Impact of Burrowing Activity of the Bannertail Kangaroo Rat on Southern New Mexico Desert Rangelands

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Abstract

The impact of the burrowing activity of the bannertail kangaroo rat *(Dipodomys spectabilis)* on southern New Mexico desert rangelands was investigated. The study was conducted on black grama *(Bouteloua eriopoda)*, dropseed (*Sporobolus* spp.), and mesquite *(Prosopis glandulosa)* grassland vegetation types. Mound density was highest in the black grama type, somewhat intermediate in the dropseed type, and lowest in the mesquite-grassland type. The surface area occupied by mounds averaged 2% over all vegetation types in the study area. Plant cover was generally greater off mounds than on mounds. Annual plant cover was greater on mounds that off mounds, suggesting that activities of bannertail kangaroo rats promote the presence of annuals.

Bannertail kangaroo rats *(Dipodomys spectabilis)* occur in great number throughout southwestern United States (Stoddard et al. 1975). These rodents feed largely on seeds which they collect in cheek pouches and store in burrows beneath their mounds.

The bannertail kangaroo rat constructs large, conspicuous mounds, usually in open locations, although the rat occasionally takes advantage of protection offered by mesquite *(Propsopis glandulosa)*, creosotebush *(Larrea tridentata)*, and other desert shrubs (Monson and Kessler 1940, Holdenried 1957, Schroder and Geluso 1975). These mounds provide suitable conditions for the establishment and development of annual plants which may be less desirable for livestock production on rangelands (Holdenried 1957). Furthermore, on or near mounds, vegetation may be covered by soil from burrows, which prevent plants from completing their growth cycle (Fitch and Bentley 1949).

Kangaroo rats exert impacts on rangelands not only through direct forage consumption, but also through their burrowing activities. When evaluating game and livestock ranges for carrying capacity, grazing use, or rate of recovery, many researchers have paid little attention to the effect of the burrowing activities of these rodents on rangelands. Jaeger (1961) maintained that in areas where competition for forage exists between livestock and the bannertail, the large amount of food collected by the latter and stored in their mounds should be considered in estimating the number of cattle that may graze on such areas.

Hawbecker (1944) challenged the contention that kangaroo rat mounds are always undesirable. He concluded that the burrowing activity of the bannertail kangaroo rats appeared to benefit the local sheep industry in California through increased production of such palatable plant species as red-stemmed filaree *(Erodium cicutarium)*. However, Norris (1950) pointed out that Hawbecker referred only to annual forage and not to the more valuable perennial forage plants.

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There are no exact figures on the longevity of mounds, but Holdenried (1957) and Best (1972) stated that it took about 23 to 30 months for a characteristic mound to develop. Once abandoned, the mound collapsed within a month or so. A review of the literature reveals no information on the rate of vegetation invasion on the mounds.

Current information on the impact of the burrowing activity of the bannertailed kangaroo rat seems to be limited mostly to opinions based on qualitative observations. At present there is a concentrated effort by individuals and government agencies to control kangaroo rat populations. These control efforts are generally based on little ecological information. It thus seems necessary to obtain quantitative information that will supplement the currently available qualitative body of knowledge and enhance understanding of the impact of the burrowing activity of bannertailed kangaroo rats. This is especially true in the desert rangelands of southern New Mexico, where the species abounds.

