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Early- and Late-Season Grazing Versus Season-Long Grazing of Short-Grass Vegetation on the Central Great Plains

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EARLY- AND LATE-SEASON GRAZING VERSUS SEASON-LONG GRAZING OF SHORT-GRASS VEGETATION ON THE CENTRAL GREAT PLAINS

by

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Cattle that graze range vegetation of the short-grass association on the Central Great Plains usually produce much larger weight gains during May, June, and July than they do during August, September, and October. This has induced many cattle producers using short-grass rangelands to make large increases in the stocking of their range during the early period, and reduce the length of the grazing season. In this arrangement, steers are sold when the feed is utilized.

In the 1940's the Rocky Mountain Forest and Range Experiment Station received numerous inquiries as to the amount of increase in cattle weight gains per acre that could be expected from this early accelerated stocking practice, and the effect of the practice upon the range vegetation.

A study was made at the Central Plains Experimental Range[3] near Nunn, Colorado, to obtain information on these questions. This report summarizes results of the study.

[3]*Operated at the time of the study by the Forest Service in cooperation with the Soil Conservation Service and the Crow Valley Livestock Cooperative Association on a portion of the northeastern Colorado Land Utilization Project.*

EXPERIMENTAL DESIGN

Nine pastures were used: seven, approximately a half-section each, one, 400 acres, and one, 200 acres. They were divided into three blocks of three pastures each, with each block representing a different subtype of the short-grass association (table 1). These subtypes are typical of the short-grass vegetation of the Central Great Plains.

Grazing Treatments

Treatments were three different periods of grazing, designated as follows:

	Length of grazing period	Approximate dates
Season-long	6 months	May 10 - Nov. 10
Early grazing	3 months	May 10 - Aug. 10
Late grazing	3 months	Aug. 10 - Nov. 10

Cattle grazed in an early-grazed pasture were moved to the late-grazed pasture in the same block. Grazing treatments were randomized within blocks in 1943 and repeated without change each year from 1943 to 1952.

All pastures were grazed as nearly as possible to the same intensity--removal of approximately 40 percent by weight of the

Table 1.--Experimental design of nine pastures with three types of grazing on three subtypes of short-grass range, Central Plains Experimental Range, 1943-52

Block number and subtype	Early grazing (May 10-Aug. 10)		Late grazing (Aug. 10-Nov. 10)		Season-long grazing (May 10-Nov. 10)	
	Pasture number	Area	Pasture number	Area	Pasture number	Area
		Acres		Acres		Acres
I - Blue grama[1]-buffalograss	1W	317	2N	400	15E	318
II - Blue grama - buffalograss - dry meadow	17N	320	17S	320	8SE	2,00
III - Fourwing saltbush - blue grama - buffalograss	13E	317	13W	320	24N	315
Total		954		1,040		833

[1] Common and botanical names of species are listed on page 16.

current growth of the short-grasses by the end of the assigned grazing period. Stocking rates for pastures grazed season-long were the estimated numbers of cattle required to make this utilization of the herbage by early November. Initially, stocking rates for the early-grazed pastures were two times the number of animals required to make this use of the herbage, if grazed season-long. These herds were transferred near August 10 each year, with little or no change in numbers, to the late-grazed pastures.

Differences in pasture size and productivity led to some variation from year to year in the number of yearling cattle grazed during the assigned grazing seasons (table 2). The season-long pastures developed more of this variation than the early-grazed or late-grazed pastures. Stocking was reduced in the early- and late-grazed pastures during the late years of the study. The average number of acres grazed per head for the period the cattle was grazed were 6.1, 6.6, and 13.1 acres during the early, late, and season-long grazing periods, respectively (table 3). The average number of acres per head-month of grazing was 2.03, 2.20, and 2.18 for the three conditions, respectively.

Utilization

Utilization of the vegetation was determined each year by an adaptation[4] of the ocular-estimate-by-plot method of Pechanec and Pickford.[5] Eighty plots were used in each pasture. Determinations were made on the early-grazed pastures immediately after removal of the cattle about August 10 each year; on the late-grazed and season-long pastures, during the week before or week after removal of the cattle near November 10 each year.

Average pasture utilization, with a few exceptions, was within the range of 30 to 50 percent of the vegetation growth produced each year (table 4). The apparent lower average utilization on the early-grazed pas-

[4] *Bement, R. E., and Klipple, G. E. A pasture-comparison method of estimating utilization of range herbage on the Central Great Plains. Jour. Range Mangt. 12: 296-298, illus. 1959.*

[5] *Pechanec, Joseph F., and Pickford, G. D. A comparison of some methods used to determine percentage utilization of range grasses. Jour. Agr. Res. 54: 753-765. 1937.*

Table 2. --Number of cattle[1] grazed, by pasture and grazing season, 1943-52

Grazing season and pasture number	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	10-year average[2]
	Number of cattle										
Early:											
1W	41	39	40	40	40	40	40	39	39	38	40
13E	60	60	60	60	60	60	60	57	60	56	59
17N	60	60	60	60	60	60	60	58	58	56	59
Total	161	159	160	160	160	160	160	154	157	150	158
Late:											
2N	40	42	40	38	40	40	40	39	39	38	40
13W	60	60	60	59	60	60	60	56	60	56	59
17S	60	60	60	60	60	60	60	58	58	56	59
Total	160	162	160	157	160	160	160	153	157	150	158
Season-long:											
15E	20	18	15	13	13	14	15	15	16	15	15
24N	29	30	26	28	29	28	34	33	33	32	30
8SE	15	18	19	19	18	19	18	18	18	18	18
Total	64	66	60	60	60	61	67	66	67	65	63

[1] Total animal months of grazing in a pasture divided by the number of months (3 or 6) in the grazing season, and quotient rounded to nearest whole number.
[2] Rounded to the nearest whole number.

tures than on the season-long and late-grazed pastures was not statistically significant.[6]

[6] *Significance of differences between means were determined by t-test.*

Thus the period of grazing in relation to the growth of the vegetation was the major factor influencing differences in vegetation changes found in this study.

