

**Western Riverside County  
Multiple Species Habitat Conservation Plan (MSHCP)  
Biological Monitoring Program**

**Aguanga Kangaroo Rat Report 2010**



**5 April 2011**

## TABLE OF CONTENTS

<b>INTRODUCTION</b> .....	<b>1</b>
GOALS AND OBJECTIVES: .....	1
<b>METHODS</b> .....	<b>1</b>
SURVEY DESIGN .....	1
TRAINING.....	2
STUDY SITE SELECTION.....	3
SURVEY LOCATIONS.....	3
FIELD METHODS .....	4
DATA ANALYSIS .....	6
<b>RESULTS</b> .....	<b>8</b>
<b>DISCUSSION</b> .....	<b>11</b>
RECOMMENDATIONS FOR FUTURE SURVEYS .....	12
<b>LITERATURE CITED</b> .....	<b>12</b>

## LIST OF TABLES AND FIGURES

<b>TABLE 1.</b> Area (ha) of modeled habitat and number of grids at each survey site.....	3
<b>FIGURE 1.</b> Grid design (5x5) for trapping small mammals.....	4
<b>TABLE 2.</b> Summary of height ranges assigned to height classes.....	6
<b>TABLE 3.</b> Summary of species recorded while surveying for Aguanga kangaroo rat 27 September - 7 October 2010.....	8
<b>FIGURE 2.</b> Aguanga kangaroo rat survey areas with occupied and non-occupied grids, 27 September - 7 October 2010.....	9
<b>FIGURE 3.</b> Mean percent cover and 95 % confidence intervals on grids occupied and unoccupied by Aguanga kangaroo rat. ....	10
<b>TABLE 4.</b> Akaike Information Criterion for small samples ( $AIC_c$ ), difference in $AIC_c$ ( $\Delta AIC_c$ ), Akaike weights ( $w_i$ ), and estimated parameters ( $K$ ) of the top 10 habitat models from a candidate set of 127 that examined effects of percent bare ground, percent litter cover, percent thatch cover, percent grass, percent forb, litter depth and thatch depth on Aguanga Kangaroo rat distribution.....	11
<b>TABLE 5.</b> Parameter estimates for explanatory variables ( $\beta$ ) and standard errors (SE) averaged across candidate sets of general-linearized models investigating presence/absence of saplings and seedlings on surveyed transects. Total weight of models that include each variable reported as $\Sigma w_i$ .....	11

## **LIST OF APPENDICES**

<b>APPENDIX A.</b> Soil and Vegetation Attributes Used to Delineate Aguanga Kangaroo Rat Habitat.....	15
<b>APPENDIX B.</b> Small Mammal Trapping Standard Operating Procedures V.2 .....	17
<b>APPENDIX C.</b> Species recorded per grid while surveying for Aguanga kangaroo rat, 27 Sept - 7 Oct 2010. ....	27

**NOTE TO READER:**

This report is an account of survey activities conducted by the Biological Monitoring Program for the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). The MSHCP was permitted in June 2004. The Monitoring Program monitors the distribution and status of the 146 Covered Species within the Conservation Area to provide information to Permittees, land managers, the public, and the Wildlife Agencies (i.e., the California Department of Fish and Game and the U.S. Fish and Wildlife Service). Monitoring Program activities are guided by the MSHCP species objectives for each Covered Species, the information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees.

MSHCP reserve assembly is ongoing and it is expected to take 20 or more years to assemble the final Conservation Area. The Conservation Area includes lands acquired for conservation under the terms of the MSHCP and other lands that have conservation value in the Plan Area (called public or quasi-public lands in the MSHCP). In this report, the term “Conservation Area” refers to the Conservation Area as understood by the Monitoring Program at the time the surveys were planned and conducted.

We would like to thank and acknowledge the land managers in the MSHCP Plan Area, who in the interest of conservation and stewardship facilitate Monitoring Program activities on the lands for which they are responsible. A list of the lands where data collection activities were conducted in 2010 is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies. Partnering organizations and individuals contributing data to our projects are acknowledged in the text of appropriate reports.

While we have made every effort to accurately represent our data and results, it should be recognized that data management and analysis are ongoing activities. Any reader wishing to make further use of the information or data provided in this report should contact the Monitoring Program to ensure that they have access to the best available or most current data.

The primary preparer of this report was the 2010 Mammal Program Lead, Jennifer Hoffman. If there are any questions about the information provided in this report, please contact the Monitoring Program Administrator. If you have questions about the MSHCP, please contact the Executive Director of the RCA. Further information on the MSHCP and the RCA can be found at [www.wrc-rca.org](http://www.wrc-rca.org).

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## **INTRODUCTION**

Aguanga kangaroo rat (*Dipodomys merriami collinus*; AKR) is a California species of special concern. The range of Aguanga kangaroo rat stretches from the Mason Valley in eastern San Diego County north along the western edge of the Colorado Desert to Earthquake and San Felipe Valleys, and northwest into the Aguanga and Wilson Valleys of southwestern Riverside County (Williams et al. 1993). Within Riverside County this species is typically found in Riversidean alluvial fan sage scrub associated with the flood plains of Temecula Creek, Wilson Creek, and their tributaries, but may also be found in Riversidean sage scrub, chaparral and grassland vegetation in adjacent upland areas (Dudek & Associates 2003). AKR is often associated with sandy-loam soils that are common throughout the designated core drainages.

The Western Riverside County MSHCP calls for the conservation of 5484 acres of suitable habitat for AKR in Temecula Creek, Wilson Creek, and their tributaries (Dudek & Associates 2003). As per the MSHCP species-specific monitoring objectives, at least 75% of conserved habitat must be occupied, with 20% of occupied habitat supporting a population of at least 5 – 15 individuals per ha, as measured over any 8-year period.

The Biological Monitoring Program documented the distribution of AKR in portions of core drainages and tributaries that occur on conserved lands in autumn 2010. We used a repeat-visit survey design to estimate Percent Area Occupied (PAO) of suitable habitat based on a GIS model created by the Biological Monitoring Program. We also measured vegetation at survey locations to refine our habitat model and to expand our knowledge of habitat parameters that influence the distribution of AKR. In 2010, our goals and objectives for surveying AKR were as follows:

### **Goals and Objectives:**

1. Document current distribution of Aguanga kangaroo rat on conserved lands.
  - a. Estimate percent area occupied of modeled habitat.
2. Refine our habitat model.
  - a. Rank importance of habitat covariates in general linear models.

## **METHODS**

### **Survey Design**

We estimated area of occupied habitat using a repeat-visit survey design within a PAO sampling framework (Mackenzie et al. 2006). We based this survey design on previous survey efforts for small mammals (see *2008 Biological Monitoring Program Stephens' Kangaroo Rat Survey Report*). We visited trapping grids every night for 4 consecutive nights, during which time populations are presumed 'closed' to changes in occupancy. A closed population is one having no gains through births or immigration and no losses through deaths or emigration. We were able to calculate detection probability and grid occupancy with data obtained through closed population trapping using Program MARK (White and Burnham 1999). Detection probability is the probability that the species will be detected if it inhabits the area of interest (Mackenzie et al. 2006).

Occupancy is the probability that a randomly selected site in an area of interest is occupied by at least 1 individual of the species of interest (Mackenzie et al. 2006).

## **Training**

Crew members attended an intensive training seminar and participated in mock-surveys before being assigned field duty. The 2-day seminar included a slide-show presentation that focused on survey protocol, animal identification, and standard operating procedures for trapping small mammals. Field staff also practiced animal handling and processing techniques on domestic white mice. Following the training seminar, crew members took a quiz covering presented material, and demonstrated proficiency at handling and taking measurements of live animals. Field crew who passed the quiz correctly answered all questions pertaining to identification of Covered Species.

Field-based training included 2 trap nights of demonstrating species identification and processing animals captured on practice grids (5 x 5) at the Potrero Unit of the San Jacinto Wildlife Area (Potrero). The demonstration period was followed by 2 trap nights of mock surveys where crew members practiced checking grids and recording data according to protocol. We only conducted midnight trap checks during the 4 nights of field-based training.

