EFFECTS OF DORMANT SEASON GRAZING ON HERBAGE PRODUCTION AND PLANT GROWTH

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Impact Statement
Preliminary data indicated that brief early summer use of dormant-season pastures and winter stocking rates intended to achieve 50% utilization of standing aboveground biomass or 50% winter utilization of standing aboveground biomass has similar or positive impacts on forage production and plant growth than seasonlong grazing or 30% winter utilization with no summer use.

Introduction
Winter, or dormant-season grazing, is practiced by many North and South Dakota livestock producers in an effort to lower winter 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).

Vallentine (2001) stated that determining when to harvest standing forage is dependent on plant factors, physical site factors, animal factors, and economic and management factors. Determining the effectiveness and practicality of dormant-season grazing requires assessing management practices to address these four points. Research is abundant regarding the effects of grazing and clipping on rangeland condition and productivity, animal production, and economics during the growing season, yet insufficient information exists regarding the effects of such practices during the dormant season. Furthermore, with the implementation of new grazing management techniques that include season-of-use changes, differences in economic return, plant growth and vigor, and subsequent plant-species composition can be expected.

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 a 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 62 ha and located 8 km southwest of Hettinger, North Dakota (El. 817m) on sections 16, T129N, R96W and 25, R97W, T129N. The Perkins County study site was approximately 58 ha and located 25 km south of Lodgepole, South Dakota (El. 803m) on sections 13, T19N, R12E, and 18, T19N, R13E.

Climate

Western North and South Dakota are characterized by a continental, cool temperate, semi-arid climate with warm summers and cold winters. Average annual precipitation is about 41 cm/yr near Hettinger, North Dakota and Lodgepole, South Dakota (Owenby and Enzell 1992). Approximately 70% of the precipitation at both locations occurs during the growing season occurring from April through early October. The study locations receive 120-130 frost-free d/yr (Omodt et al. 1968) with the warmest month, July, averaging 22º Celsius. January is the coldest month with an average temperature of –8º Celsius (Owensby and Ezell 1992).

Growing-season precipitation was 28.6 cm in 2000, which was 7.6 cm below the annual average, with all months except May and July below average during the growing season . The 2001 growing season was characterized as a dry spring and wet July, with average precipitation 4.0 cm 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. In 2002, growing-season precipitation was 13.74 cm, which was 20.42 cm below the annual average. All growing season months were below average. Less-than-average precipitation was received in November and December of 2002. Growing-season precipitation received in 2003 was 6.68 cm below the 30-year average, with only the months of May and September receiving above average precipitation during the growing season. During the 2004 growing season, precipitation was 11.6 cm below the 30-year average. Only the months of July amd October were above average precipitation.

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. The winter of 2002-2003 also had warmer-than-average temperatures compared to the 30-year average.

Spring and summer temperatures were near average for all four years. The winter of 2003-2004, and the 2004 growing season were characterized by warmer than average temperatures.

Vegetation

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

Uplands of the study areas were represented by shallow ecological sites. The soils were moderately coarse to moderately fine textured with restricting layers of shales and sandstone occurring at depths of 25 to 50 cm below the soil surface. This site is comprised of upland sedges (*Carex spp.*), little bluestem, blue grama, prairie sandreed (*Calamovilfa longifolia* (*Hook.*) Scribn.), western wheatgrass, prairie junegrass, fringed sagewort, and numerous upland forb species. Average total primary production on shallow ecological sites in the Dakotas varies from 1,350 to 2,000 kg/ha (Sedivec et al. 1991).

Midland sites on the North and South Dakota study areas were comprised of a loamy ecological site with well-drained, moderately deep and medium to fine textured soils. Plant communites were comprised of western wheatgrass, needle-and-thread, blue grama, Kentucky bluegrass (*Poa pratensis* L.), prairie junegrass, cheatgrass (*Bromus tectorum* L.), upland sedges (*Carex* spp.), green needlegrass (*Stipa viridula* Trin.) and numerous forb species. Average total primary production on these sites range from 1,700 to 3,150 kg/ha (Sedivec et al. 1991).

