

**UNDERSTORY VEGETATION OF THORN-SCRUB
WOODLANDS AT THE CHAPARRAL WILDLIFE
MANAGEMENT AREA, DIMMIT AND LASALLE COUNTIES,
TEXAS**

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ABSTRACT

The South Texas Plains was originally open savanna dominated by *Prosopis glandulosa* (honey mesquite) along with scattered brushy regions, whereas the ground layer was dominated by short and mid-grasses and forbs. This open savanna has changed to thorn-scrub woodland within the last 150 years, apparently due to anthropogenic forces, including overgrazing and reduced fire frequency. We undertook this study to determine the structure and composition of these thorn-scrub woodlands at the Chaparral Wildlife Management Area (CWMA), Dimmit and LaSalle Counties, Texas, in the northern half of the South Texas Plains. Within this 6,150 ha site the spring and fall ground layer vegetation under various thorn-scrub woodlands and adjacent aerated (roll-chopped) sites were surveyed. Species diversity was relatively high with 318 species of vascular plants encountered at the CWMA. Fern, "fern-allies", and gymnosperms were represented by 4 taxa in 3 families. Of the remaining taxa, 65 were monocots in 8 families, and 249 were dicots in 63 families. Non-native (exotic) species accounted for 17 taxa, about 5% of the species collected. The Poaceae was the most common family with 49 species, Asteraceae was second with 46 species, and the Fabaceae was represented by 32 species. No state endangered or threatened species were encountered. In both the fall and spring

surveys grasses dominated, introduced *Pennisetum ciliaris* (buffelgrass) being very important, followed by *Urochloa ciliatissima* (fringed signalgrass), *Chloris cucullata* (hooded windmill grass), *Bouteloua hirsuta* (hairy grama), *Eragrostis lehmanniana* (Lehmann's lovegrass), *Aristida purpurea* (purple three-awn), and *Digitaria cognata* (fall witchgrass). Forbs were more common during the spring survey with 98 species found in plots. *Phytologia* 93(1): 13-42 (April 1, 2011).

KEY WORDS: ground-layer vegetation, importance values, South Texas Plains, species list, spring and fall surveys, thorn-scrub communities.

The South Texas Plains once supported an open savanna with a ground layer of short and mid-grasses and forbs in which woody vegetation was dominated by *Prosopis glandulosa* (honey mesquite), along with other shrubs and trees. This region also contained a mosaic of rocky, broken uplands that were dominated by relatively dense brushy vegetation. This open savanna has changed to thorn-scrub woodland within the last 150 years, apparently due to anthropogenic forces (Correll and Johnston 1970; Van Auken 2000; Ruthven 2001). Most of these changes involve dramatic increases in native woody taxa that were historically present in low densities (Johnston 1963; Archer et al. 1988; Archer 1989). Along with this change in shrub and tree density there has been a corresponding change in ground layer species. Major shifts in the abundance of herbaceous species were probably the result of increased shading that caused a decrease in prairie species and a corresponding increase in species that were more shade-tolerant, less fire-tolerant, and more tolerant of moisture extremes.

Anthropogenic forces, particularly increased grazing pressure by domestic livestock, fire suppression, and the introduction of exotic species (particularly grasses) have reduced the abundance of native species. These changes resulted in the destruction of the extensive short and mid-grass prairie matrix (Archer et al. 1988; Ruthven et al. 2000; Ruthven 2001). *Prosopis glandulosa* was the pioneer woody species involved in this transition to thorn-scrub woodland, and is currently the common dominant throughout the southwestern United States and adjacent Mexico (Ruthven 2001). Species in two genera of

well-armed legumes (*Senegalia* and *Vachellia*) are also major components of these thorn-scrub woodlands. These two genera are segregates of the genus *Acacia* (*sensu lato*) and are common throughout the arid and semi-arid environments of the South Texas Plains (Isely 1998).

Thorn-scrub woodlands are common at the Chaparral Wildlife Management Area (CWMA). Within this community type the importance and distribution of the associated ground layer species is determined by various biotic and abiotic factors, such as climate, moisture, edaphic conditions, present and past grazing pressures, and fire. The objective of this study was to examine the structure and composition of the ground layer vegetation of the thorn-scrub woodland and adjacent disturbed sites to understand better the importance, distribution, and habitat preferences of these associated ground layer species.

STUDY AREA

All study sites were at Chaparral Wildlife Management Area (CWMA), Dimmit and LaSalle Counties, Texas (28°20'N, 99°25'W). The CWMA is in the northern half of the South Texas Plains ecological region (Correll and Johnston 1970, Diamond et al. 1987, Ruthven et al. 2000, Ruthven 2001). Located 12 km west of Artesia Wells, the CWMA is deer-proof fenced and about 6,150 ha in size. Purchased in 1969 by the Texas Parks and Wildlife Department, it serves as a research and demonstration area. Domestic livestock have grazed the CWMA since the 18th century (Lehmann 1969). The CWMA utilizes a high intensity, low frequency rotational grazing system with stocking rates of one Animal Unit per 12 ha (Ruthven 2001). Most of the CWMA was chained in 1948 (Ruthven, personal communication). Chaining involves the use of two large tractors with a heavy linked chain connected at each end to each of the tractors. The chain is pulled across the ground, disrupting and pulling out much of the woody vegetation (Lehmann 1984). The land around CWMA is rangeland, most holdings being large cattle ranches.

Hot summers and mild winters characterize the climate of CWMA; short-term droughts are common (Norwine and Bingham 1985). Average daily minimum winter (January) temperature is 5°C,

average daily maximum summer (July) temperature is 37°C, and growing season is 240 to 365 days. Average annual precipitation (1951 to 1978) is 550 mm (Stevens and Arriaga 1985; Cooper et al. 2008). Precipitation patterns are bimodal with peaks in late spring (May and June), and early fall (September and October). Topography is level to gently rolling with an average elevation of 175 m above mean sea level. The thin calcareous soils have low productivity and are dominated by Duval very fine, sandy loams, gently sloping and Duval loamy fine sands, 0 to 5% slope (Gabriel et al. 1994; Stevens and Arriaga 1985). The soil surface layer is reddish brown, slightly acid, very friable, and 0 to 40 cm thick. Also present are shallow limestone ridges (calcareous rises) where soils are mildly to moderately alkaline and have a caliche layer near the surface.

