6-2010

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1964–2007

This issue of *The Prairie Naturalist* contains a series of three papers on the western prairie fringed orchid by Dr. Bonnie Alexander and her colleagues. Dr. Alexander passed away in August, 2007, after a brief but hard fought battle with cancer and only a short while after completing her Doctorate in Natural Resources Management at North Dakota State University. Up until the time of her death, Dr. Alexander was an associate professor of biology at Valley City State University, North Dakota, where she was greatly admired by her students for always challenging them to become better and stronger members of society. Her love and enjoyment of prairie plant communities, especially those supporting populations of the western prairie fringed orchid, were always well evident. Her research on this threatened orchid species adds greatly to the information needed by researchers, managers, and decision makers to assure its persistence into the future. I applaud the junior authors of these papers for taking on the difficult task of preparing these manuscripts from Dr. Alexander's research findings in spite of her passing. Although Dr. Alexander may not have won her battle with cancer, the efforts of her co-authors have ensured that her research contributes significantly to our knowledge of a rare orchid species that she cared so deeply about.

Christopher Jacques (Editor)

Cattle Grazing Reduces Survival and Reproduction of the Western Prairie Fringed Orchid

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ABSTRACT Quantifying impacts of livestock grazing and prairie management strategies on the threatened western prairie fringed orchid (*Platanthera praeclara*) is difficult due to the erratic appearance of the orchid above-ground. We monitored above-ground survival of orchids from flowering to mature seed capsule production, comparing plant height, flower numbers, and seed capsule numbers from 2002–2004 in rotationally grazed pastures and non-grazed sites. Orchid survival differed significantly between grazed and non-grazed pastures, with the proportion of plants surviving from flower to capsule production consistently lower in grazed pastures. Mean orchid survival in grazed and non-grazed areas was 40% and 87%, respectively. The proportion of surviving plants producing capsules greater than 3 mm in diameter was significantly greater in non-grazed pastures. Flower and bud production did not differ between grazed and non-grazed areas, and plant height was significantly greater in non-grazed areas. High levels of above-ground plant mortality may reduce orchid tuber winter survival and robustness of above-ground growth the following growing season. Creation of protected orchid nursery areas within grazed pastures is suggested to reduce high mortality of above-ground orchid plants.

KEY WORDS livestock, North Dakota, orchid, *Platanthera praeclara*, tallgrass prairie, threatened species

The western prairie fringed orchid (*Platanthera praeclara*) was federally listed as a threatened species by the U. S. Fish and Wildlife Service in September 1989. Both numbers and range of this orchid have been reduced during the last 100 years, primarily due to the conversion of prairie to cropland (Bowles 1983). Western prairie fringed orchids grow in or on wetland edges within tallgrass prairie communities and also are found in disturbed sites associated with tallgrass prairie (Bowles 1983). Local extinctions and recolonizations have been observed on a regular basis in populations and are characteristic of some metapopulations (Husband and Barrett 1996). Major threats to the orchid include habitat disruption (e.g., conversion to cropland), cattle grazing, mowing, burning, herbicide application, and hydrologic changes.

Controversy surrounds management of the western prairie fringed orchid on public lands such as in southeastern North Dakota. One reason for this controversy is that cattle grazing by private ranchers is often allowed in orchid habitat. The impact of grazing on orchid populations has not previously been documented. Research on the impact of management, including grazing, on orchid populations is limited and has been confounded by the sporadic growth of the orchid (Sieg and King 1995). Thus, our objectives were to monitor orchid growth, survival, and reproduction in grazed and non-grazed sites in the Sheyenne National Grassland of southeastern North Dakota.

STUDY AREA

The Sheyenne National Grassland (SNG) is located in Ransom and Richland counties of southeastern North Dakota. The SNG lies in an ancient river delta whose sands were blown into a transverse dune field then vegetated about 2,370 years ago (Running 1996). The population of blooming orchids in the SNG fluctuated between several thousand and 15,000 plants (Alexander 2006). The Grassland is managed by the U. S. Forest Service to maintain native prairie habitat and provide cattle forage. Management techniques consisted of burning, mowing, and herbicide application, in addition to cattle grazing by local ranchers. Long-term growing season (April – October) precipitation averaged 44.8 cm for the study area. Total annual precipitation during 2002, 2003, and 2004 was 42.8, 38.7, and 50.9 cm respectively. The main study area encompassed 821 ha (2,026 acres) in what the U. S. Forest Service calls the Venlo grazing allotment. This area was fenced into three pastures consisting of East Venlo (269 ha), North Venlo (289 ha), and South Venlo (263 ha). We also marked and evaluated orchids in non-grazed (deferred) pastures in three locations within 20 km of the Venlo grazing allotment.

