# Fall cattle grazing to improve deer and elk forage on a rough fescue range

by Jeffery Jon Short

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal and Range Sciences
Montana State University


Abstract:
Cattle grazing is often used to improve wildlife habitat in the western United States. Actual habitat improvement from grazing systems is more often speculated than demonstrated. The objectives of this project were (1) to determine if fall cattle grazing could improve wildlife forage and (2) to determine an optimum level of grazing to improve wildlife forage. The effects of fall grazing were examined on rough fescue (Festuca scabrella) range on the Blackfoot-Clearwater Wildlife Management area in west-central Montana. The hypothesis was that fall cattle grazing would improve the quality of deer (Odocoileus spp.) and elk (Cervus elaphus) forage the following spring and summer. A randomized complete block design with five replications per year for two years was used. Cattle were grazed in enclosures during the fall of 1997 and 1998. Grazing levels were 0% vegetation removal (control), 50% removal, 70% removal, and 90% removal. To evaluate quality of deer and elk forage, measurements were obtained in spring and summer on green grass biomass, green forb biomass, percent green vegetation, plant diversity, and plant species composition. There were no differences among grazing levels for plant species composition, plant diversity, green grass biomass, and green forb biomass variables ($P>0.10$). The 50% and 90% removal treatments resulted in reduced total green biomass production in spring ($P<0.01$). Grazing treatments increased the percentage of green vegetation ($P<0.01$). Fall cattle grazing can be used as a wildlife habitat management tool to reduce standing dead material. The 70% removal treatment was the most effective for removing standing dead material and it did not degrade the range.

# FALL CATTLE GRAZING TO IMPROVE DEER AND ELK FORAGE ON A ROUGH FESCUE RANGE

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APPROVAL

of a thesis submitted by

Jeffrey Jon Short

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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# ABSTRACT

Cattle grazing is often used to improve wildlife habitat in the western United States. Actual habitat improvement from grazing systems is more often speculated than demonstrated. The objectives of this project were (1) to determine if fall cattle grazing could improve wildlife forage and (2) to determine an optimum level of grazing to improve wildlife forage. The effects of fall grazing were examined on rough fescue (*Festuca scabrella*) range on the Blackfoot-Clearwater Wildlife Management area in west-central Montana. The hypothesis was that fall cattle grazing would improve the quality of deer (*Odocoileus spp.*) and elk (*Cervus elaphus*) forage the following spring and summer. A randomized complete block design with five replications per year for two years was used. Cattle were grazed in enclosures during the fall of 1997 and 1998. Grazing levels were 0% vegetation removal (control), 50% removal, 70% removal, and 90% removal. To evaluate quality of deer and elk forage, measurements were obtained in spring and summer on green grass biomass, green forb biomass, percent green vegetation, plant diversity, and plant species composition. There were no differences among grazing levels for plant species composition, plant diversity, green grass biomass, and green forb biomass variables ($P>0.10$). The 50% and 90% removal treatments resulted in reduced total green biomass production in spring ($P<0.01$). Grazing treatments increased the percentage of green vegetation ($P<0.01$). Fall cattle grazing can be used as a wildlife habitat management tool to reduce standing dead material. The 70% removal treatment was the most effective for removing standing dead material and it did not degrade the range.

# CHAPTER 1

## INTRODUCTION

Livestock activities in wildlife habitat have traditionally been considered to be detrimental. This has led to the removal of domestic livestock from many lands managed for wildlife (Jourdonnais and Bedunah 1985). Views on wild ungulate/livestock relations have focused on competition among them. People have often neglected positive aspects of the relationship. This has led to conflicts between livestock and wildlife interest groups. The idea of a strictly competitive relationship between wildlife and livestock has produced unnecessary either/or management decisions.

Potential positive aspects of livestock grazing on wildlife habitat should be addressed. Through coordinated management of both livestock and wildlife on public and private lands, it may be possible to improve wildlife habitat and livestock production. The livestock industry would benefit from an increased usable land base to produce livestock. This can be achieved by opening lands to responsible grazing that were previously set aside exclusively for wildlife. Wild ungulates could benefit from improved forage in currently ungrazed areas and the implementation of grazing systems that will improve wildlife habitat in areas that are now being grazed (Frisina and Morin 1991). Thus, integrated management of rangelands for wildlife and livestock could lead to more efficient utilization of rangeland resources.

Wildlife cause damage to private property across the western United States (Adkins and Irby 1992, Conover et al. 1995). This can reduce forage available for livestock and make it difficult for livestock producers to maintain economic viability. For wildlife managers to sustain public deer (*Odocoileus* spp.) and elk (*Cervus elaphus*) herds in cooperation with private landowners, they must address this problem. Detrimental game use of private lands often occurs adjacent to public wildlife refuges (Alt et al. 1992). Improvement of forage on wildlife refuges could draw deer and elk onto improved areas and away from private lands.

In western states such as Montana, private rangeland is an important source of wildlife habitat. Without these areas of open space, there would not be enough public land to produce the abundance of wildlife present today. In Montana, livestock production is a $1 billion industry (Montana Agrc. Stat. Serv. 1994). Deer and elk hunting in Montana is a $333 million industry (Brooks 1988a, Brooks 1988b), and significant revenue accrues from wildlife tourism. Positive relationships between wildlife and livestock could work for the benefit of both industries and create a link for working together and resolving conflicts.

This study explored a possible positive relationship between cattle grazing and wildlife habitat. The objectives were to determine if fall cattle grazing could improve spring and summer range for deer and elk, and if so, to determine the optimum fall cattle grazing intensity to improve deer and elk forage. With this information, managers will be able to manage land better for multiple use and increase efficiency of land use practices.

The first hypothesis tested in this study is that fall cattle grazing will improve spring, and summer forage for white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and elk. The second hypothesis tested is that there is an optimum fall grazing intensity for improving deer and elk forage.

# CHAPTER 2

## LITERATURE REVIEW

At the turn of the century extreme overuse by domestic livestock across the American West left the majority of rangeland degraded (Jourdonnais and Bedunah 1985). Although this was initially detrimental to wild ungulate populations, deer and elk in the West have benefited from livestock grazing (Anderson and Scherzinger 1975, Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990, Alt et al. 1992, Vavra and Sheehy 1996). It was not until after livestock grazing significantly altered the range and settlers opened up the forests that deer numbers in the West became high (Longhurst et al. 1982).

Previous management decisions to remove domestic livestock from wildlife ranges were made with good intentions but were not based completely on biological evidence (Anderson and Scherzinger 1975, Jourdonnais and Bedunah 1985). These decisions did not take into account the history of large herbivore/plant relationships. Most rangelands evolved with grazing pressure from wild ungulates (Jourdonnais and Bedunah 1985, Heitschmidt 1990, Jourdonnais and Bedunah 1990). Deer and elk evolved to live in a grazed ecosystem.

## Foraging Habits of Cattle, Deer, and Elk

Cattle consume a less diverse diet than deer and elk (Kingery et al. 1996). Cattle need to consume large amounts of forage to maintain their large body size. This constraint does not allow them to select only the most valuable forage. Cattle are also limited by their large bite size, which does not permit them to select forage easily. Cattle are classified as a roughage forager (Hanley 1982). Quantity of forage is more important than quality for cattle.

Wild cervids, such as deer and elk, have more diverse feeding habits than cattle (McMahan 1964, Collins et al. 1978, Kingery et al. 1996). Cervids typically select more nutritious forage than cattle. Elk are considered an intermediate forager that primarily consume roughage but have a more diverse diet selection than cattle (Hanley 1982, Kingery et al. 1996). Deer are considered a concentrate-feeder with diets dominated by high quality forbs and shrubs (Kingery et al. 1996). This coincides with the conceptual relationship between body size and diet selection (Hanley 1982, Hudson 1985, Renecker and Hudson 1992). Large species consume large amounts of less diverse low quality roughage feeds to meet their high absolute requirements. Small species have lower overall requirements, but they have higher requirements per unit of body weight than large animals. Small species must selectively feed on a diverse diet of high quality feeds to meet their high requirements per unit of body weight.

Although they are not identical, the feeding strategies of deer and elk are similar. Deer and elk select forage that is highly nutritious (Hanley 1982, Hudson 1985). In most instances, deer graze more selectively than elk (Kingery et al. 1996). Collins et al. (1978)

found that habitat selection in elk was influenced by grazing values of available forage in the area, or where the animal obtains the best return from foraging.

Research by Kingery et al. (1996) found that interspecific competition between deer, elk, and cattle is not as prevalent as once thought. This is primarily because cattle diets differ from those of deer and elk. Cattle mostly consume graminoids and their use of forbs is low throughout the year (McMahan 1964, Kingery et al.1996).

Deer and elk select green grass during spring (Jourdonnais and Bedunah 1985, Lyon 1985). In summer, deer and elk diets consist largely of forbs (McMahan 1964, Stevens 1966, Collins et al. 1978, Kasworm et al. 1984, Jourdonnais and Bedunah 1985, Lyon 1985, Canon et al. 1987, Kingery et al. 1996). Collins et al. (1978) stated that species diversity is an important aspect of wildlife forage.

