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INFLUENCE OF PREVIOUS CATTLE AND ELK GRAZING ON THE SUBSEQUENT QUALITY AND QUANTITY OF DIETS FOR CATTLE, DEER, AND ELK GRAZING LATE-SUMMER MIXED-CONIFER RANGELANDS

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ABSTRACT: A study was conducted to determine foraging efficiency of cattle, mule deer, and elk in response to previous grazing by elk and cattle. Four enclosures, in previously logged mixed conifer (*Abies grandis*) rangelands were chosen, and within each enclosure, three 0.75 ha pastures were either: 1) ungrazed, 2) grazed by cattle, or 3) grazed by elk in mid-June and mid-July to remove approximately 40% of total forage yield. After grazing treatments, each pasture was subdivided into three 0.25 ha sub-pastures and 16 (4 animals and 4 bouts/animal) 20 min grazing trials were conducted in each sub-pasture using four steers, four tame mule deer (deer), or four tame elk during August 1998 and 1999. A bite-count technique was used to determine foraging efficiency and composition of diet. Crude protein content of deer diets tended to be higher (P < 0.20) in pastures previously grazed by cattle; whereas ADF was higher (P < 0.01) and IVDMD was lower (P < 0.05) in pastures previously grazed by elk. Crude protein content of elk diets were not influenced (P > 0.20) by previous grazing, but diet ADF, NDF were lower (P < 0.01) in pastures previously grazed by cattle. Prior grazing did not influence (P > 0.10) intake rates of deer and elk. In response to cattle grazing, cattle and elk diets shifted to more (P < 0.10) forbs and shrub/trees. In response to elk grazing, cattle consumed more grasses; whereas elk consumed more (P < 0.10) grasses and shrub/tree. Deer increased (P < 0.10) shrub/tree intake in previously grazed pastures. This study suggests that early summer grazing by cattle or elk has very little effect on the subsequent foraging efficiency of deer and elk. In addition, early summer grazing by cattle improve the quality of subsequent elk diets, but previous grazing by elk may reduce subsequent diet quality for cattle, deer, and elk.

Key Words: Cattle, Elk, Mule Deer, Diet Quality, Intake, Bite Count

Introduction

Cattle grazing occurs on all National Forests with allowable use standards set for all grazing allotments. National Forests support over 90 % of the elk (*Cervus elaphus*) and most of the mule deer population (*Odocoilleus hemionus*) during the summer in the United States (Wisdom and Thomas 1996). However, limited information is available regarding the proper timing and level of use of forested areas by cattle, as well as the interaction and consequences on the following seasons forage resources. Coe et al. (2001) concluded competition for forage could occur between elk and cattle in late summer and species interactions may be stronger between elk and cattle than deer and cattle. Furthermore, the response of elk and/or deer to cattle grazing may vary seasonally depending on forage availability and quality (Peek and Krausman, 1996; Wisdom and Thomas, 1996). In the fall, winter, and spring, elk preferred to forage where cattle had lightly or moderately grazed the preceding summer (Crane et al., 2001). Late summer and early fall forage quality and quantity can be critical for the nutritional well-being of domestic livestock and wild ungulates, because late summer nutritional deficiencies are common in regions where summer drought is a normal part of the climatic region (Svejcar and Vavra, 1985). However, the influence of early summer elk and cattle grazing on subsequent late summer foraging dynamics of cattle, deer and elk have not been evaluated quantitatively.

The objective of this study was to determine late-summer foraging efficiency of cattle, mule deer, and elk in response to prior grazing by elk and cattle on mixed-conifer rangelands.

Materials and Methods

The study was conducted on the Starkey Experimental Forest and Range which is located in the Wallowa-Whitman National Forest in the Blue Mountains of northeastern Oregon (45 deg 15’ N, 118 deg 25’ W), which is approximately 35 kilometers southwest La Grande, Oregon. Annual precipitation averages approximately 500 mm, two-thirds of which accumulates as winter snow (Skovlin and Harris, 1974). Elevations of the experimental site ranged between 1,299 m to 1,433 m.

