Seasonal Forage Production and Quality on Four Native and Improved Plant Communities in Eastern Oregon

Technical Bulletin 149

AGRICULTURAL EXPERIMENT STATION

Oregon State University
Corvallis, Oregon

September 1985

Contents

Literature Review 2
Improvement Potentials 2
Forested range 2
Mountain meadow 3
Grassland 3
Methods for Sampling Forage 4
Production 4
Forage quality 4
Forage quality parameters 5
Study Sites 5
Materials and Methods 6
Field and Laboratory Techniques 6
Statistical Analysis 8
Results and Discussion 8
Standing Crop Production 8
Forage Quality 12
Conclusions 17
Literature Cited 18
Appendix 21

AUTHORS: Tony Svejcar, former graduate student of Oregon State University, Eastern Oregon Agricultural Research Center, Union and Burns, Oregon, is currently range scientist, USDA-ARS Research Center, El Reno, Oklahoma. Martin Vavra is professor of range nutrition, Oregon State University, and Superintendent, Eastern Oregon Agricultural Research Center, Union and Burns, Oregon.

ACKNOWLEDGMENT: Funding for this project was provided by the Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, PNWFRES Project 1701.

Seasonal Forage Production and Quality on Four Native and Improved Plant Communities in Eastern Oregon

Tony Svejcar and Martin Vavra

ABSTRACT

Seasonal trends in forage quality and production were studied on improved and unimproved portions of four plant communities in eastern Oregon. The range improvements consisted of seeding and/or thinning. Improvement doubled forage production on the lodgepole pine site (thinned but not seeded), tripled production on the grassland and moist meadow sites (both seeded), and caused a sixfold rise in forage production on the mixed conifer site (thinned and seeded). However, only in the case of the grassland did range improvement lengthen the period when forage provided adequate nutrition for growth of yearling cattle; the improved nutrition can be attributed primarily to inclusion of a legume (alfalfa) in the seeding mixture. On the forested sites, thinning tended to cause forage to mature earlier and thus decline in forage quality faster than on unthinned controls.

Forestlands will face increasing demands for wood and red meat production and for wildlife habitat (Forest and Range Task Force 1972). Box (1974) stated red meat production would increase in the future, with the increase coming primarily from rangelands. Vavra and Raleigh (1976) reported little concern for efficient production of red meat on rangelands. Interior Northwest forestlands historically have been managed for multiple use. Livestock grazing and timber management coexist on most forestlands. Cattle grazing has existed as a secondary enterprise, however, and little attention has been paid to the commodity outputs of livestock production.

Timber harvest has the potential to increase forage production (Young 1965, Miller and Krueger 1976). However, research (Vavra and Phillips 1979 and 1980, Holechek and others 1981) has indicated forage quality is insufficient for animal production and maintenance during certain periods of the grazing season. All classes of cattle—mature cows, calves, and yearlings—may actually lose weight on range, usually during the latter portion of the grazing season.

This study was conducted to determine how cultural practices influenced forage quality and standing crop on several plant communities. Cultural practices studied were: (1) plowing and reseeding xeric grasslands and mesic meadows; (2) precommercial thinning of forest; and (3) commercial timber harvest followed by forage seeding.

LITERATURE REVIEW

Improvement Potentials

On forested ranges the combination of timber harvest and reseeding herbaceous species can greatly improve the quantity of forage produced per hectare. A large body of data exists on the increased kilograms per hectare (kg/ha) or animal unit months per hectare (AUM/ha) obtained, but little information is given on quantity and quality of forage and the seasonal change that occurs. Rummell and Holscher (1955) provided a guide for seeding summer range areas of eastern Oregon and Washington. The authors identified 6 million hectares of forested range, 607,100 hectares of grasslands, 280,300 hectares of mountain meadows, and 400,700 hectares of subalpine grassland in the two-state area termed "summer range." They also stated that the forage demands of domestic livestock and wild herbivores in this area were not being met.

Forested range

Although several distinct habitat types fall into the category "forested," this discussion will consider all such types that have 50 percent or more canopy cover. Most of these types are characterized by a lack of understory herbage production (< 121 kg/ha) because of shading (Wood 1972).

Young (1965) reported an increase in forage production after logging on three overstory classifications. Heavy shade, intermediate shade, and sunspots in a mixed conifer forest produced 67, 145, and 290 kg/ha respectively prior to logging. After logging, the understory produced 78, 213, and 426 kg/ha respectively for the three shade classes studied. McConnell and Smith (1970) observed an increase in understory production when dense stands of ponderosa pine *(Pinus ponderosa)* were thinned. Four-meter tree spacing produced 79 percent more forage than unthinned stands and 7.9-meter spacings increased forage by 246 percent. Stuth and Winward (1976) studied logged and unlogged lodgepole pine *(Pinus contorta)* stands in central Oregon. During 1973 and 1974 unlogged stands produced 13.7 and 20.0 kg/ha respectively, while logged stands produced 64.9 and 141.1 kg/ha.

In lodgepole pine, Engelmann spruce *(Picea engelmanni),* and Douglas-fir *(Pseudotsuga menziesii)* stands in British Columbia, McLean and Clark (1980) found that logging followed by grass seeding further increased forage production. Seeded clearcuts produced two to four times more forage per hectare than unseeded areas. Seeded forage production averaged 590 to 1,540 kg/ha for the 5 years studied. Pinegrass dominated the unseeded clearcuts, and orchardgrass and timothy were the seeded species. Miller and Krueger (1976) also reported that reseeded clearcuts produced 10 times as much forage as uncut stands. In a pasture where 31 percent of the area was clearcut, cattle derived 63 percent of their forage from the reseeded clearcut.

Mountain meadow

Although extensive hectareage of mountain meadows does not exist (Rummell and Holscher 1955), production on this type of plant community often is more than 5 to 10 times that of neighboring forest range (Pickford and Reid 1948). However, meadows often suffer from past or present abuse caused by grazing and tillage (Hull and others 1958). Desirable perennial grasses are often replaced by annuals or by less desirable grasses, weeds, and shrubs (Hull and others 1958). Rummell and Holscher (1955) listed *Wyethia* species and California false hellebore *(Veratrum californicum)* as important species that dominate meadows in poor condition.