The presence of standing dead material in forage has been noted to reduce its attractiveness to ungulates. In a captive animal study Willms and McLean (1978) reported that during spring, mule deer only utilized bunchgrasses that had standing dead material removed before spring growth. Where fall grazing had removed mature stalks deer had easier access to new spring growth (Willms and McLean 1978). Willms and McLean (1978) also found that crude protein concentrations were 2 to 3% higher in regrowth where mature stalks had been removed the previous fall. Unpalatable standing dead material is considered a barrier to grazing in bunchgrasses (Willms and McLean 1978, Willms et al. 1979, Willms et al. 1980, Willms et al. 1981, Ruyle et al. 1987). Provenza and Balph (1990) stated that standing dead material in bunchgrasses is a morphological defense against grazing, similar to thorns.

## Habitat Improvement with Cattle Grazing

During prolonged periods of absence from cattle grazing, approximately 20 years or greater, the condition of deer and elk forage has been noted to decline. Ungrazed areas accumulate dead plant material and stagnant and rank vegetation (Anderson and Scherzinger 1975, Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990). Because deer and elk select areas with highly nutritious plants, ungrazed areas provide poor deer and elk forage (Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990). Several studies state that cattle grazing can improve forage quality for wildlife (Anderson and Scherzinger 1975, Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990, Alt et al. 1992, Vavra and Sheehy 1996).

Recent programs in Montana that opened public lands, which were previously set aside for wildlife, to cattle grazing have benefited wildlife and cattle producers (Frisina and Morin 1991, Alt et al. 1992). Wildlife have benefited from improved forage on public and private lands that are in cooperative grazing programs, and livestock producers have benefited by access to more land for their cattle. A diverse and mosaic range is created with cattle grazing as cattle use areas unevenly (Jourdonnais and Bedunah 1990). Grazing can increase the amount of forbs for wildlife use (Stevens 1966, Willms et al. 1979). Longhurst et al. (1982) stated that of the traditional methods of habitat manipulation such as burning, fertilizing, mowing, and grazing, the most feasible and cost effective way to improve elk forage in the West is through the use of livestock grazing.

Research has been done on using cattle grazing to improve deer and elk winter range (Anderson and Scherzinger 1975, Neal 1982, Urness 1982, Vavra and Sheehy 1996). However, there has been little research on the effects of cattle grazing on spring and summer range. There are crucial times throughout the spring and summer when adequate forage is necessary for survival and reproduction (Julander et al. 1961). Nutritious forage is needed in the spring to restore body reserves lost during winter (Klein 1965). In summer, the demands of lactation in females and the need to accumulate body reserves for the breeding season in males necessitates good nutrition (Klein 1965). Collins et al. (1978) stated that summer wildlife habitat should be considered just as important as winter range.

Areas previously grazed by cattle have received greater use by elk than ungrazed areas in several studies (Stevens 1966, Jourdonnais and Bedunah 1985, Grover and Thompson 1986, Jourdonnais and Bedunah 1990, Frisina and Morin 1991, Alt et al. 1992, Frisina 1992, Vavra and Sheehy 1996). Deer have also been found to select grazed areas over ungrazed areas (Willms et al. 1979). One theory to explain this is that grazed sites are preferred because of reduced standing dead buildup (Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990, Alt et al. 1992). Another is that grazed sites are preferred because of increased forb levels (Stevens 1966).

Increased deer and elk use of fall grazed areas has been observed the following spring (Willms and Mclean 1978, Willms et al. 1979, Willms et al. 1980, Willms et al. 1981, Jourdonnais and Bedunah 1990, Frisina and Morin 1991). Willms et al. (1979) found that mule deer selected fall-grazed areas in the spring and that moderate to heavy fall cattle grazing made spring forage more attractive to deer. This information is currently being used to make management decisions. However, the reasons behind preferred use of grazed areas by wildlife have not been determined.

Rest-rotation grazing complicates deer and elk use of grazed areas. In a rest-rotation system pastures grazed during fall are rested the following spring and summer. This brings up a question. Are deer and elk using previously grazed areas in rest-rotation grazing systems because of improved forage or because of the absence of cattle following the fall rotation? The effects of fall grazing on spring and summer forage for deer and elk have not been explained in detail. No information is available on fall cattle grazing prescriptions to improve forage for wild ungulates.

Cattle grazing in the fall may be very valuable as a means of managing highly productive grasslands such as rough fescue (*Festuca scabrella*) in the northern Rockies. Rough fescue provides valuable forage for livestock and wildlife (Taylor and Lacey 1994) but has been noted to develop large quantities of standing dead material when grazing is absent (Jourdonnais and Bedunah 1985, Jourdonnais and Bedunah 1990). The unnatural accumulation of dead plant material reduces the range's carrying capacity and increases grazing pressure on neighboring areas (Jourdonnais and Bedunah 1985).

Grazing during the growing season can decrease the abundance and productivity of rough fescue (Johnston 1961, Taylor and Lacey 1994, McLean and Wikeem 1985, Willms et al. 1990). By grazing in the fall, when it is dormant, rough fescue is more tolerant of grazing. McLean and Wikeem (1985) found that heavy fall defoliation of rough fescue did not damage plants. Studies in British Columbia and Alberta found that annual yields of rough fescue were not affected after fall defoliation (McLean and Wikeem 1985, Willms et al. 1986). This indicates that high levels of fall cattle grazing may improve deer and elk forage without damaging rough fescue range.

It may be possible to replicate the historic influences large ungulate grazing had on rough fescue. Bison (*Bison bison*) historically wintered on rough fescue grasslands in the foothills regions of southwestern Alberta (Johnson and McDonald 1967, Reeves 1978, Quigg 1978). Although it has been stated that cattle and bison differ in diet selection and grazing behavior (Lauenroth et al. 1994), it may be possible to manage cattle to replicate the impacts of bison. Bison graze areas with very high intensity and move on, while cattle usually use areas with lighter intensity but with greater frequency (Lauenroth et al. 1994). Bison grazing creates a more heterogeneous community on the landscape (Lauenroth et al. 1994). High intensity cattle grazing during fall, when rough fescue is dormant, may replicate the historical effects of bison grazing during winter.

In this study I specifically addressed how various levels of fall cattle grazing would affect spring and summer deer and elk forage on a rough fescue range. Study sites were areas used during spring and summer by deer and/or elk and not during winter. By grazing cattle in the fall, managers are able to utilize the current year's growth for livestock production. This, in turn, would reduce standing dead vegetation and may promote new growth the following spring for use by wildlife. Also, the use of forbs by cattle is lowest during fall allowing more of these plants to be available for wildlife use (Urness 1982).

# CHAPTER 3

# METHODS

## Study Site

### General Description

This study was conducted on the Blackfoot-Clearwater Wildlife Management Area (BCWMA) in west-central Montana. The BCWMA is the largest wildlife management area in Montana, and is located 70 km northeast of Missoula near Clearwater Junction. The Montana Department of Fish, Wildlife, and Parks (MFWP) manages the BCWMA for the benefit of wildlife. Most of the area has been excluded from domestic livestock grazing since 1948 (Baty 1995). Recently, MFWP has become interested in using cattle grazing as a management tool. Permit grazing was started on portions of the BCWMA in 1990. The study site for this project was on the east side of the BCWMA on the old Boyd Ranch portion of the BCWMA.

Located next to the BCWMA is the Bandy Experimental Ranch. This is a working ranch owned by the University of Montana and Montana State University for the purpose of conducting natural resource research. Having access to a state-owned cattle herd next to the wildlife management area creates an ideal situation to do grazing research on an area that has been mostly untouched by livestock in recent years.

Climate

The climate in the study area is typical of mountainous regions in Montana. Air from the Pacific Northwest influences weather patterns. Weather systems usually move west to east. Annual precipitation varies from 30 to 75 cm with a mean of 45 cm (Steele 1981). During winter, snow accumulations on summer ranges commonly exceed 100 cm (Baty 1995). Summers are warm and dry; over 66% of precipitation falls in a period from December to June (Steele 1981). Monthly mean temperatures range from –8.4° C in January to 16.8° C in July (Steele 1981).

Weather was variable over the two years of the study. Total monthly precipitation (Fig. 1) and average daily temperatures (Fig. 2) were noticeably different between the two years of study. The second year had a warmer, wetter winter and a cooler, drier spring than year one. The cool, dry spring made year two a less productive year for vegetation growth.

Figure 1. Total monthly precipitation at Ovando, Montana.

