

Evaluation of Mesquite Mouse (*Peromyscus merriami*) Status in Pima County



**Arizona Game & Fish Department
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**EVALUATION OF
MESQUITE MOUSE (*Peromyscus merriami*) STATUS
IN PIMA COUNTY, ARIZONA**

Prepared for

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT

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ABSTRACT

The mesquite mouse, also known as Merriam's mouse (*Peromyscus merriami* Mearns), is a cryptic rodent that closely resembles a common species, the cactus mouse, *P. eremicus*. Mesquite mice are extremely difficult to distinguish from cactus mice. Traditionally, morphological characteristics such as size of the animal and several of its body parts and skeletal characteristics, particularly of the skull and baculum (penis bone), have been used to distinguish the species. More recently, techniques involving analysis of DNA have been applied to distinguish the species. Both species are found in southern Arizona and northern Mexico. Most of the known specimens of the mesquite mouse were collected from mesquite (*Prosopis velutina*) bosque (woodland) areas in Pima County.

Concern has been expressed by various authors and organizations that mesquite bosques are disappearing or diminishing in quality, and that the survival of the mesquite mouse is consequently threatened. This study, funded by a grant from the Arizona Heritage Fund to the Pima County Regional Flood Control District, investigated the current distribution of the mesquite mouse by reviewing historical records from museum specimens, examining existing potential habitat at historic locations of the species and elsewhere in the county, and conducting a live-trapping study at 19 sites representing a range of ecological communities with mesquite as a major component.

Mesquite mice, as determined by DNA analysis and morphological characteristics, were found at 10 out of 19 sites trapped. They were found at or near six out of eight historic locations. Mesquite mice were found in a variety of mesquite-dominated areas, representing the following vegetation classifications:

- 143.10, Semidesert grassland, xeroriparian scrub
- 154.100, Sonoran desertscrub xeroriparian scrub
- 224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series

All have mesquite as the dominant tree at the locations trapped, but do not appear to be exclusively remnants of old bosques.

Mesquite mice were not found in:

- isolated patches of mesquite surrounded by urban development;
- narrow, rocky washes with few mesquites; or
- mesquite-invaded grassland or upland vegetation.

They were found in sites subject to a variety of human caused impacts, but the effects of these impacts cannot be determined without further specific study.

INTRODUCTION

PURPOSE AND OBJECTIVES

The purpose of this project was to evaluate the current status of the mesquite mouse (*Peromyscus merriami*) in Pima County to identify areas where this species may still exist and can be protected. The objectives of this project were:

- 1) Examine historic records and museum specimens for best available information and interview scientists who have trapped the mouse historically; to determine locations and conditions where this species has been found in the past and gain information about where to look for it today;
- 2) Evaluate conditions at accessible historic locations and conduct a live-trapping survey if conditions are appropriate;
- 3) Identify the best remaining mesquite forests and woodlands on public lands in Pima County and conduct live trapping surveys on lands for which permission can be obtained;
- 4) Prepare a report summarizing findings, including maps and photographs of areas surveyed, narrative descriptions of habitat conditions, and management recommendations.

BACKGROUND

SPECIES STATUS

P. merriami has no status under the Federal Endangered Species Act, and no special status under Arizona law or regulations. It is one of the 56 species considered by Pima County to be a priority vulnerable species under the Sonoran Desert Conservation Plan.

The Arizona Game and Fish Department lists the mesquite mouse as a “sensitive element” and identifies specific study objectives for grant proposals:

1. Evaluate historic and current occurrence through field surveys and searches of pertinent literature and museum records;
2. Assess habitat use, population status, and population trends;
3. Identify management needs.

TAXONOMY

Peromyscus merriami is in the class Mammalia, Order Rodentia, Family Muridae, Genus *Peromyscus*, subgenus *Haplomylomys*. The species was named in 1896 by Mearns from specimens collected at Sonoyta, Sonora, Mexico during the international boundary survey. Osgood (1909) revised the genus, and placed *merriami* as a synonym of *P. eremicus*, noting that the specimens were apparently just larger individuals of the common species. The species was resurrected by Hall and Kelson (1952). Subsequent authors have accepted the specific identity of *P. merriami* based on these earlier works (Hooper 1968, Lawlor 1971, Hoffmeister 1986, Baker et al. 2003). More recent evidence, in the form of genetic and DNA analysis, clearly indicates that *P. merriami* is a distinct species with two subspecies *merriami* and *goldmani* (Avisé et al. 1974; Riddle et al. 2000).

DISTRIBUTION

P. merriami is found from south-central Arizona southward to Sinaloa, Mexico. *P. merriami* is known in Arizona from “just north of Florence” on the Gila River, southward to Lukeville on the west and southeast of Tucson on the east (Hoffmeister 1986). The majority of known records of the species in Arizona are from Pima County, along the Santa Cruz River and its tributaries.

IDENTIFICATION

Identification of this species is difficult based on morphology alone. Mearns (1907) separated *P. merriami* from *P. eremicus* on the basis of several characteristics (1) hind foot more than 22 mm., (2) skull length more than 26 mm., (3) total length more than 210 mm, and (4) chest and wrists usually colored.

Arnold (1940) in a M.S. thesis that was an ecological study of the vertebrate animals of the mesquite forest stated (p. 38): “*Peromyscus merriami* Benson, Mesquite White-footed Mouse, was the most consistent mammalian inhabitant of the mesquite forest proper.” He stated (p. 38) “this mouse has been designated by Benson as a new species to go under the name of *Peromyscus merriami* rather than *Peromyscus eremicus* as previously supposed. According to him it is identical to the typical mesquite inhabiting *Peromyscus* which he is naming from northern Mexico.” Arnold did not give a detailed description of the species. Apparently Benson did not publish the species, probably because he discovered that it had previously been published. No work by Benson was fully cited by Arnold or any other author with regard to this species.

Commissaris (1960) conducted a study of *Peromyscus* at an area described as 9 miles south of Tucson. This area includes Sahuarita Butte (currently known as Martinez Hill), a rocky lava hill which rises 325 feet above the valley floor, and a large mesquite forest along the south and west sides of the butte. (The area is on Tohono O’odham Nation land and the large mesquite forest is gone, although many smaller mesquites remain). He trapped both the rocky hill and the mesquite forest during the winter of 1956-57. Forty-five specimens, 23 from the mesquite area and 22 from Sahuarita Butte, were compared in his study. He noted slight external differences between freshly captured specimens collected in each habitat. Specimens trapped in the mesquite area were larger, and a “cinnamon” pectoral spot was often present. This pectoral spot was quite variable, however, with some specimens having large spots and others having none. Occasionally the cinnamon pectoral spot appeared in specimens from the butte. Commissaris cited Mearns (*op. cit.*) who pointed out that “The two have the same coloration, except that *P. merriami* is somewhat darker, has the light cinnamon color extending down the outer side of the forelimb to the hand, and a large pectoral patch of cinnamon that is usually wanting in *P. eremicus*.” With the exception of the pectoral area, the differences in coloration were slight, however, and often disappeared or were obscured when the animal was prepared as a study skin. Commissaris measured several features of the animals he captured. He found no sexual dimorphism in either form. He found the following differences between populations, which he presented in a table:

Table 1. A comparison of 22 specimens of *Peromyscus eremicus pullus* from Sahuarita Butte with 23 specimens of *Peromyscus merriami* from the adjacent mesquite forest; measurements in millimeters (from Commissaris 1960)

Measurement	<i>Peromyscus eremicus</i> Mean with Standard error	<i>Peromyscus merriami</i> Mean with Standard error	T	P<
Total length	181.4 ± 2.04	193.0 ± 2.66	3.46	.01
Tail length	96.9 ± 1.53	110.3 ± 1.78	1.45	.20
Body length	84.5 ± 1.18	92.2 ± 1.49	4.05	.001
Hind foot length	19.9 ± 0.16	22.2 ± 0.18	9.54	.001
Height of ear from notch	19.0 ± 0.29	21.6 ± 0.19	7.50	.001

The other measurements were skull characters, which are not included here because specimens were not collected in the present study.

He examined five adult specimens from the type series of *P. merriami*. These showed all the characters he found in the mesquite forest form of *Peromyscus* in his study area. Commissaris concluded: “it seems reasonable to conclude that *Peromyscus merriami* is a distinct species from *Peromyscus eremicus*, differing both in morphology and ecology, and that it is found inhabiting the mesquite infested lowlands of the southern part of Arizona and adjacent areas.”

Hoffmeister and Lee (1963) made a detailed study of specimens from throughout the range of what they considered to be *P. merriami*. They stated that *P. merriami* is very similar to *P. eremicus*, “the similarities are so great that specimens of the two kinds are easily confused.” “The most diagnostic characters are size and shape of baculum, length of hind foot, length of ear and mastoid breadth. Total length of animal, length of skull and coloration are sometimes useful” (Hoffmeister and Lee 1963 p. 201). They discussed the history of classification of *P. merriami*, and pointed out that the previously published works were based on examination of very few specimens. They acknowledged that Commissaris (1960) was accurate in his conclusion, despite the small number of specimens he examined. They amplified their review of that paper, pointing out that there is little doubt from the data presented by Commissaris that real differences exist between the two kinds of mice. Although these differences were statistically significant, that did not necessarily mean that they were of great magnitude. In fact, the characteristics pointed out by Commissaris were not all consistently found through examination of more specimens from a wider range of localities. They determined that the differences were relatively small and nearly all characters showed considerable overlap between the two kinds. They examined 191 specimens possessing a combination of characters that caused them to be referred to as *P. merriami*. No single character was found to be always diagnostic. They arrived at a somewhat different evaluation of known characters than Commissaris had, and found additional differences between the two forms. In order of decreasing diagnostic value these features were grouped as follows: (1) size and shape of baculum; (2) length of hind foot, length of ear, mastoid breadth; (3) size and shape of skull, total length and length of tail, coloration of abdomen. Hoffmeister (1986) supported the conclusions of Hoffmeister and Lee (1963).

Length of hind foot was suggested by Hoffmeister and Lee (1963) as a good diagnostic character among certain populations. They found that the average length of the hind foot in 30 specimens of *P. merriami* was 22.37 mm, SD 0.93, compared to the 22.2 mm ± 0.18 found by Commissaris. Hoffmeister and Lee (1963) also found length of ear to be diagnostic among

some populations, but there was considerable overlap between *P. merriami* and certain other populations of *P. eremicus*. They found length of ear (as measured by the collector of the specimen) for 29 specimens of *P. merriami* to average 21.03 mm, SD 1.12. Commissaris's mean was 21.6 mm. Total length and length of tail were stated to average larger in *P. merriami* than in *P. eremicus* but were of less diagnostic value. In *P. merriami*, Hoffmeister and Lee (1963) found total length to be usually more than 190 mm and tail length to be usually more than 100 mm in young adult animals and total length more than 195 mm with tail length more than 104 mm in older adults. Hoffmeister and Lee (1963) created a table that included assignment of individual specimens for each of five characters. Two of these were skull measurements. Dividing points of characters were assigned, with *P. merriami* being distinguished by the following measurements that can be taken from living specimens:

Length of hind foot: >21.6

Length of ear: >20.03

Total length: >191.5

Hoffmeister and Lee (1963) found some differences in coloration between specimens of the two species. As noted by Commissaris, a well-marked pectoral spot, described by Hoffmeister and Lee as "ochraceous or tawny color" (differing from the "cinnamon" of Commissaris and Mearns) was usually present in *P. merriami*; in *P. eremicus* in Arizona, specimens usually lacked a pectoral spot. In addition, they noted that most *P. merriami* had the underparts washed with a creamy color. In *P. eremicus*, the underparts did not have this creamy tinge. They concluded that this character, although sometimes very subtle, is diagnostic in most specimens.

Hoffmeister and Lee (1963) discussed the magnitude of these differences with regard to whether or not the two forms should be considered different species. They noted that the differences between *P. merriami* and *P. eremicus* were of the magnitude, if not entirely the kind, to be expected between subspecies. They stated that they were aware that some subspecies might be more distinctive than some species. If the specimens regarded as *P. merriami* were members of a marginal, allopatric group of populations, they probably would be regarded as subspecies of *P. eremicus*, and individuals that were intermediate in several characters would be considered as intergrades. However, the two forms were known to be generally sympatric but mutually exclusive in microhabitat selection at many localities. Because of their sympatric distribution as discontinuous units, and their morphological differences, Hoffmeister and Lee concluded that *P. merriami* should be regarded as a species different from *P. eremicus*.

Riddle (personal communication) stated that the differences between *P. merriami* and *P. eremicus* are clear and easily detected at the molecular level, but that differentiation by morphology alone is difficult or impossible for every specimen, and there are probably many specimens of both species that have been incorrectly identified in museums.

