Western Riverside County
Multiple Species Habitat Conservation Plan
Biological Monitoring Program

2021 Los Angeles Pocket Mouse
(Perognathus longimembris brevinasus)
Survey Report

April 2022

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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 2021 is included in Section 8.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies.

The primary author of this report was the 2021 Mammal Program Lead, Jennifer Hoffman. This report should be cited as: Biological Monitoring Program. 2022. Western Riverside County MSHCP Biological Monitoring Program 2021 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, 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.

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.

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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.

Pocket mice spend much of their lives 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 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 (Figure 1). Species Objective 4 states that 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 2006; 2007; 2008; 2011a; 2012a; 2013; 2021). 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 2007; 2008). 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 (Figure 1). Additionally, in 2011, we trapped the Santa Ana River and Jurupa Mountains (Figure 1). 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 (Dudek & Associates 2003). However, we did not capture LAPM at either location.

From the 3-yr live trapping survey effort started in 2010, we found LAPM occupancy was associated with grids dominated by bare ground and not with grids dominated by thatch and litter. Similarly, thatch and litter depths were greater at grids where LAPM was not detected. Our 2020 habitat surveys reaffirmed that bare ground was important for LAPM presence and elucidated that LAPM preferred high amounts of *Lepidospartum squamatum* (Biological Monitoring Program 2021). Our trapping data, collected from 2010 - 2012 and in 2020, showed four Core Areas, San Jacinto Wildlife Area-Lake Perris Reserve, San Jacinto River-Bautista Creek, Anza Valley, and Temecula Creek, were occupied by LAPM each trapping year (Biological Monitoring Program 2011a; 2012a; 2013; 2021). We found occupancy somewhat stable over the four trapping years at San Jacinto River-Bautista Creek Core Area and San Jacinto Wildlife Area-Lake Perris Reserve Core Area, and detection probability was highest for both of these Core Areas in 2020 (Biological Monitoring Program 2021). In 2011 and 2012, our sample size was too low to conduct satisfactory occupancy and detection probability analysis at the Anza Valley and Temecula Creek Core Areas and consequently, population trend could not be deduced.

Our efforts in 2021 continued focusing on increasing our understanding of population trend. Trapping will provide the long-term monitoring data for population trend assessment of this species. Species Objective 4 for LAPM 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 in a season. Therefore, we concentrated our efforts on the four Core Areas occupied by LAPM in past survey efforts (2010 - 2012 and 2020) to determine trend in these occupied Core Areas. Our goals and objectives for monitoring LAPM in 2021 are listed below.