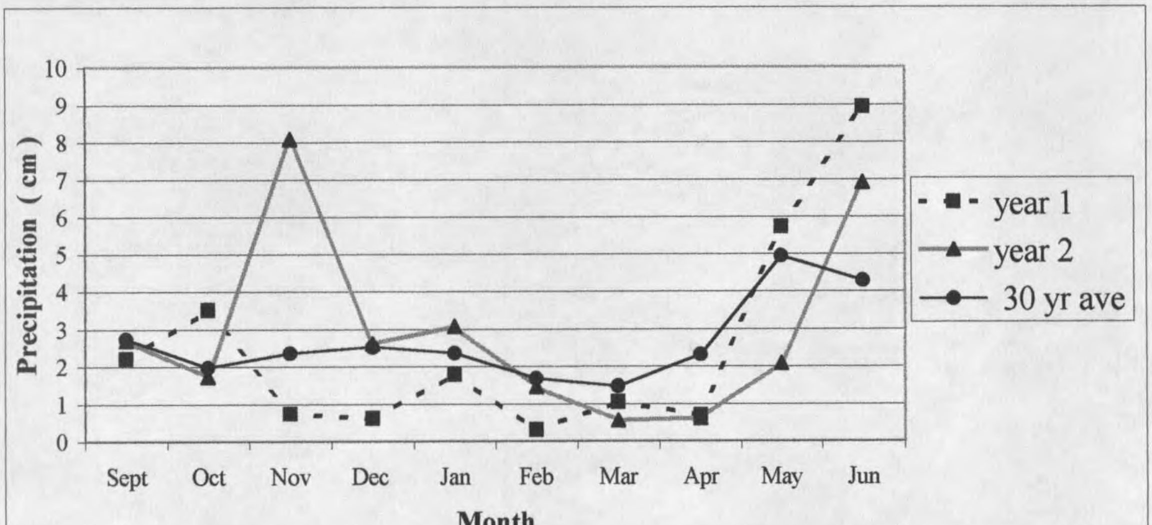
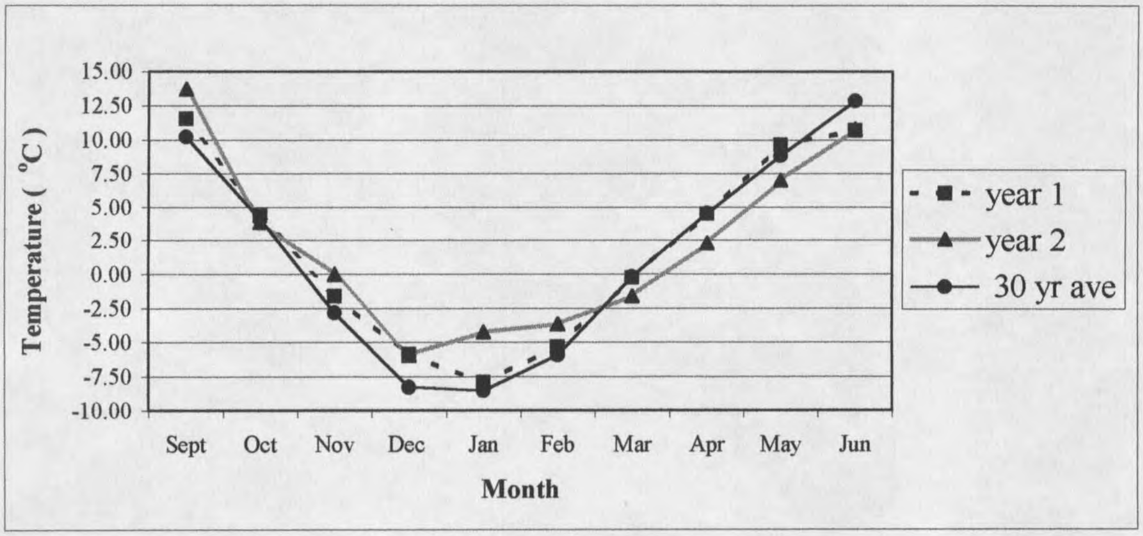


Figure 2. Average daily temperature at Ovando, Montana.




## Vegetation

The BCWMA consists of a mixture of grassland and forest on gentle, mountainous topography. Elevations range from 1,200 to 1,800 m. Grasslands on the study site are dominated by rough fescue. Several wildlife management areas across western Montana have similar rough fescue dominated vegetation types (Jourdonnais and Bedunah 1985). Additional species commonly present in grasslands include Idaho fescue (*Festuca idahoensis*), Columbian needlegrass (*Stipa columbiana*), Richardsons needlegrass (*Stipa richardsonii*), bluebunch wheatgrass (*Agropyron spicatum*), timber oatgrass (*Danthonia intermedia*), prairie junegrass (*Koeleria pyramidata*), threadleaf sedge (*Carex filifolia*), western yarrow (*Achillea millefolium*), sticky geranium (*Geranium viscosissimum*), and lupine (*Lupinus spp.*). Grasslands on the study site are intermixed with forests dominated by Douglas-fir (*Pseudotsuga menziesii*). Also common in forested areas are ponderosa pine (*Pinus ponderosa*), western larch (*Larix *occidentalis*), sub-alpine fir (*Abies lasiocarpa*), Engleman spruce (*Picea englemannii*), lodgepole pine (*Pinus contorta*), and aspen (*Populus tremuloides*).

Ungulate Use

A large number of elk and deer winter on the BCWMA. In January, 2000 it was estimated that 856 elk were wintering on the BCWMA (MDFWP, unpub. data). Mule deer numbers during winter surveys in January, 2000 totaled 514 animals (MDFWP, unpub. data). White-tailed deer were estimated at 400-550 animals in 1979 and are thought to have increased since that time (MDFWP, unpub. data).

The BCWMA was originally established by the state to provide winter range for elk. On the west side of the BCWMA, south and west facing slopes provide excellent winter range for wild ungulates. The area provides winter range for deer and elk whose summer ranges span 1,400 $km^2$ (Baty 1995).

The BCWMA is also valuable spring and summer range. There are 200-400 deer and 50-150 elk that are year-round residents on the BCWMA (Mike Thompson, pers. comm.). Parts of the BCWMA's east side are not available to use by deer and elk in the winter due to heavy snow accumulation but are used in spring and summer. Along with supporting deer and elk throughout the summer, the east side of the BCWMA is a staging area for migrating elk on their way to summer ranges in the Bob Marshall Wilderness complex. Many deer and elk use this area for birthing. Grizzly bears (*Ursus arctos*) have frequently been reported foraging and hunting in this area during spring. The spring and summer range on the BCWMA is an integral part of wildlife habitat in the area. The

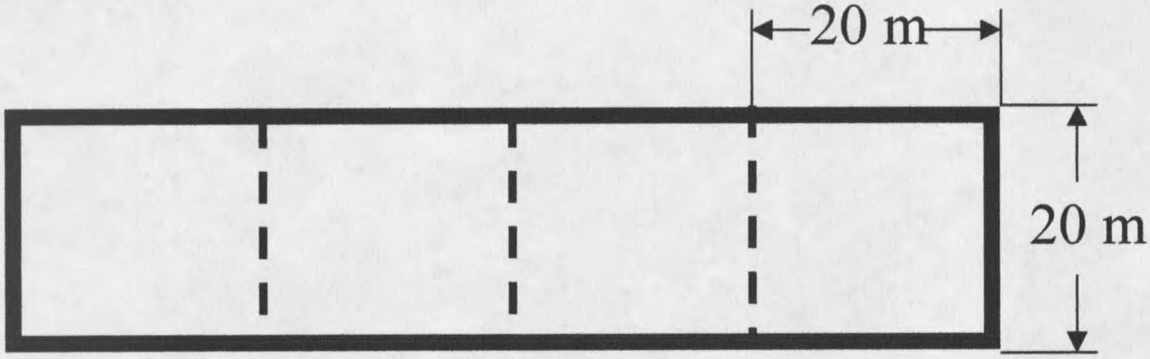
BCWMA is a prime place to manage for spring and summer range as well as winter range.

Study Design

To study the effects of fall cattle grazing on potential deer and elk forage, a controlled field experiment was conducted. To test the hypotheses, plots on the study area were treated with different levels of fall cattle grazing. In an effort to quantify potential deer and elk forage in the plots, green forb biomass, green grass biomass, total biomass, standing dead vegetation, plant composition, and plant species diversity were measured. Nutritive quality was not measured because standing dead material was assumed to be the major factor that would alter nutritive quality during spring and summer on the site.

The experimental unit of the study was a 20 x 20 m plot of 0.04 ha. Each plot was fenced off individually as a separate enclosure for cattle grazing. Each year for two years, a total of 20 enclosures were constructed on the east side of the BCWMA. Five non-overlapping blocks of enclosures were laid out in a stratified random sample design. The blocks were constructed of three strand barbed-wire fence around the perimeters and divided into individual enclosures with electric fence (Fig. 3). Each block contained one control enclosure along with three treatment enclosures. Treatments were randomly assigned within the blocks making the experiment a randomized complete block design. Enclosures were placed in blocks to maximize homogeneity among treatment plots. All five blocks were constructed on homogeneous rough fescue dominated grasslands. Three of the five enclosure blocks were placed in areas that had not had significant grazing since the BCWMA was purchased in 1948. One block was placed in a pasture that had been in a rest-rotation cattle grazing system since 1990. The remaining block was placed in a pasture grazed periodically by cattle since 1995.