ECOLOGY

Mearns (1907) reported that *P. merriami* was fairly common at Sonoyta, Sonora, in fields and brush fences. Arnold (1940) stated that although it was never found in any great numbers it was trapped in his study area wherever mesquite was present regardless of the other types of vegetation. He noted that this mouse seemed to be quite as much at home among the branches of the mesquite trees as on the ground. Commissaris (1960) trapped *P. merriami* in his mesquite study area and never in the adjacent paloverde dominated vegetation. He concluded that there appeared to be specific habitat requirements for the two forms. He cited Mearns (1907) and Dice and Blossom (1937) stating that *P. merriami* was reputed to be a lowland dweller occurring in mesquite communities and fields while *P. eremicus* was abundant in rocky areas.

Hoffmeister and Lee (1963) concluded that *P. merriami* occupied an ecological niche within its geographic range characterized by heavy stands of mature or large mesquites with a minimum of rocks and slope. In one specific attempt to obtain specimens of *P. merriami*, they made intensive collections in this type of habitat. Among 93 individuals collected, 87 proved to be of this species while only 6 were *P. eremicus*.

Hoffmeister (1986 p. 344) stated that "in my estimation the name mesquite mouse for the species is far more appropriate than Merriam's mouse. Everywhere in Arizona and northern Sonora this mouse is found in mesquite forests called bosques." He noted that the distribution of these mice corresponded rather closely with part of Nichol's "Mesquite and salt-bush bottoms." Near San Xavier Mission, Pima County, he trapped these mice along a creek bed with large numbers of immense mesquite. At Wilmot Station southeast of Tucson, they were trapped in thick stands of mesquite, cholla, prickly pear, paloverde, and grasses.

THREATS TO THE SPECIES

Mesquite bosques have declined in some parts of Arizona and northern Mexico. Areas of this community type are said to have historically represented one of the most abundant riparian communities in the Southwest, but are now reduced to remnants of what they once were. Threats that have been identified include: groundwater pumping and surface water diversion; land clearing and wood cutting; and land uses such as livestock grazing and recreation (Stromberg 1993).

Hoffmeister (1986) expressed concern that many of the stands of mesquite known to have been inhabited by mesquite mice were being cut for firewood and to make more grazing land available. Thus, he concluded, the fate of mesquite mice in Arizona was precarious. The obvious loss of certain mesquite bosques, combined with the collection of very few specimens identified as *P. merriami* in recent decades, has inspired concern for the survival of the species among some mammalogists (Hoffmeister 1986; Y. Petryszyn, E.L. Cockrum, and R.R. Johnson, personal communications).

METHODS

HISTORICAL REVIEW

We compiled the available information on this species, using references in Hoffmeister (1986), Hoffmeister and Lee (1963), and Commissaris (1960) as a starting place. We also consulted other publications and unpublished reports of small mammal trapping in southeastern Arizona for records of this species. We contacted Arizona Game and Fish Department (AGFD) biologists Tim Snow, Bill Van Pelt, and Lin Piest and asked for information from their studies and from others of which they were aware. We interviewed Dr. Yar Petryszyn, Curator of the Mammal Museum of the University of Arizona, on two occasions, and he allowed examination of specimens in the museum and field notes of collectors. We interviewed Dr. Brett Riddle, University of Nevada, Las Vegas, by telephone and email. Dr. Riddle is co-principal investigator on a National Science Foundation funded study of the genetics and distribution of species of the genus *Peromyscus*, and has the distinction of being the only person known to have trapped and positively identified *P. merriami* in Pima County in this century.

We utilized online resources and published museum records to develop a list of museums outside Tucson known or believed to have specimens of *P. merriami*. We corresponded with mammal curators at those museums and requested records of their specimens of this species, or we obtained the records from online catalogs. Museums that had specimens graciously provided information on them. All specimen records were compiled into an MS Excel spreadsheet that is believed to contain records of all specimens of *P. merriami* originating in Pima County, Arizona. This was then condensed to Appendix A, which lists all of the known historic locations at which specimens identified as *P. merriami* has been trapped, and used to prepare the GIS data layer and to plan sites to investigate. All identifications of *P. merriami* for museum specimens were tentatively accepted as accurate, but it must be noted that some may be inaccurate and it is not possible to determine which, if any, these may be.

HABITAT ASSESSMENT

Location data for sites at which specimens identified by collectors as *P. merriami* were trapped were then compiled into a Geographic Information System (GIS) database layer, under the direction of John Regan, Pima County Department of Transportation. The compiler used the best available base maps for the decades in which specimens were trapped to plot the locations as accurately as possible. Precise plotting was confounded in some cases by lack of precision in specimen locality data recorded by the collector and/or transcriber. Locality data were then plotted on a map of tentatively identified potential habitat for the species (Figure 1). Potential habitat was based on the description of habitat in Hoffmeister (1986). An existing GIS layer of data on vegetation types (Harris et al. 2000) provided the basis for tentative identification of Mesquite Series, Sonoran Deciduous Riparian Woodland as prime potential habitat for *P. merriami*.

Where the location data from specimens did not coincide well with the Mesquite Series vegetation data layer, we made a visual search of aerial photographs and vegetation maps to identify the nearest wash or extensive mesquite-dominated area to the described site. We developed a working list of potential trapping locations that integrated information on historic trapping data, mapped vegetation type, land ownership, and access.

SELECTIVE TRAPPING EFFORT

SITE SELECTION

We selected a total of 19 sites for trapping. Criteria for selection of the sites was a combination of:

- Proximity to historic locations at which mesquite mice had been trapped;
- Access by virtue of location on public lands and proximity to roads;
- Variation in vegetation within the range of mesquite-dominated woodland;
- Geographic spread through the historically known range in eastern Pima County;
- Convenience for trapping two or more sites in a night.

Detailed descriptions of the sites selected and the results obtained there are included in Appendix B and sites are indicated in Figure 1.

Precise sites of historic records for mesquite mice were occasionally problematic to relocate because boundaries have changed over time or were recorded imprecisely by the original collector. Many historic sites did not fit the above criteria for site selection, including those that are on private or Tohono O'odham Nation land. General locations for trapping were determined using the historic collectors' label information. Then specific sites for setting traps were determined by land ownership, access, and current conditions in the field. Occasionally, more than one trapping site was located within a single historic general location (e.g., three trapping sites were located within a general area described as 2 mi N and 4 mi W of Arivaca, but each site had different vegetation and soil conditions). Limitations of time and budget precluded a wider or more intensive sampling. Table 2 summarizes the trapping sites used in this study and their relationship to historic locations, the results of this study, the number of trap-nights for each site, and the number of mesquite mice caught at each site.

TRAPPING METHODS

At each site, we placed Sherman live traps baited with oats mixed with peanut butter. We put two or more cotton balls in each trap to provide insulation for animals. We set traps singly at approximately ten meter intervals along a more-or-less straight line through the mesquite-dominated habitat or along the wash, as appropriate. The number of traps placed varied with the site, and is described in Appendix B and summarized in Table 2. Generally 25 to 50 traps were set at each site. We set traps in the afternoon, and retrieved them the following morning. We took standard measurements (total length, tail, hind foot, and ear) for all *Peromyscus* species captured, and digital photographs of most of the animals. For most, but not all, individuals tentatively identified as possible *P. merriami*, we took tail and ear clippings using sharp scissors. These were placed in ethyl alcohol and submitted to the laboratory of Dr. Brett Riddle for DNA analysis. We did not take clippings from animals that appeared to be *P. eremicus*. We released all animals at the trap site at which they were captured following field processing. There was no accidental mortality of *Peromyscus*, and no animals were killed, therefore we collected no whole animal specimens.

Table 2. Summary of historic and current locations trapped during this study. Appendix A includes map with historic site numbers.

Historic Site No.	Current Site No.	Historic Record of <i>P. merriami</i>	Historic location descriptions	Current vegetation classification	Current Record of <i>P. merriami</i>	n <i>P. merriami</i> /n trap nights
33	1	yes	5.5 mi S, 7.5 mi E Continental	224.52 Mesquite series, but a narrow, rocky wash	no	0/50
33	2	yes	Sawmill Canyon Wash at FR62	143.10 Semidesert grassland, xeroriparian scrub	yes	6/50
18	3	yes	Weisner's Ranch. 11 (or 12) mi. S Tucson	154.100, Sonoran desertscrub xeroriparian scrub	yes	2/50
18	4	yes	Weisner's Ranch. 11 (or 12) mi. S Tucson	154.100, Sonoran desertscrub xeroriparian scrub	yes	2/50
8	5	yes	9 mi W of junction Ajo and Mission Road; 10 Mi W, 5.5 Mi S of Tucson; 10 mi SW Tucson	224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	yes	2/50
1	6	yes	7.8 mi. E, 3.7 mi. N of Silver Bell Peak	154.10, Sonoran Desertscrub	yes	2/50
	7	no		224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series,	yes	6/50
	8	no		mesquite-invaded upland, adjacent to 224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	no	0/25
50	9	yes	3.5 mi. E Junction Redington Rd. on Mt. Lemmon Road	224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	no	0/50
50	10	yes	3.5 mi. E Junction Redington Rd. on Mt. Lemmon Road	224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	no	0/100

Historic Site No.	Current Site No.	Historic Record of <i>P. merriami</i>	Historic location descriptions	Current vegetation classification	Current Record of <i>P. merriami</i>	n <i>P. merriami</i> /n trap nights
	11	no		224.53 Sonoran Riparian Deciduous Forest and Woodlands, Cottonwood-Willow Series and 143.10, Semidesert grassland which is densely invaded by mesquite	no	0/50
38 or 39	12	yes	2 mi N, 4 mi W Arivaca	143.10 Semidesert grassland, xeroriparian scrub	yes	2/50
38 or 39	13	yes	2 mi N, 4 mi W Arivaca	143.10 Semidesert grassland, xeroriparian scrub	yes	1/25
38 or 39	14	yes	2 mi N, 4 mi W Arivaca	143.10 Semidesert grassland, xeroriparian scrub	no	0/25
41 or 42	15	yes	at or "near" Mormon Lake	224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	yes	2/50
41 or 42	17	yes	at or "near" Mormon Lake	224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	yes	2/50
	16	no		143.10 Semidesert grassland, mesquite invaded,	no	0/50
	18	no		224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	no	0/50
	19	no		224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	no	0/50

Number of sites trapped in this study that have historic records of *P. merriami*= 7

Number of historic sites with current *P. merriami*= 6

Number of historic locations trapped with no *P. merriami* trapped in this study= 2

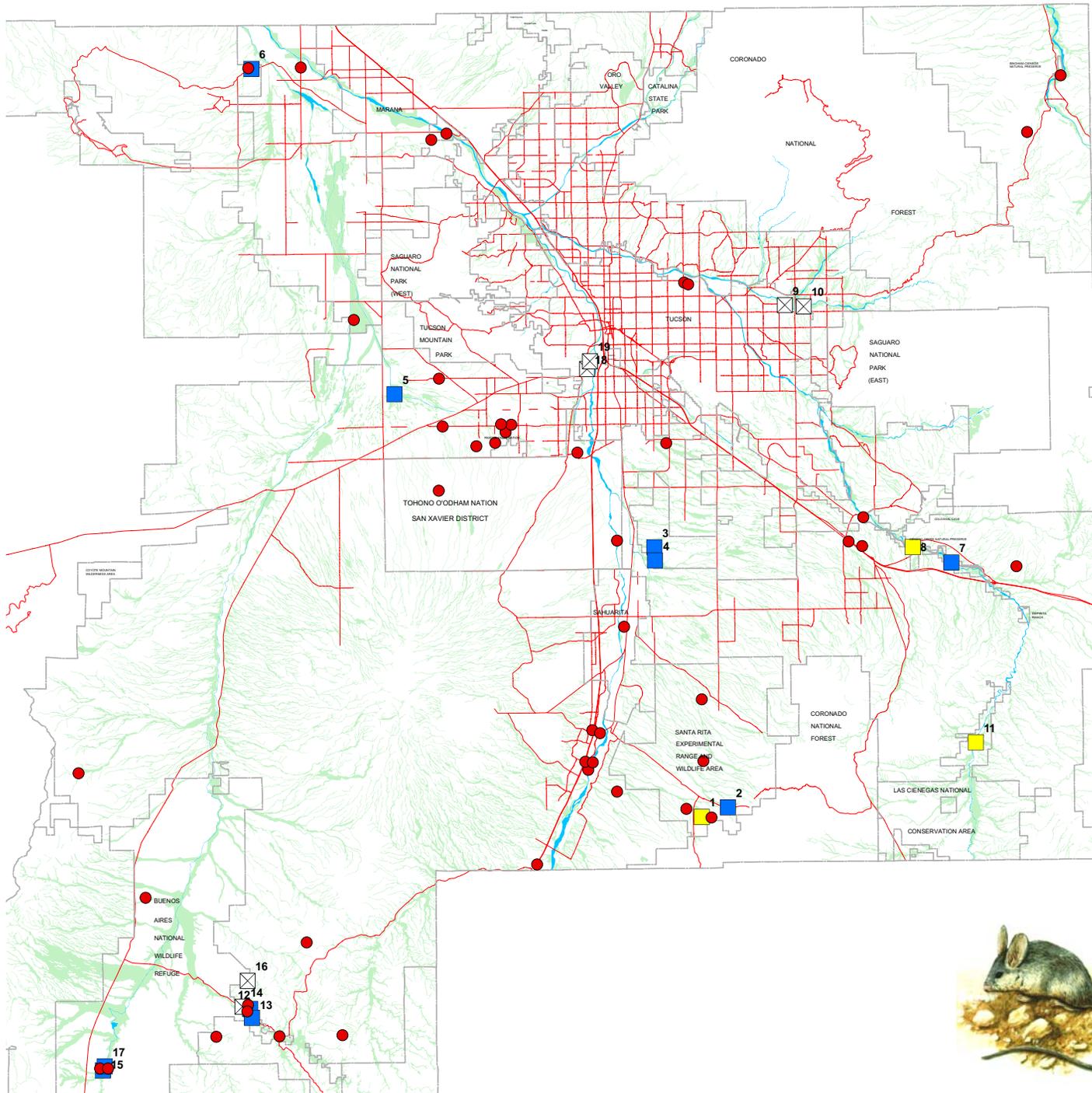
Number of sites with no historic records but with current *P. merriami* = 1

*For some locations, there were several years of record and several collectors, only one of which was selected as an example in this table.