Siemer and others (1972) studied mountain meadows in Colorado and found forage production varied from 1,570 to 6,726 kg/ha, depending on plant community sampled. Plant communities studied were (in ascending order of production) rush, sedge-rush, grass-sedge-rush, grass-sedge, and sedge. Eckert (1975) reported that meadows in poor condition could be made as productive as meadows in good condition by reseeding.

Grassland

Hull and others (1958) reported that mountain grasslands were often in depleted condition and contained undesirable plant species that were not productive. Most of the desirable species had been removed through past abuse. Reseeding often resulted in greatly increased production, however. An example given was a seeding of crested wheatgrass *(Agropyron desertorum),* smooth bromegrass *(Bromus inermis),* and yellow sweetclover *(Melilotus officinalis)* that produced 3,363 kg/ha. Rummell and Holscher (1955) reported that eastern Oregon and Washington grasslands were often in poor condition and were dominated by Sandberg bluegrass *(Poa sandbergii),* bottlebrush squirreltail *(Sitanion hystrix),* cheatgrass *(Bromus tectorum),* cluster tarweed *(Madia glomerata),* curlycup gumweed *(Grindelia squarrosa),* and St. Johnswort *(Hypericum* spp.). Reseeding resulted in increased productivity but was dependent on soil depth and annual precipitation. Forage production on reseeded sites was from 1,121 to 4,680 kg/ha, depending on species seeded and annual precipitation. Turner and Paulsen (1976) found that mountain grassland in good condition in the Central Rockies produced 1,121 to 2,242 kg/ha. They also suggested reseeding with grasses and legumes for grasslands in poor condition.

Methods for Sampling Forage

Production

In the western United States forage production is limited to specific times of the year (Vavra and Raleigh 1976). In the Pacific Northwest most annual production is limited to the spring-early summer period because of the lack of continuing precipitation during the summer months.

Several techniques exist for measuring the amount of annual forage production (Brown 1954, Pieper 1978). Because clipping and weighing samples of forage standing crop were time-consuming and tedious, Pehanec and Pickford (1937) devised the weight-estimate technique. This method has been used successfully on a wide range of plant communities. Miller and Krueger (1976) used the technique successfully on forested range that varied from 71 to 2,242 kg/ha.

The standing crop of vegetation present on a given plant community changes from year to year (Campbell 1937) and also throughout any given year (Box 1960, Ratliff and Heady 1962). Where species diversity is large, production of individual species may reach peaks at different times (Ratliff and Heady 1962). Cultural treatments such as logging and reseeding may cause fluctuations in forage production for many years. McLean and Clark (1980) found that a reseeded forest clearcut produced increasing forage yields for the first 5 years after seeding. Productivity should then remain somewhat stable until the tree canopy encloses the area (about 20 years).

Forage quality

Forage quality typically exhibits seasonal trends on most range types in the western United States (Vavra and Raleigh 1976). Although not as well documented, forage quality can vary significantly at a given point in time from one plant community to another in the same geographic or precipitation pattern area (Holechek and others 1981).

Cook and Harris (1968) studied livestock performance on desert, foothill, and mountain ranges in Utah. Desert ranges were best grazed in winter because of less severe weather and availability of forage. Foothill ranges were grazed most efficiently in the spring and mountain ranges in the summer. Valentine (1967) integrated plant communities and ranges in different condition classes on the Jornada Experimental Range in New Mexico and reported an increase in livestock production over conventional grazing. Smoliak (1968) rotated yearling steers through crested wheatgrass, Russian wildrye *(Elymus junceus),* and native range pastures to produce 2.2 times more beef than native range alone. Currie (1969) rotated cow-calf pairs through meadow, crested wheatgrass, and native range in Colorado to increase calf gains by 15 kg over those on native range alone.

Vavra and Phillips (1979, 1980) reported that beef production could be increased in late summer if cattle were moved from pastures dominated by ponderosa pine-pinegrass *(Calamagrostis rubescens)* to subirrigated native meadows or timbered north slopes. On the meadows, forage quality was high because of adequate soil moisture; forages on the north slopes were less mature than those on the south slopes and therefore higher in quality.

Forage quality parameters

Various chemical constituents of forage have been used to evaluate nutritional quality. Historically the Weende System of Proximate Analysis was used to determine the nutritional quality of feeds (Crampton and Harris 1969). The feed was divided into water, ether extract, crude fiber, nitrogen-free extract, crude protein (CP), and ash components. Tilley and Terry (1963) provided a technique to determine the *in vitro* dry matter digestibility (IVDMD) of forages. Van Soest (1964) questioned the use of the Weende System, particularly the crude fiber portion, and its worth to nutritional value.

Van Soest and Wine (1967, 1968) provided new techniques for the determination of the various components of the fibrous portion of feeds. Summative equations were developed subsequently to relate the various components to digestibility (Crampton and Harris 1969). Most of the fiber components commonly measured, however, do not correlate well with animal performance (average daily gain). Holechek (1980), working on mountain rangeland in northeastern Oregon, found IVDMD more closely related to animal performance than CP, acid detergent fiber, or lignin. In a review of the literature Holechek and others (1982) reported that for simple diets or individual forages CP and IVDMD gave good estimates of animal performance; CP did not when animal diets were high in browse.

STUDY SITES

Four sites representing contrasting community types were used in this study. According to the plant community guide of Hall (1973), the sites belonged to the following plant community types: (1) moist meadow; (2) bunchgrass on deep soil, gentle slopes; (3) lodgepole pine-pinegrass, huckleberry *(Vaccinium scoparium);* and (4) mixed conifer-pinegrass-ash soils. A portion of each site had been improved, with the remaining portion serving as a control. The moist meadow, bunchgrass grassland, and mixed conifer sites had been seeded; in addition, both forested sites had been logged. Thus the mixed conifer site had been commercially logged and seeded, the lodgepole pine site only precommercially thinned. The improvements were not uniform in age—1980 was the third growing season for the mixed conifer and grassland, the lodgepole pine site had been thinned 15 years prior to our first sampling, and the meadow had been seeded several times (the last seeding was at least 10 years before the first sampling).

