

Dalea cylindriceps Barneby
(sandage prairie-clover)

A Survey of Historical Occurrences in Nebraska



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SUMMARY

The sites of 22 historical occurrences of *Dalea cylindriceps* in Nebraska were surveyed during the summer of 2013 in an effort to assess the conservation status of this species and gain a better understanding of its ecology. Five extant occurrences were located in three counties (Box Butte, Sheridan, and Sioux). These populations were small, the largest consisting of 110 individual plants. In Nebraska, *D. cylindriceps* occurs primarily in loamy sand soil types and is mainly associated with Sandsage Prairie and Western Sand Prairie community types. The spread of exotic species, primarily cheatgrass (*Bromus* spp.) into *D. cylindriceps* habitat appears to be a significant threat. Based on this survey, it appears *D. cylindriceps* has undergone significant population decline in Nebraska. However, significant areas of potential habitat have not been searched for the species and further survey, guided by the ecological profile gained from the 2013 study, is warranted to locate populations suitable for study of life history traits, demography, population trends, etc. Further study of *D. cylindriceps* also holds promise for enhanced understanding of the ecology and dynamics of Sandsage Prairie, a plant community that is of conservation concern throughout most of its distribution in the Great Plains.

INTRODUCTION

Purpose of project

Dalea cylindriceps Barneby (Fabaceae) is a perennial herb native to the western Great Plains of North America. Occurrences are known from Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. Despite the large extent of its historical distribution, *D. cylindriceps* has been collected infrequently and occurrences are scattered and local. As noted in *Flora of Nebraska* (Kaul et al. 2011), “This distinctive species is rare almost throughout its wide geographic range.” *Dalea cylindriceps* is tracked as a species of conservation concern in all but two of the states in which it has been documented, and is ranked G3G4 by NatureServe (2013) and as a Tier I At-risk Species by the Nebraska Natural Legacy Project.

Previous research by the author indicated that *D. cylindriceps* may have experienced considerable population decline. The sites of 22 historical occurrences of *D. cylindriceps* in western Nebraska, eastern Colorado, and southeastern Wyoming were surveyed in 2010 with existing populations found at only 4 sites. Additional research was warranted to more fully assess the conservation status of *D. cylindriceps*. Of first importance is the survey of historical occurrences to determine the number of existing occurrences and to develop a detailed ecological profile that includes habitat requirements, edaphic factors, associated species, etc.

Plan of work

The aim of this project was to survey all known historical occurrences of *D. cylindriceps* in Nebraska, based on herbarium specimen data and records in the Nebraska Natural Heritage Program database. *Dalea cylindriceps* is reported to have been collected in 16 counties in the central and western parts of the state (Kaul et al. 2011). The author’s initial survey in 2010 was limited to only five Nebraska counties. Information on approximately 22 historical occurrences was gathered. Field work took place during the summer of 2013, when *D. cylindriceps* was in flower and most noticeable in the field. The work was conducted in two separate periods of time. The first, July 22-26, focused on south-central and southwest Nebraska. The second, August 21-24, focused on north-central and northwest Nebraska.

BIOLOGY AND ECOLOGY

Classification and Nomenclature

Scientific name and citation

Dalea cylindriceps Barneby, Mem. New York Bot. Gard. 27:227. 1977. TYPE: UNITED STATES: “Long’s 1st Expedition. Dr. James” [as on label], *E. James s.n.* (HOLOTYPE: NY [26677], internet image!). Collection locality and date not stated but probably along or near South Platte River in Lincoln County, Nebraska, 22-23 June 1820.

