

**Sandsage Prairie
Biologically Unique Landscape
Rare Plant Survey**



Prepared for the Nebraska Natural Legacy Project
Nebraska Game and Parks Commission

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SANDSAGE PRAIRIE BIOLOGICALLY UNIQUE LANDSCAPE RARE PLANT SURVEY

A report prepared for the
Nebraska Game and Parks Commission

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SUMMARY

The Sandsage Prairie region of southwestern Nebraska is recognized as a Biologically Unique Landscape by the Nebraska Natural Legacy Project. The region supports 14 Nebraska plants of conservation concern (S1-S2). A rare plant survey was undertaken to gain a better understanding of the ecology and conservation needs of these at-risk species and the plant communities with which they are associated. Eight are associated with Sandsage Prairie, three with Loess Mixed-Grass Prairie, two with the Rock Outcrop community type, and one of undetermined association. Most have a globally secure conservation status (G4-G5) but are at the periphery of their distribution in Nebraska where they are known from only a limited number of occurrences. Extant occurrences were found for six of the 14 targeted at-risk plants. Most of the at-risk species associated with sandsage prairie occur in sparsely vegetated habitat, primarily in open areas of loose sand on the slopes and crests of dunes, and are absent from more densely vegetated areas. The rarity of these species may be due in part to their association with a transitory niche in dynamic sand dune habitat, resulting in local fluctuations in abundance over time. Sandsage prairie in Nebraska supports a unique and specialized flora that includes species of conservation concern as well as Central Grassland endemics. Nebraska sandsage prairie also differs floristically from that in the southern Great Plains and may represent an unrecognized northern variant of this ecological system. The survey led to the discovery of the only known Nebraska occurrence of a variant of shortgrass prairie dominated by purple three-awn grass (*Aristida purpurea*). Three exemplary sites were noted for supporting relatively high numbers of at-risk plants as well as large, intact, high quality occurrences of the major upland plant communities of the Sandsage Prairie Biologically Unique Landscape.

INTRODUCTION

Purpose of Project

The Sandsage Prairie region of southwestern Nebraska (Chase, Dundy, and Perkins counties) is recognized as a Biologically Unique Landscape (BUL) by the Nebraska Natural Legacy Project. Sandsage prairie is a steppe community in which the shrub sand sagebrush, *Artemisia filifolia*, is a dominant element. This unique Great Plains ecological system ranges from Wyoming into New Mexico and Texas but the core of its distribution is on the eastern plains of Colorado and the southwest portions of Nebraska and Kansas. Sandsage prairie is important for many species of grassland birds but is declining in both quality and quantity and has been identified as a conservation priority in the state wildlife action plans of Nebraska, Colorado, and Kansas.

The primary purpose of the project was to locate and document extant occurrences of Nebraska at-risk plants associated with sandsage prairie: *Chenopodium cycloides* (sandhill goosefoot, S1); *Dalea cylindriceps* (sandsage prairie-clover, S1); *Eragrostis secundiflora* subsp. *oxylepis* (red lovegrass, S1); *Linum berlanderi* (Berlandier's flax, S1); *Mirabilis glabra* (smooth four-o'clock, S2); *Pomaria jamesii* (James' rush-pea, S1); *Penstemon ambiguus* (gilia beardtongue, S1); *Phemeranthus calycinus* (rockpink fame-flower, S1S2). Since these species are likely associated with relatively high quality occurrences of

sandsage prairie, a secondary aim of the study was to gather baseline data on the plant species composition and structure of this plant community in Nebraska. Such information is currently lacking and critically needed for informed management and restoration of sandsage in Nebraska and elsewhere in the western Great Plains. It is also needed to aid conservation agencies and organizations in identifying high quality sandsage habitat for acquisition and protection.

Search was also made for at-risk plants that occur in the general area of the Sandsage Prairie BUL but are associated with other upland community types: *Allium drummondii* (Drummond's wild onion, S1); *Artemisia carruthii* (Carruth's sagewort, S1); *Chaetopappa ericoides* (rose heath daisy, S2); *Minuartia michauxii* var. *texana* (Texas sandwort, S2); *Oxytopis multiceps* (dwarf locoweed, S2); *Ratibida tagetes* (short-ray prairie-coneflower, S1).

Plan of Work

The work was conducted by Jim Locklear, Director of Conservation at Lauritzen Gardens. The original plan of work called for three surveys during the 2016 growing season—spring, early summer, and late summer. These correspond to the primary flowering seasons identified by Francis Ramaley in his pioneering study of sandhill vegetation in northeastern Colorado (Ecological Monographs 9: 1-51. 1939). Due to a health issue, Locklear was only able to conduct one survey in 2016. The Nebraska Game and Parks Commission extended the contract into 2017 to allow for completion of the project.

The basic methodology of the project was to attempt to relocate known historical occurrences of the targeted species plus survey other areas of potential habitat encountered within the region. Surveys were conducted in three periods: May 24-27, 2016; June 5-9, 2017; August 2-6, 2017.

OVERVIEW OF STUDY REGION

Location

The Sandsage Prairie Biologically Unique Landscape is located in southwestern Nebraska and encompasses most of Dundy, Chase, and Perkins counties, extending eastward into Hayes and Hitchcock counties (Schneider et al. 2005). The region is located within the watershed of the Republican River.

