Calcareous prairie vegetation of Smith Prairie in Cleburne, Texas

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ABSTRACT

We analyzed a calcareous prairie remnant in the Grand Prairie (GP) ecoregion at Smith Prairie, near Cleburne, Texas and described species composition, biomass, and structure of vegetation. The site had not been grazed by cattle in decades, but because of a Cleburne, Texas, mowing ordinance, it has been mowed several times per year over the decades. Our analysis was conducted to provide baseline knowledge on the natural vegetation of this calcareous prairie in Texas and to provide data to the city of Cleburne that frequent mowing should be terminated to promote prairie succession. The prairie remnant was comprised of two vegetational layers: 1**)** upper-canopy, mainly along an intermittent stream consisting of a few scattered shrubs and trees including *Celtis laevigata* (sugarberry), *Juniperus asheii* (Ashe's juniper), and *Prosopis glandulosa* (honey mesquite) 2) open areas containing annual and perennial forbs and grasses. The most important forbs were *Biflora Americana* (prairie bishop) and *Salvia texana* (Texas sage). The most important grass was *Schizachyrium scoparium* (little bluestem). Prairie bishop, which is an annual forb, was common in the spring but did not occur in the other seasons. Texas sage and little bluestem, both perennial forbs, were common in all three growing seasons. Live biomass, diversity, and number of exotic species were similar to prairie remnants from the Blackland Prairie, east of the site, which were also dominated by little bluestem but had different forb species. This is the easternmost prairie remnant of the GP that has been analyzed quantitatively and seasonally. *Published online* ***www.phytologia.org*** *Phytologia 105(3): 71-83 (December 21, 2023). ISSN 030319430.*

KEY WORDS: Calcareous prairie remnant, Grand Prairie, Plant community ecology

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Greater than 90% of the area once occupied by the tallgrass prairie in North America has been modified for agriculture (Samson & Knopf 1994), resulting in a loss of biodiversity and ecosystem services. Temperate grasslands are among the most modified ecosystems on earth due to their soils and ease of conversion to cropland (Henwood 2010). In the Central Grassland of North America, 21.5 million ha of grassland, an area the size of Kansas, was converted to cropland between 2009 and 2015, with the region losing more habitat in 2014 than the Brazilian Amazon lost to deforestation during that time period (Gage et al. 2016; World Wildlife Fund 2016).

Therefore, description of the natural vegetation is an important phase in understanding and conserving Texas prairie areas. There has been limited description and vegetational analysis of such communities (TPWD 2012). The Blackland Prairie (BP), with gently rolling to nearly level topography and dark calcareous clay soils that developed with prairie vegetation, was the reason most of this region of Texas was put into cultivation. Today, only small acreages of land remain in hay meadows or rangeland with tall grass vegetation in the BP (Correll and Johnston 1979). The BP may be divided into four bands of grassland separated by various mixtures of oak woodland. The San Antonio and Fayette Prairies extend southward with the main arm of the BP extending northward to the Red River along the Oklahoma border (Smeins 2004). The Grand Prairie (GP) is an arm that extends northward between narrow oak woodlands known as the East and West Cross Timbers (Landers 1987). The north-central portion of Texas immediately

