# 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, 2011 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

July 2012

# Lower Colorado River Multi-Species Conservation Program
# Steering Committee Members

**Federal Participant Group**

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

**Arizona Participant Group**

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
Cibola Valley Irrigation and Drainage District
City of Bullhead City
City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

**Other Interested Parties Participant Group**

QuadState County Government Coalition
Desert Wildlife Unlimited

**California Participant Group**

California Department of Fish and Game
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

**Nevada Participant Group**

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

**Native American Participant Group**

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

**Conservation Participant Group**

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

# Lower Colorado River
# Multi-Species Conservation Program

## Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2011 Annual Report

*Prepared by Shannon E. McNeil, Diane Tracy, John R. Stanek, and Jenna E. Stanek, Southern Sierra Research Station*

Southern Sierra Research Station
*Research for Conservation of Biological Diversity*

**Lower Colorado River**
**Multi-Species Conservation Program**
**Bureau of Reclamation**
**Lower Colorado Region**
**Boulder City, Nevada**
**http://www.lcrmscp.gov**

**July 2012**

# Table of Contents

# List of Figures



# List of Tables

# List of Appendices



# List of Maps

# Executive Summary

The western yellow-billed cuckoo (*Coccyzus americanus*) population has declined dramatically over the past century following extensive riparian habitat loss. In 2005, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was created to assist in the recovery of yellow-billed cuckoos, and other threatened and near-threatened species occurring within the historic lower Colorado River floodplain, by creating, protecting, and maintaining wildlife habitat. This report details our fourth year of a five-year project to assess the response of yellow-billed cuckoos to current riparian habitat restoration and guide future habitat creation planned within the LCR MSCP boundary.

Between mid-June and mid-August 2011, we conducted yellow-billed cuckoo call-broadcast surveys at 50 sites along the lower Colorado, Bill Williams, and Gila Rivers, covering approximately 1,407 hectares (ha) of potentially suitable breeding habitat. Surveys included 27 restoration and 23 natural riparian sites (0). We recorded 292 survey detections, which we estimated to represent up to 67 potential (including 28 confirmed) breeding pairs within the study area. Cuckoos arrived approximately two weeks later this year compared to 2010; however, by mid-July, survey detections were comparable to the previous year. Detections declined between 2010 and 2011 at Havasu National Wildlife Refuge (NWR) and Bill Williams River (BWR) NWR, increased in the Blythe area, and were unchanged in Yuma. Survey detection probability averaged 61.2%, but varied over the season and was highest in July (69-82%) and lowest in June and August (45-49%). Cuckoo occupancy at restoration areas (62.5%) exceeded that of natural areas (52.4%). The proportion of habitat occupied in Reach 4 (Parker to Cibola, 67.9%) exceeded that of Reach 3 (Havasu NWR, 40.0%; BWR NWR, 54.2%), and Reach 5-6 (Imperial to Yuma, 42.9%).

Breeding was confirmed again in four areas: Havasu NWR (Beal), BWR NWR, Palo Verde Ecological Reserve (PVER) Phases 2 and 3, and Cibola Valley Conservation Area (CVCA) Phases 1 and 2. We confirmed breeding for the first time at Cibola NWR Crane Roost, and PVER Phase 4. LCR restoration habitat continued to increase in detections, occupancy, and confirmed breeding, and three sizeable subpopulations (with at least seven breeding pairs each) are now evident in the LCR MSCP study area. The BWR NWR (~700 ha of breeding habitat) continued to support high breeding numbers (up to 23 breeding territories), while PVER Phases 1-4 (91 ha of contiguous breeding habitat) supported 11-17 breeding pairs, and CVCA Phases 1-2 (64 ha) supported 7-11 breeding pairs in 2011.

We found 29 nests in the study area in 2011 (Chapter 2), almost twice the number we found in 2010. The nests were active between June 30 and August 20, with the highest number of active nests occurring July 22–28. Once again, we found a close coupling of peak cicada activity with cuckoo fledging at Bill Williams River NWR but not at restoration sites, which continued to exhibit relatively low cicada abundances. Clutch size ranged from two to five and averaged 2.84±0.8, higher than previously recorded in this area. Apparent nest success was 100% at Bill Williams River NWR and 50% at restoration sites. Nest depredation was the main cause of failure, and nest predators included unknown avian egg predators and a California king snake (*Lampropeltis getula californiae*). Productivity averaged 1.52 fledged young per nest, and individual egg success averaged 52%.

For the first time in the study area, we witnessed three anomalous nests containing both cuckoo and dove eggs, indicating interspecific nest parasitism had occurred. Two of these nests were inactive when found, and no doves were ever seen at any of the three nests, so it is unknown whether they were still being used by doves when the cuckoos deposited the eggs. We also suspected intraspecific nest parasitism occurred at three nests, due to large gaps in laying dates and unusually large clutch sizes.

During the 2011 season, we target-mist netted and color-banded 27 adults, and color-banded 35 hatch-year cuckoos from 14 nests (Chapter 3). We also re-sighted or recaptured seven cuckoos banded in 2010 (four banded as adults and three as nestlings), an overall re-sight rate of 11.8%. The re-sight rate among returning young banded in 2010 was 12.5%. From these re-sights, we recorded five new dispersal events: four breeding and one natal, all from returning male birds. The four adults all returned to their previous breeding sites (three at CVCA and one at BWR NWR) suggesting strong male breeding site fidelity. One positively identified second-year male returned to nest at his natal site (CVCA).

We radio-tracked 20 adult cuckoos at restoration sites in 2011 (Chapter 3). Over half were transient and likely still migrating though the LCR during the first half of the season (<July 23), spending an average of about 11 days at a site before departing. Birds that nested at their capture site remained an average of 37 days post-capture. The average home range (95% kernel density) estimate of 18 birds was 19.8 ±9.7 ha, close to our previous estimates of about 21 ha at these sites. Among seven breeding birds followed for at least seven days, the average home range estimate was 17.4 ±4.0 ha. Home ranges of 11 birds showing no breeding evidence averaged 21.4 ±12.0 ha. We also observed high breeding densities and overlapping home ranges among CVCA and PVER birds.

We again compared microclimate (temperature and relative humidity) between nests and available habitat, by placing data loggers at 186 locations during the 2011 breeding season (Chapter 4). 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 providing sufficient areas with suitable nesting microclimate in these extreme desert riparian habitats. Our main results and management recommendations are summarized in Chapter 5.

# Introduction and Project Background

## Yellow-billed Cuckoo History and Biology

The western yellow-billed cuckoo (cuckoo, YBCU) population has declined dramatically over the last 100 years due to extensive loss 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 ha (400,000-500,000 acres) of alluvial floodplain 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 common, although few early records exist (Gaines and Laymon 1984).

Over the past century, the LCR was transformed by dams into a string of storage pools, and vast areas of floodplain 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 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), though it is unclear how these estimates were calculated. Much of the LCR floodplain 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 LCR Multi-Species Conservation Program (MSCP) boundary is estimated to be 50,990 ha (126,000 acres), of which just 18% is native (LCR MSCP 2004a).

The taxonomic status of the western cuckoo remains unclear; whereas some researchers support a distinct western subspecies *occidentalis* (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 United States Fish and Wildlife Service (USFWS) determined that western yellow-billed cuckoos represent a Distinct Population Segment (DPS), and they became a candidate for listing for protection under the Endangered Species Act (USFWS 2001). In 2002, the listing was determined to be warranted but precluded by higher priority listing actions (due to limited resources) (USFWS 2002). A final listing decision is expected to be published by 2013 (USFWS 2011). Yellow-billed cuckoos are listed as endangered in California (CDFG 1978), a species of special concern in Arizona (AGFD 1988), and a sensitive species on U.S. Forest Service lands within Arizona and New Mexico (USDA 1988).

