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DEMOGRAPHY OF BLACK-TAILED PRAIRIE DOG POPULATIONS REOCCUPYING SITES TREATED WITH RODENTICIDE

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ABSTRACT.—A rodenticide, zinc phosphide, was applied to remove black-tailed prairie dogs (*Cynomys ludovicianus*) from 6 ha of a prairie dog colony in southwestern South Dakota. Another adjacent 6 ha was left untreated. The removal experiment was repeated two consecutive years. Contingency table analysis showed that the resultant population was not homogeneous; age classes by sex of the immigrant and resident subpopulations were different (P < 0.01). The ratio of adult females to yearling females was greater among immigrants than among residents (P < 0.03). Female immigrants did not produce young in the treated zone during the year of their arrival. Fewer of these females displayed distended nipples than expected (P < 0.01), indicating that these immigrants did not reproduce during the reproductive season immediately preceding dispersal and suggesting that failure to reproduce may have stimulated dispersal.

The black-tailed prairie dog (*Cynomys ludovicianus*) is a herbivorous, social ground squirrel that is native to the Great Plains of North America. Black-tailed prairie dogs live in colonies known as prairie dog towns. Within these colonies, prairie dogs dig burrows and alter the composition of the vegetation (Koford 1958, Coppock et al. 1983). Large populations of black-tailed prairie dogs presently exist within the boundaries of Badlands National Park, South Dakota.

During the 10 years prior to this study, prairie dog towns had expanded in the park and on other federal, state, and private rangeland and farmland (Schenbeck 1982). Managers of parks and refuges sought to reduce the black-tailed prairie dog populations by applying rodenticides to diminish conflicts with rangeland users beyond their boundaries. However, this practice has not always been cost-effective (Collins et al. 1984). The rapid invasion of treated colonies by other immigrating prairie dogs is a major cause of failure of prairie dog control. If a source of immigrants is present, black-tailed prairie dogs can regain their initial population numbers within 1 to 3 years following the application of rodenticide to the town (Knowles 1985). Elimination of immigrant individuals that take up residence in vacant burrows of the treated colony must be accomplished before control programs can be successful. Information is needed that can identify the origin, demography, and behavior of prairie dogs that reinhabit a colony after application of rodenticides. Our study focused on the demography of immigrant populations of black-tailed prairie dogs that formed after rodenticide treatment of the original population. The objective in this study was to determine differences in sex and age-class distributions between resident and immigrant populations.

STUDY AREA AND METHODS

The study was conducted during three summer field seasons from 1981 to 1983 on a colony northwest of the edge of the Robert's prairie dog town in Badlands National Park, southwestern South Dakota. The area received approximately 40 cm of precipitation annually, most of which fell between early April and mid-July during intense, patchy thunderstorms. The mean temperature was 10 C, ranging from −5 C in January to 26 C in July.

Soils in the study area were deep, sandy-loam sediments interspersed with thin layers of sand and gravel from former stream beds. Topography of the area was gently rolling, mixed-grass prairie. Dominant plant species were western wheatgrass (*Agropyron smithii*), buffalograss (*Buchloe dactyloides*), needle-and-thread grass (*Stipa comata*), blue grama (*Bouteloua gracilis*), Patagonia Indian-

wheat (*Plantago patagonica*), and prostrate vervain (*Verbena bracteata*).

A 12-ha segment of the colony that bordered uncolonized grassland was used. The northern 6 ha of the site was chosen for rodenticide treatment; the remaining 6 ha was left untreated. Since black-tailed prairie dogs are highly territorial, rarely leaving the boundaries of their territories to forage (King 1955), the treated and untreated zones were purposefully set out adjacently to determine if individuals from the untreated half would abandon their territories to occupy the nearby vacant burrows or expand their territories into the treated side of the colony. We trapped the population on this site before beginning treatment to determine the original demography of the resident colony and to test for heterogeneity of the population due only to the location of the zones proposed to be treated or left untreated. Rodenticide (2% zinc phosphide coated grain) was applied to the treated 6 ha after pretreatment grain was applied according to published recommendations (Tietjan 1976). Rodenticide was placed on all burrow mounds during the last week of August 1981 and 1982. The control site was left untreated. Thus, population samples of prairie dogs in the treated zone in both 1982 and 1983 were newly arrived immigrants, while a continuous population of residents was concurrently monitored in the untreated zone.