METHODS

Floristic Composition: CWMA was visited five times during the growing seasons of 2001 to 2005. During these visits voucher specimens from all habitat types throughout the CWMA were collected and deposited in the herbaria of the University of Illinois (ILL) and the Illinois Natural History Survey (ILLS), Champaign/Urbana, Illinois. The designation of exotic species follows Correll and Johnston (1970) and Nesom (2008). Nomenclature follows Jones et al. (1997), with the common names mostly from Correll and Johnston (1970).

Ground Layer Sampling: In early November of 2002 and again in late May of 2003 transects were located randomly along cardinal compass directions within each community of the four thorn-scrub communities studied. These sites were the same as those used to sample the woody vegetation of thorn-scrub communities that differed in their overstory composition (Seigler et al. 2007), and were originally selected based on the recommendation of CWMA personnel who located sites where the vegetation was mature and least disturbed. All were near level uplands with minimal disturbance, other than grazing. At these four sites (study sites 1A, 2A, 3A, 4A) a single line transect 50 m long was randomly established near the center of the long axis of each community. Adjacent to these four original study sites, CWMA personnel had previously aerated 2 to 4 hectares, with a double/tandem drum aerator pulled by a D7 bulldozer. Presently, aeration is the preferred choice of wildlife managers to improved pastures in south

Texas. The process is similar to roll-chopping, but the blades along the chopper drum are toothed and set at an angle across the face of the large drum rather than a continuous blade running parallel to the face of the drum (Ruthven and Krakauer 2004). This aerated ground had been left undisturbed for about one year. In each of these successional sites (study sites 1B, 2B, 3B, 4B) a single line transect 50 m long was randomly established near the center of the long axis of each community. In all eight sites studied (four aerated and four not aerated) quadrats 1 m² in size were located alternately along each transect (n = 50 plots). A random numbers table was used to determine the distance (0 to 9 m) a quadrat was located from the transect line. Species cover was determined using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968). The modified Daubenmire cover scale is as follows: class 1 = 0 to 1%; class 2 = >1 to 5%; class 3 = >5 to 25%; class 4 = >25 to 50%; class 5 = >50 to 75%; class 6 = >75 to 95%; class 7 = >95 to 100%. Only ground layer species rooted within the quadrat frame were recorded. Mean cover was determined for each taxon using the mid-point values for each cover class, while Importance Value (IV) was calculated by summing relative cover and relative frequency (total possible 200). Listed below are the eight study sites (Seigler et al. 2007) with the dominant overstory species encountered, these species Importance Values (possible 200), and the GPS coordinates.

Site 1A: *Senegalia greggii* (IV of 68.6), *Opuntia engelmannii* (IV of 28.5), *Vachellia rigidula* (IV of 27.5). 28°20'29"/99°22'47"

Site 1B. Aerated site next to 1A. 28°20'23"/99°22'50"

Site 2A: *Prosopis glandulosa* (IV of 89.0), *Opuntia engelmannii* (IV of 48.8), *Vachellia bravoensis* (IV of 25.9). 28°18'06"/99°21'40"

Site 2B: Aerated site next to 2A. 28°18'11"/99°21'41"

Site 3A: *Opuntia engelmannii* (IV of 56.0); *Prosopis glandulosa* (IV of 52.7); *Vachellia bravoensis* (IV of 27.3). 28°18'07"/99°21'31"

Site 3B: Aerated site next to 3A. 28°18'09"/99°21'28"

Site 4A: *Vachellia rigidula* (IV of 46.8); *Senegalia berlandieri* (IV of 44.3); *Opuntia engelmannii* (IV of 26.7). 28°18'55"/99°20'46"

Site 4B. Aerated site next to 4A. 28°18'57"/99°20'52"

The Sorensen Index of Similarity (ISs) was used to determine the degree of vegetation similarity between the sites surveyed throughout the ICCA (Mueller-Dombois and Ellenberg 1974). This

index utilizes binary data (presence/absence) to measure the similarity in species composition between study sites and is represented by the following equation: $[ISs = 2C/A+B \times 100]$, A equals the number of species in the first community, B equals the number of species in the second community, and C equals the number of species common between the two communities. Pairwise comparisons were made between each of the communities examined for both the November 2002 and the May 2003 surveys.

RESULTS

Species diversity was relatively high with 318 species of vascular plants encountered at CWMA (Appendix I). Fern, “fern-allies”, and gymnosperms were represented by 4 taxa in 3 families. Of the remaining taxa, 65 were monocots in 8 families, and 249 were dicots in 63 families. Non-native (exotic) species accounted for 17 taxa, about 5% of the species collected (Nesom 2008). As is typical of prairie and thorn-scrub vegetation, Poaceae was the most common family with 49 species, Asteraceae was second with 46 species, whereas Fabaceae was represented by 32 species. No state endangered or threatened species were encountered.

Fall Survey: Collectively, 72 species were encountered in the plots of the eight sites examined at CWMA during the fall survey (Table 1), based on the highest average importance value of each species (total IV of a species in all study sites). Grasses and grass-like species dominated, introduced *Pennisetum ciliaris* (buffelgrass) being an important component of five study sites, followed by *Urochloa ciliatissima* (fringed signalgrass), *Chloris cucullata* (hooded windmill grass), *Bouteloua hirsuta* (hairy grama), *Eragrostis lehmanniana* (Lehmann’s lovegrass), *Aristida purpurea* (purple three-awn), *Cyperus retroflexus* (flatsedge), and *Digitaria cognata* (fall witchgrass) that were common in four to seven of the sites studied. Common forbs among the top 10 species included *Evolvulus alsinoides* (ojo de víbora) and *Croton glandulosus* (northern croton), with *Tiquilia canescens* (oreja de perro) being common only in Site 4A where it was the most important species with an IV of 83.1 (200 possible). Site 4A was located on a shallow limestone ridge where soils were moderately alkaline and most of the grass species found on the other study sites

were uncommon or absent. This site had a low ISs when compared to the other sites studied in the fall survey (Table 2).