Yellow-billed cuckoos are among the latest-arriving neotropical migrants, beginning to arrive in Arizona and California in late May (Bent 1940, Hughes 1999). Diet during the breeding season consists primarily of large insects such as grasshoppers, katydids, caterpillars, praying mantids, and cicadas; also tree frogs and small lizards (Bent 1940, Hamilton and Hamilton 1965, Nolan and Thompson 1975, Laymon 1980, Laymon et al. 1997). 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 peaking mid- to late July (McNeil et al. 2011). 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. 2011). Nests consist of a loose platform of twigs, which are built by both sexes and take one to two days to build (Hughes 1999), though occasionally the nest of another species is used (Jay 1911, Bent 1940, Payne 2005). Clutch size is 1-5 (Payne 2005), usually 2-3 on the LCR (Laymon 1998, McNeil et al. 2011), though up to eight 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) similar to the adult diet. After fledging at 5 to 9 days, young may be dependent on adults for at least three weeks (Laymon and Halterman 1985).

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). 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, multiagency 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 floodplain 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 and 21 other covered 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). Yellow-billed cuckoos are one of 26 covered species included in the LCR MSCP, which aims to create over 3,278 hectares of wildlife habitat over a 50-year period.

## 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.

# 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.

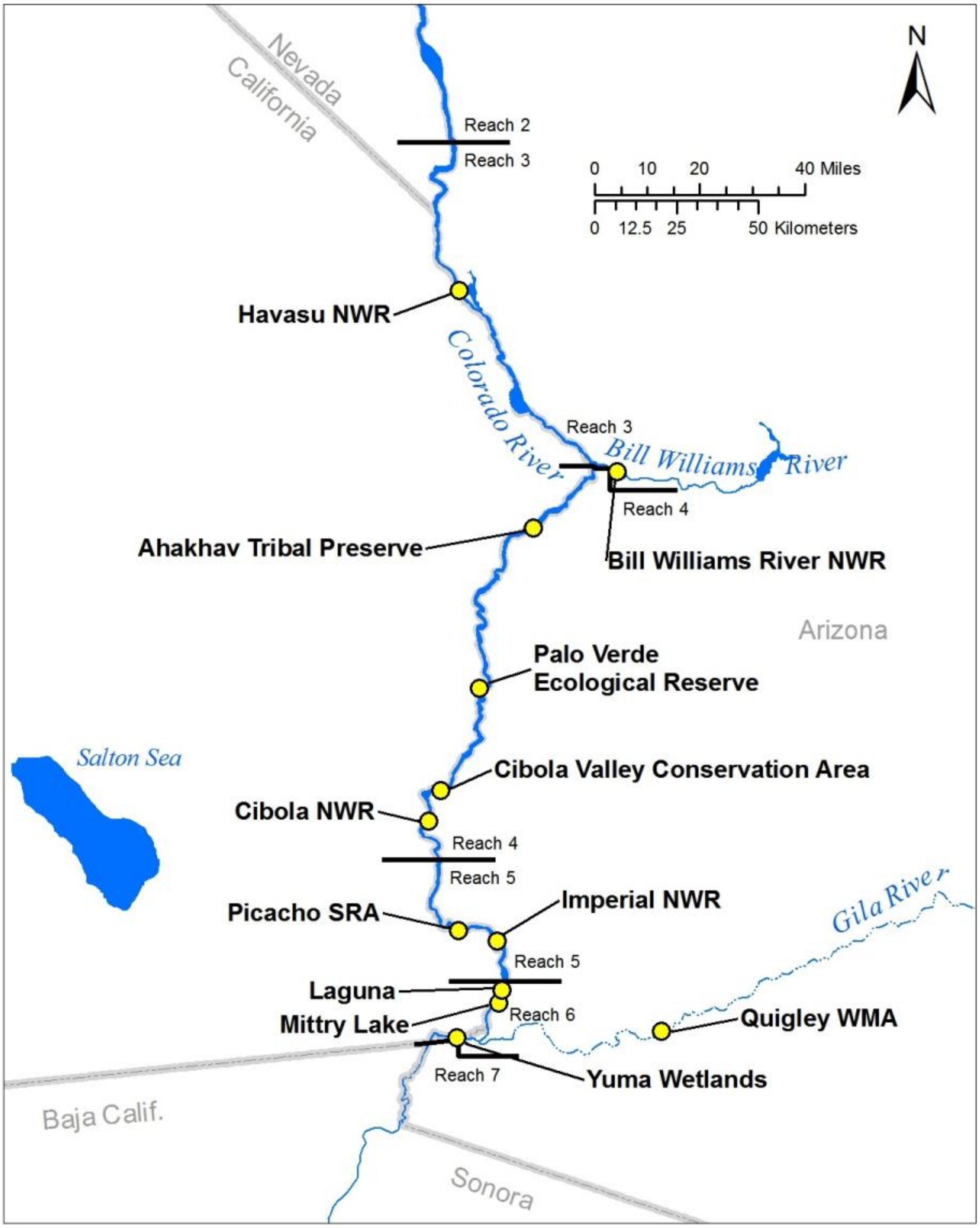
In 2011, we continued our long-term monitoring of yellow-billed cuckoos within the LCR MSCP boundary to provide an annual status assessment of the species and to identify trends in cuckoo population parameters, in particular the cuckoos' response to LCR MSCP habitat restoration. Through repeated surveys and follow-up efforts, we determined habitat occupancy and estimated the number of breeding pairs in the study area. The analyses are predominantly stratified by site type, natural vs. restoration, to maximize our power to detect cuckoo responses to habitat restoration efforts. While surveys designed to monitor a species can uncover patterns of distribution, the mechanisms behind these patterns are often better discerned through supplemental research (such as nest observations, radio telemetry, and habitat analyses) described in chapters 2-4.

# Methods

## Study Area and Survey Site Selection

We conducted yellow-billed cuckoo surveys along a 200-river-mile stretch of the lower Colorado River and tributaries, from the Havasu NWR to the United States-Mexico Southerly International Boundary (the study area). Along this river stretch, all potentially suitable habitat patches were considered for inclusion. A habitat patch was defined as an area of potentially suitable habitat 2 ha (4.9 ac) or greater in extent, that was separated from another patch of potentially suitable habitat by at least 300 meters (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 (2008-2011) reconnaissance. Sites were selected based on past cuckoo detections (Johnson et al. 2007, 2008; Halterman et al. 2009; McNeil et al. 2010, 2011), patch size, plant species composition, and habitat structure (generally woody riparian land cover structural types I-III, at least 4-5 m in height [Anderson and Ohmart 1984]). Survey sites consisted of early to mature native or mixed native/exotic riparian forest patches greater than 2 ha in size, though ideal habitat patches are thought to be greater than 40 ha (Laymon and Halterman 1989) which can support more than one breeding territory. Sites were delineated by walking the boundaries with a GPS unit. Where site boundaries were inaccessible (such as areas of BWR NWR), boundaries were estimated in ArcGIS 9.3 using geo-referenced 2004 aerial photography. Each site's size (ha) was estimated in ArcGIS.

Fifty sites were surveyed in 2011 (Map a, Table 1-1, Table 1-2, Appendix A); 27 were restoration sites and 23 were classified as natural (non-restoration native or mixed native/exotic riparian habitat). All sites surveyed in 2010 were resurveyed in 2011, except four on the Virgin and Muddy rivers (Littlefield Bridge, Smelly Jelly, Overton Wildlife, Wilson Pond), and two Havasu NWR sites (Levee Road and Farm Ditch Road). The Littlefield Bridge habitat was destroyed by a flood in early 2011, and we did not survey the others due to marginal suitability and small size. Five sites were added in the Laguna area to establish pre-restoration conditions, and one (Imperial 50) was identified as new potentially suitable habitat. Additional survey transects were also added to two existing Cibola NWR sites (Crane Roost and Perri Marsh) and one PVER site (Phase 4) due to increased habitat suitability. Site descriptions including maps are presented in Appendix A.




Map a. LCR 2011 yellow-billed cuckoo study area including river reach boundaries; survey areas shown by yellow circles. Sites listed in Tables 1-1 and 1-2 are clustered in these survey areas.

