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

Lake Birds Survey Report 2009

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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.

MSHCP reserve assembly is ongoing and it is expected to take 20 or more years to assemble 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 2009 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 2009, Avian Program Lead, Nick 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 Riverside County MSHCP states that a total of 10,340 ac (4185 ha) of open-water habitat should be conserved for bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and peregrine falcon (*Falco peregrinus*) within the following Core Areas: Diamond Valley Lake, Lake Elsinore, Lake Mathews, Lake Perris, Lake Skinner, Mystic Lake/San Jacinto Wildlife Area (SJWA), Santa Ana River/Prado Basin, and Vail Lake (Dudek & Associates 2003). Additionally, 16,100 ac (6516 ha) of open water habitat should be conserved for double-crested cormorant (*Phalacrocorax auritus*) in the aforementioned locations (Dudek & Associates 2003). Each target species must occupy ≥75% of MSHCP-defined Core Areas as stated in Volume I, Section 5.0, Table 5-8 of the MSHCP (Dudek & Associates 2003).

All 4 target species use open-water habitats throughout the year. Bald eagles (eagles) and double-crested cormorants (cormorants) conspicuously use open water habitat almost exclusively for foraging purposes (Zeiner et al. 1990, Neuman et al. 1997). Osprey feed more frequently on fish than any other prey item (Zeiner et al. 1990), thereby also requiring open water habitat for acquiring food. Peregrine falcons (falcons) use bodies of water less for foraging opportunities and more for the nearby cover and nesting opportunities provided by cliffs and canyons (Zeiner et al. 1990).

Bald eagles are primarily winter residents in western Riverside County (WRC) (Garrett and Dunn 1981), and only occasionally reside here during the summer (Dudek & Associates 2003). Indeed, 56% (n = 9) of bald eagle sightings made by Monitoring Program staff within the Plan Area have occurred during the winter (i.e., December–February), with an additional 13% (n = 2) in the fall (i.e., September–November). Only 1 eagle sighting by our staff has occurred during the summer months (i.e., June–August). Osprey are most often encountered in the region, though uncommonly, in the fall and winter (Garrett and Dunn 1981), and approximately 56% (n = 40) of osprey sightings by our staff have occurred during this time of year. Peregrine falcons occur in WRC primarily as fall transients, occasionally as winter residents, and rarely as spring transients (Garrett and Dunn 1981). Our staff have reported seeing these falcons throughout the year, with most sightings occurring in the summer (39%, n = 7), followed by the spring (28%, n = 5), fall (22%, n = 4), and winter (17%, n = 3). Double-crested cormorants tend to be year-round residents in WRC, and our staff have observed these birds throughout the year, with the majority (84%, n = 67) occurring during the spring and summer, followed by the winter (10%, n = 8) and fall (6%, n = 5).

We surveyed target species in fall 2009 and winter 2009–2010 when osprey, peregrine falcon, and bald eagle have the greatest likelihood of being present in the Plan Area. We conducted repeat-visit presence/absence surveys at point-count locations placed along shorelines of the water bodies defined above, except at Vail Lake and Mystic Lake. Vail Lake was not within the MSHCP Conservation Area during the survey period, and Mystic Lake did not contain water during this time. We surveyed artificial ponds in the SJWA part of the Mystic Lake/SJWA Core that typically contain water throughout the fall and winter for management of waterfowl habitat. We also worked in collaboration with biologists from the Santa Ana Watershed Association (SAWA) and Orange County

Water District (OCWD) to obtain data regarding our target species in the Santa Ana River/Prado Basin Core Area, because these organizations have extensive experience working in this area, and availability of Monitoring Program field personnel was limited during the fall and winter.

Goals and Objectives

1. Determine presence/absence of double-crested cormorant, osprey, bald eagle, and peregrine falcon at MSHCP-defined Core Areas in western Riverside County.

    a. Conduct repeat-visit (5 rounds) point-count surveys along the perimeters of water bodies defined as Core Areas for target species in fall 2009 and winter 2009-2010.

    b. Model detection probability to confirm presence/absence of each target species.

METHODS

Personnel and Training

Office-based training of field personnel consisted of a slideshow presentation showing all covered bird species likely to be encountered during open-water surveys. Slides also contained photographs and descriptions of similar non-covered species that could be mistaken for a covered bird. The goal was for observers to become skilled at visual identification of Covered Species likely to be encountered during surveys. We measured observer proficiency at identifying birds with a quiz consisting of slides containing unlabeled photos of covered and non-covered bird species, not all of which would be encountered during lake surveys (e.g., some marsh bird species were included on the quiz). Observers had to correctly identify all Covered Species, and could not mistake a non-covered species as a Covered Species [e.g., a red-winged blackbird (non-covered) cannot be identified as a tricolored blackbird (covered)] to pass the quiz and conduct surveys. Lastly, all participants attended a meeting during which we discussed the survey protocol and addressed any questions regarding survey methods.

Field-based training consisted of mock surveys conducted at Lake Perris State Park approximately 2 weeks prior to survey commencement. Goals of these mock surveys were to provide observers with practice in implementing the survey protocol, ensure consistency in field procedure among observers, and to raise any questions that were not apparent during the office-based portion of the training. We selected Lake Perris State Park as a training site because it typically contained several species of open water birds, and was easily accessible. Each field observer conducted 1 to 5 mock surveys before collecting data. Personnel that conducted lake bird surveys in 2009 are listed below. Biological Monitoring Program staff are either funded by the Regional Conservation Authority or the California Department of Fish and Game.

- Nicholas Peterson (Biological Monitoring Program, Program Lead)
- Masanori Abe (Biological Monitoring Program)
- Elizabeth Dionne (Biological Monitoring Program)

- Jeff Galvin (Biological Monitoring Program)
- Conan Guard (Biological Monitoring Program)
- Ana Hernandez (Biological Monitoring Program)
- Bill Kronland (Biological Monitoring Program)
- Lynn Miller (Biological Monitoring Program)
- Robert Packard (Biological Monitoring Program)
- Ashley Ragsdale (Biological Monitoring Program)
- Jonathan Reinig (Biological Monitoring Program)
- Nate Zalik (Biological Monitoring Program)

Site Selection and Survey Design

We surveyed the Santa Ana River and SJWA over multiple visits, with each visit consisting of a single survey. Survey design for large water bodies (Lake Mathews, Lake Perris, Diamond Valley Lake, Lake Skinner, and Lake Elsinore) followed a robust-design framework (Kendall et al. 1997) with each point sampled multiple times per visit (i.e., multiple secondary samples within multiple primary samples). This method provided a practical means of rigorously sampling individual open-water bodies over multiple visits given limited personnel.