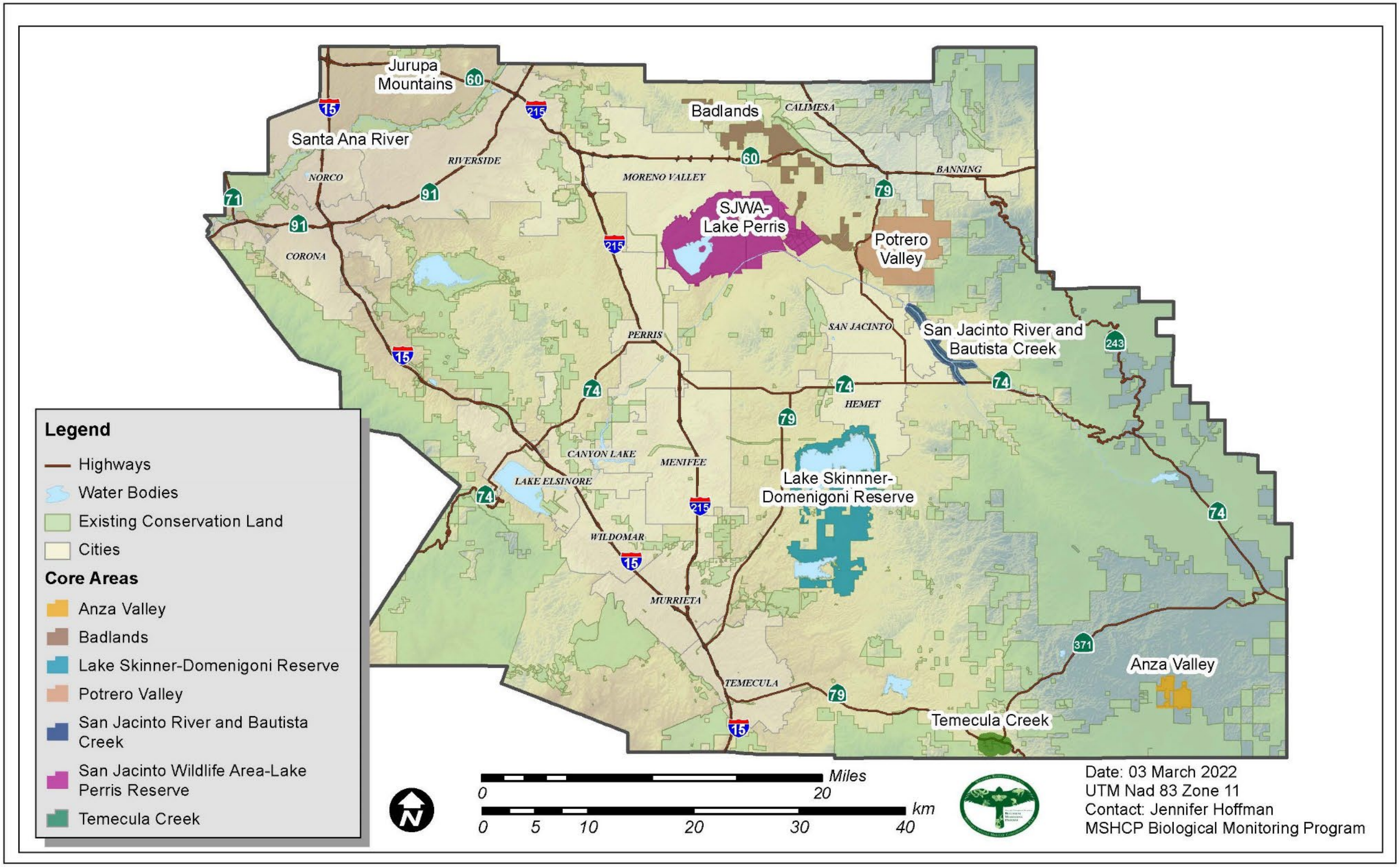

Figure 1. Los Angeles pocket mouse Core Area and additional survey areas.

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 trap) 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 and detection probabilities from trapping results for all years sampled.

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 2011a). 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 1976; 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 20 m 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; USFWS 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 2021: San Jacinto Wildlife Area-Lake Perris Reserve, San Jacinto River-Bautista Creek, Anza Valley, and Temecula Creek (Figure 2). We trapped the same grids surveyed in 2020 which is a subset of those surveyed in 2010 (Biological Monitoring Program 2021). 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.