Pinegrass (*Calamagrostis rubescens*), California brome (*Bromus carinatus*), western fescue (*Festuca occidentalis*), Kentucky bluegrass (*Poa pratenisis*), Idaho fescue (*Festuca idahoensis*), and elk sedge (*Carex geyeri*) are the dominant forage species, in terms of availability and utilization by herbivores. Several forbs species are present including western yarrow (*Achillea millefolium lanulosa*), strawberry (*Fragaria* species), hawkweed (*Hieracium* species), lupine (*Lupinus* species), willow-herb (*Epilobium paniculatum*). While common snowberry (*Symphoricarpos albus*), big whortleberry (*Vaccinium membranaceum*), grouse whortleberry (*Vaccinium scoparium*), spiraea (*Spiraea* *betulifolia lucida*) and twinflower (*Linnea borealis*), bearberry (*Arctostaphylos uva-ursi*) are the primary shrub species consumed by cattle, deer, and elk in the Blue Mountain region. Four enclosures, in previously logged mixed conifer rangelands were chosen, and within each enclosure, three 0.75 ha pastures were either: 1) ungrazed, 2) grazed by cattle, or 3) grazed by elk in mid-June and mid-July to remove approximately 40% of total forage yield. After grazing treatments, each pasture was subdivided into three 0.25 ha sub-pastures and 16 (4 animals and 4 bouts/animal) 20 min grazing trials were conducted in each sub-pasture using four steers, four tame deer, or four tame elk during August 1998 and 1999. Dietary composition and foraging efficiency of experimental animals were measured using bite-count methodology similar to that described by Wickstrom et al. (1984) and Canon et al. (1987). Food was not offered to animals each morning and between grazing trials to ensure reasonable and similar appetites each day. During each grazing trial, animals were allowed to roam free in one of the sub-pastures for 20 minute and trained observers followed each animal and recorded bites by forage species. Distance traveled (DT) was measured for each grazing bout by each observer following the animals with a measuring wheel. After completion of grazing trials each day, animals were fed alfalfa hay at 1.5% of body weight and held overnight in corrals for the next days grazing trials.

Samples of the most common plant species selected by animals during the grazing trial were collected through hand clipping and plucking. Typically, 100 to 200 simulated bites of each plant species were collected per grazing trial, placed in paper bag, and dried in a forced air oven at 50°C and weighed.

Samples were ground in a Wiley Mill to pass a 1 mm screen, analyzed for DM according to A.O.A.C (1990), CP was determined using the Kjeltec Auto System (Buch Co., Switzerland). Acid detergent fiber, NDF and IVDMD were assessed using a Filter Bag Method developed by ANKOM Technology Corporation (Fairport, NY). Regression equations (Damiran et al, 2002) were used to convert filter bag digestibility estimates to values comparable to the two stage IVDMD technique (Tilley and Terry, 1963).

Data were analyzed as a split-plot design using the Proc Mixed procedure in SAS (SAS Inst. Inc., Cary, NC). Treatment means were separated using LSmeans procedures of SAS and were considered different at the $P < 0.10$ levels.

Results and Discussion

Cattle: Cattle bites during the grazing trial were less ($P < 0.05$) in pastures previously grazed by cattle, and tended to be lower ($P = 0.11$) in pastures previously grazed by elk (Table 1). Cattle DT was not influenced ($P > 0.2$) by prior elk or cattle grazing. Cattle diets were higher in CP, and, ADF and NDF were lower ($P < 0.05$) in pastures previously grazed by cattle. *In vitro* DMD was higher ($P < 0.05$) in cattle diets from pastures previously grazed by cattle compared to pastures previously grazed by elk, but did not differ ($P > 0.2$) from ungrazed pastures. No differences were noted ($P > 0.2$) for cattle nutrient intake rates in ungrazed pastures versus pastures previously grazed by elk.