After completing the above training, crew members were able to identify 7 covered and 6 non-covered small mammal species in-hand. Crew members could also safely and proficiently handle live animals and take measurements according to standard operating procedures developed by the Biological Monitoring Program. Moreover, crew members were able to perform surveys for AKR according to the protocol described in this document. Only crew members that successfully completed training processed animals. The California Department of Fish and Game and Regional Conservation Authority funded Biological Monitoring Program personnel; volunteers are noted. Biologists conducting AKR surveys in 2010 included:

- Jennifer Hoffman (Project Lead, Biological Monitoring Program)
- Ashley Ragsdale (Biological Monitoring Program)
- Betsy Dionne (Biological Monitoring Program)
- Bill Kronland (Biological Monitoring Program)
- Elise Hinger (Biological Monitoring Program)
- Esperanza Sandoval (Biological Monitoring Program)
- Joe Sherrock (Biological Monitoring Program)
- John Dvorak (Biological Monitoring Program)
- Julie Golla (Biological Monitoring Program)
- Joanna Gibson (Biological Monitoring Program)
- Laura Magee (Biological Monitoring Program)
- Lauren Ross (Biological Monitoring Program)
- Mike Robinson (Biological Monitoring Program)
- Nicole Housel (Volunteer, Santa Ana Watershed Association)
- Sloane Seferyn (Biological Monitoring Program)
- Samantha Treu (Biological Monitoring Program)

- Tara Graham (Biological Monitoring Program)

### Study Site Selection

We defined the study area to be all conserved lands in the flood plains of Temecula Creek, Wilson Creek, and their tributaries showing suitable soil and vegetation types in GIS-based soil (Soil Survey Staff et al. 2006) and vegetation maps (CDFG et al. 2005) of western Riverside County. We modified an existing GIS-based model of suitable habitat for Los Angeles pocket mouse (*Perognathus longimembris brevinasus*) and pacific pocket mouse (*P. l. pacificus*) because these species are found in sandy washes and sandy-loam soil types, as is AKR (Germano 1997, Dudek & Associates 2003). Targeted soil types included sand and loam associated with flood plains or drainages (Germano 1997, Bornyasz 2003), counting gravelly strata, but not rock, stone, or cobble (M'Closky 1972, Meserve 1976, Winchell et al. 1999; Appendix A). Targeted vegetation types included grassland, coastal sage scrub, chaparral, desert scrub, Riversidean alluvial fan scrub, and wet meadow (e.g., playas, vernal pools) vegetation types (Dudek & Associates 2003), but not shrubland or scrub > 60% cover density (Germano 1997). We modified the existing model to remove upland alluvial soils not associated with flood plains or drainage channels. There were approximately 118 ha of available habitat within designated core drainages that our model identified as suitable for AKR (Table 1).

**Table 1.** Area (ha) of modeled habitat and number of grids at each survey site.

	<b>Aguanga Valley</b>	<b>Tule Creek</b>	<b>Lancaster Valley East</b>	<b>Lancaster Valley West</b>	<b>Sage Road</b>	<b>Upper Wilson Valley</b>
Available Habitat <sup>1</sup>	13.5	14.5	44.9	13.5	25	6.3
Accessible Habitat <sup>2</sup>	13.5	14.2	29.3	12.3	24.4	4.9
Percent surveyed <sup>3</sup>	100	98	65	91	98	78
Grids	5	5	10	4	10	2

<sup>1</sup> From model based on soil and vegetation characteristics.

<sup>2</sup> Represents inference area in which grids were randomly distributed.

<sup>3</sup> Percent of modeled habitat that is accessible and was surveyed.

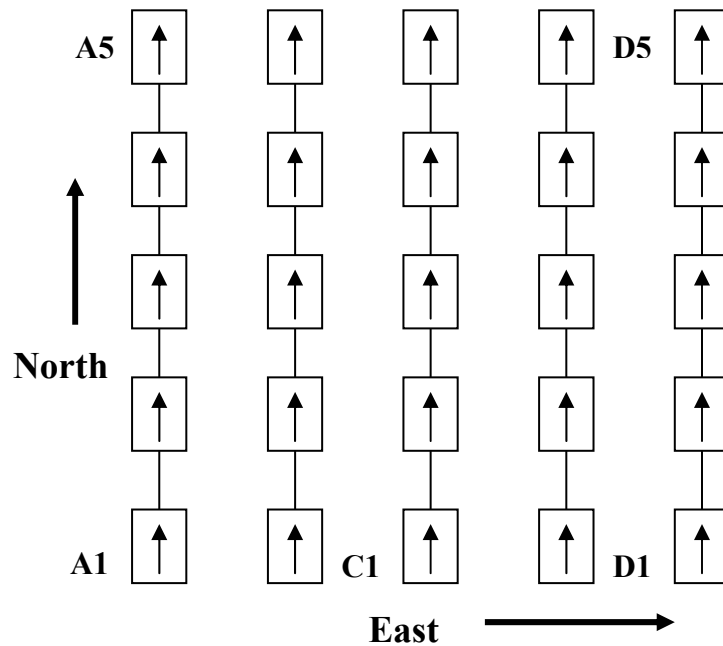
We removed from our potential sampling area any portions of suitable habitat too small or linear to be sampled (e.g., < 0.4 ha or < 30 m wide), prohibitively difficult to access (e.g., > 800 m from a road, or behind terrain that exceeded 25 degree slope), or located on conserved lands without granted access (i.e., Wilson Creek Preserve). We also removed a 10-m buffer around roads so that survey stations did not overlap transportation corridors. The resulting survey area covered 98.6 ha of accessible habitat and consisted of 6 locations separated by expanses of non-suitable habitat and/or lands not included in the Conservation Area (Table 1).

### Survey Locations

We randomly distributed sampling stations (i.e., 5 x 5 trapping grids) across the survey area using the Hawth's Tools extension (Beyer 2004) for Arc GIS v.9.3.1 (ESRI

2006). To maintain sample independence we distributed stations with a minimum spacing of 110 m between stations (Behrends et al. 1986), and imposed a sampling density of 1 survey station per 3.5 ha (Table 1). To provide additional small mammal survey data to the Center for Natural Lands Management, we increased sampling density at Sage Road to 1 survey station per 2.4 ha.

Sampling stations consisted of 25 traps arranged in a 5 x 5 grid with 10-m spacing (40 m x 40 m area) (Figure 1), representing roughly twice the size of the average reported home range for *Dipodomys merriami* in California and Arizona (0.25 ha; Behrends et al. 1986). We surveyed 36 grids over two 4-night efforts (Sunday to Thursday, 14 – 20 grids per effort) controlling for sampling bias by semi-randomizing the order of nightly trap checks (time bias) and alternating field-crew grid assignments (observer bias; MacKenzie and Royle 2005). We also scheduled efforts to coincide with new-moon cycles to control for the effect that lunar brightness may have on small-mammal activity (Daly et al. 1992).



**Figure 1.** Grid design (5x5) for trapping small mammals. Boxes represent individual traps and arrows indicate direction that open doors face. Traps are labeled alphabetically and increasing to the east, numerically and increasing to the north.

## Field Methods

### Mammal Trapping

We surveyed grids using 12" x 3" x 3.5" Sherman live traps baited with 1 tablespoon of sterilized large-white Proso millet and modified with paper clips to restrict trap doors from potentially damaging animal tails. In general, we aligned trap lines north to south and east to west (Figure 1). We marked individual trap stations using pin flags



labeled with an alphanumeric code. We then placed a single trap  $\leq 1$  m from each trap station ( $n = 25$  per grid), and marked their position with an alphanumerically labeled pin flag. We also marked the southwest corner of each grid with a wooden stake labeled with grid ID and flagged with reflective tape.

We checked traps twice each night in accordance with U.S. Fish and Wildlife Service 10(a)(1)(B) permit specifications, because the targeted habitat was potentially occupied by the federally endangered Stephens' kangaroo rat (*Dipodomys stephensi*). We opened traps 1 to 3 hours before sunset and started the first check at the midpoint of each night. After checking all traps, we reset them and added fresh bait if necessary. The second check began 1 hour before dawn, after which we closed traps and removed excess millet to avoid attracting ants. After the final dawn shift of the trapping cycle, we broke down grids by collecting all traps, excess bait, and pin flags.

Before checking each grid we recorded moon phase (quarter, half, three-quarter, full, no moon), sky code (0 = clear/few clouds, 1 = 50% clouded, 2 = overcast, 3 = fog, 4 = light drizzle), and ground moisture (wet, dry). We did not bait or open traps in the event of significant precipitation. We also noted the visit number, trap check (midnight, dawn), grid ID, recorder (3-letter initial), and start and end times (24 hour) of each grid check. Two-member teams checked grids, and the status of individual trap stations was recorded on a quality-control form as either open, occupied by an animal, closed-empty, robbed, or missing. We recorded status of traps with animals as the 4-letter species code of the animal captured. After checking the entire grid, we examined the quality-control form to ensure that we checked and closed all traps. Before leaving the grid, we recorded ambient-air and soil temperature (C).

We processed captured animals according to standard operating procedures developed by the Biological Monitoring Program for animal handling and data collection of small mammals (*Small Mammal Trapping Standard operating Procedures v.2, 31 March 2010*; Appendix B ). In general, we recorded weight (g; 100-g Pesola spring scale), ear length (mm; tip to notch), hind foot length (mm; *Chaetodipus* species only), sex, age class (adult, juvenile), reproductive condition (non-reproductive, scrotal, pregnant, lactating, perforate, plugged), capture history (new, recapture), and trap location of each initial capture of a Covered Species per survey effort. We marked the ventral surface of all Covered Species (RediSharp non-toxic permanent marker) with a color unique to individual trapping efforts to indicate the repeated capture of an animal. For recaptured animals, we only recorded species, trap location, and capture history. For non-covered species (e.g., *Peromyscus maniculatus*), we recorded presence and trap location; we did not mark the ventral surface of non-covered species. Processing times ranged between 30 s and 3 min, depending on the species and capture history.

