Vegetation Response to Continuous versus Short Duration Grazing on Sandy Rangeland

B. E. Dahl
P. F. Cotter
Texas Tech University, Box 42123, Lubbock, TX 79409-2123

R. L. Dickerson Jr.
Purina Mills, Inc., St. Louis, MO 63164

J. C. Mosley*
University of Idaho, Department of Range Resources, Moscow, ID 83844

ABSTRACT

This 8-year study compared the response of rangeland vegetation under continuous grazing vs. short duration grazing management systems. The study was conducted on a native rangeland site with a sandy soil in the Texas Rolling Plains. Yearling steers grazed the continuous grazing and short duration grazing paddocks at approximately the same stocking rate so that the study's comparison between grazing systems was not confounded by stocking rate. The continuous grazing treatment averaged 25.5 steer days acre^{-1}year^{-1} while the short duration grazing treatments averaged 27.0 steer days acre^{-1}year^{-1}. The short duration grazing treatments varied during the 8-year study, ranging from 4- to 36-paddock rotations. Plant species composition and forage production were monitored in all treatment paddocks. Over the entire 8-year study period, no significant changes in plant species composition or forage production were detected between continuous grazing and short duration grazing treatments.

Grazing management systems designed to allow plant recovery after grazing are reputed to increase the yield from desired forage plants more so than continuous grazing. One widely promoted rotational grazing system is short duration grazing (SDG). Savory and Parsons (1980) indicated that after SDG is properly applied "there is usually an increase in herbage production which frequently requires an increase in herd size." Further, Savory (1978) stated, "Our experience has been that doubling the stocking rate has been the rule rather than the exception with properly planned and executed short duration grazing." Others are more skeptical, insisting that one should not expect to increase stocking rates by more than 30% with these systems and that they are more valuable for maintaining productivity of rangelands and pastures than for increasing forage production (Gammon, 1984). After careful consideration of available research on SDG, Pieper and Heitschmidt (1988) concluded that stocking rate will always be the overriding factor affecting grazing impacts on rangelands. Van Poollen and Lacey (1979) also concluded that

Paper No. T-9-622, College of Agricultural Sciences, Texas Tech University. Accepted August 1992. *Corresponding author.

stocking rate was more important than grazing system in maintaining or improving range forage production.

To find out whether we could increase forage production through SDG, we initiated a study in the Rolling Plains of Texas in 1980. Our major objective was to compare forage yield and species composition changes under continuous *versus* short duration grazing management in a multi-year study.

SITE DESCRIPTION

The study site is native range on a sandy soil located in Garza County, approximately 10 mi northeast of Post, Texas, in the Rolling Plains (Gould, 1975). The average growing season is 216 days, beginning about 5 April and terminating on 7 November. Minimum daily temperatures average 27 F and occur during January. The average maximum temperature is 95 F and occurs in July. Annual Class A pan evaporation averages 100-105 inches. Winters are characteristically dry with low rainfall. Average annual precipitation is 18.8 inches, 75% of which occurs between April and October (Richardson et al., 1965).

The study site soil is a Brownfield fine sand, a member of the loamy, mixed thermic, arenic Aridic Paleustalfs (Richardson et al., 1965). The range site is a deep sand and is in mid-seral ecological condition. Climax vegetation for the site is a tallgrass prairie with scattered sand shinnery oak (*Quercus havardii*) mottes. Currently, the site is dominated by sand shinnery oak, sand sagebrush (*Artemisia filifolia*), yucca (*Yucca glauca*), western ragweed (*Ambrosia psilostachya*) and a variety of grasses including fringed signalgrass (*Brachiaria ciliatissima*), sand dropseed (*Sporobolus cryptandrus*), hooded windmill grass (*Chloris cucullata*), little bluestem (*Schizachyrium scoparium*), fall witchgrass (*Leptoloma cognatum*), and sand paspalum (*Paspalum setaceum*).

METHODS AND MATERIALS

The 80-acre study site was divided into a 20-acre continuously grazed paddock, four 5-acre paddocks, and four 10-acre paddocks. Because yearling steers were used to impose treatment and were not on study paddocks continually, no attempt was made to obtain animal performance data. Rather, evaluation of vegetation response among grazing treatments was the overall objective of the study. Although treatments varied somewhat over the 8-year study period, in each year continuous grazing was compared to SDG. At least four paddocks and up to 36 paddocks were used for the SDG treatments. Gammon (1984) found 6 to 10 paddocks sufficient to provide the desired range recovery. More paddocks proved to be of limited value. The variations in SDG used in this study are described below.