All prairie dogs were trapped and marked during the first week in June and third week in August 1982 and 1983. We trapped in two sessions to avoid missing individuals that were difficult to trap or had not yet immigrated. Prairie dogs were trapped using 52 Tomahawk 32-inch live-traps (no. 206) baited with commercial sweet chop, a molasses-coated mixture of cracked corn, rolled barley, and rolled oats. All animals were toe-clipped for identification and then released. Prairie dogs were classed as adults (> 1 yr), yearlings, or juveniles, based upon their condition, size, weight, and previous record of capture.

We addressed differences between immigrants and residents with the null hypothesis that the resulting population was demographically undisturbed by treatment and immigration; we expected the population to be homogeneous. Observed sex ratios, the distribution of age classes by sex, and adult to yearling ratios by sex of the newly arrived immigrant subpopulation were tested against the distribution of the untreated, continuously growing subpopulation in contingency tables with fixed-row and column values. Expected cell frequencies were generated and assumed to be the expected discrete distribution for test of population homogeneity using the chi-square statistic ($\alpha = 0.05$). An analysis was performed separately for 1982 and 1983 observed populations. The chi-square statistic was used, as well, to determine significance of *a posteriori* differences observed between the immigrants and residents.

Though an intensive effort was mounted to trap all individuals by selectively situating traps, it became obvious that some animals were not captured. We assumed that this untrapped portion of the population was small and not confined to any particular age class or sex. We also assumed that marking and trapping of the animals did not influence their dispersal behavior.

RESULTS AND DISCUSSION

Before zinc phosphide was applied, a total of 76 individuals were captured during summer 1981 (Table 1) in the zone reserved for future rodenticide treatment. Only 55 prairie dogs were captured during the same period in the adjacent part of the colony, which would remain untreated. This population was statistically homogeneous, though there were noteworthy differences between the spatially segregated subpopulations that were not statistically significant at the chosen alpha-level. The population sex ratio in the future treated zone was 1.30:1, and that observed in the future untreated zone was 0.72:1 ($X^2 = 2.78$, 1 d.f., $P = 0.10$). The juvenile sex ratio (male:female) in the future treated zone was 1.63:1, and that observed in the future untreated zone was 0.82:1 ($X^2 = 2.59$, 1 d.f., $P = 0.11$). The pretreatment age classes by sex distributions for the zonal subpopulations were not statistically different ($X^2 = 4.00$, 5 d.f., $P = 0.54$), although the number of animals on the treatment site was substantially greater than on the untreated. Application of zinc phosphide in 1981 eliminated 98.7% of the marked prairie dogs in the treatment site and 100% in 1982.

The distribution of animals into categories by age class and sex (Table 2) showed the

TABLE 1. Age-class distribution by sex of pretreatment black-tailed prairie dog subpopulations.

Pretreatment populations (1981):						
	Future treated zone			Future untreated zone		
Age class	Males	Females	Total	Males	Females	Total
Adults	9	11	20	4	8	12
Yearlings	3	3	6	1	2	3
Juveniles	31	19	50	18	22	40
	43	33	76	23	32	55

TABLE 2. Age-class distribution by sex of posttreatment black-tailed prairie dog subpopulations.

Posttreatment populations (June–August 1982 and 1983):						
	Immigrants			Residents		
Age class	Males	Females	Total	Males	Females	Total
1982:						
Adults	5	2	7	6	11	17
Yearlings	8	11	19	3	4	7
Juveniles	0	0	0	20	15	35
	13	13	26	29	30	59
1983:						
Adults	3	2	5	5	13	18
Yearlings	8	6	14	3	5	8
Juveniles	0	0	0	22	20	42
	11	8	19	30	38	68

resultant population was not homogeneous during either posttreatment year (1982: $X^2 = 40.09$, 5 d.f., P < 0.01; 1983: $X^2 = 37.10$, 5 d.f., P < 0.01). There were more yearling females and yearling males than expected on treated sites. Garrett and Franklin (1982) reported a high percentage of yearling males (91%) in the male intercolony immigrant population in Wind Cave National Park, South Dakota. However, their study of intercolony dispersal showed that 57% of the female prairie dogs captured were adults (Garrett and Franklin identified two-year-olds, and > two-year-olds), which differed strongly from our findings; only 15% were adults during 1982, 25% during 1983. It should be noted that, while Garrett and Franklin studied only long-distance intercolony dispersal of black-tailed prairie dogs, both intracolony immigration and short-distance intercolony dispersal were possible from two nearby colonies (Robert's and Hocking's dog towns). Of 64 immigrants captured in two years, only 5 previously marked immigrants (3 males, 2 females) were caught; 4 came from the adjacent untreated site (2 males, 2 females), and 1 male arrived from Hocking's dog town, less than 1 km from the edge of the study colony.