***Deer*:** Crude protein content of deer diets tended to be higher ($P = 0.20$) in pastures previously grazed by cattle; whereas ADF was higher ($P < 0.01$) and IVDMD was lower ($P < 0.05$) in pastures previously grazed by elk. Deer bite rate did not differ ($P > 0.20$) among grazing treatments, however, distance traveled was greater ($P < 0.10$) in pastures previously grazed by elk compared to ungrazed pastures. Deer DT was greater ($P < 0.10$) in pastures previously grazed by elk, but did not differ ($P > .20$) from pastures previously grazed by cattle. Deer traveled longer ($P < 0.01$) distances compared to cattle and elk. In addition, deer diets contained more ($P < 0.05$) CP and less NDF than cattle and elk diets.

***Elk*:** Crude protein content of elk diets were not influenced ($P > 0.20$) by previous grazing, whereas diet ADF and NDF concentrations were lower ($P < 0.01$) in pastures previously grazed by cattle. Elk bite rates and nutrient intake efficiency (g/m) were higher ($P < 0.1$), and distance traveled was lower ($P < 0.1$) in pastures previously grazed by elk, compared to ungrazed pastures. Prior grazing did not influence ($P > 0.10$) intake rates of deer and elk. Elk bite number/DT ratio was lower ($P < 0.1$) in previously ungrazed pastures.

In ungrazed pastures, cattle consumed diets composed primarily of grasses, and sedges (sedges and rush included). In contrast, deer selected diets composed primarily of forbs, and shrub/tree, whereas, elk selected more diverse diets with forbs, grasses shrub/tree, lichen and sedges, each composing at least 10% of the diets (Table 2). Compared to cattle and deer, elk were consuming forages more uniformly from different growth forms of forages (Figure 1,2,3). In response to previous cattle grazing, cattle and elk diets shifted more ($P < 0.10$) to forbs and shrub/trees. In response to elk grazing, cattle consumed more grasses; whereas elk consumed more ($P < 0.10$) grasses and shrub/tree components. Deer increased ($P < 0.10$) shrub/tree intake in previously grazed pastures.

Implications

This study suggests that early summer grazing by cattle or elk at the moderate utilization level has very little effect on the subsequent foraging efficiency of deer and elk. In addition, early summer grazing by cattle improve the quality of subsequent elk diets, but early summer grazing by elk may reduce subsequent diet quality for cattle, deer, and elk.

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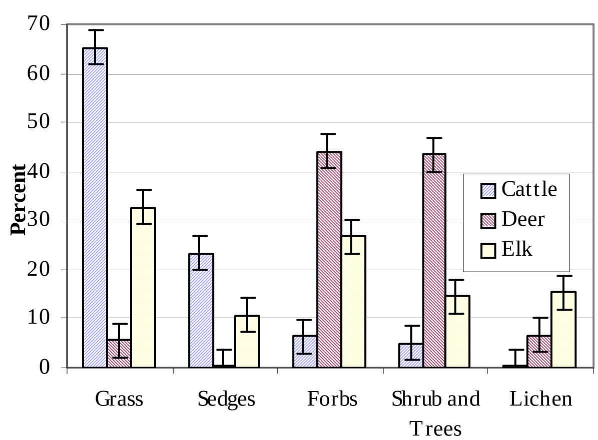

Figure 1. Cattle, deer, and elk late-summer diet composition in mixed-conifer rangelands (ungrazed pasture)

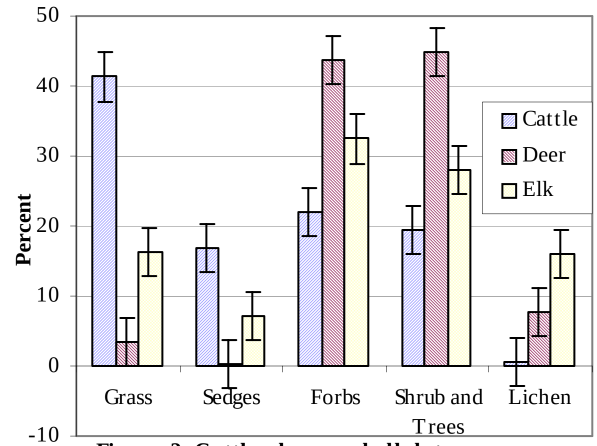

Figure 2. Cattle, deer, and elk late-summer diet composition in mixed-conifer rangelands (cattle grazed pasture)