Grazing Systems

Treatment Year 1 (1980)

Continuous grazing was compared with two simulated 8-paddock SDG rotations. Each simulated SDG system consisted of four paddocks grazed intermittently as if they were four consecutive paddocks within an 8-paddock rotation. Steers were moved to nearby pastures for the time required for the animals to have grazed the other four paddocks that did not exist (Gammon and Roberts, 1980). One SDG system was stocked at 1.6 times the continuous rate and we tried to stock the other SDG system at 2 times the continuous rate. Each paddock was rested about 50 days after being grazed.

Treatment Years 2 through 6 (1981-1985)

Continuous grazing was compared to simulated 18- and 36-paddock SDG rotations. Stocking rate was kept approximately the same among grazing treatments. Four paddocks were grazed under each SDG treatment for the prescribed period and animals were moved to adjacent pastures for the time required for them to have grazed the other 14 or 32 paddocks that did not exist. Each paddock was rested for about 50 days after being grazed.

Treatment Year 7 (1986)

Continuous grazing was compared to four simulated 6-paddock rotations. Stocking rate was the same among grazing treatments. The four 10-acre paddocks were halved so the study then had 12, 5-acre paddocks in addition to the continuous paddock. Only three paddocks existed for each of the four sets so the animals were removed from the paddocks for the amount of time required to have grazed the non-existent paddocks in each set. Paddocks were rested for an average of 38 days during this grazing season.

Treatment Year 8 (1987)

Continuous grazing was compared to a 4-paddock and an 8-paddock SDG rotation. Paddocks were rested 21 and 49 days, respectively, for the two SDG treatments. Stocking rate was similar among grazing treatments.

Stocking Rates

Proper stocking rate for the area is about 24.3 steer days acre^{-1} under yearlong continuous grazing. At this stocking rate, about one-third of the usable forage is harvested during winter when plants are dormant. To significantly increase stocking in this study, our goal was to stock each treatment for at least 24.3 steer days acre^{-1} during the growing season only (generally from March or April to October or November). Beginning and ending dates (which varied among years because of variability in spring soil moisture necessary for green-up of vegetation), steer numbers, and other data are given in Table 1.

SDG paddocks were sampled in two sets referred to as SDG-1 and SDG-2. SDG-1 samples were from the SDG treatments with fewer paddocks each year.

Vegetation Sampling

At least four 100-point step-point transects in each paddock (Evans and Love, 1957) were used to estimate species composition during 1980, 1983, 1984, and 1987. Shrub overstory composition was estimated by recording whenever a sample point occurred beneath a shrub's canopy. Forage standing crop was estimated from 20 caged 4.8-ft^2 plots per treatment each year of the study. Current year's herbaceous growth was clipped to a 1-inch stubble height and oven-dried at 140 °F for 48 hours prior to weighing. Standing crop was measured during late July or August during 1980-1982 and later in the fall other years.

Data Analysis

Analysis of variance was used to test the hypothesis that plant species composition and forage production did not differ between grazing treatments. Grazing treatments (continuous and short duration) were not replicated in space. However, it is possible to test treatment effects, year effects, and the treatment x year interaction with analysis of variance if the statistical inferences drawn are limited to the particular pastures in the study (Wester, 1992).

Table 1. Grazing season and stocking rates for the grazing treatments.

