First Year Study of the Impact of Trails on Small Mammals on City of Boulder Open Space

Carron Meaney

4470

DRAFT

Preliminary Results: First Year Study of the Impact of Trails on Small Mammals on City of Boulder Open Space

Carron A. Meaney,
Denver Museum of Natural History and
University of Colorado Museum

With Norman W. Clippinger, Alison Deans, and Melissa Rider

For Greenways Program,
City of Boulder Transportation Department

3 February 1998

SUMMARY

This report outlines the results from the first year of a three year study of the impact of trails on small mammals. We studied the impact of trails on small mammal relative abundance, species richness, and species diversity in areas with Low, Medium, and High trail density along South Boulder Creek. We also evaluated the presence and relative abundance of Preble's meadow jumping mice at the different trail densities and along East Boulder Ditch. Relative abundance of small mammals did show a consistent pattern of decrease from Low to High trail density. Species richness and diversity did not show any clear patterns. The effect of limited grazing in December, January, and February at this site appears not to have a negative impact on jumping mice. Although sample sizes are small, there is, surprisingly, suggestive evidence that trails did not have a negative impact on jumping mice presence and abundance. However, additional data are needed and we wish to underscore the potential problems in drawing conclusions from these small sample sizes. Jumping mice were found in reasonable numbers at a distance of 75 m from the creek, a fact that will need to be taken into consideration in conservation and management plans for the species, at least in areas with broad flood plains such as South Boulder Creek.

Introduction

Many people who live in Colorado do so because they love the out-of-doors. Open spaces are seen as vistas of natural beauty with plenty of room for both wildlife and human enjoyment. In recent times, however, human populations have increased drastically. At the same time, there has been an increase in outdoor recreational activities (Flather and Cordell 1995) and a decrease in available open landscapes as development proceeds. As human populations increase and open lands become more scarce, wildlife is squeezed into increasingly smaller areas. Consequently, there is a strong motivation to optimize use of existing open spaces for both recreation and wildlife.

A problem arises in riparian habitats that have trails. Riparian corridors provide important habitat to a diverse array of wildlife species, and are also enjoyed by humans for a number of different recreational uses, including hiking, cycling, bird-watching, jogging, and dog-exercising (Bekoff and Meaney 1997). We do not know what the impact of this use may be on small mammals.

A motivating factor for the present study was the known presence of Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a small mammal that has been proposed for listing as an endangered species by the U.S. Fish and Wildlife Service (62 FR 14093, March 25, 1997), on City of Boulder Open Space where a bike trail was being completed in the spring of 1997. This mouse occurs only in Colorado and Wyoming. Probably a Pleistocene relict, Preble's meadow jumping mouse previously enjoyed a wider distribution in tallgrass prairie across the eastern plains of these two states (Fitzgerald et al. 1994). Destruction of wetland areas, development along riparian areas, grazing, and gravel-mining, probably have all had a detrimental effect on their populations. As a consequence, this small mammal has become rare. Elsewhere in North America, other subspecies of meadow jumping mice are broadly distributed (Hall 1981) and populations are relatively larger.

The preferred habitat of this mouse is moist lowlands with dense vegetation, such as abandoned grassy fields, thick vegetation along ponds, streams, and marshes, and the rank herbaceous vegetation of wooded areas. In Colorado, *Z. h. preblei* shows an affinity for complex riparian communities with shrub (both tall and short), tree, grass, and forb species

habitat, and that movement along this ditch contiguous with South Boulder Creek was likely important to populations of jumping mice. As a consequence, rather than using a culvert, the Transportation Department opted to construct a bridge over the ditch, to allow passage of the two trails (Bobolink Trail and the new bike trail) over the ditch with as little interruption to the ditch corridor as possible. It was felt that any reduction or mitigation of habitat fragmentation would be a positive factor for this rare mouse.

There are solutions to the problems caused by recreationists to wildlife. For example, bald eagles are flushed from nests by human activity. However, appropriate viewing distances can be determined at which the eagles do not leave the nest (Fraser et al. 1985). Although the details of optimal human/wildlife sharing of open spaces may not always be immediately apparent, the success of managing wildlife in these areas will be dependent on an understanding of the specific wildlife species and populations being managed (Knight and Temple 1995).

Purpose

The purpose of this project is to address the question of whether trails have an impact on small mammals by comparing small mammal relative abundance (captures per 100 trap nights), species richness (number of species), and diversity (number and evenness of species), in areas with different trail densities. The null hypothesis is that there will be no effect due to trails on small mammal relative abundance, species richness, and diversity.

We are also interested in the potential impact of trails on meadow jumping mice, as measured by presence/absence and relative abundance. The null hypothesis is that trails have no effect on jumping mouse presence and relative abundance; the alternative hypothesis is that the presence of trails will reduce the presence and relative abundance of jumping mice. In addition, we will evaluate two other aspects of jumping mouse behavior: 1) the extent to which jumping mice use the underpass corridor along East Boulder Ditch, where a culvert was replaced with a bridge to facilitate movement of mice under the bridge in continuous dense vegetation, and 2) whether jumping mice traverse the existing trails.