IDENTIFICATION

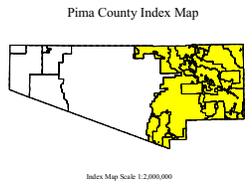
We identified all mammals trapped using a field key prepared for this project (Appendix C). Baculum and skull characteristics were not useful in the present study, which relied entirely on external characteristics of living animals. All known previous measurements for the species were based on dead specimens. Measurements of body parts, especially total body length, of living animals that are attempting to escape the clutches of the investigator are undoubtedly different from, and probably shorter than, measurements of dead specimens. We made tentative identification of *Peromyscus* to species based on measurements and coloration. Dividing points used to tentatively distinguish *P. merriami* from *P. eremicus* were based on Hoffmeister and Lee (1963). If total length was ≥ 191 mm, then we tentatively identified the animal as *merriami*. If total length was less than 191 mm, but if the hind foot was ≥ 21 mm or ear ≥ 20 mm and there was an evident cinnamon spot, we tentatively identified the animal as *merriami*. However, we labeled all specimens as “*eremicus/merriami*” until DNA analysis could confirm or refute our field determinations. Identifications were subsequently confirmed by DNA analysis conducted by Dr. Lois F. Alexander, Postdoctoral Scholar in the laboratory of Dr. Brett Riddle, University of Nevada, Las Vegas, utilizing the technique described in Riddle et al. (2000). Riddle and Alexander intend to publish their results, but have permitted use of their data as confirmation of identification for this project.

**Figure 1:
Mesquite Mouse Trapping
Locations and Suitable Habitat**



- Historic Mouse Locations
- Trapped in 2004-2005**
- "Peromyscus merriami"
- "Peromyscus eremicus"
- ⊠ "no Peromyscus"
- Administrative Boundaries
- Major Streets
- Suitable Habitat
- Major Washes
- 12 Trapping Location Number

Suitable Habitat is derived from the following BLP codes:
 124.71 - Sonoran Riparian Woodland
 143.10 - Semidesert grassland xeroriparian scrub
 154.10 - Sonoran desertscrub xeroriparian scrub
 224.52 - Sonoran Riparian and oasis forests, mesquite series
 234.71 - Sonoran deciduous swamp and riparian scrub mixed scrub series



The information depicted on this display is the result of digital analysis performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Department of Transportation Technical Services Division makes no claims regarding the accuracy of the information depicted herein.

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Scale 1:136,000



RESULTS AND DISCUSSION

HISTORICAL REVIEW

Specimen records were obtained from: Illinois Natural History Survey and University of Illinois; National Museum of Natural History (Smithsonian Institution); University of Arizona; Museum of Vertebrate Zoology, University of California, Berkeley; and Museum of Texas Tech University. Data use restrictions imposed by the owners of the data (the museums) prevent publication or inclusion of the full set of data in this report, however the full compiled data set has been submitted to Pima County. Appendix A lists all of the locations compiled from this data set. Most of the available Arizona records are from Pima County. Records from other Arizona counties include: Santa Cruz at Tumacacori, Pinal at Picacho Reservoir, and Gila at 20 miles east of Globe. A total of 295 museum records were obtained and compiled for specimens collected in Pima County, Arizona. Many of these (n= 125) were collected on the Tohono O’odham Reservation.

There has been an evident decline in numbers of *P. merriami* specimens deposited in museums over the past several decades. Figure 3 graphs the number of known specimens identified as *P. merriami* and the decade in which they were caught. Significantly, of the 295 specimens included in this record, 133 were collected by W. & L. Goodpaster from 1956 to 1974, 21 were collected by Lee W. Arnold in 1939, and 27 by L.R. Commissaris in 1956-58. In other words, 181 specimens, 61% of the known specimens, were collected by three collectors. This suggests that the number of specimens have probably depended more upon serious efforts being made by collectors who can recognize the species and who worked in appropriate areas, than any other factor. It is not possible to support or refute a hypothesis that the species has declined by examining the specimen record.

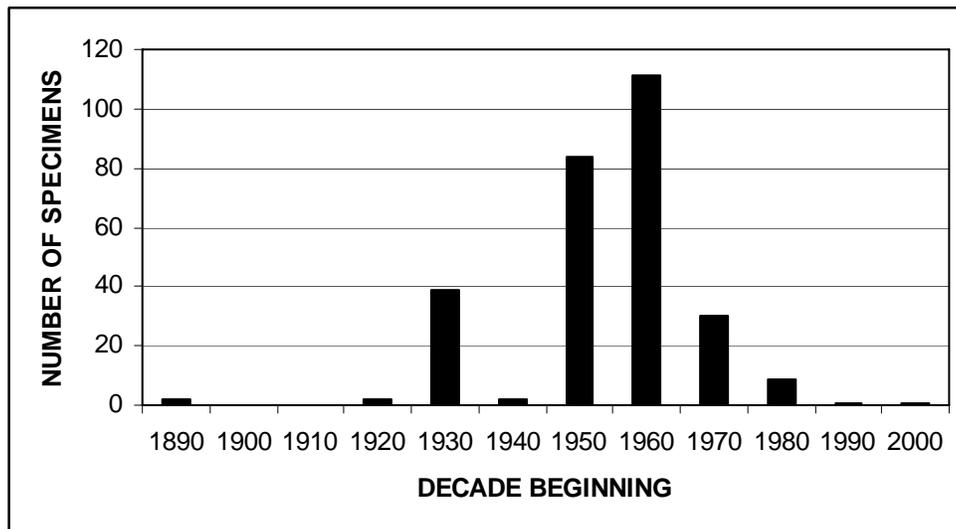


Figure 3. Number of specimens of *P. merriami* and decade of capture.

P. merriami was not identified from several areas that have been intensively studied in the past several decades that have mesquite bosques and/or mesquite lined washes. These include Saguaro National Park (Duncan 1990, Swan 2004), the Santa Catalina Mountains (Lange 1960), the Chiricahua Mountains (Maza 1965), the Huachuca Mountains (Hoffmeister and Goodpaster 1954), the upper San Pedro River valley (Duncan 1988), The Gila Box National Riparian Conservation Area (Snow et al. 2004), Tumacacori National Historic Site (B. Powell, University of Arizona, personal communication), and the State of New Mexico (Frey 2004).

HABITAT ASSESSMENT

The initial overlay of historic mesquite mouse locations and areas currently with vegetation classified as 224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series did not show a consistently strong relationship. However, all historic locations mapped are within or close to mesquite-dominated communities. The locations at or near which *P. merriami* had historically been trapped that were examined in this study still had an abundance of mesquite that could be classified under the following different mesquite-dominated vegetation associations:

- 143.10, Semidesert grassland, xeroriparian scrub
- 154.10, Sonoran desertscrub xeroriparian scrub
- 224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series

Pima County estimates of current acreage in each of these communities is:

143.10, Semidesert grassland, xeroriparian scrub	134,768 acres
154.10, Sonoran desertscrub xeroriparian scrub	126,901 acres
224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series	26,469 acres

Undoubtedly, not all vegetation in these communities provides habitat for *P. merriami*, but data are insufficient to clearly determine which sites within these communities can or cannot support *P. merriami*. Some ideas that may contribute to further characterization of suitable habitat are suggested later in this report.

Mesquite-dominated floodplain vegetation remains present at or near all of the historic locations, as indicated by aerial photographs, recent vegetation maps and direct field examination. Certainly qualitative and quantitative changes in the number, size, and density of mesquites have occurred between historic conditions and current conditions, but these have not been and cannot be documented because the historic data are lacking. Appendix B describes the current vegetation conditions at the sites that were trapped during this study. It is apparent that mesquite mice are not found only in large mesquite bosques, but in a wider variety of mesquite-dominated communities on floodplain soils.

The most famous mesquite bosque known to science was south of Tucson, on the San Xavier District of the Tohono O'odham Nation. This bosque was the site of capture of 114 of the known 295 specimens of *P. merriami* known from Pima County. It included the study sites of Arnold (1940), Commissaris (1960), and some of the specimens studied by Hoffmeister and Lee (1963). Historically, trees in this bosque reached heights of 60 feet and diameters of 4 feet, and the bosque was "miles in extent" (Swarth 1905, writing of conditions in 1902). Various authors

have discussed this site as an important birding area and its decline due to wood cutting (reviewed by Arnold 1940, Brandt 1951, Johnson and Carothers, in prep.). Other evidence strongly implicates diversion of the river, channel changes, wood cutting, and also (and perhaps most importantly) groundwater pumping (Turner 2003, Stromberg 1993). Arnold (1940) described the decline of the bosque, pointing out (p. 6): "Where once stood magnificent trees fifty and sixty feet high now stand dense thickets of second and third growth mesquite, with occasional large stumps to mark the spots where former giants once stood. It is not because of the size and height of the trees but because of the density of the remaining growth that I feel that the botanical classification 'Mesquite Forest Association' ...still fits the area today." Specimens of *P. merriami* continued to be trapped in this area, with the last known specimen from 1981. At some point in the mid-1980s, it became more difficult to obtain permission to trap in this area (Y. Petryszyn personal communication). It is not known whether *P. merriami* continues to survive there. Certainly the once magnificent mesquite bosque is no more. However, there are some mesquite dominated areas remaining in the general vicinity that were probably at one time contiguous with the large bosque. Some of these have trees with basal trunks greater than one meter in diameter, although today the trees are less than ten meters tall. At two of those sites, *P. merriami* was caught in this study (Appendix B, Sites 3 and 4).

Evidence in the form of repeat photography indicates that in at least some areas, mesquite woodland now exists where it previously did not (Turner 2003). This is evident at Cienega Creek County Park, one of the areas investigated for the present study at which several *P. merriami* were trapped (Appendix B, Site 7). Turner presented a photograph showing an almost total absence of trees in 1880, contrasted with a photograph from 1998 showing a dense riparian tree community, including a mesquite bosque and cottonwood-willow forest. He concludes that there has been a dramatic forest expansion along at least some Southwestern rivers and streams over the past century. In large part, these are attributed to hydrologic changes resulting in the general loss of sacaton dominated grasslands and improvement of conditions for woody plants. "Thus, today we have cottonwood-willow forests flanked by mesquite bosques where a century ago the valleys supported grassy expanses of sacaton and tobosa grass. The mesquite forests . . . have much the same history [as the cottonwood-willow forests]. Present in a few places when early travelers passed through our region, they quickly expanded following the downcutting of the late 19th century. Some of these have disappeared in recent years. For example, the dense mesquite forest on the Santa Cruz near San Xavier Mission slowly died as groundwater pumping depleted the aquifer beneath it." (Turner 2003, p. 32-33).

SELECTIVE TRAPPING EFFORT

P. merriami were found at six out of eight areas at or near historic locations at which *P. merriami* were trapped, and 10 out of 19 trapping sites (Tables 2 and 3, Appendix B, and Figure 1).

