

Michael L. McInnis, Assistant Professor
Dept. of Rangeland Resources, Oregon State University, Corvallis, Oregon 97331

and

Martin Vavra, Superintendent
Eastern Oregon Agricultural Research Center, Burns, Oregon 97220.

Summer Diets of Domestic Sheep Grazing Mountain Meadows in Northeastern Oregon¹

Abstract

Mountain meadows in northeastern Oregon are limited in extent, but are highly productive and can contribute substantial proportions of summer range forage for sheep. Proper range management depends in part on food habits information of animals using specific plant communities. Diets of domestic sheep grazing a dry mountain meadow during July and August were determined by microscopic examination of esophageal extrusa. Concurrent estimates of forage preference and availability were made. Sheep consumed nearly equal proportions of graminoids and forbs throughout the summer. Kentucky bluegrass was the most abundant graminoid in the diets and was preferred during both trials. Less available, but preferred grasses were timothy and prairie junegrass. Together, Northwest cinquefoil and velvet lupine comprised at least 50 percent of available forage throughout summer. Northwest cinquefoil was the most abundant forb in the diets but was not preferred. Velvet lupine was quite unpalatable and formed minor proportions of the diets. Field horsetail and yellow salsify were preferred forbs but contributed little to forage availability. Palatable species were more abundant in the diets on the first day of the trial than on the last because they were apparently consumed early, and became less available as the trial progressed. Daily changes for some forages in the diet were greater than changes between months.

Introduction

Proper rangeland management is partially dependent upon knowledge of livestock food habits. Such information allows manipulation of animals to meet their nutritional requirements and can be used to adjust timing of grazing to improve ecological integrity of the forage base. Food habits data of animals grazing specific plant communities are essential in developing models to predict carrying capacity, animal performance, and forage allocation among sympatric herbivores.

Although diets of domestic sheep (*Ovis aries*) have been studied on mountain meadows in Wyoming (May 1960) and southwestern Montana (Buchanan *et al.* 1972), no published data are available for the Blue Mountains Physiographic Province of northeastern Oregon. Here, rangelands provide three to four months of forage for nearly 100,000 sheep (Skovlin *et al.* 1976). Mountain meadows comprise only about 1 percent of total summer range in eastern Oregon and Washington (Rummell and Holscher 1955), but can produce 20 percent of summer range forage (Reid and Pickford 1946). Further, forage production on a hectare of mountain

meadow is potentially worth 24-37 ha of average timbered range (Reid and Pickford 1946).

The purpose of this study was to determine: (1) diets and forage preferences of sheep grazing a dry meadow in the Blue Mountains Physiographic Province during early July and late August, and (2) daily changes in botanical composition of diets.

Study Area

The study was conducted on the Hall Ranch of the Eastern Oregon Agricultural Research Center near Union, Oregon (Figure 1). The study area was situated in the foothills of the Wallowa Mountains on a 15 percent north facing slope at an elevation of 1,128 m. Mean annual precipitation is 58.4 cm.

The 1.6 ha study area was fenced to create a 0.8 ha holding pasture and eight 0.1 ha experimental pastures. This pasture system was located on a "dry meadow" approximating the description of Hall (1973). Tufted hairgrass (*Deschampsia caespitosa*) typifies climax stands of such meadows (Reid and Pickford 1946). However, Hall (1973) could find none in this condition, presumably because most have deteriorated into other communities as a result of overgrazing

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(Franklin and Dyrness 1973). Reid and Pickford (1946) described four stages of deterioration: (1) perennial grasses, (2) perennial grasses mixed with perennial forbs, (3) perennial forbs, and (4) annual grasses. Vegetal cover was virtually uniform throughout the study area and was dominated by Northwest cinquefoil (*Potentilla gracilis*) and velvet lupine (*Lupinus leucophyllus*). Dominant grasses were Kentucky bluegrass (*Poa pratensis*) and timothy (*Phleum pratense*).