## Vegetation

We revisited each grid within 45 days of trapping to record habitat characteristics following a modified version of the Biological Monitoring Program pilot protocol for monitoring vegetation community and wildlife habitat condition. In general, we collected point-intercept data along a single 40-m transect that spanned the distance between the southwest and northeast corners of each grid (e.g., 45° bearing from A1). We collected

point intercept data every meter starting at 1 m and recorded hits within 14 height classes (Table 2). We recorded multiple hits within the first 5 height classes and the tallest hit at each point. We focused out effort on the first 5 height classes to decrease the time commitment per transect and because according to Rosenzweig (1973), *Dipodomys merriami*, a close relative of AKR, are most influenced by vegetation less than 45 cm from the soil.

**Table 2.** Summary of height ranges assigned to height classes.

Height class	Height range (m)	Height class	Height range (m)
1	< 0.1	8	0.7 – 0.8
2	0.1 - 0.2	9	0.8 – 0.9
3	0.2 - 0.3	10	0.9 – 1.0
4	0.3 - 0.4	11	1.0 – 1.5
5	0.4 - 0.5	12	1.5 – 2.0
6	0.5 - 0.6	13	2.0 – 3.0
7	0.6 – 0.7	14	> 3.0

For all unique hits on the point-intercept pole, we assigned non-woody species to functional groups (native or non-native grass or forb), identified woody shrubs, trees, and cacti to species, and assigned branches of woody species that died because of fire to the group “burned-standing dead”. We also identified the ground layer at the base of the intercept pole at each meter as bare soil, rock, basal stem, litter (i.e., dead or detached organic matter), or thatch. Rock is defined as anything that would inhibit the germination of a seedling, for example, a rock embedded in the ground or >7.5 cm. We used a modified version of Ledeboer’s definition to differentiate thatch as a tightly intermingled layer of living and dead stems, leaves, and roots (> 0.5 cm in depth and occurring between the soil surface and the near-vertical vegetation above) (Ledeboer 1967). We measured thatch and litter depth that was > 0.5 cm.

### Data Analysis

We estimated grid occupancy ( $\Psi$ ) and nightly detection probability ( $p$ ) using a closed-capture occupancy model that derived estimates based on grid-level presence/absence data (MacKenzie et al. 2002). The output from this model was a percent estimate of occupied grids that accounted for animals present but undetected. The accuracy and precision of grid occupancy was generally a function of the number of sampling occasions and grids trapped (and to some extent nightly detection probability) rather than the absolute number of animals detected. This allows us to design surveys that

maximize the reliability of estimates given the availability of resources and project timeframes (MacKenzie et al. 2002; MacKenzie and Royle 2005).

Occupancy estimates based on the method described above rely on 4 critical assumptions: occupancy status of sites did not change over the survey period; probability of occupancy was constant among sites, or differences were modeled; probability of detections was constant among sites, or differences were modeled; and capture histories were independent among trap locations (MacKenzie et al. 2006). We kept the survey period short (4 trap nights per grid) to maximize the probability of population closure during the sampling period. We also used Program MARK to construct separate sets of candidate models that accounted for differences in grid occupancy and nightly detection probability across survey periods (White and Burnham 1999). We maintained independence among trap locations by spacing them at a minimum of 110-m intervals. We constructed 2 candidate models that examined the effect of trap night on nightly detection probability while assuming grid occupancy to be constant across occasions. We ranked candidate models in each set according to differences in Akaike's Information Criterion for small samples ( $\Delta AIC_c$ ), and calculated an Akaike weight ( $w_i$ ) for each. We then derived weighted-average estimates across the entire candidate set unless there was clear support (i.e.,  $w_i > 0.9$ ) for a single model (Burnham and Anderson 2002). Finally, we calculated the acreage of occupied suitable habitat in our study area by extrapolating occupied-grid estimates to the area of modeled moderate- to high-suitability habitat.

We attempted to refine our understanding of AKR habitat by using the R statistical package 2.5.1 (R Development Core Team 2007) to create generalized linear models (GLMs) of AKR presence based on a binomial error structure. We included 7 explanatory variables in the global model: percent grass, percent forb, percent bare ground, percent thatch, percent litter, average litter depth, and average thatch depth. We included type of ground cover (i.e., bare ground, litter, thatch), litter depth and thatch depth as close relatives of AKR are limited to areas with sparse ground vegetation (Dudek & Associates 2003). We combined native and non-native grasses into a single grass covariate, as there were not enough native grass data to be analyzed alone. Similarly, we combined native, non-native, and unidentified forbs into a single forb covariate. Percent cover for bare ground, thatch, litter, and percent grass and forb were arcsine transformed for normality before being included in the analysis.

We applied the global model described above to AKR presence/absence data, and examined model fit against a null model (i.e., containing no variables) with a Pearson chi-square goodness-of-fit test. We also calculated a variance-inflation factor ( $\hat{c}$ ) for the global model, and considered overdispersion to be present if  $\hat{c}$  greatly exceeded 1 (i.e.,  $\hat{c} > 2$ ) (Burnham and Anderson 2002). We then examined AKR presence/absence by considering candidate model sets ( $n = 127$ ) that included all combinations of the 7 explanatory variables. We ranked each model according to Akaike's Information Criterion (AIC), and calculated AIC weights ( $w_i$ ) across the entire candidate set. We then calculated weighted-average estimates ( $\hat{\beta}$ ) of modeled parameters (i.e., explanatory variables) across the entire candidate set and considered the summed weights from all models that included individual variables (Burnham and Anderson 2002).

## RESULTS

We captured Aguanga kangaroo rat on 4 of 36 grids sampled (11%) (Figure 2). We also captured the following Covered Species: Los Angeles pocket mouse (*Perognathus longimembris brevinasus*), northwestern San Diego pocket mouse (*Chaetodipus fallax fallax*), Dulzura kangaroo rat (*Dipodomys simulans*), and Stephen's kangaroo rat (*Dipodomys stephensi*), and non-covered species: dusky-footed woodrat (*Neotoma fuscipes*), Western harvest mouse (*Reithrodontomys megalotis*), cactus mouse (*Peromyscus eremicus*), brush mouse (*Peromyscus boylii*), and deer mouse (*Peromyscus maniculatus*) (Table 3, Appendix C).

**Table 3.** Summary of species recorded while surveying for Aguanga kangaroo rat 27 September - 7 October 2010.

Scientific Name	Common Name	Covered <sup>1</sup>	Total
<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	820
<i>Dipodomys merriami collinus</i>	Aguanga kangaroo rat	Y	17
<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	130
<i>Dipodomys stephensi</i>	Stephens' kangaroo rat	Y	11
<i>Perognathus longimembris brevinasus</i>	Los Angeles pocket mouse	Y	5
<i>Neotoma fuscipes</i>	Dusky footed woodrat	N	2
<i>Peromyscus boylii</i>	Brush mouse	N	1
<i>Peromyscus eremicus</i>	Cactus mouse	N	47
<i>Peromyscus maniculatus</i>	Deer mouse	N	309
<i>Reithrodontomys megalotis</i>	Western harvest mouse	N	8
<i>Peromyscus</i> spp	Unidentified deer mouse	N	7
<i>Dipodomys</i> spp	Unidentified kangaroo rat	-	1
<i>Neotoma</i> spp	Unidentified woodrat	-	1
Unidentified bird	-	-	12

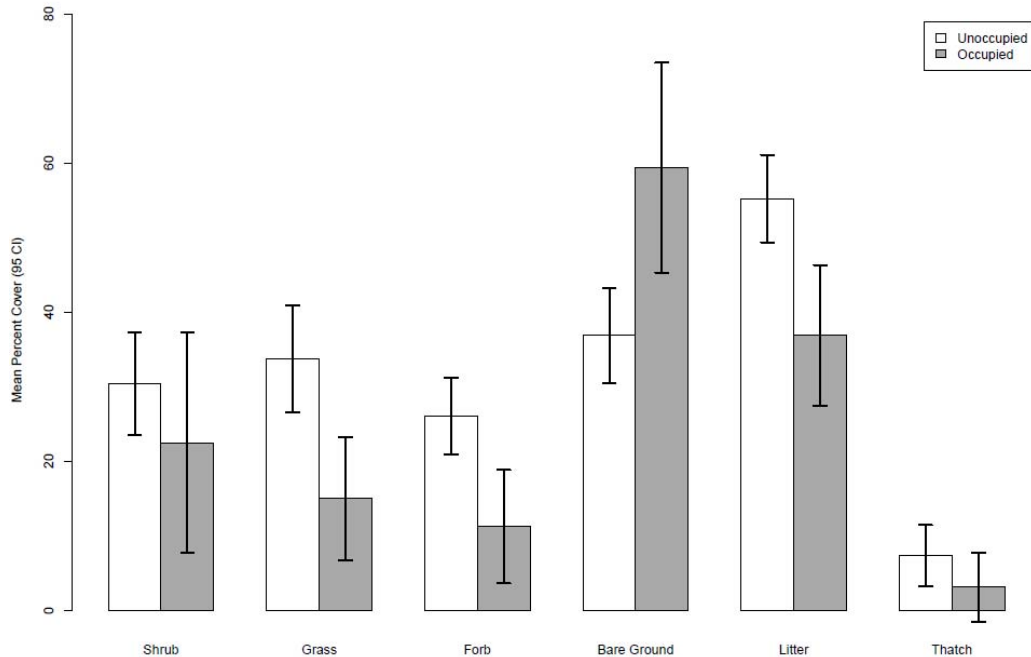
<sup>1</sup> Non-covered species were not marked and total refers to the number of times these species were captured, not number of individuals detected

We considered a single model ( $w_i = 0.99$ ) that estimated grid level probability of detection ( $p = 0.76$ ; SE = 0.13) and grid occupancy ( $\Psi = 0.111$ ; SE = 0.05) as constant across trap nights. Cumulative detection probability was high across trap nights ( $P_c = 0.995$ ). The extrapolated area of occupied moderate- to high-suitability habitat from our model-based estimates of grid occupancy was 10.9 ha.

