Western Riverside County
Multiple Species Habitat Conservation Plan
Biological Monitoring Program

2014 Coastal California Gnatcatcher (*Polioptila californica californica*) Survey Report

Male California Gnatcatcher photographed at the Southwestern Riverside County Multi-Species Reserve.

28 July 2015

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NOTE TO READER:

This report is an account of survey activities conducted by the Biological Monitoring Program for the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). The MSHCP was permitted in June 2004. Reserve assembly is ongoing and expected to take 20 or more years to complete. The Conservation Area includes lands acquired under the terms of the MSHCP and other lands that have conservation value in the Plan Area (called public or quasi-public lands in the MSHCP). In this report, the term "Conservation Area" refers to these lands as they were understood by the Monitoring Program at the time the surveys were conducted.

The Monitoring Program monitors the status and distribution of the 146 species covered by the MSHCP within the Conservation Area to provide information to Permittees, land managers, the public, and the Wildlife Agencies [i.e., the California Department of Fish and Wildlife and the U.S. Fish and Wildlife Service]. Monitoring Program activities are guided by defined conservation objectives for each Covered Species, other information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees. A list of the lands where data collection activities were conducted in 2014 is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies.

The primary author of this report was the 2014 Coastal California Gnatcatcher Survey Project Lead, Masanori Abe. This report should be cited as:

Biological Monitoring Program. 2015. Western Riverside County MSHCP Biological Monitoring Program 2014 Coastal California Gnatcatcher (*Polioptila californica californica*) Survey Report. Prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available from http://wrc-rca.org/about-rca/monitoring/monitoring-surveys/.

While we have made every effort to accurately represent our data and results, it should be recognized that data management and analysis are ongoing activities. Readers 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 most current data.

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

Contact Information:

Executive Director
Western Riverside County
Regional Conservation Authority
Riverside Centre Building
3403 10th Street, Suite 320
Riverside, CA 92501
Ph: (951) 955-9700

Western Riverside County MSHCP
Monitoring Program Administrator
c/o Adam Malisch
4500 Glenwood Drive, Bldg. C
Riverside, CA 92501
Ph: (951) 248-2552

INTRODUCTION

The Coastal California Gnatcatcher (*Polioptila californica californica*) is one of 45 avian species covered by the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) (Dudek & Associates 2003) and is classified as threatened at the federal level. The species generally inhabits coastal sage scrub (CSS) habitat. CSS is a unique plant community found in coastal and inland southern California and Baja California. This habitat type is characterized by low-growing, drought-deciduous, and semi-woody shrubs, such as California buckwheat (*Eriogonum fasciculatum*), brittlebush (*Encelia farinosa*), California sagebrush (*Artemisia californica*), black sage (*Salvia mellifera)*, and white sage (*S. apiana*) (Dudek & Associates 2003).

Gnatcatchers are non-migratory, insectivorous, and CSS-obligate. Within the MSHCP Plan Area they primarily use CSS, desert scrub, and Riversidean alluvial fan scrub during the breeding season, which occurs from mid-February to mid-August (Dudek & Associates 2003). Gnatcatchers are distributed in southern coastal California and Baja California (Atwood and Bontrager 2001). In the Plan Area, gnatcatchers are widely distributed within suitable habitat in the southwestern region, especially in the Riverside Lowlands and San Jacinto Foothills Bioregions along the Interstate 15/215 corridor from the Santa Ana River to Temecula, and into the Vail Lake area (Dudek & Associates 2003).

Gnatcatchers nest in relatively dense stands of CSS shrubs such as *E. fasciculatum*, *A. californica* and *S. apiana* (Atwood and Bontrager 2001). Population trends of gnatcatchers are not clear because data are lacking in the Breeding Bird Survey database (Sauer et al. 2008); however, their breeding habitat has declined by approximately 33% since 1993 (Atwood and Bontrager 2001), posing a significant threat to the continued persistence of gnatcatcher populations.

The species-specific objectives for gnatcatcher require confirmation of distribution and successful reproduction within at least 75% of specified Core Areas once every three years (Dudek & Associates 2003). Successful reproduction is defined as a nest that produces at least one fledgling (Dudek & Associates 2003). The Core Areas for gnatcatchers include: Alberhill, Hogbacks/Murrieta Hot Springs, Lake Mathews/Estelle Mountain/El Cerrito, Lake Skinner/Diamond Valley Lake, North Peak Conservation Bank/Meadowbrook, Quail Valley, Railroad Canyon/Sedco Hills, Vail Lake/Wilson Valley/Temecula Creek, and Wasson Canyon (Fig. 1).

For this project, we surveyed for gnatcatchers via transect surveys and area searches within habitat identified by the MSHCP as suitable for the species in the nine Core Areas (Fig. 1). During our transect surveys, we recorded all gnatcatcher detections to estimate population densities and to assess site occupancy. We also searched for and monitored gnatcatcher nests within their Core Areas to document whether they were breeding successfully. We monitored nests until they failed or fledged young.

