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

Burrowing Owl Survey Report 2011

Burrowing owl. Photo by Lynn Miller.

9 April 2012

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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. The Monitoring Program monitors the distribution and status of the 146 Covered Species within the Conservation Area to provide information to Permittees, land managers, the public, and the Wildlife Agencies (i.e., the California Department of Fish and Game and the U.S. Fish and Wildlife Service). Monitoring Program activities are guided by the MSHCP species objectives for each Covered Species, the information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees.

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

We thank and acknowledge the land managers in the MSHCP Plan Area, who in the interest of conservation and stewardship facilitate Monitoring Program activities on the lands for which they are responsible. A list of the lands where data collection activities were conducted in 2011 is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies. Partnering organizations and individuals contributing data to our projects are acknowledged in the text of appropriate reports.

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

The primary preparer of this report was the 2011 Avian Program Lead, Nicholas Peterson. If there are any questions about the information provided in this report, please contact the Monitoring Program Administrator. If you have questions about the MSHCP, please contact the Executive Director of the RCA. Further information on the MSHCP and the RCA can be found at www.wrc-rca.org.

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INTRODUCTION

The western burrowing owl (*Athene cunicularia hypugaea*) is 1 of 45 bird species covered by the Western Riverside County MSHCP (Dudek & Associates 2003). Burrowing owls are considered a Species of Special Concern at both the State and Federal levels. Additionally, the species is designated as a Partners in Flight Priority Bird Species and a U.S. Fish and Wildlife Service Species of Management Concern (Dudek & Associates 2003). Within California, burrowing owls are found throughout the Central Valley, from Redding south to the Grapevine, east through the Mojave Desert, west to San Jose and San Francisco, within the outer coastal foothills area, and within the Sonoran Desert (Grinnell and Miller 1944, Gervais et al. 2008). Inside the MSHCP Plan Area, burrowing owls inhabit the central portion of open lowlands (Garrett and Dunn 1981) and their overall distribution is scattered outside of the montane areas (Dudek & Associates 2003). The MSHCP identifies grasslands, agricultural fields, and playas and vernal pools as burrowing owl habitat within the Plan Area (Dudek & Associates 2003).

The MSHCP lists 7 species-specific conservation objectives for burrowing owls. Objective 2 identifies the following 5 Core Areas for burrowing owls, all of which Monitoring Program biologists surveyed in 2011: Lake Skinner/Diamond Valley Lake, playa west of Hemet, San Jacinto Wildlife Area (SJWA)/Mystic Lake area including Lake Perris, Lake Mathews, and along the Santa Ana River (Figure 1). These Core Areas should support a total breeding population of approximately 120 burrowing owls, with no fewer than 5 pairs in any 1 Core Area. Land managers have installed artificial burrows and managed vegetation within several Core Areas to facilitate reaching this goal, including installing 46 burrows within Lake Skinner/Diamond Valley Lake, 5 in SJWA/Mystic Lake area including Lake Perris, and 52 in Lake Mathews. Land managers or Monitoring Program biologists check all artificial and previously-occupied natural burrows at least 3 times each year (April, August, and December) to determine whether they are being used by burrowing owls, if there is burrow maintenance needed to make them hospitable to owls, and whether nearby habitat needs to be modified or managed to further encourage use by burrowing owls.

We surveyed an additional 4 locations, hereafter referred to as alternate Core Areas, based on the fact that they have been conserved to provide burrowing owl habitat or are historical nesting locations, and contain an adequate amount of land in conservation to support burrowing owls. These locations were the Badlands, the Lakeview Mountains, Sycamore Canyon Regional Park, and Proposed Core 2, west of the Johnson Ranch/Lake Skinner area (Figure 1).

Burrowing owls typically breed from March–August, with a peak in activity in April and May (Dudek & Associates 2003). They frequently nest in old California ground squirrel (*Otospermophilus beechyi*) burrows, but may also use burrows previously occupied by other small mammals, badgers (*Taxidea taxus*), or coyotes (*Canis latrans*) (Gervais et al. 2008). Additionally, burrowing owls may dig their own burrows in soft soil (Dudek & Associates 2003). Burrowing owls will also use pipes, culverts, and nest boxes for nesting where natural burrows are scarce (Robertson 1929). Young are present as early as mid-April (Haug et al. 1993), will begin emerging from burrows at about 14 d