Synonymy

Petalostemon macrostachyus Torr. [originally published as *Petalostemum macrostachyum* Torr.], Ann. Lyc. Nat. Hist. N.Y. 2:176–177. 1827. Not *Dalea macrostachya* Moric., Pl. Nouv. Am. 6. t. 5. 1833. Not *Petalostemon macrostachyum* sensu Torr. & A. Gray, Fl. N. Amer. [Torr. & A. Gray] 1:309. 1838

Petalostemon compactus sensu Swezey, Neb. Fl. Pl. (Doane Coll. Nat. Hist. Soc.) 1:6, 1891. Not *Dalea compacta* Spreng., Syst. Veg. (ed. 16) [Sprengel] 3:327. 1826. Not *Kuhnistera compacta* (Spreng.) Kuntze, Rev. Gen. Pl. 192. 1891

History of knowledge

The type specimen of what would eventually be recognized as *D. cylindriceps* was collected by Edwin James while traveling on the Stephen H. Long Expedition of 1820. In his enumeration of the plants collected on the expedition, Torrey described the species as *Petalostemum macrostachyum* and stated the locality of James’ collection as “About the forks of the Platte.” No locality information is provided on the holotype (the only known specimen) at NY, and James did not mention this species in either his published account of the expedition or in his personal diary (Goodman & Lawson 1995).

In their reconstruction of the route and itinerary of the Long Expedition, Goodman and Lawson (1995) state the expedition reached the junction of the North and South Platte rivers (just east of the present-day city of North Platte) on 22 June 1820, and surmise the type of *D. cylindriceps* was collected in present-day Lincoln County, Nebraska. Locklear (2013) concluded that the type of was collected along the South Platte River in Lincoln County somewhere between the towns of Hershey and Sutherland on 22 or 23 June 1820. This conclusion is supported by a collection of *D. cylindriceps* made on 05 August 1989 (*D. Sutherland 6802 with S. Rolfsmeier* at NEB, NY) along the South Platte River just south of Hershey.

A forthcoming paper by Locklear (2013) sorts through the complex nomenclatural history of *D. cylindriceps*, and examines the floristic and ecological literature of the Great Plains for historical accounts of this species. A reprint will be forwarded to the Nebraska Natural Heritage Program as soon as it is available as an attachment to this report.

Common name: Sandsage prairie-clover

The misleading common name “Andean prairie-clover” has been applied to *D. cylindriceps* and is currently in use by NatureServe (2013) and other databases listing plants of conservation concern. Derivation of this common name may be the result of the similarity between *Petalostemum*

macrostachyum Torr., a replaced synonym for *D. cylidriceps*, and *D. macrostachya* Moric., a replaced synonym for a species of the Andean region of South America (Locklear 2013).

Several other common names point to the dense, elongate flower spike which is a distinctive morphological feature of *D. cylidriceps*: “dense-flowered prairie clover,” “massive spike prairie-clover,” and “large-spike prairie-clover.” The common name “sandsage prairie-clover” was proposed by Locklear (2013) based on the close association of this species with plant communities in which the shrub sand sagebrush (*Artemisia filifolia*) is a prominent element.

Family classification: Fabaceae

Generic relationships: In the most recent systematic treatment of the genus *Dalea* L. (Barneby 1977), *D. cylidriceps* was placed into *Dalea* section *Kuhnistera* series *Compactae*.

Taxon codes: PDFAB1A0B0 (NatureServe 2013)

Description

Technical (from Kaul et al. 2011)

Erect short-lived perennial herbs, glabrous below spikes with stems (1) 3-6 (8) dm all, dotted with small raised glands distally. Leaves alternate, pinnate, leaflets 7-9, oblanceolate, to oblong-elliptic, (1.2-) 1.5-2.5 cm, sparingly punctate beneath. Spikes dense, axis not visible, (1.5-) 2.5-18 cm; bracts early deciduous, but interfloral ones often held in place by crowded flowers. Flowers with calyx 3.4-4.3 mm, externally pilose, its tube 1.9-2.3 mm, hyaline intervals between the ribs each with 1 row of small, pale glands, its teeth lanceolate to ovate; corolla not conventionally papilionaceous, lower petals not united to form a keel, whitish or pink, the banner 4.7-6.2 mm; epistemonous petals attached at the separation of filaments; stems 5. Pod 2.5-3 mm, distally pilosulous and gland-dotted. Flowering June to September.