There was no observed reproductive success during either 1982 or 1983 among the newly established populations of prairie dogs on the treated site. This suggests that female black-tailed prairie dogs disperse after the mating season and do not bear young during their first year in a newly established territory. If this observation can be generalized to other populations, reports of females with juveniles directly following a control effort clearly indicate a failure to eliminate animals rather than the immigration of other prairie dogs.

Nonlactating females accounted for a greater proportion of the immigrant female subpopulation than expected (1982: $X^2 = 18.16$, 1 d.f., P < 0.01; 1983: $X^2 = 12.86$, 1 d.f., P < 0.01). Nonlactating females made up 100% (13/13) of the female immigrants in 1982 and 75% (6/8) in 1983. Nonlactating females on the control site made up only 11% (1/9) of the potentially reproductive population in 1982 and were not observed (0/12) in 1983. Because the majority of black-tailed prairie dogs in South Dakota are known to disperse between May and the early part of July (Garrett and Franklin 1982), well after their breeding season, dispersal in these individuals may

TABLE 3. Demographic ratios of prairie dogs during repeated trials on a colony where one side of the colony was treated with rodenticide (2% zinc phosphide) and a similar-sized zone was untreated. Prairie dogs in treated zones were first-year immigrants in both trials. Ratios were considered different at the $P < 0.05$ (2×2 contingency table, X^2, 1 d.f.).

Demographic ratios (x:1)	1982			1983		
	Immigrant	Resident	P	Immigrant	Resident	P
Population sex ratio	1.00	0.97	0.94	1.38	0.79	0.29
Adult sex ratio	2.50	0.55	0.11[A]	1.50	0.38	0.18[A]
Yearling sex ratio	0.73	0.75	0.97	1.33	0.60	0.38
Juvenile sex ratio	[B]	1.33	[B]	[B]	1.10	[B]
Adult males: yearling males	0.63	2.00	0.19[A]	0.38	1.70	0.12[A]
Adult females: yearling females	0.18	2.75	<0.01	0.33	2.60	0.02

[A]Non-significant P-value may be result of small sample size.
[B]No juveniles captured in treated site.

have been stimulated by their failure to reproduce. King (1955) reported that females immigrated after weaning juveniles, leaving territories to their young. This may be the case for some females, especially older individuals that are among populations of dispersers. However, Hoogland (1985) has demonstrated that the success of reproductive efforts of female prairie dogs may ultimately hinge upon defending nestling offspring from infanticidal females within the territory.

Two yearling females, captured within 25 m of each other as juveniles during August 1981 within the untreated zone, were recaptured as immigrants to the treated zone in June 1982. Both traveled over 400 m to their newly acquired territories. Both females showed no signs of having lactated during that season. By August 1982 one female had returned to her untreated natal territory. A similar instance of a returning immigrant was observed by Garrett (1982). In our study this same female again immigrated into the treated area in 1983. At the time of her second immigration, she showed signs of previous lactation.

Immigrants formed a transient subpopulation. In 1982 only 54% (14/26) of the immigrants were captured during both trapping sessions, compared to 73% (43/59) of the residents ($X^2 = 2.96$, 1 d.f., $P = 0.09$). Again in 1983 fewer immigrants, 47% (9/19), were captured in both sessions than were untreated animals, 68% (46/68), though the immigrant distribution was not significantly different from the expected ($X^2 = 2.63$, 1 d.f., $P = 0.11$). King (1955) also reported that during colony expansion newly established territories were occupied by highly unstable populations where many different adults were trapped over a short period of time.

The study adds to the evidence that marked demographic differences exist between resident, undisturbed black-tailed prairie dog populations and those of immigrants. We observed that nonreproductive females comprised a large proportion of the female immigrants each year. During our study female immigrants did not produce young in their new territories during the year in which they dispersed. Also, immigrants who seem to have settled into burrows are likely to "disappear" at a greater rate than expected. Clearly, the complexity in the nature of prairie dog dispersal is just one more factor that indicates the need for careful, intensive management of colonies in parks, refuges, and on grazed public land.

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