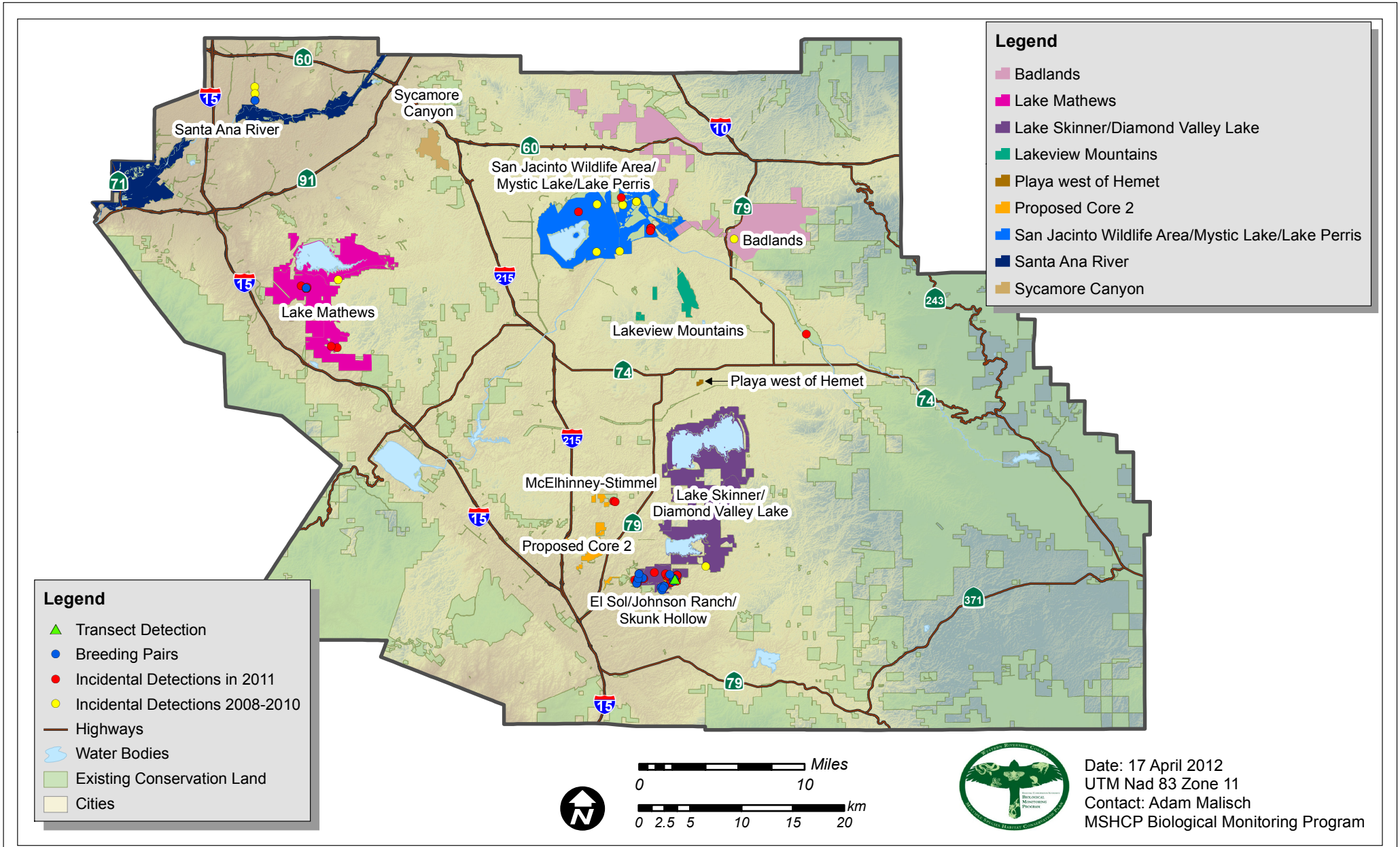

Figure 1. Burrowing owl survey areas (2011) and detections, 2008-2011.

post-hatching (Zarn 1974), and will fledge (i.e., leave immediate vicinity of burrow) at about 44 d post-hatching (Landry 1979). Burrowing owls may attempt a second brood if the first nesting attempt fails early in the season (Thomsen 1971; Butts 1973; Wedgwood 1976); otherwise, pairs produce a single brood each year.

We last surveyed for burrowing owls in 2007, focusing specifically on the following 4 Core Areas: Lake Skinner/Diamond Valley Lake, SJWA/Mystic Lake area including Lake Perris, Lake Mathews, and along the Santa Ana River. We did not survey the playa west of Hemet because there was no conserved land with appropriate habitat available at that time. We ultimately detected burrowing owls in the following 2 Core Areas during our 2007 surveys: Lake Skinner/Diamond Valley Lake and SJWA/Mystic Lake area including Lake Perris.

For this project, we walked 100-m-long transects within burrowing owl habitat in the larger aforementioned Core Areas/alternate areas (hereafter all will be referred to as "survey areas"). For the smaller survey areas (i.e., the playa west of Hemet and the Lakeview Mountains), we conducted area searches within appropriate habitat to locate individuals or breeding pairs. We conducted surveys from 14 March–23 June 2011.

Burrowing owls occurring or breeding within the Plan Area, but outside the existing Conservation Area, are outside the scope of our monitoring efforts. Although these owls may be important contributors to the status of the species, we are confined to working within the boundaries of existing conservation.

Goals and Objectives

1. Determine whether burrowing owls are using appropriate habitat within survey areas.
    a. Conduct 109 100-m-long walking transects in larger owl survey areas, and area searches in smaller survey areas, repeating each transect/area search 3 times during the project.

2. Determine how many individual burrowing owls and breeding pairs are using the survey areas.
    a. Conduct follow-up visits after any burrowing owls are detected during a survey. Two observers will simultaneously assess the number of burrowing owls using the area, and determine whether any breeding pairs are present.

METHODS

Survey Design

We conducted surveys consisting of 100-m-long walking transects separated from one another by at least 300 m, within large burrowing owl survey areas, and more specifically within habitat types identified by the most current available GIS-based vegetation map (CDFG et al. 2005) as suitable habitat (see habitat types identified in Introduction) (Appendix A). We chose transects that were 100 m long and at least 300 m apart because that allowed us to have a sufficient sample size for analysis, while at the

same time providing an adequate coverage within each survey area. The density at which we placed transects within survey areas was approximately 1 transect/76 ha of habitat. Within small survey areas (i.e., the playa west of Hemet and the Lakeview Mountains), we conducted area searches within potentially suitable habitat.

We used Hawth's Tools (Beyer 2004) in ArcGIS Geographic Information Systems (GIS) software v. 9.3.1 (ESRI 2009) to generate regularly-spaced points, 300 m apart, within potentially suitable habitat in survey areas. These points represented an endpoint of a given transect. We then randomly selected a subset of these points within each survey area to achieve a sampling density of approximately 1 transect/76 ha of owl habitat. Next, we randomly selected a bearing (0–359°) for each endpoint and calculated the coordinates of each transect's second endpoint given the known length of the transect, the location of the initial endpoint, and the random bearing. We avoided establishing transects at known burrowing owl burrow locations at the request of land managers. We coordinate with land managers to assess whether the known burrows are active at least 3 times each year (April, August, and December), the number of owls using the burrows, and whether burrow modification/maintenance or habitat management is needed.

The 2011 burrowing owl survey areas, the hectares of potentially suitable habitat within each, and the resulting number of transects were as follows:

1. Badlands, 1310 hectares, 17 transects
2. Lake Mathews, 1211 hectares, 16 transects
3. Lake Skinner/Diamond Valley Lake, 1539 hectares, 20 transects
4. Lakeview Mountains, 7 hectares, area search
5. Playa west of Hemet, 28 hectares, area search
6. Proposed Core 2, west of Lake Skinner/Johnson Ranch, 100 hectares, 1 transect
7. SJWA/Mystic Lake/Lake Perris, 3192 hectares, 42 transects
8. Santa Ana River, 764 hectares, 10 transects
9. Sycamore Canyon, 230 hectares, 3 transects

Individual survey efforts were defined by the 100-m-long transects, which required a minimum of 5 min to complete, or the survey area-wide area searches where applicable. Each transect survey/area search was conducted 3 times in 2011, based upon the timing of each breeding stage of burrowing owls: once during the egg-laying and incubation period (mid-March to mid-April), once during the early nestling period (mid-April to mid-May), and once during the late nestling period (mid-May to mid-June) (Conway et al. 2008). We commenced surveys each day 15 min before sunrise and did not start any new surveys after 1000 hrs (Conway et al. 2008). We did not survey if temperatures exceeded 35°C or during periods of heavy precipitation, fog, or strong winds (exceeding 5 on the Beaufort Scale, or 38 km hr^{-1}).

Field Methods

At the start of each survey, the observer navigated to a transect endpoint using a handheld GPS. Upon arrival, the observer recorded on the data sheet the date, their initials, and the transect visit number. Next, the observer recorded the starting weather

and temperature, followed by the start time of the transect. At this point, the observer turned on their anemometer, which remained on throughout the duration of the survey to record average and maximum wind speeds. Upon completion of the transect, the observer recorded the ending time, weather, and temperature, as well as the maximum and average wind speeds.