Materials and Methods

Treatments: Two study areas (blocks) were selected in North and South Dakota based on similar range condition and native plant species composition. Each study area was blocked and divided into four paddocks with one of four treatments 1) 50% summer-utilization (season-long control; **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 within block. The SL treatment was a 32 ha paddock and the dormant-season-use treatments were each 9 ha paddocks in North Dakota. The South Dakota DS 30 and SL treatment paddocks each 12 ha; the FL treatment was 15 ha; and the DS 50 treatment was 19 ha.

Stocking Rates: Stocking rates for the summer-use treatments were determined using the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Technical Guide (2001) 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 season-long grazing treatment was calculated for a 4-month grazing period beginning June 1 and ending October 1. The North Dakota site was stocked at 0.76 ha/AUM with ten 544 kg cows and their calves. The South Dakota site was stocked at 0.63 ha/AUM with seven 280 kg spayed heifers (Table 3). Summer use of the flash grazing paddocks was targeted for 25% utilization. The summer-use FL treatment grazing carrying capacities were 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 544 kg cows and calves or 1.78 ha/AUM and 1.69 ha/AUM, respectively, for two weeks.

Stocking rates for the winter grazing treatments were calculated after determining dry-standing plant biomass on 15 Nov. 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 50% disappearance (Laycock et al. 1972, Pearson 1975) and a dry matter intake for a 1150 lb non-lactating cow using the Beef National Research Council (1996) for beef cattle.

The North Dakota DS 50 and FL grazing treatments were each stocked with four 544 kg cows, or 1.23 and 1.22 ha/AUM, respectively, and the DS 30 treatment was stocked with three 544 kg cows, or 1.64 ha/AUM. The DS 50 treatment was stocked with 11 cows or 1.02 ha/AUM, the FL treatment stocked with 8 cows or 0.95 ha/AUM, and the DS 30 treatment stocked with 6 cows, or 1.02 ha/AUM at the South Dakota site. All South Dakota treatments 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 3lb/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. Cattle were allowed to graze at both the North Dakota and South Dakota sites for 53 days beginning on November 15 during the 2002-2003 and 2003-2004 winter grazing period.

Table 1 reports ha/AUM comparisons of treatments and percent reduction in carrying capacities compared to the SL treatment (control). From a perspective of utilized AUMs, the dormant season only grazing treatments had 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.				
Ha/AUM	0.8	0.7	1.6	1.2
% Difference from SL	0.0	+5.3	-115.8	-61.8
S.D.				
Ha/AUM	0.6	0.6	1.0	0.9
% 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, DS30 = 30% dormant season utilization, DS50 = 50% dormant season utilization

Herbage Disappearance: The degree of disappearance 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 recorded, and kg/ha plant biomass and standard error of the mean calculated for each ecological site. Percent utilization and standard errors of the mean were calculated for graminoids and forbs combined and graminoids alone.

In the summer through winter periods of 2000-2001, 5 cages were systematically placed on each of the 2 shallow ecological sites and 2 loamy ecological sites before grazing began on each treatment (n=20), with the exception of the South Dakota 30% treatment where only 5 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, 5 plots were clipped for both the loamy and shallow ecological sites on the 30% treatment, 5 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 utilization. In 2001-2002, 2002-2003, and 2003-2004 all plots from the winter grazing treatments were clipped since ice and snow cover did not prevent clipping as it had in 2000-2001.

In May 2004, 30 cages were distributed evenly across the entire pasture, regardless of ecological differences. This created a more representative sampling of the pastures.

Leaf Heights: A study examining 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 are 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, 5 needle-and-thread tillers, 10 thread-leaf sedge tillers, and10 blue grama tillers. Cool-season tillers were marked with uniquely-colored rings upon the selection of each site in mid May and each tiller measured monthly until senescence was observed for each species. Western wheatgrass and needle-and-thread tillers were measured mid monthly for leaf height (height of tallest leaf) from May to August. Thread-leaf sedge was measured mid monthly for leaf height from May to July. Blue grama was the only warm-season grass investigated for growth, thus leaf heights were measured mid monthly during its growth period as described by Goetz (1964), from June to September. Needle-and-thread and thread-leaf sedge were not measured in 2002 and 2003 to improve random distribution of the plots throughout the four treatments.