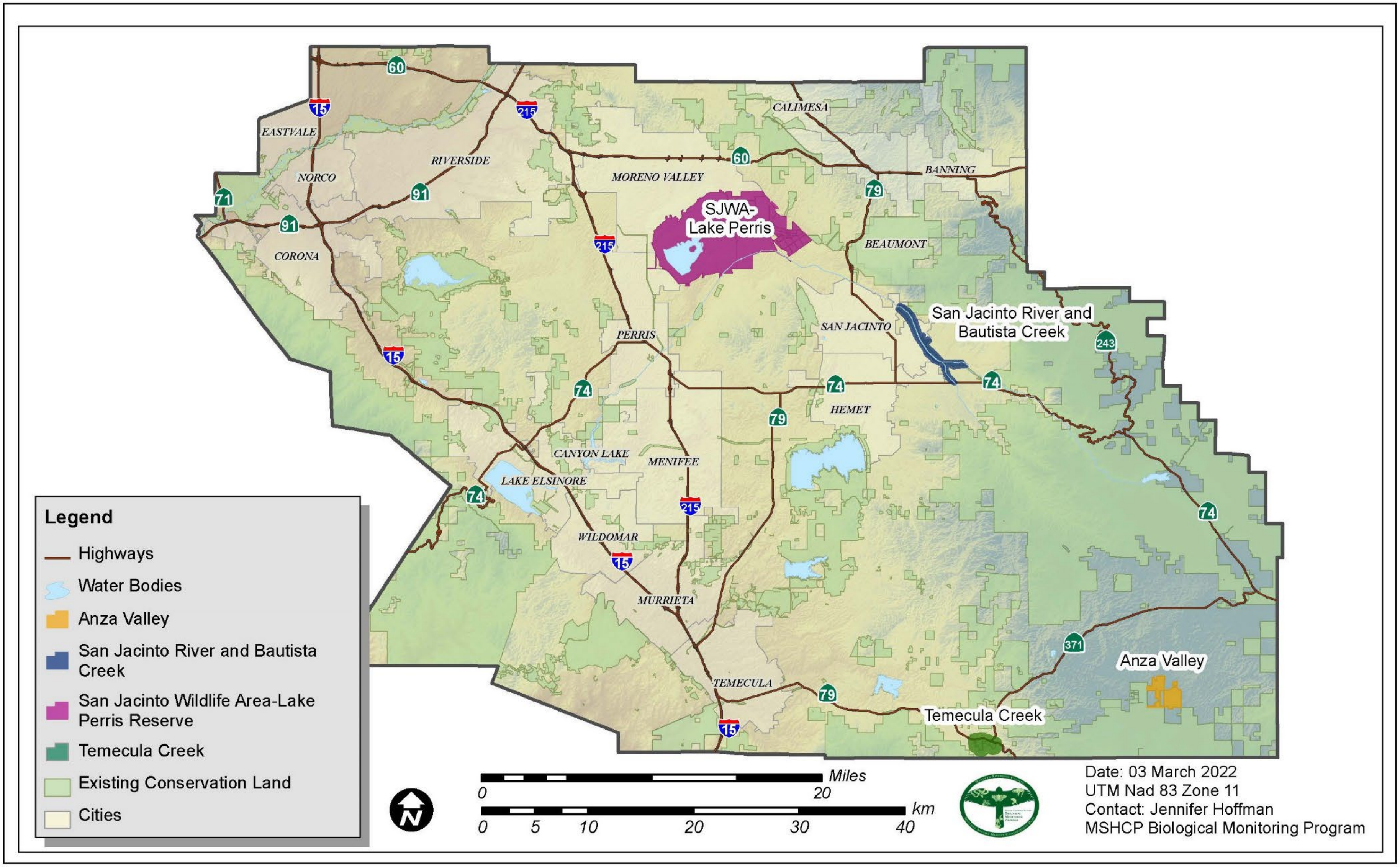

Figure 2. Los Angeles pocket mouse Core Areas surveyed in 2021.

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 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. 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 7 June to 17 September 2021, sampling 6 to 13 grids per effort. Each survey season we try to sample around the new moon cycle in an effort to control for the effect that lunar brightness can have on small-mammal activity (Daly et al. 1992). However, to accommodate two Federal holidays (Fourth of July and Labor Day), we had to trap weeks where the moon is brighter. Trapping for two week stretches allows us time for grid installment 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 3). 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 tablespoon 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 one – three h 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 at approximately 0400 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 (mostly clear, 50% clouded, overcast, fog, 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.

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 2021 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.

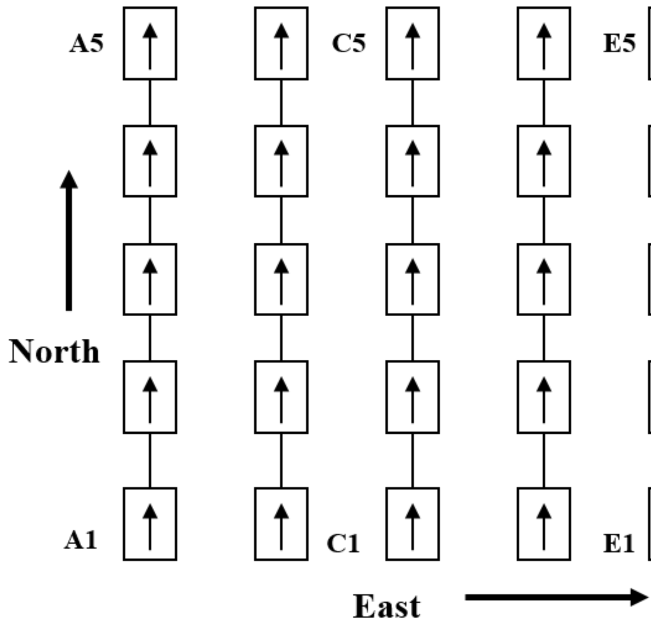

Figure 3. Grid design (5 × 5) for trapping Los Angeles Pocket Mouse. Boxes represent individual traps and small arrows indicate direction that open doors face.

Training

All Biological Monitoring Program field personnel were trained prior to the 2021 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.

<u>COVID-19 modification</u>: 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 2021. Instead, biologists in need of training, received hands on experience while actively surveying for LAPM while 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 and handling only recaptured animals. 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), nightly detection probability (*p*), and cumulative 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 two candidate models that accounted for differences in grid occupancy and nightly detection probability across survey periods (White and Burnham 1999). 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 these candidate models 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). We maintained independence among grid locations by spacing them at a minimum distance of 80-m between grid centers (Allred and Beck 1963; Shier 2009).

We also calculated a cumulative detection probability (p^*) across each site according to the following formula where p_i is the model-averaged detection probability on a given night: $P^* = 1 - \prod_{i=1}^{3} 1 - p_i$. Variances for P^* will be calculated using the delta method (MacKenzie et al. 2006). 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.

RESULTS

Trapping

We captured seven mammalian Covered Species, four non-covered mammal species and two non-covered bird species. We captured LAPM on 15 grids (19%) at two of the four Core Areas surveyed; San Jacinto Wildlife Area-Lake Perris Reserve Core Area and San Jacinto River- Bautista Creek Core Area. (Appendix A).

We captured LAPM on three of the 36 grids (8%) sampled at the San Jacinto Wildlife Area-Lake Perris Reserve Core Area (Figure 4). Of our two candidate models, the model calculating the effect of trap night on detection probability did not calculate correctly. Therefore, we re-ran our data with only one model. Resulting in grid-level probability of detection (p = 0.75, SE = 0.13) and grid occupancy (Ψ = 0.08, SE = 0.05) as constant across trap nights. Overall, the cumulative detection probability was high (p* = 1; 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 512 ac (207 ha) of occupied suitable habitat (Table 1).