south of the Red River consists of alternating, north/south trending belts of rolling prairies, savannas, woodlands, and forests (Smeins 2004). While these zones are in places distinct, the woodlands and prairies often intergrade with one another and form a patchwork mosaic, which captures the meaning of the French derived term "prairie," which implies a rolling grassland with woody plants present or within visual range (Weniger 1984). The GP as viewed by Kendall (1845) was "a prairie region utterly destitute of timber" and "as far as the eye could reach ... nothing could be seen but a succession of smooth, gently undulating prairies." Smythe (1852) described the GP as "prairie, with an occasional strip of woodland," "beautiful groves of Live Oak ... crowning every hill" and "densely tangled cedar ravines." Thus, while generally described as open grassland compared to the Cross Timbers, the GP contained woody elements (Smeins 2003), and, the river bottoms of both regions were typically forested or, at least in most places, had a major woody component (Kendall 1845). Geologic history and resultant landforms and soils distinguish the GP from the BP because this portion of Texas has been variously under epicontinental seas that have produced a great variety of sandstone, limestone, and associated sedimentary substrates (Smeins 2004). The sandy substrates generally occur where the sea margin or coastline persisted for long periods and limestone developed in what were reefs, bays, and lagoons (Hill 1887, 1901). Hill (1901) points out that although often confounded with the BP, the GP differs from it in many physical features. In general, the surfaces are flat rather than undulating and the valley slopes are scarped or terraced, rather than rounded. The residual soils and regolith are shallow in comparison with those of the BP, and are of brown colors instead of black. The chief difference is the underlying limestones (Hill 1901) of the GP. The GP occurs on limestone substrates and the Mollisols derived from them, whereas the Cross Timbers occur on sandy substrates over Alfisols (Godfrey et al. 1973). The GP is generally considered to be the southern extension of the True, Tallgrass, or Bluestem Prairie occurring on limestone-derived Mollisols that are generally rather shallow and rocky (Smeins 2004). According to Elliott et al. (2014), soils of the GP in Texas differ from those of the BP in being browner in color and containing more rock fragments, with soils of this area more frequently characterized as Mollisols, as opposed to the Vertisols more characteristic of the BP.

Diggs et al. (1999) describe the GP as a vegetational region composed of the Fort Worth Prairie to the north of the Brazos River and the Lampasas Cut Plain to the south. The GP roughly corresponds to the Comanche Plateau, a region related geologically to the Edwards Plateau to the south but from which the limestones of the Edwards Formation have in large part been eroded away, exposing older Cretaceous formations in a dissected landscape (Hill 1901; Fenneman 1931; Stephens & Holmes 1989). The most significant of these strata from the standpoint of vegetation structure and endemism are the Walnut Formation and Glen Rose Formation (Locklear 2017). These are composed of erosion-resistant limestones beds and less consolidated strata termed marl, clay, or shale, creating a diversity of habitats including barrens, glades, and seeps that supports small communities of herbaceous vegetation within the surrounding juniper-oak or oak woodland/savanna and grassland that have been called Reverchon Rocklands (Locklear 2017). The distinctiveness of the flora and vegetation of the GP has long been recognized (Hill 1901; Dyksterhuis 1946; Diamond & Smeins 1985; Smeins 2004) but little quantitative work has been produced for the GP.

We conducted this investigation to provide descriptions and analyses of calcareous prairies of the GP (Diggs et al. 1999). Currently there is a need for quantitative data of this vegetation type, which is lacking for much of Texas (Diamond et al. 1985) and because of ongoing classification and ground-truthing of natural plant communities (Elliott 2013), as well as prairie reclamation and restoration projects.

MATERIALS AND METHODS

The study area was within the GP ecoregion (Diggs et al. 1999) and Cross Timbers and Prairies vegetational area (Correll and Johnston 1979) in Johnson County, Texas (Figure 1). The site had not been grazed by cattle in decades but has been mowed once or twice per year for decades, is about 4.5 ha in size and privately owned by the Smith family in Cleburne, Texas. It is referred to as Smith Prairie and is located

at 32.3471010, -97.4342060. The GP ecoregion lies just to the west and north of the BP ecoregion in Texas, and is typified by the area between Fort Worth and Decatur (Texas Parks and Wildlife Department (TPWD) 2012). The vegetation is very similar to that of the BP, but the soils are generally shallower and the rainfall averages are less than the BP (TPWD 2012). The general soil map unit is Aledo-Bolar on a ridgetop, which are shallow to moderately deep with limestone fragments and slopes of 1-8% with the soil surface consisting of dark, grayish brown clay loam with 10% limestone fragments by volume overlaying a gravelly clay loam that is about 75% limestone fragments by volume (Coburn 1985).

Figure 1. Map of Texas showing the location of Johnson County. The site is near the city of Cleburne at 32.3471010, -97.4342060.