We used ArcGIS 9.2 Geographic Information System (GIS) software (ESRI 2006) to selectively place points around Lake Mathews, Lake Perris, Diamond Valley Lake, Lake Skinner, and Lake Elsinore so that coverage of each water body was maximized, and the entire water body could be viewed over a single span of time by multiple observers. We standardized survey effort across sites by first digitizing water-body boundaries in ArcGIS 9.2, and using the Hawth's Tools extension (Beyer 2004) to calculate perimeter (m) to area (ha) ratios. We then distributed points among water bodies with 2 – 8 km of shoreline between points, and a sampling density of 1 point per 5 m/ha per site (Lake Mathews: $n = 7$, Lake Perris: $n = 4$, Diamond Valley Lake: $n = 5$, Lake Skinner: $n = 10$, Lake Elsinore: $n = 5$, SJWA: $n = 13$) (Figure 1).

We established point-count locations at each Core Area described above where observers had the best vantage of water bodies within 30 m of each in-office generated point. We sampled each point 4 times (i.e., shifts) per visit for a total of 5 visits in fall, thus building presence/absence (1/0) detection histories (e.g., 01101) within and across visits for each Core Area. We recorded points that could not be surveyed (e.g., travel mishaps) as missing data, and maintained a constant time interval between shifts (1 h) and across surveys (2 wks) to control for potential time bias. Every point at a Core Area was surveyed simultaneously during any given visit so that the entirety of the water body was under observation during each shift. Field personnel rotated among points between shifts so that individual observers did not record data at a single point more than once per visit.

Mystic Lake was dry at the time of these surveys, so we randomly distributed 1 point at each rectangular ($n = 5$) and irregularly-shaped ($n = 8$) artificial pond at SJWA so that entire ponds could be surveyed by a single observer. We established point-count locations at each point and surveyed them once per visit over 5 visits, thus constructing a single presence/absence detection history for each point that represented the entire survey

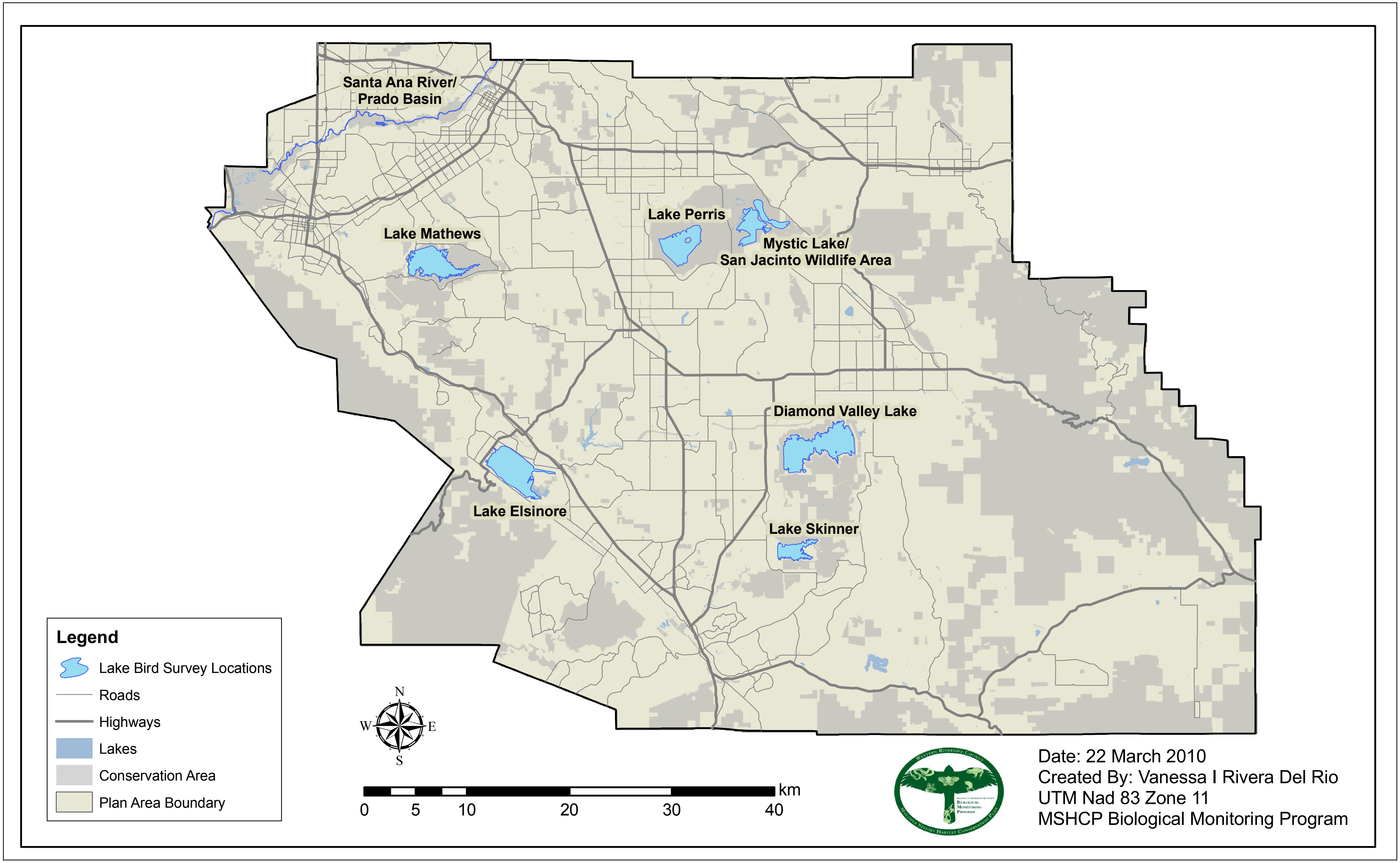

Figure 1. Lake bird survey locations, 2009-2010.

period. Time intervals between visits were 2 weeks, and coincided with survey rounds conducted at adjacent Lake Perris.

