Western Riverside County
Multiple Species Habitat Conservation Plan
Biological Monitoring Program

2020 Los Angeles Pocket Mouse
(Perognathus longimembris brevinasus)
Survey Report

15 April 2021

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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. Reserve assembly is ongoing and is expected to take 20 or more years to complete. The Conservation Area includes lands acquired 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 these lands as they were understood by the Monitoring Program at the time the surveys were conducted.

The Monitoring Program monitors the status and distribution of the 146 species covered by the MSHCP 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 Wildlife (CDFW, formerly California Department of Fish and Game) and the U.S. Fish and Wildlife Service]. Monitoring Program activities are guided by defined conservation objectives for each Covered Species, other information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees. A list of the lands where data collection activities were conducted in 2020 is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies.

The primary author of this report was the 2020 Mammal Program Lead, Jennifer Hoffman. This report should be cited as:

Biological Monitoring Program. 2021. Western Riverside County MSHCP Biological Monitoring Program 2019–2020 Los Angeles Pocket Mouse Survey Report. Prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available online: https://www.wrc-rca.org/species-surveys/.

While we have made every effort to accurately represent our data and results, the reader should recognize that data management and analysis are ongoing activities. Anyone 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.

Please contact the Monitoring Program Administrator with questions about the information provided in this report. Questions about the MSHCP should be directed to the Executive Director of the RCA. Further information on the MSHCP and the RCA can be found at www.wrc-rca.org.

Contact Information:

Executive Director
RCA/Riverside County
Transportation Commission
4080 Lemon Street, 3rd Floor
P.O. Box 12008
Riverside, CA 92502
Ph: (951) 787-7141

Monitoring Program Administrator
Western Riverside County MSHCP
Biological Monitoring Program
1835 Chicago Ave., Suite C
Riverside, CA 92507
Ph: (951) 320-2168

INTRODUCTION

Los Angeles pocket mouse (*Perognathus longimembris brevinasus*; LAPM) is a California species of special concern that historically ranged from the San Fernando Valley eastward to the city of San Bernardino and southeast to the Aguanga area of Riverside County (Williams et al. 1993). The species typically occurs on open landscapes associated with alluvial, aeolian, or well-drained upland deposits of sandy soil, and is believed to be in decline due to habitat loss affiliated with agricultural and urban development (Jameson and Peeters 1988; Williams et al. 1993; Dudek & Associates 2003). These open landscapes with sandy soils are associated with the following habitats: chaparral, coastal sage scrub (Riversidean sage scrub, Riversidean alluvial fan sage scrub, and Diegan coastal sage scrub), desert scrub, grassland, and vernal pools and playas (Dudek & Associates 2003). The current distribution of LAPM across the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) Plan Area is not well understood, partly due to seasonal cycles of activity which make this species difficult to detect.

The Los Angeles pocket mouse spends much of its life underground, with ephemeral bouts of surface activity offset by intervals of subterranean aestivation and torpor (French 1976, 1977). Timing and duration of activity cycles can vary across seasons, and appear to be a function of soil temperature, food availability, and ambient air temperature (French 1976, 1977). Detectability of LAPM is therefore dependent on conditions suitable for surface activity when the species is available for trapping, and population estimates should account for variation in detectability across and within seasons.

MSHCP species-specific objectives for LAPM call for the conservation of at least 2000 ac (approximately 809 hectare [ha]) of suitable habitat in each of seven Core Areas: 1) San Jacinto Wildlife Area-Lake Perris Reserve, 2) the Badlands, 3) San Jacinto River-Bautista Creek, 4) Anza Valley, 5) Lake Skinner-Domenigoni Reserve (i.e., Southwestern Riverside County Multi-Species Reserve), 6) Potrero Valley, and 7) Temecula Creek. Each Core Area must support a stable or increasing population and at least 30% (4200 ac) of the suitable habitat must be occupied as measured over any eight consecutive years (Dudek & Associates 2003). The Plan also identifies six additional areas from which at least 10,000 ac of suitable habitat must be conserved: 1) Santa Ana River, 2) Wilson Creek, 3) Vail Lake, 4) Warm Springs Creek, 5) San Timoteo Creek, and 6) San Gorgonio Wash.

The Biological Monitoring Program has conducted surveys for LAPM over multiple years (Biological Monitoring Program 2005, 2006, 2007, and 2010 - 2012). Our earliest surveys, focused on defining a pattern of seasonal surface activity and delineating the distribution of this species across Core Areas. We detected LAPM year-round but found seasonal variability in above-ground activity (Biological Monitoring Program 2006, 2007). In 2010, we began a 3-yr live trapping survey effort to determine species distribution, Percent of Area Occupied (PAO), detection probability, habitat suitability,

and ultimately assess population trend. We distributed trapping grids at all seven Core Areas listed for LAPM and detected the species in four: San Jacinto Wildlife Area-Lake Perris Reserve, San Jacinto River-Bautista Creek, Anza Valley, and Temecula Creek. In 2011, we trapped the Santa Ana River and Jurupa Mountains. The Jurupa Mountains, located in the northwest portion of the Plan Area, are protected for the federally-listed endangered Delhi sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*). According to the LAPM Species Account the sandy soils in this protected area make it probable for LAPM to occupy. However, we did not capture LAPM at either location.

From the 3-yr live trapping survey effort that started in 2010, we found that LAPM occupancy was associated with bare ground dominated grids but not with thatch and litter dominated grids. Similarly, thatch and litter depths were greater at grids where LAPM was not detected. At the culmination of 3-yr live trapping survey effort, we did not have enough trapping data in the Anza Valley and Temecula Creek Core Areas to perform a satisfactory analysis to show population trend. Though, we did find an increase in occupancy at San Jacinto Wildlife Area-Lake Perris Reserve, as well as a somewhat stable population in San Jacinto River-Bautista Creek Core Area.

Our efforts in 2020 focused on increasing our understanding of population trend. Trapping will provide the long-term monitoring data for population trend assessment of this species. Prior to trapping, we conducted habitat surveys at all trapping grids. These data will be analyzed with capture data to elucidate differences in habitat that might exist between LAPM occupied and non-occupied grids. The Main Objective for the Biological Monitoring Program is to demonstrate that each of the seven Core Areas supports a stable or increasing population that occupies at least 30 percent of the suitable habitat (at least 4200 acres) as measured over any 8-consecutive year period (i.e., the approximate length of the weather cycle). However, we do not currently have the personnel to trap all seven Core Areas. Therefore, we will concentrate our efforts on the four Core Areas occupied by LAPM in 2010 - 2012. Our goals and objectives for monitoring LAPM in 2020 are listed below.

Goals and Objectives

1. Document Los Angeles pocket mouse occupancy in Core Areas where occupancy was previously recorded through trapping efforts undertaken by the Biological Monitoring Program.
    a. Sample LAPM populations with 5 x 5 (28 m x 28 m, 25 traps) trapping grids.
2. Report population trend in occupied Core Areas.
    a. Estimate occupancy with a closed-capture model using Program MARK.
    b. Examine occupancy estimates from trapping results for all years sampled.
3. Evaluate associations between LAPM occupancy and habitat on trapping grids.

a. Collect habitat data using point transect methods.
b. Compare habitat data collected on LAPM occupied and non-occupied grids using a generalized linear mixed model in Program R.

METHODS

Study Site Selection

We stratified Core Areas according to our habitat suitability model, which was based on soil and vegetation characteristics known to be associated with LAPM and the closely-related endangered Pacific pocket mouse (*P. l. pacificus*; USFWS 2010, Biological Monitoring Program 2011). We specifically targeted sand and loam soils found in alluvium and well-drained upland areas (Germano 1998, Bornyasz 2003, USFWS 2010), including gravelly strata, but not rock, stone, or cobble (M'Closkey 1972; Meserve 1976a; Winchell et al. 1999). We 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 with >60% cover (Germano 1998).

