COMPETITION BETWEEN PRAIRIE DOGS AND BEEF CATTLE FOR RANGE FORAGE

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PREFACE

The principle objective of this study was to evaluate the effects of black-tailed prairie dogs on the availability and utilization of range forage by cattle and the seasonal weight gains of cattle. Small mammals and arthropods were monitored to determine if the presence of prairie dogs influence these populations. The thesis is in the format and style of the Journal of Range Management.

Funds for the study were provided by the Agricultural Research Service-USDA, Wildlife Services Division, U. S. Fish and Wildlife Service, and Oklahoma State University. Cooperating agencies include: the U. S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation, Oklahoma State University, and Wildlife Management Institute.

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COMPETITION BETWEEN PRAIRIE DOGS AND BEEF CATTLE FOR RANGE FORAGE[1]

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Abstract

Competition for range forage between black-tailed prairie dogs (Cynomys ludovicianus) and steers was evaluated in terms of the effects prairie dogs have on forage availability, utilization, and steer weight gains. Pastures grazed by steers only were designated control pastures and pastures grazed by prairie dogs and steers were designated treatment pastures. Small mammals and arthropods were monitored to determine if the presence of prairie dogs influence these populations. Prairie dogs decreased forage availability and utilization by cattle during 1977 and 1978. However the influence of prairie dogs on the forage crop did not significantly reduce steer weight gains during either year. It appears highly probable that the presence of prairie dogs may positively influence soil fertility, nutrient recycling, and subsequent forage quality, thus partially compensating for the reduction in forage availability and utilization by steers in prairie dog pastures.

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[1]Agricultural Research Service-USDA; Wildlife Services Division U. S. Fish & Wildlife Service; and Oklahoma State University, Stillwater, provided funds for this project.

[2]U. S. Fish & Wildlife Service; Oklahoma Department of Wildlife Conservation; Oklahoma State University; and Wildlife Management Institute cooperating.

Pastures containing prairie dogs were also found to support a greater biomass of small mammals. Arthropod biomass was more than three times as high in control pastures.

In areas occupied by prairie dogs (Cynomys spp.), rangeland vegetation tends to appear dramatically altered relative to surrounding sites. This physical appearance of vegetation being denuded reflects an apparent intensive competition for forage on rangelands simultaneously grazed by prairie dogs and cattle.

Although many studies have addressed questions about forage competition between prairie dogs and cattle (e.g., Bonham and Lerwick 1976, Howard et al. 1956, Koford 1958), only Taylor and Loftfield (1924) used an experimental approach. Their results are suspect, however, because vegetation samples were inadequate and vegetative productivity on experimental plots may not have been equal (Koford 1958). Also, young prairie dogs produced within their experimental enclosures were unable to disperse as they would in an unconfined population (King 1955) creating supernormal prairie dog densities relative to surrounding rangeland.

This paper describes a study of competition for forage in experimental treatment pastures simultaneously stocked with black-tailed prairie dogs (C. ludovicianus) and cattle vs. control pastures which contained only cattle. The design enabled prairie dogs to disperse and thereby maintain natural densities. We monitored differences in the physical structure of the vegetative communities in the adjacent control and experimental treatment pastures and recorded differences in annual cattle weight gains between the treatments. We also periodically

surveyed differences in the insect, rodent, and lagomorph communities in the pastures.

Study Area and Methods

The study was conducted on the USDA's Southern Great Plains Experimental Range located in Harper County, approximately 6 km northwest of Fort Supply, Oklahoma. The study area included a 30.4 ha (75 acre) grassland divided into twelve 2.5 ha (6.25 acre) pastures. Vegetation was primarily of the steppe type with blue grama (Bouteloua gracilis) being dominant and sand dropseed (Sporobolus cryptandrus) being secondarily important. Characteristic forbs of the area include wooly plantain (Plantago purshii), wavyleaf thistle (Cirsium undulatum), and Indian blanket (Gaillardia pulchella). Primary woody species are soapweed (Yucca glauca) and prickly pear (Opuntia spp.). Some sand sagebrush (Artemisia filifolia) occurs on the study area but at low densities. Forage production, plant cover, plant species composition, and beef production rates were similar among the 12 pastures during the 20 years preceding introduction of prairie dogs (data on file, USDA Southern Great Plains Field Station, Woodward, Oklahoma). More detailed descriptions of the Experimental Range are presented by Savage and Heller (1947) and USDA (1960).

Prairie dogs were released into the six pastures in the summer of 1973, and again in 1974-1975. A total of 311 prairie dogs (184 in 1973, 64 in 1974, and 63 in 1975) were stocked using the gentle release method (Lewis et al. 1979). During 1977-1978, time area counts were conducted using two observers to provide information on relative densities of prairie dogs. Burrow locations and the surrounding area of exposed soil

also were mapped and quantified for each pasture during the summer of 1977.

Prairie dogs dispersing out of treatment pastures were intensively controlled during the summer using smoke cartridges and a .22 caliber rifle.

