Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Yellow-billed Cuckoo Distribution, Abundance, and Habitat Use on the Lower Colorado River and Tributaries

2012 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

March 2013

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ACRONYMS AND ABBREVIATIONS

ANOVA	analysis of variance
BLM	Bureau of Land Management
BP	brood patch
BWRNWR	Bill Williams River National Wildlife Refuge
CDFG	California Department of Fish and Game
CI	confidence interval
cm	centimeter(s)
COB	confirmed
CP	cloacal protuberance
CVCA	Cibola Valley Conservation Area
DBH	diameter breast height
ESA	Endangered Species Act
g	gram(s)
GPS	Global Positioning System
ha	hectare(s)
KDE	kernel density estimate
km	kilometer(s)
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
m	meter(s)
MCP	minimum convex polygon
mHz	megahertz
NWR	National Wildlife Refuge
POS	possible
PRB	probable
PVER	Palo Verde Ecological Reserve
Reclamation	Bureau of Reclamation
RH	relative humidity
SD	standard deviation
SRA	State Recreation Area
USFWS	U.S. Fish and Wildlife Service
WMA	Wildlife Management Area
YBCU	yellow-billed cuckoo

Symbols

°	degrees
°C	degrees Celsius
°F	degrees Fahrenheit
%	percent

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EXECUTIVE SUMMARY

The western yellow-billed cuckoo (*Coccyzus americanus*) population has declined dramatically over the past century following extensive riparian breeding habitat loss. In 2005, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was created to create, protect, and maintain wildlife habitat for yellow-billed cuckoos and other threatened and near-threatened species occurring within the historical lower Colorado River flood plain. This report details the final year of a 5-year project to assess the response of yellow-billed cuckoos to ongoing riparian habitat restoration and guide future habitat creation planned within the LCR MSCP boundary.

Between mid-June and mid-August 2012, we conducted yellow-billed cuckoo call-broadcast surveys at 49 sites along the Muddy, Virgin, lower Colorado, Bill Williams, and Gila Rivers, covering approximately 1,300 hectares (ha) of potentially suitable breeding habitat (chapter 1). Survey sites included 14 LCR MSCP restoration, 12 non-LCR MSCP restoration, and 23 natural riparian sites. We recorded 279 survey detections, which we estimated to represent up to 80 potential (including 30 confirmed) breeding territories within the study region. Detections declined between 2011 and 2012 at Havasu National Wildlife Refuge (NWR) and Bill Williams River National Wildlife Refuge (BWRNWR), increased in the Blythe area, and remained unchanged in Yuma. The probability to detect cuckoos varied over the season and was highest in July (63 percent [%]) and lowest in June and August (49% and 43%, respectively). Cuckoo habitat use at LCR MSCP restoration sites (84.6%) exceeded that of both natural (60.9%) and non-LCR MSCP restoration habitat (30.8%). The proportion of habitat used in Reach 4 (Parker to Cibola, 71%) exceeded that of Reach 3 (Havasu NWR, 50%; BWRNWR, 73%) and Reaches 5–6 (Imperial to Yuma, 33%).

We confirmed breeding again in four areas: BWRNWR, Palo Verde Ecological Reserve (PVER) Phases 2 to 4, Cibola NWR (Cranes Roost), and Cibola Valley Conservation Area (CVCA) Phases 1 and 2. We confirmed breeding for the first time at PVER Phases 1 and 5. LCR MSCP restoration habitat continued to increase in detections, occupancy, and confirmed breeding. The BWRNWR (~700 ha of potential breeding habitat) showed a decline in breeding activity in 2012, but continued to support high breeding numbers (up to 19 territories estimated). CVCA Phases 1–2 (64 ha) also showed a decline in breeding activity, supporting three to five breeding territories in 2012. PVER (Phases 1–5, > 160 ha of contiguous breeding habitat) significantly increased in breeding activity, with an estimated 24 to 39 breeding territories in 2012 (chapter 2).

We found 28 nests in the study area in 2012 (chapter 3), similar to the number found in 2011. Nests were active between June 24 and September 8, with the highest number of active nests occurring July 22–28. Clutch size ranged from 2 to 5 eggs and averaged 3.16 ±0.8 (n = 25 nests). Apparent nest success was

78% (68% Mayfield success), with depredation the main cause of nest failure. Productivity averaged 1.9 young fledged per nest. We did not find any evidence of interspecific nest parasitism in 2012, but we suspected intraspecific nest parasitism may have occurred in at least two nests due to large gaps in laying dates, unusually large clutch sizes, and unhatched eggs. We confirmed successful double brooding for the first time in the study, all occurring at PVER.

During the 2012 season, we target-mist netted 37 adults, newly color banding 33 and recapturing 4 birds previously banded between 2009 and 2011, 3 as adults and 1 as a nestling (chapter 4). We also color banded 23 young from 11 nests. We re-sighted an additional three birds previously banded between 2008 and 2011, identifying one to individual. From these returns, we recorded five new dispersal events; four breeding and one natal, three returning males, and two females. All birds returned to their previous breeding or natal area (one at CVCA and four at PVER), continuing to support evidence of male site fidelity, as well as our first evidence of female site fidelity. Of eight LCR cuckoos fitted with geolocators in 2011, one female was recaptured in 2012 in the same net lane as her 2011 capture. She nested three times in the season (twice successful) and, together with her mate, provided our first evidence of seasonal monogamy.

We radio tracked 28 adult cuckoos in 2012 (chapter 4), including 5 at BWRNWR. Sixteen were confirmed breeders tracked to nests; 7 were apparently transient, staying an average of 11 days in one area before departing; and 5 had unknown breeding status. Three birds that left their capture site were each later relocated at separate sites 700 meters, 4.7 kilometers (km), and 5.6 km away. Birds that nested at their capture site remained an average of 41.5 days post-capture. The average home range (95% kernel density) estimate of 27 tracked birds was 17.3 ±8.2 ha (minimum convex polygon 30.1 ±49.1 ha).

We again compared microclimate (temperature and relative humidity) between nests and available habitat by placing data loggers at 199 locations during the 2012 breeding season (chapter 5). Nest locations were more humid and had significantly cooler diurnal temperatures compared to available habitat. This supports results from previous years and stresses the importance of areas with suitable nesting microclimate in these extreme desert riparian habitats.

INTRODUCTION AND PROJECT BACKGROUND

Yellow-billed Cuckoo History and Biology

The western yellow-billed cuckoo (*Coccyzus americanus*) population has declined dramatically over the last 100 years due to extensive loss or alteration of suitable breeding habitat, primarily riparian forests and associated bottomlands dominated by willow (*Salix* spp.), cottonwood (*Populus* spp.), or mesquite (*Prosopis* spp.) (Gaines and Laymon 1984; Laymon and Halterman 1987; Hughes 1999; Halterman et al. 2001). Historically, Mearns (1907) estimated 160,000–200,000 hectares (ha) (400,000–500,000 acres) of alluvial flood plain within the lower Colorado River (LCR) Valley between Fort Mohave and Yuma, which was densely wooded throughout (Grinnell 1914). At this time, cuckoos are thought to have been fairly common, although few early records exist (Gaines and Laymon 1984).

Over the past century, the LCR was transformed by dams to a string of storage pools, and vast areas of flood plain were converted to agricultural fields and urban settlements (Stromberg 2001). Grinnell and Miller (1944) noted an extensive range reduction of western cuckoos due to wide-scale habitat loss. By 1980, only 32,678 ha (80,749 acres) of riparian woodland remained in the LCR Valley (Hunter et al. 1988). In the 1970s, the regional cuckoo population was estimated (from survey detections) at 358 individuals: 244 between Davis Dam and the Mexican border plus another 114 at the mouth of the Bill Williams River (Gaines and Laymon 1984). Much of the LCR flood plain is now dominated by arrowweed (*Pluchea sericea*) and non-native tamarisk (*Tamarix ramosissima*) (Ohmart et al. 1988). The current expanse of woody riparian vegetation within the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) boundary is estimated to be 50,990 ha (126,000 acres), of which just 18 percent is native (LCR MSCP 2004a).

The taxonomic status of the western cuckoo remains unclear; whereas some researchers support a distinct western subspecies *occidentalis* based on morphological and other differences (Ridgeway 1887; Franzreb and Laymon 1993; Pruett et al. 2001), others have found no basis for separation of eastern and western cuckoos (Banks 1988; 1990, Fleischer 2001; Farrell 2006). In 2001, the U.S. Fish and Wildlife Service (USFWS) determined that western yellow-billed cuckoos represent a distinct population segment, which became a candidate for listing for protection under the Endangered Species Act (ESA) (USFWS 2001). In 2002, the listing was determined to be warranted, but precluded by higher priority listing actions (due to limited resources) (USFWS 2002). Yellow-billed cuckoos are listed as endangered in California (California Department of Fish and Game 1978), a species of special concern in Arizona (Arizona Game and Fish Department 1988), and a sensitive species on U.S. Forest Service lands within Arizona and New Mexico (U.S. Department of Agriculture 1988).

Yellow-billed cuckoos are among the latest-arriving neotropical migrants, beginning to arrive in Arizona and California in late May (Bent 1940). Their diet during the breeding season consists primarily of large insects, such as grasshoppers, katydids, caterpillars, mantids, and cicadas, and also tree frogs and small lizards (Bent 1940; Hamilton and Hamilton 1965; Nolan and Thompson 1975; Laymon 1980; Laymon et al. 1997; Hughes 1999). Nesting usually occurs between late June and late July, but can begin as early as late May and continue until late September (Hughes 1999). In the LCR region, the nesting period tends to be late June to early August and peaks in mid- to late July (McNeil et al. 2012). The main nest tree species in this region are Goodding's willow (*S. gooddingii*), Fremont cottonwood (*P. fremontii*), and tamarisk, though other trees or large shrubs such as mesquite and seep willow (*Baccharis salicifolia*) may be used (McNeil et al. 2012). Nests consist of a loose platform of twigs, which are built by both sexes and take 1 to 2 days to build, though occasionally the nest of another species is used (Jay 1911; Bent 1940; Payne 2005; McNeil et al. 2011). Clutch size is 1–5 (Payne 2005), usually 2–3 (Laymon 1998), though 8 eggs have been found in one nest due to more than one female laying in the nest (Bent 1940). Eggs are generally laid daily until clutch completion (Jay 1911), and incubation begins once the first egg is laid, lasting 9–11 days (Potter 1980, 1981; Hughes 1999). Young hatch asynchronously and are fed mostly large insects (Laymon and Halterman 1985; Laymon et al. 1997; Halterman 2009). After fledging at 5 to 9 days, young may be dependent on adults for at least 3 (Laymon and Halterman 1985) to 3-1/2 weeks (McNeil et al. 2012).

Fall migration is thought to begin in late August, with most birds gone by mid-September (Hughes 1999); however, on the LCR, some individuals appear to begin migrating in early August (McNeil et al. 2011, 2012). Their non-breeding range is believed to be the western side of the Andes (Hughes 1999), though little information exists on migration routes and non-breeding range in South America where they can be confused with the endemic pearly-breasted cuckoo (*C. euleri*), their closest relative (Payne 2005).

Lower Colorado River Multi-Species Conservation Program

The LCR MSCP is a coordinated, comprehensive, long-term, multi-agency effort, with goals including conserving habitat, working toward the recovery of threatened and endangered species, and reducing the likelihood of additional species being listed (LCR MSCP 2004b). The LCR MSCP covers areas within the historical flood plain of the Colorado River from Lake Mead to the United States-Mexico Southerly International Boundary, a distance of about 400 river miles (LCR MSCP 2004b). Developed between 1996 and early 2005, the LCR MSCP includes the creation of more than 3,278 ha (8,100 acres) of riparian, marsh, and backwater habitat for six federally (or ESA) listed species;

20 other covered species; and 5 evaluation species native to the lower Colorado River, including at least 1,639 ha (4,050 acres) of habitat for the riparian obligate yellow-billed cuckoo (LCR MSCP 2004b).

Objectives

The objectives of this project are as follows:

1. Conduct comprehensive, repeatable yellow-billed cuckoo surveys in all potentially suitable habitat types within the LCR MSCP project boundary, including habitat creation sites.

2. Determine breeding habitat selection and preferences in the study area. This includes identifying the characteristics of habitats used during the breeding season and comparing characteristics between occupied and unoccupied sites to identify factors that may influence habitat selection by cuckoos.

3. Evaluate the effectiveness of the current breeding season survey methodology (Halterman et al. 2008) and refine it to use over the term of the LCR MSCP.

Surveys conducted to meet objective 1 are discussed in chapter 1. Objective 2, breeding habitat selection and preferences, are discussed in chapters 2–5 and in the 5-year summary report (McNeil et al. 2013, in review). Objective 3 is addressed in the summary report.

Chapter 1 – Presence-Absence Surveys, Detection Probability, and Habitat Occupancy

INTRODUCTION

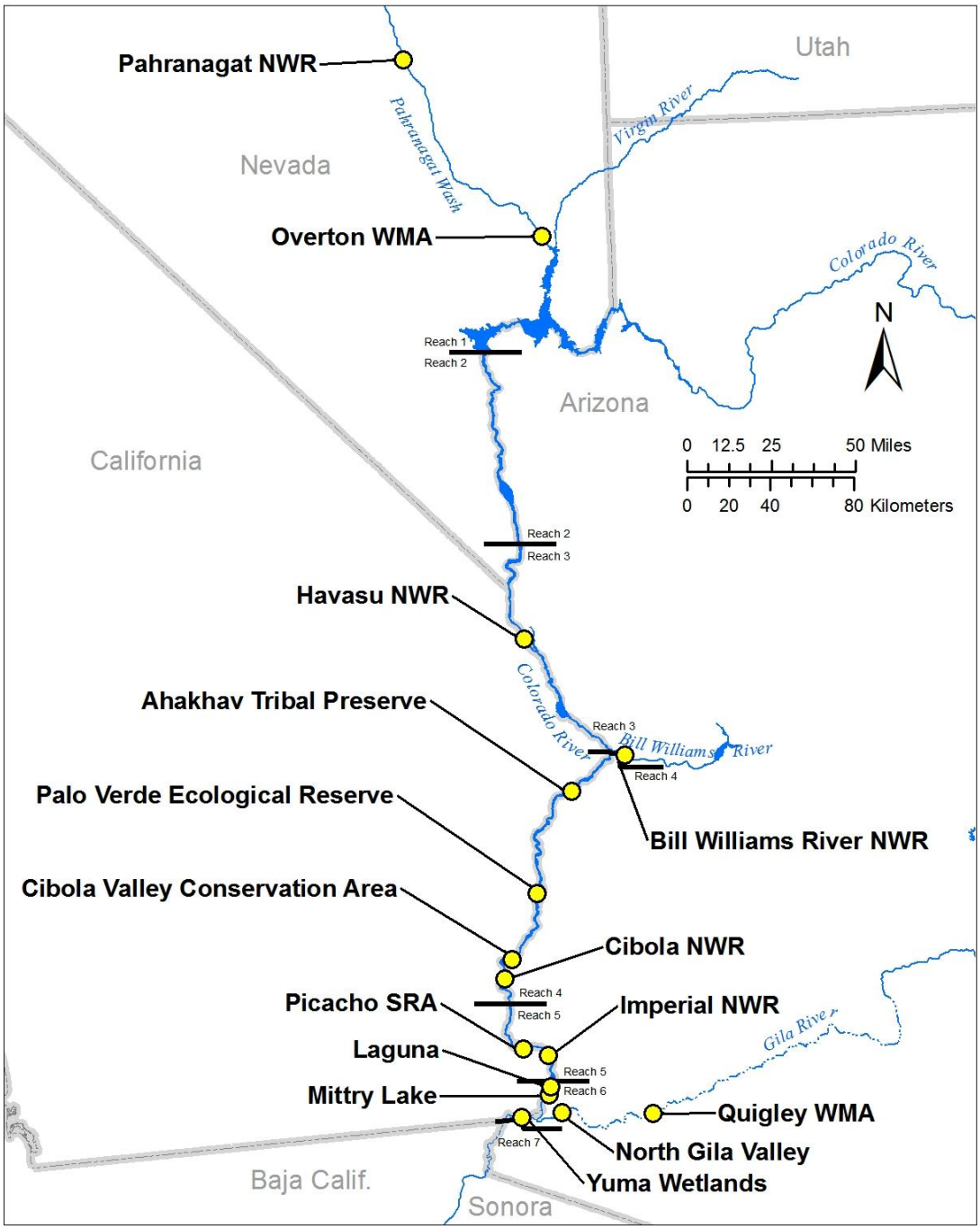
Long-term monitoring programs focus on the status and trends of species distribution and can effectively document a species' annual state and changes in their condition through time (LaRoe et al. 1995). Through repeated surveys, the annual status of populations can be assessed by examining within-season distribution, occupancy, and abundance patterns, both spatial and temporal, across the landscape. The analysis of multi-year datasets can reveal emergent trends in a number of population parameters, including fluctuations and response to environmental changes such as habitat restoration or creation.

As per study objective 1, in 2012, we continued comprehensive surveys of yellow-billed cuckoos (cuckoo, YBCU) in potentially suitable habitat types within the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) boundary to provide an annual status assessment of the species and to identify trends in population parameters, in particular the response of cuckoos to LCR MSCP habitat restoration. Through repeated surveys, we estimated cuckoo detection probability and habitat use in the study area. The analyses are stratified by restoration status (natural, LCR MSCP restoration, and non-LCR MSCP restoration) to maximize our power to detect responses to habitat restoration efforts by the LCR MSCP and to compare these responses with cuckoo changes at natural and non-LCR MSCP restoration habitat (de facto control sites). While surveys designed to monitor a species can uncover patterns of distribution and habitat use, the mechanisms behind these patterns are often better discerned through supplemental research (i.e., nest observations, radio telemetry, and habitat analyses), which is described in chapters 3–5.

METHODS

Study Area and Survey Site Selection

We conducted yellow-billed cuckoo surveys along approximately 400 river miles of the lower Colorado River (LCR) and tributaries from the Pahranagat National Wildlife Refuge to the United States-Mexico Southerly International Boundary (the study area, map 1-1). Along this river stretch, all potentially suitable habitat patches were considered for inclusion. Potentially suitable habitat consisted of early to mature native or mixed native/exotic riparian forest, with woody riparian land cover structural types I–III, at least 4–5 meters (m) in height (Anderson and Ohmart 1984). A habitat patch was defined as an area of potentially suitable habitat 2 hectares (ha) (4.9 acres) or greater in extent that was separated from



Map 1-1.—LCR yellow-billed cuckoo study area, including river reach boundaries, 2012; survey areas shown by yellow circles.
(Sites listed in tables 1-1 and 1-2 are clustered in these survey areas.)

another patch of potentially suitable habitat by at least 300 m. A survey site was defined as part of a patch, an entire patch, or a collection of patches of potentially suitable habitat treated as one site. We assessed sites both by aerial (2008–2010) and ground (2008–2012) reconnaissance. Sites were selected based on past cuckoo

detections (Johnson et al. 2007, 2008; Halterman et al. 2009; McNeil et al. 2010, 2011, 2012), patch size, plant species composition, and habitat structure. Survey sites consisted of habitat patches at least 2 ha in size, though ideal habitat patches that can support more than one breeding territory are thought to be greater than 40 ha (Laymon and Halterman 1989). Sites were delineated by walking the boundaries with a Global Positioning System (GPS) unit. Where site boundaries were inaccessible, such as areas of Bill Williams River National Wildlife Refuge (BWRNWR), boundaries were estimated in ArcGIS 9.3 using georeferenced 2004 or 2010 aerial imagery. Each site's size (in ha) was estimated in ArcGIS.

We surveyed 49 sites in 2012 (see map 1-1 and tables 1-1 and 1-2, and attachment A): 14 actively managed LCR MSCP restoration sites, 12 non-LCR MSCP restoration sites, and 23 sites classified as natural (non-restoration native or mixed native/exotic riparian habitat). All sites surveyed in 2011 were resurveyed in 2012 except one Havasu NWR site (Glory Hole–dropped due to poor suitability), one BWRNWR site (Cottonwood Patch–on private land [Planet Ranch] where we were not granted access by the new landowner), five in the Laguna area (the site of a new LCR MSCP Laguna restoration project currently under development), and two Cibola Island survey sites that we were not permitted access to after a 2011 fire (Perri Marsh and Cibola South). The BWR Cave Wash site was reduced in size to cover only U.S. Fish and Wildlife Service (USFWS) land (previously half on private Planet Ranch land). One new site was added at Palo Verde Ecological Reserve (PVER) (Phase 5) due to new habitat suitability. Four sites last surveyed in 2010 were resurveyed in 2012 (Overton Wildlife, Wilson Pond, Laguna 2, and Laguna 3). Four sites last surveyed in 2009 were resurveyed in 2012 (Pahranagat North and South, North Gila Valley "A" and "B"). The access road to North Gila Valley "B" was blocked by an adjacent landowner after the first survey, and it was not surveyed again. Additional survey transects were added to two existing Cibola NWR sites (Crane Roost and Mass Planting) due to increased habitat suitability. Site descriptions, including maps, are presented in attachment A.

Presence-Absence Surveys

The primary survey objective was to assess yellow-billed cuckoo habitat use within the study area. Cuckoos are inherently secretive, avoid detection, and call infrequently (Hamilton and Hamilton 1965). Their furtive nature coupled with their somewhat transitory behavior may lead to imperfect detection of the species (McNeil et al. 2010, 2011). Also, the use of call broadcasts can attract cuckoos from neighboring habitat into the surveyed habitat. Given these behaviors, surveys are not designed to determine the absolute number of cuckoos within an area, to solely identify breeding status, or be used to assess small-scale habitat preferences.

Table 1-1.—Northern (Reaches 1–3) yellow-billed cuckoo survey sites, 2012 (Survey areas are shown on map 1-1.)

Survey area	Site name	Site code	Size (ha)	Site type	River reach
Pahranagat NWR	Pahranagat North	PAHNTH	18.6	Natural	1
	Pahranagat South	PAHSTH	9.0	Natural	1
Overton Wildlife Management Area	Overton Wildlife	OVRW	10.1	Natural	1
	Overton Wilson Pond	OVRWP	22.8	Natural	1
Havasu NWR	Beal Restoration	HAVBR	21.3	LCR MSCP restoration	3
	North Dike	HAVND	5.1	Non-LCR MSCP restoration	3
	Pintail Slough	HAVPS	11.7	Non-LCR MSCP restoration	3
	Topock Platform	HAVTPR	9.3	Non-LCR MSCP restoration	3
BWRNWR	Bill Williams Marsh	BWMA	19.7	Natural	3
	Borrow Pit	BWBP	33.6	Natural	3
	Cave Wash	BWCW	36.4	Natural	3
	Cougar Point	BWPT	43.1	Natural	3
	Cross River	BWCR	30.2	Natural	3
	Esquerra Ranch	BWER	40.2	Natural	3
	Fox Wash	BWFW	62.5	Natural	3
	Gibraltar Rock	BWGR	66.5	Natural	3
	Honeycomb Bend	BWHB	29.6	Natural	3
	Kohen Ranch	BWKR	37.1	Natural	3
	Middle Delta	BWMD	25.2	Natural	3
	Mineral Wash	BWMW	49.8	Natural	3
	Mosquito Flats	BWMF	37.1	Natural	3
	North Burn	BWNB	30.0	Natural	3
	Sandy Wash	BWSW	50.9	Natural	3

The use of multiple call broadcast surveys during the breeding season is the standard method used to increase the probability of detecting cuckoos and determine habitat occupancy (Johnson et al. 1981; Gaines and Laymon 1984; Halterman et al. 2008). Five surveys were conducted at most sites, once per survey period (table 1-3). A sixth survey was conducted at PVER (August 16 to 31, 2012) to assess cuckoo use at those sites prior to the start of the dove hunting season. Presence-absence surveys were conducted at survey sites along point transects on foot or by kayak between sunrise and 10:30 a.m. or until temperatures reached 40 degrees Celsius (°C) (104 degrees Fahrenheit [°F]). Whenever possible, adjacent sites were surveyed on the same day to minimize the possibility of double counting the same cuckoo at adjacent sites. On these occasions, surveyors used radios to communicate with each other. Each site contained one or more transects with parallel transects spaced approximately 200 to 250 m apart. Survey points were spaced every 100 m along transects, and most transects traversed through the habitat patches. However, some transects ran along riparian habitat edges or adjacent roads to exploit greater visual detectability from these locations or because the interior of the habitat was inaccessible. Survey points were located using Garmin GPS units (±6 m horizontal accuracy), and at each point we recorded the location, time, habitat type, habitat structure, and live cicada activity (see chapter 3).

Table 1-2.—Southern (Reaches 4–6) yellow-billed cuckoo survey sites, 2012
(Survey areas are shown on map 1-1.)

Survey area	Site name	Site code	Size (ha)	Site type	River reach
Colorado River Indian Reservation	‘Ahakhav Tribal Preserve	CRIT	59.6	LCR MSCP restoration	4
PVER	Palo Verde Phase 1	PVER1	8.3	LCR MSCP restoration	4
	Palo Verde Phase 2	PVER2	24.2	LCR MSCP restoration	4
	Palo Verde Phase 3	PVER3	19.8	LCR MSCP restoration	4
	Palo Verde Phase 4	PVER4	35.8	LCR MSCP restoration	4
	Palo Verde Phase 5[1]	PVER5	51.8	LCR MSCP restoration	4
Cibola Valley Conservation Area	Cibola Valley Phase 1	CVCA1	34.8	LCR MSCP restoration	4
	Cibola Valley Phase 2	CVCA2	24.7	LCR MSCP restoration	4
	Cibola Valley Phase 3	CVCA3	37.0	LCR MSCP restoration	4
Cibola NWR	Cibola Crane Roost[2]	CIBCR	48.0	LCR MSCP restoration	4
	Cibola Eucalyptus	CIBEUC	29.4	Non-LCR MSCP restoration	4
	Cibola Mass Planting[2]	CIBMP	23.7	LCR MSCP restoration	4
	Cibola Nature Trail	CIBCNT	14.4	LCR MSCP restoration	4
	Cibola North	CIBNTH	7.2	LCR MSCP restoration	4
Imperial NWR	Imperial NWR 20A	IMP20A	2.0	Non-LCR MSCP restoration	5
	Imperial NWR 50	IMP50	4.2	Non-LCR MSCP restoration	5
	Imperial NWR South	IMPSTH	13.0	Non-LCR MSCP restoration	5
Picacho State Recreation Area (Picacho SRA)	Picacho SRA	Picacho SRA	14.8	Non-LCR MSCP restoration	5
Laguna	Laguna 2	LAG2	3.9	Natural	6
	Laguna 3	LAG3	3.8	Natural	6
Mittry Lake	Mittry Lake-Pratt	MLPR	13.0	Non-LCR MSCP restoration	6
Gila River	North Gila Valley “A”	GRNVA	3.6	Natural	6
	North Gila Valley “B”	GRNVB	4.7	Natural	6
	Quigley Wildlife Management Area	GRQP	10.6	Non-LCR MSCP restoration	6
Yuma Wetlands	Yuma East Wetlands	YUEW	9.0	LCR MSCP restoration	6
	Yuma West Wetlands	YUWW	25.5	Non-LCR MSCP restoration	6

[1] New site.
[2] Previous site with new transects added in 2012.

Table 1-3.—LCR YBCU survey period dates, 2012

Survey period	Dates
1	June 15 to June 30
2	July 1 to July 10
3	July 11 to July 20
4	July 21 to July 31
5	August 1 to August 15

Upon arriving at a survey point, surveyors listened and watched for cuckoos for 1 minute. If none were detected, surveyors used an MP3 player and hand-held speaker to broadcast a 5-second yellow-billed cuckoo contact call (the "kowlp" call) (Hughes 1999) at approximately 70 decibels, once per minute for 5 minutes. A 5-second call was followed by 55 seconds of active observation and listening. If a cuckoo was detected, call playbacks were discontinued immediately, and all pertinent data were recorded (see below). Following a detection, surveyors progressed along the point transect 300 m from the estimated location of the detected cuckoo in order to avoid additional disturbance and duplicate detections of the same bird.

For each detection, the surveyor recorded the true bearing and estimated distance from the surveyor to the cuckoo, time of detection, number of call broadcasts played, response type, behavior, vocalizations, vegetation type, presence of other cuckoos, interactions, and the presence and/or color combination of leg bands. Any observed breeding evidence was recorded, including carrying food or nesting material, copulation, the presence of a juvenile, or a nest. An individual cuckoo visually observed or heard during a survey of the point transect, including any detected while traveling between survey points, was recorded as a survey detection. If the same individual cuckoo was detected more than once during a single survey, only the initial detection was used in calculating the survey detection total and in habitat use analysis. Cuckoos detected > 300 m apart during a single survey were counted as separate individuals and, therefore, separate survey detections. Repeated detections of a cuckoo and cuckoos encountered before or after a survey were classified as non-survey or incidental detections. Information collected for incidental detections was the same as that collected for survey detections. Additionally, we recorded all avian species encountered during the surveys (attachment D). The terms related to the surveys are summarized in table 1-4.

Survey Detection Probability and Habitat Use

During surveys, it is possible that a cuckoo is present, but remains undetected. As a result, an area may be incorrectly classified as unused, which can result in underestimating true habitat use (MacKenzie et al. 2006). To account for this situation, we conducted habitat use analyses incorporating cuckoo detection probabilities. We used the program PRESENCE v5.3 (Hines 2006) to calculate detection probabilities and habitat use estimates (for surveyed areas) at natural, LCR MSCP restoration, and non-LCR MSCP restoration habitat. PRESENCE uses the detection/non-detection history of repeated presence-absence surveys to calculate detection probability and habitat use estimates (MacKenzie et al. 2006). No additional data were incorporated into these analyses.

Table 1-4.—Summary of definitions for study area, river reach, survey area, survey site, and survey point

Term	Definition
Study area	All potentially suitable cuckoo habitat along a 400-river-mile stretch of the LCR and tributaries from Pahranagat NWR to the United States-Mexico Southerly International Boundary (see map 1-1).
River reach (reach)	A discrete watershed segment used by the LCR MSCP for the analysis of impacts and conservation measures (LCR MSCP 2004a). Reach boundaries are shown on maps 1-1, 1-2, and 2-1. Sites are grouped by reach in tables 1-6, 1-7, 1-8, 1-9, and 1-10.
Survey area	A collection of clustered survey sites (tables 1-1 and 1-2).
Survey site (site)	A location consisting of an entire patch, a part of a patch, or a collection of patches of potentially suitable habitat (tables 1-1 and 1-2) surveyed in one morning. To adequately survey a site, one or more survey transects traversed each site.
Survey point	Spatially explicit points spaced 100 m apart along transects within a survey site where cuckoo call broadcasts (up to five broadcasts per point) were conducted.

To estimate detection probability and habitat use across a study area, the area is subdivided into defined areas, or sample units; detection probability and use estimates are derived from (and therefore describe) the presence, absence, and detectability of a species within these sample units (Williams et al. 2002; MacKenzie et al. 2006). Sample units should be similar in size and sized to be both meaningful to the management of, and biologically relevant to, the species of interest (MacKenzie et al. 2006; Bart 2011). In the past (Johnson et al. 2007, 2008; Halterman et al. 2009; McNeil et al. 2010), the sample units used in estimating detection probability and habitat use for this project were defined as the site boundaries; they were both arbitrary (such as at the BWRNWR) and discrete in delineation (most other sites), with considerable size variation (ranging from discrete 2-ha patches to the extensive riparian forest of the BWRNWR [~750 ha divided into arbitrary sites ~20–65 ha each]). A standardized sample unit size provides increased accuracy and decreased bias in habitat use and detection probability estimates, and by controlling for the effects of sample unit size, the estimates are more comparable across the entire study area (Williams et al. 2002). The terms related to habitat use analysis are summarized in table 1-5.

For the 2012 habitat use and detection probability analyses, we used the sample units generated for the 2011 habitat use analysis, which are based on the average size of cuckoo territory instead of site boundaries. From previous telemetry observations at LCR restoration sites, we estimated the average territory size to be between 19.8 and 21.7 ha (range 8.0–48.9 ha) (McNeil et al. 2010, 2011, 2012). Given the variation in the size of surveyed habitat patches, we included sample units with a range of sizes (as done in the past, using site boundaries as sample units). At smaller sites less than 30 ha in size, too small to break into smaller

Table 1-5.—Summary of definitions for habitat use estimation terms

Term	Definition
Habitat use	Cuckoo use of an area based on one or more survey detections. The habitat deemed "used" may have held cuckoos for a day or for the duration of the breeding season. Habitat use estimates are used in chapter 1.
Habitat occupancy	Occupancy is based on two or more total detections in an area during two or more survey periods. Multiple detections of cuckoos in an area suggest that these areas were inhabited for an extended period of time and may have been used as breeding habitat. Habitat occupancy estimates are used in chapters 2 and 5.
Sample unit	The territory-sized spatial unit used solely for statistical analysis to estimate detection probability and habitat use (prior to 2011, site boundaries were used as the sample units for detection probability and habitat use estimation).
Used sample unit	A sample unit with survey detections during one or more survey periods.
Unused sample unit	A sample unit with no survey detections during all survey periods.

sample units, we used the natural boundaries of the site to define the sample unit. At sites containing contiguous habitat patches of at least 30 ha (e.g., BWRNWR), we tessellated the habitat into a continuous grid of 1-ha hexagons in ArcGIS. We then combined adjacent hexagons into 20-ha sample units and, where possible, used knowledge of the habitat to position sample unit boundaries relative to natural habitat boundaries (Bart 2011). The combination of using site boundaries for sites less than 30 ha and hexagon-based 20-ha sample units for larger sites resulted in an average sample unit size of 17.84 ha (SD ± 5.11 ha, n = 74). The territory-based sample units were used solely for the calculation of detection and habitat use probabilities.

On the LCR, cuckoos reside in an open population; individual cuckoos have been observed leaving sites throughout the breeding season (chapter 4) and prior to the completion of the last round of surveys. In contrast, in a closed population, individuals do not leave the study area until all surveys have been completed. Due to the transiency of some cuckoos (those that move in and out of the study area and those exhibiting large pre-breeding movements [chapter 4]), the detection of a cuckoo in an area only once is an unreliable indicator that the area was used for more than a few days let alone being occupied for breeding. In an open population, these areas can be considered "used" rather than "occupied," as cuckoos may have spent only a short time within the habitat during a migratory stopover point or during a brief foraging foray from an adjacent territory (MacKenzie et al. 2006). For our presence-absence analyses, we took this more conservative approach, and using the complete 2012 survey dataset, we calculated

habitat use estimates (rather than habitat occupancy estimates) based on the proportion of sample units with at least one survey detection in one or more survey periods. However, detections spread across multiple survey periods are more likely indicators of breeding occupancy. As done previously (McNeil et al. 2010, 2011, 2012), in chapter 2 we assessed breeding habitat occupancy based on two or more total detections during two or more survey periods.

RESULTS

Presence-Absence Surveys

From June 15 to August 15, 2012, we conducted 232 presence-absence surveys across 5 survey periods at 49 sites, yielding 279 survey detections (tables 1-6 to 1-12, map 1-2). One-third of all survey detections were made at the BWRNWR (n = 92). Among LCR MSCP restoration areas, PVER (n = 81) had the greatest number of detections.

Table 1-6.—LCR YBCU survey detections for Reach 1 (Pahranagat NWR and Overton Wildlife Management Area) sites, 2012

Site name	Site code	Detections per survey period					Total survey detections
		1	2	3	4	5	
Pahranagat NWR North	PAHNTH	1 (6/26)	1 (7/10)	0 (7/20)	0 (7/31)	–	2
Pahranagat NWR South	PAHSTH	1 (6/26)	0 (7/10)	0 (7/20)	0 (7/31)	–	1
Overton Wildlife Management Area	OVRW	1 (6/25)	0 (7/9)	1 (7/19)	0 (7/30)	–	2
Overton Wilson Pond	OVRWP	0 (6/25)	1 (7/9)	1 (7/19)	0 (7/30)	–	2
Total		3	2	2	0	–	7

Table 1-7.—LCR YBCU survey detections for Reach 3 (Havasu NWR) sites, 2012

Site name	Site code	Detections per survey period					Total survey detections
		1	2	3	4	5	
Pintail Slough	HAVPS	0 (6/21)	0 (7/9)	0 (7/19)	0 (7/29)	–	0
North Dike	HAVND	0 (6/21)	0 (7/9)	0 (7/19)	0 (7/29)	–	0
Topock Platform	HAVTPR	1 (6/24)	2 (7/5)	0 (7/16)	0 (7/26)	0 (8/6)	3
Beal Restoration	HAVBR	1 (6/24)	2 (7/5)	0 (7/16)	2 (7/26)	0 (8/6)	5
Total		2	4	0	2	0	8

Table 1-8.—LCR YBCU survey detections for Reach 3 (BWRNWR) sites, 2012

Site name	Site code	Cuckoos detected per survey period					Total survey detections
		1	2	3	4	5	
Bill Williams Marsh	BWMA	1 (6/23)	0 (7/4)	0 (7/15)	0 (7/25)	2 (8/5)	3
Borrow Pit	BWBP	0 (6/17)	2 (7/1)	1 (7/11)	0 (7/22)	0 (8/1)	3
Cave Wash	BWCW	0 (6/25)	1 (7/5)	1 (7/16)	2 (7/26)	3 (8/12)	7
Cougar Point	BWPT	1 (6/20)	5 (7/3)	4 (7/15)	0 (7/25)	0 (8/5)	10
Cross River	BWCR	0 (6/19)	1 (7/2)	0 (7/14)	1 (7/24)	2 (8/2)	4
Esquerra Ranch	BWER	2 (6/24)	1 (7/4)	0 (7/15)	0 (7/25)	0 (8/9)	3
Fox Wash	BWFW	0 (6/20)	1 (7/2)	1 (7/13)	0 (7/24)	1 (8/2)	3
Gibraltar Rock	BWGR	0 (6/19)	1 (7/2)	4 (7/12)	0 (7/24)	0 (8/5)	5
Honeycomb Bend	BWHB	6 (6/25)	2 (7/5)	5 (7/16)	2 (7/26)	1 (8/9)	16
Kohen Ranch	BWKR	1 (6/19)	1 (7/2)	4 (7/12)	0 (7/24)	0 (8/5)	6
Middle Delta	BWMD	0 (6/20)	0 (7/8)	0 (7/17)	0 (7/27)	–	0
Mineral Wash	BWMW	2 (6/24)	3 (7/4)	1 (7/15)	1 (7/25)	2 (8/9)	9
Mosquito Flats	BWMF	1 (6/18)	0 (7/1)	2 (7/11)	0 (7/22)	1 (8/1)	4
North Burn	BWNB	1 (6/23)	2 (7/4)	0 (7/15)	0 (7/25)	3 (8/5)	6
Sandy Wash	BWSW	0 (6/19)	6 (7/2)	3 (7/12)	2 (7/24)	2 (8/5)	13
Total		15	26	26	8	17	92

Table 1-9.—LCR YBCU survey detections for Reach 4 (Parker to Cibola) sites, 2012

Site name	Site code	Cuckoos detected per survey period						Total survey detections
		1	2	3	4	5	6	
‘Ahakhav Tribal Preserve	CRIT	0 (6/18)	3 (7/1)	2 (7/11)	5 (7/21)	2 (8/2)		12
Cibola Crane Roost	CIBCR	2 (6/24)	3 (7/8)	3 (7/18)	6 (7/30)	5 (8/11)		19
Cibola Eucalyptus	CIBEUC	1 (6/28)	0 (7/10)	0 (7/20)	0 (7/31)	–		1
Cibola Mass Planting	CIBMP	0 (6/25)	2 (7/8)	0 (7/18)	0 (7/30)	0 (8/14)		2
Cibola Nature Trail	CIBCNT	0 (6/25)	2 (7/8)	1 (7/18)	2 (7/30)	2 (8/14)		3
Cibola North	CIBNTH	0 (6/25)	0 (7/8)	0 (7/18)	0 (7/30)	–		0
Cibola Valley Phase 1	CVCA1	2 (6/23)	4 (7/6)	4 (7/17)	2 (7/27)	0 (8/8)		12
Cibola Valley Phase 2	CVCA2	2 (6/23)	6 (7/6)	2 (7/17)	1 (7/27)	0 (8/8)		11
Cibola Valley Phase 3	CVCA3	1 (6/22)	0 (7/5)	0 (7/16)	0 (7/28)	0 (8/10)		1
Palo Verde Phase 1	PVER1	0 (6/18)	0 (7/8)	1 (7/14)	1 (7/24)	1 (8/5)	2 (8/21)	3*
Palo Verde Phase 2	PVER2	0 (6/17)	2 (7/1)	2 (7/13)	2 (7/23)	3 (8/4)	2 (8/20)	9*
Palo Verde Phase 3	PVER3	1 (6/18)	2 (7/1)	2 (7/13)	4 (7/23)	3 (8/4)	0 (8/24)	12*
Palo Verde Phase 4	PVER4	2 (6/18)	5 (7/2)	8 (7/14)	3 (7/24)	5 (8/5)	2 (8/21)	23*
Palo Verde Phase 5	PVER5	2 (6/22)	7 (7/3)	6 (7/15)	10 (7/25)	9 (8/6)	3 (8/22)	34*
Total		13	36	31	34	28	9	142*

* Survey detection totals are for survey periods 1–5.