Study Site

South Boulder Creek heads in the mountains west of Boulder; in the foothills it has been dammed to form Gross Reservoir from which it also emerges. Once down in Boulder it forms a broad floodplain. The vegetation is well-developed with shrubs and some cottonwoods along the creek, and diverse forbs and lush grasslands occur out from the creekbed as well as numerous wetlands. A number of ditches conduct water away from the creek for irrigation purposes. A large headgate is located by South Boulder Road; it draws water off into Dry Creek Ditch which fills Baseline Reservoir. A smaller ditch, East Boulder Ditch, draws water from the creek at the north end of the site.

The City of Boulder Open Space properties along South Boulder Creek between Baseline Road and South Boulder Road provide an ideal site to study small mammals in areas with low, medium, and high trail densities. A bridge crossing South Boulder Creek by the East Boulder Community Center divides the area into cardinal quadrants. The northwest quadrant has no trails and is the Low trail density unit; the southeast quadrant, with the Bobolink Trail running adjacent to the creek is the Medium trail density unit; and the northeast quadrant, with both the Bobolink Trail and the new bike trail generally running parallel to each other, is the High density trail unit (Figure 1). Thus the comparisons are between units with no trail, one trail, and two trails. The 3.5 m (10 ft) wide bike trail is

We noted the sex and age of small mammals and marked them with permanent marker for recognition of recaptures. Jumping mice were marked individually to facilitate determination of movement patterns: We marked them with a combination of ear punches (up to two on an ear), toe clips, and/or Passive Integrated Transponder (PIT) tags. PIT tags are electromagnetic, glass-encased tags that are inserted under the skin on the back. These tags emit a passive signal that is decoded by a hand-held reader similar to those in supermarkets that read bar codes. We purchased Destron-Fearing PIT tags and a mini portable reader from Biomark of Boise, Idaho. We used tags with a scanner exciter frequency of 125 kHz. As required by the Colorado Division of Wildlife, genetic tissue samples were collected from jumping mice in the form of ear punches and/or toe clips. Individuals from which tissues were collected were assigned numbers BOS2 to BOS25 (BOS = Boulder Open Space). Prior to the arrival of the PIT tags, the ear punches and toe clips also served to mark individuals.

Relative abundance was calculated as the number of individuals captured in 100 trap nights. Species richness is a simple measure of the number of different species captured on a particular unit. Species diversity can be thought of as a measure of species evenness. It was calculated by the formula developed by Shannon, as reported in Zar (1996):

$$H' = - \sum p_i \log p_i$$

where p_i is the proportion of the total number of individuals represented by species *i*. Unidentified voles were assigned to meadow or prairie vole in proportion to their representation either on the trail density units (3:1, for the two species, respectively) or on Transects 10 and 11 (49:1, respectively).

The non-parametric Kruksal-Wallis test was used to compare vegetational cover across trail density units at a given transect distance from the creek (A, B, or C). No other statistical tests were applied due to small sample sizes.

We had also proposed to use fluorescent pigment dyes to address the extent to which jumping mice in the vicinity of trails will cross them. These powdered pigments are applied to the mouse, which then leaves a trail that can be followed at night with a black light. We spent one week using the fluorescent powders on the jumping mice and following the trails at night. We were able to follow the trails only one meter or so before they were lost or ended at the ditch bank, indicating that the animal had jumped into the water. We abandoned this technique after determining that this effort was not productive in the very dense and tall vegetation characteristic of East Boulder Ditch, and would be more successful where it has been used previously, in open habitats such as desert and short-grass prairie ecosystems.

Results

The analysis of vegetation plots shows what we saw visually in the field: For the most part, transects A were similar to each other, transects B were similar to each other, and transects C were similar to each other (Table 1). Trees and shrubs presented the highest percent canopy cover at Transects A, grasses dominated at Transects C, and forbs predominated at Transects B. We used the Kruskal-Wallis statistic to test for significant differences across Low, Medium, and High trail densities at transects A, B, and C. None of the tests showed significant differences, except for shrub cover on the C transects. This was due to the fact that shrub cover in one vegetation plot on one of the C transects was 50 percent due entirely to a patch of young, short, even-growth wild rose (*Rosa arkansana*), which is categorized as a shrub because of its woody stems. We did not feel that this high

Species diversity was highest in the Low trail density units in both July and August (0.60 and 0.60); however, High trail density also had high species diversity, 0.58 and 0.53 for July and August, respectively. Medium trail density had lower values (0.43 and 0.44, respectively). Transects 10 and 11 also had low values (0.44 and 0.36) due to the prevalence of meadow voles and meadow jumping mice.