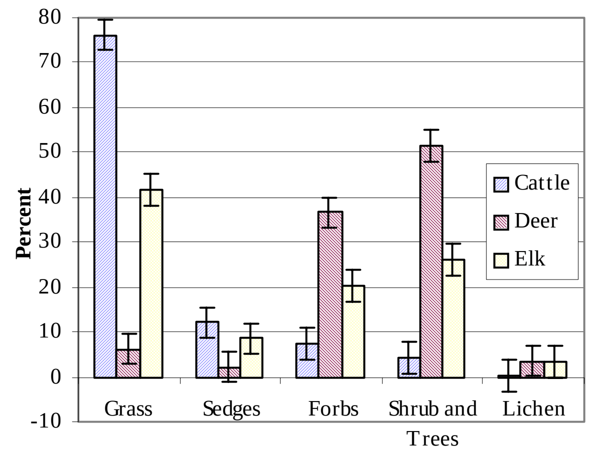

Figure 3. Cattle, deer, and elk late-summer diet composition in mixed-conifer rangelands (elk grazed pasture)

Table 1. Influence of previous cattle and elk grazing on the subsequent diet quality and quantity of diets for cattle, deer and elk grazing late-summer mixed-conifer rangelands.

Pasture	Bite	DT[1]	Diet composition, % DM basis				Diet and nutrient intake, g/min					Intake:DT ratio, g/meter		
	n/20min		CP	ADF	NDF	DMD	DM	CP	ADF	NDF	DDM	DM	DDM	Bite[2]
Cattle														
Ungrazed	578	124.7	6.35^{a}	41.32^{b}	58.63	55.57	20.68	1.275	8.538	12.347	11.378	4.134^{b}	2.262^{b}	5.298
Cattle grazed	438^{a}	130.9	7.57	38.65^{a}	52.37^{a}	56.63	11.46^{a}	0.862^{a}	4.444^{a}	6.113^{a}	6.481^{a}	1.809^{a}	1.027^{a}	3.453
Elk grazed	537	157.0	6.46^{a}	44.54	60.59	53.51^{a}	20.53	1.277	9.281	12.657	10.810	2.550^{ab}	1.349^{ab}	3.578
Deer														
Ungrazed	230	208.5^{a}	9.06	27.91^{a}	34.64^{ab}	58.71	1.84	0.168	0.502	0.635	1.083	0.231	0.136	1.448
Cattle grazed	241	229.8^{ab}	9.29	27.36^{a}	33.69^{a}	59.38	1.80	0.165	0.506	0.618	1.064	0.226	0.133	1.502
Elk grazed	216	245.6^{b}	8.72	31.72	36.76^{b}	56.72^{a}	1.93	0.164	0.628	0.728	1.092	0.258	0.143	1.414
Elk														
Ungrazed	339^{a}	141.1^{b}	7.85	32.18^{b}	45.53	59.01	9.10	0.691	3.013	4.310	5.332	1.992^{a}	1.166^{a}	3.647^{a}
Cattle grazed	368^{ab}	131.3^{ab}	8.14	29.33^{a}	40.45^{a}	58.40	7.28	0.587	2.151	2.959	4.227	1.760^{a}	1.016^{a}	4.284
Elk grazed	392^{b}	101.0^{a}	7.57	36.18	46.96	57.20^{a}	9.63	0.714	3.512	4.573	5.468	3.690	2.024	6.685
SEM	21	19.5	0.44	1.20	1.70	1.27	2.31	0.137	1.022	1.510	1.191	0.751	0.402	0.856

[ab]Column values within each animal type with different superscripts differ ($P < 0.1$, n=8).
[1]Animal traveled distance, m/20min.
[2]Animal bite number per each meter travel.

