

Survival of the western prairie fringed orchid at Pipestone National Monument

By Gary D. Willson and F. Adnan Akyuz

THE WESTERN PRAIRIE FRINGED ORCHID (*PLATANThERA praeclara*) is an erect perennial herb with a showy inflorescence or flower stalk reaching up to 75 centimeters (29.6 in.) in height and producing 5–25 white flowers (Sheviak and Bowles 1986) (fig. 1). The orchid once grew throughout the western tallgrass prairie but is now restricted to remnant sites in six states and southern Canada. It has declined because of the drainage and direct loss of habitat resulting from agricultural expansion, and was listed as a federal threatened species in 1986 (U.S. Fish and Wildlife Service 1996).

Extant populations of the western prairie fringed orchid are usually found in mesic (relatively good drainage but high moisture during most of the growing season) to wet tallgrass prairie habitats that are often subirrigated (moisture in the subsoil from a groundwater source). In these habitats, soil moisture is a critical determinant of the growth and flowering of orchid plants. Drought depresses this flowering and decreases survival (Sather 2000; Ashley 2001; Willson et al. 2006). Likewise, flooding or moisture-saturated soil depresses flowering and, if prolonged, kills orchid plants (Sieg and Wolken 1999; Willson et al. 2006). Prescribed burning of orchid habitat also influences flowering of the orchid and ultimately its survival. In a dry spring, burning can exacerbate soil moisture loss in tallgrass prairie (Knapp 1985), which causes orchid plants to abort flowers (Pleasants 1995).

Pipestone National Monument in southwestern Minnesota protects outcrops of pipestone or catlinite that American Indians have quarried from prehistoric times to the present (fig. 2). A small, isolated population of the western prairie fringed orchid occurs in the monument in mesic tallgrass prairie habitat of shallow soil overlying Sioux quartzite bedrock (Morey 1983). The orchid habitat is periodically prescribed burned in spring to control invasive cool-season grasses, primarily smooth brome (*Bromus inermis*), but is not grazed by bison or cattle. Historical (1890s) photographs of the area that later became the monument show water flowing over a ridge of Sioux quartzite into the orchid habitat from multiple overflow channels of Pipestone Creek (fig. 3, page 52). In the early 1900s the creek bed was lowered about 3 meters (10 ft) at Winnewissa Falls on Pipestone Creek (fig. 4, page 52) and the channel upstream was straightened, which reduced surface flow of water into the orchid habitat.

Because of the shallow soil and altered hydrology of its habitat in Pipestone National Monument, the western prairie fringed orchid may be prone to greater moisture stress and lower survival than plants growing in other orchid habitat with deeper soils and intact hydrology. To determine if lower survival of orchid plants occurs

Abstract

A small population of the threatened western prairie fringed orchid (*Platanthera praeclara*) occurs at Pipestone National Monument, Minnesota, in a tallgrass prairie with shallow soil and altered hydrology. During dry years, the population at Pipestone may be subject to greater moisture stress and lower survival than plants growing in other orchid habitat with deeper soils and intact hydrology. For a nine-year period we monitored the survival of 30 flowering plants at marked locations at Pipestone and compared the results with those from another monitoring study of orchid survival in unaltered habitat at Sheyenne National Grassland, North Dakota. We found plants were short-lived at both Pipestone and Sheyenne (half-lives of one to two years) and few surviving plants flowered again after the second year at Pipestone. The low survival of flowering orchids at Sheyenne following one dry year suggests that even in habitats with intact hydrology, below-normal precipitation can substantially lower survival in this species. Following a very dry year or series of dry years, survival of plants at Pipestone could be very low. Restoration of the natural hydrology at Pipestone might enhance survival but is unlikely considering the costs and likely opposition. We recommend the suspension of prescription burns at Pipestone during extended dry periods to avoid possible further lowering of survival.

Key words

western prairie fringed orchid, Pipestone National Monument, hydrology, prescribed fire, restoration

in the monument, we compared the survival of orchid plants at Pipestone with the survival of another population of these plants at Sheyenne National Grassland in southeastern North Dakota (Sieg and King 1995). Sheyenne National Grassland protects one of the largest populations of the orchid in deep-soiled habitat that is usually wet but can be dry or flooded. Pipestone and Sheyenne are similar in general soil type (mesic loam), climate (total amount and distribution of precipitation), and management (prescribed burns and no cattle grazing in orchid habitat); they differ in soil depth and hydrology. Lower survival of orchid plants at Pipestone than that at Sheyenne would suggest the population at Pipestone would benefit from restoration of the natural hydrology. However, because of the extent and depth of channelization of Pipestone Creek in the monument and upstream, the only feasible response may be changes to the management regime (e.g., prescribed fire) in the orchid habitat.

