

VASCULAR FLORA OF ALABASTER CAVERNS STATE PARK, CIMARRON GYPSUM HILLS, WOODWARD COUNTY, OKLAHOMA

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ABSTRACT

Alabaster Caverns State Park is located in the Cimarron Gypsum Hills of northwestern Oklahoma, a semi-arid region of the state. The majority of the park is dominated by mixed-grass prairie and gypsum outcrops, with some riparian habitat and wooded north-facing slopes. A vascular plant inventory conducted from 2004 through 2007 yielded 274 species in 199 genera and 66 families. The largest families were the Poaceae (52 species), Asteraceae (47), and Fabaceae (23). There were 100 annuals, 6 biennials, and 163 perennials, as well as 5 species that have more than one life history form. Forty-two species (15.3%) were not native to North America. Three taxa currently being tracked by the Oklahoma Natural Heritage Inventory (2012) were present: *Echinocereus reichenbachii* (S3G5), *Haploesthes greggii* (S1G4?), and *Marsilea vestita* (S1G5). Compared to floristic inventories of sites in the Cimarron Gypsum Hills that are less impacted by public visitation, but more intensively grazed, Alabaster Caverns State Park has a higher number of species as well as a higher proportion of introduced species.

INTRODUCTION

Palmer et al. (1995) summarized the importance of floristic inventories in providing data for research on biodiversity, environmental impact assessment, and management decisions. The need for further studies of the vascular flora of the Gypsum Hills Physiographic Province was noted by Hoagland (2000). Since that time, two publications have provided floristic inventories of areas within the Cimarron Gypsum Hills of northwestern Oklahoma. Buckallew and Caddell (2003, 2004) summarized the vascular flora of the Selman Living Laboratory, located approximately 6 miles west of Alabaster Caverns State Park in Woodward County. It supports primarily mixed-grass prairie and gypsum outcrop

communities and was part of the Selman Ranch until 1998. Hoagland and Buthod (2005) surveyed a gypsum-dominated, currently-grazed ranch located approximately 24 miles southeast of Alabaster Caverns in Major County. Alabaster Caverns was established as a state park in the 1950s and therefore has a different land-use history. It is heavily visited by the public and is a site on the Western Oklahoma Wildlife Trail. The objectives of this inventory were to contribute to our knowledge of plant distributions in Oklahoma and in the Cimarron Gypsum Hills; to compare the vascular flora of Alabaster Caverns State Park to that of previously-described, more intensively-grazed but less heavily-visited sites in the Cimarron Gypsum Hills; and to provide a resource that

can be used by state park personnel for education and conservation purposes.

STUDY AREA

Alabaster Caverns State Park is located in Woodward County, Oklahoma (36°42'00"N, -99°08'47"W; T26N R18W SW1/4 of Sec. 28 and NW1/4 of NW1/4 of Sec. 33). The land for the park was purchased by the State of Oklahoma in 1953. It became a state park in 1956 (Allen 2007) and is managed by the Oklahoma Tourism and Recreation Department. The park consists of approximately 81 hectares (=200 acres). Cedar Creek, a tributary of Long Creek, flows west to east through Cedar Canyon and roughly bisects the park. Elevation ranges from about 488 m to 532 m.

The climate is semi-arid. According to climate data for Woodward County (Oklahoma Climatological Survey 2012), average annual precipitation is about 61 cm. The growing season lasts approximately 186 days, from mid-April to mid-October. The mean annual temperature is 15.6° C, with daily average temperatures ranging from 2.0° C in January to 27.8° C in July. Temperatures range from an average low of -5.6° C in January to an average daytime high of 35° C in July. Winds average 11 miles per hour and most often are from the south or southwest.

Alabaster Caverns lies in the Cimarron Gypsum Hills Province of Oklahoma (Curtis et al. 1979). Most of the park is underlain by the Blaine Formation, consisting of alternating layers of gypsum and shale formed during the Permian Period. The gypsum outcrops on the site belong to this formation. The Flowerpot Shale, which underlies the Blaine Formation, is exposed in Cedar Canyon (Meyers et al. 1969). Soils belong to the Vernon-Cottonwood Association and are excessively-drained loams and clay loams that have formed from gypsum and gypsiferous shales (Nance et al. 1963). The potential vegetation type is mixed grass (Duck and Fletcher 1943).

METHODS

We intensively surveyed the site throughout the growing seasons of 2004 and 2005. During those years, we visited the site 19 times, from May through October of 2004, and from April to October of 2005. We also surveyed the site in March and May of 2006. During most visits, we walked the areas both north and south of the canyon, and attempted to visit all major habitats within the park. We recorded all vascular plant species we encountered, noted whether they were in flower or fruit, and collected voucher specimens. We collected exotic species only from naturalized populations, excluding cultivated species from around the visitor center and campgrounds. A few species were identified by sight and documented only by photographs, generally because of their rarity at the site or their rarity status in Oklahoma. We added a few species to our vascular plant species list during plot sampling in 2006 and 2007 for a study of the vascular plant communities across the Cimarron Gypsum Hills (Rice 2008). References used for specimen identification included Hitchcock (1971), Great Plains Flora Association (1986), Diggs et al. (1999), Tyrl et al. (2005, 2010), and Barkworth et al. (2007). The organization of taxa in our species list is based on Angiosperm Phylogeny Group (APG III) recommendations (Stevens 2012), and nomenclature follows the PLANTS Database compiled by the United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS 2012). The PLANTS Database was also used to determine whether each species was native to North America or introduced, and whether it was an annual, biennial, or perennial. In cases where species have more than one life form across their range, we noted the life form(s) encountered at Alabaster Caverns State Park. Voucher specimens were deposited in the University of Central Oklahoma (CSU) Herbarium.