Table 1-10.—LCR YBCU survey detections for Reaches 5–6 (Imperial to Yuma) sites, 2012

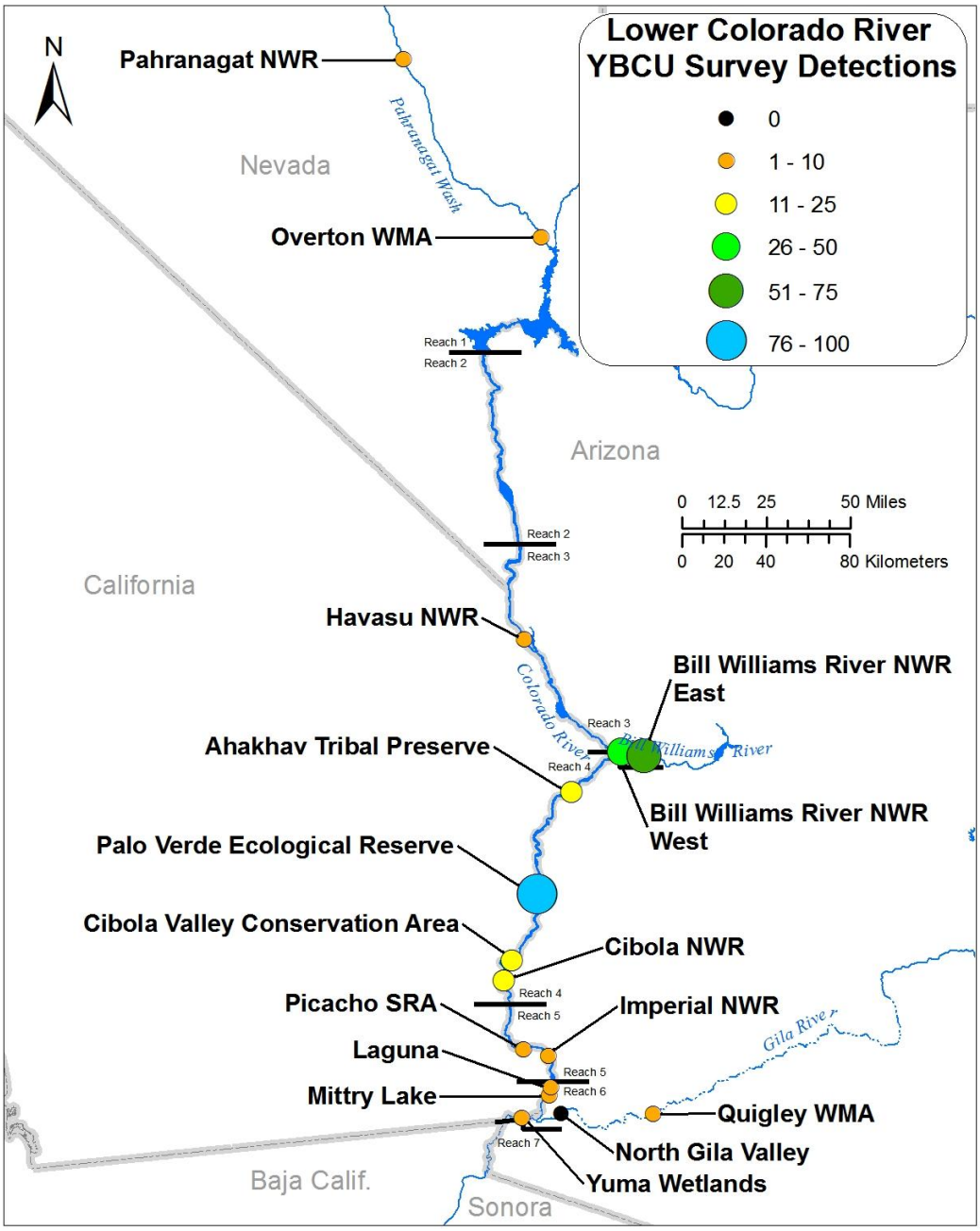
Site name	Site code	Detections per survey period					Total survey detections
		1	2	3	4	5	
Imperial NWR 20A	IMP20A	1 (6/20)	1 (7/2)	0 (7/16)	0 (7/24)	0 (8/6)	2
Imperial NWR 50	IMP50	1 (6/20)	0 (7/2)	0 (7/16)	0 (7/24)	0 (8/6)	1
Imperial NWR South	IMPSTH	0 (6/20)	3 (7/2)	2 (7/16)	1 (7/24)	0 (8/6)	6
Laguna 2	LAG2	0 (6/24)	0 (7/4)	0 (7/14)	0 (7/28)	0 (8/7)	0
Laguna 3	LAG3	2 (6/24)	0 (7/4)	0 (7/14)	1 (7/28)	0 (8/7)	3
Mittry Lake-Pratt	MLPR	1 (6/25)	3 (7/7)	2 (7/17)	1 (7/29)	0 (8/8)	7
North Gila Valley “A”	GRNVA	0 (6/25)	0 (7/7)	0 (7/17)	0 (7/29)	–	0
North Gila Valley “B”	GRNVB	0 (6/25)	–	–	–	–	0
Picacho State Recreation Area (Picacho SRA)	Picacho SRA	2 (6/26)	3 (7/8)	2 (7/20)	0 (8/1)	0 (8/9)	7
Quigley Wildlife Management Area	GRQP	0 (6/19)	0 (7/1)	1 (7/11)	0 (7/23)	0 (8/3)	1
Yuma East Wetlands	YUEW	1 (6/27)	1 (7/9)	0 (7/21)	0 (7/30)	0 (8/11)	2
Yuma West Wetlands	YUWW	1 (6/23)	0 (7/3)	0 (7/15)	0 (7/25)	0 (8/4)	1
Total		9	11	7	3	0	30

Table 1-11.—LCR YBCU survey detections by river reach for all sites, 2012 (summary of tables 1-6 to 1-10)

River reach	Cuckoos detected per survey period					Total survey detections
	1	2	3	4	5	
Reach 1 (Pahranagat NWR, Overton Wildlife Management Area)	3	2	2	0	–	7
Reach 3 (Havasu NWR)	2	4	0	2	0	8
Reach 3 (BWRNWR)	15	26	26	8	17	92
Reach 4 (Parker to Cibola)	13	36	32	34	28	142
Reaches 5–6 (Imperial to Yuma)	9	11	7	3	0	30
All sites	42	79	67	47	45	279

Table 1-12.—LCR YBCU survey detections by site type for all sites, 2012 (summary of tables 1-6 to 1-10)

River reach	Detections per survey period					Total survey detections
	1	2	3	4	5	
Natural sites	20	28	28	9	17	102
LCR MSCP restoration sites	13	41	32	37	29	146
Non-LCR MSCP restoration sites	9	13	7	2	0	31
All sites	42	86	68	48	45	279



Map 1-2.—Yellow-billed cuckoo survey detections by survey area, all survey periods, LCR 2012.

Survey Detection Probability and Habitat Use

The frequency of detecting cuckoos (the average number of survey periods in which cuckoos were found within a sample unit) was greatest at LCR MSCP restoration habitat (3.4 survey periods, SD = 1.5, n = 21 sample units) followed by natural habitat (1.6 survey periods, SD = 1.2, n = 40 sample units) and

non-LCR MSCP restoration habitat (1.2 survey periods, SD = 1.1, n = 13 sample units). Across all areas, the probability of detecting a cuckoo during a survey was lowest in June and August (49 percent [%] and 43%) and highest in July (63%) (table 1-13 and figure 1-1). However, cuckoo detection probability trends varied significantly among habitat types (table 1-13 and figure 1-1). At LCR MSCP restoration habitat, mean detectability was greater than that found at other habitat types, peaking in early July (90%) and slowly declining thereafter. At natural habitats, detectability trended lower, peaking in mid-July (57%), sharply declining (to 18%) in late July, then rebounding in August (42%). Mean detectability was lowest at non-LCR MSCP restoration habitat, steeply declining from June (68%) to August (zero).

Table 1-13.—Detection probabilities with 95% confidence intervals (CI) by survey period for LCR MSCP restoration (n = 21 sample units), non-LCR MSCP restoration (n = 13 sample units), natural (n = 40 sample units), and all areas (n = 74 sample units), 2012

(Data are also displayed on figure 1-1.)

Survey period	Detection probability estimates							
	LCR MSCP Restoration (CI)		Natural (CI)		Non-LCR MSCP restoration (CI)		All areas (CI)	
1	0.500	(0.294 – 0.706)	0.392	(0.240 – 0.570)	0.681	(0.292 – 0.917)	0.485	(0.362 – 0.610)
2	0.899	(0.674 – 0.975)	0.513	(0.340 – 0.683)	0.389	(0.141 – 0.712)	0.630	(0.500 – 0.744)
3	0.749	(0.521 – 0.892)	0.573	(0.393 – 0.736)	0.292	(0.091 – 0.630)	0.598	(0.469 – 0.715)
4	0.799	(0.571 – 0.923)	0.181	(0.083 – 0.351)	0.097	(0.013 – 0.466)	0.372	(0.260 – 0.499)
5	0.599	(0.380 – 0.785)	0.416	(0.250 – 0.605)	0.000	(0.000 – 1.000)	0.425	(0.302 – 0.557)

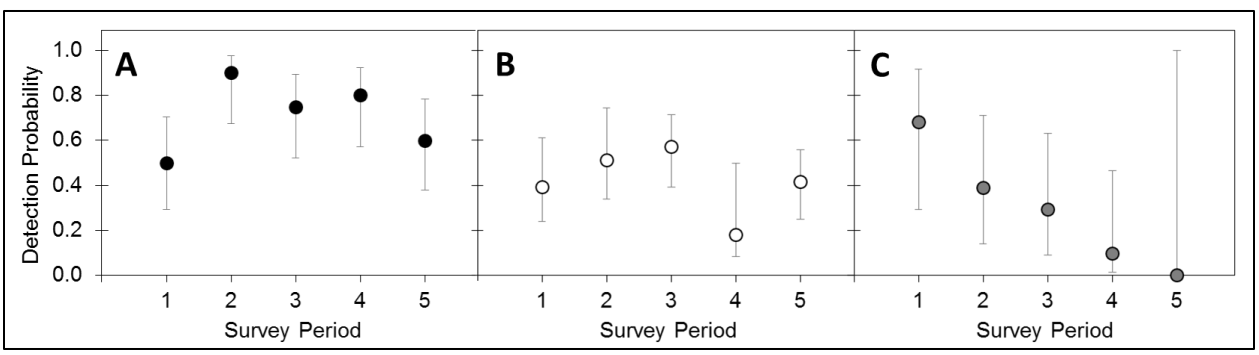


Figure 1-1.—Yellow-billed cuckoo 2012 detection probabilities with 95% confidence intervals for all habitat types.

The probability to detect cuckoos at LCR MSCP restoration habitat (A, black) peaked in survey period 2, remained high through July, and then declined in August. Natural habitat detection probabilities (B, white) peaked in mid-July (survey period 3), declined sharply in late July, and rebounded in early August (survey period 5). Non-LCR MSCP restoration habitat detection probabilities (C, gray) peaked in survey period 1 and then declined steadily to zero by survey period 5.

In examining the raw data, LCR MSCP restoration habitat had the greatest proportion of sample units with at least one detection (20 out of 21), followed by natural habitat sample units (31 out of 40) and non-LCR MSCP restoration sample units (9 out of 13), yielding observed habitat use estimates of 0.952 (LCR MSCP restoration habitat), 0.775 (natural habitat) and 0.692 (non-LCR MSCP restoration habitat, table 1-14). When incorporating detection probability with these raw observations, estimated habitat use increased at all habitat types, and LCR MSCP restoration habitat (use = 0.953, 95% CI = 0.952–0.994) exceeded that of natural habitat (use = 0.828, 95% CI = 0.775–0.931) and non-LCR MSCP restoration habitat (use = 0.791, 95% CI = 0.692–0.966, table 1-14). The lower detection probabilities at natural and non-LCR MSCP restoration habitats resulted in relatively large habitat use estimate increases compared to the observed proportion of used sample units. Nineteen percent of sample units (14 of 74) had no detections during any survey visits. The probability that these sample units may have actually been used by an undetected cuckoo was estimated to be 2.0% (95% CI = 0 – 7.7%, n = 1) at LCR MSCP restoration sample units, 22.6% (95% CI = 0 – 48.4%, n = 9) at natural area sample units, and 32.1% (95% CI = 0 – 99.5%, n = 4) at non-LCR MSCP restoration sample units.

Table 1-14.—2012 LCR yellow-billed cuckoo observed habitat use (the observed proportion of sample units with detections in one or more survey period), and PRESENCE-estimated habitat use with 95% confidence intervals at LCR MSCP restoration, non-LCR MSCP restoration, and natural sites

Habitat type	Observed habitat use	Estimated habitat use	Estimated habitat use 95% (CI)
LCR MSCP restoration	95.2%	95.3%	(95.2% – 99.4%)
Natural	77.5%	82.8%	(77.5% – 93.1%)
Non-LCR MSCP restoration	69.2%	79.1%	(69.2% – 96.6%)

DISCUSSION

As done in 2011, in 2012, we conducted three surveys in July, instead of the standard two, to explore the benefits of an increased number of surveys during peak activity. With cuckoo activity peaking in July, and migration or transient behavior underway in June and August, July surveys are the most efficient in assessing an area for cuckoo habitat use in this region (McNeil et al. 2011, 2012). The additional July survey enables greater insight into temporal trends in habitat use and breeding activity. For example, many researchers have noted declines in cuckoo response to survey broadcast calls during the latter part of their breeding effort (Hughes 1999; Johnson et al. 2004; McNeil et al. 2011). This pattern has

been observed in detection probability trends in other cuckoo research (Henneman 2010; Stanek and Stanek 2012) and appears to be evident in the detection probability trend at natural sites in 2012 (see figure 1-1). As such, this detection probability peak (in survey period 3) and subsequent steep decline (in survey period 4) may be an indirect observation of cuckoo breeding activity. If so, the clarity of the detection probability trend suggests that cuckoos breeding at natural sites are highly synchronized, which has been previously observed with the tight breeding phenology cuckoos exhibit with cicadas in these natural habitats (Rosenberg et al. 1982; McNeil et al. 2011). Had only two July surveys been conducted, this trend may have been muted or undetected.

As previously observed (Whitfield and Stanek 2011; McNeil et al. 2012), the ability to detect cuckoos was not constant throughout the breeding season. In general, the overall detection probability trend was comparable to that observed in the past, with a peak in July and lower detectability in June and August. However, detection probability trends, number of detections during a survey period, and the frequency of detecting cuckoos between survey periods differed greatly between habitat types; they were greatest at LCR MSCP restoration habitat, followed by natural habitat and then non-LCR MSCP restoration habitat. We hypothesize that these detection probability differences were at least partly density dependent as opposed to the existence of inherent variation in vocalizations and behaviors among different habitat types. Our territory estimates support this hypothesis, as we estimated more than twice the number of breeding territories at LCR MSCP restoration habitat (up to 54 territories, chapter 2) compared to natural habitat (up to 22 territories) and more than 10 times that estimated at non-LCR MSCP restoration habitat (up to 4 territories). Similarly, we know that cuckoos can be highly transient (McNeil et al. 2011, 2012), and local immigration or emigration of cuckoos to and from these habitat types likely impacted these detection probability trends.

Relative to the total number of survey detections, habitat use estimates are more easily compared among areas within one season, and from year to year, because they account for imperfect detection and annual variation in the number of detections across survey periods (MacKenzie et al. 2006; Henneman 2009). The proportion of LCR MSCP restoration habitat used by cuckoos (95.3%) exceeded that at natural habitat (82.8%) and non-LCR MSCP restoration habitat (79.1%). The differences among these habitat use estimates and breeding territory occupancy proportions (chapter 2, LCR MSCP restoration 84.6%, natural 60.9%, and non-LCR MSCP restoration 30.8%) suggest that the majority of non-LCR MSCP restoration habitat is used only briefly by cuckoos, whereas the majority of LCR MSCP restoration habitat is occupied by breeding cuckoos. The steeply declining detection probability trend observed at non-LCR MSCP restoration sites corroborates this hypothesis and suggests that most cuckoos detected at these restoration sites used them as a migratory stopover and then moved on.

In conclusion, we saw cuckoo habitat use at LCR MSCP restoration areas exceed that at non-LCR MSCP restoration and natural areas. Many LCR MSCP restoration sites newly used in 2010 and 2011 were again used by cuckoos in 2012. These include Cibola Valley Conservation Area (CVCA) Phase 2 and PVER Phases 3 and 4. Additionally, PVER Phase 5 was found to be used in its first year surveyed (2012). These restoration sites are relatively young, and in just a few years, their vegetation has progressed from short, low canopy cover plantings to habitat supporting a high density of nesting cuckoos (chapters 2 and 3). As observed in 2011, detections at LCR MSCP restoration habitat at PVER continued to rise while those at the natural habitat at the BWRNWR appeared to be in decline. PVER now rivals the BWRNWR in detections even though its habitat is approximately one fifth in size. The LCR MSCP habitat restoration efforts have thus far been successful in attracting high cuckoo densities. However, continued habitat assessment, along with cuckoo monitoring in the years to come, will help clarify the habitat features most strongly correlated to this influx of cuckoos and will also help assess changes in cuckoo habitat use and occupancy as these restoration sites mature. Additional details of occupancy and breeding evidence are described in chapters 2 and 3 as well as attachments A and B.

Chapter 2 – Breeding Territory Estimation

INTRODUCTION

Yellow-billed cuckoos are challenging to observe and, as such, difficult to research. They can have large overlapping home ranges, are furtive by nature, call infrequently, and often engage in behaviors to avoid detection (Hamilton and Hamilton 1965; Laymon et al. 1997; Bennett and Keinath 2003). Additionally, cuckoos are on their breeding grounds for only a short time, and the window to study these birds is relatively brief. Most cuckoos arrive by July and begin their fall dispersal and migration in August (Bent 1940; Hughes 1999; McNeil et al. 2011). Lastly, researchers have observed that many non-breeding cuckoos are transitory and do not stay long at their sites (Dettling and Howell 2011b; McNeil et al. 2011, 2012). To mitigate the difficulties resulting from these behaviors, surveyors use call broadcasts to increase cuckoo detection, which enables researchers to monitor habitat use (chapter 1). However, this survey method alone is inadequate to estimate cuckoo abundance, density, or breeding population size, and an accurate determination of these estimates has thus far remained elusive.

In the past, cuckoo gender and breeding status were estimated using vocal response type, and population estimates were largely derived from call broadcast surveys that were often coupled with nesting observations (Gaines 1974; Laymon et al. 1997; Halterman 2001). However, later research has shown the underlying vocalization assumptions to be questionable (Wilson 2000; Halterman 2009), and the omission of factors such as varying detection probabilities, polyandry, local movements, and within-season emigration or immigration adds uncertainty to historical population estimates (Williams et al. 2002). The estimation of breeding pair or population abundance is complicated by the difficulties in locating nests as well as detecting, capturing, and uniquely identifying cuckoos. The polyandrous behavior of some females and a cuckoo's ability to have multiple broods adds additional complications to estimating pairs and population size on unmarked birds. In light of these difficulties, we have developed alternative methods to estimate cuckoo breeding territory abundance (McNeil et al. 2010, 2011). In contrast to breeding pair or population abundance, these estimates do not require knowledge of the unique identity of each cuckoo nor the parentage of each nest.

METHODS

To estimate breeding territory abundance, we deemed areas as potentially harboring breeding cuckoos if detections occurred in two or more survey periods. We deemed that a single detection is not a reliable indicator of a breeding territory

due to the transience of non-breeding cuckoos; these birds may use an area during one survey period but not the next (Johnson et al. 2007; McNeil et al. 2011, 2012). All detections were assessed by location (using ArcGIS), observed behaviors, and detection dates. These detections were then used to categorize breeding status for each detection area as a *possible* (POS), *probable* (PRB), or *confirmed* (COB) *breeding territory* (table 2-1). Two or more total detections in an area during at least two survey periods and at least 10 days apart warranted a *possible breeding territory*. POS cuckoos observed carrying food, traveling as a pair, or exchanging vocalizations were considered a *probable breeding territory*. Breeding was only *confirmed* when a copulation, stick carry, nest, or fledgling was observed. Estimates of breeding territories utilized all detections, including incidental, survey, telemetry, and followup observations. Incidental observations include repeat detections of a cuckoo during a survey and observations of non-target cuckoos during telemetry sessions. Followup visits included nest searching, mist netting, and other site visits. During the field season, POS and PRB observations were followed up whenever possible to confirm breeding status.

Table 2-1.—Summary of definitions for breeding territory and population estimation terms

Estimation type	Term	Definition
Breeding territory estimation	Possible breeding territory (POS)	Two or more total detections in an area during two survey periods and at least 10 days apart. For example, within a certain area, one detection made during survey period 2 coupled with another detection made 10 days later during survey period 3 warrant a POS territory designation.
	Probable breeding territory (PRB)	POS territory, plus cuckoos observed carrying food, traveling as a pair, or exchanging vocalizations.
	Confirmed breeding territory (COB)	Observation of copulation, stick carry, nest, or fledgling.
Population estimation	Minimum territory estimate	The observed number of confirmed breeding territories (COB).
	Maximum territory estimate	The sum of possible (POS), probable (PRB), and confirmed (COB) breeding territories.

A minimum of two detections at least 10 days apart during two survey periods designates a territory. While not required by our definition, all of our territories tend to arise from survey detections. A territory could alternatively be designated from two followup (non-survey) detections. This latter situation is less likely to occur because survey detections are usually the impetus for directing followup activities (i.e., following a survey detection, we generally search for breeding evidence that same day and/or within a few days of the survey detection).

Therefore, by default, POS territories are designated from two survey detections in an area. Behaviors to upgrade a POS to a PRB territory are sometimes observed during the survey, but may also be made during subsequent followup visits. Confirmation of nesting activity (a COB territory) during surveys is possible, though nests and other breeding signs are more likely to be observed during additional followup searches.

Overall, we find these breeding guidelines useful to estimate the number of breeding territories within the study area. However, on some occasions, extensive follow-up visits on POS and PRB birds yielded no breeding evidence, and therefore, exceptions to these guidelines were sometimes made and documented. Using the POS, PRB, and COB classifications, we calculated minimum and maximum territory estimates (see table 2-1). The minimum number of breeding territories is the number of confirmed breeding territories and is our most conservative estimate. The maximum territory estimate is the sum of POS, PRB, and COB territories and may overestimate the true number of breeding territories. It is important to note that these POS, PRB, and COB observations are used to estimate the number of breeding territories and not the number of breeding pairs. A territory estimate represents the adults associated with a single nest, usually two adult cuckoos. However, nesting females have been observed to leave the nest before young are independent (McNeil et al. 2011); females can be polyandrous and may re-nest with another male after leaving their original nest (Halterman 2009). Following a successful or failed nest, one or both of the parents may choose to re-nest; calling this second nesting attempt an additional pair of cuckoos would be inappropriate.

We also used these territory estimates to determine site occupancy. Due to the transiency observed in cuckoos in the study area (chapter 4), we find that a single detection does not necessarily indicate that cuckoos occupied an area for more than a few days (chapter 1). Two survey detections made 10 or more days apart provide a greater indication that the habitat was occupied during the breeding season; so, we used these territory estimates to categorize sites as occupied or unoccupied. The site occupancy designations derived in this chapter were used in our microclimate analyses (chapter 5).

RESULTS

Site Territory Estimates

Possible, probable, and confirmed territory estimates as well as minimum and maximum territory estimates were derived using 279 survey detections, 2,394 telemetry detections, 2,094 incidental/followup detections, and from locating 28 nests and 2 fledglings (tables 2-2 to 2-8). Based on the timing, location, and persistence of all detected cuckoos, we estimated between 30 and

Table 2-2.—LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates for Reach 1 (Pahranagat NWR to Overton Wildlife Management Area) sites, 2012

Site name	Site code	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Pahranagat NWR North	PAHNTH	2	(4)	2	(3)	0	(0)	0	1	0	0	0	1
Pahranagat NWR South	PAHSTH	1	(4)	1	(1)	0	(0)	0	0	0	0	0	0
Overton Wildlife Management Area	OVRW	2	(4)	6	(2)	0	(0)	0	0	0	0	0	0
Overton Wilson Pond	OVRWP	2	(4)	0	(1)	0	(0)	0	1	0	0	0	1
Total		7	(16)	9	(7)	0	(0)	0	2	0	0	0	2

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-3.—LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates for Reach 3 (Havasu NWR) sites, 2012

Site name	Site code	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Pintail Slough	HAVPS	0	(4)	0	(2)	0	(0)	0	0	0	0	0	0
North Dike	HAVND	0	(4)	0	(1)	0	(0)	0	0	0	0	0	0
Topock Platform	HAVTPR	3	(5)	11	(13)	0	(0)	0	1	0	0	0	1
Beal Restoration	HAVBR	5	(5)	25	(16)	0	(0)	0	1	0	0	0	1
Total		8	(18)	36	(32)	0	(0)	0	2	0	0	0	2

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-4.—LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates for Reach 3 (BWRNWR) sites, 2012

Site name	Site code	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Bill Williams Marsh	BWMA	3	(5)	10	(6)	0	(0)	0	0	0	0	0	0
Borrow Pit	BWBP	3	(5)	7	(8)	0	(0)	0	1	0	0	0	1
Cougar Point	BWPT	10	(5)	159	(19)	178	(17)	0	0	2	0	0	2
Cross River	BWCR	4	(5)	14	(11)	0	(0)	0	1	0	0	0	1
Cave Wash	BWCW	7	(5)	29	(4)	0	(0)	0	1	1	0	0	2
Esquerra Ranch	BWER	3	(5)	2	(3)	0	(0)	0	1	0	0	0	1
Fox Wash	BWFW	3	(5)	0	(5)	0	(0)	0	0	0	0	0	0
Gibraltar Rock	BWGR	5	(5)	17	(8)	0	(0)	0	0	0	0	0	0
Honeycomb Bend	BWHB	16	(5)	73	(16)	64	(9)	1	0	2	1	1	3
Kohen Ranch	BWKR	6	(5)	7	(12)	0	(0)	0	1	1	0	0	2
Middle Delta	BWMD	0	(4)	0	(3)	0	(0)	0	0	0	0	0	0
Mosquito Flats	BWMF	4	(5)	19	(9)	5	(7)	0	1	0	0	0	1
Mineral Wash	BWMW	9	(5)	23	(7)	105	(18)	0	1	1	0	0	2
North Burn	BWNB	6	(5)	2	(7)	0	(0)	0	1	0	0	0	1
Sandy Wash	BWSW	13	(5)	3	(9)	0	(1)	0	3	0	0	0	3
Total		92	(74)	365	(127)	352	(52)	1	11	7	1	1	19

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-5.—LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates for Reach 4 (Parker to Cibola) sites, 2012

Site name	Site code	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
‘Ahakhav Tribal Preserve	CRIT	12	(5)	17	(5)	0	(1)	0	2	0	0	0	2
Palo Verde Phase 1	PVER1	3	(6)	80	(11)	40	(6)	1	0	1	1	1	2
Palo Verde Phase 2	PVER2	9	(6)	219	(27)	121	(24)	3	1	0	4	4	5
Palo Verde Phase 3	PVER3	12	(6)	95	(10)	162	(20)	2	2	0	2	2	4
Palo Verde Phase 4	PVER4	23	(6)	427	(39)	684	(75)	10	2	3	11	11	16
Palo Verde Phase 5	PVER5	34	(6)	441	(42)	465	(59)	6	4	2	6	6	12
Cibola Valley Phase 1	CVCA1	12	(5)	127	(13)	140	(25)	2	0	1	2	2	3
Cibola Valley Phase 2	CVCA2	11	(5)	134	(14)	318	(30)	1	0	1	1	1	2
Cibola Valley Phase 3	CVCA3	1	(5)	2	(0)	27	(4)	0	0	0	0	0	0
Cibola Crane Roost	CIBCR	19	(5)	96	(14)	85	(11)	2	3	1	2	2	6
Cibola Eucalyptus	CIBEUC	1	(4)	6	(0)	0	(1)	0	0	0	0	0	0
Cibola Mass Planting	CIBMP	2	(5)	0	(0)	0	(0)	0	0	0	0	0	0
Cibola Nature Trail	CIBCNT	3	(5)	5	(1)	0	(0)	0	1	0	0	0	1
Cibola North	CIBNTH	0	(4)	0	(0)	0	(0)	0	0	0	0	0	0
Total		142	(73)	1,649	(176)	2,042	(255)	27	15	9	29	29	53

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-6.—LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates for Reaches 5–6 (Imperial to Yuma) sites, 2012

Site name	Site code	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Picacho State Recreation Area (Picacho SRA)	Picacho SRA	7	(5)	5	(0)	0	(0)	0	1	0	0	0	1
Imperial NWR 20A	IMP20A	2	(5)	3	(0)	0	(0)	0	0	0	0	0	0
Imperial NWR 50	IMP50	1	(5)	0	(0)	0	(0)	0	0	0	0	0	0
Imperial NWR South	IMPSTH	6	(5)	5	(0)	0	(0)	0	1	0	0	0	1
Laguna 2	LAG2	0	(5)	0	(0)	0	(0)	0	0	0	0	0	0
Laguna 3	LAG3	3	(5)	2	(0)	0	(0)	0	1	0	0	0	1
Mittry Lake/Pratt	MLPR	7	(5)	16	(5)	0	(0)	0	0	1	0	0	1
North Gila Valley “A”	GRNVA	0	(4)	0	(0)	0	(0)	0	0	0	0	0	0
North Gila Valley “B”	GRNVB	0	(1)	0	(0)	0	(0)	0	0	0	0	0	0
Quigley Wildlife Management Area	GRQP	1	(5)	0	(1)	0	(0)	0	0	0	0	0	0
Yuma East Wetlands	YUEW	2	(5)	1	(1)	0	(0)	0	0	0	0	0	0
Yuma West Wetlands	YUWW	1	(5)	3	(0)	0	(0)	0	0	0	0	0	0
Total		30	(55)	35	(7)	0	(0)	0	3	1	0	0	4

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-7.—Summary of tables 2-2 to 2-6 LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates by river reach and for all sites, 2012

River reach	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Reach 1 (Pahranagat NWR, Overton Wildlife Management Area)	7	(16)	9	(7)	0	(0)	0	2	0	0	0	2
Reach 2 (Havasu NWR)	8	(18)	36	(32)	0	(0)	0	2	0	0	0	2
Reach 3 (BWRNWR)	95	(74)	365	(127)	352	(52)	1	11	7	1	1	19
Reach 4 (Parker to Cibola)	142	(73)	1,649	(176)	2,042	(255)	27	15	9	29	29	53
Reaches 5–6 (Imperial to Yuma)	30	(55)	35	(7)	0	(0)	0	3	1	0	0	4
Total	282	(236)	2,094	(349)	2,394	(307)	28	33	17	30	30	80

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

Table 2-8.—Summary of tables 1-6 to 1-10 LCR YBCU survey, followup, telemetry detections, visit totals, and nest searching results used to calculate breeding estimates by site type and for all sites, 2012

Site type	Survey detection total (# surveys)		Followup detection total[1] (# followup visits)		Telemetry detection total (# telemetry visits)		Nests found	Possible breeding (POS)	Probable breeding (PRB)	Confirmed breeding (COB)	Minimum territory estimate	Maximum territory estimate
Natural sites	105	(105)	376	(134)	352	(52)	1	14	7	1	1	22
LCR MSCP restoration sites	146	(70)	1,668	(192)	2,042	(255)	27	16	9	29	29	54
Non-LCR MSCP restoration sites	31	(61)	50	(23)	0	(0)	0	3	1	0	0	4
Total	282	(236)	2,094	(349)	2,394	(307)	28	33	17	30	30	80

[1] Followup detections include followup visit detections, incidental survey detections, and incidental telemetry detections.

80 breeding territories within the surveyed areas of the LCR MSCP region (map 2-1 and see table 2-2), including 33 possible, 17 probable, and 30 confirmed breeding territories (see tables 2-2 to 2-6). The 2012 maximum estimated breeding territories (80) was 38% greater than our 2011 estimate (58). Fifty-four (67.5%) of the maximum estimated territories were at LCR MSCP restoration sites, 22 (27.5%) were at natural sites, and 4 (5%) were at non-LCR MSCP restoration sites. Breeding was confirmed at natural (1 nest) and LCR MSCP restoration sites (27 nests, 2 additional fledglings (see table 2-8). (See tables 1-1 and 1-2 for a list of sites.) We did not confirm breeding at any non-LCR MSCP restoration sites nor at natural sites outside of the BWRNWR. We estimated 84.6% (11 of 13) of LCR MSCP restoration sites were occupied with POS, PRB, or COB territories, exceeding that observed at natural (60.9%, 14 of 23 sites) and non-LCR MSCP restoration sites (41.8%, 4 of 13 sites; table 2-9).

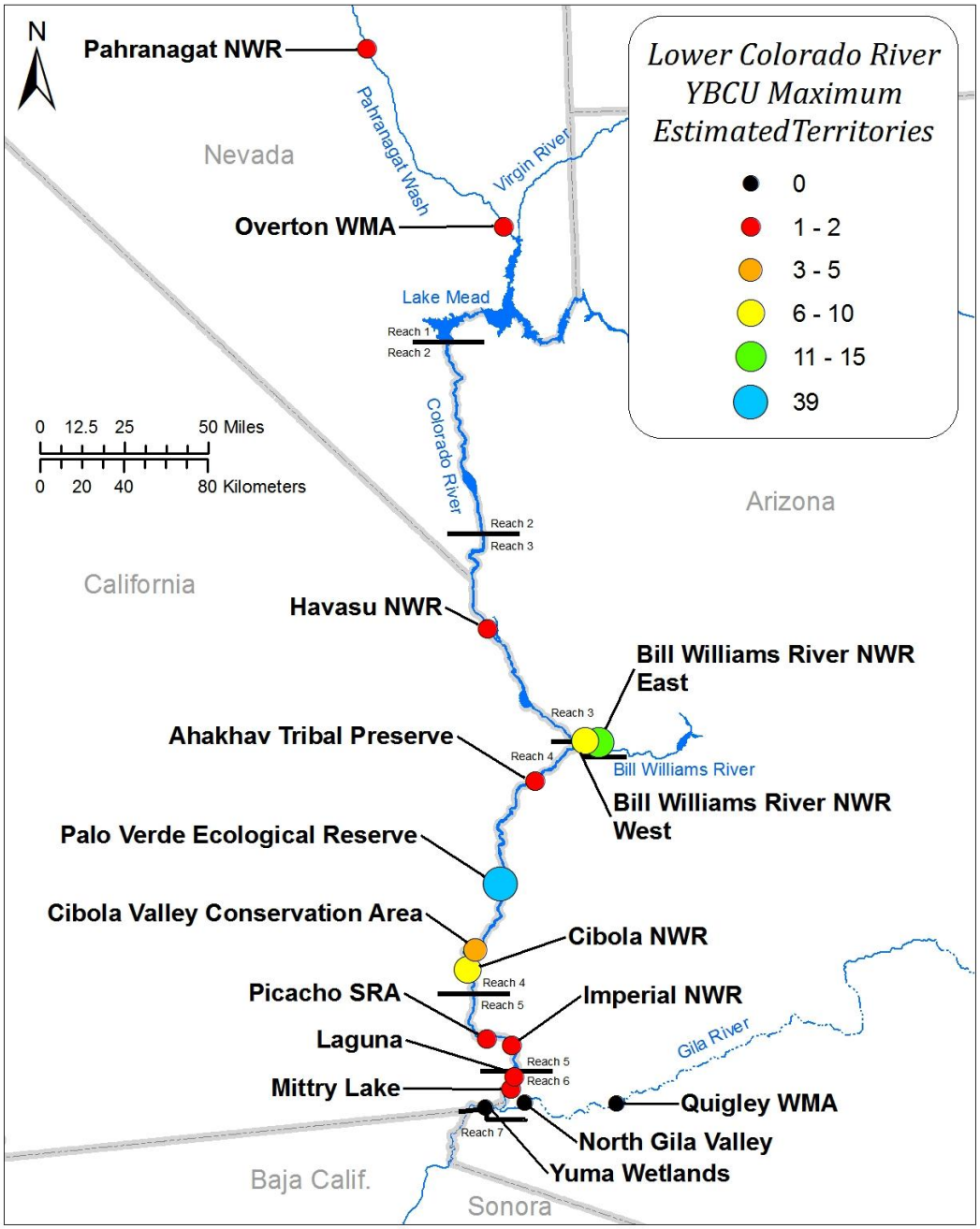
Table 2-9.—Proportion of sites occupied with breeding (POS, PRB, COB) territories, grouped by site type (natural sites, n = 23; LCR MSCP restoration sites, n = 13; non-LCR MSCP restoration sites, n = 13)

Site type (restoration status)	Proportion of sites occupied with breeding territories
Natural sites	60.9%
LCR MSCP restoration sites	84.6%
Non-LCR MSCP restoration sites	30.8%

We estimated that 50% of Reach 1 sites were occupied (two of four sites) and may have had breeding territories (table 2-10). At Pahranagat NWR (one POS; see table 2-2), two survey detections at Pahranagat North warranted a POS territory designation, though no breeding activity was observed. Pahranagat NWR was last surveyed in 2009, resulting in one June cuckoo detection and no estimated territories. Overton Wildlife Management Area (WMA) also had one POS territory.

Table 2-10.—Proportion of sites with breeding (POS, PRB, COB) territories, grouped by river reach (Reach 1 sites, n = 4; Reach 3 Havasu NWR sites, n = 4; Reach 3 BWRNWR sites, n = 15; Reach 4 sites, n = 14; Reaches 5–6 sites, n = 12)

River Reach	Proportion of sites occupied with breeding territories
Reach 1 (Pahranagat NWR, Overton WMA)	50.0%
Reach 3 (Havasu NWR)	50.0%
Reach 3 (Bill Williams River NWR)	73.3%
Reach 4 (Parker to Cibola)	71.4%
Reach 5 and 6 (Imperial to Yuma)	33.3%



Map 2-1.—Yellow-billed cuckoo breeding territories (maximum territory estimates) by survey area, LCR 2012.

Havasu NWR (two POS; see table 2-3) had no confirmed breeding in 2012, and territory estimates declined from three in 2011 to two in 2012. We estimated that two of the four sites were occupied with possible breeding territories in 2012 (see table 2-10). Beal and Topock Platform each had several survey and followup detections and one possible breeding territory each. Beal supported a single nest

in both 2010 and 2011, but breeding was not confirmed at the site in 2012. Unlike 2010 and 2011, no cuckoos were detected at Pintail Slough or North Dike in 2012.

We estimated that 73.3% of BWRNWR sites (11 of 15) were occupied with breeding territories (see table 2-10) and harbored as many as 19 territories (1 COB, 7 PRB, and 11 POS; see table 1-8), down from 23 maximum territories estimated in 2011 and 31 estimated in 2010. Breeding was confirmed only at Honeycomb Bend in 2012 (one COB and two PRB territories). Cave Wash (one PRB and one POS), Mineral Wash (one PRB and one POS), Esquerra Ranch (one POS), Cougar Point (two PRB), Kohen Ranch (one PRB and one POS), Sandy Wash (three POS), Mosquito Flats (one POS), Borrow Pit (one POS), Cross River (one POS), and North Burn (one POS) all held probable or possible territories. Many BWRNWR sites that historically harbored breeding territories (Cave Wash, Honeycomb Bend, Mineral Wash, Esquerra Ranch, Cougar Point, Kohen Ranch, Sandy Wash, and Mosquito Flats) did so again in 2012. Several sites that previously had few detections (Borrow Pit, Cross River, and North Burn) each had one possible territory in 2012. As observed in past years, the majority of estimated territories (12 of 19) was found on the eastern portion of the refuge upstream of the cliff formation known as Gibraltar Rock.

Between Parker and Cibola (Reach 4), breeding was confirmed at PVER, CVCA, and Cibola NWR (see table 2-5), and we estimated 71.4% of the sites (10 of 14) within this reach were occupied and had breeding territories (see table 2-10). The maximum territory estimate increased from 34 in 2011 to 53 in 2012; most were found at LCR MSCP restoration sites at PVER, CVCA, and Cibola NWR. ‘Ahakhav Tribal Preserve had two POS territories in 2012. PVER Phase 1 (one COB and one PRB), Phase 2 (four COB and one POS), Phase 3 (two COB and two POS), Phase 4 (11 COB, 3 PRB, and 2 POS), and Phase 5 (six COB, two PRB, and four POS) all had confirmed breeding activity. The 39 maximum estimated territories at PVER in 2012 greatly exceeded the 2011 (17) and 2010 (5) maximum territory estimates. Two nests were found at CVCA Phase 1 (two COB and one PRB), and CVCA Phase 2 supported one confirmed breeding territory (one COB and one POS). CVCA3 had no breeding evidence and little activity after June. The five breeding territories estimated at CVCA in 2012 was a decline from 13 territories estimated in 2011. At Cibola NWR, the estimated maximum number of breeding territories increased from three in 2011 to seven in 2012. Two confirmed breeding territories were found at Cibola NWR Crane Roost (two COB, one PRB, and three POS).