The Texas Native Prairie Remnant Project forms (Texas Master Naturalist, Gideon Lincecum Chapter 2009) were used to define the area as a prairie remnant and a list of species encountered, while conducting the survey is included in Table 1. To obtain quantitative data, transects that were 50 m in length were aligned N-S and E-W and crossed at 25 m. Random numbers were generated for each 25 m segment for the four cardinal directions. Using these random sites, we clipped aboveground biomass at Smith Prairie to 2 cm height in each of 12 plots (0.71 x 0.71 m; total area of 0.5 m^2; Polley et al. 2005). Samplings were taken in summer, spring and fall of 2019-2021 (Table 2) for a total of 6.0 m^2 sampled over the time of the investigation. Live (green) tissue removed from each sample was separated by species, dried to constant mass at 60°C, and then weighed as done by Polley et al. (2005) for three BP remnants.

Table 1. Plants observed using Texas Native Prairie Remnant Project form listed alphabetically by family, and scientific name (Diggs et al. 1999). Common names are in parentheses.

Agavaceae	*Yucca pallida* (pale yucca)
Apiaceae	*Biflora americana* (prairie-bishop)
	Polytaenia nuttallii (prairie-parsley)
	Treprocarpus aethusae (treprocarpus)
Asclepiadaceae	*Asclepias* spp. (milkweeds)
Asteraceae	*Ambrosia psilostachys* (western ragweed)
	Arnoglossum plantagineum (prairie plantain)

	Aster sp. (aster)
	Centaurea americana (American basketflower)
	Cirsium texanum (Texas thistle)
	Crepis pulchra (showy hawk's-beard)
	Engelmannia peristema (Engelmann's daisy)
	Gaillardia pulchella (fire-wheels)
	Guiterrezia amoena (broomweed)
	Liatris sp. (gayflower)
	Lindheimeri texana (Texas star)
	Marshallia caespitosa (Barbara's-buttons)
	Rudbeckia sp. (coneflower)
	Silphium albiflorum (white rosinweed)
	Symphyotricum ericoides (heath aster)
	Tetraneuris scaposa (Plains yellow daisy)
	Thelesperma filifolium (greenthread)
Cactaceae	*Opuntia* spp. (pricklypear cactus)
Commelinaceae	*Commelina erecta* (widow's tear)
	Tradescantia sp. (spiderwort)
Cupressaceae	*Juniperus asheii* (Ashe's juniper)
Cuscutaceae	*Cuscuta indecora* (showy dodder)
Euphorbiaceae	*Croton michauxii* (narrow-leaf rushfoil)
	Phyllanthus polygonoides (knotweed leaf-flower)
	Tragia ramosa (catnip noseburn)
Fabaceae	*Desmanthus illinoensis* (Illinois bundleflower)
	Lupinus texensis (Texas bluebonnet)
	Prosopis glandulosa (honey mesquite)
	Vicia ludoviciana (deer pea vetch)
Iridaceae	*Herbertia lahue* (herbertia)
	Sisyrinchium angustifolium (Bermuda blue-eyed-grass)
Krameriaceae	*Krameria lanceolata* (trailing ratany)
Lamiaceae	*Hedeoma reverchonii* (rock hedeoma)
	Salvia texana (Texas sage)
	Scutellaria drummondii (Drummond's skullcap)
	Warnockia scutellarioides (prairie Brazoria)
Liliaceae	*Nothoscordum bivalve* (crow poison)
Linaceae	*Linum* sp. (flax)
Onagraceae	*Calylophus berlandieri* (half-shrub sundrops)
	Gaura sp. (gaura)
	Oenothera sp. (primrose)
Oxalidaceae	*Oxalis corniculata* (creeping ladies'-sorrel)
Plantaginaceae	*Plantago* sp. (plantain)
	Plantago helleri (cedar plantain)
Poaceae	*Andropogon gerardii* (big bluestem)
	Aristida purpurea (purple threeawn)
	Bouteloua hirsuta (hairy grama)
	Bouteloua pectinata (tall grama)
	Bromus japonicus (Japanese brome)
	Buchloe dactyloides (buffalograss)
	Cynodon dactylon (Bermudagrass)
	Elymus canadensis (Canada wildrye)
	Muhlenbergii reverchonii (Reverchon's muhly)