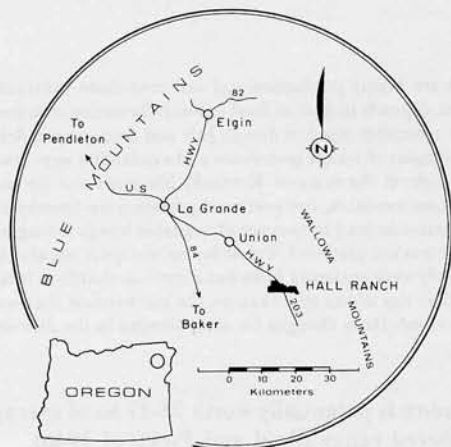


Figure 1. Location of the Hall Ranch near Union, Oregon.

Methods

Examination of esophageal extrusa is an accurate technique for determining diets of grazing animals (Rice 1970, Vavra *et al.* 1978, McInnis *et al.* 1983). Sheep used in this study were all mixed-breed yearlings. Esophageal fistulae were installed in six wethers and two ewes according to the procedures of Harris *et al.* (1967). Closure of these fistulae was accomplished using a removable stainless steel plate onto which was attached a separate rubber stopper. Dietary information was collected during two grazing trials: July 5-11 and August 19-25, respectively defined as early and late summer. Sheep were maintained on the holding pasture for five days before each trial. Following this adjustment period, two sheep were randomly assigned to each of four pastures where they remained for the duration of the trial. Four different pastures were used for the late summer trial. Water, salt, and shade were available at all times.

Prior to dawn of each of the seven consecutive mornings of both trials, sheep were outfitted with

canvas collection bags and allowed to graze for approximately one-half hour. Esophageal extrusa was then collected, and preserved by freezing. Upon thawing, samples were squeezed in cheesecloth to remove saliva, and oven dried at 100°C for 72 hours.

Three microscope slides were prepared for each sample following the procedures of Sparks and Malechek (1968). Each slide was examined at the rate of 20 systematically selected fields at 100x magnification. Identification of plant species was based on comparison with epidermal characteristics of reference material. Frequency of occurrence of each species was converted to percent composition on a dry weight basis (Sparks and Malechek 1968). Dietary composition was averaged by pasture within days for each trial. Data shown are pasture means for all days in each trial. Factorial analysis of variance was used to compare differences among days and trials for each plant species at 95 percent and 99 percent probability levels, using a fixed effects model.

To estimate forage availability, 10 randomly selected 0.446 m² circular plots were caged in every pasture prior to both trials. Green weight of each protected species was estimated (Pechanec and Pickford 1937) immediately following the trial. Samples of each species were collected, weighed, oven dried at 100°C for 48 hours, and reweighed to establish dry weight conversions. Comparison of early vs. late summer forage availability was based on analysis of variance using randomized block design. Data presented are averages for all pastures.

A relative preference index of each forage species was calculated by obtaining the ratio of its mean composition in the diet to its mean composition on the meadow (Van Dyne and Heady 1965, Krueger 1972):

$$\frac{\bar{x} \% \text{ dry weight composition in diets}}{\bar{x} \% \text{ dry weight composition on meadow}}$$

$$\bar{x} \% \text{ dry weight composition on meadow}$$

These authors stated values greater than 1 indicate preference, while values less than 1 indicate avoidance. However, for these inferences to be statistically valid, it is necessary to estimate the error associated with each preference index value (Hobbs 1982). Thus, we constructed 90 percent confidence intervals about each preference

index, and interpreted the results as follows: plants for which endpoints of the interval exceeded unity were considered preferred; plants for which endpoints were less than unity were considered rejected; and plants for which endpoints were greater and less than unity were considered neutral (Hobbs 1982).

Results and Discussion

Eleven species of graminoids and 20 species of forbs were identified in diet samples. Table 1 lists species that comprised at least 1 percent of the diets during early or late summer. Sheep consumed roughly equal amounts of graminoids and forbs during both trials. There was no significant shift in consumption of these forage classes between trials despite significant declines in biomass from early to late summer (Table 2). Our results are consistent with Skiles (1984) who concluded sheep consume nearly equal proportions of graminoids and forbs. Preference indices for graminoids remained moderately high during both trials (1.8 and 1.9, respectively), and were significantly ($p < .10$) greater than unity (Table 1). Preference indices for forbs remained significantly ($p < .10$) less than unity during each trial.

