

DRAFT Final report for focused pallid bat (*Antrozous pallidus*) and Townsend's big-eared bat (*Corynorhinus townsendii*) surveys in San Diego County, California

Prepared for the San Diego Management and Monitoring Program

Prepared by the San Diego Natural History Museum

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Introduction

Bats are a diverse group of animals and represent approximately one quarter of San Diego County's terrestrial mammals (Bond 1977, Tremor 2017). However, much about their population status in the San Diego County Multiple Species Conservation Program (MSCP) area is unknown, particularly in the North County. The lack of information makes them difficult to address in MSCP planning and management efforts.

Both the pallid bat (Antrozous pallidus) and Townsend's big-eared bat (Corynorhinus townsendii), have been proposed as covered species in the North County MSCP plan. Both are California species of special concern and the latter was in the review process to be listed as State endangered, but was determined to not merit this state listing status. Very little information exists on the status or distribution of either species, particularly in the North County MSCP area. Therefore, San Diego County-wide surveys for these species were needed to document where they were found and what their current population status was. Obtaining this information would allow for more informed consideration of the conservation planning and management of these species in the North County plan. This would also allow habitat models to be developed for the target species to aid in future planning.

The pallid bat is a large bodied species with pale blond fur and large ears (Stokes 2017). There are two subspecies in San Diego County, the desert form *Antrozous pallidus pallidus* and the coastal form, *A. p. pacificus*, which was targeted during these surveys. The pallid bat has a unique foraging strategy in that it often feeds on terrestrial arthropods such as crickets and scorpions that it takes from off of the ground. This foraging strategy presents interesting challenges to the species in that it requires open ground cover for finding and capturing large-bodied terrestrial prey. It roosts in a variety of crevice like situations including often in rural man-made structures. This affinity for roosting in man-made structures makes the pallid bat vulnerable to extirpation at roosts sites.

The pallid bat was historically considered 'widely and commonly distributed west of the divide' in San Diego County according to Krutzsch (1948). He stated roosts were often large and 'may number several hundred individuals'. He also stated roosts 'have been long used' indicating high roost site fidelity. There were '12 known colony sites in San Diego County' historically, all of which were in man-made structures. Krutzsch also noted that pallid bats were 'frequently found in association with bats of other species'.

The Townsend's big-eared bat is a delicate medium-sized bat buffy brown in color with very large ears (Stokes 2017). It is a slow flyer that mostly eats small moths that it catches close to vegetation and perhaps gleans from branches. It is a terrain hugging species that rarely ventures out in open habitats and may require unfragmented landscapes. It is an obligate cave-roosting species that most commonly roosts in caves and cave-analogs, most notably in abandoned mines but including other man-made structures. Its range is strongly associated with the presence of caves including boulder habitat that is fairly abundant in San Diego County.

The Townsend's big-eared bat was historically considered 'widely and commonly distributed from the sea coast to the desert' in San Diego County (Krutzsch 1948). It was found 'wherever suitable roosting places' were available with 'no preference for any particular associated vegetation'. There were a 'few roosting places where *Corynorhinus* (were) habitually present' mentioned in reference to places usually 'frequented by brood colonies'. These may have housed 'several hundred' bats.

Bat surveys were conducted in the South County sub-area in the early 2000s shortly after the inception of the MSCP plan (Stokes et al. 2005). Both of the target species were found during these surveys and in subsequent surveys of San Diego County parks in the South County sub-area. The current population status of these bats over 10 years later was unknown. Surveys in the South County sub-area were justified to compare the current population status with the baseline population status documented in the earlier surveys given the changes that have occurred in the habitats of the region, including fragmentation, multiple wildfires, and extreme drought. The comparison would ideally provide information for the functionality of the preserve system for these bats and would aid in determining the effectiveness of the MSCP preserve system for all species of bats.

In addition to the general lack of information on the status and distribution of these two target species, even less was known about the population structure within and between the sites where they occur. Issues such as population relatedness, dispersal, inbreeding depression, and others could not be addressed without obtaining a robust tissue collection across the documented populations. Recent inventories of existing tissue samples at San Diego State University, United States Geological Survey, and the SDNHM have revealed that the existing tissue collections in these regions were not sufficient to answer these questions. This study would provide an opportunity to begin to obtain these tissue samples in addition to the distribution and population data outlined above.

Bats' inhabitation of structures can be divided into two major behaviors, day roosting and night roosting. Day roosting bats are sleeping, resting, or caring for their pups, which, unable to fly, are left behind while the adults go out to forage. Therefore, day roost locations tend to be very secure, hidden, and thermally stable for both the adult and juvenile bats. Night roosting is a temporary behavior where

bats seek out short-term shelters, generally after an early evening foraging, in order to rest and digest before another foraging mission. Night roosts can be seen in open situations under an overhang or other simple cover.

The research goals of this study were the following:

Goals:

1. Document presence of the two bat species *Antrozous pallidus* and *Corynorhinus townsendii* including documenting day and night roosts where they could be found.
2. Determine current population status and demographics including documentation of age class, gender ratio, reproductive condition, and recruitment in areas where bats were captured. Provide comparison of results to baseline 2002-2003 MSCP bat surveys.
3. Obtain tissue for genetic analyses of population structure.
4. Provide data on target species occurrence that can be used to create species habitat models for MSCP planning.
5. Determine health of bats based on overall appearance, weight, and ectoparasite load.
6. Document bat community and diversity of MSCP areas during focused surveys for *Antrozous* and *Corynorhinus*

Surveys for the two sensitive bat species, began in the summer of 2015 in and around the habitat conservation planning areas (HCPs) of San Diego County, California. The field data collection effort was concluded in September 2017.

Methods

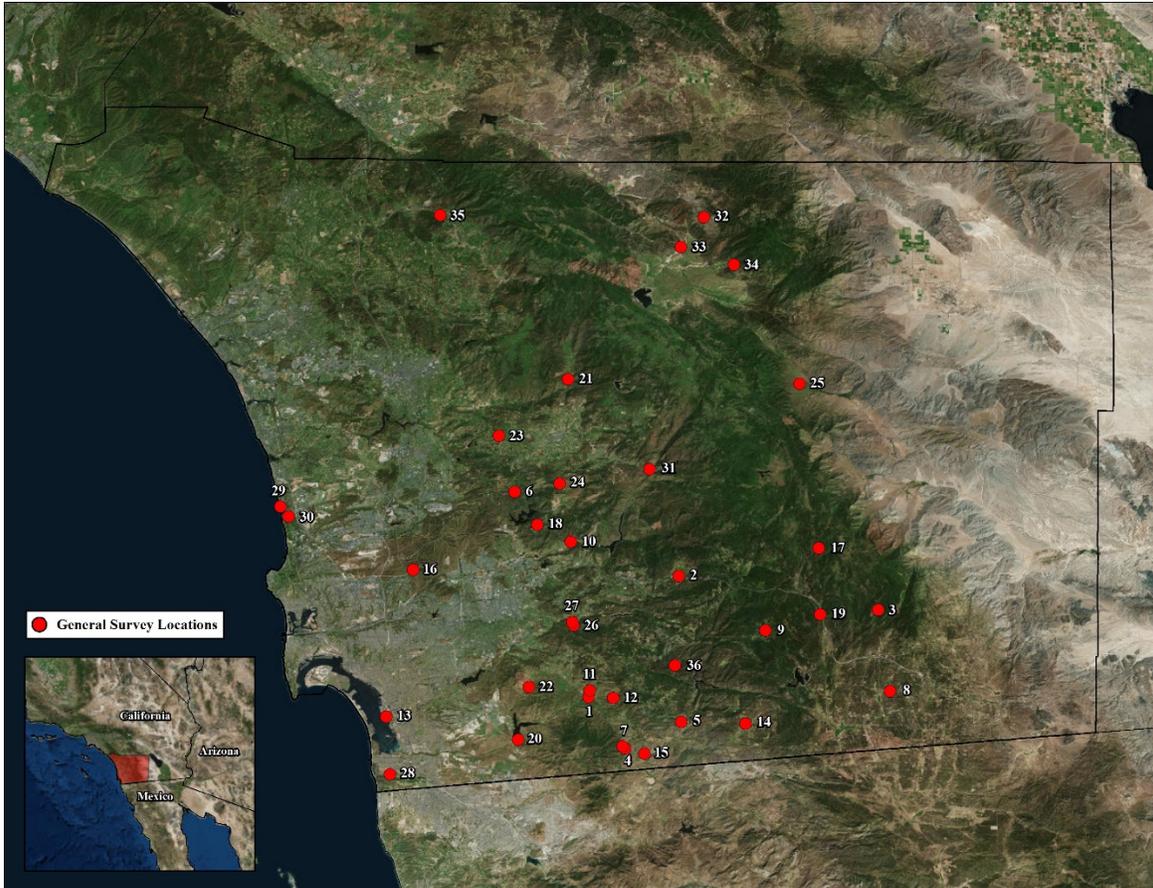
Thirty-six locations were surveyed from June of 2015 through September of 2017 (Map figure 1). While pallid bats and Townsend's big-eared bats were the focus of the surveys, the survey techniques employed did not discriminate against detecting other bat species, resulting in a community-wide bat survey. Surveys were conducted at areas where the two target species were known historically and/or had the potential to occur based on habitat preferences (Krutzsich 1948, Bond 1977, Stokes et al. 2005), and where site access could be negotiated (Table 1). The survey techniques used were:

Survey Techniques

1. Passive ANABAT bat detectors – passive ANABAT ‘express’ bat detectors (Titley Scientific™) were used to record bat vocalizations during this study. From one to seven detectors were deployed at 25 of the 36 various general survey locations around San Diego County, California. One hundred and four ANABATs were deployed on 116 nights (4.16 ANABATs/site, 4.64 nights per site) over the 2015 to 2017 study period (Appendix I). The detectors were placed approximately one meter above ground on T-posts or strapped to trees or vegetation with the microphones oriented towards expected bat flyways. Expected bat flyways included the edge of riparian reaches, edge of oak and/or coniferous woodlands, meadow edges, along scrubby ridgelines, and the edges of waterways. The detectors were left in place to passively record bat vocalizations for a minimum of three consecutive nights. In rare cases, the detectors were left in place for longer than 3 nights (e.g. up to 31 consecutive nights at the Living Coast Discovery Center). The detectors were set to automatically turn on at sunset and turn off at sunrise. They automatically recorded bat vocalizations as well as other sounds such as insect noise. After the detectors were retrieved from the field, the recorded bat vocalization data were downloaded and reviewed in the laboratory and identified to the species level when possible (O’Farrell et al. 1999).
2. Mist nets – fine mesh mist nets (Avinet™) of lengths varying from 6 meters to 12 meters were erected in expected bat flyways including over small ponds, across creeks, in vegetation flyways, and under woodland canopies to capture flying bats (CDFW scientific collecting permit #2645 - Kunz et al 1996). From one to six mist nets were used depending on the number of appropriate bat flyways at any given survey location during a survey night. Mist nets were opened at approximate sunset and were continuously tended for 3 hours. One hundred and fourteen mist nets were used on 23, 3-hour nights of netting (4.96 mist nets/3-hour night – Appendix I). After the 3-hour mist netting period the nets were closed and taken down. All captured bats were identified to species, and age, gender and reproductive condition was determined. Most bats were photographed and all were released immediately after being processed.
3. Audible – listening for audible bat vocalizations with the unaided ears always accompanied mist netting but was also conducted independently of other survey techniques on one occasion (Mission Trails Regional Park – Jackson Drive extension on January 4, 2016).
4. Day roost surveys & exit counts – diurnal inspections of known or potential bat day roosts were made opportunistically. Inspections involved peering into crevices and cavities where bats were visible, usually using a flashlight. Occasionally, bat roosts such as mines and flume tunnels could be entered and bats were sometimes captured using a hand held butterfly style net to verify the species, age, gender, and reproductive status. On a single occasion at the Torrey Pines Road bridge over the Coaster tracks, bats were observed and counted as they exited from a day roost.
5. Night roost surveys – inspections of locations where bats were roosting at night were made opportunistically. A flashlight was used to illuminate night roosting bats so the species could be verified.

Study Area

Map figure 1 represents the general survey locations within the study area that focused on areas west of the desert in San Diego County, California. The names of survey locations and land ownership/management are listed in table 1. Note there were multiple techniques (represented by multiple survey points) used at several of these locations. However, the locations are presented here as single points numbered 1-36 even though there may have been up to six mist nets and seven ANABATs used at a given location, as well as day and/or night roost surveys conducted. The locations are represented in the database that accompanies this study (individual ANABAT points and a centroid for mist net points at survey locations), and all of the survey dates and survey methods used at the various locations are represented in Appendix I.



Map Figure 1. General survey locations numbered 1-36. See table 1 below for survey location information.

Table 1. Map number reference, survey location names, and land ownership and management information.

Map number	Survey location	Land ownership and management
1	94 Bridge in Jamul	Caltrans, California Department of Fish and Wildlife
2	Alpine	Private
3	Antone Canyon Mine	United States Forest Service
4	Artery Mine	Bureau of Land Management, Private
5	Barrett Flume	City of San Diego, United States Forest Service
6	Boulder Oaks	San Diego County Department of Parks and Recreation
7	Chief of the Hills Mine	Bureau of Land Management, Private
8	Clover Flat	Back Country Land Trust
9	Corte Madera Ranch	Private
10	El Monte County Park	San Diego County Department of Parks and Recreation
11	Hollenbeck Canyon Wildlife Area	California Department of Fish and Wildlife
12	Honey Springs Ranch	California Department of Fish and Wildlife
13	Living Coast Discovery Center	United States Fish and Wildlife Service, Living Coast Discovery Center
14	Long Potrero	Back Country Land Trust
15	Marron Valley	City of San Diego, Bureau of Land Management
16	Mission Trails Regional Park	City of San Diego
17	Noble Mine	United States Forest Service
18	Oak Oasis County Park	San Diego County Department of Parks and Recreation
19	Old Hwy 80 Mine	United States Forest Service
20	Otay River Valley	San Diego County Department of Parks and Recreation
21	Pamo Valley	City of San Diego
22	Proctor Valley	California Department of Fish and Wildlife
23	Ramona Grasslands	San Diego County Department of Parks and Recreation
24	Rancho Canada	California Department of Fish and Wildlife
25	San Felipe Valley	California Department of Fish and Wildlife
26	Sloane Canyon I	California Department of Fish and Wildlife
27	Sloane Canyon II	Kumeyaay Diegueno Land Conservancy
28	Tijuana River Valley	United States Fish and Wildlife Service
29	Torrey Pines Bridge	City of Del Mar
30	Torrey Pines State Natural Reserve	California Department of Parks and Recreation
31	Upper San Diego River	United States Forest Service
32	Warner Springs I	United States Forest Service
33	Warner Springs II	Vista Irrigation District
34	Warner Springs III	Private
35	Wilderness Gardens Park	San Diego County Department of Parks and Recreation
36	Wilson Creek/Barrett Lake	City of San Diego

Results

General summary

Eighteen bat species were found during this study, including the two target species: pallid bat and Townsend's big-eared bat (Table 2). Of the 22 bat species known from San Diego County, two rare migratory nectar feeding species: lesser long-nosed bat (*Leptonycteris yerbabuebae*) and Mexican long-tongued bat (*Choeronycteris mexicana*), the rare migratory/vagrant silver-haired bat (*Lasionycteris noctivagans*), and the extremely rare spotted bat (*Euderma maculatum*) went undetected (Bond 1977, Constantine 1998, Stokes et al. 2005).

Table 2. The 22 bat species known from San Diego County including the 18 species detected in this study.

Family	Common name	Species	4-letter code	Legal status*	Detected 2015-2017
<i>Phyllostomidae</i>	Lesser long-nosed bat	<i>Leptonycteris yerbabuenae</i>	LEYE	FE	
	California leaf-nosed bat	<i>Macrotus californicus</i>	MACA	CSSC	✓
	Mexican long-tongued bat	<i>Choeronycteris mexicana</i>	CHME	CSSC	
<i>Vespertilionidae</i>	Yuma myotis	<i>Myotis yumanensis</i>	MYYU	None	✓
	Long-eared myotis	<i>Myotis evotis</i>	MYEV	None	✓
	Fringed myotis	<i>Myotis thysanodes</i>	MYTH	None	✓
	Long-legged myotis	<i>Myotis volans interior</i>	MYVO	None	✓
	California myotis	<i>Myotis californicus</i>	MYCA	None	✓
	Western small-footed myotis	<i>Myotis ciliolabrum</i>	MYCI	None	✓
	Silver-haired bat	<i>Lasionycteris noctavigans</i>	LANO	None	
	Canyon bat	<i>Parastrellus hesperus</i>	PIHE	None	✓
	Big brown bat	<i>Eptesicus fuscus</i>	EPFU	None	✓
	Western red bat	<i>Lasiurus blossevillii</i>	LABL	CSSC	✓
	Hoary bat	<i>Lasiurus cinereus</i>	LACI	None	✓
	Western Yellow bat	<i>Lasiurus xanthinus</i>	LAXA	CSSC	✓
	Spotted bat	<i>Euderma maculatum</i>	EUMA	CSSC	
	Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	COTO	CSSC	✓
	Pallid Bat	<i>Antrozous pallidus</i>	ANPA	CSSC	✓
<i>Molossidae</i>	Mexican free-tailed bat	<i>Tadarida brasiliensis</i>	TABR	None	✓
	Pocketed free-tailed bat	<i>Nyctinomops femorosaccus</i>	NYFE	CSSC	✓
	Big free-tailed bat	<i>Nyctinomops macrotis</i>	NYMA	CSSC	✓
	Western mastiff bat	<i>Eumops perotis</i>	EUPE	CSSC	✓

* FE = Federally endangered, CSSC = California Department of Fish and Wildlife designated Species of Special Concern

Passive ANABATs

Passive ANABATs recorded 53,454 recognizable bat vocalizations at the 25 ANABAT recording sites representing 17 of 18 bat species detected during this study (Table 3). The only bat found during the study undetected by passive ANABATs was the very rare California leaf-nosed bat (*Macrotus californicus*). The suite of species frequently recorded by ANABATs and widely distributed across the study area include the pocketed free-tailed bat (*Nyctinomops femorosaccus*), Mexican free-tailed bat (*Tadarida brasiliensis*), Yuma myotis (*Myotis yumanensis*), and big brown bat (*Eptesicus fuscus*). Species much less frequently recorded and at a low number of sites included migratory species such as hoary bat (*Lasiurus cinereus*), big free-tailed bat (*Nyctinomops macrotis*), and western yellow bat (*Lasiurus xanthinus*). Other bats found to be detected infrequently were the species typically found at high elevations and in transitional habitats of southern California such as the long-legged myotis (*Myotis volans*) and fringed myotis (*Myotis thysanodes*) as these habitats were not surveyed intensively. (Krutzsich 1948, SDNHM San Jacinto centennial resurvey/unpublished data). While the Townsend's big-eared bat was found at a relatively high number of ANABAT sites (18 of 25) it was recorded infrequently (158 of 53,454). Notable were the relatively low number of ANABAT detections of the pallid bat both in number of sites (10 of 25) and recordings (105 of 53,454).

