MONITORING OF PRAIRIE DOGS ON BOULDER COUNTY OPEN SPACE

Submitted by
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Abstract

Visual counts were started in 2000 and continued in 2001 on three control and four relocation sites of prairie dogs in Boulder County. The mean visual count density of prairie dogs on the control sites at Platte/Centennial in June 2000 was 6.9 animals/acre, compared with an average of 3.0 animals/acre on the relocation sites post-translocation in summer and fall 2000. By March 2001, almost one year post-release, the densities on the experimental sites (3.7 animals/acre) approach those of the baseline sites (3.9 animals/acre) though there are great differences among sites. Because no reproduction had occurred in the interim and the translocation sites were all within 300 m of a natural colony, this increase on the relocation sites is due entirely to immigration. In 2001, six new translocation sites were developed, and 578 prairie dogs were released at these sites. In order to determine the extent to which marked, translocated prairie dogs disperse, simultaneous counts were conducted at the translocation sites and all nearby natural colonies. Fifty-four translocated, marked animals were found dispersed to nearby natural colonies. Whereas 1 – 25 % of translocated animals remained at the translocation site, 8.2 – 61 % were alive and accounted for when the marked animals that had dispersed to nearby natural colonies were included. In addition to dispersal to nearby existing colonies, predation (as noted from prairie dog bones in scats and the visible presence of predators such as coyotes and badgers as well as raptors) was also an important factor in the disappearance of marked, translocated prairie dogs. The recommendation is made that in subsequent relocation efforts, new "colonies" should be created at the periphery of existing colonies.

Introduction

This study describes the second year of black-tailed prairie dog (*Cynomys ludovicianus*) monitoring conducted in conjunction with relocation efforts directed by the Boulder County Parks and Open Space Department. In the first year, we followed and attempted to monitor 664 marked prairie dogs that were translocated to four sites in Boulder County, and also conducted baseline monitoring at one site (Platte-Centennial) with natural, existing colonies. This year, we continued to monitor the 2000 sites, and also monitored six new translocation sites (Figure 1). Although translocated prairie dogs prefer collapsed natural burrows to augured holes (Truett and Savage 1998), abandoned colonies are frequently not available and in this study it was necessary to dig "starter" burrows and insert nest boxes.

Translocation is a management tool that has been employed with varying success. Important factors include knowledge of habitat quality, number of animals released, reproductive traits, and duration of the program (Griffith et al. 1989). The purpose of this monitoring project is to work hand-in-hand with the County's prairie dog relocation efforts to provide some indication of the success of these efforts, and to help with recommendations for management in relation to relocation efforts in the future.

The general research question last year was how visual count densities and behavior at translocation sites compare with baseline sites of undisturbed natural colonies. A previous study had shown that translocated prairie dogs were more sensitive to human intrusion than are resident prairie dogs (Farrar et al. 1998). Persistence, or the continued presence of translocated prairie dogs at the site of translocation, has been a problem; after much effort is put into translocation of the animals, few were still present in subsequent counts (Meaney et al. 2001). Factors relating to persistence of translocated animals that we have evaluated include whether prairie dogs are held in confinement prior to release or released the day of capture; whether animals are released adjacent to existing colonies or are more isolated; and the extent of dispersal to adjacent colonies. Because relocation requests come in from the public and require quick response by County Open Space, it is not possible to have total control over experimental design parameters. Consequently, we tracked relocation efforts with these constraints. In 2000, we found that visual count densities were extremely low at relocation sites compared with control sites, and very few marked prairie dogs were found on the relocation sites, suggesting predation, dispersal, and/or mortality on site. Although the sample size was small, the data strongly suggested that maintaining animals in captivity was not effective. And we found that there were some behavioral differences in translocated versus resident prairie dogs, indicating a higher degree of disturbance in the former (Meaney et al. 2000).

This 2001 study reports on the continuation of monitoring at the baseline site, sampled at three locations (Platte-Centennial South, West, and Central), four translocation sites from 2000 (Rabbit Mountain, Coalton Trail, Mayhoffer Dead Cow, and Mayhoffer North) and six new 2001 translocation sites (Mesa East, Mesa West, Lindsey East, Lindsey West, Mesa Northwest, and Mesa Northeast). Because of the heavy losses of translocated prairie dogs in 2000, these last six sites and nearby natural colonies were monitored more intensively in an attempt to distinguish between losses due to predation versus losses due to dispersal.