Thirty locations were selected in May 2004 within each treatment. On each location, a 0.25 m^2 quadrat was selected containing 10 western wheatgrass tillers (cool season) and 10 blue grama tillers (warm season). Tillers were marked with uniquely colored rings and measured monthly until senescence. Western wheatgrass was measured from May until August and blue grama was measured from June until September.

A general linear model (GLM) was used to test for between-subject effects for treatment-by-date interactions of leaf heights for each species. When interactions were detected ($P \leq 0.05$), treatment 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 ($P \leq 0.05$). Mean separations were performed at $P \leq 0.05$ using Tukey's Honesty Significant Difference (HSD) procedure (Steele and Torrie 1980; SPSS 1990).

Results and Discussion

Herbage Production: No differences in herbage production were found between locations ($P=0.30$). Following one year of treatment, peak primary production on the winter-only treatments were not different ($P>0.05$) than the SL control treatment (Figure 1). Furthermore, herbage production was higher ($P \leq 0.01$) on FL than SL, DS 30, or DS 50 in 2001. In 2002, peak primary production on the SL control treatment was lower ($P<0.05$) than FL and DS 50. No differences ($P>0.05$) in peak primary production were found on SL, FL, and DS 30 following the third year of treatment; however peak herbage production was lower ($P<0.05$) on DS 50 compared to the other three treatments (Figure 1). In 2003, peak primary production was lower ($P<0.05$) on DS 50 than SL, FL, or DS

30. In 2004, both SL and FL treatments had lower (P<0.05) peak herbage production than the DS 50 and 30 treatments.

On average, full use dormant-season grazing treatments did not effect herbage production, which corresponds with data reported by Coughenour (1991) who found increased nitrogen in live and dead grasses and fringed sagebrush on winter grazed areas. Increases in various aspects of rangeland productivity under moderate growing-season grazing use versus light or no grazing use were reported by Manley et al. (1995). Comparisons of grazed and ungrazed range in Wyoming revealed elevated levels of C and N in subsurface soil on grazed areas. This phenomenon is attributed to the reduction of litter and standing plant biomass as these sources immobilize a significant amount of N and C. Furthermore, increased animal traffic may enhance physical breakdown of residual plant material and soil incorporation. 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 which grazing strategies emphasizing defoliation during the dormant season that decreased probability of multiple defoliations during the growing season were less detrimental than those that increased 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 had little or no negative effect on subsequent herbage production.

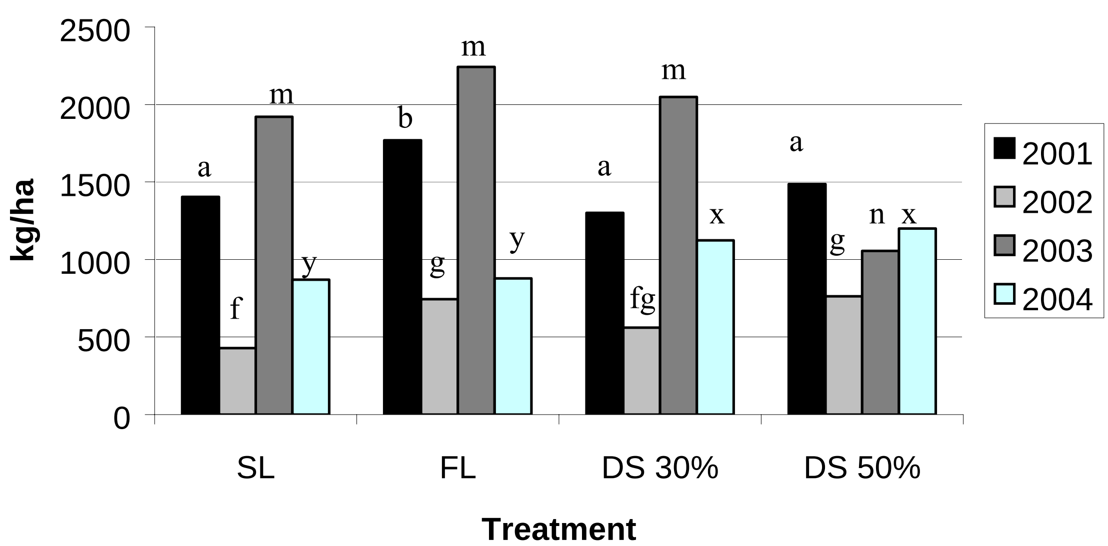

Figure 1. Peak herbage production (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001.
[ab]Treatments with the same letter are not significantly different (P>0.05).
[fg]Treatments with the same letter are not significantly different (P>0.05).
[mn]Treatments with the same letter are not significantly different (P>0.05).
[xy]Treatments with the same letter are not significantly different (P>0.05).