Table 3. Bat species detected using passive ANABAT bat detectors including number of sites and ANABAT passes.

Target species in bold boxes.			
Common name	Species	Number of ANABAT sites (25)	Number of ANABAT passes
Pocketed free-tailed bat	<i>Nyctinomops femorosaccus</i>	25	12365
Mexican free-tailed bat	<i>Tadarida brasiliensis</i>	25	9918
Yuma myotis	<i>Myotis yumanensis</i>	25	8731
Big brown bat	<i>Eptesicus fuscus</i>	24	12386
Canyon bat	<i>Parastrellus hesperus</i>	21	4782
Western small-footed myotis	<i>Myotis ciliolabrum</i>	20	2197
Western mastiff bat	<i>Eumops perotis</i>	20	700
California myotis	<i>Myotis californicus</i>	19	786
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	18	158
Western red bat	<i>Lasiurus blossevillii</i>	17	190
Long-eared myotis	<i>Myotis evotis</i>	15	417
Pallid Bat	<i>Antrozous pallidus</i>	10	105
Long-legged myotis	<i>Myotis volans</i>	9	349
Western Yellow bat	<i>Lasiurus xanthinus</i>	7	80
Fringed myotis	<i>Myotis thysanodes</i>	6	189
Big free-tailed bat	<i>Nyctinomops macrotis</i>	6	67
Hoary bat	<i>Lasiurus cinereus</i>	3	34
California leaf-nosed bat	<i>Macrotus californicus</i>	0	0
<i>Total =</i>			53454

Mist nets

Seventy-eight bats representing nine of the 18 species detected in this study were captured in mist nets (Table 4). Yuma myotis and big brown bats were captured in the greatest numbers (29 and 25 respectively). Breeding in the form of reproductive females or juvenile recruitment was observed in five of the nine captured species, including the Townsend's big-eared bat (Photo figure 1). Notably, no reproductive female or juvenile pallid bats were captured in mist nets, however, a pallid bat caught at Warner Springs appeared to be a subadult (Photo figure 2). There was no evidence of any injured or diseased bats or bats with exceptionally heavy parasite loads captured in mist nets.

Table 4. Bat species captured in mist nets including number of individuals and presence of reproductive females and/or juveniles. Target species in bold boxes.

Common name	Species	Number captured	Reproductive females and/or juveniles
Yuma myotis	<i>Myotis yumanensis</i>	29	Yes
Big brown bat	<i>Eptesicus fuscus</i>	25	Yes
California myotis	<i>Myotis californicus</i>	7	Yes
Pallid Bat	<i>Antrozous pallidus</i>	6	No
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	4	Yes
Fringed myotis	<i>Myotis thysanodes</i>	2	No
Long-eared myotis	<i>Myotis evotis</i>	2	No
Western small-footed myotis	<i>Myotis ciliolabrum</i>	2	No
Canyon bat	<i>Parastrellus hesperus</i>	1	Yes



Photo figure 1. Juvenile Townsend's big-eared bat (*Corynorhinus townsendii*) captured at Clover Flat, California in June 2016.



Photo figure 2. Subadult pallid bat (*Antrozous pallidus*) captured at Warner Springs, California in August 2016.

Audible

Audible surveys were conducted simultaneous with mist netting and were intended to detect bats that produce recognizable audible echolocation and social vocalizations: the pallid bat, western mastiff bat, big free-tailed bat, and spotted bat. Only western mastiff bats were detected audibly during this study. Western mastiff bats were heard at the following 16 locations in table 5. Most significant are locations where western mastiff bats were heard exiting from roost cliffs or heard in large numbers early in the evening indicating a roost was nearby (designated with an asterisk).

Table 5. Audible records of the western mastiff bat (*Eumops perotis*) in the study area.

Map number	Survey location	Date(s)
6	<i>Boulder Oaks</i>	6/29/2016
9	<i>Corte Madera Ranch*</i>	9/28/2017
10	<i>El Monte County Park*</i>	6/1/2016
15	<i>Marron Valley*</i>	8/18/2016
16	<i>Mission Trails Regional Park (Jackson Drive quarry)*</i>	1/4/2017
16	<i>Mission Trails Regional Park (Oak Canyon)</i>	8/24/2017
18	<i>Oak Oasis</i>	5/26/2016
21	<i>Pamo Valley</i>	7/26/2016, 7/28/2016
23	<i>Ramona Grasslands*</i>	6/22/2016, 6/23/2016
24	<i>Rancho Canada</i>	8/27/2015, 9/3/2015
25	<i>San Felipe Valley</i>	7/24/2017
26	<i>Sloane Canyon I</i>	8/5/2015
27	<i>Sloane Canyon II</i>	6/1/2017
31	<i>Upper San Diego River*</i>	7/12/2017
33	<i>Warner Springs II</i>	8/7/2017, 8/9/2017
35	<i>Wilderness Gardens Park</i>	6/14/2016, 6/15/2016
36	<i>Wilson Creek/Barrett Lake*</i>	8/4/2016

Day roost surveys and exit count

The rare California leaf-nosed bat was documented in this study only through daytime inspections of previously known roosts (Kruttsch 1948, Stokes et al. 2005). Five individuals were observed day roosting in the Barrett Flume on July 30, 2016 but none were captured after several attempts. After a number of visits to the Artery Mine in Dulzura over the past 20 years with negative results, on December 14, 2016, five individuals were observed active in this day roosting location. Two individuals were successfully captured, a male and a female, but neither in breeding condition (Photo figure 3). Only dead individuals were found in this mine historically (Kruttsch 1948, P. Brown pers. comm.). It is unknown if these five individuals were the same individuals observed in the Barrett Flume the previous summer, but based on proximity of these two roost sites to one another, this is a possibility.



Photo figure 3. California leaf-nosed bat (*Macrotus californicus*) caught in Dulzura, California in December 2016.

Pallid bats were documented using two day roost locations, both in private residences, by local bat rehabilitator Cindy Myers of Project Wildlife. One was located in a neighborhood near Warner Springs Golf Course, the other in Alpine near Viejas Casino. The pallid bat colony located in Warner Springs was humanely excluded by a pest control company in the fall of 2016; it is unknown where this colony relocated itself. The pallid bat colony in Alpine was still present and represented by approximately 15 individuals or less when last observed in September 2017 (C. Myers pers. comm.).

Townsend's big-eared bats were found in various day roost structures during this study. Most significant was the colony of approximately 150 individuals observed in the Barrett Flume on July 30, 2016 where they have been known to roost historically (Stokes et al. 2005). Six individuals were observed in this structure during the previous winter on February 3, 2016. Other day roosts where this species was found roosting as single individuals include the Antone Canyon Mine, Chief of the Hills Mine, Noble Mine, and Old Highway 80 Mine. Surveys of a number of mines in Banner (Chariot Canyon) in the

summer of 2015 revealed no roosting individuals, though bats were observed in mines in this area historically (Krutzsich 1948, Stokes unpublished data).

The only other bat found during day roost surveys was the Yuma myotis in the Barrett Flume: a single individual during the winter (February 3, 2016) and a large colony of approximately 500 individuals on July 23, 2016. This colony has existed in this location for at least 20 years (Stokes 2017).

One exit count survey was performed at the Torrey Pines Road bridge on May 22, 2017. No more than 5 or 6 Mexican free-tailed bats emerged from the bridge shortly after sunset. This bridge was previously occupied by a colony of approximately 250 Mexican free-tailed bats at its peak size in July 2008 (Stokes unpublished data). For a more accurate comparison of current population size, surveys would ideally be conducted in July.