Table 1-1. Northern (Reach 3) yellow-billed cuckoo survey sites, 2011. Survey areas are shown in Map a.

| Site Name | Site Code | Size (ha) | Site Type | Survey Area | River Reach |
|---|---|---|---|---|---|
| Pintail Slough | HAVPS | 11.7 | Restoration | Havasu NWR | Reach 3 |
| North Dike | HAVND | 5.1 | Restoration | Havasu NWR | Reach 3 |
| Glory Hole | HAVGH | 13.2 | Natural | Havasu NWR | Reach 3 |
| Topock Platform Restoration | HAVTPR | 9.3 | Restoration | Havasu NWR | Reach 3 |
| Beal Restoration | HAVBR | 21.3 | Restoration | Havasu NWR | Reach 3 |
| Cave Wash | BWCW | 88.1 | Natural | Bill Williams River NWR | Reach 3 |
| Cottonwood Patch | BWCP | 38.1 | Natural | Bill Williams River NWR | Reach 3 |
| Honeycomb Bend | BWHB | 29.6 | Natural | Bill Williams River NWR | Reach 3 |
| Mineral Wash | BWMW | 49.8 | Natural | Bill Williams River NWR | Reach 3 |
| Esquerra Ranch | BWER | 40.2 | Natural | Bill Williams River NWR | Reach 3 |
| Cougar Point | BWPT | 43.1 | Natural | Bill Williams River NWR | Reach 3 |
| Kohen Ranch | BWKR | 37.1 | Natural | Bill Williams River NWR | Reach 3 |
| Gibraltar Rock | BWGR | 66.5 | Natural | Bill Williams River NWR | Reach 3 |
| Sandy Wash | BWSW | 50.9 | Natural | Bill Williams River NWR | Reach 3 |
| Fox Wash | BWFW | 62.5 | Natural | Bill Williams River NWR | Reach 3 |
| Borrow Pit | BWBP | 33.6 | Natural | Bill Williams River NWR | Reach 3 |
| Cross River | BWCR | 30.2 | Natural | Bill Williams River NWR | Reach 3 |
| Mosquito Flats | BWMF | 37.1 | Natural | Bill Williams River NWR | Reach 3 |
| North Burn | BWNB | 30.0 | Natural | Bill Williams River NWR | Reach 3 |
| Middle Delta | BWMD | 25.2 | Natural | Bill Williams River NWR | Reach 3 |
| Bill Williams Marsh | BWMA | 19.7 | Natural | Bill Williams River NWR | Reach 3 |

Table 1-2. Southern (Reach 4-6) yellow-billed cuckoo survey sites, 2011. Survey areas shown in Map a.

| Site Name | Site Code | Size (ha) | Site Type | Survey Area | River Reach |
|---|---|---|---|---|---|
| Ahakhav Tribal Preserve | CRIT | 59.6 | Restoration | Ahakhav Tribal Preserve | Reach 4 |
| Palo Verde Phase 1 | PVER1 | 8.3 | Restoration | Palo Verde Ecological Reserve | Reach 4 |
| Palo Verde Phase 2 | PVER2 | 24.2 | Restoration | Palo Verde Ecological Reserve | Reach 4 |
| Palo Verde Phase 3 | PVER3 | 19.8 | Restoration | Palo Verde Ecological Reserve | Reach 4 |
| Palo Verde Phase 4** | PVER4 | 35.8 | Restoration | Palo Verde Ecological Reserve | Reach 4 |
| Cibola Valley Phase 1 | CVCA1 | 34.8 | Restoration | Cibola Valley Conservation Area | Reach 4 |
| Cibola Valley Phase 2 | CVCA2 | 24.7 | Restoration | Cibola Valley Conservation Area | Reach 4 |
| Cibola Valley Phase 3 | CVCA3 | 37.0 | Restoration | Cibola Valley Conservation Area | Reach 4 |
| Cibola North | CIBNTH | 7.2 | Restoration | Cibola NWR | Reach 4 |
| Cibola Mass Planting | CIBMP | 23.7 | Restoration | Cibola NWR | Reach 4 |
| Cibola Nature Trail | CIBCNT | 14.4 | Restoration | Cibola NWR | Reach 4 |
| Cibola Crane Roost** | CIBCR | 48.0 | Restoration | Cibola NWR | Reach 4 |
| Cibola Eucalyptus | CIBEUC | 29.4 | Restoration | Cibola NWR | Reach 4 |
| Cibola Island Perri Marsh** | CIBIPM | 88.3 | Restoration | Cibola NWR | Reach 4 |
| Cibola Island South | CIBSTH | 13.8 | Restoration | Cibola NWR | Reach 4 |
| Picacho SRA | PICSRA | 14.8 | Restoration | Picacho SRA | Reach 5 |
| Imperial NWR South | IMPSTH | 13.0 | Restoration | Imperial NWR | Reach 5 |
| Imperial NWR 20A | IMP20A | 2.0 | Restoration | Imperial NWR | Reach 5 |
| Imperial NWR 50* | IMP50 | 4.2 | Restoration | Imperial NWR | Reach 5 |
| Martinez Lake | IMPAST | 6.8 | Natural | Imperial NWR | Reach 5 |
| Laguna Transect 'A'* | LAGTA | 10.1 | Natural | Laguna | Reach 6 |
| Laguna Transect 'D'* | LAGTD | 14.3 | Natural | Laguna | Reach 6 |
| Laguna East* | LAGE | 13.9 | Natural | Laguna | Reach 6 |
| Laguna West* | LAGW | 1.0 | Natural | Laguna | Reach 6 |
| Mittry Lake East Road* | MLEA | 10.2 | Natural | Mittry Lake | Reach 6 |
| Mittry Lake-Pratt | MLPR | 13.0 | Restoration | Mittry Lake | Reach 6 |
| Quigley WMA | GRQP | 10.6 | Restoration | Quigley WMA | Reach 6 |
| Yuma East Wetlands | YUEW | 9.0 | Restoration | Yuma Wetlands | Reach 6 |
| Yuma West Wetlands | YUWW | 25.5 | Restoration | Yuma Wetlands | Reach 6 |

* New site for 2011. ** Previous site with new transects added in 2011.

## Presence-Absence Surveys

Yellow-billed cuckoos are inherently secretive and call infrequently (Hamilton and Hamilton 1965). 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). Relative to previous field seasons, in 2011 a change was made to our survey protocol in order to increase the likelihood of detecting breeding cuckoos, and to increase accuracy in determining habitat occupancy. We shifted our survey periods so that the majority of surveys (three of five) were conducted in July during the peak of cuckoo detectability, site occupancy, and breeding activity on the LCR

(McNeil et al. 2010, 2011). The probability of detecting a cuckoo during the times preceding and following this peak have been observed to be relatively lower, on the LCR (Johnson et al. 2007, 2008; Halterman et al. 2009; McNeil et al. 2010), and in other areas throughout their western breeding range (Henneman 2009, Dettling and Howell 2011, Whitfield and Stanek 2011). This is likely due in part to their transient nature before and after breeding (Howe 1986, Groschupf 1987, McNeil et al. 2011) and that cuckoos may be less responsive to broadcast surveys late in their breeding cycle when they have nestlings or fledglings (Halterman 2001, McNeil et al. 2011). To accommodate the additional July survey, we increased the frequency of our peak breeding season survey effort from once every 12–20 days to once every 10 days. The added July survey replaced the survey previously conducted in the latter half of August, and increased the likelihood of detecting a cuckoo if it was missed on a previous survey. Compared to the other survey rounds, the final survey (in the latter half of August) typically detected the fewest number of cuckoos (McNeil et al. 2010, 2011), which provided useful insight into the low response rate of post-breeding cuckoos and the timing of cuckoos' fall migration, but offered little information toward identifying habitat occupancy.

Table 1-3. LCR YBCU Survey Period Dates, 2011.

| 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 | Aug 1 to Aug 15 |

Cuckoo presence-absence surveys were conducted at survey sites along point transects on foot or by kayak, between sunrise and 10:30 am, or until temperatures exceeded 40° C (104° 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 to avoid double-counting cuckoos. Each site contained one or more transect with parallel transects spaced approximately 200 m apart. Survey points were spaced every 100 m along transects. Most transects traversed through the habitat patches. However, some transects ran along riparian habitat edges or adjacent roads to take advantage of greater visual detectability from these locations or because the interior of the habitat was inaccessible. Survey points were located using Garmin GPS units, and at each point we recorded the UTM location, date, time, temperature, humidity, habitat type, and habitat structure.