We surveyed grids that were originally distributed in 2010. In our initial grid survey set up we removed from our potential study sites any areas of minor development (e.g., kiosks, maintenance buildings) identified with digital aerial photography (USDA 2009) and those prohibitively difficult to access (e.g., >600 m from a road or on terrain that exceeded a 24-degree slope). We also placed a 20m negative buffer around roads, so grid stations would not overlap transportation corridors, and kept at least 80 m between grid centers, to maintain independence (Shier 2009, USWS 2010). The resulting survey area consisted of suitable habitat separated by expanses of non-suitable habitat and/or lands outside the Conservation Area.

Survey Locations

We surveyed a total of 77 trapping grids across four Core Areas in 2020: San Jacinto Wildlife Area-Lake Perris Reserve, San Jacinto River-Bautista Creek, Anza Valley, and Temecula Creek (Figure 1). We made slight modifications in the number of grids that were surveyed as compared to 2010. We did not survey grids for various reasons; nearby homeless encampments (n = 1), falling out of most recent LAPM suitable habitat model (n = 3), inaccessibly, many grids dropped due to use of personal vehicles for COVID restrictions (n = 3), dense vegetation (n = 1), and no longer being in the MSHCP Conservation Area (n = 12). Trapping grids, that were established in 2010, fell outside of Conservation for two reasons: following the adoption of the RCA's conservation layer reconciliation in 2012, and following modification of Conserved Lands by Riverside County Flood Control and Water Conservation District to establish a recharge basin in the San Jacinto River. We added grids to make up for lost grids (San Jacinto River only; n = 4) and to survey lands added to Conservation since we last trapped for LAPM (Temecula Creek; n = 5). Thus we ended up with 77 trapping grids as opposed to 88 in 2010. By trapping a majority of the grids that were distributed in 2010

we were able to compare grid occupancy between years and examine population trend further.

Trapping Survey Design

We estimated occupancy by using a repeat-visit survey design following a Percent of Area Occupied (PAO) framework (MacKenzie et al. 2006). Repeated visits consist of monitoring a trapping grid every night for four consecutive nights. During this four-night trapping effort, populations are presumed to be closed to changes in occupancy (MacKenzie et al. 2006). A closed population is defined as 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

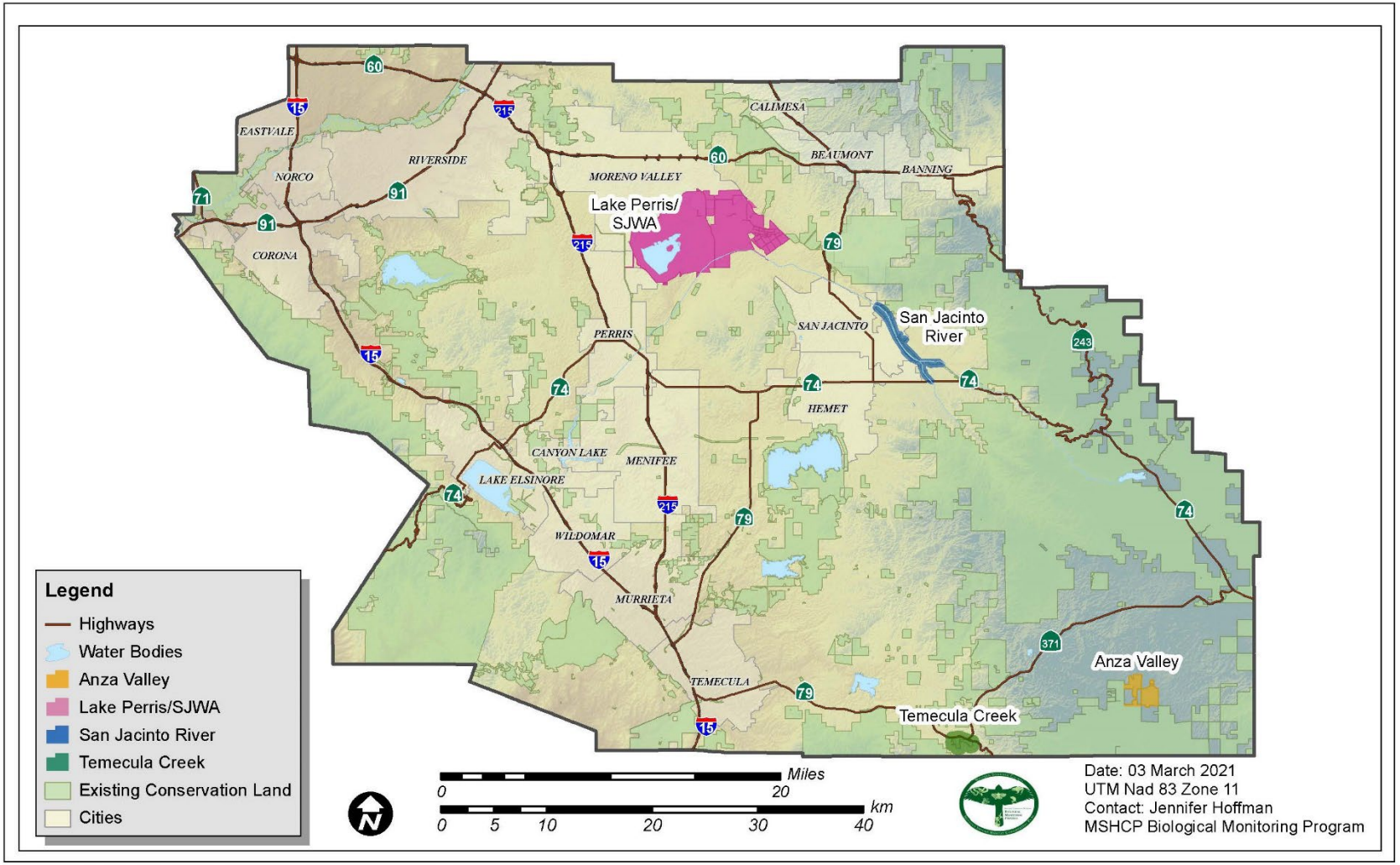

Figure 1. Los Angeles pocket mouse Core Areas surveyed in 2020.

trapping using Program MARK (White and Burnham 1999). Detection probability is the probability that the species will be detected given that 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 one individual of the species of interest (MacKenzie et al. 2006).

Trapping Methodology

We conducted a total of eight trapping sessions from 15 June to 25 September 2020, sampling 7 – 12 grids per effort. Sampling efforts coincided with the new moon to control for the effect that lunar brightness can have on small-mammal activity (Daly et al. 1992) as well as to allow time for grid installment and habitat surveys at the next Core Area to be sampled. We surveyed each grid over a single four-night effort (Monday-Thursday). We used 12″ × 3″ × 3.5″ Sherman live traps (H.B. Sherman Traps, Tallahassee, FL) modified with paper clips to prevent trap doors from potentially damaging animals' tails. Traps were spaced 7 m apart in a 5 trap × 5 trap grid, covering a 28 m × 28 m footprint (0.08 ha; Figure 2). We marked individual traps (n = 25 per grid) using pin flags labeled with an alpha-numeric code. Traps were placed ≤ 1 m from each pin flag and baited with 1 tbsp. of sterilized large white proso millet (*Panicum miliaceum*). A trap station consisted of a pin flag and a single Sherman trap.

We checked traps twice each night in accordance with U.S. Fish and Wildlife Service 10(a)(1)(B) permit specifications (USFWS TE088609-0). We opened traps 1–3 hour before sunset and started the first check near midnight. We reset each trap after checking it and added fresh bait if necessary. The second check began approximately 1 hour before dawn, after which we removed excess millet to avoid attracting ants and closed the traps. After the final dawn shift of the trapping effort, we removed all survey equipment.

Before surveying 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 during significant precipitation. We noted the visit number, trap check, grid ID, recorder, handler, and start and end times of each grid check. We recorded the status of individual trap stations on a quality control form as either open, animal, closed-empty, robbed, or missing. We used the unique four-letter species code to record each animal capture.