P. merriami was trapped in several of mesquite-dominated vegetation communities, classified as:

- 143.10, Semidesert grassland, xeroriparian scrub
- 154.100, Sonoran desertscrub xeroriparian scrub
- 224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series

They were not found in the following circumstances:

- (1) mesquite-invaded grassland (sites 11 and 16) or mesquite-invaded upland sites adjacent to floodplain sites (site 8);
- (2) narrow, rocky washes with few mesquites growing in strips only one or two trees wide (sites 1, 14, 18, 19); although site 2 might be described in these terms and did have mesquite mice, it was appreciably broader and had more mesquite than site 1; or
- (3) patches of mesquite isolated by urban development (sites 9, 10, 18, 19).

The number of sites representing each of the above conditions is small, and there is overlap in some conditions (narrow rocky and urban encroached for sites 18 and 19), and the number of trap nights is limited, so data are not sufficient to support a conclusion that such situations never support mesquite mice. However, this may present a hypothesis for further research.

In the field, based on habitat and morphology, including measurements of living mice and observations of pelage, many of the mice trapped appeared to be consistent with the descriptions of *P. merriami*. Originally, all specimens were labeled as *P. eremicus/merriami*. As it turned out, all were proved by DNA analysis to be *merriami*. Some individuals that were tentatively identified as *eremicus*, and therefore from which we did not collect specimens, may have been *merriami*. Table 3 summarizes the results for all individuals in the genus that were trapped during this study. Greater detail on all rodents trapped and the sites is included in Appendix B. Table 2 summarizes the results with regard to historic and current locations of *P. merriami*, and the relative abundance of *P. merriami* (as number trapped per number of trap nights).

Table 3. Summary of *Peromyscus* trapped during this study

Species	Specimen no.	TL	BL	Tail	HF	Ear	Sex	Age	Pectoral spot	Site
eremicus?		160	68	92	18	13	F	AD		1
merriami	KJK495	190	92	98	20	20	F	AD		2
merriami	KJK496	195	95	100	22	19	M	AD		2
merriami	KJK497	165	83	82	19	20	F	AD	YES	2
merriami	KJK498	190	98	92	21	18	F	AD		2
merriami	KJK499	191	90	101	20	20	F	AD		2
merriami	KJK500	171	80	91	21	17	F	AD	YES	2
merriami	KJK501	180	88	92	22	17	M	AD		3
merriami	KJK502	200	87	113	23	19	F	AD	YES	3
merriami	KJK503	183	80	103	22	18	M	AD	YES	4
merriami	KJK504	201	94	107	22	19	F	AD	YES	4
merriami	KJK505	199	96	103	20	20	M	AD		5
merriami	KJK506	181	86	95	21	20	M	AD	YES	5
merriami	KJK507	200	85	115	21	17	F	AD		6
merriami	KJK508	195	91	104	19	17	M	AD	YES	6
eremicus?		155	74	81	19	15	F	JUV		6
eremicus?		155	71	84	20	16	M	JUV		6
eremicus?		175	79	96	19	15	F	AD		7
merriami	KJK509	203	83	120	21	18	F	AD		7
merriami	KJK510	181	86	95	22	19	F	AD	YES	7
eremicus?		92	89	3	18	17	F	AD		7
merriami	KJK511	205	96	109	21	18	F	AD	YES	7
merriami?		189	93	96	20	21	M	AD	YES	7
merriami?		195	95	100	21	20	M	AD		7
merriami?		200	89	111	21	19	F	AD	YES	7
eremicus?		190	87	103	20	17	F	AD		8
eremicus?		185	87	98	19	16	F	AD		8
eremicus?		180	87	93	19	18	F	AD		8
eremicus?		190	86	104	20	18	M	AD		8
eremicus?		172	86	86	19	16	F	AD		8
eremicus?		189	95	94	19	17	F	AD		8
eremicus?		180	95	85	19	15	M	AD		11
eremicus?		175	83	92	18	18	F	AD		11
eremicus?		175	80	95	19	17	F	AD		11
merriami	KJK512	201	94	107	21	20	F	AD	YES	13
merriami	KJK513	195	95	100	20	20	F	AD	YES	13
merriami	KJK514	192	93	99	20	21	F	AD	YES	12
merriami	KJK515	193	92	101	23	20	F	AD	YES	17
merriami	KJK516	191	87	104	21	20	F	AD	YES	17
merriami	KJK517	179	83	96	21	21	F	AD	YES	15
merriami?		170	96	74	22	20	F	AD	YES	15

Notes: Individuals with Species lacking ? have been positively identified as *merriami* by DNA analysis. Measurements: TL= total length; BL= body length; Tail= length of tail from base to tip; HF- hind foot length; EAR= greatest length of ear from notch to tip. Sex: F= female, M= male; Age: AD= adult, JUV= juvenile. Site numbers are those in Appendix B.

CONCLUSIONS

The evidence indicates that:

1. *P. merriami* is not uncommon in the appropriate habitat, which appears to be mesquite-dominated vegetation of several types on floodplain soils;
2. *P. merriami* is geographically widespread in eastern Pima County. It was found near the northern, southern, and eastern boundaries of its historically known range, where potentially suitable habitat could be sampled. The western boundary of distribution was not examined in this study.
3. *P. merriami* is not restricted to large mesquite bosques, but can be found in several different vegetation associations as mapped by Harris et al.(2000). These are:

143.10, Semidesert grassland, xeroriparian scrub

154.100, Sonoran desertscrub xeroriparian scrub

224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series

All have mesquite as the dominant tree at the locations trapped, but do not appear to be exclusively remnants of old bosques.

4. Some areas that were historically known to provide habitat for *P. merriami* have suffered dramatic losses of large trees and alteration of the biological community. However, it is not known whether these areas continue to have mesquite mice present because they were not included in this study. Adjacent areas are known to have mesquite mice.
5. The observed decrease in collection of specimens of *P. merriami* probably reflects a decreased effort of trapping in the appropriate vegetation types by knowledgeable collectors, combined with the extreme difficulty in recognizing the species on the basis of morphology.
6. It is extremely difficult or impossible to consistently identify this species based on morphological characteristics alone. *P. merriami* cannot be positively identified on the basis of measurements or pelage. Of 23 individuals trapped and positively identified as *P. merriami* by DNA analysis, 15 had a cinnamon colored pectoral spot, eight did not. The range of measurements in millimeters for these individuals is as follows:

Total Length: 165-205

Tail: 82-120

Hind foot: 19-23

Ear: 17-21.

Although it may be reasonable to conclude that a large mouse with a cinnamon pectoral spot trapped in a mesquite-dominated situation in Pima County is probably *P. merriami*, it is not possible to rule out this species if the mouse is small and lacks the spot.

7. No nocturnal rodents were trapped at several sites that appeared to provide ideal vegetation conditions (Sites 9, 10, 18, 19). These sites are mesquite bosques or mesquite lined washes owned by Pima County. All are adjacent to residential developments. The sites are relatively small and isolated from other natural sites by areas of residential development and/or urban infrastructure. Feral or roaming domestic cats were observed at sites 18 and 19. It is possible that either isolation or predation are factors that account for the absence of nocturnal rodents at these sites.
8. Mesquite mice were caught at sites that had a wide variety of disturbances of human origin (e.g., livestock grazing, trash, power lines, dirt roads, intensive nocturnal traffic by immigrants, migrant trails, limited wood cutting). It is not possible to determine the effects of any of these disturbances without further study. Data do not support specific management recommendations for conservation of mesquite mice, other than basic conservation of large blocks of suitable habitat with some (as yet unknown) level of connectivity or proximity to each other. Restrictions on human activity, such as limiting access, reducing or eliminating livestock grazing, or disallowing specific activities including camping, horseback or mountain bike riding, or any other activity that does not result in conversion of mesquite-dominated woodland to some other vegetation type are not supported by the data.
9. Further research, targeted toward effects of specific impacts, would be necessary to determine the effects of any human activities on mesquite mice or to support changes in regulation or management of potentially suitable habitat.

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Dr. Brett Riddle and Dr. Lois Alexander, University of Nevada, Las Vegas, provided information on their specimens and conducted the DNA analysis of specimens collected during this study.

The following museum personnel provided records of their specimens of *P. merriami*: Dr. Joyce Hofmann, Illinois Natural History Survey and University of Illinois; Robert D. Fisher and Craig Ludwig, National Museum of Natural History (Smithsonian Institution); Dr. Yar Petryszyn, University of Arizona. Online museum records were obtained from: Museum of Vertebrate Zoology, University of California, Berkeley and Museum of Texas Tech University. In all cases, the data are the property of the respective museums.

The draft manuscript was reviewed by Eleanor Gladding and Amy Gaiennie, and produced in its final form by Lucy Simpson, SWCA, Tucson. An anonymous reviewer affiliated with the Arizona Game and Fish Department reviewed the draft manuscript and made many useful comments that resulted in significant improvement of the final report.

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Evaluation of Mesquite Mouse (*Peromyscus merriami*) Status in Pima County *Appendices*



**Arizona Game & Fish Department
Heritage Grant Project #105001**

May 2006

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Evaluation of Mesquite Mouse (*Peromyscus merriami*)
Status in Pima County

Arizona Game and Fish Heritage Grant #I05001

APPENDICES

APPENDIX A: POTENTIAL TRAPPING LOCATIONS.....A1
APPENDIX B: SITES TRAPPED.....B1
APPENDIX C: FIELD KEY TO RODENTS LIKELY TO BE TRAPPED.....C1

DISCLAIMER

The findings, opinions, and recommendations in this report are those of the investigators who have received partial or full funding from the Arizona Game and Fish Department Heritage Fund. The findings, opinions, and recommendations do not necessarily represent official Department policy or management practice. For further information, please contact the Arizona Game and Fish Department.

APPENDIX A

**HISTORIC LOCATIONS OF MESQUITE MOUSE (*PEROMYSCUS MERRIAMI*)
BASED ON MUSEUM LOCATIONS**

Appendix A. Historic Locations of *Peromyscus merriami* collection, based on museum records

