# SMALL-SCALE VASCULAR PLANT SPECIES RICHNESS IN SOUTHWESTERN ARKANSAS BLACKLAND PRAIRIES

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## ABSTRACT

We describe the small-scale (0.0001, 0.001, 0.1 ha.) species richness and soils of blackland prairies in southwestern Arkansas. Areas sampled were Saratoga Blackland Prairie Natural Area, Rick Evans Grandview Prairie Wildlife Management Area, and Terre Noire Natural Area. Four 0.1 ha plots had 134 species and averaged 64.8 species, eight 0.001 ha plots averaged 22.1 species, and eight 0.0001 ha plots averaged 14.5 species. The most diverse families were Asteraceae (37 species), Poaceae (23 species), and Fabaceae (11 species). The soils are predominantly alkaline high-calcium silty clay loams. The soils are similar to those of other blackland/isolated prairies in the southeast except for their higher calcium levels. Ninety-eight percent of the species were native. The occurrence of only three exotic species in the plots indicates that these sites are in very good condition.

## RESUMEN

Describimos a pequeña escala (0.0001, 0.001, 0.1 ha.) la riqueza de especies y suelos de las praderas negras del suroeste de Arkansas. Las áreas muestreadas fueron Saratoga Blackland Prairie Natural Area, Rick Evans Grandview Prairie Wildlife Management Area, y Terre Noire Natural Area. Cuatro parcelas 0.1 ha tenían 134 especies y una media de 64.8 especies, ocho parcelas 0.001 ha una media de 22.1 especies, y otras ocho de 0.0001 ha una media de 14.5 especies. Las familias más diversas fueron Asteraceae (37 especies), Poaceae (23 especies), y Fabaceae (11 especies). Los suelos son predominantemente margas calizas sedimentarias alcalinas de alto contenido en calcio. Los suelos son similares a otros de praderas negras aisladas en el sureste excepto por su mayor contenido en nivel de calcio. El noventa y ocho por ciento de las especies fueron nativas. La presencia de solo tres especies exóticas en las parcelas indica que estos lugares están en muy buenas condiciones.

## INTRODUCTION

While prairies are one of the most endangered plant communities in North America, they are also one of the best studied (see Sims & Risser 2000, Diggs et al. 2006 for discussion and literature). Thousands of books and papers have been written on the floristics, management, and restoration of prairies (e.g., Peacock & Schauwecker 2003 and references). Over the past few decades numerous floristic and soil surveys have increased our knowledge of prairies across the southeast (see Foti 1989, 1990; Foti et al. 2003; Carr 1993; MacRoberts & MacRoberts 1995, 1996, 2003; 2004; MacRoberts et al. 2009; Schauwecker 1996; Moran et al. 1997; Leidolf & McDaniel 1998; Brown et al. 2002; Moran et al. 2003; Peacock & Schauwecker 2003; Zollner et al. 2003; Barone 2005; Barone & Hill 2007; Bekele & Hudnell 2006; Echols & Zomlefer, 2010, Arkansas Natural Heritage Commission 2011 and literature). Particularly well described and managed are the blackland prairies of southwestern Arkansas (see Foti et al. 2003; Zollner et al. 2003, for description and literature). Foti (1989, 1990), Foti et al. (2003), and Zollner et al. (2003) give detailed descriptions of soils, geology, previous land use, and distribution of these prairies, which we will not repeat here.

The purpose of this paper is to describe the small-scale (0.0001, 0.001, 0.1 ha.) floristic richness of blackland prairies in southwestern Arkansas, to determine their geographical species affinities, and to compare them to Morse clay prairies in northwestern Louisiana.

## STUDY SITES AND METHODS

We studied four blackland prairie sites in southwestern Arkansas (Figs. 1–2). These were:

**Fig. 1. Blackland prairie: Grandview One.**

**1)** Saratoga Blackland Prairie Natural Area: Howard Co. 33°45'27.76"N 93°54'56.10"W. Elevation 119 m. Demopolis/Sumpter soil series (Hoelscher et al. 1975). Owned and managed by Arkansas Natural Heritage Commission, acquired in 2004.