Study Areas

The study was conducted early in the summer of 1979 on the New Mexico State University College Ranch, about 32 km north of Las Cruces. The climate is typical of southern continental interiors, with hot summers and mild winters. Annual precipitation averages nearly 22 cm, with the majority falling in July, August, and September. The area was described by Wood (1969). For this study, 3 distinct vegetation types were selected, one dominated by black grama *(Bouteloua eriopida)*, one by dropseed (*Sporobolus* spp.), and the third by mesquite-grassland. The grama type supported a few scattered individual mesquite and yucca *(Yucca elata)* shrubs, ånd several forb species and broom snakeweed *(Xanthocephalem sarothrae)* occurred on disturbed portions. The dropseed type was dominated principally by mesa dropseed *(Sporobolus flexuosus)* and sand dropseed *(Sporobolus cryptandrus)*. Individual yuccas occurred sparsely in this type as well as a few mesquite plants. Broom snakeweed occurred sporadically in fairly heavy stands on seemingly disturbed parts of this type. Annual and perennial forbs were also conspicuously scattered throughout the dropseed type, but even more so on disturbed areas. The mesquite-grassland type was characterized by broom snakeweed, mesquite, and dropseed as dominants. Throughout this type were a variety of annual and perennial forbs, with mostly annuals occurring on disturbed areas.

Methods

Density of the bannertail kangaroo rat mounds was determined by counting the mounds in 65 randomly located belt transects 12 m wide and 160 m long in each of the 3 vegetation types. The area of land disturbed by mounds was determined from the average of 2 perpendicular diameter measurements, one through the center along the longest axis and the other along the shortest distance across the mound (Mueller-Dombois and Ellenberg 1974).

Aerial plant cover measurements were made on mounds and off

Table 1. Bannertail kangaroo rat den density, size, percent active, and area disturbed in 3 vegetation types in Southern New Mexico.

Vegetation type	Mound density/ ha	Avg. area/mound (M^2)	% of area occupied by mounds	% of mounds active
Black grama	9.4 ± 6.9[1]	26.0 ± 4.07	2.5	38.0
Dropseed	7.6 ± 0.69	20.5 ± 2.43	1.6	32.0
Mesquite-grassland	2.5 ± 0.42	64.5 ± 7.93	1.6	21.8

[1]±Standard error ($P<0.05$)

mounds employing point sampling. The procedure consisted of randomly placing a 3-meter rod at 8 locations on a mound and at 8 locations at least 6 m from the periphery of the mound. At each placement of the rod, a thin steel wire was lowered vertically at 10 points (30-cm intervals) along the rod. Whatever the wire hit first was recorded. Aerial cover and composition was determined from plant contact. Differences between on mound and off mound percent composition of annual plants were tested using the paired *t*-test (Zar 1974).

Coefficients of similarity (Hansen and Beck 1968) were computed for the percent composition and cover of annual and perennials between mounds and off mounds for each type. Coefficients were also computed to assess the similarity of the percent composition of annual invading mounds in different types.

Results and Discussion

Mound Parameters

The highest mound density (9.4/ha) occurred in the black grama type, while the lowest (2.5/ha) occurred in the mesquite-grassland type (Table 1). The density of mounds in the dropseed cover type was intermediate. Analysis of variance showed a significant difference ($P<.001$) among the mean numbers of mounds on the three cover types. Fisher's protected least significant difference (LSD) procedure for pairwise comparison of means (Ott 1977) indicated that all the means differed significantly from each other ($P<.005$). Data collected in 1960-1963 by Wood (1969) on the same area as this study showed that the density of the bannertail kangaroo rat mounds in the black grama grassland was 10.1/ha using the quarter method, and 11.4/ha using the transect method.

Wood (1969) determined the size of denuded areas on and around mounds and established that 10.6% of the black grama range supported little perennial forage. This study revealed that 2.4% of the black grama range was occupied by mounds. The discrepancy between Wood's (1969) estimate of area occupied by mounds and that determined in this study was not due to a change in density, but rather to the size of individual mounds. Wood (1969) found that the average area disturbed was about 105 m^2, nearly 4 times larger than that measured in this study.

The difference between the early 60's and 1979 may be explained by foraging behavior of the bannertail and precipitation patterns. During the 1950's a serious drought had reduced and eliminated much plant cover on the College Range. In 1960 the grasslands were still recovering from the drought, and forage plants were scarce, which forced the bannertail to forage over a large area to meet dietary needs. In the 4 years prior to and including 1979, precipitation was average or above average, which assured adequate forage for the bannertail and reduced the area physically disturbed.

