Effects of Long-term Grazing and Intensity on an Elk Winter-Spring Range

T.M. Thrift*, T.K. Brewer, and J.C. Mosley.

Montana State University, Bozeman, MT 59717

ABSTRACT: This 2 year study was implemented to compare the effects of heavy and light, long-term grazing in winter-spring on the health of foothill rangeland vegetation in central Montana. Eight sites with similar slope, aspect, soil, and precipitation that have been used by elk in winter-spring for 20 years were identified with 4 located in the heavily grazed area and 4 within the lightly grazed area. Rangeland health, as characterized by plant vigor of bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), and rough fescue (*Festuca scabrella*) was evaluated in July 2004. Basal diameter of rough fescue was 19 cm smaller on the long-term heavily grazed sites ($P = 0.02$) compared to the long-term lightly grazed sites. Bluebunch wheatgrass and Idaho fescue basal diameter did not differ between heavy and light, long-term grazing ($P = 0.51$ and $P = 0.24$, respectively). Average leaf height of Idaho fescue was 2 cm shorter ($P < 0.01$) and rough fescue was 5 cm shorter ($P = 0.03$) on the long-term heavily grazed sites compared to the long-term lightly grazed sites, whereas the average leaf height of bluebunch wheatgrass did not differ ($P = 0.34$) between treatments. Percentage of filled florets of bluebunch wheatgrass ($P < 0.01$), Idaho fescue ($P < 0.01$) and rough fescue ($P = 0.01$) was 51%, 70%, and 85% less, respectively, on the long-term heavily grazed sites than the long-term lightly grazed sites. Canopy cover of rough fescue was 97% less on the long-term heavily grazed sites ($P = 0.03$), while canopy cover of bluebunch wheatgrass and Idaho fescue did not differ between long-term, heavily and lightly grazed sites ($P = 0.37$ and $P = 0.48$, respectively). Preliminary results suggest that long-term heavy winter-spring grazing reduced plant vigor of bluebunch wheatgrass, Idaho fescue, and rough fescue on foothill rangeland.

Key words: elk, long-term grazing, plant vigor, bluebunch wheatgrass, rough fescue, Idaho fescue

Introduction

Increasing elk (*Cervus elaphus)* populations combined with diminishing amounts of native rangeland in the western U.S. have caused increased levels of winter and spring use of foothill rangeland by elk. Of the 4 million ha of foothill rangeland in Montana, 1.9 million ha is foothill grassland, which is important seasonal range for wildlife and domestic livestock (Payne, 1973). In the Rocky Mountain foothill regions of Montana, elk consistently occupy rough fescue (*Festuca scabrella*)/ bluebunch wheatgrass (*Agropyron spicatum*) (Mueggler and Stewart, 1980) habitat types in winter and early spring, and have the potential to aversely affect these valuable forage resources if recovery after defoliation is not adequate during spring and summer.

Limited research is available that has quantified the effects of long-term winter-spring grazing on key grass species of foothill rangeland plant community. Brewer (2002) concluded that clipping bluebunch wheatgrass plants once per year in April and May had no adverse effects on plant yield or vigor; however clipping moderately and heavily in May for 2-3 consecutive years reduced plant yield and vigor in the summer. Light summer grazing for 20 years by sheep

did not affect the leaf height and weight or the basal area of Idaho fescue plants (Hurd, 1959). Increasing in stocking rate from light to moderate adversely affected rough fescue basal diameter on range sites with a lengthy grazing history, suggesting that rough fescue plants are susceptible to long-term grazing (Willms et al., 1985). Previous rangeland research has demonstrated that moderate levels of herbivory during summer are generally sustainable, but long-term heavy grazing intensities are not. Whether heavy grazing intensities also are unsustainable when grazing occurs in winter-spring is still uncertain.