A total of 55 individual Preble's meadow jumping mice were captured; 32 were PIT-tagged, 14 were marked by ear-punches and/or toe clips, 6 individuals were not marked permanently, and 3 individuals escaped. Appendix A and B show the date of capture, transect, trap, age, sex, reproductive condition, weight, measurements, and markings for these individuals. There were delays in the arrival of the PIT tags due to a United Parcel Service strike, and we ran out of the first batch of tags due to the surprisingly large numbers of jumping mice. Consequently, we did not have tags available at all times. On a few occasions, capture rates were so high that we decided not to take the time to mark individuals in a desire to ensure that we were able to attend to all the traps before any individuals succumbed to the summer heat. One jumping mouse did die of heat stress when high capture rates slowed down our morning trap-checking procedures. It was immediately frozen and subsequently deposited at the Denver Museum of Natural History.

Table 6 shows the 52 meadow jumping mice that we handled and the dates and locations on which they were recaptured. Recaptures were usually within one to seven traps of the previous capture location, and up to 14 traps distant. Eleven individuals were captured twice, seven individuals were captured three times, two individuals were captured four times, and one individual was captured five times. Movement between transects was minimal, and there is no indication of trail crossing. One individual (BOS 19) was captured on Transect 10 and recaptured on Transect A High, indicating that it crossed the ditch but not the trail. We did observe jumping mice swim across East Boulder Ditch after their release on a number of occasions. Another individual (4104752C29) was captured on Transect A High and moved to Transect B High; it may have crossed the trail twice or not at all. Another individual (41045B2349) went from Transect B Low to Transect A Low. Movement between Transects 10 and 11 was not uncommon, but these movements never involved crossing the bridge along East Boulder Ditch.

Discussion

Although sample sizes are small, the comparisons of percent cover for trees, shrubs, grasses, and forbs do suggest that the transects within 5 m of the creek (Transects A) are each similar; the transects between 25-50 m of the creek (Transects B) are each similar; and the transects at 75 m from the creek (Transects C) are each similar. This agrees with our observations in the field, and supports our contention that the Low, Medium, and High trail density units are similar in their patterns of vegetative cover at the differing distances from the creek. Additional data will be collected in subsequent years. Species richness of the vegetation was not remarkable. There were relatively few species of trees and shrubs on all but one of the 27 plots. Grasses were represented by two to five species, and forb species richness spanned a range of zero to greater than seven species.

The five-fold higher overall abundance of small mammals in August compared with July is probably due to the addition of young to the population. Although the proportion of juveniles and subadults were similar in the two months (45 percent in July and 46 percent in August), we presume that by August some of the young from earlier litters have reached adulthood and have themselves produced young.

al. 1997), the diverse vegetative structure, and the overall lushness of vegetation at the site are contributing factors.

The effect of very limited grazing (December through February) at this site appears not to have a negative impact on the abundance of jumping mice, as judged from Transects 10 and 11, which are almost entirely located in the area that is grazed. Transects C, all of which are grazed, had 67 percent of jumping mouse captures on Low trail density and 22 percent of the captured individuals on High trail density (Table 3). Thus jumping mice were very much in evidence at a distance of 75 m from the creek, notable in light of the fact that these animals are generally found immediately adjacent to creeks (the equivalent of Transects A) (Bakeman 1997).

The present grazing regime started around 1990. Prior to that, grazing was heavy and year around, and the pasture was denuded (Mark Grundy, personal communication). The intervening years have clearly seen a comeback in vegetation, and probably also jumping mice. The limited grazing regime used at this site seems entirely compatible with conservation and management of jumping mice. The limited consumption of vegetation and the fact that the grazing occurs when jumping mice are hibernating are contributing factors to the success of this regime.

There is no evidence that jumping mice crossed under the bridge over East Boulder Ditch. Nor is there any evidence of their crossing any of the trails. However, it is quite possible that crossings of either bridge or tail occurred by unmarked mice. Additional data from subsequent years will help discern the degree of reluctance of jumping mice to cross trails, and will hopefully show evidence of use of the East Boulder Ditch corridor under the bridge.

References

Anderson, S.H. 1995. Recreational disturbance and wildlife populations. Pp. 157-168 *in* Wildlife and recreationists: coexistence through management and research. R.L. Knight and K.J. Gutzwiller, eds. Island Press, Washington, D.C. 372 pp.

Bakeman, M. E., editor. 1997. Report on habitat findings of the Preble's meadow jumping mouse. Processed report to U. S. Fish and Wildlife Service and Colorado Division of Wildlife, iv + 91 pp.

Bekoff, M., and C.A. Meaney. 1997. Interactions among dogs, people, and the environment in Boulder, Colorado: a case study. Anthrozoos, 10(1):23-31.

Boarman, W.J., and M. Sazaki. 1996. Highway mortality in desert tortoises and small vertebrates: success of barrier fences and culverts. Pp. 1-5 *in* Highways and movement of wildlife: improving habitat connections and wildlife passageways across highway corridors. G. Evink, D. Ziegler, P. Garrett, and J. Berry, eds. Proceedings of the Florida Department of Transportation/Federal Highway Administration, Transportation-Related Wildlife Mortality Seminar, Orlando, Florida, April 30-May 2, 1996.

