Effect of Grazing Horses Managed as Manipulators of Big Game Winter Range

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Abstract

A sagebrush-grass range in northern Utah, a critical winter area for deer and elk, was grazed by domestic horses in order to evaluate their potential to reduce selectively herbaceous vegetation which competes with bitterbrush *(Purshia tridentata)*, an important big game winter forage. The diets of horses were recorded during spring and summer grazing under two stocking levels on small pastures. Horses consumed largely grass species throughout the study period in this high seral community. Forbs were important forage only under heavy stocking. No use of bitterbrush was recorded. Rate of forage disappearance, expressed on a per-animal-weight basis, was found to be lower on heavily stocked pastures. All pastures grazed by horses responded with increased seasonal twig production of bitterbrush over the non-grazed state. Seasonal twig production was greatest in response to heavy stocking during early July.

Herds of migratory mule deer *(Odocoileus hemionus hemionus)* and elk *(Cervus elaphus nelsoni)* in the Rocky Mountains and Great Basin often rely on foothill rangelands dominated by big sagebrush *(Artemisia tridentata)* and other more palatable shrubs for winter browse. Winter deer mortality in Utah appears to be inversely related to the amount of palatable browse species available (Robinette et al 1952). Bitterbrush supplies important browse on many big game winter ranges in this area. Much of present bitterbrush range in our western states is considered to be seral communities created and maintained by perturbations of some sort (Ellison 1960). Extensive livestock grazing on palatable grasses and forbs in the late 1800's and early 1900's led, in part, to widespread successional changes favoring bitterbrush, which was frequently subordinate in the pristine vegetation (Hull and Hull 1974). In response to an increase in palatable shrubs and intensive management, elk and deer prospered by mid-century.

In recent years, increasing urbanization near many foothill winter range areas has promoted a trend towards protection of big game winter range from livestock use because of water quality and soil erosion concerns. On many protected rangelands, succession is now favoring grasses since they receive little use during the growing season to balance heavy winter use of shrubs by big game (Smith 1949, Urness 1976). As palatable shrubs disappear from the community, productivity of these lands as deer winter habitat decreases. Declines in the Intermountain Region of deer herd productivity in the mid-1970's (Connolly 1981) may have been partially due to these plant community changes.

It is well recognized that controlled livestock grazing can be used in a manipulative sense to direct plant community succession (Anderson and Scherzinger 1975, Lewis 1969). Research with cattle and sheep has shown that the productivity of bitterbrush can be increased by springtime grazing of competing herbaceous vegetation (Smith and Doell 1968, Jensen et al. 1972, Smith et al. 1979). One problem encountered when using sheep or cattle for this purpose is that both animals consume bitterbrush. Smith and Doell (1968) found that on moderately stocked pastures bitterbrush utilization by cattle increased dramatically in July, in some cases exceeding utilization of grasses. Jensen et al. (1972), in developing guidelines for sheep grazing on big game winter range, also reported heavy use of bitterbrush beginning in July. Both investigations suggested that stocking and season of livestock use must be precisely controlled to avoid excessive utilization of bitterbrush. The use of horse grazing as a "biological tool" to enhance bitterbrush on big game winter range was investigated in this study because horses were presumed to select for grass species (Stoddart et al. 1975, p. 257, Wagner 1978). The objectives of this study were twofold: (1) to investigate the use of spring-summer horse grazing as a means of increasing the seasonal production of bitterbrush, and (2) to determine the effect of grazing season and stocking intensity on the diets of horses grazing sagebrush-grass rangeland.

Methods

Study Site

Field research was conducted during the summer of 1980 at Hardware Ranch, Cache County, Utah—a Division of Wildlife Resources property. The site is typical of much of the intermediate-elevation foothill range found throughout northern Utah and the Intermountain Region. Winter use by deer and elk is often heavy. Livestock use on and in the vicinity of Hardware Ranch is highly variable, from light or absent to heavy.

