Interaction between deermice, antelope bitterbrush, and cattle in southwest Montana
by Stephanie Jo Matlock-Cooley

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Biological Sciences
Montana State University


Abstract:
Antelope bitterbrush (Purshia tridentata) stands appear to be non-reproductive via seed in southwestern Montana. Deermice (Peromvscus maniculatus) association with bitterbrush was observed to determine the role they have in the germination of bitterbrush plants. Deermice habitat variable selection was compared between two bitterbrush communities in the Mt. Haggin Wildlife Management Area using radio telemetry. This study area was located 6.2 km southeast of Anaconda, Montana. One site, Railroad Gulch, appeared to be more heavily used by domestic cattle (Bos taurus) in the past than the other site, Willow Creek. Cattle were grazed at the Willow Creek site for a one-day experiment in 1991 and 1992 . Habitat use changes were compared between the two sites following the grazing activity. Deermice were found to utilize bitterbrush at 1 to 50 cm above ground, at both sites, more than any other available vegetation type, indicating a close association between the deermice and the bitterbrush plants. Cattle grazing at Willow Creek did produce significant differences in habitat variable use by the mice. Mice were found to leave the bitterbrush and utilize the recently grazed grassy areas. This short-term grazing appeared to have a positive effect on the deermice by creating new resources. Few differences in habitat variable use were noted at the Railroad Gulch site, which had no cattle grazing. Artificial bitterbrush seed caches were planted inside and outside enclosures to compare germination with and without deermice presence. Caches germinated both inside and outside enclosures indicating germination was possible. Natural bitterbrush seed caches and germinating seedlings were never observed at either site. Deermice were found to remove and hoard seed in their burrows, but not scatter hoard as typically observed south of Montana. Relying on deermice for aiding in germination of bitterbrush seed appears to be unpredictable in this area.

# INTERACTION BETWEEN DEERMICE, ANTELOPE BITTERBRUSH, AND CATTLE IN SOUTHWEST MONTANA

by

Stephanie Jo Matlock-Cooley

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Biological Sciences

MONTANA STATE UNIVERSITY
Bozeman, Montana

December 1993

APPROVAL

of a thesis submitted by

Stephanie Jo Matlock-Cooley

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

17 December
Date

Richard J. Douglas
Co-Chairman, Graduate Committee

17 December 1993
Date

Robert S. Moore
Co-Chairman, Graduate Committee

Approved for the Major Department

17 December 1993
Date

Robert S. Moore
Head, Biology Department

Approved for the College of Graduate Studies

12/28/93
Date

R. L. Bowman
Graduate Dean

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library.

If I have indicated my intention to copyright this thesis by including a copyright notice page, copying is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U. S. Copyright Law. Requests for permission for extended quotation from or reproduction of this thesis in whole or in parts may be granted by the copyright holder.

Signature Stephanie Jo Matlock-Cooley

Date December 17, 1993

To Nancy Jane Matlock and Betty Jo Matlock, the matriarchs who influenced my life.

# ACKNOWLEDGEMENTS

First, I want to thank my husband Jonathan for his patience and support during this experience. Special thanks to all my various funding sources: Montana Department of Fish, Wildlife, and Parks; the Deerlodge National Forest; Yellowstone Center for Mountain Environments at MSU; Montana State University; and Montana Tech College. I want to thank Clay and Dawn Christian of the Christian Cattle Company for allowing me to use their cattle and land to set up my base camp. I also want to thank all my field assitants: John Kuntz, John McKee, Cheryl Spencer, Karen and Sam Fauber, Emily and Pat Munday, Chelsea Carter, Sam Douglass, Paul Sawyer, and Dave for help wrangling the cows; Mark Schlipf, Becky Moore, Patty Cramer, Wyatt Fraas, Mike Ross, Susan Hund, Julie Grace, and Jonathan Cooley for help in tracking mice, vegetation analysis, and enclosure construction; Gary Matlock and Jan Thompson for a cold night of mice watching; and especially my sister Lisa Matlock who helped keep me sane and smiling and for volunteering to squeeze into the enclosures. Thanks to John Borkowski and Bill Thompson for statistical help. I also want to thank my committee members for their advice and field help: Bob Moore, Mike Frisina, Harold Picton and Carl Wambolt. Mostly I want to thank my advisor Rick Douglass for giving me great quantities of help in the field, advice, and encouragement.

TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

LIST OF FIGURES-Continued

LIST OF FIGURES-Continued

# ABSTRACT

Antelope bitterbrush (Purshia tridentata) stands appear to be non-reproductive via seed in southwestern Montana. Deermice (Peromyscus maniculatus) association with bitterbrush was observed to determine the role they have in the germination of bitterbrush plants. Deermice habitat variable selection was compared between two bitterbrush communities in the Mt. Haggin Wildlife Management Area using radio telemetry. This study area was located 6.2 km southeast of Anaconda, Montana. One site, Railroad Gulch, appeared to be more heavily used by domestic cattle (Bos taurus) in the past than the other site, Willow Creek. Cattle were grazed at the Willow Creek site for a one-day experiment in 1991 and 1992. Habitat use changes were compared between the two sites following the grazing activity. Deermice were found to utilize bitterbrush at 1 to 50 cm above ground, at both sites, more than any other available vegetation type, indicating a close association between the deermice and the bitterbrush plants. Cattle grazing at Willow Creek did produce significant differences in habitat variable use by the mice. Mice were found to leave the bitterbrush and utilize the recently grazed grassy areas. This short-term grazing appeared to have a positive effect on the deermice by creating new resources. Few differences in habitat variable use were noted at the Railroad Gulch site, which had no cattle grazing. Artificial bitterbrush seed caches were planted inside and outside enclosures to compare germination with and without deermice presence. Caches germinated both inside and outside enclosures indicating germination was possible. Natural bitterbrush seed caches and germinating seedlings were never observed at either site. Deermice were found to remove and hoard seed in their burrows, but not scatter hoard as typically observed south of Montana. Relying on deermice for aiding in germination of bitterbrush seed appears to be unpredictable in this area.

# INTRODUCTION

The goal of this research was to examine interactions among deermice (Peromyscus maniculatus), antelope bitterbrush (Purshia tridentata) reproduction, and domestic cattle grazing by using radio telemetry on deermice in two similar bitterbrush shrub communities. The objectives were to determine: 1) whether patterns of habitat use by deermice, as estimated from radiotelemetry, suggest a close association between deermice and bitterbrush; 2) whether there are differences in habitat utilization by deermice following cattle grazing; and 3) whether there are losses of bitterbrush seeds, from rodent predation that result in caches and germination of bitterbrush. This research was conducted on the Mount Haggin Wildlife Management Area (MHWMA) south of Anaconda, Montana during 1991 and 1992.

Bitterbrush is an important winter forage for many wild ungulates. Mule deer (Odocoileus hemionus), elk (Cervus elaphus), pronghorn antelope (Antilocapra americana), bighorn sheep (Ovis canadensis), and moose (Alces alces) consume bitterbrush (Cliff 1939; Dasmann 1949; Mason 1952; Harry 1957; Wilkins 1957; McCullough and Schneegas 1966; and Stuth and Winward 1977). It is especially important for big game in winter because it is nutritious and palatable (Guinta et al. 1978).

The MHWMA was purchased in 1976 by the Montana Department of Fish, Wildlife, and Parks for big game winter range

(Frisina and Canfield 1987). The available bitterbrush stands within the management area make it very attractive to mule deer and elk. Recent studies of bitterbrush stands in the MHWMA have indicated little to no recruitment (Guenther 1989, and Fraas 1992). Therefore managers are interested in understanding factors affecting maintenance of these stands.

In addition to large mammals' preference for bitterbrush, deermice, yellow-pine chipmunk (Eutamias amoenus), chipping sparrow (Spizella passerina), and blue grouse (Dendragapus obscurus) all utilize bitterbrush for both food and shelter (Gordon 1943; Mussehl 1960; Everett et al. 1978). Nelson et al. (1970) credits deermice as the major consumer of artificially planted bitterbrush seed. Deermice, yellow-pine chipmunks, and chipping sparrows, all present at the study area in the MHWMA, are presumed to be the main vertebrate bitterbrush seed predators.

