Some Consequences of Competition between Prairie Dogs and Beef Cattle

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Abstract

Competition for range herbage between black-tailed prairie dogs *(Cynomys ludovicianus)* and steers was evaluated in terms of the effects prairie dogs have on herbage availability and use, and steer weight gains. Pastures grazed only by steers were termed control pastures and pastures grazed by prairie dogs and steers were designated treatment pastures. Small mammals and arthropods were monitored to determine if prairie dogs influence populations of these animals. Prairie dogs decreased herbage availability, which apparently led to reduced utilization by cattle during 1977 and 1978. The influence of prairie dogs on the herbage crop did not cause a *statistically* significant reduction in steer weight gains. However, the lower weight gains of treatment steers amounted to market values of $14-$24/steer less than control steers. The presence of prairie dogs appears to improve herbage quality, thus partially compensating the reduction in herbage available to steers. Pastures containing prairie dogs also supported a greater biomass of small mammals. Arthropod (mainly grasshopper) biomass in August was more than three times higher in control pastures than in treatment pastures.

In prairie dog (*Cynomys* spp.) towns, rangeland vegetation seems to be dramatically altered relative to surrounding sites. The physical appearance of a severely grazed dog town (denuded prairie dog mounds surrounded by sparse, close-cropped vegetation) reflects an apparent intensive competition for herbage on rangelands simultaneously grazed by prairie dogs and cattle.

This paper describes a study of competition for herbage in pastures containing black-tailed prairie dogs *(C. ludovicianus)* and cattle (hereafter called treatment pastures). Herbage production and use and cattle weight gains in treatment pastures were compared with the same aspects of control pastures that contained only cattle. The design enabled prairie dogs to disperse and thereby maintain natural densities as they would in an unconfined population (King 1955). 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, 27 km northwest of Woodward, Okla. The study area included a 30.35-ha grassland divided into twelve 2.53-ha pastures. Blue grama *(Bouteloua gracilis)* is dominant and sand dropseed *(Sporobolus cryptandrus)* second in importance. Characteristic forbs 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.). Sand sagebrush *(Artemisia filifolia)* occurs infrequently. 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, Okla.). Detailed descriptions of the Experimental Range are presented by Savage and Heller (1947) and USDA (1960).

A total of 311 prairie dogs (184 in 1973, 64 in 1974, and 63 in 1975) were released into the six treatment pastures using the gentle release method (Lewis et al. 1979). From 1973-1978, time-area counts (census from a specific point for a specified time interval) were conducted 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 using smoke cartridges and a 0.22 caliber rifle.

Herbage availability was measured using twenty, 1.0 by 1.3-m exclosures per pasture. Herbage standing crop was measured annually using the micro-unit inventory method (Shoop and McIlvain 1963). Estimated weights on micro-plots were checked by clipping and weighing to the nearest gram about every tenth plot to insure accuracy.

Weight-gain tested hereford steers of 222-269 kg were stocked annually in the pastures. A group of three steers was grazed among three of the pastures, thus, four such groups of steers were involved in the study each year. 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 annually during August of 1977 and 1978. Foliage-dwelling and flying arthropods were sampled by means of a sweep net using the procedure of Butts (1973). Sweeps were made at predetermined, regular distances along a diagonal transect across pasture. Arthropods were identified and weighed to the nearest 0.1 g. During the summer of 1977 harvester ant *(Pogonomyrmex occidentalis)* 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 intervals of 7.5 m 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. Desert cottontail rabbits *(Sylvilagus audubonii)* were indexed at night using the spotlight technique. Sign of diggings provided an index to numbers of pocket gophers *(Geomys bursarius)*.

Results

Prairie Dog Population

During census periods some prairie dogs were either below the

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Funds for this study were provided by the Agr. Res. Serv., U.S. Dep. Agr., the Oklahoma Cooperative Wildlife Research Unit, and the Environmental Institute of Oklahoma State University. Authors thank J.A. Bissonette, P.A. Vohs, and W.E. Warde for logistical and technical assistance. They also thank E.H. McIlvain, P. Sims, and other personnel of the Southern Great Plains Field Station, U.S. Dep. Agr., who contributed to the study. S.A. Martin provided invaluable assistance in the field.