During the survey, the observer recorded on their data sheet (Appendix B) the first individual of each bird species observed. Observers recorded information for subsequently-observed individuals only if that individual was a Covered Species. This allowed us to record data on the detectability, abundance, and distribution of non-covered species without compromising the ability to detect and record Covered Species. For each observation, observers recorded the species, using a four-letter code, the sex of the bird, the age of the bird, and any notes associated with the observation. If the observer detected a burrowing owl during the survey, they also made note of the owl's approximate location on an aerial photo, which would assist observers making follow-up visits.

Training

Field personnel participating in this study demonstrated the ability to identify, both visually and aurally, grassland bird species covered by the MSHCP, including burrowing owls, horned larks (*Eremophila alpestris*), and grasshopper sparrows (*Ammodramus savannarum*). Additionally, they demonstrated the ability to visually identify northern harriers (*Circus cyaneus*), another Covered Species that uses habitats similar to those used by burrowing owls. Observers also demonstrated an understanding of the field methods associated with the study, as well as the desired methods of observing burrowing owls from a safe distance.

Monitoring Program personnel studied avian field guides (e.g., Sibley 2003) and computer software (e.g., Thayer's Guide to Birds of North America, v. 3.5) while learning to identify the above species. When they felt prepared, personnel took a quiz, administered by the Avian Program Lead, consisting of both photographs and sound recordings of birds that were likely to be encountered during surveys. Personnel had to correctly identify all Covered Species, and could not incorrectly identify non-covered species as covered.

The Biological Monitoring Program staff is funded by the Regional Conservation Authority (RCA) and the California Department of Fish and Game (DFG). The following personnel conducted burrowing owl surveys in 2011:

- Nicholas Peterson (Biological Monitoring Program Avian Program Lead, DFG)
- Masanori Abe (Biological Monitoring Program, RCA)
- Elizabeth Dionne (Biological Monitoring Program, RCA)
- Karyn Drennen (Biological Monitoring Program, RCA)
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- Tara Graham (Biological Monitoring Program, DFG)
- David McMichael (Orange County Water District)
- Lynn Miller (Biological Monitoring Program, RCA)

- Robert Packard (Biological Monitoring Program, RCA)
- Ashley Ragsdale (Biological Monitoring Program, RCA)
- Jonathan Reinig (Biological Monitoring Program, RCA)
- Joseph Sherrock (Biological Monitoring Program, DFG)

RESULTS

Survey Results

We detected 1 burrowing owl while conducting targeted owl surveys in 2011. The owl was within the Lake Skinner/Diamond Valley Lake survey area, on the El Sol property east of Johnson Ranch and the French Valley Wildlife Area. There are several artificial owl burrows in nearby areas and we suspect that the owl we detected was using at least 1 such burrow. Overall, we detected 99 bird species during burrowing owl surveys in 2011, including 20 (44%) of the 45 bird species covered by the MSHCP. We detected all 3 co-occurring covered grassland bird species observers were required to be able to identify before being able to survey for burrowing owls (Appendix C).

In addition to the burrowing owl detected on-transect, we detected burrowing owls incidentally at the following 3 (60%) Core Areas in 2011: Lake Mathews (n = 7 detections, all of which were south of Cajalco Road), Lake Skinner/Diamond Valley Lake (n = 22, all of which were at El Sol, Johnson Ranch, or Skunk Hollow), and SJWA/Mystic Lake/Lake Perris (n = 3) (Table 1, Figure 1). Although burrowing owls have been reported to us from other locations, we have only listed owl detections here that we were able to confirm.

We also surveyed 4 potentially alternate owl Core Areas in 2011, based upon the presence of appropriate owl habitat or previous owl detections. We incidentally detected burrowing owls twice at one such location in 2011, the McElhinney-Stimmel property near Proposed Core 2 (Figure 1). We have detected burrowing owls here 9 times from 2006–2011. We did not detect any burrowing owls at the Lakeview Mountains, the Badlands, or Sycamore Canyon Regional Park in 2011. Monitoring Program biologists have detected burrowing owls once in the Badlands, in 2008, and once in Sycamore Canyon Regional Park, in 2007. Finally, we incidentally detected 1 owl along the San Jacinto River in late July 2011, while conducting small mammal trapping surveys (Figure 1).

Burrowing Owl Breeding Pairs Within the Conservation Area

There were at least 14 breeding pairs of burrowing owls within the Conservation Area in 2011. One breeding pair successfully fledged young within the Lake Mathews Core Area, specifically south of Cajalco Road, on property managed by the Riverside County Habitat Conservation Agency (RCHCA) (Brian Shomo, RCHCA, pers. comm.). There were at least 12 additional breeding pairs within the Lake Skinner/Diamond Valley Lake Core Area in the area consisting of the French Valley Wildlife Area (WA), managed by DFG; and Johnson Ranch and Skunk Hollow, both of which are managed by the Center for Natural Lands Management (CNLM) (Kim Klementowski, CNLM, pers. comm.). Several pairs were using artificial burrows on the El Sol property, immediately east of

Table 1. Summary of Biological Monitoring Program burrowing owl detections within designated and alternate Core Areas, with number of breeding pairs in 2011.

	Most recent burrowing owl detection	Breeding pairs in 2011
Designated Core Areas		
Lake Mathews	2011	1
Lake Skinner/Diamond Valley Lake	2011	≥12
Playa west of Hemet	Never	0
SJWA/Mystic Lake/Lake Perris	2011	0[1]
Santa Ana River	Never[2]	0[2]
Alternate Core Areas		
Badlands	2008	0
Lakeview Mountains	Never	0
Proposed Core 2	2011	0
Sycamore Canyon Regional Park	2007	0

[1] We detected 1 pair at Lake Perris in 2011, but we did not document any breeding by the pair.

[2] We detected a breeding pair of owls about 440 m north of this Core Area in 2011.

Johnson Ranch/French Valley WA, though we did not confirm an exact number of pairs in the area. There was an additional breeding pair approximately 440 m north of the Santa Ana River Core Area, along a Riverside County Flood Control channel. This pair fledged at least 2 young (N. Peterson, DFG, pers. obs.). Finally, there was a pair of burrowing owls within Lake Perris State Park, but we were unable to confirm that the pair reproduced in 2011 (Ken Kietzer, State Parks, pers. comm.).

DISCUSSION

Survey Results

We detected just 1 burrowing owl on-transect, but it is important to reiterate that we avoided walking in areas known by land managers to contain active burrows to avoid repeated disturbance of breeding owls. For example, several transects were initially within 100 m of active artificial burrows in Johnson Ranch. Burrowing owls in that area tend to flush from the burrows when an observer approaches, and the burrowing owls are quite detectable when doing so (N. Peterson, pers. obs.). If we had surveyed those areas in 2011, we likely would have detected more burrowing owls on-transect. Areas known to contain active burrows are monitored regularly by land managers or biologists from the Biological Monitoring Program to determine whether burrowing owls are breeding in the area and how many individuals are present.