Upon arriving at a survey point, surveyors listened and watched for cuckoos for one minute. If no cuckoos were detected, surveyors used an MP3 player and handheld speaker to broadcast a five-second yellow-billed cuckoo contact call (the ‘kowlp’ call) (Hughes 1999) at approximately 70 decibels, once per minute for five minutes. A five-second contact 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 was recorded (see below). Following a detection, surveyors progressed along the point transect 300 m from the estimated location of the detected cuckoo. This was done to avoid additional disturbance and duplicate detections of the same bird. When surveys were conducted by more than one person, if a cuckoo was detected, one person continued the survey while another remained and attempted to determine breeding status.

For each detection, the surveyor recorded the true bearing and estimated distance from the surveyor to the cuckoo, time of detection, 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 also 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 was recorded as a survey detection. If the same individual cuckoo was detected more than once during a single survey, we recorded these detections as only one survey detection. Cuckoos detected >300 m apart during a single survey were counted as separate individuals and therefore separate survey detections. Cuckoos encountered any time other than during 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 surveys (Appendix D to G). Terms related to surveys are summarized in

Table 1-4.

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 200-river-mile stretch of the lower Colorado River and tributaries, from Havasu NWR to the United States-Mexico Southerly International Boundary (Map a). |
| 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 in Maps a, b and c. Sites are grouped by reach in Table 1-6, Table 1-7, Table 1-8, Table 1-9, and Table 1-10. |
| Survey Area | A collection of clustered survey sites (Table 1-1, Table 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 (Table 1-1, Table 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. |

## Breeding Territory Estimation

Yellow-billed cuckoos' furtive nature and infrequent calling coupled with large home ranges and short nesting cycle make them challenging to study (Laymon et al. 1997, Hamilton and Hamilton 1965, Halterman 2009). To add to these difficulties, they often engage in behavior to avoid detection (Hamilton and Hamilton 1965, Bennett and Keinath 2003). Moreover, 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). Furthermore, telemetry observations from 2009- 2011 indicate that many cuckoos are transitory (non–breeding) and do not stay long at our sites (McNeil et al. 2010, 2011, Chapter 3 this report). Together these behaviors make breeding territory assessment difficult. Not all cuckoo nests are found, and as a result we have developed alternate methods to estimate breeding status.

We deemed areas as possibly harboring breeding cuckoos if detections occurred in two or more survey periods. A cuckoo detection from only one survey period is not a reliable indicator of breeding territory establishment because cuckoos may use an area during one survey period, but not the next (McNeil et al. 2011). All detections were assessed by location (using ArcGIS 9.3), observed behaviors, and detection dates. These detections were then used to categorize breeding status for each detection area as a *possible*, *probable*, or *confirmed breeding territory* (Table 1-5). Two or more detections in an area during at least two survey periods and at least 10 days apart warranted a *possible breeding territory* (POS). POS cuckoos observed carrying food, traveling as a pair, or exchanging vocalizations were considered a *probable breeding territory* (PRB). Breeding was only *confirmed* (COB) when a copulation, stick carry, nest, or fledgling was observed.

Estimates of breeding status utilized all detections, including incidental, survey, and follow-up. Follow-up visits included nest searching, mist netting, telemetry, and other site visits. During the field season POS and PRB observations were followed up whenever possible to confirm breeding status. 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 so exceptions to these guidelines were sometimes made and documented.

Using the POS, PRB, and COB classifications, we calculated the minimum and maximum territory estimates (Table 1-5). The minimum number of breeding territories is the number of confirmed breeding territories (the most conservative estimate). The maximum territory estimate is the sum of POS, PRB, and COB breeding territories and may potentially overestimate the true number of cuckoo territories. It is also important to note that these POS, PRB and COB observations are used to estimate the number of cuckoo territories and not the number of cuckoo pairs. A territory estimate represents the adults associated with a single nest which is usually two adult cuckoos. However, cuckoos can be polyandrous, with nesting females leaving before young are independent in order to re-nest with another male (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. The definition of POS did change slightly during this study. For the 2012 summary report, we will use one definition and recalculate the estimates for all years.

Table 1-5. Summary of definitions for breeding territory, population, and occupancy estimation terms.

| Estimation Type | Term | Definition |
|---|---|---|
| Breeding Territory Estimation | Possible Breeding Territory (POS) | Two or more detections in an area during at least two survey periods and at least 10 days apart |
| | 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 |
| Occupancy Estimation | Sample Unit | The territory-sized spatial unit **used solely** for the statistical analysis to estimate cuckoo detection probability and habitat occupancy (prior to 2011, site boundaries were used as the sample units for detection probability and occupancy estimation) |
| | Occupied Sample Unit | A sample unit with cuckoo survey detections during two or more survey periods |
| | Unoccupied Sample Unit | A sample unit with cuckoo survey detections during zero or one survey period |

### Survey Detection Probability and Habitat Occupancy

During surveys it is possible that a cuckoo is present, but remains undetected. As a result an area may be incorrectly classified as unoccupied which can result in underestimating the true habitat occupancy (MacKenzie et al. 2006). To account for this situation, we incorporated detection probabilities into our occupancy analysis. We analyzed cuckoo presence/absence data from our repeated surveys using the program PRESENCE v 4.0 (Hines 2006) to calculate detection probabilities, occupancy estimates (for surveyed areas) and the estimated proportions of natural and restoration habitat occupied by cuckoos. Due to the transiency of some cuckoos, the detection of a cuckoo in an area only once is an unreliable indicator that the area was occupied for more than a few days, let alone being used for breeding. As done previously, we modified the inputs to the program to use our definition of occupancy, i.e. survey detections in two or more survey periods (the default is to consider an area of interest occupied if an individual is detected once). In doing so, occupancy is not triggered by a single cuckoo detection in an area across the whole season, and instead reflects the occupancy of possible, probable and confirmed breeding cuckoos.

To estimate detection probability and occupancy across a study area, the area is subdivided into smaller defined areas, or sample units; detection probability and occupancy 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, 2011) the sample units used for detection probability and occupancy analyses for this project have been defined as the site boundaries. They have been both arbitrary (such as at the Bill Williams River NWR) and discrete in delineation (most other sites), with considerable size variation (ranging from discrete 2-ha patches, to the extensive riparian forest of the Bill Williams River NWR [~750 ha, divided into arbitrary sites ~20-90 ha each]). Using a standardized sample unit size provides increased accuracy and decreased bias in occupancy 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).

For rare species such as the cuckoo, the use of inappropriately large sample units to assess occupancy is problematic, because as a sample unit size increases to encompass greater areas of habitat, the sample unit occupancy rate tends to increase toward 100% (MacKenzie et al.

2006, Dettling and Howell 2011). Resulting estimates of habitat use become inflated and less informative to researchers and land managers. In sparsely populated areas, as the sample unit size decreases and the number of sample units increase, detection probability will decline and an increasing number of sample units will be found to be unoccupied, resulting in a decline in the occupancy rate. With an approximate territory-sized sample unit, results will be biologically relevant and can be directly inferred to reflect cuckoo territory selection and habitat use; the proportion of sample units occupied can be more accurately interpreted as the proportion of habitat used within the study area.

For the 2011 occupancy and detection probability analyses, we created sample units based on the average size of a cuckoo territory, instead of using 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) (McNeil et al. 2010, 2011; Chapter 3). Given the variation in the size of surveyed habitat patches, we included sample units with a range of sizes (as we have done in the past when we used the site boundaries as our sample units). At smaller sites less than 30 ha in size, too small to break into smaller sample units, we used the natural boundaries of the site to define the sample unit. At sites containing contiguous patches of habitat of at least 30 ha (e.g. Bill Williams River NWR), we tessellated the habitat into a continuous grid of 1-ha hexagons in ArcGIS 9.3. 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 17.66 ha (S.D. ±5.61 ha, n=82). We used a t-test to assess if the variation in sample unit size was a determinant of occupancy.