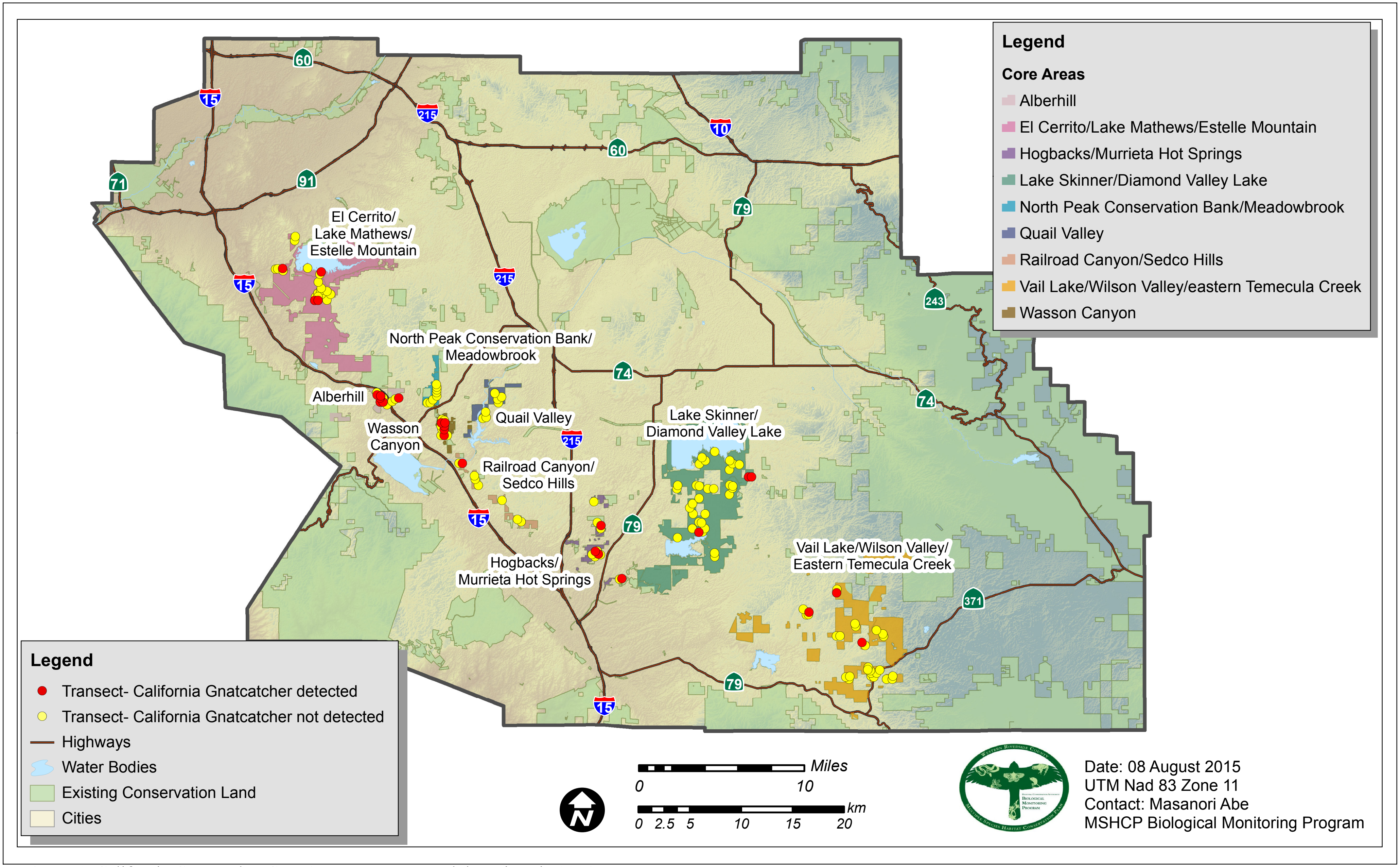

Figure 1. California Gnatcatcher Core Areas, transects, and detections in 2014.

Goals and Objectives

A. Determine whether gnatcatchers are using at least 75% of designated Core Areas.
   a. Survey transects within appropriate habitat in the Core Areas.
B. Determine whether gnatcatchers are successfully breeding in at least 75% of designated Core Areas.
   a. Locate and monitor active gnatcatcher nests until either fledging occurs or the nest fails.
C. Estimate densities and detection probabilities for gnatcatchers.
   a. Conduct distance sampling analysis using Program DISTANCE (Buckland et al. 2001; Thomas et al. 2009).
D. Estimate nest survival rates of gnatcatchers.
   a. Use the nest survival model included with Program MARK to calculate the daily survival rate (DSR) of nests (White and Burnham 1999; Dinsmore et al. 2002).

METHODS

Survey Design

We established 403 survey transects across the nine California Gnatcatcher Core Areas in 2011. We then used Hawth's Tools (Beyer 2004) in ArcGIS (ESRI 2009) to assign one set of endpoints at regularly-spaced intervals of 300 m. Next, we selected a bearing (1–360°) at random and calculated the coordinates of each transect's second endpoint given the length of the transect, the starting location, and the random bearing (Biological Monitoring Program 2011). In 2014, we reselected 131 survey transects from the 2011 transects because some of the 2011 transects did not actually occur in suitable gnatcatcher habitat or were no longer in the Conservation Area as of 2014 (Table 1). Additionally, we had fewer biologists in 2014 than in 2011, so we had to reduce sample size. During the reselection process, we used a GIS-based vegetation layer (CDFG et al. 2005), Google Earth (version 6.2), and survey experience in 2011 to identify vegetation communities with potentially suitable gnatcatcher habitat. Finally, we added 10 new transects in 2014, including six near Lake Mathews and four north of Murrieta (Table 1).