	Nasella leuchotricha (needlegrass)
	Panicum virgatum (switchgrass)
	Schizachyrium scoparium (little bluestem)
	Sorghastrum nutans (Indiangrass)
	Sorghum halapense (Johnsongrass)
	Sporobolus compositus (tall dropseed)
Polygonaceae	*Eriogonum annuum* (annual buckwheat)
Ranuncleaceae	*Anemone berlandieri* (Berlandier's anemone)
Rubiaceae	*Hedyotis nigricans* (prairie bluets)
	Sherardia arvensis (field-madder)
Sapotaceae	*Sideroxylon lanuginosum* (bumelia)
Scrophulariaceae	*Castilleja purpurea* (purple paintbrush)
Ulmaceae	*Celtis laevigata* (sugarberry)

We calculated density (plants/m^2), frequency, and importance values obtained by adding density and frequency, and dividing by two (Brower et al. 1997). Relative importance values (%) are reported (Table 3; Brower et al. 1997). Biomass, exotic species, and Simpson diversity indexes, richness, and evenness (Polley et al. 2005) as well as Shannon diversity were examined (Table 4). Shannon diversity indexes, richness, and evenness were calculated according to formulas in Ludwig and Reynolds (1988).

Species of plants were identified and classified using Diggs et al. (1999), which also served as the reference for common and scientific names. We deposited voucher specimens in the herbarium (TAC) at Tarleton State University in Stephenville, Texas.

RESULTS

Twenty-five families were observed at Smith's Prairie with the sunflower and grass families having the most species (Table 1). *Biflora americana* (prairie bishop), which is an annual forb was common in the spring but did not occur in the other seasons (Table 2). *Salvia texana* (Texas sage) and *Schizachyrium scoparium* (little bluestem), both perennials, were common in all three growing seasons (Table 2).

Biomass was about the same in the summer and fall seasons but dropped in the spring samples, which had the highest amounts of litter (Table 2). The most important forbs were prairie bishop and Texas sage (Table 3). The most important grass was little bluestem (Table 3). Live biomass, diversity, and number of exotic species were similar to prairie remnants from the BP (Table 4), which were east of the site and also dominated by little bluestem but had different forb species.

Table 2. Species arranged alphabetically, biomass (g), and number of individuals for Smith's Prairie remnant over three samples. Introduced, exotic species are indicated with an asterisk (*).

Sample 1 (2.0 m^2)	Summer	June 1, 2020
Species (29 total)	Biomass (g)	Individuals
Anemone berlandieri	0.5	4
Aristida purpurea	0.41	5
Biflora americana	38.7	299
Bouteloua hirsuta	0.16	1
Bouteloua pectinata	80.4	50
Calylophus berlandieri	3.50	27
Castilleja purpurea	14.03	20
Croton michauxii	0.81	17

Cuscuta indecora	0.10	1
Eriogonum annuum	0.05	1
Gaillardia pulchella	5.30	21
Hedeoma reverchonii	1.50	8
Hedyotis nigricans	3.69	25
Krameria lanceolata	28.38	169
Linum sp.	0.32	8
Lupinus texensis	0.16	1
Marshallia caespitosa	0.60	1
Phyllanthus polygonoides	0.25	14
Plantago sp.	2.81	9
Plantago helleri	0.50	8
Polytaenia nuttallii	1.33	24
Salvia texana	351.30	55
Schizachyrium scoparium	10.40	29
*Sherardia arvensis**	0.03	2
Sisyrinchium angustifolium	0.41	6
Tetraneuris scaposa	1.43	4
Thelesperma filifolium	0.59	9
Tragia ramosa	0.70	2
Warnockia scutellarioides	1.60	39
Unknown specimens	2.76	46
Total Biomass	552.72	
Litter	160.6	
Sample 2 (2.0 m^2)	Fall	October 5, 2020
Species (12 total)	Biomass (g)	Individuals
Bouteloua hirsuta	4.6	37
Bouteloua pectinata	2.51	2
Croton michauxii	0.44	3
Guiterrezia amoena	6.00	40
Hedeoma reverchonii	0.50	8
Herbertia lahue	0.43	1
Linum sp.	0.52	4
Salvia texana	497.70	24
Schizachyrium scoparium	77.0	59
Scutellaria drummondii	0.27	4
Thelesperma filifolium	0.56	1
Tragia ramosa	0.55	8
Unknown specimens	3.75	5
Total biomass	594.83	
Litter	212.8	
Sample 3 (2.0 m^2)	Spring	April 17, 2021
Species (24 total)	Biomass (g)	Individuals
Bouteloua pectinata	1.27	6
*Bromus japonicus**	2.74	57
Calylophus berlandieri	6.96	13
Castilleja purpurea	1.98	1
*Crepis pulchra**	0.01	1

