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POPULATION DYNAMICS AND EXPANSION RATES OF BLACK-TAILED PRAIRIE DOGS

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ABSTRACT: The purpose of this review is to describe population dynamics and annual rates of increase of black-tailed prairie dogs (Cynomys ludovicianus) and to determine annual expansion rates of uncontrolled populations. Their reproductive characteristics, including social behavior are examined as they relate to these factors.

In this analysis, the first step is to determine the average number of male and female prairie dogs of breeding age that are present at each burrow system before and after the reproductive cycle. From this determination the total number of prairie dogs is determined, based on the average density of active burrows for a specific geographic area.

Then specific natality and mortality rates are determined to establish the total population. These data are essential to management decisions regarding expansion of prairie dog colonies and related control programs.

INTRODUCTION

Wind Cave National Park (WCNP), South Dakota, is a typical area of black-tailed prairie dog habitat where no reductional control has been conducted for more than 20 years. Several studies of reproductive behavior and characteristics have recently been reported for colonies in WCNP (Garrett and Franklin 1981, 1983; Hoogland 1982). These reports provide the basic information from which prairie dog population dynamics with and without control can be modeled.

REPRODUCTIVE CHARACTERISTICS

Prairie dog colonies are made up of individual, closely related, territorial groups called "coteries" which occupy specific burrow systems. Closely associated colonies constitute aggregations of prairie dogs commonly referred to as "prairie dog towns" which occupy specific geographic areas.

In late February when breeding begins, each coterie generally consists of one adult male, two-to-four adult females, subadults (less than 2 years of age) and juveniles from litters of the previous year. Males do not begin breeding before 2 years of age; however, many females breed as subadults, but this is dependent upon an adequate nutritional plane and the presence of unrelated or distantly related adult males (Hoogland 1982, Garrett and Franklin 1983).

Currently available data indicate that juvenile females do not make a significant contribution to black-tailed prairie dog reproduction.

The gestation period for prairie dogs is approximately 34 days.

The young are born in the burrow, weaned, and first emerge above ground in May and June.

During this time period subadult males disperse from the natal coterie to other colonies or to adjacent areas and may cause expansion in areas of the original prairie dog town. Subadult females remain with the natal coterie; however, population increases also force many females to disperse. Dispersal frequently includes movements of several hundred yards to several miles, resulting in repopulation of old abandoned towns and/or establishment of new towns. In populations not subject to reductional control, the percentage of females that successfully produce litters is somewhat variable. Reproduction in adult females ranges from 56 to 100% (85.3% average) and 50 to 75% (61.7% average) in subadult females (Garrett and Franklin 1983). When both groups are combined, the average size of litters weaned is 3.8 young (range = 3 to 6) (Hansen et al. 1982).

Because the young are born and remain underground until weaned, limited data are available on prenatal mortality, natal litter size, and preweaning mortality. The literature in this regard includes one citation for a single prairie dog litter under laboratory conditions (Johnson 1927), and one citation of infanticide as a contributing factor to neonatal death loss (Hoogland 1985).

MORTALITY

Annual postweaning natural mortality rates for prairie dogs are also variable, but have been shown to average 23% for adults (19% females, 25% for males) and 44% for subadults and juveniles (Hansen et al. 1982). From these data, average mortality rates for all ages would be approximately 28.5%.

POPULATION CHARACTERISTICS

A basic population model for black-tailed prairie dogs not subject to control, similar to the one previously described, can be constructed from available data on reproduction, natality and mortality. In the following discussion, adults are considered to be animals greater than 2 full years of age, subadults are those animals between 1 and 2 years of age and juveniles are those animals less than 1 year of age.

At the beginning of the breeding season in February, a typical coterie is made up of adults, subadult females, and juveniles. The adult population has previously been characterized as one male and two-to-four females. Based upon this ratio, the subadult female population can be estimated by multiplying the average number of adult females by their reproductive success rates and litter sizes, and, in turn, multiplying the result by juvenile survival rates and percent females in the litter: (3 x 0.735 x 3.8 x 0.56 x 0.5 = 2.34). Therefore, the female subadult population would average two or three per coterie.