Physiography

The study region is situated in the northern portion of the High Plains section of the Great Plains Physiographic Province (Fenneman 1931). The surface geology of the region is influenced by Tertiary-age non-marine deposits of the Ogallala Group (Miocene to earliest Pliocene). Windblown sand and/or loess mantle the Ogallala bedrock throughout most of the study area except where it is exposed along streams and intermittent waterways. The topography of the region consists of plains that have been modified by wind and stream erosion and deposition into high divides or tablelands separated by valleys. The primary physiographic features are tablelands, dissected uplands, ravines, canyons, river valleys, sandhills, and sandhill valleys. Elevations within the study region range from ca. 885 m (2900 ft.) to 1141 m (3742 ft.).

Regional Climate

The climate of the region is semiarid and continental. Average annual precipitation in the region is 48 cm (19 in). Periods of consecutive wet and dry years tend to occur. The region is subjected to strong winds. Prevailing winds are from the northwest.

TERRESTRIAL COMMUNITIES

The following plant communities were observed during the study. Nomenclature follows *Terrestrial Ecological Systems and Natural Communities of Nebraska* (Rolfsmeier & Steinauer 2010)

Sandsage Prairie

NatureServe placement: Western Great Plains Sandhills Steppe

NNLP priority for conservation

Sandsage prairie is a steppe community in which the shrub sand sagebrush, *Artemisia filifolia*, is a dominant element. This community type is found in sandy habitat throughout a large area of the western Great Plains, from South Dakota and Wyoming south into Texas and New Mexico (Kuchler 1985). While *A. filifolia* is a constant in this community type, the co-dominant graminoids vary depending on topographic factors but are mostly tall (1-2 m; 3-6 ft.) or mid-height (0.5-1 m; 1.5-3 ft.) grasses. The earliest published description of this plant community was in *Phytogeography of Nebraska* in which Pound and Clements (1900) identified an “*Artemisia filifolia* formation.”

What has been broadly referred to as “sandsage prairie” in ecological, range management, and wildlife management literature is in reality a complex of vegetation types that occur in mosaic with stands of *Artemisia filifolia* steppe. In his research on sandhill vegetation in northeastern Colorado, Ramaley (1939) identified four upland plant communities, only one of which was dominated by *A. filifolia*. Similarly, Kelso et al. (2007) identified five zones of vegetation in their study of a sand dune complex in southeastern Colorado, but only one had a significant component of *A. filifolia*. In southwestern Nebraska, stands of *A. filifolia* steppe occur in mosaic with and grade into grass-dominated vegetation on dune crests and slopes as well as on more level terrain.

The most extensive stands of sandsage prairie in Nebraska occur in the southwest corner of the state, primarily in Dundy, Chase, and Perkins counties with small outliers in Hayes and Hitchcock counties. These are mapped as “Sandsage mixed-grass prairie” by Kaul and Rolfsmeier (1993) on their vegetation map of Nebraska. Other significant stands of *A. filifolia* occur in belts along the western edge of the Nebraska Sandhills and along the south side of the North Platte River in the Nebraska Panhandle, which Kaul and Rolfsmeier mapped as “Sand Hills borders mixed-grass prairie” to distinguish it from the *A. filifolia*-dominated vegetation of southwestern Nebraska. Jon Farrar (1993a, 1993b) authored two excellent articles on the history, ecology, and conservation challenges of sandsage prairie in Nebraska for *NEBRASKAland* magazine.

In southwestern Nebraska, sandsage prairie is associated with two geographically distinct dune fields—the Wray Dune Field and the Imperial Dune Fields (Muhs & Holliday 1995). The Wray Dune Field is the larger and extends from Yuma and Phillips counties in northeastern Colorado (covering 4680 sq. km [1807 sq. mi.]) into southwestern Nebraska (covering more than 2000 sq. km [772 sq. mi.]) where it occupies much of the western half of Dundy County and extends into the southwest portion of Chase County (Madole 1995). The sands of the Wray Dune Field were derived from South Platte River sediments (Muhs et al. 1996). The Imperial Dune Fields are located to the north and east of the Wray Dune Field in Chase and Perkins counties, with an isolated field in Hayes County. The sands of the Imperial Dune Fields were derived from both the Nebraska Sandhills (quartz-rich) and the South Platte River dune fields (K-feldspar rich) of northeastern Colorado (Muhs et al. 2000).

The topography of these dune fields varies from low, rolling hills with relatively flat crests to more choppy sandhills with steep sides and local relief from a few meters to as much as 60 m (200 ft.). Soils formed in this eolian sand are deep, excessively drained, and very rapidly permeable. The predominant

soil association of sandsage prairie in the study region is Valent sand (Paden et al. 1982, 1991; Wilson et al. 2004).

While large expanses of Nebraska sandsage prairie can be fairly uniform in structure, even small-scale variation in topographic relief and surface soil texture can create local variation in dominant grasses, associated forbs, and overall plant species diversity, resulting in zonation of vegetation. These topographic gradients accord with studies of sandsage prairie areas in eastern Colorado (Ramaley 1939; McGinnies et al. 1991; Kelso et al. 2007) and the author's observations of sandsage prairie at The Nature Conservancy's Fox Ranch Preserve, located ca. 48 km (30 miles) to the southwest of the study region in Yuma County, Colorado.

On nearly level to gently rolling terrain, where the sandy soil has a higher loam content, *Hesperostipa comata* (needle-and-thread) and *Calamovilfa longifolia* (prairie sandreed) are the dominant grasses occurring with *A. filifolia*. The cool-season *Hesperostipa comata* is particularly noticeable in late May and June when it is in flower. *Bouteloua gracilis* (blue grama) and *Carex heliophila* (sun sedge) usually make up the underlayer of this relatively dense vegetation.