Engelmannia peristema	2.27	5
Eriogonum annuum	2.96	4
Gaillardia pulchella	6.17	67
Hedeoma reverchonii	0.01	2
Marshallia caespitosa	11.28	12
Muhlenbergii reverchonii	5.07	8
Oxalis corniculata	0.02	2
Salvia texana	105.51	227
Schizachyrium scoparium	37.6	23
Scutellaria drummondii	0.96	7
*Sida arvensis**	0.02	6
Sisyrinchium angustifolium	0.05	2
Tragia ramosa	0.61	7
Treprocarpus aethusae	1.42	3
Thelesperma filifolium	1.52	15
Vicia ludoviciana	0.36	3
Unknown sedge	1.07	4
Unknown dicot	0.66	8
Unknown mint	3.74	37
Total biomass	194.32	
Litter	633.94	

Table 3. Scientific names of species, density, frequency, and relative importance values (IV) for species at Smith Prairie remnant. An asterisk indicates an introduced, exotic species. Species are arranged from greatest to least importance values

Species names	Density (D; individuals/m^2)	Frequency (F; species sampled/ Total samples)	Importance Value (IV; D+F/2)	Relative IV (%)
Salvia texana	51	1.00	26.00	19.52
Biflora americana	49.83	0.33	25.10	18.84
Krameria lanceolata	28.17	0.33	14.25	10.70
Schizachyrium scoparium	18.5	1.00	9.75	7.32
Gaillardia pulchella	14.67	0.67	7.67	5.76
Bouteloua pectinata	9.67	1.00	5.34	4.01
*Bromus japonicus**	9.5	0.33	4.92	3.69
Eriogonum annuum	0.83	0.67	0.75	0.56
Marshallia caespitosa	2.17	0.67	1.42	1.07
Anemone berlandieri	0.67	0.33	0.50	0.38
Sisyrinchium angustifolium	1.33	0.67	1.00	0.75
Calylophus berlandieri	6.67	0.67	3.67	2.76
Guiterrezia amoena	6.67	0.33	3.5	2.63
Warnockia scutellarioides	6.5	0.33	3.42	2.57
Thelesperma filifolium	4.17	1.00	2.59	1.94
Hedyotis nigricans	4.17	0.33	2.25	1.69
Polytaenia nuttallii	4.0	0.33	2.17	1.63
Castilleja purpurea	3.5	0.67	2.09	1.57
Croton michauxii	3.33	0.67	2.00	1.50

Hedeoma reverchonii	3.0	1.0	2.0	1.50
Tragia ramosa	2.00	1.00	1.5	1.13
Linum sp.	2.00	0.67	1.34	1.00
Phyllanthus polygonoides	2.33	0.33	1.33	1.0
Scutellaria drummondii	1.83	0.67	1.25	0.94
*Sida arvensis**	1.33	0.67	1.00	0.75
Plantago sp.	1.5	0.33	0.92	0.69
Muhlenbergii reverchonii	1.33	0.33	0.83	0.62
Plantago helleri	1.33	0.33	0.83	0.62
Aristida purpurea	0.83	0.33	0.58	0.44
Engelmannia peristema	0.83	0.33	0.58	0.44
Tetraneuris scaposa	0.67	0.33	0.50	0.38
Treprocarpus aethusae	0.50	0.33	0.42	0.32
Vicia ludoviciana	0.50	0.33	0.42	0.32
Oxalis corniculata	0.33	0.33	0.33	0.25
*Crepis pulchra**	0.17	0.33	0.25	0.19
Cuscuta indecora	0.17	0.33	0.25	0.19
Herbertia lahue	0.17	0.33	0.25	0.19
Lupinus texensis	0.17	0.33	0.25	0.19
Total			133.2	100.05

