

University of Nebraska - Lincoln

## DigitalCommons@University of Nebraska - Lincoln

---

Proceedings of the North American Prairie  
Conferences

North American Prairie Conference

---

1989

### Blowouts in the Nebraska Sandhills: The Habitat of *Penstemon haydenii*

James Stubbendieck

University of Nebraska - Lincoln, [jstubbendieck@unl.edu](mailto:jstubbendieck@unl.edu)

Theresa R. Flessner

University of Nebraska - Lincoln

Ronald Weedon

Department of Biology, Chadron State College, Chadron, Nebraska 69337

Follow this and additional works at: <https://digitalcommons.unl.edu/napcproceedings>



Part of the [International and Area Studies Commons](#)

---

Stubbendieck, James; Flessner, Theresa R.; and Weedon, Ronald, "Blowouts in the Nebraska Sandhills: The Habitat of *Penstemon haydenii*" (1989). *Proceedings of the North American Prairie Conferences*. 3. <https://digitalcommons.unl.edu/napcproceedings/3>

This Article is brought to you for free and open access by the North American Prairie Conference at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Proceedings of the North American Prairie Conferences by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

# BLOWOUTS IN THE NEBRASKA SANDHILLS: THE HABITAT OF *PENSTEMON HAYDENII*

James Stubbendieck, Theresa R. Flessner  
Department of Agronomy, University of Nebraska, Lincoln, Nebraska 68583

and  
Ronald R. Weedon  
Department of Biology, Chadron State College, Chadron, Nebraska 69337

**Abstract.** The Nebraska Sandhills is the largest area of sand dunes in the Western Hemisphere, occupying over 5 million ha in northcentral Nebraska. The rolling to steep dunes range in height from a few meters to over 60 m. Soils are poorly developed in wind deposited sand. The continental climate is characterized by 425 to 625 mm of annual precipitation, an average annual temperature of 10 C, and a frost-free period of 130-155 days. Upland vegetation is primarily tall grasses and midgrasses such as sand bluestem [*Andropogon gerardii* var. *paucipilus* (Nash) Fern.], prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.], little bluestem [*Schizachyrium scoparium* (Michx.) Nash], and switchgrass (*Panicum virgatum* L.). Forbs are common. Wind erosion occurs when the protective cover of vegetation is destroyed. Blowouts are active sites of erosion. Blowouts are irregular or conical craters formed when the deep, loose sands are removed by swirling action of the prevailing northwesterly winds. Blowout penstemon (*Penstemon haydenii* S. Wats.) is only found on these sites of active wind erosion and is an early successional species. Important associated species in blowouts include blowoutgrass [*Redfieldia flexuosa* (Thurb.) Vasey] and lemon scurfpea (*Psoralea lanceolata* Pursh). The number of blowouts has decreased with the control of fire and improved range management techniques. Loss of suitable habitat is one of the reasons for the decline of blowout penstemon. At the same time, there are many blowouts in the Sandhills that seem to offer suitable habitat where blowout penstemon is not found.

**Key Words.** blowout penstemon, *Penstemon haydenii*, blowouts, erosion, Sandhills, Nebraska

## INTRODUCTION

Blowout penstemon (*Penstemon haydenii* S. Wats.) was placed on the Federal Endangered Species List in October, 1987. It is endemic to the Nebraska Sandhills and is the only plant species in the state to be classified as endangered. It is the rarest plant species in the Great Plains.

The Nebraska Sandhills is an extensive area with unique vegetation. Blowouts, the habitat of blowout penstemon, are depressions in the topography caused by wind erosion. Vegetation associated with blowouts is distinctly different than vegetation associated with adjacent, noneroding areas. The purpose of this paper is to describe briefly the climate, soils, erosion processes, blowouts, and vegetation of the Nebraska Sandhills as an introduction to the Symposium on Blowout Penstemon held at the Eleventh North American Prairie Conference and to the papers on blowout penstemon which follow in these proceedings.