Manuscript received April 3, 1981.

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 the young produced in spring and adults that had overwintered. The surveys conducted winter and spring included only adults and subadults of the breeding population.

Results of the prairie dog census indicate an average minimum population in August 1977 of 61.8 ± 4.0 prairie dogs/pasture or 24.4/ha. In May 1978 the average minimum per pasture was 52.8 ± 12.7 prairie dogs or 20.9/ha. During the August 1978 census an average of 76.2 ± 27.6 prairie 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 herbage volume in control pastures. Prairie dogs attempting to establish in control pastures were quickly eliminated and generally remained only a short time within those pastures.

Burrow Counts and Denuded Areas

A total of 2,570 burrows occurred on the 15.2 ha of prairie dog pastures in August 1977. Burrow density averaged 428.3/pasture or 169.3/ha. Average denuded area/mound for the six prairie dog pastures was 1.1 m². This average is relatively small due to the large number of burrows in the sample which were only burrow openings without typical earthen mounds. Denuded areas attributed to prairie dog burrowing activities, and digging while feeding, was 0.28 ha for the 15.2 ha of prairie dog pastures, or 1.9% of the area. Total denuded area (which includes area denuded by prairie dogs, harvester ants, and plains pocket gophers) was 0.36 a or 2.4% of the area.

Herbage Availability

Herbage inventories revealed pronounced differences between pastures with respect to the availability and utilization of range forage in 1977 and 1978 (Table 1). Treatment pastures contained less herbage than control pastures for all vegetative classes, except forbs, during the 2 years. Forbs constituted 8% of the total herbage available to cattle in control pastures each year. Forbs were statistically similar in abundance in treatment and control pastures in 1977 ($F = 0.1$, $P>0.05$) and 1978 ($F = 2.0$, $P>0.05$).

Significantly less blue grama herbage 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 herbage 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 herbage 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 herbage available than the control pastures in 1977 ($F = 28.0$, $P<0.01$) and 1978 ($F = 12.7$, $P<0.01$). Herbage available to cattle in treatment pastures was 37% less than control pastures in 1977, and 33% less in 1978.

Herbage Utilization

Herbage utilization differed between treatment and control pastures during 1977 in all categories except total forbs (Table 1). 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 herbage ($F = 8.6$, $P<0.05$) were all utilized in significantly greater quantities by steers in control pastures. Steers utilized 37% more forbs in the treatment pastures, the difference was not significant ($F = 2.0$, $P>0.05$).

During 1978 (Table 1) herbage 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

Table 1. Average availability and utilization (kg/ha) of selected herbage classes in control and treatment pastures, 1977 and 1978.

Forage year and treatment	Blue grama	Sand dropseed	Other grass	Total grass	Total forbs	Total forage
1977						
Steers only						
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						
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	-90	-60	-30	37	-25
1978						
Steers only						
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						
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

Table 2. Average weight gains (kg) of 12 beef cattle in control and 12 cattle in treatment (prairie dog) pastures.

Year		Control			Treatment		
		Winter	Summer	Year	Winter	Summer	Year
1976-1977	Mean	34.8	127.5	162.3	22.2	126.7	148.8
	SD	8.7	11.4	13.4	14.1	11.7	22.8
1977-1978	Mean	30.5	108.0	138.5	25.0	105.7	130.7
	SD	6.6	11.6	11.8	11.1	13.5	21.3

herbage ($F = 7.0$, $P<0.05$), 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 herbage classes made up the following percentages of total herbage 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 275 days. The next year, steers were stocked on December 13, 1977, and remained on the pastures until September 14, 1978, a total of 276 days.

Analysis of results of 1977 and 1978 steer weight gain performances (Table 2) reveals no statistically significant difference between steers that were 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 0.8 kg/head ($F = 0.01$, $P>0.05$) and 2.3 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 12.6 kg/head ($F = 3.1$, $P>0.05$) and 5.5 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 statistically insignificant at 13.5 kg in 1977 ($F = 1.4$, $P>0.05$) and 7.8 kg in 1978 ($F = 0.5$, $P>0.05$).