Night roost surveys

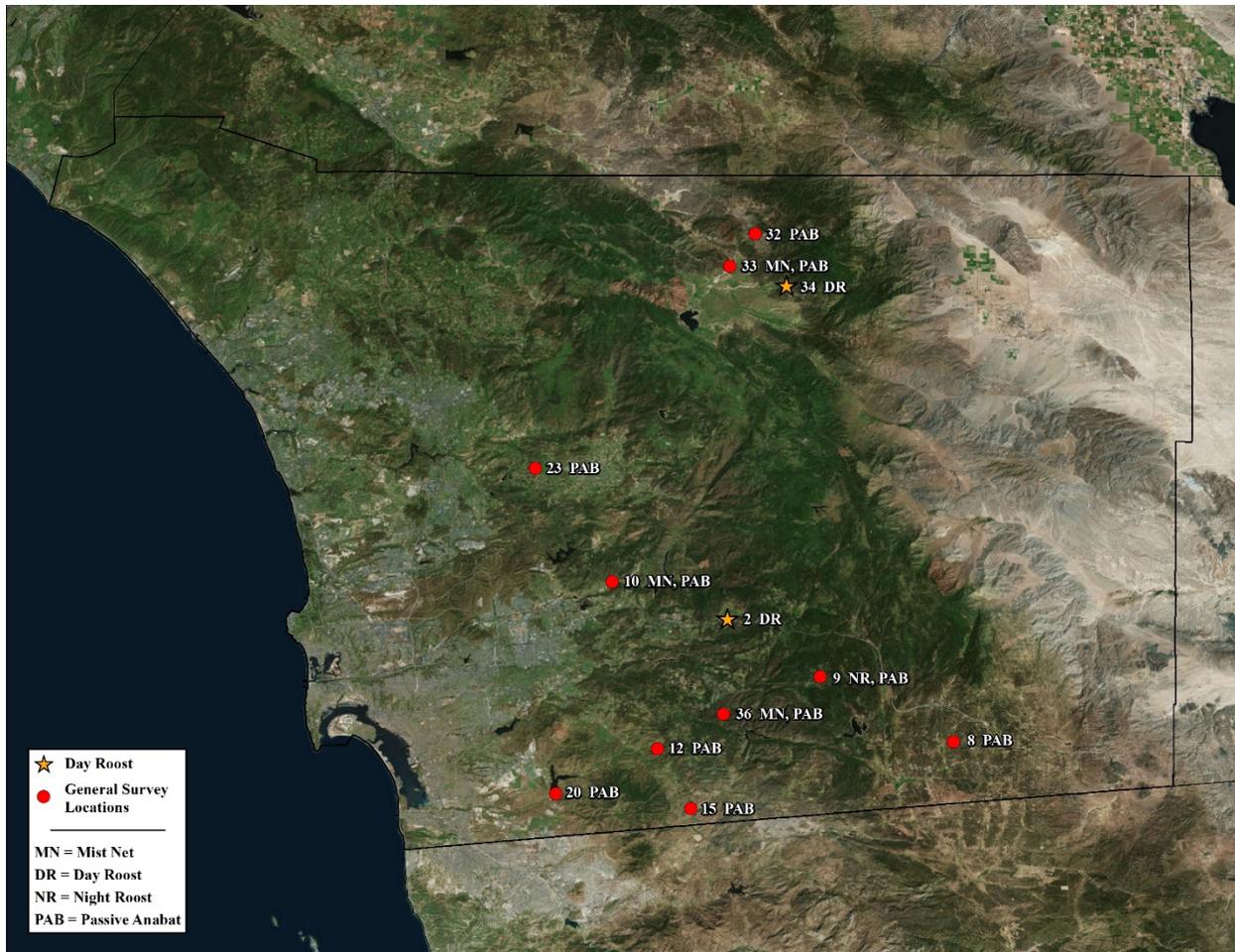
Evidence of pallid bat night roosting activity in the form of culled terrestrial arthropod parts and characteristic guano was found in several barn structures on private land on the Corte Madera Ranch on September 28, 2017 (accessed with permission from the property owner). Six Townsend's big-eared bats were observed night roosting in the same set of structures during the survey but none could be captured.

Other species observed during night roost surveys included the long-eared myotis at the Highway 94 bridge over Dulzura Creek and the CDFW-owned Honey Springs Ranch (an abandoned, dilapidated house), both on August 6, 2015. A western small-footed myotis was also observed in the highway 94 bridge on the same date.

Discussion

The results of the initial research goals of this study are discussed here:

1. *Document presence of the two bat species *Antrozous pallidus* and *Corynorhinus townsendii* including documenting day and night roosts where they could be found.*



Map figure 2. Pallid bat detections in the study area.

Pallid bat (*Antrozous pallidus* - Map figure 2) – two new day roosts were discovered during this study, both on private land and discovered via Project Wildlife bat rehabilitator Cindy Myers. One was a colony located in a residential neighborhood in the Warner Springs area. A pest control company humanely excluded this colony in the fall of 2016; it is not known where these bats went. A similar fate befell a pallid bat colony that was once day roosting in a store in Santa Ysabel in the early 2000s. This structure is located less than 20 kilometers from the Warner Springs colony site. There is a bathroom on the Warner Springs Golf Course that has had repeated evidence of night roosting pallid bats. Based on the presence of a day and night roost, multiple ANABAT detections, and mist net captures of both sexes it is clear that the Warner Springs/Henshaw basin area and upper San Luis Rey River watershed is a population center for pallid bats.

A 2nd pallid bat day roost colony was discovered in a private residence in Alpine in 2017 (C. Myers pers. comm.). This colony is located near Viejas Casino on the north side of Interstate 8. It is in fairly close proximity to a previously known pallid bat night roost in the Palo Verde area of Alpine discovered in 2002 (Stokes and Fisher 2004). This day roosting colony was comprised of approximately 15 bats or less when observed in September 2017. The homeowners were aware of the bats and were not inclined to exclude them, but rather to let them stay for now. While pallid bats were historically found along the lower Sweetwater River based on specimens turned into the public health department from the

Jamacha area in 1995, there have been no recent observations on this watershed down river of the Palo Verde area of Alpine (Stokes 2017). Notably, there were no detections despite multiple ANABAT deployments and mist netting in Sloane Canyon where habitat appears to be appropriate. However, there were mist net captures along Wilson Creek near Barrett Lake and ANABAT detections at Honey Springs Ranch. There was evidence of night roosting pallid bats found in a barn structure on Corte Madera Ranch on September 28, 2017, as well as ANABAT detections on this ranch a week prior. These recent data points possibly delineate a pallid bat population occurring from Alpine to southern Pine Valley south through Japatul and into Jamul. There was a historic night roost in the highway 94 bridge over Dulzura Creek in the late 1990s and early 2000s but no evidence of pallid bats was found here in this study (Stokes et al. 2005).

Further south and east of Jamul there were ANABAT detections in Marron Valley in 2015 and 2016 as well as in the lower Otay River Valley in 2016. Interestingly, a single male pallid bat was found day roosting under a porch at a residence on F Street in coastal urban Chula Vista in May, 2016. This location is less than a mile from a historic barn day roosting colony site described by Krutzsch (1948). The old barn site was thought to be where the new Living Coast Discovery Center is now located (M. Valen pers. comm.). Despite efforts to find pallid bats here with extensive ANABAT deployments throughout 2017 (and prior) there have been no detections yet (SDNHM unpublished data). Though this F Street location is near the mouth of the Sweetwater River, the closest recent record to this location is from lower Otay River Valley in 2016 (mentioned above).

Further east to Campo, the pallid bat was recorded with ANABATs on the Clover Flat property. There were no roosts located nor mist net captures here. Krutzsch (1948) found pallid bats in Campo historically. This area has been understudied for bats in recent history.

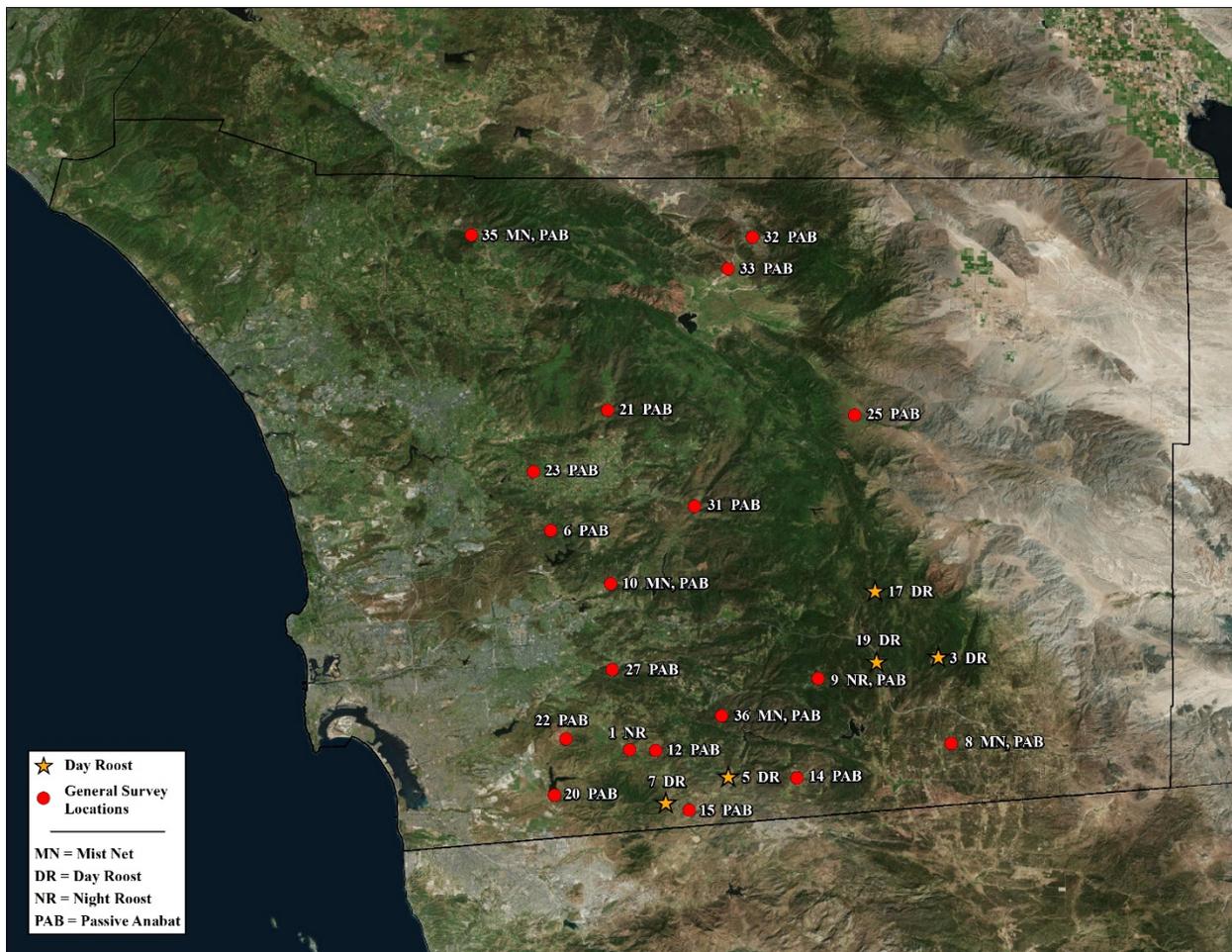
Pallid bats were captured in mist nets and recorded with ANABATs in El Monte County Park in Lakeside in May and June of 2016. The mist net capture site was identical to a mist net capture site for pallid bats in 2008 indicating high site fidelity and the possibility of a roost nearby (Stokes 2017). In both cases, only males were captured here (5 in 2008, 2 in 2016). Krutzsch (1948) had reported a pallid bat colony day roosting in a barn at the Edgemoor Farm in nearby Santee. This farm still exists but has not been investigated for roosting pallid bats. Regardless, it is evident pallid bats are still occurring along this part of the San Diego River watershed below El Capitan Reservoir. Despite the deployment of numerous ANABATs along the upper San Diego River near the Cedar Creek confluence in July 2017, there were no pallid bat detections. They could occur closer to the north end of El Capitan Reservoir on Tribal land where habitat appears appropriate.