Methods

Black-tailed prairie dog populations are amenable to density estimation by visual counts due to their diurnal activity patterns, large size, propensity to live in relatively well-defined social colonies and habit of clipping vegetation within the colony. Visual counts are a reliable and relatively rapid means of assessing density of prairie dog populations (Biggins et al. 1993; Fagerstone and Biggins 1986; Menkens et al 1990; Powell et al 1994; Dave Seery, personal communication) and are less labor intensive than mark-recapture techniques or counting plugged and reopened burrows. However, because prairie dogs are fossorial and not all aboveground simultaneously, an index of density associated with actual abundance, rather than an absolute density, must be calculated (Caughley 1977). Fagerstone and Biggins (1986) found that visual counts and mark-recapture density estimates of white-tailed prairie dogs (*C. leucurus*) were significantly correlated (r=0.95) and Knowles (1982) found that maximum visual counts of prairie dogs corresponded well with actual counts.

Since maximum counts of prairie dogs correspond well with population levels analysis can be straightforward as long as several assumptions are met and counts are made of entire colonies rather than by sampling. Spatial and temporal comparisons of relative abundances are valid if observability is the same for all trials and sites, there is demographic closure, there are no observer differences among sites and counts and double counts do not occur. If there are several sections per colony, then the sum of the maximum counts is used to obtain a colony count (Fagerstone and Biggins 1986; Menkens et al. 1990; Seery, personal communication). The maximum count made during any count period yields a minimum population estimate for that colony since it is likely that not all animals are above ground at the same time. The highest count for each colony is divided by the area of the colony to determine an index of density for the colony (individuals/ha). These two figures (minimum population estimate and density index) can be used to compare populations between colonies and among years within a colony.

An initial visit was made to each site in order to place stakes along the perimeter to define the count areas and to code GPS points in order to develop area measurements. Area was determined using program Maptech Terrain Navigator (coverage of Colorado Northcentral). The entire site was counted from one observation post. Sites were scanned with binoculars. Trained counters (field crew, volunteers, and student interns) sat in the observation spot for 15 minutes before starting the count, to minimize the effects of human disturbance.

Each site was counted for three consecutive days of good weather (no rain, wind <10 mph, temperature between 10 and 27 degrees Centigrade and cloud cover <75%) (Fagerstone and Biggins 1986, Powell et al. 1994, Tileston et al. 1966). In summer, visual counts started one-half hour after sunrise and continued until numbers began to decrease (approximately midmorning or 3.5 hours), or at the end of the day for 3.5 hours preceding sunset. In spring and fall the counts started later in the morning and earlier in the evening, and in winter they were conducted during mid-day. The goal is to count when the largest number of animals is likely to be above ground, which occurs during the cool part of the day in summer and during the warm part of the day in winter. Counts were taken at 15- minute intervals. There were two observers, if possible, per site and a site consisted of one plot. There were approximately 10-12 counts made per daily count period (morning or evening). All sites except Mayhoffer North had one observation post with a view of the whole count area. At Mayhoffer North, two observation posts were used with mutually exclusive view sheds. Counts for this site were summed. Counts were made in March, June, July, August, October, November, and December 2001.

Translocation counts were generally conducted within a week after removal of caps (Count 1), one month after cap removal (Count 2), and two months after cap removal (Count 3).

All translocations were made onto novel sites that had no evidence of prior prairie dog occupation, and therefore it was necessary to construct artificial burrows. Artificial burrows were created by digging a trench with a Ditch Witch (trenching machine) that angled down at 45 degrees to about 4 ft. into the ground. Four-inch diameter plastic ridged flexible pipe (drain tile) connected the surface to a wooden nest box, which was 24 x 8 x 10.5 inches. A one-half inch plastic air tube connected the nest box to air at ground level. These nest boxes had single entrances at Mesa West, Mesa East, Lindsay West, and Lindsay East. Because of concerns of summer temperatures being too high in the burrows, some of the nest boxes were constructed with double entrances for at Mesa Northwest and Mesa Northeast (these sites are also called Mesa Far Northwest and Mesa Far Northeast).