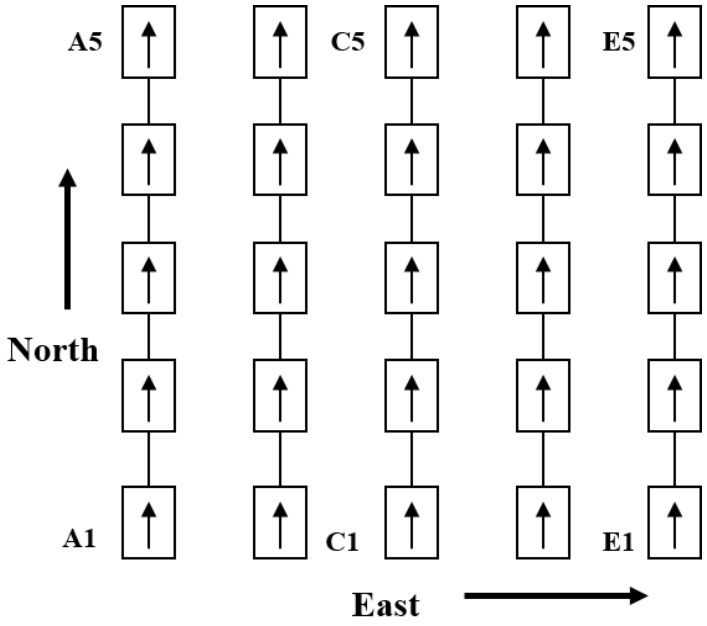

Figure 2. Grid design (5 × 5) for trapping Los Angeles Pocket Mouse. Boxes represent individual traps and small arrows indicate direction that open doors face.

We processed captured animals according to standard operating procedures developed by the Biological Monitoring Program. For a more complete description of survey methods, see *Los Angeles Pocket Mouse 2020 Occupancy Protocol*, available from the Biological Monitoring Program. We examined the quality control form to ensure that all traps were checked, baited and left open after the midnight check. At dawn, we used the quality control form to ensure that all traps were checked and closed. Prior to leaving the grid, we recorded ambient air.

Habitat Sampling

We conducted habitat surveys while setting up our trapping grids (i.e., 1 week to 1 month prior to trapping). We recorded point intercept data every 1-m along two 28-m transects that bisect the grid perpendicularly in the cardinal directions. We recorded the type of ground cover (bare ground, litter, thatch etc.) and any species or structure that hit a pole held vertically. From these data we calculated percent cover of the ground variables and vegetation species. We measured the height of only the tallest vegetation (to the closest 5 cm) hitting the pole. Finally, we recorded soil compaction using a soil penetrometer (Forestry Suppliers, model 77114) and took a photograph of the grid. For a more complete description of habitat survey methods, see *Los Angeles Pocket Mouse 2020 Habitat Sampling Protocol*, available from the Biological Monitoring Program.

Training

All Biological Monitoring Program field personnel were trained prior to the 2020 LAPM trapping field season. Program training focused on proper animal handling and identification, and data collection procedures. Only crew members with this training, or those trained on-site and working under the supervision of trained biologists, were allowed to handle animals during this effort. Crew members were able to identify seven covered and six non-covered small mammal species in-hand. Crew members handling small mammals could do so safely and proficiently and take measurements according to standard operating procedures. Prior to habitat data collection, field personnel were trained on the habitat sampling protocol.

COVID-19 modification: In the past we have had mock training in the field prior to the start of surveys. Physical distancing practices due to COVID-19 prevented mock survey training in 2020. Instead, biologists in need of training, received hands on experience while actively surveying for LAPM, following physical distancing rules. To accomplish this, more experienced handlers trained, from a safe distance, how to properly handle each species and take the necessary measurements. Until both biologists were comfortable, training was done with recaptured animals on which data was already collected. If the newly training biologist needed more experience before collecting data on new captures, roles will be reversed and the more experienced handler continued with animal captures while the other biologist continued taking data. These procedures are to be consistent with and do not supersede other departmental Covid-19 Safety Procedures.

Data Analysis

Trapping

We estimated grid occupancy (Ψ) and nightly detection probability (p) in the Core Areas surveyed for LAPM, using a closed-capture occupancy model that derived estimates based on grid-level presence/absence data (MacKenzie et al. 2002). The output from these models was a percent estimate of occupied grids that accounted for animals present but undetected. 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 allowed us to design surveys that would 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 relied on four 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 (four 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 grid locations by spacing them at a minimum of 80-m intervals. We constructed two candidate models that examined the effect of trap night, constant and varied by 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 (ΔAIC_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 (e.g., $w_i > 0.9$) for a single model (Burnham and Anderson 2002). Finally, we determined the acreage of occupied suitable habitat in all Core Areas by calculating the area of trapping grid footprints multiplied by the occupancy estimate.

Habitat Sampling

We ran two-sample t-tests, with data from our habitat surveys, to determine if differences exist between ground cover and habitat characteristics on LAPM occupied and not occupied grids at a 0.05 significance level. Prior to running the two-sample t-test we ran an F test to determine if variances were equal.

We used a generalized linear mixed model (GLMM) to test for differences in habitat on LAPM occupied and non-occupied grids. We characterized 11 predictor variables that may affect LAPM occupancy. These variables are either known to be important for LAPM, other *Perognathus* spp., or were common in the landscape warranting a closer look (Meserve 1976a, Germano 1998, Iwanowicz et al. 2016). Percent cover of rock was excluded immediately due to small sample size. We then quantified the multicollinearity among 10 remaining variables by looking at the variance inflation factor (VIF). The variance inflation factor measures the severity of multicollinearity between predictor variables in a model (Miles and Shevlin 2001). We considered multicollinearity to be present if VIF exceeded 3 (Zuur et al. 2010). Bare ground was removed due to a very high VIF. We know bare ground is an important habitat component for LAPM and by removing it we can possibly elucidate other important habitat it may be masking. We reran our collinearity test and removed thatch, the only variable > 3. Therefore, we ended up with 8 variables in our GLMM: soil compaction and percent cover for the following; *Eriogonum* spp., *Lepidospartum squamatum*, *Stephanomeria* spp., *Lactuca* spp., Poaceae, Brassicaceae and litter.

GLMMs are an extension of traditional linear regression models that allow the response variable to be binomial (to test for differences in habitat between LAPM occupied and not occupied grids) and allows the mean to depend on the explanatory variables through a link function (Bolker 2008). The GLMM was run with the library 'MuMIn' (Bartoñ 2016) and 'car' (Fox and Weisberg 2011) in R statistical software v. 3.4.3 (R Core Team 2016). "MuMIn" simplifies the information model selection process and performs model averaging based on information criteria (Bartoñ 2016). With a GLMM, some assumptions are similar to those in logistic regression (e.g., data must be independent and cannot have collinearity; Bolker 2008); however, the

assumption of data needing to be normally distributed is relaxed (Bolker 2008). We ranked each model according to Akaike's Information Criterion (AIC), and calculated AIC weights (w_i) across the entire candidate set. Model averaging was performed on all models within two ΔAICc of the best model. We report model-averaged parameter estimates, their unconditional standard error (SE), and the relative importance of each parameter to the other parameters in the final model.

RESULTS

Trapping

We captured LAPM on 32 grids (42%) at the four Core Areas surveyed (Table 1). We captured seven mammalian Covered Species, two reptilian Covered Species and seven non-covered species (Appendix A).

We captured LAPM on 12 of the 36 grids (33%) sampled at the San Jacinto Wildlife Area-Lake Perris Reserve (Figure 3). We had two occupancy models that appropriately modeled parameters but neither had clear support as the strongest model. Consequently, we model-averaged our estimates which gave results with *p* varying across trap night. The grid-level probability of detection increased from 0.65 (SE = 0.10) on the first trap night to 0.80 (SE = 0.07) for the last trap night. Overall, the cumulative detection probability was high P*c* = 0.99 (Table 1). Based on our grid level occupancy estimates, derived from our trapping data, we extrapolate that the San Jacinto Wildlife Area-Lake Perris Reserve Core Area has 2220 ac (898 ha) of occupied suitable habitat.

We captured LAPM on 15 of the 19 grids (79%) sampled at San Jacinto River-Bautista Creek (Figure 3). We had two occupancy models that appropriately modeled parameters but neither had clear support as the strongest model. Consequently, we model-averaged our estimates which gave results with *p* varying across trap night. The grid-level probability of detection increased from 0.60 (SE = 0.10) on the first trap night to 0.86 (SE = 0.06) for the last trap night. Overall, the cumulative detection probability was high P*c* = 1 (Table 1). Based on our grid level occupancy estimates, derived from our trapping data, we extrapolate that the San Jacinto River – Bautista Creek Core Area has 259 ac (105 ha) of occupied suitable habitat.

