Stocking rate effects on intensive-early stocked Flint Hills bluestem range

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Abstract

Stocking rate effects on intensive-early stocked Kansas Flint Hills range were studied from 1982 through 1987. Rates were 2X, 2.5X, and 3X normal season-long stocking rates for 200–225 kg steers. Study design was a randomized complete block with 2 replicates. Grass and forb standing crop (kg/ha) were estimated at the time of livestock removal (mid July) and again in early October. Plant basal cover and composition were taken in early June the year prior to the study and annually thereafter. Overall growing season precipitation during the study period was below normal, with late-summer precipitation much below normal in the second and third years of the study. Grass standing crop (GSC) in mid July decreased with increased stocking rate, but by early October GSC was similar under the 2.5X and 3X stocking rates, but continued to be lower than that under the 2X rate. There was no consistent response in mid July forb standing crop (FSC) with respect to stocking rate. In early October, FSC was either not affected by stocking rate (1983, 1986, and 1987) or was greater under the highest stocking rate (1982, 1984, and 1985). The major changes in botanical composition and basal cover were a reduction in Indiangrass (*Sorghastrum nutans* Nash) and an increase in Kentucky bluegrass (*Poa pratensis* L.) as stocking rate increased. Botanical composition of big bluestem (*Andropogon gerardii* Vitman) increased under the 2X rate but did not change under the higher rates. Individual steer gains were similar under the different stocking rates, but livestock breed appeared to affect magnitude of the gain. Since individual gains did not differ, gains per ha were substantially increased by the higher stocking rates.

Key Words: ***Andropogon*, grazing system, stocking rate, livestock gain**

The high-quality forage period for warm-season perennial grasslands is limited to the first 2 1/2 months of the growing season in the Kansas Flint Hills. Grazing at times other than the high-quality period results in livestock gains that are sub-optimal. The goal of any rangeland-based program for growing livestock should be maximum efficiency in converting forage to animal product. Smith and Owensby (1978) showed an increased conversion efficiency with intensive-early stocking of Kansas Flint Hills range, with twice the recommended stocking density for the first half of the growing season and no grazing during the latter half of the season. The increased conversion efficiency manifests itself in increased net returns when compared to season-long stocking (Bernardo and McCollum 1987). Livestock removed in mid-July usually are placed directly into the feedlot. Posler et al. (1985) studied alternatives for managing beef yearlings after intensive-early stocking that included direct placement into the feedlot, grazing sudangrass (*Sorghum bicolor* var. *sudanense* Hitchc.), and grazing alfalfa (*Medicago sativa* L.). They concluded that direct placement into the feedlot in mid summer was the management strategy of choice. Auen and Owensby (1988) studied winter removal of dormant Flint Hills bluestem herbage and indicated that Flint Hills ranchers could utilize herbage remaining after intensive-early stocking without affecting grassland productivity the following season. Owensby et al. (1977) had indicated earlier that the lack of grazing from mid July until frost allowed for adequate storage of reserve carbohydrates. Since Smith and Owensby (1978) also reported that slightly more than 1,200 kg/ha herbage remained when livestock were removed in mid July, evaluation of the potential for using higher stocking rates with intensive-early stocking appeared to be a logical follow-up study.

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We studied the effects of stocking densities on Kansas Flint Hills bluestem range at 2, 2.5, and 3 times the recommended season-long rate from 1 May to mid July on plant populations, herbage yield, and animal gains.

Materials and Methods

The study area was the Kansas State University Experimental Range Unit located in the northern Kansas Flint Hills near Manhattan, Kans. The warm-season, perennial grasses, big bluestem (*Andropogon gerardii* Vitman.) and indiangrass (*Sorghastrum nutans* Nash), were the dominant forage species and little bluestem (*A. scoparius* Michx.) and sideoats grama [*Bouteloua curtipendula* Michx.) Torr.], both warm-season, perennial midgrasses, were subdominants. Numerous grass, forb, and woody species constituted the remainder (Anderson and Fly 1955). Soils were transitional from Ustolls to Udolls. The principal range sites in the study area were loamy upland, breaks, and clay upland (Anderson and Fly 1955). The study pastures had similar amounts of each of the principal range sites.