In Reaches 5–6 (Imperial to Yuma–three POS and one PRB), no breeding was confirmed as in previous years, and the maximum territory estimate decreased from six (all POS) in 2011 to four (three POS and one PRB) in 2012. We estimated up to 33% of these sites (4 of 12) may have held breeding territories (see table 2-10). There was one POS territory each at Laguna 3, Picacho State Recreation Area (SRA), and Imperial South, and one PRB territory at Mittry Lake Pratt Restoration (see table 2-6).

Survey Area Territories per Hectare

For comparative analysis, neighboring sites were grouped into survey areas (table 2-11). Most survey areas had estimated maximum territory densities between 0.02–0.08 territories per ha, or 0.5 to 1.5 territories per 20 ha of habitat (table 2-11; yellow and orange circles on map 2-2). Survey areas smaller than 20 ha (e.g., Imperial NWR, Picacho SRA, Laguna, and Mittry Lake) with 0–1 POS territory exhibited relatively large territory densities due to their small habitat area. At these small survey areas, density estimates are sensitive to incremental changes in maximum territory estimates, but at larger survey areas, (greater than approximately 50 ha) density estimates are more robust. The BWRNWR had a relatively high number of territories, but exhibited a low overall territory density due to its large size. Across all survey areas, the west half of the BWRNWR had the lowest non-zero territory density (0.47 territories per 20 ha) and was an order of magnitude smaller than that observed at the highest density survey area, PVER (4.8 territories per 20 ha; table 2-11 and map 2-2). The median maximum territory density at LCR MSCP sites (1.72 territories per 20 ha of habitat) exceeded that of natural sites (0.58 territories per 20 ha of habitat) by 197% (table 2-12), and LCR MSCP restoration habitat at CVCA, PVER, and Cibola NWR survey areas all had territory densities exceeding that found at the BWRNWR (table 2-11). The median maximum territory density at non-LCR MSCP restoration sites was zero (table 2-12). Survey areas smaller than 50 ha had one or zero POS territory and no confirmed breeding activity. However, within some larger survey areas, sites smaller than 50 ha did have confirmed breeding, such as Cibola Crane Roost. With one exception (CVCA 1–3, 96.5 ha), no survey areas smaller than 100 ha had confirmed breeding.

DISCUSSION

Compared to 2011, we saw declines in estimated breeding activity in Reaches 3, 5, and 6, and mixed trends in Reach 4. As observed in 2011, the BWRNWR was eclipsed by LCR MSCP restoration habitat and did not support the majority of confirmed breeding or estimated territories. Reach 4 LCR MSCP restoration sites in the Blythe area (PVER, CVCA, and Cibola NWR) together surpassed the BWRNWR in survey detections, territory density, and number of confirmed and estimated breeding territories.

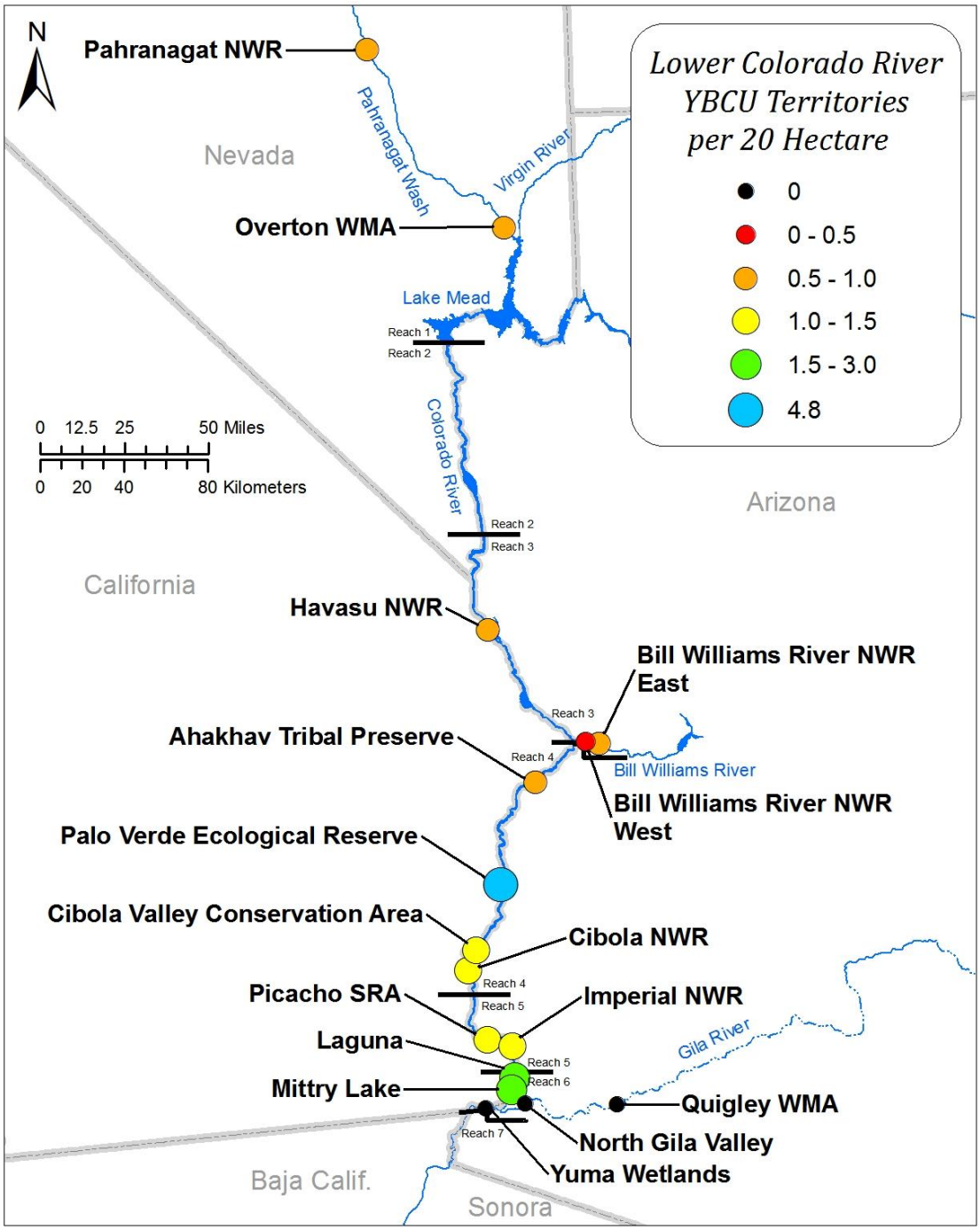
At this time, it is unclear if the observed increases at LCR MSCP restoration sites in the Blythe area originated from local Blythe birds successfully establishing new breeding territories within the area or if the increase is related to the decrease in cuckoos observed at other sites within the LCR study region or elsewhere within the species' breeding range. Either scenario is possible.

Table 2-11.—Area (ha), maximum territory estimate, maximum territory estimate per ha, and maximum territory estimate per 20 ha by survey area, sorted by area (ha)

Survey area	Area (ha)	Maximum estimated territories	Maximum estimated territories per ha	Maximum estimated territories per 20 ha
BWRNWR East	306.4	12	0.039	0.78
BWR NWR West	297.4	7	0.024	0.47
Palo Verde Ecological Reserve	162.6	39	0.240	4.80
Cibola NWR	131.9	7	0.053	1.06
CVCA	96.5	5	0.052	1.04
‘Ahakhav Tribal Preserve	59.6	2	0.034	0.67
Havasu NWR	53.8	2	0.037	0.74
Yuma Wetlands	48.7	0	0.000	0.00
Overton WMA	32.9	1	0.030	0.61
Pahranagat NWR	27.6	1	0.036	0.72
Imperial NWR	18.5	1	0.054	1.08
Picacho SRA	14.8	1	0.068	1.35
Mittry Lake	12.2	1	0.082	1.64
Quigley WMA	10.6	0	0.000	0.00
Laguna	7.7	1	0.129	2.59
Gila Valley	3.3	0	0.000	0.00

Declines in their range (Hughes 1999) may indicate that cuckoos are choosing other breeding locations (Dettling and Howell 2011a) possibly due to an increase in prey abundance or available habitat at these alternative locations (Laymon et al. 1997). Additional research exploring the genetic relatedness among cuckoo subpopulations, dispersal, and site fidelity would help answer this question. Regardless of the mechanisms behind the local increases, so far the LCR MSCP restoration efforts in these areas appear successful in attracting high breeding densities. Continued habitat assessment, along with monitoring of population trends in the years to come, will help clarify the habitat features most strongly correlated to this influx of cuckoos and will also help assess changes in cuckoo occupancy as the restoration sites mature.

Few breeding territories were found at the remaining natural habitat sites outside of the BWRNWR (three POS territories) and non-LCR MSCP restoration sites



Map 2-2.—Yellow-billed cuckoo breeding territory density (maximum estimated territories/20 ha) by survey area, LCR 2012.
Survey areas varied in size, with the largest found in Reaches 3 and 4 (between 53 and 306 ha in size, with 2–39 breeding territories), while survey areas in Reaches 1, 5, and 6 were all smaller than 50 ha and had 0–1 breeding territory (see table 2-11).

Table 2-12.—Median area (ha), median maximum estimated territories, median-based maximum estimated territories per ha, and median-based maximum estimated territories per 20 ha, by site type

Site type	Median area (ha) (range)	Median maximum estimated territories per site (range)	Median-based maximum estimated territories/ ha	Median-based maximum estimated territories/ 20 ha
Natural	30.4 (3.3 – 66.5)	1 (0 – 3)	0.029	0.58
LCR MSCP restoration	27.7 (8.3 – 73.7)	2 (0 – 16)	0.086	1.72
Non-LCR MSCP restoration	11.7 (1.6 – 29.4)	0 (0 – 1)	0	0

(four POS territories); at this time, these sites appear to provide little to no breeding habitat for cuckoos within the region. However, these habitat patches may provide vital migratory stopover habitat and enable connectivity between larger breeding areas (Gustafson and Gardner 1996; Skagen et al. 1998; chapter 4). As such, this habitat may be of critical importance to LCR cuckoos and other migrants.

Chapter 3 – Nest Searching and Monitoring

INTRODUCTION

The ability to detect changes in reproductive performance is a crucial part of assessing population health and creating solutions to species decline (DeSante et al. 2005). Long-term nest monitoring can reveal demographic trends across breeding populations and guide the creation of landscapes that support ongoing viable populations. One objective of this project includes identifying key yellow-billed cuckoo breeding habitat characteristics to use as a basis for future habitat restoration. In 2012, we continued to monitor the progress of ongoing habitat restoration as suitable cuckoo breeding habitat through intensive nest searching and monitoring, concentrating our efforts at LCR MSCP restoration sites and the BWRNWR.

METHODS

We used a number of techniques to search for nests during the breeding season. During surveys and followup visits, we located all detected cuckoos visually, if possible, and searched woody vegetation in the vicinity for nests (Martin and Geupel 1993). Cuckoos may respond from the nest to broadcast survey calls, and if they are close enough to the surveyor, the nest can be located. Another technique used the fact that nesting pairs share incubation duties (Potter 1980; Hughes 1999; Halterman 2009); soon after sunrise, the female replaces the male on the nest, both often vocalizing during the exchange. They may also call prior to arriving at the nest to feed young. One or more observers waited before dawn in the area of a suspected nest and triangulated the location of a calling bird. A third technique followed localized activity or behavioral clues (e.g., food and stick carries, alarm calls) and directed efforts into these areas until a nest was located. We also performed systematic searches, concentrating on edge and structural transition habitats. Additionally, we used radio telemetry to locate nests (chapter 4). We distinguished used cuckoo nests from similar stick nests of other species (such as doves) by the presence of bluish egg fragments remaining in or below the nest.

After locating a nest, we recorded the GPS location a few meters away from the nest; a more accurate reading was taken after nesting activity ceased. We recorded nest site characteristics such as nest substrate species and height, nest height, stage, and the banded status of adults if known. We used telescoping mirror or camera poles to check nests every 2–5 days, recording nest contents and any observed behaviors. Nestlings were banded at 3–6 days when accessible (chapter 4). Nests were judged successful if at least one young fledged, which we

determined by detecting an adult or fledgling in the vicinity of the nest within 2 days of the estimated fledge date. Young cuckoos leave the nest before they can fly; thus, they climb or hop onto nearby branches where they may remain in close proximity to the nest for several days. Nests were considered failed if they were found damaged/destroyed, with large eggshell fragments or remains, or empty before the earliest possible fledge date (~6 days after hatching) with no further activity detected nearby. Nests were considered deserted if intact eggs or live chicks were present with no further parental activity observed. Apparent nest success was calculated as the number of successful nests divided by the number of successful + unsuccessful nests. To account for nests that failed before they were found, we also calculated Mayfield nest success (Mayfield 1975), using the formula $\textit{nest survival} = [(\textit{total exposure days} - \textit{failed nests})/\textit{total exposure days}]^{\textit{nesting period}}$, using 18 as the average length of the nesting period based on our data. We calculated exposure days for each nest using the midpoint method for nests of known fate and the last known active date for nests of unknown fate. We recorded clutch size as the total number of eggs known to have been laid in each nest. To calculate nest productivity, as we did not always know how many young fledged from each nest, we used the average of the minimum and maximum possible number of young fledged per nest (minimum included only known young fledged; maximum included all young minus any young known not to have fledged).

We continued to assess the relationship between relative cicada abundance and cuckoo fledging activity by site type (restoration or natural habitat) by recording an index of relative live cicada abundance at all cuckoo survey points throughout the season. All cicadas observed on vegetation or flying as the surveyor approached the survey point, or heard calling in the area around the survey point, were indexed as follows: 0 = 0 cicadas, 1 = 1 cicada, 2 = 2–5 cicadas, 3 = 6–10 cicadas, 4 = 11–19 cicadas, and 5 = 20+ cicadas. We then compared the cicada indices to fledging events throughout the season.

When nests became inactive, detailed vegetation measurements were recorded (see 2008–2012 summary report). Additional nest site characteristics were measured in 0.1-ha (0.25-acre) circular plots centered on nest sites following Ralph et al. (1993). Visual estimates were made of the percent of the nest concealed by foliage cover in a 25-centimeter (cm) sphere centered on the nest, from a distance of 1 m above (overhead cover), below, and from the sides (side cover), in each of the four cardinal directions. Canopy cover measurements were taken using a spherical densiometer at 10 points on the plot: two at the center, four at 5 meters (m), and four at 10 m from the center in the four cardinal directions.

RESULTS

Between July 4 and September 9, 2012, we documented 28 yellow-billed cuckoo nests at 5 locations from the BWRNWR to Cibola NWR (table 3-1). We found 22 nests at PVER (Phases 1 to 5), 3 at CVCA (Phases 1 and 2), 2 at Cibola NWR (Crane Roost), and 1 at BWRNWR (Honeycomb Bend). We confirmed a total of 30 breeding territories and estimated up to 80 potential breeding territories within the surveyed sites based on the timing and duration of all activity during the season (see chapter 2 and attachment B). We found nests at several previous known breeding sites, including BWRNWR, PVER (Phases 2, 3, and 4), CVCA (Phases 1 and 2), and Cibola NWR Crane Roost. We also found nests at two sites for the first time in the study: one at PVER Phase 1 and six at PVER Phase 5. Detailed accounts of all 2012 nests are provided in attachment C.

Nesting activity peaked during the week of July 22–28 (figure 3-1). At PVER, the nesting period extended into September (three nests, one fledging on September 2, and two fledging around September 8). Cicada activity in 2012 (figure 3-2) was similar to previous years; it was more abundant at BWRNWR compared to restoration sites and peaked toward the end of July. Fledging events at restoration sites increased after the cicada peak, though the two appeared to be unrelated.

Clutch size in 2012 ranged from 2 to 5 and averaged 3.16 ± 0.8 (n = 25 nests). Seventy-two percent of eggs survived to hatch. Apparent nest success was 78%, while Mayfield nest success was 68% (n = 27 nests all at LCR MSCP restoration sites). Depredation was implicated in five of six failed nests, though the identities of the nest predators were unknown. At one depredated nest, the eggs may have been nonviable, as they failed to hatch after 13 days of incubation. The remaining nest failure was of unknown cause (weather implicated). Nest productivity averaged 1.9 young fledged per nest.

We witnessed nestling deaths at three otherwise successful nests in 2012: at Cibola Crane Roost Nest 2, a dead chick (around 3 days old) was found on August 24 hanging by a mesquite thorn under the nest (apparently fallen from the nest during a storm); at PVER2 Nest 3, a 5–6 day-old chick was found in ankle-deep irrigation water directly below the nest on September 2 (assumed to have fallen from the nest); and at PVER5 Nest 6, a chick was found dead in the nest on September 9 of unknown cause after appearing sick and weak a few days earlier. We also noted missing chicks or eggs at three nests: at PVER5 Nest 1, two eggs disappeared on separate days; at PVER5 Nest 3, the two youngest chicks went missing on the same day; and at PVER 5 Nest 6, one chick and one egg disappeared (attachment C).

Table 3-1.—Yellow-billed cuckoo nests found on the LCR, 2012

Nest	Adult 1	Adult 2	Date found	First egg	Tree sp.[2]	Tree ht (m)	Nest ht (m)	# eggs	Fate date[3]	Fate[4]	Failure cause[5]	Notes
BWHB-1	FMF	UNK	7/23	7/13	SAGO	12	9	1+	7/29	U		Nest over water, not possible to check
CIBCR-1	UNK	UNK	7/21	7/9	POFR	12	6	3	7/25	F3		Banded 3 chicks – fledged 7/25–7/27
CIBCR-2	LLL	UNK	8/11	8/9	PRGL	6.5	5	3	8/24	F2		2 fledged, 1 died – fell from nest, hooked on thorn
CVCA1-1	DRE	UNK	7/10	7/9	SAGO	8	3	5	7/25	F3		Banded 3 chicks
CVCA1-2	LWB	UNB	7/12	7/11	POFR	13.5	10.5	4	7/28	F4		
CVCA2-1	LJ	JLO	7/25	7/20	POFR	14	10	3	7/31	X	W?	Failed after storm
PVER1-1	PRI	SLS	7/20	7/11	SAGO	12	8	4	7/27	F4		SLS captured in PVER2 re-sighted at nest
PVER2-1	PUF	UNK	7/24	7/22	SAGO	15	12	3	8/07	F3		Nest found before PUF captured and tracked to nest
PVER2-2	ODB	UNB	8/4	7/31	SAGO	9	7	3	8/15	X	P	Nest empty, no activity 8/15
PVER2-3	PUF	UNB	8/19	8/17	SAGO	15	13	2	9/2	F1		Re-nest. 1 fledged; 1 fell out of nest, drowned (flood irrigation)
PVER3-1	AA	UNB	7/11	7/8	POFR	13	10	3	7/24	F3		AA previously nested PVER2 2010
PVER3-2	UNK	UNK	7/16	7/7	POFR	11	9	3	7/23	F1+		
PVER4-1	DOG	UNK	7/4	6/26	POFR	12	6	2	7/12	F2		Banded 2 chicks
PVER4-2	GMF	B	7/7	7/5	POFR	14	9.5	4	7/21	F2		GMF mate banded mB/[G,mB,Bk?]
PVER4-3	EZE	UNB	7/12	7/11	POFR	14	7	3	7/25	X	P?	Eggs failed to hatch within 13 days
PVER4-4	DEF	UNB	7/24	7/21	POFR	10	7.5	3	7/29	X	P	Broken eggshell found under nest
PVER4-5	GBO	PF	7/27	7/10	SAGO	9.5	6.5	2+	7/25	F2+		Found after fledging
PVER4-6	DEF	UNB	8/2	8/1	POFR	12	9	2	8/19	F2		Re-nest. Too high to band
PVER4-7	EZE	UNB	8/5	8/4	POFR	12	10	3	8/21	F3		Re-nest. Too high to band
PVER4-8	PRI	UNK	8/12	8/4	SAGO	9.5	7.5	2	8/18	X	P	Re-nest 1 (PRI)
PVER4-9	GBO	UNK	8/21	8/19	POFR	14	10.5	1+	8/24	X	P	Re-nest. Nest empty/eggshell on ground 8/24
PVER4-10	PRI	SLS	8/29	8/22	POFR	13	9.5	3	9/6	F3		Re-nest 1 (SLS), PRI nest 3. PRI left < 9/3
PVER5-1	QLA	UNK	7/28	7/27	SAGO	6.5	2.9	5	8/13	F2		Banded 2. 1 egg unhatched, 2 disappeared
PVER5-2	LIO?	UNK	7/30	7/15	SAGO	7.2	1.8	3	8/1	F3		Banded 2 chicks
PVER5-3	CHL	UNK	8/2	7/23	POFR	9	2	3	8/8	F1		Banded 3 chicks
PVER5-4	BZB	UNK	8/1	7/25	POFR	4.5	1.6	3	8/9	F3		Banded 3 chicks
PVER5-5	UNB	UNK	8/6	7/19	POFR	10	6	3+	8/6	F3+		Found after fledging; banded 1
PVER5-6	GFK	UNK	8/19	8/9	POFR	8.4	4.9	4	9/4	F1		2 missing, 2 banded; 1 fledged, 1 found dead in nest 9/9
Total (mean)				(7/22)				83+ eggs (3.16±0.8)			F51+ (78% apparent success, 1.9 young per nest)	

[1] Adult 1, 2: UNK = unknown; UNB = unbanded, otherwise identification of known adult captured or re-sighted 2012; PF = nesting adult banded PVER2 2009 or banded bird of unknown identity (B).
[2] Tree sp.: SAGO = *Salix gooddingii*, POFR = *Populus fremontii*, PRGL = *Prosopis glandulosa*.
[3] Fate date = Known or estimated date of first fledging or failure.
[4] Fate: F = successful (fledged at least one young), U = unknown, X = failed.
[5] Failure cause (estimated): P = predation, W = weather.

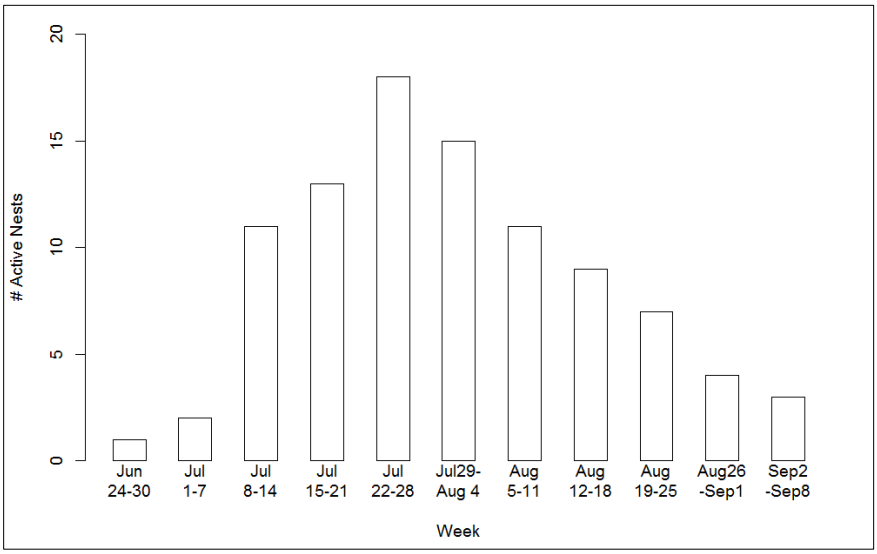


Figure 3-1.—Number of active nests by week (all sites), LCR 2012.

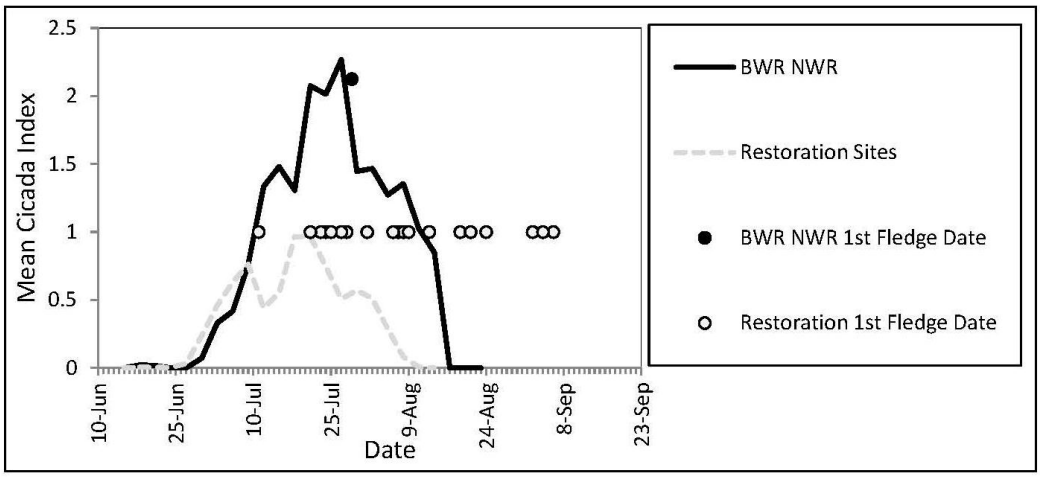


Figure 3-2.—Cicada activity and fledging dates at natural and restoration sites, LCR 2012.
Cicada abundance was greater at BWRNWR (black line) compared to restoration sites (dashed gray line). Cuckoo fledging increased around the peak of cicada activity at restoration sites (only one nest found at BWRNWR) and continued long after cicada activity had ceased.

Nests were found in three tree species in 2012: Fremont cottonwood (*Populus fremontii*) (17 nests), Goodding's willow (*Salix gooddingii*) (10 nests), and honey mesquite (*Prosopis glandulosa*) (1 nest). Nest trees ranged from 4.5 to 18 m high (mean 11.1 m) and from 6.5 to 33 cm diameter breast height (DBH) (mean

14.1 cm). Nest heights ranged from 2 m to 13 m above ground (mean 7.3 m). Canopy closure at the nests averaged 93%. Canopy closure averaged 83.7% 5 m from the nest, slightly decreasing to 80.25% 10 m away from the nest.

We found no evidence of interspecific nest parasitism or the use of used dove nests by nesting cuckoos in 2012 (previously observed in 2011). Two nests suggested possible intraspecific nest parasitism (egg dumping by cuckoos) due to irregular egg laying dates: at PVER5 Nest 6, we recorded four eggs laid over a 9-day period, and at CVCA1 Nest 1, a fifth egg was laid 4 days after laying had seemingly ceased.

We documented double brooding (individuals or pairs re-nesting after a successful nest) by four individuals (two males and two females: two of these paired together) during the 2012 season, all at PVER. One female (PRI) nested at least three times, with her first and third nests successfully fledging young. This individual may also have had an earlier successful nest (four total) prior to the first known nest, as she was also observed with two juveniles and an adult 200 m away from her first known nest around the time that nest fledged. One male (SLS) was PRI's mate for both her first and third nests, indicating seasonal monogamy. We were not able to determine the identity of PRI's mate at her second nest. Another banded male (PUF) had at least two successful nests (he was also seen with a juvenile away from his first active nest), and another banded female (GBO) had a successful nest followed by a failed nest. Additionally, two banded males (EZE, DEF) both successfully re-nested after failed nests.

DISCUSSION

We located just one nest at BWRNWR this year along with fewer survey detections and estimated breeding territories (chapters 1 and 2). We typically find a relatively small proportion of all estimated nests in this survey area due to challenging field conditions, including dense vegetation and lack of access roads, and the single nest found in 2012 was not statistically different from what we have found in previous years (averaging five nests per year from 2008–2011). However, in 2012, our field challenges increased due to loss of access to the eastern end of the refuge through Planet Ranch; as a result, we had to hike over 1 hour upstream from Mineral Wash to reach our eastern-most sites (Cave Wash and Honeycomb Bend). We have typically found the highest number of nests and other breeding evidence at these eastern sites. Also, the increased effort we placed on capturing and radio tracking adults at the BWRNWR in 2012 reduced the overall time spent nest searching. We expected that radio tracking cuckoos at the BWRNWR would contribute in the finding of several nests, as telemetry is typically responsible for a large proportion of all nests found. We also found fewer nests at CVCA in 2012 compared to 2011, along with fewer survey detections and estimated territories (chapters 1 and 2), despite similar survey,

nest searching, and telemetry effort. We, however, found twice the number of nests at PVER this year compared to 2011, which corresponded with the addition of PVER5 (approximately 74 ha) as suitable breeding habitat (bringing the total amount of suitable habitat at PVER to > 160 ha).

Clutch size averaged > 3 eggs per nest in 2012, similar to 2011 results. PVER and CVCA again had several large (four- and five-egg) clutches. Large clutch size has been correlated to high food abundance and seasonal insect outbreaks (Fleischer et al. 1985; Laymon et al. 1997; Payne 2005) and can also result from intraspecific brood parasitism. Criteria for identifying parasitic eggs include the appearance of two eggs in one 24-hour period during laying or the appearance of an egg 3 or more days after laying has seemingly ceased (MacWhirter 1989). Based on our observations that female cuckoos typically lay one egg per day, two possible instances of intraspecific parasitism were documented due to irregular egg laying dates. Species that experience high rates of intraspecific parasitism often remove parasitic eggs from their nest (Emlen and Wrege 1986; Stouffer and Power 1987; Brown and Brown 1989). Although we did note eggs disappearing from three active nests, we cannot attribute it to this behavior. There is no recent documentation of cuckoos removing eggs from nests in the literature nor have we ever observed this behavior. We also noted missing chicks at several otherwise successful nests this year. Brood reduction from adult yellow-billed cuckoos removing live chicks from nests has been previously observed (Laymon et al. 1997; Halterman 2009), though we did not observe this behavior in 2012.

Chapter 4 – Mist Netting, Color Banding, Re-sights, and Telemetry

INTRODUCTION

Yellow-billed cuckoo breeding populations in the Western United States are restricted to small and isolated riparian habitat fragments, which comprise less than 1% of the western landscape (Rich 2002). Dispersal of individuals between breeding populations is vital for genetic flow and population persistence, but can be significantly impacted by habitat fragmentation and isolation, even in birds capable of long-distance flight (Martin-Galvez et al. 2006; Martin et al. 2006; Martín et al. 2008; Ortego et al. 2008). Long-term color banding and re-sighting can provide information on natal and breeding dispersal patterns as well as other poorly understood traits such as survivorship, mate and site fidelity, breeding behavior and morphology, population demography, and genetic structure.

Cuckoos can, however, be difficult to observe due to their furtive behavior, and their bands can be even more challenging to re-sight due to their habit of crouching on their legs in dense foliage. Radio tracking greatly increases the ability to make useful behavioral observations, and can provide additional insights on home range, territoriality, duration of stay, and within-season movements. Additionally, due to the cuckoo's secrecy and rapid nesting cycle, nests are often missed. Cuckoos can also occur as transients throughout the season; thus, it is often unclear if breeding has occurred in an area. Telemetry improves breeding pair estimates by increasing the likelihood of confirming both breeding and transiency. In 2012, we continued color banding, re-sighting, and radio tracking cuckoos at LCR survey sites, concentrating our efforts on previous breeding sites including PVER, CVCA, and BWRNWR.

Home ranges from previous years of this study were estimated from cuckoos occupying LCR restoration sites, with 95% kernel density estimates (KDE) averaging 21 ± 9.72 ha (n = 43). They average considerably smaller than estimates from two western yellow-billed cuckoo telemetry studies conducted in natural habitat areas on the upper San Pedro River (38.6 ± 42.2 ha, n = 23) (Halterman 2009) and the Rio Grande (56.3 ± 58.1 ha, n = 10) (Sechrist et al. 2009). We suspected this may be due to differences between the restoration sites (generally small and discrete planted habitat patches within an agricultural matrix) and natural sites (large expanses of natural riparian forest with surrounding natural upland vegetation), and that BWRNWR home ranges may be more comparable to those from the other studies. We have previously captured relatively few adults at the BWRNWR due to difficult netting conditions, including long hikes carrying heavy equipment, dense vegetation, and tall canopy. And of these few captures, radio tracking here has been impacted by topography

(signal bounce or loss due to cliffs) and access limitations, typically causing tracked birds to become lost soon after they move away from their capture location. Despite these challenges, we increased our netting and telemetry efforts at the BWRNWR in 2012 in an attempt to compare home ranges between LCR restoration sites and the BWRNWR to determine whether LCR restoration site home ranges are smaller than natural habitat home ranges.

METHODS

Mist Netting

We captured adult cuckoos during the breeding season between mid-June and mid-August. First, we located a responsive cuckoo by broadcasting recorded conspecific vocalizations. If a cuckoo flew towards the broadcast, we found a suitable net lane and used a target-mist net technique modified from Sogge et al. (2001). We attached two to four stacked (7.8- to 12-m-high) mist nets ranging from 9 to 18 m in length between two canopy poles placed in a vegetation gap of similar canopy height. We then broadcast various recorded vocalizations from speakers placed on either side of the net to lure in cuckoos. We recorded information, such as temperature, number of cuckoos in the area, and vocalizations eliciting a response, during each attempt. If no cuckoos displayed interest after about an hour, we moved the setup to another location. We ceased our attempts when temperatures reached 40 °C (104 °F).

Color Banding

We banded newly captured cuckoos with a color-anodized (magenta in 2012) Federal aluminum band on one leg and a pinstriped color aluminum band on the other leg, forming a unique color combination. Non-target captured birds were immediately released without banding. We used a stopped wing rule to measure wing and tail, calipers to measure tarsus and bill length, and a 100-gram (g) Pesola® scale or 400-g Acculab digital scale to weigh all birds. We also banded and measured nestlings at 3–6 days if reachable (i.e., nests less than 7 m high and safely accessible by ladder). For adults, we recorded additional morphological data such as molt, feather wear, orbital ring color, cloacal protuberance (CP) score (0–3), and brood patch (BP) score (0–5 following the Monitoring Avian Productivity and Survivorship protocol). We extracted a small amount of blood from each bird by brachial vein puncture, which was placed on PermaCode™ cards and/or in a buffer containing Ethylenediamine tetraacetic acid. Genomic DNA was extracted from the buffered blood or cards using a Qiagen blood and tissue kit and protocols (Qiagen Inc., Valencia, California). Birds were sexed following a universal avian DNA-sexing method (Han et al. 2009). Accuracy of the sexing method was verified by correctly DNA-sexing tissue samples from

23 necropsy-sexed yellow-billed cuckoos (11 females and 12 males loaned from the University of Washington Burke Museum) as well as using another molecular sexing method (Fridolfsson and Ellegren 1999) on 10% of the samples as recommended (Robertson and Gemmell 2006; Casey et al. 2009).

Re-sights

We attempted to re-sight banded cuckoos by observing with binoculars or photographing the legs of all cuckoos detected. For returning second-year birds (banded as chicks the previous year), we calculated natal dispersal distance as the distance between the bird's natal nest and its (assumed first) nesting location (calculated using ArcGIS). For returning banded adults, breeding dispersal distance was calculated as the distance between each year's nests associated with the bird. If no nest was found, we used the capture location to calculate distance moved.

Telemetry

We equipped a subset of captured adults with one of two types of radio transmitters: Holohil BD-2 (Holohil Systems Ltd.) weighing 1.47 to 1.51 g, broadcasting at 151.5–152 megahertz (mHz), and Lotek Biotrack Radio PIP AG 393 (Lotek Wireless, Inc.) weighing 1.09 to 1.24 g and broadcasting at 151.0 to 151.49 mHz. Transmitters were operational for 6 to 8 weeks. We stitched each transmitter near the base of the two central rectrices with dental floss or Kevlar thread and secured the knots with a small drop of cyanoacrylate glue (Pitts 1995; Woolnough et al. 2004). We used Communications Specialists Model R1000 receivers and three-prong directional yagi antennae (AF Antronics model F151-3FB and Communications Specialists RA-150 Folded Yagi) to monitor the tagged birds. We tracked birds approximately every 1 to 3 days for up to 4 hours per session. We attempted to confirm the breeding status of all radioed birds by witnessing birds at nests or exhibiting other breeding behaviors. Vocalizations, intraspecific interactions, movements, behaviors, and habitat characteristics were also recorded during telemetry sessions. If an observer thought that their presence was disturbing the bird, they moved away from the bird and continued tracking from a distance. For home range estimation, we attempted to record at least one accurate position per hour by recording triangulations of two or three bearings, approximately 90 degrees (°) (60–120°) apart, taken within 5 minutes of each other (Springer 1979) (or simultaneously if two observers were available and up to 10 minutes at the BWRNWR to allow additional travel time between locations). Sampling error and bias associated with triangulation-based location estimates (Springer 1979) was considered to be acceptable (i.e., within 50 m of true locations) due to regular visual confirmation of bird locations, triangulation bearing angles averaging 90°, and relatively short

distances (< 100 m) from observers to target birds (Saltz 1994). If a bird's signal was no longer detected at its capture site, we regularly searched for the signal by foot or vehicle for the remainder of the season at sites along the LCR. We assumed a lack of signal with no additional re-sights of a bird was due to the bird leaving the area, though transmitter failure was also possible.

We used LOAS™ 4.0 software (Ecological Software Solutions) to estimate true bird locations based on triangulated bearings, combined these with single point visual locations, and then imported these into ArcGIS 9.3 and used Hawth's Analysis Tools (Beyer 2004) to estimate home ranges for each tracked cuckoo. Three home range estimates were calculated: minimum convex polygons (MCPs) and 95% and 50% KDEs (Silverman 1986). MCPs and 95% KDEs are commonly used to represent an animal's home range, with the 50% KDE describing an animal's core range (Laver and Kelly 2008). MCPs were obtained by connecting all outer data points to form a convex hull (following Mohr 1947). While popular due to its simplicity, the MCP is extremely sensitive to data outliers, often overestimating the animal's true home range (Worton 1995; Burgman and Fox 2003). KDEs determine the probability of locating the bird in an area at any given time and are less biased towards outliers (Seaman and Powell 1996). We assessed potential differences in average home range sizes based on gender, breeding status, site, habitat patch size, number of points, and number of days tracked by performing nonparametric analyses of variance (ANOVAs) and adjusting for multiple comparisons when applicable. We used the R statistical package 2.15.2 for data analysis (R Development Core Team 2012). A more thorough home range analysis of our complete telemetry data (2009–2012) is included in our 2008–2012 summary report.

In 2011, we fitted eight cuckoos (four females and four males) with Mk20 ASLT light-level geolocators (British Antarctic Survey) attached to leg-loop harnesses. In 2012, we attempted to recapture these eight birds to remove the harnesses and retrieve the geolocation data.

RESULTS

Mist Netting

Between June 18 and August 16, 2012, we made 111 mist netting attempts, resulting in 41 captures of 37 adults (table 4-1). Our mean capture rate was 37% per attempt. Most adults (76%) were captured between June 24 and August 4. Nets were open an average of 65 minutes per attempt. The average capture took approximately 38 minutes. Temperatures during attempts ranged from 19° to 40 °C (mean 27 °C). Mist net attempts ceased in mid-August, as birds no longer responded to call playback.

Table 4-1.—Yellow-billed cuckoo capture rate by area, 2012

Area	# of attempts	# of captures	# of females/ # of males	Capture rate
BWRNWR	12	5	1/4	42%
‘Ahakhav Tribal Preserve	1	0	–	0%
PVER	74	25[1]	11/14	34%
CVCA	19	10[2]	3/7	53%
Cibola NWR	5	1	0/1	20%
Total	111	41	15/26	37%

[1] One female captured three times and one male captured twice.
[2] One male captured twice.

Color Banding and Re-sights

Between June 19 and August 13, 2012, we newly captured and color banded 33 adults and recaptured 4 previously banded birds (10.8% of all captures, table 4-2). Almost twice as many males as females were captured. We also banded 23 hatch-year birds (table 4-3). We re-sighted another three previously banded birds (tables 4-2 and 4-4), though we were only able to identify one to individual. A second bird was one of four chicks given the same band color combination in 2008 (two at CVCA and two at BWRNWR). A third was partially re-sighted and potentially matched three adult males banded in 2011 (all from different sites). The recaptures and confirmed re-sights gave us five new dispersal records: four breeding and one natal (table 4-4).

Returning adults dispersed an average distance of 567 m from their previous breeding location (range 12–1,100 m). The four adults (three male and one female) all returned to their previous breeding sites, three to PVER and one to CVCA. The returning CVCA bird was a male first banded as an adult in 2009 who returned to CVCA2 to breed for the fourth consecutive year. The second male was initially captured and banded near a PVER2 nest in 2009 and re-sighted for the first time in 2012 feeding a fledgling from PVER4 Nest 5. The third male was banded in 2010 in PVER3 while nesting in PVER2; he was recaptured in 2012 and followed to a PVER3 nest. The returning adult female was banded in 2011 in PVER4 near a recently failed nest and recaptured in the same location in 2012. A single natal dispersal distance of 1,780 m was recorded for a third-year female banded as a chick at PVER2 in 2010 and recaptured in PVER4 in 2012 (no nest found). We did not re-sight any of the 35 chicks we banded in 2011.