Table 4. Live biomass (g/ m^2), Simpson's species diversity, species richness, number of exotics, percentage of exotic biomass, Simpson's evenness, Shannon diversity, and Shannon's evenness at the Smith Prairie remnant compared to remnants in the BP. When data was not available, N/A is used.

Prairie Names:	Smith Prairie remnant	Farmersville Prairie remnant (Polley et al. 2005)	Riesel Prairie remnant (Polley et al. 2005)	Temple Prairie remnant (Polley et al. 2005)
Live biomass (BM) (g/m^2)	261.0	290.1	217.4	158.0
Simpson's species diversity	8.84	12.70	5.60	9.00
Species richness	37	43	41	42
Number of exotic species	2	4	3	2
Exotic species (% BM)	3.46	9.20	0.50	< 0.10
Simpson's species evenness	0.24	0.30	0.14	0.21
Shannon diversity	2.67	N/A	N/A	N/A
Shannon's species evenness	0.75	N/A	N/A	N/A

DISCUSSION

Bruner (1931) found that little bluestem was the principal climax species in Oklahoma. A general increase of little bluestem may be expected to be accompanied by a general increase of perennial forbs with increases of *Bouteloua gracilis* (hairy grama) and *B. curtipendula* (sideoats grama) on shallow soils and of *Andropogon gerardii* (big bluestem) and *Sorghastrum nutans* (Indiangrass) on deep soils of the Fort Worth Prairie (Dyksterhuis 1946). Based on our limited data from this investigation, it appears safe to conclude that little bluestem originally constituted two-thirds of the understory vegetation of uplands in the Western Cross Timbers (Dyksterhuis 1948) and the GP. Samples of relicts of the Fort Worth Prairie to the east by Dyksterhuis (1946) had essentially the same percentage of little bluestem as our investigation to the west in the GP. Species more frequent in a calcareous grassland mosaic near Austin, Texas, included forbs such as *Hedyotis nigricans* (prairie bluets), *Ambrosia psilostachys* (western ragweed), *Plantago* spp. (plantains), *Aster* (aster), and *Sisyrinchium* (blue-eyed-grasses) with the dominant grass being little bluestem (Lynch,1962). This investigation south of our study site on calcareous soil contained similar forb species to those found at Smith Prairie.

Dominant species reported from the BP according to Correll and Johnston (1979) include little bluestem, big bluestem, yellow Indian grass, *Panicum virgatum* (switch grass), side-oats grama, hairy grama, *Sporobolus compositus* (tall dropseed), and *Bothriochloa laguroides* ssp. *torreyana* (silver bluestem). With heavy grazing, *Nasella leuchotricha* (needlegrass), *Buchloe dactyloides* (buffalo grass), *Bouteloua* spp. (gramas), and many annual species become abundant (Correll and Johnston 1979). Using a variety of analyses, a community type termed the *Schizachyrium* type on Mollisols of the Fort Worth Prairie was defined using data from Dyksterhuis (1946) and from 34 other relicts in Texas (Diamond and Smeins 1985). Our prairie remnant was dominated by little bluestem and was similar to the *Schizachyrium* type on Mollisols described by Diamond and Smeins (1985). Also in 1985, Coburn discussed the range type for this area near Cleburne, Texas as a climax of mid and tall grasses interspersed with an abundance of forbs. The range site was described as having 45% little bluestem with 15% Indiangrass, big bluestem, and switchgrass. Other grasses that we identified on Smith Prairie, such as sideoats grama, tall dropseed, hairy grama, buffalograss, and Texas wintergrass as well as forbs found at Smith Prairie such as *Engelmannia peristema* (Engelmann's daisy), aster, *Guara* spp. (guara), and *Liatris* spp. (gayfeather) comprised the rest of the description (Coburn 1985).