Each year from 1982 through 1987 on 1 May, six 24.3-ha pastures were stocked with yearling steers weighing 200 to 225 kg. Stocking rates of 0.47, 0.57, and 0.70 ha per steer (3X, 2.5X, and 2X, respectively) were applied in duplicate on the 6 study pastures which were burned in late April each year. The recommended season-long stocking rate (X) for steers of that size is 1.41 ha for the 5-month grazing season which begins in late April to early May. Steers were identified individually and weighed on 30 April and 16 July each year. Steers were confined without feed and water from the previous afternoon until they were weighed the following morning.

Each year grass and forb standing crop was estimated at livestock removal in mid July and again in early October by clipping 10, 0.4-m^2 plots to ground level in both loamy upland and breaks range sites. Clipped samples were dried to moisture-free.

Species composition was determined from basal cover estimates (percent of ground covered by plant bases) using the modified step-point method (Owensby 1973). Pastures were sampled annually during the first half of June. Within each pasture, 1,500 points were read along a predetermined grid. Each point was recorded as to range site. Pre-treatment species composition and basal cover were determined in 1981, and analysis of variance was conducted on the difference between pre-treatment percentages and percentages at the end of the study.

Plant standing crop data were analyzed as a randomized complete block design using SAS-ANOVA (SAS Institute, Cary, NC) with replication, stocking rate, range site, and year as the variables. Plant census data were analyzed similarly except year was not in the model. Probabilities of a significant difference are reported and means are separated using least significant difference (P=.10).