Table 3. --Average number acres of rangeland grazed per head and per head-month, by grazing seasons, 1943-52

Grazing season and stocking rate	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	10-year average
	Acres										
Early:											
Per head	5.9	6.0	6.0	6.0	6.0	6.0	6.0	6.2	6.1	6.4	6.1
Per head-month	1.97	2.00	2.00	2.00	2.00	2.00	2.00	2.07	2.03	2.13	2.03
Late:											
Per head	6.5	6.4	6.5	6.6	6.5	6.5	6.5	6.8	6.6	6.9	6.6
Per head-month	2.17	2.13	2.17	2.20	2.17	2.17	2.17	2.27	2.20	2.30	2.20
Season-long:											
Per head	13.0	12.6	13.9	13.9	13.9	13.7	12.4	12.6	12.4	12.8	13.1
Per head-month	2.17	2.10	2.32	2.32	2.32	2.28	2.07	2.10	2.07	2.13	2.18

Table 4. --Grazing removal of current growth of vegetation, in percent by weight, by pasture and grazing season, 1943-52

Grazing season and pasture number	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	10-year average
	Percent										
Early:											36
1W	30	45	40	38	31	40	35	43	34	30	37
13E	32	40	35	43	30	36	33	34	33	32	35
17N	40	45	30	41	30	38	34	36	31	31	36
Late:											40
2N	45	42	45	42	32	41	38	38	39	42	40
13W	45	45	42	40	27	43	37	38	40	42	40
17S	50	40	40	44	28	45	38	40	40	39	40
Season-long:											39
15E	45	50	30	35	28	41	36	40	39	41	38
24N	35	40	45	39	27	42	39	42	41	41	39
8SE	25	45	40	49	32	42	37	43	41	42	40

Cattle Weights

Cattle were weighed within 1 or 2 days of the 10th of each month throughout the study. All cattle were weighed the same day at each monthly weighing. The 10th of the respective months has been used throughout this report as the beginning or end of grazing periods between weighing times.

The cattle-weighing practice was to gather the cattle from the pastures during an afternoon, hold them in a corral overnight without feed or water, weigh them early the next morning, and return them to their pastures. Each animal was weighed individually 1943 through 1949. The cattle were weighed by pasture herds during 1950, 1951, and 1952.

Cattle grazed were yearling Herefords of good to choice grade. Both steers and heifers were used each year. Each pasture herd, however, was of only one sex, and at no time were steer results from one grazing period compared with heifer results from another grazing period. Steer and heifer weight gains were combined in computing grazing-season average weight gains each year, and 10-year averages.

The cattle were from 10 to 15 ownerships. They were assigned to pasture herds from ownership herds within sex classes by lot each year. The number assigned to a pasture from any one sex-ownership herd was in the same ratio to the total number of head assigned to the pasture as the number in the sex-ownership herd was to the total number of that sex in all ownerships. One or more head belonging to each owner was in each pasture herd each year. This procedure minimized the effects of differences in cattle quality and cattle wintering conditions among the ownership herds.

Vegetation Measurements

Vegetation measurements used to evaluate the influence of the treatments were as follows:

1. Square-foot-density measurements[7] by species were made on 40 permanent, 5-

[7] *Stewart, George, and Hutchings, S. S. The point-observation-plot (square-foot-density) method of vegetation survey. Amer. Soc. Agron. Jour. 28: 714-722, illus. 1936.*

foot-square plots per pasture in 1940, 1941, and 1942, before the study started; and in 1946, 1947, 1948, 1951, 1953, 1955, and 1956.

2. Grass herbage yields were measured by clipping plots in 1943, 1949, 1950, 1951, and 1953. Twenty-four plots, 6 inches wide by 30 feet long, were clipped per pasture in 1943. Eighty plots, 1 by 2 feet in size, were clipped per pasture in the later years.

Climate and Weather

Weather at the Experimental Range during the 10 years of study was near normal. Temperatures and wind movement were not unusual. The usual, relatively large, year-to-year variations prevailed in the total annual and growing-season (May-September) precipitations. The total annual precipitation at the headquarters, and the average of 24 gages in the pastures for the growing season, in inches of water, for the 10 years were as follows:

Year	Precipitation	
	Total annual	Growing season
	(Inches)	(Inches)
1943	7.78	5.88
1944	8.17	4.41
1945	12.27	8.88
1946	11.79	8.33
1947	15.53	11.06
1948	7.92	5.82
1949	13.52	9.98
1950	11.90	9.75
1951	13.10	8.63
1952	14.10	9.44
10-year average	11.61	8.22

Both of these 10-year averages were only slightly less than the 20-year (1939-58) averages of 11.84 and 8.46 inches, respectively, that are the long-time averages at the Experimental Range.

EXPERIMENTAL RESULTS

Cattle Weight Gains

Weight Gains per Head

The 10-year average weight gain per head between May 10 and August 10 on the early-grazed pastures was 170 pounds (table 5). This was 9 pounds less than the 179-pound average gain produced by the cattle in the season-long pastures during the same 3-month period, a difference that was not significant. Weight gains per head in the early-grazed pastures were larger than in the season-long pastures during the same period in only 2 of the 10 years (fig. 1). The 41-pound larger gain per head made in the season-long pastures in 1948 was the only difference of this comparison that was statistically significant. This lack of difference in weight gains is of interest, because for the 3-month period the season-long pastures received only half the grazing of the early-season pastures, and intensity of grazing often affects weight gains per animal. In this early-season grazing, it did not.

Two factors--the volume of vegetation regrowth after August 10, and the length of time for vigorous new growth in the spring--appeared to influence to a marked degree the average cattle weight gains made per head on the early-grazed pastures. Good fall regrowth and early new growth the following spring occurred each of the 5 years when the average gain per head produced on the early-grazed pastures exceeded 180 pounds. Ample old vegetation was on the early-grazed pastures in the spring of 1948, but sufficient moisture for vigorous new growth was not received until late June. Average per-head gain to July 10 that year was only 59 pounds. For reasons discussed later, the cattle in the season-long pastures in 1948 had access to a larger volume of cool-season species such as western wheatgrass and needle-and-thread. The cattle that grazed the season-long pastures produced an average gain of near 60 pounds during the May 10-June 10 period, but their average production dropped to 36 pounds per head during the June 10-July 10 period.

Ten years of accelerated stocking of the early-grazed pastures did not significantly reduce the average weight gains produced per head. The average per-head gains during the last 4 years of this study compared just as favorably with the average per-head, May 10-August 10, gains produced on the season-long pastures during the same period as they did during the first 4 years.

Table 5.--Average cattle weights and weight gains per head (steer and heifer data combined) by weighing date and grazing season, 1943-52

Grazing season and weight record	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	10-year weighted average[1]
	Pounds										
Early:											
May 10	394	398	430	420	414	433	413	424	424	445	419
August 10	596	582	593	575	598	553	597	574	602	629	589
3-month gain	202	184	163	155	184	120	184	150	178	184	170
Late:											
August 10	596	582	593	575	598	553	597	574	602	629	589
November 10	703	688	685	653	675	663	685	687	685	717	683
3-month gain	107	106	92	78	77	110	88	113	83	88	94
6-month gain (Early plus late)	309	290	255	233	261	230	272	263	261	272	264
Season-long:											
May 10	391	414	420	406	378	430	399	421	400	408	407
August 10	581	614	604	574	564	591	594	582	581	574	586
3-month gain	190	200	184	168	186	161	195	161	181	166	179
November 10	683	730	701	676	656	682	683	691	660	670	684
3-month gain	102	116	97	102	92	91	89	109	79	96	98
6-month gain	292	316	281	270	278	252	284	270	260	262	277

[1] Weighted for variation in the number of animals contributing to the yearly averages, and rounded to nearest whole digit.