Of the 72 taxa found in the plots examined, 19 taxa were recorded for only one of the eight sites examined (Table 1). Of these species, most were recorded in low number, occurring in only a few plots. Only in Site 4B did two species restricted to only one site have IVs greater than 2.5 [*Tridens muticus* (IV of 19.9) and *Sideroxylon celastrinum* (IV of 3.4)]. An additional 19 taxa were encountered in only two of the study sites. Over half of this group were common components of one study site, and only rarely encountered in another. Only two exotic species were found in the plots: *Eragrostis lehmanniana* and *Pennisetum ciliaris* (Table 1). Both species had relatively high IVs and are commonly planted for forage (Ruthven 2001, Lonard and Judd 2002).

Spring Survey: Ninety-eight species (excluding the grass taxa that are listed as a species group) were encountered in the plots of the eight sites examined at the CWMA during the spring survey (Table 3). Based on the importance value of each species (total IV of a species on all study sites) members of grass-like species dominated. As grasses were mostly dormant or vegetative, and the same species that we had encountered in the fall survey, we treated the grass taxa as a species group. Together these species usually accounted for more than one-quarter of the total IV in each of the study sites. Dominant forbs in most study sites were *Coreopsis nuecensis* (tick-seed), *Gamochaeta purpurea* (purple cudweed), *Aphanostephus riddellii* (Riddell's lazy daisy), *Oxalis dillenii* (yellow wood sorrel), *Plantago hookeriana* (tallow weed), and *Nothoscordum bivalve* (crow-poison), whereas *Oenothera grandis* (showy ragged evening primrose) and *Tiquilia canescens* (oreja de perro) were common only on the limestone ridge of Site 4A. As in the fall survey, Site 4A had a low ISs when compared to the other sites studied (Table 4).

Of the 98 taxa found in the plots examined, 32 were recorded for only one of the eight sites examined (Table 3). Of these species, most were recorded in low numbers, occurring in only a few plots. Only in Sites 4A and 4B was a species restricted to only one site with an IV greater than 2.5 [*Houstonia croftiae* (IV of 4.4) and *Draba*

cuneifolia (IV of 3.9)]. An additional 14 taxa were encountered in only two of the study sites. Over half of this group were common components of one study site, and only rarely encountered in one other. Except for the two grasses reported in the fall survey no other exotic species were encountered in the plots.

DISCUSSION

The thorn-scrub vegetation of CWMA and surrounding area is representative of that associated with the South Texas Plains (South Texas Brush Country or Tamaulipan Brushlands) (Johnston 1963, Correll and Johnston 1970). Throughout most of this rangeland, *Prosopis glandulosa* is the dominant woody species, with about 10 to 15 other woody or large succulent, mostly thorny species, varying in abundance and composition. At CWMA, *P. glandulosa* is usually the dominant woody species, but, on some areas, other woody legumes are dominant or co-dominant, particularly various species of *Senegalia* and *Vachellia* (*Acacia s.l.*). This woodland community, where dominant trees are more than 3 m tall and formed a 26-60 percent canopy, would be equivalent to the Deciduous Woodland, Mesquite-Huisache Series (*Prosopis glandulosa-Vachellia farnesiana*) of Diamond et al. (1987) with other thorny legume species replacing *V. farnesiana*.

The ground layer vegetation at the study sites at CWMA was mostly similar, many of the species encountered being found on most of the eight study sites. In particular, the associated aerated communities for each of the four thorn-scrub communities studied consistently had ISs between 56.6 and 74.1 for the fall survey (Tables 2), and 65.5 and 83.5 for the spring survey (Table 4). These aerated communities were cleared two years previous to the study but many of the ground layer species were present, many with similar IVs. The few exotic species present (*Pennisetum ciliaris*, *Eragrostis lehmanniana*) mostly did not show much of an increase in frequency, cover, or IV on most aerated communities. In contrast, *Pennisetum ciliaris*, the dominant exotic grass found on some of the study sites did increase in IV from 50.6 to 90.6 on Site 3 (Table 1). Site 3 was slightly drier with *Opuntia engelmannii* the dominant overstory species, which may have accounted for this increase due to lower grazing pressure.

On all study sites, the soil texture was relatively uniform, being sandy loams with 61 to 75% sand, 12 to 20% silt, and 11 to 19% clay, and none were saline. Soils of Sites 1, 2, and 3 were mildly to strongly acidic whereas soils at Site 4, in contrast, were from a calcareous ridge and were mildly to moderately alkaline. Although all sites had relatively high levels of available calcium, site 4, was significantly higher ($P < 0.0001$) (Seigler et al. 2007). These differences in soil pH were probably responsible for some differences recorded in ground layer species distribution at CWMA.

The *Senegalia greggii*/*Opuntia engelmannii* community had a restricted distribution at CWMA (Site 1) being common on dry sandy ridges. At this location *S. greggii* was the dominant member of the community, accounting for one-third of the total IV. This community, which is probably maintained by fire, grazing, and sandy soil, is classified as the Catclaw Acacia Series, Deciduous Scrubland (*Senegalia greggii*). The woody vegetation at this site was short with only a few individuals being more than 2 m tall while the canopy cover was estimated at 25 to 30 percent (Seigler et al. 2007). Both Site 2 and 3 are similar to the Catclaw Acacia Series, being classified as the Deciduous Woodland, Mesquite-Huisache Series (*Prosopis glandulosa-Vachellia farnesiana*) of Diamond et al. (1987) with *Opuntia engelmannii* being common and *Vachellia bravoensis* replacing *V. farnesiana*. The ground layer vegetation in both the spring and fall surveys of the Catclaw Acacia Series (Site 1) and the Mesquite-Huisache Series (Sites 2 and 3) were similar in both the spring and fall surveys with the ISs always 48 or above (Tables 2 and 4).