RESULTS AND DISCUSSION

We identified 274 species in 199 genera and 66 families (Table 1, Appendix). These included 4 monilophytes (1 species of horsetail and 3 ferns), 1 gymnosperm, 210 eudicots, and 59 monocots. There was one additional subspecific taxon. Species in the Poaceae (52), Asteraceae (47), and Fabaceae (23) far outnumbered those in other families. Only 7 other families were represented by more than 5 species: Euphorbiaceae (11), Brassicaceae (8), Caryophyllaceae (7), Plantaginaceae (7), Solanaceae (7), Apocynaceae (6), and Onagraceae (6). The largest genera were *Astragalus* (6 species), *Oenothera* (6), *Chamaesyce* (5), and *Asclepias* (5). One hundred species were annuals, 6 were biennials, and 163 were perennials. Five species had more than one life form. Thirty-six species were trees (18 species), shrubs (12), or woody vines (6). *Cylindropuntia imbricata* is included on the species list because it apparently has escaped from cultivation within the park.

Three taxa tracked by the Oklahoma Natural Heritage Inventory (2012) were present: *Marsilea vestita* (S1G5), *Haploesthes greggii* (S1G4?), and *Echinocereus reichenbachii* (S3G5). Rarity ranks, in parentheses, range from 1 (critically imperiled) to 5 (demonstrably secure) at the state (S) and global (G) levels.

The park includes primarily mixed-grass prairie and gypsum outcrop plant communities. The major plant association (Hoagland 2000) is the *Schizachyrium scoparium*-*Castilleja purpurea* var. *citrina*-*Lesquerella gordonii* herbaceous association. The north-facing slopes are wooded, and the ravines of Cedar Canyon are dominated by *Juniperus virginiana*. The areas adjacent to the visitor center and within and adjacent to the park's two campgrounds are disturbed. Although the area south of the canyon has not been grazed since the 1950s, the area north of Cedar Canyon was leased for grazing until 1997 (Caywood 2006), and contains some old-field vegetation. Wetland and riparian vegetation is found

along Cedar Creek and on the edges of a pond near the western boundary of the park.

Forty-two species (15.3 %) in 16 families were not native to North America. Four of these species (*Bothriochloa ischaemum*, *Bromus tectorum*, *Sorghum halepense*, and *Tamarix ramosissima*) are listed as Oklahoma problem species, 4 (*Ailanthus altissima*, *Erodium cicutarium*, *Melilotus officinalis*, and *Ulmus pumila*) are on the Oklahoma Watch List, and 14 are problems in border states (Oklahoma Invasive Plants Council 2012). Seventeen species of Poaceae were introduced.

Compared with the recently-grazed Selman Living Lab (Buckallew and Caddell 2003, 2004) and the currently-grazed Major County ranch (Hoagland and Buthod 2005), Alabaster Caverns State Park had a higher number of plant species, although it is smaller (81 ha) than the Selman Living Lab (129.5 ha) and approximately the same size as the Major County ranch (80+ ha). The higher number of species is in part due to the higher number and proportion of introduced species at Alabaster Caverns. Of the 229 species at the Selman Living Lab, 21 (9%) were introduced. Of the 233 species at the Major County ranch, 22 (10.6%) were introduced. The higher number of introduced species at Alabaster Caverns can be attributed to disturbance associated with the high number of visitors to the park, especially around the visitor center and campgrounds. Of the 274 species at Alabaster Caverns State Park, 175 also occur at the Selman Living Lab. Of the 99 species that occur at Alabaster Caverns but not at the Selman Living Lab, 33 are introduced species. Other differences in species composition are due to differences in land-use history and habitats between the two sites; the Selman Living Lab had been recently grazed when it was inventoried, and it includes sandsage grassland as well as a much larger floodplain than Alabaster Caverns State Park. Although the northern part of Alabaster Caverns State Park was grazed recently, the southern part has not been grazed since the 1950s. Because the Selman Living Lab is located only 6 miles

to the west of Alabaster Caverns State Park, annual temperature and precipitation are the same, and therefore do not contribute to differences in species composition. Alabaster Caverns State Park shares 163 species with the Major County ranch. Differences in species composition between those 2 sites can be attributed in part to their different grazing histories as well as to some differences in habitats. The Major County Ranch is grazed currently, and contains a large pond, disturbed areas associated with oil well pads, and more roads than Alabaster Caverns State Park. Environmental factors also differ between the sites. Although average temperature differs by only 1° C, average annual precipitation is approximately 61 cm for Alabaster Caverns State Park and approximately 70 cm for the Major County ranch.