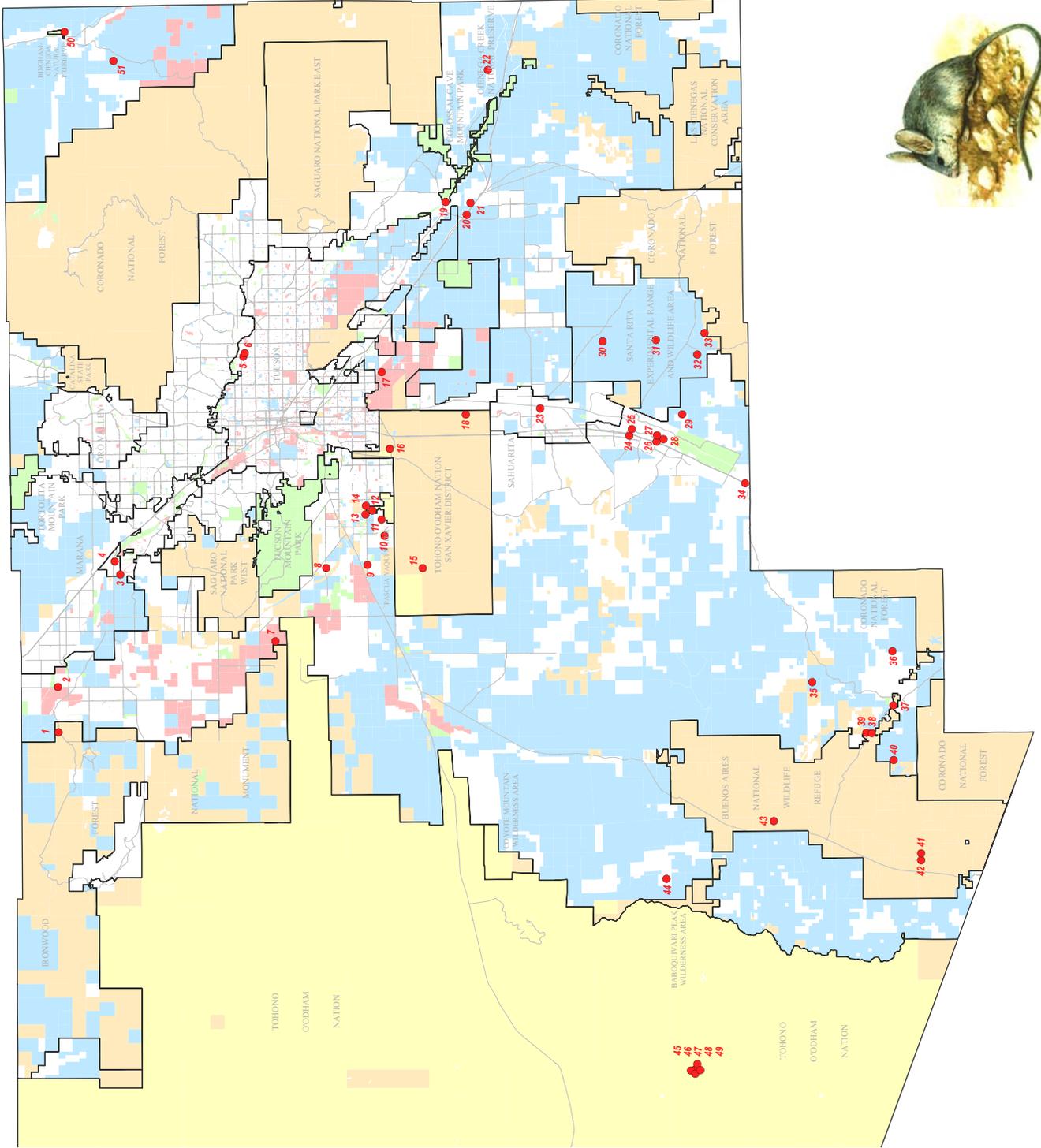
Map Number	Location Description	Year of Record*	Collector*	Trapped at or Near This Study
1	7.8 mi. E, 3.7 mi. N of Silver Bell Peak	1973	Carl Hoagstrom	X
2	Avra Valley, 5 mi. W Marana on Trico Rd., 1 1/2 mi. N Marana-Trico Rd.	1967	Ronald Wheeland	
3	1/2 m. W, on Avra Valley Rd., 1/2 mil. S of the road	1969	J. Currlin	
4	drove out freeway 10, turned onto Avra Valley Rd., went approx. 1mi. turned left to river and just across rive	1969	R.D. Ullery	
5	Fort Lowell	1893	Hoizner, F. X.	
6	Fort Lowell	1893	Holzner, F.X; Mearns	
7	13.7 mi W Tucson	1969	M. R. Lee	
8	9 mi. W Jct. Ajo & Mission Roads	1956	W. J. S.	X
9	10 mi W, 5.5 mi S of Tucson	1956	Keith E. Justice	
10	10 mi SW Tucson	1939	Lee W Arnold	
11	9 mi SW Tucson	1939	Lee W Arnold	
12	8 mi SW Tucson	1957	W. & L. Goodpaster	
13	8 mi SW Tucson	1939	Lee W Arnold	
14	8 mi SW Tucson	1939	Lee W Arnold	
15	13.75 mi SW Tucson	1939	Lee W Arnold	
16	San Xavier Mission	1974	W. D. Severinghaus	
17	T15S, R14E, Sec. 21, NE1/4	1983	J. Brown	
18	mesquite forest, Weisner's Ranch, 12 mi S Tucson	1939	L. A.	X
19	Wilmot Station, 13 mi SE Tucson	1959	D. F. Hoffmeister	
20	Old Sonoita Hwy., 0.3 mi. E Rt. 83	1992	D.A. Parizek	
21	1 mi. W, 1 mi. N, Benson Highway - Old Helvitia Rd. jct.	1956	L.R. Commissaris	
22	18 mi SE Tucson	1977	M. R. Lee	
23	12 mi S Tucson, Santa Cruz River	1980	Petryzyn, Y	
24	Continental	1921	Baily, V.	
25	Continental	1921	Baily, V.	
26	2 Mi S of Continental at Morales	1931	Taylor, W. P.	
27	2 Mi S of Continental at Morales	1931	Taylor, W. P.	
28	2 Mi S of Continental at Morales	1931	Taylor, W. P.	
29	Morales, 28 mi. S of Tucson	1931	Taylor W. P.	
30	Santa Rita Exp. Range, 7.1 mi. ESE Sahuarita	1970	J.C. Geest	
31	2 mi S, 7 mi E Continental	1963	W. & L. Goodpaster	
32	5 mi S, 6 mi E Continental	1963	W. & L. Goodpaster	
33	5.5 mi S, 7.5 mi E Continental	1963	W. & L. Goodpaster	X
34	0.5 mi E Arivaca	1959	W. & L. Goodpaster	
35	29 mi. S of Three Points	1965	S.E. Doster	
36	Clark Ranch, 4 mi. E Arivaca, 3850f.	1939	Lee W. Arnold	

37	Arivaca	1960	Bernard Maza	
38	2 mi N, 4 mi W Arivaca	1962	W. & L. Goodpaster	X
39	2 mi N, 4 mi W Arivaca	1962	W. & L. Goodpaster	
40	4 mi. E Arivaca, 3850	1939	Lee W. Arnold	
41	near Mormon Lake, 4 mi. N, 1 mi. E Sasabe, 3500ft	1953	Keith E. Justice	X
42	Morman Lake, 4 mi. N, 1 mi. E Sasabe	1953	L.D. Beatty	
43	29 mi. S of Three Points on Sasabe Rd.	1965	G.C. Bateman	
44	Sabino Canyon, Baboquivari Mts.	1956	W. & L. Goodpaster	
45	3 mi SE Topawa, Baboquivari Mts.	1956	W. & L. Goodpaster	
46	3 mi SE Topawa, Baboquivari Mts.	1956	W. & L. Goodpaster	
47	3 mi SE Topawa, Baboquivari Mts.	1956	W. & L. Goodpaster	
48	3 mi SE Topawa, Baboquivari Mts.	1956	W. & L. Goodpaster	
49	3 mi SE Topawa, Baboquivari Mts.	1956	W. & L. Goodpaster	
50	3.5 mi. E Junction Redington Rd. on Mt. Lemmon Road	1953	A.G. Baker	X
51	2 mi. S, 1 1/2 mi. W Redington, 4000ft.	1953	E.L. Cockrum	
52	0.75 mi E Lukeville, Organ Pipe Cactus National Monument	1962	W. & L. Goodpaster	
53	0.75 mi E Lukeville, Organ Pipe Cactus National Monument	1962	W. & L. Goodpaster	
54	0.75 mi E Lukeville, Organ Pipe Cactus National Monument	1962	W. & L. Goodpaster	
55	Organ Pipe Cactus Nat'l Mon., Dos Lomitos 4 mi. SE Lukeville	1988	Peryszyn Y	
56	0.75 mi E Lukeville, Organ Pipe Cactus National Monument	1962	W. & L. Goodpaster	
57	0.75 mi E Lukeville, Organ Pipe Cactus National Monument	1962	W. & L. Goodpaster	
58	1 1/2 mi. E, 2 mi. N (by rd.) Oracle, 4000ft	1953	Robert B. Murray	

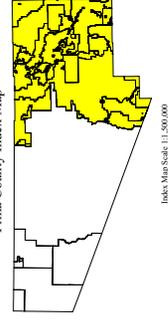
* for some locations, there were several years of record and several collectors, only one of which was selected as an example in this table.

Appendix A Map: Mesquite Mouse Historic Locations and Land Ownership Evaluation

- Historic Mouse Locations
- Federal Lands
- State Lands
- County Lands
- Municipal Lands
- Tribal Lands
- Private Lands
- Administrative Boundaries
- ≡ Major Streets



Pima County Index Map



Index Map Scale: 1:1,500,000



Scale 1:180,000

The information depicted on this display is the result of digital mapmaking performed on a variety of data sources. The accuracy of the information presented is limited to the accuracy of the data. The Pima County Department of Information Services does not assume any liability or claim regarding the accuracy of the information depicted herein.

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APPENDIX B

SITES TRAPPED

Site 1. Florida Canyon Wash



Aerial photograph scale: 1:4,000.



Florida Canyon Wash upstream from crossing of Madera Canyon Road. T19S R14E S14 UTM (Zone 12, NAD 27 CONUS): 511507mE and 3515171mN. Map: Green Valley. Elevation 3,785 feet Ownership: State of Arizona.

Historical information: This site is close to that described as 5.5 mi S, 7.5 mi E Continental at which W. and L. Goodpaster collected *P. merriami* in March 1963. It is also close to the site described as 5 mi S, 6.5 mi E Continental at which B.R. Riddle trapped *P. merriami* in March 2002.

Access: Madera Canyon Road, approximately ½ mile after road turns S, a dirt road goes off to the E and loops S to parking area between fences. To the east is private land; to the west is state land.

Vegetation conditions: The Harris Riparian map shows this site as 224.52, Mesquite Series. This is a mesquite-dominated floodplain and wash area. The wash is deeply incised in some places, and the substrate is a mix of cobbles, gravel, and sand. There are some fairly large velvet mesquites (*Prosopis velutina*) and a few netleaf hackberry (*Celtis laevigata* var. *reticulata*) trees. The area is impacted by cattle grazing. There is a ruin of an adobe house and windmill, and at least two active water tanks in the immediate vicinity. Shrubs include wolfberry (*Lycium* spp.) and catclaw acacia (*Acacia greggii*). Grasses were Lehmann lovegrass (*Eragrostis lehmannii*) and plains lovegrass (*Eragrostis curvula*).

Methods: Standard operating procedure (see methods section). Two trap lines, each consisting of 25 traps, were placed in the evening of 13 December 2004 and picked up on the morning of 14 December. One line of traps was placed along the wash bottom, the other along the floodplain.

Rodents trapped: Only one animal was caught. It is tentatively identified as an adult female *P. eremicus*. Measurements were: 160-92-18-13. It was not evidently pregnant or lactating. No specimen clipping was taken.

Site 2. Sawmill Canyon Wash



Aerial photograph scale: 1:4000



Sawmill Canyon Wash upstream and downstream from crossing of Forest Road 62. T19S R15E S18. UTM (Zone 12, NAD 27 CONUS): 514201mE and 3516113mN. Map: Helvetia. Elevation: 3,948 feet Ownership: State of Arizona.

Historical information: This site is close to or the same as where Riddle et al. caught *P. merriami* that were positively identified by genetic analysis in 2002.

Access: Madera Canyon Road to Forest Road 62 to wash crossing.

Vegetation conditions: The Harris Riparian map shows this site as 143.10, Semidesert grassland, xeroriparian scrub. This is a mesquite-dominated wash and narrow floodplain. The substrate is sand and gravel with a few cobbles. Some of the mesquites appear to be quite old, averaging one to two feet in basal diameter, and some are much larger. Some are up to 20 feet tall. Trees are not dense, but scattered along the wash. The wash is partially incised, but the majority of its length appears to be fairly stable. Trees were velvet mesquite and netleaf hackberry. Shrubs were spiny hackberry (*Celtis pallida*), lotebush (*Zizyphus obtusifolia*) and catclaw acacia. Grasses included Lehmann lovegrass and sacaton (*Sporobolus wrightii*). There are some signs of grazing, but not as heavily impacted by cattle as Florida Canyon Wash.

Methods: Standard operating procedure (see methods section). Two trap lines, each consisting of 25 traps, were placed in the evening of 13 December 2004 and picked up on the morning of 14 December. Both lines were placed along the wash, one upstream the other downstream from the parking place.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>eremicus?</i>	160	92	18	13	F	AD	no specimen
<i>Chaetodipus</i>	<i>intermedius</i>	180	110	22	5	M	AD	no specimen
<i>Perognathus</i>	<i>flavus</i>	154	90	15	5	M	AD	no specimen
<i>Peromyscus</i>	<i>merriami</i>	190	98	20	20	F	AD	Pregnant; specimen KJK495
<i>Chaetodipus</i>	<i>intermedius</i>	155	93	21	8	F	AD	no specimen
<i>Peromyscus</i>	<i>leucopus</i>	125	60	20	17	F	AD	Pregnant; no specimen
<i>Peromyscus</i>	<i>merriami</i>	195	100	22	19	M	AD	testes abdominal; specimen KJK496
<i>Chaetodipus</i>	<i>intermedius</i>	160	92	21	8	M	AD	testes abdominal; no specimen
<i>Peromyscus</i>	<i>merriami</i>	165	82	19	20	F	AD	cinnamon spot on thorax; specimen KJK497
<i>Peromyscus</i>	<i>merriami</i>	190	92	21	18	F	AD	Pregnant; specimen KJK498
<i>Dipodomys</i>	<i>merriami</i>	232	148	34	13	F	AD	no specimen
<i>Peromyscus</i>	<i>merriami</i>	191	101	20	20	F	AD	Pregnant; specimen KJK499
<i>Peromyscus</i>	<i>merriami</i>	171	91	21	17	F	AD	cinnamon spot on thorax; specimen KJK 500

Site 3. Arnold #1



Aerial photograph scale 1:4,000



Unnamed wash, tributary of Santa Cruz River. T16 S R14E S21. UTM (Zone 12, NAD 27 CONUS): 506947mE and 3542578mN. Map: Tucson SW. Elevation: 2,673 feet
Ownership State of Arizona.