Boyle, S.A., and F. B. Samson. 1985. Effects of non-consumptive recreation on wildlife: a review. Wildl. Soc. Bull., 13:110-116.

Brittingham, M.C. and S.A. Temple. 1983. Have cowbirds caused forest birds to decline? BioScience 33:31-35.

Meserve, P.L. 1971. Population ecology of the prairie vole, *Microtus ochrogaster*, in the western mixed prairie of Nebraska. American Midland Naturalist, 86:417-433.

Miller, C.K. 1994. Environmental impacts of passive recreational trails in riparian areas. Proceedings of the 6th Annual Colorado Riparian Association Conference. 12 pp.

Miller, J.R., N.T. Hobbs, J.A. Wiens. 1997. Avian diversity and predator assemblages in lowland riparian areas across a gradient of urbanization. A final report to the City of Boulder Open Space Department.

Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. the effects of roads on populations of small mammals. Journal Applied Ecology, 11:51-59.

Paton, P.W.C. 1994. The effect of edge on avian nests success: how strong is the evidence? Conservation Biology, 8:17-26.

Robinson, S.K. 1988. Reappraisal of the costs and benefits of habitat heterogeneity for nongame wildlife. Transactions of the North American Wildlife and Natural Resources Conference, 53:145-155.

Ryon, T.R. 1996. Evaluation of historical capture sites of the Preble's meadow jumping mouse in Colorado. M.S.E.S. Thesis, University of Colorado, Denver.

Shenk, T. 1998. Conservation assessment and preliminary conservation strategy for Preble's meadow jumping mouse (*Zapus hudsonius preblei*). Colorado Division of Wildlife, unpublished report.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management, 47 (4):893-901.

Swihart, R.K., and N.A. Slade. 1984. Road crossing in *Sigmodon hispidus* and *Microtus ochrogaster*. Journal of Mammalogy, 65 (2):357-360.

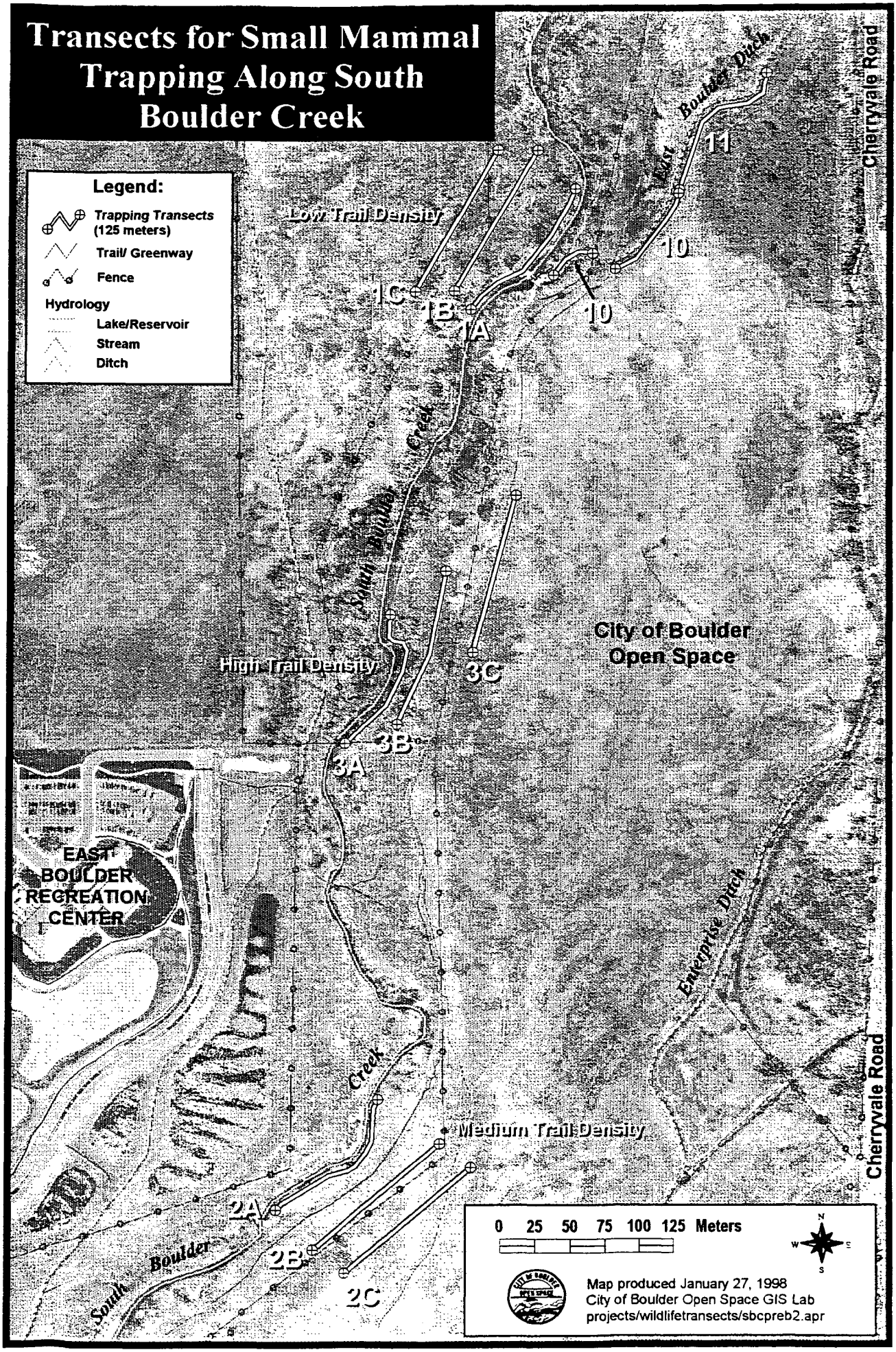
Weber, S.E. 1995. Life on the edge: small mammal and vegetation community response to trail-induced ecotones in southern California chaparral. Abstract, 9th Annual meeting of the Society for Conservation Biology, Colorado State University, June 7-11, 1995.

