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FORAGE SELECTION BY BIGHORN SHEEP EWES AND LAMBS IN SOUTHCENTRAL COLORADO

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ABSTRACT

Summer food habits of Rocky Mountain bighorn (Ovis canadensis canadensis) ewes and lambs on 2 lambing ranges in southcentral Colorado were estimated and compared. Diets were also compared to the botanical composition and herbage production of each area. Food habits were estimated using fecal analysis, and vegetation was quantified using a double-sampling method. The grasses, mountain muhly (Muhlenbergia montana), blue grama (Bouteloua gracilis), Arizona fescue (Festuca arizonica), and sedges (Carex), made up 50% or more of the ewe and lamb diets, with true mountain mehaogany (Cercocarpus montanus) and other browse making up the other half. Ewe and lamb diets were similar on each lambing area but differed significantly between areas. Kulczinski's Similarity Index was greater than 75% for the diets of ewes and lambs on each lambing area but averaged less than 50% between areas. Ewes and lambs are selective and adaptive feeders, choosing different forage plants on different areas. The sheep did not select forage plants in proportion to their availability on the range.

INTRODUCTION

Rocky Mountain bighorn sheep occupy a variety of habitats from New Mexico to the Canadian Rockies. Many bighorn sheep herds have been declining in numbers and distribution since the late 1800s. Reasons for the decline are not fully understood. Man's encroachment upon bighorn sheep ranges, and especially upon winter ranges is thought to have been partly responsible for the decline (Buechner 1960). Poor lamb survival has contributed to declines in bighorns populations (Bear and Jones 1973) and could be related to loss of forages with loss of winter range. However little has been published in Colorado on lamb food habits and on the nutritional plane of lambs during summer before they enter the stressful winter period when forage quality and quantity are greatly reduced (Mautz 1978). Lambs grow rapidly during summer and fall and must store enough

energy and nutrients to carry them through winter. Lactating ewes also have additional energy needs. The summer diets of ewes and lambs thus are key factors influencing how well animals survive the winter in cold climates with a substantial snowcover.

Objectives of this study were to determine if lambs choose a diet similar to that of thier mothers, and to determine if ewes and lambs select forage plants or choose diets proportional to the vegetation on lambing areas.

STUDY AREA

The study area is in southcentral Colorado in Saguache County, approximately 15 to 48 km west of the town of Saguache. The area contains 2 lambing ranges differing greatly in botanical composition as well as elevation. Commonly called Trickle Mountain, the area has been studied by Shephard (1975), and Todd (1975). However nothing has been published on herbage production related to food habits of bighorn ewes and lambs in the area.

Bighorns were indigenous to the Trickle Mountain area but the herd died out in the late 1800s. Bighorns were reintroduced from the Tarryall range in 1951.

BUFFALO ROCKS LAMBING AREA

The Buffalo Rocks lambing area is 48 km west of the town of Saguache north of highway 114. The area used by bighorn ewes for lambing is approximately 625 ha and ranges in elevation from 2682 m to 3238 m. East Pass Creek flows below the south-facing cliffs of the lambing area.

Most of the Buffalo Rocks lambing area is climax montane forest dominated by ponderosa pine (Pinus ponderosa), Douglas fir (Pseudotsuga menziesii), and lodgepole pine (Pinus contorta). Extensive grasslands occur on steep, xeric, south-facing slopes especially along the south edge of the lambing area.

Ewes make frequent use of a lava outcrop on the west boundary of the area. It consists of precipitous rocky cliffs which are south-facing and sparsely covered with rock spirea (Holodiscus dumosus), wax currant (Ribes cereum), and mountain muhly (Muhlenbergia montana). The dominant grass on the eastern 2/3 of the lambing area is Arizona fescue (Festuca arizonica). The entire Buffalo Rocks lambing area is located on U.S. Forest Service Land.

MIDDLE CREEK LAMBING AREA

The Middle Creek lambing area is 15 km west of Saguache just north of highway 114. The area covers approximately 1400 ha between 2418 and 2821 m elevation. The area is bordered by Jack's Creek on the west. Middle Creek

and Cross Creek traverse the area. The area is dominated by blue grama (Bouteloua gracilis). It is located on BLM land with the exception of a riparian zone which is privately owned and harvested for hay.