In 2001, animals were not held in captivity prior to release. Marking of all dogs was continued. In order to collect data on dispersal, we located all the adjacent natural colonies, determined the distance to them from the translocation site, and monitored these natural colonies simultaneously with the translocation counts for the presence of marked prairie dogs that had dispersed to there from the translocation sites.

Results and Discussion

The baseline site, Platte Centennial, was sampled at three locations: South, West, and Central (as was done in 2000). There was a decline in numbers and density of animals between June 2000, just after the birth pulse when population numbers are at their highest, and March 2001, when annual mortality including predation will have taken its toll. In June 2001, all three sites show an increase, although densities remain slightly lower than in June 2000 (Table 1). These data show the natural, baseline fluctuations that can be expected, and suggest that recruitment (births and immigration) was outpaced by population losses (predation and emigration) at this site during this time interval.

The four translocation sites for which we continued monitoring from 2000 are Mayhoffer Dead Cow, Rabbit Mountain, Coalton Trail, and Mayhoffer North (Table 1). Mayhoffer Dead Cow is not a good representative of the translocation sites. It is located immediately adjacent to a large natural colony that easily overwhelms any trends that might be due to translocation, and we combined the natural and translocation sites because so few animals remained at the translocation site. Because of this confounding factor, we will not include the counts for Mayhoffer Dead Cow in the following comparisons of the baseline and translocation sites.

The mean densities per acre at the three translocation sites (excluding Mayhoffer Dead Cow) were 3.0, 3.7, and 3.1 for post-translocation, March, and June, respectively. This compares with 6.9, 3.9, and 5.7, respectively, for Platte-Centennial (see table next page).

Mean prairie dog densities per acre on baseline and 2000 translocation sites. From Table 1.

Site	June 2000 or Post-translocation	March 2001	June 2001
Platte-Centennial	6.9 (June 2000)	3.9	5.7
Rabbit Mountain, Coalton Trail, and Mayhoffer North	3.0 (Post-translocation)	3.7 (range 0.4-5.9)	3.1

Whereas the baseline site has a higher density in June and then a decline by March, reflecting over-summer and –winter predation and other mortality, the translocation sites show a slight increase between post-translocation and March. The translocation sites show a return to the post-translocation densities by June 2001, whereas the baseline mean is lower in 2001 than in 2000. No reproduction could have occurred during that time interval. This difference may reflect changes in the number of prairie dogs that were surface-active; the first count was immediately post-translocation when time spent on the surface may be reduced. The difference may also reflect some immigration of prairie dogs to the translocation site. However, in South Dakota, most inter-colony dispersal occurred in late spring (Garrett and Franklin 1988).

In contrast, the March 2001 data do not show a notable difference between the three Platte Centennial sites and the three experimental sites (a mean of 3.9 animals/acre for the former and 3.7 animals/acre for the latter). Overall, this suggests that by one year post-release, densities at some translocation sites are approaching those of baseline sites. This is likely true for the Coalton Trail site, which is very close to Mayhoffer Dead Cow and has good soils. But it does not hold for Mayhoffer North, which is also fairly close to a natural colony but has relatively bad soils with many more large cobbles.

A total of 578 prairie dogs were translocated to six release sites with artificial burrows during summer and fall 2001. The number of animals released at each site, number of artificial burrows, distances to existing colonies, and counts are presented in Table 2. The counts conducted post-release are very low. Our own observations at the sites, combined with those provided by Boulder County Open Space, provide extremely useful indications of what occurs after translocation. Numerous coyote and badger scat were seen at Lindsay East, as well as direct observations of seven coyotes on site. At Lindsay West in August, seven marked prairie dogs were observed at the periphery of a natural colony about 360 m distant. These animals were an adult and two juveniles together at a newly-dug burrow, two juveniles together at another new burrow, and two separate adult males at two other new burrows. In addition seven other marked dogs were seen at the natural colony across the creek, at a distance of 250 m. One marked Lindsey prairie dog was seen at Mayhoffer Dead Cow, a distance of approximately 1.4 km. Other workers have seen similar movement; mean movement distance at Wind Cave National Park was 2.4 km (Garrett and Franklin 1988).