Where the topography is stronger and the dunes taller, the sharper slopes and steeper crests of the dunes make them more vulnerable to wind activity. In such terrain there are often areas where the vegetation has been thinned to the point that open sand is exposed and, in severe cases, blowouts form. As has been documented in the Nebraska Sandhills (Barnes et al. 1984), greater numbers of forbs and higher species richness occur on dune crests and upper slopes where disturbance by wind erosion has reduced the dominance of grasses. In such habitat there is a dynamic give-and-take between erosion and re-vegetation, facilitated by a succession of plant species each adapted to a particular stage of the progression from open sand to stable vegetation. The sequence of species involved in Nebraska sandsage prairie parallels that which occurs in the Nebraska Sandhills (Pool 1914; Tolstead 1942; Weaver 1965) and in sandsage prairie in northeastern Colorado (McGinnies et al. 1991), with *Muhlenbergia ammophila* (blowout grass; formerly *Redfieldia flexuosa*) and *Psoralidium lanceolatum* (lemon scurf-pea) being early pioneers, succeeded later by *Muhlenbergia pungens* (sandhills muhly).

Ecological data from herbarium specimen labels, coupled with field observations of historical collection sites and newly discovered localities, reveal that most of the species of conservation concern in Nebraska sandsage prairie occur in sparsely vegetated habitat, primarily in open areas of loose sand on the slopes and crests of dunes, and are absent from more densely vegetated areas. This is especially true of *Chenopodium cycloides*, *Linum berlandieri*, *Mirabilis glabra*, and *Penstemon ambiguus*. *Andropogon hallii* (sand bluestem) and *Muhlenbergia pungens* are typically the dominant grasses in such sites. Association with a transitory niche in the ever-changing sand dune environment could result in local fluctuations in the presence and abundance of these species over time (see discussion under Conservation Issues).

Occurrences of sandsage prairie in Nebraska and adjacent northeastern Colorado are at the northern limits of the distribution of this ecological system in the Great Plains. Comparison of the floristic composition of Nebraska sandsage prairie with that of southern occurrences (Sherwood & Risser 1980; Dick-Peddie 1993; Kelso et al. 2007; Neid et al. 2007; Nesom & O'Kennon 2008; Kuhn et al. 2011) reveals variation along a north-to-south gradient, with higher species diversity found in occurrences in the southwestern Great Plains. Some species, such as *Dalea lanata*, *Oenothera cinerea*, *Oenothera engelmannii*, and *Palafoxia rosea*, occur in sandsage prairie in Colorado, Kansas, Oklahoma, and Texas but are absent from Nebraska and other northern occurrences. Other species characteristic of southern stands reach the northern limits of their distribution in the sandsage prairie region of southwestern Nebraska, notably *Chenopodium cycloides*, *Eragrostis secundiflora* subsp. *oxylepis*, *Linum berlandieri*, *Penstemon*

ambiguus, *Pomaria jamesii*, and *Ratibida tagetes*. These plants are known from very few occurrences in Nebraska and are all of conservation concern; none occur in the Nebraska Sandhills.

Floristic comparisons also reveal a suite of species associated with sandsage prairie in Nebraska and northeastern Colorado that are mostly absent from the southern reaches of this ecological system. These include *Penstemon angustifolius* (narrowleaf beardtongue), *Phlox andicola* (plains phlox), *Physaria ludoviciana* (bladderpod), and *Prunus pumila* var. *bessseyi* (sand cherry). In addition, *Hesperostipa comata* is more prevalent in the tall grass layer and *Carex heliophila* in the understory layer of northern stands (Daley 1972; Sims et al. 1976; Rolfsmeier & Steinauer 2010). Both are cool-season species, in contrast to warm season graminoids that dominate southern stands. Such differences may warrant recognition of a northern and southern expression of sandsage prairie, much as Kuchler (1974) recognized a northern and southern expression of shortgrass prairie in Kansas.

Loess Mixed-Grass Prairie

NatureServe placement: Central Mixed Grass Prairie
NNLP priority for conservation

This grassland community occurs in parts of southwestern Nebraska, northwestern Kansas, and northeastern Colorado where deep deposits of loess mantle the High Plains surface. Classified as Peoria Loess, these deposits represent the westernmost part of the North American midcontinent loess province (Muhs et al. 1999). Peoria Loess was deposited during the Last Glacial maximum in North America (ca. 25,000 to ca. 13,000 calibrated years before present), and is thought to be the thickest “Last Glacial” loess in the world, with some of the deepest deposits (> 20 m) occurring in southwestern Nebraska (Bettis et al. 2003; Muhs et al. 2008).

The landscape of the loessal region of southwestern Nebraska consists of nearly level to gently rolling tablelands dissected by entrenched streams and intermittent drainageways into moderately to steeply sloping hills, ridges, ravines, and canyons. Many of the canyons are notable topographic features and some have scenic values rivaling that of any other region of Nebraska or the central Great Plains. Among these are the “Little Grand Canyon” north of Wauneta in Chase County and Oak Canyon, a two-mile long tributary of Driftwood Creek in Hitchcock County where an isolated stand of 300 to 400 *Quercus macrocarpa* (bur oak) trees occurs.

Loess Mixed-Grass Prairie is characterized by a mixture of tall (1-2 m; 3-6 ft.) and mid (0.5-1 m; 1.5-3 ft.) grasses, often with an understory of short (< 0.5 m; < 1.5 ft.) grasses (Weaver 1965; Hulett et al. 1968; Lauver et al. 1999; Colorado Natural Heritage Program 2005; Rolfsmeier & Steinauer 2010). In southwestern Nebraska, occurrences of Loess Mix-Grass Prairie on level to gently rolling terrain have largely been converted to cropland, but significant stands persist on slopes associated with hills, breaks, and canyons where cultivation is more difficult. Such stands are typically dominated by mid-grasses *Schizachyrium scoparium* (little bluestem) and *Bouteloua curtipendula* (sideoats grama).