Leaf Heights: No differences (P<0.05) in western wheatgrass leaf heights were detected between treatments for the months of May and June 2001. 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 of grazing treatment on late growing season plant production were also observed by Trent et al. (1988). Fall grazed winter wheat plants relied on photosynthesis later in the growing season than 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.

No difference (P<0.05) in western wheatgrass leaf heights were detected between treatments for the months of June and August in 2002. In May, leaf heights in the SL and DS 30 treatments were shorter (P<0.05) that the FL treatment. The leaf heights in the SL treatment were shorter (P<0.05) than the DS 50 in July (Figure 3). In 2003, no differences (P<0.05) in western wheatgrass leaf heights were detected among any treatment within all months (Figure 4).

In 2004, only July showed no differences (P<0.05) in treatments for western wheatgrass leaf heights. In May, leaf heights in the SL and FL treatments were shorter (P<0.05) than the DS 30 and DS 50 treatments. The leaf heights in the FL treatment were shorter (P<0.05) than the DS 50 in June, and the SL treatment leaf heights shorter (P<0.05) than the DS 50 treatment in June and August (Figure 5).

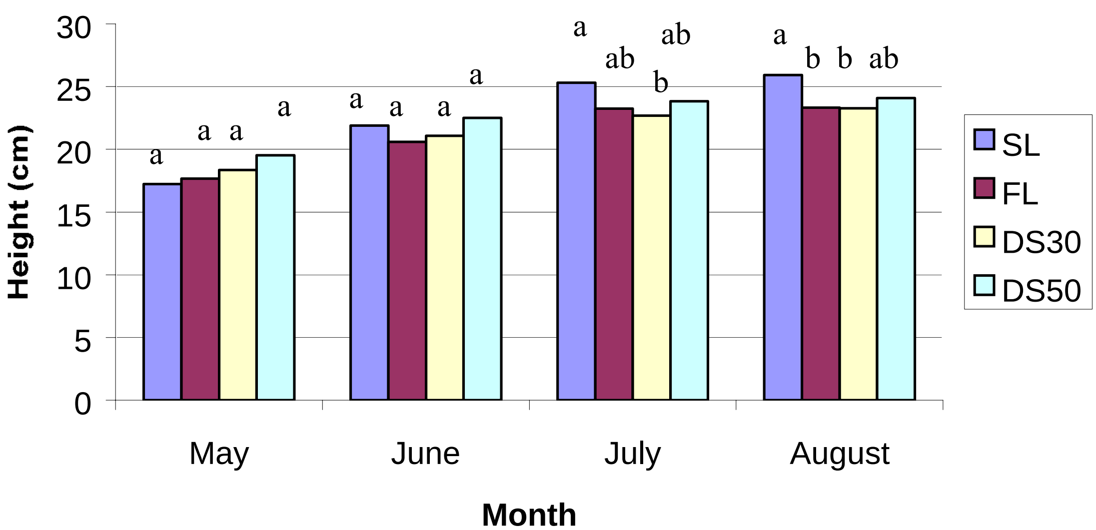

Figure 2. Western wheatgrass leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001.
[ab] Treatments with the same letter are not significantly different within each month (P>0.05).