## REVIEW OF THE LITERATURE

### Soils and Climate

The Nebraska Sandhills occupies over 5 million hectares of northcentral Nebraska (Keech and Bentall 1971, Bleed and Flowerday 1989). It is the largest sand dune area in the Western Hemisphere, with nearly level areas and rolling hills with slopes exceeding 30% (Keech and Bentall 1971, Bleed and Flowerday 1989). The area is primarily used for cattle grazing on relatively large ranches (Burzlaff 1962, Gosey 1986, Stubbendieck 1989). The sandy soils (mixed, mesic Typic Ustipsamment) are characterized by low organic matter, low water-holding capacity, low natural fertility, and a high risk of wind erosion if the soil is

exposed (Elder 1969, Keech and Bentall 1971). The soil is usually stabilized by a grass cover. Beneath the soil is a thick sequence of permeable rocks filled to overflowing with water. This water-filled rock layer, known as the Ogallala aquifer, feeds the many existing streams and lakes of the area (Bose 1977, Bleed 1989).

The climate of the area may be classified as continental, with 70% of the total precipitation (425-625 mm) falling during the growing season (Burzlaff 1962, U.S. Department of Commerce 1973, Wilhite and Hubbard 1989). The frost-free period is 130-155 days (Neild 1977). Cold winters and warm summers are characteristic. Average maximum and minimum temperatures for January are about 1 C and -12 C (Neild *et al.* 1967). Extreme lows of less than -40 C have been recorded. July is the hottest month with maximum and minimum temperatures of about 32 C and 15 C (Neild *et al.* 1967). Extreme highs of more than 45 C have been recorded.

Wind is an ever-present part of the climate of the Nebraska Sandhills. The state has little surface relief, and with the lack of surface roughness winds can attain high velocities. Winds are generally strongest in winter and early spring and blow from a northwesterly direction (Dewey 1977, Wilhite and Hubbard 1989). During these periods, sustained winds of about 50 m/sec with gusts to nearly double that velocity are not uncommon.

### Wind Erosion

Wind erosion and blowout formation do not occur as long as vegetative cover is not disturbed. Once wind erosion starts, it is difficult to stop. Causes of wind erosion in the Sandhills are best explained by the physics of wind action on the soil particles. The mechanism of wind erosion involves three factors: 1) wind velocity, 2) nature of the surface, and 3) soil (Baver *et al.* 1972). Bagnold (1941) reported that almost 75% of the soil particles were transported from the soil surface by saltation. Several factors are involved in saltation. Wind may roll sand grains along the surface until they hit objects such as other sand grains, and then they bounce back into the air or knock the obstructing sand grains into the air. These grains fall back to the surface at a rather flat angle varying from 10 to 16 degrees, depending on the size of grain, height of rise, wind velocity, and other factors (Ordway 1972). These falling grains put themselves or other grains in motion by their impact.

### Blowouts

Blowouts are one of the most striking features of the Sandhills. These blowouts are different in form and ecological relationships from those in historical reports from other parts of the world (Cowles 1899, Gleason 1910, Cockayne 1911). Blowouts originate on the exposed upper slopes when the vegetative cover is disturbed or removed. Historically, repeated fires and concentrations of grazing animals caused the disturbance (Pool 1914). Over the period of a few years to a few decades, an embryonic blowout develops into a full scale, active blowout. Sand is blown from the exposed windward side of the slope and deposited onto the leeward side. As the erosion becomes more active and the blowout deepens, roots of the prairie vegetation are exposed, and soon whole plants

blow away. As the crater deepens, the sand on the sides slides into the depression. The sharp, steep edges caused by the sliding sand help to catch the wind and cause increased turbulence breaking more sand particles free. The loose sand is quickly blown out and deposited on the leeward side of the crater (Pool 1914).

The northwest inner slope of an active blowout generally has a gradient of about 30 degrees and has the longest slope. This side is never directly exposed to the wind. The opposite side is usually much steeper, sometimes nearly perpendicular, because sand continually rolls down from this side and is blown out over the side. The leeward side of the hill, the area of sand deposition, usually has a gradient of about 60 degrees. This slope is usually vegetated by perennial grass species that can yearly grow up through 0.2-0.7 meters of deposited sand (Pool 1914).