Year	Treatment	Date Begin	Date End	Steers (No.)	Steer days per acre
1980	Continuous	28 Mar	11 Nov	2	22.8
	4-Paddock SDG (1.6 X)[1]	28 Mar	17 Nov	10	36.5
	4-Paddock SDG (2.0 X)[1]	28 Mar	17 Nov	10	39.5
1981	Continuous	15 Apr	25 Sept	3-4	38.9
	18-Paddock SDG	16 May	22 Oct	46-51	38.0
	36-Paddock SDG	16 May	22 Oct	45-51	38.0
1982	Continuous	9 Apr	17 Dec	2	25.2
	18-Paddock SDG	9 Apr	2 Nov	18	25.2
	36-Paddock SDG	9 Apr	2 Nov	18	25.2
1983	Continuous	11 Mar	1 Nov	2	23.5
	18-Paddock SDG	11 Mar	7 Sept	18-22	25.7
	36-Paddock SDG	11 Mar	7 Sept	18-22	22.7
1984	Continuous	13 Jun	25 Sept	2	10.4
	18-Paddock SDG	13 Jun	25 Sept	19	12.3
	36-Paddock SDG	13 Jun	25 Sept	19	10.4
1985	Continuous	4 May	29 Jan[2]	2	27.0
	18-Paddock SDG	15 May	7 Mar	17	24.1
	36-Paddock SDG	15 May	7 Mar	17	23.2
1986	Continuous	13 May	13 Oct	3-7	36.2
	6-Paddock SDG	13 May	17 Oct	4-9	36.2
	6-Paddock SDG	13 May	17 Oct	4-9	36.2
1987	Continuous	29 Apr	2 Sept	2-4	19.6
	4-Paddock SDG	29 Apr	2 Sept	3-6	19.4
	8-Paddock SDG	29 Apr	2 Sept	3-6	19.3

[1] Stocked at 1.6 or 2 times the continuous rate.
[2] Ending date in 1986.

RESULTS AND DISCUSSION

Grazing animals encountered a lack of forage before the grazing season ended in the double-stocked pastures in 1980. This prohibited us from attaining twice the number of steer days $acre^{-1}$ that we had obtained with continuous grazing. Consequently, in each of the remaining years of the study, we attempted to maintain all stocking rates equal among grazing treatments. Our objective was to test if short duration grazing (SDG) provides a differential vegetation response to continuous grazing management when stocking rates are similar for both grazing systems.

Precipitation during the study period varied from well above the 18.8-inch long-term annual average most years to slightly below average during 1982 and 1984 (Table 2). Growing season precipitation (January-September) in 1983 and 1984 was only about half that of the other years of the study, and forage production consequently was reduced during these dry years. Despite low forage production, stocking rates were maintained at about the target rate (24.3 steer days $acre^{-1}$) during 1983 (Table 1). However, a dry spring and 2 consecutive dry growing seasons with low forage production forced a reduced stocking rate (about 11 steer days $acre^{-1}$) in 1984. In 1987, the stocking level was below target because we terminated the study early: the grazing impact through the summer was at the target rate, vegetation sampling had been completed, and we believed that nothing would be gained by two more months of grazing. Throughout the 8-year duration of the study, stocking rates averaged 25.5 and 27.0 steer days $acre^{-1}$ for continuously grazed and SDG paddocks, respectively.

Table 2. Rainfall recorded during the study near Post, Texas.

Year	Jan - Mar	Apr - Jun	Jul - Sept	Oct - Dec	Total
	Inches				
1980	1.33	8.09	9.38	3.13	21.93
1981	2.31	8.57	5.88	8.02	24.78
1982	1.15	11.70	2.13	3.10	18.08
1983	2.62	5.50	1.28	11.78	21.18
1984	0.56	3.20	3.96	8.02	15.73
1985	2.29	8.26	7.35	7.92	25.82
1986	0.20	6.71	9.61	6.58	23.10
1987	3.28	12.53	7.30	TRACE	(23.11)

Nine grasses, 6 forbs and 1 shrub comprised 80 to 90% of the species composition on study pastures (Table 3). Eight of the 9 grasses are traditionally considered increasers or invaders under heavy continuous grazing (Richardson et al., 1965). Little bluestem was the only grass present that tends to decrease under continuous grazing. Of the forbs, only western ragweed acts as an increaser under continuous grazing. Erect dayflower (*Comelina erecta*), a palatable plant, is expected to decrease under heavy continuous grazing. All other forbs were annuals whose abundance depended on climatic conditions.

Over the 8-year study period, no changes were detected (P>0.05) in species composition due to grazing system. Generally, species changes from year to year in one grazing treatment were reflected by similar changes in other treatments. Apparent trends due to treatment were inconsistent. For example, from 1980 to 1987, shrub understory composition declined from 14 to 8% under continuous grazing with little change occurring in the SDG treatments; nevertheless, shrub overstory increased 6 to 9% in all treatments (Table 3). Sand shinnery oak overstory increased 10% from 1980 to 1987 in all treatments. However, sand shinnery oak had no more understory hits than in 1980. This indicates that the increase in oak overstory involved a larger canopy spread that was not accompanied by an increase in plant numbers. Fringed signalgrass, a stoloniferous species that is opportunistic in covering bare ground in sandy ranges, increased 14% under continuous grazing, and 6 and 13% in the two SDG treatments (Table 3).