Small Mammal Populations

Results of small mammal live-trapping surveys are summarized in Table 3. All the small mammals listed are primarily herbivorous except the insectivorous grasshopper mouse. Insects are also important in the diet of thirteen-lined ground squirrels. Numbers of small mammals live-trapped were consistently greater in treatment pastures than in control pastures during all survey periods, although the difference in total numbers for 1977-1978 was not significant ($F = 4.2$, $P>0.05$). However, grasshopper mice, 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 were difficult to interpret. Numbers of rabbits seen were low and similar between treatment and control pastures. However, based on 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. He 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 when spotlight counts were conducted.

Number of pocket gopher mounds 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 in our areas were believed to be inconsequential.

Arthropod Populations

Sweep net sampling of the arthropod populations revealed significant differences in biomass between treatment and control pastures. Sweep samples of control pastures consistently had over three times the biomass of insects in 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 4). Sweep net samples were made up almost entirely of Orthopterans (grasshoppers).

Numbers of harvester ant mounds were similar in treatment and control pastures with an average of 10.5/ha and 11/ha, respec-

Table 3. Biomass (g) and numbers of small mammals livetrapped during 3000 trap days and percent difference between control and treatment pastures, 1977-1978.

Species	Control pasture		Treatment pastures		% difference	
	Biomass	No.	Biomass	No.	Biomass	No.
Onychomys leucogaster Northern grasshopper mouse	954.5	26	3037.5	82	218	215
Perognathus hispidus Hispid pocket mouse	832.0	24	248.0	8	235	200
Spermophilus tridecemlineatus Thirteen-lined ground squirrel	1453.0	12	2751.0	23	89	92
Peromyscus maniculatus Deer mouse	77.0	8	209.0	13	171	63
Peromyscus leucopus White-footed mouse	34.0	3	73.5	3	116	0
Reithrodontomys montanus Plains harvest mouse	42.0	5	0	0	-	-
Dipodomys ordi Ord's kangaroo rat	71.5	1	0	0	-	-
Total	3464.0	79	6319.0	129	82	63

Table 4. Arthropod biomass on control and treatment pastures.

	Sample 1 Aug 9-14 1977	Sample 2 Aug 8-13 1978	Sample 3 Aug 12-26 1978
Control Pastures (steers only)			
Total	132.0	252.5	167.0
X	22.0	42.1	27.8
SD	9.4	8.4	7.3
Treatment Pastures (steers and prairie dogs)			
Total	37.5	78.0	53.5
X	6.3	13.0	8.9
SD	3.6	3.5	

tively. However, the denuded area around any mounds was greater in treatment pastures (total of 0.01 ha) than in control pastures (0.004 ha) indicating that the effect of these ants was greater in treatment pastures.

Discussion

The results of the study are summarized for comparative purposes in Table 5.

Effects on the Vegetative Community

Prairie dogs are frequently described as competitors with livestock for range herbage. The competitive interaction, however, should vary with population density of the prairie dog or stocking intensity of the cattle. The mean density of 25.1 prairie dogs/ha in this study is similar to densities reported in natural populations (Hassien 1976).

Steer numbers were maintained at a stocking rate of 1/2.5 ha which is considered "moderate" (McIlvain and Savage 1951) for the Southern Great Plains Experimental Range. However, length of the grazing season during this study probably represents a heavy stocking rate, because it was 275 days versus only 172 days for McIlvain and Savage's study. Bement (1969) found that maximum dollar returns per acre from yearlings on shortgrass range were obtained when 336 kg/ha of air-dry forage 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 certainly forced a competitive interaction.

Table 5. Summary of factors influencing vegetation in control and experimental pastures, and consequences of those influences to cattle forage weight gains.