Wilcove, D. 1985. Nest predation in forest tracts and the decline of migratory songbirds. Ecology 66:1211-1214.

Zar, J.H. 1996. Biostatistical Analysis. Prentice Hall, New Jersey.

Acknowledgments

We wish to thank Cary Richardson, Mark Grundy, Todd Kipfer and others of the City of Boulder Open Space Department for their assistance with the loan of traps, construction of signs, discussions about the present and historic land use at the site, and GIS support. Carol Kampert, Barbara Spagnuolo, Allison Jones, and Jason Mulvihill-Kuntz were a great help in the field. Thanks to Cheri Jones, Ron Beane, and Michael Grant for discussions about the scope and design of the project. David Armstrong kindly reviewed an earlier draft of the report. A very special thank you to Gary Lacy of the Greenways Program for funding the project.


Transects for Small Mammal Trapping Along South Boulder Creek
Legend:
Trapping Transects (125 meters)
Trail/ Greenway
Fence
Hydrology
Lake/Reservoir
Stream
Ditch
Low Trail Density
High Trail Density
Medium Trail Density
1C
1B
1A
1D
1E
2A
2B
2C
3C
3B
3A
East Boulder Ditch
Cherryvale Road
South Boulder Creek
Boulder Creek
Enterprise Ditch
City of Boulder Open Space
EAST BOULDER RECREATION CENTER
0 25 50 75 100 125 Meters
N
W
E
S
Map produced January 27, 1998
City of Boulder Open Space GIS Lab
projects/wildlifetransects/sbcpreb2.apr