We captured LAPM on 2 of the 12 grids (17%) sampled at Anza Valley (Figure 3). We ran both models but found they did not calculate correctly, likely because this Core Area had very little capture data. Overall, there were two occupied grids, one grid captured LAPM all four nights and the other captured LAPM only on the first and last trapping night. Therefore, we ran a single model (w_i = 1.0) that estimated grid-level probability of detection and grid occupancy as constant across trap nights (Table 1). The cumulative detection probability was high Pc = 0.99, and was likely not calculated correctly and should be viewed with caution. Based on our grid level occupancy estimates, derived from our trapping data, we extrapolate that the Anza Valley Core Area has 218 ac (88 ha) of occupied suitable habitat.

We captured LAPM on 3 of the 10 grids (30%) sampled at Temecula Creek (Figure 3). We considered a single model (wi = 0.97) that estimated grid-level probability of detection (p = 0.19; SE = 0.16) and grid occupancy (Ψ = 0.53; SE = 0.40) as constant across trap nights. The cumulative detection probability was Pc = 0.57. Our results for this Core Area should be viewed with some caution as the sample size was small and standard error for occupancy was quite large (Table 1). Based on our grid level occupancy estimates, derived from our trapping data, we extrapolate that the Temecula Creek Core Area has 92 ac (37 ha) of occupied suitable habitat.

Table 1. Grid occupancy and detection probability per Core Area occupied by Los Angeles pocket mouse from 2010-2012 and 2020. *n* = number of trapping grids, *n* Occ = number of LAPM occupied grids, p = detection probability, Ψ = grid occupancy, standard error (SE), and P_c = cumulative detection probability. Highest values are shown in bold.

Core Area	Year	*n*	*n* Occ.	p	Ψ	P_c
San Jacinto Wildlife Area-Lake Perris	2010	40	5	0.52 (0.13)	0.13 (0.06)	0.95
	2011	40	11	0.67 (0.07)	0.28 (0.07)	0.99
	2012	40	12	0.61 (0.08)	0.31 (0.07)	0.98
	2020	36	12	**0.70 (0.07)**	**0.34 (0.08)**	0.99
San Jacinto River-Bautista Creek	2010	20	17	0.74 (0.05)	**0.85 (0.08)**	0.99
	2011	20	12	0.63 (0.07)	0.61 (0.11)	0.98
	2012	17	13	0.64 (0.07)	0.78 (0.11)	1
	2020	19	15	**0.76 (0.06)**	0.79 (0.09)	1
Anza Valley	2010	23	7	0.35 (0.11)	**0.37 (0.13)**	0.83
	2011	12	2	0.46 (0.20)	0.18 (0.12)	0.91
	2012	12	3	-	-	-
	2020	12	2	**0.75 (0.16)**	0.17 (0.11)	0.99
Temecula Creek	2010	5	3	**0.46 (0.17)**	**0.66 (0.25)**	0.91
	2011	5	3	**0.46 (0.17)**	**0.66 (0.25)**	0.91
	2012	5	1	-	-	-
	2020	10	3	0.19 (0.16)	0.53 (0.40)	0.57

- denotes not enough data for proper analysis

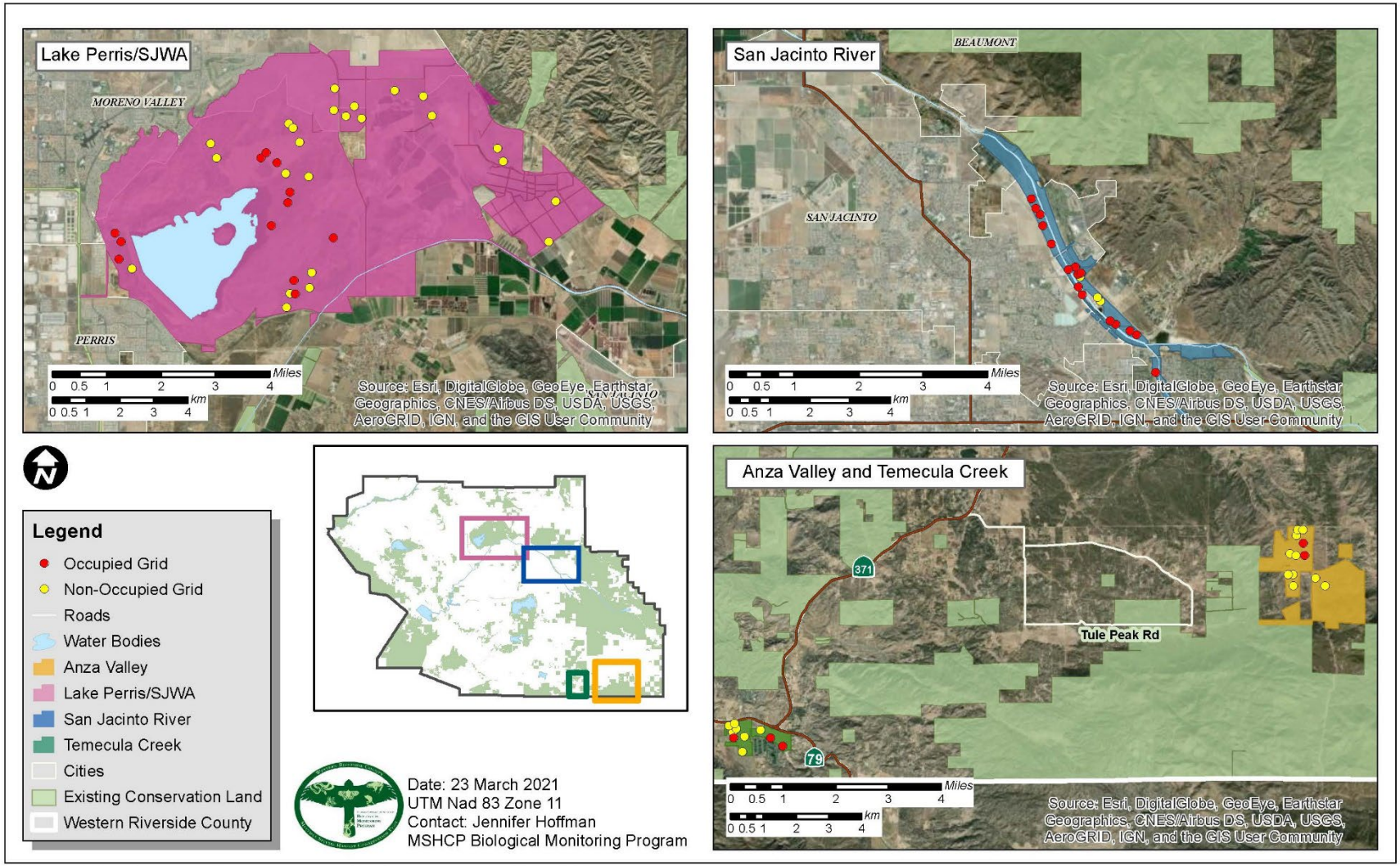

Figure 3. Los Angeles pocket mouse occupied and non-occupied grids in 2020.

Habitat Sampling

We used two-sample t-tests to compare ground and habitat characteristics, among grids where LAPM were present and grids where LAPM were not present (Table 2). Habitat characteristics included plant species, genera, or families. We combined *Eriogonum* species into one variable due to similarity in seed size, structure, and potential use by LAPM. *Stephanomeria* species were combined to the genus. We also combined all grasses (Poaceae) and mustards (Brassicaceae) into their own respective variables. We found grids where LAPM were present had significantly more bare ground and *Lepidospartum squamatum* while grids where LAPM where not present had significantly more *Eriogonum* spp. (Table 2).

Table 2. Results of two sample t-test comparing percent cover of plant species and ground characteristics that were present on both occupied (n = 32) and not occupied (n = 45) grids surveyed for LAPM in 2020. Number (n) of grids where characteristics were present and mean percent cover are included for reference. Bold p values are significant at the 0.05 level. Two sample t test for equal and unequal variances were used, as appropriate.