The pallid bat was recorded with an ANABAT on Santa Maria Creek (Ramona Grasslands) in north Ramona in 2016. There was a historic day roost colony site in downtown Ramona, as well as in a bridge in San Pasqual Valley (Krutzsch 1948). These roost sites do not exist anymore, but pallid bats were recorded with ANABATs in San Pasqual Valley in the early 2000s (Stokes et al. 2005). Pallid bats are still occurring in this region of the county, albeit based on scant ANABAT data only. If there was continuity in the pallid bat population between these historic Ramona and San Pasqual Valley sites with the Warner Springs and upper San Luis Rey population they would have possibly been expected in Pamo Valley where habitat appears to be appropriate yet there were no detections based on ANABAT deployments and mist netting in 2016. Despite numerous bats found at the San Diego Zoo Safari Park in San Pasqual Valley submitted to the public health department dating back to 2007, there have been no pallid bats

(SDNHM unpublished data). The north Ramona and San Pasqual Valley pallid bat population is elusive and perhaps on the brink of extirpation.

Based on the available data it appears pallid bats are still primarily in areas that remain rural such as Warner Springs, Pine Valley, Campo, and Marron Valley. They are also occurring at edges of development such as in Ramona, Alpine, Lakeside, Otay River, and Jamul. The few recordings by ANABATs (only 105 of 53,454 recordings during the study) suggest they are existing in low numbers and/or have low acoustic detectability. There were no captures of pallid bats in breeding condition, though one captured at Warner Springs may have been a subadult and a juvenile from Alpine was turned into Project Wildlife in 2017 (C. Myers pers. comm.).

Of primary concern is the fact that none of the 12 historical roosts in the county exist today. The two roosts discovered during this study were comprised of 15 (Alpine) and less than 50 individuals (Warner Springs). A night roosting population of coastal pallid bats observed on Marine Corps Base Camp Pendleton in 2012 consisted of approximately 35 individuals. None of these recent roosts are even approximating being inhabited by the ‘several hundred’ bats that were observed in roosts historically.



Map figure 3. Townsend's big-eared bat detections in the study area.

Townsend's big-eared bat (*Corynorhinus townsendii* – Map figure 3) – found more widely distributed than the pallid bat in this study (18 locations compared to 10 for pallid bats), but also possibly occurring in low numbers overall and/or having low acoustic detectability based on only 158 of 53,454 ANABAT recordings.

A large population of approximately 150 individuals was re-found in the Barrett Flume, where it had been observed in the early 2000s in roughly the same areas of the flume (Stokes et al. 2005). A small group of the locally rare California leaf-nosed bat was also observed here during both studies. The presence of both of these sensitive bat species, plus a large colony of at least 500 Yuma myotis, indicates the importance of this structure to bats in the habitat conservation planning landscape. A lactating female Townsend's big-eared bat was captured in a mist net along Wilson Creek northeast of the Barret Flume and Barrett Lake.

Highly associated with abandoned mines and caves, it is not surprising Townsend's big-eared bats were found in areas where old historic mining districts occur. These include Otay Mountain, where bats (single individuals) were found in the Chief of the Hills Mine in both summer and winter. This mine was historically occupied by the species (Stokes et al 2005). There were ANABAT recordings from nearby Marron Valley, in the lower Otay River Valley, in Proctor Valley, at the Honey Springs Ranch, and a male was captured in the highway 94 bridge over Dulzura Creek in 2015. These rural valleys near the Otay Mountain mining district are likely good foraging areas for the species. There were ANABAT recordings of the species in Long Potrero and in Campo. There was also a mist net capture of a juvenile in Campo at Clover Flat indicating possible continuity of the population along the southern border of rural San Diego County from Proctor Valley eastward. Though mines on McGinty Mountain in Jamul were not surveyed, ANABAT recordings of the species in Sloane Canyon indicate presence here and its occurrence in the mines is probable.

The Descanso District of the Cleveland National Forest (CNF) has several mines historically occupied by Townsend's big-eared bats (SDNHM unpublished data). A few mines were surveyed during this study and were occupied by single individual bats including a mine in Antone Canyon, along Old Highway 80 near Cottonwood Creek, and the Nobel Mine. These are just a few of many mines that could potentially house Townsend's big-eared bats, including significant maternity colonies. It should be noted that the mines visited in this study and other studies for bats are receiving human visitation, generally for recreation, despite various factors that make them difficult to locate and access. For example, the mine in Antone Canyon does not show on Topo maps, requires 4-wheel drive to get to its trailhead, requires a fairly lengthy hike to get to, and yet when visited during this study there was a geocache found in the back of it (and only 1 bat). Despite several mines on USFS land having been gated with bat friendly gates to keep people out of them, several of these have had their gates cut with a welding torch allowing human access (D. Stokes pers. obs.). Places that historically would have been likely ideal roost sites for Townsend's big-eared bats are now potentially significantly impacted by human visitation and disturbance.

A group of 6 night roosting individuals were observed in a barn structure on the Corte Madera Ranch near Pine Valley. This large ranchland property is relatively centered between the CNF mining district and the Barrett Flume and Otay Mountain. Anabat recordings from the upper San Diego River were in proximity to mines along Boulder Creek, where the species has been observed roosting as recently as January 2018 (D. Stokes pers. obs.).

Another historically significant mining district for Townsend's big-eared bats that was surveyed as a separate study in 2015 was the Banner area where a number of mines in Chariot Canyon were visited (CDFW State-wide assessment for *Corynorhinus townsendii*). Though bats had been observed in these mines in the late 1990s, no bats were found in a handful of mines visited during the summer of 2015. These mines appear to receive regular human visitation, which could explain the absence of roosting bats. Nearby in a bridge located in Sentenac Canyon, approximately 150 Townsend's big-eared bats were observed during an opportunistic visit to the bridge in April, 2014, prior to these studies (D. Stokes pers. obs.). A small group of bats was observed in a portion of the bridge in summer of 2015 but the entire bridge was not thoroughly surveyed. Townsend's big-eared bats were also recorded with ANABATs at nearby San Felipe Valley in July 2017.

Townsend's big-eared bats were recorded with ANABATs and a lactating female was captured in a mist net in El Monte County Park in Lakeside. A colony historically occurred in the El Monte flume located south of the park. This structure has been gated with metal grates that appear to be unsuitable for bats to pass through based on the grate small size. There was also a historic colony in a cave at 'Mussey Grove', an area that appears to have been submerged by the impoundment of San Vicente Reservoir (Krutzsch 1948). The species were observed in at least one of the mines located in a canyon to the north of El Monte County Park and breeding females were captured at Oak Oasis County Preserve during previous research in the area in 2008. The capture of a reproductive female at El Monte during this study suggests there is still a breeding population in this general area.

ANABAT recordings at Boulder Oaks County Park, Ramona Grasslands, in Pamo Valley, and up in the Warner Springs area indicate the Townsend's big-eared bat is prevalent in Ramona and northward to the Henshaw Basin. There were ANABAT recordings and a mist net capture at Wilderness Gardens Park along the San Luis Rey River proving the species occurs at least this far west along the San Luis watershed, near the mining district in Pauma Valley.