Soils supporting Loess Mixed-Grass Prairie in the study region are primarily of the Colby association (Hoppe et al. 1970; Paden et al. 1982; Scheinost 1982; Wilson et al. 2004). This association consists of gently sloping to steep soils on the upper slopes of canyons and along drainageways. Colby soils are well drained and somewhat excessively drained silty soils formed in loess. Keith association soils predominate on nearly level to gently sloping uplands in the study region in landscape positions above Colby soils, but much of the acreage in this soil association is under cultivation.

Three plants of conservation concern in Nebraska are associated with Loess Mixed-Grass Prairie in the study region—*Allium drummondii* (S1), *Artemisia carruthii* (S1), and *Chaetopappa ericoides* (S2).

Threadleaf Sedge Western Mixed-Grass Prairie

NatureServe placement: Northwestern Great Plains Mixed-Grass Prairie

This grassland community occurs throughout much of the High Plains of the Nebraska Panhandle, but appears to be of limited distribution within the study region in southwestern Nebraska. The dominant graminoid is *Carex filifolia* (threadleaf sedge), with *Hesperostipa comata* typically co-dominant. This community was observed in association with rocky uplands that border Frenchman Creek in Chase County, particularly in the more rugged terrain from Enders Reservoir southeast to the town of Wauneta, where there is an intergradation with the Rock Outcrop community type discussed below. Within the study region, the Threadleaf Sedge Western Mixed-Grass Prairie community occurs in soils of the Otero-Canyon association (Paden et al. 1982), which are loamier than the silty Colby association soils that support Loess Mixed-Grass Prairie throughout much of southwestern Nebraska.

Purple Three-Awn Grassland

NatureServe placement: Western Great Plains Shortgrass Prairie

A single occurrence of this poorly-defined grassland community was encountered in southwestern Perkins County. The rangeland had the appearance of shortgrass prairie but the dominant grass was *Aristida purpurea* (purple three-awn) rather than *Bouteloua gracilis*. The community occurred on nearly level land adjacent to an area of rolling sandhills dominated by sandsage prairie, but species like *Hesperostipa comata*, *Calamovilfa longifolia*, and *Andropogon hallii* typical of sandy habitat in the study region were lacking or of minor occurrence. The most prominent forb was *Ipomoea leptophylla* (bush morning-glory) but other relatively tall forbs were noticeable above the graminoid layer—*Asclepias stenophylla* (narrowleaf milkweed), *Mirabilis hirsuta* (hairy four-o'clock), and *Psoraleidum tenuiflorum* (slender-flower scurfpea).

The grassland does not correspond to any community delineated in *Terrestrial Ecological Systems and Natural Communities of Nebraska* (Rolfmeier & Steinauer 2010) but does correspond to the “wire-grass” association identified for eastern Colorado by Shantz (1911) where *Aristida purpurea* is the dominant species. Shantz noted this association was particularly abundant in Washington and Yuma counties in northeastern Colorado and occurred on soils intermediate between sandhills and the loamier soils that support *Bouteloua gracilis*–*Buchloe dactyloides* (buffalograss) shortgrass prairie. He described the general appearance of the association as a shortgrass mat overtopped by low tufts of *A. purpurea*, which imparted a light silvery cast to the vegetation. He also noted the presence of several comparatively tall forb species in the association, most prominently *Psoraleidum tenuiflorum* and *Ipomoea leptophylla*. This grassland association was recognized as a variant of shortgrass prairie by McGinnies et al. in their 1991 publication on vegetation and land use changes in eastern Colorado from 1904 to 1986. The composition and structure *A. purpurea* grassland described by Shantz (1911) and McGinnies et al. (1991) for eastern Colorado correspond to the appearance of the grassland encountered in Perkins County.

The soil of the Perkins County site where this community was observed is mapped as Rosebud sandy loam (Paden et al. 1991). While the presence of *Aristida purpurea* in Great Plains grasslands is often considered indicative of past abuse or disturbance, the Perkins County occurrence appeared to be in relatively good ecological condition.

Rock Outcrop

NatureServe placement: Western Great Plains Cliff and Outcrop

This community type is associated with outcroppings of Ogallala Group bedrock exposed by downcutting along the Republican River and its tributaries. Significant areas of rock outcrop habitat are associated with Buffalo Creek and Rock Creek in Dundy County, Frenchman Creek and its tributaries, and a number

of other streams and intermittent drainageways entering the Republican River between Benkelman and McCook.

Rock outcrop habitat presents environmental conditions more stressful than that supporting the surrounding grassland vegetation. These conditions include soils that are poorly developed or absent with little moisture-retaining organic matter that dry more quickly than adjacent areas during much of the growing season. Such conditions mostly exclude the surrounding grassland vegetation and result in habitat that experiences full exposure to the sun and wind, which desiccates plant tissues and makes the environment even more xeric by increasing runoff of rainfall and hindering accumulation of moisture-replenishing snow cover in winter. Rock outcrop habitat also experiences high light levels during the daytime and radiation of heat to the sky at night, which in turn results in wider fluctuations in daily temperatures than would be experienced in other habitats.