The study pastures were approximately at 1,750 m elevation on a gently sloping southern exposure. Soils belong to the Ant Flat-Goring Series, being derived from quartsite-calcareous sandstone. They are predominately well-drained silty clay loams. Annual precipitation varies from 46 to 66 cm with the major portion falling as snow. The frost-free period ranges from 90 to 130 days. Spring rains during May of 1981 were 53% above the 10-year average for this month (U.S. Weather Bureau).

Vegetation is a grass-forb-shrub community co-dominated by big sagebrush *(Artemisia tridentata* subsp. *vaseyana)* and bitterbrush. Other shrubs include Douglas rabbitbrush *(Chrysothamnus viscidiflorus)* and low sagebrush *(Artemisia arbuscula)*. The herbaceous component is largely beardless wheatgrass *(Agropyron inerme)*, Kentucky bluegrass *(Poa pratensis)*, prairie junegrass *(Koeleria cristata)*. Pacific aster *(Aster chilensis)*, mulesear wyethia *(Wyethia amplexicaulus)* silky lupine *(Lupinus sericeus)*, and common yarrow *(Achillea millefolium)*. Table 1 shows the average production of these major species and the totals for each forage class on the study pastures. Major species were defined as those cumulatively composing greater than 75% of the total production on each pasture.

Grazing Treatments

The experimental layout was a 2×3 factorial design in which

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Table 1. Mean current annual production in kg/ha for 12 major plant species and for total forage classes at Hardware Ranch in the spring of 1980 prior to grazing

	Grazing period 1		Grazing period 2		Grazing period 3		
	Mod.	Heavy	Mod.	Heavy	Mod.	Heavy	Control
Grass							
Sandburg bluegrass	37	45	5	37	8	7	2
Kentucky bluegrass	52	59	49	97	23	52	62
beardless wheatgrass	80	83	203	112	204	118	159
prairie junegrass	59	72	53	68	47	32	10
Total grass	326	343	500	419	414	351	375
Forbs							
silky lupine	23	38	44	88	17	93	50
common yarrow	18	20	120	77	72	37	52
Pacific aster	95	141	140	185	214	159	129
mulesear wyethia	209	234	141	265	128	78	112
Total forbs	439	523	553	672	508	490	501
Shrubs							
Douglas rabbitbrush	48	26	96	72	43	75	29
big sagebrush	169	282	275	252	213	251	194
low sagebrush	184	138	143	162	179	210	133
antelope bitterbrush	143	96	177	205	193	101	136
Total shrubs	602	591	708	758	684	675	542
Total production	1367	1457	1761	1849	1606	1516	1418

grazing treatments were applied to 12 adjacent pastures. The design also included a nongrazed control pasture (Fig. 1). Three grazing periods (beginning June 7, July 3, July 29) which closely aligned with the flowering, rapid growth and hard seed stages of bitterbrush phenology, and 2 grazing intensities (moderate, 40% utilization of grasses; and heavy, 80% utilization of grasses) were studied. Each of the 6 grazing treatments was replicated once. The 2 levels of utilization were achieved by varying pasture size and adjusting the duration of each grazing period. Moderately and heavily grazed pastures were 1 and 0.5 ha, respectively. The control pasture, which served as an area to measure bitterbrush seasonal twig growth and herbaceous plant production in the nongrazed state, was 1 ha. Grazing trials were terminated when daily vegetation biomass estimates indicated that the targeted grass utilization values were realized.

Sixteen adult horses (4 per treatment) were grazed for 5–9 days on each treatment pasture. The mean horse weight was 506 kg (σ=72.3). An attempt was made to find horses that were either raised on or were familiar with native grass/shrub rangeland. To be certain that the diet selected by the horses was not biased by lack of experience with the vegetation type, all the animals grazed a 12.1 ha holding pasture for 3 weeks prior to the first trial and between trials. To increase the number of horses grazing each treatment pasture, thus reducing the effect of individual animal diet variability, the horses were rotated between the replicates of a particular grazing treatment halfway through a trial. This increased the number of horses having impact on a pasture from 4 to 8.