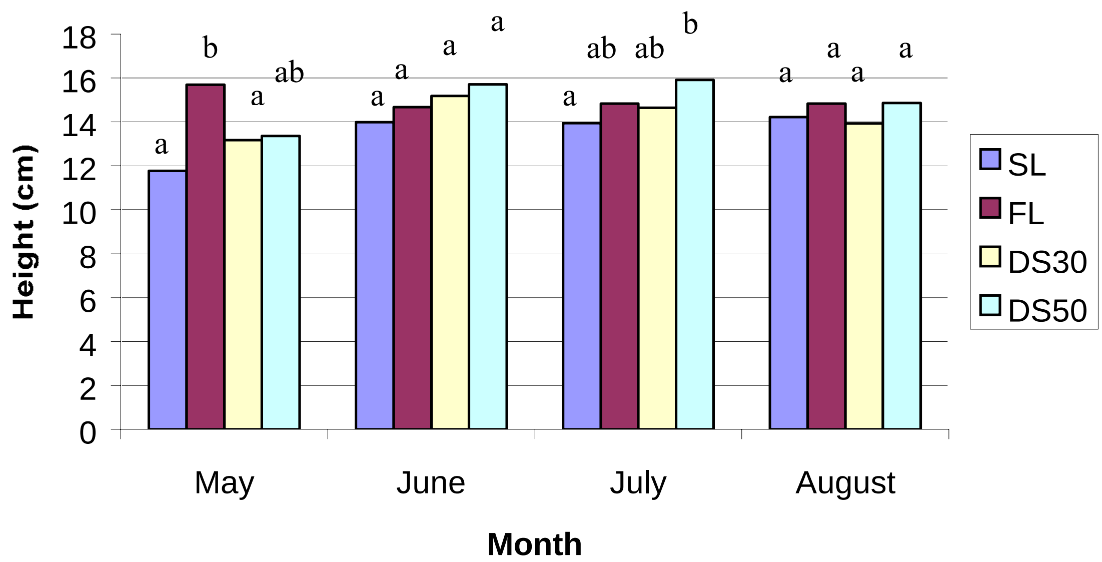

Figure 3. Western wheatgrass leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2002. [ab] Treatments with the same letter are not significantly different within each month (P>0.05).

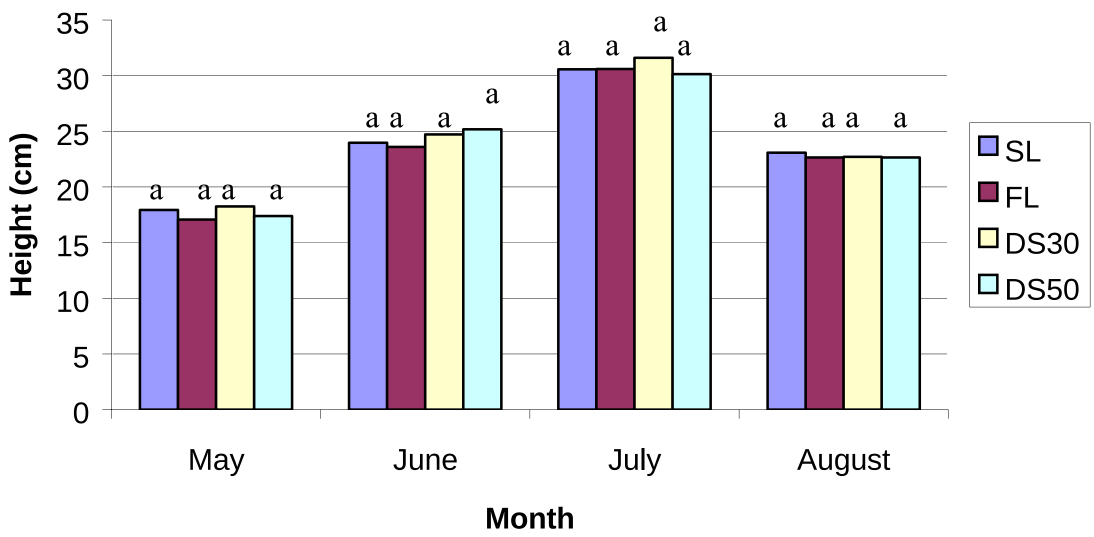

Figure 4. Western wheatgrass leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2003. [ab] Treatments with the same letter are not significantly different within each month (P>0.05).