Deermice are found in higher numbers in bitterbrush communities than surrounding habitats (Douglass, 1989). The low recruitment rate of bitterbrush in the MHWMA inspired the need to determine the specific use by deermice in the bitterbrush community, and to evaluate the effect of caching on bitterbrush germination.

An interesting aspect of bitterbrush ecology is its apparent coevolution with rodents. Deermice and yellow-pine chipmunks consume and cache bitterbrush seed (Gordon 1943; Sanderson 1962; West 1968; Everett et al. 1978; Evans et al.

1983). The seeds are high in carbohydrates and are preferred by deermice over other native seeds (Everett et al. 1978, and Kelrick et al. 1986). Simultaneously, the caching behavior is an important factor in germination of bitterbrush, because rodents remove outer husks that contain a germination inhibitor (Fraas 1992). Most bitterbrush stands are established due to this caching behavior of rodents (Hormay 1943; Stanton 1959).

The role that cattle grazing activities may play on the behavior and abundance of deermice is another factor involved in the bitterbrush-deermice interaction. Cattle grazing has been shown to increase deermice numbers in mesic habitats and decrease their abundance in xeric habitats (Black and Frischknecht 1971; Grant et al. 1982; Page et al. 1977; Hanley and Page 1982; Medin and Clary 1989; Samson et al. 1989). This effect on deermice abundance, and consequently on their activities, can potentially affect the interaction between deermice and bitterbrush.

Because MHWMA has low bitterbrush recruitment, cattle grazing, and deermice activity, it is an ideal location to study these interactions.

## STUDY AREA

This study was conducted in the Mount Haggin Wildlife Management Area (MHWMA), approximately 6.2 km southeast of Anaconda, Montana (Figure 1). This is a semiarid area located east of the Anaconda mountain range and near the Continental Divide. Annual precipitation was 362 mm in 1991 and 312 mm in 1992.

Heavy human use of this area in the past has affected the areas present appearance and vegetative structure. In the late 1800s, the area was extensively logged for timber used by mining and smelter operations in both Butte and Anaconda (Monninger 1992). It was also heavily grazed by cattle, sheep, horses, and mules for the mining operations and thousands of inhabitants in the area (Guenther 1989). The subsequent smelting activities added to the initial impacts. In 1902, the Washoe Smelter was built south of Anaconda and operated until 1980; published data from 1955 indicate copper, zinc, sulfuric acid, and arsenic products were generated (Kelly 1983). Present use is limited to some seasonal livestock grazing in portions of the MHWMA, and recreational fishing and hunting.

Two sites, Willow Creek (WC) and Railroad Gulch (RRG), were chosen for this study, in the MHWMA, for their abundance of bitterbrush stands and relatively similar vegetative compositions, aspects, slopes, and elevations. The Willow Creek site is approximately 100 m northwest of Willow Creek on a grassy slope bounded by a drainage dominated by Douglas fir