Despite these challenging environmental conditions, rock outcrop habitat in the study region supports a diverse and distinctive assemblage of forb species. These include Great Plains endemics *Astragalus sericoleucus* (silky orophaca) and *Paronychia depressa* (James' nailwort) plus species at the periphery of their ranges including those with Rocky Mountain/Wyoming Basin affinities such as *Artemisia frigida* (fringed sage), *Erigeron canus* (hoary fleabane), *Orobanche fasciculata* (clustered cancer-root), *Oxytropis multiceps*, and *Tetranneuris acaulis* (stemless tetranneuris) along with *Minuartia michauxii* var. *texana* and *Tetranneuris scaposa* (bitterweed), two species of the south-central Great Plains. *Tetranneuris scaposa* is typically the dominant forb in rock outcrop habitat in southwestern Nebraska. *Oxytropis multiceps* (S2) and *Minuartia michauxii* var. *texana* (S2) are species of conservation concern in Nebraska.

In southwestern Nebraska, rock outcrop habitat occurs within the context of Loess Mixed-Grass Prairie and, to a lesser extent, Threadleaf Sedge Western Mixed-Grass Prairie. In the former situation, outcroppings of Ogallala bedrock are mostly mantled by Peoria Loess and the Rock Outcrop community has a landscape position below that of the uplands vegetated with Loess Mixed-Grass Prairie. In the latter situation, rock outcrop habitat occurs along the crests of hills and bluffs and plants of the Rock Outcrop community and Threadleaf Sedge Western Mixed-Grass Prairie are somewhat intermixed. The structure and species composition of Rock Outcrop communities in southwestern Nebraska are similar to that observed in the Arikaree Breaks area of Cheyenne County in northwestern Kansas.

SPECIES OF CONSERVATION CONCERN

The study targeted 14 plants of conservation concern in Nebraska. An annotated list appears below. All are perennial herbs except for *Chenopodium cycloides* and *Linum berlandieri*, which are annual herbs. Technical descriptions can be found in *Flora of Nebraska* (Kaul et al. 2011) and *Flora of the Great Plains* (GPFA 1986).

Nebraska conservation status rankings are S1 (critically imperiled) or S2 (imperiled). Global conservation status ranks are G3 (vulnerable), G4 (apparently secure), or G5 (secure). With the exception of *Chenopodium cycloides* and *Dalea cylindriceps*, which are rare throughout their ranges and globally vulnerable to extinction (G3), the targeted plants are relatively widely distributed and secure in their core range (rank of G4 or G5) but are at the periphery of their distribution in Nebraska where they are only known from a limited number of occurrences. Such peripheral populations may be genetically distinct from those located in the core of the species distribution and important to the conservation of the species.

The basic methodology of the project was to attempt to relocate known historical occurrences of the targeted species plus survey other areas of potential habitat encountered within the region. The majority of the historical occurrences surveyed are based on specimens held by the University of Nebraska Bessey Herbarium (NEB). Most of these collections were made in the 1990s (20+ years ago) and in some cases

much earlier. Extant occurrences were found for six of the 14 targeted at-risk plants. Locality data and other ecological information for extant occurrences is provided in the Rare Plant Survey forms included in the Appendix.

Most of the land in the Sandsage Prairie BUL is in private ownership and locating landowners or managers to secure permission to access the sites of historical occurrences or potential habitat proved problematic. Large areas of potential habitat in the study region were not searched and could support additional populations of the at-risk species targeted in this study.

Two moss species of conservation concern occur within the Sandsage Prairie BUL. *Molendoa ogalalense* (formerly *Ozobryum ogalalense*) is a very rare and critically imperiled (G1) moss that was collected in southeastern Hitchcock County in 1991 (Merrill 12919; KSC). The habitat of the occurrence is described as “on mortarbeds [of the Ogallala Formation] exposed in arroyo” (Merrill 1992). Attempt was made to relocate this occurrence but the landowner of the presumed site could not be found to secure permission to access the property. *Pterygoneurum subsessile* var. *kieneri* is only known from the type specimen collected in 1941 by Walter Kiener (Kiener 10627; MO, NEB) in Chase County, Nebraska. Information on herbarium specimen labels states the locality as “8 miles west of Champion” and that the plants were growing on “grassland soil.” Attempt was made to relocate suitable habitat eight miles west of Champion but very little native vegetation was observed in the area.

A unique expression of *Calamovilfa longifolia* was encountered in association with sandsage prairie in Dundy County that was initially thought to be *C. gigantea* (giant sandreed) because of the height of the plants (some individuals up to 2 m [6 ft.] tall) and the larger size and more open architecture of the panicle. *Calamovilfa gigantea* is characteristic of sandsage prairie in the southern Great Plains but has not been reported from sandsage in Nebraska. Examination of specimens by botanists Dr. Robert Kaul (University of Nebraska-Lincoln) and Dr. David Sutherland (University of Nebraska-Omaha) determined the species to be *C. longifolia* but these plants may represent an undescribed subspecies.

Allium drummondii Regel
Drummond’s wild onion

Rank: S1 (G5)
Primary distribution: South-central Great Plains
Nebraska counties: Frontier, Hitchcock, Lincoln, Red Willow
Historical occurrences searched: 1 (Brown 1237 in 1940)
Extant occurrences found: 1 historical (Brown 1237) @ 20 individuals + 2 new @ < 10 and 50-75 individuals, respectively
Plant community association: Loess Mixed-Grass Prairie

Artemisia carruthii A.W. Wood ex Carruth
Carruth’s sagewort

Rank: S1 (G4?)
Primary distribution: Southwestern United States
Nebraska counties: Frontier
Historical occurrences searched: 1 (Rolfmeier 14813 in 1999)
Extant occurrences found: none
Plant community association: Loess Mixed-Grass Prairie

Chaetopappa ericoides (Torr.) G.L. Nesom
Rose heath daisy

Rank: S2 (G5)

Synonym: *Leucelene ericoides* (Torr.) Greene

Primary distribution: Southwestern United States

Nebraska counties: Chase, Franklin, Furnas, Perkins, Red Willow

Historical occurrences searched: 2 (*Rydberg 166* in 1891; *Stephens 65379* in 1973)

Extant occurrences found: 1 historical (*Stephens 65379*) @ 75 individuals

Plant community association: Loess Mixed-Grass Prairie

Notes: Also known from rocky mixed-grass prairie in south-central Nebraska where occurrences are probably more numerous.