	Control Pastures	Treatment Pastures
Factors		
Beef cattle (n)	6	6
Prairie dogs (n)	trace	240-456
Small mammals		
Northern grasshopper mouse	X[1]	3X
Hispid pocket mouse	3X	X
Thirteen-lined ground squirrel	X	2X
Other small mammals	X	X
Desert Cottontail Rabbit	less	more
Grasshoppers	3X	X
Consequences (to beef cattle)		
Forage available (Kg/yr)	1,000-1,400	670-1,000
Forage use (Kg/yr)	900-1,300	650-950
Cattle weight gains (Kg/yr)	138-162	131-149

[1]The X's indicate for comparative purposes the relative populations of small mammals and arthropods, e.g., treatment pastures contained three times as many grasshopper mice as occurred in control pastures.

Previous studies of prairie dog food habits (Fagerstone 1979, Lerwick 1974, Summers and Linder 1978) have been interpreted relative to potential for competition with beef cattle. Our studies reveal considerable dietary overlap of prairie dogs and cattle, particularly relative to grasses. Hansen and Gold (1977) also noted that prairie dogs and cattle selected similar herbage in each season.

Prairie dogs affect rangeland vegetation in at least two ways. Firstly, and most obviously, they remove a percentage of the herbage crop. Secondly, their clipping selectively influences the abundance of various plants (Koford 1958). Through time Bonham and Lerwick (1976) noted on the Central Plains Experimental Range in Colorado that prairie dog grazing preceded increases in the densities of plants with greater tolerance to their grazing. Continuous clipping of tall and mid grasses by prairie dogs reduces relative proportions of these grasses, favoring shortgrass species that are more tolerant of grazing (Branson 1953). Grazing by prairie dogs lowers potential production by reducing or eliminating the tall and mid grass species which characteristically produce greater quantities of aboveground biomass.

The decline of tall and mid grass species in favor of the dominant shortgrass species (blue grama) as a percentage of total herbage in treatment pastures is not completely detrimental. Savage and Heller (1947) considered blue grama to be the superior warm weather grass for grazing purposes on the Southern Great Plains Experimental Range due to its chemical composition, palatability, and protein content.

Prairie dog activity slightly favored forb production within our 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 that forbs, particularly annuals, flourished in the disturbed soils of the prairie dog towns.

Availability of herbage influenced utilization. Steers apparently consumed different quantities and relative proportions of the various herbage items in control and treatment pastures. Control steers utilized 318 kg/ha and 283 kg/ha more total herbage than treatment steers for 1977 and 1978, respectively. Sand dropseed and the category "other grasses" averaged 24% of the total herbage utilized by steers in control pastures, although these grasses averaged less than 7% of the total herbage for treatment steers, during 1977 and 1978. Treatment steers fed primarily on blue grama (X = 76%) and forbs (X = 17%).

The data on herbage availability and utilization indicates that severe competition may have existed between steers and prairie dogs in treatment pastures.

Effects on Steer Weight Gains

The statistically similar steer weight gain performances during the green-herbage period indicates that sufficient herbage 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 herbage availability and utilization for treatment pastures.

Plausible explanations of why weight gains of treatment steers and control steers were not significantly different, though the former consumed considerably less forage, include:

(1) The greater proportions of blue grama and forbs in 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, Hoehne et al. 1968, Savage and Heller 1947).

(2) The constant clipping of vegetation by prairie dogs may be maintaining herbage in an early phenological stage. Herbage quality diminishes with plant tissue age and higher quality herbage gives higher nutritional yield (Armstrong et al. 1964, Braun 1973, McNaughton 1979, Miller et al. 1965). In addition, palatability and nutritional level of herbage improves with clipping.

(3) 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 (Hassien 1976, Laycock and Richardson 1975) indicates especially that the presence and activities of fossorial small mammals can increase the quantity and availability of total soluble salts of important nutrients.

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

Effect 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 probably respond to the presence of unused prairie dog burrows which provide 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, Slade and Balph 1974).

Results of insect surveys disagree with early studies (Coyer 1938, Smith 1940, Weese 1939) which suggested that arthropod populations increase with grazing intensity. Biomass of arthropods was about three times greater in control pastures than in treatment pastures (Table 5). Arthropod populations in treatment pastures may have been limited by the more dense populations of insectivorous grasshopper mice (Bailey and Sperry 1929, Cockrum 1952) and thirteen-lined ground squirrels (Bailey 1893, Fitzpatrick 1925). Prairie dogs also have been shown to eat insects (Koford 1958, Smith 1958). Western burrowing owls *(Speotyto cunicularia hypungaea)* occurred on treatment pastures in good numbers and are also insectivorous (Butts 1973).