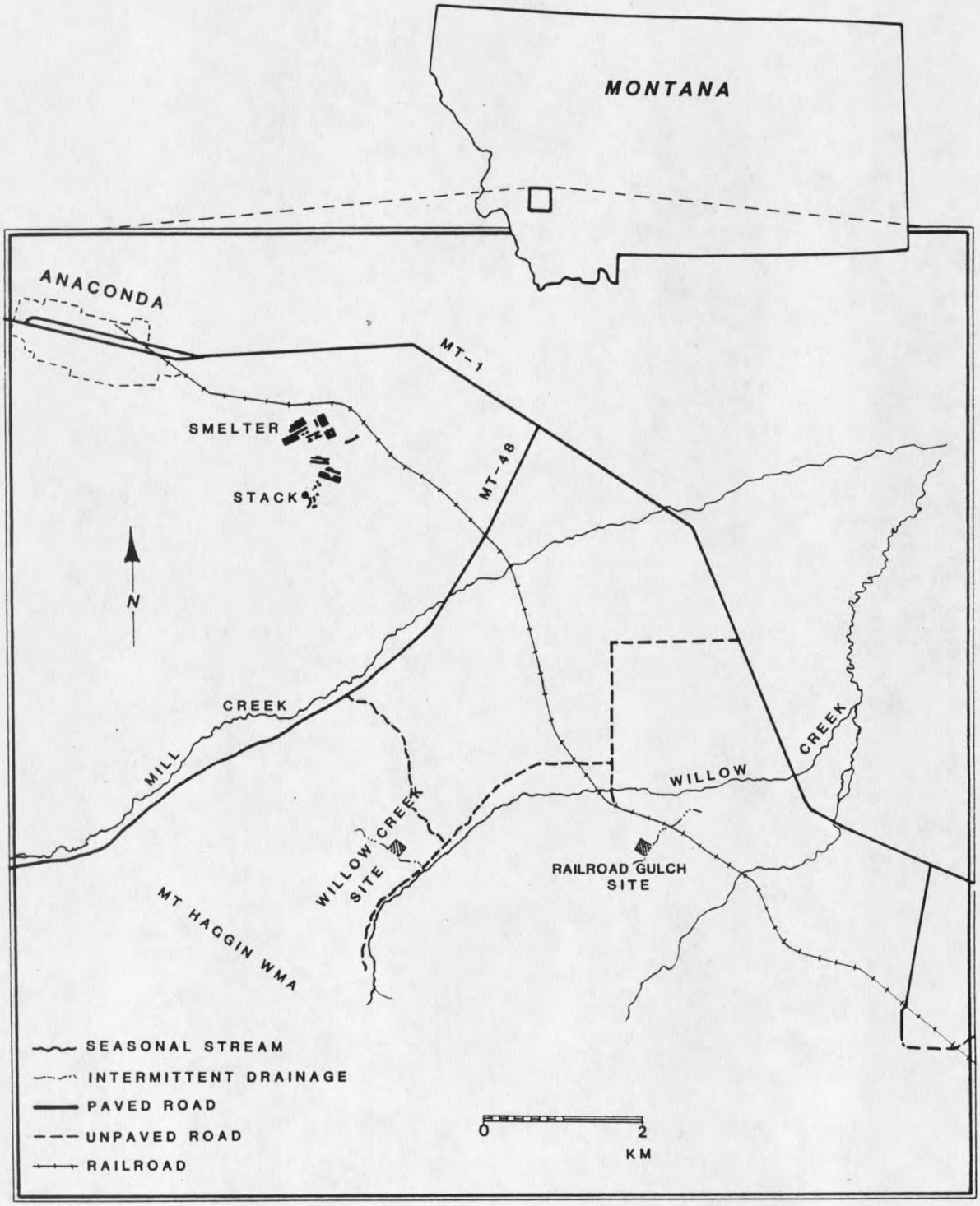


Figure 1. Map of the project area on Mt Haggin Management Area.

(Pseudotsuga menzeisii) to the northeast. It is 1707 m (5600 ft) in elevation with an eastern aspect. Vegetation at this site should be in a seral stage of Mueggler and Stewart's (1980) bitterbrush-bluebunch wheatgrass (Agropyron spicatum) habitat type; however, non-native species have persisted and the plant community is in a seral stage with leafy spurge (Euphorbia esula) dominating. Other plants dominating this site are Kentucky bluegrass (Poa pratensis), lupine (Lupinus wyethii), and Wood's rose (Rosa woodsii), all of which indicate past disturbance of the area, (Guenther 1989). For a complete list of species at this site see Table 6 in the Appendix. This site is not presently grazed and has been rested since 1980 (Frisina pers. com.).

The Railroad Gulch site is situated in a drier, rockier area 3.2 km (2 miles) east of the Willow Creek site. There is a drainage to the north dominated by Douglas fir. Elevation of this site is 1616 m (5300 ft) and the aspect is northeast. Vegetation is in a similar state as Willow Creek, but the dominant species in this community are spotted knapweed (Centaurea maculosa), Kentucky bluegrass, and Wood's rose, again indicating past disturbance of the area. Both sites are being invaded by Douglas fir and Rocky Mountain juniper (Juniperus scopulorum) trees (complete species list in Table 6 in Appendix). Possible past smelter influences and overgrazing practices make this site appear more heavily disturbed than the Willow Creek site. Occasional, light cattle

grazing occurs at this site in early spring and late fall.