METHODS

VEGETATION

Fresh ewe fecal pellets were collected at 2-week intervals from 8 May to 28 August 1978, and from 11 May to 24 August 1979 on the Buffalo Rocks lambing area. Lamb fecal pellets were collected concurrently from 1 July to 28 August 1978, and 30 June to 24 August 1979. Ewe fecal pellets were collected at 2-week intervals on the Middle Creek lambing area from 22 May to 11 August 1978, and 11 May to 14 August 1979. Lamb pellets were collected concurrently with ewe pellets from 1 July to 11 August 1978 and 15 June to 14 August 1979. Collections were made only when ewes and lambs were seen on a site to insure freshness and avoid collecting fecal pellets of mule deer (Odocoileus hemionus) or pronghorns (Antilocapra americana). Only as many pellet groups as there were sheep observed were collected on each site. Whenever possible, 15 pellet groups consisting of at least 15 pellets each were collected for ewes and for lambs. Very wet fecal pellets were sprinkled with table salt to prevent decomposition. The maximum time span for a collection period was 10 days.

Fecal pellets were taken to the Composition Analysis Laboratory at Colorado State University, Fort Collins, Colorado, within 14 days of collection. The fecal material was oven dried at 50C for at least 72 hours. Each fecal sample was ground separately and collected over a 1 mm screen. Plan fragments were then treated with household bleach for several minutes and washed with tap water over a 0.1 mm screen. Microscope slides were prepared according to Sparks and Malcheck (1968). One slide was prepared for each pellet group and was treated as one sample. The frequency of each plant taxa occurring in 20 fields for each slide using a 100X microscope was recorded. The frequency of plant fragments was converted to % relative density. Spearman's Rank-Order Correlation Coefficients were calculated for the estimated ewe and lamb diets for each lambing area (Snedecor and Cochran 1976). The % overlap in the diets was calculated using Kulczinski's Similarity Index for each collection period for both years. All plant taxa found in the diets were used for this test. Spearman's Rank-Order test was used to compare the relative abundance of each plant taxa found in th diets with the relative abundance of those taxa on the range. Only plant species comprising at least 2% of the diet were used for this test.

RESULTS

VEGETATION

The Buffalo Rocks lambing area is dominated by mountain muhly and Arizona fescue. The dominant forb is pinque (Hymenoxys richardsonii) and

the most abundant shrub is common juniper (Juniperus communis). Herbaceous standing crop (Table 1) varied among vegetation types. Estimated heraceous standing crop for the Buffalo Rocks lambing area was 561 kg/ha in July 1978, and 266 kg/ha in 1979.

Botanical composition of the Middle Creek lambing area is dominated by blue grama in the dry areas and by sedges in the riparian areas. The most abundant for is annual goosefoot (Chenopodium sp.) and the most common shrub is fringed sagewort (Artemisia frigida). Estimated herbaceous standing crop was 829 kg/ha in 1978.

FOOD HABITS

Diets of ewes and lambs on the Buffalo Rocks lambing area was dominated by mountain muhly, Arizona fescue, true mountain mahogany, and cinquefoil (Potentilla sp.) (Tables 2 & 3) during the summers of 1978 and 1979. Grasses predominated in the early summer diets, whereas browse species increased in the late summer diets.

Diets of ewes and lambs on the Middle Creek lambing area in the summers of 1978 and 1979 were dominated by blue grama and mountain muhly in early summer, and blue grama and sedges in mid-summer. In late summer mountain mahogany and wax currant increased in their diets (Tables 4 & 5).

Table 1. Herbaceous standing crops on the Buffalo Rocks and Middle Creek lambing areas during July of 1978 and 1979.