Total forage availability and utilization by cattle were measured using twenty, 1.0-1.3-m exclosures per pasture. Forage availability and utilization were measured annually using the micro-unit forage inventory method (Shoop and McIlvain 1963). The micro-unit method uses the objective principal of counting, or taking inventory of, estimated micro-units of range forage by species within micro-plots. The micro-unit is estimated by a visual appraisal combined with the sense of touch. Estimated weights of micro-plots are normally checked by clipping and weighing to the nearest gram about every tenth plot to insure accuracy. Forage utilization and availability to cattle were compared between control and treatment pastures.

Weight-gain tested hereford steers of 222-269 kg (490-592 lb) were stocked annually in the pastures. A group of three steers were grazed among three of the pastures, thus, four such groups of steers were involved in the study allowing for two replications to analyze cattle weight responses. Cattle received a protein supplement of 4.8 kg of cottonseed per week per head from November 1 through April 15. Cattle were weighed once monthly throughout the grazing season.

Biomass of herbivorous insects was estimated on each of the 12 pastures once annually during August. Foliage and flying arthropods were sampled by means of a standard arthropod sweep net using the procedure of Butts (1973). Sweeps were made at predetermined, regular

distances along a diagonal transect across each pasture. Arthropods were identified and weighed to the nearest 0.1-g. During the summer of 1977 harvester ant mounds also were counted and the area of associated denuded vegetation recorded for each pasture.

The small mammal population in each pasture was inventoried twice annually in summer and winter. Small rodents were captured using a variety of live traps set at 7.5-m intervals along the diagonal transects used to sample arthropods. Small rodents were identified to species, weighed to nearest 0.1-g, marked by toe clipping, and released. Rabbits were indexed using the spotlight technique. Sign of diggings provided an index to numbers of pocket gophers.

Results

Prairie Dog Population

During census periods some prairie dogs were either below the ground surface or not observable because of visual barriers such as vegetation or low hills. Therefore, numbers of prairie dogs observed were actually conservative estimates of the population present. Surveys of prairie dogs during August 1977 and August 1978 included both the young produced in spring and adults that had overwintered. The survey conducted in May 1978 included only adults and subadults and represented the breeding population.

Results of the prairie dog census (Table 1) indicate an average minimum population in August 1977 of 61.8 prairie dogs/pasture or 24.4/ha. In May 1978 the average minimum per pasture was 52.8 prairie dogs or 20.9/ha. During the August 1978 census an average of 76.2 prairie

Table 1. Numbers of prairie dogs observed during time-area counts of treatment pastures on the USDA Southern Great Plains Experimental Range, Harper County, Oklahoma, 1977 and 1978.

Census period	Pasture number						Total	Mean ± SD	Prairie dogs/ha
	7	8	9	10	11	12			
Aug 22-27, 1977	66	62	68	57	60	58	371	61.6 ± 4.4	24.4
May 16-25, 1978	69	62	64	44	35	43	317	52.8 ± 13.9	20.9
Aug 12-26, 1978	102	107	95	31	54	68	457	76.2 ± 30.2	30.1

dogs were observed per pasture or 30.1/ha.

A problem was encountered with prairie dogs moving into the south end of control pastures from treatment pastures and attempting to establish burrows. This encroachment by prairie dogs in control pastures was not considered to significantly affect control pastures forage. Prairie dogs attempting to establish in control pastures were quickly controlled and generally remained within the pastures only a short time.

Burrow Counts and Associated Denuded Areas

A total of 2,570 burrows occurred on the 15.2 ha of prairie dog pastures in August 1977 (Table 2). Burrow density averaged 428.3/ pasture or 169.1/ha. Average denuded area/mound for the six prairie dog pastures was 1.1-m^2. This average is relatively small due to the large number of burrows in the sample which were only burrow openings without typical earthen mounds. Total denuded area attributed to prairie dog burrowing activities equaled 0.36 ha for the 15.2 ha of prairie dog pastures, or 2.4% of the area.

Forage Availability

Forage inventories revealed pronounced differences between pastures with respect to the availability and utilization of range forage in 1977 and 1978 (Tables 3 and 4). Pastures containing prairie dogs contained less available forage in all classes except forbs during the two years. Forb species made up 14% and 20% of the total forage available to cattle in prairie dog pastures in 1977 and 1978, respectively. Forbs constituted 8% of the total forage available to cattle in control

Table 2. Total burrow counts, burrow densities, and associated area of denudation in treatment pastures containing prairie dogs, USDA Southern Great Plains Experimental Range, Harper County, Oklahoma, August 1977.

	Pasture					
	7	8	9	10	11	12
Total burrows	539	428	412	369	385	437
Burrows/ha	215.6	171.2	164.8	147.6	154.0	174.8
Average area (m^2) denuded/mound	1.0	1.0	1.1	1.1	1.4	1.1
Denuded area (m^2)/ha	269.0	215.8	231.7	202.0	270.9	240.4

Table 3. Average availability and utilization (kg/ha/yr) of selected forage classes in six pastures containing steers only and six pastures containing prairie dogs and steers, 1977.