Linearity of the Santa Ana River and absence of large open water bodies in the Prado Basin at the time of these surveys made it difficult to sample the entire Core simultaneously. Instead, we used ArcGIS 9.2 and the Hawth's Tools extension to regularly distribute points along the Santa Ana River ($n = 34$) at a minimum of 1-km intervals along portions of the river shoreline that were in conservation. We surveyed points along the Santa Ana River over 3 days per survey round: the eastern third (i.e., from the San Bernardino County line to 100 m west of Van Buren Boulevard, $n = 11$) on day 1, the central third (i.e., Hidden Valley Wildlife Area, $n = 8$; northeast of Hidden Valley Wildlife Area, $n = 2$) on day 2, and the western third (i.e., Aliso Canyon, $n = 2$, east of Prado Basin to the intersection of Bain Street and Limonite Avenue, $n = 9$; Prado Basin: $n = 11$) on day 3.

We conducted surveys in fall 2009 (14 September – 19 November) and winter 2009 – 2010 (7 December 2009 – 18 February 2010). We did not conduct winter surveys if each target species was detected on ≥ 75% of open-water bodies listed by the MSHCP during fall surveys. Moreover, we targeted winter surveys only at open-water bodies where we did not detect target species during fall surveys.

Field Methods

We conducted surveys from Monday–Thursday of each week because state-mandated furloughs of California Department of Fish and Game (CDFG) vehicles and personnel occurred on the first 3 Fridays of each month, and we wanted to maintain a consistent 2-week interval between visits to each site. We surveyed each Core Area on the same day of the week across visits, beginning 14 September. Diamond Valley Lake and Lake Skinner were surveyed on alternate Mondays (e.g., Diamond Valley Lake on 14 September, Lake Skinner on 21 September, etc.); Lake Elsinore and the eastern third of Santa Ana River on alternate Tuesdays; Lake Mathews and the central third of Santa Ana River on alternate Wednesdays; and Lake Perris/Mystic Lake/SJWA and the western third of the Santa Ana River on alternate Thursdays.

We accessed survey points by foot, bicycle, or vehicle depending on terrain, distance between points, and the rules and regulations of agencies managing specific water bodies. We began surveys 30 minutes after sunrise or at predetermined start times (see exception below) and did not survey past 1400 h. Each survey was 20 minutes in length with a 40-minute travel period between points, except along the Santa Ana River where survey start times were not predetermined because observers had to face vehicle traffic when traveling between points. We synchronized watches at a predetermined meeting location prior to surveying large open-water cores and SJWA.

We surveyed each point with binoculars (8–10 magnification power), and recorded species and, when possible, sex and age (juvenile, adult) of all Covered Species detected. We recorded individual birds separately unless they were part of a large conspecific flock, in which case we recorded a single observation and estimated the number of birds. We randomly assigned approximately 2/5 of observers at each survey (i.e., 4 at Lake Skinner, 3 at Lake Mathews, 2 each at Diamond Valley Lake, Lake Perris, Lake Elsinore, SJWA and each of the Santa Ana River sections) hand-held weather stations (Kestrel 3000 Pocket Weather Meter, Nielsen-Kellerman Company, Boothwyn, PA) used to measure temperature (°C) and wind speed (km/h). All observers were not assigned a Kestrel because of the limited availability of Kestrels, but the proportion of points at which Kestrels were used was held constant across surveyed water bodies. For a complete description of lake bird survey methods in 2009 see *Western Riverside County MSHCP Biological Monitoring Program Lake Birds Survey Protocol, January 2009* (Appendix A).

Data Analysis

We analyzed datasets from the Santa Ana River/SJWA and large open-water bodies (e.g., Lake Perris, Lake Skinner) separately because survey methods differed between these areas. We estimated per shift (large open-water bodies) and per visit (Santa Ana River/SJWA) detection probabilities (p) using a closed-capture occupancy model (MacKenzie et al. 2006). We also considered areas with confirmed target species observations *used* rather than *occupied* (i.e., exclusive residency over a season) because we were unable to meet assumptions of population closure or independence of detections among sampling points. The default species objective described in section 5 of the MSHCP also refers to use rather than occupancy.

We used Program MARK (White and Burnham 1999) to construct a candidate set of occupancy models that examined the time-varying (i.e., per among visit) effects on p at Santa Ana River and SJWA. Data were pooled across visits for the large open-water portion of our survey, and candidate models examined time-varying (i.e., among shifts within visits) effects on p. We did not estimate parameters for individual large water bodies because the number of points at each lake were too few, and detectability of target species was likely similar among sites. We modeled all estimates of use ($\hat{\psi}$) as being constant across time and among sites because we were interested in overall presence/absence rather than change in use over time.

We ranked models in each candidate set according to Akaike's Information Criterion for small samples, modified to account for overdispersed data ($QAIC_c$). Overdispersion can occur when detections among sampling points are not independent, and can lead to inflated estimates of precision (MacKenzie and Bailey 2004). We suspected overdispersion in our data because birds that occurred in the middle of water bodies were likely detected simultaneously by multiple observers. We estimated an overdispersion parameter ($\hat{c}$) based on the observed deviance (D_{obs}) of the global model in each candidate set, and used the following formula where df is the deviance degrees of freedom: $\hat{c} = D_{obs} / df$ (White and Burnham 1999, MacKenzie et al. 2006). The overdispersion parameter was then included with the calculation of $QAIC_c$, and used to adjust variances and covariances in each model in the candidate set. We considered AIC_c and did not adjust variances/covariances for data that were not overdispersed (i.e., $\hat{c} \cong 1$) (Burnham and Anderson 2002). We calculated Akaike weights (w_i), and averaged estimates of p across the entire candidate set unless a single model showed clear support (e.g., $w_i > 0.9$) (Burnham and Anderson 2002). We then calculated cumulative detection probabilities (P^*) across visits (Santa Ana River/SJWA) and shifts (large water bodies) according to the following formula where p_i is the detection probability on a given visit or shift: $P^* = 1 - \prod_{i=1}^{5} 1 - p_i$. Variances for P^* were calculated using the delta method (MacKenzie et al. 2006).