Smeins (2004) described late-successional communities of the GP that ware characterized by little bluestem, big bluestem, Indiangrass, and switchgrass. Midgrasses including sideoats grama, *Nasella leuchotricha* (needlegrass), tall dropseed, silver bluestem, and hairy grama may be important on shallow soils or may increase as grazing intensity increases (Smeins 2004). Woody species are usually in low abundance, particularly where fire is a frequent influence; however, *Quercus* spp. (oak), *Celtis laevigata* (sugarberry), and *Prosopis glandulosa* (honey mesquite) are commonly found locally across the grassland (Smeins 2004). Elliott (2013) and Elliott et al. (2009-2014) reported that little bluestem tends to dominate sites of this system, with sideoats grama as another significant component. At Smith Prairie, sideoats grama was a minor component and was not sampled in our quantitative portion of the investigation. Other grasses that were frequently present include needlegrass, silver bluestem, *Aristida* spp. (threeawn), big bluestem, buffalograss, tall dropseed, hairy grama, Indiangrass, *Muhlenbergii* spp. (muhly), *Chloris verticillata* (tumble windmillgrass), and *Erioneuron pilosum* (hairy tridens) as well as forb species such as *Symphyotrichum ericoides* (heath aster), western ragweed, *Tragia ramosa* (catnip noseburn), *Amphiachyris dracunculoides* (common broomweed), *Dyschoriste linearis* (narrowleaf dyschoriste), Texas sage, evening primroses (*Oenothera* spp.), prairie bluets, *Thelesperma* spp. (greenthread), *Dalea* spp. (prairie clover), and *Psoralidium* spp. (scurfpea) may be encountered (Elliott 2013; Elliott et al. 2009-2014). At our site, we observed all of these except silver bluestem, tumble windmillgrass, hairy tridens, heath aster, common broomweed, narrowleaf dyschoriste, prairie clover, and scurfpea. We identified a different species of aster

and broomweed at the site. Overall, our site description closely matched that of Elliott (2013) and Elliott et al. (2014).

The most important forbs at Smith Prairie were prairie bishop and Texas sage. The most important grass was little bluestem which is common in prairie relicts (Dyksterhuis 1946; Launchbaugh 1955). Other important grasses and forbs (%IV >4.00) included *Bouteloua pectinata* (tall grama) and *Gaillardia pulchella* (fire-wheels). Prairie bishop, an annual herb on limestone prairies, slopes, and roadsides (Diggs et al. 1999) was the dominant forb along with Texas sage. Texas sage is a perennial herb on limestone prairies and outcrops (Diggs et al. 1999), like the limestone substrate at Smith Prairie. Little bluestem is a perennial grass that is often a vegetational dominant in north Texas prairies (Diggs et al. 1999) and tall grama is another perennial grass that occurs on well drained calcareous soils on hills and outcrops (Diggs et al. 1999). Fire-wheels are perennial forbs (Diggs et al. 1999) that occur in prairies and disturbed areas (Diggs et al. 1999).

Endemic species found in our investigation, limited to or primarily centered in the GP (Locklear 2017) include white rosinweed (*Silphium albiflorum*) and pale yucca (*Yucca pallida*), both of which occur throughout the GP region and overlapping into the Edwards Plateau (Locklear 2017). A number of species are strongly associated with rock outcrop communities in the `GP and were found during our investigation, but range more widely (Locklear 2017), including tall dropseed, *Hedeoma reverchonii* (rock hedeoma), *Marshallia caespitosa* (Barbara's-buttons), and *Muhlenbergia reverchonii* (Reverchon's muhly). Exotic species were also sampled at Smith Prairie and TPWD (2012) lists *Cynodon dactylon* (Bermudagrass) as a problematic exotic, but did not mention *Bromus japonicus* (Japanese brome) or *Sorghum halepense* (Johnsongrass), which are also prairie invaders. All three of these exotic grasses occurred at Smith Prairie with Japanese brome becoming common in the spring (Table 2) and Bermudagrass and Johnsongrass occurring on prairie fringes, primarily near the homesite and roadsides near the study site.