# METHODS

## Experimental Design

The habitat use, activity, and home ranges of deermice were determined using radiotelemetry. The effects of cattle-grazing activity on these aspects of deermouse ecology were investigated in two manners: 1) by comparing habitat use in two areas, one of which appears to have been more heavily disturbed in the past than the other; and 2) by using cattle introduced into home range areas of radio- collared deermice.

Along with the telemetry-based habitat selection, the ecological relationship between deermice and bitterbrush was determined by examining artificial bitterbrush seed cache survival, and determining seed removal rates by deermice.

## Procedures

Study sites were chosen for similar aspects, slope and bitterbrush density. Within both sites, WC and RRG, grids 170 m x 170 m, were constructed with dimensions of 10 columns and 10 rows.

### Live Trapping

One hundred Sherman live traps, baited with peanut butter and oats, were placed at each site along staked columns 19 m apart for 600 trap nights, May 17-20 1991, and 200 trap nights, May 15, 1992. Traps were checked each morning. Captured animals were weighed and individually marked with numbered fish fingerling tags clipped into the right ear.

Species, sex, age class, and reproductive condition were recorded for each animal. After a two-week period, traps were placed at both grids to recapture resident deermice. Deermice captured with an ear tag (from the May trapping) and weighing over 20 g (adult weight) were considered residents.

Radio Tracking

Four resident deermice at each site were fitted with 1.8 g to 2.5 g radio collars. Radio collars contained SM-1 transmitters (AVM Instrument Co.) and were attached to the necks of animals with nylon wire ties. Mice were released and thereafter tracked nightly from 2100 h to 0100 h for a two-week period. Signals were detected using an AVM LA-12 DS receiver and a three element Yagi antenna. Signals were detected within 50 m, and exact location of collared animals was determined to within 0.5 m. Deermice positions, when animals were immobile for 1 minute or more, were marked with small numbered surveyor's flags placed 1 m south of the exact location of the animal. Each animal was located from 3-25 times per night at one site. Tracking was alternated from site to site unless a field assistant was available and then tracking was done concurrently at both sites. At the end of the two-week tracking period, mice were recaptured with live traps near day burrows and collars removed. This procedure was repeated throughout the summer of 1991 with different mice and terminated August 12, 1991. These procedures were repeated again in the summer of 1992 with a set of five mice tracked

from May 16 to June 4, 1992 (Table 7 in the Appendix).

Habitat Analysis

A point frame (Figure 2) was used to analyze a representative sample of the habitat cover at both sites (Barbour et al. 1987). A one-meter point frame was placed directly over 40 chosen locations, and two perpendicular sets (five points north-south and five points east-west) of analyses were performed for a total of 400 habitat variable points. The habitat was analyzed at three levels; surface, 20 cm above the surface, and 50 cm above the surface. Percent cover for each strata was determined using the equation:

$$\% \text{ cover} = \frac{\text{no. of pins hitting plant type A} \times 100}{\text{total no. pins}}$$

Percent cover was examined by separating habitat into various variables. These variables were: ground (including rocks and bare ground), club-moss (Selaginella densa), litter (including dead plant material and animal feces), grasses, forbs, bitterbrush (btt), rabbitbrush (rbt) (Chrysothamnus spp.), rose, open spaces (no hits by points), gooseberry (goose) (Ribes spp.), and trees (including juniper, Douglas fir and maple (Acer glabrum)).

Deermouse habitat use is defined as the percent cover at each level for every flagged mouse location. The point frame was used, as in the representative sample, over each mouse location.