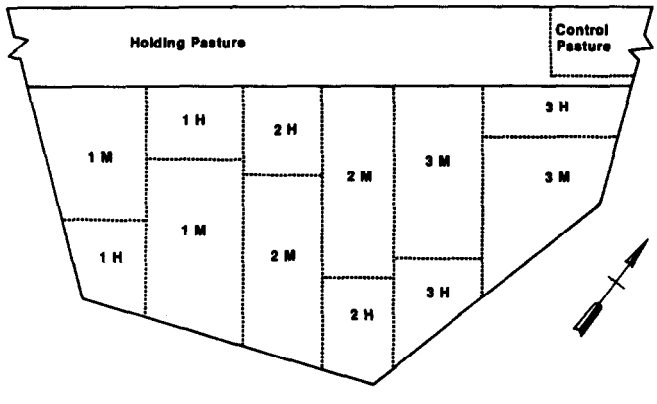

Fig. 1. *Diagram showing the pasture layout for 3 grazing periods (1,2,3) and 2 stocking intensities (moderate and heavy). Replicates share common identification labels.*

Vegetation Measurements

The calibrated weight-estimate method (Tadmor et al. 1975) was used to estimate above-ground production of vegetation in the treatment and control pastures immediately before and after each grazing period. The difference between measurements on the treatment pastures represented the forage utilized (forage disappearance) by the horses. The difference between measurements on the ungrazed control pasture estimated plant growth during the grazing periods. Forty 1-m^2 plots were estimated in each pasture, with every fifth plot being first estimated and then clipped and weighed. In this manner, calibration regressions were constructed for each plant species.

Bitterbrush utilization by the horses was determined by measuring the total length of twigs on 40 permanently marked branches in each pasture before and after a grazing trial (Smith and Urness 1962). The effect of horse grazing treatments on the seasonal production of bitterbrush was determined by comparing 1980 (treatment year) to 1979 (non-treatment year) seasonal production on a marked branch basis within each experimental pasture and the control pasture. The 1980 seasonal production for each marked branch was measured in September using the total twig length method. Production for 1979 and utilization by big game for the winter of 1979–1980 were determined solely from post-winter big game browsing measurements of the diameter and lengths of the remaining portions of twigs in the spring of 1980 (Jensen and Urness 1981). Using this method, total twig length for the marked branches was "reconstructed" by developing a regression equation for twig basal diameter and length of nonbrowsed twigs to basal diameters of browsed twigs.

Bite count data (Neff 1974) were also collected as a method of determining horse dietary composition within the duration of a grazing trial. Two, 10-minute sampling periods per pasture, in which the observer directly counted bites of each species consumed by an individual horse, were run daily in each treatment pasture. The horse to be observed was randomly selected for each sampling period. Initially, the diet was quantified by hand plucking representative bites of each species consumed. This method was eventually abandoned when difficulties in determining the size of bites were encountered. Horses rapidly selected forage within dense vegetation, making it difficult for a single observer to simulate bites

Table 2. Mean percent utilization by horses of 12 major plant species at Hardware Ranch during three periods of 1980 (early June; early and late July).

	Grazing period 1		Grazing period 2		Grazing period 3	
	Mod.	Heavy	Mod.	Heavy	Mod.	Heavy
Grass						
Sandburg bluegrass	51.0	83.4	23.7	54.8	11.0	47.1
Kentucky bluegrass	43.5	71.3	47.9	65.4	65.4	85.3
beardless wheatgrass	42.7	70.9	46.0	85.5	45.1	85.3
prairie junegrass	50.5	84.3	54.0	86.1	45.6	79.3
Total grass	44.9	73.6	42.1	75.3	40.9	79.1
Forbs						
silky lupine	1.8	13.7	3.4	10.4	4.0	9.3
common yarrow	4.9	14.0	2.4	14.4	4.0	14.0
Pacific aster	3.1	12.5	4.8	9.2	9.0	20.8
mulesear wyethia	12.5	26.5	16.6	34.2	11.7	18.2
Total forbs	7.7	18.3	7.4	20.0	7.8	17.6
Shrubs						
Douglas rabbitbrush	1.0	2.1	1.3	0.0	0.0	1.8
big sagebrush	0.0	0.0	0.0	4.2	0.8	0.0
low sagebrush	1.0	2.5	0.0	4.6	0.0	7.2
antelope bitterbrush	0.0	0.0	0.0	0.0	0.0	0.0
Total shrubs	0.5	0.6	0.6	0.8	0.8	1.3