In conclusion, the Townsend's big-eared bat appears to be found throughout rural San Diego County with populations in and peripheral to most of the old historic mining districts, which are strongly associated with abundant exposed geological features found countywide. This species appears to occur in a higher density across the county than the pallid bat, with habitat and therefore population connectivity provided by its strong association with roosting habitat in the form of caves and cave-analogs. In contrast, the pallid bat may depend more heavily on the presence of much less common large undeveloped rural valleys and landscapes with suitable ground cover in the county for its foraging needs rather than a particular roosting substrate. The pallid bat's affinity for roosting in manmade structures, where usually occurring as an unwanted guest, is likely not helping it from a conservation standpoint. The creation of artificial roosting structures on conserved lands where pallid bat populations occur will likely benefit the species (e.g. pallid bat refugia - see management recommendations).

- 2. Determine current population status through demographics including documentation of age class, gender ratio, reproductive condition, and recruitment in areas where bats were captured. Provide comparison of results to baseline 2002-2003 MSCP bat surveys.*

During the 2002-2003 MSCP bat study, nine of twelve captured species showed evidence of breeding and/or recruitment of juveniles while only five of nine species did during this study. The reduced

number of bats captured in breeding condition could simply be a result of significantly fewer bats caught during this study (78 bat captures) compared to the 2002-2003 study (151 bat captures – Stokes et al. 2005). Although no pallid bats in breeding condition were captured during this study, it should be noted a juvenile pallid bat was brought into the care of Project Wildlife bat rehabilitator Cindy Myers, who returned the bat to where it came from - the roost location of the small colony of approximately 15 pallid bats in the private residence in Alpine.

3. *Obtain tissue for genetic analyses of population structure.*

Genetic tissue was obtained from eight Townsend's big-eared bats and six pallid bats (as well as one long-eared myotis) during this study. Tissue was collected opportunistically while mist netting and during roost searches (CDFW SCP 2645). Based on the few tissue samples collected during this study a follow up effort focusing on tissue collections from known population locations would likely be required for a detailed population structure study of either of the target species.

4. *Provide data on target species occurrence that can be used to create species habitat models for MSCP planning.*

Ninety-six unique data points (ANABAT detections, roosting bats, and captures) were taken for the Townsend's big-eared bat and 55 for the pallid bat during this study. These datapoints can be inputted into GIS and used to generate predictive habitat models for the species for the purposes of future conservation planning.

5. *Determine health of bats based on overall appearance, weight, and ectoparasite load.*

There were no captured bats showing any evidence of disease or ill health. All captured bats appeared normal and healthy. While some ectoparasites were observed on captured bats, no individuals carried an exceptional parasite load as had, for instance, been observed on a pallid bat in Descanso in 2003 (Stokes and Fisher 2004). There was no visible trace of the White-Nose Syndrome (WNS) fungus *Pseudogymnoascus destructans* on any bats.

6. *Document bat community and diversity of MSCP areas during focused surveys for Antrozous and Corynorhinus*

In addition to the two target species pallid bat and Townsend's big-eared bat, 16 other bat species were documented during this study. Including the target species, eight California species of special concern were found. There were four species documented as widespread and particularly active (frequently recorded with ANABATs) in the study area: pocketed free-tailed bat, Mexican free-tailed bat, Yuma myotis, and big brown bat. These are the same four bat species most frequently detected during the 2002-2003 MSCP bat surveys, though not in the same order of detection frequency (Stokes et al. 2005). The three next most frequently detected species in this study were also the same three from the 2002-2003 study: canyon bat, western small-footed myotis, and western mastiff bat. The species infrequently detected in this study were the California leaf-nosed bat, hoary bat, and big free-tailed bat. The

California leaf-nosed bat was found in the same location, the Barrett Flume, as in 2002-2003 as well as the artery mine (Stokes et al. 2005). The other two species are migratory visitors to the county and were detected infrequently during the 2002-2003 research as well. Three species detected during this study that went undetected in 2002-2003 were the fringed and long-legged myotis, and western yellow bat. The first two are mid to high elevation species and were not expected in the 2002-2003 study focused on the inland valleys and low foothills, while this study targeted several mid to high elevation survey sites. The western yellow bat was not found in 2002-2003 but was found at seven sites during this study. This may be an artifact of a greater familiarity with the species' echolocation calls currently compared to the previous study. However, it is possible this species is expanding its range into the area, which has been indicated by other research including examination of public health records (Constantine 1998, Stokes 2017). The only species found in the 2002-2003 MSCP bat survey not found in this study was the Mexican long-tongued bat, which was only documented through a chance public contact incident where a small colony was found roosting under a porch in Coronado (D. Wilkins pers. comm., Stokes et al. 2005). Based on these comparisons, the bat community in San Diego County appears to be very similar to what it was in the 2002-2003 study. This suggests that the MSCP preserve system has been effective for maintaining bat populations to date.

The target species pallid bat and Townsend's big-eared bat were found at a greater number of sites during this study compared to the 2002-2003 study. This is not surprising since the locations and habitats where they were expected were being targeted, including sites not surveyed in the 2002-2003 study such as Warner Springs, Pamo Valley, Campo, Corte Madera Ranch, and broader areas of the Descanso District of the Cleveland National Forest. Notable was the absence of pallid bats night roosting in the highway 94 bridge over Dulzura Creek in this study whereas multiple individuals were observed here in 2002-2003. The reason for this is unclear, since the species was detected acoustically nearby at Honey Springs Ranch indicating at least continued presence in the area.

Although not targeted for this study, there are at least two other bat species that are rare or perhaps becoming rare in the study area: the California leaf-nosed bat and the western red bat. The former is primarily a desert dwelling species known historically from a few inland valley cave and mine locations including along the Santa Margarita River and De Luz Creek, in Pauma Valley, and Dulzura (Kruttsch 1948). Only the Dulzura area was surveyed during this study and revealed the bats still present (Barrett Flume and Artery Mine). Previous studies of Camp Pendleton Marine Corps Base have not revealed the bat in the Santa Margarita River/De Luz area (Brown and Berry 1999, Stokes 2012). There have not been any documented bat studies in the area of Pauma Valley where the species roosted historically in an abandoned mine. Of the detected species in the study area, the California leaf-nosed bat appears to be by far the rarest. The western red bat was not captured during this study but was recorded with ANABATs at 17 of 25 locations based on 190 recorded calls (Table 3). Based on ANABAT recordings, it appears to have a similar population status as the Townsend's big-eared bat in the study area – perhaps somewhat widely distributed but possibly occurring in low numbers (and/or having low acoustic detectability).

Management recommendations

Bats operate on a large scale requiring landscape level and cross-jurisdictional management. Areas surveyed in this study were targeted as part of a landscape level approach focusing on various parcels that make up part of this landscape. Protection and management of roosts is the highest conservation priority for the pallid bat and Townsend's big-eared bat in the landscape management area. Other habitat features such as open water sources for drinking and high quality foraging areas such as riparian and oak woodlands should also be considered for management. Survey area-specific management recommendations listed in a prioritized manner follow. The details of where specifically recommended structures (and designs) and features should be placed will be provided during meetings and follow up documentation:

Barrett Flume (City of SD water authority, USFS) –

A large number of Townsend's big-eared bats were observed in several stretches of the flume, approximately 150 bats in four separate stretches. There is a large (500+ bats) colony of Yuma myotis in one particular stretch of the flume. There were also a few California leaf-nosed bats in the flume, which is one of the rarest species in the MSCP area. All three species of bats have been present in the flume for at least 30 years (P. Brown pers. comm., Stokes et al. 2005). The flume is one of the most significant sensitive bat species roosts in the region and warrants protection. There has always been small amounts of human disturbance at the flume, though the potential for increased human traffic here is always a possibility, as it is easily accessible at key points where access could be made more difficult. These key access points include the flume bridge section at the west end accessible by parking in a pull out along Highway 94 and a road that leads up to the middle reaches of the flume from Barrett Lake Road. A fence and gate at the west end of the flume bridge and a gate across the bottom of the access road leading to the middle reaches would be two steps greatly reducing human visitation to the flume. Installing and enforcing 'No Trespassing' signs along the flume may also be a deterrent. Of the most critical concern is how the bats could be impacted through actions of the City of SD water authority through flume maintenance and/or reconstruction. The bats seem to be stable with the 'status quo/benign neglect' as far as the City of SD water authority activities are concerned. However, a change in city water authority policy and maintenance activities or reconstruction would strongly warrant evaluation from a bat management and conservation perspective.

Corte Madera Ranch (Private) –

A large, privately managed ranchland property where a high diversity of bat species were found including both target species: six Townsend's big-eared bats were observed night roosting in private ranch structures and there was evidence (culled arthropod parts and guano) of night roosting pallid bats in these same structures (south end of ranch property). Both species were also recorded with ANABATs on site. An old horse barn structure was historically inhabited by a very large Yuma myotis colony (1000+ bats), which was still present during this study, though no count was made (Stokes 2017). It is recommended that this structure be purchased and set aside as a dedicated artificial bat roost structure. It could be modified to be more accommodating to both cave and crevice roosting bats. The presence of

extensive oak and conifer woodland habitat and several large perennial open water sources makes this ranch landscape an ideal place for bats.