During translocation work at Mesa Northwest and Mesa Northeast, prairie dogs were observed leaving the site, moving to and establishing a peripheral burrow on an adjacent existing colony while coyotes were present. An adult male was observed moving north toward the ridge and did not return, and another marked adult male was seen at Mesa North (the 2000). At Mesa Northeast, four dogs ran south to the Mesa North release site while three coyotes hunted nearby. Two of these observations show translocated animals establishing burrows at the periphery of a natural colony, as was common in Wind Cave National park (Garrett and Franklin 1988).

In addition to these anecdotal observations we also monitored the nearby natural colonies for marked prairie dogs at the same time we made observational counts of the translocated colonies. We observed 54 of the translocated animals on nearby natural colonies (Table 3). By including these dispersed animals with the counts made on the translocated sites, we were able to document that 8 to 61 percent of the translocated prairie dogs were still alive two months post-release. At Mesa Northwest, for example, 99 animals were released, 25 animals were counted on site, and 35 marked animals from the site were counted at an adjacent natural colony; thus 25 percent had persisted at the site and 61 percent of the 99 animals were accounted for somewhere. In fact, more than half of the translocated animals dispersed. There are several possibilities to account for the remaining translocated animals that were not found: 1) the counts are all minimum counts and there may actually be more animals at either the translocation site and/or the natural colonies that simply have not been observed; 2) prairie dogs may have moved to other more distant natural colonies, some of which are about 1.5 km away (such as the serendipitous observation of a Lindsey animal at Mayhoffer Dead Cow, 1.4 km distant); 3) predation likely accounts for some of the "missing" animals. Coyotes, ferruginous hawks, red-tailed hawks, golden eagles, bald eagles, and badger have all been seen or their sign observed during monitoring counts; and 4) animals may have died in their burrows.

The original plan for this study had been to relocate prairie dogs onto experimental sites that were at a great enough distance to existing colonies that movement between colonies was not a confounding factor in evaluating success. Dispersal distances of prairie dogs between points of capture in South Dakota had an average distance of 2.4 km (Garrett and Franklin 1988) and it was not possible to find such isolated and appropriate areas within County Open Space lands. Another concern had been aggression between residents and newcomers placed adjacent to existing colonies (Hoogland 1979, 1995, 1996). However, the observations of the present study show that prairie dogs actively seek existing colonies and disperse to them from the translocation sites, and that dispersal to nearby existing colonies is an important factor in the disappearance of marked, translocated prairie dogs. It would be of interest to be able to address the question of persistence and reproduction of dispersing animals at the colonies to which they have moved.

Management Recommendations

Our first recommendation for future relocation efforts is to utilize existing colonies, and place translocated animals at the periphery of existing colonies, rather than attempting to locate isolated sites. Many of the environmental factors, such as soil type, soil moisture, slope, aspect, and vegetation that are important habitat factors for prairie dogs, are likely to be suitable at existing colonies as judged by the presence of the prairie dogs. And losses may be greatly reduced by a decline in the motivation to disperse across open prairie with the attendant increase in vulnerability to predation.

Although not directly related to the present study, we were made aware that prairie dogs were causing a problem because of their "intrusion" onto certain locations (private property owners, cemetery, etc.). Thus there ensues an ongoing and expensive effort to constantly remove the dogs from these sites. It appears that further research into the development of effective barriers would be useful. Barriers such as permanent native rock walls with an underlying fence of either metal flashing or woven wire to about 3 feet underground in combination with several rows of native shrubs may be effective. Although expensive at first, the costs may pale in comparison with ongoing relocation efforts that may at times be faced with the problem of no further available translocation sites.

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Table 1. Count numbers and densities per acre of prairie dogs at baseline and translocation sites in 2000 and 2001, Boulder County.

SITE (Size in acres)	# of Animals Released in 2000	2000 Counts; density (month)	2001 Counts; density March	2001 Counts; density (month)		Adjacent Colonies Present?
Platte Centennial – South[1] (12.97)	Natural Colony	124; 9.6 (June)	76; 5.8	95; 7.3 (June)		NA
Platte Centennial –West[1] (11.44)	Natural Colony	84; 7.3 (June)	31; 2.7	70; 6.1 (June)		NA
Platte Centennial – Central[1] (26.71)	Natural Colony	99; 3.7 (June)	89; 3.3	96; 3.6 (June)		NA
Mayhoffer Dead Cow[2] (28.09)	Translocated Colony 87	98; 3.5 (Sept.-Oct.)	107; 3.8	NA		Yes
Rabbit Mountain (13.17)	Translocated Colony 233	54; 4.1 (October)	62; 4.7	89; 6.5 (June)		Yes
Coalton Trail (6.10)	Translocated Colony 127	17; 2.8 (July)	36; 5.9	NA		Yes
Mayhoffer North (8.31)	Translocated Colony 217.	18; 2.2 (November)	3; 0.4	6; 0.7 (July)	12; 1.4 (Sep)	Yes Closest is 150 m away

[1] These are all sampling units that are part of the same larger colony.