Forage class	Blue grama	Sand dropseed	Other grass	Total grass	Total forbs	Total forage
Steers only (X_1)						
Availability	1200	108	161	1469	131	1600
Utilization	994	69	121	1184	98	1282
% utilization	83	64	75	81	75	80
Prairie dogs and steers (X_2)						
Availability	818	8	49	875	141	1016
Utilization	775	7	48	830	134	964
% utilization	95	88	98	95	95	95
Between treatments						
% difference availability *	-32	-93	-70	-40	8	-37
% difference utilization *	-22	-89	-60	-30	37	-25

*Numbers represent % difference between treatments computed $\frac{X_2 - X_1}{X_2} \times 100$

Table 4. Average availability and utilization (kg/ha/yr) of selected forage classes in six pastures containing steers only and six pastures containing prairie dogs and steers, 1978.

Forage class	Blue grama	Sand dropseed	Other grass	Total grass	Total forbs	Total forage
Steers only (X_1)						
Availability	599	87	238	924	80	1004
Utilization	547	81	225	853	75	928
% utilization	91	93	95	92	94	92
Prairie dogs and steers (X_2)						
Availability	473	5	56	534	136	670
Utilization	455	5	53	513	132	645
% utilization	96	100	95	96	97	96
Between treatments						
% difference availability *	-21	-94	-76	-42	70	-33
% difference utilization *	-17	-93	-76	-40	76	-30

*Numbers represent % difference between treatments computed $\frac{X_2 - X_1}{X_2} \times 100$

pastures each year. However, the abundance of forbs was not significantly different between treatment and control pastures in either 1977 ($F = 0.1$, $P > 0.05$) or 1978 ($F = 2.0$, $P > 0.05$).

Significantly less blue grama was available to steers in treatment pastures than in control pastures ($F = 31.8$, $P < 0.01$) in 1977. In 1978 the difference between treatment and control pastures in availability of blue grama was not significant ($F = 2.4$, $P > 0.05$).

Sand dropseed was significantly less available in prairie dog pastures than in control pastures in 1977 ($F = 15.7$, $P < 0.01$) and 1978 ($F = 8.6$, $P < 0.05$). Sand dropseed composed less than 1% of the total available forage for cattle in prairie dog pastures, compared to 7% and 8% in control pastures for 1977 and 1978, respectively.

Aboveground biomass of other grass species was also significantly reduced in treatment pastures compared to control pastures. Other grass species constituted 10% and 24% of the total forage in control pastures and only 5% and 8% in treatment pastures in 1977 and 1978, respectively. Differences between treatments were significant in 1977 ($F = 6.2$, $P < 0.05$) and 1978 ($F = 5.9$, $P < 0.05$). Treatment pastures had significantly less total forage available than the control pastures in 1977 ($F = 28.0$, $P < 0.01$) and 1978 ($F = 12.7$, $P < 0.01$). The presence of prairie dogs reduced total available forage by 37% in 1977 and 33% in 1978 compared to pastures without prairie dogs.

Forage Utilization

Forage utilization differed between treatment and control pastures during 1977 in all forage classes except total forbs (Table 3). Blue grama ($F = 5.8$, $P < 0.05$), sand dropseed ($F = 14.9$, $P < 0.01$), other

grass ($F = 6.0$, $P < 0.05$), total grass ($F = 11.3$, $P < 0.01$), and total forage ($F = 8.6$, $P < 0.05$) were all utilized in significantly greater quantities by steers in control pastures. Steers utilized 37% more forbs in the treatment pastures, but the difference was not significant ($F = 2.0$, $P > 0.05$).

During 1978 (Table 4) forage utilization by steers in control pastures was greater for sand dropseed ($F = 9.4$, $P < 0.05$), other grass ($F = 6.0$, $P < 0.05$), total grass ($F = 20.4$, $P < 0.01$), and total forage ($F = 7.0$, $P < 0.05$), than in pastures containing prairie dogs. Utilization of blue grama and total forbs was similar between treatment and control pastures (1977: $F = 0.7$, $P > 0.05$; 1978: $F = 2.1$, $P > 0.05$).

The four major forage classes made up the following percentages of total forage utilized by steers in control pastures in 1977 and 1978, respectively: blue grama 78% and 59%, sand dropseed 5% and 9%, other grass 9% and 24%, and total forbs 8% and 8%. In treatment pastures, steers took the following percentages: blue grama 80% and 71%, sand dropseed 0.7% and 0.7%, other grass 5% and 8%, and total forbs 14% and 20% in 1977 and 1978, respectively.

Steer Weight Gains

Steers were stocked the first year on December 22, 1976, and remained on the pastures until September 22, 1977, a total of 274 days. The second year, steers were stocked on December 13, 1977, and remained on the pastures until September 15, 1978, a total of 276 days. Weights of steers from initial stocking date through the grazing season are shown in Figures 1 and 2.