The territory-based sample units are used solely for the calculation of detection probability and occupancy. For the final 2012 summary report, annual detection probability and occupancy will be calculated using these territory-based sample units for the entire 2008-2012 dataset, to enable standardized between-year comparisons. If a past or future surveyed location was not surveyed in 2011, a new sample unit for this location will be delineated based on the methods described above.

## Detection Study

A main objective of this project is to evaluate the effectiveness of the current survey protocol. As part of this evaluation, we performed a separate detection study of the radio-tagged cuckoos (Chapter 3) present at sites during surveys, to increase our understanding of how our survey broadcasts affect cuckoo responsiveness and detectability. Cuckoo response and detection may be affected by environmental (e.g. wind, temperature, time of day), surveyor (e.g. observer experience, distance to cuckoo), and individual cuckoo factors (e.g. sex, mated status, breeding stage). The primary goals of this detection study are to:

1) Identify factors important to the responsiveness and detectability of cuckoos.

2) Estimate the probability of cuckoo response and probability of cuckoo detection using the current call broadcast survey protocol.

3) Identify the factors that can be controlled or affected by the survey protocol and make recommendations to achieve optimal levels of response and detectability of cuckoos during surveys.

Results will be used in conjunction with other evaluations to increase survey protocol efficiency and refine the methodology for future LCR MSCP use.

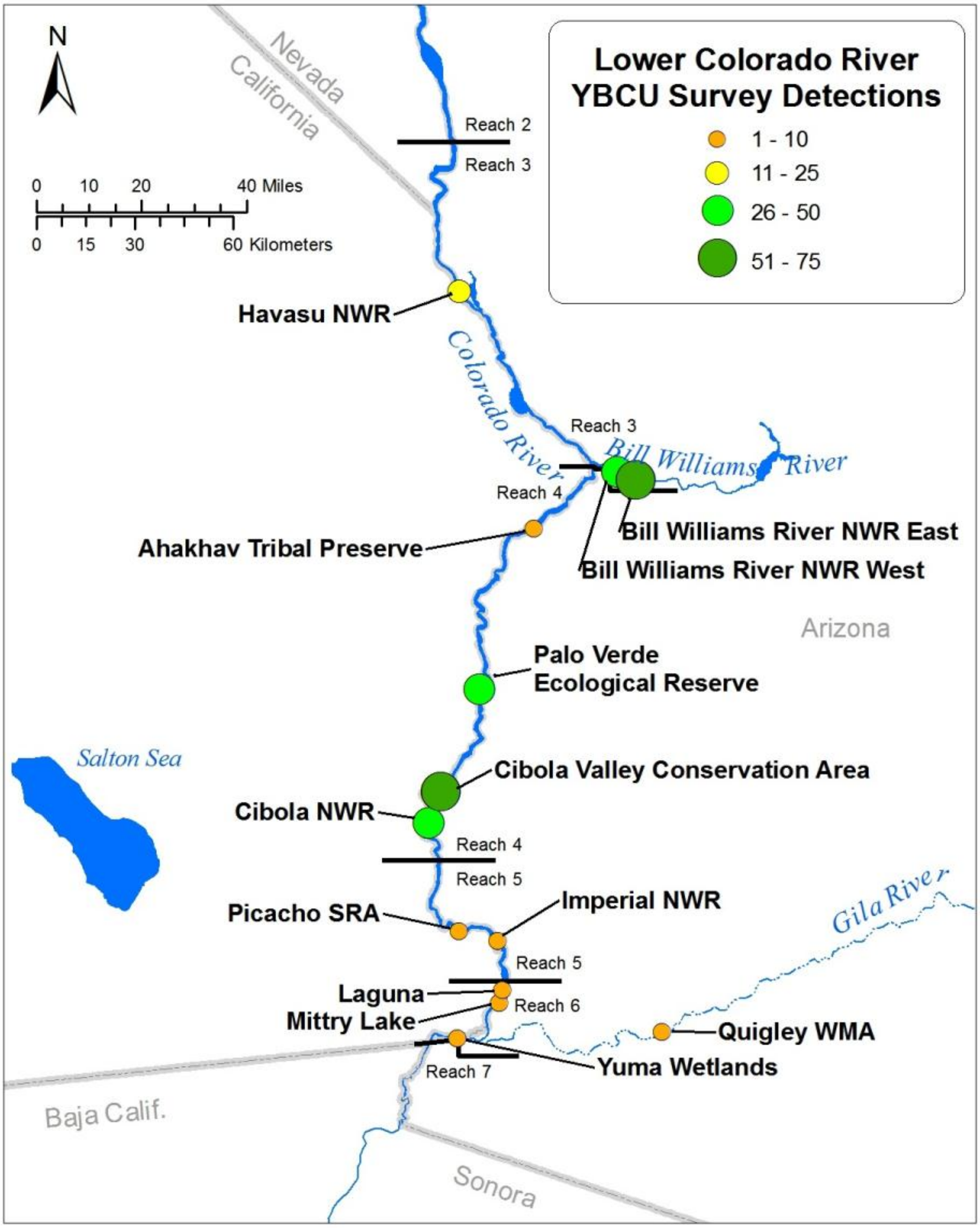
For this detection study, during each survey at sites with radio-tagged cuckoos (RTCs) present, the surveyor conducted a standard call-broadcast survey (described above), while additional observers (one radio-tracker per RTC) positioned themselves to record any RTC vocalizations or movements in response to each survey call broadcast.  The standard survey protocol was unmodified for the detection study, except for a limited number of surveys: if the targeted RTC did not respond to the broadcast calls, but a non-targeted cuckoo did respond, the surveyor continued to survey subsequent points at 100 m intervals instead of moving 300 m away from detected birds.  This was done to increase the sample size for the detection study, and was deemed not to have affected the survey results as no additional survey detections were recorded during these additional broadcast calls.  At all survey points in which a RTC was within 400 m of the surveyor, the surveyor used a hand-held radio to inform the radio-trackers of the surveyor's location, call broadcast number (from 1-5), and the estimated direction and distance to any cuckoos detected by the surveyor.  The radio-trackers recorded all vocal and movement responses by their target RTC towards or away from the surveyor during each call broadcast. Estimated distances between surveyors and RTCs were calculated using ArcMap 9.3, and detection and response data were calculated for each call broadcast, survey point, and survey.  In addition to data obtained from the coordinated survey and telemetry efforts, breeding status and nest stage were gathered from nest visit observations.  Cuckoo sex was determined through genetic analysis of blood samples taken when the RTCs were captured (Chapter 3).

We will use logistic general linear models to estimate the probabilities of cuckoo response and detection, and to identify factors affecting these probabilities and factors affected by the survey protocol.  The probability of response analysis will explore the effects of temperature, relative humidity (RH), time of survey point, distance between surveyor and cuckoo, wind, noise, date, sex, and breeding status on a cuckoo's probability of response.  The probability of detection analysis will examine the effects of distance, response call type, observer experience, time, temperature, RH, date, wind, and noise on the probability of a surveyor detecting a responding cuckoo. Due to the relatively small data set generated, the 2011 data will be combined with data to be collected in 2012, and presented in our 2012 summary report.

# Results

## Presence-Absence Surveys

From June 15 to August 15 2011, we conducted 245 yellow-billed cuckoo presence-absence surveys across five survey periods at fifty sites, yielding 292 detections (Map b, Table 1-6 to 1-10). Approximately one third of all survey detections were made at the Bill Williams River NWR (107) and nearly two thirds (176) were made at restoration sites this year. Among restoration areas, CVCA (59) and PVER (42) had the greatest number of detections.




Map b. Yellow-billed cuckoo survey detections by survey area, all survey periods, LCR 2011.