Pipestone National Monument

Pipestone National Monument includes about 114 hectares (281 acres) of native and restored tallgrass prairie. In the monument, the western prairie fringed orchid is found in a diverse plant

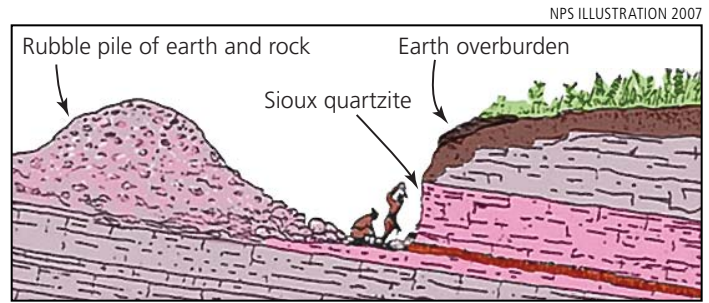


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Figure 1. The showy flower of the western prairie fringed orchid is a unique resource at Pipestone National Monument, where a small population of this threatened plant species persists. Scientists and managers are striving to understand factors affecting preservation of the orchid, including hydrology, precipitation, and prescription burns.

community that is dominated by little bluestem (*Schizachyrium scoparium*) and other native grasses (Becker 1986). The soil where the orchid occurs is a silty clay loam developed on loess (windblown silt) with a depth to bedrock of 2 to 3 meters (3.3 to 6.6 ft) (U.S. Soil Conservation Service 1975) (see fig. 2). The annual precipitation averages about 65.4 centimeters (25.8 in.) with 78% or 51.0 centimeters (20.1 in.) falling as rain in April through September (Midwest Regional Climate Center 2004). Since 1972, the prairie habitat of the orchid has been prescription burned, on average every three to four years, usually in early May.

Erratic growth patterns of the orchid make it difficult to monitor. In some years an orchid may produce a tall, visible flower stalk, while in other years it produces only one to three basal leaves (vegetative stage) (fig. 5, page 52) or no aboveground growth. In 1993 the monument began an annual, mid-July count of flowering plants, the orchid's most detectable life-stage (Willson 2000). In



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Figure 2. American Indians quarry pipestone, a red-colored rock layer interbedded in Sioux quartzite bedrock. The quarries are located near the orchid habitat and expose the thin layer of soil that lies above the bedrock.

addition, the distribution of flowering plants was mapped during the annual counts. From 1993 to 2008, the number of flowering plants varied considerably, with annual counts ranging from 0 to 221 (table 1, page 53). The distribution of flowering plants also varied from year to year but, when flowering plants were present, most were clustered in the wetter portion of the habitat (fig. 6, page 53).

Sheyenne National Grassland

Sheyenne National Grassland encompasses about 27,244 hectares (67,269 acres) of stabilized dunes associated with the glacial Sheyenne Delta. The western prairie fringed orchid occurs in lowland depressions or swales, where it grows in association with mesic plants such as woolly sedge (*Carex lanuginosa*), Baltic rush (*Juncus arcticus*), and northern reed grass (*Calamagrostis stricta*) (Sieg and King 1995). A layer of silt interbedded with clay located up to 30 meters (98 ft) below the soil surface impedes drainage, which results in the relatively high water level in the swales (Baker and Paulson 1967). Sandy loam and loamy sand are the most common soils in the swales (U.S. Soil Conservation Service 1975). The mean annual precipitation is 49.7 centimeters (19.6 in.), most of which falls as rain during the April–September growing season (High Plains Regional Climate Center 2009). Most of the grassland is managed for cattle production under three regimes—grazed-rotational, grazed-season long, and grazed-prescription burned—but some areas are ungrazed or ungrazed-prescription burned.