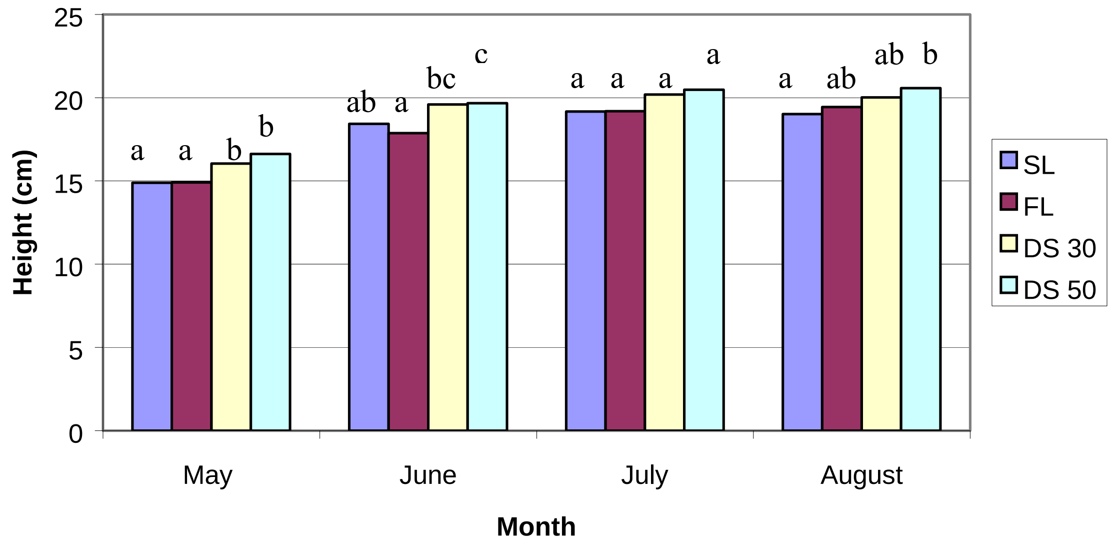

Figure 5. Western wheatgrass leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2004.
[abc] Treatments with the same letter are not significantly different within each month (P>0.05).

Light winter use (DS 30) resulted in shorter leaf heights than heavy winter use for needle-and-thread, thread-leaf sedge, and blue grama in 2001. Light winter use also resulted in lower needle-and-thread and blue grama leaf heights than SL. These data suggest increased utilization during the dormant period result in increased herbage yield the following year. Treatment by date interactions were not detected (P<0.05) for blue grama in 2001, thus monthly leaf height data were combined. However, in 2002 and 2004 there were treatment by date interactions (P<0.05) in July. No treatment by date interaction was detected (P<0.05) in 2003.

Blue grama leaf heights in 2001 were not different (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 6). In July 2002, Blue grama leaf heights were shorter (P<0.05) in the SL treatment than the FL and DS 50 treatments. No differences (P<0.05) in leaf heights were detected in August and September (Figure 7). There were no differences found (P<0.05) in blue grama leaf heights in 2003 (Figure 8). In July and September 2004, the SL treatment blue grama leaf heights were shorter (P<0.05) than the FL, DS 30, and DS 50 treatments. In May, the FL treatment leaf heights were shorter (P<0.05) than the DS 30 and DS 50 treatments, and the SL treatment heights were shorter (P<0.05) than the FL treatment. In August, 2004, the SL treatment was shorter (P<0.05) than the DS 50 treatment (Figure 9).