Vachellia rigidula and *Senegalia berlandieri* dominated limestone ridges (calcareous rises) at CWMA (Site 4). This community was dominated by shrubs or small trees 0.5 to 3 m tall that formed 26 percent or more of the total canopy and was equivalent to the Deciduous Shrubland, Blackbrush Series (*Vachellia rigidula*) of Diamond et al. (1987). Though many of the ground layer species encountered were associated with all of the study sites, some of the species associated with the limestone ridges were found only associated with Sites 4A and B, or were much more common on those sites. Ground layer species mostly associated with these limestone ridges included *Aristida purpurea*, *Astragalus nuttalianus*, *Bouteloua trifida*,

Dyssodia pentachaeta, *Justicia pilosella*, *Lepidium lasiocarpum*, *Menodora heterophylla*, *Nama jamaicense*, *Nothoscorum bivalve*, *Oenothera grandis*, *Spermolepis echinata*, *Tiquilia canescens*, and *Tridens muticus* (Table 1 and 3). Of these, *Aristida purpurea* and *Tridens muticus* were only found at aerated Site 4B of the limestone ridge. The ISs for Site 4A during the fall survey was 17.0 to 30.8, less than half of the ISs recorded for the other sites (Table 2).

In a study on the CWMA involving species distribution under *Prosopis glandulosa* many of the common species found were the same we reported as common in the present study. Ruthven's (2001) list included *Bouteloua hirsuta*, *Chloris cucullata*, *Digitaria cognata*, *Eragrostis lehmanniana*, *Eragrostis secundiflora*, *Panicum capillarioides*, *Paspalum setaceum*, *Urochloa ciliatissima*, and *Evolvulus alsinoides* (Table 1). In a later study involving the species abundance and distribution after aeration, Ruthven and Krakauer (2004) found that aeration maintained woody species diversity, that the woody cover increased very rapidly after aeration, and that grass and forb richness, diversity, and evenness did not differ significantly among treatments.

The reasons for the continued prevalence of thorn-scrub woodland communities along with their associated ground-layer species are not entirely clear, but overgrazing and fire suppression were probably the primary causes (Van Auken 2000). At the time of European settlement much of the South Texas Plains was covered with open savanna and a dense groundcover of grasses and forbs. Many of the herbaceous species of this savanna were associated with the short and mid-grass prairie of central Texas. At that time wildfires were undoubtedly frequent and of sufficient intensity to prevent or delay encroachment by native woody species. However, overgrazing by livestock reduced the fuel load. This associated with fire suppression allowed for a significant decrease in fire frequency creating ideal conditions for the rapid explosion of native invaders. With the development of thorn-scrub communities, the resulting canopy closure, an increased water loss due to more rapid run-off resulted in a decrease of the integrity of the prairie. This decrease in the prairie community structure resulted in a corresponding loss in biodiversity.

ACKNOWLEDGEMENTS

We wish to acknowledge support of this work by a grant from the International Arid Lands Consortium (O1R005), and a grant from the National Science Foundation (NSF DEB 04-15803). We thank The Texas Parks and Wildlife Department, and in particular C. Ruthven, J. F. Gallagher, and D. R. Synatzske of the Chaparral Wildlife Management Area, Dr. Richard Kazmaier, West Texas A & M University, Canyon, Texas, and Dr. Larry Gilbert, University of Texas, Austin, Texas. We acknowledge the help of Dr. Stephen Hill, Illinois Natural History Survey, Champaign, Illinois for the identification of the species of Malvaceae, and Dr. Gordon Tucker, Eastern Illinois University, Charleston, Illinois for help in identifying the species of Cyperaceae. We also appreciate the critical review of the manuscript by Dr. Paul Sørensen, Northern Illinois University, DeKalb, Illinois; and Mr. C. Ruthven, Project Leader, Matador Wildlife Management Area, Paducah, Texas.

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Table 1. Importance value (IV) of the ground layer species encountered in a fall survey (2002) of thorn-scrub vegetation (1A, 2A, 3A, 4A) and adjacent aerated sites (1B, 2B, 3B, 4B) at the Chaparral Wildlife Management Area, Dimmit and LaSalle Counties, Texas. Also listed is the cover of bare ground and litter, and the total number of species in the plots of each site. Only species with an IV of ± 4.5 for a site are included. * non-native species.

Species / Sites	1A	1B	2A	2B	3A	3B	4A	4B
* <i>Pennisetum ciliaris</i>	--	--	25.6	33.9	50.6	90.6	--	23.2
<i>Urochloa ciliatissima</i>	18.7	23.6	33.6	30.6	28.9	10.8	--	--
<i>Evolvulus alsinoides</i>	20.3	19.7	20.1	23.1	21.8	15.2	1.7	2.1
<i>Croton glandulosus</i>	12.9	12.2	29.9	44.9	10.1	2.6	--	--
<i>Chloris cucullata</i>	0.9	6.6	22.3	14.0	9.4	21.5	--	12.4
<i>Tiquilia canescens</i>	--	--	--	--	--	--	83.1	3.0
<i>Bouteloua hirsuta</i>	38.3	24.5	7.8	10.2	--	--	--	--
* <i>Eragrostis lehmanniana</i>	20.6	30.4	2.5	1.2	10.3	2.2	4.4	1.1
<i>Aristida purpurea</i>	5.1	3.8	4.8	--	6.1	1.0	--	46.4
<i>Cyperus retroflexus</i>	6.7	7.1	7.2	8.1	8.0	1.3	--	7.7
<i>Digitaria cognata</i>	2.2	10.4	2.9	4.6	4.0	1.8	--	17.4

Table 1 (continued).								
Species / Sites	1A	1B	2A	2B	3A	3B	4A	4B
<i>Palafoxia texana</i>	5.1	24.7	2.1	1.6	3.0	0.6	--	0.7
<i>Bouteloua trifida</i>	--	--	--	--	--	--	20.7	7.0
<i>Diodia teres</i>	29.8	2.4	--	--	--	--	--	--
<i>Dyssodia pentachaeta</i>	--	0.8	--	--	--	--	23.8	2.5
<i>Nothoscordum bivalve</i>	--	--	--	--	3.2	--	20.8	--
<i>Sida abutifolia</i>	--	0.9	2.6	2.2	3.4	6.0	5.3	1.8
<i>Paspalum setaceum</i>	1.4	--	6.8	--	7.5	0.6	--	3.8
<i>Tridens muticus</i>	--	--	--	--	--	--	--	19.9
<i>Eragrostis secundiflora</i>	3.3	7.4	0.5	--	3.6	--	2.1	1.8
<i>Setaria texana</i>	--	--	--	3.7	--	--	2.1	11.0
<i>Panicum capillarioides</i>	--	--	2.6	--	1.1	10.7	1.7	--
<i>Setaria reverchonii</i>	0.9	8.4	3.9	--	1.7	0.7	--	--
<i>Cenchrus spinifex</i>	7.1	0.8	2.1	4.5	0.6	--	--	--
<i>Opuntia engelmannii</i>	--	1.0	5.5	--	5.4	0.7	--	2.5
<i>Mollugo verticillata</i>	0.9	--	3.0	1.7	4.5	3.5	--	0.6
<i>Justicia pilosella</i>	--	--	--	--	--	1.0	8.0	2.3
<i>Phyllanthus polygonoides</i>	0.9	--	--	--	--	10.1	--	--
<i>Eragrostis curtipedicillata</i>	--	--	1.0	--	1.1	2.2	--	6.6
<i>Eragrostis sessilispica</i>	5.3	--	1.6	3.8	--	--	--	--
<i>Menodora heterophylla</i>	--	--	--	--	--	--	9.5	1.1
<i>Chamaecrista fasciculata</i>	2.3	8.0	--	--	--	--	--	--
<i>Dalea nana</i>	6.3	0.8	--	--	--	--	--	--

