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The Effect Of Range Condition And Intensity Of Grazing Upon Daily Intake And Nutritive Value Of The Diet On Desert Ranges

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The desert ranges of the Intermountain area furnish forage for about nine million head of cattle and sheep for five to six months each winter. Many of these ranges are in good condition, but many are in poor condition.

When ranges are overgrazed, grazed during unsuitable seasons, grazed by the wrong kind of livestock, or otherwise used improperly, they deteriorate. Obvious results from grazing abuse are changes in plant density and species composition (Klemmedson, 1956; Short and Woolfolk, 1956; Stewart *et al.*, 1940; Parker, 1954; Reid and Pickford, 1946). Ranges in supposedly good condition produce at maximum potential, whereas ranges in poor condition produce less than their potential (Humphrey, 1949; Goebel and Cook, 1960).

A few investigators have stated that poor ranges support a greater number of plants low in nutritive value compared to good ranges (Renner and Johnson, 1942; Hutchings, 1954). However, Goebel and Cook (1960) found that many species that become abundant on poor ranges were as nutritious as dominants on good ranges, and in some cases were higher in nutrient content.

Studies by Cook *et al.* (1953) and Pieper *et al.* (1959) showed that increased intensity of grazing reduced daily forage intake and digestibility of the nutrients. On ranges producing a single species, increased intensity of grazing decreased the nutrient content of the diet; but on ranges supporting mixtures, change in use from one species to another accompanying increased intensity of grazing actually increased the nutrient intake in some cases.

Cook *et al.* (1950) found that forage remaining on good ranges following grazing was lower in nutrient content than originally and that continued use caused still greater reductions in nutrient value.

The present study was carried out on typical salt-desert ranges in southwestern Utah during two winter grazing seasons, 1957 and 1959, from November to March, to determine the effect of range condition and intensity of grazing on the daily intake and nutritive value of the diet.

Description of the Area

Vegetation in the study area included the shrubs big sagebrush (*Artemisia tridentata*), bud sage (*Artemisia spinescens*), winterfat (*Eurotia lanata*), fourwing saltbush (*Atriplex canescens*), and yellowbrush (*Chrysothamnus stenophyllus*). Grasses included needle-and-thread grass (*Stipa comata*), squirreltail (*Sitanion hystrix*), galleta grass (*Hilaria jamesii*), sand dropseed (*Sporobolus cryptandrus*), blue grama (*Bouteloua gracilis*), Indian ricegrass (*Oryzopsis hymenoides*), three-awn grass (*Artistida longiseta*), and downy bromegrass (*Bromus tectorum*). Forbs included globemallow (*Spaeralcea grassulariaefolia*) and Russian-thistle (*Salsola kali* var. *tenuifolia*).

The region is used primarily as winter range for livestock. Overgrazing in many areas has resulted in marked changes in vegetation cover compared to protected areas.

The average annual precipitation for the area is about 9 inches with maximum temperatures reaching 102°F in summer and as low as —26°F during the winter.

Methods and Procedures

A total of six areas which showed ranges in obviously different condition on the two sides of existing fences were studied for two winter grazing seasons. At one location three fence-line contrasts were selected where grass was more abundant than shrubs on the good range and where shrubs were more abundant than grass on the adjacent poor range. At a second location three other study areas were

FIGURE 1. Experimental sheep grazing desert range judged to be in good condition.

selected where browse was more abundant than grass on good ranges and grass was more abundant than browse on adjacent poor ranges. Ranges on the protected side were termed "good" range and those on the deteriorated side, "poor." Classification of range condition followed the procedure outlined by the two-phase method currently being used by the Bureau of Land Management (1957).

The size of the paddocks was such as to allow equal volume of herbage on each side of the fence. Six wether sheep equipped with fecal collecting bags and three with esophageal-fistula cannulae were grazed in each paddock for collecting fecal and forage samples (Figure 1). Herbage production and diets were determined by the method outlined by Edlefsen *et al.* (1960). The fistulated sheep were penned each evening and turned out to graze with the other animals at daybreak the following morning. It required from 2 to 3 hours to obtain forage samples. The remainder of the day the fistulated animals were allowed to graze for themselves with the other experimental animals.

