spring Beauty** (S 125 B)
Portulacaceae *Portulaca pilosa* L. **Chisme** (S 536 DG)
Portulacaceae *Talinum calycinum* Engelm. **Rock-Pink** (S 387 DG; S 625 DG; S 746 DG; ROK 12203 B)
Primulaceae *Dodecatheon meadia* L. **Common Shooting-Star** (S 593 LSW)
Ranunculaceae *Anemone berlandieri* Pritz **Ten-Petal Anemone** (S 123 B; WCM/VAM 26)
Ranunculaceae *Delphinium carolinianum* Walt. ssp. *virescens* (Nutt.) R.E.Brooks (KRN 788 R/B)
Rhamnaceae *Ceanothus herbaceus* Raf. (ROK 23003 R)
Rhamnaceae *Frangula caroliniana* (Walter) A. Gray **Carolina Buckthorn** (S 410 B/SW; S 739 XR)
Rosaceae *Crataegus viridis* L. **Greenhaw** (S 565 DG)
Rosaceae *Photinia serratifolia* (Desf.) Kalkman **Photinia** (S 741 XR)
Rosaceae *Prunus mexicana* S. Watson **Mexican Plum** (S 131 ES)
Rosaceae *Prunus rivularis* Scheele **Thicket Plum** (S 316 B; WCM/VAM 316)
Rosaceae *Rosa setigera* Michx. **Prairie Rose** (S 321 SW)
Rosaceae *Sanguisorba annua* (Nutt. ex Hook.) Torr. & A. Gray **Prairie Rose** (S 150 B; ROK 12147 DG; ROK 12156 DG)
Rubiaceae *Galium aparine* L. **Catchweed Bedstraw** (WCM/VAM 10; WCM/VAM 50)
Rubiaceae *Galium pilosum* Aiton **Hairy Bedstraw** (S 687 LSW)
Rubiaceae *Galium virgatum* Nutt. **Southwest Bedstraw** (S 136 EH; S 230 B; S 256b DG)
Rubiaceae *Hedyotis nigricans* (Lam.) Fosberg **Prairie Bluets** (S 475 B; TFR 230 B; WCM/VAM 273)
Rubiaceae *Houstonia pusilla* Schoepf **Tiny Bluet** (S 124 B)
Rubiaceae *Richardia scabra* L. **Rough Mexican Clover** (WCM/VAM 21)
Rubiaceae *Sherardia arvensis* L. **Field Madder** (S 564 R; WCM/VAM 37; WCM/VAM 51)
Rutaceae *Zanthoxylum hirsutum* Buckley **Prickley-Ash** (S 217 B; S 401 EH)
Salicaceae *Populus deltoides* Bartram ex Marshall **Cottonwood** (S 801 R)
Sapindaceae *Cardiospermum halicacabum* L. **Common Balloonvine** (S 422 GS; S 757 P)
Sapindaceae *Sapindus saponaria* L. var. *drummondii* Hook & Arn **Western Soapberry** (S 296 LSW)
Sapindaceae *Ungnadia speciosa* Endl. **Mexican Buckeye** (S 134 LSW; S 388 DG; S 750 DG; WCM/VAM 43)
Sapotaceae *Sideroxylon lanuginosum* Michx. ssp. *oblongifolium* (Nutt.) T.D. Penn. **Chittamwood** (S 508 DG; WCM/VAM 43)
Scrophulariaceae *Agalinis densiflora* (Benth.) S. F. Blake **Fine-Leaf Gerardia** (S 432 EH)
Scrophulariaceae *Agalinis heterophylla* (Nutt.) Small ex Britton **Prairie Agalinis** (S 465 B; S 469 B)
Scrophulariaceae *Buchnera americana* L. **American Bluehearts** (S 318 SW)
Scrophulariaceae *Buchnera floridana* Gand. **American Bluehearts** (ROK 20718 HS)
Scrophulariaceae *Castilleja indivisa* Engelm. **Texas Paintbrush** (S 156 B; WCM/VAM 234)
Scrophulariaceae *Castilleja purpurea* (Nutt.) G. Don **Purple Paintbrush** (WCM/VAM 54; WCM/VAM 95)
Scrophulariaceae *Castilleja purpurea* (Nutt.) G. Don var. *purpurea* **Purple Paintbrush** (S 155 B)
Scrophulariaceae *Gratiola quartermaniae* D. Estes **Limestone Hedge Hyssop** (S 256 GS; S 267 GS; S 566 GS; ROK 20515B GS)
Scrophulariaceae *Penstemon cobaea* Nutt. **Wild Foxglove** (S 259 EH; S 184 EH)
Scrophulariaceae *Veronica peregrina* L. ssp. *xalapensis* (Kunth) Pennell **Jalapa Speedwell** (S 211 B)
Scrophulariaceae *Veronica peregrina* L. ssp. *peregrina* **Necklaceweed** (S 560 GS; S 561 GS)
Solanaceae *Physalis heterophylla* Nees **Clammy Ground Cherry** (S 782 W/R)
Solanaceae *Solanum citrullifolium* A. Braun. **Melon-Leaf Nightshade** (WCM/VAM 243)