**2)** Rick Evans Grandview Prairie Wildlife Management Area. Prairie One. Hempstead Co. 33°48'00.87"N 93°48'00.00"W. Elevation 130m . Demopolis/Sumpter soil series (Hoelscher & Laurent 1979). Owned and managed by Arkansas Game and Fish Commission, acquired in 1997.

**3)** Rick Evans Grandview Prairie Wildlife Management Area. Prairie Two. Hempstead Co. 33°48'31.98"N 93°46'57.78"W. Elevation 123 m. Demopolis/Sumpter soil series (Hoelscher & Laurent 1979). Owned and managed by Arkansas Game and Fish Commission, acquired in 1997.

**4)** Terre Noire Natural Area. Clark Co. 34°04'22.41"N 93°10'42.39"W. Elevation 84 m. Sumpter soil series (Hoelscher 1987). Owned and managed by Arkansas Natural Heritage Commission and The Nature Conservancy, acquired from 1991 to 2009.

More information can be found on these prairies on the web (Arkansas Natural Heritage Commission 2011).

In each prairie site we established one 0.1 ha study plot away from prairie edge. We selected in each case an area that looked "typical" of that prairie. All plots were on a slight slope; they did not straddle ridgetops. Each plot measured 20 m × 50 m or 31.6 m × 31.6 m (0.1 ha). Within each 0.1 ha plot were two nested 3.16 m × 3.16 m (0.001 ha) plots. Each of these in turn had a 1 m × 1 m (0.0001 ha) nested plot within it. Thus, there were four 0.l ha plots, eight 0.001 ha plots, and eight 0.0001 ha plots. We surveyed each plot for total species. All species in the plots were recorded every month over a year between 16 April and 5 November 2010. A specimen of most species was collected and deposited at the Arkansas Natural Heritage Commission herbarium (ANHC).