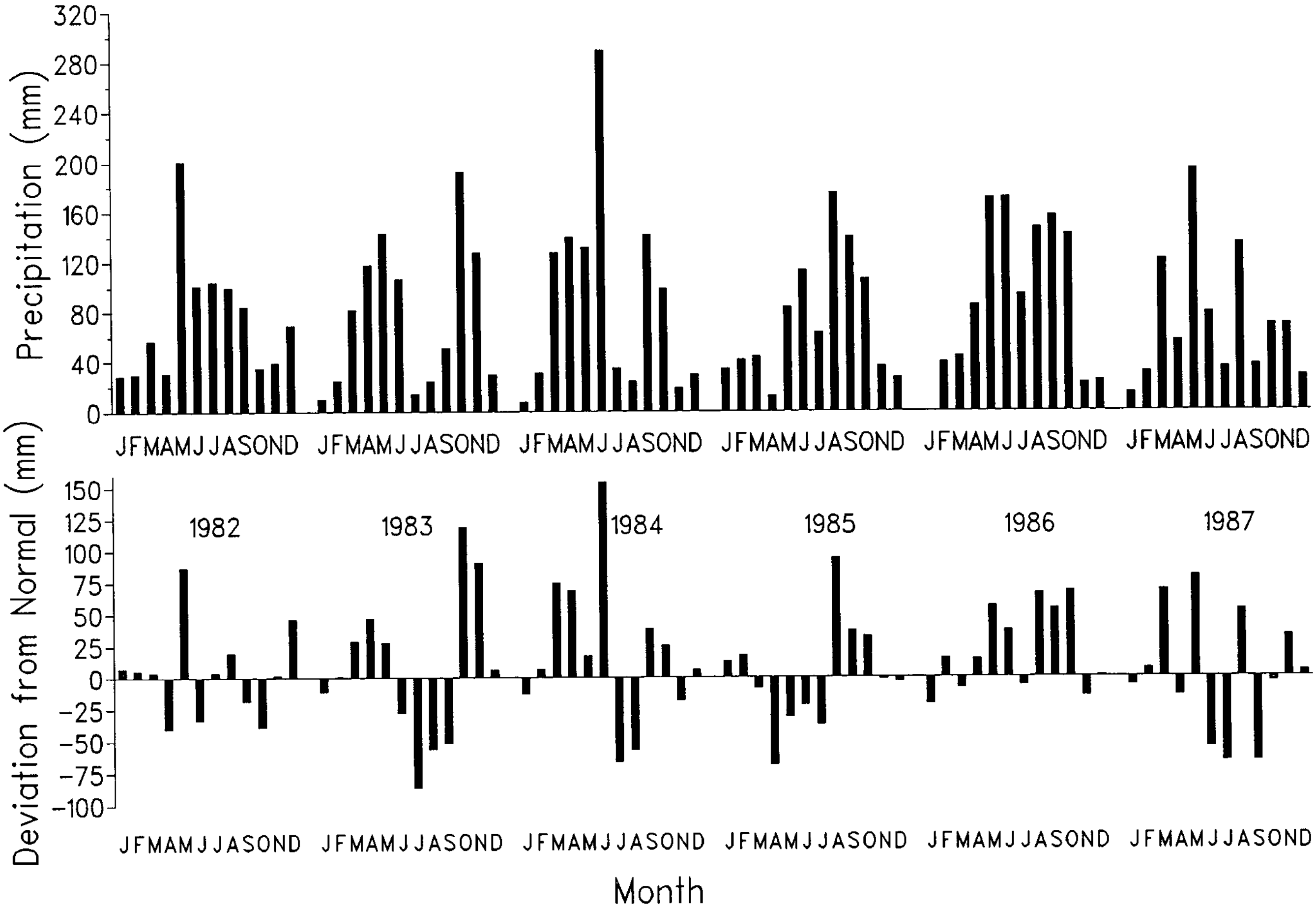

Fig. 1. *Monthly precipitation and deviation from normal precipitation from 1982 through 1987 at Manhattan, Kansas.*

Livestock gains were analyzed using SAS-GLM (SAS Institute, Cary, NC) with replication, stocking rate, and year as classes. Means were separated using least significant difference ($P = 0.01$).

Results

Precipitation

The 30-year average annual precipitation is 84 cm with 52 cm occurring during the growing season. Growing season precipitation during the initial year of the study was above the 30-year average (Fig. 1). Precipitation during the latter half of the growing season in 1983 and 1984 was well below average, and in 1985 was below average until late summer. In 1986, growing season precipitation was above average, but in 1987 it was below average. Overall precipitation throughout the study was below average.

Grass Standing Crop

Grass standing crop (GSC) at the time of livestock removal varied among treatments and years but not between range sites (Fig. 2). During most years, GSC was greater for the 2X rate than for the 2.5X and 3X rates on both major range sites. In 2 of the 6 years, GSC was greater on the 2.5X rate pastures than on the 3X, but was similar during the other 4 years. In 1985, there appeared to be no difference in GSC among pastures stocked at different rates. During the latter half of the 1983 and 1984 growing seasons, there was essentially no regrowth on any treatment pasture because of insufficient precipitation. That likely accounted for the reduced herbage production during the early season 1985. Even though there was substantial yearly variation in GSC at livestock removal, no downward trend was apparent at any stocking rate, indicating that sustained herbage production was likely at any of the rates tested.

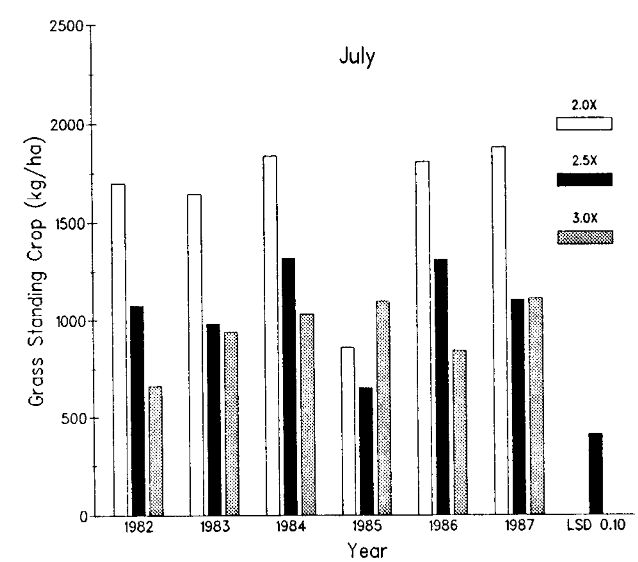

Fig. 2. *Grass standing crop (kg/ha) in mid July for indicated years and stocking rates on intensive-early stocked Flint Hills range. Data represent an average over loamy upland and breaks range sites.*