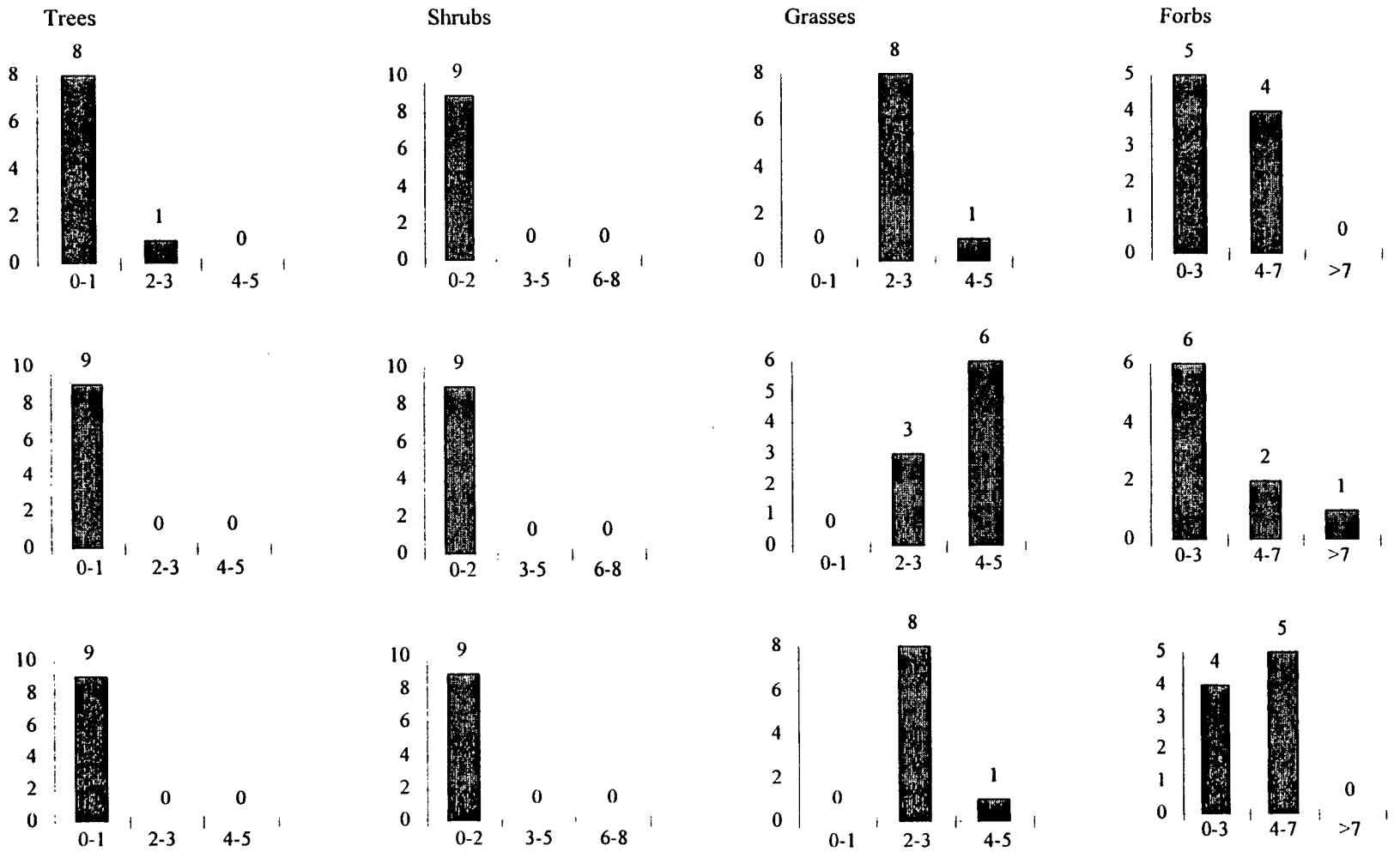


Figure 2. Frequency of vegetation plots across species richness categories for trees, shrubs, grasses, and forbs. The top row is Low trail density, the middle row is Medium trail density, and the bottom row is High trail density. The horizontal axis is the number of species and the vertical axis is the number of plots.

Table 1. Percent cover of trees, shrubs, grasses, and forbs at Low, Medium, and High trail densities.

% Tree Canopy Cover

	Transect		
Trail Density	A	B	C
Low (n=3)	30.0	16.7	0
Medium (n=3)	20.0	0	0
High (n=3)	46.7	20.0	0
Probability	0.651	0.558	---
Kruskal-Wallis statistic	0.858	1.167	---

% Grass Cover

	Transect		
Trail Density	A	B	C
Low (n=3)	76.7	56.7	93.3
Medium (n=3)	90.0	86.7	90.0
High (n=3)	66.7	76.7	93.3
Probability	0.080	0.516	0.565
Kruskal-Wallis statistic	5.054	1.322	1.143

% Shrub Canopy Cover

	Transect		
Trail Density	A	B	C
Low (n=3)	26.7	10.0	10.0
Medium (n=3)	3.3	0	0
High (n=3)	40.0	6.7	*23.3 (6.7)
Probability	0.395	0.558	*0.030 (0.061)
Kruskal-Wallis statistic	1.859	1.167	*7.000(5.600)

% Forb Cover

	Transect		
Trail Density	A	B	C
Low (n=3)	23.3	33.3	6.7
Medium (n=3)	13.3	20.0	13.3
High (n=3)	30.0	43.3	10.0
Probability	0.097	0.499	0.264
Kruskal-Wallis statistic	4.667	1.390	2.667

* Values in parentheses calculated without wild rose in one plot. See text.

Table 3. Small Mammal Captures at Low, Medium, and High Trail Density Units in August, 1997. Recaptures in parentheses.

Species	LOW			MEDIUM			HIGH			TOTAL
	A	B	C	A	B	C	A	B	C	
Microtus ochrogaster										
Prairie vole	1	6	9	5	5	10	3	3	5	47 (3)
Microtus pennsylvanicus										
Meadow vole	8	24	17	29	9	5	15	15	10	132 (9)
Microtus species										
vole species	2	1		3	1	1				8 (1)
Mus musculus										
House mouse			4			1	2			7 (3)
Peromyscus maniculatus										
Deer mouse	10	7		8			3	1		29 (17)
Reithrodontomys megalotis										
Western harvest mouse								1		1
Spermophilus tridecemlineatus										
Thirteen-lined ground squirrel		1								1
Zapus hudsonius										
Meadow jumping mouse	1	4	10	1			6	1	2	25 (12)
Total	105			78			67			250 (45)

Table 5. Small mammal relative abundance (per 100 trap-nights), species richness, and species diversity across Low, Medium, and High trail densities in July and August. Transects 10 and 11 are also shown.

	July				August			
	Low	Medium	High	Transect 10	Low	Medium	High	Transects 10 & 11
Relative Abundance (Number Captures/100 trap-nights)	5.7	5.7	4.3	26.0	35.0	26.0	22.3	30.0
Species Richness	4	5	4	4	6	5	6	4
Species Diversity	0.60	0.43	0.58	0.44	0.60	0.44	0.53	0.36

Note: Samples based on 300 trap-nights for each trail density. Transects 10 and 11 based on 100 trap-nights each, and July data based on Transect 10 only.