We captured LAPM on 12 of the 19 grids (63%) sampled at San Jacinto River-Bautista Creek Core Area (Figure 4). Of our two candidate models, the model calculating the effect of trap night on detection probability did not calculate correctly. Therefore, we re-ran our data with only one model. Resulting in grid-level probability of detection (p = 0.72, SE = 0.07) and grid occupancy (Ψ = 0.64, SE = 0.11) as constant across trap nights. Overall, the cumulative detection probability was high (p* = 0.99; 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 291 ac (118 ha) of occupied suitable habitat (Table 1).

We did not capture LAPM at any of the 12 grids surveyed at Anza Valley, nor did we capture any LAPM at the ten grids surveyed at Temecula Creek.

Table 1. Grid occupancy and detection probability per Core Area occupied by Los Angeles pocket mouse from 2010-2012, 2020 and 2021. *n* = number of trapping grids, *n* Occ = number of LAPM occupied grids, p = detection probability, Ψ = grid occupancy, standard error (SE), and *p** = cumulative detection probability. Highest values are shown in bold.

Core Area	Year	*n*	*n* Occ.	p	Ψ	*p**
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
	2021	36	3	**0.75 (0.13)**	0.08 (0.05)	1
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
	2021	19	12	0.72 (0.07)	0.64 (0.11)	0.99
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
	2021	12	0	**-**	**-**	**-**
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
	2021	10	0	-	-	

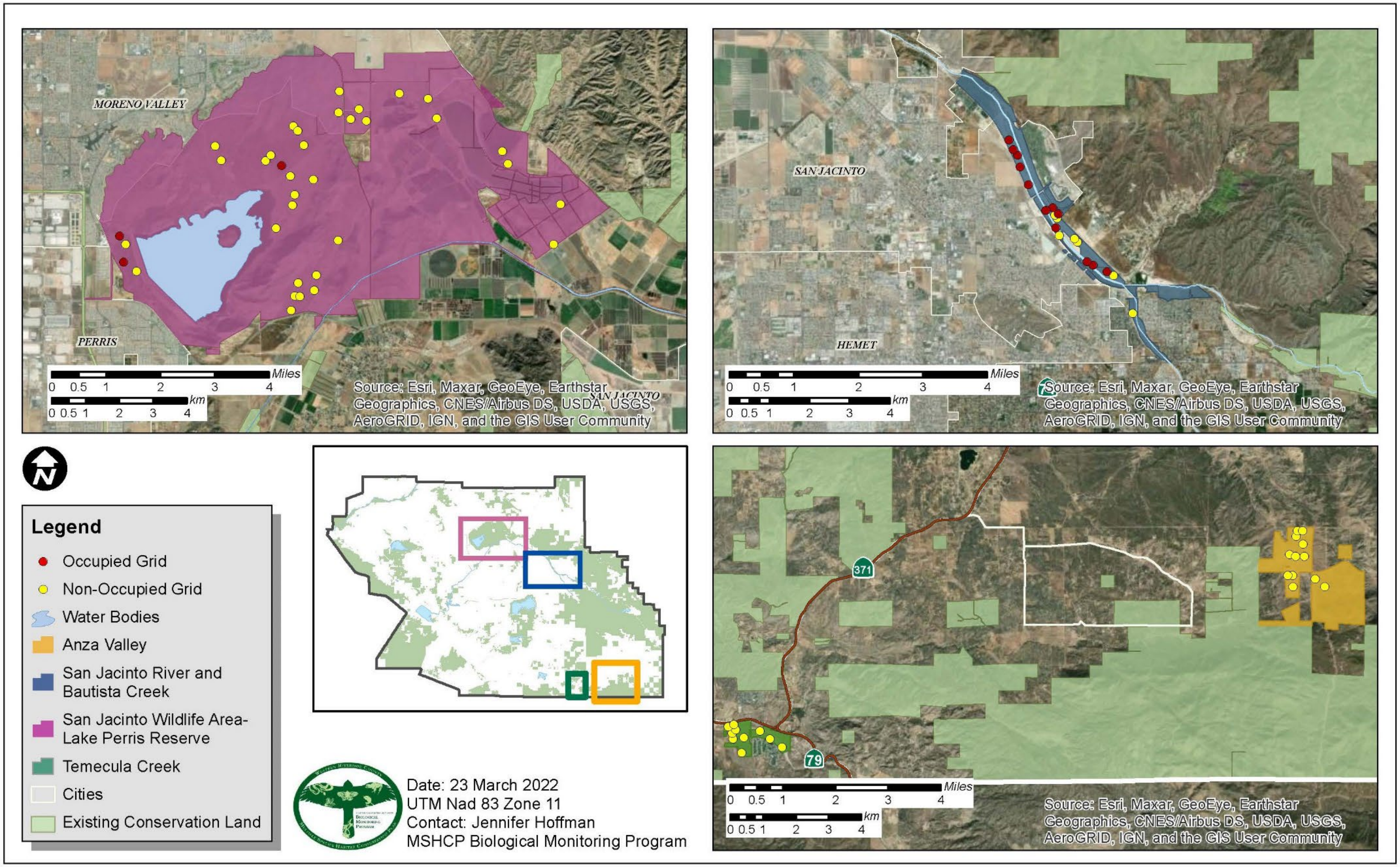

Figure 4. Los Angeles pocket mouse occupied and non-occupied grids in 2021.