Table 1-6. LCR YBCU survey detection results by river reach, and for all sites, 2011.

| River Reach | Cuckoos Detected Per Survey Period | | | | | Total Survey Detections | Possible Breeding[1] | Probable Breeding[2] | Confirmed Breeding[3] | Min Pairs[4] | Max Pairs[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | | | | | |
| Reach 3 (Havasu NWR) | 3 | 5 | 5 | 1 | 0 | 14 | 2 | 0 | 1 | 1 | 3 |
| Reach 3 (Bill Williams River NWR) | 10 | 27 | 29 | 26 | 15 | 107 | 11 | 3 | 9 | 9 | 23 |
| Reach 4 (Parker to Cibola) | 8 | 36 | 44 | 33 | 25 | 146 | 13 | 4 | 18 | 18 | 35 |
| Reach 5 and 6 (Imperial to Yuma) | 2 | 15 | 5 | 3 | 0 | 25 | 6 | 0 | 0 | 0 | 6 |
| All Sites | 23 | 83 | 83 | 63 | 40 | 292 | 32 | 7 | 28 | 28 | 67 |

[1] Possible breeding pair = two or more detections in an area during at least two survey periods and at least 10 days apart.
[2] Probable breeding pair = possible breeding pair + food carry or traveling as a pair or vocalization exchange.
[3] Confirmed breeding pair = copulation, stick carry, nest or fledgling.
[4] Maximum YBCU pairs = possible breeding pairs + probable breeding pairs + confirmed breeding pairs.
[5] Minimum YBCU pairs = confirmed breeding pairs.

Table 1-7. LCR YBCU survey detection results and breeding estimates for Reach 3 (Havasu NWR) sites, 2011.

| Site Name | Site Code | Cuckoos Detected Per Survey Period | | | | | Total Survey Detections | Possible Breeding[1] | Probable Breeding[2] | Confirmed Breeding[3] | Min Pairs[4] | Max Pairs[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | | | |
| Pintail Slough | HAVPS | 1 | 2 | 2 | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 2 |
| North Dike | HAVND | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Glory Hole | HAVGH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Topock Platform | HAVTPR | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Beal Restoration | HAVBR | 2 | 2 | 2 | 1 | 0 | 7 | 0 | 0 | 1 | 1 | 1 |
| Total | | 3 | 5 | 5 | 1 | 0 | 14 | 2 | 0 | 1 | 1 | 3 |

[1] Possible breeding pair = two or more detections in an area during at least two survey periods and at least 10 days apart.
[2] Probable breeding pair = possible breeding pair + food carry or traveling as a pair or vocalization exchange.
[3] Confirmed breeding pair = copulation, stick carry, nest or fledgling.
[4] Maximum YBCU pairs = possible breeding pairs + probable breeding pairs + confirmed breeding pairs.
[5] Minimum YBCU pairs = confirmed breeding pairs.

Table 1-8. LCR YBCU survey detection results and breeding estimates for Reach 3 (Bill Williams River NWR) sites, 2011.

| Site Name | Site Code | Cuckoos Detected Per Survey Period | | | | | Total Survey Detections | Possible Breeding[1] | Probable Breeding[2] | Confirmed Breeding[3] | Min Pairs[4] | Max Pairs[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | | | |
| Cave Wash | BWCW | 1 | 3 | 2 | 1 | 0 | 7 | 0 | 0 | 1 | 1 | 1 |
| Cottonwood Patch | BWCP | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Honeycomb Bend | BWHB | 3 | 2 | 4 | 3 | 1 | 13 | 0 | 1 | 3 | 3 | 4 |
| Mineral Wash | BWMW | 3 | 4 | 4 | 6 | 2 | 19 | 2 | 0 | 1 | 1 | 3 |
| Esquerra Ranch | BWER | 1 | 3 | 2 | 1 | 2 | 9 | 2 | 0 | 1 | 1 | 3 |
| Cougar Point | BWPT | 2 | 3 | 2 | 1 | 2 | 10 | 0 | 0 | 2 | 2 | 2 |
| Kohen Ranch | BWKR | 0 | 2 | 5 | 3 | 1 | 11 | 0 | 2 | 0 | 0 | 2 |
| Gibraltar Rock | BWGR | 0 | 1 | 1 | 1 | 0 | 3 | 0[6] | 0 | 0 | 0 | 0 |
| Sandy Wash | BWSW | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 1 |
| Fox Wash | BWFW | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Borrow Pit | BWBP | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 1 |
| Cross River | BWCR | 0 | 2 | 0 | 3 | 0 | 5 | 2 | 0 | 0 | 0 | 2 |
| Mosquito Flats | BWMF | 0 | 2 | 3 | 2 | 2 | 9 | 1 | 0 | 1 | 1 | 2 |
| North Burn | BWNB | 0 | 2 | 0 | 1 | 2 | 5 | 1 | 0 | 0 | 0 | 1 |
| Middle Delta | BWMD | 0 | 1 | 1 | 3 | 0 | 5 | 1 | 0 | 0 | 0 | 1 |
| Bill Williams Marsh | BWMA | 0 | 1 | 2 | 0 | 2 | 5 | 0[7] | 0 | 0 | 0 | 0 |
| Total | | 10 | 27 | 29 | 26 | 15 | 107 | 11 | 3 | 9 | 9 | 23 |

[1] Possible breeding pair = two or more detections in an area during at least two survey periods and at least 10 days apart.
[2] Probable breeding pair = possible breeding pair + food carry or traveling as a pair or vocalization exchange.
[3] Confirmed breeding pair = copulation, stick carry, nest or fledgling.
[4] Maximum YBCU pairs = possible breeding pairs + probable breeding pairs + confirmed breeding pairs.
[5] Minimum YBCU pairs = confirmed breeding pairs.
[6] Detections attributed to cuckoo territories in BWKR.
[7] Detections during the second and third survey periods were attributed to nearby cuckoo territories in adjacent sites.

Table 1-9. LCR YBCU survey detection results and breeding estimates for Reach 4 (Parker to Cibola) sites, 2011.

| Site Name | Site Code | Cuckoos Detected Per Survey Period | | | | | Total Survey Detections | Possible Breeding[1] | Probable Breeding[2] | Confirmed Breeding[3] | Min Pairs[4] | Max Pairs[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | | | |
| Ahakhav Tribal Preserve | CRIT | 1 | 4 | 4 | 1 | 0 | 10 | 2 | 0 | 0 | 0 | 2 |
| Palo Verde Phase 1 | PVER1 | 0 | 0 | 2 | 1 | 2 | 5 | 1 | 0 | 0 | 0 | 1 |
| Palo Verde Phase 2 | PVER2 | 0 | 1 | 3 | 2 | 4 | 10 | 2 | 0 | 3 | 3 | 5 |
| Palo Verde Phase 3 | PVER3 | 0 | 2 | 3 | 2 | 3 | 10 | 2 | 1 | 2 | 2 | 5 |
| Palo Verde Phase 4 | PVER4 | 1 | 2 | 9 | 4 | 2 | 18 | 0 | 1 | 5 | 5 | 6 |
| Cibola Valley Phase 1 | CVCA1 | 2 | 5 | 3 | 6 | 2 | 18 | 2 | 1 | 4 | 4 | 7 |
| Cibola Valley Phase 2 | CVCA2 | 0 | 4 | 10 | 9 | 4 | 27 | 0 | 1 | 3 | 3 | 4 |
| Cibola Valley Phase 3 | CVCA3 | 2 | 2 | 6 | 1 | 3 | 14 | 2 | 0 | 0 | 0 | 2 |
| Cibola North | CIBNTH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cibola Mass Planting | CIBMP | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Cibola Nature Trail | CIBCNT | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Cibola Crane Roost | CIBCR | 1 | 2 | 3 | 5 | 2 | 13 | 1 | 0 | 1 | 1 | 2 |
| Cibola Eucalyptus | CIBEUC | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Cibola Island Perri Marsh | CIBIPM | 1 | 8 | 1 | 2 | 3 | 15 | 1 | 0 | 0 | 0 | 1 |
| Cibola Island South | CIBSTH | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Total | | 8 | 36 | 44 | 33 | 25 | 146 | 13 | 4 | 18 | 18 | 35 |

[1] Possible breeding pair = two or more detections in an area during at least two survey periods and at least 10 days apart.
[2] Probable breeding pair = possible breeding pair + food carry or traveling as a pair or vocalization exchange.
[3] Confirmed breeding pair = copulation, stick carry, nest or fledgling.
[4] Maximum YBCU pairs = possible breeding pairs + probable breeding pairs + confirmed breeding pairs.
[5] Minimum YBCU pairs = confirmed breeding pairs.