The major vegetation associations at Alabaster Caverns and brief descriptions of common species are as follows:

1. *Schizachyrium scoparium*-*Castilleja purpurea* var. *citrina*-*Lesquerella gordonii* herbaceous association

This was the predominant vegetation association in the park, on the gypsum outcrops and shallow soils on gypsum (Figures 1-3). Common associated species included *Aristida purpurea*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Chamaesyce glyptosperma*, *Croton monanthogynous*, *Dalea enneandra*, *Echinocereus reichenbachii*, *Heterotheca stenophylla*, *Lithospermum incisum*, *Mentzelia nuda*, *Mentzelia oligosperma*, *Nama stevensii*, *Oenothera hartwegii*, *Oenothera serrulata*, *Opuntia phaeacantha*, *Paronychia jamesii*, *Phacelia integrifolia*, *Polanisia dodecandra*, *Polygala alba*, *Portulaca pilosa*, *Psilostrophe tagetina*, *Sporobolus cryptandrus*, *Thelesperma magapotamicum*, *Tridens muticus* var. *elongatus*, and *Yucca glauca*. Two of these species, *Phacelia integrifolia* (Figure 4) and *Nama stevensii* (Figure 5), as well as the less-commonly encountered *Haploesthes greggii* (Figure 6), are found only on gypsum substrates in Oklahoma and are considered obligate gypsophiles. Two of the

species in this habitat, *Echinocereus reichenbachii* (Figure 7) and *Haploesthes greggii*, are being tracked by the Oklahoma Natural Heritage Inventory. Woody species occurred mainly on the steep north-facing slopes and ravines of Cedar Canyon, and included *Celtis laevigata* var. *reticulata*, *Cornus drummondii*, *Gleditsia triacanthos*, *Juniperus virginiana*, *Morus rubra*, *Rhus glabra*, *Rhus aromatica*, *Ribes aureum*, *Sapindus saponaria*, *Sideroxylon lanuginosum*, *Symphoricarpos orbiculatus*, *Ulmus americana*, *Ulmus rubra*, and *Vitis acerifolia*.

2. Wetland and riparian vegetation

This vegetation was found along the banks of Cedar Creek as well as the margins of the pond. Associated species included *Amorpha fruticosa*, *Baccharis salicina*, *Carex grvida*, *Eleocharis montevidensis*, *Equisetum* spp., *Nasturtium officinale*, *Pluchea odorata*, *Populus deltoides*, *Ranunculus sceleratus*, *Salix nigra*, and *Vitis riparia*. A wet depression in the grassland on the north side of the canyon supported *Marsilea vestita*, a species tracked by the Oklahoma Natural Heritage Inventory.

3. Disturbed areas and old-field vegetation

This type of vegetation was found in disturbed areas along roadsides and trails near the visitor center, in campgrounds, and in areas with deeper soils north of the canyon that were grazed until 1997. Common species in disturbed areas along roadsides, trails, and campgrounds were *Arenaria serpyllifolia*, *Bothriochloa ischaemum*, *Bromus* spp., *Chamaesaracha coniodes*, *Digitaria ciliaris*, *Erodium cicutarium*, *Glandularia pumila*, *Holosteum umbellatum*, *Lamium amplexicaule*, *Melilotus officinalis*, *Quincula lobata*, *Veronica* spp., and *Tribulus terrestris*. Common species in old fields included *Ambrosia psilostachya*, *Amphiachyris dracunculoides*, *Aristida oligantha*, *Artemisia ludoviciana*, *Bothriochloa laguroides*, *Bromus* spp., *Chamaesyce* spp., and *Gutierrezia sarothrae*. Many of these species increase with grazing. Thickets of *Prunus angustifolia* were also present.

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Table 1 Summary of floristic collections from Alabaster Caverns State Park in the Cimarron Gypsum Hills, Woodward County, Oklahoma*

Taxonomic Group	Families	Genera	Species	Native spp.	Exotic spp.
Monilophyta	3	4	4	4	0
Pinophyta	1	1	1	1	0
Magnoliophyta					
Eudicots	57	151	210	185	25
Monocots	5	43	59	42	17
Total	66	199	274	232	42

*Table format follows Palmer et al. (1995)

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APPENDIX

Annotated species list for Alabaster Caverns State Park, Woodward County, Oklahoma. Nomenclature and common names are based on USDA, NRCS (2012). Organization of taxa is based on Angiosperm Phylogeny Group (APG III) recommendations (Stevens 2012). Life history (A=annual, B=biennial, P=perennial) and collection numbers follow the species names. Taxa introduced to North America are indicated with an asterisk (*) and those on the Oklahoma Natural Heritage Inventory Plant Tracking List are indicated with a symbol (+). Voucher specimens were deposited in the University of Central Oklahoma Herbarium (CSU).