DISCUSSION

We captured LAPM in two of the four Core Areas surveyed in 2021. We recorded our lowest occupancy estimate to date at the San Jacinto Wildlife Area-Lake Perris and second lowest at San Jacinto River-Bautista Creek. However, we show detection probability at both Core Areas was still high (> 0.7). Therefore, we continue to be confident in our trapping methods. We have not met Species Objective 4, requiring a stable or increasing population of LAPM in each of the seven Core Areas, as we have not detected LAPM in all seven Core Areas in the 8- consecutive year period from 2014-2021.

Overall, we see a stable population trend with respect to grid occupancy and detection probably only at San Jacinto River - Bautista Creek Core Area (Figure 5 & Figure 6). Detection probability has increased somewhat steadily at San Jacinto Wildlife Area-Lake Perris Reserve Core Area, while occupancy in this Core Area fell sharply in 2021 (Figure 6). We did not have enough data in 2012 or 2021, to obtain reliable results for occupancy and detection probability estimates at our Anza Valley and Temecula Creek Core Areas. Consequently, we cannot make any assumptions about population trend in these Core Areas. Nevertheless, we are optimistic about the stability of these populations in two Core Areas, San Jacinto River - Bautista Creek Core Area and San Jacinto Wildlife Area-Lake Perris Reserve Core Area, after viewing this years' occupancy and detection probability estimates with respect to previous year's results.

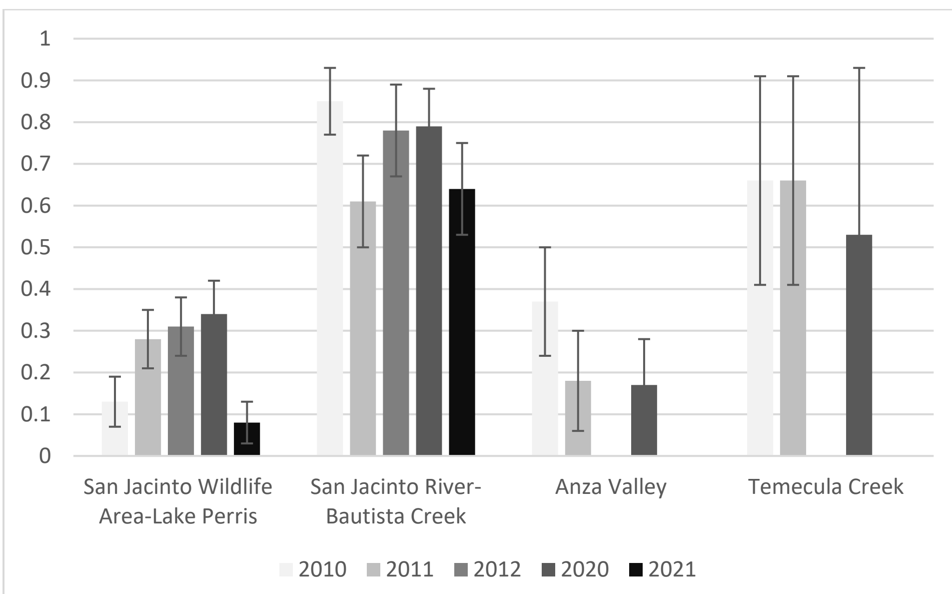

Figure 5. Occupancy estimates at each of the LAPM occupied Core Areas for trapping seasons 2010-2012, 2020 and 2021.