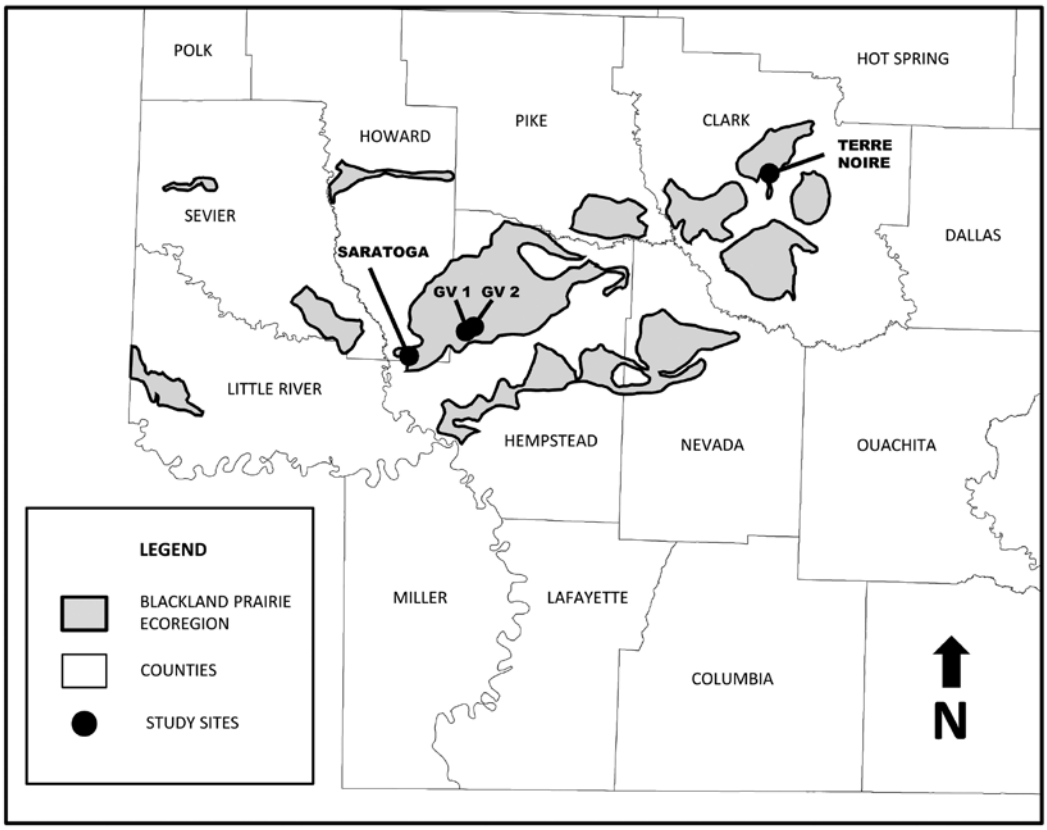


**Fig. 2. Location of study sites in southwestern Arkansas.**

Nomenclature generally follows Kartesz and Meacham (2005) and *Flora of North America* (1993–2006). The main floras used to identify plants were Smith (1994), Diggs et al. (1999, 2006), Yatskievych (1999–2006), and *Flora of North America* (1993–2006).

We collected soil samples from the upper 20 cm in the center of each 0.1 ha plot. These were analyzed for pH, various elements, and soil texture at Louisiana State University Soil Testing and Plant Analysis Laboratory.

Using Sorenson's Index of Similarity we compared the four study plots and these with Morse clay prairies of northwestern Louisiana that we studied previously using the same plot design as used in the present study (MacRoberts et al. 2009).

Using the list of species we found in the four Arkansas prairies and data from *Flora of North America* (1993–2006), NatureServe (2011), USDA Plant Database (2011), and Kartesz and Meacham (2005), we plotted the North American distribution of native species found in the plots by state, region, or province to determine the geographic affinities of Arkansas blackland prairies.

All sites in our sample at one time had been hayfields with light to heavy grazing and fire suppression (Arkansas Natural Heritage Commission 2010). They are now being restored by clearing invasive woody vegetation (e.g., *Juniperus virginiana*) and by prescribed fire (Akin et al. 2009).

## RESULTS

The four 0.1 ha plots had a total of 134 species: Saratoga had 66, Grandview One had 49, Grandview Two had 59, and Terre Noire had 85. They averaged 64.8 species (Table 1). Eight 0.001 ha plots averaged 22.1 species,

TABLE 1. Vascular flora of four Arkansas blackland prairie plots (S = Saratoga, GV1 = Grandview One, GV2 = Grandview Two, TN = Terre Noire. (* = exotic species). All species were collected by B.R. & M.H. MacRoberts. Numbers following the species refer to those collections. No number = no collection.

**Acanthaceae**
*Ruellia humilis* Nutt.; S 8593, GV1, GV2

**Apiaceae**
**Daucus carota* L.; GV2 8565, TN 8647
*Eryngium yuccifolium* Michx.; TN
*Polytaenia nuttallii* DC.; S 8522
*Zizia aurea* (L.) W.D. J. Koch; TN

**Apocynaceae**
*Apocynum cannabinum* L.; GV2 8562, TN

**Aquifoliaceae**
*Ilex decidua* Walter; S, GV1, GV2, TN

**Asclepiadaceae**
*Asclepias tuberosa* L.; S 8589, GV1, GV2
*Asclepias viridis* Walter; S 8606, GV1 8536, GV2, TN
*Asclepias viridiflora* Raf.; S 8629, GV1, GV2 8690, TN