We re-sighted five juveniles post-fledging (four banded and one unbanded with a banded parent), all at PVER (table 4-4). The greatest dispersal distance observed

Table 4-2.—Adult yellow-billed cuckoos captured on the LCR, 2012

S code	Date	ID	Band #	Band code[1]	Sex[2]	Age[3]	Band colors[4]	Att[5]	Breeding evidence
BWMW	6/25	TRD	1202-68001	N	M	AHY	Mg/Bk-G	T	Signal lost > 7/10
	6/25	BLL	1202-68002	N	M	AHY	Mg/Bk-lB	T	Signal lost > 7/23
	6/26	FMF	1202-68003	N	M	AHY	Mg/Bk-Lv-Bk	T	Nested BWHB; signal lost > 8/02
	7/10	HED	1202-68004	N	M	AHY	Mg/G-lB	T	Signal lost > 7/11
BWPT	7/16	LIM	1202-68005	N	F	AHY	Mg/G-Lv	T	Signal lost > 7/23
CIBCR	6/19	SMA	1713-67911	N	M	AHY	Mg/Lv-G	T	Signal lost 6/29
CVCA1	6/24	LWB	1202-68027	N	M	AHY	Mg/Bk-R	T	Nested CVCA1; signal lost 8/20
	6/27	DRE	1202-68030	N	M	AHY	Mg/Bk-W	T	Nested CVCA1; signal failed 8/12
	6/27	KIM	1713-67912	N	M	AHY	Mg/Ag-R	T	Signal lost > 7/19
	6/28	DRE	1202-68030	R*	M	AHY	Mg/Bk-W	T	Same-year recap; nested CVCA1; signal failed 8/12
	7/19	LLL	1713-67914	N	F	AHY	Mg/lB-mB-lB	T	Signal lost CVCA 7/22; relocated at CIBCR (nest 2) 8/11; signal lost 9/7
CVCA2	7/2	ICE	1202-68037	N	M	AHY	Mg/W-Y-W	T	Signal lost 7/13
	7/22	LJ	1212-13733	R	M	A4Y	W Ag/W O	T	Returned to previous breeding territory; nested CVCA2; signal lost > 8/1
	7/22	JLO	1713-67922	N	F	AHY	Mg/Y-Bk	T	Nested CVCA2 (LJ's mate); signal lost 7/31
CVCA3	6/24	SAL	1202-68028	N	M	AHY	Mg/Bk-Lv	T	Signal lost > 7/03
	6/24	PEP	1202-68029	N	F	AHY	Mg/Bk-mB	T	Re-sighted CIBEUC 6/28
PVER2	6/30	SLS	1202-68031	N	M	AHY	Mg/Y-Bk	-	Nested PVER1, PVER4 – PRI 's mate at two nests (PVER1-N1, PVER4-N10)
	7/29	TEE	1202-68034	N	F	AHY	Mg/G-mB	T	Signal lost > 8/6
	7/31	PUF	1202-68035	N	M	AHY	Mg/Ag-G	T	Nested PVER2 (x2); signal lost 9/4
	8/5	ODB	1202-68009	N	M	AHY	Mg/W-Bk-W	-	Nested PVER2 (last seen before nest failure)
	8/6	PUF	1202-68035	R*	M	AHY	Mg/Ag-G	T	Recaptured same season; re-nested PVER2; signal lost 9/4
PVER3	7/2	AA	1212-13752	R	M	A3Y	Bl Ag/R G	T	First captured 2010 PVER3; nested PVER3; T fell off by 8/10
	8/13	AFM	1713-67924	N	F	AHY	Mg/lB-Y-lB	-	Not observed after release
PVER4	6/22	GMF	1202-68021	N	F	AHY	Mg/W-Bk	T	Nested PVER4; transmitter failed
	7/3	QLA	1202-68032	N	F	AHY	Mg/Lv-mB	T	Nested PVER5; signal lost 8/22
	7/5	DOG	1713-67923	N	M	AHY	Mg/lB-W-lB	-	Nested PVER4; not re-sighted after nest fledged (7/12)
	7/7	EZE	1202-68033	N	M	AHY	Mg/Lv-R	T	Nested PVER4; signal failed by 8/9
	7/17	PRI	1222-90578	R	F	ASY	mB/Lv-Y	TG	Nested PVER1 (x1), PVER4 (x2); signal lost 9/3
	7/17	JAZ	1713-67915	N	M	AHY	Mg/Y-W	-	Not observed after release
	7/18	GBO	1202-68022	N	F	AHY	Mg/R-Y-R	T	Nested PVER4 (x2); signal lost 8/28
	7/20	DEF	1713-67921	N	M	AHY	Mg/Y-O	T	Nested PVER4 (2); signal lost 9/9
	7/30	GMF	1202-68021	R*	F	AHY	Mg/W-Bk	-	Same-year recap; removed failed transmitter
	7/30	WKA	1212-13757	R	F	TY	Y-Bk-Y/Ag	T	Recaptured chick from PVER2-N1-10 (AA = father); signal lost > 8/9
	8/14	GMF	1202-68021	R*	F	AHY	Mg/W-Bk	-	Recaptured for third time this season – new area
PVER5	7/29	BZB	1202-68006	N	M	AHY	Mg/O-Lv	T	Nested PVER5; signal lost 9/7
	8/2	LIO	1202-68007	N	M	AHY	Mg/R-Lv	-	Not observed after release
	8/4	JLY	1202-68008	N	F	AHY	Mg/Y-lB-Y	T	Signal lost > 8/6
	8/7	CHL	1202-68010	N	F	AHY	Mg/W-mB	-	Nested PVER5; re-sighted at nest 8/8
	8/8	GFK	1713-67906	N	M	AHY	As/Lv-O	T	Nested PVER5; signal lost 9/12
	8/8	MET	1713-67907	N	M	AHY	As/R-Lv-R	-	Not observed after release
	8/12	TOZ	1713-67908	N	F	AHY	As/lB-O-lB	-	Re-sighted 8/18 near PVER5-N5

[1] Band code: N = new capture, R = recapture, * = same-year recapture.
[2] Sex: By DNA.
[3] Age: AHY = after hatch year, ASY = after 2nd year, TY = 3rd year, A3Y = after 3rd year, A4Y = after 4th year.
[4] Colors (left/right, top bottom): Mg = magenta (Federal band), Ag = gold, As = silver (Federal band), Bk = black, Bl = blue, G = green, lB = light blue, Lv = lavender, mB = mid blue, O = orange, R = red, W = white, Y = yellow.
[5] Attachment: T = transmitter, G = Geolocator attached in 2011 removed.

Table 4-3.—Hatching-year yellow-billed cuckoos banded on the LCR, 2012

Band date	Site code	Nest #	Chick #	Parent(s)[1]	Federal band #	Band combo[2]
7/25	CIBCR	1	1	UNK	1202-68023	mB-Lv/Mg
7/25	CIBCR	1	2	UNK	1202-68024	Ag-R/Mg
7/25	CIBCR	1	3	UNK	1202-68025	O-Bk/Mg
8/24	CIBCR	2	1	LLL	1202-68061	Y-Lv/Mg
7/24	CVCA1	1	1	DRE	1202-68040	Y-lB-Y/Mg
7/24	CVCA1	1	2	DRE	1202-68041	R-lB/Mg
7/24	CVCA1	1	3	DRE	1202-68042	W-lB/Mg
7/11	PVER4	1	1	DOG	1202-68038	R-lB-R/Mg
7/11	PVER4	1	2	DOG	1202-68039	R-Bk/Mg
7/26	PVER4	5	1	GBO, PF	1202-68048	O-lB/Mg
8/11	PVER5	1	1	QLA	1202-68058	Lv-Bk-Lv/Mg
8/11	PVER5	1	2	QLA	1202-68059	Lv-G/Mg
8/1	PVER5	2	1	LIO?	1202-68049	Y-mB-Y/Mg
8/1	PVER5	2	2	LIO?	1202-68050	Bk-lB/Mg
8/7	PVER5	3	1	CHL	1202-68051	G-Lv/Mg
8/7	PVER5	3	2	CHL	1202-68054	Lv-W-Lv/Mg
8/7	PVER5	3	3	CHL	1202-68052	O-W-O/Mg
8/8	PVER5	4	1	BZB	1202-68055	Ag-Lv/Mg
8/8	PVER5	4	2	BZB	1202-68056	lB-Y/Mg
8/8	PVER5	4	3	BZB	1202-68057	Lv-R-Lv/Mg
8/6	PVER5	5	1	UNK	1202-68053	G-Y/Mg
9/2	PVER5	6	1	GFK	1202-68062	W-G/Mg
9/2	PVER5	6	2	GFK	1202-68063	Lv-O/Mg

[1] See tables 4-2 and 4-4 for details of parents (if known).
[2] Band color codes (top to bottom, left/right): Bk = black, Bl = blue, G = green, Go = gold, lB = light blue, O = orange, R = red, W = white, Y = yellow. "-" between colors indicates a split band.

Table 4-4.—Yellow-billed cuckoo re-sights, recaptures, and dispersal distances, LCR 2012

Dispersal type	YBCU ID	Color combo[1]	Sex[2]	2012 age[3]	Band site	Band date	Return site[4]	Re-sight date[5]	Time since banded[6]	Distance moved (m)[7]
Breeding	PF	O W/Ag Bl	M	A4Y	PVER2	8/3/09	PVER4*	8/05	3 years	1,100
	AA	Bl Ag/R G	M	ATY	PVER3	7/7/10	PVER3*	7/02	2 years	590
	LJ	W Ag/W O	M	A4Y	CVCA2	7/11/09	CVCA2*	7/22	3 years	110
	PRI	mB/Lv-Y	F	ASY	PVER4	8/7/11	PVER4*	7/17	1 year	12[8]
	BUT or CD or NUR	mB/(Bk+G)	M	ASY	PVER2 or CVCA1 or CIBCR	2011	PVER4*	7/21	1 year	1,450[9] 34,250 39,600
Natal	WKA	Y-Bk-Y/Ag	F	TY	PVER2	7/15/10	PVER4	7/30	2 years	1,780[10]
	HY '08[11]	P-Bl/Ag	U	5Y	CVCA1 or BWHB	2008	PVER4	7/26	4 years	
Within-season	LLL	Mg/lB-mB-lB	F	AHY	CVCA1	7/19	CIBCR	8/13	25 days	5,600
	PEP	Mg/	F	HY	CVCA3	6/24	CIBEUC	6/28	4 days	4,700
	SLS	Mg/Y-Bk	M	AHY	PVER2	6/30	PVER1	7/27	27 days	800
	SLS	Mg/Y-Bk	M	AHY	PVER2	6/30	PVER4	9/13	75days	1,180
Post-fledging	BGB	O-lB/Mg	U	HY	PVER4	7/27	PVER2	8/27 38d	31 days	1,470
							PVER4	8/15 26d	19 days	100
	BBZ	Ag-Lv/Mg	U	HY	PVER5	8/08	PVER5	9/03 31d	26 days	270
	B52	Y-mB-Y/Mg	U	HY	PVER5	8/01	PVER5	8/10 14d	9 days	230
							PVER5	8/14 18d	13 days	145
	B55	G-Y/Mg	U	HY	PVER5	8/06	PVER5	8/15 21d	14 days	420
							PVER5	9/03 35d	28 days	50
							PVER5	9/04 36d	29 days	30
	BDEF	UNB[12]	U	HY	PVER4		PVER4	9/03 23d		460
	BDEF	UNB[12]	U	HY	PVER4		PVER4	9/04 24d		465

[1] Colors (left/right; top to bottom): Ag = gold, Bl = blue, Bk = black, G = green, lB =light blue, Lv = lavender, Mg = magenta, mB = mid blue, O = orange, P = pink, R = red, W = white, Y=yellow. "-" indicates pinstripe band.
[2] DNA sex: M = male, F = female, otherwise not sexed.
[3] Age: HY = hatching year (juvenile), SY = second year, ASY = after second year, TY = third year, ATY = after third year, A4Y = after fourth year, 5Y = fifth year.
[4] * = Breeding confirmed at return site.
[5] For fledglings, includes age in days when re-sighted.
[6] Time (years or days) between banding and re-sight.
[7] Distance between natal or previous nest and 2012 nest unless otherwise stated.
[8] Distance between assumed 2011 nest and closest 2012 nest.
[9] Partial re-sight (combination of G and Bk) matched three possible birds. Most likely is BUT (the only breeding bird, also the closest).
[10] Distance between 2009 natal nest and 2012 capture site (nest not found 2012).
[11] In 2008, four nestlings (two at CVCA and two at Bill Williams Honeycomb Bend) were banded with the same color combination, and at least one was re-sighted in 2012. Without capturing and reading the individual band number, its identity and natal site remain unknown (though most likely CVCA1).
[12] BDEF was an unbanded juvenile seen being fed by DEF.

was by a 38-day-old from PVER4 Nest 5 who was re-sighted 1,470 m away in PVER2. It appeared to be with a nearby adult, though no food carries were observed. It was previously re-sighted at 26 days old 100 m from its natal nest (with both banded parents re-sighted nearby). Another 31-day-old was re-sighted 270 m from its nest during telemetry of its male parent who appeared to be feeding the juvenile. A 35-day-old was observed with an adult and another juvenile 50 m from its natal nest, though again no food carries were observed. It was previously re-sighted 420 m from its natal nest at 21 days old (see table 4-4).

Telemetry

We attached radio transmitters to 28 adult cuckoos and followed each between 0 and 22 days (averaging 9.6 days tracked, 37.2 points/bird, 4.1 points/bird/day; table 4-5).

Telemetry observations indicated that most birds (75%) stayed at their capture site within a defined territory until leaving the area whether they nested or not. The number of days spent at the capture site was related to eventual breeding status. We confirmed 16 birds as breeding by tracking them to 20 nests. Confirmed breeders spent significantly more days at their capture area (average 41.5 days, $n = 16$) than birds that left before breeding was confirmed (average 11.0 days, $n = 11$, t-test, $p < 0.0001$; table 4-6). Departure of birds from sites was steady throughout the season (figure 4-1). Birds leaving sites in the first half of the season (< July 24) stayed at least 1 to 29 days (average 12.3 days, $n = 9$) with no breeding evidence, and most were assumed to be migrating through the sites. Conversely, birds that left later in the season remained at their capture site longer (average 36.1 days, $n = 19$, two sample t-test, $p < 0.0001$), including 15 confirmed breeders.

Three birds left their capture site and were each later relocated at a separate site: one transient bird moved from CVCA3 south 4.7 kilometers (km) to Cibola Eucalyptus where she was briefly re-sighted during a June 28 survey; another transient bird captured at Cibola Crane Roost was briefly located (by telemetry) ~700 m west across the river, also at Cibola Eucalyptus, returning to his capture site shortly before his signal was lost on June 29; and a female captured at CVCA1 was found nesting 5.6 km to the south at Cibola Crane Roost. Four other birds moved at least 1 km away from their capture site to a contiguous site, two each at BWRNWR and PVER.

At BWRNWR, one male moved 1,600 m upstream of his Mineral Wash capture site to nest at Honeycomb Bend. Another male, also captured at Mineral Wash, moved 5 km downstream to Sandy Wash before temporarily settling 2.5 km upstream at Cougar Point. This bird occupied a probable breeding area; however,

Table 4-5.—Radio telemetry results and home range estimates of 28 adult yellow-billed cuckoos radio tracked at LCR sites, 2012

Site		Habitat size (ha)	ID	Sex[1]	Cap date	Last date	Breeding stage	# days tracked	Min. days	# pts	pts/day	MCP (ha)[2]	95% KDE (ha)	50% KDE (ha)
BWRNWR	Cougar Point	500	LIM	F	7/16	7/23	Possible nesting	4	8	41	10.3	2.6	7.4	1.4
	Mineral Wash		BLL	M	6/25	7/23	No evidence	9	29	34	3.8	192.4	24.1	12.0
			TRD	M	6/25	7/9	No evidence	9	15	28	3.1	10.2	14.8	2.8
			FMF	M	6/26	8/2	Pre- to nesting	6	38	37	6.2	40.5	16.2	1.9
			HED	M	7/10	7/12	No evidence	2	3	5	2.5	0.5	7.7	1.5
PVER	PVER2	160	TEE	F	7/29	8/4	No evidence	4	7	19	4.8	10.8	12.8	2.2
			PUF	M	7/31	9/3	Nesting x2	16	45	50	3.1	4.6	9.7	2.2
	PVER3		AA	M	7/2	8/3	Pre- to post-nesting	10	32	43	4.3	10.4	11.6	2.3
	PVER4		GMF	F	6/22	8/14	Pre- to post-nesting	10	55	44	4.4	10.7	15.8	2.7
			QLA	F	7/3	8/25	Pre-nesting, nesting	14	53	64	4.6	190.4	23.4	3.4
			EZE	M	7/7	8/19	Pre- to post-nesting	15	44	59	3.9	7.7	11.8	2.9
			PRI	F	7/17	9/1	Nesting x3	21	54	87	4.1	28.0	17.0	3.8
			GBO	F	7/18	8/28	Nesting, post-nesting	21	51	80	3.8	15.3	17.5	3.2
			DEF	M	7/20	9/8	Pre- to post-nesting	22	51	59	2.7	17.7	23.0	3.3
			WKA	F	7/30	8/9	No evidence	4	11	27	6.8	50.9	22.9	4.3
	PVER5		BZB	M	7/29	9/3	Nesting, post-nesting	15	42	49	3.3	21.0	23.2	4.8
			JLY	F	8/4	8/6	No evidence	2	3	9	4.5	4.7	15.3	3.0
			GFK	M	8/8	9/10	Nesting	22	34	48	2.2	10.4	13.2	2.3
CVCA	CVCA1	60	LWB	M	6/24	8/12	Pre- to post-nesting	17	50	67	3.9	20.3	21.6	3.3
			DRE	M	6/26	8/12	Pre- to post-nesting	12	47	52	4.3	10.6	19.0	3.1
			KIM	M	6/27	7/19	No evidence	10	23	45	4.5	31.8	28.0	5.1
	CVCA2		ICE	M	7/2	7/12	No evidence	5	11	17	3.4	3.7	10.4	3.0
			JLO	F	7/22	7/30	Nesting/failed	4	12	15	3.8	4.2	10.3	2.0
			LJ	M	7/22	8/1	Nesting/failed	6	14	16	2.7	5.4	12.9	2.6
	CVCA3	37	PEP	F	6/24	6/24	No evidence	0	1	0	–	–	–	–
			SAL	M	6/24	7/3	No evidence	3	10	9	3.0	4.3	13.5	3.2
Cibola	CVCA1/Crane Roost	60/57	LLL	F	7/19	8/29	Pre- to nesting	4	42	6	1.5	41.9	14.8*	1.9
	Crane Roost		SMA	M	6/19	6/29	No evidence	5	11	31	6.2	61.7	48.1	15.0
Mean (n = 28) > 9 pts (n = 23) tracked > 6 d (n = 15)								9.7 11.3 14.9	28.4 32 41.7	37.2 44 53.9	4.1 4.3 3.7	30.1 33.1 38.8	17.3 18.0 18.2	3.7 3.9 3.8

[1] Sexed by DNA; F = female, M = male.
[2] Minimum convex polygon.

Table 4-6.—Minimum number of days at site post-capture by breeding status, LCR 2012

Status	n	Minimum days at site	
		Range	Mean ± SD
Early departure (< July 24)	9	1 - 29	12.33 ± 8.96
No breeding confirmed	12	1 - 29	11.0 ± 8.19
Later departure (≥ July 24)	19	3 - 55	36.05 ± 17.63
Confirmed breeding	16	12 - 55	41.5 ± 13.06

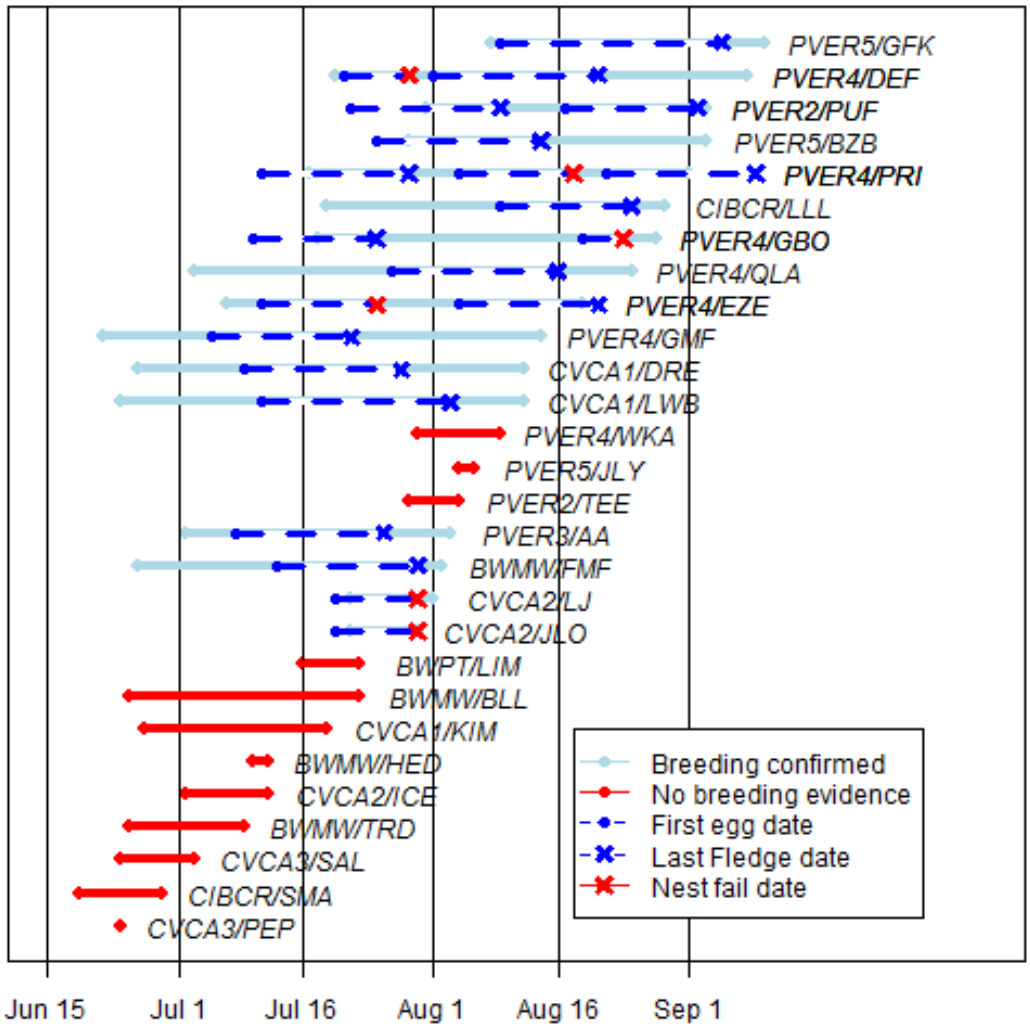


Figure 4-1.—Capture, last known presence, and nesting dates of tracked yellow-billed cuckoos, LCR 2012.
First circle = date of capture, last circle = date last detected at site (the following birds either dropped their transmitter or their transmitter failed, so for these birds, the last date represents when the bird was last re-sighted: PEP, AA, GMF, EZE, QLA, PUF). Birds are ordered by last known date at a site to show the regular departure of birds throughout the season. LLL was captured at CVCA1 and nested at Cibola NWR Crane Roost.

there were already two other birds in the same area (a probable pair). A female captured at Cougar Point probably nested close to her capture location (her home range overlapped an area where multiple food carries were seen); however, she left the area 6 days after capture before her breeding status could be confirmed. Two other BWR birds captured at Mineral Wash left or experienced transmitter failure shortly after capture. At PVER, a female moved 1,500 m west from PVER4 to PVER2 and then 3.6 km back east to PVER5 where she nested 2,100 m from her original capture location. A banded non-radioed male was re-sighted 800–1,200 m east of his PVER2 capture location, nesting at PVER1 and then PVER4.

The average home range size (95% KDE) of 27 birds tracked for at least 2 days was 17.3 ± 8.2 ha. MCPs we highly variable, averaging 30.1 ± 49.1 ha (median 10.7 ha). We found no significant differences in average home range size (MCP, 95% KDE, or 50% KDE) based on gender, breeding status, site, habitat patch size, number of points used, or number of days tracked ($P > 0.05$ for all ANOVAs), though birds with little data (either few points or days) tended to have relatively small home ranges. Females and non-breeding birds tended to have larger and more variable average home ranges compared to males and breeding birds respectively (table 4-7). Of 15 confirmed breeding birds with at least 10 location points, the average 95% KDE was 16.4 ± 4.8 ha. The home range of five non-breeding birds with at least 10 points was 25.1 ± 14.7 ha. The core range (50% KDE) averaged 3.7 ± 3 ha for all tracked birds. For nesting birds, the core range averaged 2.9 ± 0.8 ha (equivalent to a circle of radius 95 ± 50 m surrounding the nest).

Of eight LCR cuckoos fitted with geolocators in 2011, we recaptured one female in 2012. When first captured in 2011 at PVER4, we suspected she was the unbanded female at the failed PVER4 Nest 4. We recaptured her on July 17, 2012, at her previous capture location at PVER4, approximately 70 m from her suspected 2011 nest. After recapture, we removed the harness and geolocator and thoroughly examined her. She appeared healthy and showed no negative impacts from the leg harness attachment. After removing the geolocator, we fitted her with a transmitter and found her to be approximately 7 days into nesting at PVER1 nearby. She was radio tracked until September 2, when she apparently departed the site, leaving an active nest two days into the nesting stage. She nested at least three times in 2012; her nesting activities are described in the nest accounts for PVER1Nest 1, PVER4 Nest 8, and PVER4 Nest 10 (attachment C). The geolocation data were successfully downloaded and are reported separately.

DISCUSSION

This year we increased our banding effort, both at the BWRNWR to obtain home range estimates and at PVER due to the high number of cuckoos. This resulted in a 28% increase in the number of adults captured compared to 2011. We

Table 4-7.—Average home ranges in ha ± SD by gender, breeding status, and site, 2012 (Medians are included for MCPs due to highly skewed distribution.)

Factor	Group	Home range estimate, ha (mean ±SD)		
		MCP (median)	95% KDE	50% KDE
Gender	Male (n =17)	26.69 ± 45.51 (10.43)	18.16 ± 9.7	4.21 ± 3.65
	Female (n = 10)	35.95 ± 56.75 (13.04)	15.74 ± 4.98	2.79 ± 0.91
	Male ≥ 10pts (n = 15)	29.92 ± 47.65 (10.63)	19.17 ± 9.85	4.45 ± 3. 82
	Female ≥ 10pts (n = 8)	39.11 ± 63.12 (13.04)	15.91 ± 5.63	2.87 ± 0.97
	Male > 6 days (n = 11)	30.67 ± 54.2 (10.63)	18.17 ± 6.19	4.02 ± 2.81
	Female > 6 days (n = 4)	61.1 ± 86.53 (21.66)	18.45 ± 3.41	3.27 ± 0.48
Breeding status	Non-breeding (n = 7)	43.54 ± 69.18 (10.2)	20.93 ± 14.01	6.1 ± 5.24
	Breeding (n = 16)	27.46 ± 44.99 (12.99)	16.32 ± 4.66	2.86 ± 0.78
	Non-breeding ≥ 10pts (n = 5)	59.99 ± 77.42 (31.85)	25.07 ± 14.67	7.59 ± 5.57
	Breeding ≥ 10pts (n = 15)	26.5 ± 46.4 (10.66)	16.42 ± 4.81	2.93 ± 0.76
	Non-breeding > 6 days (n = 3)	78.15 ± 99.54 (31.85)	22.29 ± 6.75	6.65 ± 4.77
	Breeding > 6 days (n = 12)	28.95 ± 51.28 (12.99)	17.24 ± 4.92	3.12 ± 0.72
Site	BWRNWR (500 ha, n = 5)	49.25 ± 81.62 (10.2)	14.04 ± 6.9	3.94 ± 4.54
	Cibola NWR (57 ha, n = 2)	51.82 ± 14.03 (51.82)	31.47 ± 23.53	8.45 ± 9.26
	CVCA (64 ha, n = 8)	11.5 ± 10.76 (5.42)	16.51 ± 6.6	3.18 ± 0.98
	PVER (160 ha, n = 13)	29.44 ± 49.93 (10.75)	16.72 ± 4.96	3.12 ± 0.81
	All birds (n = 27)	30.12 ± 49.09 (10.66)	17.26 ± 8.24	3.68 ± 2.99

banded significantly fewer hatch year birds this year (23) compared to the previous year (35) despite a similar number of nests found, likely related to the large number of inaccessible nests (> 7 m high) this year (chapter 3).

Up to this year, our re-sight results have led us to speculate that male cuckoos have high site fidelity, and that both natal and breeding dispersal may be female-biased, as is the case for most bird species (Greenwood 1980). Of our few returns, all re-sighted males returned to their natal or previous breeding site, while two females (one ASY and one SY) dispersed 33–38 km to other areas (from CVCA to PVER and from CRIT to BWRNWR), the only long-distance dispersal events we have recorded to date. However, this year, apart from three adult males all returning to their previous breeding sites as expected, we recaptured two banded females at their previous breeding or natal area (one returning adult and one returning hatch-year-banded third year). It remains unclear whether female cuckoos actually have lower site fidelity than males as our data suggests, or if other factors are masking true female site fidelity, such as reduced visibility of females due to behavioral differences; in response to call broadcasts, female cuckoos are less likely to fly closer to surveyors than males (Halterman 2009), providing fewer opportunities to re-sight banded females. Possibly for the same reason, fewer female cuckoos are typically captured than males. Additionally, there are on average 33% fewer adult females in wild bird populations (Donald 2007). Clearly more data are required.

After a relatively high return rate of 12.5% among returning banded hatch-year birds last year, in 2012 we failed to re-sight any young banded in 2011. Given the

relatively high re-sight rate in previous years, it seems unlikely that none of the 35 banded 2011 hatch year birds returned to their natal site or nearby, and many likely went undetected. Four birds banded prior to 2011 were re-sighted for the first time in 2012, including a fifth-year and two after-fourth-year birds, our oldest known birds to date. This highlights the challenges of re-sighting banded cuckoos (male or female) and the need for continued long-term monitoring of banded subpopulations.

Several within-season movements between non-contiguous sites were observed this year, all in the Cibola area (CVCA and Cibola NWR/Eucalyptus). Previously, we had only recorded one within-season movement, also in the Cibola area, when a male captured at Cibola NWR Island Unit was relocated at CVCA1. These areas are relatively close to each other (within 5–6 km), closer than most other survey areas are to each other. Many sites such as Cibola Eucalyptus no longer appear to be suitable breeding habitat; however, these re-sights show they may be used as stopover habitat, which is important for connecting breeding habitat throughout the LCR.

Although dispersal is commonly believed to be easy or common among highly mobile species such as migratory birds, it is strongly influenced by ecological factors affecting dispersal costs (Weatherhead and Forbes 1994). Long-distance migrants often exhibit strong natal philopatry and only slightly higher mean dispersal distances compared to resident or less mobile taxa (Hansson et al. 2002; Ortego et al. 2008). In landscapes impacted by fragmentation, breeding birds must weigh the risk of mortality from dispersing through unfamiliar or hostile environments (Yoder et al. 2004) against the risk of inbreeding if they do not disperse (Hansson et al. 2004). Several studies have found reduced dispersal in isolated bird populations (Martin et al. 2006; Martín et al. 2008; Ortego et al. 2008), and western yellow-billed cuckoos are believed to have lower dispersal capabilities due to their habitat isolation and reduction (Bennett and Keinath 2003). Farrell (2006) found genetic evidence suggesting increased levels of inbreeding in western compared to eastern cuckoos.

Young cuckoos have previously been observed receiving parental care at least 2 (Laymon 1998) to 3 weeks post-fledging (Laymon and Halterman 1985). In 2011, we re-sighted two fledglings, 3 and 3-1/2 weeks post-fledging, both still apparently receiving parental care. This year, we witnessed juveniles with adults nearby, 4 to 4-1/2 weeks post-fledging. Additional information on post-fledging dispersal may help guide future management decisions such as September dove hunting at LCR MSCP breeding sites.

As found in previous years, telemetry results indicated that after cuckoos arrived at a site, they typically remained in one area over the length of their stay whether they nested or not. Some eventual nesters, as well as birds with unknown breeding status, were observed to make relatively large movements (1–5 km) prior to settling on a specific area. Just over one-third of the birds we tracked in

2012 (mostly during the first half of the season) left their capture site within 2 weeks, before breeding was confirmed. It is likely that some of these birds were migrating through the area and stopping at the sites long enough to replenish nutrients (Chernetsov 2006). In previous years, over one-half the birds we tracked appeared to be transient. More captured birds may have stayed to breed this year due to increased breeding habitat availability at PVER where an additional 57 ha of habitat became newly available (Phase 5). All adults captured and tracked at PVER before July 24 remained at PVER to breed. The only adults that departed PVER soon after capture were all captured relatively late in the season (July 29 to August 4) and may have nested earlier. Conversely, all other capture areas (BWR, CVCA, and Cibola NWR) showed relatively high transiency among captured adults (> 50% of all captures); these areas also saw little if any change in the amount of available breeding habitat (with the possible exception of Cibola NWR where we only captured one adult).

Our 2012 home range estimates were similar to our estimates from previous years (95% KDE averaging 21 ha) (McNeil et al. 2012). They average considerably smaller than estimates from other areas such as the San Pedro River (38.6 ha) (Halterman 2009) and Rio Grande (56.3 ha) (Sechrist et al. 2009) and may indicate differences in habitat area, quality, or prey densities. They may also be due to differences in tracking and estimation methods among researchers. This year, we also radio tracked five adults at the BWRNWR. We expected these home ranges to be larger than those at restoration sites and comparable to estimates from similar large, intact riparian forests on the Rio Grande and San Pedro River; however, we did not find this to be the case. A combination of small sample size, tracking difficulties, transiency, and possible transmitter failure limits the usefulness of our 2012 BWRNWR results; however, they suggest that these birds also settled into relatively small foraging/nesting areas.

Continued color banding, re-sighting, and telemetry at LCR breeding sites has enabled the assessment of annual responses to habitat of varying patch sizes, connectivity, and quality, and, if continued, may confirm or refute the existence of physical limits to dispersal in this region. We recommend continued long-term banding and monitoring of these as well as other western cuckoo breeding subpopulations.

Chapter 5 – Microclimate

INTRODUCTION

Birds respond directly and indirectly to microclimate variations depending on specific habitat preferences and life history traits (Champlin et al. 2009). A habitat's microclimate can affect a species' foraging and nesting decisions and can be an indicator of habitat suitability. For example, in extreme environments, birds may shift their habitat use based on physiological comfort (Champlin et al. 2009) or prey availability (Wachob 1996; Wilson et al. 2005). In the Southwestern United States, Walsberg (1986) documented that during the summer months, phainopeplas (*Phainopepla nitens*) selected relatively cooler habitats to balance thermoregulatory demands. Additionally, the importance of microclimate to nesting birds has been documented for several species (Hoekman et al. 2002; D'Alba et al. 2009; Robertson 2009). These studies found that small-scale temperature and/or humidity differences affected reproductive outcomes. However, few studies have specifically addressed avian habitat selection due to differences in microclimate in extreme desert riparian habitats where temperature and humidity likely have a strong effect.

A primary objective of this study is to determine breeding habitat selection and to compare habitat (including microclimate) characteristics between occupied and unoccupied sites. In 2010 and 2011, our results showed that microclimate at yellow-billed cuckoo nests had lower diurnal temperatures compared to available habitat (randomly chosen non-nest locations within occupied sites) (McNeil et al. 2011, 2012). Correspondingly, nests were also more likely to have higher diurnal relative humidity. No significant differences in humidity or temperature (diurnal or nocturnal) were found between occupied and unoccupied sites or between natural and restoration sites (McNeil et al. 2011, 2012). To achieve our objectives and further our understanding of microclimate influences on yellow-billed cuckoo distribution on the LCR, we continued to monitor microclimate in 2012 at occupied and unoccupied sites (sites were deemed occupied if there were detections in two or more of the five survey periods). We also compared microclimate between nests and available habitat.

METHODS

We used one model of Thermocron iButton® (Embedded Data Systems LLC) to measure temperature (DS1921G) and another model (DS1923) to measure both temperature and relative humidity (RH) during the 2012 breeding season. We programmed and uploaded data from iButtons® (hereafter called data loggers)

using a dual iButton® receptor interface cable and high-speed USB interface adapter (SK-IB-R Connectivity Kit made by Embedded Data Systems LLC) and One Wire Viewer© software (Maxim Integrated Products). The data loggers were set to record temperature and RH once each hour on the hour. They were programmed to record temperature to the nearest 0.5 °C and to 0.6% RH.

A stainless steel wire was glued to each data logger with epoxy before it was suspended from a 5.1 cm x 5.1 cm x 1 cm plastic container, which provided shade. The containers were painted to reflect solar gain and suspended with wire approximately 2 m above the ground in a tree closest to the center of microclimate monitoring plots. Data loggers were deployed in early to mid-June and randomly distributed at sites throughout the study region. Additional data loggers were placed below nests within a few days of discovery. We took care to conceal the data loggers and to minimize disturbance to nesting birds. Data loggers were retrieved between early and mid-September. We used a randomized complete block design where each survey site was designated as a block to control for inherent latitudinal and vegetative microclimate differences. Each data logger produced microclimate measurements through time during the breeding season (June–September), creating a repeated measures dataset. Temperature and RH data loggers were placed at 202 locations (183 random locations and 19 nests) within 41 sites; 107 loggers recorded temperature only (table 5-1).

Data Analysis

We averaged hourly data from each data logger to estimate diurnal (05:00:01-19:00:00) and nocturnal (19:00:01-05:00:00) means and maximum temperature and RH for each day. We used these measurements to determine microclimate differences between occupied and unoccupied sites and between nests and available habitat within occupied sites. For this last analysis, we truncated the data to between July 8 and September 15 when nests were active.

We used logistic regression general linear mixed-effects models to analyze temperature and humidity. Effects of Julian day and site were included as random effects in the models to analyze measurements through time and to account for latitudinal and vegetative microclimate differences within the study area. We used AIC_C and deviance residual goodness-of-fit tests to assess model fit; final models were checked for overdispersion. The variance-covariance matrices were scalar with a compound symmetry structure. We used odds ratios from the output of the logistic regression to evaluate the influence of microclimate on site occupancy and nest placement versus availability. An odds ratio greater than 1 indicates a positive relationship, whereas an odds ratio less than 1 signifies a

Table 5-1.—The number of data loggers by survey site at nests and at random locations within occupied and unoccupied sites

Site code	Occupied/ unoccupied[1]	Temperature and RH data loggers		Temperature only data loggers
		Nest[2]	Randomly located	Randomly located
BWBP	U	0	3	3
BWCR	O	0	3	3
BWER	O	0	2	4
BWFW	O	0	2	4
BWGR	U	0	2	4
BWHB	O	1	4	2
BWKR	O	0	2	4
BWMA	O	0	3	3
BWMD	U	0	2	4
BWMF	O	0	2	3
BWMW	O	0	1	3
BWNB	O	0	0	5
BWPT	O	0	3	3
BWSW	O	0	2	1
CIBCNT	O	0	1	2
CIBCR	O	2	1	3
CIBMP	U	0	1	2
CIBNTH	U	0	1	1
CRIT	O	0	3	1
CVCA1	O	1	2	3
CVCA2	O	1	2	2
CVCA3	U	0	2	3
HAVBR	O	0	3	3
HAVND	U	0	1	3
HAVPS	U	0	1	4
HAVTPR	O	0	2	2
IMP20A	O	0	1	0
IMP50	U	0	1	1
IMPSTH	O	0	1	1
LAG3	O	0	2	1
MLPR	O	0	1	3
OVRWP	O	0	0	2
PAHNTH	O	0	2	3
PAHSTH	U	0	1	3
PICSRA	O	0	1	2
PVER1	O	1	1	1
PVER2	O	3	2	4
PVER3	O	2	4	2
PVER4	O	8	3	4
YUEW	U	0	2	2
YUWW	U	0	3	3
Total	29 O/ 12 U	19	76	107

[1] Sites were deemed occupied if there were one or more detections in two or more of the five survey periods. Only occupied sites were used as available habitat for the nest site selection analysis.
[2] Only data loggers that measured temperature and humidity were place at nest locations.

negative relationship (Ott and Longnecker 2001). We performed separate analyses for nocturnal and diurnal RH and temperature due to high multi-collinearity among these four variables. We used the R statistical package 2.11.1 for all data analyses (R Development Core Team 2010).

RESULTS

Microclimate averages are displayed on figure 5-1 and in table 5-2. Both temperature and humidity showed temporal variation (figure 5-1). As expected, temperature and RH were negatively correlated, both diurnally (r_{75} = -0.778, r^2 = 0.606, n = 77, P < 0 .001) and nocturnally (r_{75} = -0.754, r^2 = 0.569, n = 77, P < 0.001). We found no effect of diurnal and nocturnal temperatures or RH on site occupancy (occupied vs. unoccupied sites) (tables 5-3 and 5-4).