The average gains per head after the cattle were moved to the late-grazed pastures on August 10 were much smaller than those produced up to August 10. It is of interest that early and late gains appeared to be related (fig. 2). Early gains were high in 1943, 1947, 1949, 1951, and 1952. Four of these 5 years were the years of lowest late-season gains. Contrarily, 1948 and 1950 were years of poor early gains followed by good late-season gains.

Lower gains per head also were obtained during the second 3 months of the season-long grazing treatment. The average per-head weight gains produced in the late-grazed and season-long pastures during the August 10-November 10 period were not significantly different in any one of the 10 years (fig. 3).

Average monthly weight gains per head produced on the early-grazed pastures were quite similar to those produced on the season-long pastures, during the same monthly periods, for almost all of the 10 years (fig. 4). Only one of the 30 monthly differences--that for the period ending June 10, 1948--was statistically significant. Likewise, the average per-head monthly gains produced on the late-grazed pastures were quite similar to those produced on the season-long pastures during the same monthly periods.

The cattle lost weight in the late-grazed pastures during the October 10-November 10 period in 4 of the 10 years, and only one-half pound was gained during that period in a fifth year. Weight losses were also experienced during that period in 1 year, and gains were

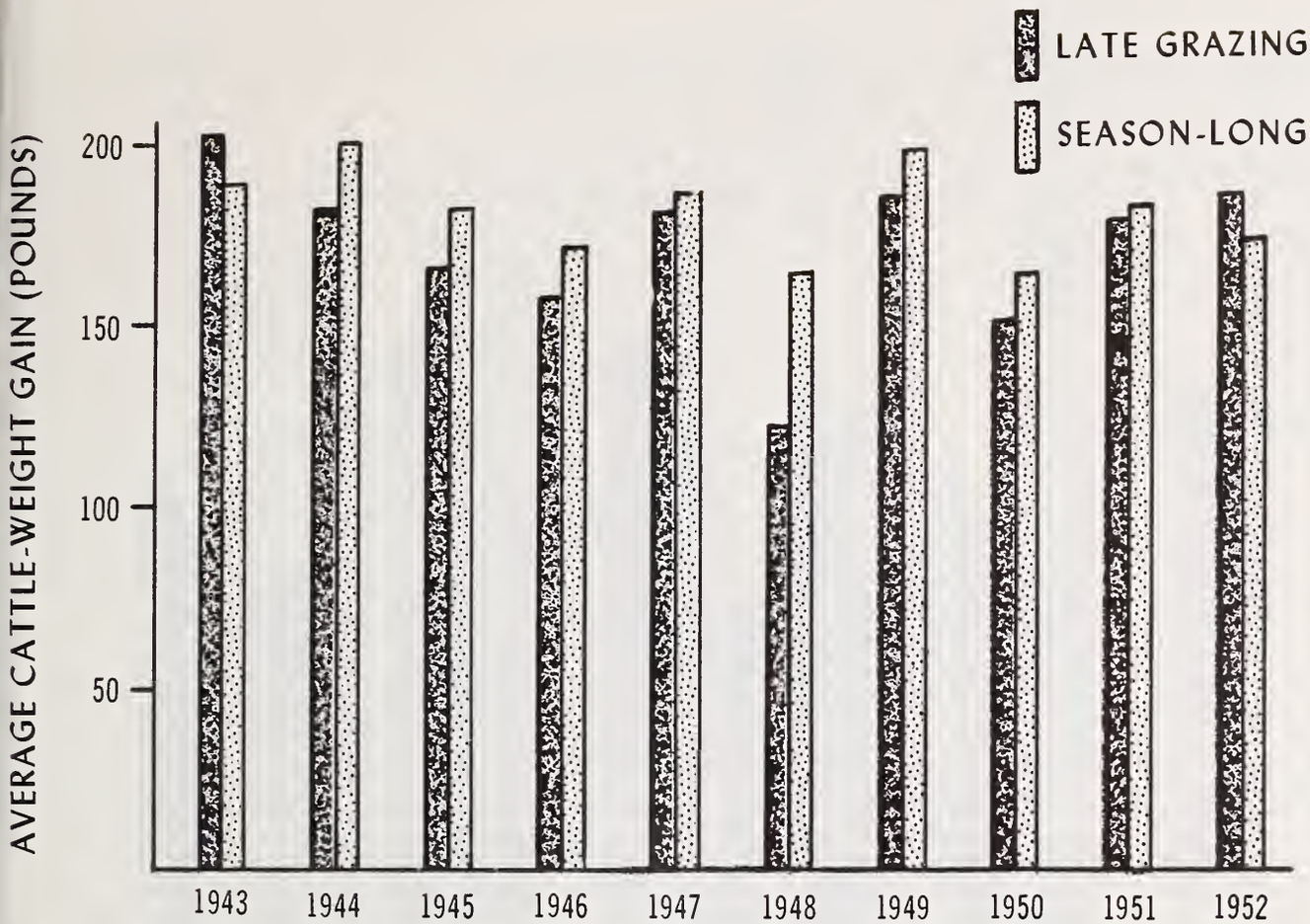

Figure 1.--Average cattle weight gains per head produced in early-grazed and season-long pastures during May 10-August 10 period each year, 1943-52.