	Habitat Characteristic	LAPM detection	n	mean	*SD*	t	p*
Vegetation	*Eriogonum* spp.	Occupied	6	0.007	0.016	2.619	**0.012**
		Not occupied	16	0.043	0.090		
	Stephanomeria spp.	Occupied	21	0.149	0.228	0.929	0.357
		Not occupied	25	0.104	0.168		
	Brassicaceae	Occupied	17	0.057	0.103	1.206	0.232
		Not occupied	24	0.092	0.149		
	Lepidospartum squamatum	Occupied	16	0.072	0.095	3.166	**0.003**
		Not occupied	5	0.015	0.047		
	Lactuca spp.	Occupied	8	0.015	0.033	1.618	0.055
		Not occupied	11	0.039	0.094		
	Poaceae	Occupied	27	0.348	0.409	1.827	0.073
		Not occupied	41	0.511	0.352		
Ground	Bare Ground	Occupied	28	0.45	0.38	2.960	**0.004**
		Not occupied	38	0.23	0.29		
	Litter	Occupied	31	0.36	0.25	-1.962	0.053
		Not occupied	43	0.48	0.31		
	Thatch	Occupied	19	0. 19	0.28	-1.346	0.182
		Not occupied	29	0.29	0.34		
	Soil Compaction	Occupied	32	1.51	1.14	-1.133	0.261
		Not occupied	43	1.81	1.16		

We generated a global model with eight explanatory variables: percent cover *Eriogonum* spp. (ER), percent cover *Lepidospartum squamatum* (LP), percent cover *Stephanomeria* spp. (ST), percent cover litter (L), soil compaction (S), percent cover *Lactuca* spp. (LA), percent cover Brassicaceae (BR) and percent cover of Poaceae (P). From our eight explanatory variables we generated 256 models comprised of different variable combinations, three of which were included in the top model set (< 2 AICc of the best model; Table 3). Los Angeles pocket

mouse presence was best explained by mixed models that included the variables, listed in order of relative importance, *Lepidospartum squamatum*, *Eriogonum* spp., and *Stephanomeria* spp. (Table 4). These models contained 40% of the Akaike weight with no other model accounting for > 2% of the weight. Three variables (*Lepidospartum squamatum*, *Eriogonum* spp., and *Stephanomeria* spp.) were included in the top model (Table 3). Model-averaged parameter estimates of the top models showed *Lepidospartum squamatum* and *Eriogonum* spp. were always among the top models (< 2 ΔAICc) resulting in maximum relative importance values (Table 4). Similarly, only one of these variables had significant p-values, suggesting LAPM prefer higher amounts of *Lepidospartum squamatum*.

Table 3. Models that best explained Los Angeles pocket mouse presence, ranked using Akaike's Information Criterion values corrected for small sample size. Columns include number of parameters (K), Log Likelihood, AICc values, delta AICc (ΔAICc), and model weight.

	K	logLik	AICc	Δ AICc	wt
ER+LP+ST	4	-40.57	89.7	0	0.07
ER+L+LP+ST	5	-39.71	90.26	0.56	0.05
ER+LP	3	-42.04	90.41	0.7	0.05
ER+LP+S+ST	5	-39.86	90.56	0.85	0.04
BR+ER+LP+ST	5	-39.97	90.79	1.08	0.04
ER+LA+LP	4	-41.18	90.92	1.22	0.04
ER+LA+LP+ST	5	-40.07	90.98	1.28	0.03
BR+ER+LP+S+ST	6	-39.13	91.47	1.76	0.03
ER+L+LA+LP+ST	6	-39.16	91.52	1.82	0.03
BR+ER+LA+LP+ST	6	-39.23	91.67	1.97	0.02

*variable names: Brassicaceae (BR), *Eriogonum* spp. (ER), litter (L), *Lactuca* spp. (LA), *Lepidospartum squamatum* (LP), soil compaction (S) and *Stephanomeria* spp. (ST).

Table 4. Model averaged parameter estimates of the top models for determining LAPM presence relative to habitat variables collected.

	Estimate	**Unconditional SE**	***Z***	***p***	**95 % confidence interval**	**Relative importance**
(Intercept)	-0.5398	0.5017	1.06	0.289	(-1.53, 0.45)	-
ER	-25.1355	13.6201	1.82	0.069	(-52.27, 2.00)	1.00
LP	16.8319	5.9148	2.8	**0.005**	(5.04, 28.61)	1.00
ST	2.0907	1.7547	1.18	0.238	(-0.45, 5.74)	0.79
L	-0.3112	0.8365	0.37	0.712	(-4.06, 0.87)	0.19
S	-0.0574	0.1674	0.34	0.734	(-0.85, 0.21)	0.18
BR	-0.5596	1.4657	0.38	0.705	(-6.79, 1.92)	0.23
LA	-1.4646	3.4057	0.43	0.670	(-14.07, 4.63)	0.31

*variable names: Brassicaceae (BR), *Eriogonum* spp. (ER), litter (L), *Lactuca* spp. (LA), *Lepidospartum squamatum* (LP), soil compaction (S) and *Stephanomeria* spp. (ST).

DISCUSSION

Trapping

We captured LAPM in the four Core Areas trapped in 2020, and we recorded the highest overall grid occupancy during this trapping year. These results are similar to those reported in 2012 when these same four Core Areas were occupied by LAPM. However, since we did not trap all seven Core Areas, we have not met Species Objective 4 requiring a stable or increasing population in each of the seven Core Areas.

Overall, we see a stable or increasing trend with respect to grid occupancy and detection probably in the four occupied Core Areas (Figures 4 & 5). However, this trend is not uniform across all Core Areas. For example, occupancy has increased steadily at San Jacinto Wildlife Area-Lake Perris Reserve (Figure 4). While at San Jacinto River - Bautista Creek, occupancy dipped in 2011 only to rise again in 2012 and 2020. Similarly, in 2020, we had our highest detection probabilities at the San Jacinto Wildlife Area-Lake Perris Reserve and San Jacinto River - Bautista Creek Core Areas (Figure 5). We did not have enough data to obtain statistically reliable results on these two metrics at our Anza Valley and Temecula Creek Core Areas. Finally, we can only speculate about the status of LAPM population in the intervening years between our 2012 and 2020 trapping seasons. However, we are optimistic about the stability of these populations after viewing this years' occupancy and detection probability estimates and their similarity to previous year's results.

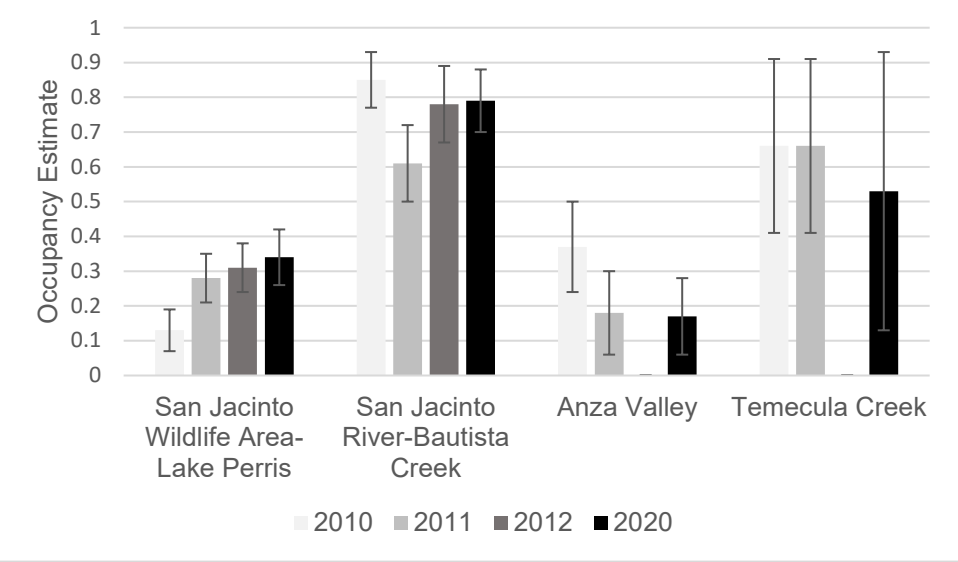

Figure 4. Occupancy estimates at each of the LAPM occupied Core Areas for trapping seasons 2010-2012 and 2020.