Solanaceae *Solanum dimidiatum* Raf. **Western Horse-Nettle** (S 286 R; WCM/VAM269)
Solanaceae *Solanum elaeagnifolium* Cav. **Silver-Leaf Nightshade** (S 303 R/DG; ROK 22681 R)
Solanaceae *Solanum ptychanthum* Dunal **American Nightshade** (S 781 W/R)
Solanaceae *Solanum rostratum* Dunal **Buffalo-Bur** (S 442 R; S 722 W)
Ulmaceae *Celtis laevigata* Willd. var. *reticulata* Torr. **Net-Leaf Hackberry** (S 228 B; S507 DG)
Ulmaceae *Ulmus americana* L. **American Elm** (S 796 P; WCM/VAM 23)
Ulmaceae *Ulmus crassifolia* Nutt. **Cedar Elm** (S 800 LSW)
Urticaceae *Parietaria pensylvanica* Muhl. ex Willd var. *pensylvanica* **Hammerwort** (S 649 LSW)
Valerianaceae *Valerianella amarella* (Lindh. ex Engelm.) Krok **Hairy Cornsalad** (S 143 GS; S 568 EH/R)
Valerianaceae *Valerianella radiata* (L.) Dufr. **Beaked Cornsalad** (S 149 B)
Valerianaceae *Valerianella woodsiana* (Torr. & A. Gray) Walp. **Wood's Cornsalad** (S 553 B)
Verbenaceae *Glandularia bipinnatifida* (Nutt.) Nutt. **Prairie Verbena** (S 620 EH; S 135 EH)
Verbenaceae *Glandularia canadensis* (L.) Nutt. **Rose Vervain** (WCM/VAM 39)
Verbenaceae *Glandularia pumila* (Rydb.) Umber **Pink Verbena** (S 122 G) **Verbenaceae** *Lippia nodiflora* (L.) Michx. **Frogfruit** (S 374 B)
Verbenaceae *Verbena halei* Small **Slender Vervain** (S 703 GS; S 233b B; WCM/VAM 115)
Verbenaceae *Vitex agnus-castus* L. var. *agnus castus* **Common Chastetree** (S 690 B)
Violaceae *Hybanthus verticillatus* (Ortega) Baill **Nodding-Green Violet** (S 205 DG; KRN 789 DG)
Viscaceae *Phoradendron tomentosum* (DC.) Engelm. ex A. Gray **Mistletoe** (S 534 B; WCM/VAM 1)
Vitaceae *Cissus incisa* Des Moul **Cowitch** (S 390 B)
Vitaceae *Vitis cinerea* Engelm var. *cinera* **Sweet grape** (S 295 LSW)
Vitaceae *Vitis mustangensis* Buckley **Mustang Grape** (S 301 LSW/R; WCM/VAM 233)