Sheep were grazed for a preliminary period of six days on similar range adjacent to the trial paddocks. Each trial area was grazed for two five-day collection periods. In the first five-day period the animals used the forage only lightly, whereas the second five-day period was considered heavy use.

Forage samples were collected daily from each fistulated sheep in each area. The first forage samples were collected the day before fecal samples were collected and forage collection was terminated the day before fecal collection ended. A composite forage sample for each sheep was taken for each period on each area.

Fecal bags were emptied twice daily, in the early morning and at nightfall. The feces of each sheep were stored in separate containers and weighed at the end of each five-day trial period. A composite sample for each period from each sheep was taken for chemical analyses. All data are presented on an oven-dry basis.

Daily forage intake and digestion coefficients were determined by the lignin-ratio technique (Cook *et al.*, 1951).

Results and Discussion

Production

Data from the study areas showed that the paddocks rated "good" produced from 59 to as

Table 1. Average species composition, production, utilization, and diet from three trials at each of two locations where fenceline contrasts presented good and poor range conditions

Condition and species	Pounds per acre	Period 1 Utilization at end of period	Period 1 Diet	Period 2 Utilization at end of period	Period 2 Diet
Location 1		— — — — (percent) — — — —			
Good					
Indian ricegrass	73.32	73.6	23.60	97.5	10.12
Galleta grass	93.27	27.1	11.05	61.1	18.31
Needle-and-thread grass	263.64	31.8	36.66	70.5	58.93
Three-awn grass	.00	0.0	.00	0.0	.00
Grasses	430.28	37.9	71.31	72.8	87.36
Yellowbrush	41.76	4.9	.90	26.6	5.23
Winterfat	92.31	63.5	25.63	75.9	6.61
Big sagebrush	8.14	45.8	1.63	56.6	.51
Browse	142.21	45.3	38.16	60.3	12.35
Globe mallow	1.78	68.0	.53	96.5	.29
Total and Average	574.27	39.8	100.00	69.9	100.00
Poor					
Indian ricegrass	43.87	87.2	38.30	96.8	8.04
Galleta grass	49.59	28.5	14.15	60.6	30.32
Needle-and-thread grass	.88	65.0	.57	85.0	.33
Three-awn grass	.75	0.0	.00	65.0	.00
Grasses	95.09	55.7	53.02	77.0	38.69
Yellowbrush	157.41	2.3	3.63	18.6	48.88
Winterfat	40.54	65.0	26.39	73.5	6.57
Big sagebrush	41.76	36.4	15.26	43.7	5.73
Browse	239.71	18.8	45.28	32.2	61.18
Globe mallow	.44	90.2	.40	98.5	.07
Russian thistle	2.79	46.6	1.30	47.7	.06
Total and Average	338.03	29.5	100.00	45.1	100.00