Table 6 (continued). Individual Preble's meadow jumping mice and their capture dates and locations.

Tag number and markings	16-Jul	17-Jul	18-Jul	19-Aug	20-Aug	21-Aug	22-Aug
BOS7 Third left front toe missing. Adult female.		Transect 10 trap 20	Transect 10 trap 11				
BOS8 Fourth right front toe clipped. Adult male.		Transect 10 trap 19					
BOS9 Fourth left front toe clipped. Adult female.		Transect 10 trap 15					
BOS10 4104767316 Fifth right front toe clipped. Adult female.		Transect 10 trap 14		Transect 11 trap 22	Transect 11 trap 21	Transect 11 trap1	
BOS11 Fifth left front toe clipped. Adult female.		Transect 10 trap 11	Transect 10 trap 17				
BOS12 First right rear toe clipped. Adult male.		Transect 10 trap 10	Transect 10 trap 21				
BOS15 41045D6662 Second right front toe clipped. Adult female.			Transect 10 trap 19	Transect 10 trap 15			Transect 10 trap 22

Table 6 (continued). Individual Preble's meadow jumping mice and their capture dates and locations.

Tag number and markings	16-Jul	17-Jul	18-Jul	19-Aug	20-Aug	21-Aug	22-Aug
BOS23 4104632151 Adult male				Transect A Low trap 24			
BOS24 4104301245 Adult male				Transect B Low trap 9			
BOS25 4100707A0B Two plugs taken from each ear. Adult male				Transect C Low trap 22	Transect C Low trap 25		Transect C Low trap 21
4104752C29 Adult female				Transect A High trap 24		Transect A High trap 19	Transect B High trap 3
410458367D Juvenile female					Transect 10 trap 22		
4104597F75 Adult male					Transect A Med trap 15		Transect A Med trap 15
41045B2349 Subadult female					Transect B Low trap 7		Transect A Low trap 11
41045D2950 Adult male					Transect B Low trap 9		Transect B Low trap 3

Table 6 (continued). Individual Preble's meadow jumping mice and their capture dates and locations.

Tag number and markings	16-Jul	17-Jul	18-Jul	19-Aug	20-Aug	21-Aug	22-Aug
Blue mark on chest Adult female						Transect C Low trap 11	
Blue mark on chest Subadult male						Transect C Low trap 25	
Blue mark on chest male						Transect A High trap 16	
Blue mark on chest Subadult female						Transect B High trap 3	
No marking Adult female						Transect 10 trap 12	
No marking Adult female						Transect 10 trap 15	
Notch in left ear and blue mark on chest Adult male						Transect C Low trap 2	
Notch in right ear and blue mark on chest Adult male						Transect C High trap 1	
41004D070B Subadult female							Transect C Low trap 1

APPENDIX

Table A (contiinued). Captures of Preble's meadow jumping mice along South Boulder Creek and East Boulder Ditch in July, 1997.

Date	Unit and Transect	Trap	Age	Sex	Reproductive Condition	Weight (g)	Measurements (mm) head&body-tail-hind foot	Marked	Tag Number and markings
17 July	Low B	13	A	F	Yes	--	---	N	No samples taken.
18 July	Transect 10	2	J	M	Non	--	65 - 113 - 26	N	BOS16. One plug each ear. Third right front toe clipped.
18 July	Transect 10	11	A	F	Yes	--	---	Y	Recapture BOS7. No ear plugs. Third left toe missing.
18 July	Transect 10	14	-	-	-	--	80 - 120 - 29	Y	Recapture from 7/16. One right ear plug only.
18 July	Transect 10	16	-	-	-	16.0	---	N	Escaped. Unmarked.
18 July	Transect 10	17	A	F	Yes	--	84 - 120 - 28	Y	Recapture BOS11. Fifth left front toe missing.
18 July	Transect 10	19	A	F	Yes	22.0	85 - 118 - 29	N	BOS15. Second right front toe clipped.
18 July	Transect 10	21	A	M	Yes	--	78 - 113 - 28	Y	Recapture BOS12. First right rear toe missing.

Age: A (Adult), S (Subadult), J (Juvenile)
Reproductive Condition: Non (non-reproductive), Yes (males with descended testes or females with mammae notably visible), U (undetermined).
Marked: N (not marked and thus not previously captured unless escaped during previous capture), Y (previously marked during present trapping session by toe clip, PIT Tag, and/or marker pen), R (recapture from first trapping session in July), U (undetermined).
Tag Number and Markings: Ten-digit numbers are the PIT tag numbers, BOS (Boulder Open Space) numbers are the genetic tissue sample numbers submitted to Biosphere Genetics, toe clip numbers start with medial digit.

Table B (continued). Captures of Preble's meadow jumping mice along South Boulder Creek and East Boulder Ditch in August, 1997.