[2] This site consisted of a small number of translocated animals released adjacent to a large, well- established natural colony. The counts are of the natural colony and the translocated colony combined.

Table 2. Translocation sites, number of animals released, number of burrows and entrance type they were released to, distances to nearby existing colonies, and 2001 counts from six relocation sites, Boulder County.

SITE (Size)	Number of Animals Released	Number of artificial burrows and entrance type	Distances to Existing Colonies (m)	2001 Counts (date)			Comments
				Count 1	Count 2	Count 3	
Mesa West	103	35 single entrance	799 952 336	5 (July)	3 (Aug)	3 (Sep)	Cows on site 7/31/01
Mesa East	103	29 single entrance	529 632	5 (July)	3 (Aug)	0 (Sep)	Cows on site 7/31/01
Lindsay West	96	34 single entrance	362 251 180	8 (Aug)	5 (Sep)	5 (Oct)	
Lindsay East	97	62 single entrance	542 240	20 (Sep 10)	5 (Sep 22)	5 (October)	Coyote and badger scat with prairie dog bones found on site
Mesa North West	99	60 single and double entrances	270 603 291 425	N/a	25 (Nov 11)	18 (Dec 18)	Because releases occurred continuously 1 wk counts were possible
Mesa North East	80	35 single and double entrances	478 345 256	N/a	12	0 (Dec 18)	Because releases occurred continuously 1 wk counts were possible

Note: Count 1 is at 1 week, Count 2 is at 1 month, and Count 3 is at 2 months post-cap removal.

Table 3. Prairie dog movements and persistence, 2000 and 2001.

Site	Number Released	2 Month Count	Number of Animals that Moved	Distances Moved	Persistence at Translocation Site after 2 months (%)	Percent Alive at 2 Months
Mayhoffer North (2000)	217	3	N/a		1%	N/a
Mesa West (2001)	103	3	N/a		3%	N/a
Mesa East (2001)	103	0	N/a		0	N/a
Lindsey West (2001)	96	5	8	362m and 1.4 km	5%	13.5%
Lindsey East (2001)	97	1	7	240m	1%	8.2%
Mesa Northwest (2001)	99	25	35	270m and 256m	25%	61% (1 month)
Mesa Northeast (2001)	80	14	4 (2 from Mesa NW)	478m and 345m	5%	23% (1 month)