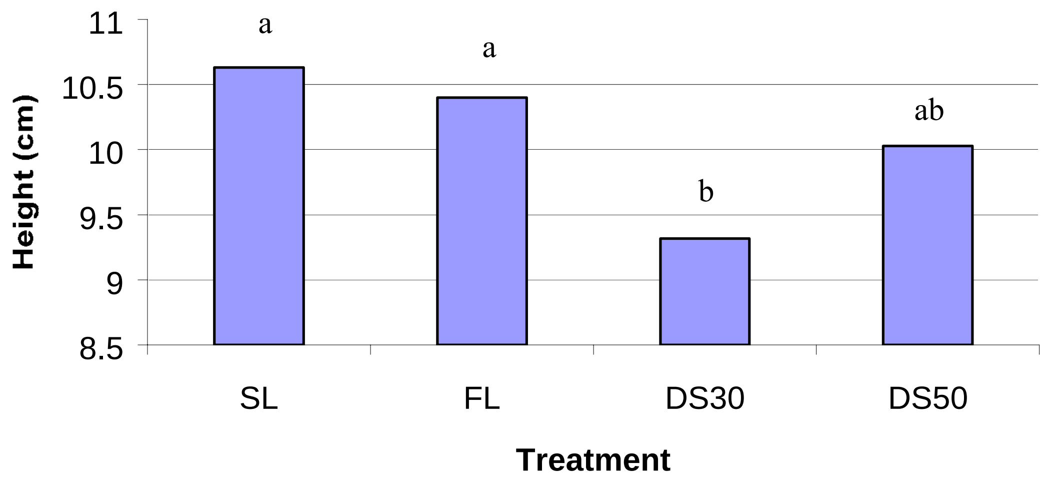

Figure 6. Blue grama leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2001.
[ab] Treatments with the same letter are not significantly different (P>0.05).

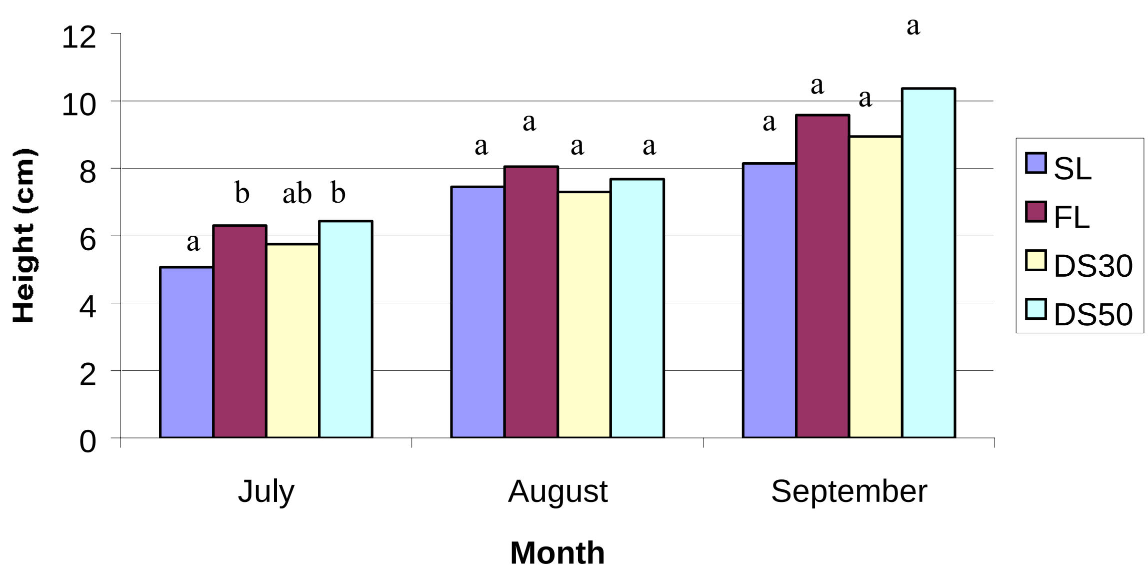

Figure 7. Blue grama leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2002.
[ab] Treatments with the same letter are not significantly different (P>0.05).