MONILOPHYTA

Equisetaceae

Equisetum L. sp. (horsetail) – P; GMC1215

Marsileaceae

+*Marsilea vestita* Hook & Grev. (hairy watercress) – P; GMC1145

Pteridaceae

Cheilanthes feei T. Moore (slender lipfern) – P; GMC800

Pellaea atropurpurea (L.) Link (purple cliffbreak) – P; GMC815

GYMNOSPERMS/PINOPHYTA

Cupressaceae

Juniperus virginiana L. var. *virginiana* (eastern redcedar) – P; GMC816

ANGIOSPERMS/MAGNOLIOPHYTA

EUDICOTS

Amaranthaceae

Amaranthus tuberculatus (Moq.) Sauer (roughfruit amaranth) – A; GMC1245

**Chenopodium album* L. var. *album* (lambsquarters) – A; KR930

Chenopodium berlandieri Moq. (pitseed goosefoot) – A; GMC1217

Anacardiaceae

Rhus aromatica Aiton – P; GMC811

Rhus copallinum L. (winged sumac) – P; GMC1177

Rhus glabra L. (smooth sumac) – P; GMC849

Toxicodendron radicans (L.) Kuntze (eastern poison ivy) – P; GMC1267

Apiaceae

Ammoselinum popei Torr. & A. Gray (plains sandparsley) – A; KR753

Sanicula canadensis L. (Canadian blacksnakeroot) – B; GMC1170

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance (Red River scaleseed) – A; GMC1165

Apocynaceae

Apocynum cannabinum L. (Indianhemp) – P; GMC 1137

Asclepias asperula (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson
(antelopehorns) – P; GMC1096

Asclepias engelmanniana Woodson (Engelmann's milkweed) – P; GMC1186
Asclepias latifolia (Torr.) Raf. (broadleaf milkweed) – P; GMC1189
Asclepias viridiflora Raf. (green comet milkweed) – P; GMC870
Asclepias viridis Walter (green antelopehorn) – P; GMC1136

Asteraceae

Achillea millefolium L. (common yarrow) – P; GMC1107
Ambrosia psilostachya DC. (Cuman ragweed) – P; GMC897
Ambrosia trifida L. (great ragweed) – A; GMC914
Amphiachyris dracunculoides (DC.) Nutt. (prairie broomweed) – A; GMC922
Artemisia dracunculus L. (tarragon) – P; GMC921
Artemisia filifolia Torr. (sand sagebrush) – P; GMC895
Artemisia ludoviciana Nutt. ssp. *ludoviciana* (white sagebrush) – P; GMC941
Baccharis salicina Torrey & A. Gray (willow baccharis) – P; GMC901
Brickellia eupatorioides (L.) Shinnery var. *corymbulosa* (Torr. & A. Gray) Shinnery
(false boneset) – P; GMC1242
Chaetopappa ericoides (Torr.) G. L. Nesom (rose heath) – P; GMC1063
Cirsium undulatum (Nutt.) Spreng. (wavy leaf thistle) – P; GMC1161
Conyza canadensis (L.) Cronquist (Canadian horseweed) – A; KR929
Conyza ramosissima Cronquist (dwarf horseweed) – A; GMC1256
Echinacea angustifolia DC. (blacksamson echinacea) – P; GMC1136
Erigeron cf. *divergens* Torr. & A. Gray (spreading fleabane) – B; GMC973
Erigeron strigosus Muhl. ex Willd. (prairie fleabane) – A; GMC1097
Evax prolifera Nutt. ex DC. (bighead pygmyweed) – A; GMC1030
Gaillardia pulchella Foug. (Indian blanket) – A; GMC828
Gaillardia suavis (A. Gray & Engelm.) Britton & Rusby (perfumeballs) – P; GMC1133
Grindelia papposa G. L. Nesom and Suh (Spanish gold) – A; GMC1203
Grindelia squarrosa (Pursh) Dunal (curlycup gumweed) – B; GMC935
Gutierrezia sarothrae (Pursh) Britton & Rusby (broom snakeroot) – P; GMC907
+ *Haploesthes greggii* A. Gray (false broomweed) – P; GMC1147
Helianthus annuus L. (common sunflower) – A; GMC854
Helianthus petiolaris Nutt. (prairie sunflower) – A; GMC1244
Heterotheca stenophylla (A. Gray) Shinnery (stiffleaf false goldenaster) – P; GMC891
Hymenopappus tenuifolius Pursh (Chalk Hill hymenopappus) – B; GMC1128
Iva annua L. (annual marshelder) – A; GMC1257
Lactuca ludoviciana (Nutt.) Riddell (biannual lettuce) – B; GMC814
Liatris punctata Hook. (dotted blazing star) – P; GMC926
Machaeranthera pinnatifida (Hook.) Shinnery (tansyaster) – P; GMC1160
Packera plattensis (Nutt.) W.A. Weber & Á. Löve (prairie groundsel) – B, P; GMC1104
Pluchea odorata (L.) Cass. (sweetscent) – A; GMC1251
Psilostrophe tagetina (Nutt.) Greene var. *cerifera* (A. Nelson) B. L. Turner (woolly
paperflower) – P; GMC843
Pyrrhopappus grandiflorus (Nutt.) Nutt. (tuberous desert-chicory) – P; GMC1005
Ratibida columnifera (Nutt.) Woot. & Standl. (upright prairie coneflower) – P; GMC1113
Senecio riddellii Torr. & A. Gray (Riddell's ragweed) – P
Solidago missouriensis Nutt. var. *fasciculata* Holz (Missouri goldenrod) – P; GMC1220
Solidago petiolaris Aiton (downy ragged goldenrod) – P; GMC908