Table 1. Extent of suitable habitat and number of transects established per Core Area surveyed in 2014.

Core Area	Suitable habitat (ha)	No. of transects
Alberhill	280	11
Hogbacks / Murrieta Hot Springs	544	12
Lake Mathews / Estelle Mountain / El Cerrito	700	21
Lake Skinner / Diamond Valley Lake	2600	34
North Peak Conservation Bank / Meadowbrook	304	8
Quail Valley	510	7
Railroad Canyon / Sedco Hills	426	8
Vail Lake / Wilson Valley / Temecula Creek	1500	29
Wasson Canyon	342	11

Transects were 100 m long and separated from one another by at least 300 m. Within CSS, we did not survey in areas where the slope exceeded 35 degrees because biologists are less able to adequately focus on observing birds while safely walking the transects. We chose to survey transects that were 100 m long and at least 300 m apart because this would maximize the area we could survey within each Core Area and provide a sufficient sample size for data analysis.

Field Methods

Line Transects

We surveyed each transect just once if we detected a gnatcatcher during the first round of the transect survey or found a nest near a transect line; otherwise, we surveyed it twice during the course of this project. We chose to discontinue surveys after two rounds because we were able to detect the species at 100% of their Core Areas during just two survey rounds in 2011 (Biological Monitoring Program 2012). We began the first round of surveys on 4 March 2014, and the second round on 28 April 2014. We commenced transect surveys at sunrise and did not begin new surveys after 1100 h. We did not survey if temperatures exceeded 35 °C or during periods of heavy precipitation, fog, or strong winds (exceeding 38 km/h or 5 on the Beaufort Scale).

We began by navigating to either of the transect endpoints using a handheld GPS unit. When we were 50 m from the transect start point, we recorded on the data sheet the date, biologist initials, the transect ID, and the transect visit number. Next, we turned on the anemometer, which remained on throughout the duration of the survey to record average and maximum wind speeds, and recorded the starting weather and temperature. We recorded any birds detected between this point and the start of the transect as incidental or in-transit birds. Upon arriving at the transect start point, we recorded starting time and then began walking the transect, using a GPS unit and a compass to walk a straight line toward the opposite endpoint of the transect. We spent a minimum of 5 min on each transect, stopping every 25 m to look and listen for birds. Upon completion of the transect, we recorded the ending time, weather, and temperature, as well as the maximum and average wind speeds.

When we encountered a gnatcatcher during a survey, we recorded on the data sheet the four-letter species code, the sex and age of the bird, the bearing in the direction of the bird relative to the transect (0–360°), and the distance (m) of the bird from us. Additionally, we recorded our position (m) relative to the starting point (A or B) to determine whether a detected bird was perpendicular to the 100-m-long transect. We measured distances to gnatcatchers with a laser rangefinder and distances from endpoints using a GPS unit. If a gnatcatcher flew out of sight, we left the transect to follow the bird in an attempt to find an active nest. When we did this, we recorded the time we left the transect as well as when we returned to the transect. We always returned to the exact departure spot along the transect when we finished following the gnatcatcher. This was ensured by using the GPS unit to record the exact location where we left the transect to pursue the gnatcatcher. We always surveyed the full length of each transect regardless of how much time we spent following a gnatcatcher or whether we located an active nest while doing so.

If we encountered non-covered species, we recorded on the data sheet the first individual of each species observed. We recorded observations of additional individuals only for Covered Species.

Nest Searching and Monitoring

We conducted nest searches for gnatcatchers without time-of-day constraints, and continued until the species objective was met (i.e., we observed successful fledging) or the end of the breeding season, whichever came first. When we found a pair of gnatcatchers during a survey or while approaching a survey transect within a Core Area, we stayed in that area to observe behaviors that indicated nesting, such as carrying nesting materials or food, or producing begging or alarm calls (Martin and Geupel 1993). Additionally, we searched for nests of gnatcatchers in apparently suitable habitat in the Core Areas, even if survey transects were not nearby, and we conducted the same approach as described above. During observation, we tried to stay >30 m from the potential nest site to minimize both stress on the gnatcatchers and the likelihood of potential predators being drawn to the nest. If it was too difficult to observe these behaviors due to rough terrain or dense vegetation cover, we tried to identify the primary area used by the gnatcatchers, then systematically checked each shrub within this area (Reynolds 1981). If we found an active nest, we marked the location of the nest using a handheld GPS unit. The marked location was as close to the nest as possible.

We re-visited active nests once each week (Heath et al. 2008) and recorded the monitoring results on the nesting data sheet. Investigation of the actual nest was as brief and non-intrusive as possible because the primary focus of this project was to document successful nests, and of secondary importance was gathering information about clutch size, length of incubation stage, etc. If investigating a nest's contents might damage the nest substrate, or unnecessarily stress the parents, we instead observed whether it was active by watching the behavior of the parents from a safe distance (Heath et al. 2008). Each time we checked nest status, we took different paths to the nest to avoid making a clear path to the nest, which decreased the chance that predators could detect the nest by following our scent trails (Martin and Geupel 1993). Follow-up visits occurred until the nest fledged young or failed (Heath et al. 2008). The nest was successful if at least one nestling fledged (Dudek & Associates 2003).