Diameter breast height (dbh) and number of trees were measured on improved and unimproved portions of the two forested sites. Two square plots measuring 30.5 meters on a side were established in both the improved and unimproved mixed conifer sites, and in the improved lodgepole site. The plot size was reduced to 7.6 meters on a side in the unimproved lodgepole pine site because of the excessive number of trees. Within each plot, all trees were counted and measured for dbh. On the mixed conifer site, trees taller than 60 cm with dbh less than 10.0 cm were counted as saplings. Grand fir *(Abies grandis)* dominated the improved mixed conifer site (48% composition), but western larch *(Larix occidentalis)*, ponderosa pine, and Douglas-fir were also present. The unimproved site was dominated by Douglas-fir (67% composition), but also contained the other three tree species. Diameter breast height and trees per hectare on the two forested types are presented in Table 1. A list of major forage species sampled from each site appears in Table 2.

Table 1. Average diameter breast height (dbh), trees per hectare, and saplings per hectare for improved and unimproved mixed conifer and lodgepole pine community types

	Mixed conifer			Lodgepole pine[1]	
	dbh	Trees/ha	Sapling/ha	dbh	Trees/ha
	cm	*no.*	*no.*	*cm*	*no.*
Unimproved	24.5	428	95	8.9	2,867
Improved	25.3	277	9	18.3	489

[1]The lodgepole pine stand was uniform and considered even-aged, so no attempt was made to separate trees and saplings.

Monthly precipitation on a reference site in Grant County is presented in Table 3. Both years of the study were well above average in precipitation. However, average monthly maximum temperature for April was higher in 1980 (16.1°C) than in 1981 (13.6°C); the same was true for May (average maximum was 15.8° and 17.7°C) of 1981 and 1980, respectively.

MATERIALS AND METHODS

Field and laboratory techniques

Standing crop of each of the major forage species listed in Table 2 was determined by using a double sampling technique (NAS-NRC 1962). On each sampling date a total of 60 plots measuring 50 cm on a side were recorded on improved and unimproved sites within each community type.

Table 2. Forage species sampled on improved and unimproved sites in each of the four plant community types

Site and species	Community type
	GRASSLAND
Unimproved sites	
Bluebunch wheatgrass *(Agropyron spicatum)*	
Idaho fescue *(Festuca idahoensis)*	
Sandberg bluegrass *(Poa sandbergii)*	
Junegrass *(Koleria cristatam)*	
Improved sites	
Intermediate wheatgrass *(Agropyron intermedium)*	
Alfalfa *(Medicago sativa)*	
	MOIST MEADOW
Unimproved sites	
Cinquefoil *(Potentilla* sp.)	
Wyethia *(Wyethia amplexicaulis)*	
Improved sites	
Intermediate wheatgrass *(Agropyron intermedium)*	
Timothy *(Phleum pratense)*	
Smooth bromegrass *(Bromus inermis)*	
	MIXED CONIFER
Unimproved sites	
Pinegrass *(Calamagrostis rubescens)*	
Snowberry *(Symphoricarpos albus)*	
Improved sites	
Timothy *(Phleum pratense)*	
Orchardgrass *(Dactylis glomerata)*	
	LODGEPOLE PINE
Unimproved site	
Pinegrass *(Calamagrostis rubescens)*	
Improved site	
Pinegrass *(Calamagrostis rubescens)*	

Only current year's growth of shrubs was sampled. Sampling dates varied from site to site depending on the typical growth period of the site and, consequently, on the period important for livestock grazing. Sites were sampled monthly during the period generally most important for standing crop production (Table 4). Sites were sampled until peak standing crop was achieved. Exclosure cages were used if cattle grazing occurred during the sampling period.

Table 3. Monthly precipitation recorded at Long Creek, Grant County, Oregon[1]

	Precipitation (cm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980....	5.3	1.9	4.7	2.5	5.0	6.3	2.2	0.6	4.3	1.7	4.5	6.0	45.0
1981....	1.4	4.5	6.4	4.7	10.8	4.3	1.2	—	2.9	4.0	5.4	10.8	56.4
10-year average....	3.0	2.4	3.1	3.6	4.3	2.7	1.4	2.4	2.3	3.0	3.4	4.3	35.9

[1]This recording station is closest to the grassland site, and actual values may not be representative for other sites.

Table 4. Approximate sampling dates for plant community types

Date	Grassland	Moist meadow	Mixed conifer	Lodgepole pine
4/20	X			
5/20	X			
6/20	X[1]		X	X
7/20	X	X	X	X
8/20		X[1]	X[1]	X[1]
9/20		X	X	X

[1]Period during which peak standing crop was attained.

Forage samples also were collected on each of the sampling dates listed in Table 4. Four transects were established on each of the improved and unimproved sites, and forage samples were collected for each species along each of these transects. Thus there were four samples for each species on each date. Plants were clipped to approximately 50 percent utilization. Samples were analyzed for CP using a macro-kjeldahl technique (AOAC 1970) and for IVDMD using a modified Tilley and Terry (1963) technique.

Statistical analysis

Two-way analysis of variance was used to test differences in main effects for date and species and date x species interaction of percent CP and IVDMD within each study site and year of collection (Steel and Torrie 1980).

RESULTS AND DISCUSSION

Standing Crop Production

On the two unforested community types (grassland and meadow), range improvements resulted in large differences in measured standing crops (Table 5). By June 25, 1980, the unimproved grassland had a total standing crop of 766 kg/ha, whereas that of the improved site was 2,773

Table 5. Standing crop (kg/ha) for important forage species on improved and unimproved grassland and meadow sites[1]

GRASSLAND					
	Unimproved			Improved	
Sampling date	Bluebunch wheatgrass	Idaho fescue	Sandberg bluegrass, junegrass	Intermediate wheatgrass	Alfalfa
		kg/ha		kg/ha	
1980					
April 25	28	43	43	224	70
May 25	194	221	130	1,303	994
June 25	256	360	150	1,549	1,224
1981					
April 25	24	49	40	124	21
May 25	64	86	92	327	202
June 25	170	208	163	932	743

MEADOW			
	Unimproved[2]		Improved
	Cinquefoil	Mule's ear wyethia	Timothy, smooth bromegrass, intermediate wheatgrass[3]
		kg/ha	kg/ha
1980			
July 25	236	60	1,088
August 25	314	—	1,412
1981			
July 25	281	181	997
August 25	—	—	1,264

[1]Sampling dates approximate.
[2]Missing points indicate plants had senesced and were unavailable.
[3]These three species were approximately equal in abundance.

kg/ha. The values on June 25, 1981, were 541 and 1,675 kg/ha for unimproved and improved sites, respectively. Thus the improvement resulted in production of 3.6 and 3.1 times more forage than the unimproved pasture for 1980 and 1981, respectively. Bartel and others (1975) reported mean annual production of intermediate wheatgrass-alfalfa pastures in southwestern Colorado to be 3,288 kg/ha, indicating that this combination can be highly productive. Both improved and unimproved sites had good stands of forage species, and differences in standing crop were directly attributable to the greater potential of introduced species. Introduced species generally are selected for production potential (Vallentine 1971). Both years of the study were well above average in precipitation. The relative differences between native and introduced species may be less under more droughty conditions. Studies in western Canada suggest that alfalfa may be lost from a stand under dryland grazing conditions (Lodge 1971, Cooke and others 1973).