- **Sonchus asper* (L.) Hill (spiny sowthistle) – A; GMC1142
Symphotrichum ericoides (L.) G. L. Nesom (white heath aster) – P; GMC944
 **Taraxacum officinale* F. H. Wigg (common dandelion) – P; GMC822
Tetranneuris scaposa (DC.) Greene (stemmy four-nerve daisy) – P; GMC1053
Thelesperma megapotamicum (Spreng.) Kuntze (Hopi tea greenthread) – P; GMC803
 **Tragopogon dubius* Scop. (yellow salsify) – B; GMC1143
Vernonia baldwinii Torr. (Baldwin's ironweed) – P; GMC900, GMC864
Xanthium strumarium L. var. *canadense* (Mill.) Torr. & Gray (Canada cocklebur) – A; GMC1253

Boraginaceae

- Lappula occidentalis* (S. Watson) Greene (flatspine stickseed) – A; KR752
Lithospermum incisum Lehm. (narrowleaf stoneseed) – P; GMC968

Brassicaceae

- **Camelina rumelica* Velen. (graceful false flax) – A; GMC1089
 **Capsella bursa-pastoris* (L.) Medik. (shepherd's purse) – A; GMC979
Descurainia pinnata (Walter) Britton (western tansymustard) – A; GMC1031
Draba reptans (Lam.) Fernald (Carolina draba) – A; GMC965
Lepidium densiflorum Schrad. (common pepperweed) – A; GMC1086
Lepidium oblongum Small (veiny pepperweed) – A, B; GMC1081, GMC963
Lesquerella gordonii (A. Gray) S. Watson (Gordon's bladderpod) – A; GMC966, GMC1057
 **Nasturtium officinale* W.T. Aiton (watercress) – P; GMC1179

Cactaceae

- Cylindropuntia imbricata* (Haw.) F.M.Knuth (tree cholla) – P
Echinocereus reichenbachii (Terscheck ex Walp.) hort ex Haage (lace hedgehog cactus) – P
Escobaria missouriensis (Sweet) D.R. Hunt (Missouri foxtail cactus) – P; GMC1195
Escobaria vivipara (Nutt.) Buxbaum var. *vivipara* (spinystar) – P; GMC1164
Opuntia phaeacantha Engelm. (tulip pricklypear) – P; GMC1144

Campanulaceae

- Triodanis perfoliata* (L.) Nieuwl. (clasping Venus' looking-glass) – A; GMC1122

Cannabaceae

- Celtis laevigata* Willd. var. *laevigata* (sugarberry) – P; GMC1071
Celtis laevigata Willd. var. *reticulata* (Torr.) L.D. Benson (netleaf hackberry) – P; GMC917
Celtis occidentalis L. (common hackberry) – P; GMC804

Caprifoliaceae

- Symphoricarpos orbiculatus* Moench (coralberry) – P; GMC915

Caryophyllaceae

- **Arenaria serpyllifolia* L. (thymeleaf sandwort) – A; GMC821
Cerastium nutans Raf. (nodding chickweed) – A; GMC1064
 **Cerastium pumilum* W. Curtis (European chickweed) – A; GMC1039
 **Holosteum umbellatum* L. (jagged chickweed) – A; GMC976
Paronychia jamesii Torr. & A. Gray (James' nailwort) – P; GMC883

Silene antirrhina L. (sleepy silene) – A; GMC1123

**Stellaria media* (L.) Vill. ssp. *pallida* (Dumort) Asch. & Graebon. (common chickweed) – A; GMC1014

Celastraceae

Celastrus scandens L. (American bittersweet) – P; GMC1002

Cleomaceae

Polanisia dodecandra (L.) DC. (redwhisker clammyweed) – A; GMC868

Clusiaceae

**Hypericum perforatum* L. (common St. Johnswort) – P; GMC1166

Convolvulaceae

Evolvulus nuttallianus Schult. (shaggy dwarf morning-glory) – P; GMC1088

Ipomoea leptophylla Torr (bush morning-glory) – P; GMC1146

Cornaceae

Cornus drummondii C.A. Mey. (roughleaf dogwood) – P; GMC799

Cucurbitaceae

Cucurbita foetidissima Kunth (Missouri gourd) – P; GMC1172

Euphorbiaceae

Acalypha ostryifolia Riddell (pineland threeseed mercury) – A; GMC927

Chamaesyce stictospora (Engelm.) Small (slimseed sandmat) – A; GMC892

Chamaesyce glyptosperma (Engelm.) Small (ribseed sandmat) – A; GMC1219

Chamaesyce maculata (L.) Small (spotted sandmat) – A; GMC1241

Chamaesyce missurica (Raf.) Shinnery (prairie sandmat) – A; GMC869

Chamaesyce serpens (Kunth) Small (matted sandmat) – A; GMC1259

Croton monanthogynus Michx. (prairie tea) – A; GMC930

Croton texensis (Klotzsch) Mull. Arg. (Texas croton) – A; GMC886, GMC862, GMC902

Euphorbia dentata Michx. (toothed spurge) – A; GMC953

Euphorbia marginata Pursh (snow on the mountain) – A; GMC937

Euphorbia spathulata Lam. (warty spurge) – A; GMC1060

Fabaceae

Amorpha canescens Pursh (leadplant) – P; GMC825

Amorpha fruticosa L. (false indigo bush) – P; GMC840

Astragalus gracilis Nutt. (slender milkvetch) – P; GMC993

Astragalus lotiflorus Hook. (lotus milkvetch) – P; GMC967, GMC992

Astragalus missouriensis Nutt. (Missouri milkvetch) – P; GMC1092, GMC1269, GMC969