For a complete description of survey methods see the *2014 Western Riverside County MSHCP Biological Monitoring Program Coastal California Gnatcatcher Survey Protocol*, available from the Biological Monitoring Program.

Training

Biologists practiced visual and aural bird identification, using a variety of avian field guides available in the office and a computer software program, Thayer's Guide to Birds of North America (Version 3.5), for several weeks prior to the beginning of field surveys. No biologist began surveys before passing an examination that required correctly identifying audio recordings and photos of all covered CSS bird species, and at least 80% of typical co-occurring, non-covered species. Biologists conducting nest searches received additional training in the reproductive biology of gnatcatchers.

Biologists who successfully completed the above training were able to correctly identify covered and co-occurring, non-covered CSS birds, by both sight and sound. Additionally, they were able to 1) conduct transect surveys for gnatcatchers; 2) locate and monitor nests of gnatcatchers, as described above; and 3) accurately record field data. Nest searchers were also able to monitor gnatcatcher nests in a manner that minimized stress on the adult birds and minimized the likelihood of attracting potential nest predators.

Data Analysis

Density Estimation

We used distance-sampling methodology and the program DISTANCE to estimate the detection probability and population density of gnatcatchers in their Core Areas in 2014 (Buckland et al. 2001; Thomas et al. 2009). Distance sampling allows for density estimation with incomplete detection of animals (i.e., not all animals present need to be observed to estimate density). Detection probability of distance analysis represents the probability of detection of target species within a survey strip by fitting data to several detection curves. The method relies on fitting data to a pre-defined detection function based on the assumption that objects become less detectable with increasing distance from the biologist (Buckland et al. 2001). Distance sampling also requires that three assumptions be met: 1) complete detection of subjects on the transect line, 2) subjects are observed before any movement response to the biologist, and 3) distances are measured accurately (Buckland et al. 2001). We examined detection histograms (i.e., number of observations per distance category) during the survey period for spikes in the number of observations away from the transect (suggesting violation of assumption 2), and for relatively few observations near the transect centerline in relation to other distance categories (suggesting violations of assumptions 1 and 2). Proper training and use of laser rangefinders was designed to satisfy assumption 3, though see relevant comments in the discussion section.

We pooled data across the entire 2014 survey season to fit a detection function and derive estimates of population density. We did not conduct stratified estimates by individual Core Areas because sample sizes were too low to derive area-dependent detection probabilities (distance sampling requires relatively large sample sizes, usually 40–60 detections per stratum for a simple model with no covariates [Buckland et al. 2001]). For gnatcatcher analysis, we grouped gnatcatcher observations into six 10-m distance categories (e.g., 0–10, 11–20, …, 51–60 m).

We evaluated the full combinations of uniform and half normal key functions with cosine, simple-polynomial, and Hermite-polynomial series expansions. We did not use hazard-rate key function for analysis because this model function frequently overestimates the unknown parameters unless the detection function curve is tightly matched to the hypothetical curve (Buckland et al. 2001). We assessed model fit by graphical inspection of the detection function and a chi-square goodness of fit test. We excluded models from the candidate set that demonstrated significant lack of fit based on the above criteria. We ranked competing models using Akaike's Information Criterion (AICc) adjusted for small sample size and weights, then model-averaged if necessary (Burnham and Anderson 2002).

Nest Survival

We estimated a nest survival rate for gnatcatchers by using the nest survival model in Program MARK (White and Burnham 1999; Dinsmore et al. 2002). We pooled all reproductive data from the Core Areas, and then estimated a DSR. The sample size (*n* = 19) was too small for us to estimate area-dependent DSR. We raised DSR estimates to the 30th power to estimate survival rates from egg initiation day to fledging, which is usually 30 d (Atwood and Bontrager 2001).

RESULTS

We detected gnatcatchers in 100% of their designated surveyed Core Areas in 2014 (Tables 2 and 3), specifically 16 individuals during the first round and 13 individuals during the second round (Fig. 1). We observed gnatcatchers on 26 of 141 (18.4%) transects within their Core Areas (Fig. 1, Table 2). We detected gnatcatchers most frequently within the Alberhill Core Area (6 of the 11, or 55% of, transects), followed by Wasson Canyon Core Area (5 of the 11, or 45% of, transects) (Table 2).

Table 2. Distribution of transects, number of transects, and detection rates of California Gnatcatchers in Core Areas surveyed in 2014.

Core Area	Number of transects	Number of transects where detected (% of total)	Mean number of individuals/transect
Alberhill	11	6 (55)	0.64
Hogbacks / Murrieta Hot Springs	12	4 (33)	0.42
Lake Mathews / Estelle Mountain / El Cerrito	21	4 (19)	0.19
Lake Skinner / Diamond Valley Lake	34	3 (9)	0.09
North Peak Conservation Bank / Meadowbrook	8	0[1]	0
Quail Valley	7	0[1]	0
Railroad Canyon / Sedco Hills	8	1 (13)	0.13
Vail Lake / Wilson Valley / Temecula Creek	29	3 (10)	0.14
Wasson Canyon	11	5 (46)	0.46

[1] We detected gnatcatchers incidentally within this Core Area in 2014.