Best (1972) and Schroder and Geluso (1975) reported that, in

Table 2. Aerial cover (%) and composition of (%) of plant species found on and off bannertail kangaroo rat mounds in 3 vegetation types in southern New Mexico.

	Black Grama				Dropseed				Mesquite-Grassland			
	On-mound		Off-mound		On-mound		Off-mound		On-mound		Off-mound	
Species	Cover	Comp	Cover	Comp	Cover	Comp	Cover	Comp	Cover	Comp	Cover	Comp
Annuals												
Amaranthus retroflexus	—	—	—	—	0.1	0.6	—	—	0.2	0.7	—	—
Aphanostephus ramoissimus	12.0	55.6	14.0	25.8	12.1	53.8	12.2	28.4	2.5	7.9	1.0	2.9
Chenopodium spp.	—	—	—	—	0.1	0.3	—	—	0.1	0.2	—	—
Cryptantha crassisepala	0.4	1.8	0.4	0.7	0.8	3.7	0.7	1.7	0.8	2.7	0.2	0.4
Dithyrea wislizeni	0.8	3.6	0.1	0.3	2.4	10.8	0.5	1.1	4.5	14.5	0.8	2.4
Lesquerella gordonii	3.3	15.4	1.6	3.1	0.4	1.7	0.1	0.3	—	—	—	—
Machaeranthera tanacetifolia	—	—	—	—	0.1	0.6	—	—	—	—	—	—
Mentzelia albicaulis	0.1	0.6	0.3	0.5	0.3	1.1	0.1	0.2	1.2	3.9	0.3	0.7
Nama hispidum	—	—	0.8	1.6	0.2	0.8	1.4	3.2	2.8	9.2	2.3	6.6
Plantago patagonica	—	—	0.2	0.3	—	—	—	—	—	—	—	—
Salsola kali	2.0	9.5	0.4	0.7	1.9	8.5	T	0.1	3.2	10.4	—	—
Xanthocephalum sphaerocephala	—	—	—	—	—	—	—	0.1	0.2	0.7	2.1	
Total annuals	18.6	86.5	17.8	33.0	18.4	81.9	15.0	35.0	15.4	49.7	5.3	15.1
Perennials												
Aristida longiseta	—	—	0.2	0.3	—	—	0.2	0.4	—	—	0.2	0.6
Bouteloua eropida	—	—	18.7	34.5	—	—	—	—	—	—	0.3	0.7
Erioneuron-pulchellum	1.0	4.7	0.8	1.4	1.0	4.2	1.6	3.7	—	—	0.4	1.0
Sporobolus spp.	0.6	2.9	7.8	14.3	1.5	6.8	19.8	46.0	1.3	4.1	10.4	29.6
Baileya multiradiata	—	—	0.4	0.7	0.1	0.6	0.4	0.8	0.5	1.7	—	—
Cassia bauhinoides	0.1	0.6	0.1	0.2	—	—	0.2	0.4	—	—	—	—
Croton corymbulosus	—	—	0.8	1.4	0.1	0.6	1.3	2.9	—	—	—	—
Ephedra spp.	—	—	0.1	0.2	—	—	—	—	—	—	0.2	0.6
Hymenopappus robustus	—	—	0.4	0.7	0.4	1.7	0.4	1.0	—	—	0.1	0.1
Opuntia spp.	—	—	—	—	—	—	0.1	0.2	—	—	—	—
Prosopis glandulosa	—	—	0.2	0.3	—	—	0.5	1.1	2.2	6.9	5.7	16.2
Psilostrophe tagetinae	—	—	0.1	0.2	—	—	—	—	—	—	—	—
Solanum elaeagnifolia	0.3	1.2	—	—	—	—	T	0.1	0.5	1.7	0.2	0.6
Sphaeralcea coccinia	—	—	—	—	—	—	—	—	0.7	2.2	0.6	1.6
Xanthocephanlum sarothrae	0.9	4.1	6.8	12.6	0.5	2.2	2.6	6.1	10.0	32.5	11.6	32.8
Yucca elata	—	—	0.1	0.2	0.5	1.7	0.5	1.1	0.1	0.5	0.2	0.6
Zinnia grandiflora	—	—	—	—	—	—	0.1	0.3	—	—	0.2	0.4
Total perennials	2.9	13.5	36.5	67.0	4.1	17.8	27.7	64.1	15.3	49.6	30.1	84.8