Astragalus mollissimus Torr. (woolly locoweed) – P; GMC1093

Astragalus nuttallianus DC. var. *austrinus* (Small) Barneby (smallflowered milkvetch) – A; GMC1049

Astragalus plattensis Nutt. (Platte River milkvetch) – P; GMC1046, GMC1047, GMC1099

Dalea aurea Nutt. ex Pursh (golden prairie clover) – P; GMC863

Dalea candida Michx. ex Willd. var. *candida* (white prairie clover) – P; GMC866

Dalea enneandra Nutt. (nineanther prairie clover) – P; GMC1154

Dalea purpurea Vent. (purple prairie clover) – P; GMC1153
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald (Illinois bundleflower) – P; GMC924
Gleditsia triacanthos L (honeylocust) – P; GMC986
 **Medicago minima* (L.) L. (little bur-clover) – A; GMC1043
 **Melilotus officinalis* (L.) Lam. (sweetclover) – A,B; GMC827, GMC850
Mimosa quadrivalvis L. (fourvalve mimosa) – P; GMC1090
Pediomelum cuspidatum (Pursh) Rydb. (largebract Indian breadroot) – P; GMC1091, GMC 1135
Prosopis glandulosa Torr. (honey mesquite) – P; GMC932
Psoraleidium tenuiflorum (Pursh) Rydb. (slimflower scurfpea) – P; GMC1169
Robinia pseudoacacia L. (black locust) – P; GMC1070
Vicia americana Muhl. ex Willd. (American vetch) – P; GMC1000
Vicia ludoviciana Nutt. (Louisiana vetch) – A; GMC1094

Fagaceae

Quercus muehlenbergii Engelm. (chinkapin oak) – P

Geraniaceae

**Erodium cicutarium* (L.) L'Her. ex Aiton (redstem stork's bill) – A; GMC 836
 **Geranium pusillum* L. (small geranium) – A; 1020

Grossulariaceae

Ribes aureum Pursh var. *villosum* DC. (golden currant) – P; GMC971

Hydrophyllaceae

Nama stevensii C.L. Hitchc. (Steven's fiddleleaf) – A; GMC1041
Phacelia integrifolia Torr. (gyp phacelia) – A,B; GMC1187

Lamiaceae

Hedeoma hispida Pursh (rough false pennyroyal) – A; GMC795
 **Lamium amplexicaule* L. (henbit deadnettle) – A; GMC981
Monarda clinopodioides A. Gray (basil beebalm) – A; GMC1159
Teucrium laciniatum Torr. (lacy germander) – P; GMC1134

Linaceae

Linum pratense (Norton) Small (meadow flax) – A; GMC1066
Linum rigidum Pursh (stiffstem flax) – A; GMC1067

Loasaceae

Mentzelia nuda (Pursh) Torr. & A. Gray var. *stricta* (Osterh.) Harrington (bractless blazingstar) – B,P; GMC1188
Mentzelia oligosperma Nutt. ex Sims (chickenthiel) – P; GMC802

Malvaceae

Callirhoe involucrata (Torr. & A. Gray) A. Gray (purple poppymallow) – P; GMC1006
Sphaeralcea coccinea (Nutt.) Rydb. (scarlet globemallow) – P; GMC1051

Molluginaceae

Mollugo verticillata L. (green carpetweed) – A; GMC1229

Moraceae

Morus rubra L. (red mulberry) – P; GMC1138

Nyctaginaceae

Mirabilis linearis (Pursh) Heimerl (narrowleaf four o'clock) – P; GMC1180

Mirabilis nyctaginea (Michx.) MacMill. (heartleaf four o'clock) – P; GMC1139

Oleaceae

Forestiera pubescens Nutt. (stretchberry) – P; GMC1249

Onagraceae

Oenothera cinerea (Wooton & Standl.) W.L. Wagner & Hoch (woolly beeblossom) – P; GMC809

Oenothera curtiflora W.L. Wagner & Hoch (velvetweed) – A; GMC1148

Oenothera glaucifolia W.L. Wagner & Hoch (false gaura) – P; GMC807

Oenothera hartwegii Benth. (Hartweg's sundrops) – P; GMC1127

Oenothera serrulata Nuttall (yellow sundrops) – P; GMC1110

Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch (scarlet beeblossom) – P; GMC1052, GMC1126

Orobanchaceae

Agalinis aspera (Douglas ex Benth.) Britton (tall false foxglove) – A; GMC1228

Castilleja purpurea (Nutt.) G. Don var. *citrina* (Pennell) Shinnars (prairie Indian paintbrush) – P;
GMC991

Orobanche ludoviciana Nutt. ssp. *multiflora* (Nutt.) T.S. Collins ex H.L. White & W.C.
Holmes (manyflower broomrape) – A; GMC1196

Oxalidaceae

Oxalis corniculata L. (creeping woodsorrel) – A; GMC983

Oxalis dillenii Jacq. (slender yellow woodsorrel) – P; GMC1019

Papaveraceae

Argemone polyanthemos (Fedde) G.B. Ownbey (crested pricklypoppy) – A

Corydalis micrantha (Engelm. ex A. Gray) A. Gray (smallflower fumewort) – A; GMC1271