Average GSC on the loamy upland and breaks range sites in early October was greater ($P<0.01$) under the 2X rate (2,132

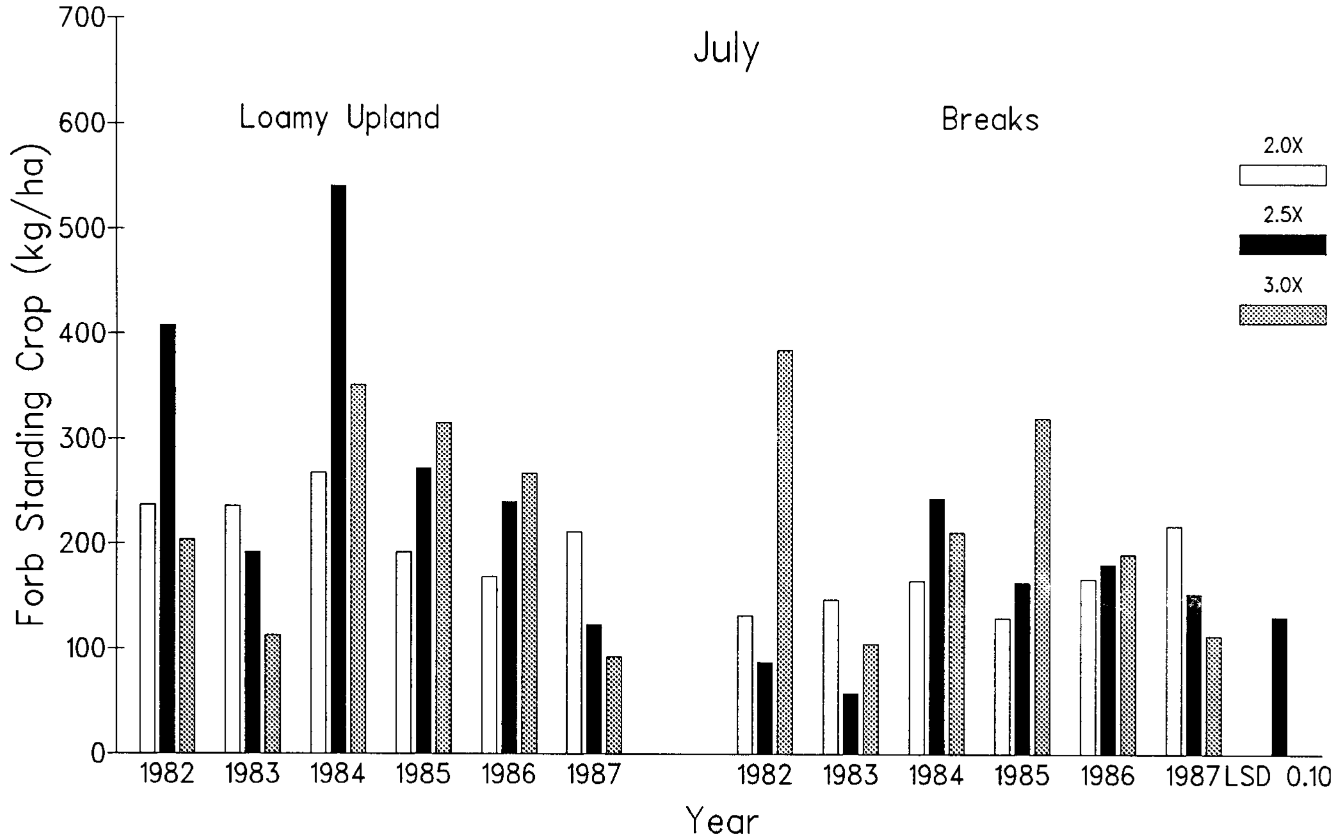

Fig. 3. *Forb standing crop (kg/ha) in mid July for indicated years, stocking rates and range sites on intensive-early stocked Flint Hills range.*