Table 1 (continued).

Species / Sites	1A	1B	2A	2B	3A	3B	4A	4B
<i>Ambrosia psilostachya</i>	--	--	--	--	0.6	6.1	--	--
Other species	11.0	6.5	11.6	11.9	15.1	10.8	16.8	25.1
Total	200	200	200	200	200	200	200	200
Bare ground/litter cover	51.80	44.78	47.80	32.53	49.77	28.09	79.21	39.63
Total species for each site	27	27	30	23	32	27	20	36

Table 2. Sorensen Index of Similarity of the ground layer vegetation at the eight communities examined in a fall survey (2002) at the Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, Texas.

Site	1A	1B	2A	2B	3A	3B	4A
1A							
1B	74.1						
2A	63.2	56.1					
2B	52.0	48.0	56.6				
3A	61.0	57.6	77.4	58.2			
3B	48.1	48.1	63.2	48.0	64.4		
4A	17.0	25.5	20.0	27.9	30.8	29.8	
4B	34.9	38.1	45.5	47.5	47.1	50.8	57.1

Table 3. Importance value (IV) of the ground layer species encountered in a spring survey (2003) of thorn-scrub vegetation (1A, 2A, 3A, 4A) and adjacent aerated sites (1B, 2B, 3B, 4B) at the Chaparral Wildlife Management Area, Dimmit and LaSalle Counties, Texas. Also listed is the cover of bare ground and litter, and the total number of species in plots of each site. Only species with an IV of ± 4.5 for a site are included. * non-native species

Species	1A	1B	2A	2B	3A	3B	4A	4B
Total grasses (living/dead)	67.6	52.6	59.6	45.2	56.7	74.2	39.0	77.7
<i>Coreopsis nuecensis</i>	34.4	49.2	6.1	35.1	22.3	0.6	--	--
<i>Gamochaeta purpurea</i>	--	--	13.2	15.2	8.0	23.6	--	4.3
<i>Aphanostephus riddellii</i>	5.7	8.2	5.6	8.9	6.2	0.5	16.5	9.8
<i>Oxalis dillenii</i>	0.6	2.9	13.1	8.0	9.0	13.9	1.1	10.8
<i>Plantago hookeriana</i>	9.6	7.7	11.5	8.1	13.1	1.8	--	1.1
<i>Oenothera grandis</i>	--	--	0.2	1.1	1.0	0.3	26.9	11.8
<i>Nothoscordum bivalve</i>	6.7	5.5	3.8	1.9	4.8	0.2	7.1	0.2
<i>Nuttallanthus tenanus</i>	--	1.5	4.7	9.2	5.6	7.9	--	0.4
<i>Evolvulus alsinoides</i>	6.8	5.5	3.1	5.6	4.9	2.1	--	0.2
<i>Dyssodia tenuiloba</i>	0.6	0.3	3.0	0.3	8.4	5.7	3.3	6.5
<i>Cyperus retroflexus</i>	6.0	4.6	5.4	2.3	5.6	2.2	--	0.2
<i>Tiquilia canescens</i>	--	--	--	--	--	--	25.7	0.6
<i>Evax prolifera</i>	3.3	1.9	5.1	0.9	1.0	0.9	6.8	5.3
<i>Lesquerella argyraea</i>	6.7	6.3	4.7	4.5	1.9	0.2	--	--
<i>Ambrosia confertiflora</i>	--	--	6.7	--	4.3	11.1	--	--
<i>Chamaesaracha coniodes</i>	6.7	9.9	--	--	--	--	4.7	0.8
<i>Palafoxia texana</i>	1.3	9.2	1.9	1.4	6.3	1.1	0.1	0.4
<i>Thelesperma filifolium</i>	8.7	7.3	2.2	1.2	0.3	0.2	--	--

<i>Gaura mckelveyae</i>	0.6	--	4.3	2.3	3.5	5.8	0.3	1.3
<i>Lepidium virginicum</i>	--	--	4.4	6.3	2.6	2.8	--	1.5
<i>Triodanis perfoliata</i>	--	0.5	7.2	4.8	3.2	1.4	--	--
<i>Dalea nana</i>	8.7	4.4	2.4	--	--	0.2	1.3	--
<i>Sida abutilifolia</i>	1.2	1.2	1.7	2.6	1.9	1.9	4.7	1.3
<i>Plantago virginica</i>	--	--	3.5	0.5	3.1	0.8	6.7	1.1
<i>Parietaria pensylvanica</i>	--	--	1.0	2.9	0.3	7.4	--	4.0
<i>Nama jamaicense</i>	--	--	--	0.5	--	--	2.3	12.4
<i>Descurainia pinnata</i>	--	--	--	3.2	--	8.5	--	1.8
<i>Astragalus nuttalianus</i>	0.2	1.1	1.2	0.9	2.5	--	4.6	2.0
<i>Lepidium lasiocarpum</i>	0.2	--	--	--	--	--	5.9	5.9
<i>Talinum parviflorum</i>	4.7	1.4	2.4	0.3	2.1	0.7	--	--
<i>Spermolepis echinata</i>	--	--	--	--	--	--	7.1	4.1
<i>Euphorbia micromera</i>	1.0	0.2	1.3	0.2	1.3	--	5.8	1.1
<i>Linum imbricatum</i>	3.9	4.9	1.3	0.2	0.6	--	--	--
<i>Gymnosperma glutinosum</i>	--	--	--	--	--	--	0.2	9.5
<i>Menodora heterophylla</i>	--	--	--	--	--	--	5.8	1.0
Other species	14.8	13.7	19.4	26.4	19.5	24.0	24.1	22.9
Total	200	200	200	200	200	200	200	200
Bare ground/litter	33.1	17.0	21.2	8.5	25.4	6.8	29.3	12.5
Total species for each site	35	39	44	47	42	43	39	53

Table 4. Sorensen Index of Similarity of the ground layer vegetation at eight communities examined in a spring survey (2003) at the Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, Texas.