An excellent technical illustration of *D. cylidriceps* by artist Bellamy Parks Jansen appeared in *Common Legumes of the Great Plains: An Illustrated Guide* (Stubbendieck & Conard 1989), and is reproduced in a forthcoming paper by Locklear (2013).

Non-technical

A perennial herb growing from a taproot with one to several erect stems, sometimes branched from the middle, generally 12-24 in. tall but mature individual up to 32 in. tall. Leaves are pale green in color, pinnately compound, an individual leaf composed of 7 to 9 narrow leaflets arranged on both sides of a common axis. Flowers are very small, less than ¼ in. long, whitish, and arranged in dense, elongate (1-6 in.) spike at the stem tip.

Local field characters

With its large size (12-24 in., up to 32 in. tall) and dramatically elongate flower spikes (up to 7 in. long), a mature, multi-stem *D. cylidriceps* plant (Figure 1) is a striking and noticeable object in the landscape. When in flower, it is unlikely to be confused with any other member of the genus *Dalea* or family Fabaceae. However, the flower spikes of single-stem plants (Figure 2) are not nearly as long and such individuals bear a superficial resemblance to *Dalea aurea*.

Geographic Distribution

Total historical distribution

Occurrences of *D. cylindriceps* have been documented from 8 states. Nebraska and Colorado have the greatest number of county occurrences (16 each), followed by New Mexico (13 counties). The following list was derived from herbarium records (COLO, CS, CSCN, KANU, KHD, KSC, NMC, NY, RM, TEX, UNM) augmented by additional reports from systematic and floristic literature. The conservation status in each state is provided in parentheses.

Colorado (S3?): 16 counties (Adams [Isely 1998]; Arapaho [Isely 1998]; Baca; Bent; Cheyenne; Denver; El Paso; Jefferson; Kiowa; Larimer; Lincoln; Morgan [Isely 1998], Prowers; Sedgwick; Washington; Weld)

Kansas (S2): 3 counties (Grant; Morton; Stanton)

Nebraska (S2): 16 counties (see below)

New Mexico (SNR): 13 counties (Bernalillo [Isely 1998]; Dona Ana; Harding; Lincoln; Los Alamos [Peterson 2000]; McKinley; Rio Arriba; Roosevelt; Sandoval; San Juan; Santa Fe; Tarrant; Union)

Oklahoma (S1): 1 county (Cimarron)

South Dakota (SNR): 1 county (Fall River)

Texas (S2): 4 counties (Culbertson; Howard; Martin; Mitchell [Isely 1998])

Wyoming (S1): 2 counties (Goshen; Platte)

Historical occurrences in Nebraska

Twenty-two historical occurrences of *D. cylindriceps* from 12 Nebraska counties were identified from herbarium specimen data (CSCN; KANU; NEB; OMA) and from the records of the Nebraska Natural Heritage Program.

<u>County</u>	<u>Occurrences</u>	<u>Year(s) of collection/observation</u>
Box Butte	1	2004
Brown	1	1897
Cherry	1	1800s
Dawes	1	1976
Dundy	3	1916; 1996; 2010
Garden	4	1890; 1968; 1970; 2001
Keith	1	1930
Lincoln	1	1989
Morrill	3	1978; 1992; 2004
Scotts Bluff	1	1891
Sheridan	3	1953; 1983; 1986
Sioux	<u>2</u>	1967; 1997

In their map of the distribution of *D. cylindriceps* in Nebraska, Kaul et al. (2011) show occurrences in 4 counties not listed above (Buffalo; Chase; Frontier; Keya Paha). The author has found no specimens to document these occurrences.

Extant occurrences in Nebraska

Survey of the sites of 22 historical occurrences of *D. cylindriceps* in Nebraska resulted in the location of five extant occurrences of the species.