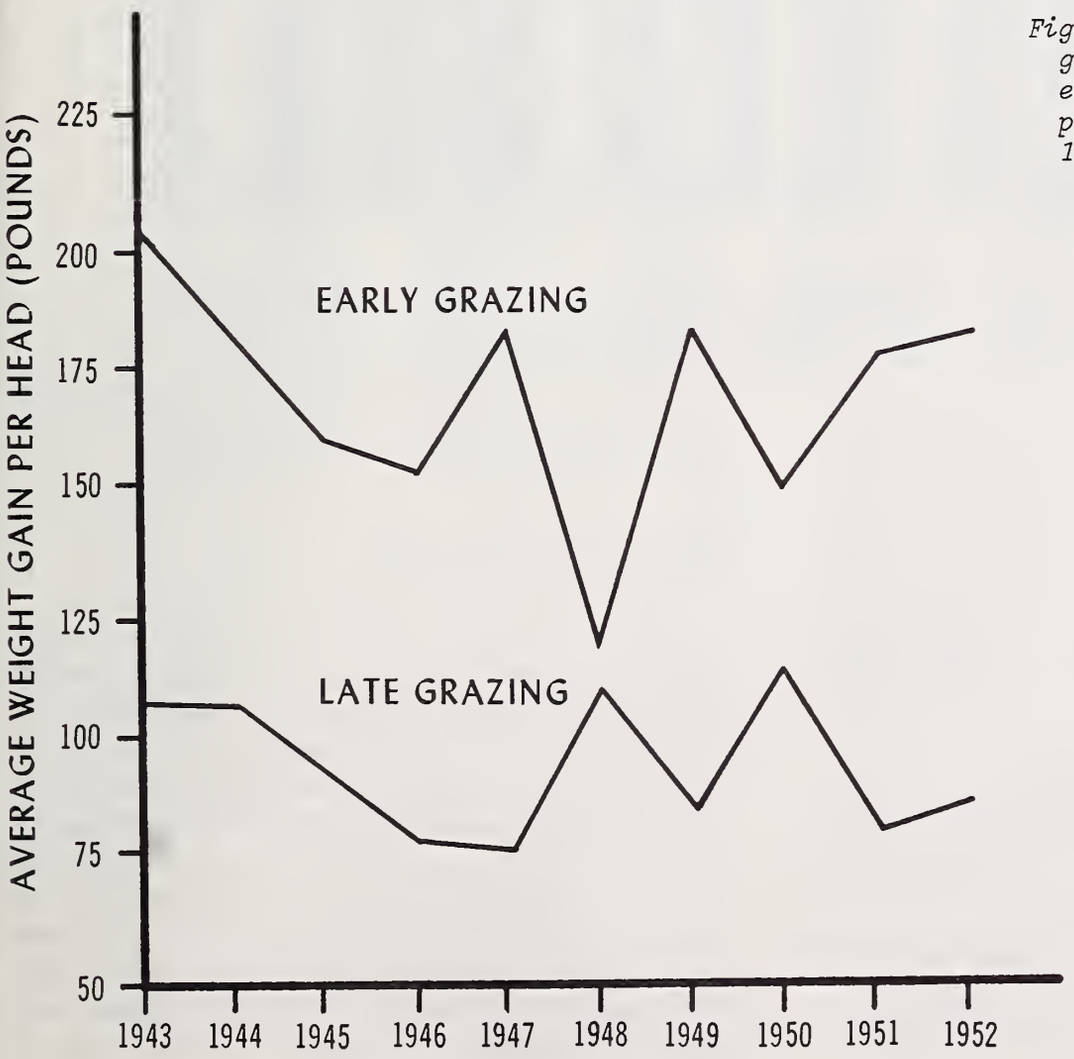

Figure 2.--Average pounds of weight gain produced per head during early grazing and late grazing by years, 1943-52.

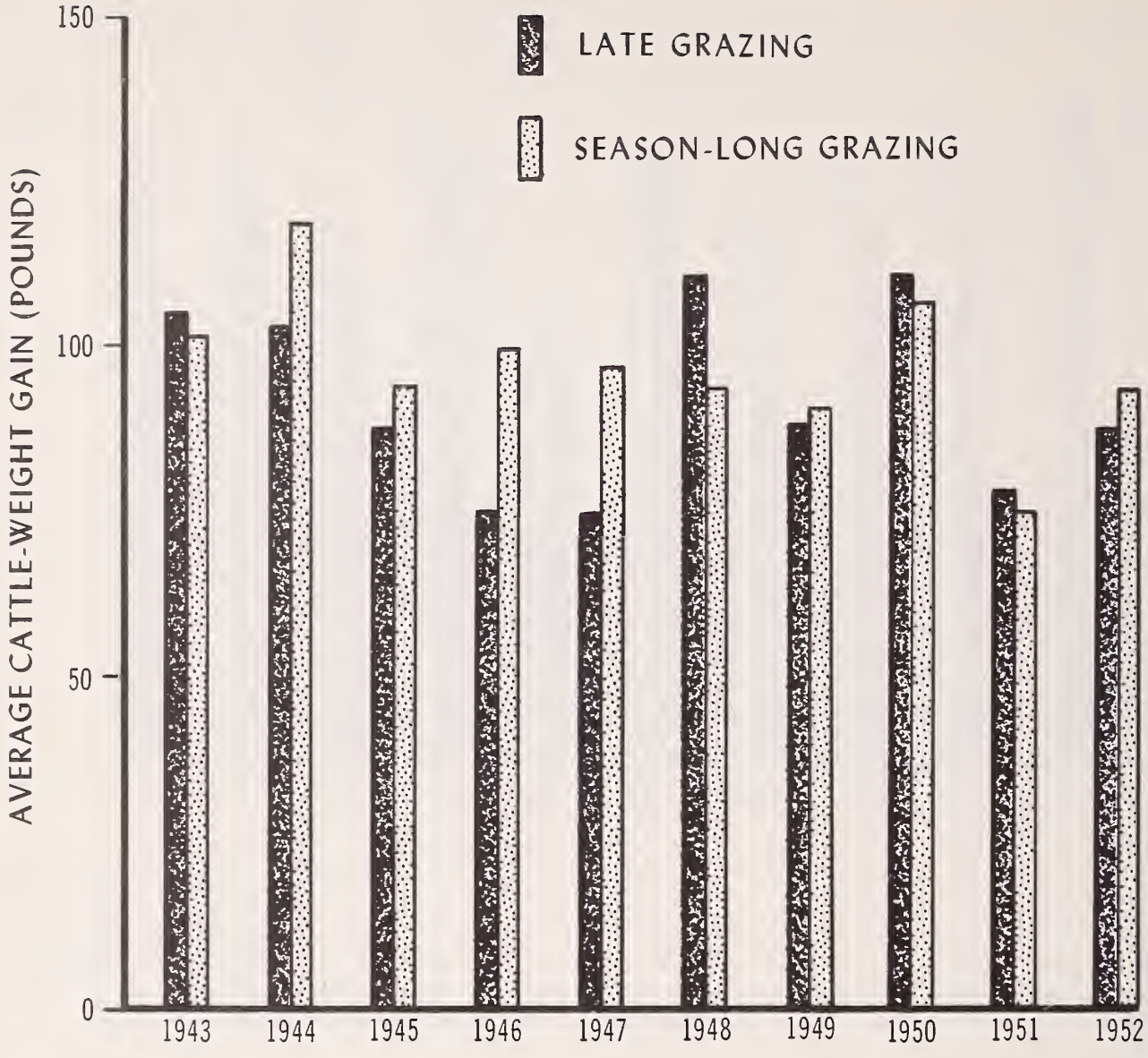

Figure 3.--Average cattle weight gains per head produced in late-grazed and season-long pastures during August 10-November 10 period each year, 1943-52.

less than 5 pounds per head in 2 other years by the cattle in the season-long pastures. Only in 2 years were gains of more than 10 pounds per head made during this period under each treatment. These results, and similar results from other grazing-management studies that used yearling cattle to graze short-grass range vegetation,[8] [9] indicate the advisability of moving yearling cattle intended for fall sale to market prior to mid-October.