On the meadow site, both species differences and prior management must be considered in evaluating the influence of range improvement. The unimproved meadow site was in poor condition and contained almost no grass plants. Rummell and Holscher (1955) found a similar situation on meadows in poor condition that they examined in eastern Oregon and Washington. The forbs that dominated the unimproved site tended to senesce during midsummer, making forage unavailable for both grazing and clipping. Thus, seeding provided a substantial increase in forage availability during late summer. During the periods before forbs senesced, introduced species produced 2.2 to 3.7 times more standing crop (Table 5). In the study region moist meadows generally are grazed from mid to late summer because they are easily compacted up to that point. The data presented here point to a major problem encountered in deteriorated meadows—forage may disappear soon after the meadows can be grazed safely. Pickford and Reid (1948) noted that wet meadows in good condition are capable of producing 5 to 10 times more forage for summer grazing than timbered range. Thus, meadows in poor condition represent a major loss in potential forage production. Range improvement probably would not result in as great a relative increase in standing crop production if compared to a meadow in good condition.

Standing crops on the two forested communities are presented in Table 6. The differences in standing crop on the improved and unimproved lodgepole pine sites resulted from removal of overstory. Thinning increased the peak standing crop of pinegrass 47 and 134 percent during 1980 and 1981, respectively. In northeastern Oregon, Young (1965) found that pinegrass growing in sunspots produced 2.0 and 4.3 times more forage than when it was grown under intermediate and heavy shade, respectively. Stuth and Winward (1976) observed dramatic increases in understory production when lodgepole pine stands in central Oregon were logged.

The increase in standing crop production on the improved versus unimproved mixed conifer site can be associated with both thinning of overstory and seeding of introduced species. At peak standing crop the improved site produced 6.6 and 6.2 times more than the unimproved site for 1980 and 1981, respectively.

Tree cover has been shown to greatly influence understory production. McConnell and Smith (1965, 1970) measured major increases in understory production when ponderosa pine stands were thinned. Dodd and others (1972) found a highly significant ($p < 0.01$) correlation between tree

Table 6. Standing crop (kg/ha) for important forage species on improved and unimproved lodgepole pine and mixed conifer sites[1]

Sampling date	LODGEPOLE PINE	
	Unimproved	Improved
	Pinegrass	Pinegrass
	kg/ha	*kg/ha*
1980		
June 25	37	95
July 25	86	148
August 25	116	170
1981		
June 25	42	156
July 25	82	201
August 25	89	208

	MIXED CONIFER			
	Unimproved		Improved	
	Pinegrass	Snowberry	Orchardgrass	Timothy
	kg/ha		*kg/ha*	
1980				
June 25	64	61	328	348
July 25	98	114	997	1,034
August 25	201	207	1,324	1,356
1981				
June 25	85	64	251	250
July 25	82	115	555	466
August 25	110	141	778	788

[1]Sampling dates approximate.

crown cover and total herbage production in coniferous stands in British Columbia. The value of complete overstory removal (clearcutting) to grazing was demonstrated by Basile and Jensen (1971) and McLean and Clark (1980).

Forage Quality

The potential of range improvements for increasing forage production has been well documented (Vallentine 1971). However, the influence of improvement practices on forage quality has not received much attention. Both quality and quantity of forage are important to livestock, and quality is especially important if the animals are growing. Forage quality was evaluated both on the basis of CP and IVDMD, since both can limit the potential for livestock production.

Seasonal forage quality on improved and unimproved grassland sites is presented in Table 7. The analysis of CP and IVDMD data indicates significant ($p < .01$) main effects for date and species. There was no date by species interaction. In this analysis Idaho fescue and bluebunch wheatgrass were the only unimproved grassland species considered. If we consider the three major forage grasses—bluebunch wheatgrass, Idaho fescue, and intermediate wheatgrass, CP values were similar, particularly during 1980. Sandberg bluegrass always had the lowest CP values of any grassland species tested. Several studies cited by Skovlin (1967) also indicated that Sandberg bluegrass was lower in CP than associated bunchgrasses. Data from Willms and others (1980) also indicated bluebunch wheatgrass had CP levels 47 percent higher than Sandberg bluegrass during the April-May period. As Skovlin (1967) mentioned, Sandberg bluegrass starts growth earlier than the other species. Junegrass exhibited a variable response, with relatively low CP values in 1980 and relatively high values in 1981. Crude protein of both Sandberg bluegrass and junegrass tended to decline more rapidly than in the other species. The CP content of alfalfa (Table 7) was 1.6 to 2.6 times higher than that of any of the grass species. The difference between alfalfa and grass was most evident late in the season when the grasses became deficient in CP. As an example of adequate CP, a 300-kg growing heifer would require at least 7.8 percent CP in the diet to gain weight (NAS-NRC 1976). Because of its high CP content, alfalfa is critical to sustaining beef production in this plant community as the season advances.