Table 1-10. LCR YBCU survey detection results and breeding estimates for Reach 5-6 (Imperial to Yuma) sites, 2011.

| Site Name | Site Code | Cuckoos Detected Per Survey Period | | | | | Total Survey Detections | Possible Breeding[1] | Probable Breeding[2] | Confirmed Breeding[3] | Min Pairs[4] | Max Pairs[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | | | |
| Picacho SRA | PICSRA | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 |
| Imperial NWR South | IMPSTH | 1 | 2 | 1 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 |
| Imperial NWR 20A | IMP20A | - | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Imperial NWR 50 | IMP50 | - | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 1 |
| Martinez Lake | IMPAST | - | 0 | 1 | 1 | - | 2 | 1 | 0 | 0 | 0 | 1 |
| Laguna Transect 'A' | LAGTA | 0 | 1 | 0 | 0 | - | 1 | 0 | 0 | 0 | 0 | 0 |
| Laguna Transect 'D' | LAGTD | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 |
| Laguna East | LAGE | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 |
| Laguna West | LAGW | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 |
| Mittry Lake East Road | MLEA | - | 1 | 0 | 0 | - | 1 | 0 | 0 | 0 | 0 | 0 |
| Mittry Lake-Pratt | MLPR | 0 | 3 | 1 | 1 | 0 | 5 | 1 | 0 | 0 | 0 | 1 |
| Quigley WMA | GRQP | 1 | 2 | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 1 |
| Yuma West Wetlands | YUWW | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Yuma East Wetlands | YUEW | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | 2 | 15 | 5 | 3 | 0 | 25 | 6 | 0 | 0 | 0 | 6 |

[1] Possible breeding pair = two or more detections in an area during at least two survey periods and at least 10 days apart.
[2] Probable breeding pair = possible breeding pair + food carry or traveling as a pair or vocalization exchange.
[3] Confirmed breeding pair = copulation, stick carry, nest or fledgling.
[4] Maximum YBCU pairs = possible breeding pairs + probable breeding pairs + confirmed breeding pairs.
[5] Minimum YBCU pairs = confirmed breeding pairs.

From 2010 to 2011, the number of survey detections between sites and across all sites exhibited mixed trends (Figure 1-1). Across all areas, June cuckoo detections were down 65% in 2011 compared to 2010. However, by July and into August, cuckoo detection trends from across all sites combined were nearly identical between 2010 and 2011. Between the two years, temporal detections declined at the Bill Williams River NWR and Havasu NWR. In contrast, Reach 4 (Parker to Cibola) sites saw an increase in July and August survey detections from 2010 to 2011. Surveys in Reach 5 and 6 (Imperial to Yuma) appeared to detect more migrants in early July in 2011, but overall changed little from 2010 to 2011 (low numbers after an early peak). Overall detection trends suggest that fall migration is well underway by mid-August. The total detection numbers are not compared as the arrival and departure of cuckoos from our sites vary by year, which affects the number of survey detections made during the season.

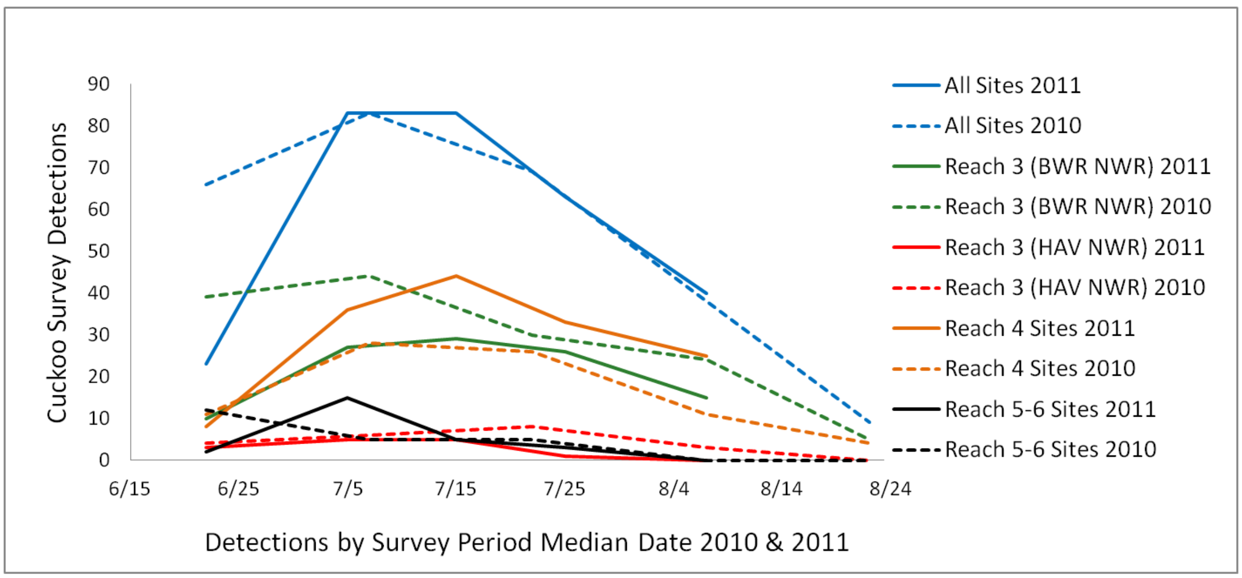



Figure 1-1. Survey detections per survey period median date, 2010 and 2011. Detections in 2011 (solid lines) and 2010 (dashed lines) are displayed by the median date for each survey period for all sites (blue), Reach 3-Bill Williams River NWR (green), Reach 3-Havasu NWR (red), Reach 4 (Parker to Cibola) (orange), and Reach 5-6 (Imperial to Yuma) (black).

## Breeding Territory Estimation

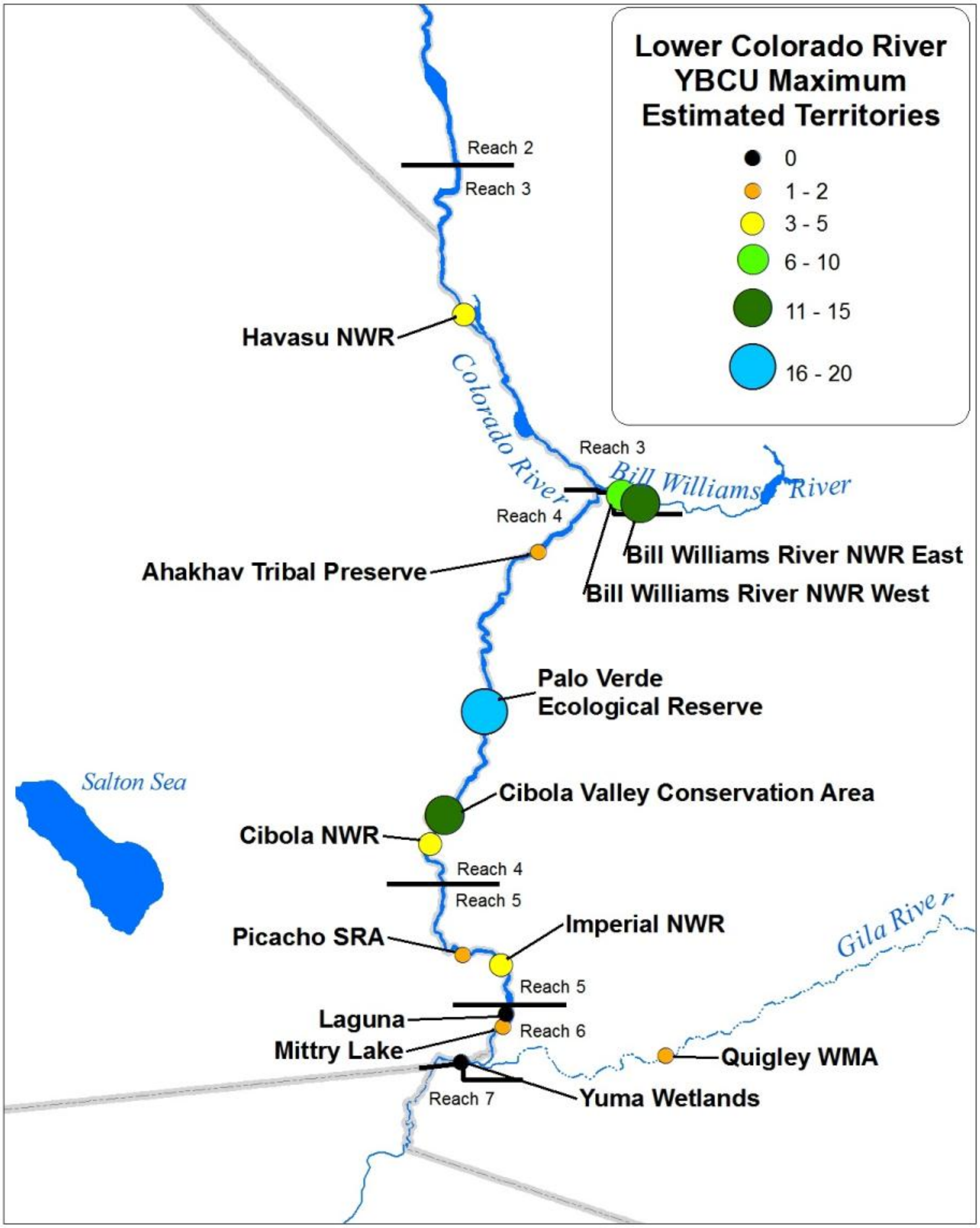
Based on the timing, location and persistence of all detections, we estimated between 28 and 67 breeding territories within the surveyed areas of the LCR MSCP region (map c, Table 1-6), including 32 possible, 7 probable, and 28 confirmed breeding territories (Table 1-6 to 1-9). Of the 67 maximum estimated breeding territories, 24 were at natural sites and 43 were at restoration sites.