Plant cover changes attributable to climatic variation were conspicuous between 1983 and 1984 due to unusual weather in 1983. May was a reasonably good forage growth month in 1983 with 3.24 inches of rainfall. However, with only 0.93 inches of rainfall from the end of May to 15 July, there was little forage growth. Also, August and September rains were insufficient to provide plant growth. Then, over 9 inches of rain fell from 7 to 20 October, and there was a small amount of plant growth. Three weeks of record cold in December 1983 (NOAA, 1983) caused severe winter injury or death of many grass plants. Consequently, grass species composition declined in 1984 by half in all grazing treatment pastures, and forb and shrub composition approximately doubled. We believe that the regrowth following the 15 July rain and the mid-October rains was insufficient to recharge root and stem base carbohydrates. Consequently, the severe cold in December killed many of the weakened grasses and others had only one or two live tillers per plant during the summer of 1984. The composition of the longer-lived perennials, such as little bluestem and purple threeawn (*Aristida purpurea*), was not affected by these climatic events. By 1987, the grasses had nearly recovered to their original composition. The stoloniferous fringed signalgrass actually increased its coverage.

Forage production varied considerably from year to year (Table 4) depending on rainfall and other climatic influences (e.g., winter-killed grasses in 1983-84). However, changes in standing crop due to grazing treatment through the eighth growing season were not statistically significant (P>0.05).

Table 3. Species composition (%) from step-point transects.

	1980			1983			1984			1987		
	CONT	SDG 1[1/]	SDG 2	CONT	SDG 1	SDG 2	CONT	SDG 1	SDG 2	CONT	SDG 1	SDG 2
Grasses												
Aristida purpurea	1	1	1	2	2	1	2	2	3	2	2	3
Brachiaria ciliatissima	26	21	20	24	21	20	17	8	10	40	34	26
Cenchrus incertus	5	4	6	13	9	6	1	2	2	5	5	6
Chloris cucullata	5	13	10	4	6	8	2	2	3	3	2	5
Leptoloma cognatum	10	8	10	10	8	11	2	1	1	5	2	8
Paspalum setaceum	6	5	6	9	6	6	1	1	1	7	6	6
Sporobolus cryptandrus	6	8	8	8	6	4	4	7	6	5	5	4
Schizachyrium scoparium	1	2	1	T[2/]	2	1	2	4	4	1	2	2
Stipa comata	T	1	1	T	1	2	T	T	T	T	1	2
Other grasses	6	10	5	2	5	6	5	5	2	2	9	6
Total grasses	66	73	68	72	66	65	36	32	32	70	68	68
Forbs												
Ambrosia psilostachya	8	7	6	6	9	8	5	5	3	2	2	2
Aphanostephus ramosissimus	2	1	1	2	2	2	14	14	10	6	5	6
Eriogonum annuum	2	1	2	3	2	3	5	2	2	3	2	2
Hymenopappus flavescens	4	2	3	1	T	T	0	0	0	1	1	1
Comelina erecta	1	T	T	1	1	T	1	1	1	1	T	1
Heterotheca latifolia	T	0	T	1	2	3	6	10	3	2	1	1
Other forbs	3	4	6	5	7	8	7	7	13	7	9	4
Total forbs	20	15	18	19	23	24	38	39	32	22	20	17
Shrubs												
Quercus havardii	14	8	12	7	8	7	24	21	27	7	9	12
Other shrubs	0	4	2	2	3	4	2	8	9	1	3	3
Total shrub understory	14	12	14	9	11	11	26	29	36	8	12	15
Shrub overstory												
Artemisia fillifolia	1	3	2	1	1	1	1	2	3	1	3	2
Quercus havardii	28	24	33	21	22	18	26	27	32	38	33	43
Xanthocephalum sarothrae	1	5	3	1	1	2	1	1	2	T	1	1
Yucca glauca	1	2	2	2	2	1	1	2	2	1	3	3
Other shrub overstory	1	0	2	0	0	0	0	1	0	1	0	1
Total shrub overstory	32	34	42	25	26	22	29	33	39	41	40	50

[1/] SDG systems divided into 2 sets. SDG 1 is SDG treatment having fewer paddocks each year.
[2/] T indicates values under 0.5%.