The trends in IVDMD were somewhat different than those of CP. The combined digestibilities of Sandberg bluegrass and junegrass were equal to or greater than that of bluebunch wheatgrass and Idaho fescue until the last sampling date. Bluebunch wheatgrass was more digestible than Idaho fescue, and junegrass was slightly more digestible than Sandberg bluegrass. When improved and unimproved species were compared, both

Table 7. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for species on improved and unimproved sites of the grassland community type

Site and species	Approximate sampling dates: April 25, 1980 CP	IVDMD	May 25, 1980 CP	IVDMD	June 25, 1980 CP	IVDMD	July 25, 1980 CP	IVDMD
	%		%		%		%	
Unimproved								
Bluebunch wheatgrass	18.3	68.6	11.5	67.6	9.5	61.8	6.0	46.5
Idaho fescue	19.8	69.1	11.5	61.4	9.2	56.3	6.0	44.5
Sandberg bluegrass	17.9	74.9	6.6	60.1	6.1	56.5	2.6	38.1
Junegrass	—	—	8.3	67.4	8.7	58.0	3.9	38.9
Improved								
Intermediate wheatgrass	19.1	75.5	12.8	70.8	9.3	66.9	6.5	51.9
Alfalfa	31.2	76.2	26.9	77.7	24.3	74.6	15.8	64.0
	April 25, 1981		May 25, 1981		June 25, 1981		July 25, 1981	
Unimproved								
Bluebunch wheatgrass	16.9	67.2	14.2	70.5	10.8	59.0	7.9	50.5
Idaho fescue	16.3	66.7	11.9	63.8	10.0	58.6	4.5	43.7
Sandberg bluegrass	15.0	72.7	9.4	67.5	8.2	63.8	2.3	41.6
Junegrass	20.0	73.4	15.6	72.3	10.5	65.4	4.0	44.9
Improved								
Intermediate wheatgrass	20.8	77.9	11.5	75.0	12.5	71.1	9.0	58.2
Alfalfa	35.7	77.1	31.1	77.6	26.3	77.3	19.3	69.8

of the species from the improved site were always higher in digestibility than any of the species from the unimproved site. The differences were most apparent during the second half of the sampling period, when IVDMD was generally deficient. Again, using NAS-NRC tables, a 300-kg growing heifer would require forage with a digestibility of approximately 60 percent to obtain the energy necessary for weight gain.

Alfalfa maintained a digestibility in excess of requirements throughout the growing season, whereas IVDMD for intermediate wheatgrass declined to a much greater extent. White and Wight (1981) also found that dryland alfalfa maintained relatively high digestibility late into the season. In the present study, digestibility of alfalfa declined 12.2 and 7.3 percent during the sampling periods for 1980 and 1981, respectively. Intermediate wheatgrass digestibility declined 23.6 and 19.7 percent respectively during the same period in 1980 and 1981.

Forage quality on improved and unimproved sites of the moist meadow can be compared only on half of the sampling dates because of forb senescence (Table 8). Data from the moist meadow were analyzed only for 1980, since the forbs senesced after the first sampling date of 1981. The CP and IVDMD data both had significant ($p < 0.01$) main effects for date

Table 8. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for species on improved and unimproved sites of the moist meadow community type[1]

Site and species	Approximate sampling dates					
	July 25, 1980		Aug. 25, 1980		Sept. 25, 1980	
	CP	IVDMD	CP	IVDMD	CP	IVDMD
	%		%		%	
Unimproved						
Mule's ear wyethia	11.1	75.7	6.0	74.3	—	—
Cinquefoil	11.3	66.7	5.5	54.4	—	—
Improved						
Intermediate wheatgrass	10.0	74.6	4.8	63.1	3.3	52.5
Timothy	8.7	68.7	4.5	58.8	2.3	47.4
Smooth bromegrass	11.9	69.6	4.5	59.7	2.4	50.5
	July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved						
Mule's ear wyethia	10.8	83.3	—	—	—	—
Cinquefoil	10.1	60.4	—	—	—	—
Improved						
Intermediate wheatgrass	9.3	74.2	5.2	56.5	3.2	48.9
Timothy	8.5	74.7	4.9	59.4	3.6	51.8
Smooth bromegrass	11.2	76.3	6.6	60.0	3.5	50.7

[1]Some dates are missing on unimproved sites because species senesced and could not be sampled.

and species, as well as a significant date x species interaction. The CP values of the forbs on the unimproved site were at least 10.0 percent on the first sampling during both years. However, CP values dropped about 50 percent by the end of August 1980. On the other dates, forbs had dried and shattered and were unavailable. The improved species also had adequate CP levels on the first sampling date (July 25). The improved species did not cure at CP levels that would be adequate to maintain weight gains in growing cattle; values were deficient by August 25. Similarly, Heinrichs and Carson (1956) found intermediate wheatgrass and smooth bromegrass had 4.2 and 7.3 percent CP, respectively, at the mature seed stage.

Digestibility values followed trends similar to those for CP. Two points of interest in the IVDMD data were: (1) wyethia was much more digestible than cinquefoil, and (2) digestibility of improved species approached levels sufficient to maintain some livestock weight gain into the second sampling period (August 25).

On the mixed conifer site, the unimproved species had higher CP levels than the introduced species (Table 9). Analysis of CP and IVDMD data indicates that date, species, and date x species interaction were

Table 9. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for species on improved and unimproved sites of the mixed conifer community type

Site and species	Approximate sampling dates							
	June 25, 1980		July 25, 1980		Aug. 25, 1980		Sept. 25, 1980	
	CP	IVDMD	CP	IVDMD	CP	IVDMD	CP	IVDMD
	%		%		%		%	
Unimproved								
Pinegrass	12.8	63.5	12.0	54.1	10.4	50.7	8.3	48.8
Snowberry	12.2	62.7	10.4	55.6	10.0	60.9	6.5	54.7
Improved								
Timothy	10.9	70.5	8.7	59.9	8.5	53.6	3.1	48.7
Orchardgrass	10.3	72.0	7.3	59.9	10.4	52.9	4.9	49.2
	June 25, 1981		July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved								
Pinegrass	15.6	63.3	12.9	52.9	10.8	50.5	7.2	50.1
Snowberry	16.5	65.3	12.6	62.9	10.9	62.3	7.6	63.0
Improved								
Timothy	12.0	72.5	9.8	54.9	6.2	48.9	3.8	46.9
Orchardgrass	13.9	69.1	8.1	56.3	6.7	51.9	5.2	52.0

significant ($p<0.01$) for both years. This trend was particularly evident during 1981 when both of the unimproved species had higher CP levels than either of the improved species on all four sampling dates. The unimproved species maintained adequate CP levels later into the season than did the improved species. McLean and Clark (1980) compared CP levels on pinegrass, orchardgrass, and timothy growing on a clearcut in British Columbia. They found pinegrass had higher CP than the other species from late June to mid-August, and attributed the difference to the faster rate of maturity of the introduced species.

