Food Habits of Cattle on Shortgrass Range in Northeastern Colorado

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Highlight: Cattle food habits and plant composition in the diets were similar on the light and heavily grazed pastures on shortgrass prairie near Nunn, Colorado. Blue grama (36% and 40%), scarlet globemallow (15% and 11%), and sun sedge (9% and 9%) collectively averaged about 60% of the monthly diets at both grazing intensities. The proportions between diets and available forage in each pasture were significantly related for the 12 major foods. Diversity indices of diets and available pasture vegetation were positively correlated. Preference indices averaged the same for the major forages. Significant differences in diet were observed between months and years at both intensities. Fireweed summer-cypress, western wheatgrass, evening-primrose, slimflower scurfpea, and scarlet globemallow ranked highest in preference; and although blue grama was the principal component in the cattle diets, only fringed sagewort ranked lower in preference.

Heavy grazing by livestock on shortgrass ranges may reduce the measured biomass of forage at the end of a grazing period, but the frequency of plant species is not appreciably changed (Hyder et al. 1966). Cattle grazing to some extent harms growth and production of certain utilized plants on shortgrass ranges (Klipple and Costello 1960). Efficient management of ranges depends, in part, on the identification of plants that are palatable and nutritious to livestock. There is a growing interest about the relations between the proportions of foods eaten to foods available, and quantities of foods consumed to foods produced on shortgrass ranges. How does plant diversity in a pasture influence plant diversity in the diets of cattle?

This study was initiated to examine plant species composition of cattle diets, to determine species composition of available herbage, and to compare the biomass of foods eaten with foods available during the summer grazing period on shortgrass range. Chemical composition of the cattle diets and intake rates were measured concurrently and were reported by Vavra et al. (1973).

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Methods

The study area is located at the Central Plains Experimental Range about 13 km northeast of Nunn, Colorado. Diets and vegetation were measured on two adjacent pastures that had been grazed for 6 months from May to November under heavy and light intensities by cattle for the previous 32 years. Grazing had been regulated so that 60% of the current herbage growth of dominant forage grasses was grazed at the end of the season on the heavy use pasture, and 20% on the light use pasture (Bement 1969). During the 5 years prior to this study, the stocking rate was about 0.73 and 1.38 ha per yearling month for the heavy and light grazed pastures, respectively. Yearlings were grazed until it was judged that the herbage remaining averaged 280 kg/ha and 390 kg/ha on the heavy and light grazed pastures, respectively.[1] The climate of the area is semiarid with a 29-year (1939–1967) average annual precipitation of about 31 cm/year (Bement 1968). Most of the precipitation falls as rain during the summer. The precipitation during this study was 42 cm in 1969 and 24 cm in 1970.

The vegetation on the two pastures was sampled while being grazed by cattle at light and heavy stocking rates during 1969 and 1970. The sampling procedures for the pasture vegetation were described by Uresk et al. (1975). All plants were clipped biweekly from 0.25 m^2 plots at ground level; and the clippings were sorted, sacked by species, and the dry weights were determined after oven drying at 50–60°C.

The foods of cattle were determined from samples collected from esophageal-fistulated cattle in June, July, and August during both years (Vavra et al. 1973). There were 75 esophageal samples per pasture in 1969 and 88 per pasture in 1970. Approximately the same numbers of samples were examined each month of each year. The percentages of each forage in the samples were determined by microhistological procedures reported by Sparks and Malechek (1968) and Flinders and Hansen (1972). There were 40 microscope fields examined at 100× for each esophageal sample.

The kg/ha of each major food consumed each month by cattle for each pasture was calculated by multiplying the mean fraction of a food in the diet × days of use × daily intake rate × 1/128 ha (intake estimates were derived for nonfistulated cattle (Vavra et al. 1973). The availability of each food item for each month for each pasture was estimated by summing the estimated kg/ha of the food consumed by cattle and the kg/ha of the same food in the average monthly aboveground biomass. A preference index (Krueger 1972) for each major food was determined by dividing the kg/ha of forage consumed by the kg/ha of the same forage available (× 100).

Plant diversity for foods consumed and for the pasture vegetation was determined by the formula used by Pielou (1966) and Lloyd (1968). The percentage similarity (= % identical) between cattle diets and pasture vegetation was determined each month using Kulcyznski's formula

[1] From personal communications with R. E. Bement, Agr. Res. Serv.

Table 1. The estimated dry weights (kg/ha/mo.) of foods consumed and foods available to cattle averaged for light and heavy stocking rates at the Central Plains Experimental Range, northeastern Colorado.