In 1987 at Sheyenne, Sieg and King (1995) established three belt transects (10 × 30–80 meters [33 × 98.4–262.5 ft]) in an ungrazed-prescription burned exclosure that encompassed three swales. They permanently marked the location of a total of 10 flowering orchid plants on each of the three transects and, from 1988 through 1994, resurveyed these locations each year, noting if plants were present or absent during peak flowering in late June through early July.

NPS/PIPESTONE NATIONAL MONUMENT HISTORICAL PHOTO COLLECTION

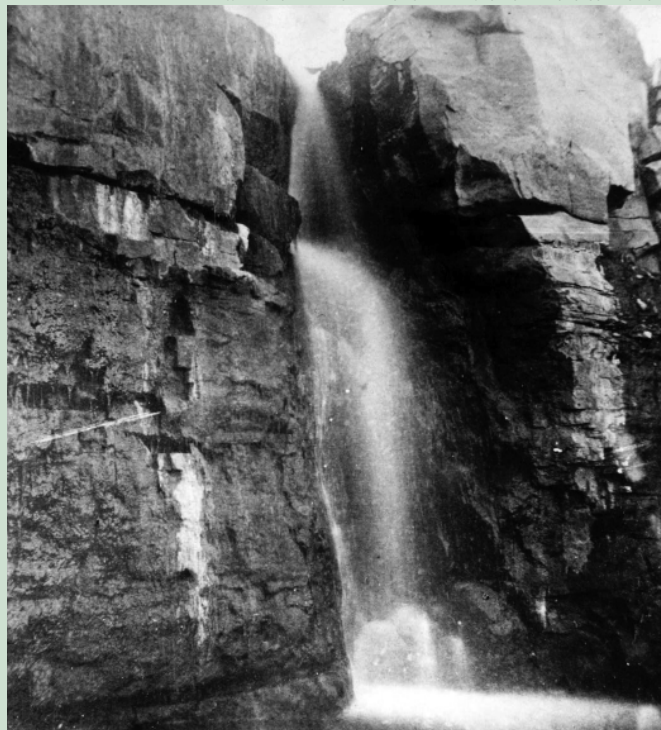


Figure 3. Overflow channel and falls of Pipestone Creek, 1890s.

NPS/NATHAN KING



Figure 4 (above left). Pipestone Creek plunges over a cliff of Sioux quartzite as Winnewissa Falls. The creek bed was altered above and below the falls in the early 1900s, reducing the amount of surface water reaching orchid habitat.

NPS/GARY WILLSON

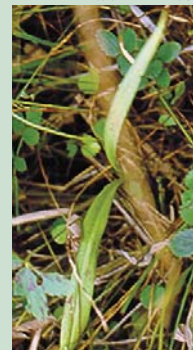


Figure 5 (above right). Erratic growth patterns make the orchid difficult to monitor. In some years an orchid may produce a tall, visible flower stalk (see fig. 1), while in others it produces only one to three basal leaves (the vegetative stage shown here) or no aboveground growth.

Methods

In July 1995, as part of the annual census of flowering orchids in Pipestone National Monument, we permanently marked the locations of the 37 flowering western prairie fringed orchids counted that year. For the next nine years (1996–2004), we revisited the marked locations during the July census. At each location, we recorded the life stage of each orchid as flowering, vegetative, or absent. In 1997, seven markers were inadvertently removed after the habitat was prescription burned. We compared the survival of the remaining 30 orchid plants in this population with that of 30 orchid plants that Sieg and King tracked in ungrazed–prescription burned habitat at Sheyenne National Grassland. The orchid habitats at Pipestone and Sheyenne were generally similar in climate, soil type, and management but substantively different in soil depth and hydrology. We assumed the age distribution of the flowering plants at both locations was similar, although the ages of the flowering plants were unknown (i.e., plants were first encountered as flowering individuals of unknown age, not as seedlings).

Results

Appendix A (page 55) shows the status (i.e., flowering, vegetative, or absent) of orchid plants for each year of the nine-year moni-

toring record at Pipestone National Monument, and table 2 (page 54) shows a summary of these data. Table 3 (page 54) shows the number of orchid plants surviving in each year of monitoring at Pipestone and Sheyenne.