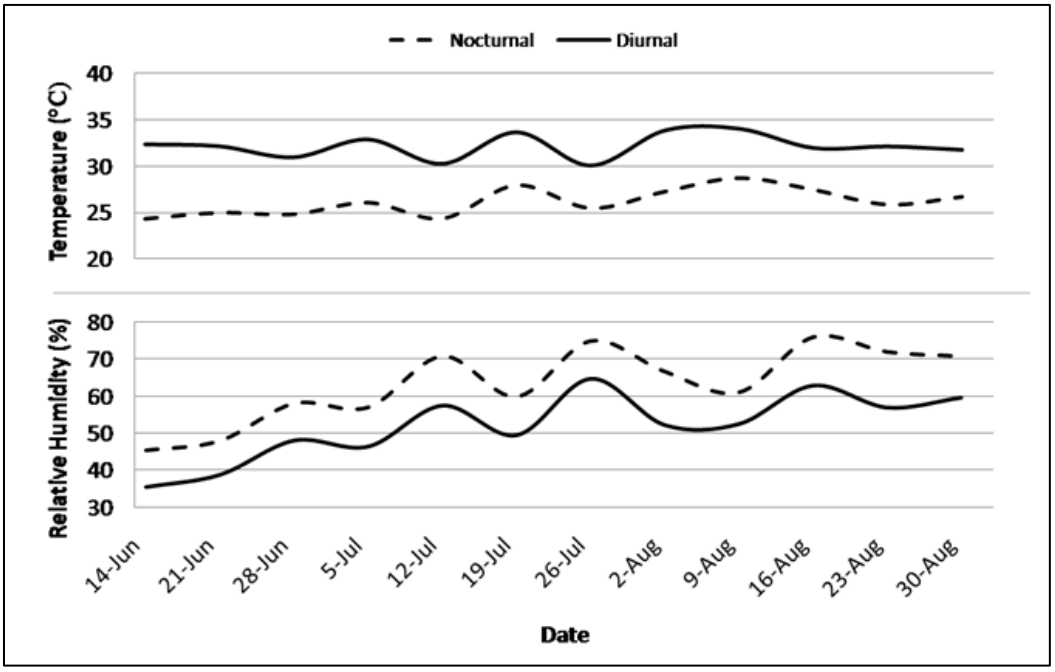


Figure 5-1.—Overall average diurnal and nocturnal temperature (°C) and relative humidity (%) averaged by week during the 2012 survey season.

We found that microclimate was significantly different at nests compared to available habitat (figures 5-2, 5-3, 5-4, and 5-5). These differences were significant when controlling for latitude and repeated measurements (tables 5-5, 5-6). Nest sites were more likely to be located in areas with lower diurnal temperatures and higher diurnal RH. Our results show a 28.1% increase in the odds of nest placement for every 1 °C decrease in average diurnal temperature and a 4.7% increase in the odds of nest placement for every

Table 5-2.—Microclimate averages and standard errors at restoration and non-restoration sites, occupied and unoccupied sites, nest habitat, and available habitat

Status[1]	Temperature (°C)		Humidity (% RH)	
	Diurnal	Nocturnal	Diurnal	Nocturnal
Restoration sites	33.08 ± 0.34 (n = 91)	26.84 ± 0.32 (n = 91)	50.43 ± 2.79 (n = 40)	62.74 ± 2.96 (n = 40)
Non-restoration sites	31.30 ± 0.31 (n = 89)	25.64 ± 0.31 (n = 89)	54.64 ± 2.60 (n = 37)	65.29 ± 2.85 (n = 37)
Occupied sites	31.77 ± 0.27 (n = 129)	26.01 ± 0.27 (n = 129)	54.32 ± 2.23 (n = 57)	65.60 ± 2.42 (n = 57)
Unoccupied sites	33.28 ± 0.47 (n = 51)	26.82 ± 0.42 (n = 51)	47.16 ± 3.58 (n = 20)	59.36 ± 3.80 (n = 20)
Nest habitat	29.86 ± 0.50 (n = 19)	26.03 ± 0.44 (n = 19)	59.16 ± 11.75 (n = 19)	79.41 ± 2.76 (n = 19)
Available habitat	31.91 ± 0.27 (n = 129)	26.42 ± 0.25 (n = 129)	57.30 ± 2.11 (n = 57)	68.93 ± 2.22 (n = 57)

[1] Occupied and unoccupied site averages were calculated by averaging data from each data logger on each day/night, then averaging the occupied and unoccupied sites. Site type (restoration and non-restoration) averages were also calculated this way. Nest habitat averages were calculated by averaging temperatures recorded from each data logger on each day/night placed at nest locations when nests were active. Available habitat averages used data from data loggers only at occupied sites that were not at nest locations. n = the number of data loggers used in calculating the respective averages.

Table 5-3.—Site occupancy (occupied sites compared to unoccupied sites) results of logistic regression mixed-effects models for average diurnal and nocturnal temperature and humidity, LCR 2012
(No significant results [P <0.05])

Microclimate variable	Odds ratio	Estimate	Standard error	Wald statistic *p*-value
Diurnal average temperature	0.902	-0.103	2.115	0.961
Nocturnal average temperature	0.941	-0.061	2.332	0.979
Diurnal average relative humidity	1.018	0.017	0.380	0.963
Nocturnal average relative humidity	1.013	0.013	0.387	0.973

Table 5-4.—Site occupancy (occupied sites compared to unoccupied sites) results of logistic regression mixed-effects models for maximum diurnal and nocturnal temperature and humidity, LCR 2012
(No significant results [P <0.05])

Microclimate variable	Odds ratio	Estimate	Standard error	Wald statistic *p*-value
Diurnal maximum temperature	0.943	-0.059	1.477	0.968
Nocturnal maximum temperature	0.933	-0.070	1.971	0.972
Diurnal maximum relative humidity	1.012	0.012	0.470	0.980
Nocturnal maximum relative humidity	1.010	0.010	0.426	0.982

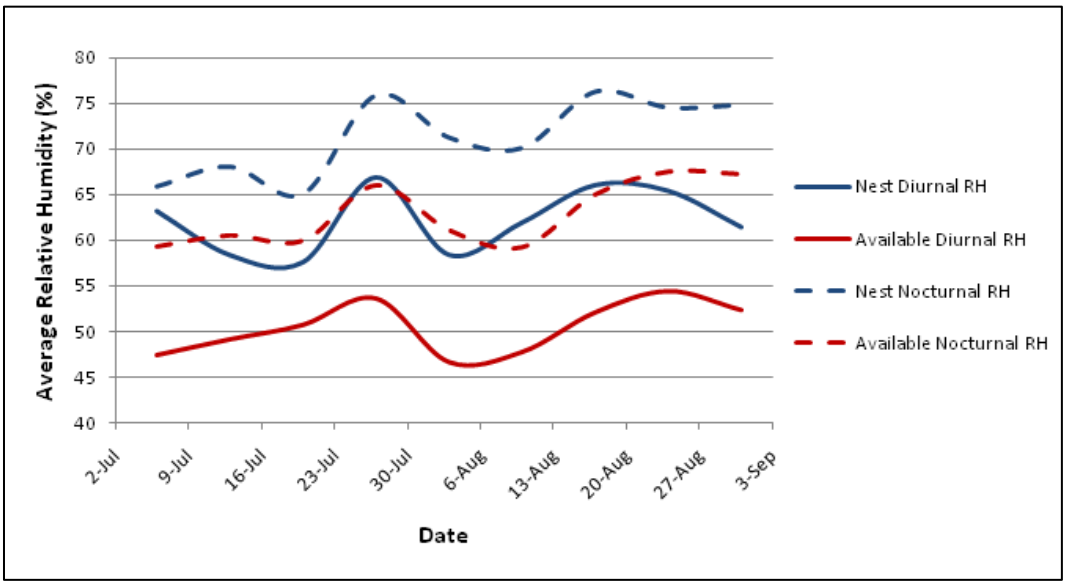


Figure 5-2.—Average diurnal and nocturnal relative humidity (%) by week during the peak breeding season at nest habitat and available habitat (within occupied sites only) during the 2012 season.

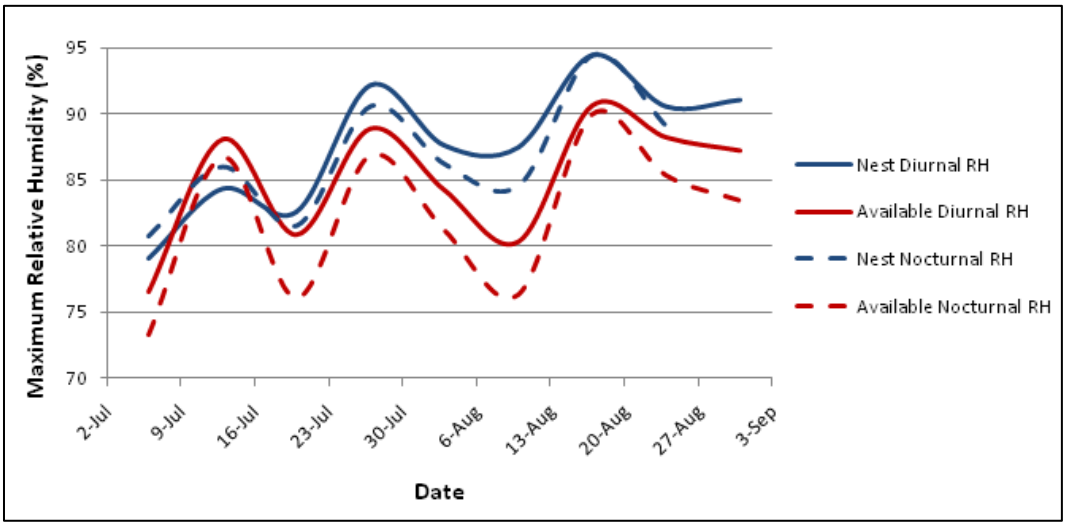


Figure 5-3.—Maximum diurnal and nocturnal relative humidity (%) by week during the peak breeding season at nest habitat and available habitat (within occupied sites only) during the 2012 season.

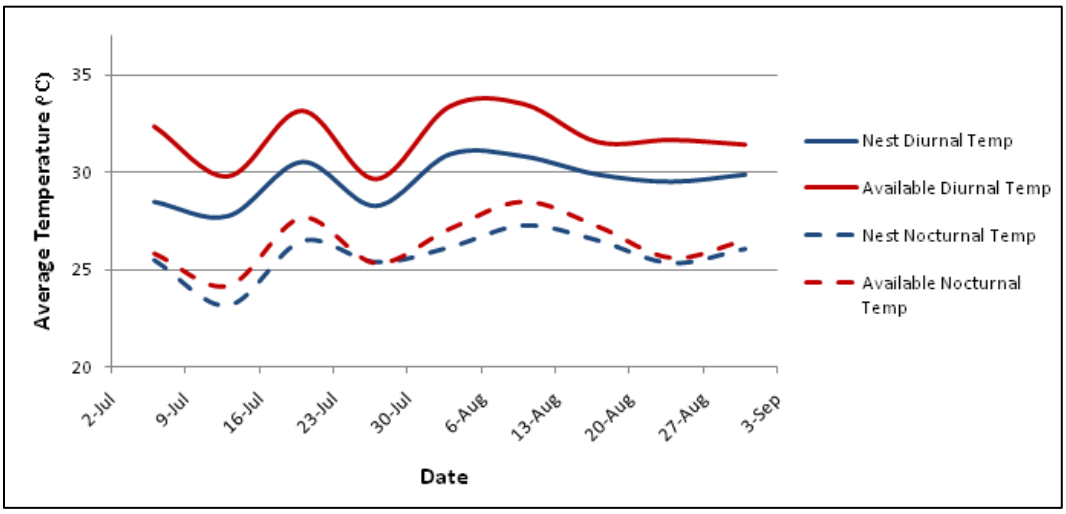


Figure 5-4.—Average diurnal and nocturnal temperature (°C) by week during the peak breeding season at nest habitat and available habitat (within occupied sites only) during the 2012 season.

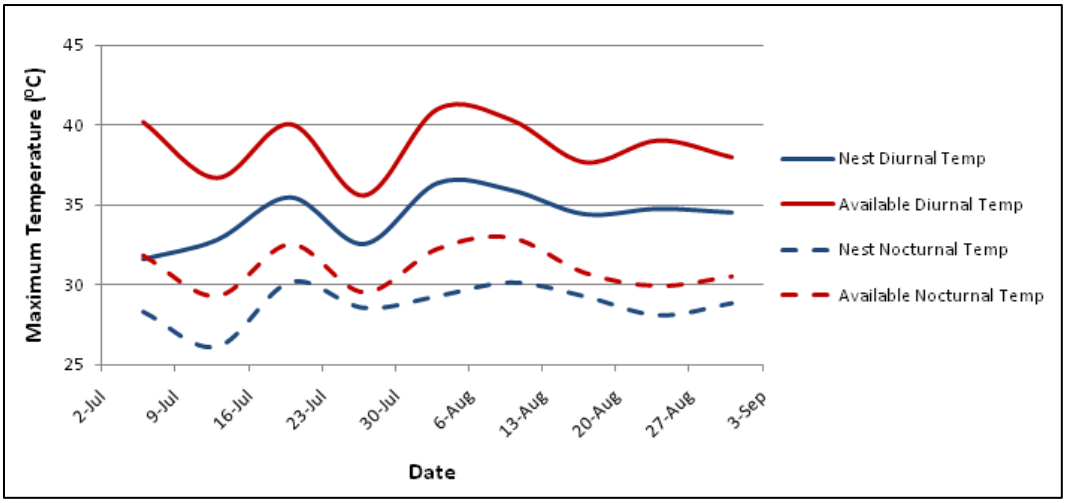


Figure 5-5.—Maximum diurnal and nocturnal temperature (°C) by week during the peak breeding season at nest habitat and available habitat (within occupied sites only) during the 2012 season.

1% increase in average diurnal humidity (table 5-5). Similarly, nest sites were more likely to be located in areas with lower nocturnal temperatures and higher nocturnal RH with a 4.7% decrease in the odds of nest placement for every °C increase in average nocturnal temperature and a 1.8% increase in the odds of nest placement for every 1% increase in average nocturnal humidity (table 5-5).

Table 5-5.—Nest site selection results of logistic regression mixed-effects models for average diurnal and nocturnal temperature and humidity, LCR 2012

(The odds ratio is used to interpret the difference in nest plots compared to available habitat for temperature and humidity. An odds ratio > 1 indicates a positive association with nest placement, whereas an odds ratio < 1 signifies a negative relationship.)

Microclimate variable	Estimate	Standard error	Wald statistic *p*-value	Odds ratio	95% LCL	95% UCL
Nest diurnal average temperature	-0.330	0.018	<0.001	0.719	0.694	0.745
Nest nocturnal average temperature	-0.048	0.013	0.016	0.953	0.929	0.978
Nest diurnal average RH	0.046	0.004	<0.001	1.047	1.039	1.055
Nest nocturnal average RH	0.018	0.003	<0.001	1.018	1.012	1.024

Table 5-6.—Nest site selection results of logistic regression mixed-effects models for maximum diurnal and nocturnal temperature and humidity, LCR 2012

(The odds ratio is used to interpret the difference in nest plots compared to available habitat for temperature and humidity. An odds ratio > 1 indicates a positive association with nest placement, whereas an odds ratio < 1 signifies a negative relationship.)

Microclimate variable	Estimate	Standard error	Wald statistic *p*-value	Odds ratio	95% LCL	95% UCL
Nest diurnal maximum temperature	-0.232	0.009	<0.001	0.793	0.778	0.808
Nest nocturnal maximum temperature	-0.212	0.012	<0.001	0.809	0.790	0.829
Nest diurnal maximum RH	0.018	0.006	0.006	1.018	1.005	1.031
Nest nocturnal maximum RH	0.013	0.006	0.022	1.013	1.002	1.025

DISCUSSION

We found no significant differences in humidity or temperature (diurnal or nocturnal) between occupied and unoccupied sites. The lack of association between site occupancy and microclimate suggests that cuckoos are not selecting sites based on temperature and humidity alone. Similar to our results in 2008–2011 (McNeil et al. 2010, 2011, 2012), our 2012 findings indicate that cuckoos are selecting cooler, more humid locations for nest placement particularly in relation to ambient diurnal microclimate. Likewise, there is evidence from numerous avian studies that microclimate plays a role in nest site selection (Beissinger et al. 2005; Rhodes et al. 2009; Robertson 2009). During the early stages of offspring development, microclimate must be regulated in the nest because embryos are unable to regulate their own temperature. Most species

maintain eggs at temperatures of 32–35 °C regardless of habitat, incubation strategy, or body size (Webb 1987; Williams 1996). Typical lethal limits have been found at extremes, with a lower limit of 25–27 °C and an upper limit of 40.5–44 °C (Webb 1987; Conway and Martin 2000). Breeding birds along the LCR are exposed to these types of upper limit extreme environmental conditions (often exceeding 43 °C in July) during nesting. Therefore, greater canopy cover and dense vegetation at the nest site (Laymon et al. 1997; McNeil et al. 2011) is likely required to provide a more suitable microclimate for nest incubation and rearing young. On the LCR in Arizona, southwestern willow flycatchers (*Empidonax traillii extimus*) chose nest sites that were more humid and had cooler mean temperatures relative to their available habitat (McLeod et al. 2008). Our results are similar in that cuckoos also selected nest sites at cooler and more humid locations, which may improve nest success. Ensuring that restoration sites have high humidity and areas of dense canopy, which result in decreased relative temperatures) (McNeil et al. 2011) may increase the availability of suitable nesting locations for yellow-billed cuckoos.

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ATTACHMENT A

Site Descriptions

A total of 49 sites (including 15 Lower Colorado River Multi-Species Conservation Program [LCR MSCP] restoration sites) were surveyed during the 2012 season, comprising approximately 1,300 hectares (ha) of woody riparian habitat. The sites are described by geographic area, with the most northerly sites presented first. Within these areas, the sites are listed alphabetically by site code. Some sites were removed, added, or altered in boundary extent, and this are indicated where applicable.

PAHRANAGAT NATIONAL WILDLIFE REFUGE

Lincoln County, Nevada (White River Drainage)

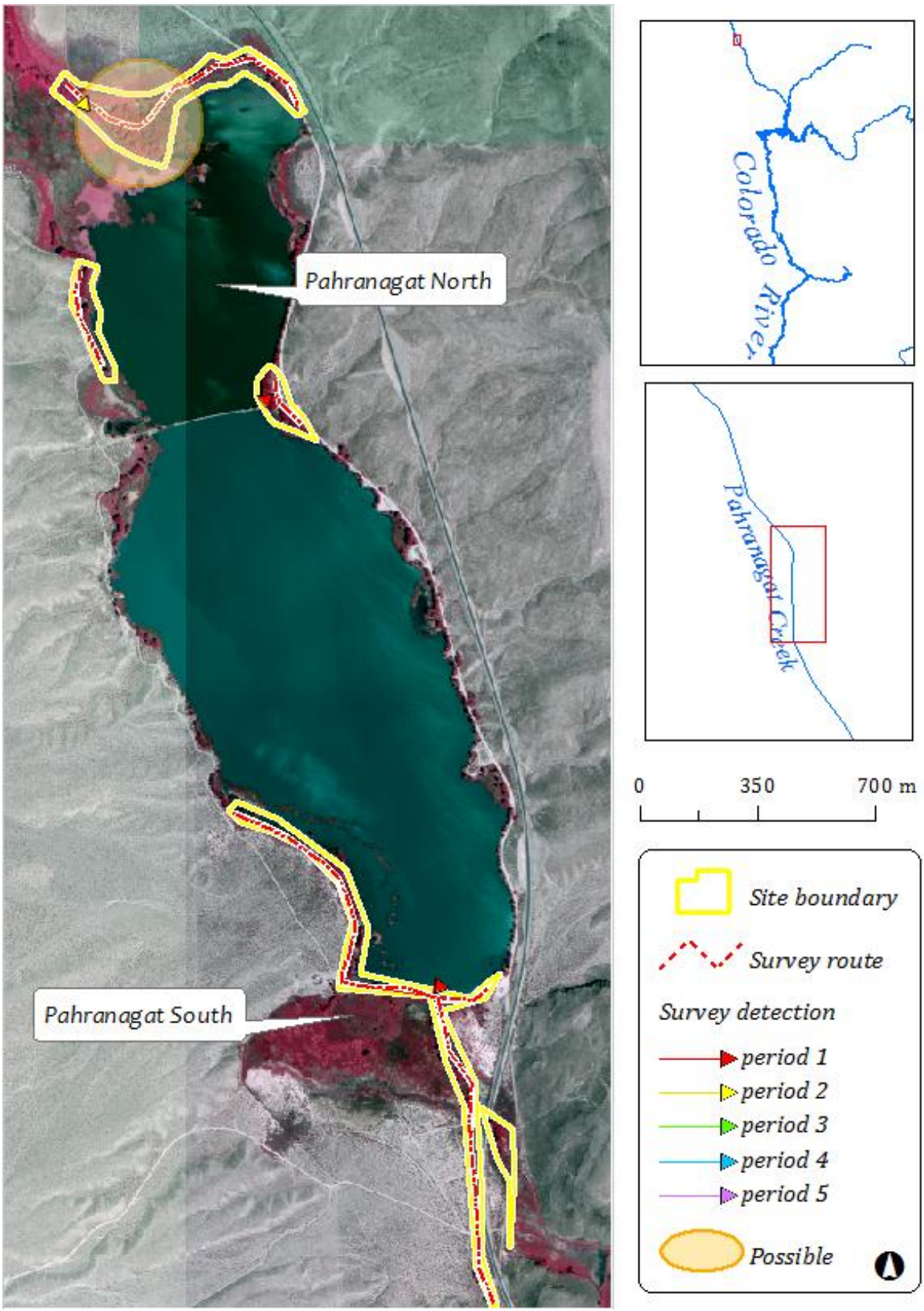
Pahranagat National Wildlife Refuge (NWR) is owned and managed by the U.S. Fish and Wildlife Service (USFWS). The refuge is approximately 145 kilometers (km) north of Las Vegas on U.S. Highway 93 near the town of Alamo. Within the Refuge there are four water impoundments managed as habitat for migratory birds. Water levels are kept highest during the winter for waterfowl habitat. The inlet and outlet of upper Pahranagat Lake are lined with mature Fremont cottonwood (*Populus fremontii*) and Goodding's willow (*Salix gooddingii*). Two sites along the perimeter and immediately below upper Pahranagat Lake were surveyed for cuckoos in 2008, 2009, and 2012.

Upper Pahranagat Lake North (PAHNTH) Elevation 1020 m; 16.8 ha

Upper Pahranagat North consists of a contiguous patch of native habitat surrounding the inlet of Pahranagat Creek as well as a narrow string of native habitat following the perimeter of the northern end of the lake. Mature Fremont cottonwood and Goodding's willow dominate the high canopy while a dense layer of yerba mansa (*Anemopsis californica*) and milkweed (*Asclepias speciosa*) provide a thick groundcover. Along Pahranagat Creek upstream of the site, extensive fields used for grazing extend up the valley toward the creek's water source, Pahranagat Springs. Adjacent upland vegetation is characteristic of the Mojave Desert in the region, dominated by creosote bush (*Larrea tridentata*) and Joshua trees (*Yucca brevifolia*). Minor adjustments were made to the route in 2009 when two survey points were moved from the edge to the interior of the habitat in order to provide better coverage of the area. Two detections were made during surveys in 2012, with one possible breeding pair (see table 2-2 and map A-1).

Upper Pahranagat Lake South (PAHSTH) Elevation 1020 m; 17.4 ha

The southern portion of Upper Pahranagat Lake has a narrow stringer of native riparian vegetation along the south and west shores of the lake as well as the first 900 meters (m) of the outlet channel downstream from the dam. Mature Fremont cottonwood makes up about 95 percent (%) of the overstory; the remainder is Goodding's willow. Young cottonwoods and willows make up the sparse understory. Cattails (*Typha* sp.) line the western edge of the riparian habitat near the southern outlet to Pahranagat Lake. Areas downstream of the survey stretch are drier and more typical of Mojave Desert vegetation. Surveys returned a single detection in 2012 (see table 2-2 and map A-1).



Map A-1.—Pahranagat NWR yellow-billed cuckoo survey detections and possible breeding territory, 2012.

OVERTON WILDLIFE MANAGEMENT AREA

Clark County, Nevada (Muddy River Drainage)

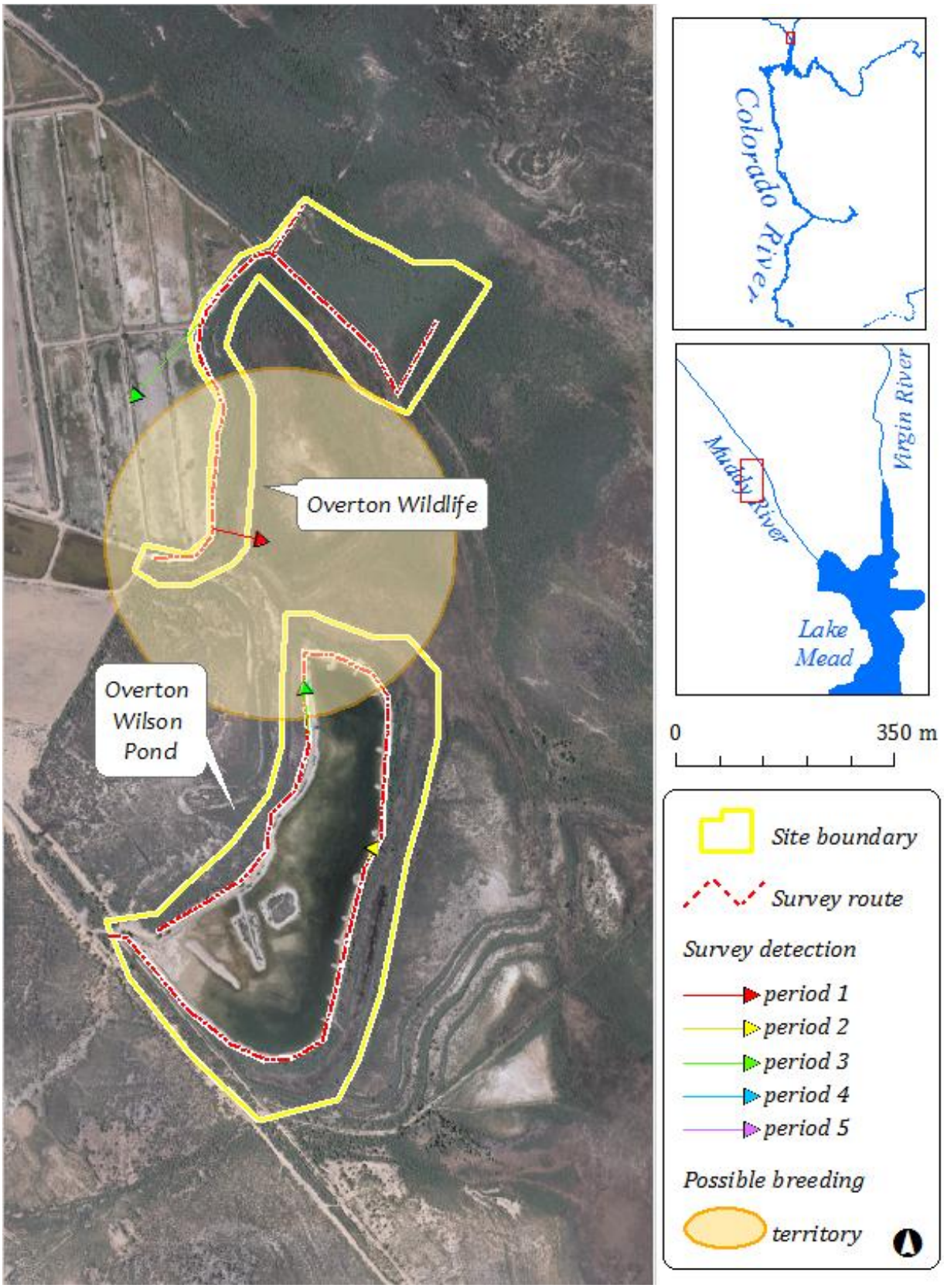
Overton Wildlife Management Area (WMA) lies in the Moapa Valley about 3.2 km south of Overton on SR 169. The WMA consists of 7,145.5 ha (17,657 acres) of Mojave Desert upland and riparian flood plain where the Muddy River flows into the Overton arm of Lake Mead. Nevada Department of Wildlife manages this area as wildlife habitat. Within the flood plain, 66 ha (165 acres) of agricultural crops, including barley and alfalfa, are grown to enhance habitat for migrating and wintering waterfowl. Most riparian habitat not managed for waterfowl has been invaded by tamarisk (*Tamarix* spp.). There are small patches of remnant Goodding's willow overstory with tamarisk understory along the main channel of the Muddy River. A narrow strip of Fremont cottonwoods lines the perimeter of the agricultural fields. Two sites were surveyed during the 2012 season (Overton Wildlife and Wilson Pond).

Overton Wildlife (OVRW) — Elevation 365 m; 10.1 ha

The survey route follows a line of young cottonwoods between an access road and fallow fields, continuing along the flood plain of the Muddy River. Dominant trees are Goodding's willow, which line the main channel, and tamarisk forming a dense understory. Young cottonwoods are also scattered through the site. Potential cuckoo habitat at this site is composed of a scattered mosaic of young cottonwood, willow, and tamarisk. Several fields to the west are dry during the cuckoo breeding season and flooded in the winter to provide waterfowl habitat. Upstream to the north, east, and south, patches of young tamarisk line the main fork of the Muddy River. Adjacent to the riparian vegetation are creosote bush-dominated Mojave Desert uplands. Two detections were made during 2012 surveys which, along with OVRWP detections, represented one possible breeding territory (see table 2-2 and map A-2).

Wilson Pond (OVRWP) — Elevation 365 m; 22.8 ha

This site was newly added in 2010 after several incidental cuckoo detections in 2009 by Bruce Lund. The riparian vegetation consists of cottonwood, Goodding's willow, tamarisk, and seep willow (*Baccharis salicifolia*). The survey route along the road is bordered by a thin stand of intermittent cottonwood and willow with abundant seep willow and tamarisk. Surrounding habitat is dominated by tamarisk. In 2012, two detections were made which, along with the OVRW detections, represented one possible breeding territory (see table 2-2 and map A-2).



Map A-2.—Overton WMA yellow-billed cuckoo survey detections and possible breeding territory, 2012.

HAVASU NATIONAL WILDLIFE REFUGE

Mohave County, Arizona (Colorado River Drainage)

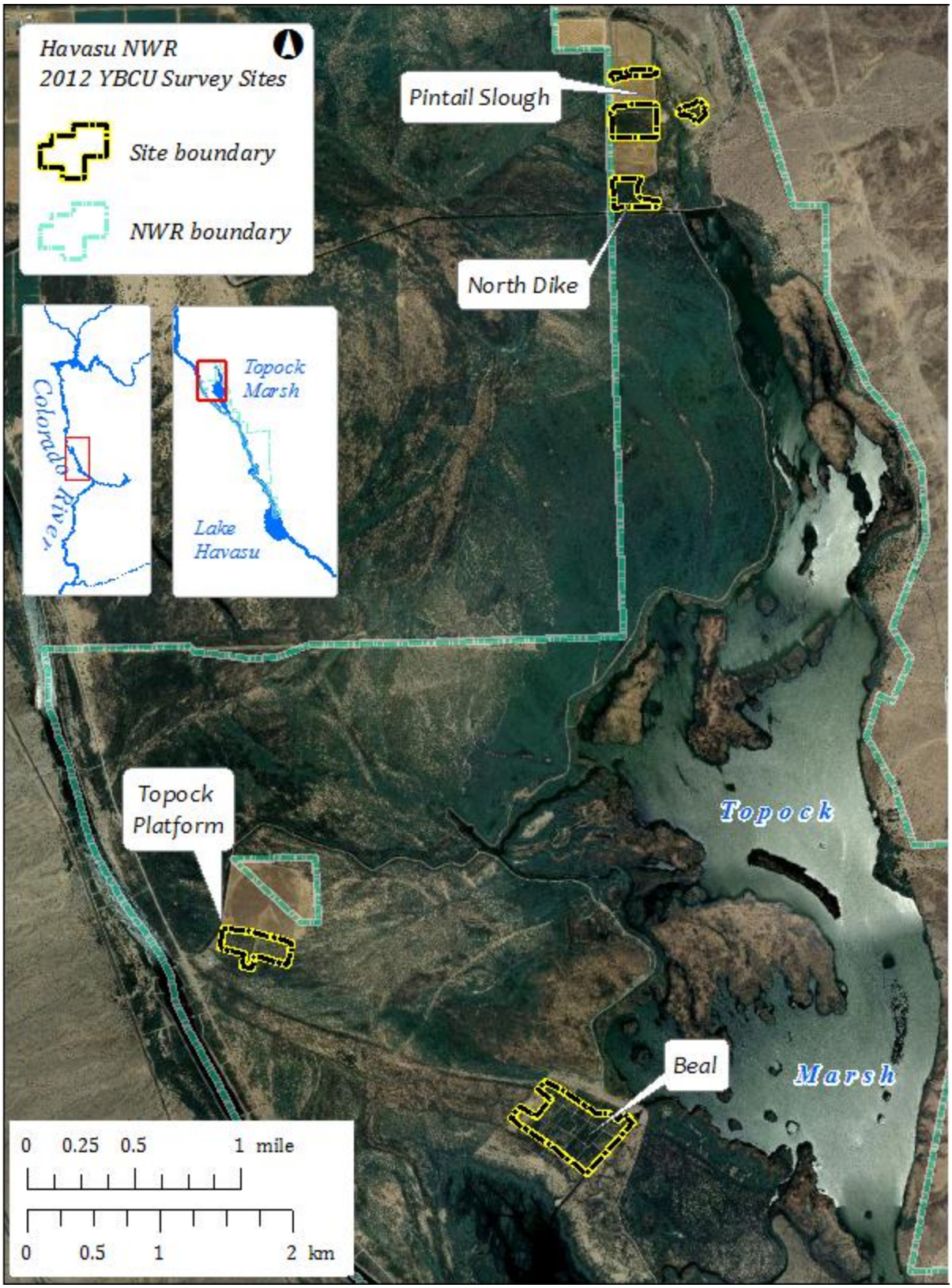
Havasu NWR was established in 1941 and encompasses over 30 river miles of the Colorado River and adjacent land from Needles, California, to Lake Havasu City, Arizona. Cuckoo habitat within the refuge is almost entirely within the Topock Marsh area, a historic river meander east of the main river channel currently managed as wildlife habitat. Water levels are increased in the early spring to benefit southwestern willow flycatchers and gradually lowered during the fall. Four sites were surveyed here in 2012 (map A-3), all restoration sites: two are on the north end of the marsh, separated by 350 m (Pintail Slough and North Dike), and the other two are 5–7 km southwest, between the main channel of the Colorado River and Topock Marsh (Topock Platform and Beal).

Beal Restoration (HAVBR) — Elevation 137 m; 21.3 ha

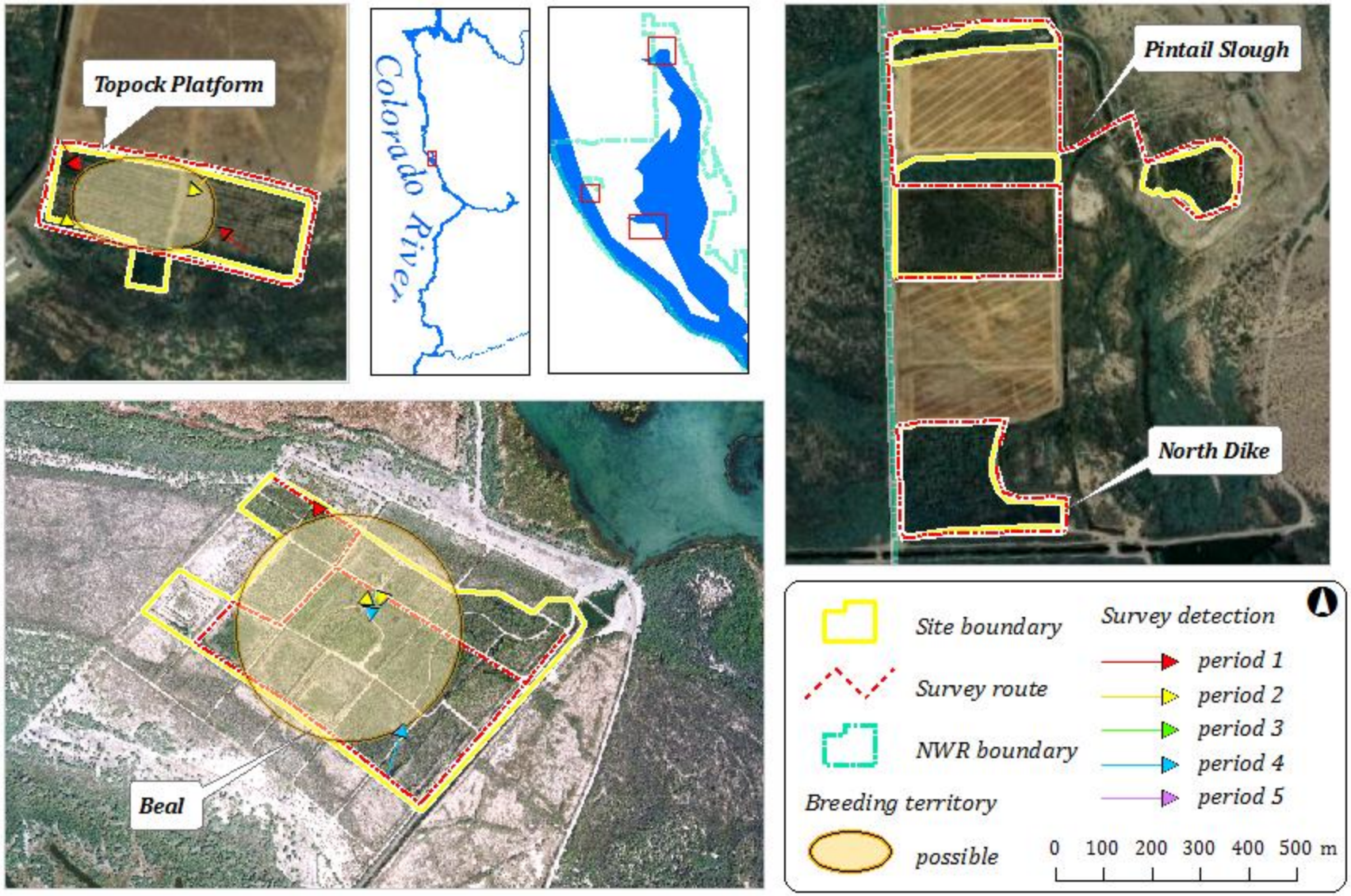
Beal lies approximately 3 km south of Topock Platform between Beal Lake and Topock Marsh. The site consists of a mosaic of native trees planted in the historical Colorado River flood plain. Approximately 21.3 of the 43.4 ha planted from 2003 to 2005 as part of Phases 1 and 2 (LCR MSCP 2006a) were surveyed for cuckoos in 2012. Nearly 5 ha of cottonwood and 4 ha of mixed Goodding's willow and mesquite were planted. The remaining area is relatively open with a sparse native overstory and an understory of arrowweed (*Pluchea sericea*), screwbean mesquite (*Prosopis pubescens*), and coyote willow (*Salix exigua*). The overstory averages 5–10 m high, with 10–100% canopy closure. The understory ranges from 1–3 m and covers about 40% of the area. Multiple access roads cross the site and define the perimeter. There is year-round water in an irrigation ditch bordering the southeastern edge of the site, which connects Beal Lake on the southwest with Topock Marsh to the northeast. In 2012, over three survey periods, five cuckoos were detected, representing one possible breeding pair (see table 2-3 and map A-4).

North Dike (HAVND) — Elevation 140 m; 5.1 ha

North Dike is a mature restoration site along the north dike of Topock Marsh. The patch has an overstory of Fremont cottonwood and Goodding's willow and an understory of seep willow and honey mesquite (*Prosopis glandulosa*). An agricultural field borders the site to the north. The site is surrounded by access roads, with a cement-lined irrigation canal along the western edge. To the south and west is a historic flood plain dominated by mesquite and tamarisk. Hunting activity occurs late in the field season. We had no cuckoo detections here in 2012 (see table 2-3 and map A-4).



Map A-3.—Havasu NWR yellow-billed cuckoo survey sites, 2012.



Map A-4.—Havasu NWR yellow-billed cuckoo survey detections and estimated breeding territories, 2012.

Pintail Slough (HAVPS) Elevation 140 m; 11.7 ha

This site consists of a narrow stand of large cottonwoods (50–60-centimeter diameter breast height) lining the slough, a restored field 250 m to the south, and another stand 300 m southeast. The slough is lined with cattails, and the surrounding understory is a mix of tamarisk, arrowweed and quail bush (*Atriplex lentiformis*). The southeast habitat is dominated by cottonwoods, which established naturally following flooding of nearby wintering waterfowl habitat. The southern planted field has a sparse overstory of cottonwoods and a dense ground cover of non-native Johnson grass. A system of access roads intersects the site. Water was present at the site intermittently through the season. No cuckoos were detected at this site in 2012 (see table 2-3 and map A-4).