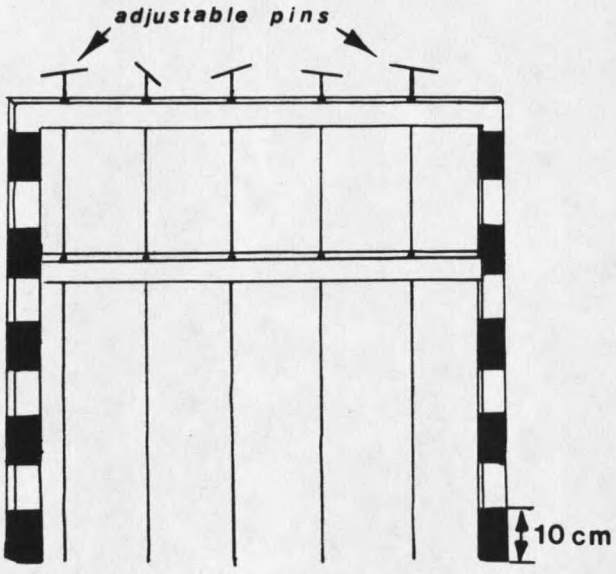


Figure 2. A point frame with five movable pins.

Cattle Introduction

Of the eight initially collared animals, five surviving mice (2 at WC and 3 at RRG) were followed from June 3-7, 1991. On June 8, 1991, 130 Hereford/Angus hybrid cows and calves were brought into the WC grid and allowed to graze for a period of one hour at different sections of the grid and then moved, via human hazing and horseback riders, to a new section of the grid. Cattle were contained by humans and riders surrounding each section. After five hours cattle were removed from the site.

The same procedures were utilized in 1992. Five new mice were tracked from May 29-June 1, 1992, and 30 Charolais yearling bulls were introduced and grazed in the same method

as in 1991.

After cattle were removed, the previously collared set of mice were tracked from June 9-10 in 1991 and June 2-4 in 1992. Mice were followed during the same time period at the RRG site as a control. Deermouse habitat use for both sites was measured prior to and after cattle introduction.

Habitat Modification Measurement

Grass heights were measured in 1991 as an indication of habitat modification by cattle. Four 100 m transects (two north-south and two east-west through grid) were established and grass height was measured at every 1 m interval. Grass heights were measured prior to and after cattle introduction. Grass height measurements were not taken in 1992.

Seed Removal Comparisons

Four bitterbrush were randomly chosen at WC, and four at RRG. If the plant was dead or larger than 2 m long and 1 m high another was randomly chosen due to the constraints of enclosure size. A trench 15 cm deep was dug around each bush to set enclosures below ground. Each bush was enclosed with 6 mm mesh hardware cloth structures which were sewn together with fishing line. Once the enclosures were positioned around the bush, the bases were buried and enclosures were wired to rebar set into the trenches. Each enclosure had an entrance lid closed with twist ties for accessibility. Sherman live traps were placed inside enclosure to capture any confined

mice. Ten 15 cm diameter paper plates were placed around the base of the enclosed bush to determine fallen seed abundance. Two bushes exterior to and nearest the enclosed bush, for each of the four bushes at each of the sites, were chosen to determine possible seed removal by deermice, and plates were also placed under those bushes. Seeds were counted in situ on enclosed bushes and also on two outer bushes to determine initial seed numbers. This was done just prior to complete ripening, July 6-10, 1991. Fallen seeds were counted on the plates inside and outside of the enclosures after ripening of seed was completed, August 11-12, 1991, and few remaining seeds were still attached to bushes.

Simulated Caches

Bitterbrush seed was acquired in three manners: 1) 1,000 seeds were purchased in 1991, from Native Seeds, Inc. in Lehi, Utah; 2) seeds were hand collected from both sites in 1991; and 3) seeds were collected in 1990, from surrounding local bitterbrush sites by another researcher. Simulated caches were planted both inside and outside enclosures during the late summer, August 12-13, 1991. Ten caches were planted inside the enclosures, and five caches each were planted at each of the two outside bushes (Table 8 in the Appendix). Caches were planted 2.5 cm to 3 cm deep to simulate deermouse bitterbrush cache depths (Hormay 1943). Caches were marked with metal tabs and two caches were planted at each tab. Ten seeds were cached in one pile on the north side of the tab and 20 seeds were

cached in one pile on the south side. Caches were checked one month later on September 14, 1991 to determine disturbances. All discarded hulls from disturbed caches were collected.