Materials and Methods

Study Area

This study was conducted on eight study sites located within the Sun River Wildlife Management Area (SRWMA) in northwestern Montana. The SRWMA is approximately 8,100 ha in size and is located approximately 14.5 km northwest of Augusta, Montana, and 162 km west of Great Falls, Montana. The study area averages 34.9 cm of annual precipitation, with at least 50% occurring as rain from April through September (Western Regional Climate Center, 2004). The game preserve has been home to approximately 2,150 hundred elk from November to early May from 1982-2003 and has been used exclusively by elk since its establishment in 1913.

The study sites are located within a rough fescue/bluebunch wheatgrass habitat type (Mueggler and Stewart, 1980) and Beanlake-Winspect Stony Loam soil type (Montagne et al., 1982). Dominant grass species include rough fescue (*Festuca scabrella* Torr.), bluebunch wheatgrass (*Agropyron spicatum* Pursh.), Idaho fescue (*Festuca idahoensis*, Elmer), Columbia needlegrass (*Achnatherum nelsonii* Scribn.), prairie junegrass (*Koeleria macrantha* Ledeb.), threadleaf sedge (*Carex filifolia* Nutt.), and elk sedge (*Carex garberi* Fern.). Dominant forbs include dotted gayfeather (*Liatris punctata* Hook), Western yarrow (*Achillea millefolium* L. var.), hairy golden aster, death camas (*Zigadenus venenosus* S. Wats.), and wild onion (*Allium ascalonicum* L.). Shrubby cinquefoil (*Potentilla fruticosa* auct. non L.) and fringed sage (*Artemisia frigida* Willd.) are the only shrub species present.

Eight sites with the same habitat type, soil type, percent slope, aspect and elevation were selected. Elevation on the sites is approximately 1,350 m with an average slope of 5% and southwest aspect. Four sites, located in the southeast portion of the game range, were chosen in an area of the game range that has historically been used lightly by elk from November through early May, due its proximity to a county road that receives moderate traffic year-round. Four additional sites were chosen in the northwest portion of the game range where human influences are minimal and historical heavy grazing has occurred when elk are present from November through early May.

Measured Responses

Three, 60-meter transects were identified at each of the four heavily grazed sites and four lightly grazed sites and used to quantify plant vigor and percent canopy cover of bluebunch wheatgrass, Idaho fescue, and rough fescue. Plant vigor was quantified with measures of average leaf height (Mueggler, 1975; Rickard et al., 1975), basal diameter (Cook and Stubbendieck, 1986), and percentage of filled florets per plant (Patton et al., 1988) on the nearest

bluebunch wheatgrass, Idaho fescue, and rough fescue plant at 3-meter intervals along each of the three, 60-meter transects per site (n=60 per grass species). Average leaf height of individual plants was measured in July by measuring the average height of current year's leaves in their natural position to the nearest centimeter from the center of the plant crown (USDA-USDI, 1996). Basal diameter of individual plants was measured in July by measuring the distance across the plant crown at the widest point to the nearest 0.5 centimeters. Inflorescences from each of the three target grass species were collected and the percentage of filled and empty florets was determined in the laboratory (Patton et al., 1988). In July, canopy cover of vegetation was estimated using the Daubenmire method (USDA-USDI, 1996) on each of the three, 60-meter transects per site. At three locations, at 20-meter intervals along each transect, percent canopy cover of species present was estimated inside a 20x50-centimeter Daubenmire frame (n=9 per site).

Statistical Analysis

The experimental design for this study is completely randomized. Sites are the experimental units (n=8). Analysis of variance (ANOVA) procedures in SAS (SAS Inst. Inc., Cart, NC) was used to test for differences between the effects of long-term, heavy grazing and long-term, light grazing on bluebunch wheatgrass, Idaho fescue, and rough fescue. Significant differences are declared at $P \leq 0.10$.