We detected burrowing owls at 3 (60%) Core Areas in 2011, which is an increase over the results of previous burrowing owl surveys conducted by our Program in 2006 and 2007, when we detected burrowing owls at 2 (40%) Core Areas. During the 2006 and 2007 owl surveys, our Program detected burrowing owls on several occasions at the Lake Skinner/Diamond Valley Lake and SJWA/Mystic Lake/Lake Perris Core Areas, but just

twice (both incidentally) at the Lake Mathews Core Area, despite having approximately 100 survey points there in 2007. Some of the owl detections within that Core Area in 2011 likely represented either dispersing or migrating individuals, because we were unable to find the birds on follow-up visits; however, at least 1 pair stayed and fledged young. Since the 2007 surveys, the RCHCA has been actively managing the area south of Cajalco Road in which the breeding owl pair was located in 2011, through a combination of livestock grazing and prescribed burns. These management techniques seem to have improved owl habitat to the extent that at least 1 pair of burrowing owls not only used, but successfully reproduced, in an area that had been sporadically used by burrowing owls since 2007.

We did not detect burrowing owls in conserved lands in the Santa Ana River or playa west of Hemet Core Areas in 2011, nor have Monitoring Program biologists ever detected burrowing owls within the boundaries of either of these Core Areas. We did not survey the playa for burrowing owls prior to 2011 because there was no land included in the Conservation Area prior to 2008. We conducted area searches of the available property in 2011 and did not find any burrowing owls or indication of overall appropriate owl habitat. The property is flat and generally open (i.e., void of trees), and thus suitable for burrowing owls in those respects (Green and Anthony 1989, Haug et al. 1993); however, the vegetation is homogeneously tall (i.e., >1 m), which is unsuitable for burrowing owls. Management for burrowing owls on this property should begin with shortening the vegetation, at least patchily, which may encourage burrowing owls known to occupy the nearby Hemet-Ryan Airport, just 300 m to the east, to disperse into the property. The Santa Ana River Core Area also seems to lack appropriate owl habitat within the current Core Area boundaries defined in the MSHCP. Much of the Core Area consists of riparian habitat and we do not recommend altering that to create owl habitat. Instead, we recommend extending the official boundaries of the Santa Ana River Core Area to include the Riverside County Flood Control and Water Conservation District channel north of Limonite Avenue and east of Bain Street, extending north to 56th Street, along which we detected non-breeding burrowing owls in late 2010, and a breeding pair in July 2011 (Figure 1).

Of the 4 alternate Core Areas that we surveyed in 2011, Proposed Core 2 has been the only location in which our biologists have repeatedly detected burrowing owls since 2006. The area has patches of short vegetation, numerous rock piles, and seems to be very suitable for burrowing owls. Provided that the habitat continues to be managed to support burrowing owls, we recommend either including this area in the Lake Skinner/Diamond Valley Lake Core Area, or making it a separate Core Area for burrowing owls altogether.

Burrowing Owl Breeding Pairs Within the Conservation Area

There were at least 14 breeding pairs of burrowing owls, or 28 individuals, within the Conservation Area in 2011. This number falls short of the 120 breeding individuals required by the MSHCP to meet the species objective, but is an increase over the number of breeding pairs documented in 2007 (6 pairs total, 3 in SJWA/Mystic Lake/Lake Perris and 3 in the Lake Skinner Core Area). In 2006, we documented 20 breeding pairs within

the Conservation Area, with 1 pair at Warm Springs (i.e., near Proposed Core 2), 7 pairs at Johnson Ranch, and 12 pairs at SJWA/Mystic Lake/Lake Perris.

We documented more breeding pairs ($n \geq 12$) at the Lake Skinner Core Area in 2011 than we did in 2006 or 2007. In fact, this Core Area exceeded the minimum requirement ($n \geq 5$) established by the MSHCP for the number of breeding pairs of burrowing owls within a Core Area. The increase in the number of breeding pairs within this Core Area since 2006, specifically within Johnson Ranch, Skunk Hollow, and El Sol, likely resulted from a combination of 1) an increase in the number of artificial burrows installed and maintained; 2) control of vegetation height via livestock grazing and mowing; and 3) translocation to the property of several burrowing owls, some of whom stayed and bred in 2011. In addition to the artificial burrows, there is a population of California ground squirrels in this area, and we have observed that dispersing young burrowing owls frequently make use of the natural burrows created by squirrels. Based upon the results of these active management techniques for burrowing owls, these methods should serve as a model for other land managers within our Plan Area who are interested in creating conditions that are suitable for breeding burrowing owls. Indeed, management tools such as translocation of burrowing owls and installation of artificial burrows have been used throughout California (Trulio 1995, Rosenberg et al. 1998).

One pair successfully bred in the Lake Mathews Core Area in 2011, and the pair fledged at least 3 young. The pair nested in an artificial burrow and used nearby pipes for perch sites and refuge. If the area around the burrow continues to be maintained by RCHCA as described previously, we expect that the number of burrowing owls occupying the Core Area will continue to increase.

We detected 1 breeding pair approximately 440 m north of the Santa Ana River Core Area in 2011. The burrow was within an earthen embankment that parallels the Flood Control channel and was also next to a gate used by Riverside County Flood Control and Water Conservation District personnel to access the channel. The dirt along the embankment was compacted, so the burrow was probably not entirely excavated by the burrowing owls; instead, it may have been an old squirrel burrow or a crack, caused by erosion, which was enlarged by the burrowing owls. Most of the channel in either direction from the burrow was either pockmarked by squirrel burrows or lined with furrows caused by erosion, indicating that the channel could potentially be suitable for additional pairs of burrowing owls. Since the area is relatively close to the Santa Ana River Core Area and appears to be appropriate burrowing owl habitat, we recommend including this particular stretch of the channel in the Santa Ana River Core Area for burrowing owls.

We did not detect any breeding pairs at SJWA/Mystic Lake/Lake Perris in 2011, which is a large change from the 12 pairs we documented there in 2006. Overall detections of burrowing owls have declined precipitously at SJWA and Lake Perris since 2006 (i.e., $n = 21$ detections in 2006, $n = 14$ in 2007, and $n = 2$ in 2011). The only pair of burrowing owls that seemed to be using this Core Area throughout 2011 spent their time near a series of well-maintained artificial burrows north of Lake Perris; however, we did not document that this pair attempted to breed. The other owl that we detected within this

Core Area in 2011 appeared to be a single individual, and the observation occurred outside of the breeding season (mid-September).