Figure 3. Grazing enclosure block layout.




Treatments

During mid September in 1997 and again in 1998, short duration, high intensity cattle grazing was implemented on enclosures in the grazing treatment groups. Treatments were applied after rough fescue plants had entered dormancy. Cattle from the Bandy Experimental Ranch were used to graze the treatment enclosures. Eight cow/calf pairs were used for each block. When one treatment was completed, cattle were moved to the next treatment within that block. Grazing treatments were overseen so that grazing could be terminated when the areas were grazed to the desired levels.

In each block, one enclosure was grazed to 50 percent relative utilization, one to 70 percent relative utilization, one to 90 percent relative utilization, and one left ungrazed as a control. Relative utilization is the percent removal by weight of vegetation relative to what is currently there (Frost et al. 1994). These grazing treatments were equivalent to moderate, heavy, and severe grazing (Table 1). A pilot study conducted in 1995 and 1996 indicated that treatments over 50 percent relative utilization were needed to reduce standing dead vegetation and initiate a response in forb production (Gross, unpub. data). Also, Willms et al. (1979) indicated that moderate or heavy fall grazing by cattle was needed to make forage more attractive to deer. Utilization in the treatment enclosures was measured by the grazed class method of ocular utilization estimation (Kingery et al. 1992). Treatments were all applied between September 15$^{th}$ and September 25$^{th}$.

Table 1. Average utilization levels for treatment plots. Utilization expressed as percent removed.

| Year of treatment | Treatment | Mean | Standard Deviation |
|---|---|---|---|
| 1997 | 50% (moderate) | 48.88% | 2.50% |
| | 70% (heavy) | 70.64% | 3.36% |
| | 90% (severe) | 88.00% | 1.37% |
| 1998 | 50% (moderate) | 49.43% | 2.60% |
| | 70% (heavy) | 69.26% | 0.95% |
| | 90% (severe) | 89.19% | 1.44% |
| 1997+98 | 50% (moderate) | 49.15% | 2.42% |
| | 70% (heavy) | 69.95% | 2.44% |
| | 90% (severe) | 88.59% | 1.47% |

Vegetation Sampling

Vegetation data were collected during the spring and summer of 1998 and 1999. All of the enclosures were sampled identically for all variables. Timing of sampling was done according to plant phenology. Spring sampling started in mid May in 1998 and five days later in 1999. Summer vegetation measurements were taken at seed ripe for the majority of herbaceous species in the area, at the peak of vegetation production. This occurred in late June in 1998 and ten days later in 1999.

A double sampling procedure was used to estimate vegetation production (Pechanec and Pickford 1937). Weights of green grass, green forb, and standing dead material were estimated on a dry matter basis for fifteen 0.25 $m^2$ quadrats in each enclosure. The quadrats were spaced at one-meter intervals along one 10 m transect and one 5 m transect (Fig. 4). Vegetation within every fifth quadrat was clipped to ground level, sorted, bagged, dried, and weighed for calibration of the estimates. Summer production measurements were taken on the other side of transects used for spring collection (Fig. 4). Linear regression analysis compared estimated to actual weight for forb, grass, and standing dead vegetation with $R^2$ values ranging from 0.72 to 0.97 (Table 2). This provided regression equations to calibrate the estimated weights. Weights were used to determine the amount of green grass, green forb, and standing dead present in enclosures. Percent green biomass was used to report the amount of standing dead present in enclosures. This shows how much green vegetation is present relative to standing dead.

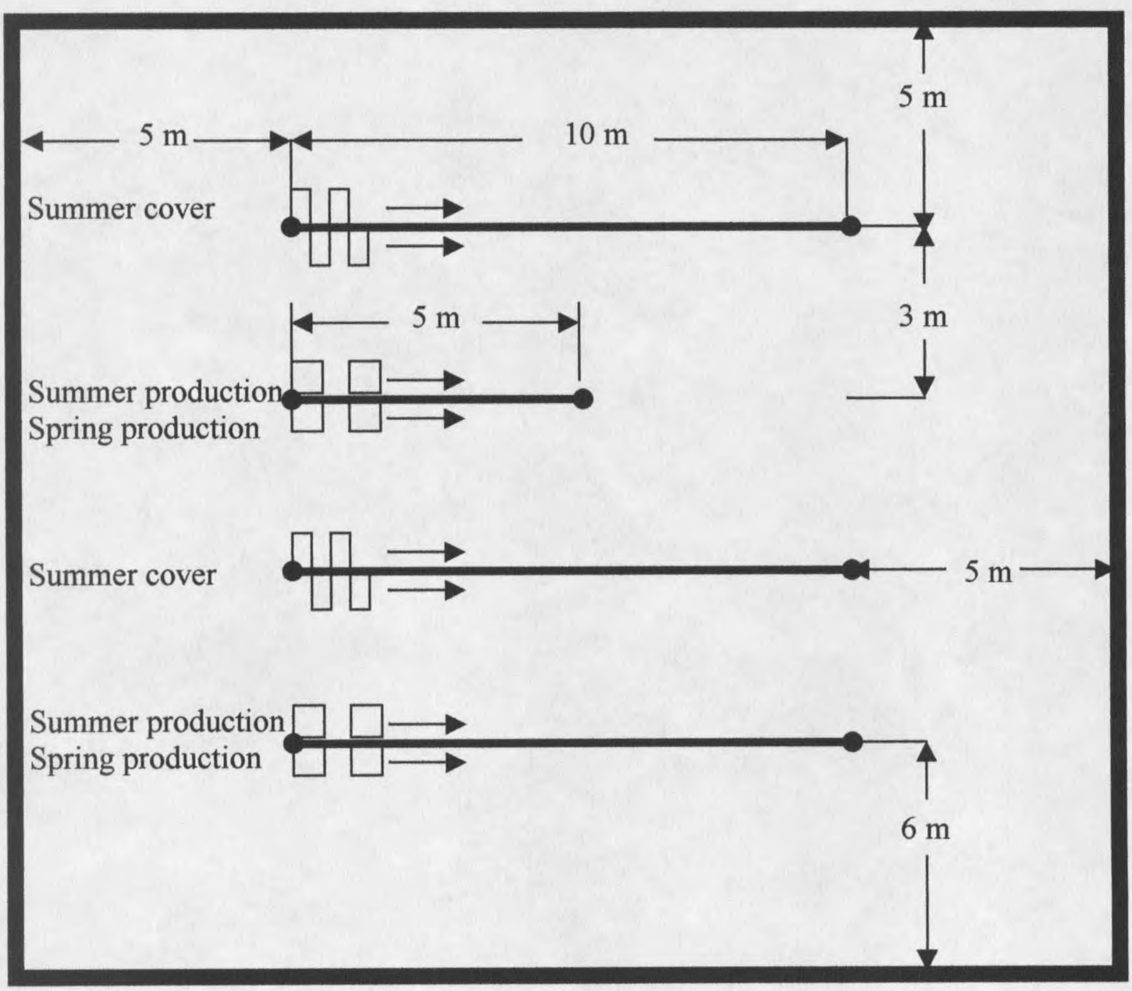
Table 2. Regression results for double sampling procedure (N=60 for each regression).

| Year | Season | Standing Dead($R^2$) | Green Grass($R^2$) | Green Forbs($R^2$) |
|---|---|---|---|---|
| 1998 | Spring | 0.91 | 0.81 | 0.72 |
| 1998 | Summer | 0.78 | 0.89 | 0.87 |
| 1999 | Spring | 0.97 | 0.71 | 0.84 |
| 1999 | Summer | 0.89 | 0.86 | 0.85 |

The canopy-coverage method of vegetational analysis (Daubenmire 1959) was used to measure botanical composition, species richness, and proportional abundance in the enclosures. Botanical composition was calculated according to Daubenmire (1959).

Species richness was measured as the number of species present. Proportional abundance was measured as percent species cover relative to total vegetative cover. Cover measurements were taken during summer data collection. Each enclosure had two 10 m transects for cover sampling. A 20 x 50 cm Daubenmire frame was placed every half meter on alternating sides along the transects to estimate vegetation canopy cover totaling 40 frame locations per enclosure (Fig. 4).

Figure 4. Sampling scheme within enclosures.



Statistical Analysis

Analysis of variance (ANOVA) was used to test for differences in forage characteristics. The analyses were conducted using the general linear model in SAS version seven (SAS 1998). The initial ANOVA model included year, block, treatment, year×treatment interaction, and block×treatment interaction. Interactions that were not significant ($P>0.10$) were dropped from the final model. All main effects were kept in the final model. Least significant difference (LSD) multiple comparison tests were used to identify statistical differences among treatment levels if the ANOVA was significant. Alpha levels for all tests were set at 0.10.

