Effects of dormant season grazing on herbage production and plant growth

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In May through November, seasonal forage availability declined considerably between the time of peak production and the beginning of the winter grazing season. Considering these losses, stockpiling of forage throughout the growing season for use in late fall or winter resulted in lost herbage production potential. Furthermore, AUMs/ha for winter-only grazing areas were severely reduced relative to season-long grazing use. Incorporating a brief early-summer grazing period on winter pastures could increase land use and reduce economic loses by increasing stocking rates (AUMS/ha).

From an ecological and land-use efficiency perspective, a dormant season grazing system that incorporates moderate early summer use combined with winter stocking rates utilizing 50% of the standing plant biomass is a preferable, and moreover, a beneficial management alternative. This method yielded greater herbage production than other treatments and resulted in greater needle-and thread and thread-leaf sedge leaf heights than the season-long or DS 30 grazing treatments. This method, however, reduced western wheatgrass leaf heights late in the growing season. If dormant-season defoliation has little effect on these grasses, limiting litter accumulation on stockpiled pastures by ensuring at least moderate utilization (50%) of standing plant biomass may positively affect subsequent herbage production. Furthermore, season-long grazing may have a more negative effect on needle-and-thread and thread-leaf sedge growth than winter use at higher (50%) utilization levels. The direct effects of dormant-season grazing on individual plant species versus conventional season-long use, at present, are undistinguished in relevant literature. This research indicates that the four species examined were generally unaffected by dormant season grazing.

Preliminary data regarding dormant-season grazing of native rangeland in the western Dakotas indicated that brief early summer use of dormant-season pastures and winter stocking rates intended to achieve 50% utilization of standing aboveground biomass is the preferred management option relative to grazing treatments of 30 or 50% winter utilization with no summer use. This method was beneficial from both a land-use and ecological standpoint. Subsequent data are necessary; however, to evaluate the long-term ecological and economic sustainability of this management.

Introduction

Many North and South Dakota livestock producers practice winter or dormant-season grazing in an effort to lower feed costs. Dormant season grazing, while not an exclusive winter-grazing period, is defined as grazing during that time period between plant quiescence in late fall and green up in early spring. Although adequate information exists regarding nutritional management of winter grazing cattle, little is known about the ecological effects of these practices "on range or pasture land in the upper Midwest and northern Great Plains. Furthermore, research-emphasizing inferences for specific winter-grazing management is lacking. Various aspects of dormant season grazing have been examined in a variety of ecosystem types, and conventional wisdom dictates that defoliation during winter months while plants are dormant has little to no effect on plant vigor (Riesterer et al. 2000).

Winter grazing is an appealing management option to many ranchers. Producing hay or purchasing winter feeds is labor and capital intensive, while winter grazing offers the potential for flexibility in making management decisions. Furthermore, this practice allows for more efficient utilization of range resources. The objectives of this study were to determine the impacts of winter grazing on herbage production, growth rate of dominant grass species (short-term), and changes in plant species composition using various levels and combinations of winter and summer use (long-term subsequent research).

Study area

This study was located in Adams County, North Dakota and Perkins County, South Dakota. The Adams County study site was approximately 153 acres and located 5 miles southwest of Hettinger, North Dakota (El. 817m) on sections 16, T129N, R96W and 25, R97W, T129N. The Perkins County study site was approximately 143 acres and located 16 miles south of Lodgepole, South

Dakota (El. 803m) on sections 13, T19N, R12E, and 18, T19N, R13E.

Climate

Growing-season precipitation was 11.3 inches in 2000, which was 4.7 inches below the annual average, with all months except May and July below average. The 2001 growing season was characterized as a dry spring and wet July, with average precipitation 1.6 inches below the 30-year average. The fall and winter of 2000-01 received above average precipitation; however, the fall and winter of 2001-02 received considerably less precipitation, particularly in November and December.

Monthly average temperatures were generally above the 30-year average in 2000, with the exception of June, November, and December. Warmer-than-average temperatures characterized the winter of 2001-2002, as November and December 2001 and January and February 2002 were substantially warmer than the 30-year average. Spring and summer temperatures were near average in both years.