METHODS

In the Venlo allotment of the SNG, flowering orchid within three pastures were counted, marked, and mappe

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using a handheld Garmin Legend Global Positioning System (Garmin International, Inc., Olathe, Kansas, USA) during July of 2002–2004. We searched pastures beginning in early July, although exact dates varied depending on development of orchid blooms each year. We marked orchids with a plastic cattle ear tag, washer, and pole barn spike driven into the ground 1 m east of each orchid; we set markers at this distance to avoid potential metal ion toxicity effects. At the time of flowering, we measured plant height from the ground to the tip of the top flower, and enumerated flowers and buds. Sampling units consisted of all blooming orchids in each of three grazed pastures.

Each pasture was grazed using a twice-over rotational grazing system. Pastures were grazed using a standard stocking rate of 0.4 ha per animal unit month (AUM = one 450 kg cow and a calf grazing for one month). We subdivided grazing periods into early, mid, and late; each corresponding to different above-ground life stages of the orchid as described by Wolken (1995). We defined the early grazing period when greater than 50% of the grazing occurred before June 15 and corresponded to the vegetative stage of the orchid. In the vegetative stage, plants have a low profile, few leaves, and short, flexible flower stalks. We defined the mid grazing period when greater than 50% of the grazing occurred after June 15 but before August 31. This period corresponded to the period of time during which the orchids were extending flower stalks and producing flowers and seed capsules. We defined the late grazing period when greater than 50% of grazing occurred after August 31; corresponding to the period when orchid seed capsules were fully developed and seeds were assumed to be nearly mature. Orchid plants moved into dormancy during this period, becoming brown and atrophied. Seed capsules opened in mid-September.

For comparison with grazed pastures, we marked and evaluated orchids in non-grazed (deferred) pastures. In 2002, we used data from Self (2002) in two non-grazed pastures on the Viking Prairie allotment 20 km east of the Venlo allotment and 20 orchids on The Nature Conservancy land 12 km southeast of the Venlo allotment. In 2003, we marked and evaluated all orchids in the Penberthy South (adjacent to the Venlo allotment) deferred pasture. In 2004, we marked and evaluated orchids in Middle McLeod allotment (10 km southeast of the Venlo allotment) that had not been grazed for a year. Following cattle removal from grazed pastures and prior to seed dispersal in all pastures, we re-evaluated all orchids and subsequently counted and recorded total numbers of seed capsules.

Statistical Analysis

We compared rates of orchid survival between grazed and non-grazed pastures within each year of the study using a two sample t-test with heterogeneous variance (Zar 1999). We compared differences in plant height, flower (and bud) production, and capsule production between grazed and non-grazed pastures using an analysis of variance (ANOVA) with a repeated observation model (Zar 1999); differences were considered significant at $P < 0.05$.

RESULTS

We marked 551 orchids in grazed pastures and 106 orchids in non-grazed pastures. In grazed pastures, there were 271 orchids in 2002, 140 in 2003, and 69 in 2004, corresponding to a 292% population reduction during our study. The pastures sampled each year in our non-grazed treatment changed annually so total orchid populations could not be followed across years for these sites.

Percentage of orchids surviving from flowering to capsule maturity was consistently lower ($P < 0.05$) in grazed pastures than in non-grazed pastures (Fig. 1). Orchid survival in grazed and non-grazed areas was 40% and 87%, respectively. Survival or orchids in non-grazed areas increased from 30% in 2002 to 58% in 2004. Further, overall orchid survival averaged across grazed and non-grazed areas was 51% (Fig. 1).

We used orchid plant height and number of flowers produced as measures of robustness in this study. Plant height in grazed pastures ($\bar{X}$ = 43 cm) was significantly less ($P < 0.001$) than in non-grazed sites ($\bar{X}$ = 52 cm). Mean number of flowers per plant was similar ($P = 0.24$) between grazed ($\bar{X}$ = 7.6) and non-grazed ($\bar{X}$ = 8.6) pastures. Percentage of flowers producing capsules also was similar ($P = 0.73$) between grazed (34%) and non-grazed pastures (39%). Moreover, we found no difference ($P = 0.46$) in the mean number of capsules per plant between grazed ($\bar{X}$ = 2.2) and non-grazed ($\bar{X}$ = 3.1) pastures. However, percentage of orchids producing mature capsules was greater ($P = 0.01$) on non-grazed pastures (55%) than on grazed pastures (35%).

DISCUSSION

Presence of a seed bank (viable seeds remaining in the habitat from previous years) has been considered important in the stability and growth of the western prairie fringed orchid population (Sieg and King 1995). If orchids do not survive the growing season, they do not produce mature seeds and, consequently, do not contribute to the seed bank or recruitment of orchids into the population. Previous studies have found mortality rates from flowering to capsule maturity ranging from 16% (Pleasants 1995) to 64% (Wolken 1995) in non-grazed areas.