Perennial forbs, with a coverage of 8.21 percent and frequency of 100%, were of great significance in the relict vegetation of the Fort Worth Prairie and annual grasses and forbs were both progressively displaced by perennial grasses and forbs (Dyksterhuis 1946). Forbs were more important than grasses at Smith Prairie and this trend is explained by the following. A definite trend in composition of decreaser, increaser, and invader grasses occurred on various study areas as vegetation retrogression occurred as was reported by Sims and Dwyer (1964). The decreasers, little bluestem, big bluestem, Indiangrass, and switchgrass comprised 93 percent of the grasses in the study area that was managed properly and declined to 0% in those that were overgrazed (Sims and Dwyer 1964). Of the species of increaser grasses reported by Sims and Dwyer (1964), only sideoats grama, hairy grama. and tall dropseed increased in overgrazed sites. Forbs were important in many of their study areas and western ragweed tended to increase with a decline in grassland condition (Sims and Dwyer 1964). Annual and total forb species numbers increased in most cases under progressively heavier grazing with annual forbs appearing to react to seasonal weather changes and grazing practices more quickly than the grasses (Sims and Dwyer 1964). Disturbance caused by mowing at Smith Prairie may have contributed to the high forb presence found there during the investigation.

Live biomass and number of exotic species were similar to prairie remnants from the BP (Polley et al. 2005; Table 4), which were east of the site and also dominated by little bluestem but had different forb species. These forb species accounted for much of the diversity at Smith Prairie. Diversity at Smith Prairie in the GP was similar to that of remnants investigated in the BP (Polley et al. 2005; Table 4) but GP grasslands had a high diversity of perennial and annual forbs resulting in high species richness (Smeins 2004). Plants in Riesling and Temple prairies (Polley et al. 2007) in the BP had similarities to the GP remnant in this investigation. Temple Prairie remnant dominants from most to least dominant based on biomass included little bluestem, *Helianthus maximiliani* (Maxmillian sunflower), and *Elymus canadensis* (Canada wild rye) while the Riesel Prairie remnant was dominated by little bluestem, *Desmanthus*

illinoensis (Illinois bundleflower), *Arnoglossum plantagineum* (prairie plantain), and Indiangrass. Smith Prairie had little bluestem, prairie bishop, and Texas sage as dominants.

Mowing or the reestablishment of grazing in anthropogenically stressed grasslands can enhance biodiversity (Collins et al. 1998). Frequent mowing has likely changed biodiversity of Smith Prairie. In treatment plots that were mowed weekly for either one or two growing seasons, and control plots that were unmowed, Williams et al. (2007) found that forbs in mowed plots had significantly greater root and shoot mass than those in control plots in the first and second growing seasons but were not significantly more abundant. However, by the fourth growing season, forbs were twice as abundant in the mowed treatments and there were no lasting negative impacts of frequent mowing on the grass population observed (Williams et al. 2007). Tälle et al. (2018) found mowing effects were site-specific, differing between site and study conditions.

In summary, the composition of Smith Prairie is similar to other prairies reported on through time with the exception of high forb composition, usually caused by grazing, but likely influenced by mowing in the case of Smith Prairie. The prairie remnant was comprised of two vegetational layers: 1**)** upper-canopy, mainly along an intermittent stream and consisting of a few scattered shrubs and trees including sugarberry, Ashe's juniper, and honey mesquite. 2) open areas containing annual and perennial forbs and grasses. The most important forbs were prairie bishop and Texas sage. These two forbs were found in other prairie descriptions but were never listed as dominants. The most important grass was little bluestem, which is commonly described as the dominant grass in north Texas prairies. Prairie bishop, which is an annual forb, was common in the spring but did not occur in the other seasons. Texas sage and little bluestem, both perennials, were common in all three growing seasons. Dyksterhuis (1946) described a *Schizachyrium* type for the Fort Worth Prairie and our results were generally similar to his, for Smith Prairie. Live biomass, diversity, and number of exotic species were similar to prairie remnants from the BP, east of our site, which were also dominated by little bluestem, but had different forb species.

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