RESULTS

The fall portion of our study began on 15 September 2009 and ended on 19 November 2009. During this time, we detected all 4 target species: osprey were detected at every Core Area we surveyed in the fall (100% of Core Areas); double-crested cormorants were detected at every Core Area except Mystic Lake/SJWA, though one was incidentally detected there in early 2009 (100% of Core Areas); peregrine falcons were detected at every Core Area except Mystic Lake/SJWA, but our biologists incidentally observed one there in early 2009 (100% of Core Areas); and bald eagles were detected in the Prado Basin and at Lake Mathews, though our biologists incidentally detected them at Lake Perris in winter 2009–2010, and previously reported observations of eagles in SJWA (early 2009) and Lake Skinner (2008) (71% of Core Areas) (Table 1). We continued to survey at Diamond Valley Lake and Lake Elsinore during the winter months to detect bald eagle at ≥ 1 of these lakes, which would thereby meet the species objective for use at ≥ 75% of Core Areas.

Table 1. Most recent detections of target species and their locations.

	Species			
	Bald eagle	**Double-crested cormorant**	**Osprey**	**Peregrine falcon**
Mystic Lake/SJWA	Early 2009	Early 2009	Fall 2009	Early 2009
Lake Skinner	2008	Fall 2009	Fall 2009	Fall 2009
Lake Perris	Winter 2009–10	Fall 2009	Fall 2009	Fall 2009
Lake Mathews	Fall 2009	Fall 2009	Fall 2009	Fall 2009
Lake Elsinore	Not seen	Winter 2009–10	Fall 2009	Winter 2009–10
Diamond Valley Lake	Winter 2009–10	Fall 2009	Fall 2009	Fall 2009
Santa Ana R./Prado	Fall 2009	Fall 2009	Fall 2009	Fall 2009

During the fall, we conducted a total of 723 point-count surveys over 5 survey rounds. We detected double-crested cormorant most frequently (33–60% of points), followed by osprey (7–38%), peregrine falcon (0–3%), and bald eagle (0-1%) (Table 2).

Table 2. Number of fall survey points (percentage) each round from which we detected target species.

Species	**Visit 1**	**Visit 2**	**Visit 3**	**Visit 4**	**Visit 5**	**Overall**
Bald eagle	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	2 (0.3)
Double-crested cormorant	42 (33)	70 (47)	80 (52)	95 (59)	78 (60)	365 (51)
Osprey	9 (7)	38 (26)	49 (32)	43 (27)	50 (38)	189 (26)
Peregrine falcon	1 (0.8)	2 (1)	0 (0)	5 (3)	0 (0)	8 (1)

Double-crested cormorant, osprey, and peregrine falcon objectives were all met in the fall. We conducted a focal search for bald eagle at Lake Elsinore and Diamond Valley Lake during the winter portion of the project to gather the additional observations necessary to document that bald eagle objectives were being met. We did not detect bald eagles at Lake Elsinore on 20 January, but we did detect an eagle at Diamond Valley Lake on 2 February, after which we terminated the project because all objectives were met.

As noted previously, we analyzed presence-absence data from SJWA and the Santa Ana River separately from the lakes. During the fall surveys, we did not detect any bald eagle along the river or at SJWA, so we did not conduct an analysis for the species at those locations. We detected osprey twice (at SJWA) and peregrine falcon once (along the western third of the river), which was not frequent enough to calculate detection probabilities. We detected double-crested cormorant 6 times: twice along the western third of the river (on the same transect), and 4 times along the central third of the river; however, these data were insufficient to calculate detection probabilities for cormorants along the river and SJWA.

We detected double-crested cormorant and osprey frequently enough at lakes to conduct detection probability analyses. We detected bald eagle once, so we did not conduct analyses with data for this species. We detected peregrine falcon 8 times, but that was not frequently enough to conduct analyses. For both cormorant and osprey, the p(.) model was always the best-fit model, according to Program MARK (Appendix B). Cumulative detection probabilities (P^*) for cormorant across 4 survey shifts ranged from 0.98 during survey round 1 to 1.00 during survey round 4. We were unable to analyze cormorant results from survey round 3[1]. For osprey, P^* ranged from 0.80 during the first survey round to 0.99 in the fifth survey round.

DISCUSSION

Using data collected during this survey effort and previously recorded observations made by Monitoring Program biologists or partnering agencies we can confirm that species-specific monitoring objectives are currently being met for bald eagle, peregrine falcon, osprey, and double-crested cormorant.

In general, and with the exception of bald eagle, the dates during which we conducted our fall surveys should have minimized the chances of us detecting migrant target species: double-crested cormorant are year-round residents in the Plan Area (Zeiner et al. 1990), though local populations increase as winter residents appear, osprey tend to arrive by September or October (Poole et al. 2002), and peregrine falcon tend to arrive from late September–mid-October (White et al. 2002). Bald eagles arrive on their wintering grounds anytime from mid-August–mid-November (Buehler 2000), and we did not detect them until Round 4 (late October–early November).

We may have been able to wait 2–3 weeks to commence this study, to allow for most winter residents of our target species to arrive. For example, we saw a substantial increase in the number of osprey detections after Round 1, possibly as more migrants

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[1] The ĉ value for the global model in this case exceeded 10, which indicates that the model structure is inadequate and does not account for an acceptable amount of variation in the data (Burnham and Anderson 2002).

arrived for the winter. Similarly, though not quite as substantially, we saw a slight increase in the number of double-crested cormorant detections throughout all 5 survey rounds, possibly as winter residents arrived and joined year-round residents on the lakes (Zeiner et al. 1990). Overall, we saw too few falcons or eagles to draw any substantial conclusions about whether we could have detected more individuals of those species if we had waited to start the project 2–3 weeks later.

The relatively low detection rate for double-crested cormorant along the Santa Ana River was likely due to several factors. First, there was only 1 river point from which we detected a cormorant in more than 1 survey round. Such a low rate of repeated detections will naturally lower, or, in our case, make it impossible to calculate, the detection probability rate in a study design in which we are assuming a closed population (i.e., cormorants should not be moving in or out of the survey area over the course of the study; thus, if we detect one in Round 1, we should theoretically be able to detect it in subsequent rounds). Second, we had a small sample size of cormorant detections along the river ($n = 6$). Third, and perhaps most importantly, the river is not a place where cormorants will congregate to forage, due to the fast-moving water (Hatch and Weseloh 1999). Instead, they are most likely to use the river as a corridor along which they will fly. Riparian vegetation along the river, and at the survey points, probably decreased the probability of an observer detecting a cormorant unless it was flying directly overhead. This too, will negatively influence detection probabilities.