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 moderate localized insect irruptions.

Harvester ants 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 herbage 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 a response to higher nutrient levels in the soil directly adjacent to the mounds (Rogers and Lavigne 1974).

Conclusions

Findings of this study generally support Hansen and Gold's (1977) conclusions that prairie dogs regulate prairie ecosystems by influencing primary production (herbage availability), and increasing diversities of plant and animal communities. The *significance* of the effects of prairie dogs on the weight gains of steers, however, can be viewed from different perspectives.

Cattle grazing in treatment pastures with prairie dogs gained less weight anually than in control pastures without prairie dogs. These trends in weight gains did not show *statistical* difference, possibly due to a positive impact that prairie dogs may have on range herbage and/or major losses of available herbage to insects in pastures without prairie dogs. These two factors very likely compensated, in part, the clipping and harvesting of range herbage by prairie dogs.

Alternatively from an *economic* perspective, cattle operations often realize low profit margins. In terms of cost to the rancher (at a January 1981 market price of $0.80.lb) the loss would have been $23.81/steer in 1977 and $13.76/steer in 1978. These represent significant economic losses.

Thus, this study shows that (under heavy stocking levels of beef cattle) prairie dogs may reduce the profit margin of a ranching operation. How these results would change with "proper" cattle stocking rates is uncertain.

Literature Cited

Armstrong, D.G., K.L. Blaxter, and R. Waite. 1964. The evaluation of artificially dried grass as a source of energy for sheep. III. The prediction of nutritive value from chemical and biochemical measurements. J. Agr. Soc. (Camb.) 62:417.

Bailey, V. 1893. The prairie ground squirrels or spermophiles of the Mississippi Valley. U.S. Dep. Agr., Div. Ornith. and Mamm., Bull. 4:1-69.

Bailey, V., and C.C. Sperry. 1929. Life history and habits of grasshopper mice, genus *Onychomys*. U.S. Dep. Agr. Tech. Bull. 145:1-20.

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

Bonham, C.D., and A.C. Lerwick. 1976. Vegetation changes induced by prairie dogs on shortgrass range. J. Range Manage. 29:221-225.

Branson, F.A. 1953. Two new factors affecting resistance of grasses to grazing. J. Range Manage. 6:165-171.

Braun, J.M.N. 1973. Primary production in the Serengeti: purpose, methods and some results of research. Ann. Univ. Abidjan, Ser. E., Ecol. 4:171-188.

Butts, K.O. 1973. Life history and habitat requirements of burrowing owls in western Oklahoma. M.S. Thesis, Oklahoma State Univ., Stillwater 188 p.

Cable, D.R., and R.P. Shumway. 1966. Crude protein in rumen contents and in forage. J. Range Manage. 19:124-128.

Cockrum, E.L. 1952. Mammals of Kansas. Univ. Kansas Publ., Mus. Natur. Hist. 7:1-303.

Costello, D.F. 1944. Natural revegetation of abandoned plowed land in the mixed prairie association of northeastern Colorado. Ecology 25:312-326.

Coyer, W.R. 1938. Insect distribution and seasonal succession in overgrazed and normal grasslands. M.S. Thesis, Univ. Oklahoma, Norman. 78 p.

Dano, L. 1952. Cottontail rabbit *(Sylvilagus audubonii baileyi)* populations in relation to prairie dog *(Cynomys ludovicianus ludovicianus)* towns. M.S. Thesis, Colorado State Univ., Ft. Collins, 132 p.

Evans, F.S., and R. Holdenried. 1943. A population study of the Beechey ground squirrel in central California. J. Mammal. 24:231-260.

Fagerstone, K.A. 1979. Food habits of the black-tailed prairie dog *(Cynomys ludovicianus)*. M.A. Thesis, University of Colorado, Boulder. 161 p.