Survey Methodology

When we conducted burrowing owl surveys in 2006 and 2007, we used a call-playback survey protocol. We had more success detecting burrowing owls during surveys using this technique, but we did not avoid known nesting areas as we did in 2011. One of the things we sought to do in 2011 was to locate areas being used by burrowing owls that were previously unknown to our Program. Owls at known breeding locations in 2011 were already being monitored closely as part of regular artificial burrow monitoring and maintenance, which was not occurring in 2006 and 2007.

Unfortunately, we did not detect enough burrowing owls on-transect to calculate detection probabilities, which would have enabled us to differentiate whether we did not observe burrowing owls in a given area because a) they were not present or b) our methods were not effective at detecting burrowing owls that were present. Therefore, we cannot conclude with any degree of certainty that Core Areas in which we did not detect burrowing owls were actually unoccupied; rather, we can only report that we did not detect burrowing owls in those areas during our surveys.

We chose to conduct walking surveys in 2011, absent a call-playback component, because most (74%) of our owl detections occur while our biologists are either driving or walking within owl habitat, and not while we are broadcasting owl vocalizations. Furthermore, some investigators who recommend using call-playback surveys for burrowing owls report that more than 70% of initial owl detections during call-playback surveys occur before vocalizations are broadcast (Conway et al. 2008). Conway et al. (2008) do not indicate whether those initial detections resulted directly from burrowing owls that flushed when observers approached a survey point, but the majority (>85%) occurred during the first minute of the survey period, which was passive (i.e., no broadcast of owl vocalizations) and immediately followed the approach of observers.

Recommendations for Future Surveys

For future surveys, our Program will need to decide whether to conduct "silent" walking transects (i.e., no broadcast survey component), as we did in 2011, or broadcast surveys at individual point stations. There are benefits and drawbacks to both techniques, with literature largely supporting the use of broadcast surveys; however, we have detected too few burrowing owls using either technique to necessarily justify one over the other. Instead, we may want to use a combination of techniques during future owl surveys, with observers walking transects but also stopping at designated points along the transect to broadcast owl calls. Alternatively, we may choose to forego conducting surveys within potentially suitable habitat that is not known to be occupied, and instead concentrate monitoring efforts at known burrowing owl sites and rely on incidental observations of burrowing owls from land managers and our biologists.

As we have done with other bird projects, we should consider ground-truthing all potential owl survey locations immediately prior to the start of the survey season. The vegetation layer upon which we base our survey locations is several years old and

inaccurate in several areas. We could have avoided surveying several areas in 2011 that contained excessively tall vegetation, and thus was unsuitable for burrowing owls, if we had ground-truthed them in advance.

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Appendix A. Western Riverside County MSHCP Biological Monitoring Program Burrowing Owl Survey 2011 Protocol

INTRODUCTION

The Burrowing Owl (*Athene cunicularia hypugaea*; hereafter "owl") is one of 45 bird species covered by the Western Riverside County MSHCP (Dudek & Associates 2003). Owls are considered a Species of Special Concern at both the State and Federal levels. Additionally, the species is designated as a Partners in Flight Priority Bird Species and a Fish and Wildlife Service Species of Management Concern at the Federal Level (Dudek & Associates 2003). Within California, owls are found throughout the Central Valley, from Redding south to the Grapevine, east through the Mojave Desert, west to San Jose and the San Francisco bay area, within the outer coastal foothills area, and within the Sonoran Desert (Grinnell and Miller 1944). In the Plan Area, owls inhabit the central portion within the open lowlands (Garrett and Dunn 1981) and their overall distribution is scattered outside of the montane areas (Dudek & Associates 2003). The MSHCP identifies grasslands, agricultural fields, and playas and vernal pools as owl habitat within the Plan Area (Dudek & Associates 2003).

The Western Riverside County MSHCP identifies seven species objectives for owls. Objective 2 identifies the following five Core Areas for owls, all of which we will be surveying in 2011 (Figure 1): Lake Skinner/Diamond Valley Lake, playa west of Hemet, San Jacinto Wildlife Area/Mystic Lake area including Lake Perris area, Lake Mathews, and along the Santa Ana River. These Core Areas should support a total of approximately 120 owls, with no fewer than 5 pairs in any one Core Area. We will also be surveying within an additional four locations, based on the fact that they have been conserved to provide owl habitat or are historical nesting locations, and contain an adequate amount of land in conservation to support owls. These locations will be the Lakeview Mountains, the Badlands, Sycamore Canyon Regional Park, and Proposed Core 2, west of the Johnson Ranch/Lake Skinner area.

Owls tend to breed from March–August, with a peak in activity in April and May (Dudek & Associates 2003). Owls typically nest in old ground squirrel burrows, but may also use burrows previously occupied by small mammals, badgers, or marmots. Additionally, owls may dig their own burrows in soft soil (Dudek & Associates 2003). Owls will also use pipes, culverts, and nest boxes for nesting where natural burrows are scarce (Robertson 1929). Young are present as early as mid-April (Haug et al. 1993) and will begin emerging from burrows at about 14 d post-hatching (Zarn 1974) and will fledge (i.e., leave immediate vicinity of burrow) at about 44 d post-hatching (Landry 1979). Western owls may attempt a second brood if the first nesting attempt fails early in the season (Thomsen 1971; Butts 1973; Wedgwood 1976); otherwise, pairs produce a single brood each year.

For this project, we will be walking 100-m-long transects within owl habitat in the larger aforementioned Core Areas/alternate areas (hereafter all will be referred to as "Core Areas"). For the smaller Core Areas (i.e., the playa west of Hemet and the Lakeview Mountains), we will conduct area searches within owl habitat to locate individuals or breeding pairs. None of the species objectives require us to document

nesting success of owls, so observers will not be conducting burrow checks for this project. Surveys will start in mid-March 2011 and will end in mid-June 2011.

Goals

A. Determine whether Burrowing Owls are using Core Areas and habitats designated by the MSHCP; and

B. Determine how many individual owls and breeding pairs are using the Core Areas designated by the MSHCP.

Objectives

1. Conduct 109 100-m-long walking transects in larger owl Core Areas, and area searches in smaller Core Areas, repeating each transect/area search three times during the project; and

2. Conduct follow-up visits after an owl is detected during a survey, during which time two observers will assess the number of owls using the area, as well as whether any breeding pairs are present.