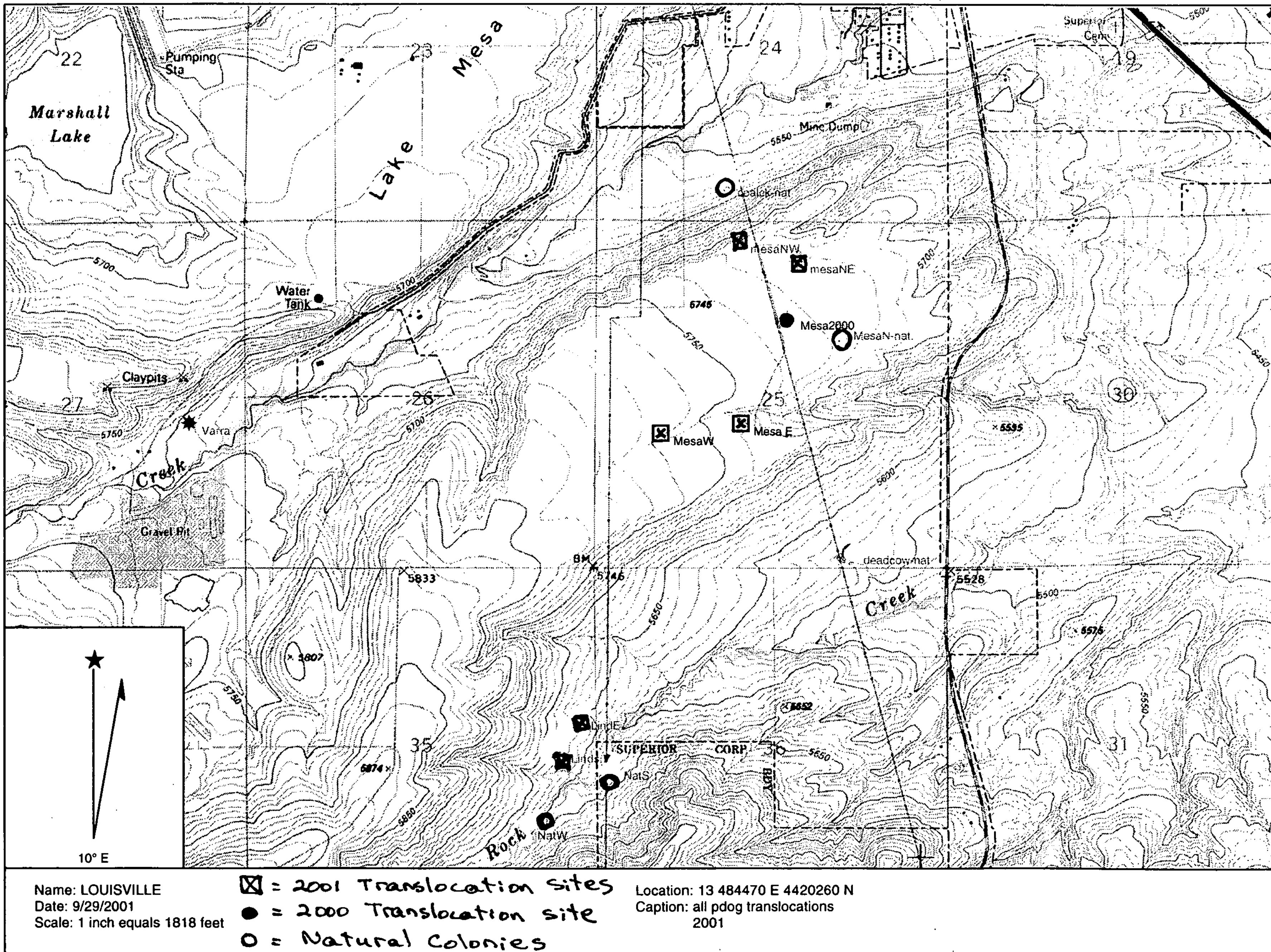

Figure 1. Location of six translocation sites from 2001, and the 2000 translocation sites and natural sites to which some of these prairie dogs dispersed, Boulder County, Colorado.

APPENDIX

Data Summary Table from Boulder County
Prairie Dog Releases
(prepared by Boulder County Open Space staff)