The two introduced grasses had digestibility values equal to or greater than those of pinegrass. The digestibility of the introduced grasses was higher than that of pinegrass on the first sampling date (June 25) of both years. McLean and Tisdale (1960) cited high crude fiber content as a potential problem with the forage value of pinegrass. Snowberry, on the other hand, maintained higher digestibility than any of the grasses during the last half of the sampling period. Apparently, snowberry either cured at higher digestibility levels than the grasses or remained physiologically active longer.

The lodgepole pine site for this study was unique in that the same single forage species dominated both the improved and the unimproved sites. Pinegrass on the unimproved site had higher CP levels on all sampling dates during both years (Table 10). During both 1980 and 1981

Table 10. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for pinegrass on improved and unimproved sites of the lodgepole pine community type

Site and species	Approximate sampling dates							
	June 25, 1980		July 25, 1980		Aug. 25, 1980		Sept. 25, 1980	
	CP	IVDMD	CP	IVDMD	CP	IVDMD	CP	IVDMD
	%		%		%		%	
Unimproved								
Pinegrass	16.7	66.2	12.7	55.1	10.8	48.8	7.2	51.9
Improved								
Pinegrass	14.8	63.9	11.5	53.3	9.2	50.1	4.9	46.6
	June 25, 1981		July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved								
Pinegrass	18.3	62.6	12.5	54.9	10.9	51.6	8.2	49.7
Improved								
Pinegrass	15.3	60.2	10.7	55.5	8.4	50.8	5.3	47.6

there were significant ($p < 0.01$) main effects of date and treatment, but no significant ($p > 0.05$) interaction in CP content. IVDMD also exhibited significant ($p < 0.01$) main effects of date and treatment; the interaction was significant ($p < 0.05$) only in 1980, however. It has been reported that plants growing under shaded conditions have higher CP levels than those growing on open sites (McEwen and Dietz 1965).

Pinegrass was more digestible on the unimproved site than it was on the improved site; the single exception occurred on the August 25, 1980, sampling date. The delayed phenology and apparently cooler daytime temperatures on the unimproved site may have accounted for the higher digestibility. In general, the digestibility values of pinegrass on the mixed conifer and lodgepole pine sites were similar to those reported for the same species on a lodgepole pine site in British Columbia (McLean 1967).

CONCLUSIONS

Grassland sites generally are grazed earlier than other range sites in eastern Oregon; our sampling period lasted from April to July. Forage on the improved grassland site tended to be higher in CP and IVDMD than forage on the unimproved site. Beef production on the unimproved grassland site would be limited by low digestibility levels in June, whereas the improved site maintained adequate levels of both protein and digestibility 1 or 2 months longer (assuming 7.8% CP and 60% IVDMD are required to maintain growing yearlings). The relative difference between the improved and unimproved sites is greatest during the last half of the grazing season. Thus, if range condition can be maintained on the unimproved site, a viable management option would be to graze these areas the first half of the season and the improved sites the second half of the grazing season.

The unimproved portion of the moist meadow consisted entirely of forbs that senesced when soil moisture began to decline. Meadows in poor condition represent a major loss of forage on potentially very productive sites (Pickford and Reid 1948). The quality of the forbs is comparable to that of the improved grasses during the period before the forbs senesced; the grasses, however, were approximately 2 to 4 times more productive. Forage quality of the grasses was insufficient for maintaining weight gains in growing cattle after July in both years of the study. Grazing meadows earlier than July generally is not attempted because of soil compaction problems; however, as the soil dries in midsummer, forage quality declines quickly. Cattle production on moist meadows in poor condition will be limited until better improvement practices and more desirable species for seeding are developed.

Both of the forested sites were sampled from June through September, the period during which grazing generally would take place. The unimproved mixed conifer site was fairly limited in production of standing crop; the thick overstory was probably a limiting factor. The improved site produced 6.4 times more standing crop than the unimproved site over the two years of the study. On both the improved and unimproved mixed conifer sites, digestibility reached limiting levels 1 to 2 months before crude protein. Nutrient limitations occurred during July on both sites. The additional standing crop on the improved site would allow a large increase in carrying capacity compared to the unimproved site, but nutrient deficiencies probably would limit livestock weight gains.

Both lodgepole pine sites had pinegrass as the only major forage species. Thinning of the lodgepole overstory increased production of pinegrass during both study years; the average increase was approximately 90 percent. Thinning also caused a decrease in quality of the understory pinegrass. Pinegrass had low IVDMD levels (<56.0%) by late July on both sites. However, in both the lodgepole pine and mixed conifer communities the unthinned sites tended to maintain higher forage quality later into the grazing season. This may relate to more rapid advance in phenology on thinned sites. In a managed rotational system there may be an advantage to grazing thinned sites earlier in the season and unthinned sites later.

LITERATURE CITED

A.O.A.C. 1970. Official methods of analysis (11th ed.). Assoc. Off. Anal. Chem., Washington, D.C.

Bartel, L. E., R. W. Marquiss, G. G. Davis, and C. W Cook. 1975. Use and management of seeded rangelands in the San Juan Basin of Colorado. Colo. State Univ. Expt. Sta., Gen. Series 956.

Basile, J. V., and C. E. Jensen. 1971. Grazing potential on lodgepole pine clearcuts in Montana. USDA For. Serv. Res. Paper INT-98.

Box, T. W. 1974. Increasing red meat from rangeland through improved range management practices. J. Range Manage., *27:*333-336.

Box, T. W. 1960. Herbage production in four range plant communities in south Texas. J. Range Manage., *13:*72-76.

Brown, D. 1954. Methods of surveying and measuring vegetation. Commonwealth Agric. Bureau Farnham Royal, Bucks, England.

Campbell, R. S. 1937. Problems of measuring forage utilization on western ranges. Ecol., *18:*528-532.

Cook, C. W., and L. E. Harris. 1968. Nutritive value of seasonal ranges. Utah State Univ. Agric. Expt. Sta. Bull. 472.

Cooke, D. A., S. E. Beacom, and J. A. Robertson. 1973. Comparison of continually grazed bromegrass-alfalfa with rotationally grazed crested wheatgrass-alfalfa, bromegrass-alfalfa, and Russian wild ryegrass. Can. J. Anim. Sci., *53:*423-429.