Chenopodium cycloides A. Nelson

Sandhill goosefoot

Rank: S1 / Nebraska Tier I at-risk species (G3)

Primary distribution: Southwestern Great Plains

Nebraska counties: Chase, Dundy, Perkins

Historical occurrences searched: 4 (*Rolfsmeier 10724* in 1992; *Rolfsmeier 11183* in 1992; *Rolfsmeier 12954* in 1996; *Rolfsmeier 14788* in 1999)

Extant occurrences found: none

Plant community association: Sandsage Prairie

Notes: See Ladyman 2006 for conservation assessment; Central Grassland endemic (Locklear 2017)

Dalea cylindriceps Barneby

Sandsage prairie-clover

Rank: S1 / Nebraska Tier I at-risk species (G3)

Synonyms: *Petalostemon macrostachyus* Torr.; *Petalostemon campactum* (Sprengel) Swezey, misapplied (see Locklear 2013)

Primary distribution: Western Great Plains

Nebraska counties: Box Butte, Brown, Buffalo, Chase, Cherry, Dundy, Frontier, Garden, Keith, Keya Paha, Lincoln, Morrill, Scotts Bluff, Sheridan, Sioux

Historical occurrences searched: 3 (*Bates s.n.* in 1916; *Rolfsmeier 12963* in 1996; Locklear observation in 2010)

Extant occurrences found: none

Plant community association: Sandsage Prairie

Notes: Recent field work in Nebraska has shown this species to be most common along the western perimeter of the Nebraska Sandhills in association with the Western Sand Prairie community (Locklear 2015).

Eragrostis secundiflora J. Presl in C. Presl subsp. *oxylepis* (Torr.) S.D. Koch

Red lovegrass

Rank: S1 (G5TNR)

Synonym: *Eragrostis oxylepis* (Torr.) Torr.

Primary distribution: South-central Great Plains

Nebraska counties: Chase, Dundy

Historical occurrences searched: 2 (*Rolfsmeier 10997* in 1992; *Rolfsmeier 12956* in 1996)

Extant occurrences found: none

Plant community association: Sandsage Prairie

Linum berlandieri Hook.
Berlandier's flax

Rank: S1 (G5)
Synonym: *Linum rigidum* Pursh var. *berlandieri* (Hook.) Torr.
Primary distribution: South-central Great Plains
Nebraska counties: Dundy
Historical occurrences searched: none
Extant occurrences found: 1 new @ < 10 individuals
Plant community association: Sandsage Prairie
Notes: Central Grassland endemic (Locklear 2017)

Minuartia michauxii (Fenzl) Farw. var. *texana* (B.L. Robins. ex Britton) Mattf.
Texas sandwort

Rank: S2 (G5T3T5)
Synonym: *Arenaria stricta* Michx. subsp. *texana* (B.L. Robins.) Maguire
Primary distribution: South-central Great Plains
Nebraska counties: Chase, Franklin, Hitchcock, Phelps, Red Willow, Webster
Historical occurrences searched: 2 (*Tolstead 411380* in 1941; *McGregor 23793* in 1971)
Extant occurrences found: 1 historical (*Tolstead 411380*) @ ca. 100 individuals
Plant community association: Rock Outcrop
Notes: Also known from rock outcrop habitat in south-central Nebraska where occurrences are probably more numerous; Central Grassland endemic (Locklear 2017).

Mirabilis glabra (S. Watson) Standley
Smooth four-o'clock

Rank: S2 (G5)
Primary distribution: Southwestern Great Plains
Nebraska counties: Chase, Dundy, Garden, Grant, Morrill, Perkins, Sheridan, Sioux
Historical occurrences searched: 5 (*Rolfsmeier 10740* in 1992; *Rolfsmeier 11002* in 1992; *Rolfsmeier 12957* in 1996; *Rolfsmeier 14797* in 1999; *R. Steinauer 2189* in 2004)
Extant occurrences found: 2 historical (*Rolfsmeier 10740*; *Rolfsmeier 11002*) @ ca. 10 individuals each
Plant community association: Sandsage Prairie

Oxytropis multiceps Torr. & A. Gray
Dwarf locoweed

Rank: S2 (G5)
Primary distribution: Wyoming Basin
Nebraska counties: Banner, Chase, Dundy, Kimball
Historical occurrences searched: 2 (*McGregor 23784* and *23895* in 1971)
Extant occurrences found: none
Plant community association: Rock Outcrop

Penstemon ambiguus Torr.
Gilia beardtongue

Rank: S1 (G4G5)
Primary distribution: Southwestern Great Plains

Nebraska counties: Chase
Historical occurrences searched: 2 (*R. Steinauer 2175* and *2183* in 2004)
Extant occurrences observed: none
Plant community association: Sandsage Prairie
Notes: This showy species is frequently encountered in sandsage prairie in northeastern Colorado.