Location 2					
Good					
Indian ricegrass	31.27	35.0	7.08	78.9	16.47
Squirreltail	.91	21.9	.13	38.7	.17
Three-awn grass	1.90	0.0	.00	1.7	.04
Galleta grass	65.37	20.8	4.23	53.3	25.49
Needle-and-thread grass	34.50	50.4	11.25	83.4	13.66
Sand dropseed	1.90	1.5	.02	12.0	.24
Grasses	135.85	25.8	22.71	60.2	56.07
Yellowbrush	76.60	2.9	1.44	26.6	21.77
Winterfat	125.33	88.7	71.95	97.7	13.53
Big sagebrush	28.50	4.7	.87	24.5	6.77
Browse	230.43	49.9	74.25	65.1	42.07
Globe mallow	4.35	68.0	1.91	90.1	1.15
Russian thistle	5.73	30.3	1.12	40.6	.71
Forbs	10.08	46.6	3.04	62.0	1.86
Total and Average	376.36	41.1	100.00	63.2	100.00
Poor					
Indian ricegrass	16.57	82.0	11.16	91.3	3.05
Squirreltail grass	.00	0.0	.00	0.0	.00
Three-awn grass	3.46	13.3	.38	19.8	.44
Galleta grass	125.10	37.9	38.95	59.6	53.77
Needle-and-thread grass	7.73	80.8	5.13	90.9	1.54
Sand dropseed	1.83	15.0	.22	56.0	1.49
Grasses	154.69	43.9	55.85	63.6	60.29
Yellowbrush	97.53	15.3	12.26	27.3	23.17
Winterfat	24.83	88.3	18.01	98.3	4.91
Big sagebrush	30.30	39.2	9.76	53.2	8.40
Browse	152.66	31.9	40.03	44.0	36.48
Globe mallow	2.00	94.3	1.55	97.0	.10
Russian thistle	8.10	38.7	2.57	58.2	3.13
Forbs	10.10	49.7	4.12	65.8	3.23
Total and Average	317.45	38.3	100.00	54.2	100.00

much as 136 pounds more herbage per acre than those in poor condition (Table 1). Good ranges produced considerably more Indian ricegrass, needle-and-thread grass, and winterfat, whereas poor ranges produced more three-awn grass, yellowbrush, and in some cases galleta grass.

Utilization and Diet

Even though the same quantity of herbage was available for the experimental animals on both good and poor ranges, the overall use of forage was never as high on poor ranges as on good ranges. This difference was generally greater during the second grazing period than the first (Table 1).

In some areas in good condition where species of secondary palatability were sparse, the use was higher on these secondary plants than on poor ranges where they were abundant. This was true of both yellowbrush and big sagebrush where they produced less than 0.3 percent of the herbage on good ranges. It appears that under these conditions animals ate them for variety. This suggests that some plants invade an area in rather large quantities in order to become established on ranges in downward trend. On all ranges in poor condition, the species which were more palatable on good ranges were consumed extremely heavily before the less palatable species were eaten even moderately.

With increased utilization—period 2 compared to period 1—intensity of use generally increased more on grasses than on browse. This was more pronounced on good than on poor ranges (Table 1).

The average diet from the three study areas at Location 1 during the first grazing period contained more grass than browse under both good and poor range conditions. However, during the second grazing period the diet on poor ranges contained twice as much browse as grass, and the diet on good ranges contained seven times more grass than browse (Table 1).

The average diet from the three study areas at Location 2 during the first grazing period contained more than three times as much browse as grass on good ranges, but on poor ranges the diet during the first period contained only slightly more grass than browse. During the second grazing period, the diet on good ranges contained slightly more grass than browse, and the diet on poor ranges contained almost twice as much grass as browse (Table 1).

Thus, the quantity of the various forage classes on the range is not an index to the quantities of each in the diet.

Chemical Content of Diet

The changes in nutrient content of the diet with increased intensity of use is a result of changes in species and portions of plants consumed.

The ingested forage on poor ranges from the three areas at Location 1 was higher in protein, lignin, and ash, whereas ingested forage on good ranges was higher in cellulose and gross energy (Table 2). This might be expected since grass made up materially more of the diet on good ranges and browse made up more of the diet on poor ranges. Grasses on desert winter ranges are generally higher in cellulose and other carbohydrates than browse; however, browse species are higher than grasses in protein, ash, and lignin (Cook *et al.*, 1954).