kg/ha) than under the 2.5X (1,641 kg/ha) and 3X (1,721 kg/ha) rates which were not different. GSC varied among years, but differences among stocking rate were similar each year. Weather appeared to be the primary determinant as to the amount of GSC in a given year within each stocking rate. There was no downward trend at any stocking rate.

Forb Standing Crop

Amount of forb standing crop (FSC) in mid July under different stocking rates was dependent on year and range site (Fig. 3). There was no consistent response to stocking rate. Apparently, there was an interaction with weather fluctuations that resulted in a variable response to stocking rate on the different range sites.

In early October FSC either was not affected by stocking rate (1983, 1986, and 1987) or was greater under the higher stocking rates (1982, 1984, and 1985). Forb standing crop under the 2.5X rate was greater than under the 2X rate only in 1984. Stocking rate effects on FSC were similar among years on the 2 principal range sites.

Basal Cover and Composition

Basal Cover

There was little change in total basal cover during the course of the study. However, basal cover of indiangrass on the loamy upland site was reduced more under the 3X stocking rate than under the 2X rate, but the change under the 2.5X rate did not differ from that of either the 2X or 3X rates (Table 1). On the breaks range site, reduction in basal cover of little bluestem was greater under the 2X and 3X stocking rates than under 2.5X where there was no change from pre-treatment levels (Table 1). Sideoats grama basal cover was reduced more under the 2X and 3X stocking rates than under the 2.5X stocking rate. Perennial forb basal cover was essentially unchanged under the higher stocking rates but was reduced under the 2X rate.

Table 1. Change in percent basal cover from 1981 to 1987 for indicated species and range sites stocked at 2, 2.5, and 3 times the season-long recommended rate from 1 May to 15 July.[1]

	Stocking Rate		
	2X	2.5X	3X
Loamy Upland			
Sorghastrum nutans			
1981	1.42	1.83	1.78
1987	1.25	1.51	1.27
Change	-0.17a	-0.32ab	-0.51b
Breaks			
Andropogon scoparius			
1981	1.26	0.91	0.77
1987	0.80	0.90	0.33
Change	-0.46a	-0.01b	-0.44a
Bouteloua curtipendula			
1981	1.96	1.03	1.16
1987	1.10	0.94	0.82
Change	-0.86a	-0.09b	-0.34a
Perennial Forbs			
1981	0.63	0.15	0.16
1987	0.30	0.20	0.16
Change	-0.33a	+0.05b	0.00a

[1]Values with a common letter do not differ ($P = 0.10$).

Botanical Composition

Only 3 species changed in botanical composition from pre-treatment levels. On the loamy upland site, stocking at the 3X rate resulted in a greater reduction in indiangrass compared to pre-treatment levels than the lower stocking rates (Table 2). Prior to

Table 2. Change in percent composition from 1981 to 1987 for indicated species and range sites stocked at 2, 2.5, and 3 times the season-long recommended rate from 1 May to 15 July.[1]

	Stocking Rate		
	2X	2.5X	3X
Loamy Upland			
Sorghastrum nutans			
1981	21.1	26.8	21.5
1987	19.5	23.0	17.0
Change	−1.6a	−3.8b	−4.5b
Poa pratensis			
1981	0.2	0.8	4.4
1987	0.9	2.0	9.4
Change	+0.7a	+1.2a	+5.0b
Breaks			
Andropogon gerardii			
1981	31.2	32.4	27.8
1987	36.8	32.1	27.9
Change	+5.6a	−0.3b	+0.1b
Sorghastrum nutans			
1981	18.8	22.9	18.5
1987	17.8	18.2	17.0
Change	−1.0a	−4.7b	−1.5a

[1]Values with a common letter do not differ ($P = 0.10$).

the study, indiangrass made up 21.5% of the stand compared to 17.0% at the end. Kentucky bluegrass (*Poa pratensis* L.) increased from 4.4% to 9.4% of the composition on the loamy upland site under the 3X stocking rate. There was no change in Kentucky bluegrass under the lower stocking rates (Table 2).