	Kilograms/hectare/month consumed					Kilograms/hectare/month available[1]				
	Months 1969–70[2]			Pastures		Months 1969–70[2]			Pastures	
Foods of cattle	June	July	August	Light	Heavy	June	July	August	Light	Heavy
Blue grama (*Bouteloua gracilis*)	107	122	212	93	201	597	557	635	573	619
Scarlet globemallow (*Sphaeralcea coccinea*)	36	63	38	38	53	53	85	54	66	62
Sun sedge (*Carex heliophila*)	45	29	25	22	44	72	47	39	42	95
Western wheatgrass (*Agropyron smithii*)	19	52	16	22	36	22	53	18	25	37
Eveningprimrose (*Oenothera coronopifolia*)	11	24	8	16	12	13	28	15	23	14
Needleandthread (*Stipa comata*)	25	5	1	15	6	29	7	4	20	6
Slimflower scurfpea (*Psoralea tenuiflora*)	6	6	16	13	6	9	9	19	18	7
Fireweed summercypress (*Kochia scoparia*)	7	<1	14	9	5	7	<1	14	9	5
Spreading wildbuckwheat (*Eriogonum effusum*)	6	28	34	8	36	19	44	54	34	45
Red threeawn (*Aristida longiseta*)	30	10	13	6	30	68	52	63	89	34
Buffalograss (*Buchloe dactyloides*)	11	2	10	3	12	43	11	11	8	43
Fringed sagewort (*Artemisia frigida*)	6	5	21	3	18	54	63	106	123	25
Other forbs + shrubs	16	21	30	7	37	286	450	404	305	455
Other grasses + grasslikes	5	<1	5	2	4	29	23	32	40	16
Average monthly totals	330	367	443	257	500	1301	1429	1468	1375	1463

[1] Kg/ha/mo. available = kg/ha/mo. consumed + kg/ha/mo. aboveground standing crop (= not consumed).
[2] 1969 and 1970 averaged.

(Oosting 1956), which relates the degree to which the diets from each pasture approached being identical.

Statistical procedures recommended by Steel and Torrie (1960) and Snedecor and Cochran (1973) were used to determine significant differences ($p<.05$). Scientific names are shown with the common names in Table 1.

Results

Blue grama, scarlet globemallow, and sun sedge averaged about 60% of the monthly cattle diets on both pastures over the two summer grazing seasons (Table 1). On the light and heavy use pastures blue grama averaged 36% and 40%, scarlet globemallow 15% and 11%, and sun sedge 9% and 9%, respectively. There were four additional categories of foods in each pasture that averaged more than 5% in the monthly diets. On light and heavy use pastures, western wheatgrass was 9% and 7%, respectively. On the light use pasture eveningprimrose and needleandthread each averaged 6%, and slimflower scurfpea 5%. On the heavy use pasture spreading wildbuckwheat and the category "other forbs + shrubs" averaged 9% each and red threeawn 6% of the monthly diets.

A large number of forbs, grasses, and shrubs collectively averaged 4% of the mean monthly diets on the light use pasture and 8% on the heavy use pasture. In 1970, which was considerably drier during the summer than 1969, the kg/ha of these minor species eaten was significantly higher on both pastures than they were in 1969. However, significantly more scarlet globemallow, spreading wildbuckwheat, and eveningprimrose were consumed from both pastures in 1969 than in 1970. About 96% and 92% of the 12 major plants in the light and heavy use pastures, respectively, were from blue grama, scarlet globemallow, sun sedge, western wheatgrass, buffalograss, and fringed sagewort.

There were significant differences for the estimated kg/ha of certain foods consumed by cattle between months and years within each pasture, and between pastures compared by months. The average estimated forage consumption per month was 257 kg/ha on the light use pasture and 500 kg/ha on the heavy use pasture (Table 1). Generally, trends between kg/ha of most plant species consumed for months within years, and for comparable months between light and heavy use pastures were not related. Blue grama consumption was highest in August for both pastures each year. The availability of forage on each pasture progressively increased from June to August each year and the availability of herbage was not significantly higher on the heavy use pasture than on the light use pasture (Table 1).

Discussion

Different analyses suggested that the proportions of the major foods in cattle diets were similar on the light and heavy use pastures. The mean (± SE) monthly similarity of cattle diets was 73 ± 3% and the plant composition similarity for the two pastures was 78 ± 3%.

There was a significant positive correlation ($r = 0.9$) for the magnitude of different plants in the cattle diets and in the availability of plants on a between pasture comparison by

Table 2. The preference rankings[2] of the major foods of cattle.

	Monthly average (N = 4)			Overall (N = 12)
Foods of cattle[1]	June	July	August	Mean ± SE
Fireweed summercypress	100	100	100	100 ± 14
Western wheatgrass	86	100	89	92 ± 4
Eveningprimrose	85	86	53	75 ± 9
Slimflower scurfpea	67	67	84	73 ± 10
Scarlet globemallow	68	74	70	71 ± 7
Sun sedge	63	62	64	63 ± 8
Needleandthread	86	71	25	61 ± 12
Spreading wildbuckwheat	32	64	63	53 ± 11
Buffalograss	26	18	91	45 ± 12
Red threeawn	44	19	21	28 ± 12
Blue grama	18	22	33	24 ± 4
Fringed sagewort	11	5	20	12 ± 13

[1] Scientific names are in Table 1.
[2] $\frac{FC}{FA} \times 100 = \frac{\text{Forage consumed}}{\text{Forage available}} \times 100$. FC and FA were averaged for 1969 and 1970.