Historical information: This is close to the site worked by Lee W. Arnold in 1938 and 1939, known as Weisner's Ranch. 11 (or 12) mi. S Tucson 20 June 1939 and other dates. The actual site is on private property, currently owned by ASARCO Inc. and no longer is mesquite dominated.

Access: Enter by road off Nogales Hwy at approximately 3544525N; drive E through two gates to power line. Drive south approximately 1 mile to site.

Vegetation conditions: The Harris Riparian map shows this site as 154.100, Sonoran desertscrub xeroriparian scrub. The area is partially carpeted with closely cropped grass. Soil is deep sandy loam, eroded in places, also wash bottom with few cobbles. Trees: velvet mesquite, blue paloverde (*Parkinsonia florida*), Jerusalem thorn (*Parkinsonia aculeata*), catclaw acacia. Some of the mesquites were more than 2 feet basal diameter and over 20 feet tall. Shrubs: wolfberry species, catclaw acacia, lotebush. Grasses and forbs: Bermuda grass (*Cynodon dactylon*), buffelgrass (*Pennisetum ciliare*), rough cocklebur (*Xanthium strumarium*). Cactus apple (*Opuntia phaeacantha*) and walkingstick cactus (*Opuntia spinosior*) were also present, and a few barrel cactus (*Ferocactus* sp). The site is heavily grazed and cattle were present.

Methods: Standard operating procedure (see methods section). Two trap lines, each consisting of 25 traps, were placed in the evening of 14 December 2004 and picked up on the morning of 15 December. Both lines were placed along the wash, one upstream the other downstream from the parking place.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>merriami</i>	180	92	22	17	M	AD	testes abdominal; specimen KJK501
<i>Peromyscus</i>	<i>merriami</i>	200	113	23	19	F	AD	pregnant; cinnamon spot on thorax; specimen KJK502
<i>Peromyscus</i>	<i>leucopus</i>	167	79	21	19	M	AD	testes abdominal; no specimen

Site 4. Arnold #2



Aerial photograph scale 1:4,000



Unnamed wash, tributary of Santa Cruz River. T16 S R14E S28. UTM (Zone 12, NAD 27 CONUS): 506995mE and 3541242mN. Map: Tucson SW. Elevation: 2,677 feet Ownership State of Arizona.

Historical Information: This is close to the site worked by Lee W. Arnold in 1938 and 1939, known as Weisner's Ranch. 11 (or 12) mi. S Tucson 20 June 1939 and other dates. The actual site is on private property, currently owned by ASARCO Inc. and no longer is mesquite dominated.

Access: Enter by road at off Nogales Hwy at approximately 3544525N; drive E through two gates to power line. Drive south approximately 1.8 mile to site, approximately 0.8 mi S of previous site.

Vegetation conditions: Harris Riparian map shows this site as 154.100, Sonoran desert scrub xeroriparian scrub. Soil is deep sandy loam, eroded in places with some very deep and narrow gullies, also wash bottom with few cobbles. Part of the wash is braced with old car bodies. Immediately downstream from the site is a concrete dam and riprapped bank. Trees: velvet mesquite, blue paloverde, Jerusalem thorn, catclaw acacia. Some of the mesquites were more than 2 feet basal diameter and over 20 feet tall. Shrubs: wolfberry species, catclaw acacia, lotebush. Grasses and forbs: Bermuda grass, buffelgrass, rough cocklebur. Cactus apple and walkingstick cactus were also present, and a few barrel cactus. Vines of Drummond's clematis (*Clematis drummondii*) are abundant. There were a few saguaros (*Carnegia gigantea*) and creosote bushes (*Larrea tridentata*) at the east end of the trap lines. The site is heavily grazed and cattle were present.

Methods: Standard operating procedure (see methods section). Two trap lines, each consisting of 25 traps, were placed in the evening of 14 December 2004 and picked up on the morning of 15 December. Both lines were placed along the wash, each following a separate braid, going upstream from the parking place. One trap was not relocated.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>merriami</i>	183	103	22	18	M	AD	testes abdominal; cinnamon spot on thorax; specimen KJK503
<i>Peromyscus</i>	<i>merriami</i>	201	107	22	19	F	AD	cinnamon spot on thorax; specimen KJK504
<i>Peromyscus</i>	<i>leucopus</i>	169	80	20	18	M	AD	No specimen

Site 5. Snyder Hill Road



Aerial photograph scale: 1:4,000.



Unnamed wash, disjunct tributary of Brawley Wash. T14S R11E S34. UTM (Zone 12, NAD 27 CONUS): 480670mE 3558348mN. Map: Brown Mountain. Elevation: 2,320 feet. Ownership: Pima County.

Historical information: This site roughly coincides with several historic locations at which *P. merriami* was trapped. They are:

W.J.S. 11 October 1956. 9 mi W of junction Ajo and Mission Road

K. E. Justice. 27 December 1956. 10 Mi W, 5.5 Mi S of Tucson.

Lee Arnold. 21 October 1939. 10 mi SW Tucson and other locations with a mile or two and several dates.

Access: Sandario Road to Snyder Hill Rd. Go E on Snyder Hill to curve. Park in one of the side cuts of the road on the north side and climb over a barbed wire fence.

Vegetation conditions: The Harris riparian map shows this as 224.52, Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series. This is a dense thicket of velvet mesquite on a substrate of sandy-silty soil. Sheet flow and wash flow are interrupted by a levee at the west side of this property. The only trees are velvet mesquite, generally less than one foot in basal diameter and less than 15 feet tall. Shrubs present include wolfberry species, snakeweed (*Gutierrezia* sp.), burroweed (*Isocoma tenuisecta*), and lotebush. The area is apparently not grazed at the present time. Some scattered debris is present, and there is an old road at the north end of the area we trapped.

Methods: Standard operating procedure (see methods section). Two trap lines, each of 25 traps, approximately 100 yards apart, more or less parallel northward from the fence line were set on the afternoon of 15 December 2004 and picked up on the morning of 16 December 2004.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Neotoma</i>	<i>albigula</i>						AD	released without measuring
<i>Peromyscus</i>	<i>merriami</i>	199	103	20	20	M	AD	testes abdominal; specimen KJK505
<i>Dipodomys</i>	<i>merriami</i>	209	123	35	12	M	AD	testes abdominal; no specimen
<i>Peromyscus</i>	<i>merriami</i>	181	95	21	20	M	AD	testes abdominal; cinnamon spot on thorax; specimen KJK 506
<i>Onychomys</i>	<i>torridus</i>	145	56	19	17	F	AD	Pregnant; no specimen
<i>Peromyscus</i>	<i>leucopus</i>	172	80	20	14	M	AD	testes abdominal; no specimen

Site 6. Ironwood Forest National Monument



Aerial photograph scale 1:5,000



Unnamed wash, tributary of Los Robles Wash. T11S, R10E, S19 UTM (Zone 12, NAD 27 CONUS): 466399mE and 3591471mN Map: West of Marana. Elevation: 1,920 feet. Ownership: Federal—Ironwood Forest National Monument.

Access: along Silverbell Road, a short spur goes north just past wash.

Historical information: This site is approximately where a specimen identified as *P. merriami* was trapped by Carl Hoagstrom on 12 May 1973 at 7.8 mi. E, 3.7 mi. N of Silver Bell Peak, 1900 feet

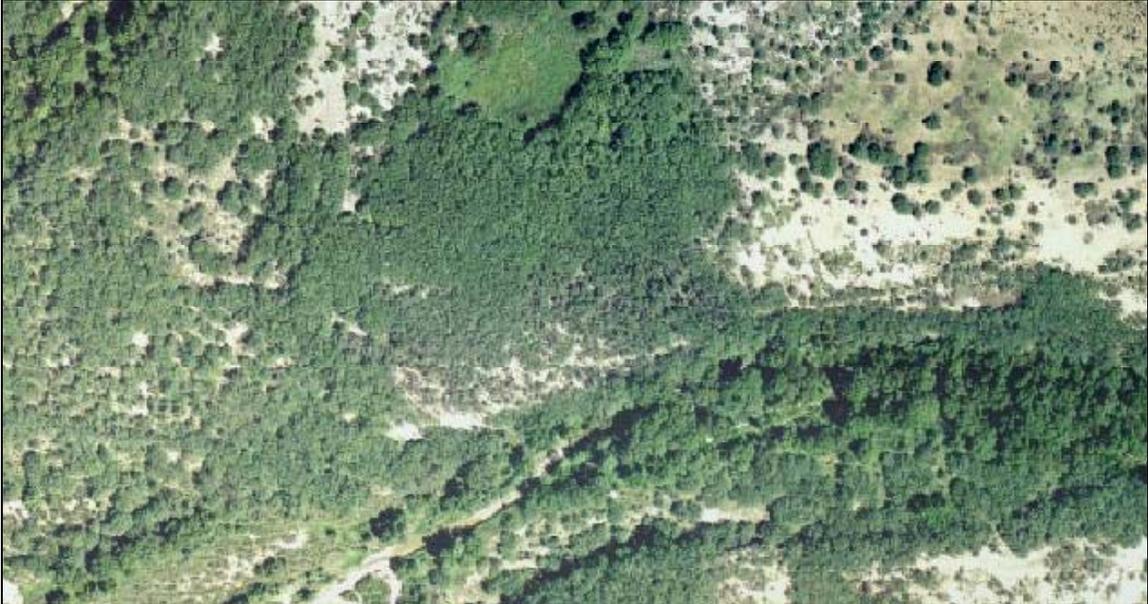
Vegetation conditions: The Harris Riparian map shows this site as 154.10, Sonoran Desertscrub. The area is obviously impacted by illegal traffic, much littered with plastic bags, cans, blankets, clothing, etc. It has been used as a dumpsite for glass and metal, which are scattered throughout. Upstream from the road, there is a single wash, downstream there are several braids and islands. This is a classic desert wash, lined with mesquite and ironwood, some blue paloverde and catclaw acacia as trees. Shrubs included creosote bush, mostly but not entirely outside the wash, wolfberry species, catclaw and whitethorn acacia (*Acacia constricta*). Grasses and forbs included *Bowlesia incana*, and red brome (*Bromus rubens*). The area appears to be grazed, but not very heavily.

Methods: Standard operating procedure (see methods section). Two trap lines, each of 25 traps, one upstream from the road, the other downstream. Because the downstream habitat was braided and had islands, traps were limited to the xeroriparian community and not set in a more-or-less straight line. A third trap line of 25 traps was set approximately 150 yards east of the wash, in upland vegetation, to ascertain small mammal activity for comparison to the wash. Traps were set on the afternoon of 15 December 2004 and picked up on the morning of 16 December.

Rodents trapped:

Genus	species	TL	T	HF	E	Sex	Age	Comments
<i>Dipodomys</i>	<i>merriami</i>	255	155	33	12	F	AD	desert trap line, only animal trapped
<i>Peromyscus</i>	<i>merriami</i>	200	115	21	17	F	AD	Specimen KJK507
<i>Neotoma</i>	<i>albigula</i>							released without measuring
<i>Peromyscus</i>	<i>merriami</i>	195	104	19	17	M	AD	testes abdominal; cinnamon spot on thorax; specimen KJK 508
<i>Peromyscus</i>	<i>eremicus?</i>	155	81	19	15	F	JUV	creosote bush dominant; no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	155	84	20	16	M	JUV	no specimen

Site 7. Cienega Creek County Park #1



Aerial photograph scale 1:4000



Mesquite woodland along Cienega Creek floodplain. T16S R17E S33. UTM (Zone 12, NAD 27 CONUS): 537102mE and 3540785mN. Map: Rincon Peak. Elevation: 3,460 feet. Ownership: Pima County. Cienega Creek County Park.

Access: From Pantano Road (aka Marsh Station Road), bridge over Cienega Creek, go 3.16 miles to gate at 538002mE and 3541704mN. Go through two gates, to parking area immediately E of railroad track. Walk SW to the mesquite area.

Historical information: There are no records of Mesquite Mouse from this area. It is unknown whether anyone has trapped this area. Turner (2003) shows that the area had few, if any, mesquite or other trees in 1880, but had become dominated by mesquite and cottonwood-willow vegetation in 1998.

Vegetation conditions: The Harris Riparian map shows this area as 224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series, and 234.712 Sonoran Deciduous Riparian Scrub. There are two terraces of sandy-loamy soil above Cienega Creek. The first terrace has cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and mesquite trees, some quite large. The second terrace has dense, smaller mesquites, with dense grass and vines. Shrubs include wolfberry species, lotebush, with creosote bush in the drier areas of the upper terrace. There is dense native bunch grass, mostly big sacaton (*Sporobolus wrightii*), and some young grass, apparently red brome and other annuals beginning to grow. The area has not been grazed for about ten years.