Table 3. Coefficients of similarity for cover and composition comparing on-mound with off-mound vegetation.

	Annuals		Perennials	
	% similarity of:		% similarity of:	
Vegetation type	cover	composition	cover	composition
Blackgrama	80.0	52.1	12.2	21.4
Dropseed	81.7	55.8	25.8	39.1
Mesquite-grassland	45.0	40.7	63.4	68.7

general, the bannertail prefers open grassland and mixed grass-shrub types. In this study, both the black grama and dropseed grasslands were interspersed with yucca and a few mesquite shrubs. Findley et al. (1975) stated that grasses make up an important part of the diet of the bannertail kangaroo rat, and that the species is abundant where grasses such as *Bouteloua* spp. and tobosa *(Hilaria mutica)* are common. The observed difference in mound density between the 2 grasslands is possibly due to differences between physical heights of black grama and dropseed since some mesquite and yucca were present on both types. Moreover, the results of this study seem to suggest that the bannertail kangaroo rat is a climax species in the area studied.

The low mound density in the mesquite-grassland type was possibly a result of invasion by shrubs such as mesquite and broom snakeweed, as is shown by a low percentage (21.8%) of active mounds. Monson and Kessler (1940) excavated mounds of the bannertail kangaroo rat in Arizona and New Mexico and found mesquite beans among the stored food material. Wood (1969) also excavated mounds of the bannertail on the College Ranch and found, among other things, seeds of broom snakeweed. Reynolds (1950), after studying Merriam's kangaroo rat in Arizona, stated that when seed is available a large volume is stored undermounds. These seeds left in the ground are in a more favorable environment for germination and establishment than are those lying on top of the ground. Reynolds and Glendening (1949) reported that Merriam's kangaroo rat collects mesquite seeds as a preferred food item and concluded that this rat is a factor in mesquite propagation on southern Arizona rangelands.

Therefore, in southern New Mexico the bannertail kangaroo rat may be partly responsible for the spread of mesquite and broom snakeweed. Apparently, the propensity of the bannertail to store seeds not only limits the potential production of perennials but also decreases the amount of habitat suitable for the rat itself.

The average area of mounds in the black grama and dropseed grasslands were similar and relatively small, compared to the average area of mounds in the mesquite-grassland (Table 1). This is probably because most mounds in the mesquite-grassland type were observed to be old, without well-defined edges. Thus the diameters measured on these old mounds possibly included the denuded area around mounds, which normally represent the foraging area of the bannertailed kangaroo rat.

Vegetational Cover and Composition

The on-mound and off-mound cover and botanical composition for the respective vegetation types are shown in Table 2. In all 3 vegetation types, the percent composition of annual plants was significantly higher on mounds than off mounds. Coefficients of similarity were 52.1, 55.8, and 40.7%, respectively, for black grama, dropseed, and mesquite-grassland types, which suggested that species composition of annuals on mounds had limited similarity to that off mounds (Table 3). This implies that the environment on the mounds is suitable for the growth of annual plants, which agrees with previous research observations (Hawbeck 1944 and Holdenreid 1957).

Conversely, the botanical composition of perennials was lower on mounds than off mounds in all 3 types (Table 2). The coefficients of similarity between on mound and off mound composition of perennials were, respectively, 21.4, 39.1, and 68.7% for black grama, dropseed and mesquite-grassland (Table 3). The coefficients for the 2 grasslands reflect strong dissimilarity; that for mesquite-grassland suggests a tendency toward similarity. This latter situation can be partly explained since most of the mounds in this cover type were no longer occupied, and there had been considerable mesquite and snakeweed invasion on these mounds.