MAGNOLIOPHYTA: LILIOPSIDA
Agavaceae *Yucca arkansana* McKelvey **Arkansas Yucca** (S 260 EH)
Agavaceae *Yucca pallida* McKelvey **Pale Yucca** (S 345 B; KRN 884)
Commelinaceae *Commelina erecta* L. var. *erecta* **Dayflower** (S 437 LSW)
Commelinaceae *Commelina erecta* L. var. *angustifolia* (Michx.) Fernald **Narrow-Leaf Dayflower** (S 347b R)
Commelinaceae *Tradescantia humilis* Rose **Texas Spiderwort** (S 647 B)
Commelinaceae *Tradescantia occidentalis* (Britton) Smyth **Prairie Spiderwort** (S 190 WS)
Cyperaceae *Carex cherokeensis* Schwein. **Cherokee Caric Sedge** (S 688 XR; KRN 713 LSW)
Cyperaceae *Carex microdonta* Torr. & Hook. **Small-Tooth Caric Sedge** (S 133 HS; S 142 GS; S 180 HS; S 335 HS; KRN 780 P)
Cyperaceae *Carex muehlenbergii* Schkuhr ex Willd. var. *enervis* Boott (S 178 B)
Cyperaceae *Carex planostachys* Kunze **Cedar Caric Sedge** (S 169 EH; S 323 SW; S 631 LSW; S 652 B; KRN 777)
Cyperaceae *Cyperus acuminatus* Torr. & Hook. ex Torr. **Taper-Leaf Flat Sedge** (S 528 DG)
Cyperaceae *Cyperus lupulinus* (Spreng.) Marcks **Slender Flat Sedge** (S 664 B)
Cyperaceae *Cyperus setigerus* Torr. & Hook. (S 291 GSWCM/VAM 268)
Cyperaceae *Eleocharis montevidensis* Kunth (S 337 HS; S 641 GS; S 611a GS)
Cyperaceae *Eleocharis occulta* S. G. Smith **Limestone Spikerush** (S 141 GS; S 173 HS; S 268 GS; S 341 HS; S 642 GS; KRN 658 HS; KRN 781 P)
Cyperaceae *Eleocharis palustris* (L.) Roem. & Schult. **Large-Spike Spike-Rush** (S 645 GS)
Cyperaceae *Fimbristylis puberula* Michx. (S 317 HS/SW)
Cyperaceae *Fimbristylis puberula* Michx. var. *puberula* (S 333 HS; S 406 HS/SW; S 407 HS/SW; KRN 778; KRN 782 P)