# CHAPTER 4

# RESULTS

## Vegetation Production

### Spring

Total green biomass production in spring was affected by fall treatment level (P=0.07). The 50 and 90 percent treatments resulted in a reduced amount of green biomass compared to the control (Fig. 5). Green grass production in spring was not different (P=0.12) among treatments (Figure 6). Percent green vegetation in spring was affected by treatment (P<0.01). Control treatments averaged 49% green vegetation whereas grazing treatments increased average percent green vegetation with grazing intensity (Fig. 7).

### Summer

Total green biomass production in summer (Fig. 8) was not different among treatments (P=0.21). Summer forb production was also not different among treatments (P=0.83; Fig. 9). Percent green vegetation in summer had a significant year×treatment interaction (P<0.01). In 1998 percent green vegetation was different among treatment groups (P<0.01). Control treatments averaged 56% green vegetation and average percent green vegetation increased with grazing intensity (Fig. 10). In 1999 percent green vegetation was also different among treatments (P<0.01). Control treatments averaged

71% green vegetation and average percent green vegetation increased with grazing intensity (Fig. 10).

Figure 5. Mean total green biomass production in spring (P=0.07). Means with similar lowercase letters are not different (P>0.10).

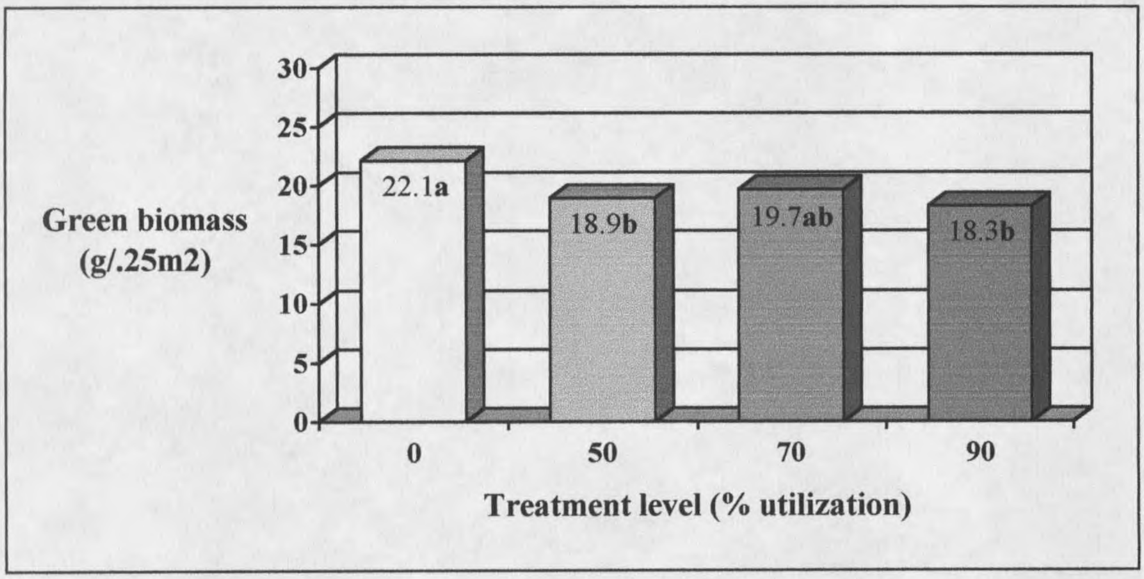



Figure 6. Mean green grass production in spring. ANOVA indicated no significant treatment effect (P=0.12).

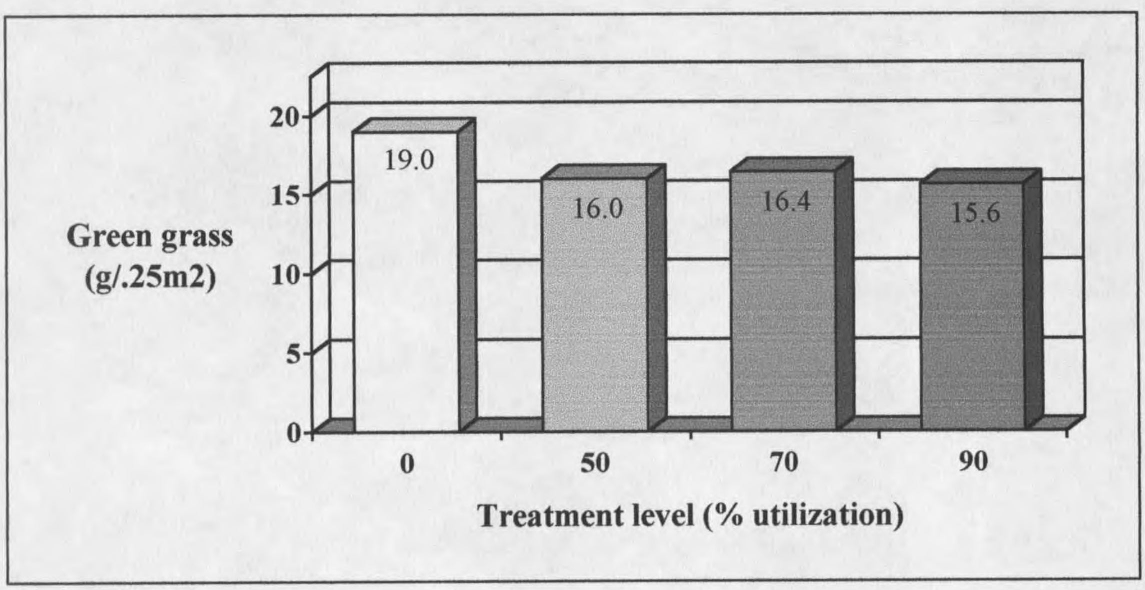


Figure 7. Mean percent green vegetation in spring (P<0.01). Means with similar lowercase letters are not different (P>0.10).

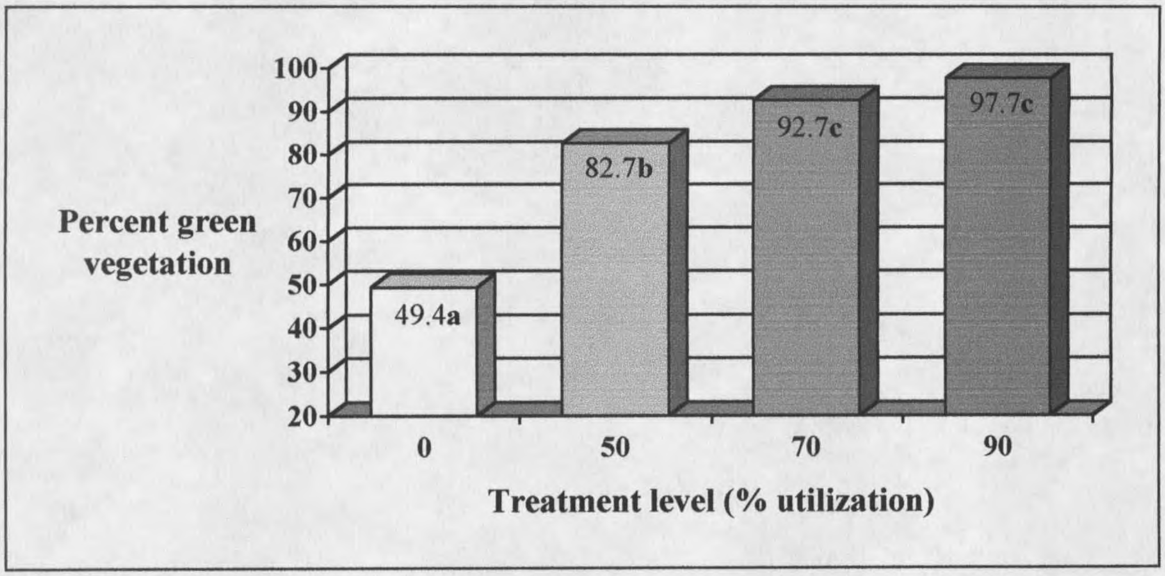



Figure 8. Mean total green biomass production in summer. ANOVA indicated no significant treatment effect (P=0.21).