Phemeranthus calycinus (Engelm.) Kiger
Rockpink fame-flower

Rank: S1S2 (G5)
Synonym: *Talinum calycinum* Engelm.
Primary distribution: South-central Great Plains
Nebraska counties: Brown, Chase, Cherry, Jefferson, Keith, Perkins
Historical occurrences searched: 2 (*Rolfsmeier 10748* in 1992; *R. Steinauer 2180* in 2004)
Extant occurrences found: none
Plant community association: Sandsage Prairie

Pomaria jamesii (Torr. & A. Gray) Walp.
James' rush-pea

Rank: S1 (G5)
Synonym: *Caesalpinia jamesii* (Torr. & A. Gray) Fisher
Primary distribution: Southwestern North America
Nebraska counties: Chase, Dundy
Historical occurrences searched: 4 (*Tolstead 411024* in 1941; *Tolstead s.n.* in 1941; *Rolfsmeier 10992* in 1992; *R. Steinauer 2173* in 2004)
Extant occurrences found: 1 new @ < 10 individuals
Plant community association: Sandsage Prairie
Notes: Central Grassland endemic (Locklear 2017).

Ratibida tagetes (E. James) Barnhart
Short-ray prairie-coneflower

Rank: S1 (G4G5)
Primary distribution: Southwestern North America
Nebraska counties: Chase, Dundy
Historical occurrences searched: 1 (*McGregor 24585* in 1972)
Extant occurrences found: none
Plant community association: Not determined; Kaul et al. (2011) state the habitat in Nebraska as sandsage prairie but the collection locality of *McGregor 24585* is described as “in prairie in ravine,” suggesting loess mixed-grass prairie.

CONSERVATION ISSUES

Sandsage Prairie

Eight Nebraska plants of conservation concern are associated with the Sandsage Prairie community type. Extant occurrences of *Linum berlandieri*, *Mirabilis glabra*, and *Pomaria jamesii* were found during the study, but the numbers of individuals per occurrence were very small (10 or fewer individuals). Relocation and search of the sites of historical occurrences of *Chenopodium cycloides*, *Dalea cylindriceps*, *Eragrostis secundiflora* subsp. *oxylepis*, *Penstemon ambiguus*, and *Phemeranthus calycinus*

confirmed these plants are likewise associated with sandsage prairie, but no extant populations were found at the sites.

It is possible that these at-risk plants were more common and widely distributed in the past, given that extensive tracts of sandsage prairie in Nebraska have been converted to irrigated cropland, degraded by intensive grazing, or subject to extensive alteration to enhance grazing potential, primarily through the use of herbicides to decrease the density of *A. filifolia* in favor of grasses (Farrar 1993a). Sandsage prairie has also been impacted by the invasion of exotic weeds, notably cheatgrass (mostly *Bromus japonicus*) and yellow sweetclover (*Melilotus officinalis*), which compete with the native flora.

It is also possible that the rarity of these plants is due in large part to their ecology as sand specialists. The historical occurrences are largely based on herbarium material collected in the 1990s (20+ years ago) or earlier, yet in most cases the native vegetation at these sites was still intact and in relatively good condition. The apparent absence of these species from sites of historical occurrences may be a function of their association with a unique but transitory niche in the ever-changing sand dune environment. In such naturally dynamic habitat, species composition, patterns of vegetation, and percent canopy cover can change over time in response to fluctuations in annual precipitation or other natural disturbances.

Plants associated with such unstable habitat are typically specialized to a particular ecological niche or stage of recovery related to disturbance, and recurring disturbance can result in fluctuations in the presence and abundance of these species over time. Such plants are considered “fugitive” species and have a life history adapted to transient environments (Platt 1975). Annual species like *Chenopodium cycloides* and *Linum berlandieri* are adapted to quickly exploit disturbed habitat and persist in a soil seed bank when competition from other plants increases. Perennial species associated with disturbed sites in sandsage prairie are often short-lived, such *Cirsium canescens*, which is monocarpic (flowering once and dying) (Kaul et al. 2011), or *Mentzelia nuda*, which is polycarpic but short-lived (Keeler 1987).

Dalea cylindriceps, one of the at-risk plants in this study, exhibits characteristics of a fugitive species. A short-lived or even monocarpic perennial (Barneby 1977; Kaul et al. 2011), it is often associated with sparsely vegetated areas within sandsage prairie. McGregor (1986) noted that *D. cylindriceps* “sometimes flowers the first year and frequently expires at the end of the second or third season” when growing on dunes and areas of loose sand, yet is often a longer-lived perennial in more stable areas. This species may also employ phenological synchrony to exploit recently-disturbed habitat, as observed by the author on a dune in Keith County, Nebraska where most of the plants in a dense, sizable population were uniformly large, robust, multi-stemmed individuals with multiple inflorescences, giving the impression that the population was the result of a synchronized germination event.

To the extent that at-risk species associated with sandsage prairie in Nebraska have a fugitive life history, their apparent absence from the sites of historical occurrences may be a result of natural changes in vegetation structure over time, or changes exacerbated by human activities. In their studies of the structure of dune communities in southeastern Colorado, Kelso et al. (2007) found highest levels of plant diversity associated with intermediate stages of succession and suggested that rangeland management practices to stabilize vegetation could diminish populations of sand specialists. They proposed allowing some open dune complexes to persist in the landscape not only for the benefit narrowly-adapted sand specialists but also to provide source material for the natural introduction or reintroduction of these stabilizing species in the event of dune reactivation caused by prolonged drought. Such management practices could find application in the sandsage prairie region of Nebraska.

In addition to at-risk species, the presence of endemic plants in the flora is an indication of the biological diversity and distinctiveness of a region. Nebraska sandsage prairie supports 13 species that are endemic to the Central Grassland of North America (Locklear 2017). All are specialists of sand habitat.