Plantaginaceae

Nuttallanthus canadensis (L.) D.A. Sutton (Canada toadflax) – A; KR441

Penstemon cobaea Nutt. (cobaea beardtongue) – P; GMC1056

Plantago patagonica Jacq. (woolly plantain) – A; GMC1087

Plantago rhodosperma Decne. (redseed plantain) – A; GMC1062

**Veronica arvensis* L. (corn speedwell) – A; GMC1045

Veronica peregrina L. ssp. *xalapensis* (Kunth) Pennell (hairy purslane speedwell) – A; GMC964

**Veronica polita* Fr. (gray field speedwell) – A; GMC 984

Polygalaceae

Polygala alba Nutt. (white milkwort) – P; GMC865

Polygonaceae

**Polygonum persicaria* L. (spotted ladythumb) – A; GMC1190

Polygonum ramosissimum Michx. (bushy knotweed) – A; GMC1191

Rumex altissimus Alph. Wood (pale dock) – P; GMC1209

Portulacaceae

**Portulaca oleracea* L. (little hogweed) – A; GMC1232

Portulaca pilosa L. (kiss me quick) – A; GMC925

Primulaceae

Androsace occidentalis Pursh (western rockjasmine) – A; GMC1272

Ranunculaceae

Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks (Carolina larkspur) – P

Ranunculus sceleratus L. (cursed buttercup) – A

Rhamnaceae

Ceanothus herbaceus Raf. (Jersey tea) – P; GMC1106

Rosaceae

Prunus angustifolia Marsh. (Chickasaw plum) – P; GMC844, GMC972

Rubiaceae

Galium aparine L. (stickywilly) – A; GMC1003

Galium circaezans Michx. (licorice bedstraw) – P; GMC1193

Stenaria nigricans (Lam.) Terrell var. *nigricans* (prairie bluet) – P; GMC1167

Salicaceae

Populus deltoides Bartram ex Marsh. (eastern cottonwood) – P

Salix nigra Marsh. (black willow) – P; GMC997

Sapindaceae

Sapindus saponaria L. var. *drummondii* (Hook. and Arn.) L.D. Benson (western soapberry) – P;
GMC1206

Sapotaceae

Sideroxylon lanuginosum Michx. (gum bully) – P; GMC835, GMC1207

Simaroubaceae

**Ailanthus altissima* (Mill.) Swingle (tree of heaven) – P

Solanaceae

Chamaesaracha coniodes (Moric. ex Dunal) Britton (gray five eyes) – P; GMC1044

Physalis cf. *hederifolia* A. Gray (ivyleaf groundcherry) – P; GMC857

Physalis longifolia Nutt. (longleaf groundcherry) – P; GMC1205

Physalis mollis Nutt. (field groundcherry) – P; GMC1216

Quincula lobata (Torr.) Raf. (Chinese lantern) – P; GMC1085

Solanum elaeagnifolium Cav. (silverleaf nightshade) – P; GMC896
Solanum rostratum Dunal (buffalobur nightshade) – A; GMC936

Tamaricaceae

**Tamarix ramosissima* Ledeb. (saltcedar) – P; GMC1192

Ulmaceae

Ulmus americana L. (American elm) – P; GMC970
**Ulmus pumila* L. (Siberian elm) – P; GMC978
Ulmus rubra Muhl. (slippery elm) – P

Urticaceae

Parietaria pensylvanica Muhl. ex Willd. (Pennsylvania pellitory) – A

Verbenaceae

Glandularia bipinnatifida (Nutt.) Nutt. (Dakota mock vervain) – P; GMC1050
Glandularia pumila (Rydb.) Umber (pink mock vervain) – A; GMC830

Violaceae

Viola bicolor Pursh (field pansy) – A; GMC962

Vitaceae

Cissus trifoliata (L.) L. (sorrelvine) – P; GMC845
Parthenocissus quinquefolia (L.) Planch. (Virginia creeper) – P; GMC823
Vitis acerifolia Raf. (mapleleaf grape) – P; GMC1175
Vitis riparia Michx. (riverbank grape) – P; GMC826, GMC1208

Zygophyllaceae

**Tribulus terrestris* L. (puncturevine) – A; GMC1198

MONOCOTS

Amaryllidaceae

Allium drummondii Regel (Drummond's onion) – P; GMC987

Asparagaceae

Androstephium coeruleum (Scheele) Greene (blue funnel lily) – P; GMC974
Yucca glauca Nutt. var. *glauca* (soapweed yucca) – P; GMC1061

Commelinaceae

Tradescantia occidentalis (Britton) Smyth (prairie spiderwort) – P; GMC1095

Cyperaceae

Carex gravida L.H. Bailey (heavy sedge) – P; GMC838
Cyperus lupulinus (Spreng.) Marcks (Great Plains flatsedge) – P; GMC929
Eleocharis montevidensis Kunth (sand spikerush) – P; GMC1273