Vegetation

The study areas were found in the northern mixed-grass prairie and described as the Missouri Slope Vegetation Zone (USDA-SCS 1984). The plant communities were described as a wheatgrass-needlegrass vegetation type (Barker and Whitman 1994). Dominant midgrass species were western wheatgrass (*Pascopyrum smithii*) and needle-and-thread (*Stipa comata*), and dominant short graminoid species were thread-leaf sedge (*Carex filifolia*) and blue grama (*Bouteloua gracilis*) (Barker and Whitman 1994, Shiflet 1994). Plant names were referenced from McGregor et al. (1986) and USDA-USFS (2002).

Methods and design

Treatments

A total of two study areas (blocks) were selected in North and South Dakota based on similar range condition and composition of native plant species. Each study area was blocked and divided into four paddocks with one of four treatments 1) season-long summer grazing at 50% utilization (SL), 2) 25% summer use for 2 weeks in early and mid June and 50% dormant season utilization [flash grazing (Hart 2001)] (FL), 3) 30% dormant season utilization (DS 30), and 4) 50% dormant season utilization (DS 50) assigned randomly to

a paddock. The SL treatment was an 80-acre paddock and the dormant season use treatments each 23-acre paddocks in North Dakota. The DS 30 and SL treatment paddocks were each 30 acres in size, the FL treatment 37 acres, and the DS 50 treatment 48 acres at the South Dakota site.

Stocking rates

Stocking rates for the summer use treatments were determined using the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Technical Guidelines (1984) for the Missouri Slope Vegetation Zone. Summer use paddocks were surveyed for ecological site composition using the USDA SCS soil surveys for Adams County, North Dakota (Ulmer 1987) and Perkins County, South Dakota (Wiesner 1980). The stocking rate for the SL was calculated for a 4-month grazing period beginning June 1 and ending October 1. The North Dakota site was stocked at 1.9 ac/AUM with ten 1150 lb cows and their calves. The South Dakota site was stocked at 1.6 ac/AUM with seven 620 lb spayed heifers.

Summer grazing use of the flash grazing treatments (FL) was targeted for 25% utilization. The FL treatment carrying capacity was calculated by stocking for 50% use of the total available AUMs in June while considering that 50% of the total annual production occurred by mid June, thus achieving a 25% utilization of total annual biomass. The North and South Dakota sites were stocked with ten and sixteen 1150 lb cows and their calves or 4.4 ac/AUM and 4.1 ac/AUM; respectively, for two weeks.

Stocking rates for the winter grazing treatments were calculated after determining dry-standing plant biomass on Nov. 15, 2000. Ten randomly placed $0.25m^2$ frames were clipped for each ecological site (n=2) existing within a given replicate (n=20). The USDA SCS (Wiesner 1980, Ulmer 1987) soil survey maps and technical guides were used to estimate ecological site composition within each paddock to calculate total standing biomass. Final stocking rates for each treatment were computed by calculating 25% grazing-use efficiency with 30 or 50% disappearance, depending on treatment (Laycock et al. 1972, Pearson 1975) and a dry matter intake for an 1150 lb non-lactating cow using the National Research Council (1996) for beef cattle.

The North Dakota DS 50 and FL grazing treatment paddocks were each stocked with four 1,150 lb cows, or 3.1 ac/AUM; and the DS 30 treatment paddock was stocked with three 1,150 lb cows, or 4.1 ac/AUM. The South Dakota DS 50 treatment was stocked with 11 cows or 2.5 ac/AUM, the FL treatment stocked with 8 cows or 2.4 ac/AUM, and the DS 30 treatment stocked with 6 cows, or 2.5 ac/AUM. All South Dakota paddocks were stocked

with cows weighing an average of 1150 lb.

Winter grazing cattle were allowed ad libitum access to white salt and trace minerals and were supplemented with 3 lb/day on an as-fed basis of 30% crude protein all-natural cake. During the winter grazing period of 2000-2001, cattle grazed as snow cover allowed for 53 days beginning November 15 on both the North and South Dakota study sites. During the dormant-season grazing period of 2001-2002, cattle grazed on the North Dakota site for 53 days beginning November 15. The cattle on the South Dakota site grazed for 35 days and animal numbers were increased to meet set stocking rate guidelines, as turn out was delayed until January 12 due to mechanical failures affecting the watering system.