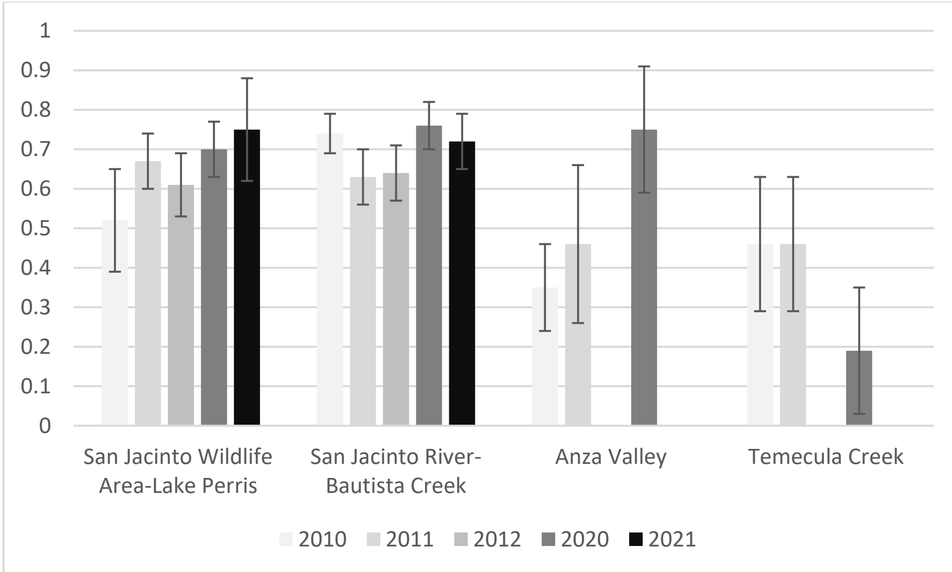

Figure 6. Detection probability at each of the LAPM occupied Core Areas for trapping seasons 2010-2012, 2020 and 2021.

Small mammals can respond to, and rebound from, the release of drought pressure in a period of a few months or in the next growing season (Ernest et al. 2000; Bradley et al. 2006). Riverside County was abnormally dry between 2009 and 2021 with many of those years classified as severe drought according to the U.S. Drought Monitor (USDM 2021). Also according to the USDM, Riverside County experienced above normal rainfall amounts in 2019. Normal annual rainfall in the Riverside area between 2009 and 2020 was 18.67 cm (NOAA 2021). In 2019, the area had almost double the normal with 36.78 cm of rain, which likely led to our high total number of rodent captures in 2020 (Whitford 1976; Hegewisch and Abatzoglou 2021; NOAA 2021). We captured more heteromyid rodents (*Perognathus*, *Dipodomys* and *Chaetodipus*) in all years apart from 2020, where we captured more non-heteromyid rodents (genus *Peromyscus*, *Mus*, and *Reithrodontomys*). After drought, rodents in the genera *Mus* and *Peromyscus* can take advantage of the increase in plant primary production and respond with intensified reproduction, allowing their densities to exceed that of rodents in the genera *Dipodomys* and *Perognathus* (Whitford 1976). The effects of drought may take longer to show in Heteromyid rodents which are adapted to arid climates, and whose access to cached food in underground burrows allows them to remain on the landscape when resources are reduced (Brown and Harney 1993; Monasmith et al. 2010; Bock et al. 2011). Fluctuations in small mammal populations, due to limited or changing resources in a semi-arid climate like Riverside County, are common and should be considered when determining population trend based multiyear datasets (Thibault et al. 2010; Kelt 2011; Prugh et al. 2018).

In May 2021, a prescribed fire in Lake Perris State Recreation Area burned 601 ac in an area that included four LAPM trapping grids (Ken Kietzer personal communication). Prior to the prescribed burn we caught both Heteromyid and non-

Heteromyid rodents on the grids within the burn area (Biological Monitoring Program 2011; 2012; 2013; 2020). Our trapping results, three months' post fire, resulted in captures of only members of the Family Heteromyidae (*Dipodomys*, *Perognathus*, and *Chaetodipus*). While our grid occupancy for LAPM decreased, from three occupied grids in 2020 to one occupied grid in 2021, we are not concerned. Members of the family Heteromyidae can survive fires and appear on site shortly after the area has burned (Quinn 1979; Monasmith et al. 2010; Bock et al. 2011). We noticed species richness was lower as compared to 2020 but could be temporary as small mammal fauna can take a few years to return to a site post-fire (Quinn 1979; Monasmith et al. 2010).

In 2021, we had 7724 ac (3126 ha) available for trapping in the four LAPM Core Areas we surveyed in 2021, and estimated approximately 2705 ac (1095 ha; 35%) were occupied by LAPM occupied. Currently there are approximately 104,537 ac (42,305 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 Core Areas where LAPM have not been detected is planned for the 2023 trapping season.

Recommendations

Future surveys efforts should include targeting LAPM in the three Core Areas not surveyed since 2010; Badlands, Lake Skinner-Domenigoni Reserve, and Potrero Valley as Species Objective 4 states that each Core Area must support a stable or increasing population (Dudek & Associates 2003). Additionally, habitat surveys should be conducted in these Core Areas that will allow for a comparison of habitat at Core Areas where LAPM have been consistently detected. Small mammal trapping requires an intensive effort and careful planning, and our field efforts have been greatly diminished in recent years due to a lack of resources, resulting in smaller staff size and a reduced survey effort. We can cover larger survey areas, and obtain detection data with less effort, by shortening the duration of our trapping sessions; from 4 to 2-nights. Most of our trapping grids are occupied by LAPM on or before night two. The data from a shorter trapping session would provide us with a quick understanding of site occupancy, will be a starting point for where we should focus our more intense 4-night surveys, and is not meant as a substitute for our 4-night trapping effort.