Crampton, E. W., and L. E. Harris. 1969. *Applied Animal Nutrition,* 2nd ed. W. H. Freeman and Co., San Francisco.

Currie, P. P. 1969. Use seeded ranges in your management. J. Range Manage., *22:*432-434.

Dodd, C. J. H., A. McLean, and V. C. Brink. 1972. Grazing values as related to tree-crown covers. Can. J. For. Res., *2:*185-189.

Eckert, R. E., Jr. 1975. Improvement of mountain meadows in Nevada. U.S. Dept. of Interior, BLM Res. Rept. 4400.

Forest and Range Task Force. 1972. The nation's range resources—a forest-range environmental study. For Res. Rept. No. 19.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA For. Serv. Agric. Handbook No. 553.

Heinrichs, D. H., and R. B. Carson. 1956. Chemical composition of nine grasses at six stages of development. Can. J. Agric. Sci., *36:*95-105.

Holechek, J. L. 1980. The effects of vegetation type and grazing system on the performance, diet and intake of yearling cattle. Ph.D. thesis, Oregon State Univ., Corvallis.

Holechek, J. L., M. Vavra, and J. Skovlin. 1981. Diet quality and performance of cattle on forest and grassland range. J. Anim. Sci., *53:*291-298.

Holechek, J. L., M. Vavra, and R. D. Pieper. 1982. Methods for determining the nutritive quality of range ruminant diets: A review. J. Anim. Sci., *54:*363-376.

Hull, A. C., Jr., D. F. Hervey, C. W. Doran, and W. J. McGinnies. 1958. Seeding Colorado rangelands. Colo. State Univ. Expt. Sta. Bull. 498-S.

Lodge, R. W. 1971. Seasonal beef production from Russian wildrye-alfalfa pastures. J. Range Manage., *24:*410-414.

McConnell, B. R., and J. G. Smith. 1965. Understory response three years after thinning pine. J. Range Manage., *23:*129-132.

McConnell, B. R., and J. G. Smith. 1970. Response of understory vegetation to ponderosa pine thinning in eastern Washington. J. Range Manage., *23:*209-212.

McEwen, L. C., and D. R. Dietz. 1965. Shade effects on chemical composition of herbage in the Black Hills. J. Range Manage., *18:*184-190.

McLean, A. 1967. Beef production on a lodgepole pine-pinegrass range in southern British Columbia. J. Range Manage., *20:*214-216.

McLean, A., and M. B. Clark. 1980. Grass, trees, and cattle on clearcut-logged areas. J. Range Manage., *33:*213-217.

McLean, A., and E. W. Tisdale. 1960. Chemical compositions of native forage plants in British Columbia in relation to grazing practices. Can. J. Plant Sci., *40:*405-423.

Miller, R. F., and W. C. Krueger. 1976. Cattle use on summer foothill rangelands in northeastern Oregon. J. Range Manage., *29:*367-371.

NAS-NRC. 1962. Basic problems and techniques in range research. NAS-NRC Publ. 890, Washington, D.C.

NAS-NRC. 1976. Nutrient requirements of beef cattle. National Academy of Science-National Research Council, 5th rev. ed.

Pehanec, J. R., and G. D. Pickford. 1937. A weight estimate method for determination of range or pasture production. J. Amer. Soc. Agron., *29:*894-904.

Pickford, G. D., and E. H. Reid. 1948. Forage utilization on summer cattle ranges in eastern Oregon. USDA Circular No. 796.

Pieper, R. D. 1978. Measurement techniques for herbaceous and shrubby vegetation. Dept. of Anim. and Range Sci., New Mexico State Univ., Las Cruces, New Mexico.

Ratliff, R. D., and H. R. Heady. 1962. Seasonal changes in herbage weight in an annual grass community. J. Range Manage., *15:*146-149.

Rummell, R. S., and C. E. Holscher. 1955. Seeding summer ranges in eastern Oregon and Washington. USDA Farmers' Bull. No. 2091. GPO, Washington, D.C.

Siemer, E. G., G. O. Boatwright, and C. B. Rumburg. 1972. Forage yield and forage quality on scattered mountain meadows. Colo. State Univ. Expt. Sta. PR72-15.

Skovlin, J. M. 1967. Fluctuations in forage quality on summer range in the Blue Mountains. USDA For. Serv. Res. Paper PNW-44.

Smoliak, S. 1968. Grazing studies on native range, crested wheatgrass, and Russian wildrye pastures. J. Range Manage., *21:*47-50.

Steel, R. G. D., and J. H. Torrie. 1980. *Principles and Procedures of Statistics.* McGraw-Hill Book Co., Inc., New York City.

Stuth, J. W., and A. H. Winward. 1976. Logging impacts on bitterbrush in the lodgepole pine-pumice region of central Oregon. J. Range Manage., *29:*453-456.

Tilley, J. M., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc., *18:*104-111.

Turner, G. T., and H. A. Paulsen, Jr. 1976. Management of mountain grasslands in the central Rockies: The status of our knowledge. USDA For. Serv. Res. Paper RM-161, Rocky Mtn. For. and Range Expt. Sta.

Valentine, K. A. 1967. Seasonal suitability, a grazing system for ranges of diverse vegetation types and condition classes. J. Range Manage., *20:*395-397.

Vallentine, J. F. 1971. *Range Development and Improvements,* 2nd ed. Brigham Young Univ. Press, Provo, Utah.

Van Soest, P. J. 1964. Symposium on nutrition and forage and pastures: New chemical procedures for evaluating forages. J. Anim. Sci., *23:*838-845.

Van Soest, P. J., and R. H. Wine. 1967. Use of detergents in the analysis of fibrous feeds. IV. The determination of plant cell wall constituents. J. Assoc. Offic. Agric. Chem., *50:*50-56.

Van Soest, P. J., and R. H. Wine. 1968. Determination of lignin and cellulose in acid detergent fiber with permanganate. J. Assoc. Offic. Agric. Chem., *51:*780-787.

Vavra, M. and R. L. Phillips. 1979. Diet quality and cattle performance on forested rangeland in northeastern Oregon. Proc. West. Sec. Am. Soc. Anim. Sci., *30:*170-173.

Vavra, M., and R. L. Phillips. 1980. Drought effects on cattle performance, diet quality and intake. Proc. West. Sec. Am. Soc. Anim. Sci., *31:*157-160.