[8] *Klipple, G. E., and Costello, David F. Vegetation and cattle responses to different intensities of grazing on short-grass ranges of the Central Great Plains. U. S. Dept. Agr. Tech. Bul. 1216, 82 pp., illus. 1960.*

[9] *Launchbaugh, J. L. Jr. The effect of stocking rate on cattle gains and on native shortgrass vegetation in west-central Kansas. Kans. Agr. Expt. Sta. Bul. 394, 29 pp., illus. 1957.*

Weight Gains per Acre

Early grazing produced larger weight gains per acre than season-long grazing every year, and the differences were significant in 8 of the 10 years (fig. 5). The 7-pound difference between the 10-year average gains per acre was highly significant. Also, the weight gains per acre from the season-long grazing were larger than those made from late grazing in all years, and the differences were significant in 9 of the 10 years. The 6.8-pound difference between the 10-year average weight gains per acre was highly significant. Cattle grazed on

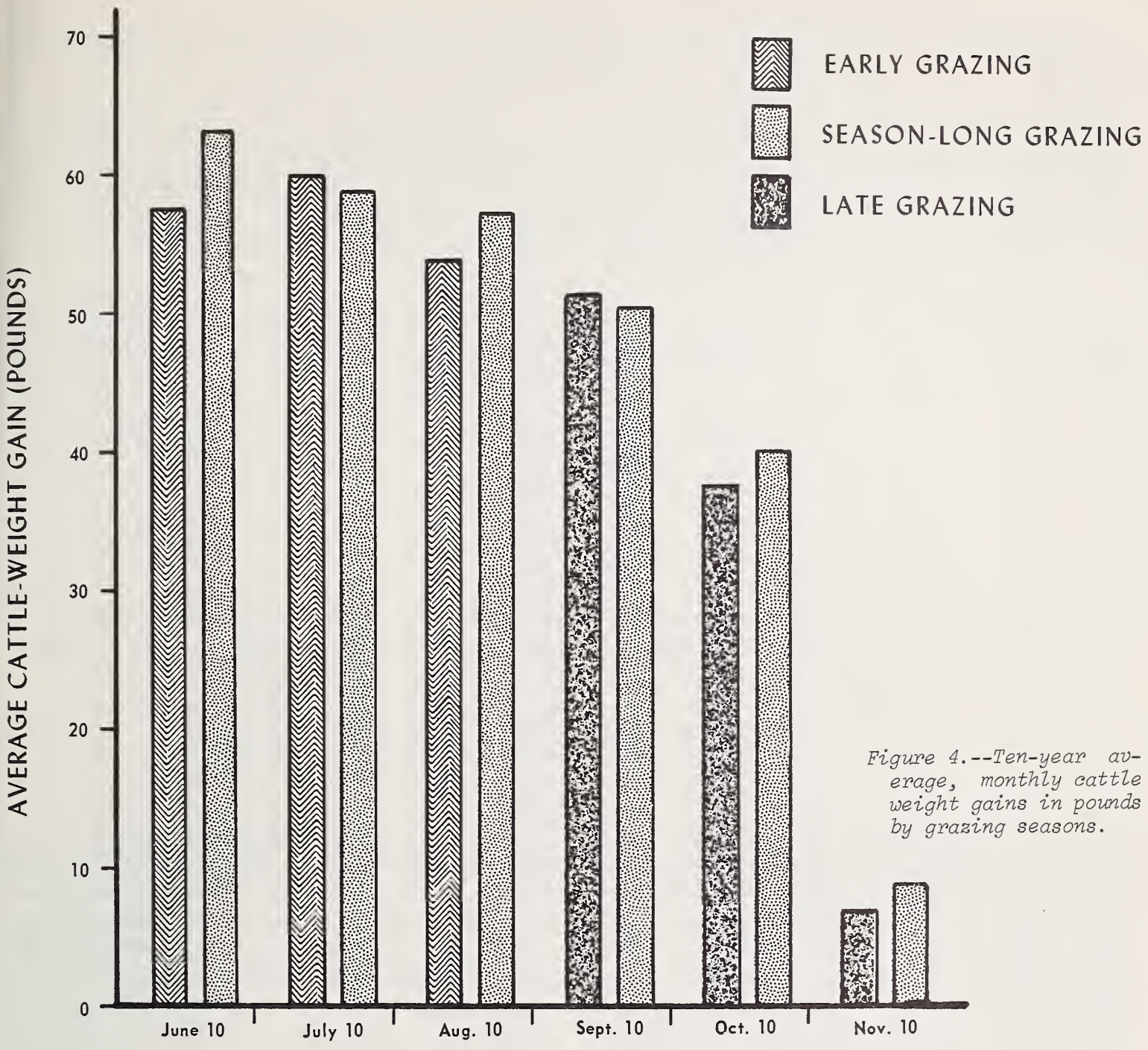

Figure 4.--Ten-year average, monthly cattle weight gains in pounds by grazing seasons.

the season-long pastures produced average weight gains per acre approximately intermediate between those on the early-grazed and late-grazed pastures. It is interesting that the general seasonal average gain per acre of the cattle grazed on the same area season-long was 21.1 pounds, compared with 21.2 pounds when the cattle grazed one area for the first 3 months and then were moved to the second area for the last 3 months.

Effects on the Range Vegetation

Approximately equal amounts of forage were removed during each of the three grazing periods (see table 4). Each grazing period, however, represented a different time in the growth cycle of the grazed species. Early grazing removed the forage of most species during the time of lush vegetative growth. Late grazing removed the forage during the time the vegetation was maturing and during early dormancy. Season-long grazing spread the forage removal over the total time period of both early and late grazing, but the intensity of forage removal was much lighter each day.

The reaction of the vegetation to the time of grazing was studied from the standpoint of changes in ground cover: by the total vegeta-