County of occurrence

EO1	Box Butte
EO2	Morrill
EO3	Sheridan
EO4	Sheridan
EO5	Sioux

Appendix A presents locality and ecological information for each of five the extant occurrences (EO1-5). Appendix B provides information for the 17 other historical occurrences (HO1-17) that were surveyed in 2013.

Environment and Habitat

Regional climate

Across the distribution of *D. cylindriceps* in Nebraska, mean annual precipitation ranges from 51 cm (20 in.) on the east to 38 cm (15 in.) on the west. Average length of growing season ranges from 150 days in the east to 120 days in the northwest.

Physiographic and topographic characteristics

Dalea cylindriceps is strongly associated with sandy habitat in Nebraska although it is mostly absent from the main body the Nebraska Sandhills, the largest dune field in the Western Hemisphere. In southwestern Nebraska, *D. cylindriceps* is associated with the Imperial Dune Fields (Muhs & Holliday 1995), which appear to have been formed of sand 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). In the Nebraska Panhandle, *D. cylindriceps* occurs in areas of sandy soils on terraces above the North Platte River and in transitional areas of sandy soils and soils developed in loess or in residual materials derived from bedrock (Elder 1969). These areas are primarily vegetated with sandsage prairie. *Dalea cylindriceps* occurs in level to gently undulating terrain in this habitat rather than on the steeper slopes and crests of dunes.

Outside of regions of eolian sand, *D. cylindriceps* occurs in habitat associated with escarpments and outcroppings of calcareous sandstones, primarily of the Arikaree Group (Late Oligocene to Early Miocene). These occurrences are found in the Nebraska Panhandle where the ancient High Plains tableland has been entrenched by the North Platte and Niobrara rivers and their tributaries into dissected uplands, forming escarpments, ridges, buttes, and other rough, broken topography. In these settings, *D. cylindriceps* occurs on relatively gentle lower slopes below the outcroppings in soils derived from bedrock residuum. The matrix vegetation is primarily Western Sand Prairie.

Elevations of *D. cylindriceps* occurrences in Nebraska range from 884 m / 2900 ft. at HO12 in Lincoln County to 1000 m / 3280 ft. at HO6 in Dundy County and 1298 m / 4259 ft. at EO5 in Sioux County.

Edaphic factors

The soil type with which extant occurrences of *D. cylindriceps* are associated is listed below. Also listed is the soil type for historical occurrences where *D. cylindriceps* was not found during the survey but for which locality data was precise enough to allow comparison with county soil survey maps. The majority (55%) of the occurrences were associated with loamy sands, with the rest either sandy loams or fine sands.

	<u>County</u>	<u>Soil type</u>
EO1	Box Butte	Valentine loamy fine sand
EO2	Morrill	Valent fine sand; Lisco very fine sandy loam
EO3	Sheridan	Valentine loamy sand
EO4	Sheridan	Valentine loamy sand
EO5	Sioux	Ashollow loamy very fine sand
HO5	Dundy	Valentine loamy fine sand
HO6	Dundy	Valentine fine sand
HO13	Morrill	Valentine fine sand
HO14	Morrill	Otero very fine sandy loam
HO15	Scotts Bluff	Tripp fine sandy loam
HO17	Sioux	Ashollow loamy very fine sand

Biological Characteristics

Plant community types in Nebraska

The plant community type with which extant occurrences of *D. cylindriceps* are associated in Nebraska is listed below (following Rolfsmeier & Steinauer 2010), along with that of historical occurrences where *D. cylindriceps* was not found but for which locality data allowed relocation and observation of the site. The close association of *D. cylindriceps* with Sandsage Prairie has been previously noted (Locklear 2013), but recognition of the strong association with Western Sand Prairie in Nebraska was a distinctive outcome of the 2013 survey.