We often capture LAPM while trapping for other MSHCP Covered Species (i.e., Aguanga kangaroo rat in Temecula Creek and San Bernardino kangaroo rat in San Jacinto River-Bautista Creek (Biological Monitoring Program 2011b; 2012b; 2016; 2017; and 2018). Trapping data from these survey efforts can be compiled, standardized, and examined to further elucidate LAPM trend in those Core Areas.

Our overall capture numbers were low at the Anza Valley Core Area. In 2021, we captured only three (3) individual kangaroo rats (*Dipodomys* spp) and no LAPM. We are unsure what has caused this low capture rate. Some possible issues could be changes in vegetation (i.e., increase grasses resulting in less bare ground), drought, or exposure to toxins due to illegal trespass grows in the area. The region surrounding the Anza Valley Core Area is largely unincorporated. The passing of Proposition 64 in 2016, made possession and growing more than six marijuana plants a misdemeanor, which may have resulted in increased illegal grows in unincorporated areas of the state (Marchini and Parino 2016). Illegal pesticides, such as carbofuran, which is utilized by growers to keep pests from destroying crops, supplies, and getting into food storage, are known to harm and/or kill wildlife (Eisler 1985; Thompson et al. 2017). Carbofuran was taken from illegal grows approximately 9 km from our Anza Valley trapping location (personal communication Jonathan Reinig Riverside County Parks and Open Space).

An amendment should be made to our survey protocol that includes taking a photograph of each trapping grid prior to conducting habitat surveys and during grid install. These photographs will provide a literal snapshot of field conditions in all years we conduct surveys, and not just years with habitat surveys, as is currently the case. In examining these photos, we will be able to assess overall habitat condition, potential cover, and food available for small mammals at the time of trapping. Photo documenting each trapping grid will require minimal interference with our normal grid install routine. Photos should consistently be taken from the same location each time (i.e., in a 5x5 grid take photo from C1 trap location looking North) to provide the best comparison of the site.

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 Regional Conservation Authority and the California Department of Fish and Wildlife. Program staff who conducted surveys in 2021 were Masanori Abe, Andrea Campanella, Tara Graham, Marisa Grillo, Jennifer Hoffman (Mammal Program Lead), Cristina Juran, Nathan Pinckard, Nicole Tomes Orlale, Esperanza Sandoval, and Taylor Zagelbaum.

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APPENDIX A. Species recorded per grid while surveying for Los Angeles pocket mouse in 2021. Note: For Covered Species; 'Total' refers to the number of individuals captured per species per grid. For non-covered species; 'Total' refers to the number of captures per species per grid.

Grid	Scientific Name	Common Name	Covered	Total
ANVA-05	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	1
ANVA-06	None	-	-	-
ANVA-07	None	-	-	-
ANVA-08	None	-	-	-
ANVA-09	None	-	-	-
ANVA-10	None	-	-	-
ANVA-13	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
ANVA-14	None	-	-	-
ANVA-15	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
ANVA-16	None	-	-	-
ANVA-17	None	-	-	-
ANVA-18	None	-	-	-
LPSJ-01	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	1
LPSJ-02	*Dipodomys stephensi*	Stephens' kangaroo rat	Y	1
LPSJ-03	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	1
LPSJ-04	None	-	-	-
LPSJ-05	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	8
	Dipodomys stephensi	Stephens' kangaroo rat	Y	2
	Peromyscus maniculatus	Deer mouse	N	4
LPSJ-06	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
LPSJ-07	*Dipodomys simulans*	Dulzura kangaroo rat	Y	2
LPSJ-08	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	6
	Dipodomys simulans	Dulzura kangaroo rat	Y	3
	Dipodomys sp.	Kangaroo rat	-	1
LPSJ-09	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	4
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
LPSJ-10	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	4
	Dipodomys simulans	Dulzura kangaroo rat	Y	5
LPSJ-11	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	12
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Neotoma lepida intermedia	San Diego desert woodrat	Y	8
	Peromyscus eremicus	Cactus mouse	N	3
	Chaetodipus sp.	Spiny pocket mouse	-	1
LPSJ-12	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	6
	Dipodomys stephensi	Stephens' kangaroo rat	Y	2