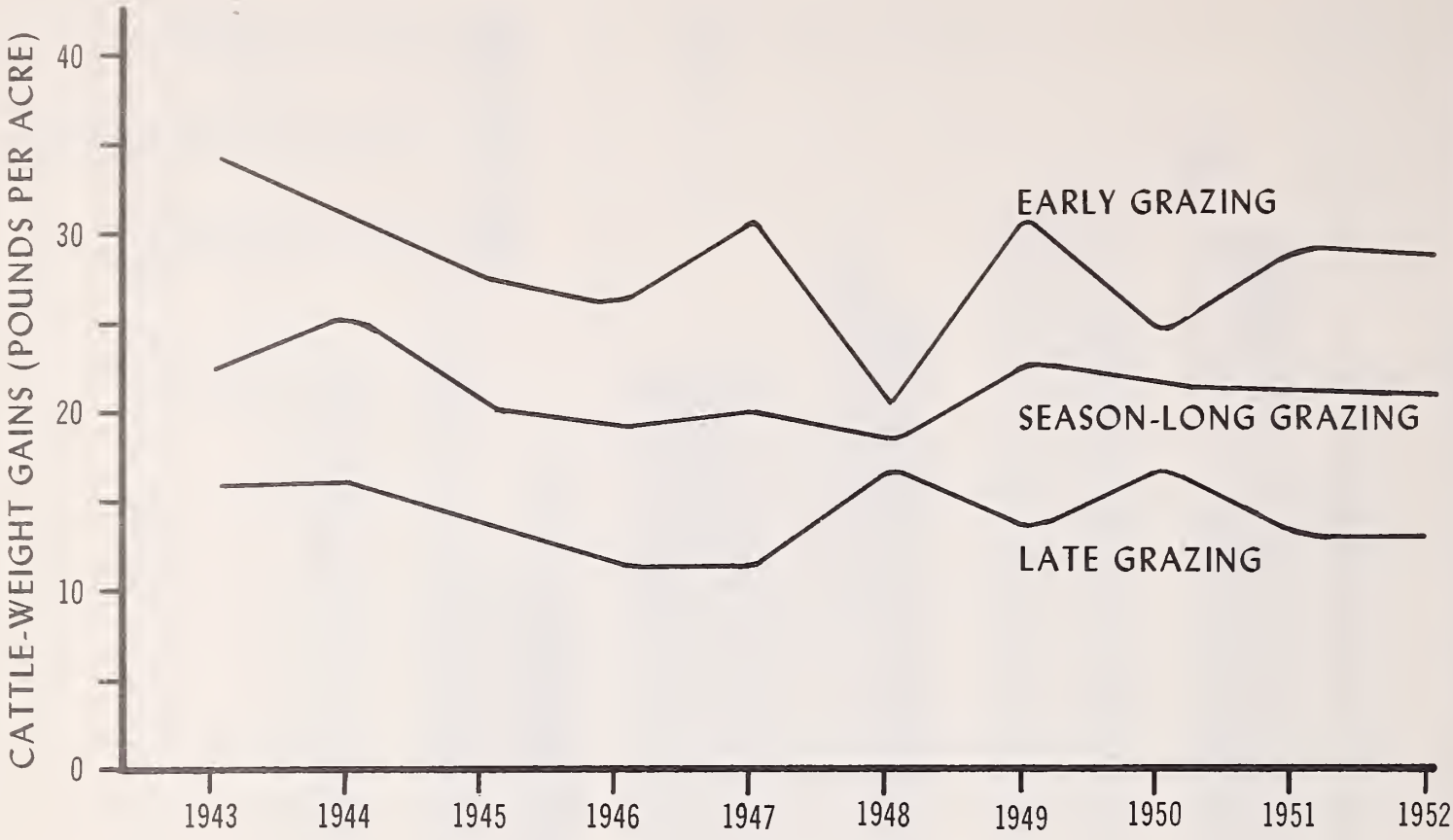

Figure 5.--Average cattle weight gains in pounds per acre by grazing seasons and years, 1943-52.

tion, by botanical groups of species, by a few individual species that produced large percentages of the forage, and by a few individual undesirable species. Changes in the composition of the vegetation, and changes in the per-acre production of herbage by the short-grass and mid-grass groups of grazed species, were also studied. Data from the 1951 and 1953, and the 1955 and 1956 examinations of the vegetation on six pastures were also compared for possible effects of the seasons of grazing on the way the vegetation reacted to the acute drought of 1954.

Changes in Ground Cover

Square-foot-density measurements were made on the same observation plots, thereby reducing sampling errors. The effects of year-to-year climatic variations on vegetation measurements, also, were reduced by combining data for a 3-year period at the beginning and middle of the study, and a 2-year period at the end.

The first period of examination, 1940-42, preceded the start of the study. All 3 years were favorable for plant growth. That period, however, had been preceded by several years of below-average rainfall that began in 1934 and culminated in the acute drought of 1939. All pastures used in the study were grazed lightly or moderately during the 1940-42 period. The vegetation was in high-fair or better condition by 1943.

At the start of the study, the vegetation on experimental pastures was quite similar as to total cover (table 6). The only significant difference observed was the 2.24 percent average difference between the early-grazed and season-long pastures. No significant differences were found in the middle and final sampling periods. The total vegetation cover on all three groups of pastures was less at the close of the experiment than at the start.

Grasses and grasslike plants as a group made up most of the cover for all three grazing treatments in all sampling periods. They

Table 6.--Average percentage of ground surface covered by live vegetation of principal species by botanical groups, grazing treatments, and time periods

Botanical groups and species	Early grazing			Late grazing			Season-long grazing		
	1940 1941 1942	1946 1947 1948	1951 and 1953	1940 1941 1942	1946 1947 1948	1951 and 1953	1940 1941 1942	1946 1947 1948	1951 and 1953
	Percent								
Grass and grasslike:									
Alkali sacaton	0.06	0.13	0.06	0.07	0.10	0.11	0.05	0.59	0.28
Blue grama	8.80	9.68	7.58	6.26	7.42	6.02	5.11	7.40	5.10
Buffalograss	.28	.23	.29	.63	.70	.29	2.01	2.04	1.57
Inland saltgrass	.29	.11	.06	.38	.11	.09	.06	.09	.29
Needle-and-thread	.03	.07	.02	.08	.10	.08	[1] T	.01	.01
Ring muhly	.02	.01	.01	.05	.02	.03	.34	.25	.13
Sand dropseed	.02	.01	.03	.02	.02	.05	.02	.10	.05
Three-awns	.14	.17	.33	.30	.24	.33	.44	.61	.30
Western wheatgrass	.17	.05	.02	.28	.16	.06	.28	.18	.04
Sedges	.02	.02	.02	.02	.07	.11	.02	.08	.01
Other grasses	.04	.01	.01	.08	.06	.03	.28	.07	.01
Total	9.87	10.49	8.43	8.17	9.00	7.20	8.61	11.42	7.79
Forbs:									
Cryptantha	.20	T	.01	.26	.02	.01	.15	.02	.01
Goosefoots	.28	T	T	.31	.02	.02	.20	T	T
Milkvetches	.02	T	.01	.01	.08	.03	.06	.03	.01
Poverty sumpweed	--	.01	T	.14	.05	.04	.02	T	T
Prairie sunflower	.06	T	T	.10	.02	.01	T	--	--
Rush skeletonplant	.02	T	T	.02	.01	.01	.02	T	T
Russianthistles	.02	T	T	.11	T	.01	.04	T	T
Scarlet globemallow	.40	.04	.01	.29	.06	.03	.19	.10	.01
Scurfpeas	.16	.01	T	.20	.09	.03	.06	T	.03
Silky sophora	.05	.01	.01	.05	.02	T	.07	.03	.01
Slenderbush eriogonum	.16	.06	.16	.37	.22	.14	.21	.15	.10
Tansyleaf aster	.04	T	.01	.23	T	.01	.24	T	T
Other forbs	.14	.04	.03	.26	.07	.01	.35	.05	.02
Total	1.55	.17	.24	2.35	.66	.35	1.61	.38	.19
Browse:									
Broom snakeweed	.04	.04	.02	.01	.07	.03	.07	.11	.03
Fourwing saltbush	.62	.33	.34	.45	.31	.15	.21	.11	.12
Fringed sagebrush	.13	.09	.20	.07	.13	.09	.07	.04	.06
Plains pricklypear	.88	.32	.32	.83	.39	.47	.29	.17	.29
Rubber rabbitbrush	.24	.12	.05	.10	.20	.11	.22	.27	.11
Other browse	--	.06	.01	.03	.02	.01	.01	.03	T
Total	1.91	.96	.94	1.49	1.12	.86	.87	.73	.61
Total vegetation	13.33	11.62	9.61	12.01	10.78	8.41	11.09	12.53	8.59

[1] T = less than 0.005 percent.

increased between the first and middle time periods under all three grazing treatments, but only the average increase in the season-long pastures was significant. Grass and grasslike plants as a group lost cover in all three grazing treatments between the middle and final period of sampling. The season-long pastures suffered the largest loss, the early-grazing less, and late-grazing the least. Below-average growing conditions during the later years of the experiment are believed to be a major contributing factor to these decreases.