We surveyed 141 transects during the first round (4 March–30 April 2014) and 126 transects during the second round of surveys (28 April–4 June 2014) over the nine Core Areas. We surveyed 15 fewer transects during the second round because we had already detected gnatcatchers from 14 transects and found one nest nearby one transect during the first round. In addition, we detected 85 other species including 14 Covered Species during line transect surveys (Appendix).

Nest Survival and Reproduction

We documented successful reproduction by gnatcatchers in eight (88%) of the nine Core Areas in 2014, including 29 nesting attempts within all (100%) Core Areas as well as four family groups, consisting of fledglings and adults (Fig. 2, Table 3). Of the 29 nesting attempts, 11 (37.9%) succeeded, 16 (55.2%) failed due to depredation, one (3.4%) was abandoned during the nestling stage because the nest was leaning at a 90-degree angle, and one (3.4%) had an unknown nesting fate (Table 3). We observed a total of 15 family groups of gnatcatchers within the Core Areas, 11 of which were from nests we monitored. The remaining four groups were observed during transect surveys or incidentally while we walked between transects. All of the fledglings we detected were still highly dependent upon their parents and had limited flight skills, so we assume they fledged within the Core Areas.

Table 3. Distribution and outcome of California Gnatcatcher nests and number of family groups detected within designated Core Areas in 2014.

		No. nests per outcome (% of known nests in Core Area)			
Core Area	No. nests	Successful	Failed	Unknown	No. family groups[1]
Alberhill	2	1 (50)	1 (50)	0	0
Hogbacks / Murrieta Hot Springs	2	0	2 (100)	0	2
Lake Mathews / Estelle Mountain / El Cerrito	5	4 (80)	0	1 (20)	0
Lake Skinner / Diamond Valley Lake	3	2 (67)	1 (33)	0	0
North Peak Conservation Bank / Meadowbrook	4	0	4 (100)	0	0
Quail Valley	3	1 (33)	2 (67)	0	1
Railroad Canyon / Sedco Hills	2	1 (50)	1 (50)	0	1
Vail Lake / Wilson Valley / Temecula Creek	2	1 (50)	1 (50)	0	0
Wasson Canyon	2	1 (50)	1 (50)	0	0
Total	**25**	**11 (44)**	**13 (52)**	**1 (4)**	**4**

[1] We detected these family groups without finding a nest location.

Estimated DSR for gnatcatcher nests was 0.978 (95% CI = 0.956–0.989), suggesting a nest success rate of 51.3%, assuming an average of 30 d from the first day of egg laying until fledging (Grishaver et al. 1998; Atwood and Bontrager 2001). We included data from19 gnatcatcher nesting attempts in the nest survival analysis. We excluded 10 nests from the analysis because four nests were found after failed, five nests were found during the construction stage but failed before confirmed egg laying stage, and one nest had an unknown nesting outcome. We did not have enough nest sample data to calculate variations in nest survival based upon nest stage or among Core Areas.