We recorded 37 shrub species on AKR trapping grids with a mean percent cover of 29.51% (SE = 3.24). The dominant shrub species at Temecula Creek, Wilson Creek, and their tributaries were *Eriogonum fasciculatum*, *Lotus scoparius*, *Artemisia californica*, *Simmondsia chinensis*, and *Baccharis salicifolia*. In general, the herbaceous layer was dominated by non-native grasses (mean = 25.32%, SE = 3.31) and native forbs (mean = 16.96%, SE = 2.64); native grasses and non-native forbs accounted for far less cover and did not contribute much to the overall composition of the layer. The ground layer was composed mainly of litter (mean = 42.74%, SE = 3.64) and bare ground (mean = 30.96%, SE = 3.21); thatch cover accounted for a substantially less cover.



Grids occupied by AKR had different average vegetation and ground cover percentages than grids without any observed AKR. In general, we documented lower percent cover of forbs and grasses at grids occupied by AKR; moreover, these grids contained a higher percent cover of bare ground and a lower percent cover of litter (Figure 3). Confidence intervals for shrub cover, thatch cover, litter depth, and thatch depth overlapped between occupied and unoccupied grids.



**Figure 3.** Mean percent cover and 95% confidence intervals on grids occupied and unoccupied by Aguanga kangaroo rat.

Our global model fit data for AKR presence ( $\chi^2 = 0.57$ ,  $df = 7$ ,  $\hat{c} = 0.08$ ); however, none of our habitat models contained more than 5% of the Akaike weight (Table 4). Similarly, none of the habitat covariates modeled for AKR presence showed clear support in GLM models as the 95% confidence intervals for all variables overlapped zero (Table 5).

**Table 4.** Akaike Information Criterion for small samples ( $AIC_c$ ), difference in  $AIC_c$  ( $\Delta AIC_c$ ), Akaike weights ( $w_i$ ), and estimated parameters ( $K$ ) of the top 10 habitat models from a candidate set of 127 that examined effects of percent bare ground, percent litter cover, percent thatch cover, percent grass, percent forb, litter depth, and thatch depth on Aguanga kangaroo rat distribution.

Model	$AIC_c$	$\Delta AIC_c$	$w_i$	$K$
Bare ground	25.11	0	0.05	2
Forb	25.50	0.39	0.04	2
Bare ground + Forb	26.13	1.02	0.03	3
Litter depth + Forb	26.15	1.05	0.03	3
Litter + Forb	26.39	1.28	0.03	3
Grass	26.45	1.34	0.03	2
Bare ground + Thatch depth	26.82	1.71	0.02	3
Bare ground + Grass	26.84	1.73	0.02	3
Bare ground + Litter depth	26.88	1.77	0.02	3
Bare ground + Litter	26.90	1.79	0.02	3

**Table 5.** Parameter estimates for explanatory variables ( $\beta$ ) and standard errors (SE) averaged across candidate sets of general linear models investigating effects on Aguanga kangaroo rat distribution. Total weight of models that include each variable reported as  $\Sigma w_i$ .

Variables	$\beta$	SE	$\Sigma w_i$
Bare ground	2.41989	3.07289	0.4458
Litter	0.10374	2.60974	0.3438
Thatch	-0.3907	1.82945	0.3124
Litter depth	-0.28834	0.48444	0.3465
Thatch depth	0.18024	0.67533	0.2936
Grass	-0.57435	1.14869	0.3313
Forb	-1.98483	3.37448	0.4524

## DISCUSSION

After creating a model of suitable habitat based on vegetation and soil characteristics presumed to be appropriate for this species, we trapped 98 ha and estimated that AKR occupied approximately 10.94 ha (11%). Currently there are approximately 201 ha of suitable AKR habitat in conservation that are accessible to the Monitoring Program. This is well below the 2219 ha goal stated in objective 1 of the species account (Dudek & Associates 2003). More acreage of occupied AKR habitat may be documented through granted right of entry to areas currently closed to access (e.g., Wilson Creek Preserve) and through acquisition of additional properties.

Data gathered to examine the relationship between AKR presence and measurable habitat variables showed interesting patterns but none of the habitat covariates showed

clear support in GLM models as the 95% confidence intervals for all variables overlapped zero. This could be due to small sample size or an unknown and untested variable. Still, the strong fit of the global model suggests that these variables played some role in AKR presence. A simple comparison of vegetation cover on grids where AKR were present ( $n = 4$ ) and grids where AKR were not present ( $n = 32$ ) showed that herbaceous vegetation cover was lower on grids occupied by AKR. In addition, calculated values showed that bare ground dominated the ground layer at occupied grids, whereas litter was dominant on unoccupied grids. In general, these observations of vegetation cover support conclusions by Rosenzweig (1973 and 1969) that *Dipodomys merriami* select sparsely vegetated habitats.

### **Recommendations for Future Surveys**

We will use data collected in 2010 to design expanded future efforts that will include estimation of population density. The very high cumulative detection probability (99%) gives us great confidence that we are detecting AKR when it is present with the current study design. However, with little information obtained from habitat model estimates, substantial questions remain concerning the roles that shrub cover, ground cover, and herbaceous cover type play in influencing the distribution of AKR across the landscape.

We should modify future sampling designs with the goal of identifying the minimum area of suitable habitat required for presence of AKR. Grids should either be selectively installed within patches too small (i.e.,  $< 0.4$  ha, or  $< 30$  m wide) for random placement, or spacing reduced between traps (e.g., 7-m spacing) so that 5 x 5 grids can randomly fit within a greater number of habitat fragments. Grid spacing of this size will allow for comparable results with other small mammal trapping efforts (e.g., Los Angeles pocket mouse, San Bernardino kangaroo rat, etc.) completed by the Biological Monitoring Program. Care should be taken to determine accessibility (e.g., distance from roads, slope, etc) *a priori* because it may be impractical to conduct night surveys in remote areas with high-density vegetation (i.e.,  $>60\%$  for Riversidean alluvial fan scrub, coastal sage scrub, and chaparral, and  $>5\%$  for riparian scrub) and inferences should be made to only those areas that can be sampled. Soil data should be collected in upcoming trapping efforts, analyzed, and added to the habitat model. Understanding the extent of AKR range within in the Plan Area, as well as its relationship with the environment is a crucial step in appropriate management of this species. We will be able to better understand and quantify that relationship through further trapping efforts.

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## Appendix A. Soil and Vegetation Attributes Used to Delineate Aguanga Kangaroo Rat Habitat.

Soil (Table 1) and vegetation (Table 2) attributes described below represent feature classes included in GIS-based map layers (CDFG 2006; Soil Survey Staff et al. 2006) clipped to the 2010 Conservation Area east of Vail Lake. Represented soil and vegetation reflect habitat characteristics believed to support the occurrence of Aguanga kangaroo rat (*Dipodomys merriami collinus*). We used Arc GIS v. 9.3 (ESRI 2006) to select the described features, and merged layers to create a single habitat model for portions of Temecula Creek, Wilson Creek, and tributaries in conservation. We then defined an area of inference based on modeled habitat that accounted for inaccessible slopes (e.g., > 24 degrees), road disturbance, and distance from roads. Grid centers were randomly distributed across the defined area of inference according to survey design.

**Table 1.** Soil attributes and area (ha) included in suitable-habitat model for Aguanga kangaroo rat on conserved lands in designated core drainages.