Table 2. Influence of previous cattle and elk grazing on the subsequent diet composition (Relative frequency, %) of diets for cattle, deer and elk grazing late-summer mixed-conifer rangelands.

	Pasture type											
	Ungrazed				Cattle grazed				Elk grazed			
Forage growth form	Bite	CP	NDF	DDM	Bite	CP	NDF	DDM	Bite	CP	NDF	DDM
Cattle												
Grass	66.98	60.51	68.48	63.35	44.38	35.96	49.07	38.42	74.63	72.71	78.68	73.94
Sedges[1]	20.08[b]	24.00[c]	23.48[b]	24.02[b]	16.47[b]	15.60[b]	18.54[b]	17.09[b]	13.11[b]	11.93[b]	12.56[b]	12.57[b]
Forbs	7.91[a]	8.75[b]	4.65[a]	6.99[a]	21.39[b]	27.29[b]	17.27[b]	24.06[b]	7.15[ab]	10.37[b]	5.84[ab]	8.78[b]
Shrub and Trees	4.78[a]	6.24[ab]	3.17[a]	5.25[a]	17.47[b]	20.47[b]	14.77[b]	19.85[b]	5.00[a]	4.70[ab]	2.80[a]	4.48[ab]
Lichen[2]	0.26[a]	0.50[a]	0.21[a]	0.39[a]	0.30[a]	0.69[a]	0.36[a]	0.58[a]	0.11[a]	0.28[a]	0.12[a]	0.24[a]
Deer												
Grass	2.70[a]	5.11[a]	7.97[a]	5.58[a]	1.80[a]	3.06[a]	4.57[ab]	3.49[ab]	3.96[a]	6.12[a]	8.64[a]	6.31[a]
Sedges	0.14[a]	0.29[a]	0.48[a]	0.33[a]	0.15[a]	0.26[a]	0.42[a]	0.30[a]	1.43[a]	2.06[a]	2.85[a]	2.23[a]
Forbs	55.54	48.00[b]	42.42	44.29	48.81	47.86	42.90	43.60	46.89	42.13	35.79[b]	38.20[b]
Shrub and Trees	39.80[b]	39.88[b]	41.67	42.45	47.06	41.34	43.19	44.13	46.59	45.78	49.16	49.20
Lichen	1.83[a]	6.72[a]	7.45[a]	7.35[a]	2.19[a]	7.49[a]	8.92[b]	8.48[b]	1.15[a]	3.91[a]	3.56[a]	4.05[a]
Elk												
Grass	21.78[c]	29.46	39.56	31.87	9.64[ab]	14.22[b]	22.26[bc]	15.56[b]	36.43	41.45	50.05	40.85
Sedges	4.25[a]	9.22[a]	13.62[a]	10.28[a]	2.59[a]	5.66[a]	10.27[a]	6.94[a]	4.02[a]	7.35[a]	10.78[ab]	8.35[a]
Forbs	44.54	29.90	20.43[a]	28.03	50.86	35.42	25.62[b]	33.23	35.11	23.58[b]	14.02[bc]	22.06[b]
Shrub and Trees	17.07[bc]	14.81[a]	12.29[a]	14.68[a]	26.40[c]	27.43	25.70[b]	28.12	22.29[b]	23.98[b]	21.95[c]	25.42[b]
Lichen	12.37[b]	16.61[a]	14.10[a]	15.14[a]	10.53[b]	17.28[b]	16.15[ac]	16.15[b]	2.16[a]	3.64[a]	3.20[a]	3.31[a]

[abc]Column values within each animal type with different superscripts differ ($P < 0.1$, n=8)

[1]rush included in this growth form of forages

[2]Tree hair lichen (*Bryoria fremontii*)