On good range at Location 1 the average diet decreased in protein and cellulose and increased in ash, lignin, and other carbohydrates with increased utilization. These changes are partly a result of increased quantity of grass in the diet with in-

Table 2. Average nutrient content of ingested material from fence-line contrasts displaying good and poor conditions, grazed at two intensities at two separate locations shown in Table 1.[1]

Location and condition	Utilization	Ether extract	Total protein	Ash	Lignin	Cellulose	Other carbohydrates	Gross energy
				(percent)				kcal/lb
Location 1								
Good	39.8	2.7	8.0	9.3	12.0	25.8	42.2	1722
	69.9	2.9	7.3	9.7	12.7	23.6	43.8	1717
Average		2.8	7.6	9.5	12.4	24.7	43.0	1720
Poor	29.5	2.9	9.2	11.5	12.1	22.2	42.1	1678
	45.1	3.1	9.6	11.6	14.3	20.0	41.4	1634
Average		3.0	9.4	11.5	13.2	21.1	42.7	1656
Location 2								
Good	41.1	3.2	8.6	9.9	12.4	23.5	42.4	1791
	63.2	2.1	7.6	10.3	11.9	24.2	43.9	1804
Average		3.6	8.1	10.1	12.2	23.8	43.2	1797
Poor	38.3	2.7	7.4	11.2	11.3	23.7	43.7	1787
	54.2	2.4	7.0	11.9	12.9	23.2	42.6	1737
Average		2.5	7.2	11.5	12.1	23.5	43.2	1762

[1]Forage material was collected from esophageal fistulae and chemical content was corrected for ash content of the saliva.

creased intensity of use. The effect of increased intensity of utilization resulting from the consumption of coarser material counteracted the influence of increased grass in the diet somewhat, since both ash and lignin increased (Table 2).

On poor ranges at Location 1 the diet increased in protein, ash, and lignin and decreased in cellulose, other carbohydrates, and gross energy with increased utilization. The increase in protein was a result of the increase of browse in the diet. Other changes in nutrient intake were a result of both increased consumption of coarse material and increased browse in the diet.

At Location 2, under light use, the average diet on good ranges was higher in protein and lignin compared to diets on poor ranges which were higher in cellulose and other carbohydrates. However, with heavy use—period 2—the average diet on good ranges was higher in protein, cellulose, and other carbohydrates, whereas diets on poor ranges were higher in lignin and ash.

The increase of cellulose and other carbohydrates and the decrease of lignin with increased utilization on good ranges at the second location was largely a result of the marked change from a high percentage of browse in the diet during period 1 to a high percentage of grass during period 2 (Table 1). There was a slight increase of grass in the diet on poor ranges during the second period. However, increased consumption of coarser material with increased intensity of utilization apparently offset the effect of increased grass in the diet, since all nutrients except ash and lignin decreased with increased use (Table 2).

Digestibility

The average digestibility coefficients from the three areas at Location 1 showed that the digestibility of protein and ether extract was higher on poor range than on adjacent good range, but the digestibility of cellulose, other carbohydrates, and gross energy was higher on good range (Table 3).

The digestibility of protein decreased and the digestibility of cellulose, other carbohydrates, and gross energy increased with increased intensity of use on good ranges as a result of increased grass in the diet. However, on poor ranges where browse increased in the diet with increased grazing intensity the digestibility of protein increased slightly, but the digestibility of cellulose, other carbohydrates, and gross energy decreased.

On the three areas at Location 2 digestibility of protein was materially higher on good ranges compared to poor ranges for both periods. The digestibility of other chemical constituents in the diet was not consistently high or low on good or poor ranges because it was affected differently by intensity of grazing (Table 3).

Digestibility of protein decreased and digestibility of cellulose, other carbohydrates, and gross energy increased with increased intensity of grazing on good ranges where grasses replaced browse in the diet as degree of use increased. However, on poor ranges where forage classes remained about the same percentage in the diet during both grazing periods, the digestibility of all constituents decreased with increased intensity of utilization (Table 3).

Daily Intake

In all cases daily intake of forage was less on poor ranges than on adjacent good ranges (Table 3). Intensity of utilization decreased daily consumption of forage in all study areas. This was more pronounced on poor ranges than on good.

Conclusions

The nutrient content of herbage on good compared to poor ranges depends upon the species composition. This is especially true of the quantity of herbage produced by browse species compared to grass species. If palatable browse herbage predominates, the diet will be higher in protein, ash, lignin, and ether extract; but if palatable grass herbage predominates, the diet will be higher in cellulose, other carbohydrates, and metabolizable energy.