Kentucky bluegrass, timothy, Northwest cinquefoil, field horsetail (*Equisetum arvense*), yellow salsify (*Tragopogon dubius*), and Oregon checkermallow (*Sidalcea oregana*), collectively formed at least 80 percent of the diets throughout summer. Kentucky bluegrass was the most abundant graminoid in the diets during both trials. This species was also the most productive graminoid on the meadow during the early summer trial. There was no significant change in the amount consumed from early to late summer despite a decline in availability. Preference indices for this species were significantly ($p < .10$) higher than unity during both trials and increased from 2.3 in July to 5.6 in August. The proportion of timothy in the diets increased significantly from 10 percent to 13 percent as summer progressed. The preference index for this grass declined from 2.3 during early summer to 1.7 during late summer, but was significantly ($p < .10$) greater than unity only in July. Prairie junegrass (*Koeleria cristata*) was preferred throughout summer, but was limited in availability and comprised only minor proportions of the diets. Sedges (*Carex* spp.) contributed

substantially to the available forage base during July and August (28 percent and 42 percent, respectively, of total graminoid biomass). However, the preference index for sedges was a neutral 1.0 in early summer, and decreased to 0.3 by late summer.

Together, Northwest cinquefoil and velvet lupine accounted for at least 50 percent of total herbage biomass throughout the summer. Northwest cinquefoil was the most commonly consumed forb during both trials. However, preference indices for this species were 0.6 and 0.8 during July and August, respectively. Confidence intervals about these indices demonstrated lack of preference for this forb. Velvet lupine was absent from the diets during early summer, and comprised only 2 percent of late summer diets. Despite the abundance of this forb on the meadow, its slight occurrence in diets made it one of the least preferred forbs studied.

Some forbs were preferred even though their availability on the meadow was low. The preference index for field horsetail was 13.4 during early summer, and 6.9 during late summer. Yet, this forb made up less than 1.5 percent of available herbage on the meadow during either trial. Yellow salsify contributed less than 1 percent of total herbage availability during the July and August trials. However, this forb had the highest preference index of any species throughout the summer despite a significant decline in the amount consumed during late summer. Other preferred forbs were Oregon checkermallow and common dandelion (*Taraxacum officinale*).

Buchanan *et al.* (1972) found greater daily than seasonal changes in diets of sheep grazing mountain meadows in southwestern Montana for many forage species. Our results indicate a similar trend. While there was no significant difference between trials in total graminoid or forb consumption, daily amounts of these forage classes in diets shifted significantly as the trials progressed (Table 2). On the first day of the early trial, sheep consumed diets consisting of 34 percent graminoids and 66 percent forbs (Figure 2). By the last day, the proportion of graminoids increased to 64 percent and forbs declined to 36 percent. Sheep selected more palatable and easily available species early in the trial. As the trial progressed, these apparently became less available, and sheep consumed plants that had previously been less preferred.

TABLE 1. Dietary composition, herbage biomass, and preference of forage species comprising at least 1 percent of sheep diets during early and late summer.

	Early		Late		Dietary Composition ^a (percent Dry Weight)		Dry Weight Biomass ^b (kg/ha)		90 percent Confidence Interval and Preference Rating	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Early	Late
Graminoids										
Kentucky bluegrass	25	1.9	26	2.2	145	11.0	46	3.4	1.2 - 3.4 (P) ^c	3.8 - 7.4 (P)
Timothy	10	1.0	13	1.2	59	18.0	74	40.5	1.0 - 3.6 (P)	0.1 - 3.3 (N)
Sedges	8	1.1	3	0.4	111	26.4	111	14.7	0.5 - 1.3 (N)	0.2 - 0.4 (R)
Prairie junegrass	3	0.6	4	0.4	13	2.7	9	1.2	1.5 - 4.5 (P)	3.5 - 5.3 (P)
Smooth brome	1	0.2	t ^d	0.06	2	1.3	t	t	-17.2 - 30.6 (N)	-
Other grasses	5	0.4	3	0.3	60	25.7	25	1.6	0.0 - 2.2 (N)	0.7 - 1.7 (N)
Total Graminoids	52	3.1	50	2.9	390	55.0	265	36.5	1.4 - 2.1 (P)	1.5 - 2.5 (P)
Forbs										
Northwest cinquefoil	19	3.5	22	1.8	450	113.2	256	56.6	0.3 - 0.9 (R)	0.4 - 1.2 (N)
Field horsetail	9	1.8	9	1.4	9	5.7	13	7.5	3.2 - 30.0 (P)	2.6 - 11.1 (P)
Yellow salsify	10	1.4	5	0.8	5	1.8	3	0.2	12.2 - 41.2 (P)	9.9 - 23.0 (P)
Oregon checkermallow	7	0.9	9	1.3	44	9.8	27	6.7	1.3 - 2.8 (P)	2.0 - 4.5 (P)
Common dandelion	2	0.3	2	0.2	12	2.3	8	4.2	1.0 - 3.3 (P)	-2.4 - 7.4 (N)
Velvet lupine	0	-	2	0.4	218	35.5	299	70.0	-	0.0 - 0.2 (R)
Other forbs	1	0.3	1	0.3	208	53.8	118	16.5	0.0 - 0.1 (R)	0.0 - 0.2 (R)
Total Forbs	48	3.1	50	3.1	946	63.8	724	91.4	0.6 - 0.7 (R)	0.6 - 0.8 (R)
Total	100		100		1,336		989			