Lambing Area	Vegetation Type	ha/type	kg/ha 1978 x ± se	kg/ha 1979 x ± se
Buffalo	Mountain shrub	23	455 ± 192	213 ± 109
	Ponderosa pine bunchgrass	446	535 ± 255	233 ± 56
	Aspen	56	749 ± 359	343 ± 96
	Douglas fir[a]	26	345 ± 217	
	Bunchgrass	77	654 ± 149	221 ± 49
	Blue grama	7	864 ± 273	331 ± 100
	Riparian[b]	17		1197 ± 164
Middle Creek[c]	Blue grama ridges	537		1036 ± 412
	Blue grama slopes	775		222 ± 48
	Riparian	100		4424 ± 459

[a] The Douglas fir stand was old growth in which no sheep use was observed, and was not sampled again in 1979.

[b] The riparian type was sampled only in 1979.

[c] The Middle Creek lambing range vegetation was sampled only in 1979.

Table 2. Mean percentages of plant taxa in the diets of bighorn sheep ewes and lambs on the Buffalo Rocks study area in southcentral Colorado, 1978.

Forage Taxa	May	June		July		August	
	Ewe	Ewe	Lamb	Ewe	Lamb	Ewe	Lamb
Grasses and Grasslike Plants							
Agropyron	6	2	4	4	2	2	2
Bouteloua	1	1	2	4	2	9	7
Carex	5	6	7	5	7	3	2
Festuca	17	7	2	3	1	3	2
Juncus	6	1	1	1	0	2	1
Muhlenbergia	16	20	29	39	21	18	19
Poa	7	3	1	2	1	3	1
Forbs and Browse							
Artemisia[a]	18	2	2	1	8	3	4
Cercocarpus	3	24	24	17	18	26	28
Potentilla	4	11	12	7	10	6	5
Rhus	1	8	7	4	5	5	5
Ribes	3	1	2	2	7	2	8
Number of Samples	24	29	10	30	30	30	34

[a] *Artemisia tridentata* made up most of the sages in the Buffalo Rocks bighorn diets whereas *Artemisia frigida* made up most of the Middle Creek bighorn sage portion of the diets.

Table 3. Mean percentages of plant taxa in the diets of bighorn sheep ewes and lambs on the Buffalo Rocks study area in southcentral Colorado, 1978.

Forage Taxa	May	June		July		August	
	Ewe	Ewe	Lamb	Ewe	Lamb	Ewe	Lamb
Grasses and Grasslike Plants							
Agropyron	4	1	1	3	1	1	1
Bouteloua	1	1	1	1	1	3	2
Carex	20	9	8	12	7	4	3
Festuca	27	14	1	9	1	3	1
Juncus	4	1	1	4	1	2	2
Muhlenbergia	7	20	8	11	10	11	10
Poa	5	1	1	1	1	1	1
Forbs and Browse							
Artemisia[a]	6	1	1	1	2	1	1
Cercocarpus	1	16	22	28	30	50	54
Potentilla	10	20	30	9	20	3	6
Rhus	1	7	18	3	7	2	4
Ribes	1	1	1	3	2	2	2
Number of Samples	30	30	15	30	30	30	30

[a] *Artemisia tridentata* made up most of the sages in the Buffalo Rocks bighorn diets whereas *Artemisia frigida* made up most of the Middle Creek bighorn sage portion of the diets.

Table 4. Mean percentages of plant taxa in the diets of bighorn sheep ewes and lambs on the Buffalo Rocks study area in southcentral Colorado, 1978.

Forage Taxa	June		July		August	
	Ewe	Lamb	Ewe	Lamb	Ewe	Lamb
Grasses and Grasslike Plants						
Agropyron	3	7	8	2	1	1
Bouteloua	6	9	10	11	6	4
Carex	14	12	17	14	4	2
Eleocharis	11	1	3	1	1	1
Festuca	8	5	7	2	1	1
Juncus	4	1	7	2	1	1
Muhlenbergia	8	9	4	5	3	3
Oryzopsis	3	2	2	1	1	1
Poa	2	3	3	1	1	1
Forbs and Browse						
Artemisia[a]	3	8	2	8	1	5
Atriplex	2	1	5	6	4	3
Ceratoides	1	5	3	8	1	1
Cercocarpus	4	1	6	3	61	61
Potentilla	7	8	1	2	5	3
Rhus	4	1	7	6	2	3
Ribes	2	5	2	5	1	4
Number of Samples	19	15	30	30	15	15

[a] *Artemisia tridentata* made up most of the sages in the Buffalo Rocks bighorn diets whereas *Artemisia frigida* made up most of the Middle Creek bighorn sage portion of the diets.