Site	1A	1B	2A	2B	3A	4B	4A
1A							
1B	75.7						
2A	58.2	65.1					
2B	48.8	55.8	83.5				
3A	54.5	61.7	88.4	83.1			
3B	46.2	53.7	75.9	77.8	75.3		
4A	40.5	43.6	43.4	41.9	44.4	39.0	
4B	38.6	39.1	51.5	62.0	54.7	54.2	65.2

Appendix I. Vascular plant species at Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, listed alphabetically by family under major plant groups. Collecting numbers after each name are those of D. S. Seigler, and deposited in the herbarium of the University of Illinois (ILL). Specimens by L.R.Phillippe (P before the number) are deposited in the Illinois Natural History Survey herbarium (ILLS). Nomenclature follows Jones et al. (1997). (*exotic species)

FERN AND FERN-ALLIES

MARSILEACEAE

Marsilea vestita Hooker & Greville; 15043, 15490

PTERIDACEAE

Astrolepis cochisensis (Goodding) Benham & Windham; 15642

Cheilanthes alabamensis (Buckley) Kunze; 15643

GYMNOSPERMS

EPHEDRACEAE

Ephedra antisiphilitica C.A. Meyer; 14911, 15505

MONOCOTS

AGAVACEAE

Agave americana L.; 15639

Yucca constricta Buckley; 15154

Yucca treculeana Carrière; 15463, 15683

COMMELINACEAE

Commelina erecta L.; 14868, 15601

CYPERACEAE

Carex tetrastachya Scheele; 15200, 15607

Cyperus acuminatus Torrey & Hooker; 15046

Cyperus echinatus (L.) A. Wood; 15045

Cyperus retroflexus Buckley; 15005, 15377

Eleocharis palustris (L.) Römer & Schultes; 15497

Fimbristylis vahlii (Lamarck) Link; 15126

Schoenoplectus saximontanus (Fernald) Raynal; 15488

LILIACEAE

Cooperia drummondii Herb; 15103

Nothoscordum bivalve (L.) Britton; 15184

NAJADACEAE

Najas guadalupensis (Sprengel) Magnus; 15625

POACEAE

Agrostis hyemalis (Walter) B.S.P.; 15487

Aristida purpurea Nuttall var. *purpurea*; 15216, 15397

Aristida purpurea Nuttall var. *wrightii* (Nash) Allred; 14935

Bothriochloa barbinodis (Lagasca) Herter; 14937, 15349

Bouteloua barbata Lagasca; 15085

Bouteloua hirsuta Lagasca; 15108, 15415

Bouteloua trifida Thurber; 15388, 15519

**Bromus catharticus* Vahl; 15174

Cenchrus spinifex Cavanilles; 14944

- Chloris cucullata* Bischoff; 14918, 15083
**Cynodon dactylon* (L.) Persoon; 14963
**Dactyloctenium aegyptium* (L.) Beauvois; 15086
**Dichanthium annulatum* (Forsskäl) Stapf; 15034
Digitaria californica (Benth) Henrard; 14936
Digitaria ciliaris (Retzius) Köler; 15074, 15208
Digitaria cognata (Schultes) Pilger; 15206, 15373
Eragrostis curtipedicellata Buckley; 14989, 15427
**Eragrostis lehmanniana* Nees; 15146, 15413
Eragrostis pectinacea (Michaux) Nees var. *miserrima* (Fournier) J. Reeder; 15572
Eragrostis reptans (Michaux) Nees; 15127
Eragrostis secundiflora Presl; 15082, 15414
Eragrostis sessilispica Buckley; 14971
Heteropogon contortus (L.) Beauvois; 14987, 15365
Leptochloa dubia (Kunth) Nees; 15366
Nasselia leucotricha (Trinius & Ruprecht) Pohl; 15655
**Panicum antidotale* Retzius; 15348
Panicum capillarioides Vasey; 15368, 15376
Panicum hallii Vasey var. *filipes* (Scribner) F.Waller; 15396, 15481
Panicum hians Elliott; 15048
Panicum nodatum Hitchcock & Chase; 15198
Panicum oligosanthos Schultes; 15375
Panicum virgatum L.; 15736
Pappophorum bicolor Fournier; 15390
Pappophorum vaginatum Buckley; 15205
Paspalum lividum Trinius; 15745
Paspalum setaceum Michaux; 14947, 15197
**Pennisetum ciliaris* (L.) Link; 14919, 15351
Setaria firmula (Hitchcock & Chase) Pilger; 15426
Setaria leucopila (Scribner & Merrill) K. Schumann; 15196, 15733
Setaria macrostachya Kunth; 15132, 15733
Setaria pumila (Poiret) Römer & Schultes; 15047
Setaria reverchonii (Vasey) Pilger; 14970
Setaria texana W. Emery; 15395
**Sorghum halapense* (L.) Persoon; 15011
Sporobolus cryptandrus (Torrey) A.Gray; 15369
Trichloris pluriflora Fournier; 14934, 15670
Tridens eragrostoides (Vasey & Scribner) Nash; 15199, 15389

Tridens muticus (Torrey) Nash; 14976, 15403

Urochloa ciliatissima (Buckley) Webster; 15360, 15416

PONTEDERIACEAE

Heteranthera limosa (Swartz) Willdenow; 15747

POTAMOGETONACEAE

Potamogeton nodosus Poiret; 15489

DICOTS

ACANTHACEAE

Carlowrightia texana Henrickson & Daniel; 15423

Justicia pilosella (Nees) Hilsenbeck; 14958, 15387

Ruellia nudiflora (A. Gray) Urban var. *runyonii* (Tharp & Barkley) B.