The juvenile population would equal the average number of female adults multiplied by the adult female reproductive success rate and litter size (3 x 0.853 x 3.8 = 9.7), plus the number of subadult females multiplied by the subadult reproductive success rate and litter size (2 x 0.585 x 0.617 x 3.8 = 2.7), or approximately 12 juveniles, multiplied by juvenile survival rate (0.56), or approximately 7. From these calculations, the total population structure of a coterie in February would consist of one adult male, three adult females, two subadult females and seven juveniles.

ANNUAL POPULATION INCREASES

Using the population structure estimates for the February breeding period, an estimate of the population size in early June can be determined. This time period would correspond with the emergence of weaned juveniles and represent the maximum population prior to the beginning of dispersal by subadult males. Utilizing the reproductive characteristics for adult and subadult females previously described, an additional 12 animals (juveniles) would be present, essentially doubling the original population. The end result is twice as many animals competing for the same limited space and food base as the original population.

DISPERSAL

As the population increases with each successive reproductive cycle, dispersal of the excess animals into surrounding areas is common for several reasons.

First, burrow systems have a limited amount of living space within them, and only provide adequate shelter and protection for a small number of animals.

Secondly, due to danger from predation, prairie dogs restrict their feeding to a limited area close to the burrow. Additionally, young prairie dogs attain near-adult size in a very short period of time, requiring a large supply of high-energy, high-protein food (Hansen et al. 1982). As this type of plant growth is not normally present in sufficient quantities in the central portion of prairie dog towns, especially in older towns, it becomes necessary for these animals to forage outwards from the towns.

Thirdly, prairie dogs seem to avoid in-breeding, even at the expense of not breeding at all (Hoogland 1982). However, the problem of in-breeding is normally prevented by excess family members relocating outward from the natal coterie. These animals may move to other coteries within the town, they may join other migrating individuals to form new coteries in abandoned burrow systems, or they may establish new burrow systems on the periphery of the town. In the study carried out by Hansen et al. (1982), the incidence of these three types of expansion was 11, 21, and 68%, respectively.

Studies in Wind Cave National Park reported by Coppock (1981) included prairie dog population and burrow densities in three different situations: (1) an "old" town site, first colonized in the late 1940s, poisoned out in 1953 and repopulated in 1967; (2) a "middle-aged" town which had been occupied since 1973; and (3) expansion areas which had been established since 1978 around these two town sites. Population densities for these three areas averaged 5.6, 10.4, and 12 prairie dogs per acre, respectively. Respective burrow densities for both active and inactive burrows in these same areas averaged 69.2, 95.6, and 101.6 per acre. Active burrows averaged 27.5, 73.2, and 94.8 per acre, respectively.

The burrow densities reported in the previous study are well above densities which ranged from 4.4 to 26.8 burrows per acre in Johnson and Campbell Counties, Wyoming, reported for black-tailed prairie dogs by Campbell and Clark (1981). The differences can be attributed to the lack of reductional control in Wind Cave National Park, in contrast to reductional control applied in the Johnson and Campbell Counties.

Population densities reported by Coppock (1981) bring up several points. First, after a prairie dog colony becomes established and the population increases, vegetation available on the site may not meet the population needs due to inadequate quality, quantity or palatability. This would require the animals to expand outwards into unoccupied areas, or to areas where the population is lower and vegetation less affected. Second, the study by Coppock was carried out during May. Sampling during this time period would quite likely result in an estimate that is considerably below the actual numbers present since young of the year would not yet have appeared above ground. If these young are added to the averages for adult and subadult populations, the true population might well be 50% or more above the number actually seen.

ENVIRONMENTAL EFFECTS

The effect of prairie dog infestations on the quantity and quality of vegetation available for use by livestock and herbivores should not be underestimated. The average daily forage intake by black-tailed prairie dogs is 88.6 grams, based on 35% dry matter content (Hansen and Gold 1977). This would amount to 32.3 kg (71.1 pounds) of forage per year. The average conversion factor for livestock (cattle and sheep) is 19 pounds of forage for each pound of red meat produced (Cook 1978). Therefore, the 71.1 pounds of feed represents a potential of 3.74 pounds of red meat which is not produced. A further reduction is caused by the loss of forage clipped off around burrows. In areas without control, major causes of prairie dog mortality are predation, disease, and accidents. Predation is partially reduced through environmental modification of the colony site. These modifications include clipping of all vegetation close to the burrow, and mounding dirt around the burrow entrance to provide a platform from which to observe approaching danger.