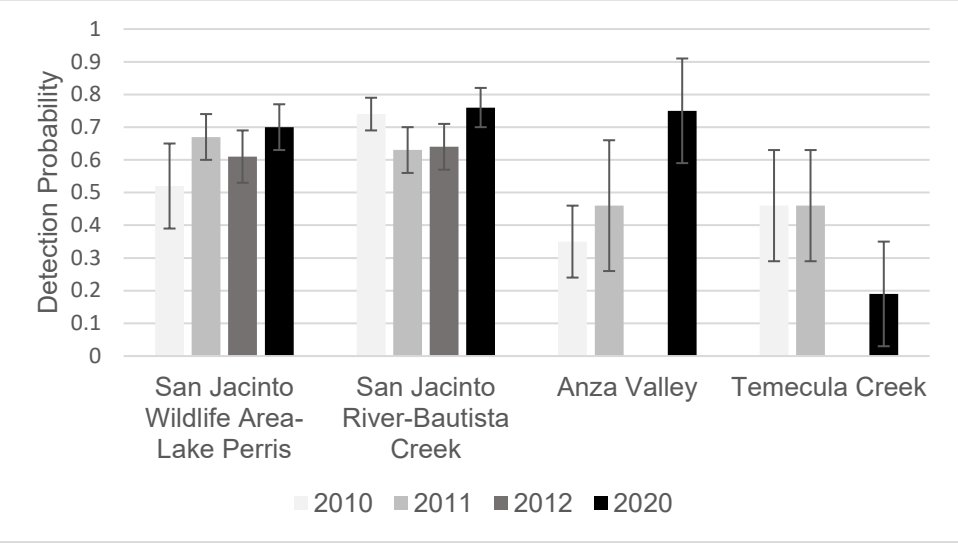

Figure 5. Detection probability at each of the LAPM occupied Core Areas for trapping seasons 2010-2012 and 2020.

In, 2020, we had 7724 ac (3126 ha) available for trapping in four LAPM Core Areas and estimated approximately 2705 ac (1095 ha; 35%) were occupied by LAPM occupied. Currently there are approximately 92,049 ac (37,251 ha) of suitable Los Angeles pocket mouse habitat in Conservation. This exceeds the goal of 14,000 ac (5666 ha) stated in Objective 1 of the Species Account (Dudek & Associates 2003). Although our model predicts suitable habitat exists within all Core Areas, we have not found LAPM occupying all Core Areas. A thorough, on the ground, trapping and habitat survey effort in these non-occupied Core Areas may help to elucidate any potential causes of non-occupancy by LAPM.

Habitat Surveys

We found trapping grids occupied by LAPM had significantly higher percent cover *Lepidospartum squamatum* than non-occupied trapping grids. Additionally, *Lepidospartum squamatum* was the most important variable in our regression analysis for explaining LAPM occupancy. As an indicator species and major component of mature alluvial scrub, *L. squamatum* are a clone forming, long lived shrub, in the family Asteraceae (Hanes et al. 1989, Montalvo et al. 2017). We recorded *L. squamatum* at two of our occupied Core Areas; San Jacinto River – Bautista Creek and Temecula Creek. These Core Areas are dominated by Riversidean alluvial fan sage scrub which is part of alluvial scrub community (Barbour and Wirka 1997, CDFW 2015). The importance of *L. squamatum* in relation to LAPM occupancy is likely based on habitat type, diversity and quality. While *L. squamatum* may provide cover for LAPM, it is also likely that the soils, well drained alluvial deposits, are preferred and shared by these two species (Hanes et al. 1989, Montalvo et al. 2017).

On the contrary, we found mean percent cover of *Eriogonum* spp. at non-occupied grids was six times higher than at occupied grids. *Eriogonum* spp., was also present in all of the top GLMM models (< 2 ΔAICc) with its *p* value approaching significance. *Eriogonum fasciculatum* and *E. gracile* were the most common *Eriogonum spp.* we recorded. The former is codominant with *L. squamatum* in alluvial scrub and is important or included in the food habits of *Perognathus* spp. (Meserve 1976b, Montalvo and Beyers 2010, Richardson et al. 2013, Iwanowicz et al. 2016). Additionally, the vegetative parts of *E. fasciculatum* are eaten by Stephens' kangaroo rats (*Dipidomys stephensi*), an MSHCP Covered Species, during dryer parts of the year when seeds are not available (Brehme et al. 2006). We found the negative relationship between *Eriogonum* spp. and LAPM occupancy to be confounding and we remain uncertain what relationship exists between LAPM and *Eriogonum* spp.

Recommendations

Small mammal trapping requires an intensive effort. Consequently, we have only surveyed for Los Angeles pocket mouse in four of their seven Core Areas since 2011. Our field efforts have been greatly diminished in recent years due to a lack of resources, resulting in smaller staff size and inadequate number of vehicles for field use. In 2020, we had to make further adjustments to our trapping effort due to the COVID 19 pandemic. These adjustments included driving non-four wheel drive personal vehicles to field sites, which resulted in our dropping three trapping grids in Anza Valley. Efforts should be made to expand our survey efforts through the use of volunteers and changing the protocol to include shorter trapping durations for presence/not presence surveys at the three remaining Core Areas listed in Objective 1 of the LAPM Species Account; the Badlands, Lake Skinner-Domenigoni Reserve, and Potrero Valley, as well as any other areas of interest for LAPM.

Notably, we captured house mouse (*Mus musculus*) on 31 of 36 (86%) grids trapped at San Jacinto Wildlife Area-Lake Perris Reserve. The percentage of grids occupied by house mouse is a strikingly higher than what we saw in our previous surveys at this Core Area. For example, in 2012, we had 5 of 40 grids (10%) occupied by house mouse. It is concerning that LAPM, a species of special concern, may be susceptible to local extirpation by these non-native grassland dwelling mice. It is recommended that we keep local land managers informed of this situation.

As time allows, on all LAPM trapping grids, future habitat surveys should examine the importance of certain plant species at a finer scale. For example, we found percent grass cover approaching significance, with more grass cover at LAPM non-occupied grids. However, the grass *Bromus tectorum* has been shown to be an important factor in the diet of the Great Basin pocket mouse (*Perognathus parvus*; Richardson et al. 2013). While this exact species of grass may not be important to LAPM, this example shows that an examination at a refined scale may reveal how different seed producing plants may influence the occupancy of Core Areas by LAPM.

Acknowledgements

We thank 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. Funding for the Biological Monitoring Program is provided by the Western Riverside County Regional Conservation Authority and the California Department of Fish and Wildlife. Program staff and volunteers who conducted surveys in 2020 were Masanori Abe, Andrea Campanella, Tara Graham, Marisa Grillo, Jennifer Hoffman, Cristina Juran, Mandy Leach, Robert Packard, Nathan Pinckard, and Esperanza Sandoval, Taylor Zagelbaum. Volunteers from Riverside County Flood Control District were Leslie Levy and Jason Swenson.

LITERATURE CITED

Barbour MG, Wirka J. 1997. *Classification of Alluvial Scrub in Los Angeles, Riverside and San Bernardino Counties*. University of California at Davis.

Biological Monitoring Program. 2005. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2006. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2005_AR_TR_Monitor_AppM5_Mammals.pdf

Biological Monitoring Program. 2006. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2007. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2006_AR_TR_Monitor_LAPM_Report.pdf

Biological Monitoring Program. 2007. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2008. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2007_AR_TR_Monitor_LAPM_Report.pdf

Biological Monitoring Program. 2010. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2011. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2010_AR_TR_Monitor_Los_Angeles_Pocket_Mouse.pdf

Biological Monitoring Program. 2011. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2012. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2011_AR_TR_Monitor_Los_Angeles_Pocket_Mouse.pdf

Biological Monitoring Program. 2012. Western Riverside County MSHCP Biological Monitoring Program Los Angeles Pocket Mouse (*Perognathus longimembris brevinasus*) Survey Report, 2013. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from: https://wrc-rca.org/species/surveys/Los_Angeles_Pocket_Mouse/RCA_2012_AR_TR_Monitor_Los_Angeles_Pocket_Mouse.pdf

Bornyasz M. 2003. Pacific pocket mouse translocation receiver site soil habitat study. Incomplete draft report prepared for California Dept. Fish and Game. May 15, 2003.