Year-to-year survival of plants at marked locations was similar in the Pipestone and Sheyenne populations, except for the first year of monitoring (1988 at Sheyenne and 1996 at Pipestone), when survival was 50% at Sheyenne and 83% at Pipestone. At the end of the nine-year monitoring period at Pipestone we found that two plants had survived—one flowered and the other was vegetative—that year, whereas at the end of the seven-year monitoring period at Sheyenne, Sieg and King found six plants had survived. At Pipestone, we found only two orchids had flowered in the second year of monitoring (1997), although three had flowered in the fifth and sixth years. Furthermore, only two orchid plants flowered for three consecutive years. Sieg and King did not report these data for the plants they monitored.

Discussion

Half-life is the period of time during which half of the individuals in a population die (as used by Hutchings 1989). At Sheyenne, Sieg and King (1995) found orchid plants were short-lived, with a

Table 1. Flowering western prairie fringed orchid plants at Pipestone National Monument, 1993–2008

Year	Number of Flowering Plants
1993	33
1994	18
1995	37
1996	55
1997	3
1998	0
1999	16
2000	125
2001	95
2002	124
2003	221
2004	146
2005	149
2006	101
2007	1
2008	10

half-life of one year in the ungrazed-burned habitat. Most orchid species have half-lives that are longer than five years (Hutchings 1989). Such a short half-life may have been the result of very dry conditions (50% of long-term average precipitation) in 1987 at the beginning of their monitoring (Sieg and King 1995). At Pipestone we found survival of the orchid was somewhat longer, but still very short with a half-life of about one to two years. Precipitation at Pipestone was also below normal in one year during the monitoring period, but that year—1997—was the second year and was only moderately dry (70% of normal precipitation).

The low survival of flowering orchids at Sheyenne following one dry year suggests that even in habitats with intact hydrology (in this case subirrigated), below normal precipitation can substantially lower survival. Although we did not monitor the survival of flowering plants following a very dry year at Pipestone, we believe the altered hydrology and shallow soil there may compound the negative effect of low precipitation on orchid survival. Following a very dry year, or a series of dry years, orchid survival at Pipestone may be as low as or lower than the first-year survival of flowering plants that were monitored at Sheyenne. Very low survival of the orchid plants, very low flowering of surviving plants, and a short-lived seed bank (Alexander 2006; Batty et al. 2000) could lead to extinction of the small population at Pipestone following a prolonged drought. Recolonization would be very unlikely, considering the next closest western prairie fringed orchid population is about 29 kilometers (18 mi) away.

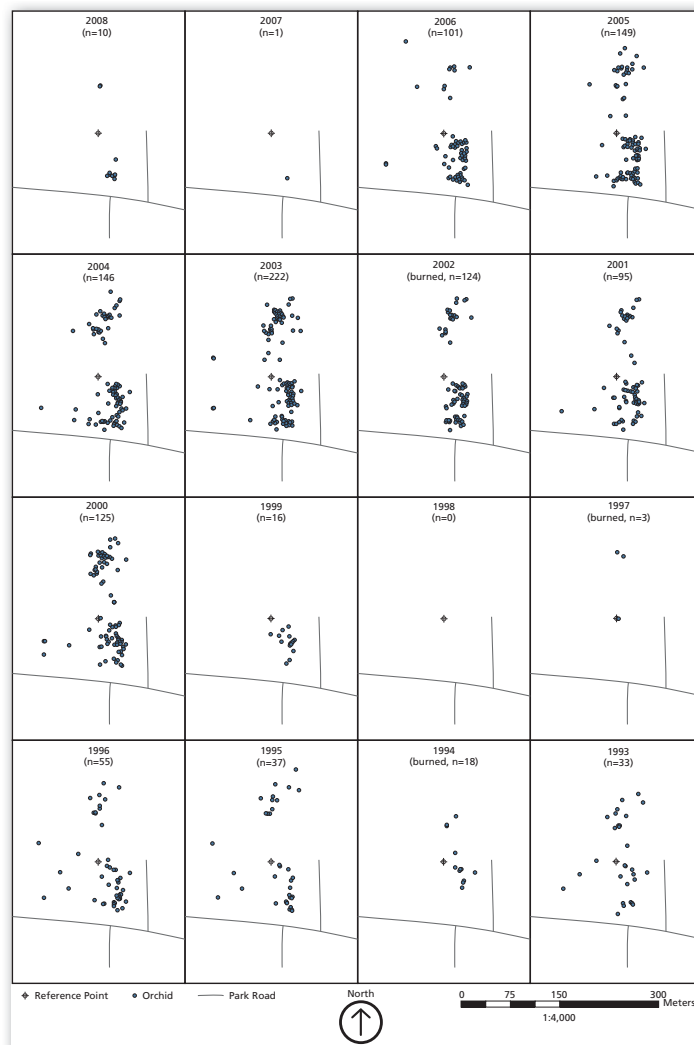


Figure 6. Distribution of flowering western prairie fringed orchid plants at Pipestone National Monument, 1993–2008.