CYPERACEAE *Fuirena simplex* Vahl. **Umbrella Sedge** (S 409 HS/SW)
CYPERACEAE *Fuirena simplex* Vahl var. *aristulata* (Torr.) Kral (S 265 GS; S 340 HS; S 701 GS)
CYPERACEAE *Rhynchospora nivea* Boeck. **Snowy White-top Sedge** (S 336 HS/SW)
CYPERACEAE *Scleria ciliata* Michx. **Fringed Nut-Rush** (S 416 LSW/SW)
CYPERACEAE *Scleria verticillata* Muhl. ex Willd **Low-Nut Rush** (S 523 HS/SW)
IRIDACEAE *Nemastylis geminiflora* Nutt. **Prairie Celestial** (S 137 EH; S 558 EH; 2 569 B)
IRIDACEAE *Sisyrinchium langloisii* Greene **Pale Blue-Eyed Grass** (S 165 EH; S 171 B)
JUNCACEAE *Juncus bufonis* L. **Toad Rush** (S 215 GS; S 288 GS)
JUNCACEAE *Juncus capitatus* Weigel **Capped Rush** (S 266 GS; S 613 GS)
JUNCACEAE *Juncus filipendulus* Buckley **Ring-Seed Rush** (KRN 922; KRN 930; ROK 20002)
JUNCACEAE *Juncus interior* Wiegand **Inland Rush** (S 580 GS; S 611 GS; S 612 GS; S 642 GS)
JUNCACEAE *Juncus marginatus* Rostk. **Grass-Leaf Rush** (ROK 13319 GS)
JUNCACEAE *Juncus nodatus* Coville **Jointed Rush** (ROK 20068 GS)
JUNCACEAE *Juncus texanus* (Engelm.) Coville **Texas Rush** (S 343 HS; S 408 HS/SW; S 700 GS; S 264b GS)
JUNCACEAE *Juncus torreyi* Coville **Torrey's Rush** (S 299 GS; S 344 HS)
LILIACEAE *Allium canadense* L. var. *hyacinthoides* (Bush) Ownbey & Aase **Wild Onion** (S 144 GS)
LILIACEAE *Allium canadense* L. var. *fraseri* Ownbey **Wild Onion** (S 183 EH; S 248 GS; KRN 753 GS)
LILIACEAE *Allium drummondii* Regel **Prairie Onion** (S 154 B; S 225 GS; WCM/VAM 34)
LILIACEAE *Camassia scilloides* (Raf.) Cory **Wild Hyacinth** (S 222 B)
LILIACEAE *Cooperia drummondii* Herb. **Rain-Lily** (S 380 DG)
LILIACEAE *Cooperia pedunculata* Herb. **Prairie Rain-Lily** (WCM/VAM 254)
LILIACEAE *Nothoscordum bivalve* (L.) Britton **Crow Poison** (S 488 B; S 537 GS; S 749 GS)
LILIACEAE *Zigadenus nuttallii* (A. Gray) S. Watson **Death-Camass** (S 221 B)
ORCHIDACEAE *Spiranthes cernua* (L.) L.C.Rich. **Nodding Ladies'-Tresses** (KRN 663 B)
ORCHIDACEAE *Spiranthes magnicamporum* Sheviak **Great Plains Ladies'-Tresses** (S 486 B; S 529 HS; S 530 HS)
POACEAE *Aegilops cylindrica* Host **Jointed Goat Grass** (TFR 217 B)
POACEAE *Agrostis perennans* (Walter) Tuck. **Autumn Bent Grass** (S 214 GS)
POACEAE *Andropogon gerardii* Vitman ssp. *gerardii* **Big Bluestem** (S 457 MGH; ROK 22679 DG)
POACEAE *Andropogon glomeratus* (Walter) Britton, Sterns, & Poggenb. **Bushy Bluestem** (S 525 HS/SW)
POACEAE *Aristida lanosa* Muhl. ex Elliott **Woolly-Sheath Threeawn** (S 735 EH/SW)
POACEAE *Aristida oligantha* Michx. **Prairie Threeawn** (S 795 EH/SW)
POACEAE *Aristida purpurea* Nutt. var. *nealleyi* **Blue Threeawn** (S 218 B; S 355 B)
POACEAE *Aristida purpurea* Nutt. **Blue Threeawn** (S 315 B)
POACEAE *Arundo donax* L. **Giant Reed** (S 798 B)
POACEAE *Avena fatua* L. **Wild Oats** (S 193 R/DG)
POACEAE *Bothriochloa barbinodis* (Lag.) Herter var. *barbinodis* **Cane Bluestem** (S 428 EH; S 489 B; S 503 EH)
POACEAE *Bothriochloa ischaemum* L. var. *songarica* (Rupr. Ex Fisch. & C.A.Mey) Celerier & Harlan **King Ranch Bluestem** (S 342 HS; S 449 DG; S 452 DG; S 499 EH; WCM/VAM 282)
POACEAE *Bothriochloa laguroides* (DC.) Herter. ssp. *torreyana* (Steud.) Allred & Gould **Silver Bluestem** (S 352 EH/SW; S 370 B; S 719 DG)
POACEAE *Bouteloua curtipendula* (Michx.) Torr. **Side-Oats Grama** (S 451 DG)
POACEAE *Bouteloua hirsuta* Lag. **Hairy Grama** (S 737 EH/SW; WCM/VAM 265)
POACEAE *Bouteloua pectinata* Feath. **Tall Gramma** (S 427 EH; S 458 MGH; S 473 B; S 725 B)
POACEAE *Bouteloua rigideseta* (Steud.) Hitchc. **Texas Grama** (S 535 B; TFR 221 B)