Nebraska Sandhills blowouts are irregularly conical or rounded depressions of varying depth and diameter (Figure 1). They usually occur on the northwest sides of upper slopes and hills. The northwest side of the rim is usually much lower than the southeast rim. Sand is continually deposited in a southeasterly direction building that rim. Initially, blowouts may cover a few square meters and be a few centimeters deep. Extreme cases may reach an area of more than 3 hectares and a depth of over 30 meters. An average size is about 0.1 to 0.3 hectares in area and 4 to 10 meters in depth.



FIG. 1. A Nebraska Sandhills blowout, the habitat of blowout penstemon (*Penstemon haydenii*).

These natural blowouts should not be confused with wind eroded fields or plane sand sweeps. Nor should they be confused with eroded areas around wind-mills or in other areas where livestock congregate and disturb the vegetation. The term "blowout" should be restricted to the naturally occurring, crater-shaped depressions.

A blowout is not static. The area of active wind erosion continually moves across the landscape at the speed of a few meters a year. Succession constantly occurs on the windward side. A blowout may exist for decades before it reaches maturity. Maturity is reached when the blowing sand is deposited in a deep valley or lake, and no longer accumulates on the leeward side (Pool 1914). The leeward side then is lowered as the wind blows through the hilltop. The steep front slope is eliminated, which eliminates the wind turbulence and the erosion force of the wind.

#### Vegetation

The first careful botanical work in the Sandhills was done by H. J. Webber in 1889 (Pool 1914). Webber made a list of the plant species and carefully recorded notes for each of his collections. Smith (1892) described the distribution of plants in the Sandhills as well as the topography. A taxonomic study by Rydberg (1895) produced the most extensive collection of plants and notes on the Sandhills up to that time.

Raymond Pool (1914) conducted an extensive study of the vegetation of the Sandhills. His doctoral thesis included an inventory and ecological interpretation of the flora based on plant community associations. Pool (1914) named and described the Bunchgrass, Muhlenbergia, Speargrass, Wiregrass Transition, and Blowout Associations as occurring on Nebraska Sandhills upland. The "Bunchgrass Association" was identified as the most extensive and important climax community present in the Sandhills prairie in the early 1900's (Pool 1914). This association was dominated by little bluestem [*Schizachyrium scoparium* (Michx.) Nash] and sand bluestem [*Andropogon gerardii* var. *paucipilus* (Nash) Fern.]. Other important species of this association were prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.], needleandthread (*Stipa comata* Trin. & Rupr.), prairie junegrass [*Koeleria pyramidata* (Lam.) Beauv.], sand lovegrass [*Eragrostis trichodes* (Nutt.) Wood], and indian ricegrass [*Oryzopsis hymenoides* (R. & S.) Ricker]. Switchgrass (*Panicum virgatum* L.) was present in this association but was not common.

Dominants of the Blowout Association were prairie sandreed, lemon scurfpea (*Psoralea lanceolata* Pursh), and blowoutgrass [*Redfieldia flexuosa* (Thurb.) Vasey]. Other important species were cristatella (*Cristatella jamesii* T. & G.), sand lovegrass, plains muhly [*Muhlenbergia cuspidata* (Torr.) Rydb.], sandhill muhly (*Muhlenbergia pungens* Thurb.), birdegg milkvetch [*Astragalus ceramicus* Sheld. var. *filifolius* (Gray) Germ.], clammyweed [*Polanisia dodecandra* (L.) DC. subsp. *trachysperma* (T. & G.) Iltis], and blowout penstemon.

Burzlauff (1962) subdivided the grasslands of the Nebraska Sandhills into three range sites: the dry valley, the rolling sands, and choppy sandhill range site. Each site possessed different soil and vegetation characteristics.

On the dry valley site, prairie sandreed, blue grama [*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.], sixweeks fescue [*Vulpia octoflora* (Walt.) Rydb.], sand dropseed [*Sporobolus cryptandrus* (Torr.) Gray], and needleandthread dominated species composition, in order of decreasing abundance. Soils were considered to be loamy fine sands.