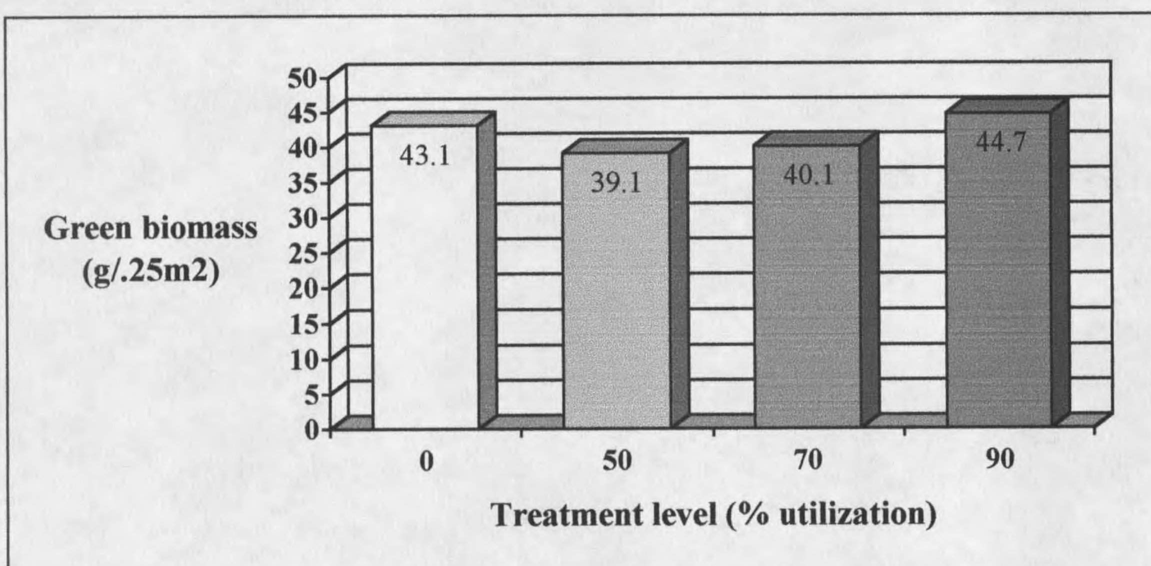


Figure 9. Mean forb production in summer. ANOVA indicated no significant treatment effect (P=0.83).

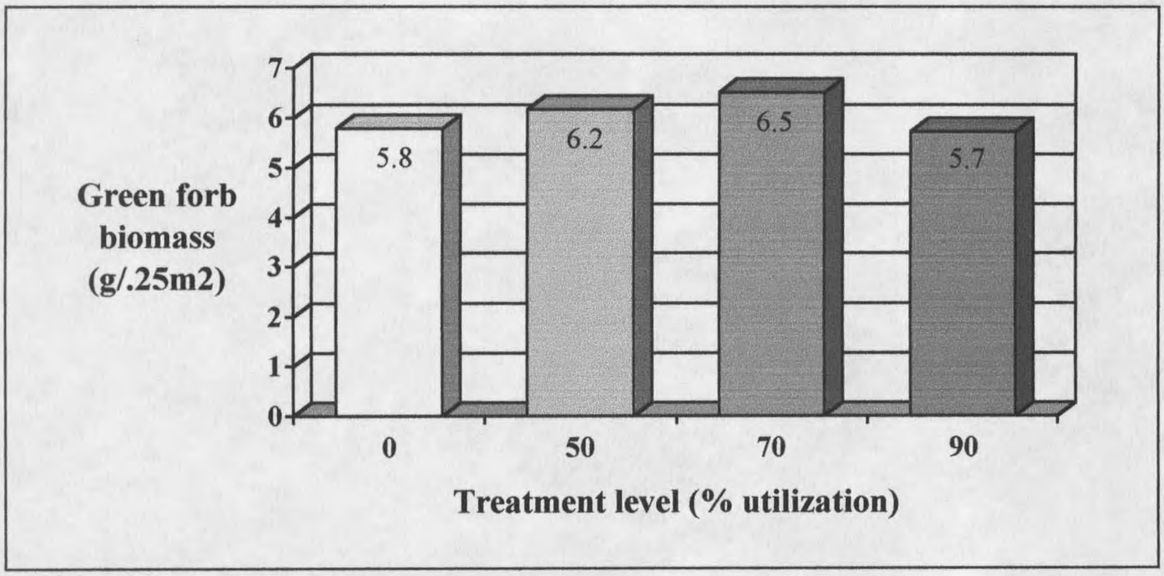
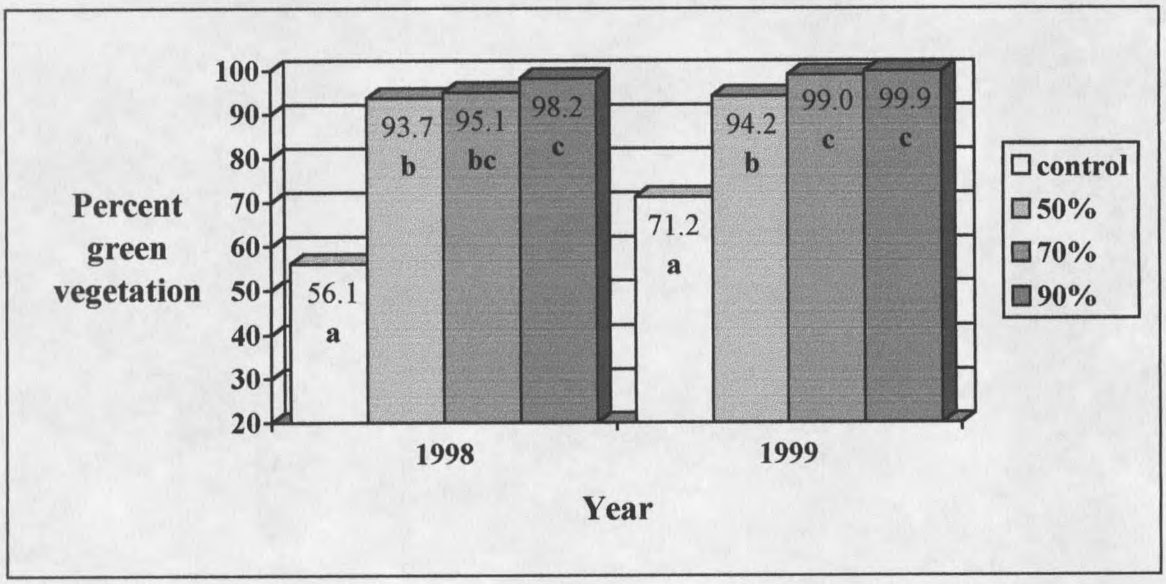



Figure 10. Mean percent green vegetation in summer. Years are reported separately due to a significant year×treatment interaction (P<0.01). ANOVA results for 1998 and 1999 were both (P<0.01). Means with similar lowercase letters are not different within years (P>0.10).



## Vegetative Cover

Species richness did not differ among treatment levels (P=0.54). The average number of species present in each treatment ranged from 17.5 to 19.4 (Fig. 11). Relative abundance of rough fescue averaged between 59% and 62% (Fig. 12). There were no differences among treatment levels in relative abundance of rough fescue (P=0.97), or any other species (Table 3). Botanical composition of enclosures is reported in Table 3. There were no differences among treatment levels in percent composition of species. Standing dead material was the only composition variable that was different among treatment levels (P<0.01). The control contained a substantially higher cover of standing dead material than did the grazing treatments (Table 3).

Forage variables were also analyzed for previously grazed and previously ungrazed sites separately. ANOVA was performed on each forage variable in each season on previously grazed sites and on previously ungrazed sites independently. This was to see how past management affected the results of the study. Past management did not change the ANOVA result for any of the forage variables (Table 4). Means were slightly higher on previously grazed sites than previously ungrazed sites across all treatment levels for summer forb production and species richness (Table 4). Means were slightly lower on previously grazed sites than previously ungrazed sites across all treatment levels for percent abundance of rough fescue (Table 4).

Figure 11. Mean species richness. ANOVA indicated no significant treatment effect (P=0.52).

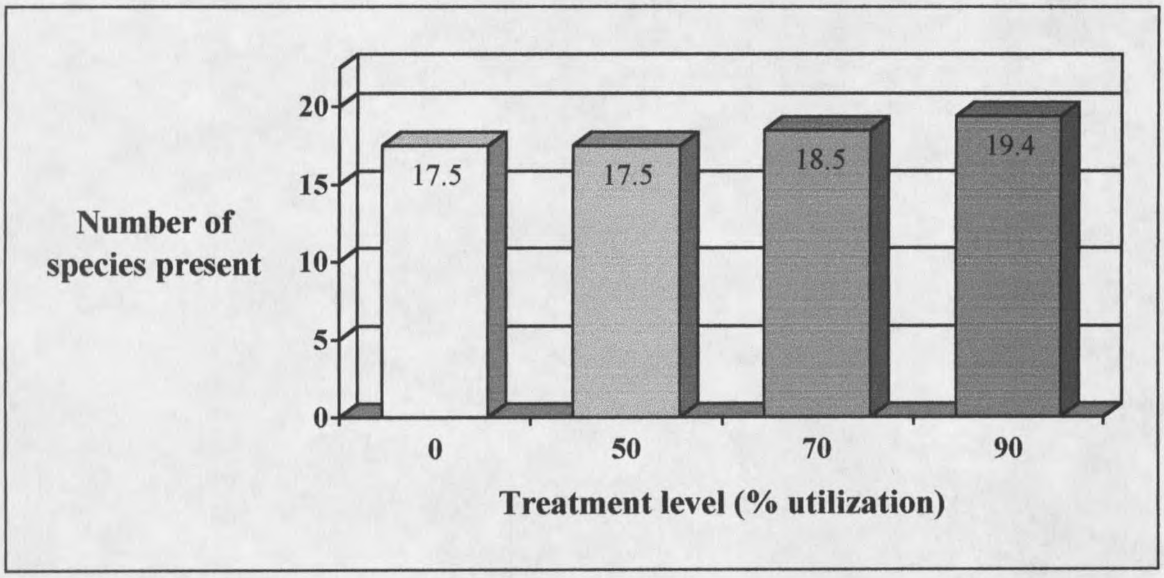



Figure 12. Mean relative abundance of rough fescue based on canopy cover. ANOVA indicated no significant treatment effect (P=0.97).