while recording frequency of the plant species consumed.

Results and Discussion

Forage Utilization by Horses

Horses primarily utilized grasses throughout the study although forbs were moderately consumed in heavily stocked pastures (Table 2). Analysis of variance for all plant species measured showed highly significant ($p<0.01$) differences in utilization of grasses versus forbs, and forbs versus shrubs. Utilization of individual grass or shrub species was not statistically separable, yet L.S.D. planned comparisons within the forb class showed thistle (*Circium* sp.), a minor vegetation component, and mulesear wyethia received significantly higher utilization when compared to all others. The main effect of grazing period was not significant ($p<0.20$) in affecting utilization of forage classes.

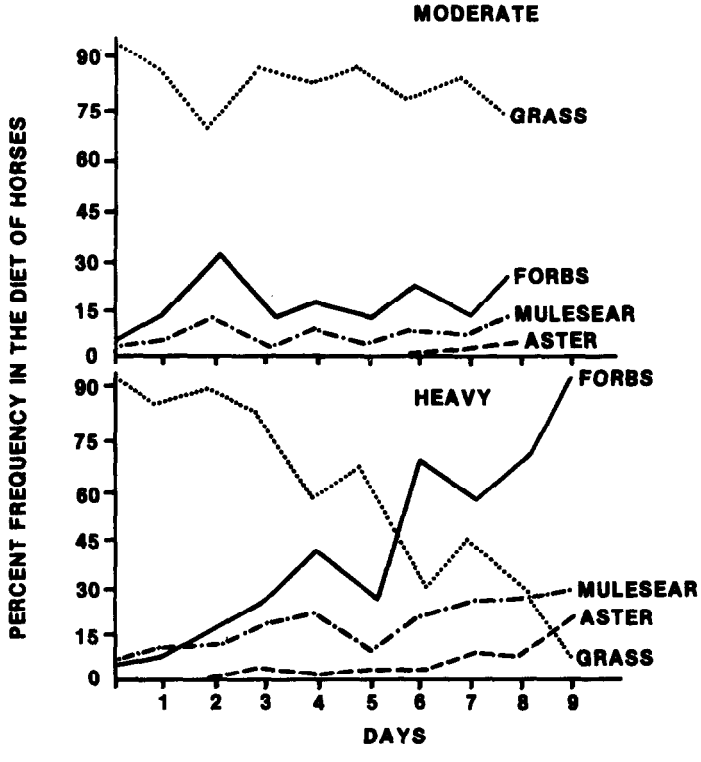

Fig. 2. *The average daily frequency of total grasses and forbs plus the two major forb species, Pacific aster and mulesear, in the diets of horses for moderate and heavy stocking intensities. The data are pooled for three grazing periods.*

During all grazing periods horses consistently selected grass species over other forage classes. Grasses were favored even when they had cured, while the major forb present, Pacific aster, remained green. Because the three grazing periods closely aligned with early development, flowering, and curing of grass species, it can be inferred that forage maturity and, thus, fiber content, had little effect on horse diet selection between forage classes. This is contrary to research with ruminants such as cattle and sheep, which generally exhibit strong selection for green versus cured forage (Arnold and Dudzinski 1978, p. 100, Stoddart et al. 1975, p. 204). Analysis of variance for the main effect of grazing intensity was highly significant ($p<0.01$) due to horses consuming proportionately more forbs and less grass under heavy stocking.