Series	Soil Classification	Symbol	Area (ha)
Gorgonio	loamy sand	GhC	1.8
		GhD	0.1
		GIC	1
Grangeville	fine sandy loam	GrB	0.2
		GtA	0
		GvB	0.7
Greenfield	sandy loam	GyC2	14.1
Hanford	loamy fine sand	HaC	6.2
	coarse sandy loam	HcC	38.2
		HcD2	65.9
		HeC2	5.6
Honcut	sandy loam	HnD2	0.4
Metz	fine sandy loam	MgB	0.8
Mottsville	loamy sand	MoD	0
Pachappa	fine sandy loam	PaC2	1.2
Ramona	sandy loam	RaB3	0.1
		RaD2	5
		RdD2	9
		RdE3	2.5
Riverwash	n/a	RsC	12.7
San Emigdio	sandy loam	SdD	2.2
	fine sandy loam	SeC2	2.9
		SeD2	12.6
Tujunga	loamy sand	TuB	0.1
		TvC	19.2

## Appendix A. Cont.

**Table 2.** Vegetation attributes and area (ha) included in suitable-habitat model for Aguanga kangaroo rat on conserved lands in designated core drainages. Vegetation categories based on the Western Habitat Relationships (Mayer and Laudenslayer 1988) classification system unless otherwise noted.

Code <sup>1</sup>	Name	Density <sup>2</sup>	Area (ha)
ACS	Alkali Desert Scrub - Riversidean Alluvial Fan Scrub <sup>3</sup>	3	0.44
		4	5.08
AGS	Annual Grassland	1	9.07
		4	0
COV	Cropland and Orchard-Vineyard	9	14.94
CRC	Chamise-Red Shank Chaparral	2	1.04
		4	0.22
		5	2.86
CSC	Coastal Scrub	2	21.5
		3	73.05
		4	30.17
		5	1.39
CSC	Coastal Scrub - Riversidean Alluvial Fan Scrub <sup>4</sup>	2	1.59
		3	9.11
		4	7.74
		5	4.02
MCH	Mixed Chaparral	2	11.82
		3	0.11
		4	1.55
		5	0.29
RIV, LAC	Riverine, Lacustrine	9	0.32
VRI	Valley Foothill Riparian	5	6.13

<sup>1</sup> Mayer KE, Laudenslayer WF. 1988. A guide to wildlife habitats of California. California Department of Forestry, Sacramento, California.

<sup>2</sup> 0 = unknown, 1 = > 60%, 2 = 40 - 60%, 3 = 24 - 40%, 4 = 10 - 25%, 5 = 2 - 10%, 9 = not applicable

<sup>3</sup> MSHCP designates alkali desert scrub as Riversidean alluvial fan scrub

<sup>4</sup> MSHCP classifies coastal scrub with *Lepidospartum squamatum* dominant as Riversidean alluvial fan scrub.

## **APPENDIX B. Small Mammal Trapping Standard Operating Procedures V.2**

These are standard procedures developed by the Western Riverside County MSHCP Biological Monitoring Program for trapping small mammals. Individual projects may have specific procedures and requirements that vary from those described here. Variations from these standard procedures will be described in the Methods section of individual project protocols.

All of the procedures described below require training and experience. It is your responsibility to alert the Mammal Program Lead or other lead staff if you are not comfortable with the training you have received. Alert the Mammal Program Lead or other lead staff if you are scheduled for an activity that you do not feel qualified to conduct.

### **I. SITE SELECTION**

Site selection criteria is project specific, but generally involve the use of Geographic Information Systems (GIS) software to stratify Core Areas by suitable habitat based on vegetation, soil, and slope characteristics known to be associated with the target species. An area of inference is drawn from modeled habitat that accounts for site accessibility (e.g., distance from road, slope, land ownership), and points are randomly distributed across this area. Universal Transverse Mercator (UTM) coordinates are assigned to each random point, and field crew verify accessibility of points. Area of inference is adjusted and points redistributed in the event that plots can not be accessed. Trapping plots are then centered on each random point.

### **II. INSTALLING TRAP PLOTS**

#### **Equipment:**

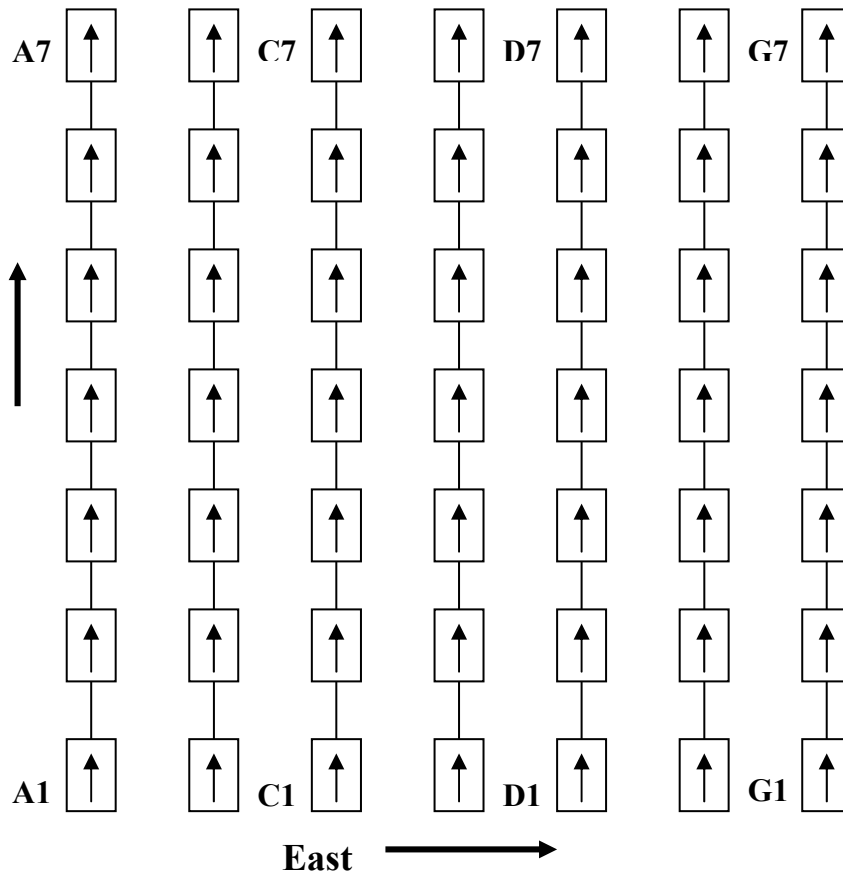
Modified Sherman traps  
Millet  
Coordinates  
Ant powder  
50-m or 100-m tape  
Flagging/Pin flags

Reflective tape  
Sharpie pens  
Trap carrying bags  
Handheld GPS unit/ Compass  
Trash bags

#### **Plot Layout**

Trap grids vary in size according to project-specific goals, but are installed following identical procedures. Coordinates of points randomly generated in the office represent trapping grid centers (e.g., trap station C3 for a 5x5 grid). Trap lines are labeled alphabetically and increasing eastward, with trap stations within a line labeled numerically (e.g. A1, A2...A7) and increasing northward (Figure 1). Each trap station is marked with a labeled pin flag and, when necessary, flagging and reflective tape. Trap lines are also marked with reflective tape if landscape features make it difficult to follow them in the dark. Trap spacing, number of trap lines within a grid, and the number of stations on a line varies according to project-specific goals.

Grid lines are installed by stretching 2 measuring tapes (e.g., 50 m, 100 m) north-south and east-west from the random point, using a declinated compass as a guide.

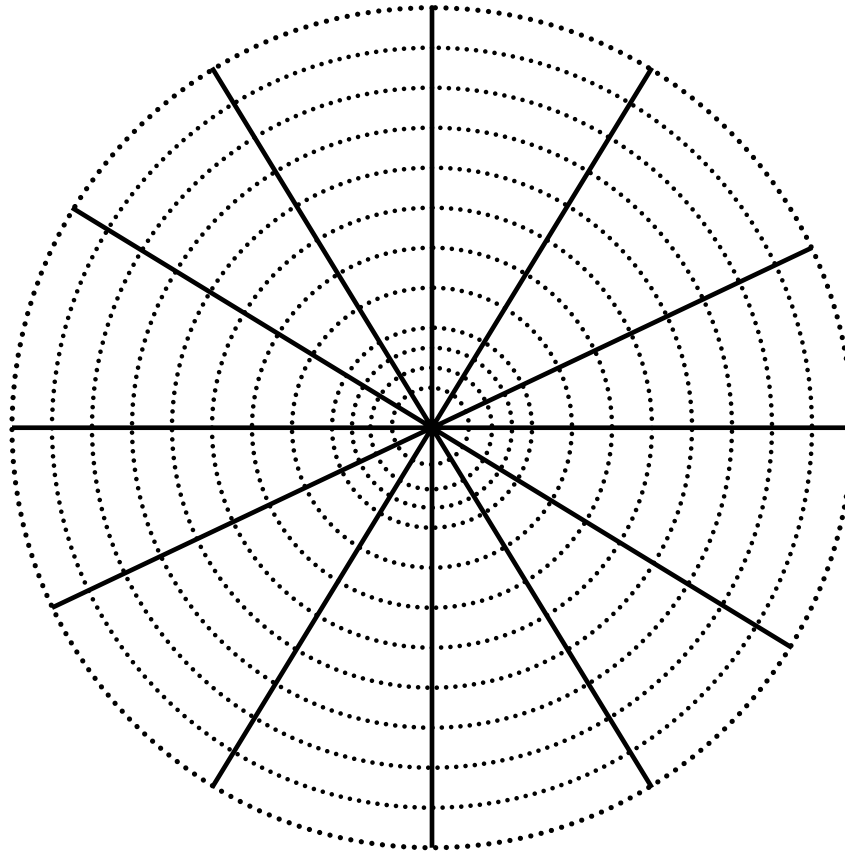


**Figure 1.** Grid design (7x7) for trapping small mammals. Boxes represent individual traps and arrows indicate direction that open doors face. Traps are labeled alphabetically and increasing to the east, numerically and increasing to the north.