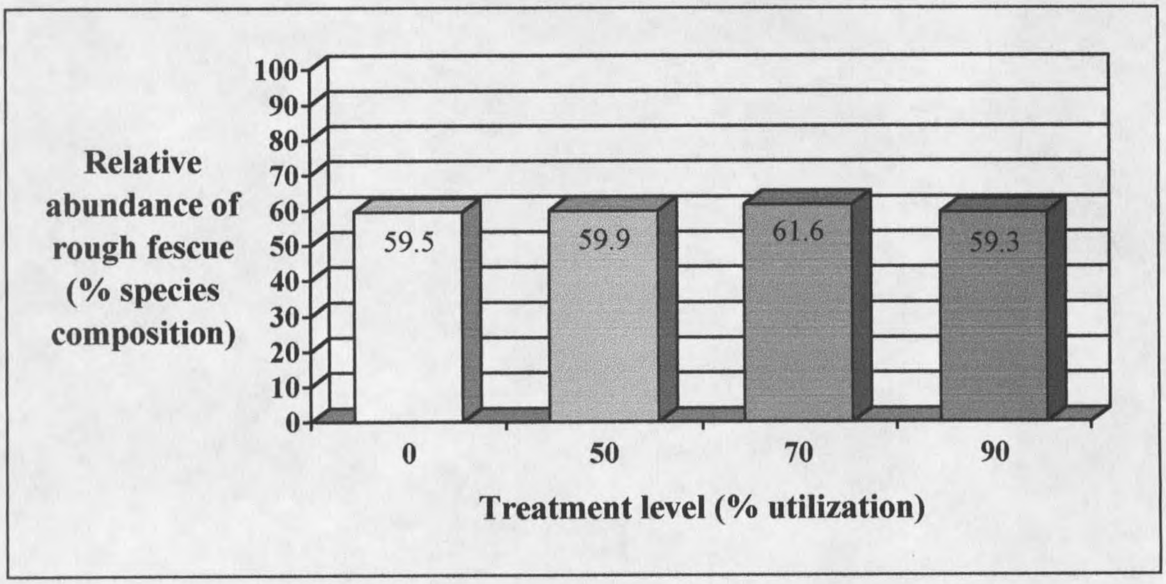


Table 3. Mean (±SD) percentage botanical composition of grazing enclosures based on canopy cover. Differing letters within rows indicate differences (P<0.10).

| Common name | Species | Contol | Grazed 50% | Grazed 70% | Grazed 90% |
|---|---|---|---|---|---|
| **Graminoids** | | | | | |
| rough fescue | *Festuca scabrella* | 59.5±18.9 | 59.9±15.4 | 61.6±13.9 | 59.3±13.4 |
| Idaho fescue | *Festuca idahoensis* | 6.3±8.1 | 4.5±6.4 | 3.8±5.4 | 4.2±6.9 |
| timothy | *Phleum pratense* | 0.5±1.4 | 0.1±0.4 | 0.3±0.9 | 0.9±1.6 |
| prairie junegrass | *Koeleria pyramidata* | 0.2±0.3 | 0.5±0.6 | 0.7±0.7 | 1.1±1.4 |
| Columbian needlegrass | *Stipa columbiana* | 1.4±2.6 | 3.8±7.1 | 2.7±4.7 | 0.8±1.1 |
| Richardson's needlegrass | *Stipa richardsonii* | 1.5±3.2 | 1.4±2.9 | 2.4±4.6 | 1.2±1.6 |
| timber oatgrass | *Danthonia intermedia* | 0.6±0.7 | 3.4±3.6 | 0.9±1.9 | 1.2±1.2 |
| bluebunch wheatgrass | *Agropyron spicatum* | 1.1±2.5 | 0.6±1.4 | 0.1±0.1 | 0.8±2.1 |
| western wheatgrass | *Agropyron smithii* | 0.0±0.0 | 0.1±0.3 | 0.0±0.1 | 0.0±0.0 |
| sedges | *Carex* spp. | 4.0±6.5 | 5.1±7.8 | 5.5±10.7 | 5.2±7.9 |
| Total | | 75.2±11.6 | 79.4±9.5 | 78.1±12.0 | 74.8±11.7 |
| **Forbs** | | | | | |
| western yarrow | *Achillea millefolium* | 2.3±1.9 | 3.5±2.0 | 3.1±2.6 | 3.9±3.1 |
| sticky geranium | *Geranium viscosissimum* | 2.7±5.4 | 1.0±1.5 | 3.0±5.8 | 1.9±3.0 |
| alpine pussytoes | *Antennaria alpina* | 2.9±3.8 | 1.9±3.0 | 2.0±2.6 | 1.6±2.5 |
| hawkweed | *Hieracium* spp. | 0.9±1.1 | 0.5±0.7 | 0.7±0.8 | 0.4±0.6 |
| wild buckwheat | *Eriogonum sphaerocephalum* | 0.5±0.5 | 1.2±2.3 | 0.6±1.0 | 0.4±0.6 |
| common ragweed | *Ambrosia artemisiifolia* | 0.3±0.6 | 0.4±0.8 | 0.6±0.7 | 0.5±0.7 |
| bedstraw | *Galium* spp. | 0.9±1.5 | 0.7±1.5 | 0.2±0.5 | 0.9±1.4 |
| prairie smoke | *Geum triflorum* | 0.1±0.3 | 0.1±0.3 | 0.2±0.4 | 0.4±0.7 |
| graceful cinquefoil | *Potentilla gracilis* | 1.1±1.3 | 0.6± 0.6 | 0.4±0.4 | 1.3±1.2 |
| lupine | *Lupinus* spp. | 7.5±5.9 | 3.8± 4.1 | 5.0±5.7 | 2.8±4.2 |
| strawberry | *Fragaria* spp. | 0.9±1.0 | 0.4±0.3 | 0.6±0.6 | 0.8±1.0 |
| dubius salsify | *Tragopogon dubius* | 0.0±0.0 | 0.0±0.0 | 0.1±0.3 | 0.2±0.6 |
| goldenweed | *Haplopappus armerioides* | 0.3±1.0 | 0.3±0.4 | 0.1±0.2 | 0.2±0.5 |
| slender blue penstemon | *Penstemon procerus* | 0.6±0.7 | 0.5±0.8 | 0.5±0.8 | 1.0±1.3 |
| common toadflax | *Linaria vulgaris* | 0.1±0.2 | 0.9±2.7 | 0.0±0.0 | 0.0±0.0 |
| mustard | *Descurainia* spp. | 0.0±0.0 | 0.0±0.0 | 0.0±0.0 | 0.1±0.3 |
| death camas | *Zygadenus* spp. | 0.0±0.1 | 0.1±0.1 | 0.1±0.2 | 0.1±0.1 |
| silver sage | *Artemisia cana* | 0.0±0.1 | 0.2±0.4 | 0.5±1.0 | 0.5±0.9 |
| fleabane daisy | *Erigeron* spp. | 1.2±1.3 | 1.0±1.6 | 1.2±1.1 | 1.5±2.0 |
| sandwort | *Arenaria* spp. | 0.1±0.1 | 0.4±0.7 | 0.3±0.9 | 0.7±2.1 |
| bluebell | *Campanula rotundifolia* | 0.0±0.0 | 0.1±0.2 | 0.2±0.2 | 0.2±0.2 |
| campion | *Silene scaposa* | 0.0±0.1 | 0.0±0.0 | 0.1±0.2 | 0.0±0.0 |
| showy pussytoes | *Antennaria pulcherrima* | 0.0±0.0 | 0.2±0.5 | 0.0±0.0 | 0.1±0.2 |
| hairy goldenaster | *Chrysopsis villosa* | 0.0±0.1 | 0.1±0.2 | 0.0±0.0 | 0.4±1.2 |
| spotted knapweed | *Centaurea maculosa* | 0.1±0.1 | 0.0±0.0 | 0.0±0.0 | 0.0±0.0 |
| annual forbs | | 0.6±0.6 | 1.2±1.3 | 1.1±0.9 | 3.8±4.0 |
| other forbs | | 1.8±2.4 | 1.6±2.3 | 1.1±1.4 | 1.6±2.5 |
| Total | | 24.8±11.6 | 20.6±9.5 | 21.9±12.0 | 25.2±11.7 |
| **Other** | | | | | |
| bare ground | | 1.5±2.1 | 3.2±3.6 | 4.3±4.3 | 4.6±5.2 |
| litter | | 26.7±10.1 | 31.9±15.0 | 33.5±17.1 | 27.8±16.3 |
| standing dead | | 31.7±11.2**a** | 2.4±2.7**b** | 0.2±0.4**b** | 0.0±0.0**b** |