	<u>County</u>	<u>Plant community type</u>
EO1	Box Butte	Sandsage Prairie (Figure 3)
EO2	Morrill	Sandsage Prairie; Western Alkaline Meadow (Figure 5)
EO3	Sheridan	Western Sand Prairie
EO4	Sheridan	Western Sand Prairie (Figure 4)
EO5	Sioux	Western Sand Prairie
HO5	Dundy	Sandsage Prairie
HO6	Dundy	Sandsage Prairie
HO12	Lincoln	Riverine Gravel Prairie
HO13	Morrill	Sandsage Prairie
HO14	Morrill	Western Sand Prairie
HO15	Scotts Bluff	Sandsage Prairie
HO17	Sioux	Western Sand Prairie

Sandsage Prairie – *Dalea cylindriceps* is frequently associated with communities in which the shrub *Artemisia filifolia* is a dominant element. These communities are comprised of a moderate to dense layer of *A. filifolia* interspersed with tall or mid-height grasses, primarily *Calamovilfa longifolia* or *Hesperostipa comata*. See Figure 3.

Western Sand Prairie – This grassland community type is vegetated by tall and mid-height grasses, primarily *Calamovilfa longifolia* and *Hesperostipa comata*. This community type is of more limited distribution in Nebraska than the Sandhills Dune Prairie that occurs throughout the Nebraska Sandhills. Kaul and Rolfsmeier (1993) mapped this community under the name “Sandhills Borders Mixed-grass Prairie.”

Two extant occurrences (EO3, EO4) associated with Western Sand Prairie on the northern edge of the Sandhills in Sheridan County occur on a relatively level upland terrace between the Niobrara River valley and the dunes to the south. The landscape position and species composition of these occurrences appears to coincide with what Tolstead (1942) classified as Mixed Prairie, which he recognized as distinct from the grassland types associated with dune sands in his study of vegetation in Cherry County, Nebraska. These two occurrences supported the largest populations of *D. cylindriceps* in what appeared to be the most unaltered habitat. In both situations, *D. cylindriceps* plants were not uniformly distributed throughout the matrix grassland but were concentrated in associations that were a subset of the surrounding community. The plants in EO3 occurred in a *Sporobolus cryptandrus* / *Bouteloua gracilis* association within the larger *Andropogon hallii* / *Calamovilfa longifolia* community. The plants in EO4 occurred in a *Schizachryium scoparium* / *Carex filifolia* association within the larger *Hesperostipa comata* / *Bouteloua gracilis* community (Figure 4).

Riverine Gravel Prairie – One historical occurrence (HO12) is associated with a gravelly/sandy terrace above the channel of the South Platte River in Lincoln County. While considerable areas of this habitat exist along the North Platte and South Platte rivers west of North Platte, Nebraska (Sutherland & Rolfsmeier 1989), much of it has been invaded by exotics, particularly since the river channel is seldom subject to the scouring floods that used to make such habitat more open in the past.

Western Alkaline Meadow – When discovered in 1992, the *D. cylindriceps* plants of EO2 were described as “locally common” and growing “atop [a] nearly bare sandsage prairie dune along south side of alkaline prairie meadow.” When surveyed in 2010 and 2013, no *D. cylindriceps* plants were found “atop” the dune, and areas between *Artemisia filifolia* shrubs were largely occupied by cheatgrass. The only *D. cylindriceps* plants found were growing just off the dune in a level sandy area around the margin of a saline flat (Figure 5). Rolfsmeier (1993) noted that a mosaic of sandsage prairie dunes and saline meadows can be found in many places in the North Platte River valley in the Nebraska Panhandle and that species normally associated with sandsage prairie dunes infrequently become established in the meadows, citing the occurrence of *D. cylindriceps* at EO2 as an example.

Community ecology

The plant communities with which *D. cylindriceps* is associated in Nebraska occur in naturally dynamic habitats in which species composition, patterns of vegetation, and percent canopy cover change over time in response to fluctuations in annual precipitation or other natural disturbances. Within these plant communities, *D. cylindriceps* occurs in areas of more open canopy structure rather than in more densely-vegetated areas (Figures 1-5).