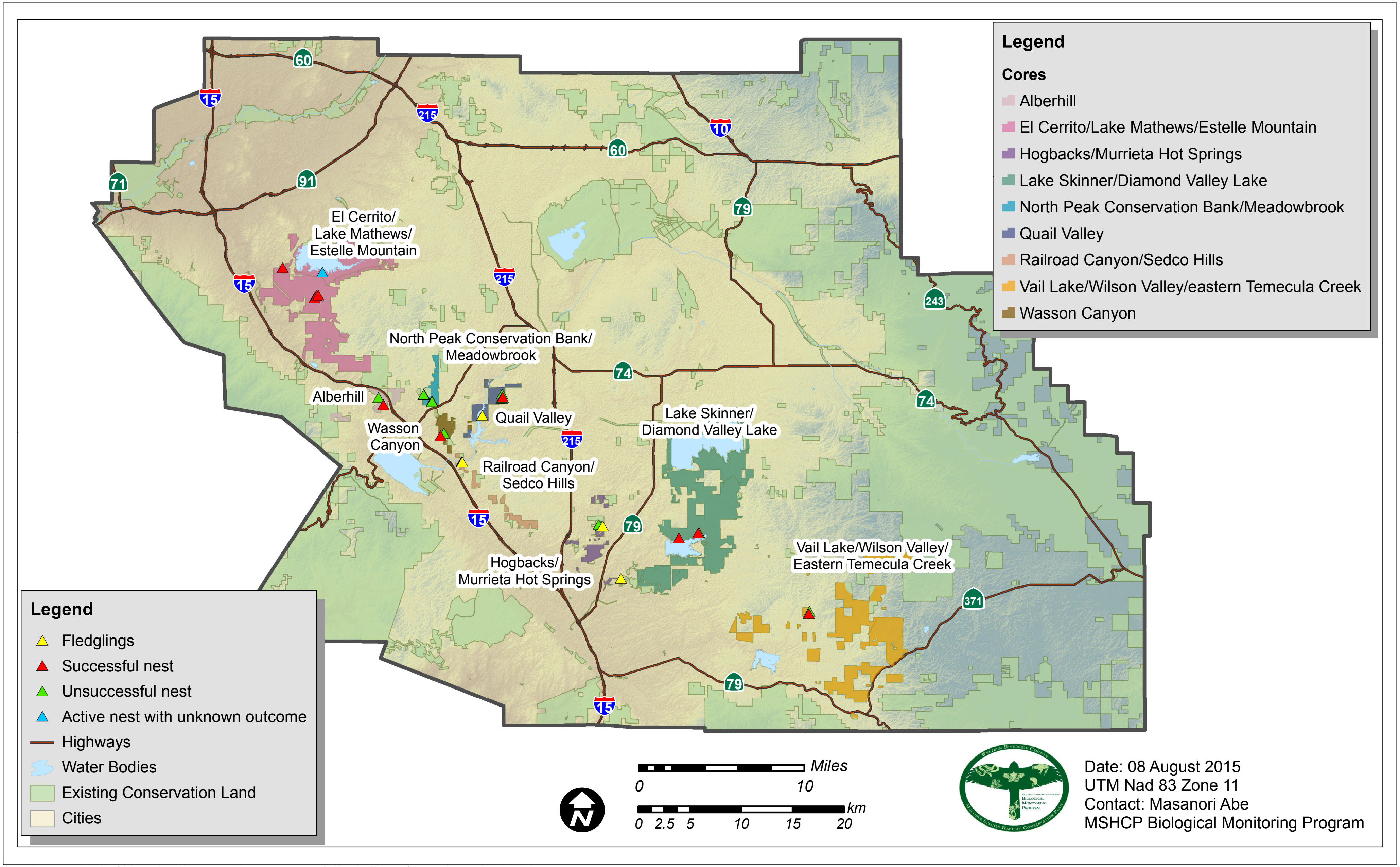

Figure 2. California Gnatcatcher nest and fledgling detections in 2014.

Density Estimation

The model-averaged density estimate of gnatcatchers was 0.12 individuals/ha (95% CI = 0.07–0.22 individuals/ha), detection probability was 0.45 (95% CI = 0.33–0.62), and effective strip half-width was 27 m (95% CI = 20–37 m). We detected 29 gnatcatchers during surveys, but four detections were eliminated from distance sampling analysis because the birds were beyond the survey strips, and three others were also eliminated due to distance data missing from the data sheet. As a result, we were able to use only 22 detections for the analysis. The models identified as best by AICc analyses were the half-normal key function; no series expansions of this model improved the AICc values of key function. The two other models, uniform key function with a cosine expansion, and uniform key function with simple-polynomial expansion, were within two delta AIC values from the best model, so we averaged these models to estimate density and detection probability.

DISCUSSION

We detected California Gnatcatchers at all of the designated Core Areas during the current reporting period and also documented successful reproduction by gnatcatchers in 88% (8 of the 9) of the Core Areas in 2014. Therefore, both the use and reproductive objectives are currently being met for gnatcatchers within the current reporting period (2012–2014).

Gnatcatchers seem to consistently occupy Core Areas along the I-15 corridor that contain a suitable density of CSS shrubs, and patches of CSS shrubs of an optimum size. For example, at Lake Mathews/Estelle Mountain/El Cerrito Core Area, where availability of apparently suitable gnatcatcher habitat was relatively low in relation to the size of the whole Core Area. When we set up the survey transects on apparently suitable habitat, we frequently detected the species. On the other hand, gnatcatchers were not detected in areas where transects occurred on apparently unsuitable gnatcatcher habitat. Within the southern half of the Core Area, where land was steeper, rockier, and drier, and CSS shrubs were distributed only sparsely, we did not detect any gnatcatchers in 2011. In the northern half of the Core Area, we detected gnatcatchers in locations where transects were within relatively dense stands of CSS shrubs. As a result, we felt the occupancy rate of gnatcatchers was very high when their suitable habitat was available. In other words, the best habitat appeared to be saturated by gnatcatchers along I-15.

We detected the highest number of gnatcatchers per transect in the Alberhill Core Area (0.64 individuals/transect) (Table 2), followed by the Wasson Canyon Core Area (0.46 individuals/transect). This is similar to our 2011 results (0.58 individuals/transect in Wasson Canyon and 0.36 in Alberhill, Biological Monitoring Program 2011). In these Core Areas, the availability of the dense stands of CSS shrubs were very high relative to the size of the Core Areas; therefore, we likely encountered potential breeding or foraging habitat for the species while walking transects.

In the Lake Skinner/Diamond Valley Lake Core Area, we detected gnatcatchers less frequently during transect surveys than the Core Areas above. However, we saw several pairs of gnatcatchers and nesting attempts incidentally during area searches. Much of this Core Area was covered by very tall, dense, healthy CSS vegetation that provided ideal breeding and foraging habitats for a variety of CSS-dependent birds. Healthy CSS vegetation for gnatcatchers was characterized by the density, size, and height of vegetation. Because of the size of the Core Area, it supported the greatest number of gnatcatchers in our study sites. We also noticed there are still unoccupied, but apparently suitable sites for gnatcatchers in this Core Area. We had to prioritize our work within this Core Area in 2014 due to staff shortages and thus chose not to survey the south-facing slopes around Diamond Valley Lake. We did not survey the south-facing slope north of Diamond Valley Lake where Metropolitan Water District biologist Bill Wagner reported breeding gnatcatchers, because of the shortage of biologists and having already confirmed reproduction within this Core Area.