Methods: Two trap lines of 25 traps were set on 16 December 2004 and picked up on 17 December 2004. One was entirely on the upper terrace, mostly under the mesquites at the edge of the open grassland. The second was along the edge of the upper terrace, then down to the lower terrace where ten traps were placed.

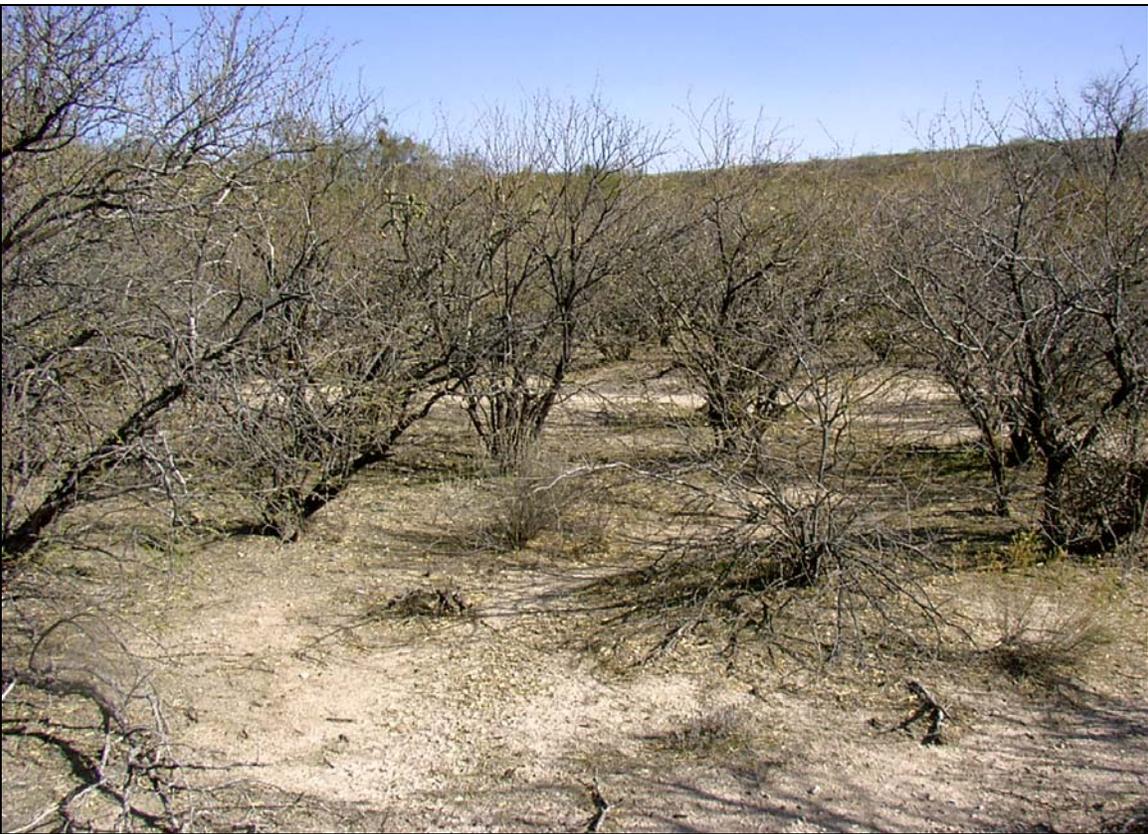
Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Chaetodipus</i>	<i>penicillatus</i>	180	95	23	8	F	AD	upper terrace; no specimen
<i>Onychomys</i>	<i>torridus</i>	145	46	19	15	F	AD	pregnant, upper terrace; no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	175	96	19	15	F	AD	pregnant, upper terrace; no specimen
<i>Peromyscus</i>	<i>merriami</i>	203	120	21	18	F	AD	upper terrace; specimen KJK509
<i>Chaetodipus</i>	<i>baileyi</i>	190	115	23	9	F	AD	upper terrace; no specimen
<i>Chaetodipus</i>	<i>intermedius</i>	160	89	20	9	F	AD	upper terrace; no specimen
<i>Peromyscus</i>	<i>merriami</i>	181	95	22	19	F	AD	upper terrace, cinnamon spot; specimen KJK510
<i>Peromyscus</i>	<i>eremicus?</i>	92	3	18	17	F	AD	pregnant, no specimen
<i>Peromyscus</i>	<i>merriami</i>	205	109	21	18	F	AD	pregnant, cinnamon spot: specimen KJK511
<i>Peromyscus</i>	<i>merriami?</i>	189	96	20	21	M	AD	cinnamon spot, no specimen
<i>Peromyscus</i>	<i>merriami?</i>	195	100	21	20	M	AD	lower terrace, no specimen
<i>Reithrodontomys</i>	<i>fulvescens</i>	138	79	17	12	F	AD	lower terrace, no specimen
<i>Peromyscus</i>	<i>merriami?</i>	200	111	21	19	F	AD	pregnant, upper terrace, cinnamon spot, no specimen

Site 8: Cienega Creek County Park #2



Aerial photograph scale 1:4,000



Floodplain of Cienega Creek, downstream from railroad bridge. T16S R17E S30. UTM (Zone 12, NAD 27 CONUS): 533196mE and 3542375mN. Map: Vail. Elevation 3,291. Ownership: Pima County. Cienega Creek County Park.

Access: Park on W side of Marsh Station Road, walk along road that parallels railroad tracks to drainage running down into creek.

Historical information: There are no records of Mesquite Mouse from this area. It is unknown whether anyone has trapped at this area.

Vegetation conditions: The Harris Riparian map shows this area as 224.52 Sonoran Riparian Deciduous Forest and Woodlands, Mesquite Series. However, the actual trap line went along the edge of the mesquite bosque, along the base of the hills which are Arizona Upland with saguaros, various *Opuntia* species and barrel cactus, with scattered mesquites. Shrubs included creosote bush, triangle bur ragweed (*Ambrosia deltoidea*), snakeweed, and spiny hackberry. Mesquites were generally small, less than one foot basal diameter. Closer to the stream, not on the trap line, there are larger mesquites. The area is very heavily impacted by illegal traffic. There is much trash present and many trails.

Methods: One line of 25 traps was placed along the edge of the bosque on 16 December and picked up on 17 December 2004.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>eremicus?</i>	190	103	20	17	F	AD	pregnant, no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	185	98	19	16	F	AD	pregnant, no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	180	93	19	18	F	AD	pregnant, no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	190	104	20	18	M	AD	testes abdominal, no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	172	86	19	16	F	AD	pregnant, no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	189	94	19	17	F	AD	not pregnant, no specimen

Site 9. King Street



Aerial photograph scale 1:4,000



Tanque Verde Wash floodplain. T14S R15E S1 UTM (Zone 12, NAD 27 CONUS): 522314mE 3566894mN. 1480 N King Street, on E side of end of King Street. Map: Tucson East. Elevation: Ownership: Pima County.

Access: Take Tanque Verde Road E to Tanque Verde Loop Rd. go S to Linden, W to King, S to end.

Historic information: This may be close to the historic location:

3.5 mi. E Junction Redington Rd. on Mt. Lemmon Road 5 January 1953 A.G. Baker

Following these directions exactly puts one on private land that does not appear to be suitable habitat, and the Mt. Lemmon Road goes NE. If the directions should have been "3.5 mi E of Junction of Redington Rd. and Mt. Lemmon Road" this would be very near this location.

Vegetation conditions: This is a grove of tall, large diameter mesquite trees that seems to be in virgin condition. It apparently was someone's home and acreage. Now the home is gone, there is a small amount of scattered junk. The only trees present appear to be velvet mesquite. There are few shrubs. The area is surrounded by low-density residential development.

Methods: A total of 50 traps were placed in 3 parallel lines, from the fence on the West side of the property, extending eastward. Traps were placed at about 10 m intervals, and lines were approximately 10 m apart. Traps were placed on the afternoon of 21 December and retrieved on the morning of 22 December 2004.

Rodents trapped: None.

Site 10. Isabella Lee County Preserve



Aerial photograph scale: 1: 3,000.



Floodplain of Tanque Verde and Agua Caliente Wash. T14S R15E S2 UTM (Zone 12, NAD 27 CONUS): 520415mE 3567046mN. Map: Tucson East. Elevation: 2,550 ft. Ownership: Pima County

Access: Tanque Verde Road E to Bonanza, then S to end of road.

Historic information: This site includes the confluence of two major washes, Tanque Verde Creek and Agua Caliente Wash. This may be close to the historic location:

3.5 mi. E Junction Redington Rd. on Mt. Lemmon Road 5 January 1953 A.G. Baker

However, at that time, this was private land that might not have been accessible to trapping.

Vegetation conditions: Vegetation is a mosaic of several groves of tall, large diameter mesquite trees that seem to be in virgin condition, clusters of smaller mesquites, large mesquites, walnuts (*Juglans major*), a few cottonwoods and netleaf hackberries along the washes, and open areas dominated by grasses and annual plants. Prior uses of the site were for grazing. A sanitary sewer line crosses the site. Currently the site is heavily used by recreational equestrians, who have created multiple trails, and occasionally by birders, hikers, and mountain bicyclists. The site is surrounded by low density residential development.

Methods: A total of 50 traps were placed in 2 parallel lines, beginning at the trail on the east side of the property and extending westward through the densest mesquites available. Traps were placed at about 10 m intervals, and lines were approximately 10 m apart. Variations from this spacing were made to avoid open areas with no trees. Traps were placed on the afternoon of 22 December and retrieved on the morning of 23 December 2004.

Rodents trapped: None.

A second survey, placing the traps along approximately the same lines, was conducted on 13-14 January, with moon at new plus 3 days, to rule out potential adverse effects of moonlight on trap success at this site. Once again, no rodents were trapped. It appears that there are few nocturnal rodents on this site. The area has abundant round-tailed ground squirrels (*Citellus tereticaudus*) and nests of white-throated woodrats (*Neotoma albigula*), but none of these rodents were caught in traps.

Site 11. Cienega Creek, Empire-Cienega Ranch



Aerial photograph scale: 1:3,000



Floodplain of Cienega Creek, within Empire-Cienega Resource Conservation Area. T18S R17E S26. UTM (Zone 12, NAD 27 CONUS): 539445mE and 3522507mN. Map: Spring Water Canyon. Elevation: 4,280 feet Ownership: U.S. Government (BLM)

Historical information: This area was formerly private land. There are no records of *P. merriami* having been trapped here.

Access: Take entrance road to Empire-Cienega Conservation Area from Sonoita Highway. This is road EC901. Stay on it until it comes to unmarked side road leading down to an old agricultural field. Continue on the road around the field to NW corner, where there is a gate.

Vegetation conditions: This area is shown on the Harris Riparian map as 224.53 Sonoran Riparian Deciduous Forest and Woodlands, Cottonwood-Willow Series and 143.10, Semidesert grassland. This is an area of some very large mesquites, basal diameter up to 6 feet, but most of them are smaller and of short stature. The understory is dense dead prickly Russian thistle (*Salsola tragus*) in places, and down wood in some places and, and much of it consist of dense, vigorously growing big sacaton. Trees present include mesquite, Goodding's willow, Fremont cottonwood, and netleaf hackberry. Shrubs include wolfberry and lotebush.

Methods: Fifty traps in two sets of 25 were set on January 1, 2005 and picked up on January 2, 2005. One set went upstream, the other downstream from the gate. Each set consisted of two parallel lines placed so as to remain within the mesquite-dominated area.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>eremicus?</i>	180	85	19	15	M	AD	testes abdominal; no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	175	92	18	18	F	AD	Pregnant; no specimen
<i>Peromyscus</i>	<i>eremicus?</i>	175	95	19	17	F	AD	Pregnant; no specimen

Site 12. Arivaca Creek Access Site, Buenos Aires National Wildlife Refuge



Aerial photograph scale: 1:3,000.



Floodplain of Arivaca Creek, at creek access point parking lot. Map: Arivaca. T21S R10E Section 19, NW ¼. UTM (Zone 12, NAD 27 CONUS): 465648mE 3495155mN. Elevation: 3,540 feet Ownership: United States of America (Buenos Aires National Wildlife Refuge).

Access: Parking area for trail access, south side of Arivaca-Sasabe Road, approximately milepost 9.

Historical Information: This site is close to that described as 2 mi N, 4 mi W Arivaca at which W. and L. Goodpaster trapped several *P. merriami* in March 1962.

Vegetation conditions: The Harris Riparian Vegetation map indicates that this site is 143.10, Semidesert grassland, xeroriparian scrub. To the west of the parking area is a grove of mesquites that are approximately evenly aged and spaced, about 1 to 2 feet in basal diameter and 15 to 20 feet tall. Mid- and understory are not well developed in this area, except an understory of annual grasses and forbs. To the east of the parking lot is a narrow strip of big, old mesquites with a dense midstory of wolfberry, spiny hackberry, and lotebush and dense understory of mixed annual forbs.