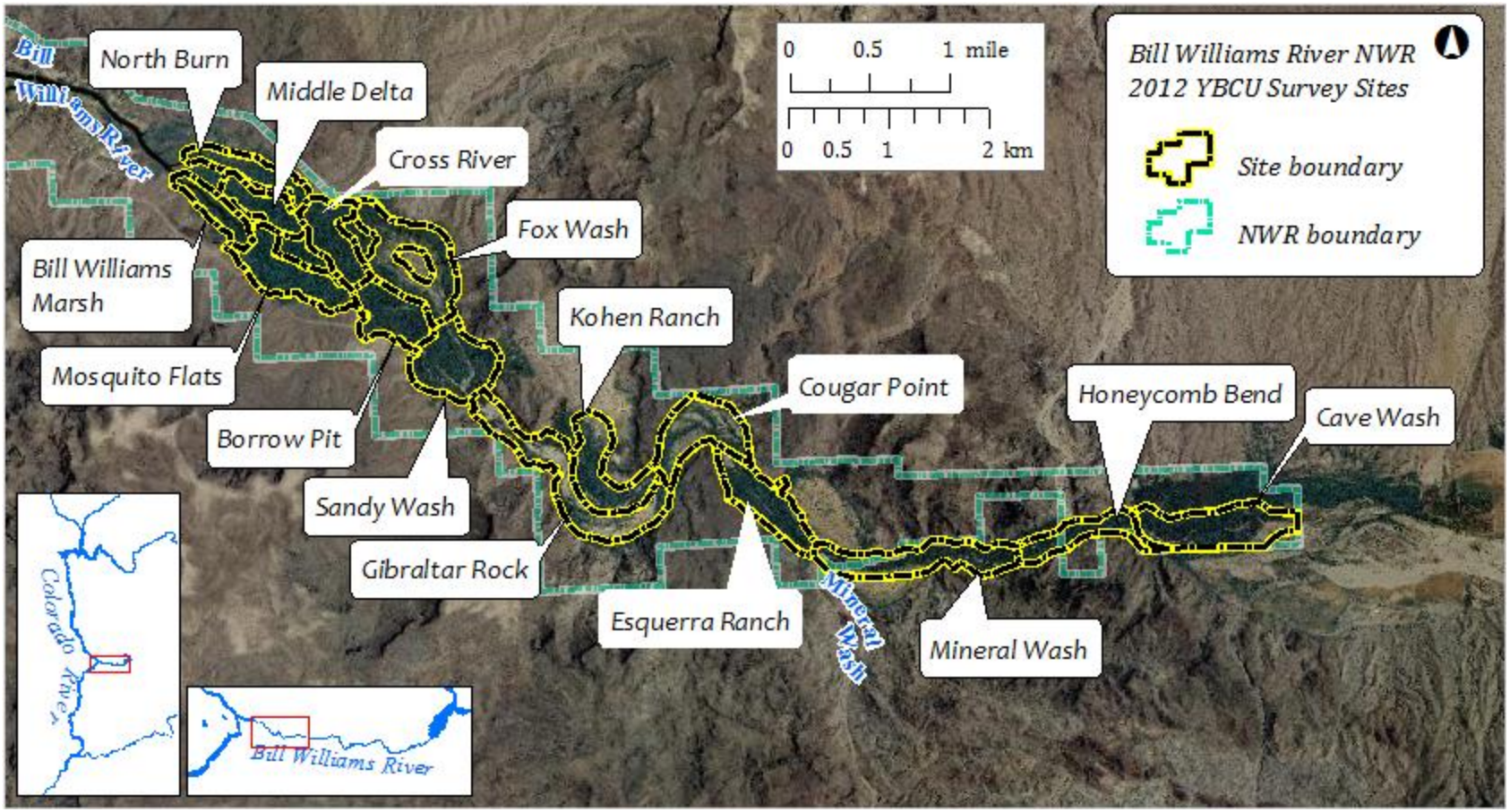
Topock Platform (HAVTPR) Elevation 141 m; 9.3 ha

The Topock Platform site was planted as a nursery for other restoration efforts and includes 8.8 ha (21.7 acres) of restored native habitat located next to fields flooded in winter for waterfowl habitat. During the summer, this habitat patch is dry and supports a healthy cicada population. Three distinct areas make up the site. The section adjacent to the public access parking and Topock Platform consists of Fremont cottonwoods and Goodding's willows with tall (8–14 m) moderate canopy cover. The understory is open, with about 20% cover of 1–5-m-high screwbean mesquite, Goodding's willow, and Fremont cottonwood. To the east is a stand of shorter and more sparsely planted young cottonwoods and willows. Along the southern edge is a small stand of dense mesquites. Bermuda grass (*Cynodon* sp.) dominates the ground cover throughout the site. The landscape to the south and east is dominated by extensive stands of quailbush, arrowweed, and dense tamarisk with a few remnant willows and mesquites. Three cuckoo detections were made in 2012, representing one possible breeding territory (see table 2-3 and map A-4).

BILL WILLIAMS RIVER NATIONAL WILDLIFE REFUGE

Mohave and Yuma Counties, Arizona (Bill Williams River Drainage)

The Bill Williams River NWR was established in 1941 and is located 14.3 km south of Lake Havasu City, Arizona. It consists of 2,430 ha (6,000 acres) of Bill Williams River drainage managed by USFWS to protect the largest remaining natural riparian habitat in the lower Colorado River Valley. This refuge extends from Lake Havasu upstream on the Bill Williams River for 16 km and historically supports the most extensive and productive yellow-billed cuckoo habitat in the lower Colorado River (LCR) watershed. Portions of the Bill Williams River contain perennial surface water. The managed hydrologic regime enables overbank flooding necessary for natural regeneration of native vegetation and persistence of cottonwood-willow forest. Regular winter releases from Alamo Dam since 2005 have resulted in recent natural riparian habitat regeneration. The habitat composition and structure in the eastern half of the refuge is significantly different from that found downstream from Gibraltar Rock in the western half. East of Gibraltar Rock, shallow underground bedrock and cliffs bordering the riparian area increase perennial flows and surface water; west of Gibraltar Rock the river channel widens into a sandy, broad flood plain, which persists to the western edge of the refuge at its interface with Lake Havasu. Fifteen survey sites within the BWRNWR, covering over 700 ha (1,680 acres) of potential cuckoo habitat, were surveyed in 2012 (map A-5).



Map A-5.—Bill Williams River NWR yellow-billed cuckoo survey sites, 2012.

Bill Williams Marsh (BWMA) Elevation 133 m; 19.7 ha

This route is surveyed by kayak and provides access to habitat within the broad western flood plain. The route follows the main channel of the Bill Williams River, which floods seasonally from upstream waters, and is periodically inundated by fluctuating lake levels. The riparian habitat consists of cottonwood-willow with a dense understory of tamarisk. The shore is lined with cattails. There is regular boating and fishing activity at this site. The 2009 Saguaro Slot (BWSS) route paralleled this route from the xeric uplands and covers the same area, so the two sites were merged in 2010. Three cuckoo detections were made at this site in 2012, but no breeding activity was suspected at this site because most detections were attributed to an adjacent Mosquito Flats territory (see table 2-4 and map A-6).

Borrow Pit (BWBP) Elevation 140 m; 33.6 ha

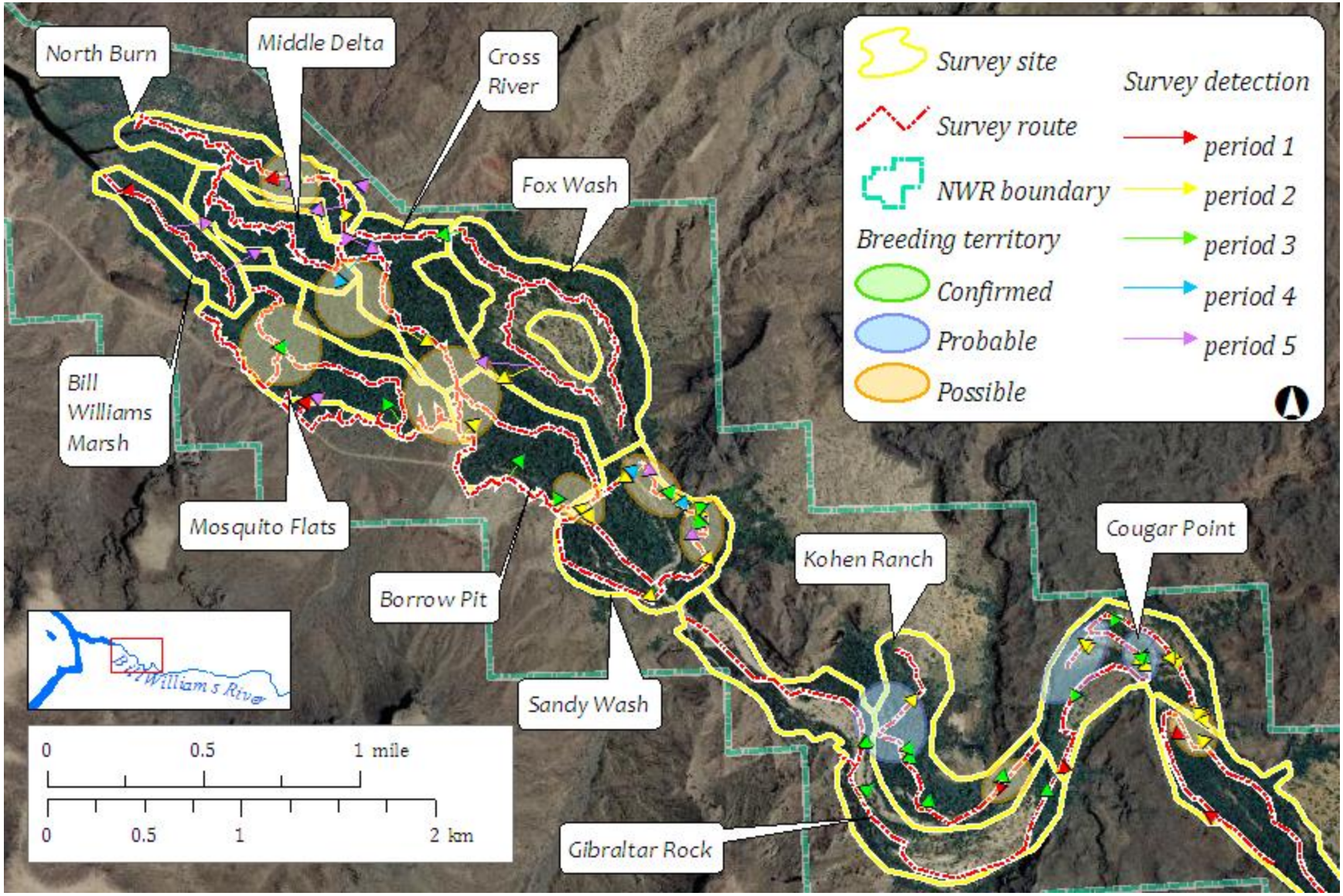
This route was created in 2009 and follows a trail along an old river channel paralleling the west end access road. The survey is conducted from the dry river channel and bluffs overlooking the habitat. It connects Cross River to the west and Sandy Wash to the east. The habitat along the southern half of the route contains mature riparian cottonwood-willow forest with a dense tamarisk understory. The northern half includes occasional dense stands of tall cottonwoods and willows and extensive dense tamarisk. There were small ponds of standing water present on the site until mid-July. There were three survey detections in 2012, representing one possible breeding territory (see table 2-4 and map A-6).

Cave Wash (BWCW) Elevation 175 m; 56 ha

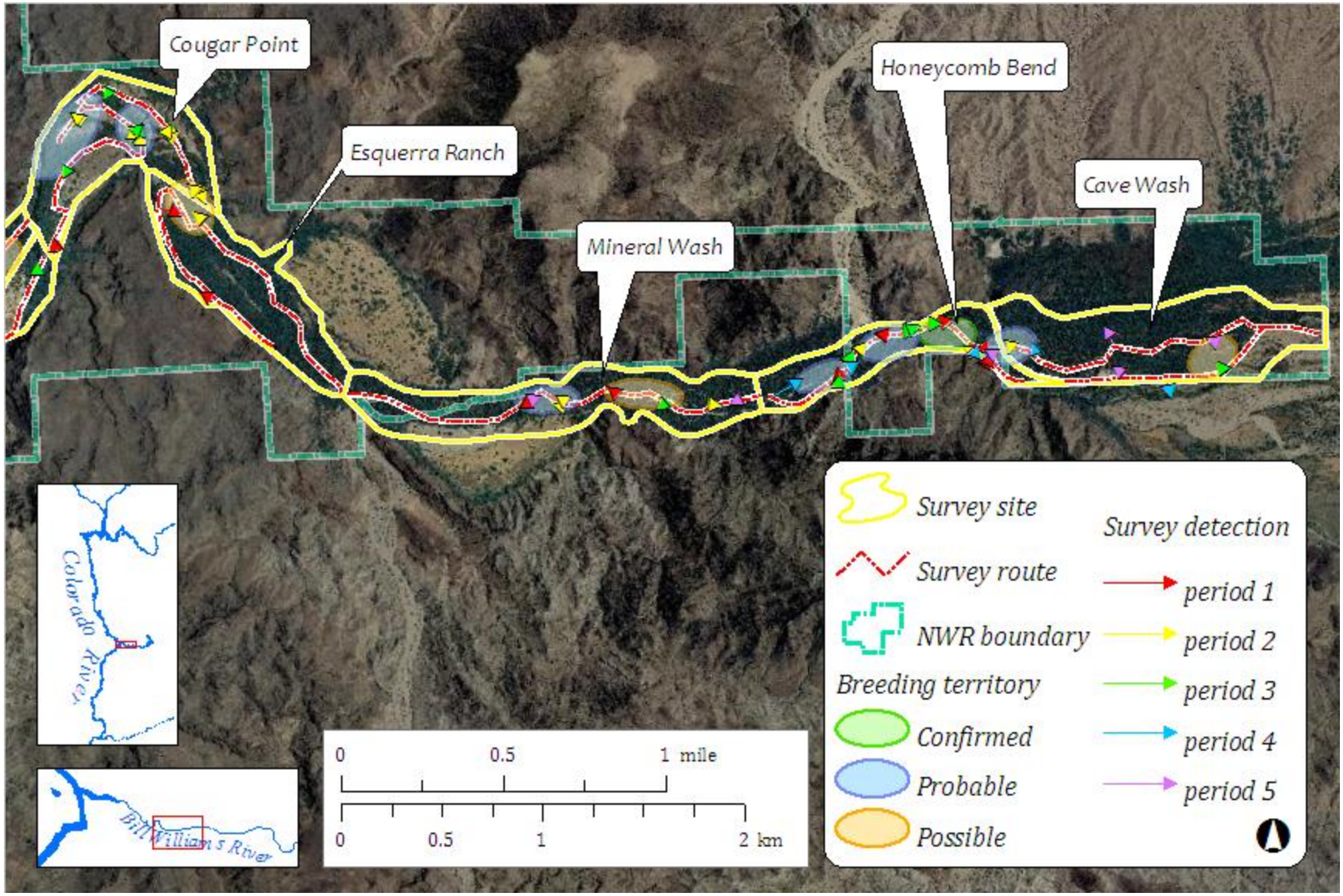
This site borders the eastern edge of the refuge. The surveyed area included portions of Planet Ranch until 2012 when an ownership change caused loss of access. This section of the refuge consists of a broad riparian area with historic and recently formed river channels. The survey route follows the river channel. There are extensive areas of dense tamarisk, although the vegetation is predominately native. Water is seasonally present in some side channels and perennial in the main channel. The main channel is lined with young cottonwood, willow, and tamarisk averaging 8 m high, surrounding dense marsh vegetation. There were seven survey detections in 2012, representing one possible and one probable breeding territory (see table 2-4 and map A-7).

Cougar Point (BWPT) Elevation 165 m; 43.1 ha

This site is the western section of the pre-2009 Big Bend route and lies between the Esquerra Ranch and Gibraltar Rock routes. The route follows the river bend around Cougar Point. The northernmost part runs through an area of extensive forest, which regenerated following 2005 flooding. The southern part skirts older forest along the old main river channel, which is composed of cottonwoods, willows, and a dense understory of tamarisk and arrowweed. Several meanders contain perennial water. There were 10 survey detections in 2012, with two probable breeding territories (see table 2-4 and map A-7).



Map A-6.—Bill Williams River NWR west yellow-billed cuckoo survey detections and estimated breeding territories, 2012.



Map A-7.—Bill Williams River NWR east yellow-billede cuckoo survey detections and estimated breeding territories, 2012.

Cross River (BWCR) — Elevation 140 m; 30.2 ha

This route was established in 2009 and bisects the Bill Williams River delta approximately 1 km upstream of Lake Havasu. It connects Borrow Pit to the south and North Burn to the north. The site is primarily composed of tall cottonwoods and willows with a mixed native and dense tamarisk understory. There are also smaller patches of younger cottonwood-willow forest and occasional monotypic patches of dense tamarisk. Multiple old river channels meander through the site. The site is bordered both upstream and downstream by contiguous riparian habitat. There were four survey detections in 2012, representing one possible breeding territory (see table 2-4 and map A-6).

Esquerra Ranch (BWER) — Elevation 165 m; 40.2 ha

This site is the eastern section of the 2008 Big Bend route, which was split in 2009 to increase coverage of the habitat, and lies between the Mineral Wash and Cougar Point routes. The name Esquerra Ranch was chosen after consulting with refuge personnel who do not use the name "Big Bend." The route begins at the intersection of Mineral Wash Road and the Bill Williams River. The route makes a loop downstream along the current river channel to a river bend (also known as Cougar Point) and then upstream along an old (pre-2005) river channel. Both channels contain perennial water and are lined with cottonwoods, willows, and a dense understory of tamarisk and arrowweed. Active beaver dams create regularly spaced ponds along both stream channels. The site is bounded by a steep cliff on the southwest and a broad dry upland area (the former Esquerra Ranch) to the northeast. Within the survey site there were three survey detections in 2012, with one possible breeding territory (see table 2-4 and map A-7).

Fox Wash (BWFW) — Elevation 140 m; 62.5 ha

This route lies north of Sandy Wash and ends in a wide flood plain to the west. Scattered dense bands of tall cottonwoods and willows line the main channel. Narrower and more open native vegetation line several of the older channels. The interior is open with patches of scrubby tamarisk, while narrow patches of marsh vegetation surround remnant pools along the main channel. Mature cottonwood and mesquite are interspersed throughout the site. There were three survey detections in 2012 and no evidence of breeding (see table 2-4 and map A-6).

Gibraltar Rock (BWGR) — Elevation 145 m; 66.5 ha

This site is located between the Cougar Point and Sandy Wash sites and south of the Kohen Ranch site. Prior to 2011, the survey route was very long and followed an old road and the old river channel. In 2011, the route was truncated to include only the eastern, old river channel portion. This eastern portion of the route is generally xeric and open with patches of large native trees and a dense understory of tamarisk. The western portion of the route traverses along the old refuge road under "Gibraltar Rock"; since 2006, no cuckoos have ever been detected along this stretch of the route. Water was present in the main channel of the site early in the season, but the site was completely dry by August. There were five survey detections in 2012 (all attributed to possible Kohen Ranch breeding territories) and no suspected breeding activity within the site (see table 2-4 and map A-6).

Honeycomb Bend (BWHB) Elevation 170 m; 29.6 ha

This route follows a narrow stretch of the Bill Williams River, connecting with Cave Wash to the east and Mineral Wash to the west. Tall cottonwoods and willows with a dense understory of willow, arrowweed, and tamarisk dominate the multi-structured habitat. The river is perennial, and multiple beaver dams have created ponds lined with dense willows, cattails, and tamarisk. The riparian area is restricted by surrounding cliffs. Intermittent overbank flooding occurs at the site. The ground cover is sparse and dominated by leaf litter. In 2012, we had 16 survey detections with 1 confirmed (nest) and another 2 probable breeding territories (see table 2-4 and map A-7).

Kohen Ranch (BWKR) Elevation 145 m; 37.1 ha

This site covers areas of natural regeneration following prolonged flooding during 2005–06. The route passes through mature cottonwood-willow forest as well as a mix of park-like vegetation, with a high cottonwood overstory and Bermuda grass ground cover. There is a 2009 USFWS mesquite restoration site on the edge of this route, which may be included in future surveys. The Bill Williams River flowed through the site for the duration of the field season. We had six survey detections in 2012, representing one possible and one probable breeding territory (see table 2-4 and map A-6).

Middle Delta (BWMD) Elevation 135 m; 25.2 ha

This site was added in 2009 and traverses an extensive patch of mature, mixed exotic vegetation extending upstream of the Bill Williams River delta between the Bill Williams Marsh and North Burn routes. The eastern (upstream) end of the route has extensive patches of mature cottonwood overstory with an open understory. To the west, the overstory consists of patches of mature willow, which become sparse closer to Lake Havasu. The understory is dominated by dense tamarisk. Although no water was found within the site, the western end is bordered by two forks of the Bill Williams River delta. There were no survey detections at this site in 2012 (see table 2-4 and map A-6).

Mineral Wash (BWMW) Elevation 165 m; 49.8 ha

This linear route is located between Honeycomb Bend and Esquerra Ranch, following the river channel from a restricted canyon bordered by cliffs to an open flood plain bordered by old agricultural fields. The river is lined with bands of tall dense willows, large cottonwoods, and an understory of willows, tamarisk, arrowweed, mesquite, and marsh vegetation. Perennial water flows through the site, and seasonal flooding occurs during winter and summer rains. A public access road follows Mineral Wash, and there is some recreational activity where the road terminates at the river. In 2012, there were nine survey detections representing one possible and one probable breeding territory (see table 2-4 and map A-7).

Mosquito Flats (BWMF) Elevation 140 m; 37.1 ha

This route was significantly modified in 2010. The western section was formerly surveyed from bluffs overlooking the riparian habitat; skirting along the edge of the riparian habitat was ceded to the Bill Williams Marsh route for logistical reasons. The riparian habitat at the western end of the refuge spreads out into a wide flood plain. The 2008 route followed the southern edge of the habitat, but in 2009, the route was moved to follow a new trail accessing more of the dense cottonwood-willow forest with occasional stands of tamarisk and scattered mesquite in the interior of the site. Both the 2008 exterior and 2009 interior routes were surveyed in 2012. There is light visitor use in the summer, and some vehicle traffic on the main road to the south. The water table is high here, and there were several standing ponds and water-filled side channels on or near the route. There were four survey detections in 2012 and one possible breeding territory (see table 2-4 and map A-6).

North Burn (BWNB) Elevation 133 m; 30 ha

The route begins at the northern branch of the Bill Williams River slough and continues along that channel. The overstory ranges from 8–18 m high and provides around 70% cover, while the understory is 2–8 m, providing around 75% cover. The route encompasses two distinct habitat types. The eastern third of the site is a mixed native forest with a mature cottonwood-willow overstory. The western two-thirds of the site are dominated by tamarisk. This area burned in 2005 and regenerated with mostly tamarisk and quailbush. The site is surrounded by tamarisk-dominated flood plain and Sonoran Desert upland habitat to the north and east. There were six survey detections in 2012, with one possible breeding territory (see table 2-4 and map A-6).

Sandy Wash (BWSW) Elevation 145 m; 50.9 ha

This route connects Gibraltar Rock to the southeast, Fox Wash to the north, and Cross Rive to the northwest. This section of the refuge gradually widens into a flood plain laced with dry river channels. The route makes a loop around the eastern end of the broad flood plain, following an old road and river channel. The site is structurally diverse, with an overstory of tall cottonwoods and willows with a tamarisk-dominated understory on the southern edge, mature tamarisk in the central part, and tall dense native-dominated cottonwood-willow to the east. There was standing water along the old river channel at the eastern part of the site during the field season, but the rest was dry. Hikers and researchers frequently use this easily accessible route. There were 13 survey detections in 2012, with three possible breeding territories (see table 2-4 and map A-6).

‘AHAKHAV TRIBAL PRESERVE

Colorado River Indian Tribal Lands, Arizona

‘Ahakhav Tribal Preserve lies along the Colorado River approximately 3.5 km southwest of Parker, Arizona. The site is bordered by Mojave Road to the south and agricultural fields to the east and west. Established in 1995, the preserve comprises 507 ha (1,253 acres) of mixed native habitat, restored river channels, and a 1.4-ha park.

‘Ahakhav Tribal Preserve (CRIT) Elevation 108 m; 59.6 ha

Over 54 ha of riparian habitat have been restored at this site since 2001. Periodic revegetation in some previously restored areas has resulted in multi-layer patches with canopy heights ranging from to 2–16 m. Species composition consists of 45 ha of mosaic plantings of cottonwood and Goodding’s willow and approximately 15 ha of honey and screwbean mesquite. Ground cover is sparse, with little understory and sandy soil. There was little standing water during our visits. The survey route follows roads around the perimeter and interior of the site. There were 12 survey detections in 2012, representing 2 possible breeding territories (see table 2-5 and map A-8).

PALO VERDE ECOLOGICAL RESERVE

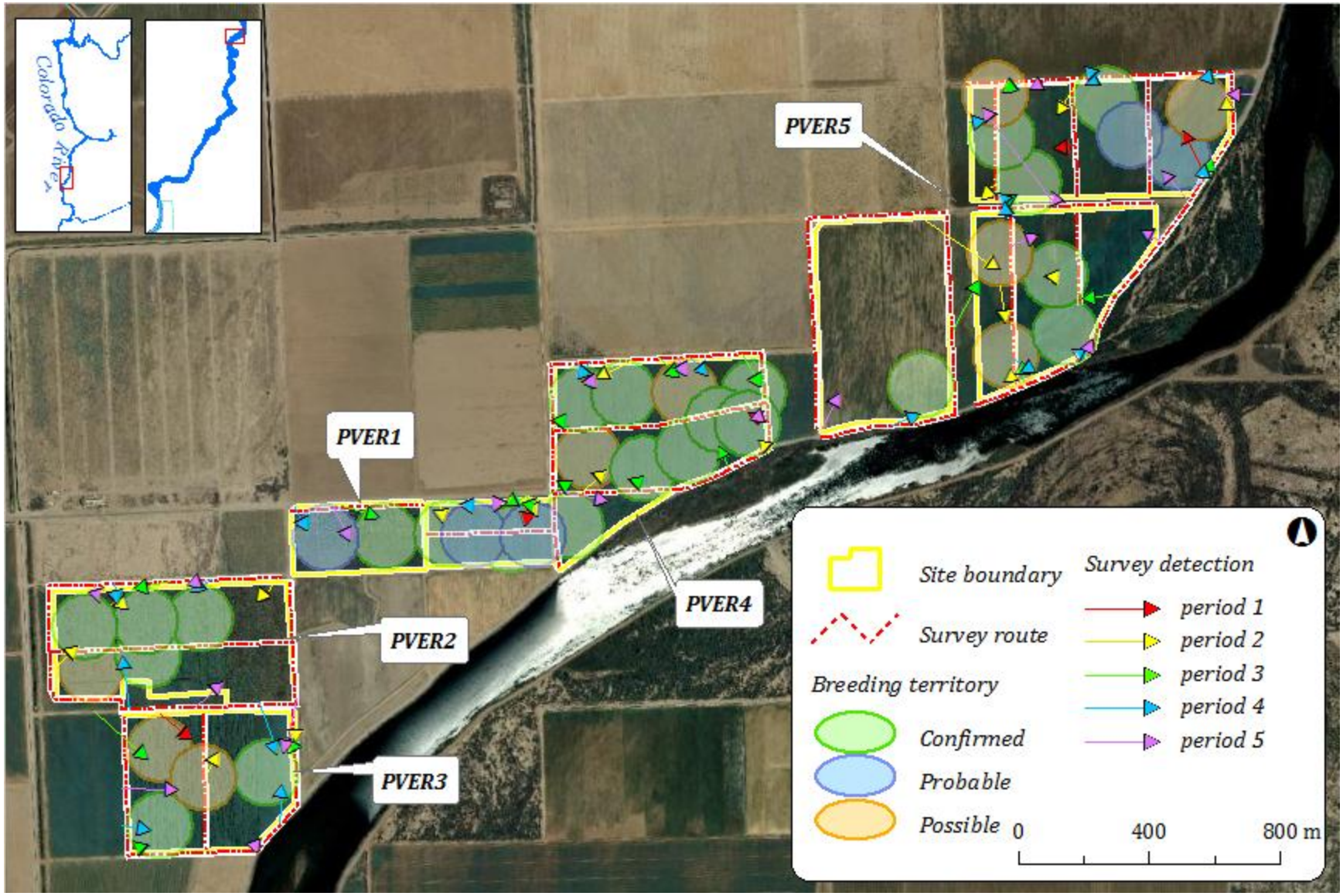
Riverside County, California

Palo Verde Ecological Reserve (PVER) is located 12 km north of Blythe, California. The 547-ha (1,351-acre) site was acquired by the State of California in 2004. Riparian restoration activities are being implemented by the Bureau of Reclamation (Reclamation), with public use and hunting managed by the California Department of Fish and Game. Details of planting and management are outlined in the Palo Verde Ecological Reserve Restoration Development Plan Overview (LCR MSCP 2006b) and in the specific development plans for each phase (see www.lcrmscp.gov) as they are planted. Phases 1–5 were fully surveyed in 2012, comprising over 160 contiguous ha of suitable breeding habitat spread over 4 linear km bordering the LCR (map A-9).

Palo Verde Ecological Reserve Phase 1 (PVER1) Elevation 86 m; 8.3 ha

PVER Phase 1 was planted in 2006. In 2012, the cottonwood-willow overstory was 4–15 m tall, with high canopy cover. The site is bordered by dirt access roads used to conduct the surveys. Agricultural fields border the site to the north. PVER4 is adjacent to the east, and PVER2 is just to the southwest. In 2012, we had three survey detections (surveys 1-5), with one probable and one confirmed breeding territory, and the first nest found at this site (see table 2-5 and map A-9).

Map A-8.—'Ahakhav Tribal Preserve yellow-billed cuckoo survey detections and possible breeding territories, 2012.



Map A-9.—PVER yellow-billed cuckoo survey detections and estimated breeding territories, 2012.

Palo Verde Ecological Reserve Phase 2 (PVER2) Elevation 86 m; 24.2 ha

PVER2 was planted in 2007 and first surveyed in 2009. The site consists of Goodding's willow, coyote willow, and Fremont cottonwood plantings. These trees now range in height from 3–14 m, with high canopy cover. Coyote willow has grown rapidly and now averages about 6 m high. The plantings were designed to maximize the amount of edge between Goodding's willow and coyote willow, considered to be preferred habitat for the southwestern willow flycatcher (LCR MSCP 2006b). In 2012, we had nine cuckoo detections (surveys 1–5), with one possible and four confirmed breeding territories (three nests and one juvenile) (see table 2-5 and map A-9).

Palo Verde Ecological Reserve Phase 3 (PVER3) Elevation 86 m; 19.8 ha

Phase 3 was planted with cottonwood and willow strips for southwestern willow flycatcher habitat in 2008. The species composition and density was planted to mimic a natural riparian landscape when fully mature. Phase 3 was first surveyed for cuckoos in 2010. Tree heights range from 4–14 m, and canopy cover is high. In 2012, there were 12 survey detections (surveys 1–5) and 2 confirmed breeding territories (2 nests) (see table 2-5 and map A-9).

Palo Verde Ecological Reserve Phase 4 (PVER4) Elevation 86 m; 35.8 ha

Phase 4 was planted with cottonwood and willow strips in 2009 and first fully surveyed in 2011. Tree heights range from 4–15m and canopy cover is high. In 2012, we had 23 survey detections (surveys 1–5) and 11 confirmed breeding territories (see table 2-5 and map A-9).

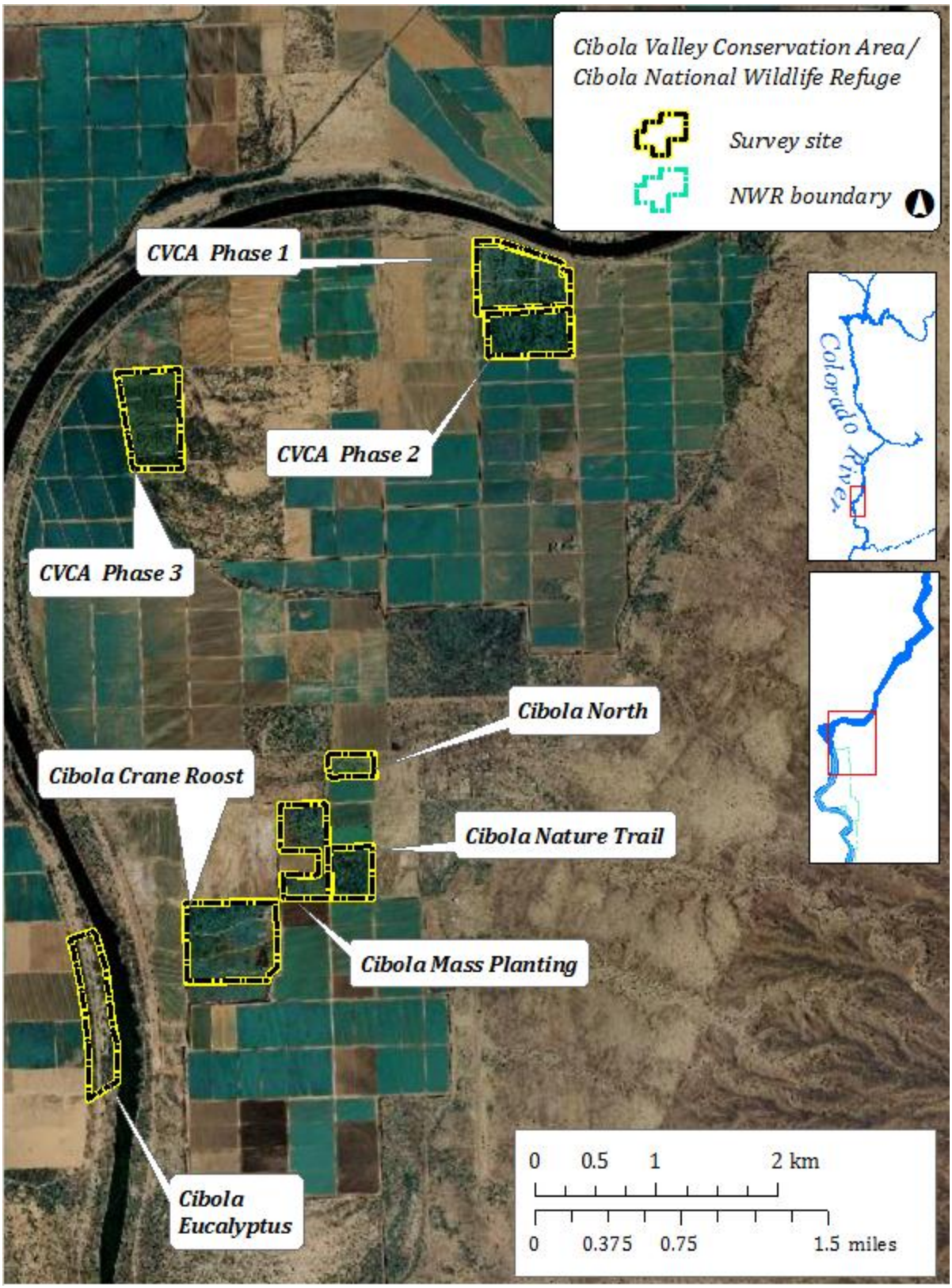
Palo Verde Ecological Reserve Phase 5 (PVER5) Elevation 86 m; 73.7 ha

Phase 5 was planted with cottonwood and willow strips in 2010 and first surveyed in 2012. Tree heights range from 3–8 m, and canopy cover is high in patches. We had 34 survey detections (surveys 1–5), with 6 confirmed (6 nests), 2 probable, and 4 other possible breeding territories (see table 2-5 and map A-9).

CIBOLA VALLEY CONSERVATION AREA

La Paz County, AZ

Cibola Valley Conservation Area (CVCA) is located 24.2 km south of Blythe, California, south and east of the Colorado River and the California/Arizona border. Within Cibola Valley, 407.6 ha (1,019 acres) of land owned by the Mohave County Water Authority have been identified for riparian restoration, as outlined in the Cibola Valley Conservation Area Restoration Development Plans (LCR MSCP 2007–2011). Riparian restoration has been implemented by Reclamation with hunting and public access managed by Arizona Game and Fish Department (AGFD). Since 2006, up to 101 ha (250 acres) of native riparian trees have been planted in three phases. Phases 1 and 2 are located in adjacent fields, and Phase 3 is approximately 2.6 km to the west (map A-10). Agricultural fields dominate the area surrounding the sites.



Map A-10.—CVCA and Cibola NWR yellow-billed cuckoo survey sites, 2012.

Cibola Valley Conservation Area Phase 1 (CVCA1) Elevation 72 m; 34.8 ha

This site consists of six fields planted in 2006. The Colorado River flows approximately 100 m north of the site. The dominant tree species are Fremont cottonwood, Goodding's willow, and coyote willow. Canopy heights range from 5–16 m, with high canopy closure. There is little understory at the site, and groundcover consists of alfalfa and Bermuda grass. The site was periodically flood-irrigated throughout the season. River Road and several dirt access roads define the perimeter of CVCA1, and additional dirt roads cross the site. Cuckoo surveys were first conducted at CVCA1 in 2008. In 2012, we had 12 survey detections and 2 confirmed plus 1 probable breeding territory (see table 2-5 and map A-11).

Cibola Valley Conservation Area Phase 2 (CVCA2) Elevation 72 m; 24.7 ha

CVCA2 was planted in 2008 and is adjacent and to the south of CVCA1, separated by a dirt access road and a concrete-lined irrigation ditch. Fremont cottonwood and Goodding's willow are the co-dominant trees, with heights ranging from 4–12 m, with high canopy cover. Phase 2 was first surveyed in 2009. In 2012, we had nine survey detections, with one possible and one confirmed breeding territory (see table 2-5 and map A-11).

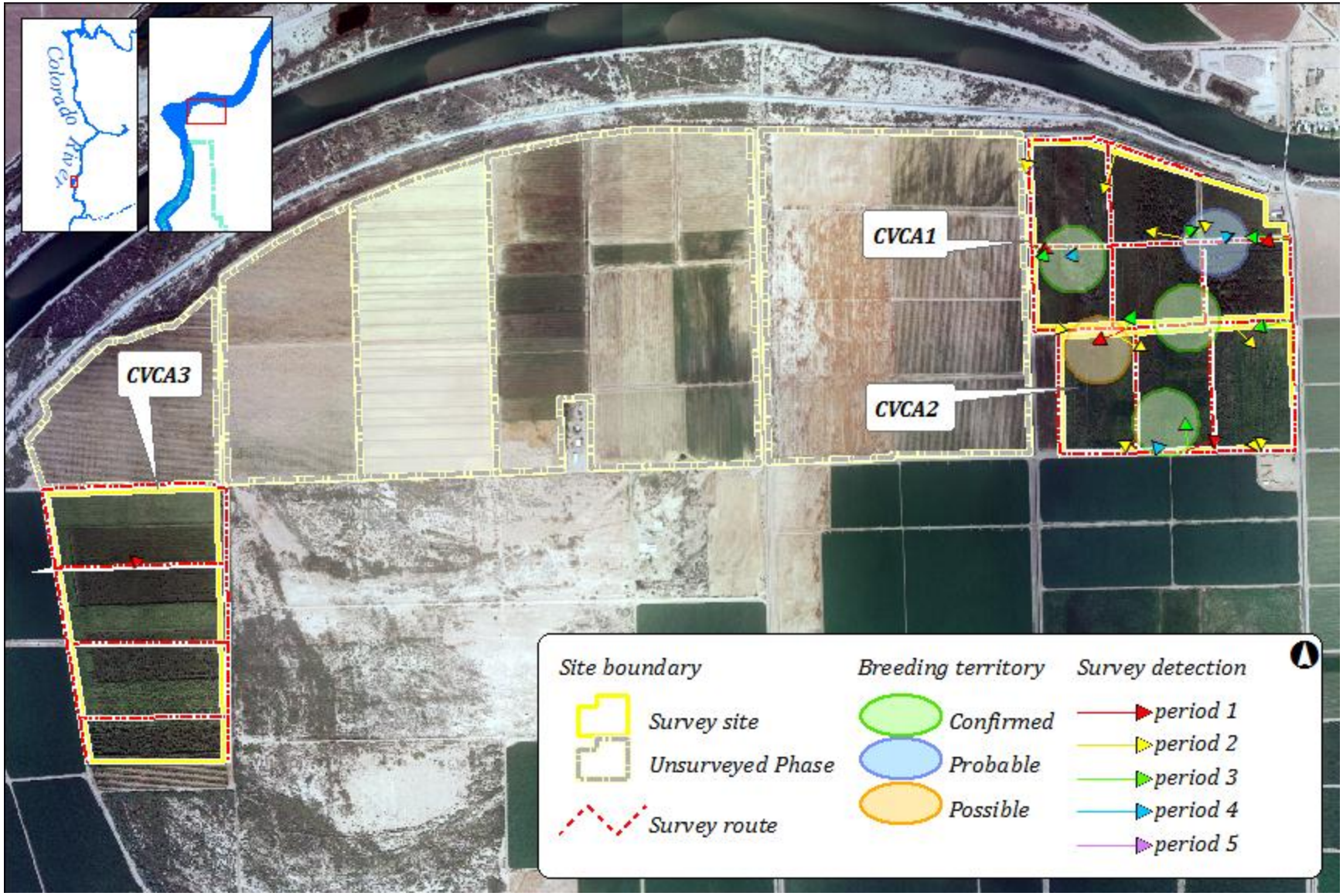
Cibola Valley Conservation Area Phase 3 (CVCA3) Elevation 72 m; 37 ha

CVCA Phase 3 is located 2.6 km west of CVCA1 and CVCA2 and 400 m east of the Colorado River. The site was planted in 2007 with Fremont cottonwood, Goodding's willow, coyote willow, and mesquite, which is not yet suitable habitat for cuckoos. Tree heights vary from 5–13 m, and canopy cover averages 80%. Dirt access roads are on all sides and between the plantings. Surveys were first conducted at this site in 2009. In 2012, there was one survey detection (see table 2-5 and map A-11).