METHODS

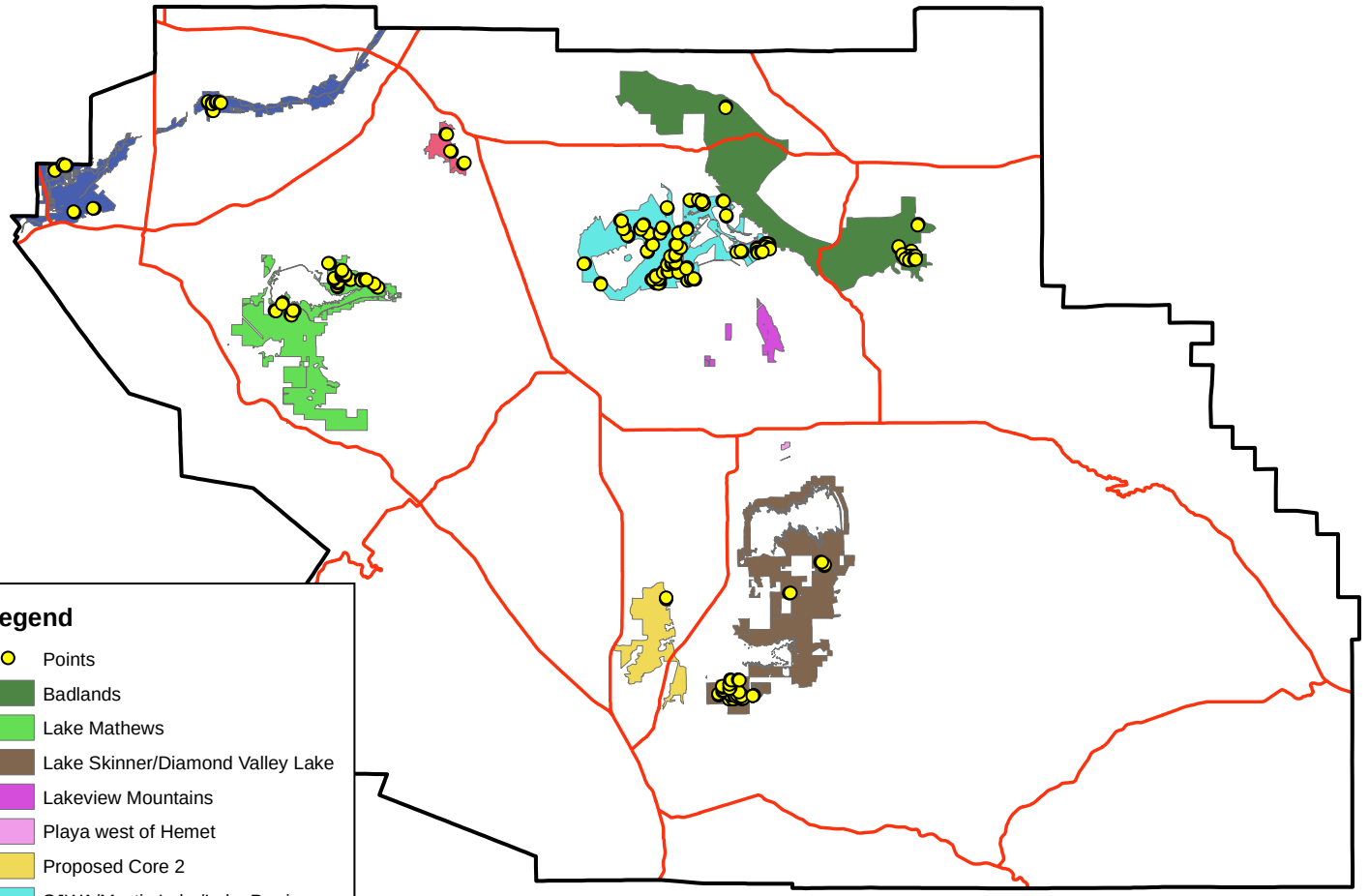
Survey Design

We will conduct surveys, consisting of 100-m-long walking transects separated from one another by at least 300 m, within large owl Core Areas, and more specifically within habitat types identified as likely owl habitat by the MSHCP (see habitat types identified in Introduction). We chose transects that are 100 m long and at least 300 m apart because that will allow us to have a sufficient sample size for analysis, while at the same time providing an adequate survey coverage area within each Core Area. Within small Core Areas (i.e., the playa west of Hemet and the Lakeview Mountains), we will conduct area searches within potential owl habitat. The density at which we placed transects within owl Core Areas was approximately 1 transect/76 ha of owl habitat.

We used Hawth's Tools (Beyer 2004) in ArcGIS 9.2 Geographic Information Systems (GIS) software (ESRI 2009) to generate regularly-spaced points, 300 m apart, within owl habitat in owl Core Areas. These points represented one endpoint for each transect. We then randomly selected a subset of these points within each Core Area to achieve a sampling density of 1 transect/76 ha of owl habitat. Next, we randomly selected for each endpoint a bearing (0–359°) and calculated the coordinates of each transect's second endpoint given the known length of the transect, the location of the initial endpoint, and the random bearing.

The following are the Burrowing Owl Core Areas, the hectares of suitable habitat within each, and the resulting number of transects:

Figure 1. BUOW Core Areas & Survey Locations, 2011



1. Badlands, 1310 hectares, 17 transects
2. Lake Mathews, 1211 hectares, 16 transects
3. Lake Skinner/Diamond Valley Lake, 1539 hectares, 20 transects
4. Lakeview Mountains, 7 hectares, area search
5. Playa west of Hemet, 28 hectares, area search
6. Proposed Core 2, west of Lake Skinner/Johnson Ranch, 100 hectares, 1 transect
7. San Jacinto Wildlife Area/Mystic Lake/Lake Perris, 3192 hectares, 42 transects
8. Santa Ana River, 764 hectares, 10 transects
9. Sycamore Canyon, 230 hectares, 3 transects

Individual survey efforts will be defined by the 100-m-long transects, which will take a minimum of 5 min to complete, or the Core Area-wide area searches where applicable. Each transect survey/area search will be conducted three times in 2011: once during the laying and incubation period (mid-March to mid-April), once during the early nestling period (mid-April to mid-May), and once during the late nestling period (mid-May to mid-June) (Conway et al. 2008). We will commence surveys each day 30 min before sunrise and will not start any new surveys after 1000 hrs (Conway et al. 2008). We will not survey if temperatures exceed 35°C or during periods of heavy precipitation, fog, or strong winds (exceeding 5 on the Beaufort Scale, or 38 km/h).

Field Methods

At the start of each survey, the observer will navigate to a transect endpoint using a handheld GPS. Upon arrival, the observer will record on the data sheet the date, their initials, and the transect visit number. Next, the observer will record the starting weather and temperature, followed by the start time of the transect. At this point, the observer will turn on their anemometer, which will remain on throughout the duration of the survey to record average and maximum wind speeds. Upon completion of the transect, the observer will record the ending time, weather, and temperature, as well as the maximum and average wind speeds.

During the survey, the observer will record on their data sheet the first individual of each species observed. Observers will record information for subsequently-observed individuals only if that individual is a Covered Species. This will allow us to record data on the detectability, abundance, and distribution of non-covered species within the Plan Area without compromising the ability to detect and record Covered Species. For each observation, observers will record the species, using a four-letter code; the sex of the bird; the age of the bird; and any notes associated with the observation. If the observer detects a Burrowing Owl during the survey, they will also make note of the owl's approximate location on an aerial photo, which will assist observers making follow-up visits.