Bartoñ K. 2016. MuMIn: Multi-Model Inference. R package version 1.15.6. Available from https://CRAN.R-project.org/package=MuMIn

Bolker BM. 2008. Ecological models and data in R. Princeton University Press, Princeton, NJ.

Burnham KP, Anderson DR. 2002. Model selection and multimodel inference: A practical information-theoretic approach. 2nd Edition. New York (NY): SpringerVerlag.

Brehme C, Burnham K, Kelt D, Olsen A, Montgomery S, Hathaway SR, Fisher R. 2006. Stephens' Kangaroo Rat (*Dipodomys stephensi*) Monitoring Protocol for MCB Camp Pendleton. Prepared for AC/S Environmental Security, Marine Corps Base, Camp Pendleton.

[CDFW] California Department of Fish and Wildlife. Aerial Information Systems (AIS). 2015. *Vegetation Mapping Update- Western Riverside Co*. Publication Date: 2015-05.

Daly MD, Behrends PR, Wilson MI, Jacobs LF. 1992. Behavioural modulation of predation risk: Moonlight avoidance and crepuscular compensation in a nocturnal desert rodent, *Dipodomys merriami*. Animal Behaviour 44:1–9.

Dudek & Associates. 2003. Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). Final MSHCP, Volumes I and II. Prepared for County of Riverside Transportation and Lands Management Agency. Prepared by Dudek & Associates, Inc. Approved June 17, 2003.

Fox J, Weisberg S. 2011. An {R} Companion to Applied Regression, Second Edition. Sage, Thousand Oaks, CA.

French AR. 1976. Selection of high temperatures for hibernation by the pocket mouse, *Perognathus longimembris*: ecological advantages and energetic consequences. Ecology 57:185-191.

French AR. 1977. Circannual rhythmicity and entrainment of surface activity in the hibernator, *Perognathus longimembris*. Journal of Mammalogy 58:37-43.

Germano DJ. 1998. Distribution and habitat affinities of the Pacific pocket mouse (*Perognathus longimembris pacificus*). Final report for the California Dept. Fish and Game, Contract No. FG5129WM. August 1998.

Hanes TL, Friesen RD, Keane K. 1989. Alluvial scrub vegetation in coastal southern California. General Technical report. PSW. 1989;110.

Iwanowicz, DD, Vandergast AG, Cornman RS, Adams CR, Kohn JR, Fisher RN, Brehme CS. 2016. Metabarcoding of fecal samples to determine herbivore diets: A case study of the endangered Pacific pocket mouse. *PloS one*, *11*(11), e0165366.

Jameson EW Jr, Peeters HJ. 1988. California mammals. Berkeley, CA: University of California Press.

MacKenzie DI, Nichols JD, Lachman GB, Droege S, Royle JA, Langtimm CA. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248–2255.

MacKenzie DI, Royle AJ. 2005. Designing occupancy studies: General advice and allocating survey effort. Journal of Applied Ecology 42:1105–1114.

MacKenzie DI, Nichols JD, Royle JA, Pollock KH, Bailey LL, Hines JE. 2006. Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence. San Diego, CA: Academic Press.

M'Closkey RT. 1972. Temporal changes in populations and species diversity in a California rodent community. Journal of Mammalogy 53:657–667.

Meserve PL. 1976a. Habitat and resource utilization by rodents of a California coastal sage scrub community. Journal of Animal Ecology 45:647–666.

Meserve PL. 1976b. Food relationships of a rodent fauna in a California coastal sage scrub community. *Journal of Mammalogy*, 57:300-319.

Miles J, Shevlin M. 2001 Applying regression and correlation: A guide for students and researchers. Sage, Thousand Oaks, CA.

Montalvo AM, Beyers JL. 2010. Plant Profile for *Eriogonum fasciculatum*. Native plant recommendations for southern California ecoregions. Riverside-Corona Resource Conservation District and US Department of Agriculture, Forest Service, Pacific Southwest Research Station, Riverside, CA. 9 p. 2010.

Montalvo AM, Riordan EC and Beyers J. 2017. Plant profile for *Lepidospartum squamatum*. *Native Plant Recommendations for Southern California Ecoregions*.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Richardson KA, West SD, Gitzen, RA. 2013. Cheatgrass (*Bromus tectorum*) dominates cheek pouch contents of the Great Basin pocket mouse (*Perognathus parvus*). *Western North American Naturalist*, 73:158-167.

Shier DM. 2009. Behavioral ecology and translocation of the endangered Pacific little pocket mouse (*Perognathus longimembris pacificus*): San Diego, California, Zoological Society of San Diego, Interagency Agreement between U.S. Fish and Wildlife Service and CRES, 28 p.

[USDA] United States Department of Agriculture. 2009. Farm Service Agency Aerial Photography Field Office, National Agriculture Imagery Program, Riverside, County. Online: http://www.fsa.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai

[USFWS] U.S. Fish and Wildlife Service. 2010. Pacific Pocket Mouse (*Perognathus longimembris pacificus*) 5-Year Review: Summary and Evaluation. Report by U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office, Carlsbad, California.

White GC, Burnham KP. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 Supplement:120-138.

Williams DF, Genoways HH, Braun JK. 1993. Taxonomy. pp. 38–196 In: Gennoways HH, Brown JH, editors. Biology of the Heteromyidae. Special Publication Number 10, American Society of Mammologists. Provo, UT: Brigham Young University.

Winchell CS, Pavelka MA, Graham RC, Ribic CA. 1999. Pacific pocket mouse distribution in relation to soil type. Wildlife Society 1999 Annual Conference. Austin (TX).

Zuur AF, Ieno EN, Elphick CS. 2010. A protocol for data exploration to avoid common statistical problems. Methods in Ecology and Evolution 1:3–14.

APPENDIX A. Species recorded per grid while surveying for Los Angeles Pocket Mouse in 2020. Note: non-covered species were not marked, and total refers to the number of times these species were captured, not number of individuals detected.

Grid	Scientific Name	Common Name	Covered	Total
ANVA-05	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	1
	Phrynosoma blainvillii	Blainville's horned lizard	Y	1
ANVA-06	*Peromyscus maniculatus*	Deer mouse	N	1
ANVA-07	None	-	-	-
ANVA-08	None	-	-	-
ANVA-09	None	-	-	-
ANVA-10	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
ANVA-13	*Peromyscus maniculatus*	Deer mouse	N	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Neotoma spp	Unidentified woodrat	N	1
ANVA-14	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	1
ANVA-15	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
ANVA-16	None	-	-	-
ANVA-17	None	-	-	-
ANVA-18	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
LPSJ-01	*Peromyscus maniculatus*	Deer mouse	N	21
	Mus musculus	House mouse	N	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	9
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	25
	Peromyscus spp	unidentified deer mouse	N	1
LPSJ-02	*Mus musculus*	House mouse	N	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	2
LPSJ-03	*Mus musculus*	House mouse	N	3
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	9
LPSJ-04	*Mus musculus*	House mouse	N	37
	Reithrodontomys megalotis	Western harvest mouse	N	3
LPSJ-05	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	20
	Dipodomys stephensi	Stephens' kangaroo rat	Y	8
LPSJ-06	*Mus musculus*	House mouse	N	6
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	18
	Reithrodontomys megalotis	Western harvest mouse	N	15
LPSJ-07	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	6
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	3
	Dipodomys stephensi	Stephens' kangaroo rat	Y	5