The Core Areas in which we detected gnatcatchers less frequently did not contain large patches of suitable habitat for the species. In Quail Valley and North Peak Conservation Bank/Meadowbrook Core Areas, we were not able to detect any gnatcatchers during transect surveys; however, we observed a family group and several nesting attempts in Quail Valley and two pairs with five nesting attempts in North Peak Conservation Bank/Meadowbrook Core Areas incidentally during an area search. A pair of gnatcatchers in North Peak Conservation Bank rebuilt a nest in exactly the same spot where they built a previous nest, which had failed about 10 d prior (Fig. 3). This re-nesting attempt ultimately failed.

Figure 3. Adjacent nests constructed by a gnatcatcher pair within the North Peak Conservation Bank/Meadowbrook Core Area.

Nest Survival and Reproduction

We documented successful reproduction by gnatcatchers in 8 (88%) of 9 designated Core Areas. Breeding patches in which we found gnatcatcher nests included dense, tall, CSS vegetation stands and the size of the patches was relatively large. This type of habitat supported many pairs of gnatcatchers. Gnatcatchers, in general, tried to renest following failed attempts. They generally stayed in a territory until at least one nest succeeded or the end of breeding season arrived.

The DSR for gnatcatcher nests in 2014 (0.978 [95% CI = 0.956–0.989]) was similar to the DSR we reported in 2011 (0.97 [95% CI = 0.94–0.99]) and greater than the gnatcatcher DSR values we reported in 2007 (0.93 [95% CI = 0.88–0.95]). Our 2014 DSR value was on the high end of rates reported by other investigators in Riverside and San Diego Counties (Grishaver et al. 1998). However, our results in 2014, 2011 and 2007 were based upon relatively small sample sizes and longer nest checking periods; therefore, the results could reflect this sampling bias.

Gnatcatchers used eight CSS shrub species as nest substrate in CSS habitat. The most commonly used nest substrate was *S. apiana* (*n* = 10, or 35.7%) followed by *E. fasciculatum* (*n* = 5, or 17.9%), *Keckiella antirrhinoides* (*n* = 4, or 14.3%), *E. farinosa* (*n* = 3, or 10.7%), *A. californica* (*n* = 2, or 7.1%), *S. mellifera* (*n* = 2, or 7.1%), and *Rhus trilobata* (*n* = 1, or 3.6%). One nest (3.6%) was built in an unidentified substrate. These data include all nests we found during survey even if a nest was rebuilt by the same pair.

Density Estimation

The density estimate of gnatcatchers in 2014 (0.12 individuals/ha) was slightly higher than the estimate in 2011 (0.09 individuals/ha) which is encouraging. However, both of these values may not accurately represent the true density of gnatcatchers in their Core Areas, for two possible reasons. First, the number of detections used for density estimation was low, especially in 2014 (*n* = 22). Due to staffing shortages, we reduced the number of survey transects and rounds. Because of this, we eliminated many of the transects that were not in apparently suitable habitat for gnatcatchers, but we also had to eliminate some transects that were in apparently suitable habitat for the species. As a result, our sample size was lower than the 40 detections recommended by Buckland et al. (2001) for distance sampling analysis. We conducted the analysis anyway because we wanted to use this estimate as one of the metrics to track the population changes of gnatcatchers.

Second, due to the difficulty of accurately representing the true extent of apparently suitable gnatcatcher habitat in their Core Areas, our result was most likely an under estimate of their true density. Our GIS-based vegetation layer (CDFG et al. 2005) was updated in 2015 but that update was not available at the time of 2014 surveys and the older vegetation data did not necessarily accurately identify all suitable habitat for gnatcatchers. We used Google Earth imagery as well, but some habitat types and conditions remained hard to identify. Having biologists on-the-ground was the best way to map habitat types of gnatcatchers, but this is very time consuming. As a result, some transects were still within relatively poor-quality habitat for gnatcatchers, and our delineation of suitable gnatcatcher habitat was likely larger than true size.

For example, the Lake Mathews/Estelle Mountain/El Cerrito (*n* = 95 transects in 2011), Core Area is very large, but the true size of the suitable habitat was very small. After assessments during 2011 surveys we found approximately 10% of transects actually occurred in suitable CSS habitat and the remaining 90% of transects were in grasslands, on rocky hillsides, or in areas with sparsely-distributed CSS shrubs. These habitat types are not preferred by gnatcatchers, and that may have produced density estimates that are substantially lower than true density levels within accurately suitable habitats in the Core Area.

Moreover, we were not always able to accurately measure the exact distance to birds detected along transects, due to rough terrain and very dense stands of CSS or chaparral shrubs, which interfered with the function of our rangefinders.

Finally, four of the Covered Species we detected during gnatcatcher surveys are California Species of Special Concern, including Grasshopper Sparrow (*Ammodramus savannarum*), Loggerhead Shrike (*Lanius ludovicianus*), Northern Harrier (*Circus cyaneus*), and Yellow Warbler (*Setophaga petechia*). Seven of the Covered Species we detected require CSS habitat for foraging or nesting, including Bell's Sparrow (*Artemisiospiza belli*), Cactus Wren (*Campylorhynchus brunneicapillus*), Horned Lark (*Eremophila alpestris*), Loggerhead Shrike, Northern Harrier, Southern California Rufous-crowned Sparrow (*Aimophila ruficeps canescens*), and Turkey Vulture (*Cathartes aura*). These non-target species observation data are used as current documentation of species distributions, as starting points for future focused survey efforts, and to provide information about appropriate habitat for the detected species in the future.