Results and Discussion

Preliminary results are presented for July 2004. Long-term heavy grazing did not adversely affect the basal diameter of bluebunch wheatgrass or Idaho fescue ($P = 0.51$ and $P = 0.24$, respectively) (Table 1). These preliminary results contrast the results presented by Pond (1960), Mueggler (1975), and Clark et al. (1998), which suggest that heavy spring grazing will reduce basal area of these two species. Basal diameter of rough fescue was smaller ($P = 0.02$) on long-term heavily grazed sites compared to long-term lightly grazed sites (Table 1). Johnston et al. (1971) demonstrated that long-term, light, season-long grazing reduced basal area of rough fescue after 16 years compared to ungrazed rough fescue plants. Similarly, Willms et al. (1985) concluded that increases in stocking rates from light grazing to moderate or heavy grazing on rough fescue grasslands with a long grazing history decreased rough fescue basal area compared to plants measured inside exclosures that received no grazing for 12 years.

Average leaf height of Idaho fescue ($P < 0.01$) and rough fescue ($P = 0.03$) were adversely affected by long-term heavy grazing (Table 1). Pond (1960) also concluded that leaf lengths were larger on Idaho fescue that was ungrazed, or lightly or moderately grazed compared to heavily grazed Idaho fescue plants. Contrary to the findings of Vogel and Van Dyne (1966), Mueggler (1975), Clark et al. (1998), and Brewer (2002), preliminary results report the average leaf height of bluebunch wheatgrass did not differ between treatments ($P = 0.34$) as a result of long-term heavy grazing.

Long-term heavy grazing adversely affected the percentage of filled florets of all three species. Percentage of filled florets for bluebunch wheatgrass, Idaho fescue, and rough fescue was 51%, 70%, and 85% less, respectively, on the long-term heavily grazed sites than on the long-term lightly grazed sites (Table 2). Mueggler (1975) decreased plant vigor by clipping

bluebunch wheatgrass plants in April, which reduced the maximum length of flower stalks. Clipping Idaho fescue plants exposed to full and partial competition at the flower development and seed ripe stages eliminated flower stalk production (Mueggler 1975).

Percent canopy cover of rough fescue on long-term heavily grazed sites was 97% less ($P = 0.03$), compared to long-term lightly grazed sites (Table 2). Percent canopy cover of bluebunch wheatgrass and Idaho fescue did not differ between long-term heavily grazed and long-term lightly grazed sites ($P = 0.37$ and $P = 0.48$, respectively).

Implications

Our preliminary results suggest that long-term, repeated use of foothill rangeland in winter-spring has the potential to adversely affect the forage resources present on these sites. Because foothill rangeland is critical seasonal habitat for wildlife and livestock in Montana, a better understanding of the potentially adverse effects is necessary for managing a sustainable foothill rangeland plant community.

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Table 1: Basal diameter and average leaf height of bluebunch wheatgrass, Idaho fescue and rough fescue in July 2004 on long-term, heavily and lightly grazed sites.

	Basal Diameter (cm)		Average Leaf Height (cm)	
Grass Species	Heavy	Light	Heavy	Light
Bluebunch wheatgrass	7.9a	7.1a	17.3a	16.7a
Idaho fescue	8.3a	9.3a	4.8a	6.7b
Rough fescue	6.9a	26.2b	11.8a	16.6b

Means in the same row, within the same vegetative parameter, followed by the same letter do not differ ($P \leq 0.10$)

Table 2: Percentage of filled florets and percent canopy cover of bluebunch wheatgrass, Idaho fescue and rough fescue in July 2004 on long-term, heavily and lightly grazed sites.

	Filled Florets (%)		Canopy cover (%)	
Grass Species	Heavy	Light	Heavy	Light
Bluebunch wheatgrass	37.4a	77.6b	7.7a	3.6a
Idaho fescue	23.4a	78.5b	1.5a	2.6a
Rough fescue	8.7a	57.3b	0.4a	15.8b

Means in the same row, within the same vegetative parameter, followed by the same letter do not differ ($P \leq 0.10$)