Table 5. Mean percentages of plant taxa in the diets of bighorn sheep ewes and lambs on the Buffalo Rocks study area in southcentral Colorado, 1978.

Forage Taxa	May	June		July		August	
	Ewe	Ewe	Lamb	Ewe	Lamb	Ewe	Lamb
Grasses and Grasslike Plants							
Agropyron	1	2	2	1	2	1	1
Bouteloua	7	7	10	23	14	26	29
Carex	26	13	31	16	29	33	27
Festuca	6	4	3	8	5	1	1
Juncus	1	1	1	1	1	1	1
Muhlenbergia	1	1	2	1	1	1	1
Poa	1	1	1	1	1	1	1
Forbs and Browse							
Artemisia[a]	6	1	7	2	5	1	3
Ceratoides	1	24	3	2	1	2	1
Cercocarpus	13	4	6	6	4	1	1
Potentilla	2	4	9	1	2	1	2
Rhus	1	3	3	1	1	1	1
Ribes	9	2	7	9	12	10	14
Number of Samples	30	30	30	30	30	15	15

[a] *Artemisia tridentata* made up most of the sages in the Buffalo Rocks bighorn diets whereas *Artemisia frigida* made up most of the Middle Creek bighorn sage portion of the diets.

DISCUSSION

VEGETATION

The Buffalo Rocks and the Middle Creek lambing areas differ significantly in species composition and herbage production. Herbage production at Middle Creek is higher primarily because of its larger riparian area. Comparison of the areas using Spearman's Rank-Order Correlation Coefficients for plant taxa making up 1% of the standing crops yields a negative value (-0.02) indicating discordance. (Table 6)

COMPARISON OF VEGETATION AND DIETS

Ewe diets were not significantly correlated with forage availability at either lambing area (Table 6). The ewe diet was more similar to the available vegetation at the Middle Creek lambing area than was the case at the Buffalo Rocks lambing area.

FOOD HABITS COMPARISONS

Ewes occupying the Buffalo Rocks lambing area chose similar summer diets in 1978 and 1979. Spearman's Rank-Order Correlation test applied to plant taxa making up 2% in the mean diets gave a coefficient of +0.79 (P 0.01, Table 6). Ewes of the Buffalo Rocks area ate the same forage plants in nearly the same order both years. At Middle Creek, ewe diets in the summers of 1978 and 1979 were less similar (RHO +0.45) and were not significantly correlated. One explanation for the dissimilarity is that moisture condition in the winters of 1978 and 1979 were different, and the summer of 1979 was much drier in the Middle Creek area than in the previous year.

Lambs on the Buffalo Rocks area ate a diet similar to that of their mothers. Diet overlap exceeded 80% during the summers of 1978 and 1979 (Table 7). Similarities between ewe and lamb diets became stronger as the summers progressed. Several factors may explain this trend. Lambs do not travel with the ewes to feed away from escape terrain for the first weeks after they are born, but rather lambs are confined to the lambing rocks with 1-2 ewes who watch them. Consequently, lambs do not have the same choices of forage plants that ewes have. Furthermore, this period coincides with the time that lambs obtain the greater part of their energy needs and nutritive requirements from ewes' milk.

Summer diets on the Middle Creek area also showed similarities between ewes and lambs (Table 8). Diet overlap exceeded 75% in each year. Ewe and lamb diets generally became more similar as the summer progressed, probably for the same reasons cited above.

Dietary overlap betwen Buffalo Rocks and Middle Creek ewes was only 47% for the summer of 1979 (Table 9). Dietary overlap between lambs of the 2 lambing areas was only 30%.

Table 6. Spearman's Rank Order Correlation Coefficients for plant taxa making up 1% or greater of the botanical composition by weight, and for forage taxa 2% or greater in the summer diets of the Buffalo and Middle Creek ewes and lambs.