Analysis of results of 1977 and 1978 steer weight gain performances

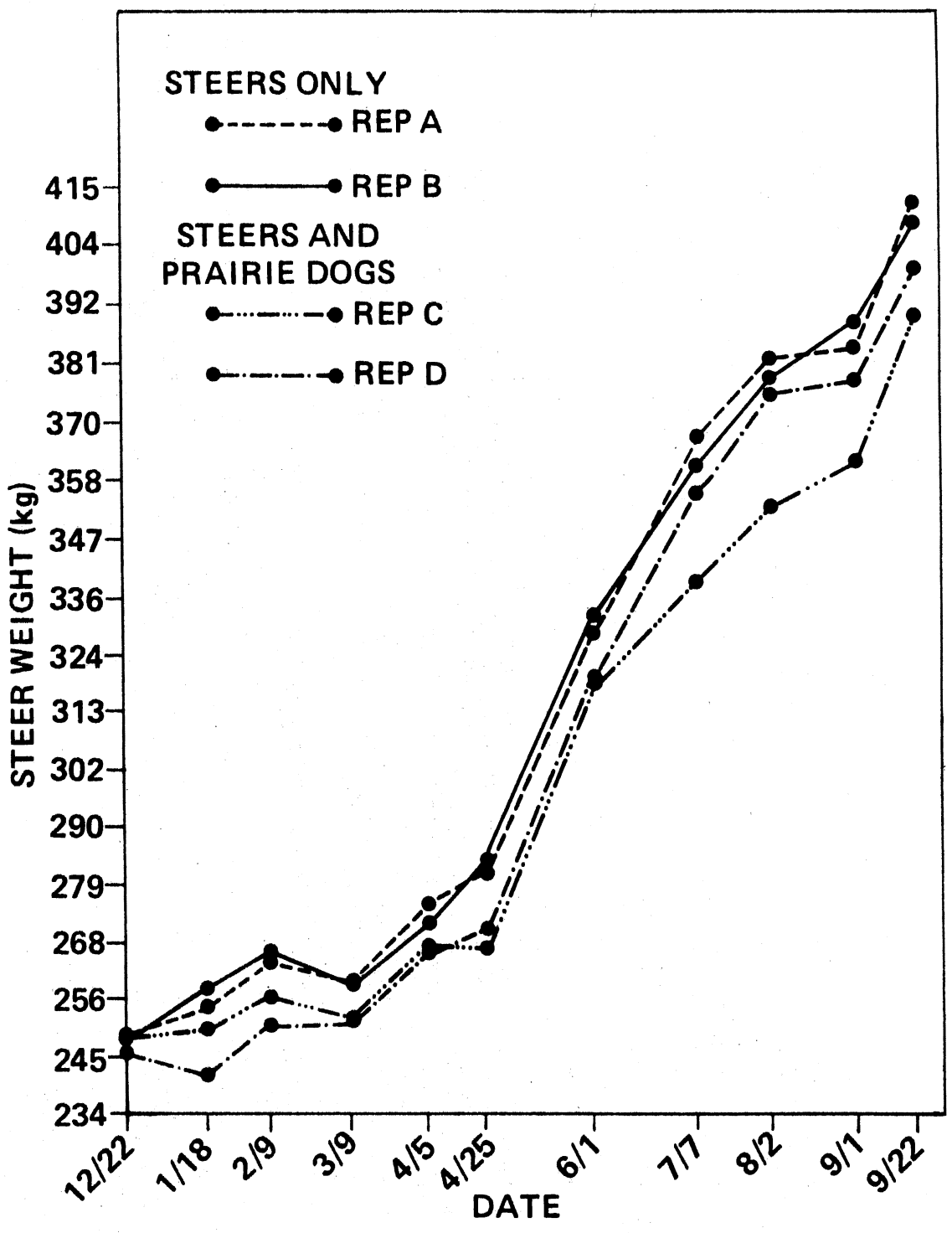

Fig. 1. Comparison of steer weights (kg) for control pastures (steers only) and treatment pastures (steers and prairie dogs) for 274 days in 1976 and 1977. Weights represent the average of three steers per replicate.