Table 4. Standing crop of herbaceous plants for eight years under continuous and two levels of short duration grazing management.

Year	Treatment	Grass (lbs/acre)	Forbs (lbs/acre)
1980[1]	Continuous	778	304
	4-Paddock SDG (1.6 X Continuous)	716	134
	4-Paddock SDG (2 X Continuous)	744	451
1981[1]	Continuous	945	614
	18-Paddock SDG	834	389
	36-Paddock SDG	978	433
1982[1]	Continuous	954	366
	18-Paddock SDG	783	312
	36-Paddock SDG	957	550
1983[2]	Continuous	286	239
	18-Paddock SDG	308	236
	36-Paddock SDG	342	182
1984[2]	Continuous	282	182
	18-Paddock SDG	197	250
	36-Paddock SDG	266	177
1985[2]	Continuous	1474	21
	18-Paddock SDG	1377	23
	36-Paddock SDG	1097	9
1986[2]	Continuous	1513	Trace
	6-Paddock SDG	1549	4
	6-Paddock SDG	1260	Trace
1987[2]	Continuous	1468	320
	4-Paddock SDG	1315	228
	8-Paddock SDG	1499	302

[1] Vegetation clipped in late July or August.
[2] Vegetation clipped in October or November.

CONCLUSIONS

By maintaining equivalent stocking rates among grazing treatments (except for the first year), any differences in vegetation response among treatments are likely due to grazing system and not stocking rate. During 8 years, species composition changed dramatically among years but little variation existed among grazing treatments, indicating that climatic variation had more influence on species composition in this study than grazing system. Likewise, standing crop of vegetation varied greatly among years but no difference in standing crop existed among grazing treatments ($P > 0.05$).

This study supports a growing body of research that shows stocking rate is more important than grazing system in managing natural rangelands (Gammon, 1984; Skovlin, 1987; Pieper and Heitschmidt, 1988; Bryant et al., 1989; Fourie and Bransby, 1988). Nevertheless, we believe that continuous grazing has the least potential of any grazing system for increasing the abundance of desired plants on rangeland (Gammon, 1984). We also believe that most any grazing system can maintain range condition, provided that the range is not overstocked. However, if one overstocks no grazing scheme will be effective in maintaining or improving range condition.

REFERENCES

Bryant, F.C., B.E. Dahl, R.D. Pettit, and C.M. Britton. 1989. Does short-duration grazing work in arid and semi-arid regions? J. Soil and Water Conserv. 44:290-296.

Evans, R.A., and R.M. Love. 1957. The step-point method of sampling: a practical tool in range research. J. Range Manage. 10:208-212.

Gammon, D.M. 1984. An appraisal of short duration grazing as a method of veld management. Zimbabwe Agric. J. 81:59-64.

Gammon, D.M., and B.R. Roberts. 1980. Grazing behaviour of cattle during continuous and rotational grazing of the matapos sandveld of Zimbabwe. Zimbabwe J. Agr. Res. 18:13-27.

Gould, F.W. 1975. The grasses of Texas. p. 653. Texas A&M Univ. Press, College Station.

NOAA. 1983. Texas climatological data. U.S. Dep. Comm. Nat. Climate Cent., Asheville, NC.

Pieper, R.D., and R.K. Heitschmidt. 1988. Is short-duration grazing the answer? J. Soil and Water Conserv. 43:133-137.

Richardson, W.E., D.G. Grica, and L.A. Putnam. 1965. Soil survey of Garza County, Texas. p. 84. USDA Soil Conservation Service.

Savory, A. 1978. A holistic approach to ranch management using short duration grazing. p. 555-557. In Proceedings of the First International Rangeland Congress, Denver, CO. Aug. 14-18.

Savory, A., and S. Parsons. 1980. Stock management and the Savory grazing method. p. 240-244. In Beef cattle science handbook. The International Stockmen's School, Tucson, AZ. Jan. 7-10.

Skovlin, J. 1987. Southern Africa's experience with intensive short duration grazing. Rangelands 9(4):162-167.

Van Poollen, H.W., and J.R. Lacey. 1979. Herbage response to grazing systems and stocking intensities. J. Range Manage. 32:250-253.

Wester, D.B. 1992. Viewpoint: replication, randomization, and statistics in range research. J. Range Manage. 45:285-290.