Spearman's rank order statistic (Snedecor and Cochran 1973). The reasons why certain plants were more available between months or years is not clear from the present data but these differences may have been primarily influenced by rainfall and weather conditions (Uresk et al. 1975).

There was no significant correlation between the appropriately paired monthly similarity indices between cattle diets, or between amount of the vegetation on the two pastures. The monthly diversity indices for cattle diets and available pasture vegetation were not related between lightly and heavily grazed pastures. However, a comparison of monthly diversity indices between diets and vegetation available within the same pasture were positively and significantly correlated ($P<.01$). There was a nonsignificant negative correlation coefficient between the amounts of blue grama and the amounts of needleandthread + western wheatgrass consumed, suggesting that blue grama might be used when more palatable plants are less abundant in pastures.

Numerous ratios between foods eaten divided by foods available have been used in the literature to indicate relative preference indices (Krueger 1972). These values have been used to rank various plants with regard to their preference. Fireweed summercypress, western wheatgrass, eveningprimrose, slimflower scurfpea, and scarlet globemallow ranked highest in preference (Table 2). Together these five foods made up a total of 28% of the monthly diets on the pastures. Blue grama averaged 38% in the overall monthly diets. Fringed sagewort (2% of diets) was the only plant which ranked lower in palatability than blue grama for the 12 most important foods of cattle (Table 2). Average preference indices were lower in August than earlier for eveningprimrose, needleandthread, and red threeawn but were higher in August for slimflower scurfpea, spreading wildbuckwheat, buffalograss, and blue grama. Average preference indices of the major cattle foods, when paired by sampling dates and compared between pastures, were significantly correlated ($P<.01$).

If the vegetation on the two pastures in this study was similar when the light and heavy cattle grazing treatments began 32 years earlier, it appears that the cattle grazing treatments have had similar effects on the major plant species in both pastures. If the average monthly removals of forage were the same for June, July, and August as observed in this study one major difference between the use of the pastures has been of the amount of herbage harvested by cattle. Over the 3 months in summer more forage might be harvested per year at the heavier grazing intensity applied in this study than by the lighter treatment. The findings support literature (Hyder et al. 1966), which suggests that the long term different summer cattle grazing treatments have not substantially changed plant composition on this shortgrass ecosystem.

Literature Cited

Bement, R. E. 1968. Herbage growth rate and forage quality on shortgrass range. PhD Diss., Colorado State Univ., Fort Collins. 53 p.

Bement, R. E. 1969. A stocking rate guide for beef production on blue grama range. J. Range Manage. 22:83-86.

Flinders, J. T., and R. M. Hansen. 1972. Diets and habitats of jackrabbits in northeastern Colorado. Range Sci. Dep. Sci. Ser. No. 12. Colorado State Univ., Fort Collins. 29 p.

Hyder, D. N., R. E. Bement, E. E. Remmenga, and C. Terwilliger, Jr. 1966. Vegetation-soils and vegetation-grazing relations from frequency data. J. Range Manage. 19:11-17.

Klipple, G. E., and D. F. Costello. 1960. Vegetation and cattle responses to different intensities of grazing on shortgrass ranges on the central great plains. U.S. Dep. Agr. Tech. Bull. 1216. 82 p.

Krueger, W. C. 1972. Evaluating animal forage preference. J. Range Manage. 25:471-475.

Lloyd, M. 1968. On the calculation of information—theoretical measures of diversity. The Amer. Midland Naturalist 79:257-272.

Oosting, H. J. 1956. The study of plant communities. W. H. Freeman, San Francisco. 440 p.

Pielou, E. C. 1966. The measurement of diversity in different types of biological collections. J. Theoret. Biol. 13:131-144.

Snedecor, G. W., and W. G. Cochran. 1973. Statistical methods. Iowa State Univ. Press, Ames. 593 p.

Sparks, D. R., and J. C. Malechek. 1968. Estimating percentage dry weight in diets using a microscope technique. J. Range Manage. 21:264-265.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., Inc., New York City, New York.

Uresk, D. W., P. L. Sims, and D. A. Jameson. 1975. Dynamics of blue grama within a shortgrass ecosystem. J. Range Manage. 28:205-208.

Vavra, M., R. W. Rice, and R. E. Bement. 1973. Chemical composition of the diet, intake and gain of yearling cattle on different grazing intensities. J. Anim. Sci. 36:411-414.