Otay Mountain Mines (Private, BLM) –

The two mines on Otay Mountain surveyed during this study (and previously) are the 'Chief of the Hills Mine' and the 'Artery Mine'. After further review of land ownership data it appears these mines are on small private land parcels surrounded by BLM land. These mines are known roosts for the sensitive bat species Townsend's big-eared bat and California leaf-nosed bat. The latter species was observed in the 'Artery Mine' dating back to the 1940s and again in the 1970s in the form of dead individuals only (Krutzsch 1948, P. Brown pers. comm.). In this study, five live individuals were observed and two were captured in December 2016: a male and a female. Townsend's big-eared bats have been observed in the 'Chief of the Hills Mine' on numerous occasions dating back to the mid-1990s but a large maternity colony has not been seen here. On one occasion, at least a dozen individuals were seen here in torpor during the winter but most visits here have revealed only single roosting individuals (Stokes 2017). Both mines show on Topo maps and are located in an area of recreational use by the public. Both mines warrant protection in the form of bat gates but would need to be acquired by a public agency beforehand. Purchasing of these mines as conservation easements is warranted.

Warner Springs/Henshaw Basin (VID, US Navy, Private) –

A large, relatively undisturbed valley/basin where the public is not allowed access with the exception of the Warner Springs resort and golf course. The area supports a high diversity of bat species. Both target species were found here including a colony of pallid bats, which was excluded from a residential neighborhood near the Warner Springs Resort in fall of 2016. The area has a number of habitat features bats appear to favor including exposed geological features, riparian vegetation, oak woodland, and open water sources in the form of the natural near-perennial flow of the San Luis Rey River and maintained artificial open water sources (above ground cattle troughs) large enough to accommodate drinking pallid bats. Both target bat species could benefit from an artificial roost structure designed to accommodate both crevice and cave-roosting species.

Marron Valley (City of SD water authority, BLM) –

Both target species were detected here during this study. This relatively undisturbed valley appears to be one of the southwestern-most footholds for both bat species in San Diego County and the U.S., and supports a high diversity of bats. The lack of major disturbances here is likely a result of a locked gate on Marron Valley Road leading down into the valley proper. Occasional fires may benefit the pallid bat now that grazing no longer exists here, keeping the vegetation cover in upland areas relatively open and accessible to this terrestrial forager. The valley tends to lack riparian trees such as oaks and sycamores, however, and the bats would probably benefit from a riparian vegetation/tree restoration effort here now that cattle have been removed. Although roosting habitat for the Townsend's big-eared bat occurs nearby in the form of abandoned mines, these mines are highly subjected to human visitation and disturbance. Both target bat species could benefit from an artificial roost structure designed to accommodate both crevice and cave-roosting species.

Honey Springs Ranch/Jamul (CDFW) –

A small property in a rural landscape at the edge of suburban development where both target species are still occurring. There is an abandoned house on the CDFW-managed property that was being used as a night roost by a few bats including the long-eared myotis when surveyed in 2015. While neither target species were observed in this structure, it is highly possible they would use it as a day and/or night roost if afforded undisturbed access. Both species were recorded with ANABATs on site. Conversion of this structure to a dedicated artificial bat house is recommended. The house in its current condition is vulnerable to disturbance including vandalism. Building a fence around the house would secure it and would likely result in a lower probability of disturbance to it and night roosting bats. The house also has the potential to be used as a day roost, if left undisturbed. The Honey Springs Ranch would also likely benefit from having an above ground water trough maintained with water throughout the summer. This would be an attractant to bats, and might make the house more attractive as a day and/or night roost.

Pamo Valley (City of SD water authority, USFS) –

This large, relatively undisturbed valley positioned between Ramona and the Warner Springs/Henshaw Basin area is characterized by fairly extensive riparian and oak woodland habitat with several near-perennial open water sources providing good foraging habitat for bats. The Townsend's big-eared bat was detected here along with a high diversity of other bat species though there were no detections of the pallid bat, surprisingly. It appears to be suitable for the latter species, which occurred nearby at Warner Springs/Henshaw Basin and in Ramona. While good foraging and drinking habitats for bats are found here, this valley could benefit from the creation of an artificial bat roost structure to accommodate both cave and crevice-roosting bats. It should be noted that the local rancher mentioned there used to be a barn in the valley that was inhabited by a large number of bats that burned down in the Witch Creek Fire (B. Neal, pers. comm.). A fireproof artificial bat roost structure is recommended here.

Clover Flat (BCLT) –

A relatively large valley in Campo where a high diversity of bats were found including both target species: a juvenile Townsend's big-eared bat was captured here and there were ANABAT recordings of the pallid bat. The valley is characterized by fairly extensive riparian and oak woodland habitats, as well as a few near-perennial open water sources making it ideal for bats. This property could benefit from an artificial bat roost structure.

Long Potrero (BCLT) –

There was a Townsend's big-eared bat detection here, and although Pallid bats were not detected, this area appears suitable for them. Recently acquired by the Back Country Land Trust, and subsequently gated, the bats will likely benefit from minimal human disturbances here. There are several above ground concrete water troughs and earthen water tanks that could be very important to bats if maintained with water throughout the summer. These potential water sources were dry during the late summer of 2015, perhaps due to the drought at the time. There is an old concrete house-like structure on or immediately adjacent to the west end of this property. This house is suitable as a night roost for bats in its current condition. Modifications to the house (rebuilding the roof) could make it suitable as a day roost as well.

Otay River Valley (SD County) –

A somewhat disturbed valley representing the southwestern-most area of San Diego County where both target species were found during this study based on ANABAT recordings. At the edge of urban development, this valley is accessible to human recreational activities towards the west end but the canyon below the Otay Lakes dam is difficult to access by vehicle or even on foot. An artificial bat roost structure would be feasible in this canyon and could provide a roosting resource for both species. Bats in this canyon and the westerly lower valley portion would also benefit from a riparian and oak woodland restoration effort here.

El Monte Valley (SD County, BLM) –

A relatively undisturbed valley at its east end, more developed to the west, both species were caught in mist nets in El Monte County Park and were caught here previously in 2008 indicating high site fidelity. There are several abandoned mines north of the county park on BLM land where the Townsend's big-eared bat was observed roosting during previous research. The presence of suitable foraging riparian and oak woodland habitat and open water sources nearby (El Capitan Reservoir at east end and a sand mining pond at west end) make this valley at the edge of suburban development a western outpost for both species on the San Diego River watershed. Despite the presence of mines and an abundance of exposed geological features, the bats in this valley could benefit from an artificial bat roost structure in a protected location.

Ramona Grasslands/Boulder Oaks/Barnett Ranch (SD County) –

These county preserves located in Ramona, though not in a contiguous undeveloped landscape, are characterized by a variety of suitable habitats (riparian, oak woodland, open water sources) for both bat species. Both were recorded with ANABATs at Ramona Grasslands and the Townsend's big-eared bat was at Boulder Oaks. Barnett Ranch has not yet been surveyed but appears suitable for the latter and perhaps pallid bats. Both species were found in the town of Ramona historically and both appear to be holding on here, although pallid bats appear to have become rare. Bats could benefit from an artificial roost structure, preferably on the Ramona Grasslands preserve and located in a protected area away from easy public access.

Cleveland National Forest Mines (USFS) –

There were several observations of Townsend's big-eared bats in mines on the Cleveland National Forest (CNF). The presence of abandoned mines in a forested environment is likely ideal for this species, and the CNF is probably a core area for this bat in San Diego County. While undisturbed abandoned mines provide what appears to be preferred roosting habitat for the Townsend's big-eared bat, many of the mines on the CNF show signs of perhaps regular human visitation and disturbance. Even remote mines surveyed have some sort of human visitation, including the presence of geocaches. With several of the mines that had been protected with bat gates, the gates had been compromised with a welding torch allowing human access. A continued effort to put bat friendly gates on mines including the Antone Canyon Mine and the Old Highway 80 Mine and fix compromised gates at the Noble Mine complex could be a management priority for the Townsend's big-eared bat on the CNF. Maintenance of open water in select troughs based on previous captures of this bat species is also recommended. The troughs

historically used include the trough near Water of the Woods, the troughs at Laguna Ranch, and the Penny Pines troughs near Filaree Flat.

Banner Grade and Sentenac Canyon (BLM, Private, Cal-trans, and CDPR) –

A series of surveys of mines in the Banner Grade area in 2015 did not reveal the presence of any roosting Townsend's big-eared bats, which is surprising. However, human visitation and disturbance at these mines appears high. There were a number of mines not surveyed in 2015, including mines historically used by large numbers of bats: the Ready Relief Mine and Hubbard Mines. These BLM mines are land-locked behind private land and are very difficult to access without trespassing.

To the east from Banner Grade is a bridge in Sentenac Canyon in Anza Borrego Desert State Park. A large number of Townsend's big-eared bats was first observed here in 1996 (K. Miner, D. Stokes pers. obs.). Recent surveys in 2014 and 2015 revealed that the large colony (150 estimated in 2014, about 50 observed in one section in 2015) of bats was still roosting in the bridge. It is possible this colony is part of the same population of bats historically found in the Banner mines. Cal-trans and Anza Borrego State Park were aware of the colony and ensured proper management of it. The knowledge of this regionally significant colony site needs to be transferred on to successive employees. There is a small parking lot at the west end of the bridge that allows people to park and easily gain access to the underside of the bridge. Because of this, human disturbance at this bridge roost is always a possibility. Blocking vehicular access to this parking area could be an important action to reduce the possibility of disturbance at this bridge.