Bitterbrush was not utilized throughout the entire experiment, even under the heavy stocking regime during the mid-summer grazing period. This is contrary to the grazing habits of both sheep and cattle (Jensen et al. 1972, Smith and Doell 1968). Other shrubs such as big sagebrush, Douglas rabbitbrush, and low sagebrush received little or no use. Saskatoon serviceberry *(Amelanchier alnifolia)* and Woods rose *(Rosa woodsii)* were both moderately browsed in the heavily stocked pastures, but were too scarce to accurately estimate utilization.

Intra-grazing period variability in forage consumption was evident when daily bite-count data were analyzed (Fig. 2). Frequency of grass consumption remained steady (averaging 83%) throughout all moderate-intensity trial periods. On heavily stocked pastures, grass selection steadily dropped as grass in the pastures was utilized. On the first day of the trial period, frequency of grass selection averaged 92%; by the last day grass selection averaged only 11%, with forbs making up the bulk of the diet. The point at which grasses became less numerous in the diet than forbs was estimated to be near the point where grasses had received 65% utilization.

Forage Disappearance from the Pastures.

Mean daily forage disappearance ranged from a high of 2.52 kg air dry weight/100 kg horse body weight on moderately grazed pastures in period 1, to a low of 1.96 kg ADW/100 kg BW on the heavily grazed pastures in period 3 (Fig. 3). The average values were 2.43 and 2.07 kg ADW/100 kg BW for moderately and heavily grazed pastures, respectively. Although disappearance largely was due to horse consumption, factors such as trampling

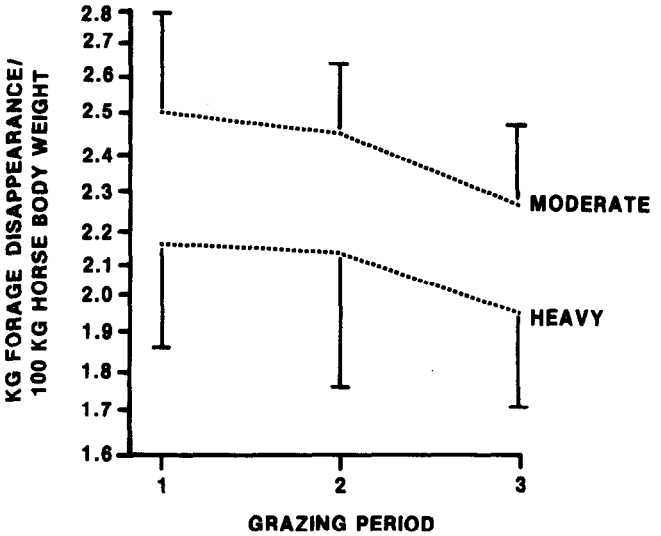

Fig. 3. *The mean daily disappearance of vegetation and one half 95% confidence intervals for heavy and moderate and grazing intensities during 3 grazing periods in 1980.*

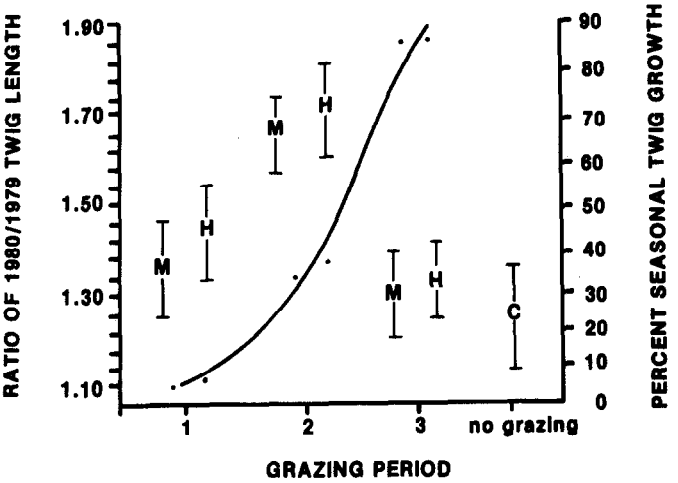

Fig. 4. *The ratio, and 95% C.I., of 1980 to 1979 bitterbrush total twig length for 7 grazing treatments (treatments labeled H, heavy; M, moderate moderate and C control). The scale to the right applies to the curve which approximates the progression of seasonal twig length for the spring and summer of 1980.*