On the rolling sands site, the most important dominant was prairie sandreed, followed by sand bluestem, sand dropseed, hairy grama (*Bouteloua hirsuta* Lag.), and sixweeks fescue. Soils of this site were classified as Valentine fine sands.

Tall grasses, prairie sandreed and sand bluestem, dominated the choppy sandhill range site. Subdominants, little bluestem and sand lovegrass, were restricted to the north and east-facing slopes of the choppy hills. Sandhill muhly and hairy grama were more common on ridge tops and south and west exposures. Soils were classified as stabilized dune sand. Although blowoutgrass was of minor importance on stabilized soils of the choppy sandhill site, it is the first to establish in blowouts, or other areas of wind erosion, followed by lemon scurfpea, sandhill muhly, and other grasses and forbs (Weaver 1965). Currently, dominant species are sand bluestem, little bluestem, prairie sandreed, and needleandthread (Weaver 1965, U.S. Department of Agriculture 1981).

#### Blowout Penstemon

Another of the initial species to establish in a blowout was blowout penstemon. This perennial, multistemmed forb is generally found growing in areas of bare sand or in association with blowoutgrass within the blowout and near its leeward side, in the area of sand deposition (Weedon *et al.* 1982). Blowout penstemon is especially well adapted to blowouts, for its stems root adventitiously, maintaining the plant in the shifting sands of these sites (Stubbendieck *et al.* 1983, Stubbendieck and Weedon 1984). Also, its nearly horizontal buried stems produce fibrous roots, providing anchorage in this unstable environment (Weedon *et al.* 1982). However, blowout penstemon is successional in nature, colonizing the blowout once the sand has been physically stabilized and declining when other vegetation becomes well established (Weedon *et al.* 1982).

Blowout penstemon was once a common plant in blowouts (Pool 1914). However, it was thought to be extinct from 1940 until it

was rediscovered in 1968 (Stubbenieck *et al.* 1983). Since that time, extensive searching has led to the rediscovery of nearly 4,250 plants. The reason(s) for its decline from being a common plant in the early 1900's to its current population are unknown. With wildfire control and improved range management practices, the amount of Sandhills blowout habitat has greatly decreased (Stubbenieck *et al.* 1982). Also, the drought of the 1930's severely impacted numerous prairie plant species, and it may also have had a negative influence on blowout penstemon (Weaver 1954, Stubbenieck 1986).

Even though blowout penstemon is taxonomically in a genus of plants widely appreciated for its appearance, it is distinguished by a striking beauty of its own. Its large, milky blue to lavender flowers also possess a distinct fragrance. Aside from its beauty and ability to invade and stabilize blowouts, other intrinsic values of this species are yet unknown. Thus, the preservation of blowout penstemon and its habitat, the blowout, is essential to realize fully the values of this unique plant.

#### ACKNOWLEDGEMENTS

Appreciation is expressed to the Nebraska Game and Parks Commission for financial support of the research on blowout penstemon. Journal Series Number 8410, Agricultural Research Division, University of Nebraska.