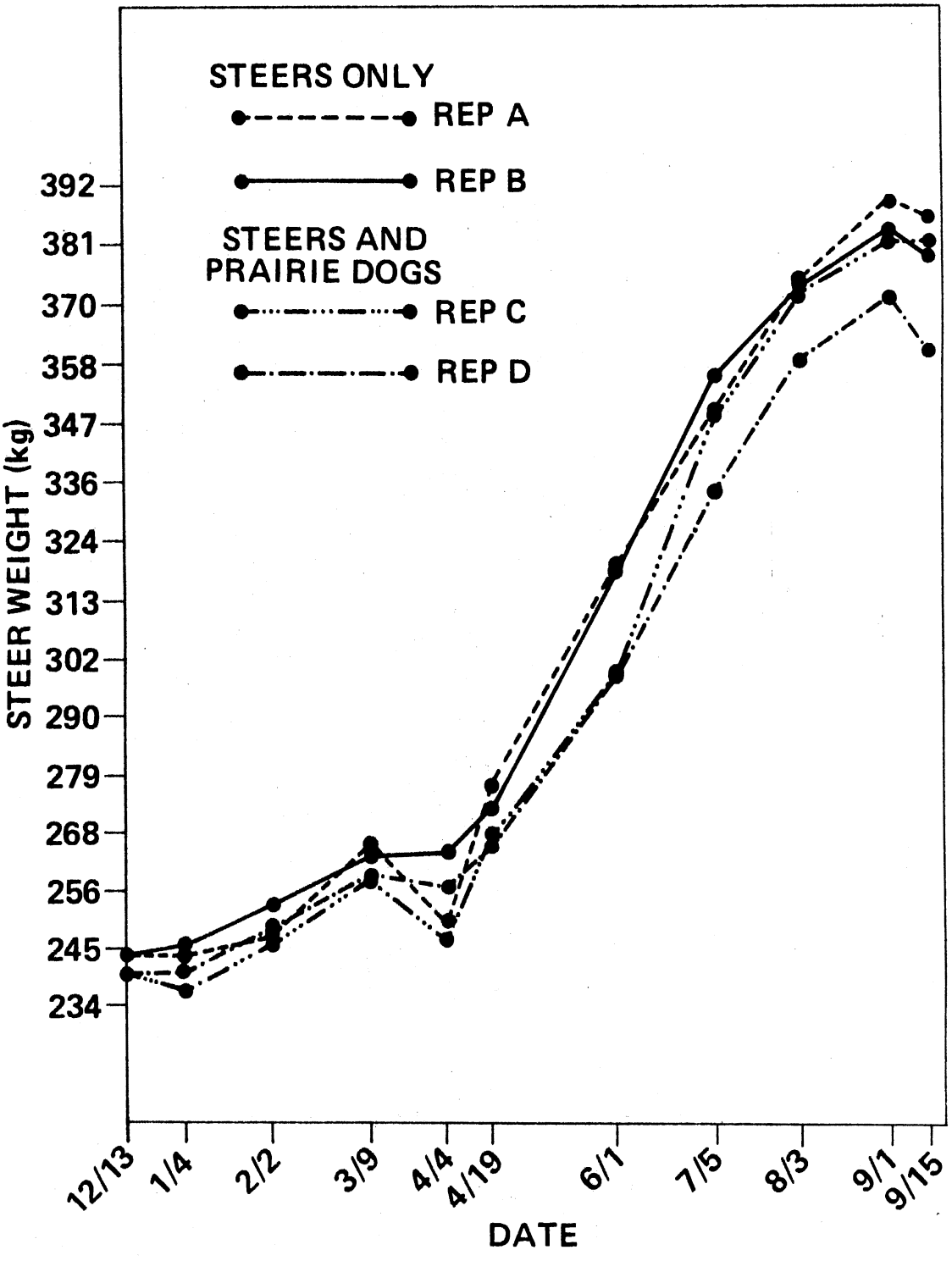

Fig. 2. Comparison of steer weights (kg) for control pastures (steers only) and treatment pastures (steers and prairie dogs) for 276 days in 1977 and 1978. Weights represent the average of three steers per replicate.

reveals no significant difference between steers grazing treatment pastures and control pastures during winter, summer, or annual periods. Mean treatment gains for summer were similar in both years. Steers grazing control pastures averaged 1 kg/head ($F = 0.01$, $P > 0.05$) and 2 kg/head ($F = 0.08$, $P > 0.05$) greater summer gains than steers grazing treatment pastures in 1977 and 1978, respectively.

Differences in weight gains between treatment and control pastures in winter were more pronounced. Steers in pastures without prairie dogs averaged gains of 13 kg/head ($F = 3.1$, $P > 0.05$) and 6 kg/head ($F = 0.9$, $P > 0.05$) more during winter than steers in pastures with prairie dogs in 1977 and 1978, respectively. Differences in annual weight gain performance between treatment and control pastures also were insignificant in 1977 ($F = 1.4$, $P > 0.05$) and 1978 ($F = 0.5$, $P > 0.05$).

Small Mammal Population

Results of small mammal live-trapping surveys are summarized in Table 5. Numbers of small mammals live-trapped were consistently greater in treatment pastures than in control pastures during all survey periods, although the difference in pooled numbers for 1977-1978 was not significant ($F = 4.2$, $P > 0.05$). However, grasshopper mice (Onychomys leucogaster), the most common species encountered, were three times more abundant in treatment pastures than in control pastures ($F = 28.2$, $P < 0.01$).

Spotlight counts for desert cottontail rabbits (Sylvilagus audubonii) and transect counts of pocket gopher (Geomys bursarius) mounds were largely inconclusive. Numbers of desert cottontails seen were low and similar between treatment and control pastures. However, based on

Table 5. Biomass and numbers of small mammals livetrapped during 3000-trap days, and % difference between treatments, 1977-1978.