Frequently associated species in Nebraska

The following lists species most frequently encountered in association with extant occurrences of *D. cylindriceps* in Nebraska. All are rather widely distributed in sandy habitat throughout the central and western Great Plains. None could be considered a consistent indicator of *D. cylindriceps* habitat, although *Asclepias arenaria*, *Eriogonum annuum*, and *Mentzelia nuda* were almost always associated.

Ambrosia psilostachya
Andropogon hallii
Argemone polyanthemus
Artemisia filifolia
Asclepias arenaria
Bouteloua curtipendula
Bouteloua gracilis
Calamovilfa longifolia
Carex filifolia
Carex heliophila
Croton texensis
Dalea candida
Dalea purpurea
Dalea villosa
Erigeron bellidiastrum
Eriogonum annuum
Helianthus petiolaris
Hesperostipa comata
Mentzelia nuda
Monarda pectinata
Opuntia fragilis
Pediomelum argophyllum
Schizachyrium scoparium
Sporobolus crypandrus
Tradescantia occidentalis
Yucca glauca

Dominance and frequency

Of the five extant occurrences, two consisted of fewer than five individual plants and these were very minor elements in the plant community. In the other three occurrences, *D. cylindriceps* was common and one of the most visibly conspicuous forbs in the plant community.

Total individuals counted

EO1	57
EO2	4
EO3	110
EO4	68
EO5	3

Life history traits

Depending on latitude and fluctuations in annual precipitation, *D. cylindriceps* may flower from late June into early September. In Nebraska, the peak of flowering appears to be late-July through August. In the present survey, *D. cylindriceps* plants were in flower on 21-23 August 2013 in west-central and northwest Nebraska. Four of the five extant occurrences consisted of both flowering and non-flowering individuals.

	<u>Flowering</u>	<u>Non-flowering</u>
EO1	31	26
EO2	2	2
EO3	107	3
EO4	55	13
EO5	3	0

Flowering plants ranged from large (40-60 cm tall) multi-stem individuals bearing numerous flower spikes (Figure 2) to individuals consisting of a single stem tipped by one spike (Figure 3). The four largest plants at EO1 had 9, 10, 14, and 17 stems each. The larger multi-stem plants had the characteristic elongate spike, ranging from 14-18 cm in length. The smaller single-stem plants were generally less than 20 cm tall and bore much shorter spikes, potentially causing a surveyor to doubt whether the plants really were *D. cylindriceps*. Non-flowering individuals were even shorter, generally less than 8 cm tall, but could be identified by the distinctive pale green foliage of *D. cylindriceps*.

Within a given occurrence, *D. cylindriceps* plants often occurred in clusters of individuals that included multi-stem and single-stem flowering individuals plus smaller non-flowering ones. These clusters of individuals were spatially separated from other clusters.

At EO1 in Box Butte County on 22 August 2013, the spikes of the largest individuals were beginning to shatter and release seed at the base while still flowering at the distal end. One day later at the more northern occurrences of EO3 and EO4 in Sheridan County, the plants were actively flowering and no seed was being released.

CONSERVATION

Threats

Of the 22 known historical occurrences of *D. cylindriceps* in Nebraska, 11 could be relocated with enough certainty to determine whether the species was still present. Of these, extant populations were found at only five sites. If *D. cylindriceps* has been extirpated from the remaining sites, then it appears this species has undergone significant population decline in Nebraska and is need of conservation action. While our knowledge of this species is still too incomplete to make definitive statements about causes of population decline and threats to future survival, some preliminary observations can be made.

Spread of exotic species

The spread of exotic species into *D. cylindriceps* habitat could be the most significant threat faced by this species, with cheatgrass (*Bromus* spp.) and yellow sweetclover (*Melilotus officianalis*) being the most serious invaders. The plant associations in which *D. cylindriceps* occurs are not

densely vegetated but typically have a somewhat open canopy of shrubs or grasses with considerable amounts of bare soil. Most *D. cylindriceps* plants occur in these open areas. In several of the occurrences surveyed, cheatgrass and sweet clover completely occupy such areas.