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
LPSJ-08	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	6
	Dipodomys stephensi	Stephens' kangaroo rat	Y	9
	Reithrodontomys megalotis	Western harvest mouse	N	7
LPSJ-09	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	7
	Dipodomys stephensi	Stephens' kangaroo rat	Y	6
	Mus musculus	House mouse	N	9
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	6
	Reithrodontomys megalotis	Western harvest mouse	N	5
LPSJ-10	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	3
	Microtus californicus	California meadow vole	N	1
	Peromyscus maniculatus	Deer mouse	N	4
	Mus musculus	House mouse	N	18
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	35
LPSJ-11	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	32
	Mus musculus	House mouse	N	3
	Peromyscus maniculatus	Deer mouse	N	4
	Neotoma lepida intermedia	San Diego desert woodrat	Y	12
	Peromyscus eremicus	Cactus mouse	N	4
LPSJ-12	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	15
	Mus musculus	House mouse	N	30
	Peromyscus maniculatus	Deer mouse	N	2
	Dipodomys stephensi	Stephens' kangaroo rat	Y	13
LPSJ-13	*Mus musculus*	House mouse	N	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	7
	Dipodomys stephensi	Stephens' kangaroo rat	Y	12
LPSJ-14	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	19
LPSJ-15	*Mus musculus*	House mouse	N	11
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Dipodomys stephensi	Stephens' kangaroo rat	Y	2
	Reithrodontomys megalotis	Western harvest mouse	N	2
LPSJ-16	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	3
	Reithrodontomys megalotis	Western harvest mouse	N	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	6
	Peromyscus maniculatus	Deer mouse	N	7
	Mus musculus	House mouse	N	45
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	3

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
LPSJ-17	*Peromyscus maniculatus*	Deer mouse	N	10
	Mus musculus	House mouse	N	80
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	10
	Reithrodontomys megalotis	Western harvest mouse	N	1
LPSJ-18	*Mus musculus*	House mouse	N	10
LPSJ-19	*Mus musculus*	House mouse	N	24
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	5
LPSJ-20	*Mus musculus*	House mouse	N	25
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	3
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	2
LPSJ-21	*Mus musculus*	House mouse	N	16
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
LPSJ-22	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	27
	Reithrodontomys megalotis	Western harvest mouse	N	1
	Dipodomys stephensi	Stephens' kangaroo rat	Y	2
	Peromyscus eremicus	Cactus mouse	N	1
	Mus musculus	House mouse	N	41
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
LPSJ-23	*Mus musculus*	House mouse	N	9
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	3
LPSJ-24	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	12
LPSJ-26	*Mus musculus*	House mouse	N	12
LPSJ-27	*Mus musculus*	House mouse	N	18
LPSJ-28	*Mus musculus*	House mouse	N	21
LPSJ-29	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	11
	Peromyscus spp	unidentified deer mouse	N	1
	Mus musculus	House mouse	N	22
	Peromyscus maniculatus	Deer mouse	N	2
	Dipodomys stephensi	Stephens' kangaroo rat	Y	11
	Dipodomys spp	Kangaroo rat	-	1
LPSJ-30	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	28
	Dipodomys stephensi	Stephens' kangaroo rat	Y	4
	Mus musculus	House mouse	N	65
	Peromyscus maniculatus	Deer mouse	N	11
	Aspidoscelis tigris	Western whiptail	Y	1
LPSJ-31	*Mus musculus*	House mouse	N	120
	Peromyscus maniculatus	Deer mouse	N	7
LPSJ-32	*Mus musculus*	House mouse	N	44
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
LPSJ-33	*Microtus californicus*	California meadow vole	N	1
	Mus musculus	House mouse	N	69

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
LPSJ-36	*Mus musculus*	House mouse	N	53
	Microtus californicus	California meadow vole	N	1
LPSJ-37	*Peromyscus maniculatus*	Deer mouse	N	1
	Mus musculus	House mouse	N	43
	Reithrodontomys megalotis	Western harvest mouse	N	4
LPSJ-38	*Peromyscus maniculatus*	Deer mouse	N	11
	Mus musculus	House mouse	N	152
LPSJ-40	*Microtus californicus*	California meadow vole	N	1
	Mus musculus	House mouse	N	8
SJRI-01	*Peromyscus maniculatus*	Deer mouse	N	38
SJRI-02	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Peromyscus maniculatus	Deer mouse	N	70
	Otospermophilus beecheyi	California ground squirrel	N	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	3
SJRI-03	*Reithrodontomys megalotis*	Western harvest mouse	N	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	3
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	6
	Peromyscus maniculatus	Deer mouse	N	85
SJRI-04	*Dipodomys merriami parvus*	San Bernardino kangaroo rat	Y	7
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
	Peromyscus maniculatus	Deer mouse	N	87
	Dipodomys spp	Kangaroo rat	-	1
SJRI-07	*Peromyscus maniculatus*	Deer mouse	N	38
SJRI-08	*Peromyscus maniculatus*	Deer mouse	N	44
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	1
SJRI-09	*Peromyscus maniculatus*	Deer mouse	N	96
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	3
SJRI-10	*Peromyscus maniculatus*	Deer mouse	N	101
	Dipodomys simulans	Dulzura kangaroo rat	Y	3
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Reithrodontomys megalotis	Western harvest mouse	N	2
SJRI-11	*Peromyscus maniculatus*	Deer mouse	N	38
SJRI-12	*Peromyscus maniculatus*	Deer mouse	N	41
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
SJRI-13	*Peromyscus maniculatus*	Deer mouse	N	55
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	8
	Reithrodontomys megalotis	Western harvest mouse	N	1
SJRI-14	*Peromyscus maniculatus*	Deer mouse	N	55
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	2
SJRI-15	*Peromyscus maniculatus*	Deer mouse	N	83
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	5
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	1
SJRI-16	*Peromyscus maniculatus*	Deer mouse	N	56
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Mus musculus	House mouse	N	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
SJRI-17	*Peromyscus maniculatus*	Deer mouse	N	11
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Rattus spp	Old world rats	N	1
SJRI-21	*Dipodomys simulans*	Dulzura kangaroo rat	Y	3
	Reithrodontomys megalotis	Western harvest mouse	N	5
	Peromyscus maniculatus	Deer mouse	N	55
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
SJRI-22	*Peromyscus maniculatus*	Deer mouse	N	65
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Reithrodontomys megalotis	Western harvest mouse	N	4
SJRI-23	*Dipodomys simulans*	Dulzura kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	6
	Peromyscus maniculatus	Deer mouse	N	41
SJRI-24	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	6
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	1
	Peromyscus maniculatus	Deer mouse	N	101
TMCR-01	*Neotoma lepida intermedia*	San Diego desert woodrat	Y	2
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	6
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Peromyscus maniculatus	Deer mouse	N	9
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
TMCR-02	*Neotoma lepida intermedia*	San Diego desert woodrat	Y	2
	Peromyscus maniculatus	Deer mouse	N	22
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	4

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
TMCR-03	*Dipodomys merriami collinus*	Aguanga kangaroo rat	Y	5
	Neotoma lepida intermedia	San Diego desert woodrat	Y	4
	Peromyscus eremicus	Cactus mouse	N	1
	Peromyscus maniculatus	Deer mouse	N	12
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	8
TMCR-04	*Peromyscus maniculatus*	Deer mouse	N	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
	Peromyscus eremicus	Cactus mouse	N	1
TMCR-05	*Dipodomys merriami collinus*	Aguanga kangaroo rat	Y	9
	Peromyscus boylii	Brush mouse	N	9
	Neotoma lepida intermedia	San Diego desert woodrat	Y	4
	Peromyscus maniculatus	Deer mouse	N	11
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	1
TMCR-06	*Dipodomys merriami collinus*	Aguanga kangaroo rat	Y	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	2
	Peromyscus maniculatus	Deer mouse	N	11
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	8
TMCR-07	*Peromyscus maniculatus*	Deer mouse	N	15
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	7
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	6
	Neotoma lepida intermedia	San Diego desert woodrat	Y	3
TMCR-08	*Peromyscus boylii*	Brush mouse	N	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	7
	Peromyscus maniculatus	Deer mouse	N	19
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	14
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	3
TMCR-09	*Dipodomys merriami collinus*	Aguanga kangaroo rat	Y	3
	Chaetodipus fallax fallax	NW San Diego pocket mouse	Y	7
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	2
	Peromyscus maniculatus	Deer mouse	N	10
TMCR-10	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	8
	Peromyscus boylii	Brush mouse	N	1
	Peromyscus maniculatus	Deer mouse	N	7
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1