SOURCE: YOUNG ET AL. 2008. NOTE: ORCHID LOCATIONS ARE APPROXIMATE.

Restoration of the natural flow of Pipestone Creek might supplement soil moisture in the orchid habitat and mitigate the effects of reduced precipitation in dry years, but restoration is unlikely considering the cost and opposition from upstream urban and agricultural interests. In addition, surface flow of water into the orchid habitat would likely contain agricultural chemicals that might affect orchid flowering and survival. The only practical strategy may be changes in resource management, primarily the use of prescription burns. We recommend not burning the orchid habitat during an extended dry period when burning may increase soil moisture loss and further reduce the survival of plants and the ability of surviving plants to flower (Pleasants 1995; Willson et al. 2006).

Table 2. Number of flowering, vegetative, and absent western prairie fringed orchid plants at permanently marked locations at Pipestone National Monument, 1995–2004

Stage	Year									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Flowering	30	18	2	0	0	3	3	1	1	1
Vegetative	0	7	10	8	11	5	4	2	0	1
Absent	0	5	18	22	19	22	23	27	29	28

Table 3. Survival of western prairie fringed orchid plants at marked locations during 1987–1994 at Sheyenne National Grassland and during 1995–2004 at Pipestone National Monument

Site	Year (Sheyenne/Pipestone) and Number of Plants									
	1987/ 1995	1988/ 1996	1989/ 1997	1990/ 1998	1991/ 1999	1992/ 2000	1993/ 2001	1994/ 2002	— ¹ / 2003	— ¹ / 2004
Sheyenne (1987–1994)	30	15	13	8	7	9	7	6	— ¹	— ¹
Pipestone (1995–2004)	30	25	12	8	11	8	7	3	1	2

¹Monitoring at Sheyenne ended in 1994.

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Appendix A: Annual monitoring results at marked locations where western prairie fringed orchid plants flowered at Pipestone National Monument in 1995

ID	Year									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
9501	2	1	1	1	1	1	2	0	0	0
9502	2	2	0	0	0	0	0	0	0	0
9503	2	2	0	0	1	0	0	0	0	0
9504	2	2	0	0	0	0	0	0	0	0
9505	2	0	0	0	0	0	0	0	0	0
9506	2	2	0	1	1	0	1	0	0	0
9507	2	2	0	0	1	0	0	0	0	0
9508	2	2	0	1	1	1	2	2	0	2
9510	2	2	1	0	0	1	0	0	0	0
9511	2	1	0	0	0	0	0	0	0	0
9514	2	2	1	1	1	0	0	0	0	0
9516	2	1	0	0	1	1	0	0	0	0
9517	2	2	0	0	0	0	0	0	0	0
9518	2	1	0	0	1	0	1	0	2	0
9519	2	2	0	0	0	0	0	0	0	0
9521	2	0	1	0	1	1	0	0	0	0
9522	2	1	1	0	0	0	0	0	0	0
9523	2	2	0	0	0	0	0	0	0	0
9524	2	2	0	0	0	0	0	0	0	0
9525	2	2	2	0	0	0	0	0	0	0
9526	2	1	0	0	0	0	0	0	0	0
9527	2	2	2	0	0	0	0	0	0	0
9528	2	0	1	0	0	0	0	0	0	0
9529	2	2	1	1	1	0	0	0	0	0
9530	2	1	1	1	1	2	1	1	0	1
9531	2	0	0	0	0	0	0	0	0	0
9532	2	0	0	0	0	0	0	0	0	0
9533	2	2	1	1	0	2	0	0	0	0
9534	2	2	1	1	0	0	1	1	0	0
9536	2	2	0	0	0	2	2	0	0	0

2 = Flowering
1 = Vegetative
0 = Absent

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