Vavra, M., and R. J. Raleigh. 1976. Coordinating beef cattle management with the range forage resource. J. Range Manage., *29:*449-452.

White, L. M., and J. R. Wight. 1981. Seasonal dry matter yield and digestibility of seven grass species, alfalfa, and cicer milkvetch in eastern Montana. Agron. J., *73:*457-462.

Willms, W., A. McLean, R. Tucker, and R. Ritchey. 1980. Deer and cattle diets on summer range in British Columbia. J. Range Manage., *33:*55-59.

Wood, Ben. 1972. Forest grazing. OSU Ext. Circ. 798.

Young, J. A. 1965. Forage production and utilization in a mixed conifer forest in the Wallowa Mountain foothills. Ph.D. thesis, Oregon State University, Corvallis.

APPENDIX

Table A-1. Coefficient of variability[1] of samples analyzed for crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) on the grassland site

Site and species	April 25, 1980 CP	April 25, 1980 IVDMD	May 25, 1980 CP	May 25, 1980 IVDMD	June 25, 1980 CP	June 25, 1980 IVDMD	July 25, 1980 CP	July 25, 1980 IVDMD
	%		%		%		%	
Unimproved								
Bluebunch wheatgrass	1.1	2.3	7.0	3.1	1.7	4.3	24.7	8.6
Idaho fescue	8.2	2.0	4.3	2.5	3.3	2.2	13.5	6.5
Sandberg bluegrass	4.7	2.7	8.6	2.5	7.2	1.3	15.1	5.3
Junegrass	—	—	7.2	1.6	6.8	5.7	7.2	5.4
Improved								
Intermediate wheatgrass	4.6	1.1	16.3	4.1	14.9	1.7	8.5	6.4
Alfalfa	2.3	3.7	3.0	1.5	3.0	2.2	7.0	5.6
	April 25, 1981		May 25, 1981		June 25, 1981		July 25, 1981	
Unimproved								
Bluebunch wheatgrass	2.3	1.9	2.3	1.1	6.0	5.3	8.6	1.7
Idaho fescue	2.4	1.7	1.0	1.4	4.3	3.4	18.3	8.4
Sandberg bluegrass	7.1	2.4	4.8	2.9	8.6	2.4	13.9	4.9
Junegrass	6.3	4.3	1.4	1.6	9.6	2.0	9.4	4.1
Improved								
Intermediate wheatgrass	6.9	0.5	5.2	2.8	12.2	1.1	3.7	3.6
Alfalfa	2.5	3.3	2.7	3.0	6.6	0.7	5.8	0.8

[1](standard deviation/mean) x 100. Four samples were taken for each species on each date.

Table A-2. Coefficient of variability[1] of samples analyzed for crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) on the lodgepole pine site

Site and species	Approximate sampling dates June 25, 1980 CP	IVDMD	July 25, 1980 CP	IVDMD	Aug. 25, 1980 CP	IVDMD	Sept. 25, 1980 CP	IVDMD
	%		%		%		%	
Unimproved								
Pinegrass	3.4	1.5	5.0	1.9	3.1	3.1	15.1	4.3
Improved								
Pinegrass	6.5	3.0	4.8	3.8	5.9	3.2	9.5	2.0
	June 25, 1981		July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved								
Pinegrass	3.5	3.0	5.8	1.0	4.9	1.7	6.1	1.5
Improved								
Pinegrass	1.7	1.6	6.0	2.0	11.5	4.4	5.1	2.9

[1](standard deviation/mean) x 100. Four samples were taken for each species on each date.

Table A-3. Coefficient of variability[1] of samples analyzed for crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) on the mixed conifer site

Site and species	Approximate sampling dates							
	June 25, 1980		July 25, 1980		Aug. 25, 1980		Sept. 25, 1980	
	CP	IVDMD	CP	IVDMD	CP	IVDMD	CP	IVDMD
	%		%		%		%	
Unimproved								
Pinegrass	6.4	1.8	1.1	2.4	3.3	2.4	9.6	1.5
Snowberry	3.3	9.6	7.0	8.0	3.8	1.1	5.2	0.9
Improved								
Timothy	8.1	1.7	20.7	1.8	19.3	1.5	2.8	6.5
Orchardgrass	13.7	1.7	14.4	3.5	24.3	6.0	19.5	5.7
	June 25, 1981		July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved								
Pinegrass	4.4	1.4	4.2	3.0	5.8	2.7	5.8	2.1
Snowberry	2.7	6.1	4.3	4.0	3.9	3.3	6.1	2.4
Improved								
Timothy	6.6	2.0	11.4	6.2	3.3	3.4	13.4	3.8
Orchardgrass	6.8	2.8	25.7	5.2	4.9	1.5	16.2	3.8

[1](standard deviation/mean) x 100. Four samples were taken for each species on each date.

Table A-4. Coefficient of variability[1] of samples analyzed for crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) on the moist meadow site

Site and species	July 25, 1980 CP	July 25, 1980 IVDMD	Aug. 25, 1980 CP	Aug. 25, 1980 IVDMD	Sept. 25, 1980 CP	Sept. 25, 1980 IVDMD
	%		%		%	
Unimproved						
Mule's ear wyethia	3.6	4.2	8.0	1.4	—	—
Cinquefoil	6.5	3.2	7.6	4.9	—	—
Improved						
Intermediate wheatgrass	5.0	3.4	5.9	1.8	13.9	2.6
Timothy	8.9	4.8	8.7	2.7	11.9	1.7
Smooth bromegrass	9.3	3.1	9.8	3.6	7.5	6.7

Site and species	July 25, 1981 CP	July 25, 1981 IVDMD	Aug. 25, 1981 CP	Aug. 25, 1981 IVDMD	Sept. 25, 1981 CP	Sept. 25, 1981 IVDMD
Unimproved						
Mule's ear wyethia	2.9	0.9	—	—	—	—
Cinquefoil	3.3	3.3	—	—	—	—
Improved						
Intermediate wheatgrass	3.6	1.8	4.4	1.0	8.7	2.3
Timothy	6.4	1.8	10.3	3.2	5.0	3.3
Smooth bromegrass	2.0	2.2	8.9	2.5	16.8	0.9

[1](standard deviation/mean) x 100. Four samples were taken for each species on each date.