L. Turner; 15201

AMARANTHACEAE

Alternanthera caracasana Kunth; 15750

Amaranthus albus L.; 15001, 15120

Froelichia floridana (Nuttall) Moquin; 14865, 14959

Froelichia gracilis (Hooker) Moquin; 15101, 15678

Gossypianthes lanuginosus (Poiret) Moquin; 15562

Tidestromia lanuginosa (Nuttall) Standley; 15121, 15372

ANACARDIACEAE

Rhus microphylla Engelmann; 15677

APIACEAE

Bowlesia incana Ruiz & Pavón; 15483

Daucus pusillus Michaux; 15159, 15604

Spermolepis echinata (DC.) Heller; 15167, 15615

ARISTOLOCHIACEAE

Aristolochia erecta L.; 15177, 15580, 15595

ASCLEPIADACEAE

Asclepias emoryi (Greene) Vail; 14962

Cynanchum barbigerum (Scheele) Shinnery; 14902, 15420

Cynanchum laeve (Michaux) Persoon; 15744

Cynanchum racemosum (Jacquin) Jacquin var. *unifarium* (Scheele) Sundall; 15128

Matelea gonocarpos (Walter) Shinnery; 15425

Matelea parviflora (Torrey) Woodson; 15004

ASTERACEAE

Acourtia runcinata (D. Don) B. L. Turner; 15641

Amblyolepis setigera DC.; 15568, 15623

Ambrosia confertiflora DC.; 14923, 15593

Ambrosia psilostachya DC.; 14977, 15092

Aphanostephus riddellii Torrey & Gray; 15540

Aphanostephus ramosissimus DC.; 15362

Baccharis neglecta Britton; 15624, 15734

Berlandiera texana DC.; 15651

**Calyptocarpus vialis* Lessing; 15089

Centaurea americana Nuttall; 15661

Chloracantha spinosa (Benth) Neson; 15050

Cirsium texanum Buckley; 14972, 15496

Coryza canadensis (L.) Cronq. var. *glabrata* (Gray) Cronquist; 15006

Coreopsis nuecensis Heller; 15538

Coreopsis tinctoria Nuttall; 14893, 15565

Dichaetophosa campestris A. Gray; 15158, 15898

Dyssodia pentachaeta (DC.) Robinson; 15166, 15393

Dyssodia tenuiloba (DC.) Robinson; 14877, 15567

Evax prolifera DC.; 15178

Florestina tripteris DC.; 14898, 15370

Gaillardia pulchella Fougereux; 14892, 15590

Gamochaeta purpurea (L.) Cabrera; 15051

Gutierrezia texana (DC.) Torr. & Gray var. *glutinosa* (Schauer) Lane; 14909

Gymnosperma glutinosum (Sprengel) Lessing; 14973

Helenium linifolium Rydberg; 14884

Helianthus annuus L.; 15743

Helianthus debilis Nuttall; 14864, 15742

Heterotheca subaxillaris (Lamarck) Britton & Rusby; 15075

Hymenopappus scabiosaeus L'Heritier var. *corymbosus* (Torrey & Gray) B. L. Turner; 15645

Krigia occidentalis Nuttall; 15637

Liatrix mucronata DC.; 14993, 15131

- Melampodium cinereum* DC.; 14879, 15535
Palafoxia texana DC.; 14897, 15170
Parthenium confertum A.Gray; 15384, 15516
Pseudognaphalium obtusifolium (L.) Hilliard & Burt; 15647
Pyrrhopappus carolinianus (Walter) DC.; 15500
Pyrrhopappus pauciflorus (D. Don) DC.; 14956, 15611
Ratibida columnifera (Nuttall) Wooton & Standley; 15009
Senecio ampullaceus Hooker; 15586
Simsia calva (Engelmann & Gray) A.Gray; 15023
**Sonchus aspera* (L.) Hill; 15168
Thelesperma burridgeanum (Regel, Körnicke & Rach) Blake; 14891
Thelesperma filifolium (W. Hooker) A.Gray; 15646a
Verbesina encelioides (Cavanilles) A.Gray; 14863
Verbesina microptera DC.; 15385
Xanthisma texanum DC.; 15371

BORAGINACEAE

- Cordia boissieri* A.DC.; 15095
Cryptantha texana (A. DC.) Greene; P35386
Heliotropium procumbens Miller; 15125, 15664
Heliotropium texanum I.M. Johnston; 15209, 15355, 15411
Lappula occidentalis (Watson) Greene; 15480, 15650
Lithospermum incisum Lehmann; 15189
Tiquilia canescens (DC.) Richardson; 14933

BRASSICACEAE

- Arabis petiolaris* (A.Gray) A.Gray; 15465
Descurainia pinnata (Walter) Britton; 15162, 15513
**Diplotaxis muralis* (L.) DC.; 15872
Draba cuneifolia Torrey & Gray; 15632, 15870
Lepidium lasiocarpum Torrey & Gray; 15190
Lepidium virginicum L.; 14926
Lesquerella argyraea (A.Gray) Watson; 14881, 15539
Lesquerella lasiocarpa (A.Gray) Watson; 15485, 15618
Rorippa teres (Michaux) Stuckey; 15493
**Sisymbrium irio* L.; 15175, P36371