**Asteraceae**
*Ambrosia bidentata* Michx.; TN 8707
*Ambrosia trifida* L.; GV2
*Arnoglossum plantagineum* Raf.; S 8600, GV1, GV2, TN
*Brickellia eupatorioides* (L.) Shinners; S 8713
*Coreopsis lanceolata* L.; TN
*Echinacea pallida* (Nutt.) Nutt.; S, GV1, TN
*Echinacea purpurea* (L.) Moench; TN 8638
*Erigeron philadelphicus* L.; TN 8541
*Erigeron strigosus* Muhl. ex. Willd.; S 8582, TN 8560, 8582
*Erigeron tenuis* Torr. & A. Gray; S 8525, GV1
*Eupatorium altissimum* L.; TN 8706, 8731
*Eupatorium semiserratum* DC.; GV2, TN
*Gaillardia aestivalis* (Walter) H. Rock; S 8584, 8603, 8716
*Grindelia lanceolata* Nutt.; S 8680, GV1, TN 8682
*Helenium autumnale* L.; GV2 8653, 8727
*Helianthus grosseserratus* M. Martens; TN 8734
*Helianthus hirsutus* Raf.; TN
*Heliopsis helianthoides* Sweet; S 8602
*Liatris hirsuta* Rydb.; S 8676, 8711
*Liatris squarrulosa* Michx.; S 8721, GV1, GV2 8726, TN 8704, 8737
*Ratibida pinnata* (Vent.) Barnhart; TN 8640,
*Rudbeckia hirta* L.; S, GV1, GV2, TN
*Rudbeckia missouriensis* Engelm; S 8677; GV1, GV2 8685; TN 8682,
*Rudbeckia triloba* L.; TN 8684
*Silphium integrifolium* Michx.; GV2 8654, 8655
*Silphium laciniatum* L.; S, GV1, GV2, TN
*Solidago altissima* L.; TN 8705,
*Solidago nemoralis* Aiton; S 8722, TN 8736
*Solidago radula* Nutt.; GV2 8728
*Solidago rigida* L.; S, GV1 8700, 8670, 8723, TN 8735
*Symphyotricum laeve* (L.) Á. Löve & D. Löve; S 8741, GV1 8746, GV2
*Symphyotrichum lateriflorum* (L.) Á. Löve & D. Löve; S 8744, GV2, TN
*Symphyotrichum oolentangiense* (Riddell) G.L. Nesom; S 8742, TN 8733
*Symphyotrichum patens* (Aiton) G.L. Nesom; S 8715,
*Symphyotrichum pilosum* (Willd.) G.L. Nesom; GV1, GV2 8725
*Vernonia baldwinii* Torr.; TN
*Xanthium strumarium* L.; GV2 8697

**Boraginaceae**
*Heliotropium tenellum* (Nutt.) Torr.; GV1, GV2, TN 8644
*Lithospermum canescens* (Michx.) Lehm.; S 8519, GV1
*Onosmodium bejariense* DC. ex A.DC.; S, TN 8681,

**Campanulaceae**
*Lobelia spicata* Lam.; S, GV1, TN 8637, 8636

**Caprifoliaceae**
*Lonicera sempervirens* L.; TN
*Viburnum rufidulum* Raf.; TN 8538

**Clusiaceae**
*Hypericum sphaerocarpum* Michx.; S 8583, TN 8548

**Cornaceae**
*Cornus drummondii* C.A. Mey.; S, TN

**Cuscutaceae**
*Cuscuta pentagona* Engelm.; S 8631, GV1, GV2

**Cyperaceae**
*Carex cherokeensis* Schwein.; S 8528, GV1, GV2, TN
*Carex meadii* Dewey; S 8529, 8530
*Carex microdonta* Torr. & Hook.; S 8531, GV1, GV2, TN 8543
*Scirpus pendulus* Muhl.; TN, 8552

**Ebenaceae**
*Diospyros virginiana* L.; S 8605, GV1, GV2, TN

**Euphorbiaceae**
*Croton monanthogynus* Michx,; GV1 8673, GV2 8689
*Euphorbia bicolor* Engelm & A. Gray; S 8678, GV1, GV2, TN
*Euphorbia corollata* L; S 8585, 8597, GV2, TN
*Tragia urticifolia* Michx.; S, GV1, GV2, TN

**Fabaceae**
*Acacia angustissima* (Mill.) Kuntze; S, GV2 8686, TN
*Cercis canadensis* L.; S, TN
*Chamaecrista fasciculata* (Michx.) Greene; GV2, TN
*Dalea candida* Michx. ex Willd.; TN 8641
*Dalea purpurea* Vent.; S, GV1, GV2 8563, TN,
*Desmanthus illinoensis* (Michx.) MacM. ex Rob. & Fern.; GV1, GV2, TN 8642
*Galactia regularis* (L.) Britton, Strns, & Poggenb.; S 8633, GV1, TN
**Melilotus albus* Medik.; TN
*Mimosa nuttallii* (DC.) B.L. Turner; S 8592, GV2, TN
*Neptunia lutea* (Leavenw.) Benth.; S 8632, GV1
*Rhynchosia latifolia* Nutt. ex Torr. & A. Gray; TN 8643