POACEAE *Briza minor* L. **Little Quaking Grass** (S 292 GS)
POACEAE *Bromus catharticus* Vahl **Rescue Grass** (S 224 GS; WCM/VAM 65)
POACEAE *Bromus japonicus* Muhl. ex Willd **Japanese Brome** (S 245 B; WCM/VAM 33)
POACEAE *Bromus tectorum* L. var. *tectorum* **Cheat Grass Brome** (S 238 B)
POACEAE *Buchloe dactyloides* (Nutt.) Engelm. **Buffalo Grass** (S 592 B; WCM/VAM 149)
POACEAE *Cenchrus spinifex* Cav. **Common Sandbur** (S 730 EH/SW)
POACEAE *Chloris verticillata* Nutt. **Tumble Windmill Grass** (S 582 R; WCM/VAM262)
POACEAE *Coelorachis cylindrica* (Michx.) Nash **Carolina Joint-Tail** (S 660 B)
POACEAE *Desmazeria rigida* (L.) Tutin (S 573 L)
POACEAE *Digitaria cognata* (Schult.) Pilg. ssp. *pubiflora* (Vasey) Wipff **Western Witch Grass** (S 447 DG; S 506 EH; S 640 B)
POACEAE *Eleusine indica* (L.) Gaertn. **Goose Grass** (WCM/VAM 264)
POACEAE *Elymus canadensis* L. **Canada Wild Rye** (S 274 B; S 276 B)
POACEAE *Eragrostis curtipedicellata* Buckley **Gummy Love Grass** (S 493 B; S 637 B; S 789 B)
POACEAE *Eragrostis intermedia* Hitchc. **Plains Love Grass** (S 662 B)
POACEAE *Eragrostis pilosa* (L.) P.Beauv. **India Love Grass** (S 663 B)
POACEAE *Eragrostis secundiflora* J. Presl. ssp. *oxylepis* (Torr.) S.D. Koch **Red Love Grass** (S 734 EH/SW)
POACEAE *Eragrostis sessilispica* **Tumble Love Grass** (KRN 889)
POACEAE *Eriochloa sericea* (Scheele) Munro ex Vasey **Texas Cup Grass** (S 654 B)
POACEAE *Erioneuron pilosum* (Buckley) Nash **Hairy Tridens** (S 379 DG; S 588 DG; S 235 DG)
POACEAE *Hordeum pusillum* Nutt. **Little Barley** (S 151 B; S 208 DG; S 251 GS)
POACEAE *Limnodea arkansana* (Nutt.) L.H. Dewey **Ozark Grass** (S 656 B)
POACEAE *Lolium perenne* L. ssp. *perenne* **Perennial Rye Grass** (S 196 R/DG; S 243 B)
POACEAE *Lolium perenne* L. **Perennial Rye Grass** (S 262 GS; S 383 DG)
POACEAE *Muhlenbergia reverchonii* Vasey & Scribn. **Seep Muhly** (S 438 GS; S 505 EH; S 726 B)
POACEAE *Nassella leucotricha* (Trin. & Rupr.) Barkworth **Texas Winter Grass** (S 278 B; TFR 220 B)
POACEAE *Panicum aciculare* Desv. var. *angustifolium* Elliott **Needle-Leaf Rosette Grass** (S 339 HS)
POACEAE *Panicum acuminatum* Sw. var. *lindheimeri* (Nash) Lelong **Lindheimer's Rosette Grass** (S 263 GS; S 338 HS; S 520 MGH/SW)
POACEAE *Panicum acuminatum* (Sw.) Gould & C.A.Clark **Tapered Rosette Grass** (ROK 12205 GS)
POACEAE *Panicum capillare* L. **Witchgrass** (S 786 R; S 799 B)
POACEAE *Panicum hallii* Vasey var. *hallii* **Hall's Panic Grass** (S 650 B)
POACEAE *Panicum obtusum* Kunth **Vine Mesquite** (S 277 B)
POACEAE *Panicum oligosanthes* Schult. var. *scribnerianum* (Nash) Gould **Scribner's Rosette Grass** (S 244 B; S 491 B)
POACEAE *Panicum virgatum* L. **Switchgrass** (S 468 HS/SW; 470 B; S 500 EH; S 524 HS/SW; S 692 DG)
POACEAE *Phalaris caroliniana* Walter **Wild Canary Grass** (S 272 GS; S 644 GS)
POACEAE *Poa annua* L. **Annual Bluegrass** (S 250 GS)
POACEAE *Polypogon monspeliensis* L. **Rabbit's-Foot** (S 290 GS)
POACEAE *Schedonnardus paniculatus* Nutt, **Tumble Grass** (S 324 B)
POACEAE *Schizachyrium scoparium* (Michx) Nash **Little Bluestem** (S 461 MGH; S 477 B)
POACEAE *Setaria parviflora* (Poir) Kerguelen **Knot-Root Bristle Grass** (S 444 R)
POACEAE *Setaria pumila* (Poir.) Roem. & Schult. **Yellow Bristle Grass** (S 412 EH)
POACEAE *Setaria reverchonii* (Vasey) Pilg. **Reverchon's Bristle Grass** (ROK 12155 DG)
POACEAE *Sorghastrum nutans* (L.) Nash **Yellow Indian Grass** (S 462 MGH; S 485 B)
POACEAE *Sorghum halepense* (L.) Pers. **Johnson Grass** (TFR 222 B)