On the breaks range site, big bluestem increased from the pre-treatment level of 31.2% of the composition to 36.8% at the end of the study under the 2X stocking rate, whereas percent big bluestem at the higher rates was essentially unchanged from pre-treatment levels (Table 2). Percent indiangrass on the breaks site was essentially unchanged from pre-treatment levels under the 2X and 3X stocking rates, but under the 2.5X rate there was a reduction from 22.9% to 18.2% (Table 2).

Steer Gains

Steer gains (kg/head) varied among years, but within a given year, they were similar on pastures stocked at different rates (Table 3). Differences in steer gains among years were likely due to changes in type of cattle used in the study. In 1982 and 1983, steers were purchased from local auction facilities and were mostly average-frame British (Hereford and Angus) crossbred cattle. During the remainder of the study, steers with larger frame size came from a single source and were British × Zebu crosses. Since individual animal gains were the same among stocking rates, gain per hectare was increased linearly as stocking rate increased (Table 3).

Table 3. Steer gains (kg/steer and kg/ha) on Kansas Flint Hills range intensive-early stocked from 1 May to 15 July at 2, 2.5, and 3 times the recommended season-long stocking rate.[1]

Year	2X (kg/steer)	2.5X (kg/steer)	3X (kg/steer)	Mean	Stocking Rate 2X (kg/ha)	Stocking Rate 2.5X (kg/ha)	Stocking Rate 3X (kg/ha)
1982	63	58	62	61 a	86	96	128
1983	60	55	62	59 a	83	91	127
1984	75	75	76	76 b	103	124	156
1985	94	84	79	86 c	129	138	163
1986	84	86	89	86 c	115	142	182
1987	81	83	85	83 c	111	136	175
Mean	76	74	75		105	121	155

[1]Year means followed by a common letter are not different ($P<0.01$).

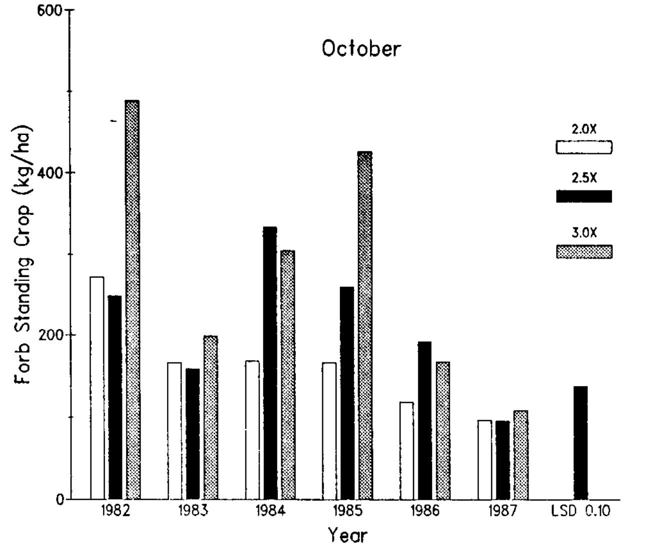

Fig. 4. *Forb standing crop (kg/ha) in early October for indicated years and stocking rates on intensive-early stocked Flint Hills range. Data represent an average over loamy upland and breaks range sites.*

Discussion

Under intensive-early stocking, precipitation during July and August is particularly important for regrowth, and only in 2 of the study years was precipitation average or above average. Owensby et al. (1969) reported earlier that defoliation during the growing season reduced water usage. Intense defoliation during the early growing season may conserve sufficient soil moisture to allow for adequate growth during the late season even during years with below average late-season precipitation. Since there was no downward trend trend in GSC in October as evidenced by the lack of a significant year × stocking rate interaction, apparently Flint Hills range can sustain even the 3X stocking rate for a prolonged period. For any stocking rate we tested, no grazing from mid July to frost likely allows for sufficient time to store adequate food reserves for vigorous growth the following spring.