If an observer detects an owl during a transect, we will schedule a follow-up visit to the site within three days. Follow-up visits will require two observers and will allow us to determine the number of owls in the area and whether any are breeding individuals. Follow-up visits will begin with the two observers approaching the site of the initial owl

detection. At this stage, observers will be at least 50 m from one another, which will increase the likelihood of flushing any owls that are perched on the ground. Throughout the visit, observers will keep in contact with one another via cell phones or two-way radios. If an owl is detected, observers will maintain a minimum distance of 50 m from the owl to minimize stressing the bird. If the bird exhibits stressed behavior (e.g., head bobbing, distress vocalizations), observers will retreat to a minimum distance of 75 m from the owl. While observing the owl(s), observers will continue to maintain a distance of 50 m from one another, which will allow them to observe different behaviors from the owl, based on their vantage point. During this time, observers will make note of how many owls they observe and whether there is any indication of an active nesting burrow. Signs of an active nesting burrow may include food carries to a burrow entrance (usually by the male owl), brief glimpses of an adult owl at a burrow entrance before the owl retreats into the burrow (usually the female), or young owls clustered around a burrow entrance and receiving food from their parents. After 30 min of observation, observers will meet with one another to compare notes and attempt to determine how many owls are present and whether any are breeding. If necessary, observers will continue to monitor the owls beyond the 30-min mark to make these determinations.

If we determine that a pair of breeding owls is present during the observations, we will continue conducting our transects in the area only if the transect is not within 50 m of the suspected burrow site. We will also notify land managers of the presence of breeding owls. If we do not suspect that a breeding pair is present, we will continue to monitor the area weekly for four additional weeks. If, after these five visits, we are still unable to identify a breeding pair in the area, we will discontinue our visits and conclude that a breeding pair is not present. Transects in these areas will continue as scheduled.

During the observations of owls, observers will at no time approach suspected or confirmed active burrows and attempt to assess their contents, stage, etc. None of the species objectives for Burrowing Owls require us to document nest success for the species, but instead require us to document the number of breeding pairs. This can be achieved by making observations of owl behavior from a safe distance. Furthermore, our presence at an active burrow will likely alter the behavior of the adults in such a way that could cause nest failure via abandonment, etc. Given the status of this species, we want to avoid this at all times.

Field Procedure

1. Observer will navigate to one of the transect's endpoints using a handheld GPS.

2. Before commencing the survey, the observer will record on their data sheet the date, visit number, their initials, starting weather, and starting temperature. The observer will also ensure that their anemometer is turned on and remains on throughout the duration of the survey.

3. The observer will then record the starting time and commence the survey. During the survey, the observer will navigate, using their GPS, to the opposite end of the transect. While doing so, the observer will walk at a constant speed that allows them to scan for owls and other covered bird species.

4. If the observer detects a covered species during the survey, they will record on the data sheet the abundance, age, and sex of the bird(s). If the observer detects a Burrowing Owl, they will make note of its approximate location on an aerial photo.

5. Upon reaching the opposite end of the transect, the observer will record the end time, weather, and temperature, and also the average and maximum wind speeds during the survey.

6. As stated previously in the Field Methods section, surveys will not commence during periods of precipitation exceeding a light drizzle. If heavy precipitation occurs after the survey has commenced, the survey period will continue as usual. If surveys cannot commence due to heavy rain, observers will wait until the precipitation subsides completely or lessens to a drizzle. If heavy precipitation occurs for more than 2 h, the observer will cancel surveys for the rest of the day and return to the office.

7. The same procedure detailed in step 6 will apply if fog appears before the start of a survey.

8. The same procedure detailed in step 6 will apply if, at the start of a survey, wind exceeds 38 km/h, or a 5 on the Beaufort Scale, which is characterized by large branches in motion, whistling heard overhead in utility wires, and objects such as empty plastic garbage cans tipping over.

9. If observers detect an owl during a survey, we will schedule a follow-up visit to site. During this visit, two observers will attempt to determine the number of owls at the site and whether any are breeding individuals. At no time during this process will observers approach a suspected or confirmed burrow.

Equipment

- Binoculars (at least 8x magnification power)
- Handheld GPS
- Field maps/aerial photos
- Anemometer
- Thermometer (if anemometer does not contain a thermometer)
- Data sheets

TRAINING

Field personnel participating in this study will demonstrate the ability to identify, both visually and aurally, Burrowing Owls, Horned Larks, and Grasshopper Sparrows. Additionally, they will demonstrate the ability to visually identify Northern Harriers. They will also demonstrate an understanding of the field methods associated with the study, as well as the desired methods of observing Burrowing Owls from a safe distance.

Personnel will study avian field guides (e.g., Sibley 2003) and computer software (e.g., Thayer's Guide to Birds of North America, v. 3.5) while learning to identify the above species. When they feel they are prepared, personnel will take a quiz, administered by the Avian Program Lead, that will consist of both photographs and sound recordings of birds that will likely be encountered during the owl surveys. Personnel must correctly identify the aforementioned covered species, and must not incorrectly identify non-covered species as covered.

Following completion of the above quiz, personnel will be required to read the field protocol and discuss with the Avian Program Lead any questions they may have. The Avian Program Lead will then discuss the proper ways of observing owls from a distance to ensure continuity between personnel.

Training Results

Participants who successfully complete the above training will be able to correctly identify Northern Harriers, Burrowing Owls, Horned Larks, and Grasshopper Sparrows. Additionally, they will be able to conduct surveys, specifically transects, for owls. Participants will also be able to accurately record field data in a manner that is similar to previous projects in which they have participated. Finally, participants will be able to observe owls in a manner that will minimize stress on the birds.

DATA MANAGEMENT

While observers are in the field, they will collect data on paper data sheets that are designed to correspond with a data entry form within the MSHCP electronic database. This will assure inferential integrity of collected data. After observers have returned to the office, they will enter their field data into an electronic Microsoft Access database, after which the data sheet will be stored in a folder labeled "Burrowing Owl Data Entered." When personnel have spare office time, they will take data sheets from that folder and double-check the corresponding data that have been entered into the database

for accuracy. When complete, data sheets will then be placed in a folder labeled "Burrowing Owl Data Double-checked."

DATA ANALYSIS

For each Covered Species, we will estimate per visit detection probabilities (p) using a closed-capture occupancy model available in Program MARK (White and Burnham 1999, MacKenzie et al. 2006). Next, we will construct a candidate set of models that examines the time-varying (i.e., among visits) effect on p, but will model estimates of use ($\hat{\psi}$) as being constant across visits because we will be assuming a closed population of Covered Species within our study areas.