Species	Steers only		Steers and prairie dogs		% difference	
	Biomass (g)	No.	Biomass (g)	No.	Biomass	No.
Onychomys leucogaster	954.5	26	3037.5	82	218	215
Perognathus hispidus	832.0	24	248.0	8	235	200
Spermophilus tridecemlineatus	1453.0	12	2751.0	23	89	92
Peromyscus maniculatus	77.0	8	209.0	13	171	63
Peromyscus leucopus	34.0	3	73.5	3	116	0
Reithrodontomys montanus	42.0	5				
Dipodomys ordi	71.5	1				
Total	3464.0	79	6319.0	129	82	63

observations of rabbits during prairie dog surveys, the density of rabbits in treatment pastures was much higher than indicated by spotlight counts. Dano (1952) found more cottontails in dog towns than in similar adjacent range where there were no prairie dogs. Dano thought the abundance of cottontails on prairie dog towns was largely due to the abundance of burrows that provide ideal cover. Rabbit activity appeared to coincide more with the early morning and evening feeding periods of the prairie dogs rather than at night. Numbers of pocket gopher mounds also were low (< 0.5/ha) in treatment and control pastures. Phillips (1936) noted that pocket gophers were absent from heavily overgrazed pastures. The effects of pocket gophers on range forage at these densities are considered to be inconsequential.

Arthropod Population

Sweep net sampling of the arthropod population revealed significant differences in biomass between treatment and control pastures. Sweep samples of control pastures consistently had greater than three times the biomass of insects than did treatment pastures during sample periods August 9-14, 1977 ($F = 12.23$, $P < 0.01$), August 8-13, 1978 ($F = 49.98$, $P < 0.01$), and August 21-26, 1978 ($F = 26.90$, $P < 0.01$) (Table 6). Sweep samples were comprised almost entirely of Orthopterans (grasshoppers) for both control and treatment pastures.

Numbers of harvester ant (Pogonomyrmex occidentalis) mounds were similar in treatment and control pastures with an average of 10.5/ha and 11/ha, respectively. The relative size of ant mounds was greater in treatment pastures where the denuded area was 109.3 m^2 (0.01 ha) in contrast to 43.9 m^2 (0.004 ha) in control pastures.

Table 6. Comparison of arthropod biomass between steers only and steers and prairie dog pastures, collected by sweep net on the USDA Southern Great Plains Experimental Range, Harper County, Oklahoma during 1977 and 1978.

	Pasture number	Sample 1 Aug 9-14 1977	Sample 2 Aug 8-13 1978	Sample 3 Aug 12-26 1978
Steers only				
	1	21.5	28.5	25.0
	2	33.5	54.0	44.0
	3	21.5	37.0	26.0
	4	16.0	49.5	26.0
	5	33.0	38.5	22.5
	6	6.5	45.0	23.5
Total		132.0	252.5	167.0
$\bar{X}$		22.0	42.1	27.8
SD		10.3	9.3	8.0
Steers and prairie dogs				
	7	3.5	12.5	12.0
	8	5.5	9.5	6.0
	9	1.0	7.5	4.0
	10	7.0	14.5	7.5
	11	12.5	18.0	14.5
	12	8.0	16.0	9.5
Total		37.5	78.0	53.5
$\bar{X}$		6.3	13.0	8.9
SD		4.0	4.0	3.9

Discussion

Impacts on Vegetative Community

Prairie dogs are frequently described as competitors with livestock for range forage (Bailey 1905, Bailey 1926, Bell 1921, Kelso 1939, Merriam 1902, Stoddard and Smith 1955, Taylor and Loftfield 1924, Valentine 1971). The intensity of competition, however, should vary with population density of the two species. The mean prairie dog density of 25.1/ha in this study is comparable to densities reported for natural populations (Hassien 1976, King 1955, Koford 1958, Tileston and Lechleitner 1966).

Steer numbers were maintained at a stocking rate of 1/2.5 ha. This stocking rate is the same as that reported by McIlvain and Savage (1951) for the Southern Great Plains Experimental Range and was termed moderate. The mean grazing season during this study, however, was 275 days versus 172 days for McIlvain and Savage's study and probably is more representative of a heavy stocking rate. Bement (1969) found that maximum dollar returns per acre from yearlings on shortgrass range were obtained when 336 kg/ha of air-dry herbage remained at the end of the grazing season. His average optimum stocking rate was 1.1 ha/yearling/month. Herbivore densities in our experimental pastures approximated a situation where competition should have been substantial and quantifiable in terms of cattle weight-gain performances.

Previous studies have addressed competition for forage relevant to prairie dog food habits (Fagerstone 1979, Kelso 1939, Lerwick 1974, Summers 1976, Summers and Linder 1978). Our studies reveal considerable dietary overlap of the two species, particularly with regard to the

grasses which are mainstays in the diets of both cattle and prairie dogs. Hanson and Gold (1977) also noted that prairie dogs and cattle selected similar forage in each season.