Date	Unit and Transect	Trap	Age	Sex	Reproductive Condition	Weight (g)	Measurements (mm) head&body-tail-hind foot	Marked	Tag Number and markings
19-Aug-97	High - Transect A	14	A	F	N	21.5	76 - 125 - 29	N	BOS18. Two plugs taken from each ear. Hair collected. Not a distinct dorsal band.
19-Aug-97	High - Transect A	3	A	F	Y	22	73 - 122 - 29	N	41046E1574 Two plugs taken from each ear. Hair collected. Very distinct dorsal band. Visible mammae.
20-Aug-97	Transect 10	13	J	M	N	14	56 - 106 - 25	N	4104620B34
20-Aug-97	Transect 10	14	A	M	N	19	---	N	4104722E62
20-Aug-97	Transect 10	16	A	F	Y	25	75 - 123 - 31	R,Y	No PIT tag. From 7\16. One right ear plug.
20-Aug-97	Transect 10	2	A	F	Y	24	72 - 121 - 29	N	41045E1118
20-Aug-97	Transect 10	21	A	M	N	23	---	N	4104694501
20-Aug-97	Transect 10	22	J	F	N	10	---	N	410458367D
20-Aug-97	Transect 10	23	A	M	N	20	---	N	41046E6A36
20-Aug-97	Transect 11	7				-	---	R,Y	410471641A BOS3.
20-Aug-97	Transect 11	8				-	---	Y	410475423B BOS20.
20-Aug-97	Transect 11	18				-	---	Y	4104764E14 BOS21.
20-Aug-97	Transect 11	20				-	---	Y	410470790F BOS22.

Table B (continued). Captures of Preble's meadow jumping mice along South Boulder Creek and East Boulder Ditch in August, 1997.

Date	Unit and Transect	Trap	Age	Sex	Reproductive Condition	Weight (g)	Measurements (mm) head&body-tail-hind foot	Marked	Tag Number and markings
21-Aug-97	Transect 10	15	A	F	Y	32	92 - 124 - 29	N	No PIT tag.
21-Aug-97	Transect 11	19				-	---	R,Y	410471641A BOS3.
21-Aug-97	Transect 11	22				-	---	Y	4104764E14 BOS21.
21-Aug-97	Transect 11	24				-	---	R,Y	4104767316 BOS10.
21-Aug-97	Low - Transect C	1				-	---	Y	41047D5331
21-Aug-97	Low - Transect C	2	A	M	U	25.5	82 - 117 - 30	N	Notch in left ear. Marked on chest with a blue marker. No PIT tags.
21-Aug-97	Low - Transect C	11	A	F	U	28.5	78 - 118 - 29	N	Marked on chest with a blue marker. No PIT tags.
21-Aug-97	Low - Transect C	25	S	M	U	27.5	72 - 117 - 29	N	Marked on chest with a blue marker. No PIT tags.
21-Aug-97	High - Transect A	19				-	---	Y	4104752C29
21-Aug-97	High - Transect A	16	U	M	N	17	---	N	Marked on chest with a blue marker. No PIT tags.
21-Aug-97	High - Transect A	8				-	---	Y	41046D0663

Table B (continued). Captures of Preble's meadow jumping mice along South Boulder Creek and East Boulder Ditch in August, 1997.

Date	Unit and Transect	Trap	Age	Sex	Reproductive Condition	Weight (g)	Measurements (mm) head&body-tail-hind foot	Marked	Tag Number and markings
22-Aug-97	Low - Transect B	3				-	---	Y	41045D2950
22-Aug-97	Low - Transect B	4	J	F	N	11.5	---	N	4150593C38
22-Aug-97	Low - Transect C	21				-	---	Y	41007D7A0B BOS25.
22-Aug-97	Low - Transect C	20	A	M	N	26	---	N	4150391306
22-Aug-97	Low - Transect C	14	S	U	N	19	---	Y	41010A036B03 Blue chest.
22-Aug-97	Low - Transect C	9	U	M	N	-	---	N	
22-Aug-97	Low - Transect C	1	S	F	N	19	---	N	41004D070B
22-Aug-97	Medium - Transect A	15				-	---	Y	4104597F75
22-Aug-97	High - Transect A	15				-	---	Y	41047B6876
22-Aug-97	High - Transect A	8				-	---	Y	41046E1579
22-Aug-97	High - Transect B	3				-	---	Y	4104752C29

Age: A (Adult), S (Subadult), J (Juvenile)
Reproductive Condition: Non (non-reproductive), Yes (males with descended testes or females with mammae notably visible), U (undetermined).
Marked: N (not marked and thus not previously captured unless escaped during previous capture), Y (previously marked during present trapping session by toe clip, PIT Tag, and/or marker pen), R (recapture from first trapping session in July), U (undetermined).
Tag Number and Markings: Ten-digit numbers are the PIT tag numbers, BOS (Boulder Open Space) numbers are the genetic tissue sample numbers submitted to Biosphere Genetics, toe clip numbers start with medial digit.