The reactions of the important forage species to the three treatments are of value to sound grazing management of this type of range vegetation. Blue grama was the dominant species on all pastures. It was present on 95 percent of the plots on the early-grazed pastures in the 1940-42 sampling period, and on 99 percent of the plots during the two later periods. It had average frequencies of 87, 90, and 96 percent on the late-grazed pastures; and 79, 91, and 89 percent on the season-long pastures, respectively, during the first, middle, and final examination periods. Blue grama, as measured by cover, increased under all grazing treatments between the initial and middle periods of observation and then decreased. The greatest increase between the first two periods was under season-long grazing and the least under early grazing. The subsequent reductions in blue grama cover were such that the overall change for the period of study was a significant reduction under the early-grazing treatment, and essentially no change under the late-season and season-long treatments.

Buffalograss was the second most important grass on the pastures. It maintained its ground cover on the early-grazed pastures, but lost on the late-grazed and the season-long pastures.

Western wheatgrass was second to blue grama in frequency of occurrence among the grasses, but usually made less cover than buffalograss. Three-awns were a close third. Western wheatgrass was reduced under all three grazing treatments. Other grasses such as needle-and-thread, alkali sacaton, sand dropseed, and inland saltgrass were minor parts of the cover and made no significant changes during the period of study.

Forbs as a group averaged 1.55, 2.35, and 1.61 percent cover respectively on the early-grazed, late-grazed, and season-long pastures during the 1940-42 period. Their total cover during the two later periods was only a fraction of a percent on all three groups of pastures. Annual forbs provided approximately one-half to two-thirds of the forb cover at the start of the study. Many were entirely absent or appeared only as occasional plants during the later sampling periods. Perennial forbs such as scarlet globemallow, the good forage species, the leguminous scurfpeas and silky sophora, and slenderbush eriogonum, a poor forage, usually decreased on the average from the first to the last sampling period.

Scarlet globemallow and blue grama were the only species that occurred on more than 50 percent of the plots. Globemallow is high in protein, is freely grazed by cattle, and usually is available by early May. It decreased on all pastures on all treatments.

Scurfpeas were the only other perennial forbs grazed regularly. They all but disappeared from the early-grazed pastures, and showed major losses in cover on the late-grazed and season-long pastures. Several of the annual forb species, when available, were grazed by the cattle. Annual forbs, however, are too uncertain to be considered as a regular source of forage.

Cover of browse species as a group declined from the initial to the later periods of observation. Most of this loss was between the 1940-42 and 1946-48 periods. Fourwing saltbush and plains pricklypear were the chief species contributing to these losses. Changes by other browse species varied considerably among the grazing treatments. Over the period of study, total browse cover was significantly reduced on the early-grazed and late-grazed pastures but not on the season-long pastures.

Fourwing saltbush was the only browse species that the cattle grazed freely. This species had lost approximately half of its 1940-42 cover by 1946-48 on the early-grazed

and season-long pastures, and then maintained itself during the later years. It was progressively reduced on the late-grazed pastures. Fourwing saltbush had significantly lower cover at the end of the study than it had at the start on both the early-grazed and late-grazed pastures.

Broom snakeweed and rubber rabbitbrush lost cover on the early-grazed and season-long pastures, and approximately maintained themselves on the late-grazed pastures. Fringed sagebrush increased on the early-grazed pastures between the middle and final examination periods. It was quite conspicuous in the remaining vegetation at the close of the early grazing period during the later years of the experiment. Fringed sagebrush approximately maintained itself on the late-grazed and season-long pastures.

Plains pricklypear is an undesirable species in the short-grass association over wide areas of the Central Great Plains. Its average cover was approximately equal to or larger than the average cover of any one other browse species throughout this experiment on all of the pastures. The general reactions of this species to the grazing seasons were loss in cover on the early-grazed and late-grazed pastures and maintenance on the season-long pastures.

Changes in the Composition

The more important changes in the composition of the vegetation were the decreases in the forbs between the initial and middle examination periods, and the increase in blue grama during that time interval. These changes were quite similar under all three grazing treatments. Changes in percentage composition between 1946-48 and 1951 and 1953 were small. Forb and browse species were contributing proportionately less and grass species more at the close of the study than when it began. The grazing treatments did not develop any significant changes in the composition of the vegetation.

Changes in Herbage Production

Herbage production and changes in herbage production over a period of years are the more reliable measures of the impact of grazing management procedures. The average yields in pounds per acre by the two groups of grasses and sedges--short-grasses and sedges, and mid-grasses--on the three pastures in each grazing season for 1 year early in the experiment, 1943; for 3 years late in the experiment; and for 1953, the year following the close of the grazing treatments, are listed in table 7.

In 1943, at the start of the study, average yields of short-grass herbage on the early-grazed and late-grazed pastures were larger than on the season-long pastures. Mid-grass herbage yields were similar for all treatments that year. Both short-grass and mid-grass yields were less in 1949 than in 1943 for all three treatments.

Short-grass yields under season-long grazing increased to an average 602 pounds per acre in 1953, significantly larger than the 498 pounds produced in 1943. On the late-grazed pastures, average yield of short-grasses was 653 pounds in 1953, larger than the 467 pounds obtained in 1949, but smaller than the 743-pound average yield obtained in 1943. The early-grazed pastures produced 535-pound average yield in 1953, which was not significantly larger than either the 514 pounds produced in 1949 or the 460 pounds produced in 1950. It was significantly smaller than the 712-pound average yield produced in 1943.

Mid-grass herbage yields continued to decline under all grazing treatments. Decreases were most severe on the early-grazed pastures, and about the same on the late-grazed and season-long pastures. The 1953 yield of mid-grass herbage was only approximately 10 percent of what it had been in 1943 on the early-grazed pastures, compared with approximately 38 and 40 percent for the late-grazed and season-long pastures.

In general, total production was maintained on the season-long pastures but reduced under early-grazing and late-grazing. The loss was greatest on the early-grazed pastures. Lack of grazing after July, if it benefited the vegetation at all, did not provide sufficient benefit to offset the adverse effects of accelerated

Table 7.--Average herbage production of air-dry hay by forage groups and grazing seasons, 1943, 1949, 1950-53

Grazing seasons and forage groups	1943	1949	1950	1951	1953
	Pounds per acre				
Early:					
Short-grasses and sedges[1]	712	514	460	601	535
Mid-grasses[2]	206	137	83	99	20
Total	918	651	543	700	555
Late:					
Short-grasses and sedges	743	467	499	481	653
Mid-grasses	230	183	173	193	88
Total	973	650	672	674	741
Season-long:					
Short-grasses and sedges	498	381	305	403	602
Mid-grasses	231	171	128	133	92
Total	729	552	433	536	694

[1] Blue grama, buffalograss, and fine-leaf sedges.
[2] Western wheatgrass, needle-and-thread, sand dropseed, alkali sacaton, inland saltgrass, little bluestem, prairie sandreed, and side-oats grama.

stocking during the early part of the growing season.