Measuring tapes are held taut and close to the ground, and secured with survey pins. Pin flags are then distributed along the tapes at the appropriate intervals, depending on project-specific protocol. Finally, measuring tapes are stretched north-south from each of the pin flags placed along the east-west line described above. Pin flags are then distributed along these north-south lines to fill-out the rest of the grid (Figure 1).

We may also use a trapping web design, depending on project-specific goals. Trap lines within a web radiate from a central point at regular intervals, with a greater density of traps occurring near the center relative to the edges (Figure 2). Trap stations along each trap line are assigned an alpha-numeric label similar to that used for grids, with numbers increasing as you move away from the web center. Trap stations and lines are marked as described above for grids, and routes between lines at the web perimeter are marked with reflective tape. Trap spacing, number of trap lines, and number of traps per line varies depending on the target species.

Trapping webs are installed by stretching a measuring tape from the random point in a predetermined bearing. The tape is held taunt and close to the ground, and secured with survey pins. Additional tapes are stretched from the center point at regular intervals until the circle is filled. Pin flags are distributed along each line according to project-specific protocol.



**Figure 2.** Trapping web design where solid lines represent trap lines radiating from a central point, and dashed lines represent concentric trap rings set at defined distances. Trap stations are placed where solid and dashed lines intersect.

### **Trap Placement and Setting**

Unfold the trap and push the front door until it engages with the treadle tab. The front door can easily be found by noticing that there is a seam on the left side of the trap when the door is facing you. There should also be a paperclip that prevents that door from completely closing and potentially damaging animal tails (replace paperclip is missing).

Lightly tap on the side or bottom of trap. A light tap will be about as hard as if you were trying to make a spider fall off the side of the trap. The door should snap shut if the trap is set properly. You can adjust the sensitivity by pulling the tab forward or pushing it backward if. Pushing back will make the door more sensitive, a forward pull will make it less sensitive. Please ask if you cannot find the tab.

Place the trap on the ground at the station (marked with labeled pin flag) parallel with the trap line and with the opening facing northward once you are sure the sensitivity is correct. Traps should be placed on a level surface so that the entrance is flush with the ground, and it does not teeter. Use your boot to scrape out an even space if necessary. Traps should be placed parallel to the trap line. Take about 1 tablespoon of millet and toss most of it into the trap. Make sure that the millet is in the back of the trap, behind the treadle, otherwise an animal is likely to be too close to the door when it shuts and damage its tail. Place the remainder of the millet in a line just in front of the trap (e.g., about 5 – 10 seeds).

### **Ant Caution**

Ants can kill animals in a trap. Sprinkle provided ant powder liberally under and in front of traps if ants are present. Make sure that there are no ants inside the trap before you add bait. Apply ant powder if there are ants even if you are doing the last trap check of the day/night unless the grid is being closed. Do not set a trap if the ants are particularly thick and you feel they are too numerous for the powder to be effective. Be sure to record that the trap was not set.

## **III. CHECKING TRAPS**

### **Equipment per handler**

1 Headlamp	Animal Mortality Record
3 Pesola® Scales: 20g, 100g and 300g	Species field guide/key
1 Ruler (clear 6-inch)	Digital camera
1 Kestrel (per team)	Waste bags for used millet
3 Animal handling bags	Ant powder (pre approved only)
PDA (1 per team if grids)	Extra batteries
Non-toxic marker	

Traps are checked twice per night. The first check (i.e. midnight check) is approximately 5 hours after sunset, and the second check is just before dawn. Grids are typically checked in teams of 2, and webs in teams of 4 to 8. Grid teams consist of a single recorder, with both crew members handling animals. Handlers typically record their own data on trapping webs, depending on trap-line assignments. Each trap line is typically checked by a single person regardless of trap design used.

Walk along trap lines noting pin-flag number and whether each trap is open, closed and empty, or closed with a capture. Make note of the status of each trap in the appropriate box on your trap-check quality control sheet to ensure that no traps are missed. Mark “O” for open traps, “C” for closed with no capture, “R” for robbed traps, (traps that are open with no bait inside), and use the four-letter species alpha code for traps closed with an animal inside. Only record the status of the traps you or your handling/recording partner checked. Adjust the treadle on robbed traps.

### **Empty traps**

Visually check each open trap to verify that it is not occupied by a pocket mouse. We have captured several pocket mice in seemingly open traps because the animal had



not tripped the treadle. Physically pick-up the trap to check for bait and ensure that treadles are set properly. Place the trap parallel to the trap line and facing north if you are conducting a midnight check. See instructions below for closing traps after a dawn check.

Pick-up closed traps and gently shake with the door facing upwards so that the contents move to the back of the trap. This will ensure that very small animals (e.g. pocket mouse) will not be crushed when you open the trap door. Slowly open traps that seem too light to contain an animal to ensure that a pocket mouse or small *Peromyscus* is not inside. Gently depress the treadle to check for animals underneath. Harvest mice, pocket mice and determined *Peromyscus* fit easily under the treadle. Set treadle, replace bait (in necessary) and place trap parallel to trap line if empty. Follow animal handling procedures described below if there is an animal in the trap.

### **Occupied traps**

Pick up the trap if the door is closed, and take notice of the weight. Follow the directions below if it feels like an animal is inside. Use caution as occasionally non-mammal species may be captured (see rattlesnakes below).

Hold the trap parallel to your body with the door facing upward and the side of the trap with the split panel facing you (solid panel should be facing you if left handed). Place a handling bag over the top of the trap so that the crease at the bag's opening fits snugly into a trap corner. Wrap the excess portion of the bag around the trap so that there are no spaces, and hold it securely against the trap with your working hand (e.g. right hand). Extend the bag so that there is a large and unobstructed space opening into the bag from the trap door. Gently shake the trap downward so that the animal moves to the back of the trap and will not be crushed by the door as you open it inwards. Open and hold the trap door through the bag with the fingers on your working hand. Invert the trap quickly and firmly with a downward shake so that the animal falls into the bag. Be firm but remember you have a live animal in the trap. Quickly grasp the plastic bag and form a tight barrier between the animal and the trap as soon as it enters the bag and is completely clear from the trap door. Many species have very long tails and you should be careful that these too are clear from trap doors before allowing them to close. Remove the bag completely from the trap. Be careful of wire hinges on the trap tearing into the plastic bag.

Be aware of ants! Treat as needed as specified above.

### **Closing traps**

Traps should be closed after dawn checks by disposing of excess bait in a waste bag, closing traps, and placing them on the ground perpendicular to trap lines. Closed traps must be placed perpendicular to distinguish them from non-checked parallel traps, and to ensure that we do not leave an animal in a trap during the day. Also, each trap must be checked for animals before closing by placing your hand inside and pushing the treadle to the bottom. Animals sometimes hide under the treadle and go undetected. Never close a trap without looking inside and checking the treadle first.

Animals left in traps after the dawn check will die as a result of extreme heat exposure. Animals that enter and trip traps left open after the dawn check will also perish. Take precautions to ensure that all traps are empty and closed after each dawn check.

### **Missing traps**

Make a methodical search if you can not find a trap at a station. Do another search once you are finished checking the grid and make note for bait and trapping crews if the trap can not be located. You should look until you either find the trap or you are very certain it is not in the area. Involve other crew members in the search if they are available. Leave notice for the morning or bait crews if the trap can not be found so that a daylight search can occur. You should be very reluctant to leave a trap unaccounted for because captured animals will die from daytime heat, or a predator will likely return for a second helping if it had moved the trap.

### **Rattlesnake in trap**

Traps will feel abnormally heavy when occupied by a snake. Tap on the trap lightly and listen for a rattle if you are uncertain if a snake is in the trap. Note, however, that rattlesnakes tend to not rattle, even when disturbed, if the ambient temperature is particularly cold. Do the following if you hear a rattle or are otherwise certain that a rattlesnake is in a trap: 1) Look around and choose location that is free of obstacles. 2) Place the trap on the ground with the door facing you. 3) Pull the pin out of the bottom-left side of the trap being careful to move backwards away from the trap. 4) The trap should collapse and the snake will be free to exit. 5) *Cautiously* use a shovel handle (located in field vehicle) to collapse the trap from a safe distance if needed (note that rattlesnakes can strike to distance of 1/3 to 1/2 their body length!). You can turn the trap upside down if that makes it easier for you to remove the pin. This procedure will free all snakes in a trap, but you need to be alert and prepared to move when you are releasing a rattlesnake. *Do not attempt to remove a rattlesnake if you are at all uncomfortable with the procedure.* Rather, ask an experienced crew member for help.