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
LPSJ-13	*Dipodomys simulans*	Dulzura kangaroo rat	Y	3
	Dipodomys sp.	Kangaroo rat	-	1
LPSJ-14	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Dipodomys stephensi	Stephens' kangaroo rat	Y	4
LPSJ-15	*Dipodomys simulans*	Dulzura kangaroo rat	Y	2
LPSJ-16	*Dipodomys simulans*	Dulzura kangaroo rat	Y	1
	Dipodomys stephensi	Stephens' kangaroo rat	Y	1
LPSJ-17	*Peromyscus maniculatus*	Deer mouse	N	1
LPSJ-18	None	-	-	-
LPSJ-19	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
LPSJ-20	None	-	-	-
LPSJ-21	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
LPSJ-22	*Dipodomys simulans*	Dulzura kangaroo rat	Y	2
	Dipodomys stephensi	Stephens' kangaroo rat	Y	1
	Peromyscus maniculatus	Deer mouse	N	1
LPSJ-23	None	-	-	-
LPSJ-24	None	-	-	-
LPSJ-26	None	-	-	-
LPSJ-27	None	-	-	-
LPSJ-28	None	-	-	-
LPSJ-29	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	4
LPSJ-30	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	7
	Dipodomys stephensi	Stephens' kangaroo rat	Y	1
LPSJ-31	*Mus musculus*	House mouse	N	1
LPSJ-32	None	-	-	-
LPSJ-33	None	-	-	-
LPSJ-36	None	-	-	-
LPSJ-37	*Peromyscus maniculatus*	Deer mouse	N	1
LPSJ-38	None	-	-	-
LPSJ-40	None	-	-	-
SJRI-01	None	-	-	-
SJRI-02	*Dipodomys merriami parvus*	San Bernardino kangaroo rat	Y	1
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Neotoma lepida intermedia	San Diego desert woodrat	Y	3
	Peromyscus eremicus	Cactus mouse	N	1
	Peromyscus maniculatus	Deer mouse	N	27
	Reithrodontomys megalotis	Western harvest mouse	N	1

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
SJRI-03	*Dipodomys merriami parvus*	San Bernardino kangaroo rat	Y	6
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	5
	Callipepla californica	California quail	N	1
	Peromyscus maniculatus	Deer mouse	N	5
SJRI-04	*Dipodomys merriami parvus*	San Bernardino kangaroo rat	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	2
	Peromyscus maniculatus	Deer mouse	N	55
	Dipodomys sp.	Kangaroo rat	-	1
SJRI-07	*Peromyscus maniculatus*	Deer mouse	N	5
SJRI-08	*Peromyscus maniculatus*	Deer mouse	N	20
SJRI-09	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	5
	Melozone crissalis	California towhee	N	1
	Peromyscus maniculatus	Deer mouse	N	53
SJRI-10	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	6
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	3
	Peromyscus maniculatus	Deer mouse	N	26
SJRI-11	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	3
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	1
	Peromyscus maniculatus	Deer mouse	N	10
SJRI-12	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	2
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	1
	Peromyscus maniculatus	Deer mouse	N	15
SJRI-13	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	4
	Dipodomys merriami parvus	San Bernardino kangaroo rat	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	5
	Peromyscus maniculatus	Deer mouse	N	3
SJRI-14	*Dipodomys merriami parvus*	San Bernardino kangaroo rat	Y	3
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Peromyscus maniculatus	Deer mouse	N	32
SJRI-15	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	5
	Dipodomys simulans	Dulzura kangaroo rat	Y	1
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	5
	Peromyscus maniculatus	Deer mouse	N	19

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
SJRI-16	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	3
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	1
	Mus musculus	House mouse	N	1
	Peromyscus maniculatus	Deer mouse	N	25
	Reithrodontomys megalotis	Western harvest mouse	N	2
SJRI-17	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	1
	Peromyscus maniculatus	Deer mouse	N	6
SJRI-21	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	3
	Dipodomys simulans	Dulzura kangaroo rat	Y	4
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	Y	4
	Melozone crissalis	California towhee	N	1
	Peromyscus maniculatus	Deer mouse	N	30
SJRI-22	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	1
	Peromyscus maniculatus	Deer mouse	N	25
SJRI-23	*Perognathus longimembris brevinasus*	Los Angeles pocket mouse	Y	5
	Peromyscus maniculatus	Deer mouse	N	10
SJRI-24	*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	24
TMCR-01	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	3
	Reithrodontomys megalotis	Western harvest mouse	N	1
TMCR-02	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
TMCR-03	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	5
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	2
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
TMCR-04	None	-	-	-
TMCR-05	*Dipodomys merriami collinus*	Aguanga kangaroo rat	Y	3
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
	Peromyscus maniculatus	Deer mouse	N	1
TMCR-06	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	4
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	2
	Dipodomys simulans	Dulzura kangaroo rat	Y	2
	Peromyscus maniculatus	Deer mouse	N	3
TMCR-07	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	4
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	5
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
TMCR-08	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	12
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	2
	Neotoma lepida intermedia	San Diego desert woodrat	Y	1
	Peromyscus maniculatus	Deer mouse	N	1

Appendix A. Continued.

Grid	Scientific Name	Common Name	Covered	Total
TMCR-09	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	3
	Dipodomys merriami collinus	Aguanga kangaroo rat	Y	1
	Neotoma lepida intermedia	San Diego desert woodrat	Y	3
TMCR-10	*Chaetodipus fallax fallax*	NW San Diego pocket mouse	Y	1
	Peromyscus maniculatus	Deer mouse	N	1