Recommendations for Future Surveys

Understanding population trends is critical when monitoring sensitive species (Marsh and Trenham 2008). In 2014, we were unfortunately unable to obtain enough observations to calculate a robust density estimate, due to the lack of ample survey transects and rounds. If we increase the number of survey transects and rounds, the detection of gnatcatchers should increase, producing the sample size to better conduct distance sampling analysis. However, we have to shorten each survey round and complete the survey within the active gnatcatcher season to achieve this. Increasing either the number of transects surveyed per round, or the number of rounds conducted within a season would require more biologists.

During the non-breeding season for gnatcatchers, we can ground-truth the potentially suitable habitat within Core Areas. After accurately delineating suitable from unsuitable habitat we can distribute transects more resourcefully. In addition to being an inefficient use of resources, transects on unsuitable habitats lower the precision and increase the bias of estimated results for the survey effort.

We also need to spend additional time training biologists to estimate the location of individuals that are detected by song only, especially for dense and steep CSS habitats. Many biologists were uncomfortable estimating the location of birds (i.e., the source of the song) in those habitats during 2014 surveys, and they left the distance section blank on the data sheets even if they detected the target species on the transect. As a result, we had to exclude those detection records, reducing the sample size for density analysis.

Reproductive information is a key factor when estimating the future trend of sensitive species and evaluating pertinent habitat attributes (Shaffer 2004). However, the abundance of birds, itself, is not always related to reproductive success, habitat quality, or future population trends (Van Horne 1983). Furthermore, nest searching and monitoring requires many trained biologists and is very time-consuming. Our sample size for analysis of reproduction was low due to limited availability of trained biologists and time during the breeding season in 2014. Increasing the accuracy of this analysis, and thus estimating future population trends more accurately, requires us to spend more time training biologists, conducting nest searches, and monitoring more nests, which could increase the sample size for data analysis. Moreover, a comparison of the nest vegetation characteristics of successful and unsuccessful nests could guide future habitat management and estimates of population trends but requires a larger sample size.

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Appendix. Avian species detected during 2014 Coastal California Gnatcatcher surveys. Species in bold are MSHCP Covered Species.

COMMON NAME	SCIENTIFIC NAME
American Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparverius*
American Robin	*Turdus migratorius*
Anna's Hummingbird	*Calypte anna*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Band-tailed Pigeon	*Patagioenas fasciata*
Barn Swallow	*Hirundo rustica*
Bell's Sparrow	***Artemisiopiza belli***
Bewick's Wren	*Thryomanes bewickii*
Black Phoebe	*Sayornis nigricans*
Black-chinned Sparrow	*Spizella atrogularis*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Black-throated Sparrow	*Amphispiza bilineata*
Blue Grosbeak	*Passerina caerulea*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brewer's Sparrow	*Spizella breweri*
Brown-headed Cowbird	*Molothrus ater*
Bullock's Oriole	*Icterus bullockii*
Bushtit	*Psaltriparus minimus*
Cactus Wren	***Campylorhynchus brunneicapillus***
California Quail	*Callipepla californica*
California Thrasher	*Toxostoma redivivum*
California Towhee	*Melozone crissalis*
Canyon Wren	*Catherpes mexicanus*
Cassin's Kingbird	*Tyrannus vociferans*
Chipping Sparrow	*Spizella passerina*
Cliff Swallow	*Petrochelidon pyrrhonota*
Coastal California Gnatcatcher	***Polioptila californica californica***
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***
Eurasian Collared-Dove	*Streptopelia decaocto*
Fox Sparrow	*Passerella iliaca*
Grasshopper Sparrow	***Ammodramus savannarum***
Great Blue Heron	***Ardea herodias***
Great Egret	*Ardea alba*
Greater Roadrunner	*Geococcyx californianus*
Hooded Oriole	*Icterus cucullatus*
Horned Lark	***Eremophila alpestris***
House Finch	*Carpodacus mexicanus*
House Wren	*Troglodytes aedon*
Hutton's Vireo	*Vireo huttoni*
Ladder-backed Woodpecker	*Picoides scalaris*

Appendix Continued.

COMMON NAME	SCIENTIFIC NAME
Lark Sparrow	*Chondestes grammacus*
Lazuli Bunting	*Passerina amoena*
Lesser Goldfinch	*Spinus psaltria*
Lesser Scaup	*Aythya affinis*
Loggerhead Shrike	***Lanius ludovicianus***
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Northern Harrier	***Circus cyaneus***
Northern Mockingbird	*Mimus polyglottos*
Nuttall's Woodpecker	*Picoides nuttallii*
Phainopepla	*Phainopepla nitens*
Pied-billed Grebe	*Podilymbus podiceps*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Wren	*Salpinctes obsoletus*
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*
Steller's Jay	*Cyanocitta stelleri*
Tree Swallow	***Tachycineta bicolor***
Turkey Vulture	***Cathartes aura***
Violet-green Swallow	*Tachycineta thalassina*
Western Bluebird	*Sialia mexicana*
Western Grebe	*Aechmophorus occidentalis*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
Western Scrub-Jay	*Aphelocoma californica*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-faced Ibis	***Plegadis chihi***
White-throated Swift	*Aeronautes saxatalis*
Wrentit	*Chamaea fasciata*
Yellow Warbler	***Setophaga petechia***
Yellow-rumped Warbler	*Setophaga coronata*