**Fagaceae**
*Quercus muehlenbergii* Engelm.; S 8601, TN

**Gentianaceae**
*Sabatia angularis* (L.) Pursh; TN 8553, 8645

**Hypoxidaceae**
*Hypoxis hirsuta* (L.) Coville; S, TN 8523, 8546

**Iridaceae**
*Nemastylis geminiflora* Nutt.; S
*Sisyrinchium campestre* E.P.Bicknell; TN 8544, 8545
*Sisyrinchium pruinosum* E.P. Bicknell; S 8527, GV1 8534

**Lamiaceae**
*Prunella vulgaris* L.; TN
*Salvia azurea* Lam.; S 8718, GV1, GV2, TN
*Salvia lyrata* L.; S, GV1, GV2, TN

**Linaceae**
*Linum sulcatum* Riddell; S 8628, TN

**Lythraceae**
*Lythrum alatum* Pursh; GV2 8651

TABLE 1. Continued.

**Melanthiaceae**
*Zigadenus nuttallii* A. Gray; S 8518

**Onagraceae**
*Gaura demareei* P.H. Raven & D.P. Greg.; GV1, GV2, TN 8701
*Oenothera speciosa* Nutt.; GV2
*Stenosiphon linifolius* (Nutt.) Heynh.; S 8679, GV1

**Oxalidaceae**
*Oxalis violacea* L.; GV1, GV2 8535

**Poaceae**
*Andropogon gerardii* Vitman; S 8720
*Andropogon glomeratus* (Walter) Britton, Strns, Poggenb.; GV2, TN
*Andropogon virginicus* L.; GV2 8748
*Aristida oligantha* Michx.; GV2 8730
*Aristida purpurascens* Poir.; S 8714
*Bothriochloa laguroides* (DC.) Herter ; GV2 8729, 8747, 8750, 8751
*Bouteloua curtipendula* (Michx.) Torr.; S 8630
*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark; TN 8549
*Dichanthelium oligosanthes* (Schult.) Gould; GV1 8568, GV2
*Eragrostis hirsuta* (Michx.) Nees.; GV2 8696, TN 8732
*Eragrostis spectabilis* (Pursh) Steud.; S, GV1 8745
*Panicum anceps* Michx.; GV2, TN
*Panicum capillare* L.; GV2 8696a
*Panicum flexile* Scribn.; TN 8732a
*Panicum virgatum* L.; TN
**Schedonorus arundinaceus* (Schreb.) Dumort; GV1 8570, GV2 8561
*Schizachyrium scoparium* (Michx.) Nash; S, GV1, GV2, TN
*Setaria parviflora* (Poir.) Kerg.; GV1 8569, GV2, TN
*Sorghastrum nutans* (L.) Nash; S 8719, GV1, GV2, TN
*Sphenopholis obtusata* (Michx.) Scribn.; GV1 8566, TN 8555
*Sporobolus compositus* (Poir.) Merr. var. *compositus*; GV 2 8649
*Sporobolus clandestinus* (Biehler) Hitchc.; GV1, GV2 8749
*Tridens flavus* (L.) Hitchc.; S, TN 8753

**Polygalaceae**
*Polygala verticillata* L.; GV2 8650

**Ranunculaceae**
*Anemone berlandieri* Pritz.; S 8521, GV1
*Anemone virginiana* L.; TN 8646
*Delphinium carolinianum* Walter; S 8588

**Rhamnaceae**
*Ceanothus herbaceus* Raf.; GV1
*Frangula caroliniana* (Walter) A. Gray; S, TN 8540

**Rosaceae**
*Fragaria virginiana* Mill.; S, TN 8539
*Rosa carolina* L.; GV1, GV2, TN 8550
*Rosa setigera* Michx.; S 8604

**Rubiaceae**
*Houstonia longifolia* Gaertn.; TN 8558
*Spermacoce glabra* Michx.; GV2 8652, 8688
*Stenaria nigricans* Terrell.; S 8586, TN

**Scrophulariaceae**
*Agalinis heterophylla* (Nutt.) Small ex Britton; GV2 8724
*Penstemon cobaea* Nutt.; S
*Penstemon digitalis* Nutt. ex Sims; GV2 8564