Data Summary for
2001 Boulder County Prairie Dog Relocation Project

	Mesa West	Mesa East	Lindsay West	Lindsay East	Mesa Northwest	Mesa Northeast
Trap Site	**Hirschfeld**	**James Construction**	**Colp (soil = NdD)**	**Colp (soil = NdD)**	**Colp, Lastoka, Keyes, Cemetery**	**Hillside**
Trap Start Date	6/5/01	6/11/01	7/9/01	7/30/01	10/1/01	9/29/01
Trap End Date	6/11/01	6/30/01	8/23/01	9/13/01	11/1/01	10/11/01
Total Estimated	64	85	193 for both		No complete estimate	No complete estimate
Total Trapped	103	103	96	97	99	80
Total Adults Trapped	39	33	30	29	40	74
Total Juveniles Trapped	64	70	66	68	59	6
Total AF to Lactating Females Trapped	20/17	20/12	12/1	14/0	15/0	WPM Data
Estimated Age of Juveniles At Trap Start	11 weeks	16 weeks	20 weeks	23 weeks	27 weeks	27 weeks
Release Site Size (m^2)	**TO BE DETERMINED**					
Number of Artificial Burrows	35	29	34	62	60 (29 single entrance,31 double entrance)	35 (14 single entrance, 21 double entrance)
Number of Coteries installed at release site	7	7	10	12	10	8
Coterie Pattern at Release site	Circle	Diamond shape	Diamond shape	Diamond shape w/ center burrow	Diamond shape w/ center burrow	Diamond shape w/ center burrow, both single and double entrance
Type of Burrow	Artifical with single opening	Artifical with single entrance	Artifical with single entrance	Artifical with single entrance	Artifical with both single and double entrance	Artifical with both single and double entrance
Number of Artificial Burrows per Coterie	3-6	2-9	3-4	4-8	3-7	2-5
Distance between burrows	8m	8m	8m	3m	2-4m	2-4m
Distance between Coteries	13m	15m	15m	5m	4-6m	3-8m
Dominant Vegetation at Release Site	Buffalo grass, scattered cheat grass, yucca and mixed herbaceous groundcover	Buffalo grass, scattered cheat grass, fringed sage, blue grama, yucca and mixed herbaceous	Western wheatgrass, buffalo grass and mixed herbaceous groundcover	Buffalo grass, western wheatgrass, cheat grass, toadflax, diffuse knapweed, yellow alysum, scattered sagewort, blue grama	Buffalo grass, , cheat grass, diffuse knapweed, scattered western wheatgrass, blue grama and fringed sage	Buffalo grass, western wheatgrass, cheat grass, diffuse knapweed, scattered yellow alysum, blue grama and yucca
Soil Type	VcC	VcC	VcC	VcC	VcC	VcC
Number of Caps	19	21	23	39	47	33
Average Number of Days in Cap	2	2	2	4	5	-
Minimum Number of Days in Cap	1	0	0	1	2	4
Maximum Number of Days in Cap	4	5	6	7	7	7
Average Number of Pdogs in Cap	5	5	4	3	2	3
Minimum Number of Pdogs in Cap	2	1	1	1	1	2
Maximum Number of Pdogs in Cap	11	10	9	4	3	4
Number of Mixed Coteries*	4	6	4	0	1	WPM Data
Number of Days from First Release to first New Burrow	1	11	2	-	2	WPM Data
Number of New burrows Found after First Release	2	2	2	15+	14	1
Total Number of New Burrows at end of Project	2	1	0	9	28	5
Maximum Number Pdogs seen 30 days after Release**	5/9	5/10	8/-	20/20	25/-	4/-
Maximum Number Pdogs seen 60 days after Release**	3/-	3/2	5/-	5/-	NC/-	NC/-
Maximum Number Pdogs seen 90 days after Release**	3/4	0/-	NC/-	5/5	NC/-	NC/-

Notes:

* Animals from different known coteries were put together in same box.

**, First number=data from Meaney's staff, second number=data from Boulder County staff, NC=not complete, - =data not collected

SOILS

VcC = Valmont Cobbly Clay (1-5% slopes)/ found on high terraces and outwash fans/ surface≈ 8" of cobbly caly loam or cobbly clay/ too many cobbles and too much gravel for cultivation

NdD = Nederland very cobbly sandy loam (2-12% slopes)/ found on outwash fans/ many stones and cobbles on the surface/ surface ≈ 4" of sandy loam w/ cobbles/ below that is sandy loam

SeE = Samsil-Shingle (5-25% slope)/ found in uplands/ ≈ 40% samsil soil (well-drained soils/ surface is calcareous clay ≈ 3" thick underlain by ≈ 9" of clay) and ≈ 40% shingle (shallow, well-drained soils. The surface is ≈ 4" loam underlain by ≈ 9" loam)

KuD = Kutch clay loam (3-9% slopes)/ moderately deep, well-drained soils

NuB = Nunn Clay loam (1-3% slopes)/ deep well drained soils on terraces and valley side slopes in loamy alluvium

CaB = Calkens sandy loam (1-3% slopes)/ stream terraces and bottoms/ deep soils formed in loamy alluvium on low terraces and bottom lands

VcE = Valmont cobbly clay loam (5-25% slopes)/ on side slopes of high terraces or outwash fans/surface ≈ 6" cobbly clay loam/ below ≈ 12" of clay loam

Natural colonies & soil type

Lindsey = SeE and Te

Coal Creek = KuD, NuB and CaB with some Te

Dead Cow = NuB with some VcE

Mesa North = Te and VcC

Platte-Centennial = Te and VcC