In our study, cattle grazing had a significant detrimental impact on orchid plant survival to capsule maturity (60% mortality in grazed versus 23% in non-grazed areas). Increased mortality in grazed pastures has two implications for long-term survival of the western prairie fringed orchid in North Dakota. First, only about half as many plants survive to produce seed capsules in grazed pastures than in non-grazed pastures (Fig. 1), and there was an additional

20% reduction in the number of seed capsules produced by plants that survive and reproduce in grazed pastures. Thus, for every 100 flowering orchids produced each season, approximately 1.75 million fewer seeds are produced per 100 plants in grazed pastures. These numbers demonstrate the magnitude of the reduction in orchid seed production in grazed pastures. However, it is not known what ecological significance this may have on population viability.

The second implication of cattle grazing is that the western prairie fringed orchid is a perennial plant and relies on carbohydrate reserves produced during the growing season to survive winter dormancy and produce growth the next season. When above-ground photosynthetic parts of an orchid are affected by grazing or trampling, the plant has no means of replenishing reserves. Bowles (1983) suggested that removal of above-ground biomass before adequate storage has occurred may disrupt the orchid lifecycle, preventing flower production in subsequent seasons. This loss of energy reserve could also render the tuber vulnerable to winter kill. Either of these factors could reduce future orchid growth and reproduction.

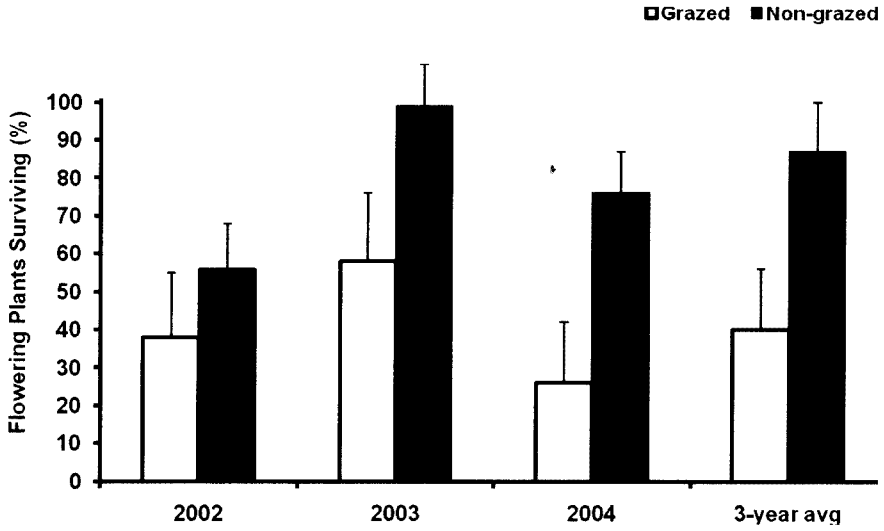

Figure 1. The percentage of flowering western prairie fringed orchids (*Platanthera praeclara*) surviving to mature capsule production annually and the 3-year average in grazed and non-grazed pastures on the Sheyenne National Grassland in southeastern North Dakota, 2002–2004. Plant survival was lower in the grazed pastures each year as well as for the 3-year average ($P < 0.05$).

We studied the robustness of orchid plants using plant height, flower production, and capsule production. Difference in mean heights between orchids in grazed and non-grazed pastures suggests that cattle grazing directly impacts orchid growth. Plant height could possibly be influenced by the drying of the soil resulting from reduction in ground cover. Sieg and King (1995) suggested that orchid plant height was a response to moisture levels. Shorter plant height also could be associated with removal of above-ground orchid growth by cattle during a previous growing season, thereby reducing carbohydrate reserves available for growth in the current season.

Self (2002) found no difference between number of flowers produced in grazed and non-grazed areas. We also found similar numbers of flowers per plant occurring in grazed and non-grazed areas. Additionally, we found capsules per flower and mean capsules per plant were similar between grazed and non-grazed areas. Similarities in flower production combined with a difference in plant height could reflect that plants surviving to flowering in grazed pastures sacrificed vegetative growth to ensure that carbohydrate reserves were sufficient to produce a normal number of flowers and capsules.

MANAGEMENT IMPLICATIONS

To remediate cattle grazing effects, we suggest identification of areas where orchids grow in both wet and dry years within core (concentrated) and secondary (scattered) orchid areas and fence out core orchid areas to cattle grazing. These fenced areas would serve as protected orchid nurseries for seed production and would provide buffers to potential catastrophic loss. The enclosed areas may need to be mowed, grazed, or burned after seeds are released (approximately mid-September) if a heavy growth of vegetation is identified as impairing orchid growth.

ACKNOWLEDGMENTS

We thank Darla Lenz and the USDA Forest Service, Dakota Prairie Grasslands for their financial and technical support of this research project.

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Submitted 6 March 2009. Accepted 6 March 2010.
Associate Editor was David M. Mushet.