**Smilacaceae**
*Smilax bona-nox* L.; TN

**Valerianaceae**
*Valerianella radiata* (L.) Dufr.; TN 8547

**Verbenaceae**
*Glandularia canadensis* (L.) Nutt.; S 8520, GV1, TN
*Verbena simplex* Lehm.; GV1 8567, TN

and eight 0.0001 ha plots averaged 14.5 species (Table 2). Asteraceae, Poaceae, and Fabaceae dominated with 37, 23, and 11 species, respectively. Sorenson's Index of Similarity among the four prairies shows a range between 42.7 and 59.7 (Table 3). Soil test results are shown in Table 4. Figure 3 shows the North American distribution of native Arkansas blackland prairie species listed in Table 1.

## DISCUSSION

The parts of blackland prairies within which our plots were located identify best with the community type described by Zollner et al. (2003:115) as "dry-mesic blackland prairie," with patches of "dry prairie" largely a consequence of erosion, and mesic elements on lower slopes. Species richness of these prairies appeared to be on the low side when compared with similar data from other open-habitat communities and with other southeastern prairies, for example, Morse clay prairies of northwestern Louisiana (MacRoberts et al. 2009). Four 0.1 ha plots in Morse clay prairies were 20% to 25% richer than the four Arkansas plots (see MacRoberts et al. 2009 and references). There were only three exotic species in the Arkansas plots, indicating the very good condition of these prairies (MacRoberts et al. 2008). The Sorensen's Index of Similarity among the four 0.1 ha plots ranged from 42.7 to 59.7 indicating that they border on being the same plant community: 50% similarity is generally accepted for the cutoff for same community. Why the four sites differed this much is not obvious but may have to do with the small sample size. However, we got the impression not only that each prairie was different but that each was fairly uniform (Fig. 1). In the immediate area surrounding the 0.1 ha plots, there were only 10 species that did not occur in any plot, which seems to confirm our subjective impression of floristic uniformity across large prairie areas. The soils of all the prairies are similar and consist of Demopolis/Sumter series, which occurs on a deep mantle of black soil high in organic matter over a substrate of Cretaceous chalk

TABLE 2. Species richness in Arkansas blackland prairies.

| Plot and plot size (ha) | No. of plots | Average species (range) |
|---|---|---|
| **Saratoga Prairie** | | |
| 0.0001 | 2 | 14.5(14–15) |
| 0.001 | 2 | 26.5(26–27) |
| 0.1 | 1 | 66 |
| **Grandview One Prairie** | | |
| 0.0001 | 2 | 13(10–16) |
| 0.001 | 2 | 20(19–21) |
| 0.1 | 1 | 49 |
| **Grandview Two Prairie** | | |
| 0.0001 | 2 | 12(12–12) |
| 0.001 | 2 | 18.5(17–20) |
| 0.1 | 1 | 59 |
| **Terre Noire Prairie** | | |
| 0.0001 | 2 | 18.5(10–27) |
| 0.001 | 2 | 23.5(13–34) |
| 0.1 | 1 | 85 |
| **Total** | | |
| 0.0001 | 8 | 14.5(10–27) |
| 0.001 | 8 | 21.1(13–34) |
| 0.1 | 4 | 64.8(49–85) |

TABLE 3. Index of Similarity (Sorenson's) among four Arkansas blackland prairies (S = Saratoga; GV1 = Grandview One, GV2 = Grandview Two, TN = Terre Noire). Formula is $(2C/(A + B) \times 100$ where C = number of species in common between two samples, A = total species in sample A, and B = total species in sample B.

| | S | GV1 | GV2 | TN |
|---|---|---|---|---|
| S | – | – | – | – |
| GV1 | 42.7 | – | – | – |
| GV2 | 42.9 | 59.7 | – | – |
| TN | 57.0 | 47.7 | 47.6 | – |

TABLE 4. Soils data for Arkansas backland prairies.