Methods: Fifty traps in two groups were placed at this location on the afternoon of January 15, 2005 and picked up on the morning of January 16, 2005. One group was a 5 by 5 trap grid with 10 meter spacing set in the mesquite grove on the west side of the parking area. The second group was a line through the dense vegetation on the east side of the parking area, with a right angle bend to parallel Arivaca Creek eastward. Measurements were taken only on animals in the genus *Peromyscus*.

Rodents trapped: No small mammals were captured on the west side. At least ten of the traps had been disturbed, possibly by coyotes, foxes, or ravens, and one trap was missing and could not be relocated.

On the east side, the following animals were trapped and released:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>merriami</i>	201	107	21	20	F	AD	pregnant, cinnamon spot, specimen KJK512
<i>Peromyscus</i>	<i>merriami</i>	195	100	20	20	F	AD	pregnant, cinnamon spot, specimen KJK513
<i>Neotoma</i>	<i>albigula</i>							

Site 13. McCafferty Canyon at confluence with Alamito Canyon



Aerial photograph scale: 1:3,000.



Rocky wash in McCafferty Canyon at confluence with Alamito Canyon. Map: Arivaca. T21S R10E S18. UTM (Zone 12, NAD 27 CONUS): 465463mE and 3496037mN Elevation 3,585 feet Ownership: State of Arizona.

Historical Information: This site is close to that described as 2 mi N, 4 mi W Arivaca at which W. and L. Goodpaster trapped several *P. merriami* in March 1962.

Vegetation conditions: The Harris Riparian Vegetation map indicates that this site is 143.10. The site is a narrow (<20 feet wide) rocky sandy wash lined with small mesquites and catclaw acacia. Desert broom, lotebush, and spiny hackberry were also present.

Methods: Twenty-five traps were placed along the wash upstream from the road on the afternoon of January 15, 2005 and picked up on the morning of January 16, 2005.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus</i>	<i>merriami</i>	192	99	20	21	F	AD	pregnant, cinnamon spot, specimen KJK514

Site 14. Unnamed Rocky Wash. Buenos Aires National Wildlife Refuge

No aerial photograph is available.



An unnamed rocky wash located in T21S R9E S13. Map: Arivaca. UTM (Zone 12, NAD 27 CONUS): 464681mE 3496284mN. This wash is a tributary of Arivaca Creek. Elevation 3,557 feet Ownership: United States of America (Buenos Aires National Wildlife Refuge).

Historical Information: This site is close to that described as 2 mi N, 4 mi W Arivaca at which W. and L. Goodpaster trapped several *P. merriami* in March 1962.

Vegetation conditions: The site is not indicated as Class A or B mesquite mouse habitat, as originally defined. The Harris Riparian Vegetation map does not distinguish this site. The site consists of an incised wash and terrace of mesquites, most of the trees are <15 feet tall and <1 feet in basal diameter, but some are much larger.

Methods: Set 25 traps, 12 on S side of road, 13 on N side of road on the afternoon of January 15, 2005 and picked up on the morning of January 16, 2005.

Rodents trapped: Only one animal, an *Onychomys torridus*, was trapped. No measurements were taken.

Site 15. Mormon Lake, West Side, Buenos Aires National Wildlife Refuge



Mormon Lake, on the west side of the lake. T22 S R8E S4. UTM (Zone 12, NAD 27 CONUS): 450450mE and 3489932m N. Map: Presumido Peak. Elevation: 3,500 feet

Historical information: *P. merriami* was trapped at or “near” Mormon Lake on 19 December 1953 by K. E. Justice and L.D. Beatty.

Access: The site is bordered on the east and west sides by dirt roads.

Vegetation conditions: The site is a dense patch of fairly small (to 5 meters tall) mesquites. Tree and brush clearing has occurred on the west side of the patch, along the dirt road. There is little mid or under story vegetation.

Methods: Standard operating procedure (see methods section). Two parallel lines of 25 traps each were placed on 16 January and retrieved on 17 January 2005. Measurements were taken only on animals suspected *P. merriami*.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Onychomys torridus</i>								
<i>Peromyscus</i>	<i>merriami</i>	179	96	21	21	F	AD	emaciated; pregnant, cinnamon spot, specimen KJK517
<i>Dipodomys merriami</i>								
<i>Peromyscus</i>	<i>merriami</i>	170	74	22	20	F	AD	tail amputated and healed; pregnant, cinnamon spot, cream wash
<i>Dipodomys merriami</i>								
<i>Peromyscus leucopus</i>								
<i>Peromyscus leucopus</i>								
<i>Peromyscus leucopus</i>								
<i>Onychomys torridus</i>								
<i>Dipodomys merriami</i>								
<i>Onychomys torridus</i>								

Site 16. Upland Site, Buenos Aires National Wildlife Refuge
No aerial photograph is available.



To contrast with the small mammals trapped in the riparian areas, we also trapped the mesquite-invaded grassland area between Arivaca Wash and Puertocito Wash, T20S R9E Section 32. UTM (Zone 12, NAD 27 CONUS): 458328mE and 3500771mN. Map: Las Guijas. Elevation: 3,430 feet Ownership: United States of America (Buenos Aires National Wildlife Refuge).

Historical information: No historical information is available for this site.

Access: The area is around a campsite along a dirt road leading northward from the Arivaca Road.

Vegetation conditions: This is a mesquite-invaded grassland, with mesquites generally small (<10 feet tall and <1 feet basal diameter), with mixed native and non-native grasses.

Methods: Standard operating procedure (see methods section). One line consisting of 25 traps was set on 15 January and checked on 16 January. Animals were minimally handled, not measured, weighed, or sexed. The same traps were reopened and rebaited in the evening of 16 January and picked up in the morning of 17 January, 2005.

Rodents trapped:

Genus	Species
Jan 16	
<i>Dipodomys</i>	<i>merriami</i>
<i>Onychomys</i>	<i>torridus</i>
<i>Chaetodipus</i>	<i>baileyi</i>
Jan 17	
<i>Dipodomys</i>	<i>merriami</i>
<i>Onychomys</i>	<i>torridus</i>
<i>Chaetodipus</i>	<i>intermedius</i>
<i>Onychomys</i>	<i>torridus</i>

Site 17. Mormon Lake, North Side, Buenos Aires National Wildlife Refuge

No aerial photograph is available.



Mormon Lake, an artificial impoundment on the Buenos Aires National Wildlife Refuge, along a dirt bank at the north end of the lake. T22S R8E S3. UTM (Zone 12, NAD 27 CONUS): 450831mE and 3490211mN. Map: Presumido Peak. Elevation: 3,500 feet Ownership: United States of America (Buenos Aires National Wildlife Refuge).

Historical Information: *P. merriami* was trapped at or “near” Mormon Lake on 19 December 1953 by K. E. Justice and L.D. Beatty.

Access: The site is easily accessed by means of a dirt road on the north side of the lake.

Vegetation conditions: Vegetation consists of primarily mesquites growing along the earthen dam that creates the “lake” and north of the dam, where soil moisture was higher than surrounding areas. Mid- and under-story vegetation was very limited, and consisted of sparse wolfberry, snakeweed, and burroweed. The area is very heavily impacted by immigrant traffic and there was much litter on the ground.

Methods: Standard operating procedure (see methods section). One line of 50 traps was set on 16 January and picked up on 17 January 2005. Measurements were taken only on animals in the genus *Peromyscus*.

Rodents trapped:

Genus	Species	TL	T	HF	E	Sex	Age	Comments
<i>Peromyscus leucopus</i>		134	63	17	15	F	AD	Pregnant
<i>Peromyscus merriami</i>		193	101	23	20	F	AD	Pregnant, cinnamon spot, cream wash, specimen KJK515
<i>Peromyscus leucopus</i>		142	62	19	14	M	AD	testes abdominal
<i>Onychomys torridus</i>								
<i>Peromyscus merriami</i>		191	104	21	20	F	AD	Pregnant, cinnamon spot, cream wash, specimen KJK515
<i>Peromyscus leucopus</i>								

Site 18. West Branch of the Santa Cruz River, South



A narrow wash with steep sides, at this location only about 3 or 4 feet deep. T14S R13E S27. UTM (Zone 12, NAD 27 CONUS): 500245mE and 3560720 mN. Map: Tucson. Elevation: 2,390 feet Ownership: Pima County.

Historical information: The West Branch has been the focus of biological studies recently and has been found to include diverse plants (Maus 2003) and animals (Rosen 2003) that are considered representative of the Santa Cruz River valley in Tucson before the ecological devastation that affected most of the area. On both sides of the wash, within a few hundred meters, there are houses and house trailers, horse properties, and other domestic livestock. Feral cats were seen in the vicinity. As far as is known, this site has not been trapped for rodents.

Access: Along the power line access road on the north side of the mobile home park at Freedom Lane and Ajo Road.

Vegetation conditions: This is a mesquite-dominated wash, with some trees up to 2 feet in basal diameter, most smaller. The riparian vegetation at this site is generally only one or two trees wide, and is bordered by inactive agricultural land and residences. Many of the trees show signs of having been cut at some time in past decades.

Methods: Standard operating procedure (see methods section). Two parallel trap lines consisting of 25 traps each were placed on each side of the wash on the afternoon of 21 March 2005 and retrieved in the morning of 22 March.

Rodents trapped: None.

Site 19. West Branch of the Santa Cruz River, North



A narrow wash with steep sides, at this location only about 3 or 6 feet deep. T14S R13E S26. UTM (Zone 12, NAD 27 CONUS): 500565mE and 3561499 mN. Map: Tucson. Elevation: 2,380 feet Ownership: Pima County.

Historical information: The West Branch has been the focus of biological studies recently and has been found to include diverse plants (Maus 2003) and animals (Rosen 2003) that are considered representative of the Santa Cruz River valley in Tucson before the ecological devastation that affected most of the area. On both sides of the wash, within a few hundred meters, there are houses and house trailers, horse properties, and other domestic livestock. Feral cats were seen in the vicinity. As far as is known, this site has not been trapped for rodents.

Access: Park at the gate at the end of the County easement to the South of Church Wash and walk to the site.

Vegetation conditions: This is a mesquite-dominated wash, with some trees up to 2 feet in basal diameter, most smaller. The riparian vegetation at this site is generally only one or two trees wide, and is bordered by inactive agricultural land and residences. Many of the trees show signs of having been cut at some time in past decades.

Methods: Standard operating procedure (see methods section). Two parallel trap lines consisting of 25 traps each were placed on each side of the wash on the afternoon of 21 March 2005 and retrieved in the morning of 22 March.

Rodents trapped: None.

APPENDIX C

FIELD KEY TO RODENTS LIKELY TO BE TRAPPED

FIELD KEY TO RODENTS LIKELY TO BE TRAPPED

Squirrels

Not Squirrels

- Fur-lined cheek pouches HETEROMYIDAE
- No cheek pouches MURIDAE

HETEROMYIDAE

- Soles of hind feet densely haired Dipodomys
 - 5 toes on hind foot..... ordii
 - 4 toes on hind foot
 - Size large, total length >300 mm..... spectabilis
 - Size small, total length <260 mm merriami
- Soles of hind feet naked Perognathus and Chaetodipus
 - TL < 150 mm, HF <20mm (tiny, soft and silky) Perognathus flavus
 - TL>150, HF >20 mm (bigger, rougher looking)
 - HF <22 mm, H and B <80Chaetodipus intermedius
 - HF >22 mm, HB >80
 - Tail much longer than HB, HB usually > 95 mmbaileyi
 - Tail slightly longer than HB, HB usually < 95 mm, pencil tip tail.... penicillatus

MURIDAE

Larger animal, > 200 mm

- Small ears Sigmodon arizonae
- Large ears Neotoma albigula

Smaller animal, ≤ 200 mm

- Upper incisors grooved on anterior face Reithrodontomys
 - Dorsum golden brownish, belly grayish white washed with buff, tail >77 mmfulvescens
 - Dorsum grayish or brownish, venter grayish, tail < 77mmmegalotis
- Upper incisors not grooved
 - Short tail, < 60% of HB Onychomys torridus
 - Longer tail, > 60% HB Peromyscus
 - TAKE ALL MEASUREMENTS!!!!!!!!!!!!!!!!!!!!!!!!!!!!
 - Tail shorter than bodyleucopus
 - Tail longer than body
 - TL < 190, Tail < 100, Body <85, HF <22, Ear < 20..... eremicus
 - TL > 190, Tail > 100, Body > 85, HF > 22, Ear > 20 **COULD BE MERRIAMII!!!**