Make note of the incident on the data sheet in the notes section. Either repair the trap in the field or replace it with an extra one and repair it in the office.

## **IV. PROCESSING ANIMALS**

### **Weighing the animal**

Be sure to zero the Pesola® scale each night before attempting to weigh animals. Look at the scale while it is empty and see that it reads zero. Use the knob at the top of the scale to adjust as necessary.

Seal opening in the handling bag by folding the corners inward and the top down over the folded corners. Wait until the animal is calm, then clip the scale to the top flap of the bag, making sure that each flap is within the grasp of the scale's clamp. Record weight in grams under 'Total wt' on the data sheet. Save bag contents to weigh later.

### **Handling the animal**

Work the animal to the bottom of the handling bag , trying to avoid trapping it's head in a corner. This is best accomplished by placing the bag against your thigh, and decreasing the amount of open space by sliding your hand downward from the top of the bag against your leg. Secure the animal through the bag in the palm of your working hand (e.g., right-handed, left-handed), being careful to avoid the head and biting teeth. Open bag and grasp the animal firmly by the scruff of the neck with your non-working hand. Alternatively, grasp the animal's tail *at the base* after you have secured them through the bag with your non-working hand. Never hold an animal by its tail away from the base. The tail can easily break off or, more likely, the skin will slide away and leave a bloody appendage. Let the animal rest on your upper leg or chest (you are still holding its tail at the base) and scruff it snugly.

### **Incidental deaths**

Record the species and sex and under fate record "dead" if an animal is found dead in a trap. Place the deceased animal in two Ziploc® bags (one inside the other, both zipped closed) if it is a Covered Species. Use a marker to label the top bag with the date, time, site, grid ID, trap ID, and observer initials. Bring the animal back to the office to be placed in the freezer for later disposition. Fill out a mortality record form located in the trap kits for each dead animal or incident while you are in the field. Place the completed form on the Mammal Program Lead's desk when you return to the office. If the dead animal is a listed species (SKR, SBKR), also put a copy of the Mortality Record on the Program Administrator's desk. Designate one crew member to call the Program Administrator at home on Saturday morning if the mortality occurs on a Friday night. We are required to notify the Fish and Wildlife Service within 24 hours of finding a listed animal that is dead.

### **Incidental births**

Place the mother on the ground and watch her if she enters a burrow if an animal gives birth while in the trap. Place the babies in the entrance of that burrow and leave them alone. Place the babies outside the trap and record the incident in the notes section on the data sheet if you do not know where she went.

### **Hot or cold animals**

Place cold animals (lethargic and unresponsive) in a pocket close to your body until it is revived. You can bring the animal into a heated vehicle if you are really worried, but be careful about placing the animal directly in front of heater vents. They are small and can overheat quickly. Release the animal at the station where it was captured once it begins to warm up and move around. An animal that is overheated will also be lethargic and may have moisture around its mouth. Cool down an overheated animal by wetting its fur with plain water and fanning or blowing on the animal. Record the species and sex of the animal and make note of the incident and the outcome.

### **Marking the animal**

Animals are marked by injecting a PIT tags, applying an ear tag, or coloring with a non-toxic marker. Always be clear about the marking method being used when you are checking traps or recording data.

Marker: Write on the ventral surface of the animal with a specified color.

PIT tag: See separate protocol for marking PIT tags. Do not attempt this procedure without training and permission lead staff.

Ear tag: See protocol for applying ear tags. Do not attempt this procedure without training and permission from lead staff.

### **Recaptured animals**

An animal is considered a “recapture” if it was previously captured during the particular survey effort that you are trapping. Recaptured animals are identified by the color mark on their ventral side that is unique to a particular trapping effort. Other marks will vary from project to project and may even vary from night to night. Be sure you are clear on the marking scheme being used anytime you are trapping. Only record species, sex, and reproductive condition for recaptured animals.

### **Identify the species**

You should be comfortable with identification of local small mammal species before conducting surveys. Use the field guide included in your mammal packet to help with identification as needed. You can also consult crew mates if there is confusion. Record the species on your data sheet the 4 letter alpha code. Species codes are included in your mammal packet if you forget one. If you cannot identify a species, take and record all standard measurements, and take photographs of the animal for later identification. Do not spend too much time on this task. Record the capture as new or recapture on the data sheet.

### **Sexing the animal**

Males and females can be differentiated using the following cues:

- Look first for an enlarged scrotum or signs of lactation (bare skin around enlarged nipples).
- Males have a greater distance between anus and genitals than females (in females the genitalia is typically within 1-2 mm of the anus). The skin between the anus and genitals tends to be hairless in females.
- Check for baculum: Using your finger or the tip of a pencil, gently push the genitalia upward (toward the animal’s head). If a tiny boney spur protrudes from the genitalia, the animal is a male. Record the ‘sex’ on the data sheet.

### **Reproductive status of the animal**

The categories of reproductive status are: scrotal, or not reproductive for males; pregnant, perforate, lactating, plugged or not reproductive for females. Record the status on the data sheet under ‘condition’.

Females: Note if the individual is lactating by the presence of enlarged nipples with an area of bare skin immediately surrounding the nipple. Large extended abdomen indicating possible pregnancy. Perforate means the vagina is open. Plugged means a copulatory plug is present. This is a mucous plug that forms in the vaginal orifice a few hours after mating. It looks like a big mucus scab over the vaginal area.

Males: Look for the presence of an enlarged, deflated, or small wrinkled scrotum in males. Any visual indication of a scrotum is to be considered a reproductive individual.

### **Age**

Note the age as juvenile 'J' or adult 'A' depending on pelage. Juveniles of all species are smaller and usually quite gray. They may appear to have large ears and feet in relation to the body size.

### **Measuring the animal**

Be sure you are comfortable with all of these procedures.

Tail length: measure from the dorsal side (top) to the end of the tail bone (not the end of the hair).

Hind foot: Measure from the heel to the tip of the longest claw.

Ear: Distance from notch at front base of ear to distal-most border of the fleshy part of the ear. Do not push on or deform the ear with your ruler.

Take all measurements on all animals whenever possible. Weather conditions, personnel shortages, or other foreseen reasons may require that some data not be recorded. At a minimum, record species, sex, and reproductive status. You should make educated decisions about what to record and how to protect animals if some crisis occurs (e.g., trap predation). See separately provided Mammal Trapping Guidelines for weather guidance. The following measurements can be used to identify species, and are the minimum measurements that are to be recorded for each.

- *Chaetodipus* – weight, ear at notch, hind foot length. (guards hairs on rump distinguish from *Perognathus*)
- *Peromyscus* – all measurements on data sheet
- *Neotoma* – weight, color of top of hind foot, color of hairs on the throat at their base.
- *Dipodomys* – weight, ear length, number of toes
- *Reithrodontomys* – weight, spots on ear bases? Grooves on upper incisors?
- *Microtus* – weight
- *Perognathus* – LAPM: weight, spots on ears, and lacking guard hairs.

Record species and measurements taken for purpose of identifying all other species not listed above.

Remove the animal from the bag after processing, and gently release it by placing on the ground at the trap station where it was captured. Weigh the bag with the contents, and record that weight under 'bag wt'. Do not remove millet, waste, etc. from bag before

obtaining bag weight. Transfer excess millet or feces from the handling bag to a waste bag. The handling bag is then reused for the next animal unless it is torn or soiled. Record the fate of the animal as 'R' released, 'E' escaped, or 'D' dead.

**Grid quality control:**

Trapping teams must verify that all traps have been checked when a grid is completed by reviewing the quality-control form. Each crew member that checked traps will say out loud which traps they checked starting with trap A-1 and finishing at the last trap (G-7 or H-8). Sign the sheet recording that you verified that all traps had been checked. Count robbed and closed-but-empty traps after you have ensured that all traps have been checked, and subtract them from the total number of traps on the grid. Record that number as the number of trap nights.

**V. PICKING UP TRAP LINES**

**Equipment:**

- Shoulder bags for carrying traps and pin flags
- Rubber bands/Trap boxes
- Waste bag for emptying traps

Collect traps as you check grids on the final check of a survey effort. Empty remaining millet and waste into a trash bag, and collapse the trap for easy carrying in the shoulder bags. Pin flags are to be left in the field, only during ongoing projects. Flagging placed to mark trails must be picked up on the way out of the grid for the last time during that trapping session. If we are using the grid again, the trail can be remarked when the grid is reopened. Count the traps at the end of the collection effort. Make sure all of the traps are accounted for after collection at each grid.

Sort pin flags by letter and place rubber bands around sorted groups if they are to be collected. Make sure that all pin flags, flagging tape, and reflective tape is removed, as we do not want to be responsible for trash in the Conservation Area.