Prairie dogs affect rangeland vegetation primarily in two ways. The most obvious is removal of a certain percentage of each year's forage crop and, secondly, through long-term influences on the abundance of various plants (Koford 1958). Bonham and Lerwick (1976) noted on the Central Plains Experimental Range in Colorado that prairie dogs altered plant species composition, thereby encouraging increases in plants with greater tolerance to their grazing. Continuous clipping of tall and mid grasses by prairie dogs selectively reduced relative proportions of these grasses, favoring the shortgrass species which are more tolerant of grazing (Branson 1953). This grazing by prairie dogs lowers the potential production of an area by reducing or eliminating the tall and mid grass species which characteristically produce greater quantities of above ground biomass.

The decline of tall and mid grass species in favor of the dominant shortgrass species (blue grama) in treatment pastures containing prairie dogs is not regarded as completely detrimental. Savage and Heller (1947) considered blue grama to be the superior warm weather grass on the Southern Great Plains Experimental Range due to its chemical composition, palatability, protein content and other factors involved in evaluating plants for grazing purposes.

Prairie dog activity slightly favored forb production within treatment pastures. Koford (1958) and Bonham and Lerwick (1976) found forbs to be more plentiful within dog towns than outside the towns. Hassien (1976) also found forbs, particularly the annuals, to flourish

in the disturbed soils of prairie dog towns.

Availability of forage influenced utilization. Steers consumed different quantities and relative proportions of the various forage items in control and treatment pastures. Control steers utilized 318 kg/ha and 359 kg/ha more total forage than treatment steers for 1977 and 1978, respectively. Sand dropseed and other grasses averaged 23% of the total forage utilized by steers in control pastures, although these grasses averaged less than 7% of the total forage for treatment steers, during 1977 and 1978. Treatment steers foraged primarily on blue grama ($\bar{X}$ = 76%) and forbs ($\bar{X}$ = 17%).

The data on forage availability and utilization indicates that severe competition may exist between steers and prairie dogs in treatment pastures.

Impact on Steer Weight Gains

Despite apparent competition for forage items, differences in weight gains of steers between control and treatment pastures were statistically insignificant. The similar weight gain performances during the green-forage period indicates that sufficient forage was available to meet the demands of both steers and prairie dogs, even under a regime of heavy utilization. Differences in steer weight gains were only apparent during the fall and winter months when most vegetation was dormant. These differences remain slight, however, considering the gross differences in forage availability and utilization for treatment pastures.

Several plausible explanations exist to explain why weight gains of treatment steers were comparable to control steers even though the former

consumed considerably less forage.

(1) The greater relative proportions of blue grama and forbs in the diets of treatment steers may have partially compensated for the reduction in their intake of tall and mid grass species. Protein content of forbs usually is superior to that of grasses (Cable and Shumway 1966, Savage and Heller 1954). Hoehne et al. (1968) found forbs consumed by cattle grazing native range had higher dry matter digestion coefficients and contained greater quantities of ash, calcium, phosphorous, crude protein, and total sugars, but actually contained less dry matter than grasses consumed at the same time.

(2) The constant clipping of vegetation by prairie dogs may be maintaining forage in an early phenological stage. Forage quality diminishes with plant tissue age and higher quality forage gives higher nutritional yield (Armstrong et al. 1964, Braun 1973, Glover et al. 1960, Miller et al. 1965, Oelberg 1956).

(3) Prairie dogs may also be favorably influencing the palatability and nutritional level of forage in treatment pastures. McNaughton (1979) found after an extensive review of literature that productivity of herbivore-affected plant tissues may be compensated or stimulated by: increased photosynthetic rates in residual tissue, reallocation of substrates from elsewhere in the plant, mechanical removal of older tissues functioning at less than a maximum photosynthetic level, consequent increased light intensities upon potentially more active underlying tissues, reduction of the rate of leaf senescence thus prolonging the active photosynthetic period of residual tissue, hormonal redistributions promoting cell division, elongation, and activation of remaining meristems (resulting in more

rapid leaf growth and promotion of tillering), enhanced conservation of soil moisture by reduction of the transpiration surface and reduction of mesophyll resistance relative to stomatal resistance, and nutrient recycling from dung and urine.

(4) Prairie dogs may influence forage quality by increasing the organic content and fertility of the soil through the addition of their feces, urine, and bodies. Previous research on rodents (Green and Murphy 1932, Green and Reynard 1932, Grinnell 1923, Hassien 1976, Koford 1958, Laycock and Richardson 1975, Taylor 1930) and jack rabbits (Vohries and Taylor 1933) indicate the presence and activities of these small mammals, particularly the burrowing ones, can effectively increase the quantity and availability of total soluble salts of important nutrients. Hassien (1976) found the average concentrations of organic matter and extractable phosphorus, potassium, and calcium were significantly greater in surface soil samples from black-tailed prairie dog towns than in those from adjacent range.