During survey rounds 1–4, we had very high cumulative detection probability for cormorants across the 4 survey rounds. This indicates that our method of surveying for, and detecting, the species was quite successful. In general, there was a slight increase in $P*$ during each survey round, but when we factor in the small standard error associated with each high $P*$, we cannot conclude whether there was any actual increase or decrease in $P*$ over the first 4 survey rounds (Appendix B).

We noticed a similar trend with osprey, with the lowest $P*$ during survey round 1 (0.80) and the highest during round 5 (0.99), but when we factor in the standard errors associated with each $P*$, we cannot conclude whether there was any actual increase or decrease in $P*$ over the 5 survey rounds (Appendix B). Unlike double-crested cormorant, osprey do not congregate in large groups, which will naturally decrease the likelihood of an observer being able to detect the species. Furthermore, osprey often soared high over the lakes, unlike low-flying cormorants, and could have been unnoticed by observers for that reason as well. With the exception of survey round 1, though, $P*$ for osprey was high (> 0.94), indicating that during the first survey round either there were fewer osprey present, or our observers were not as efficient at detecting them. As noted earlier, osprey tend to arrive in the Plan Area by September–October. Survey round 1 started in September, so it is quite possible that fewer osprey were present then compared to subsequent surveys, which lasted from early October through November.

In general, we were more likely to detect double-crested cormorant than osprey during our surveys. This is likely a result of the general habits of these 2 species. Whereas cormorants tended to congregate in large groups, whether roosting, sunning, or foraging, osprey tended to perch and forage individually or in pairs, making the probability of detecting them less likely than cormorant. There was also a marked difference in the flight behaviors of these 2 species. Cormorants tended to fly low over the water, often near survey points, making detecting them relatively easy. Osprey, on the other hand, tended to soar higher up in the sky, meaning that observers had to make more of an effort to detect them (i.e., osprey were not usually flying right in front of observers).

Overdispersion of the data was a factor in double-crested cormorant survey rounds 1–4, and all 5 osprey survey rounds (i.e., $\hat{c} > 1.0$ for the global model in each case). As discussed previously, we anticipated that overdispersion would be a factor because it was possible for multiple observers to detect the same bird at the same time (i.e., lack of independence in such observations). Such overdispersion can lead to inflated estimates of precision, but we were able to account for this circumstance during analysis in Program MARK, and calculated standard error values should therefore be accurate.

Provided that one accounts for it during data analysis, overdispersion is not necessarily a bad thing. The primary goal of this study was to detect target species, which we successfully did. Calculated $\hat{c}$ values indicated that the number of observers at lakes made independent observations of individual birds less likely, but if we had used fewer observers during surveys, it is quite possible that we would have failed to detect some target species. Given our objectives, and the choice between using several simultaneous observers (potentially resulting in multiple detections of individuals and thus overdispersion of the data) and having fewer observers (possibly resulting in target species being missed), we conclude that our survey methods were appropriate and ultimately successful in detecting our target species.

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Appendix A. Western Riverside County MSHCP Biological Monitoring Program Lake Birds Survey Protocol, 2009

INTRODUCTION

Of 45 bird species covered by the Western Riverside County MSHCP, 4 have species-specific objectives that include the conservation of open water habitat. A total of 10,340 ac (4185 ha) of open water habitat should be conserved for Bald Eagle (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), and Peregrine Falcon (*Falco peregrinus*) within the following Core Areas: Diamond Valley Lake, Lake Elsinore, Lake Mathews, Lake Perris, Lake Skinner, Mystic Lake/San Jacinto Wildlife Area (SJWA), Santa Ana River/Prado Basin, and Vail Lake (Dudek & Associates 2003). Additionally, 16,100 ac (6516 ha) of open water habitat should be conserved for Double-crested Cormorant (*Phalacrocorax auritus*) in the aforementioned locations (Dudek & Associates 2003). Each target species must occupy ≥75% of MSHCP-defined core areas as stated in Volume I, Section 5.0, Table 5-8 of the MSHCP (Dudek & Associates 2003).

All 4 target species use open-water habitats throughout the year. Bald Eagles and Double-crested Cormorants conspicuously use open water habitat almost exclusively for foraging purposes (Zeiner et al. 1990, Neuman et al. 1997). Osprey feed more frequently on fish than any other prey item (Zeiner et al. 1990), thereby also requiring open water habitat for acquiring food. Peregrine Falcons use bodies of water less for foraging opportunities and more for the nearby cover and nesting opportunities provided by cliffs and canyons (Zeiner et al. 1990).

Within western Riverside County (WRC), Bald Eagles are primarily winter residents (Garrett and Dunn 1981) and only occasional summer residents (Dudek & Associates 2003). Indeed, 56% (n = 9) of Bald Eagle sightings made by MSHCP staff within our Plan Area have occurred during the winter (i.e., December–February), with an additional 13% (n = 2) in the fall (i.e., September–November). Only 1 eagle sighting by our staff has occurred during the summer months (i.e., June–August). Osprey are most often encountered, though uncommonly, in the fall and winter (Garrett and Dunn 1981). Approximately 56% (n = 40) of Osprey sightings by our staff occur during this time of year. Peregrine Falcons occur in WRC primarily as fall transients, occasionally as winter residents, and rarely as spring transients (Garrett and Dunn 1981). Our staff have reported seeing these falcons throughout the year, with most sightings occurring in the summer (39%, n = 7), followed by the spring (28%, n = 5), fall (22%, n = 4), and winter (17%, n = 3). Double-crested Cormorants tend to be year-round residents in WRC, and our staff have observed these birds throughout the year, with the majority (84%, n = 67) occurring during the spring and summer, followed by the winter (10%, n = 8) and fall (6%, n = 5).

We will survey target species in fall 2009 and winter 2009–2010 when Osprey, Peregrine Falcon, and Bald Eagle have the greatest likelihood of being present in the Plan Area. We will conduct repeat-visit presence/absence surveys at point-count locations placed along shorelines of the water bodies defined above, except at Vail Lake and Mystic Lake. Vail Lake is currently not within the MSHCP Conservation Area, and Mystic Lake may not contain water in the fall or winter unless substantial rains occur before then. The water body has been dry for at least the past year, and will not be surveyed for open-water birds if it remains in this condition. The SJWA, part of the Mystic Lake/SJWA Core, contains several artificial ponds that will contain water throughout the fall and winter for management of waterfowl habitat. We will also work in collaboration with biologists from the Santa Ana Watershed Association (SAWA) and Orange County Water District (OCWD) to survey the Santa Ana River/Prado Basin Core Area because these organizations have extensive experiences working in this core area, and availability of Biological Monitoring field personnel will be limited during the fall and winter.