**VI. CLEANING AND STORING TRAPS**

All traps must be cleaned and disinfected before being between sites. Make sure all millet and waste material are knocked out of the traps before soaking them in a 10% bleach and water solution for 10 minutes. Thoroughly rinse the traps with water and allow them to air dry outside preferably in the sun. Place the folded traps into the plastic buckets with lids once dry.

### Appendix C. Species recorded per grid while surveying for Aguanga kangaroo rat, 27 September - 7 October 2010.

Grid	Scientific Name	Common Name	Covered <sup>1</sup>	Total
AKR-01	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	17
AKR-01	<i>Peromyscus maniculatus</i>	Deer mouse	N	4
AKR-02	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	12
AKR-02	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-02	<i>Peromyscus maniculatus</i>	Deer mouse	N	2
AKR-02	<i>Reithrodontomys megalotis</i>	Western harvest mouse	N	1
AKR-03	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	14
AKR-03	<i>Dipodomys merriami collinus</i>	Aguanga kangaroo rat	Y	7
AKR-03	<i>Perognathus longimembris brevinasus</i>	Los Angeles pocket mouse	Y	2
AKR-03	<i>Peromyscus maniculatus</i>	Deer mouse	N	2
AKR-04	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	10
AKR-04	<i>Perognathus longimembris brevinasus</i>	Los Angeles pocket mouse	Y	1
AKR-04	<i>Neotoma fuscipes</i>	Dusky footed woodrat	N	1
AKR-04	<i>Reithrodontomys megalotis</i>	Western harvest mouse	N	4
AKR-05	<i>Dipodomys merriami collinus</i>	Aguanga kangaroo rat	Y	7
AKR-05	<i>Perognathus longimembris brevinasus</i>	Los Angeles pocket mouse	Y	2
AKR-05	<i>Peromyscus maniculatus</i>	Deer mouse	N	2
AKR-06	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	31
AKR-06	<i>Dipodomys merriami collinus</i>	Aguanga kangaroo rat	Y	1
AKR-06	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-06	<i>Peromyscus eremicus</i>	Cactus mouse	N	2
AKR-07	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	13
AKR-07	<i>Dipodomys merriami collinus</i>	Aguanga kangaroo rat	Y	2
AKR-07	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-07	<i>Peromyscus eremicus</i>	Cactus mouse	N	2
AKR-07	<i>Peromyscus maniculatus</i>	Deer mouse	N	1
AKR-08	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	19
AKR-08	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-09	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	25
AKR-09	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	8
AKR-10	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	36
AKR-10	<i>Dipodomys spp</i>			1
AKR-10	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	4
AKR-10	<i>Peromyscus spp</i>			1
AKR-10	<i>Peromyscus eremicus</i>	Cactus mouse	N	1

<sup>1</sup> Non-covered species were not marked and total refers to the number of times these species were captured, not number of individuals detected

**Appendix C. Cont.**

<b>Grid</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Covered<sup>1</sup></b>	<b>Total</b>
AKR-11	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	23
AKR-11	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-11	<i>Peromyscus</i> spp			1
AKR-12	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	12
AKR-12	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	7
AKR-12	<i>Peromyscus maniculatus</i>	Deer mouse	N	3
AKR-13	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	13
AKR-13	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	7
AKR-13	<i>Neotoma fuscipes</i>	Dusky footed woodrat	N	1
AKR-13	<i>Peromyscus maniculatus</i>	Deer mouse	N	1
AKR-14	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	9
AKR-14	<i>Neotoma</i> spp	Unidentified woodrat	-	1
AKR-14	<i>Peromyscus boylii</i>	Brush mouse	N	1
AKR-14	<i>Peromyscus eremicus</i>	Cactus mouse	N	2
AKR-15	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	28
AKR-15	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-15	<i>Peromyscus eremicus</i>	Cactus mouse	N	3
AKR-15	Unidentified bird	-	-	1
AKR-16	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	33
AKR-17	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	71
AKR-17	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-18	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	18
AKR-18	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	7
AKR-18	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-18	<i>Peromyscus maniculatus</i>	Deer mouse	N	1
AKR-19	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	33
AKR-19	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-19	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-19	<i>Peromyscus maniculatus</i>	Deer mouse	N	2
AKR-20	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	19
AKR-20	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3

<sup>1</sup> Non-covered species were not marked and total refers to the number of times these species were captured, not number of individuals detected



**Appendix C. Cont.**

<b>Grid</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Covered<sup>1</sup></b>	<b>Total</b>
AKR-21	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	54
AKR-21	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	2
AKR-21	<i>Peromyscus eremicus</i>	Cactus mouse	N	5
AKR-21	<i>Peromyscus maniculatus</i>	Deer mouse	N	10
AKR-21	Unidentified bird	-	-	1
AKR-22	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	4
AKR-22	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	5
AKR-22	<i>Peromyscus</i> spp	Unidentified deer mouse	-	1
AKR-22	<i>Peromyscus maniculatus</i>	Deer mouse	N	8
AKR-23	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	15
AKR-23	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	8
AKR-23	<i>Peromyscus eremicus</i>	Cactus mouse	N	3
AKR-23	<i>Peromyscus maniculatus</i>	Deer mouse	N	40
AKR-23	Unidentified bird	-	-	1
AKR-24	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	4
AKR-24	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-24	<i>Dipodomys stephensi</i>	Stephen's kangaroo rat	Y	1
AKR-24	<i>Peromyscus maniculatus</i>	Deer mouse	N	20
AKR-24	<i>Reithrodontomys megalotis</i>	Western harvest mouse	N	2
AKR-25	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	19
AKR-25	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	6
AKR-25	<i>Peromyscus maniculatus</i>	Deer mouse	N	19
AKR-25	<i>Reithrodontomys megalotis</i>	Western harvest mouse	N	1
AKR-25	Unidentified bird	-	-	3
AKR-26	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	26
AKR-26	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	4
AKR-26	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-26	<i>Peromyscus maniculatus</i>	Deer mouse	N	19
AKR-26	Unidentified bird	-	-	6
AKR-27	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	27
AKR-27	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	7
AKR-27	<i>Peromyscus eremicus</i>	Cactus mouse	N	2
AKR-27	<i>Peromyscus maniculatus</i>	Deer mouse	N	22
AKR-28	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	16
AKR-28	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	7
AKR-28	<i>Peromyscus</i> spp	Unidentified deer mouse	-	3
AKR-28	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-28	<i>Peromyscus maniculatus</i>	Deer mouse	N	14

<sup>1</sup> Non-covered species were not marked and total refers to the number of times these species were captured, not number of individuals detected

**Appendix C. Cont.**

<b>Grid</b>	<b>Scientific Name</b>	<b>Common Name</b>	<b>Covered<sup>1</sup></b>	<b>Total</b>
AKR-29	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	9
AKR-29	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-29	<i>Dipodomys stephensi</i>	Stephen's kangaroo rat	Y	8
AKR-29	<i>Peromyscus maniculatus</i>	Deer mouse	N	3
AKR-30	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	36
AKR-30	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	2
AKR-30	<i>Peromyscus maniculatus</i>	Deer mouse	N	28
AKR-31	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	42
AKR-31	<i>Dipodomys stephensi</i>	Stephen's kangaroo rat	Y	1
AKR-31	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-31	<i>Peromyscus maniculatus</i>	Deer mouse	N	20
AKR-32	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	55
AKR-32	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	1
AKR-32	<i>Peromyscus eremicus</i>	Cactus mouse	N	6
AKR-32	<i>Peromyscus maniculatus</i>	Deer mouse	N	14
AKR-32	Unidentified animal	-	-	1
AKR-33	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	16
AKR-33	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	2
AKR-33	<i>Peromyscus eremicus</i>	Cactus mouse	N	1
AKR-33	<i>Peromyscus maniculatus</i>	Deer mouse	N	35
AKR-34	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	26
AKR-34	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	3
AKR-34	<i>Peromyscus eremicus</i>	Cactus mouse	N	7
AKR-34	<i>Peromyscus maniculatus</i>	Deer mouse	N	14
CNLM01	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	21
CNLM01	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	10
CNLM01	<i>Peromyscus eremicus</i>	Cactus mouse	N	5
CNLM01	<i>Peromyscus maniculatus</i>	Deer mouse	N	20
CNLM02	<i>Chaetodipus fallax fallax</i>	Northwestern San Diego pocket mouse	Y	25
CNLM02	<i>Dipodomys simulans</i>	Dulzura kangaroo rat	Y	8
CNLM02	<i>Dipodomys stephensi</i>	Stephen's kangaroo rat	Y	1
CNLM02	<i>Peromyscus</i> spp	Unidentified deer mouse	-	1
CNLM02	<i>Peromyscus eremicus</i>	Cactus mouse	N	3
CNLM02	<i>Peromyscus maniculatus</i>	Deer mouse	N	2

<sup>1</sup> Non-covered species were not marked and total refers to the number of times these species were captured, not number of individuals detected