Poaceae

- **Aegilops cylindrica* Host (jointed goatgrass) – A; GMC1108
Andropogon hallii Hack. (sand bluestem) – P; GMC950
Aristida oligantha Michx. (prairie threeawn) – A; GMC1221, GMC1262
Aristida purpurea Nutt. (purple threeawn) – P; GMC861
 **Bothriochloa ischaemum* (L.) Keng (yellow bluestem) – P; GMC955
Bothriochloa laguroides (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould (silver beardgrass) – P; GMC1162
Bouteloua curtipendula (Michx.) Torr. (sideoats grama) – P; GMC846
Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths (blue grama) – P; GMC872
Bouteloua hirsuta Lag. (hairy grama) – P; GMC884
 **Bromus catharticus* Vahl (rescuegrass) – A; GMC989
 **Bromus arvensis* L. (field brome) – A; GMC1119
 **Bromus tectorum* L. (cheatgrass) – A; GMC1124, GMC988
Buchloe dactyloides (Nutt.) J.T. Columbus (buffalograss) – P; GMC1116, GMC1027, GMC960
Cenchrus spinifex Cav. (coastal sandbur) – A; GMC834
Chloris verticillata Nutt. (tumble windmill grass) – P; GMC1231
 **Dactylis glomerata* L. (orchardgrass) – P; GMC1140
Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould (Scribner's rosette grass) – P; GMC1101, GMC1152
Digitaria ciliaris (Retz.) Koeler (southern crabgrass) – A; GMC1230, GMC1255
Echinochloa muricata (P. Beauv.) Fernald (rough barnyardgrass) – A; GMC1264
 **Eleusine indica* (L.) Gaertn. (Indian goosegrass) – A; GMC1254
Elymus canadensis L. (Canada wildrye) – P; GMC1155
Elymus virginicus L. (Virginia wildrye) – P; GMC1210
 **Eragrostis cilianensis* (All.) Vign. ex Janchen (stinkgrass) – A; GMC1222
Eragrostis secundiflora J. Presl ssp. *oxylepis* (Torr.) S.D. Koch (red lovegrass) – P; GMC920
Eragrostis spectabilis (Pursh) Steud. (purple lovegrass) – P; GMC943
Erioneuron pilosum (Buckley) Nash (hairy woollygrass) – P; KR404
Hordeum pusillum Nutt. (little barley) – A; GMC1102, GMC791
 **Lolium perenne* L. (perennial ryegrass) – P; GMC788
Muhlenbergia racemosa (Michx.) Britton, Sterns & Poggenb. (marsh muhly) – P; GMC904
Panicum capillare L. (witchgrass) – A; GMC1218, GMC856
Panicum obtusum Kunth (vine mesquite) – P; GMC1248, GMC946
Panicum virgatum L. (switchgrass) – P; GMC874
Pascopyrum smithii (Rydb.) Á. Löve (western wheatgrass) – P; GMC1129
Phalaris caroliniana Walter (Carolina canarygrass) – A; GMC1083
 **Poa annua* L. (annual bluegrass) – A; GMC980
Poa arida Vasey (plains bluegrass) – P; GMC1018
 **Poa pratensis* L. (Kentucky bluegrass) – P; GMC990, GMC1007, GMC790, GMC1022
 **Schedonorus phoenix* (Scop.) Holub (tall fescue) – P; GMC1021
Sclerochloa dura (L.) P. Baeuv. (common hardgrass) – A; GMC977
Schizachyrium scoparium (Michx.) Nash (little bluestem) – P; GMC940
 **Secale cereale* L. (cereal rye) – A; GMC1011
 **Setaria pumila* (Poir.) Roem. & Schult. (yellow foxtail) – A; GMC1240
 **Setaria viridis* (L.) P. Beauv. (green bristlegrass) – A; GMC911, GMC1199
Sorghastrum nutans (L.) Nash (Indiangrass) – P; GMC898

**Sorghum halepense* (L.) Pers. (Johnsongrass) – P; GMC824, GMC912
Sporobolus compositus (Poir.) Merr. var. *compositus* (composite dropseed) – P; GMC931, GMC1223
Sporobolus cryptandrus (Torr.) A. Gray (sand dropseed) – P; GMC876, GMC1225, GMC1234
**Thinopyrum ponticum* (Podp.) Z.-W. Liu & R.-C. Wang (tall wheatgrass) – P; GMC1265
Tridens flavus (L.) Hitchc. (purpletop tridens) – P; GMC1213
Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinnery (slim tridens) – P; GMC 1224,
GMC1233
Tripsacum dactyloides (L.) L. (eastern gamagrass) – P; GMC847, GMC1184
Vulpia octoflora (Walter) Rydb. (sixweeks fescue) – A; GMC1033, GMC994



Figure 1 *Schizachyrium scoparium*-*Castilleja purpurea* var. *citrina*-*Lesquerella gordonii* herbaceous association on gypsum at Alabaster Caverns State Park. Photo courtesy of William Caire.



Figure 2 *Castilleja purpurea* var. *citrina* on gypsum outcrop at Alabaster Caverns State Park. Photo by G. Caddell.



Figure 3 *Lesquerella gordonii* with basal rosette of *Phacelia integrifolia* on gypsum outcrop at Alabaster Caverns State Park. Photo by G. Caddell.



Figure 4 *Phacelia integrifolia*, an obligate gypsophile, at Alabaster Caverns State Park. Photo by G. Caddell.



Figure 5 *Nama stevensii*, an obligate gypsophile, at Alabaster Caverns State Park. Photo by G. Caddell.



Figure 6 *Haploesthes greggii*, an obligate gypsophile, at Alabaster Caverns State Park. Photo by G. Caddell.



Figure 7 *Echinocereus reichenbachii* at Alabaster Caverns State Park. Photo by G. Caddell.