The nutrients in herbage on poor ranges are as highly di-

Table 3. Average daily intake of dry matter and digestibility of forage material from adjacent good and poor range at two separate locations when grazed at two intensities.

Location and condition	utilization	Daily intake	Digestibility: Ether extract	Total protein	Cellulose	Other carbohydrates	Gross energy	Digestible protein	Digestible protein intake	Metabolizable energy	Metabolizable energy intake
	(percent)	(lbs/day)	(percent)						(lb)	(kcal/lb)	(kcal)
Location 1											
Good	39.8	3.21	5.9	37.9	50.2	60.0	38.1	3.03	.097	501	1608
	69.9	3.03	20.1	37.1	50.3	65.6	41.4	2.71	.082	576	1745
Average		3.12	13.0	37.5	50.2	62.8	39.7	2.85	.089	538	1679
Poor	29.5	3.01	20.7	41.8	44.1	59.1	37.5	3.85	.116	497	1496
	45.1	2.53	30.1	42.9	43.4	54.8	36.0	4.12	.104	423	1070
Average		2.77	24.4	42.4	43.8	36.9	36.8	3.99	.111	460	1274
Location 2											
Good	41.1	3.09	29.8	51.0	42.1	47.6	36.0	4.39	.136	567	1752
	63.2	2.93	30.1	43.6	49.9	63.4	41.0	3.31	.097	604	1770
Average		3.01	29.9	47.3	46.0	55.5	38.5	3.83	.115	586	1764
Poor	38.3	2.63	33.5	35.5	45.0	56.1	37.2	2.63	.070	512	1347
	54.2	2.23	26.8	32.0	34.3	54.7	33.3	2.24	.050	431	894
Average		2.43	30.2	33.8	39.6	55.4	35.2	2.44	.060	472	1147

gested as nutrients in herbage on good ranges when degree of utilization is similar. However, light grazing on relatively unpalatable species may be associated with extremely heavy use of the more palatable ones.

Increased use on both good and poor ranges results in decreases in the daily intake of forage. Generally, more intensive grazing decreases the content of the more desirable nutrients in the forage, and furthermore, decreases the digestibility of these nutrients because of forced utilization of the coarser plant material. However, decreased nutrient content and digestibility with increased utilization may be compensated for when the diet changes from one forage class to another or from heavily used species to species only lightly or not previously used.

Summary

During two winter grazing seasons—1957 and 1959—a study was conducted on typical desert ranges in southwestern Utah to determine the effect of range condition and intensity of grazing upon the daily intake and nutritive content of the grazing animals' diet.

At each of two locations three areas displaying fence-line contrasts of good and poor range were selected and fenced so that areas on each side included equal herbage for the same number of experimental animals. Three sheep with esophageal fistula and six wethers equipped with fecal collecting bags were grazed on each side of the fence. Daily intake and digestibility were determined by the lignin-ratio technique. Each paddock was grazed for two five-day periods, the first representing light use and the second, heavy use.

Ranges in good condition produced more herbage than those in poor condition.

Even though the same quantity of herbage was available on both good and poor ranges, the use was lighter on poor ranges.

Diets showed that animals ate more grass in some areas and more browse in others. Likewise, diets changed from a large percentage of one forage class to a large percentage of another with increased intensity of use.

The nutrient content of the diets on good and poor ranges depended upon the species composition and the intensity of utilization. When browse was high in the diet, the nutrient intake was generally high in protein, ash, lignin, and ether extract; but when grass was high in the diet, the nutrient intake was generally high in cellulose, other carbohydrates, and metabolizable energy.

The digestibility of nutrients in diets on both poor and good ranges was about the same if use of similar species was not too different. Increased utilization decreased digestibility of forage unless the diets changed substantially in percentages of grass or browse.

Daily intake was less on poor ranges than on good ranges, and increased intensity of grazing reduced daily intake on both good and poor ranges.

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