POACEAE *Sporobolus compositus* (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi **Meadow Dropseed** (S 471 B; S 504 EH; S 736 EH/SW; 791 B)
POACEAE *Sporobolus ozarkanus* Fernald **Ozark Dropseed** (S 793 DG)
POACEAE *Tridens albescens* (Vasey) Wooton & Standl. **White Tridens** (S 249 GS; S 646 GS)
POACEAE *Tridens flavus* (L.) Hitchc. **Purpletop** (S 399 EH; S 738 XR)
POACEAE *Tridens muticus* (Torr.) Nash var. *elongatus* (Buckley) Shinners **Rough Tridens** (S 448 DG; S 479 B)
POACEAE *Tridens muticus* (Torr.) Nash var. *muticus* **Slim Tridens** (S 495 DG)
POACEAE *Tripsacum dactyloides* L. **Eastern Gamma Grass** (S 330 B)
POACEAE *Trisetum interruptum* Buckley **Prairie Trisetum** (S 209 G; S 231 B; S 250b DG)
POACEAE *Triticum aestivum* L. **Bread Wheat** (ROK 12140 R)
SMILACACEAE *Smilax bona-nox* L. **Saw Greenbriar** (S 397 EH; S 518 MGH/SW; WCM/VAM 138)
TYPHACEAE *Typha domingensis* Pers. **Narrow-Leaf Cat-Tail** (S 285 HS)

VITA

Education

Newman Smith High School, Carrollton, Texas — May 2005
Diploma
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Professional Experience

Botanical Research Institute of Texas
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Teaching Experience

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ABSTRACT

By Rebecca Kathleen Swadek B.S. 2009
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Political boundaries frequently define local floras. This floristic project takes a geological approach inspired by *Dalea reverchonii* (Comanche Peak Prairie Clover), which is endemic to glades of the Walnut Formation. The Cretaceous Walnut Formation (Comanchean) lies on the drier western edge of the Fort Worth Prairie in North Central Texas. Its shallow limestone soils, formed from alternating layers of hard limestone and clayey marl, support a wide variety of habitats. Glades of barren limestone typically appear on ridgetops, grassland savannas form on eroding hillslopes, and seeps support a variety of hyperseasonal vegetation. Vouchers were collected from January 2010 to December 2011 resulting in 79 families 268 genera 423 species and 437 taxa. The largest families being the Poaceae, Asteraceae, and Fabaceae. Results indicate floristic affinities to Limestone Cedar Glades of the Southeastern United States and to calcareous Apacherian Savannas of Southwestern North America.