One nonlethal control method which has been suggested is deferred grazing by livestock (Snell and Hlavachick 1980). The theory behind this recommendation is that additional vegetation obstructs prairie dog view while providing more cover for mammalian predators, thus limiting expansion. This method may have some limited potential in areas of tall grass or other lush vegetation. However, in many areas of Wyoming, low levels of precipitation and limited plant growth do not permit tall vegetation to occur. As a consequence, deferred grazing does not provide an effective alternative to reductional control even if the theory were entirely accurate.

Also, because livestock production is based on annual forage availability and includes deferred grazing, this practice would demand much additional rangeland. For many livestock operations, particularly marginal economic units, the costs associated with loss of forage due to prairie dogs, or to deferment of grazing in the attempt to control them, would be severe.

In the study by Hansen and Gold (1977), the loss of forage by clipping and burrowing amounted to 35.1 pounds per prairie dog, which would mean a loss of 1.85 additional pounds of beef or lamb for each prairie dog present. Therefore, the potential loss of meat production would equal 5.59 pounds per prairie dog. It must be pointed out that not all of the herbage consumed or clipped by prairie dogs would necessarily be utilized by livestock. Hansen and Gold (1977) estimated a 64% similarity in forage preference between prairie dogs and cattle. The amount of vegetation lost due to clipping that might otherwise have been utilized by livestock, has apparently not been estimated and might differ according to the area sampled. However, if an assumption is made that the percentage of forage lost in this fashion is approximately the same as that consumed by prairie dogs, this would result in a combined reduction of 3.58 pounds of meat production per year for each prairie dog present. In a prairie dog town averaging 15 prairie dogs per acre, this would amount to a potential loss of 53.7 pounds of red meat per acre.

PRAIRIE DOG CONTROL

When control of prairie dogs is necessary, two interrelated factors must be considered: the time of year and the percent reduction needed to prevent a population increase. Three hypothetical situations are described here from population estimates previously developed. The population is assumed to be 100 prairie dogs at the beginning of breeding in February. The first example concerns a control program conducted during February or March, while the second and third deal with programs in late summer (September-October).

In a prairie dog town containing 100 individuals in February (prior to reproduction) which have not been subjected to control, all animals should be equally susceptible to a systematic population reduction program. Thus, if a 55% reduction is achieved, 4 adult males, 11 adult females, 7 subadult females and 25 juveniles would remain. Reproduction in March-June by those remaining would yield:

$$11 \times 0.853 \times 3.8 = 36 \text{ young from adult females}$$

$$7 \times 0.617 \times 3.8 = 16 \text{ young from subadult females}$$

$$+ \text{ original 47 individuals} = 99 \text{ present}$$

Therefore, it would be necessary to achieve a minimum of 55% yearly reduction simply to maintain the population at the prior level, excluding reinvasion of individuals from surrounding areas.

If this same town had not been subjected to reductional control, the original population would have increased to 219. To reduce it to the original population level of 100, would also require a 55% reduction, or the removal of 119 animals, versus 55 animals in the first example. This would mean a possible 214% increase in the initial control effort, plus a follow-up program the following spring (prior to breeding), to maintain the population at this level.

A program similar to the one described above would require a minimum initial reduction rate of 77% to avoid the need for reductional control again in the following February.

SUMMARY AND CONCLUSION

There is a frequent misunderstanding by persons involved with management decisions relating to control projects for black-tailed prairie dogs. This misunderstanding frequently leads to disappointment or dissatisfaction by managers following programs directed towards reducing population densities to manageable levels. In contrast, land managers frequently underestimate the annual expansion rate of black-tailed prairie dogs in uncontrolled populations.

Persons applying population reduction to black-tailed prairie dogs must recognize that unless a minimum of 77% control is achieved the first year, and if the remaining 23% are not removed, the potential for complete repopulation of the area to precontrol levels within 3 years is very probable.

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