Fitzpatrick, F.L. 1925. The ecology and economic status of *Citellus tridecemlineatus*. Iowa Univ. Stud. Natur. Hist. 11:1-40.

Hansen, R.M., and I.K. Gold. 1977. Blacktail prairie dogs, desert cottontails and cattle trophic relations on shortgrass range. J. Range Manage. 30:210-214.

Hassien, F.D. 1976. A search for black-footed ferrets in Oklahoma panhandle and adjacent area and an ecological study of black-tailed prairie dogs in Texas County, Oklahoma. M.S. Thesis, Oklahoma State Univ., Stillwater. 111 p.

Hoehne, O.E., D.C. Clanton, and C.L. Streeter. 1968. Chemical composition and in vitro digestibility of forbs consumed by cattle grazing native range. J. Range Manage. 21:5-7.

King, J. 1955. Social behavior, social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Contrib. Lab. Vert. Biol. 67. Univ. Michigan, Ann Arbor. 123 p.

Koford, C.B. 1958. Prairie dogs, whitefaces, and blue grama. Wildl. Monogr. 3, The Wildl. Soc. 78 p.

Laycock, W.A., and B.Z. Richardson. 1975. Long term effects of pocket gopher control on vegetation and soils of a subalpine grassland. J. Range Manage. 28:458-462.

Lerwick, A.C. 1974. The effects of the black-tailed prairie dog on vegetative composition and their diet in relation to cattle. M.S. Thesis. Colorado State Univ., Ft. Collins. 106 p.

Lewis, J.C., E.H. McIlvain, Robert McVickers, and Berkeley Peterson. 1979. Techniques used to establish and limit prairie dog towns. Proc. Oklahoma Acad. Sci. 59:27-30.

McIlvain, E.H., and D.A. Savage. 1951. Eight year comparison of continuous and rotational grazing on the Southern Plains Experimental Range. J. Range Manage. 4:42-47.

McNaughton, S.J. 1979. Grazing as an optimization process: grass-ungulate relationships in theSerengeti. Amer. Natur. 113:691-703.

Miller, W.J., C.M. Clifton, O.L. Brooks, and E.R. Beatty. 1965. Influence of harvesting age on digestibility and chemical composition of pelleted coastal bermudagrass. J. Dairy Sci. 48:209-212.

Phillips, P. 1936. The distribution of rodents in overgrazed and normal grasslands of central Oklahoma. Ecology 17:673-679.

Rogers, L.E., and R.J. Lavigne. 1974. Environmental effects of western harvester ants on the shortgrass plains ecosystem. Environ. Entomol. 3:994-997.

Savage, D.A., and V.G. Heller. 1947. Nutritional qualities of range forage plants in relation to grazing with beef cattle on the Southern Plains Experimental Range. U.S. Dep. Agr. Tech. Bull. 943. 61 p.

Shoop, M.C., and E.H. McIlvain. 1963. The micro-unit forage inventory method. J. Range Manage. 16:172-179.

Shotwell, R.L. 1941. Life histories and habits of some grasshoppers of economic importance on the Great Plains. U.S. Dept. Agr. Tech. Bull. 774. 48 p.

Slade, N.A., and D.F. Balph. 1974. Population ecology of Uinta ground squirrels. Ecology 55:989-1003.

Smith, C.C. 1940. The effect of overgrazing and erosion upon the biota of the mixed-grass prairie of Oklahoma. Ecology 21:381-397.

Smith, R.E. 1958. Natural history of the prairie dog in Kansas. Misc. Pub. 16. Mus. of Natural History and State Biol. Survey, Univ. Kansas. 36 p.

Summers, C.A., and R.L. Linder. 1978. Food habits of the black-tailed prairie dog in western South Dakota. J. Range Manage. 31:134-136.

U.S. Department of Agriculture. 1960. Soil survey of Harper County, Oklahoma. Series 1956, No. 8, Washington, D.C. 60 p.

Weese, A.O. 1939. The effect of overgrazing on insect populations. Oklahoma Acad. Sci. Proc. 19:95-99.

Wight, J.R., and J.T. Nichols. 1966. Effects of harvester ants on production of a saltbush community. J. Range Manage. 19:68-71.