(5) Prairie dogs may also affect other characteristics of the vegetative community due to their influences on nutrient availability and soil fertility. Increases in forage production (Freeman and Humphrey 1956, Honnas et al. 1959, Klipple and Retzer 1959, Kneebone 1957, Lodge 1959, Woofolk and Duncan 1962), protein content (Burzlaff et al. 1968, Klipple and Retzer 1959, Lodge 1959, Rogler and Lorenz 1974), green feed period (Freeman and Humphrey 1956, Honnas et al. 1959), water use efficiency (Rogler and Lorenz 1974, Smika et al. 1965, Wight and Black 1972), and cattle gains (Woolfolk and Duncan 1962), as a result of fertilization of native range with commercial fertilizers and manure, are well documented. Cattle have also been shown to

consistently exhibit a greater preference for fertilized forage than for unfertilized forage (Allison et al. 1977, Hooper et al. 1969, Smith and Lang 1958). This preference may explain the deteriorated condition of many prairie dog towns in comparison to adjacent range. If cattle are in fact attracted to prairie dog towns because of higher quality forage, there would be a greater probability of the cattle overutilizing the available forage and increasing the rate and severity of range deterioration. Hassien (1976) attempted to determine cattle use of prairie dog towns versus adjacent rangeland by counting cattle droppings. The average number of cattle droppings per hectare was about 30% greater on prairie dog towns than on adjacent rangeland.

Although prairie dogs are reducing forage availability and subsequent utilization of forage by cattle, it appears possible that their effects on forage quality and composition partially compensate for the reduction in forage use.

Impacts on Rodent and Insect Communities

Comparison of small rodent and arthropod populations in treatment pastures and control pastures indicate that prairie dogs substantially influenced biomass of these populations. Total biomass and numbers of small rodents were greater in treatment pastures. Grasshopper mice and thirteen-lined ground squirrels in particular were considerably more numerous in treatment pastures than in control pastures. These two species benefit from the presence of prairie dogs because of the abundance of unused prairie dog burrows which are available for shelter (Koford 1958, Smith 1958). Maintenance of vegetation in a relatively low successional stage by prairie dogs is particularly

favorable to ground squirrels (Evans and Holdenried 1943, Weaver and Flory 1934).

Results of insect surveys disagree with those of previous researchers (Coyner 1938, Smith 1940, Weese 1939) who indicated that populations of arthropods increase as grazing intensity increases. Biomass of arthropods was approximately three times greater in control pastures than in treatment pastures. It appears likely that the more dense populations if insectivorous grasshoppper mice (Bailey and Sperry 1929, Cockrum 1952) and thirteen-lined ground squirrels (Bailey 1893, Fitzpatrick 1925) in conjunction with prairie dogs themselves, which have been shown to eat insects (Kelso 1939, Koford 1958, Smith 1958) and western burrowing owls (Speotyto cunicularia hypungaea) which occur on the treatment pastures in good numbers and which are also primarily insectivorous (Butts 1973), are effectively limiting the arthropod population.

Insect populations, particularly Orthopterans, are cyclic in nature and during severe outbreaks can inflict serious damage to range vegetation and croplands (Shotwell 1941). Prairie dogs, in creating habitat for insectivores, may indirectly depress localized insect outbreaks.

Harvestor ants (Pogonomyrmex occidentalis) appear to be slightly favored by the presence of prairie dogs. Lower successional stages (found in prairie dog towns) generally support more harvester ants than higher successional stages on rangeland (Costello 1944). The denuding of areas at ant mounds may not result in a loss of forage because higher production at the periphery of ant mounds compensates for the denuded area in the middle (Wight and Nichols 1966). This higher herbage

production at the periphery of ant mounds may be in response to higher levels of nutrients available in the soil directly adjacent to the mounds (Rogers and Lavigne 1974).

Conclusions and Considerations

Findings of this study generally agree with those of Hansen and Gold (1977) indicating that prairie dogs are important ecosystem regulators because they influence primary production (forage availability), increase plant diversity, disturb the soil, and increase animal diversity. These effects, however, were not shown to significantly reduce the weight gains of steers grazing treatment pastures containing prairie dogs.

Prairie dog towns are distinctive in their range site qualities and require separate management strategies than adjacent range to prevent degradation of the resource. Foremost of these strategies should be the control of livestock distribution. If prairie dogs do in fact enhance forage quality, as this study and previous research indicates, then livestock distribution will be greatly influenced and could result in cattle concentrating on prairie dog towns and overutilizing the available forage. Kalmbach (1948) stated that the primary damage to range usually has its origin and persistence in excessive use by livestock and that the damage may be aggravated by small herbivorous mammals which increase as a natural consequence and, therefore, as indicators of misuse of the land.

Inferences about the relationship between prairie dogs and human use of rangeland may at first appear to be perfectly obvious and unquestionable. Extended examination, however, may reveal that many

factors previously overlooked are involved and an understanding of these may lead to an entirely different view.

It is important for those who are involved with the management of our rangeland resources to take a broader ecological view of the overall, long-term impact of these colonial burrowing rodents on the soils, vegetation, and fauna of the shortgrass prairie ecosystem.

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