We will then rank models in each candidate set according to Akaike's Information Criterion (AIC_c) for small samples, calculate Akaike weights (w_i), and average estimates of p across the entire candidate set (Burnham and Anderson 2002). We will then calculate cumulative detection probabilities (P^*) across visits according to the following formula, where p_i is the detection probability on a given visit or shift: $P^* = 1 - (\prod_{i=1}^{3} 1 - p_i)$.

TIMELINE

- **December 2010–February 2011:** Protocol development
- **Late February–mid-March 2011:** Training
- **Mid-March–mid-June 2011:** Burrowing Owl surveys, with follow-up visits to assess number of owls and breeding pairs
- **December 2011:** Initial drafts of report, including data analysis, are completed
- **May 2012:** Final draft of survey report is complete

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Appendix B. Data sheet for burrowing owl surveys, 2011.

MSHCP BUOW Data Sheet, 2011

Station ID: _____ Visit #: _____

Date: _____

Observer: _____

Start time: _____

End time: _____

Site conditions circle one:

Max wind: _____ Beaufort km/hr

Avg. wind: _____

Sky code: _____

Ambient noise: _____

Start temp.: _____ End temp.: _____

Species code	Sex (M, F, U)	Age (Ad, Juv, Unk)	Notes

Notes, species observed in transit, etc.

Beaufort Wind Codes: 0 = calm, smoke rises vertically; 1 = wind direction shown by smoke drift; 2 = wind felt on face, leaves rustle at times; 3 = leaves & small twigs in constant motion, light flag extended; 4 = wind raises dust & loose paper, small branches in motion; 5 = small trees sway, crested waves on inland waters.

Sky Condition Codes: 0 = clear or few clouds; 1 = partly cloudy; 2 = mostly cloudy; 3 = fog or smoke; 4 = light drizzle; 5 = constant snow; 6 = constant rain.

Noise Codes: 0 = no noise; 1 = noise, but not affecting bird detection; 2 = moderate noise, may be affecting detection; 3 = loud noise, reducing ability to detect birds; 4 = very loud noise, difficult to hear anything at all.

Appendix C. Avian species detected during burrowing owl surveys in 2011. Species in **bold** are Covered Species.

COMMON NAME	SCIENTIFIC NAME
Acorn Woodpecker	*Melanerpes formicivorus*
American Avocet	*Recurvirostra americana*
American Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparverius*
American Wigeon	*Anas americana*
Anna's Hummingbird	*Calypte anna*
Barn Swallow	*Hirundo rustica*
Bewick's Wren	*Thryomanes bewickii*
Black Phoebe	*Sayornis nigricans*
Black-chinned Hummingbird	*Archilochus alexandri*
Black-chinned Sparrow	*Spizella atrogularis*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Black-necked Stilt	*Himantopus mexicanus*
Blue Grosbeak	*Guiraca caerulea*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown-headed Cowbird	*Molothrus ater*
Bullock's Oriole	*Icterus bullockii*
Burrowing Owl	***Athene cunicularia***
Bushtit	*Psaltriparus minimus*
California Quail	*Callipepla californica*
California Thrasher	*Toxostoma redivivum*
California Towhee	*Melozone crissalis*
Canada Goose	*Branta canadensis*
Canyon Wren	*Catherpes mexicanus*
Caspian Tern	*Hydroprogne caspia*
Cassin's Kingbird	*Tyrannus vociferans*
Cinnamon Teal	*Anas cyanoptera*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Ground-Dove	*Columbina passerina*
Common Raven	*Corvus corax*
Common Yellowthroat	*Geothlypis trichas*
Cooper's Hawk	***Accipiter cooperii***
Costa's Hummingbird	*Calypte costae*
Dark-eyed Junco	*Junco hyemalis*
Double-crested Cormorant	***Phalacrocorax auritus***
Downy Woodpecker	***Picoides pubescens***
European Starling	*Sturnus vulgaris*
Grasshopper Sparrow	***Ammodramus savannarum***
Great Blue Heron	***Ardea herodias***
Great Egret	*Ardea alba*
Greater Yellowlegs	*Tringa melanoleuca*
Great-tailed Grackle	*Quiscalus mexicanus*

COMMON NAME	SCIENTIFIC NAME
Hooded Oriole	*Icterus cucullatus*
Horned Lark	***Eremophila alpestris***
House Finch	*Carpodacus mexicanus*
House Wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferus*
Lark Sparrow	*Chondestes grammacus*
Lawrence's Goldfinch	*Spinus lawrencei*
Lazuli Bunting	*Passerina amoena*
Least Bell's Vireo	***Vireo bellii pussilus***
Lesser Goldfinch	*Spinus psaltria*
Lesser Nighthawk	*Chordeiles acutipennis*
Loggerhead Shrike	***Lanius ludovicianus***
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Northern Harrier	***Circus cyaneus***
Northern Mockingbird	*Mimus polyglottos*
Northern Pintail	*Anas acuta*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Nutmeg Mannikin	*Lonchura punctulata*
Nuttall's Woodpecker	*Picoiodes nuttallii*
Osprey	***Pandion haliaetus***
Phainopepla	*Phainopepla nitens*
Pied-billed Grebe	*Podilymbus podiceps*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Pheasant	*Phasianus colchicus*
Rock Wren	*Salpinctes obsoletus*
Ruddy Duck	*Oxyura jamaicensis*
Savannah Sparrow	*Passerculus sandwichensis*
Say's Phoebe	*Sayornis saya*
Song Sparrow	*Melospiza melodia*
Southern California Rufous-crowned Sparrow	***Aimophila ruficeps canescens***
Spotted Towhee	*Pipilo maculatus*
Swainson's Hawk	***Buteo swainsoni***
Tree Swallow	***Tachycineta bicolor***
Tricolored Blackbird	***Agelaius tricolor***
Turkey Vulture	***Cathartes aura***
Unidentified blackbird	Family Icteridae
Unidentified duck	Family Anatidae
Unidentified gull	Family Laridae
Unidentified hummingbird	Family Trochilidae
Unidentified kingbird	*Tyrannus* spp.
Unidentified sparrow	Family Emberizidae
Unidentified swallow	Family Hirundinidae
Vaux's Swift	*Chaetura vauxi*

COMMON NAME	**SCIENTIFIC NAME**
Vesper Sparrow	*Pooecetes gramineus*
Violet-green Swallow	*Tachycineta thalassina*
Western Bluebird	*Sialia mexicana*
Western Grebe	*Aechmophorus occidentalis*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-faced Ibis	***Plegadis chihi***
White-tailed kite	***Elanus leucurus***
White-throated Swift	*Aeronautes saxatalis*
Yellow Warbler	***Setophaga petechia***
Yellow-breasted Chat	***Icteria virens***
Yellow-rumped Warbler	*Setophaga coronata*