Argemone polyanthemus (prickly poppy)
Asclepias arenosa (sand milkweed)
Astragalus ceramicus var. *filifolia* (painted milkvetch)
Chenopodium cycloides (sandhills goosefoot)
Dalea villosa (silky prairie-clover)
Eriogonum annuum (annual wild buckwheat)
Ipomoea leptophylla (bush morning-glory)
Linum berlandieri (Berlandier's flax)
Mentzelia nuda (sand-lily)
Muhlenbergia ammophila (formerly *Redfieldia flexuosa*; blowout grass)
Phlox andicola (plains phlox)
Polanisia jamesii (James' clammy-weed)
Prunus pumila var. *besseyi* (sand cherry)

Within Nebraska, sandsage prairie supports a unique and specialized flora that includes species of conservation concern as well as Central Grassland endemics that are sand habitat specialists. Within the larger regional context, sandsage prairie in Nebraska (and adjacent northeastern Colorado) differs floristically from that in the southern Great Plains and may represent an unrecognized northern expression or variant of this ecological system.

Loess Mixed-Grass Prairie

Extant occurrences of *Allium drummondii* and *Chaetopappa ericoides* were found in association with the Loess Mixed-Grass Prairie community type. Relocation and search of the site of the only known Nebraska occurrence of *Artemisia carruthii* confirmed this species is likewise associated with loess mixed-grass prairie, but no extant individuals were found at the site.

As noted by Rolfsmeier and Steinauer (2010), this community type has largely been converted to cropland, particularly on nearly level to gently rolling terrain, but significant stands persist on slopes associated with hills, breaks, and canyons where cultivation is more difficult. Known occurrences of *Allium drummondii* and *Artemisia carruthii* in Nebraska are associated with rangeland on broad divides and upland areas that have escaped cultivation. These species may have been more common in the past but are now restricted to vulnerable populations in areas of remnant and often degraded grassland. *Chaetopappa ericoides* is associated with slopes and hillsides, often in the context of exposed rock outcrops, and extant populations in the study region are probably more numerous and secure. Its small stature and relatively inconspicuous flowers may cause it to be overlooked. This species is also known from rocky mixed-grass prairie in south-central Nebraska, where its occurrences are probably secure.

The Nebraska Natural Legacy Project recognizes a Loess Canyons Biologically Unique Landscape to the northeast of the study region in Lincoln, Dawson, and northern Frontier counties. The Loess Mixed-Grass Prairie community type is a priority for conservation in this BUL, but this grassland is fragmented and remaining occurrences in the region are often degraded by overgrazing and invasion by *Juniperus virginiana*. It is noteworthy that some of the highest quality occurrences of loess mixed-grass prairie in Nebraska and the central Great Plains are found in the Sandsage Prairie BUL.

Purple Three-Awn Grassland

The purple three-awn (*Aristida purpurea*) grassland encountered in southwestern Perkins County is the first reported observation of this plant community in Nebraska. While originally described by plant ecologist Homer L. Shantz (1911) from eastern Colorado, the only other published reference to this

association is a study of vegetation and land use changes in eastern Colorado based on the photographic records of Shantz (McGinnies et al. 1991). Regarding the conservation status of this community, Shantz (1911) noted that the soil conditions indicated by this association “are undoubtedly the most favorable for crop production of any found in eastern Colorado” and McGinnies et al. (1991) reported that “very little of the original wiregrass [*A. purpurea*] type now remains [in eastern Colorado] because most of it has been plowed and planted to wheat.” It seems likely that this variant of shortgrass prairie is either overlooked or greatly diminished in extent and should be a high priority for conservation in Nebraska.

Exemplary Sites

Three sites in the study region were noted for supporting relatively high numbers of at-risk plants as well as large, intact, high quality occurrences of the major upland plant communities of the Sandsage Prairie Biologically Unique Landscape. Enders Reservoir in Chase County is owned by the state of Nebraska and is accessible to the public. The other two are private lands and the landowners have not been identified. Locality data for the private lands sites are provided in the Appendix.

Dundy County SW

Ownership: Private; landowner(s) unknown

Location: southwestern Dundy County

Plant communities represented: Sandsage Prairie

At-risk plants associated with the area: *Chenopodium cycloides*; *Dalea cylindriceps*; *Eragrostis secundifolius* subsp. *oxylepis*; *Mirabilis glabra*

Additional notes: A unique form of *Calamovilfa longifolia* was encountered in the area that may prove to be a new subspecific taxon (see discussion under Species of Conservation Concern).

Enders Reservoir

Ownership: State of Nebraska

Location: southeastern Chase County

Plant communities represented: Sandsage Prairie; Threadleaf Sedge Western Mixed-Grass Prairie; Rock Outcrop

At-risk plants associated with the area: *Chenopodium cycloides*; *Eragrostis secundifolius* subsp. *oxylepis*; *Mirabilis glabra* (extant in 2017); *Pomaria jamesii*

Additional notes: Three additional at-risk plants are known from historical occurrences near Enders Reservoir (no extant occurrences found in 2017)—*Minuartia michauxii* var. *texana*, *Oxytropis multiceps*, *Ratibida tagetes*

Perkins County SW

Ownership: Private; landowner(s) unknown

Location: southwestern Perkins County

Plant communities represented: Sandsage Prairie; Purple Three-awn grassland

At-risk plants associated with the area: *Chenopodium cycloides*; *Mirabilis glabra* (extant in 2017); *Phemeranthus calycinus*

Additional notes: The only known Nebraska occurrence of purple three-awn (*Aristida purpurea*) grassland occurs in the area.

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