Aerial plant cover was generally higher off mounds than on mounds (Table 2). The low percent cover on mounds was probably due to the fact that kangaroo rats eliminate vegetation after it has started to grow by covering it with soil from burrows, and by cutting and then carrying plant parts into the mounds (Fitch and Bentley 1949). However, the percent of annual cover was very similar between on and off mounds in the black grama and dropseed types, while it tended to be dissimilar in the mesquite-grassland type (Table 3).

The percent aerial cover of perennial plants was generally higher off mounds than on mounds. Similarity coefficients were very low for the 2 grasslands types (Table 3). Generally, important perennial grasses such as black grama and dropseed were either absent or comprised very little of on-mound vegetation (Table 2).

Percent cover and composition of annuals and perennial on active and inactive mounds were calculated for each vegetation type (Table 4). Generally, one would expect the total cover on active mounds to be lower than that on inactive mounds because of disturbance from burrowing and foraging activities of the bannertail and probably due to lack of a good seed source. This appeared to be the case in the black grama type. However, total cover figures on active and inactive mounds on the other 2 types were similar. No plausible explanation could be found for this apparent anomaly.

Coefficients of similarity were calculated to determine the degree of similarity in the species composition for the three cover types. The values were 54.0% for black grama vs dropseed, 35.2% for black grama vs mixed shrub-grassland, and 47.0% for dropseed vs mixed shrub-grassland. On the basis of these figures it was established that the 3 cover types were different from one another.

Coefficients of similarity were calculated to determine the degree of similarity in the percent composition of annuals on mounds among vegetation types. The values were 79.5% for black grama vs dropseed, 34.2% for black-grama vs mixed shrub-grassland 49.1% for dropseed vs mixed shrub-grassland. It appears that the on-mound species compositions of annuals in the two grassland cover types were similar. However, the composition of annuals on mounds in the grassland types seems to be different from that of the mixed shrub-grassland (Table 2). This difference between on-mound composition of annuals on the grasslands and mesquite grassland was probably due to the invasion of mesquite and broom-snakeweed on the mounds in the mesquite-grassland.

Table 4. Percent cover and composition of annual and perennial plants on active and inactive mounds in the black grama, dropseed, and mixed mesquite-grassland cover types.

	Active Mounds				Inactive Mounds			
	Annuals		Perennials		Annuals		Perennials	
Vegetation type	Cover	Comp	Cover	Comp	Cover	Comp	Cover	Comp
Black grama	17.4	84.0	3.3	16.0	34.6	90.0	2.7	9.2
Dropseed	16.0	70.0	6.9	29.9	18.9	84.9	3.4	14.8
Mesquite-grassland	17.4	56.3	13.4	43.8	15.1	50.5	14.8	49.6

Conclusions

1. The bannertail kangaroo rat prefers open grasslands interspersed with a few shrubs, but shows greatest preference for areas with short grass. In the area studied, the bannertail seems to be associated mainly with climax grassland (black grama). Grasslands with heavy mesquite infestation seem to be the least suitable habitat.

2. Burrowing and foraging activities by the bannertail affected the composition and cover of plants growing on mounds. Annuals were more commonly found growing on mounds, while the reverse was true for perennials. This substantiates the contention that activities of the bannertail kangaroo rat encourage development of annual plants and can thus lower perennial plant production on southern New Mexico desert rangelands.

3. The range management implications of the results of this study are complicated by the fact that very little is known about the biology and ecology of the bannertail. Moreover, the apparent association with climax grassland might limit any attempt to control or restrict the population. The problem is further aggravated by lack of information on how many rats actually construct each mound, and how long it takes an abandoned mound to be revegetated by desirable perennial grasses in southern New Mexico.

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