Comparison	Number of Pairs	RHO Value	Significance
Buffalo R. vs. Middle C. Vegetation of 1979	12	-0.02	none
Buffalo R. ewes 1978 vs. 1979	12	+0.79	$P < 0.01$
Buffalo R. ewes vs. lambs, 1979	23	+0.78	$P < 0.01$
Buffalo R. ewes vs. vegetation, 1979	6	-0.20	none
Middle C. ewes 1978 vs. 1979	16	+0.45	none
Middle C. ewes vs. lambs, 1979	26	+0.78	$P < 0.01$
Middle C. ewes vs. vegetation, 1979	8	+0.57	none

Table 7. Kulczinski's Similarity Indices showing the percentages of dietary overlap between ewes and lambs on the Buffalo Rocks study area, summers 1978 and 1979.

Time Period	% Overlap 1978	1979
June 17 - June 30	76.0	71.0
July 1 - July 14	76.7	63.6
July 15 - July 28	57.2	70.4
July 29 - Aug. 11	71.2	88.0
Aug. 12 - Aug. 25	78.6	82.4
Summer (June 17 - Aug. 25)	84.2	81.9

Table 8. Kulczinski's Similarity Indices showing the percentages of dietary overlap between ewes and lambs on the Middle Creek study area, summer 1978 and 1979.

Time Period	% Overlap 1978	1979
June 17 - June 30	52.9	31.9
July 1 - July 14	60.1	68.5
July 15 - July 28	63.6	61.5
July 29 - Aug. 11	83.7	85.2
Summer (June 17 - Aug. 25)	75.3	76.3

Table 9. Comparison of Buffalo Rocks vs. Middle Creek ewe and lamb diets of the summer of 1979.

Time Period	Percent Overlap Kulczinski's Index	
	Ewes	Lambs[a]
May 6 - May 19	47.4	
May 20 - June 2	32.9	
June 3 - June 16	36.4	
June 17 - June 30	55.4	28.4
July 1 - July 14	38.0	28.8
July 15 - July 28	34.1	35.1
July 29 - Aug. 11	25.9	22.3
Summer (May 6 - Aug. 11)	47.6	30.0

[a] Lamb fecal pellets were not collected until the second half of June.

Table 10. Preference indices for the Buffalo Rocks and Middle Creek bighorn sheep ewes for the summer of 1979.

Lambing Area	Forage Species[a]	Preference Index (% in diet) (% on range)
Buffalo Rocks	Cercocarpus montanus	100
	Carex sp.	1.7
	Muhlenbergia sp.	0.85
	Festuca arizonica	0.65
Middle Creek	Cercocarpus montanus	100
	Festuca arizonica	1.7
	Bouteloua gracilis	0.93
	Carex sp.	0.88

[a] These 4 species were the most important in the ewe diets and accounted for at least 60% of the total diets.

These data suggest tha bighorn ewes and lambs are selective feeders and are more opportunistic than were previously assumed (Capp 1968). Bighorn ewes and lambs do not require a specific vegetation type or specific forage plants in order to thrive. The Buffalo Rocks and Middle Creek areas are quite different in vegetation, herbage production, and elevation, yet they have increased in numbers in both areas.

Even though ewe and lamb diets were similar in composition the qualitative intakes may have been quite different. Langlands (1969) reported that younger domestic sheep tended to select diets higher in protein than did older sheep. The smaller mouth sizes of the lambs may enable them to be more selective of plant parts. Walker, et al. (1981) found the botanical compositions of cow and calf diets to be quite similar, but reported the nutritional quality differences were probably due to plant parts being selected.

FORAGE PREFERENCE

The most preferred forage plant of both ewe groups was true mountain-mahogany (Table 10). Little mountain-mahogany was present on the lambing ranges, and shrubs present on the escape terrains were either decadent or dying form heavy use. Other preferred forages of the ewes and lambs were sedges, mountain muhly, Arizona fescue, and blue grama (Table 10). Most of these forages were consumed especially during early phenological stages. Cook (1977) reported digestible protein values for these plants ranging from 5.8 to 12.3% in the vegetative stage and suggested that digestible protein may be the best single factor determining nutrient quality of range forage. An adequate level of digestable protein for domestic lactating ewes and nursing lambs ranges from 4.7 to 6.8% (Cook 1977). Although lambs are nursed throughout the summer they do learn to select the same forage plants that sustain the ewes.

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