San Felipe Valley (CDFW) –

This large valley is characterized by transitional and desert vegetation and fair amounts of oak and riparian woodlands. It provides habitat linkage from Anza Borrego desert up to the Warner Springs and Henshaw Basin area. The Townsend's big-eared bat was found on the property but no pallid bats during 2017 surveys. There are mines and other structures historically used by the former and a known maternity colony site nearby in Sentenac Canyon. There are also numerous abandoned mines nearby in Banner and Julian, including several historically occupied by Townsend's big-eared bats, but most of these mines are now subjected to heavy human disturbance. There are numerous artificial water sources on site in the form of small drinkers for game species; however, most of these appear too small to be effectively used by bats as drinking sources. There are at least two larger artificial troughs that are a suitable size for drinking bats but both were in a state of disrepair during 2017 surveys. Restoration of these troughs as suitable bat drinking sources is highly recommended. Additionally, there are several old ranch structures on the property now managed by CDFW. It is recommended that a suitable structure(s) on the property be converted to artificial bat roosts, or that an artificial bat roost structure is created. This is an ideal location for such a structure where it would be protected from public access. Interesting that no pallid bats were detected here. While it is a large, low gradient valley that seems ideal for pallid bats, there are large swaths of exotic vegetation and ground cover that might inhibit pallid bat foraging activity. A management practice (light grazing, prescribed fire) to reduce the exotic vegetation could be considered and may benefit the pallid bat.

Sloane Canyon I & II (CDFW, Tribal land) -

A Townsend's big-eared bat was detected here. No pallid bats were detected and have not been found on the Sweetwater River below the Palo Verde area of Alpine, above Loveland Reservoir, dating back to 1995 when two individuals were submitted to the public health department from the Jamacha area (SDNHM unpublished data). However, the best pallid bat habitat appears to be found on tribal land: the stretch of oak lined sandy riverine habitat in between the State CDFW properties of Sycuan Peak Ecological Reserve and 'Lake Emma'. While this area is characterized by good foraging habitat and open water sources, the bats could benefit from an artificial roost structure if it was safe from human disturbance.

Rancho Canada (CDFW) –

Neither target species were detected here during the SDNHM surveys but the habitat looks appropriate for both species. There are abandoned mines (already gated with bat gates) and a natural cave that are suitable for Townsend's big-eared bats, and there appears to be good foraging habitat for both Townsend's big-eared bats and pallid bats. There is a cattle pond near the middle of the property (the 2015 survey location) that does not appear to hold water into the summer, when bats may depend upon it most. Maintaining the water in this pond throughout the summer is recommended. This property could also benefit from an artificial bat roost structure that would be protected from public disturbance.

Proctor Valley (CDFW) –

There was a Townsend's big-eared bat detection here in 2015. Proctor Valley is generally devoid of riparian vegetation and trees. While there are 2 groves of eucalyptus trees, there are very few native trees such as oaks and sycamores. Restoration and/or translocation of riparian vegetation including planting of oaks, sycamores, cottonwoods, and willows is recommended if feasible.

Hollenbeck Canyon (CDFW) –

A Townsend's big-eared bat was detected here in 2015. No pallid bats were found, but they were found here during MSCP bat surveys in 2002 and 2003 and likely still occur here. The property has suitable foraging habitats for both species. It is relatively undisturbed and although there are daytime human recreational activities taking place, these should not be impacting bats. Roosting habitat may be lacking; this would be a suitable place for an artificial bat roost structure that could be built away from human traffic and would likely benefit the 2 target bat species, if built correctly. This is one of the preserves where an artificial bat roost structure that could exist long term is highly recommended. The abandoned house on the Honey Springs Ranch could serve as an artificial bat roost for this preserve.

Highway 94 Bridge in Jamul (Cal-trans, CDFW) –

A Townsend's big-eared bat was found night roosting here, and single individuals have been occasionally observed day roosting in the past. No pallid bats were found here, though a small population (less than 10 bats) used it as a night roost in the early 2000s and before. It is difficult to tell if disturbance is an issue here. Cal-trans has erected retaining walls that provide some blockage to human access to this bridge, but access is not completely restricted. Since most of the bat use here appears to be by night roosting bats, disturbance is less likely to be an issue. However, with the construction of the

nearby Hollywood Casino in Jamul, the amount of traffic and potential for human disturbance at this bridge increases significantly.

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Appendices

Appendix I. Survey locations, dates, techniques, and effort summarized.

Map number	Survey location	Survey date(s)	Survey effort
1	94 Bridge in Jamul	8/6/2015	1 hour (Night Roost search)
2	Alpine	9/2/2017	1 hour (Day Roost Search)
3	Antone Canyon Mine	7/1/2015	1 hour (Day Roost Search)
4	Artery Mine	12/14/2016	1 hour (Day Roost Search)
5	Barrett Flume	7/23/2016	1 hour (Day Roost Search)
6	Boulder Oaks	6/27/2016 - 6/29/2016	3 nights (6 ANABATs)
7	Chief of the Hills Mine	6/26/2015, 12/14/2016	1 hour Day Roost Search (x 2 visits)
8	Clover Flat	6/27/2017 - 6/29/2017, 6/29/2017	3 nights (5 ANABATs), 3 hours (4 mist nets & audible)
9	Corte Madera Ranch	9/19/2017-9/21/2017, 9/28/2017	3 nights (5 ANABATs), 3 hours (2 mist nets & audible), 1 hour (Night Roost Search)
10	El Monte County Park	5/25/2016 - 6/1/2016, 6/1/2016	8 nights (3 ANABATs), 3 hours (6 mist nets & audible)
11	Hollenbeck Canyon Wildlife Area	8/17/2015 - 8/20/2015, 8/6/2015	4 nights (1 ANABATs), 3 hours (6 mist nets & audible)
12	Honey Springs Ranch	8/17/2015 - 8/20/2015, 8/6/2015	4 nights (1 ANABATs), 1 hour (Night Roost Search)
13	Living Coast Discovery Center	10/7/2015 - 11/6/2015	31 nights (3 ANABATs)
14	Long Potrero	9/1/2015 - 9/3/2015	3 nights (4 ANABATs)
15	Marron Valley	9/18/2015 - 9/20/2015, 8/16/2016 - 8/18/2016	3 nights (2 ANABATs), 3 nights (5 ANABATs)
16	Mission Trails Regional Park	8/22/2017 - 8/24/2017, 1/4/2017 & 8/24/2017	3 nights (5 ANABATs), 1 night (audible), 3 hours (5 mist nets & audible)
17	Noble Mine	7/2/2105	1 hour (Day Roost Search)
18	Oak Oasis County Park	5/25/2016 - 5/31/2016, 5/26/2016	7 nights (3 ANABATs), 3 hours (6 mist nets & audible)
19	Old Hwy 80 Mine	7/1/2015	1 hour (Day Roost Search)
20	Otay River Valley	8/23/2016 - 8/25/2016	3 nights (5 ANABATs)
21	Pamo Valley	7/25/2016 - 7/27/2016, 7/26/2016, 7/28/2016	3 nights (5 ANABATs), 3 hours (6 mist nets & audible), 3 hours (6 mist nets & audible)
22	Proctor Valley	8/17/2015 - 8/20/2015, 8/17/2015	4 nights (1 ANABATs), 3 hours (5 mist nets & audible)
23	Ramona Grasslands	6/21/2016 - 6/23/2016, 6/22/2016, 6/23/2016	3 nights (6 ANABATs), 3 hours (6 mist nets & audible), 3 hours (6 mist nets & audible)
24	Rancho Canada	8/27/2015, 9/3/2015	3 hours (4 mist nets & audible), 3 hours (3 mist nets & audible)
25	San Felipe Valley	7/24/2017 - 7/26/2017, 7/25/2017, 7/26/2017	3 nights (4 ANABATs), 3 hours (2 mist nets & audible), 3 hours (4 mist nets & audible)
26	Sloane Canyon I	8/17/2015 - 8/20/2015, 8/5/2015	4 nights (1 ANABATs), 3 hours (5 mist nets & audible)
27	Sloane Canyon II	5/30/2017 - 6/1/2017, 6/1/2017, 8/15/2017 - 8/17/2017	3 nights (5 ANABATs), 3 hours (5 mist nets & audible), 3 nights (4 ANABATs)
28	Tijuana River Valley	8/30/2016 - 9/1/2016	3 nights (5 ANABATs)
29	Torrey Pines Bridge	5/22/2017	1 hour (Day Roost Exit Count)
30	Torrey Pines State Natural Reserve	5/15/2017 - 5/17/2017	3 nights (5 ANABATs)
31	Upper San Diego River	7/11/2017 - 7/13/2017, 7/12/2017	3 nights (7 ANABATs), 3 hours (5 mist nets & audible)
32	Warner Springs I	8/8/2016 - 8/10/2016	3 nights (5 ANABATs)
33	Warner Springs II	8/7/2017 - 8/9/2017, 8/7/2017, 8/8/2017, 8/9/2017	3 nights (6 ANABATs), 3 hours (5 mist nets & audible), 3 hours (5 mist nets & audible), 3 hours (2 mist nets & audible)
34	Warner Springs III	8/9/2017	1 hour (Day Roost Search)
35	Wilderness Gardens Park	6/13/2016 - 6/15/2016, 6/14/2016, 6/15/2016	3 nights (6 ANABATs), 3 hours (6 mist nets & audible), 3 hours (6 mist nets & audible)
36	Wilson Creek/Barrett Lake	8/2/2016 - 8/4/2016, 8/4/2016	3 nights (5 ANABATs), 3 hours (6 mist nets & audible)