Changes in composition from pre-treatment levels primarily involved a decrease in indiangrass and an increase in Kentucky bluegrass at the higher stocking rates. Apparently, indiangrass, unlike big bluestem (Smith and Owensby 1978), is not favored by intensive use early in the season followed by a late-season rest. McKendrick et al. (1975) indicated that new tillers for the next growing season in indiangrass arise in late summer. Perhaps, the intensive use during early summer does not allow for sufficient photosynthetic area to generate tillers following livestock removal. The increase in Kentucky bluegrass at higher stocking rates most likely resulted from reduced fire intensity because of a lower fuel load (Anderson et al. 1970).

Earlier studies with intensive-early stocking (Smith and Owensby 1978, Bernardo and McCollum 1987) indicated no reduction in individual animal performance during the first half of the grazing season compared to season-long stocking at stocking rates twice season-long rates. We found that the increasing the stocking rates to 2.5 and 3 times season-long rates did not reduce individual animal performance compared to 2 times season-long rates. Consequently, gain/ha increased linearly, resulting in a greater conversion efficiency than that found in previous studies.

Conclusions

1. Grass standing crop at the end of the growing season under 2.5X and 3X stocking rates was less than that under the 2X rate. There was no downward trend in amount of grass standing crop over the course of the study at any stocking rate. Apparently, herbage production can be sustained in all stocking rates tested.

2. Percent of composition and basal cover of the major dominants changed little during the study period. Indiangrass appeared to be adversely affected, particularly at the higher stocking rates. Kentucky bluegrass was favored by the 3X rate.

3. Stocking rate did not affect individual steer gains overall. Because of the higher stocking rates, gain per hectare was significantly increased. Livestock type apparently had a significant impact on steer gains.

Literature Cited

Anderson, K.L., and C.L. Fly. 1955. Vegetation-soil relationships in Flint Hills bluestem pastures. J. Range Manage. 8:163-169.

Anderson, K.L., E.F. Smith, and C.E. Owensby. 1970. Burning bluestem range. J. Range Manage. 23:81-92.

Auen, L.M., and C.E. Owensby. 1988. Effects of dormant-season herbage removal on Flint Hills rangeland. J. Range Manage. 41:483-484.

Bernardo, D.J., and F.T. McCollum. 1987. An economic analysis of intensive-early stocking. Oklahoma Agr. Exp. Sta. Res. Rep. P-887.

McKendrick, J.D., C.E. Owensby, and R.M. Hyde. 1975. Big bluestem and indiangrass vegetative reproduction and annual reserve carbohydrate and nitrogen cycles. Agro-Ecosystems 2:75-93.

Owensby, C.E., R.M. Hyde, and K.L. Anderson. 1969. Effects of clipping and supplemental nitrogen and water on loamy upland bluestem range. J. Range Manage. 23:341-346.

Owensby, C.E. 1973. Modified step-point system for botanical composition and basal cover estimates. J. Range Manage. 26:302-303.

Owensby, C.E., E.F. Smith, and J.R. Rains. 1977. Carbohydrate and nitrogen reserve cycles for continuous, season-long and intensive-early stocked Flint Hills bluestem range. J. Range Manage. 30:258-260.

Posler, G.L., G.M. Ward, J.G. Riley, C.E. Owensby, E.F. Smith, K.K. Bolsen, R.M. Helsel, and N.S. Hill. 1985. Alternatives for managing beef yearlings after intensive-early stocking of Kansas Flint Hills range. p. 1161-1163. *In:* Proc. 15th International Grassland Cong. (eds. T. Okubo and M. Shiyomi). Kyoto, Japan.

Smith, E.F., and C.E. Owensby. 1978. Intensive-early stocking and season-long stocking of Flint Hills bluestem range. J. Range Manage. 31:14-18.