Goals

1. Determine presence/absence of Double-crested Cormorant, Osprey, Bald Eagle, and Peregrine Falcon at MSHCP-defined Core Areas in western Riverside County.

Objectives

a. Conduct repeat-visit (5 rounds) point-count surveys along the perimeters of water bodies defined as core areas for target species in fall 2009 and winter 2009-2010.

b. Confirm presence/absence of each target species at defined core areas by estimating detection probabilities using a closed-capture occupancy model included with Program MARK.

METHODS

Survey Design

We will use ArcGIS 9.2 Global Information System (GIS) software (ESRI 2006) to selectively place points around Lake Mathews, Lake Perris, Diamond Valley Lake, Lake Skinner, Lake Elsinore, and the ponds at SJWA so that coverage of each water body is maximized. Placement of points will take into account irregularities of shorelines, and will be established so the entire water body can be viewed over a single span of time by multiple observers, each standing at a point. We will also standardize survey effort across sites by first digitizing the boundaries of each water body in ArcGIS 9.2, and then use the Hawth's Tool extension (Beyer 2004) to calculate the perimeter (m) to area (ha) ratios. Next, we will distribute points among water bodies so that a sampling density of 1 point per 5 m/ha is maintained across sites (Lake Mathews: $n = 7$; Lake Perris: $n = 4$; Diamond Valley Lake: $n = 5$: Lake Skinner: $n = 10$; Lake Elsinore: $n = 5$, SJWA: $n = 13$), thus maximizing coverage of each water body given available field personnel, and minimizing likelihood of overlapping coverage. Spacing between points using the specified sampling density will be 2–8 km of shoreline. We will survey Mystic Lake opportunistically if substantial rain events occur, but are unable to distribute points at this time because the water body currently does not exist.

We will establish point-count locations within 30 m of each in-office generated point, from which observers will have the best vantage of water bodies. We will sample each point at individual core areas (except Santa Ana River/Prado Basin and SJWA) 4 times (i.e., shifts) per visit for a maximum of 5 visits per season (i.e., fall and winter), thus building presence/absence (1/0) detection histories (e.g., 0110) within and across visits for each core area (i.e. robust-design framework). We will terminate surveys before 5 visits if cumulative detection probabilities for each target species approaches 1. Each survey will be 20 min in length with a 40-min travel period between points. Time intervals between survey start times will be held constant at 1 hr, and timing between visits to individual core areas will be 2 weeks. Every point at a core area will be surveyed simultaneously during any given visit so that the entirety of the water body is under observation during each shift. Field personnel will also rotate among points between shifts so that individual observers do not record data at a single point more than once per visit.

We will survey the Santa Ana River/Prado Basin differently than other core areas because the linearity of the feature and absence of large expanses of open water will make it difficult to sample points simultaneously. Instead, we will use ArcGIS 9.2 and the Hawth's Tools extension to regularly distribute points along the Santa Ana River (n = 34) at a minimum of 1-km intervals along accessible portions of the river's shoreline. Within SJWA, we will distribute 1 survey point at each of the 5 rectangular artificial ponds, and 8 points at the northern ponds. We will establish point-count locations at each point and survey them once per visit over 5 visits, thus constructing a single presence/absence detection history for each point that represents the entire survey period. We will terminate surveys before 5 visits if cumulative detection probabilities approach 1. Time intervals between visits will be 2 weeks to coincide with survey rounds conducted at large open-water core areas. The Santa Ana River/Prado Basin Core Area will be surveyed over the course of 3 days during each survey round. The eastern third of the river (i.e., from just south of the San Bernardino County line to 100 m west of where the Van Buren Blvd. bridge crosses the river) will be surveyed on the first day (n = 11); the central third (i.e., Hidden Valley Wildlife Area [WA]: n = 8; along the river to the northeast of Hidden Valley WA: n = 2) will be surveyed on the second day; and the western third of the river (i.e., Aliso Canyon: n = 2, from east of the Prado Basin to an area south of the intersection of Bain Street and Limonite Avenue in Mira Loma: n = 9) will be surveyed on the third day.

We will conduct surveys in fall 2009 (14 September to 19 November) and winter 2009 – 2010 (7 December 2009–18 February 2010). We will not conduct winter surveys if each target species is detected on ≥ 75% of open-water bodies listed by the MSHCP during fall surveys. Moreover, we will target winter surveys only at open-water bodies where we had not detected target species during fall surveys.

Field Methods

We will only be able to conduct surveys from Monday–Thursday of each week because of State-mandated furloughs of California Department of Fish and Game (CDFG) vehicles and personnel. We will survey each core area on the same day of the week across visits, beginning 14 September, to maintain a constant 2-week interval between visits. Diamond Valley Lake and Lake Skinner will be surveyed on alternate Mondays (e.g., Diamond Valley Lake on 14 September, Lake Skinner on 21 September, etc.); Lake Elsinore and the eastern third of Santa Ana River will be surveyed on alternate Tuesdays; Lake Mathews and the central third of Santa Ana River will be surveyed on alternate Wednesdays; and Lake Perris/Mystic Lake/SJWA and the western third of the Santa Ana River, including Prado Basin, will be surveyed on alternate Thursdays.

Survey points within different core areas will be accessed differently depending on whether vehicles are permitted by the local land manager or practical. At Diamond Valley Lake and Lake Perris, both of which have a bicycle path circumnavigating the lake, our observers will use bicycles to access the survey points. At Lakes Skinner, Mathews, and Elsinore, bicycles are either impractical or not allowed, so our observers will drive to each point (points are too distant from each other for walking to be practical within our inter-survey period time of 40 min). Along the Santa Ana River, observers will park as close as possible to points before continuing the rest of the way on foot, which may require walking through dense vegetation. Observers will follow instructions on accessing points written by observers who ground-truthed the points; however, if conditions warrant (e.g., the river's water level fluctuated), alternate routes can be used. Observers will access points within SJWA and the Prado Basin by vehicle or foot depending on the location of the points.