Table 1 shows ac/AUM comparisons of treatments and percent change in carrying capacities compared to the SL treatment (control). From a perspective of utilized AUMs, the dormant season only grazing treatments reduced carrying capacities relative to season-long use; however, the FL treatment numerically increased carrying capacities slightly relative to season-long use (3.2 to 5.3%).

Table 1. Stocking rate comparisons among grazing treatments in North and South Dakota.

	SL	FL	DS 30	DS 50
N.D.				
Ac/AUM	1.98	1.93	3.95	2.97
% Difference from SL	0.0	+5.3	-115.8	-61.8
S.D.				
Ac/AUM	1.48	1.44	2.47	2.22
% Difference from SL	0.0	+3.2	-61.9	-38.1

SL = season-long summer grazing, FL = 25% summer use for 2 weeks in early and mid June and 50% dormant season utilization, DS 30 = 30% dormant season utilization, DS 50 = 50% dormant season utilization

Herbage production

Herbage production of graminoids and forbs for each treatment was determined using a paired-plot clipping technique (Milner and Hughs 1968). Twenty cages were distributed in each pasture during the treatment period. One plot within and outside each cage was clipped using a 0.25m^2 quadrat. Clipped herbage

was separated into grasses and forbs, dry matter weights were recorded, and lb/ac plant biomass and standard error of the mean were calculated for each ecological site.

In the summer through winter periods of 2000-2001, five cages were systematically placed on each of the two shallow ecological sites and two loamy ecological sites before grazing began on each treatment (n=20), with the exception of the South Dakota 30% treatment where only five cages were placed on a shallow ecological site since this site made up only 10% of the study area on the treatment. During the winter of 2001 on the North Dakota sites, five plots were clipped for both the loamy and shallow ecological sites on the 30% treatment, five shallow plots were clipped on the 50% treatment, and no plots were clipped on the FL treatment due to ice and snow cover. On the summer treatments of 2001, the 20 sites within each pasture selected for the tiller study were used to determine production. In 2001-2002, all plots from the winter grazing treatments were clipped since ice and snow cover did not prevent clipping as it had in 2000-2001.

Leaf Heights

A study to examine leaf heights throughout the growing season was initiated in May of 2001, to determine the growth patterns of western wheatgrass, needle-and-thread, thread-leaf sedge, and blue grama within each treatment. The species were selected as they were described as the predominant forage base of the study region (Barker and Whitman 1994, Shiflet 1994). Furthermore, these species were described as commonly existing together in various successional stages of rangeland in western North Dakota (Hansen and Hoffman 1988). Goetz (1963) monitored the growth and development of native range plants in western North Dakota and used leaf height as a main indicator of plant growth. Furthermore, researchers have correlated leaf and plant height with plant vigor, forage yield, competition, range condition and trend, and defoliation levels (Short and Woolfolk 1956, Buwai and Trlica 1977).

Twenty locations indicative of the dominant forage base were selected randomly within each treatment in May 2001. On each location, a 0.25 m^2 quadrat was selected containing at least 10 western wheatgrass tillers, five needle-and-thread tillers, 10 thread-leaf sedge tillers, and 10 blue grama tillers. Cool-season tillers were marked with uniquely colored rings upon the selection of each site in mid-May and each tiller was measured monthly until senescence was observed for each species. Western wheatgrass and needle-and-thread tillers were measured mid-month for leaf height (height of tallest leaf) from May to August. Thread-leaf sedge was measured mid-month for leaf height from May to July. Blue grama was the only warm-season grass investigated for growth; thus, leaf heights were measured mid-month during its growth period

as described by Goetz (1963), from June to September.

Statistics

A general linear model (GLM) was used to test for between-subject effects for treatment-by-date interactions of leaf heights for each species and herbage production. When interactions were detected (P#0.05), treatments by date comparisons were made using a GLM model to determine differences between treatments and date. When interactions were not detected, data from all periods and replicates were combined and a GLM model was used to determine differences among treatments (P#0.05). Mean separations were performed at P#0.05 using Tukey's Honesty Significant Difference (HSD) procedure (Steele and Torrie 1980, SPSS 1990).