Reaction of Vegetation to 1954 Drought

Data from six of the nine pastures, two in each grazing treatment, were analyzed to determine possible effects of past grazing-season treatments upon the way the range vegetation came through the 1954 acute drought. Averages of the data for 1951 and 1953 were compared with the average data for 1955 and 1956. No real differences were found due to treatment. Major individual species and botanical groups of species reacted alike to the drought conditions on all six pastures. Ground cover of the more palatable grasses was reduced by the drought. Alkali sacaton and inland saltgrass, found where shallow water tables exist, increased in ground cover. Forbs, both desirable and undesirable, increased in ground cover, with annual forbs making the larger increases. The deep-rooted, more desirable browse species--fourwing saltbush and common winterfat--increased in ground cover while the poor-forage and nonforage browse species did not change or lost in ground cover.

Mechanical Impact of Concentrated Stocking

Some undesirable conditions developed under the concentrated use of the early 3-month period. Cow-path gullies developed far more rapidly on the early-grazed pastures than they did on the season-long or late-grazed pastures. The increased trailing to and from salt and water resulted in loose soil in the cattle trails, which blew and washed away.

Two partially healed blowout areas, one on sandy land in early-grazed pasture 13E, and one on heavy soil in early-grazed pasture 17N, became active again during the study. These areas were near water, and the cattle used them for resting and rubbing. Practically

no revegetation of open soil occurred on the pastures subjected to early grazing. Some of the cattle trails became relatively deep.

In contrast, buffalograss became established on portions of a number of trails on the season-long pastures during the early years of the study. A few new trails opened up during the later years of the study, however, on those pastures that were less favorable for plant growth. On the late-grazed pastures, perennial grasses also became established on a number of cattle trails that were bare soil at the start of the experiment in 1943. Several small gullies, active when the study started, became inactive in the late-grazed pastures during the 10 years. Taller vegetation, especially Russianthistle, that grew on many of the cattle trails in the late-grazed pastures during the May-July period often induced the cattle to make new trails. Thus many of the trails on the late-grazed pastures were used for only 1 or 2 years before they were abandoned. The trails did not become so deep, and they often had a chance to become partially covered with perennial vegetation before they were used again.

SUMMARY

A grazing experiment was conducted on the Central Plains Experimental Range near Nunn, Colorado from 1943 through 1952 to compare (1) increased stocking during a 3-month early grazing period (May 10-August 10, approximately) followed by a second 3 months on other pastures that had been deferred during the early period, with (2) average stocking during a 6-month season-long grazing period (May 10-November 10, approximately).

Three groups of three pastures were used in the experiment to allow for three randomized replications of each grazing period. Each of the nine pastures was grazed for 10 years during the period assigned to it.

The number of cattle grazed for the 3-month period was approximately two times the number grazed for the 6-month period. Stocking objectives on all treatments were to make moderate utilization of the current growth of the herbage during the period of grazing. Pasture herds were moved from the early-grazed to the late-grazed pastures in the same block with practically no change in numbers. The moderate intensity of herbage removal was obtained quite regularly throughout the experiment.

Both yearling steers and yearling heifers were grazed. The two sexes were kept separate at all times, and all three herds used in a block of pastures during any one year were of the same sex. Weight gains on steers and heifers were combined in determining average weight gains per acre.

Cattle concentrated on the early-season pastures made about the same gains each month as cattle grazing on the season-long pastures at the same time. Also, cattle concentrated on the late-season pastures made about the same gains each month as those grazing the season-long pastures. Because more cattle were concentrated in the early-grazed pastures, significantly larger average weight gains per acre were made than on the season-long pastures. Likewise, because cattle were not on the late-grazed pastures during the early period when best gains were made, significantly smaller average weight gains per acre were made on the late-grazed pastures than on the season-long pastures.

The vegetation on the early-grazed pastures suffered significant losses in herbage production. The pastures also suffered mechanical damage to the vegetation and soil from the heavier stocking for a shorter time period.

The vegetation on the late-grazed pastures also lost some in production but there was no mechanical damage. Loss in ground cover from die-out of entire clumps of blue grama during relatively short, 3- to 4-week periods of hot dry weather in late July and August, followed rather luxuriant early-season growth. These losses were quite heavy in 1948 after a year of high blue grama production in 1947.

The vegetation on the pastures grazed season-long maintained production during the 10 years of the experiment.

COMMON AND BOTANICAL NAMES OF SPECIES MENTIONED

GRASSES AND GRASSLIKE PLANTS

Alkali sacaton	*Sporobolus airoides* Torr.
Blue grama	*Bouteloua gracilis* (H. B. K.) Lag.
Buffalograss	*Buchloe dactyloides* (Nutt.) Engelm.
Inland saltgrass	*Distichlis stricta* (Torr.) Rydb.
Little bluestem	*Andropogon scoparius* Michx.
Needle-and-thread	*Stipa comata* Trin. & Rupr.
Prairie sandreed	*Calamovilfa longifolia* (Hook.) Scribn.
Ring muhly	*Muhlenbergia torreyi* (Kunth) Hitchc.
Sand dropseed	*Sporobolus cryptandrus* (Torr.) A. Gray
Side-oats grama	*Bouteloua curtipendula* (Michx.) Torr.
Three-awns	*Aristida* spp.
Western wheatgrass	*Agropyron smithii* Rydb.
Sedges	*Carex* spp.

FORBS

Cryptantha	*Cryptantha* spp.
Goosefoots	*Chenopodium* spp.
Milkvetches	*Astragalus* spp.
Poverty sumpweed	*Iva axillaris* Pursh
Prairie sunflower	*Helianthus petiolaris* Nutt.
Rush skeletonplant	*Lygodesmia juncea* (Pursh) D. Don.
Russian thistles	*Salsola* spp.
Scarlet globemallow	*Sphaeralcea coccinea* (Pursh) Rydb.
Scurfpeas	*Psoralea* spp.
Silky sophora	*Sophora serecia* Nutt.
Slenderbush eriogonum	*Eriogonum microthecum* Nutt.
Tansyleaf aster	*Aster tanacetifolius* H. B. K.

BROWSE

Broom snakeweed	*Gutierrezia sarothrae* (Pursh) Britt. & Rusby
Common winterfat	*Eurotia lanata* (Pursh) Moq.
Fourwing saltbush	*Atriplex canescens* (Pursh) Nutt.
Fringed sagebrush	*Artemisia frigida* Willd.
Plains pricklypear	*Opuntia polyacantha* Haw.
Rubber rabbitbrush	*Chrysothamnus nauseosús* (Pall.) Britt.

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