Observers will meet with one another at predetermined locations prior to surveying large open-water cores. Observers will then synchronize their watches with one another and independently travel to point-count locations, beginning surveys 30 min after sunrise. Survey shifts will occur simultaneously to provide a "snapshot" of the entire core area, from the vantage point of several observers, during each 20-min survey interval. Observers will use a hand-held radio or cellular phone to notify other field personnel if they are unable to reach a point-count location before the predetermined time (e.g., bicycle flat tire). Other field personnel will provide needed assistance, but predetermined start times will not be altered. We will record points that could not be surveyed because of travel mishaps as missing data, and will maintain a constant time interval between shifts and across surveys to control for potential time bias. We will not simultaneously survey points along the Santa Ana River and Prado Basin because of logistics involved with coordinating crews on a linear and vegetated landscape. Instead, the day's first survey will begin 30 min after sunrise and subsequent surveys will commence no later than 1400 hrs. Field crew surveying the Santa Ana River/Prado Basin will also meet at a predetermined location (e.g., DFG office in Riverside, OCWD office at Prado Basin) before beginning observations.

The observer will record species and abundance of individual covered species when encountered during the survey. Additionally, observers will record the sex and age (i.e., juvenile vs. adult) of individuals if they can be determined. We will record individual birds separately on the datasheet unless they are part of a large conspecific flock, in which case we will record a single observation and estimate the number of birds. Every observer will use binoculars (8–10 magnification power), and approximately 2/5 of observers at each survey (i.e., 4 at Lake Skinner, 3 at Lake Mathews, 2 each at Diamond Valley Lake, Lake Perris, Lake Elsinore, SJWA and each of the Santa Ana River sections) will be randomly assigned Kestrels (anemometer), which will be used to measure temperature and wind speed. Each observer will not be assigned a Kestrel because of the limited availability of Kestrels, and the proportion of points at which Kestrels will be used will be held constant to maintain survey effort across water bodies.

Field Procedure

1. Observer will use GPS to navigate to survey points.
2. Observers will fill out their datasheet with their initials and the date before starting the survey. They will also record: the visit #, which indicates whether it is the first, second, etc. visit to the water body (the visit # will not exceed 5); the point #, which corresponds with the survey point number; and the shift #, which will indicate whether the observer is at their first, second, third, or fourth survey point of the day.
3. Observers assigned Kestrels, or surveying the Santa Ana River/Prado Basin, will then collect and record the following environmental data approximately 1–2 min before starting the survey: air temperature (°C), sky information (0 = clear/few clouds, 1 = 50% clouded, 2 = overcast, 3 = fog, 4 = light drizzle; surveys should not be started if precipitation exceeds a light drizzle), average wind speed (km/h), and maximum wind speed. Observers not assigned a Kestrel or surveying the Santa Ana River/Prado Basin will only be responsible for recording start sky information with respect to environmental data. Lastly, observers will record the start times of each shift.
4. Observation period will start at the pre-determined time; first shift at 30 min after sunrise, and each subsequent shift at 60-min intervals. Surveys along the Santa Ana River and at Prado Basin will not be held to a 60-min interval, but will begin 30 min after sunrise and begin no later than 1400.
5. During the 20-min survey period, observer will record all covered species encountered. Survey time will be measured with either the timer function on an observer's digital watch or a digital handheld timer.
6. The following information will be recorded for each bird detected: species (4-letter code), sex (if known), age (if known), and abundance (1 unless a large conspecific flock).
7. There will be space at the bottom of the datasheet in which observers can record any notes they feel are relevant to the survey. Such notes can include descriptions of birds the observer was unable to identify, malfunction of any equipment, etc.
8. Upon completion of survey period, observers assigned Kestrels will record air temperature, sky information, and both average and maximum wind speeds during the survey period; all other observers will record end sky information only. All observers will also record the end time for each shift.
9. Observer will gather up all equipment and navigate to the next survey point on their list. The subsequent survey will begin in 40 min (i.e., 1 hr after the start of the previous survey), unless at Santa Ana River/Prado Basin.
10. At the beginning and end of a survey day during which the observer uses a bicycle to access points, the observer will inspect the bicycle for any damage

that could affect use of the bicycle in future surveys (e.g., make sure the chain is properly seated and there are no tire punctures). Observers using a bicycle will be required to carry with them a bicycle tire patch/repair kit.

11. As stated previously in the **Field Methods** section, surveys will not commence during periods of precipitation exceeding light drizzle. If, however, heavy precipitation occurs after the survey has commenced, the 20-min survey period will continue as usual. In the event that surveys cannot commence due to heavy rain, observers will wait for exactly 1 hr beyond when the rained out survey was to begin (i.e., the next scheduled start time), and the rain-out shift will be recorded as 'missing data'. After 1 hr, if conditions warrant, the current shift can commence; however, if heavy precipitation is still occurring, observers will wait an additional hour (exact) before starting the next shift. If heavy rain continues at that time, subsequent surveys for the day will be cancelled.

12. The same procedure detailed in step 11 will apply if fog forms during a shift or at any time during a day's survey.

13. The same procedure detailed in step 11 will apply if, at the start of a shift, 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. There will not be a temperature cut-off for this survey.

Equipment

- Binoculars
- Anemometer (if assigned)
- Thermometer
- Datasheet(s)
- GPS
- Map
- Watch
- Timer
- Bicycle (if required)

TRAINING

Office-based training of field personnel will consist of providing observers with a PowerPoint slideshow showing the covered bird species, both target and non-target for this study, most likely to be encountered during open water surveys. Slides will contain photographs and descriptions of covered species, as well as photos of similar species that could cause confusion for observers. The goal will be for observers to accurately identify, by sight, covered species that are likely to inhabit open water habitat. When an observer feels confident of their skills, they will take a test consisting of several PowerPoint slides that contain photos of covered and non-covered bird species. To pass the test, the observer 1) must correctly identify all covered species, and 2) must not incorrectly identify a non-covered species as a covered species (e.g., a Red-winged Blackbird [non-covered] cannot be identified as a Tricolored Blackbird [covered]).

Approximately 2 weeks prior to survey commencement, observers will accompany the Avian Program Lead to Lake Perris, where each observer will conduct a mock survey while the Lead observes. This will allow the observer to raise any questions regarding protocol that were not apparent in the office, and will also ensure consistency in field procedure among observers. Lake Perris will be useful as a mock survey site because it typically contains several species of open water birds, and the perimeter of the lake is easily accessible by automobile.