Results and discussions

Herbage production

No differences in herbage production were found between locations (P=0.296, F=1.097) in 2000. Following one year of treatment, peak primary production on the winter-only treatments did not differ (P>0.05) from the SL control treatment (Figure 1). Furthermore, herbage production was higher (P#0.01) on FL than SL, DS 30, and DS 50 after one year of treatment. No differences or positive effects of moderate dormant season grazing treatments, similar to data reported by Coughenour (1991) who found increased nitrogen in live and dead grasses and fringed sagebrush on winter grazed areas, were found. Likewise, Schacht et al. (1998) observed that mowing dormant range of switchgrass, little bluestem, and big bluestem resulted in a higher yield of annual growth than a non-mowed control. Engle et al. (1998) also reported that grazing strategies emphasizing defoliation during the dormant season that decrease probability of multiple defoliations during the growing season are less detrimental than those that increase the probability of multiple defoliations, such as the FL treatment in this study. Relevant research by Auen and Owensby (1988), Coughenour (1991), Engle et al. (1998), Schacht et al. (1998) and Reisterer et al. (2000) indicate dormant-season harvesting of grasses has little or no negative effect on subsequent herbage production.

Figure 1. Peak herbage production on the summer grazed season long (SL), June flash + 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001. Treatments with the same

letter are not significantly different (P>0.05).
(Click here for a 24KB black and white graph.)

Leaf Heights

No differences (P<0.05) in western wheatgrass leaf heights were detected between treatments for the months of May and June 2002. In July, western wheatgrass leaf heights in the DS 30 treatment were shorter (P<0.05) than the SL treatment and in August both the FL and DS 30 treatment leaf heights were shorter (P<0.05) than the SL treatment (Figure 2). Negative effects from grazing treatment on late growing season plant production were also observed by Trent et al. (1988). Fall grazed winter wheat plants relied more heavily on photosynthesis later in the growing season than did the non-grazed wheat plants as they were unable to draw from carbohydrate reserves during grain filling. Similarly, Buwai and Trlica (1977) found heavy quiescent defoliation of western wheatgrass reduced TNC relative to a non-defoliated control. Furthermore, moderate and heavy dormant defoliation of western wheatgrass reduced both herbage yield and plant height when compared to the control.

Figure 2. Western wheatgrass leaf heights on the summer grazed season long (SL), June flash + 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001. Treatments with the same letter within each month are not significantly different (P>0.05).
(Click here for a 38KB black and white graph.)

Light winter use (DS 30) resulted in shorter leaf heights than heavy winter use for needle-and-thread, thread-leaf sedge, and blue grama. Light use also resulted in lower needle-and-thread and blue grama leaf heights than SL. These data suggest increased utilization during the dormant period results in increased herbage yield the following year. Treatments by date interactions were not detected (P<0.05) for needle-and-thread, thread-leaf sedge, and blue grama; thus, monthly leaf height data were combined.

Needle-and-thread leaf heights throughout the growing season did not differ between the SL, FL, and DS 50 treatments (P< 0.01); however, the DS 30 treatment had lower leaf heights (P<0.05) than the SL treatment (Figure 3). Thread-leaf sedge leaf height was also greater in the FL and DS 50 treatments (P<0.01) than the DS 30 and SL treatments. The DS 30 and SL treatments did not differ in leaf height (P<0.05) throughout the growing season (Figure 3). Blue grama leaf heights did not differ (P<0.05) between the SL, FL, and 50% treatments; however, the SL and FL treatments were higher (P<0.01) than the

DS 30 treatment (Figure 3).

Figure 3. Needle-and-thread, thread-leaf sedge, and blue grama leaf heights on the summer grazed season long (SL), June flash + 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001. Treatments with the same letter within each grass species (a,b,c, for needle-and-thread, k,l for thread-leaf sedge, and x,y for blue grama) are not significantly different (P>0.05). (Click here for a 23KB black and white graph.)

These findings are consistent with the peak herbage production observations and studies by Coughenour (1991) and Manley et al. (1995) who reported positive effects on herbage production with increased levels of herbage removal during the dormant season. If dormant-season defoliation is not detrimental to needle-and-thread, blue grama, and thread-leaf sedge, removal of standing-dead plant material and the corresponding reduction in litter on the soil surface may be important to subsequent herbage production and plant growth. Removal of standing dead plant material has been noted to elevate soil temperatures; thus, accelerating decomposition and mineralization in the spring. Furthermore, nutrient turnover rates are accelerated under grazed systems by returning mineral nitrogen to the soil in a readily decomposable form, thereby bypassing slower plant litter decomposition pathways (Coughenour 1991).

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