CIBOLA NATIONAL WILDLIFE REFUGE

La Paz County, Arizona (Colorado River Drainage)

Cibola NWR is 29.8 km south of Blythe, California, within the historic flood plain of the Colorado River. The refuge, exceeding 6,475 ha (16,000 acres), was established in 1964 and is managed by USFWS to preserve and protect wildlife habitat. The Refuge includes both the historic Colorado River channel as well as a new channel constructed in the late 1960s. The old channel still receives irrigation water and portions are maintained as wildlife habitat, while the new channel carries the Colorado River flow and is extensively levied. Within the refuge, fields of alfalfa and grain crops border tamarisk and mesquite-dominated uplands. Two sites at the Cibola Island Unit surveyed in 2011 were not surveyed in 2012 due to a late-season fire in 2011, causing loss of access. Five sites at Cibola NWR were surveyed in 2012 (see map A-10).



Map A-11.—CVCA yellow-billed cuckoo survey detections and estimated breeding territories, 2012.

Cibola Eucalyptus (CIBEUC) Elevation 70 m; 29.4 ha

Cibola Eucalyptus is adjacent to the refuge on the California side of the river. It is a mixed native restoration site dominated by cottonwoods and eucalypts west of the levee road and cottonwood, tamarisk, Goodding's willow, and mesquite to the east. Overstory in the two patches is approximately 10%, and height varies from 3–15 m. The understory is sparse, with about 30% cover. A mixed understory of arrowweed, quailbush, palo verde, tamarisk, mesquite, and Goodding's willow averages 3–6 m high. The surrounding area consists of wheat and alfalfa fields to the north, west, and south and the Colorado River main channel to the east. The site had one survey detection in 2012 (see table 2-5 and map A-12).

Cibola Mass Planting (CIBMP) Elevation 75 m; 23.7 ha

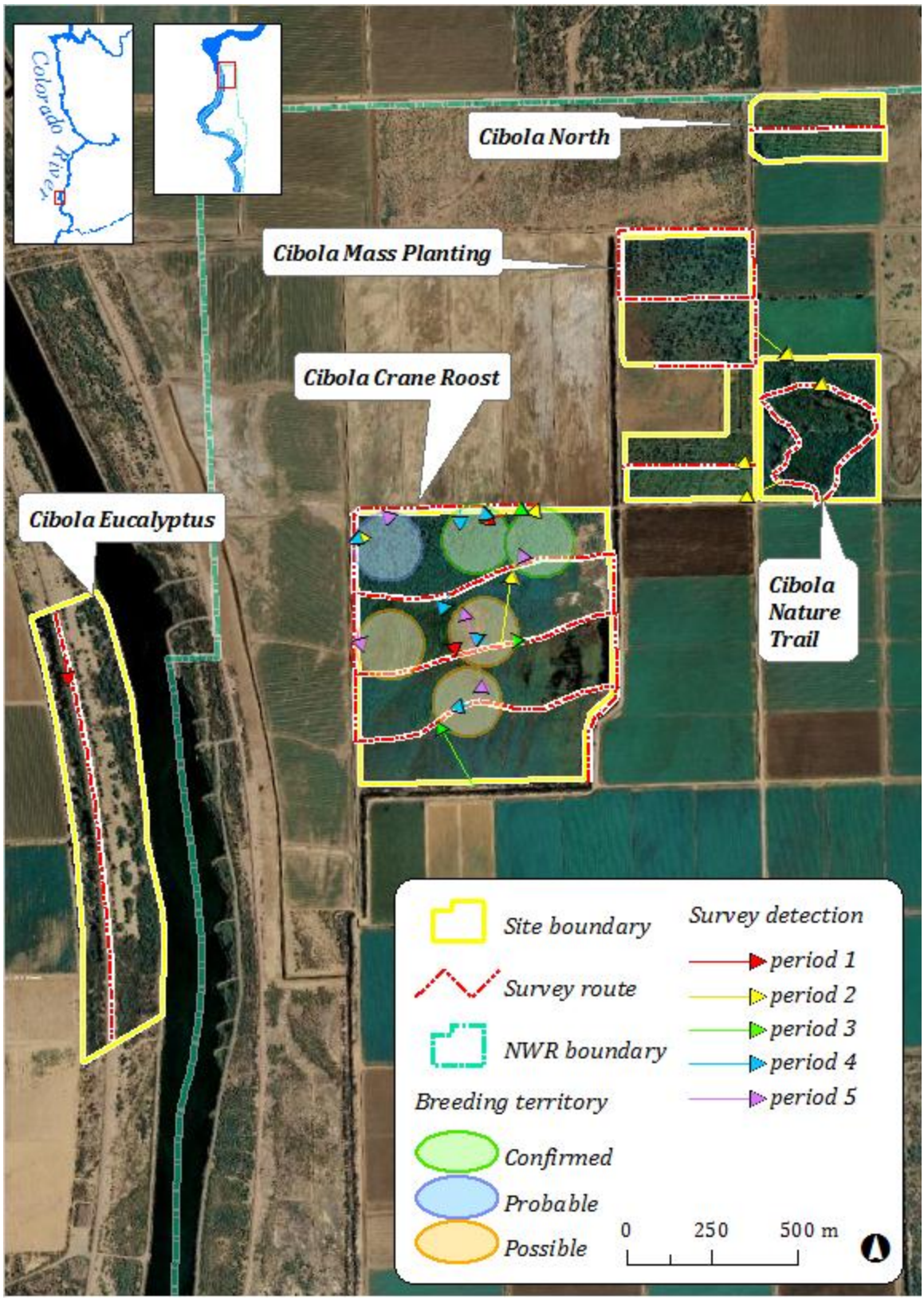
This area is adjacent to the Nature Trail site and was previously surveyed as part of the Nature Trail survey (2009–2010). A separate and expanded survey was conducted in this area beginning in 2011 as the available habitat had matured. The site consist of a thickly planted grove of cottonwoods, several fields of mixed open areas and cottonwoods, and an experimental seeded plot of mixed native trees. The site had two survey detections in 2012, one attributed to a bird at Cibola Nature Trail (see table 2-5 and map A-12).

Cibola Nature Trail (CIBCNT) Elevation 75 m; 14.4 ha

This restoration site was first planted in 1999. The route follows a well-maintained walking trail that winds through the habitat. The species composition and height varies across the site, creating high structural diversity. Cottonwoods dominate a 5–12-m tall canopy, providing about 40% canopy cover. The understory includes Goodding's willow, honey and screwbean mesquite, seep willow, coyote willow, and young cottonwoods. Average understory measures 3 m, with approximately 50% cover. This site was periodically flooded during the survey season. Much of the surrounding area is agricultural. In 2008, this site was extended to include restored patches to the west (Mass Planting and Crane Roost). These sites have grown in size and maturity and are now surveyed separately. There were three survey detections here in 2012, with one possible breeding territory (see table 2-5 and map A-12).

Cibola North (CIBNTH) Elevation 71 m; 7.2 ha

Cibola North is a more open, structurally homogeneous site with a cottonwood overstory averaging 12 m high, providing around 60% canopy closure. The ground cover is dominated by Bermuda grass. The site is bordered on its northern edge by Baseline Road and agricultural fields. Fallow fields of sparse tamarisk, arrowweed, and quail bush extend east and west of the site. The Mass Planting site is 200 m southwest, separated by an agricultural field. Cibola Nature Trail is 580 m to the south, separated by three agricultural fields. There were no survey detections at this site in 2012 (see table 2-5 and map A-12).



Map A-12.—Cibola NWR yellow-billed cuckoo survey detections and estimated breeding territories, 2012.

Crane Roost (CIBCR) Elevation 75 m; 48 ha

Phase 1

Phase 1 consists of a block of dense 10–14-m-high cottonwoods, a grove of dense mesquites 5–7 m high, and a plot containing a mix of seep willow, mesquite, tamarisk, and tall emergent cottonwoods. Canopy cover at all plots is high.

Phase 2

Several roads surround and dissect the more recently planted fields of mixed cottonwoods and willows just south of the older Phase 1 plot. In 2012, the site was still sparse, but contained a few patches of dense cottonwoods 3–8 m tall with high canopy cover. There were 19 survey detections here, with 3 possible, 1 probable, and 2 confirmed breeding territories (2 nests found) (see table 2-5 and map A-12).

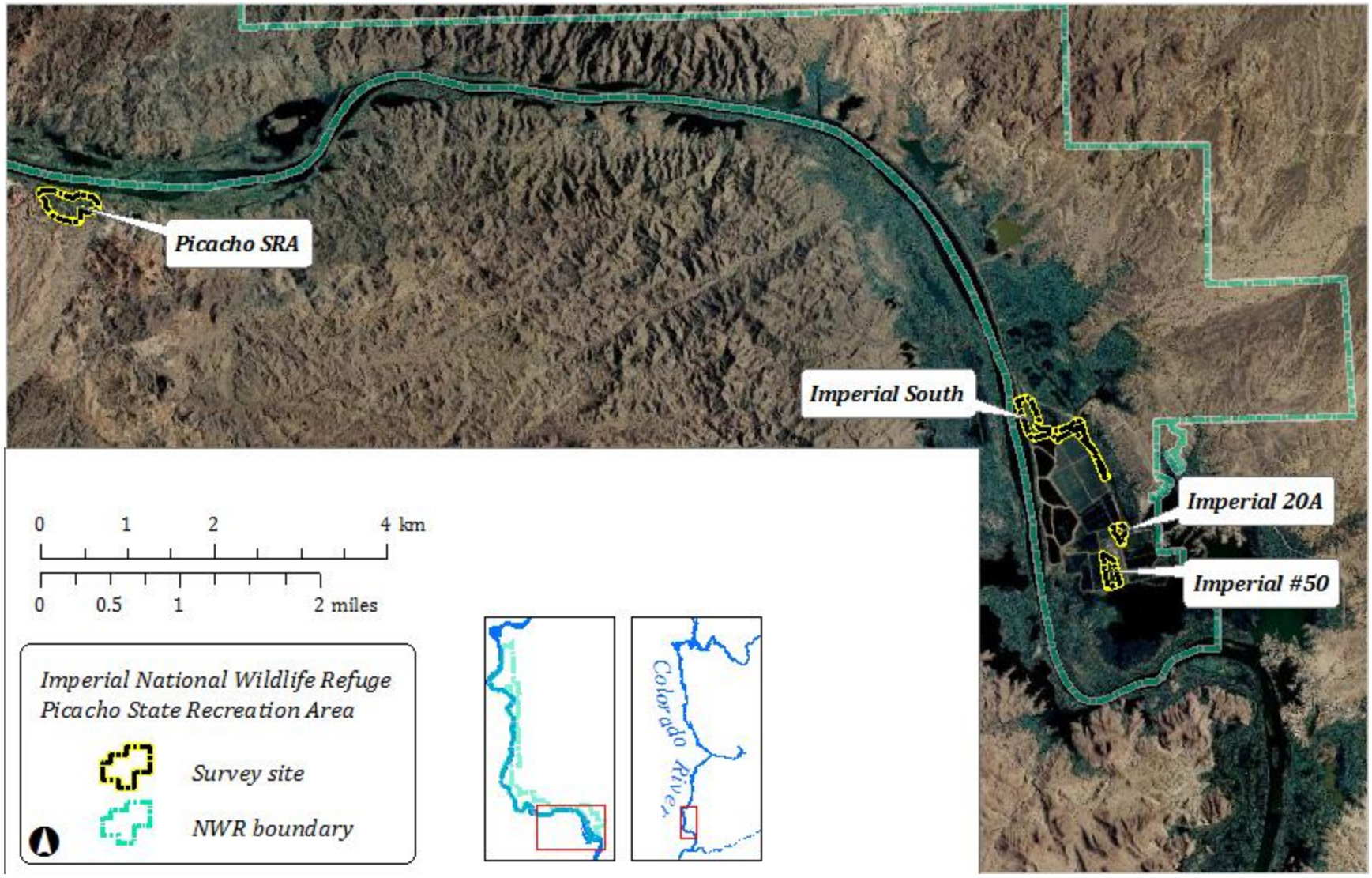
PICACHO STATE RECREATION AREA

Imperial County, California (Colorado River Drainage)

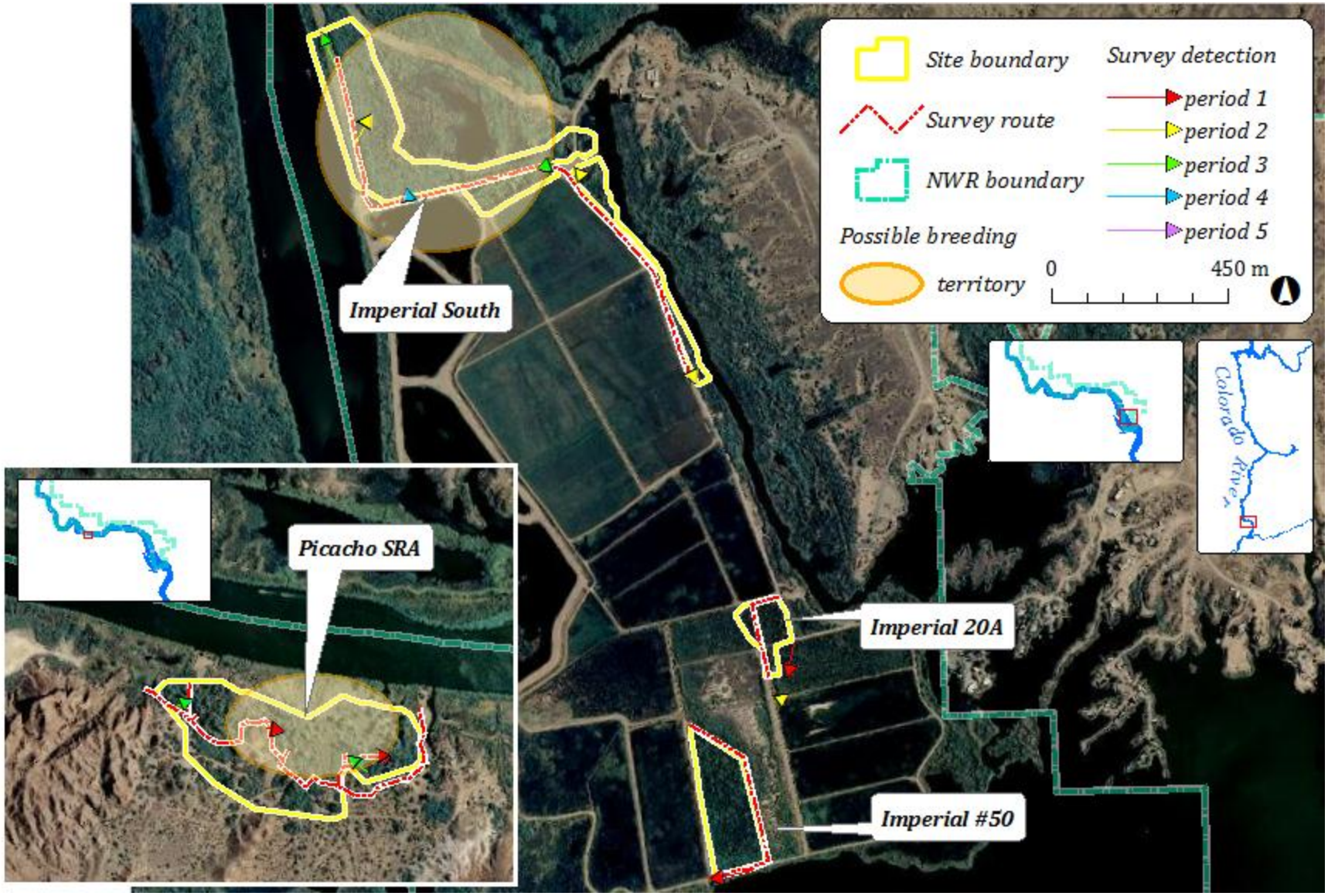
Picacho State Recreation Area (SRA) is a historic mining town site currently State owned and managed by the California State Parks Department. It is 38.6 km north of Winterhaven, California, on the Colorado River (map A-13).

Picacho State Recreation Area (PICSRA) Elevation 59 m; 14.8 ha

Picacho SRA is a cottonwood-willow dominated restoration site situated where Picacho Wash flows into the Colorado River. The structurally diverse vegetation, planted after tamarisk clearing in 1996, appears naturalized. Fremont cottonwood, Goodding's willow, and honey and screwbean mesquite dominate the 6–17-m-tall canopy, averaging 30% cover. A diverse understory of arrowweed, quailbush, blue palo verde (*Cercidium floridum*), seep willow, mesquite, willow, and cottonwood provides about 50% cover. The site is bordered by the mature tamarisk-dominated Picacho SRA campground and adjacent Sonoran Desert uplands to the west and the river to the east. There were seven survey detections in 2012, representing one possible breeding territory (see table 2-6 and map A-14).



Map A-13.—Picacho SRA and Imperial NWR yellow-billed cuckoo survey sites, 2012.



Map A-14.—Picacho SRA and Imperial NWR yellow-billed cuckoo survey detections and possible breeding territories, 2012.

IMPERIAL NATIONAL WILDLIFE REFUGE

Yuma County, Arizona (Colorado River Drainage)

Imperial NWR was established in 1941 and encompasses 10,307 ha (25,768 acres) of riparian area and associated Sonoran Desert uplands. The headquarters is 40.3 km north of Yuma, off Martinez Lake Road. The refuge follows 48.3 km of the Colorado River, including some of the last remaining unchannelized stretches. Refuge management activities include protecting backwater lakes, managing marshes, farming crops for wintering waterfowl, and restoring wetlands and associated riparian vegetation. In 2011, one new survey site was added (Imperial 50; see map A-13).

Imperial 20A Restoration (IMP20) — Elevation 61 m; 2 ha

Imperial 20A is a native restoration site 560 m from the main body of Martinez Lake. Stunted Fremont cottonwoods form a sparse canopy (10% cover). The overstory varies from 4–14 m high and is interspersed with mesquite. A thick ground cover of saltgrass (*Distichlis spicata*), Bermuda grass, and *Phragmites* provide 90% ground cover. The site is bordered by seasonally flooded wildlife ponds to the north, mixed native marshland to the east, and fields to the south and west. There were two survey detections in 2012 and no breeding evidence (see table 2-6 and map A-14).

Imperial 50 Restoration (IMP50A) — Elevation 61 m; 4.2 ha

This restoration site is a densely planted mix of cottonwood and mesquite with a dense quail bush perimeter. This site was newly added in 2011 as the vegetation matured. It is surrounded on three sides by agricultural fields and one side by restored marshland. One gravel road and two dirt roads surround the perimeter as well as an irrigation canal to the north. It is approximately 200 m southwest of Imperial 20A. In 2012, there was one survey detection (see table 2-6 and map A-14).

Imperial South Restoration (IMPSTH) — Elevation 60 m; 13 ha

Imperial South (INWR Forest) consists of a small native nursery planted in 1994 and a band of cottonwood and willow habitat lining a finger of Martinez Lake. The nursery comprises mature 5–14-m-tall Fremont cottonwood, Goodding's willow, and mesquite, with approximately 60% canopy closure. There is a low, sparse (about 5% cover) understory of young cottonwood, mesquite, arrowweed, common reed, seep willow, and tamarisk. Surrounding habitat includes an open field, impoundment ponds, and a mix of tamarisk, willow, and marsh to the north. There were six survey detections in 2012 and one possible breeding territory (see table 2-6 and map A-14).

LAGUNA

Imperial County, California

Three Laguna sites were first surveyed in 2009 on Bureau of Land Management (BLM) managed lands near Imperial Dam. The sites are made up of several small riparian habitat patches, some with small pools, surrounded by a dry tamarisk matrix. The Laguna 1 site was surveyed in 2009 but dropped in 2010 due to its small size. In 2012, Laguna 2 and Laguna 3 were surveyed (map A-15).

Laguna 2-3 (LAG2, LAG3) Elevation 50 m; 3.9 and 3.8 ha

Goodding's willow is the dominant tree species at the Laguna sites, providing an overstory 8–12 m high and canopy cover averaging 70%. A small amount of Fremont cottonwood and tamarisk are also present. The understory consists of tamarisk, cattails, and arrowweed. The two sites are relatively close to each other: LAG2 is 500 m north of LAG3. LAG3 is bisected by Imperial Road. There were no detections at LAG 2 in 2012. There were three survey detections at LAG3 in 2012, representing one possible breeding territory (see table 2-6 and map A-16).

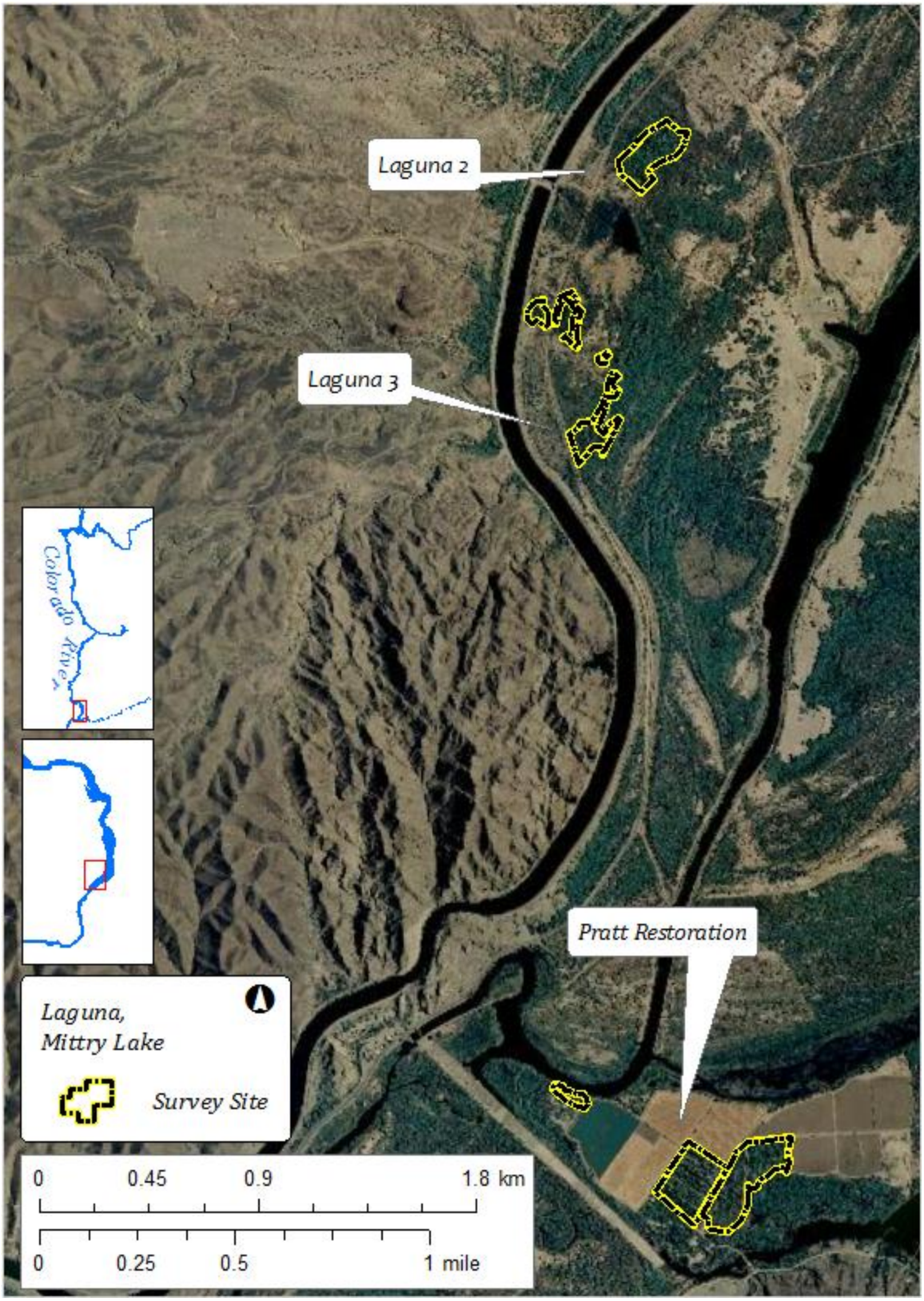
MITTRY LAKE WILDLIFE MANAGEMENT AREA

Yuma County, Arizona (Colorado River Drainage)

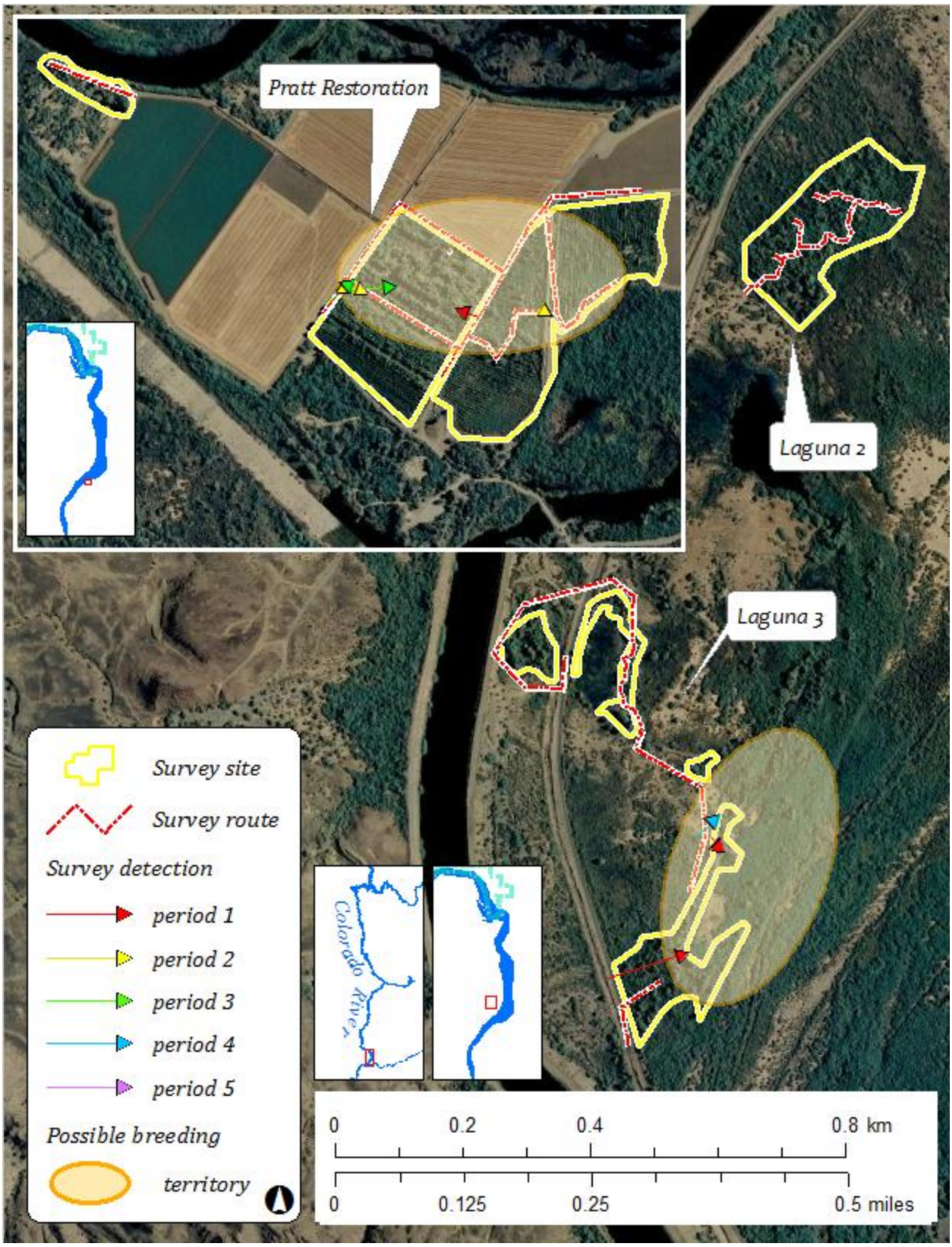
Mittry Lake WMA is managed by AGFD for wildlife habitat and outdoor recreation. The area is around 15 km northeast of Yuma between Laguna and Imperial Dams (map A-16).

Pratt Restoration (MLPR) Elevation 40 m; 14 ha

Pratt Restoration is a cooperative restoration planted in 1999 on a BLM agricultural lease. The overstory is 5–11 m, with around 70% canopy cover, and comprises approximately 80% cottonwood and 20% Goodding's and coyote willow. There is about 30% understory cover" (< 5 m) of seep willow, Goodding's willow, mesquite, cottonwood, and tamarisk. Actively farmed fields border the north and east sides of the site, and a young restoration site abuts the southeastern edge. The amount of available habitat approximately doubled in 2010, but a pre-season fire in 2011 destroyed most of the surrounding tamarisk-dominated vegetation at this site. The restorations sites were slightly damaged but saved by the surrounding roads, concrete canals, and firefighting efforts. There were seven survey detections at this site in 2012, representing one probable breeding territory (see table 2-6 and map A-16).



Map A-15.—Laguna, Mittry Lake yellow-billed cuckoo survey sites, 2012.



Map A-16.—Laguna, Mittry Lake yellow-billed cuckoo survey sites, detections, and possible breeding territories, 2012.

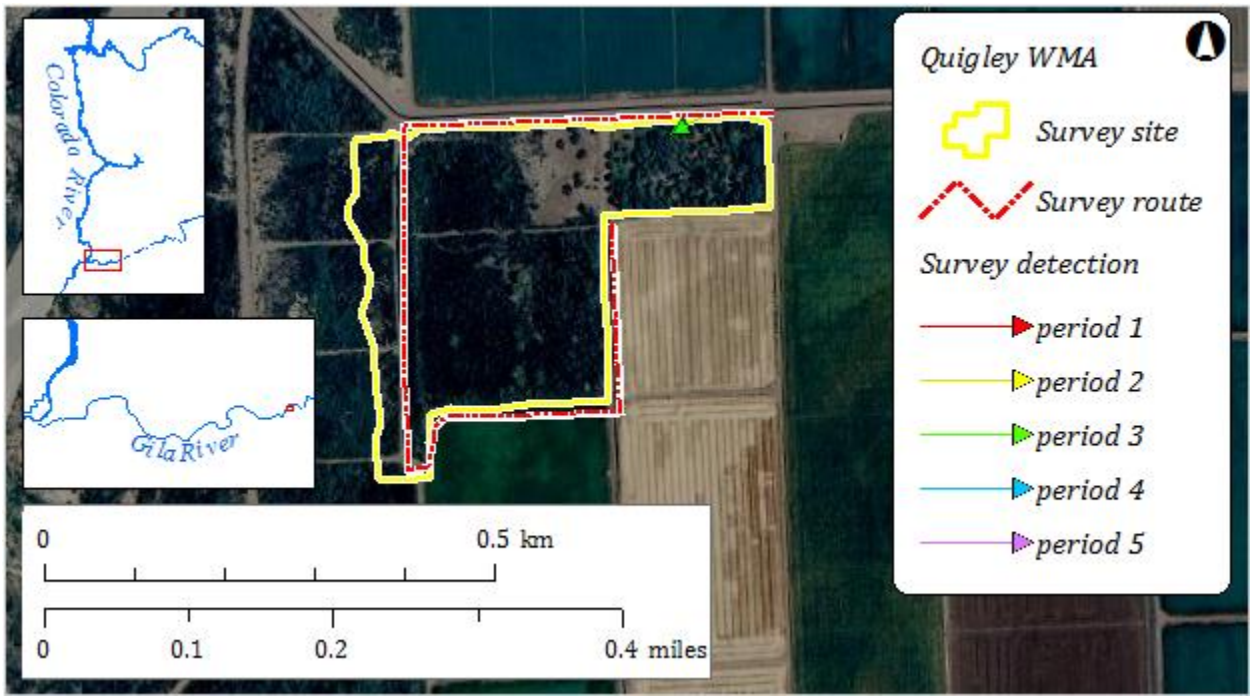
QUIGLEY WILDLIFE MANAGEMENT AREA

Yuma County, Arizona (Gila River Drainage)

Quigley WMA is 4 km north of Tacna in the historic Gila River flood plain. This 248-ha (612-acre) WMA is owned and managed by AGFD for wildlife and recreation. Potentially suitable cuckoo habitat at this site includes mixed exotic/native historic flood plain and a small native-dominated restoration area surrounded on three sides by agricultural fields.

Quigley WMA (GRQP) — Elevation 75 m; 10.6 ha

The Quigley survey site consists of a small restoration plot to the east and adjacent mixed native habitat to the west. The restoration plot contains an overstory of mature cottonwood, tamarisk, willow, and mesquite 5–13 m high, providing about 30% canopy cover. The 1–5 m understory contains tamarisk, arrowweed, seep willow, mesquite, willow, and cottonwood. The mixed native area contains scattered dead and stressed cottonwoods, willows, and mesquites. There was one survey detection in 2012 (see table 2-6 and map A-17).



Map A-17.—Quigley WMA yellow-billed cuckoo survey detections, 2012.

NORTH GILA VALLEY

Yuma County, Arizona (Gila River Drainage)

Patches of riparian forest persist along the banks of the Gila River near the Colorado/Gila confluence 6.5 km east of Yuma, Arizona. A Gila Confluence site was surveyed in 2008 but dropped in 2009 due to poor habitat quality. It was replaced by two North Gila Valley sites.

North Gila Valley (GRNVA, GRNVB) Elevation 44 m; 3.6 and 4.8 ha

These two small sites are located in the North Gila Valley, Yuma, on the north side of the Gila River, and consist of mature patches of Goodding's willow and Fremont cottonwood. The overstory is 9–15 m high, and canopy cover averages 70%. Understory consists of dense tamarisk and arrowweed. The two sites are separated by about 680 m of this low shrubby habitat. Ever-encroaching agricultural fields border the sites to the north. These sites were first surveyed in 2009. GRNVB was dropped after the first survey due to access loss. There were no detections here in 2012 (see table 2-6 and map A-18).

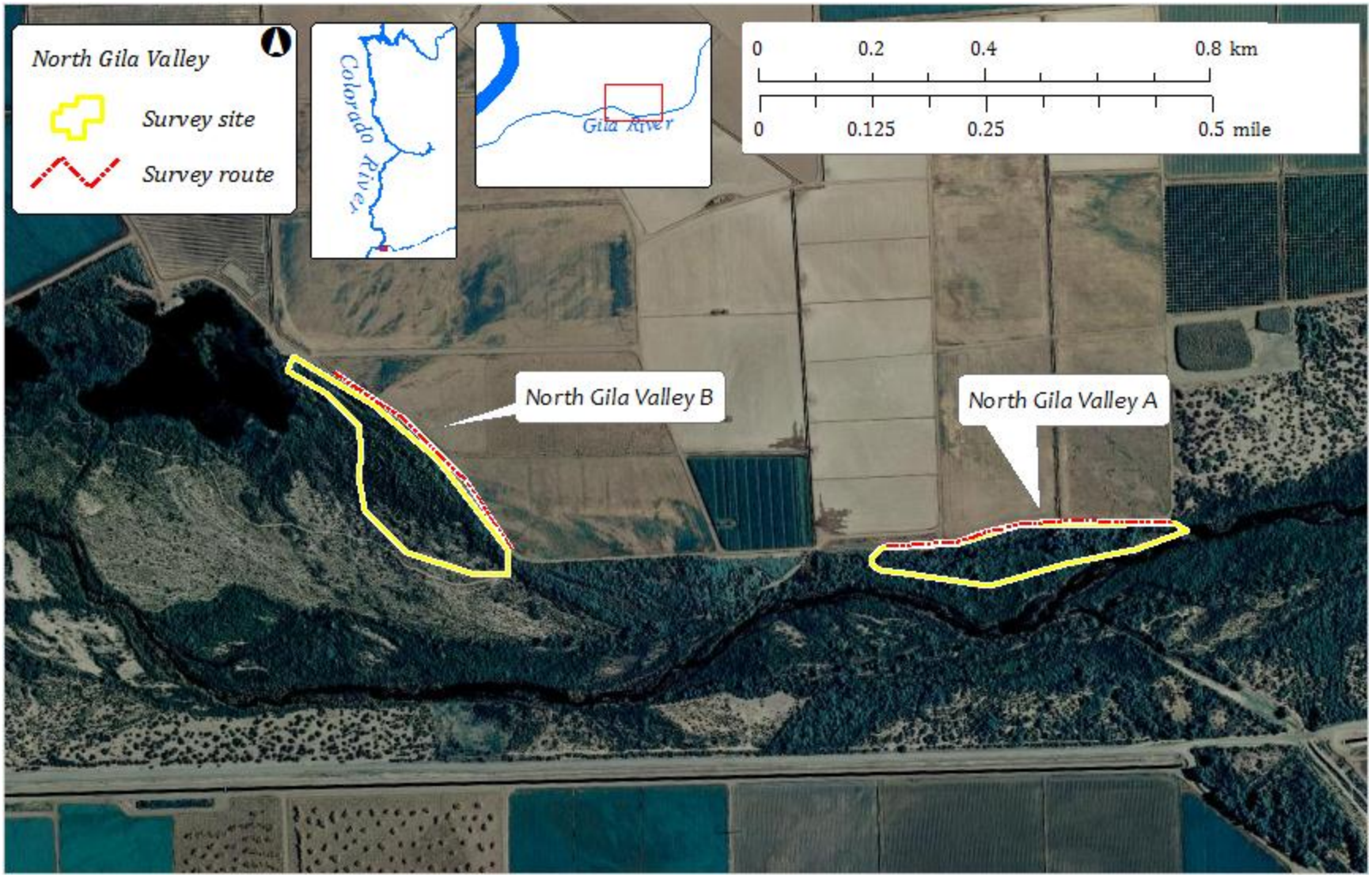
YUMA WETLANDS

Yuma County, Arizona (Colorado River Drainage)

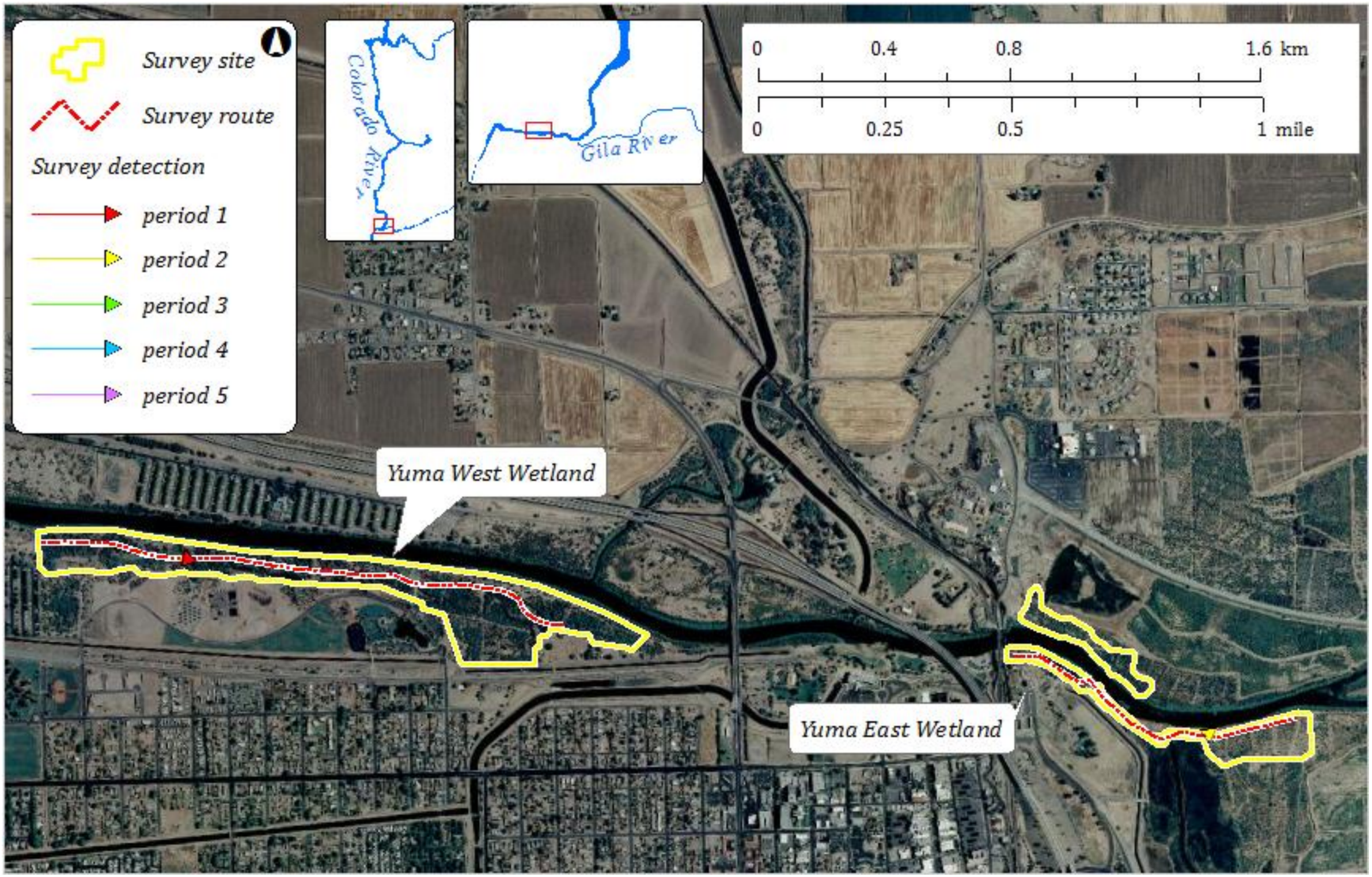
Yuma East and West Wetlands are restoration sites along the banks of the Colorado River in Yuma. Until recently, the area was a mix of exotic plants, trash dumps, and squatter camps. The West Wetlands is a 55-ha (135-acre) city park managed by the Yuma Department of Parks and Recreation. The East Wetlands is part of the Yuma Crossing Natural Heritage Area, which is under joint management by the City of Yuma, the Quechan Tribe, AGFD, and private ownership. Planting at Yuma West began in 1999 and at Yuma East in winter 2003–04 (map A-19).