loss influenced these values (Laycock and Harniss 1974). Wildlife use (rodents and rabbits) and plant growth was accounted for by measurements in the control pasture.

Analysis of variance for the main effect of grazing period was nonsignificant ($p<0.20$). The main effect of grazing intensity on the rate of forage disappearance was significant ($p<0.16$), indicating that disappearance rates were lower on heavily grazed pastures. This may be the result of increased searching time for desired species, lower intake, or greater animal interactions due to the smaller experimental pastures used for heavy stocking.

Bitterbrush Response to Horse Grazing

Analysis of the variability of shrub utilization by big game during the winter of 1979–1980 in individual pastures failed to reject ($p<0.05$) the hypothesis that pasture means were equal. It was then assumed that winter utilization of bitterbrush by big game was relatively uniform over all treatment pastures. The average (per marked branch) total twig length for the 1979 growing season was reconstructed by developing the regression, twig length = 97.9–139 twig basal diameter r^2=.82, n=531). Figure 4 shows the ratio of 1980 bitterbrush twig length over the 1979 twig length for each horse-grazing treatment, and the seasonal progression of bitterbrush twig growth for the control pasture. Timing of bitterbrush twig elongation agrees closely with data from Jensen et al. (1972), except that initiation of growth was delayed nearly 2 weeks. Delayed growth likely resulted from cooler spring temperatures during 1980.

Analysis of variance for the main effect of treatment was highly significant ($p<0.01$), indicating a true difference in treatment response. The non-grazed pasture when compared by linear combinations (Ostle and Mensing 1975) to all other treatments was significant ($p<0.01$) in affecting twig production. Linear combinations contrasting both intensities in grazing period 2 with those in period 1 and 3 showed period 2 to be significantly ($p<0.05$) higher in productivity. Maximum production of bitterbrush in response to heavy horse grazing in period 2 seems reasonable since period 2 occurred at a time when bitterbrush twigs were rapidly developing (Fig. 4). Removal of herbaceous vegetation competing with bitterbrush for soil moisture at this point probably caused increased browse production (Hubbard and Sanderson 1961), although soil moisture measurements were not taken. No difference between twig growth in period 3 and the control can be explained since at the time of this trial twig growth had almost ceased. Lower values in period 1 may be due to post-grazing understory regrowth effectively competing for limited soil moisture.

The main effect of grazing intensity was significant in affecting twig production at the $p<0.05$ level. Production of bitterbrush twigs on heavily grazed pastures in period 2 was 46.2% greater than in the nongrazed pasture. Smith and Doell (1968), also working at Hardward Ranch, reported that when herbaceous vegetation was periodically hand clipped within a 1.5 m radius of shrub bases, bitterbrush total seasonal twig length increased 58% over non-treated shrubs. It appears that controlled horse grazing can be used with nearly the same effectiveness. A year of "normal" soil moisture stress could magnify the shrub production benefits recorded in this study.

Domestic horse populations in the Intermountain states have been increasing, particularly near population centers. Obtaining animals for this study was relatively easy because many horse owners need forage for their animals in early spring, thus were eager to obtain free grazing. Many Intermountain big game winter ranges are owned and managed by state wildlife agencies in generally small parcels which could be temporarily fenced for horse grazing treatments. Horses in this study were readily contained within economical, single-strand electric fences, which can be dropped quickly in the winter to avoid interference with big game movements if multiple-year grazing regimes are necessary to achieve vegetation management goals.

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