Table 4. ANOVA results where previously ungrazed blocks and previously grazed blocks were run separately.

| Season | Forage Variable | Grazing History | ANOVA P-value | Mean Values of Variable by Treatment Level Contol | 50% | 70% | 90% |
|---|---|---|---|---|---|---|---|
| Spring | Green Biomass (g/.25m²) | Previously Grazed | P=0.30 | 22.1 | 18.2 | 21.0 | 18.4 |
| | | Previously Ungrazed | P=0.25 | 22.1 | 19.4 | 18.8 | 18.1 |
| Spring | Green Grass (g/.25m²) | Previously Grazed | P=0.35 | 18.2 | 15.1 | 16.5 | 15.0 |
| | | Previously Ungrazed | P=0.38 | 19.4 | 16.9 | 16.4 | 16.1 |
| Spring | Percent Green Vegetation | Previously Grazed | P<0.01 | 55.7**a**[1] | 81.7**b** | 92.5**c** | 97.9**c** |
| | | Previously Ungrazed | P<0.01 | 45.2**a** | 83.4**b** | 92.8**c** | 96.5**c** |
| Summer | Green Biomass (g/.25m²) | Previously Grazed | P=0.18 | 40.3 | 35.5 | 39.7 | 47. 4 |
| | | Previously Ungrazed | P=0.62 | 45.0 | 41.5 | 40.4 | 43.0 |
| Summer | Green Forbs (g/.25m²) | Previously Grazed | 1998[2] P=0.13<br>1999[2] P=0.14 | 7.0<br>9.2 | 9.0<br>5.2 | 10.0<br>9.1 | 6.6<br>9.3 |
| | | Previously Ungrazed | P=0.68 | 4.3 | 5.6 | 4.5 | 4. 3 |
| Summer | Percent Green Vegetation | Previously Grazed | 1998[2] P<0.01<br>1999[2] P=0.01 | 52.6**a**<br>72.0**a** | 94.2**b**<br>96.7**b** | 96.3**b**<br>99.3**b** | 98.4**b**<br>99.9**b** |
| | | Previously Ungrazed | 1998[2] P<0.01<br>1999[2] P<0.01 | 58.4**a**<br>70.7**a** | 93.2**b**<br>92.5**b** | 94.2**b**<br>98.9**b** | 98.1**b**<br>99.8**b** |
| Summer | Percent Rough Fescue[3] | Previously Grazed | P=0.97 | 55.7 | 55.7 | 53.2 | 52.4 |
| | | Previously Ungrazed | P=0.90 | 62.0 | 62.6 | 67.3 | 64.0 |
| Summer | Species Richness[4] | Previously Grazed | P=0.57 | 19.0 | 18.0 | 20.3 | 20.5 |
| | | Previously Ungrazed | P=0.78 | 16.5 | 17.2 | 17.3 | 18.7 |

[1] Means in the same row followed by different letters are significantly different (P≤0.10)

[2] Years are reported separately due to a significant year×treatment interaction (P≤0.10).

[3] Relative abundance of rough fescue based on canopy cover.

[4] Number of species present.

# CHAPTER 5

# DISCUSSION

## Vegetation Production

### Spring

Total green biomass production in spring is an important forage variable for deer and elk since they select for green growth during this time (Jourdonnais and Bedunah 1985, Lyon 1985). Green biomass production was reduced in the spring as a result of grazing to 50 or 90 percent relative utilizations in the fall. This does not coincide with reports that fall grazing would provide for earlier growth in spring (Vavra and Sheehy 1996). The 70 percent treatment, however, did not reduce green biomass production in spring. Green grass production alone in spring was not affected by treatment level. Earlier warming of soil in grazed areas may not be as important as the moisture held by residual material for spring biomass production. However, this study did not measure timing of spring green-up. It is possible that grazed treatments greened-up earlier, due to quicker soil warming, but did not have enough soil moisture to produce greater spring biomass than control plots.

Percent green vegetation in spring was affected by grazing treatments. Higher grazing intensities created higher levels of green vegetation in relation to standing dead material. The 70 and 90 percent utilization treatments produced the highest percentages of green vegetation. Willms et al. (1981) reported that deer did not use areas in spring until new growth extended above standing dead material. When standing dead material is removed preferred green growth is accessible by deer and elk. These findings supported those of Willms et al. (1979), that availability of spring forage was related to degree of prior fall grazing by cattle. In a study of spring forage selection by deer Willms and McLean (1978) found that forage was only utilized from plants where mature stalks had been removed prior to spring growth. Availability of forage in spring was improved with fall grazing.

Summer

Green biomass production was not significantly different among treatment levels. Total green biomass production in summer is the overall production on the site. McLean and Wikeem (1985) and Willms et al. (1986) also found that fall defoliation did not reduce herbage production the following year. The cause of differences in spring production due to grazing intensity did not affect summer production. Forbs are an important forage for deer and elk in summer (McMahan 1964, Stevens 1966, Collins et al. 1978, Kasworm et al. 1984, Jourdonnais and Bedunah 1985, Lyon 1985, Canon et al. 1987, Kingery et al. 1996). Green forb biomass in summer was not significantly different among treatment levels. This result contradicts the theory that deer and elk are attracted to sites grazed by cattle the previous fall due to increased forb levels. However, the results reported in Table 4 suggest that areas that have been grazed previously produced greater amounts of forbs. To increase summer forb levels with cattle grazing may take several years of treatments and possibly cattle grazing during the growing season.

Percent green vegetation in summer increased with increasing grazing intensity. As in spring, the 70 and 90 percent utilization treatments produced the highest ratio of green to standing dead vegetation. I have already discussed the effect standing dead material has on deer and elk forage. Deer and elk select for forbs in the summer, but the amount of standing dead material present affects whether forbs are available for consumption. Through maintaining forb production and increasing forb availability, grazing treatments may have improved summer forage for deer and elk.

Results were the same for percent green vegetation on previously grazed and previously ungrazed blocks. This means that standing dead material is not only a potential barrier to grazing on sites that have not been grazed in 50 years, it is also a potential barrier on sites that are currently in grazing systems on our study area.

## Vegetative Cover

Species richness and species relative abundance were used as two indicators of species diversity. Species diversity is high if there is high species richness (many species per unit area) and low relative abundance (cover of each species is roughly similar). The number of species present and the relative abundance of rough fescue were not significantly different among treatment groups. Using these measures there were no differences in species diversity among treatment levels. All the treatment levels had moderate species diversity. A fairly high number of species were present, but the vegetation was dominated by rough fescue at an average of 60 percent of the vegetation.

Species diversity has been noted as an important aspect of wildlife forage (Collins et al. 1978). Species diversity was maintained on the sites after fall cattle grazing treatments.

Results from the analyses of previously grazed and previously ungrazed blocks separately indicate that past grazing increased species diversity. Relative abundance of rough fescue was lower on previously grazed sites across all treatment levels including the control. Species richness was slightly higher on previously grazed sites across all treatment levels including the control. Past grazing reduced the relative abundance of rough fescue and increased species richness, thereby increasing species diversity.

# CHAPTER 6

# MANAGEMENT IMPLICATIONS

The results from this study site indicate that the availability of spring and summer deer and elk forage can be improved with fall cattle grazing. The reduction of unpalatable standing dead material without compromising deer and elk forage production is possible with fall grazing. The 70 percent utilization treatment was optimal for managing deer and elk forage. The 70 percent treatment optimized percent green biomass in both spring and summer, did not reduce green biomass production in spring, did not reduce green forb production in summer, and did not reduce the species diversity of the sites.

By grazing cattle in the fall, managers are able to utilize the current year's growth for livestock production while improving the availability of spring and summer deer and elk forage. Treatment areas should be selected carefully. It would be inadvisable to apply a fall treatment of 70 percent utilization to an area that is valuable deer or elk winter range since that forage will be needed during winter. Treated areas should also be monitored. McLean and Wikeem (1985) indicated that fall use followed by heavy spring use could damage rough fescue plants. If there is very high deer and elk use during spring the range could be degraded and management should be altered.

Use of rough fescue at high levels can be sustainable according to results by Willms et al. (1986). However, it will be important to monitor the status of rough fescue stands due to the high value of rough fescue as wildlife forage. Monitoring of sites can be as easy as using repeat photography to track how the sites have changed over time.

Information from this study could be incorporated into rest-rotation or deferred-rotation grazing systems. Pastures designated as spring and summer range could be grazed to a target 70 percent utilization during their early fall rotation. This would improve forage in those pastures for deer and elk during the year following treatment and allow recovery after cattle grazing.

Future research is needed to determine long-term impacts of fall grazing treatments. Information is needed on the effect of fall grazing treatment several years after application and after multiple years of treatment. Knowing the effects of repeated yearly treatment vs. rest in different increments following treatment will be important in using treatments within a grazing system.

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