Training Results

Observers that successfully complete training will confidently and accurately be able to identify covered bird species that are commonly found in open water habitat. Additionally, they will be able to efficiently and consistently conduct point count surveys.

DATA MANAGEMENT

While observers are in the field, data will be collected on paper datasheets that are constructed to correspond with a data entry form within the MSHCP electronic database. This will assure inferential integrity of collected data (Appendix A). After MSHCP observers have returned to the office, data will be entered into an electronic Microsoft Access database, after which the datasheet will be stored in a folder labeled "Lake Birds Data Entered." When personnel have spare office time, they will take datasheets from that folder and double-check the corresponding data that have been entered into the database for accuracy. Once complete, datasheets will then be placed in a folder labeled "Lake Birds Data Double-checked." SAWA/OCWD observers will mail or deliver their completed datasheets to the Biological Monitoring Program's Avian Lead (Nick Peterson) at the completion of each survey round.

DATA ANALYSIS

We will analyze datasets from the Santa Ana River/Prado Basin and large open-water bodies (e.g., Lake Perris, Lake Skinner) separately, because survey method will differ between these areas. Santa Ana River/Prado Basin will be sampled over multiple visits, with each visit consisting of a single survey. Survey design for large water bodies will follow a robust-design framework (Kendall et al. 1997) because it provides a practical method of rigorously sampling individual open-water bodies within multiple visits (i.e., multiple secondary samples within multiple primary samples), thus maximizing the efficient use of available personnel. The robust-design analysis, however, requires a very large dataset to estimate parameters that we are not particularly interested in at this time (e.g., survival, availability). Our primary analytical interest is to estimate a probability of detecting individual target species to quantify our ability to record presence of birds, and to confirm potential absence of target species from surveyed water bodies.

We will estimate per shift (large open-water bodies) and per visit (Santa Ana River/Prado Basin) detection probabilities (p) using a closed-capture occupancy model available in Program MARK (White and Burnham 1999; MacKenzie et al. 2006). This model also estimates parameters for either occupancy or use. We will consider area use rather than occupancy because we will not be able to meet assumptions of population closure or independence of detections among point-count locations, and the default species objective described in section 5 of the MSHCP speaks to use rather than occupancy (i.e., exclusive residency over a season). We will construct a candidate set of models that examines the time-varying (i.e., among visits) effect on p at Santa Ana River/Prado Basin, but will model estimates of use ($\hat{\psi}$) as being constant across visits because our objectives do not include measuring changes in this parameter within seasons. Data will be pooled across visits for the large open water portion of our survey, and candidate models will examine time-varying (i.e., among shifts within visits) and group (i.e., among visits) effects on p, and $\hat{\psi}$ will be modeled as being constant across time and among sites. We will not estimate parameters for individual large water bodies because the number of points at each lake is likely too few for estimating variances.

We will 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 (Santa Ana River/Prado Basin) and shifts (large water bodies) according to the following formula where p_i is the detection probability on a given visit or shift: $P* = 1 - \prod_{i=1}^{5} 1 - p_i$.

TIMELINE

- July–August: Protocol development
- Mid-August–early September: Training
- Late August: Meeting/distribution of protocol to SAWA/OCWD.
- 14 September to 30 November: Autumn surveys will occur during the periods of meteorological autumn when surveys can occur Monday–Thursday on two consecutive weeks, a time period that will equal 1 survey round.
- The first round of surveys will commence on 14 September 2009 because 1 September is on a Tuesday and the following week begins with Labor Day on 7 September, during which no work will be conducted. The round will end on 24 September. Order of core area surveys within each round: Diamond Valley Lake, first Monday; Lake Elsinore, first Tuesday; Lake Mathews, first Wednesday; Lake Perris/Mystic Lake/SJWA, first Thursday; Lake Skinner, second Monday; eastern third of Santa Ana River, second Tuesday; central third of Santa Ana River, second Wednesday; western third of Santa Ana River and Prado Basin, second Thursday.
- Round 2: 28 September–8 October
- Round 3: 12–22 October
- Round 4: 26 October–5 November
- The last round of surveys will commence on 9 November and terminate on 19 November. Ideally, that will be the fifth round of surveys; however, we prefer a minimum of 3 rounds of surveys, so we will have a few weeks of flexibility in our

survey timing in case any unforeseen issues arise that preclude us from being able to survey at any point after 14 September.

- 1 December 2009–19 February 2010: Winter surveys will occur during the periods of meteorological winter when surveys can occur Monday–Thursday on two consecutive weeks, a time period that will equal 1 survey round.
- The first round of winter surveys will commence on 7 December 2009 because 1 December is on a Tuesday. The round will end on 17 December. Order of core area surveys within each round will be identical to autumn surveys.
- Round 2: 21–31 December
- Round 3: 4–14 January
- Round 4: 25 January–4 February
- Round 5: 8–18 February
- 14 September 2009–18 February 2010: data entry, check data, organization of GIS shapefiles.
- 22 February 2010: end of survey meeting.
- March–July 2010: Analysis of data, followed by writing of report detailing this study.

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Appendix B. Detection probability results (Program MARK) for double-crested cormorant and osprey, fall 2009.

Species	Survey Round	Ĉ of global model[1]	Best-fit model	$QAIC_C$	Δ $QAIC_C$	$QAIC_C$ weight	No. parameters	-2logL	*p*	*P**	± SE
DCCO[2]	1	3.5	p(.)	36.9	0	0.97	2	113.6	0.61	0.98	0.05
	2	2.2	p(.)	65.2	0	0.98	2	132.0	0.73	0.99	0.01
	3	3.3	p(.)	45.3	0	0.98	2	133.3	0.71	0.99	0.01
	4	4.5	p(.)	31.2	0	0.98	2	121.4	0.81	1.00	0.00
Osprey	1	2.2	p(.)	27.1	0	0.98	2	48.6	0.33	0.80	0.36
	2	2.3	p(.)	38.3	0	0.95	2	123.6	0.59	0.97	0.06
	3	4.6	p(.)	36.1	0	0.94	2	132.8	0.64	0.98	0.05
	4	3.5	p(.)	22.1	0	0.98	2	144.2	0.51	0.94	0.16
	5	9.4	p(.)	16.4	0	0.99	2	110.5	0.71	0.99	0.05

[1] In all of these cases, the global model was the p(t) model.
[2] Double-crested cormorant.