| | | Calcium | Copper | Magnesium | Phosphorous | Potassium | Sodium | Sulfur | Zinc | Soil |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample** | pH | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | Texture |
| **Saratoga** | 7.7 | 24,488 | 0.895 | 107 | 4.6 | 276.8 | 13.8 | 8.7 | 1.8 | Silty clay loam |
| **Grandview One** | 7.8 | 18,809 | 1.181 | 137 | 3.9 | 266.4 | 14.8 | 10.1 | 1.2 | Silty clay |
| **Grandview Two** | 7.8 | 19,177 | 1.000 | 151 | 2.4 | 266.7 | 19.5 | 7.8 | 1.2 | Silty clay |
| **Terre Noire** | 7.7 | 15.940 | 0.974 | 102 | 5.8 | 234.3 | 11.8 | 10.2 | 1.5 | Silty clay loam |

or marl (Foti 1989; Hoelscher et al. 1975; Hoelscher & Laurent 1979; Hoelscher 1987). The soils of all Arkansas blackland prairies are very similar to soils in prairies across the southeast, except for their very high level of calcium: twice to four times that of most southeastern prairies (MacRoberts & MacRoberts 1995, 1996; MacRoberts et al. 2003, 2009; Brown et al. 2002; Echols & Zomlefer 2010). As can be seen in Figure 3 the Arkansas blackland prairies are floristically decidedly eastern and central. Comparisons among the native flora of the Arkansas blackland prairies and Morse clay prairies in northwestern Louisiana give an index of similarity (Sorenson's) of 46, again indicating that they border on being the same community.

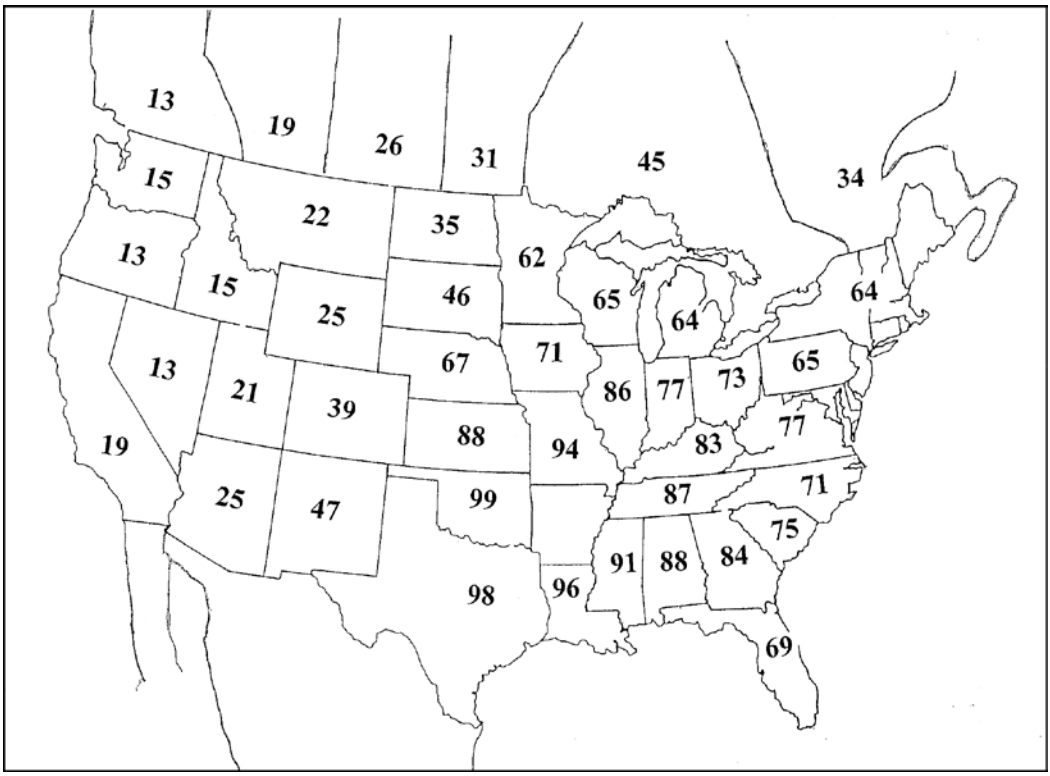


**Fig. 3. North American distribution of native Arkansas blackland prairie species. Numbers are percent of total that occur in state, province, or region.**

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