^aBased on 28 sheep diets per season.

^bBased on 4 pastures per season, each subsampled with 10 plots.
cp = preferred; N = neutral; R = rejected.

TABLE 2. Results of analysis of variance for differences in dietary composition between trials and among days within trials; and herbage availability between trials.

Species	Dietary Composition			Biomass
	Trial	Days	Trial X Days	
Graminoids				
Kentucky bluegrass	ns ^a	*	*	**
Timothy	*	ns	*	ns
Sedges	**	ns	ns	ns
Prairie junegrass	ns	**	ns	*
Smooth brome	**	ns	ns	ns
Other grasses	*	*	ns	**
Total Graminoids	ns	*	ns	*
Forbs				
Northwest cinquefoil	ns	ns	ns	*
Field horsetail	ns	ns	ns	ns
Yellow salsify	**	**	ns	ns
Oregon checkermallow	ns	**	ns	ns
Common dandelion	ns	ns	ns	ns
Velvet lupine	**	*	ns	ns
Other forbs	ns	**	ns	**
Total Forbs	ns	**	ns	**

^ans, *, and ** respectively refer to not significant, significant at the 95 percent probability level, and significant at the 99 percent probability level.

Three species collectively formed 51 percent of the diets on the first day of the early trial: timothy (14 percent), field horsetail (15 percent), and yellow salsify (22 percent). These species were highly palatable, but totaled only 5.5 percent of the available forage. By the last day of the trial, this group of forages totaled only 19 percent of the diets. Dietary amounts of all three species declined significantly as the early trial progressed, but only yellow salsify declined significantly through both trials (Table 2). Preference indices for these species during early summer indicate high palatability throughout the trial. The daily decline in proportions consumed apparently

reflects diminished availability as the trial progressed.

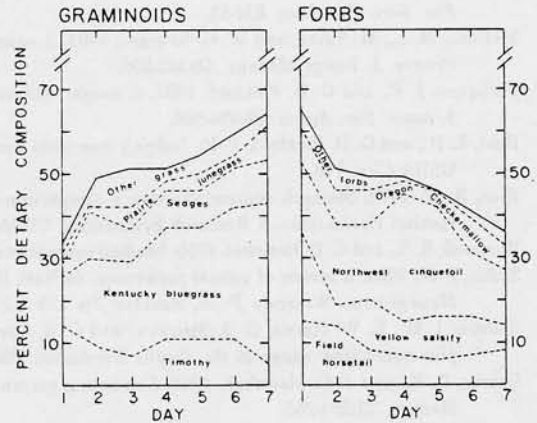


Figure 2. Daily changes in percent dietary composition of graminoids and forbs for the early summer trial.

Preference indices for Kentucky bluegrass, sedge, and Northwest cinquefoil on the first day of the early trial were 1.1, 0.4, and 0.5, respectively. Despite their low palatability, these species totaled more than 52 percent of available forage, and collectively formed 31 percent of the diets on the first day. As the trial progressed, proportions of favored species diminished in the diets and were replaced by less favored but more abundant species, notably Kentucky bluegrass. A similar, though less pronounced trend was observed during the late summer trial.

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