When discovered in 1992, the *D. cylindriceps* plants of EO2 were described as “locally common” and growing “atop [a] nearly bare sandsage prairie dune along south side of alkaline prairie meadow.” When surveyed in 2010 and 2013, no *D. cylindriceps* plants were found “atop” the dune, and areas between *Artemisia filifolia* shrubs that apparently were “bare” in 1992 were largely occupied by cheatgrass. Even in the relatively high quality habitat of EO3, cheatgrass appeared to be spreading into the open areas to the exclusion of *D. cylindriceps*.

Grazing

Grazing pressure could be another threat factor for *D. cylindriceps*. Prairie-clovers such as *D. purpurea* are known to be preferred forage of cattle and decrease under heavy grazing pressure, and Stubbendieck and Conard (1989) note that *D. cylindriceps* is “grazed by cattle and horses, as well as by wildlife” and “decreases with continued heavy grazing.” This relatively large herbaceous plant is certainly a noticeable object to humans and is presumably an easy target for grazers. Some evidence for the impact of grazing on this species may come from observation of roadside occurrences such as EO1, EO5, and HO6, where there was much greater forb diversity in the roadside vegetation where the *D. cylindriceps* plants occurred than on the other side of the fence where cattle had been grazing.

Habitat loss

Total habitat loss does not appear to be a significant threat factor for *D. cylindriceps* in Nebraska, where native vegetation is still intact at most historical occurrences. This is unlike the situation along the Front Range of eastern Colorado, where the author’s 2010 survey found a number of sites where the native vegetation had been completely replaced by agricultural crops or suburban/ex-urban development.

Information Needs

Further survey in Nebraska

The five extant occurrences of *D. cylindriceps* in Nebraska located in this survey consist of relatively few individuals and two are essentially roadside populations. There are doubtless more occurrences of *D. cylindriceps* in Nebraska than are known at present and additional search is warranted to find larger populations occurring in habitat of better condition and integrity. One of the insights gained from the 2013 survey is the strong association of *D. cylindriceps* with loamy sand soil types. Given this connection, investigators could strategically identify potential habitat to search by using county soil survey maps to identify areas of loamy sands.

Population monitoring

Monitoring studies of existing populations of *D. cylindriceps* is needed to answer questions of life history, demography, and population trends. Research into life history traits (phenology, reproductive ecology, etc.) is needed to determine how these shape demography and population trends. Study is also needed to determine the role and impact of natural disturbance in the presence and abundance of *D. cylindriceps* over time. Such studies will require the location and long-term observation of high quality occurrences of *D. cylindriceps*. The two extant occurrences

in Sheridan County, EO3 and EO4, are sizable and occur in intact vegetation of good condition, and may present potential sites for monitoring studies if landowner permission can be secured.

Range-wide assessment of conservation status

Additional research is needed to more fully assess the conservation status of *D. cylindriceps* throughout its range. While an attempt was made to survey all known historical occurrences in Nebraska, survey of historical occurrences throughout the range of the species is needed to assess its conservation status and to develop a more complete understanding of habitat requirements, edaphic factors, disturbance factors, associated species, etc.

Further study of *D. cylindriceps* in Nebraska and throughout its range also holds promise for a better understanding of the ecology and dynamics of Sandsage Prairie, a plant community that is of conservation concern throughout most of its distribution in the western Great Plains (NatureServe 2013). Given its close association, *D. cylindriceps* could serve as an indicator species of high quality occurrences of sandsage prairie and of habitat integrity and health.

***Dalea cylindriceps* growth habit**

Figure 1 (top): Multi-stem plant at EO4 | Figure 2 (below): Single-stem plant at EO1



Figure 3: *Dalea cylindriceps* associated with Sandsage Prairie
Box Butte County, Nebraska (EO1)



Figure 4: *Dalea cylindriceps* associated with Western Sand Prairie
Sheridan County, Nebraska (EO4)



Figure 5: *Dalea cylindriceps* associated with Western Alkaline Meadow
Morrill County, Nebraska (EO2)



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