#### LITERATURE CITED

- Bagnold, R.A. 1941. The physics of blown sand and desert dunes. Methuen, London.
- Baver, L.D., W.H. Gardner, and W.R. Gardner. 1972. Soil physics. John Wiley and Sons, New York.
- Bleed, A. 1989. Groundwater. Pages 67-92. In A. Bleed and C. Flowerday (eds.). An atlas of the Sand Hills. University of Nebraska Conservation and Survey Division, Resource Atlas No. 5.
- Bleed, A., and C. Flowerday. 1989. Introduction. Pages 1-15. In A. Bleed and C. Flowerday (eds.). An atlas of the Sand Hills. University of Nebraska Conservation and Survey Division, Resource Atlas No. 5.
- Bose, D.R. 1977. Rangeland resources of Nebraska. Society for Range Management Old West Regional Range program, Denver.
- Burzlaff, D.F. 1962. A soil and vegetation inventory and analysis of three Nebraska Sandhills range sites. University of Nebraska Agricultural Experiment Station Research Bulletin 206.
- Cockayne, L. 1911. Report on the dune-areas of New Zealand, their geology, botany, and reclamation. Department of Lands, Government of New Zealand.
- Cowles, H.C. 1899. The ecological relations of the vegetation of the sand dunes of Lake Michigan. The Botanical Gazette 27:95-391.
- Dewey, K.F. 1977. Wind. Pages 72-74. In M. P. Lawson, K. F. Dewey, and R. E. Meyers (eds.). Climatic atlas of Nebraska. University of Nebraska Press, Lincoln.
- Elder, J.A. 1969. Soils of Nebraska. University of Nebraska, Conservation and Survey Division, Resource Report Number 2.
- Gleason, H.A. 1910. The vegetation of the island sand deposits of Illinois. Illinois State Laboratory, Natural History Survey Bulletin 9:23-174.
- Gosey, J. 1986. Beef improvement impact seen in Sandhills today. University of Nebraska, Institute of Agriculture and Natural Resources Quarterly 32:12-13.
- Keech, C.F., and R. Bentall. 1971. Dunes on the plains: The Sandhills region of Nebraska. University of Nebraska, Conservation and Survey Division, Resource Report Number 4.
- Neild, R.E. 1977. The freeze-free season. Pages 29-31. In M.P. Lawson, K. F. Dewey, and R.E. Neild (eds.). Climatic atlas of Nebraska. University of Nebraska Press, Lincoln.
- Neild, R.E., N.J. Rosenberg, and R.E. Meyers. 1967. Temperature patterns and some relations to agriculture in Nebraska. University of Nebraska Agricultural Experiment Station Miscellaneous Publication 16.
- Ordway, R.J. 1972. Earth science. Second edition. Van Nostrand Reinhold, New York.
- Pool, R.J. 1914. A study of the vegetation of the Sandhills of Nebraska. Minnesota Botanical Studies IV:188-312.
- Rydberg, P.A. 1895. Flora of the Sandhills of Nebraska. Contributions from the United States National Herbarium 3:133-203.
- Smith, J.G. 1892. Grasses of the Sandhills of Nebraska. Nebraska State Board of Agriculture Annual Report.
- Stubbenieck, J. 1986. Blowout penstemon: The Sandhills rare jewel. Nebraska Quarterly 32:17
- Stubbenieck, J. 1989. Range management. Pages 227-233. In A. Bleed and C. Flowerday (eds.). An atlas of the Sand Hills. University of Nebraska Conservation and Survey Division, Resource Atlas No. 5.
- Stubbenieck, J., and R.R. Weedon. 1984. Germination and establishment of blowout penstemon (*Penstemon haydenii* S. Wats.) Abstracts of papers, Society for Range Management 37:199.
- Stubbenieck, J., J. Traeger, and R.R. Weedon. 1983. Propagation of blowout penstemon (*Penstemon haydenii* S. Wats.). Proceedings of the Nebraska Academy of Sciences 93:16.
- Stubbenieck, J., R.K. Engel, W. Schacht, J. Traeger, and R.R. Weedon. 1982. Germination characteristics of *Penstemon haydenii* Wats. Proceedings of the Nebraska Academy of Sciences 92:18.
- United States Department of Agriculture. 1981. Nebraska range site descriptions and guide for determining range condition and suggested initial stocking rates. United States Department of Agriculture, Soil Conservation Service, Washington, DC.
- United States Department of Commerce. 1973. Monthly normals of temperature, precipitation, and heating and cooling degree days, 1941-70. Climatology of the United States Number 81.
- Weaver, J.E. 1954. North American prairie. Johnsen Publishing Company, Lincoln, Nebraska.
- Weaver, J.E. 1965. Native vegetation of Nebraska. University of Nebraska Press, Lincoln.
- Weedon, R.R., J. Stubbenieck, and M. Beel. 1982. Blowout penstemon. NEBRASKAland 60:49-51.
- Wilhite, D.A., and K.G. Hubbard. 1989. Climate. Pages 17-28. In A. Bleed and C. Flowerday (eds.). An atlas of the Sand Hills. University of Nebraska Conservation and Survey Division, Resource Atlas No. 5.