BUDDLEJACEAE

- Polypremum procumbens* L.; 15740

CACTACEAE

Ancistocactus scheeri (Salm-Dyck) Britt. & Rose; 15156

Echinocereus enneacanthus Engelman; 15119

Opuntia engelmannii Salm-Dyck; 15012

Opuntia leptocaulis DC.; 15024

CALLITRICHACEAE

Callitriche terrestris Rafinesque; 15869

CAMPANULACEAE

Triodanis perfoliata (L.) Niewland; 15550, 15648

CAPPARACEAE

Koerberlinia spinosa Zuccarini; 15113

Polanisia dodecandra (L.) DC. subsp. *riograndensis* Iltis; 14946

CARYOPHYLLACEAE

Loeflingia squarrosa Nuttall; 15557

Silene antirrhina L.; 15173, 15596

**Stellaria media* (L.) Villars; 15650

CELASTRACEAE

Schaefferia cuneifolia A.Gray; 14912, 15510

CHENOPODIACEAE

Chenopodium berlandieri Moquin; 14928, 15666

CONVOLVULACEAE

Convolvulus equitans Bentham; 14996, 15574

Evolvulus alsinoides (L.) L.; 14984, 15381

Evolvulus sericeus Swartz; 15556 15638

Ipomoea cordatotriloba Dennstaedt; 14955, 15424

CUCURBITACEAE

Ibervillea lindheimeri (A.Gray) Greene; 14983

Ibervillea tenuisecta (A.Gray) Small; 15118

CUSCUTACEAE

Cuscuta gronovii Willdenow; 14931, 14978

EBENACEAE

Diospyros texana Scheele; 14874, 15553

EUPHORBIACEAE

Argythamnia neomexicana Müller of Aargau; 15394, 15617

Bernardia myricifolia (Scheele) Watson; 15755, P36474

Croton capitatus Michaux; 14995, 15123

Croton glandulosus L.; 15042, 15357

Croton lindheimerianus Scheele; 14896

Euphorbia micromera P. Boissier; 14924, 15522

Jatropha dioica Cervantes; 14951, 15016

Phyllanthus polygonoides Sprengel; 14975

FABACEAE

Acaciella angustissima (Miller) Britton & Rose; 15007, 15741

Aeschynomene indica L.; 15746

Astragalus nuttallianus DC. var. *austrinus* (Small) Barneby; 15476

Astragalus nuttallianus DC. var. *nuttallianus*; 15619

Chamaecrista fasciculata (Michaux) Greene; 14895, 15093

Dalea emarginata (Torrey & Gray) Shinnery; 14880, 15542

Dalea nana Torrey; 14980, 15406

Dalea pogonathera A.Gray; 14979, 15537

Desmanthus virgatus (L.) Willdenow; 15033, 15739

Eysenhardtia texana Scheele; 14953

Indigofera miniata Ortega; 15096

Lupinus texensis Hooker; 15180, 15585

**Medicago polymorpha* L.; 15171, 15649

**Melilotus indicus* (L.) Allioni; 15646b

Mimosa latidens (Small) B.L. Turner; 14887, 15183

Neptunia pubescens Benthams; 15036

Parkinsonia aculeata L.; 15044

Parkinsonia texana (A.Gray) Watson; 14907

Prosopis glandulosa Torrey; 14929, 15134

Senegalia berlandieri (Benthams) Britton & Rose; 14905

Senegalia x emoryana (Benthams) Britton & Rose; 15401

Senegalia greggii (A.Gray) Britton & Rose; 14890

Senegalia roemeriana (Scheele) Britton & Rose; 14954

Senna lindheimeriana (Scheele) Irwin & Barneby; 14949

Senna roemeriana (Scheele) Irwin & Barneby; 15620

Tephrosia lindheimeri A.Gray; 14894
Vachellia bravoensis (Isley) Seigler & Ebinger; 14889
Vachellia farnesiana (L.) Wight & Arnott; 14967
Vachellia rigidula (Benthham) Seigler & Ebinger; 14994
Vachellia rigidula x schaffneri; 15114
Vicia ludoviciana Nuttall; 15470, 15635
Zornia bracteata J. F. Gmelin; 14878, 15579

FAGACEAE

Quercus virginiana Miller; 15097

FUMARIACEAE

Corydalis aurea Willdenow var. *aurea*; 15554

GENTIANACEAE

Sabatia campestris Nuttall; 14986

GERANIACEAE

Erodium texanum A. Gray; 15520

HYDROPHYLLACEAE

Nama hispidum A.Gray; 14886, 15605
Nama jamaicense L.; 15495, 15633
Nama stenocarpum A.Gray; 15663, P35259
Phacelia congesta Hooker; 14966, 15501

KRAMERIAACEAE

Krameria lanceolata Torrey; 14871, 15561

LAMIACEAE

Monarda punctata L.; 14888
Salvia ballotiflora Benthham; 15018, 15582
Scutellaria drummondii Benthham var. *drummondii*; 15502
Stachys crenata Rafinesque; 15494, 15662

LINACEAE

Linum berlandieri Hooker; 14908, 15546
Linum imbricatum (Rafinesque) Shinnery; 14872, P35341

MALVACEAE

- Abutilon fruticosum* Guillemin & Perrottet; 15399
Abutilon wrightii A.Gray; 15606
Herissantia crispa (L.) Brizicky; 15419, 15428
Malvastrum coromandelianum (L.) Garcke; 15203
Rhynchosida physocalyx (A.Gray) Fryxell; 15603, 15610
Sida abutifolia Miller; 14938, 15398
Sida ciliaris L.; 15738a
Sida lindheimeri Engelman & A.Gray; 15410
Sida tragiifolia A.Gray; 15211, 15674
Sidastrum paniculatum (L.) Fryxell; 15409
Sphaeralcea pedatifida (A.Gray) A.Gray; 14915, 15511

MOLLUGINACEAE

- Glinus radiatus* (Ruiz & Pavón) Rohrbach; 15130
Mollugo verticillata L.; 14997, 15087

NYCTAGINACEAE

- Acleisanthes longiflora* A.Gray; 14870, 15079
Boerhaavia erecta L.; 15405
Mirabilis albida (Walter) Heimerl; 15035, 15352
Nyctaginia capitata Choisy; 15081

OLEACEAE

- Forestiera angustifolia* Torrey; 14906
Fraxinus pennsylvanica Marshall; 15091
Menodora heterophylla Moricand; 14943, 15523

ONAGRACEAE

- Calylophus berlandieri* Spach; 14900, 15530
Gaura brachycarpa Small; 14960, 15609
Gaura mckelveyae (Munz) Raven & Gregory; 14866, 15541
Ludwigia peploides (Kunth) Raven; 15613
Oenothera grandis (Britton) Smyth; 14957, 15600
Oenothera speciosa Nuttall; 15468, 15924

OXALIDACEAE

- Oxalis dillenii* Jacquin; 14925, 15467

PAPAVERACEAE

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