Caches were monitored during the summer of 1992. The first seedlings were observed on May 16, 1992 and surviving seedlings were counted. Surviving seedlings were counted again on June 4, 1992, and June 21, 1993.

Statistical Methods and Analyses

Statistical analysis was completed with the use of the SAS statistical package (SAS Institute, Inc. 1988). Deermouse habitat use means and the representative sample of vegetation means were compared by using the Student's t-test. Mouse habitat use comparisons for post grazing June, July, and August periods between sites and years were analyzed with t-tests, as were the pre/post cattle grazing mouse habitat use differences between sites and years.

## RESULTS/DISCUSSION

### Deermice Habitat Use vs. Representative Vegetation

Mice locations were used from the pre-cattle grazing period to compare with the representative vegetation sample measured prior to cattle grazing. A total of 3 mice at RRG, and 4 at WC were tracked during this period in 1991, and 1 at RRG and 4 at WC in 1992. A total of 63 mice locations were compared to 40 representative sample locations at WC in 1991, and 113 mice locations to 40 representative locations in 1992. At RRG, 85 mice locations were compared to 40 representative sample locations in 1991, and 52 mice locations to 40 representative locations in 1992 (means and standard deviations in Table 9 in the Appendix).

### Willow Creek vs. Railroad Gulch Habitats

The significant differences between the representative habitat variable means at the two sites are listed in Table 1. In 1991, the significant differences at the two sites for the surface level were between litter ($P=0.0139$), forbs ($P=0.0077$), and bare ground ($P=0.0345$). In 1992, litter and ground at the surface were also significantly different ($P<0.0001$) between the two sites. The trend for these differences is similar for both years (Figure 3). In both years, litter was more abundant at WC than RRG, and bare ground was more abundant at RRG than WC. WC had more

Table 1. t-test significance levels for mean differences between Railroad Gulch (RRG) and Willow Creek (WC) habitats, between deermice habitat use at each site and the representative habitat at each site, and between deermice habitat use at RRG and WC. (Btt=Bitterbrush, Rbt=Rabbitbrush, Moss=Club-moss, Open=No hits by points, Goose=Gooseberry)

| Habitat Variable | RRG vs.WC Vegetation | | WC Mice vs. WC Veg. | | RRG Mice vs. RRG Veg. | | RRG vs WC Mice | |
|---|---|---|---|---|---|---|---|---|
| | 91 | 92 | 91 | 92 | 91 | 92 | 91 | 92 |
| Surface | | | | | | | | |
| Litter | *** | *** | *** | *** | *** | *** | | |
| Forb | *** | | | *** | | *** | *** | |
| Btt | | | | *** | | *** | ** | |
| Rbt | | *** | | ** | | *** | ** | |
| Grass | | *** | | *** | *** | | *** | |
| Moss | | *** | ** | | *** | *** | | |
| Ground | ** | *** | | | *** | *** | | |
| 20 cm Above Ground | | | | | | | | |
| Litter | *** | ** | | | *** | ** | *** | *** |
| Forb | *** | ** | | | *** | | *** | ** |
| Btt | | *** | *** | *** | *** | *** | ** | ** |
| Rbt | | | | | *** | | *** | ** |
| Grass | ** | *** | | *** | *** | *** | *** | |
| Rose | | | | | | | | |
| Rock | | | | | | | | |
| Open | | *** | *** | *** | *** | *** | | |
| Goose | | | | | | *** | | *** |
| Tree | | | | | | | | |
| 50 cm Above Ground | | | | | | | | |
| Litter | | *** | | | | | | *** |
| Forb | | | | *** | | | ** | *** |
| Btt | | | *** | *** | *** | *** | *** | |
| Rbt | | | | | ** | | *** | |
| Grass | | ** | *** | | | | *** | |
| Open | | | *** | *** | *** | *** | | ** |
| Goose | | | | | | ** | | *** |
| Tree | | | | | | | | |

*** = P≤0.01
** = P=0.01 to 0.05
Blank = P>0.05

grass and litter covering the ground, and RRG was largely bare ground with grass and litter located sporadically (Figures 4 and 5).