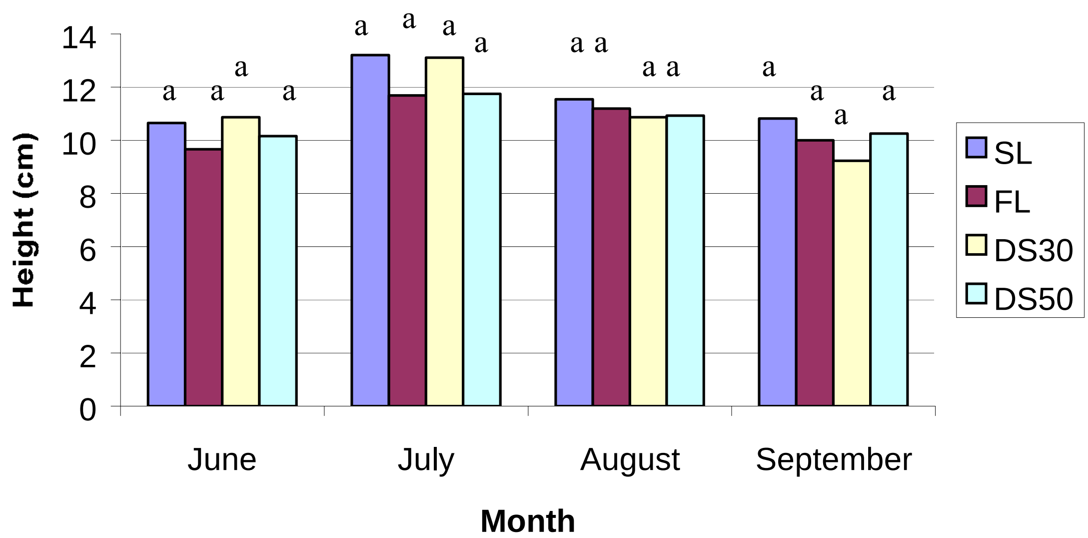

Figure 8. Blue grama leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2003.

[ab] Treatments with the same letter are not significantly different (P>0.05).

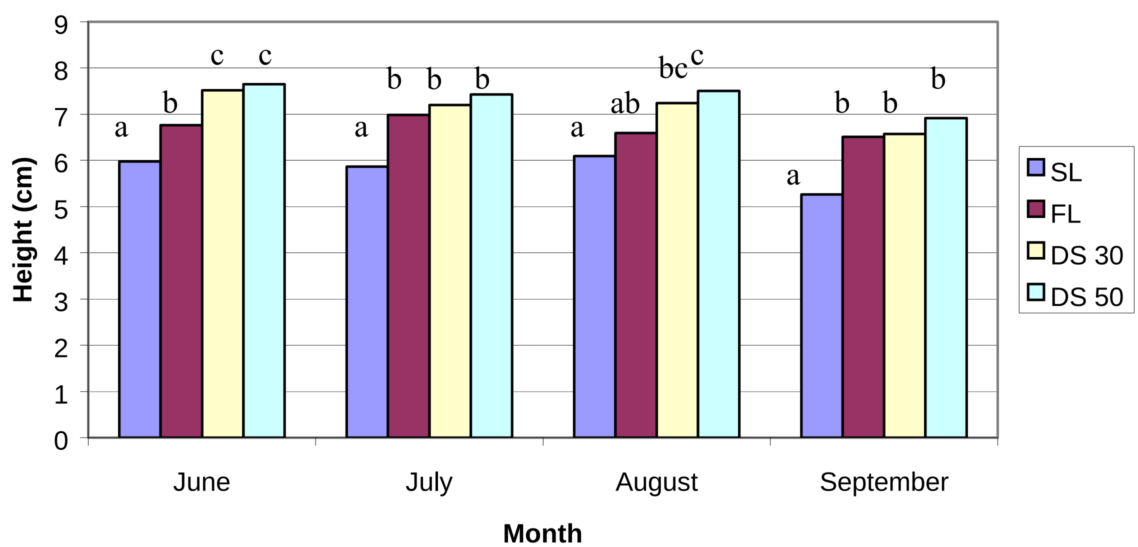

Figure 9. Blue grama leaf height (mean ±S.E.) on the season-long (SL), June flash and 50% dormant-season use (FL), 30% dormant-season use (DS 30), and 50% dormant-season use (DS 50) in 2004.

[abc] Treatments with the same letter are not significantly different (P>0.05).

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 reported 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).

Summary

During the months of May through November in 2000, 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 results 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 can 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 or winter stocking rates utilizing 50 % of the standing biomass alone. These methods 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 reduced western wheatgrass leaf heights late in the growing season in 2001, however, western wheatgrass and blue grama leaf heights were not affected in 2002, 2003 and 2004 compared to summer grazing alone or an increase as seen in the 2004 50 % dormant season grazing alonr treatment. If the conclusion is made that 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, SL grazing may have a more negative affect on needle-and-thread, thread-leaf sedge, western wheatgrass, and blue grama growth than winter use at higher (50%) utilization levels. The direct effects of dormant-season grazing on individual plant species versus conventional SL use, at present, is undistinguished in relevant literature. This research indicates western wheatgrass and blue grama were generally unaffected by dormant-season grazing or benefitted.

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