Yuma East Wetlands (YUEW) Elevation 36 m; 9 ha

This site is immediately east of the Ocean to Ocean Bridge, and lies on both the north and south banks of the Colorado River, approximately 1.2 km upstream of Yuma West. It was first surveyed in 2009. The planted habitat consists of a mosaic of open Fremont cottonwood, Goodding's willow, and mesquite spp. Overstory at the site ranges from 3–10 m with 50% canopy cover. Surveys were conducted from the south side. There were two survey detections in 2012 (see table 2-6 and map A-19).



Map A-18.—North Gila Valley yellow-billed cuckoo survey sites (no detections), 2012.



Map A-19.—Yuma East and West Wetlands yellow-billed cuckoo survey sites and detections, 2012.

Yuma West Wetlands (YUWW) Elevation 36 m; 24.3 ha

Yuma West Wetlands consists of a mosaic of cottonwood, Goodding's willow, and mesquite. Overstory at the site ranges from 6–12 m with an estimated 30% canopy cover. Arrowweed, saltbush, seep willow, mesquite, tamarisk, and young naturally regenerating willow and cottonwood make up a diverse understory. Site management includes regular understory clearing for fuel reduction and safety. The Colorado River borders the northern edge of the site, and residential areas border the south, east, and west. There was one survey detection in 2012 (see table 2-6 and map A-19).

ATTACHMENT B

Breeding Territory Evidence

Site code	Breeding status	Behaviors observed
BWCR	2 POS	Detections in this area 6/23 and 8/05 and 7/02 to 8/02
BWCW	1 PRB	Detections in this area 6/25 to 8/09,VEX 6/25 and 7/29
BWER	1 POS	Detections in this area 6/24 to 7/04
BWHB	2 PRB	Detections in this area 6/25 to 7/30, VEX 6/26, 7/16,7/24, distraction display 7/30
BWHB	1 COB	FMF territory, nest found 7/23
BWKR	1 POS	Detections in this area 6/19/ and 7/12
BWKR	1 PRB	Detections in this area 7/02 and 7/18, VEX on 7/18 FU
BWMF	1 POS	Detections in this area 6/18 to 8/01
BWMW	1 POS	Detections in this area 6/24 to 7/25, TRD territory
BWMW	1 PRB	Detections in this area 6/24 to 7/12, VEX 7/10 FU, HED territory
BWNB	1 POS	Detections in this area 6/23 to 07/04
BWPT	2 PRB	BLL in area 7/08–7/24, LIM 7/17–7/23, VEX 7/08–7/23, food carry 7/23
BWSW	3 POS	Detections in several areas 7/01 to 8/05
CIBCR	2 COB	Nest 1, nest 2 (LLL)
CIBCR	1 PRB	Pair detected several times northwest corner 6/23–8/11–multiple ALA calls
CIBCR	3 POS	Detections in multiple areas 7/18–8/11
CRIT	2 POS	Detections in two areas 7/01 to 8/04 and VEX 8/04 FU
CVCA1	2 COB	Nest 1 (DRE), nest 2 (LWB)
CVCA1	1 PRB	Multiple detections same area 6/23–7/27 VEX
CVCA2	1 PRB	Multiple detections same area 6/23–7/17, VEX 7/14 plus soft kukking 7/17
CVCA2	1 COB	Nest 1 (LJ/JLO)
HAVBR	1 POS	Detections on 6/24, 7/5, and 7/26
HAVTPR	1 POS	Detections on 6/24 and 7/5
OVRW	1 POS	Detections on 6/25 and 7/19
PAHNTH	1 POS	Detections on 6/26 and 7/10
PVER1	1 COB	Nest 1 (PRI/SLS)
PVER1	1 PRB	Pair detected 7/14 to 8/5, multiple ALA calls
PVER2	1 POB	Multiple detections in SW corner 7/1 to 7/23
PVER2	4 COB	Nest 1 (PUF), nest 2 (ODB), nest 3 (PUF), + juvenile seen (not from any of the nests)
PVER3	2 COB	Nest 1 (AA), nest 2
PVER3	2 POS	Multiple detections in two areas 6/18 to 8/4
PVER4	2 POS	Multiple detections in two areas 7/2 to 8/5
PVER4	2 PRB	Two pairs observed over several weeks 6/18 to 8/5
PVER4	5 COB	Nest 1 (DOG), nest 2 (GMF), nest 3 (EZE), nest 4 (DEF), nest 5 (GDB/PF)
PVER4	5 COB	Nest 6 (DEF), nest 7 (EZE), nest 8 (PRI/SLS?), nest 9 (GBO), nest 10 (PRI/SLS)
PVER5	4 POS	Multiple detections in same areas 7/3 to 8/6
PVER5	2 PRB	Two pairs, multiple detections 6/22 to 8/6
PVER5	6 COB	Nest 1 (QLA), nest 2 (LIO?), nest 3 (CHL), nest 4 (BZB), nest 5 (UNB), nest 6 (GFK)

ATTACHMENT C

Nest Accounts

BILL WILLIAMS RIVER NATIONAL WILDLIFE REFUGE

We found one nest at the Bill Williams River National Wildlife Refuge (BWRNWR) in 2012. Overall, we estimated up to 11 possible, 7 probable, and 1 confirmed breeding territory within BWRNWR in 2012 (see the breeding evidence table in attachment B).

BWHB N1 was found on July 23. The adult male (FMF) was captured at Mineral Wash on June 26 and radio tracked until he disappeared from the site by July 1. His signal was later relocated upstream on July 12 on the Honeycomb Bend route. A contact call was heard in the nest area on July 19, 4 days before the nest was found. The nest was located over water and too high for its contents to be checked. The nest was visited seven times from July 23 to August 9 and was still active up to July 30, but the fate of the nest was never determined.

PALO VERDE ECOLOGICAL RESERVE (CALIFORNIA)

Twenty-two nests were found at PVER: 1 in Phase 1, 3 in Phase 2, 2 in Phase 3, 10 in Phase 4, and 6 in Phase 5. We estimated up to 39 breeding territories at PVER, including 7 possible, 5 probable, and 24 confirmed territories over the 2012 season.

PVER1 N1 was found on July 20 by telemetry of a nesting female (PRI). The nest was mirrored 2 days later and contained a 1-day-old chick and three eggs. The oldest chick fledged by July 27, and both PRI and her banded mate (SLS) were observed carrying food to the nest tree and feeding the fledgling. A third banded cuckoo was partially re-sighted within 1 meter (m) of the nest. PRI attacked the unidentified banded cuckoo, who flew away. It was later observed foraging approximately 40 m away from the nest. Immediately afterward, PRI approached the nest and appeared to hide behind the trunk. SLS presented a yellow curled leaf to PRI with a tail-pumping motion and then briefly mounted PRI. SLS returned almost immediately bearing a small stick and copulated with PRI. Both left the nest, and PRI returned later with a katydid and SLS with caterpillar, which he beat against a branch to subdue. All nestlings fledged by July 30, and several juveniles were heard as well as an adult observed feeding juveniles west and south of the nest on August 1. PRI went on to nest twice more (PVER4 N8, PVER4 N10), and SLS was PRI's mate at PVER4 N10.

PVER2 N1 was found on July 24 by following activity in the area. The nest was high and well hidden at the top of a Goodding's willow. On July 31, a male (PUF) was captured and banded around 150 m north of the nest, and on August 1,

he was radio tracked and found incubating the nest. On August 4, the nest contained three chicks estimated at 2 to 4 days old. All young fledged by August 9. During vegetation surveys on August 29, a cuckoo responded from this area, possibly a juvenile or adult from the nest. PUF was also observed with a juvenile on August 13 (not from this nest) and was found at a new nest (PVER2 N3) on August 19.

PVER2 N2 was found on August 4 by triangulating survey detections and followup calls. On August 6, and the nest was found to contain three eggs, which all hatched by August 13. On August 5, an adult male (ODB) was captured nearby and later observed on the nest on August 10. On August 15, the nest was found empty (depredated), with no further activity detected in the area.

PVER2 N3 was found on August 19 by telemetry of PUF. The nest was high in a Goodding's willow and difficult to see or reach. It was checked on August 25 and contained two eggs. PUF and an unbanded mate were observed feeding nestlings on August 31. On September 2, a well-developed ~6-day-old chick was found dead in ankle-deep irrigation water directly below the nest. After 45 minutes of no activity, a ladder and camera pole were brought to the nest. The nest contained the other nestling, which was later observed fledged and sitting in the nest tree. The unbanded adult fed the fledgling over the next few days with PUF's signal no longer found at the nest after September 1 and not picked up at PVER after September 4.

PVER3 N1 was found on July 11 through telemetry of a male (AA) recaptured on July 2, previously banded at the same site in 2010. The nest contained three eggs on July 16. On July 24, a fledgling was observed sitting 50 centimeters from the nest, and all had fledged by July 26. The transmitter fell off AA on August 4 and was found in a tree a few days later.

PVER3 N2 was found on July 16 by triangulation of survey and followup calls coming from the nest. On July 17, the nest contained three eggs. The next day, an adult was seen carrying food to the nest. The nest was very close to the habitat edge and a road, and on July 23 while still exiting the vehicle, an adult immediately began knocking. The adult continued giving alarm calls and flew from tree to tree, appearing agitated. Eggshells were found on the ground approximately 5 m from the nest. When the nest was checked, it was found empty. At least one chick fledged due to the adults' behavior at the nest tree over the next several days, though no fledglings were observed.

PVER4 N1 was found on July 4 with two eggs by following several calls heard from the nest area. On July 7, two nestlings were observed, and one adult was re-sighted at the nest as a male (DOG) captured and banded nearby on July 5. The nestlings were banded on July 11, and by July 12, both had fledged.

PVER4 N2 was found on July 7 by radio tracking a female (GMF) who had been captured and banded nearby on June 22. On July 8, the nest was checked and contained four eggs. On July 16, two nestlings were visible. Both nestlings fledged by July 23. No evidence was found of the fate of the other two eggs/nestlings, and no eggs were found when the nest was mirrored post-fledging. The adult male was partially re-sighted with a blue band (an adult banded in 2011) but was never fully identified.

PVER4 N3 was found on July 12 with two eggs after following two softly calling birds and observing nesting material being carried. A banded male (EZE) banded on July 7 was tracked to the nest; the adult female was unbanded. After a storm on the night of July 15, one egg was found beneath the nest. The nest was mirrored and still contained two eggs (therefore, three eggs total were laid). On July 23, the nest still had two eggs and was considered late in hatching (> 11 days). On July 25, the adults were observed agitated and alarm calling. The nest was mirrored and contained one egg and fragments of another egg. One egg or nestling was probably depredated that morning, and adults soon abandoned the remaining egg and left the nest area.

PVER4 N4 was found on July 24 after radio tracking a male (DEF) captured on July 20. The nest contained three eggs when found. The nest was active when checked on July 26, but by July 29, the nest had been depredated. It appeared abandoned, and eggshell fragments were found on the ground near the nest. The nest was mirrored and contained multiple egg fragments.

PVER4 N5 was found after fledging on July 26 after followups of multiple, survey detections and activity in the area. A fledgling (approximately 6 days old) was found in a tree in the area of activity, hand captured, and banded. The next day, the actual nest (empty except for small blue egg fragments) was located approximately 2 m away from the fledgling. We identified one additional fledgling near the nest and re-sighted one parent as GBO (female banded on July 18). The adult male was re-sighted feeding the fledglings, identified as PF, an A4Y captured as an adult in 2009 at PVER2.

PVER4 N6 was the second nest found for DEF (first nest PVER4 N4) after the first nest was depredated. The nest was found by radio tracking DEF on August 2 and August 3. When checked, the nest contained two eggs. The first nestling fledged on August 19, and the second fledged by August 21. DEF's mate was an unbanded female. During nest vegetation surveys on August 29, a cuckoo responded from this area, possibly a juvenile or adult from this nest.

PVER4 N7 was the second nest found for EZE, with the first nest failing by July 25. The nest was found by radio tracking EZE on August 5 and, when checked on August 6, contained three eggs. Three large nestlings were observed in the nest on August 19. On August 21, one fledgling was seen in the tree. The next day, two fledglings were heard calling from the nest tree.

PVER4 N8 was the second known nest for PRI after a successful nest in PVER1. The nest was found through radio tracking on August 12, with two eggs observed. One egg hatched on August 14, and on August 15, the nest contained one nestling and one egg. When the nest was checked on August 18, it appeared abandoned, and when mirrored, contained no eggs or nestlings and was assumed to be depredated between August 15–17. Because one nestling could have possibly fledged at 5 days, frequent checks were made at and near the nest tree, but no evidence of fledging was found.

PVER4 N9 was found by telemetry on August 21 and was GBO's second known nest (first nest PVER4 N5). GBO was incubating on the nest when found, and she was observed at the nest on August 22. When the nest was checked on August 24, it was empty with a large leaf inside. A search of the ground found a broken egg about 3 m from the nest with puncture marks. It is unknown if the egg or eggs were depredated in the nest or were knocked from the nest and then depredated. The eggs may have fallen from the nest during a storm on the night of August 22. GBO abandoned the nest and was tracked by telemetry back at her previous nest area on August 24 and 25.

PVER4 N10 was PRI's third known nest located on August 29 through telemetry. The nest was watched in the early morning on August 31 and September 1 to document potential effects of dove hunting (September 1). September 2 was the last day PRI was located at the nest, and her signal was gone from all PVER sites by September 3. Observations over the next few days (in case of transmitter failure) failed to detect PRI at the nest. SLS, her mate from her first nest (PVER1 N1), was again identified as her mate at this nest. The nest contained three chicks on September 4, and all fledged by September 9. Both SLS and one juvenile were re-sighted on September 13, and the other two juveniles were heard calling nearby.

PVER5 N1 was found on July 28 with two eggs after radio tracking a female (QLA) captured on July 3. Five eggs were laid by August 5, though only two of these eggs hatched. The two nestlings were banded on August 11 when an egg was also noted missing. The oldest fledged on August 13, and a second egg was noted missing. The youngest fledged several days later, with the parents abandoning the remaining unhatched egg.

PVER5 N2 was found on July 30 after radio tracking an adult with a nearby nest (BZB, nesting 25 m away). The nest contained three large nestlings. One had fledged by August 1 when the remaining two were banded. All had fledged by August 3. One adult was unbanded, its mate may have been banded (LIO, captured and banded August 2 nearby), but was never positively identified at the nest.

PVER5 N3 was found on August 2 after followup visits to an active area. The nest contained three eggs when found; all had hatched by August 4. All three

nestlings were banded on August 7. When the nest was visited the next day, only the oldest banded chick was found, with no sign of the two younger chicks. When observed again an hour later, an adult was found sitting on the nest with the fledgling sitting nearby. The nest may have been depredated, or the chicks may have been removed by another cuckoo or a parent (observed by SSRS in 2005 and 2009). The unusual behavior of the adult sitting on the empty nest (not observed before) may have been a protective reaction to the chick's removal. An adult captured near the nest on August 7 (CHL) was re-sighted at the nest.

PVER5 N4 was found with three eggs on August 1 by radio tracking an adult male (BZB, captured July 29). All three nestlings were banded on August 8, and all had fledged by August 14. During a telemetry session on BZB, the oldest fledgling was re-sighted 4 weeks after fledging.

PVER5 N5 was found on August 6 after following up on a survey detection that morning. Adults responded to our presence with alarm calls, and a juvenile was observed sitting next to the nest, which was then hand captured and banded. A second juvenile was heard nearby. The next day, a third juvenile was also heard. At least one parent was unbanded. The banded fledgling was re-sighted several times over the next month.

PVER5 N6 was found on August 19 by radio tracking an adult male (GFK) captured August 8. The nest contained three eggs and one newly hatched nestling (estimated lay date August 9). On August 24, the chick was missing, and on the following day, an egg had disappeared. The remaining two eggs hatched August 27-28 (estimated lay dates August 16-17). Both nestlings were banded on September 2. On September 4, a nestling was seen hanging at an odd angle out of the nest, limp and shaking. A ladder was brought, and we found that the legs had fallen through the nest twigs and appeared to be stuck. The nestling was extracted, and it seemed weak but uninjured and immediately began begging for food. During this time, the older chick jumped to the ground. It was placed back in the nest uninjured and observed in the nest later. On September 7, GFK was observed bringing food to the older chick, but the second chick was not seen or heard, and we were unsure if it had fledged. On September 9, small flies were observed at the nest, and after bringing a ladder to the nest, the second chick was found dead in the nest. Due to the long laying period for this nest (9 days from August 9 to 17), we suspected intraspecific parasitism may have occurred at this nest.

CIBOLA VALLEY CONSERVATION AREA

We found three nests at the Cibola Valley Conservation Area (CVCA) in 2012: two in Phase 1 and one in Phase 2. Two nests successfully fledged seven young.

In addition to the three confirmed territories, we estimated one additional probable and one possible breeding territory (see the breeding evidence table in attachment B).

CVCA1 N1 was found on July 10 after tracking a male (DRE) captured on June 26. The nest was found with two eggs, and four eggs were laid by July 12. On July 16, a fifth egg was found lodged between branches inches below the nest. It is possible this egg laid 4 days afterwards was laid parasitically. Three eggs hatched, and on July 24, all nestlings were banded. All fledged by July 28. The juveniles were visually located in the surrounding low coyote willows over the next few days. The remaining two unhatched eggs were later salvaged for future genetic analysis.

CVCA1 N2 was found on July 12 after tracking a male (LWB) captured on June 24. LWB's mate was unbanded. The nest was high and camera pole-checked on July 17 with four eggs. On July 26, four large nestlings were seen in the nest. One fledged by July 27, and all were assumed to have fledged by August 3.

CVCA2 N1 was found on July 25 by telemetry of a female (JLO) captured on July 22. The male (LJ) was recaptured on July 22; this was his fourth year returning to the site. LJ previously nested in the same territory in 2010 (CVCA2 N1) and 2011 (CVCA2 N3). Three eggs were observed on July 26, and a nestling hatched on July 30. It rained on July 29, and a storm passed through the site on the night of July 30. No nest activity was observed on July 31. Radio tracking on July 31 failed to pick up JLO's signal, with LJ's signal 200 m away from the nest. The nest may either have been depredated or failed due to bad weather. A check of the nest found no evidence of nestlings or eggs. LJ left the site by August 3.

CIBOLA NATIONAL WILDLIFE REFUGE

In 2012, we found two nests at the Cibola Crane Roost site, successfully fledging five young. We estimated four possible, three probable, and two confirmed breeding territories at Crane Roost (see the breeding evidence table in attachment B).

CIBCR N1 was found on July 21 during a mist netting attempt. Though no birds were captured, a cuckoo was heard repeatedly calling from a nearby tree. A search in the area revealed a nest containing two nestlings and one egg. The three nestlings were banded on July 25, with one fledging that day. All fledged by July 28.

CIBCR N2 was found after several days of searching in an area of regular activity. Nest searchers worked through dense mesquite/seep willow/tamarisk, gradually moving closer to the nest area. The nest was finally located in a mature

honey mesquite on August 11. On August 12, the nest contained three eggs. On August 16, a radio-tagged bird was discovered at the nest and identified as LLL (female) banded on July 19 at CVCA1 (see telemetry account). On August 24, one chick remained in the nest, one had already fledged, while the third ~3-day-old chick was found dead below the nest, hanging from a mesquite thorn. The nest was askew and at an acute angle, possibly dislodged by an August 22 storm. The remaining nestling was banded, and the dead chick was salvaged for later genetic analysis.

ATTACHMENT D

Birds Encountered during Yellow-billed Cuckoo (YBCU) Surveys, 2012

Table D-1.—Birds encountered during YBCU surveys, Reach 1 (Pahranagat National Wildlife Refuge, Overton Wildlife Management Area), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	OVRW	OVRWP	PAHNTH	PAHSTH
Abert's towhee	2	3		
American coot		3	3	3
American crow	1	1	1	2
Bell's vireo		**4**	**1**	**1**
Bewick's wren	1		2	2
Black phoebe			1	3
Black-chinned hummingbird			1	
Black-crowned night-heron		1	2	2
Black-tailed gnatcatcher	1	2		
Blue grosbeak	1	1	1	
Blue-gray gnatcatcher				1
Brown-crested flycatcher	1	1	3	3
Brown-headed cowbird	3	4	2	2
Bullock's oriole		2	1	1
Canada goose		1	2	2
Chipping sparrow				1
Clark’s grebe			1	
Cliff swallow	2	1		
Common raven	2	1	1	1
Common yellowthroat	1	4	3	3
Crissal thrasher		2		
Double-crested cormorant			3	
Eurasian collared dove				1
Gadwall			1	
Gambel's quail	2	4		2
Great blue heron	1	1	3	2
Great horned owl				2
Greater roadrunner	1	2	2	1
Great-tailed grackle	1	1	1	1
House finch	1		1	
Indigo bunting				1
Killdeer		1	2	
Ladder-backed woodpecker	1	2	2	2

Table D-1.—Birds encountered during YBCU surveys, Reach 1 (Pahranagat National Wildlife Refuge, Overton Wildlife Management Area), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	OVRW	OVRWP	PAHNTH	PAHSTH
Least bittern		1		
Lesser goldfinch	1		3	3
Lesser nighthawk		1		
Lesser nighthawk		1		
Lucy's warbler	1	1	1	2
Mallard		1	2	
Marsh wren			1	
Mourning dove	3	3	1	1
Northern mockingbird	2		1	1
Northern rough-winged swallow		2		1
Peregrine falcon	1			1
Phainopepla			1	2
Pied-billed grebe		2	2	1
Red-shouldered hawk				1
Red-tailed hawk			2	1
Red-winged blackbird	2	3	1	2
Ruddy duck			2	3
Say's phoebe				1
Snowy egret			1	1
Song sparrow	1		3	2
Spotted sandpiper				1
Summer tanager			**3**	**1**
Turkey vulture				2
Unknown gull			1	1
Verdin		2		
Vermillion flycatcher				**2**
Violet-green swallow				1
Virginia rail		2	1	
Western grebe			1	
Western kingbird			2	3
Western tanager				1
White-faced Ibis		1	2	2
White-throated swift	1			

Table D-1.—Birds encountered during YBCU surveys, Reach 1 (Pahranagat National Wildlife Refuge, Overton Wildlife Management Area), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	OVRW	OVRWP	PAHNTH	PAHSTH
White-winged dove	1	1		
Willow flycatcher			**3**	
Yellow warbler	**2**	**4**	**2**	**3**
Yellow-billed cuckoo	**2**	**2**	**2**	**1**
Yellow-breasted chat	3	4	2	1
Yellow-headed blackbird			1	

Table D-2.—Birds encountered during YBCU surveys, Reach 3 (Havasu National Wildlife Refuge), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	HAVBR	HAVND	HAVPS	HAVTPR
Abert's towhee	5	2	3	3
American coot	2			
American kestrel	1		1	
Ash-throated flycatcher	1		1	2
Bell's vireo	**5**	**1**	**4**	**1**
Bewick's wren	1			1
Black-chinned hummingbird	1	1	2	
Black-tailed gnatcatcher	4	2	1	1
Blue grosbeak	3	2	2	1
Brown-crested flycatcher	5	2	1	3
Brown-headed cowbird	4	4	4	1
Bullock's oriole	2		2	
Cliff swallow		2	2	
Common moorhen	1			
Common raven	1		1	1
Common yellowthroat	3	2	3	1
Crissal thrasher			2	
Eurasian collared dove				1
Gambel's quail	2	4	4	5
Gila woodpecker			**1**	**1**
Great blue heron			3	
Great egret			1	1
Greater roadrunner	2		2	1
Great-tailed grackle	4	4	4	
Green heron		1	1	
House finch	1	3	3	1
Indigo bunting	1		1	1

Table D-2.—Birds encountered during YBCU surveys, Reach 3 (Havasu National Wildlife Refuge), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	HAVBR	HAVND	HAVPS	HAVTPR
Killdeer	1			
Ladder-backed woodpecker	1	1		4
Lesser nighthawk	2	2	3	3
Lucy's warbler	1			1
Mourning dove	4	4	4	5
Northern mockingbird			1	1
Northern rough-winged swallow	1	2	3	
Red-tailed hawk		1	1	
Red-winged blackbird	2	1	4	
Rose-breasted grosbeak				1
Say's phoebe		1	1	1
Song sparrow	1		2	2
Summer tanager	**2**			
Unknown gull			1	
Verdin			1	
Western kingbird		1	1	1
White-faced Ibis	2			
White-winged dove	5	4	4	4
Yellow warbler	**3**			
Yellow-billed cuckoo	**3**			**2**
Yellow-breasted chat	5	4	4	5
Yellow-headed blackbird	1			

Table D-3.—Birds encountered during YBCU surveys, Reach 3 (Bill Williams River National Wildlife Refuge), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	BWBP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKR	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Abert's towhee	4	1	3	4	4	4		3		1	5	3	2	4	5
American kestrel					1			1						2	
Anna's hummingbird		1				1						1	1		
Ash-throated flycatcher	1		1	1	2	4	1	2			3	3	1		1
Bell's vireo	**4**	**4**	**5**	**5**	**3**	**5**	**4**	**5**	**1**	**1**	**5**	**5**	**4**	**5**	**5**
Bewick's wren	4	4	4	4	5	3	2	1	4	3	5	2	4	2	4
Black phoebe			2	3	1		4	2	4			3		3	1
Black rail			**1**				**1**								
Black-chinned hummingbird													1		
Black-headed grosbeak												1			1
Black-tailed gnatcatcher	2		1		3	2	1	1			4	1		3	
Blue grosbeak	1	1	5	3	5	5	3	5	1		3	3		4	5
Brewer's blackbird						1									
Brown-crested flycatcher	5	4	1	1	5	1	1		3	4	5	1	4	1	3
Brown-headed cowbird	3	3	3	3	3	2	1	4	3	2	3	3	4	3	3
Bullock's oriole			1		3		1	1						1	1
Cactus wren	1									1	1				
Canyon wren	5	4		4	5	5	5	2	3	2	5	4	2	5	5
Clapper rail								1							1
Clark’s grebe									1						
Cliff swallow			1	1	1	3		1				1		3	1
Common black hawk				1											
Common ground dove								1							
Common moorhen			4	1			5		2			1		1	
Common nighthawk				1											
Common raven			1			1						1		1	
Common yellowthroat	4	5	4	5	5	2	4	4	4	4	5	5	3	5	4
Coopers hawk			1			1						1		1	1
Crissal thrasher	3	1		1	3	3	1	1	1		4		2	2	
Double-crested cormorant									1						
Eurasian collared dove															1
Flicker species			2	1										1	
Gambel's quail	3		1	2	3	5	2	4	2		3	2		5	2
Gila woodpecker	**3**	**2**	**5**	**5**	**3**	**5**	**4**	**5**	**3**	**2**	**5**	**5**	**3**	**5**	**5**
Great blue heron						1	1		3			1		1	

Table D-3.—Birds encountered during YBCU surveys, Reach 3 (Bill Williams River National Wildlife Refuge), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	BWBP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKR	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Great egret									2						
Great horned owl			2	1		1	1		1	1	2	1	1		1
Greater roadrunner	4	2	2	3	3	4		2	1	1	4		2	4	5
Great-tailed grackle			2		1		2		1			1			
Green heron				2	4		2	1	5			3		2	1
Hooded oriole						1						1			
House finch	2		1			1	2		1			2			1
Indigo bunting		1		1				1							
Ladder-backed woodpecker	5	2	5	4	5	4	2		5	4	5	4	5	4	3
Lark sparrow															1
Lawrence's goldfinch															1
Lazuli bunting														1	
Least bittern			1				1		4					1	
Lesser goldfinch	2				1	1					2		1	2	
Lesser nighthawk	1	3	1	1	3	3	1	2			1	2	2	2	
Loggerhead shrike					1	1		1						2	
Lucy's warbler	2	3			1		2		2	2	3	2		1	1
Mallard				1		1		2							
Mourning dove	4	5	5	5	5	5	5	5	5	2	5	5	4	5	4
Northern rough-winged swallow	1			1	1				3				2		
Osprey									3						
Pacific-slope flycatcher				1								1			1
Peregrine falcon				1											
Pied-billed grebe									2						
Red-tailed hawk				1		1	2					2		3	
Red-winged blackbird					1				1				1	1	1
Say's phoebe								1							1
Sharp-shinned hawk							1								
Song sparrow	5	4	4	3	5	2	5	4	5	4	5	5	4	4	3
Spotted sandpiper									2						
Summer tanager	**3**	**1**	**4**	**4**	**1**	**1**	**4**	**3**	**1**		**4**	**3**	**1**	**3**	**2**
Turkey vulture			1	5		5	2	4				3		4	
Unknown empdid															1
Unknown flycatcher							1					1			
Unknown gnatcatcher			1	1		2	1	1						1	2

Table D-3.—Birds encountered during YBCU surveys, Reach 3 (Bill Williams River National Wildlife Refuge), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	BWBP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKR	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Unknown gull									1						
Unknown hummingbird	1											1			1
Unknown ibis				2											
Unknown myiarchus			4	4		2	3	3				2		5	3
Unknown swallow sp.			3			1	2	1				2			1
Unknown warbler								1							
Unknown wren						1		2						1	
Verdin	3	1	1	1	3	2					4		2	1	
Violet-green swallow								1						1	
Warbling vireo			1	1				1				1			
Western grebe									1						
Western kingbird			2	1	3		1	1	1			1	1		1
Western screech owl							1								
Western tanager	1		1				1								
Western wood-pewee	1							1							1
White-faced Ibis	1					1	1					1			
White-throated swift		1				1							1	2	1
White-winged dove	5	5	5	4	5	5	4	5	4	4	5	4	4	5	5
Wilson's warbler												1			
Yellow warbler	**1**	**5**	**2**	**4**	**1**	**1**	**5**	**5**	**3**	**3**	**5**	**4**	**3**	**4**	**3**
Yellow-billed cuckoo	**2**	**3**	**4**	**2**	**3**	**2**	**5**	**3**	**2**		**3**	**5**	**3**	**3**	**4**
Yellow-breasted chat	5	5	5	4	5	5	5	5	5	4	5	5	5	4	5
Yellow-headed blackbird									1						

Table D-4.—Birds encountered during YBCU surveys, Reach 4 (‘Ahakhav Tribal Preserve to Cibola NWR), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	CIBCNT	CIBCR	CIBEUC	CIBMP	CIBNTH	CRIT	CVCA1	CVCA2	CVCA3	PVER1	PVER2	PVER3	PVER4	PVER5
Abert's towhee	5	4	3	5	1	5	4	5	3	4	5	2	5	5
American avocet													1	
American coot														2
American kestrel			1			2								
Anna's hummingbird						5			1					
Ash-throated flycatcher	3		3	1	2	3		3	3		3		2	1
Barn owl							1			1	1			
Bell's vireo	**3**													
Bewick’s wren						1								
Black phoebe		1		1		3					1	1	1	2
Black-chinned hummingbird			1			1	1	1	2	2	1			1
Black-crowned night-heron														1
Black-headed grosbeak				1			1		1					
Black-tailed gnatcatcher						3								
Blue grosbeak	3	4	2	5	3	1	5	5	5	5	5	4	5	5
Blue-gray gnatcatcher													1	
Brown pelican											1			1
Brown-crested flycatcher		1												
Brown-headed cowbird	4	3	3	4	2	4	4	4	4	4	5	2	4	4
Bullock's oriole			2		1	4	3		1		2	1		
Cattle egret						1				2				1
Cliff swallow		2		1		2			1	1	1	2	2	4
Common black hawk	1				1									
Common ground dove					1	1	1							3
Common nighthawk					1			1						
Common raven							1					1		1
Common yellowthroat	3	3	1	4	1	2	2		1	2	5	1	3	5

Table D-4.—Birds encountered during YBCU surveys, Reach 4 (‘Ahakhav Tribal Preserve to Cibola NWR), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	CIBCNT	CIBCR	CIBEUC	CIBMP	CIBNTH	CRIT	CVCA1	CVCA2	CVCA3	PVER1	PVER2	PVER3	PVER4	PVER5
Cooper’s hawk							1	1						
Crissal thrasher					1	2								
Eurasian collared dove	1	1	3		2	2	4	4	4	2	3		3	2
Gambel's quail	1	4	3	4	3	5	2	2	4	4	4	1	1	4
Gila woodpecker					**1**									
Great blue heron		1	2								1			2
Great egret		1		3							2			3
Great horned owl	1		1	1	2	5	1	1		1		2	1	1
Greater roadrunner					1	1				1		1		5
Great-tailed grackle		2	2			4	2	1				1		3
House finch	1			2		5	1	1	1		3	1	2	
Inca dove											1		1	
Indigo bunting				1			2		1	1			2	1
Killdeer	1	2	1	2		2	2					1	1	
Ladder-backed woodpecker	1	2	2	2		3	1	2	2		1		1	1
Lesser goldfinch						4	1		1		1			
Lesser nighthawk			1	1		1					2			
Loggerhead shrike		1	1	3	1	1			1		1			1
Lucy's warbler			1			5	1		2	1	2	1	1	2
Mourning dove	5	4	3	5	4	5	2	5	5	5	5	3	5	5
Northern mockingbird				2	1									
Northern rough-winged swallow		1				2			1		1	1	2	3
Osprey		1												
Phainopepla						1								
Red-tailed hawk	1		1	1		2			1					1
Red-winged blackbird	1	4	3	4		1	3	5	5	4	5	4	4	5
Say's phoebe				1		1	1				1			

Table D-4.—Birds encountered during YBCU surveys, Reach 4 (‘Ahakhav Tribal Preserve to Cibola NWR), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	CIBCNT	CIBCR	CIBEUC	CIBMP	CIBNTH	CRIT	CVCA1	CVCA2	CVCA3	PVER1	PVER2	PVER3	PVER4	PVER5
Song sparrow	2	4		5			1		1	2	4		5	5
Summer tanager				**1**		**4**			**1**		**1**	**1**		
Tropical kingbird						1								
Turkey vulture	1		3			5	1					1	2	2
Unknown myiarchus						1								
Verdin	1				1	1								
Vermillion flycatcher						**4**			**1**					
Western kingbird	3	3	4	4	2	5	5	5	4	2	5	3	5	3
Western meadowlark		2				3								1
Western tanager		1				1								
Western wood-pewee					1									
White-faced Ibis			1			1								1
White-winged dove	5	4	4	5	4	5	5	5	5	5	5	4	5	5
Yellow warbler	**4**	**1**				**1**	**2**		**1**				**4**	
Yellow-billed cuckoo	**4**	**5**	**1**	**1**		**4**	**4**	**4**	**1**	**3**	**4**	**5**	**5**	**5**
Yellow-breasted chat	3	3	1	5	3	2	3	3	4	1	3		5	5
Yellow-headed blackbird		1		1		2					2		1	1
Zone-tailed hawk						1								

Table D-5.—Birds encountered during YBCU surveys, Reaches 5–6 (Imperial to Yuma), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	GRNVA	GRNVB	GRQP	IMP20A	IMP50	IMPSTH	LAG2	LAG3	MLPR	PICSRA	YUEW	YUWW
Abert's towhee	3	1	5		3	3	3	5	4	2	4	5
American coot						2						
American kestrel			3			1						3
American redstart						1						
Anna's hummingbird			1				2		1		3	5
Ash-throated flycatcher	1		3	2	2	2	1	5	3	4	1	4
Bell's vireo					**3**		**2**			**4**	**3**	
Black phoebe	2		4	1		1		1	3		3	3
Black rail						**2**						
Black-chinned hummingbird			1		1		2	1			1	5
Black-headed grosbeak	1		1							1		2
Black-necked stilt										1		
Black-tailed gnatcatcher	1	1	1	4	4	3	4	5	2	3	2	5
Black-throated gray warbler											1	
Blue grosbeak	1		1				1	4	4		3	2
Brown-crested flycatcher						1		1		2		
Brown-headed cowbird	2		5		1	2	1	2	4		3	4
Bullock's oriole	2		2	2	1	1			4	1	1	4
California gull						1						
Clapper rail											1	
Clark’s grebe					1							
Cliff swallow	2		3			2	1	3	2		1	3
Common ground dove	2		4			2	1		5			2
Common moorhen	2							2	1		3	
Common yellowthroat	3			2	4	5	3	5	1	4	4	4
Cooper’s hawk												3
Crissal thrasher	1							1	1			2
Eurasian collared dove			1								1	5
European starling			1						1			4
Gambel's quail	1		5	1	2	3		4	4	3	1	5
Gila woodpecker			**1**			**1**	**2**	**5**	**3**	**4**	**2**	**5**

Table D-5.—Birds encountered during YBCU surveys, Reaches 5–6 (Imperial to Yuma), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	GRNVA	GRNVB	GRQP	IMP20A	IMP50	IMPSTH	LAG2	LAG3	MLPR	PICSRA	YUEW	YUWW
Great blue heron						2		1			2	1
Great egret						1		2	2	1	2	
Great horned owl									1			
Greater roadrunner									1		2	1
Great-tailed grackle	2	1	2	5	4	3		4	4	3	4	5
Green heron					1	1		4			3	3
House finch	3		4			1			1		2	4
House sparrow												2
Inca dove			3								1	1
Indigo bunting									2			
Killdeer				1							3	
Ladder-backed woodpecker	3		1		1	2	4	5	2	4	3	5
Lazuli bunting	1		1									
Least bittern						1		1			3	
Lesser goldfinch	3		5	1							2	
Lesser nighthawk			1	2	2	2		2	3		1	
Loggerhead shrike			3	2	1	2		5	3	3	2	1
Lucy's warbler							1					
Mallard					1							
Marsh wren						1		2			3	
Mourning dove	4	1	5	4	3	5	4	4	5	3	4	5
Northern mockingbird				1	1						2	5
Northern rough-winged swallow	1			1	1					1		1
Orange-crowned warbler											1	1
Peregrine falcon	1		1									
Phainopepla				1	1							2
Pied-billed grebe						2			1		1	
Red-tailed hawk	1		1	1		1			1			
Red-winged blackbird		1	3	1	1	2		1	2	1	2	3
Rock pigeon											2	1
Rooster			1							1		1

Table D-5.—Birds encountered during YBCU surveys, Reaches 5–6 (Imperial to Yuma), 2012

(The number of survey periods each species was detected is displayed. Lower Colorado River Multi-Species Conservation Program covered species are in **bold.**)

Species name	GRNVA	GRNVB	GRQP	IMP20A	IMP50	IMPSTH	LAG2	LAG3	MLPR	PICSRA	YUEW	YUWW
Say's phoebe											1	
Snowy egret			1			2		2	1		3	1
Song sparrow	4				3	4		4	5			
Swainson's hawk			1									
Tree swallow						1						
Turkey vulture	3		3			1			1	4	1	3
Unknown empdid							1					
Unknown hummingbird			1					1				
Verdin	4	1	4	2	5	4	5	4	5	4	4	5
Virginia rail						**1**					**2**	
Warbling vireo							1					
Western grebe						1						
Western kingbird	2		5	5	5	4	2		4	3	3	4
Western meadowlark								1				
Western tanager			1		1				2	2		
White-faced Ibis					1							
White-throated swift			1						1	1		
White-winged dove	3	1	5	4	5	5	5	5	5	3	4	5
Willow flycatcher						**1**	**1**					
Wilson's warbler			1									
Yellow warbler			**1**									
Yellow-billed cuckoo			**1**	**2**	**1**	**3**		**2**	**4**	**3**	**2**	**1**
Yellow-breasted chat	4				3	4	4	5	2	2		
Yellow-headed blackbird					1	1			1			