At Havasu NWR (2 POS, 0 PRB, 1 COB,

Table 1-7), the Beal Restoration area had one confirmed breeding territory for the second consecutive year. Similar to 2010 findings, numerous survey and non-survey detections were made at Pintail Slough, but no breeding activity was observed. No other Havasu NWR sites generated enough cuckoo activity to suggest breeding or occupancy.

As expected, the Bill Williams River NWR supported a large number of breeding cuckoos (Table 1-8, 9 COB, 3 PRB, 11 POS). We estimated a maximum of 23 territories here in 2011, which is down from 31 maximum territories estimated in 2010. Breeding was confirmed at Cave Wash (1 territory), Honeycomb Bend (3 territories), Mineral Wash (1 territory), Esquerra Ranch (1 territory), Cougar Point (2 territories), and Mosquito Flats (1 territory). The majority (8 of 9) of these confirmed territories were found on the eastern portion of the refuge, upstream of the cliff formation known as Gibraltar Rock.

In the Parker to Cibola Reach, breeding was confirmed at PVER, CVCA, and Cibola NWR (Table 1-9). PVER Phase 2 (3 COB, 2 POS), Phase 3 (2 COB, 1 PRB, 2 POS), and Phase 4 (5 COB, 1 POS) all had confirmed breeding activity. Six nests (from four breeding pairs) were found at CVCA Phase 1 (4 COB, 1PRB, 2 POS), and CVCA Phase 2 supported three confirmed breeding territories (3 COB, 1 PRB). CVCA 3 had two possible breeding territories. Cibola NWR Crane Roost had one confirmed breeding pair and another possible breeding pair. Cibola Island Perri Marsh had one possible territory and appeared to have been used mostly as a migratory stopover point in early July. Potential breeding activity in Reaches 5-6 (Imperial to Yuma) included one possible breeding territory each at Picacho SRA, Imperial South, Imperial 50, Martinez Lake, and Mittry Lake Pratt Restoration (Table 1-10).




Map c. Yellow-billed cuckoo breeding territories (maximum territory estimates) by survey area, LCR 2011.

## Survey Detection Probability and Habitat Occupancy

The probability of detecting a cuckoo (at the territory-based scale) was lowest in June and August (45-49%) and highest in July (69-82%) (

Table 1-11, Figure 1-2). In any given survey period, the detectability of cuckoos did not differ significantly between natural and restoration areas as indicated by the overlapping confidence intervals.

Table 1-11. Detection probabilities (using territory-based sample units) with 95% confidence intervals (CI) by survey period for restoration, natural, and all areas. "All Areas" data is displayed in

Figure 1-2.

| Survey | Detection Probability Estimates | | | | | |
|---|---|---|---|---|---|---|
| Period | Restoration (CI) | | Natural (CI) | | All Areas (CI) | |
| 1 | 0.478 | (0.295 - 0.668) | 0.419 | (0.225 - 0.642) | 0.453 | (0.314 - 0.599) |
| 2 | 0.727 | (0.528 - 0.864) | 0.747 | (0.517 - 0.890) | 0.736 | (0.590 - 0.843) |
| 3 | 0.842 | (0.647 - 0.939) | 0.796 | (0.567 - 0.921) | 0.822 | (0.683 - 0.908) |
| 4 | 0.651 | (0.454 - 0.807) | 0.747 | (0.517 - 0.890) | 0.692 | (0.546 - 0.808) |
| 5 | 0.498 | (0.315 - 0.682) | 0.499 | (0.293 - 0.705) | 0.498 | (0.358 - 0.639) |

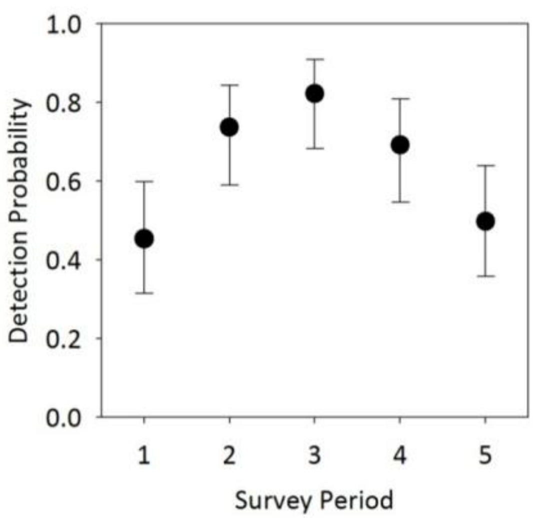



Figure 1-2. Yellow-billed cuckoo 2011 detection probabilities (using territory-based sample units) with 95% confidence intervals for all areas.

Cuckoo occupancy in restoration areas (62.5%) exceeded that of natural areas (52.4%). The proportion of habitat occupied in the Parker to Cibola Reach (67.9%) exceeded that of the Bill Williams River NWR (54.2%), Havasu NWR (40.0%), and Imperial to Yuma Reaches (42.9%) (Table 1-12). Forty-four percent of our sample units (36 of 82) were deemed unoccupied by breeding cuckoos: 14 sample units had no detections and 22 had one detection during all survey visits. The probability that a sample unit deemed unoccupied actually held cuckoos that remained undetected on two or more survey visits was estimated to be 0.6% (S.D. = 0.39%, n=36). We found no difference in mean sample unit size between restoration (17.16 ha, S.D = 3.92) and natural areas (18.8 ha, S.D = 6.37, P = 0.17), and no relationship between sample unit size and occupancy (P = 0.35).

Table 1-12. 2011 LCR yellow-billed cuckoo occupancy rate by reach (using territory-based sample units).

| River Reach | Occupancy |
|---|---|
| Reach 3 (Havasu NWR) | 40.0% |
| Reach 3 (Bill Williams River NWR) | 54.3% |
| Reach 4 (Parker to Cibola) | 67.9% |
| Reach 5-6 (Imperial to Yuma) | 42.9% |

## Site-based vs. Territory-based Sample Unit Comparison

To assess the effect of sampling scale on our detection probability and occupancy estimates, we also calculated these estimates using the former site-based sample units (used from 2008-2010; see Halterman et al. 2009, McNeil et al. 2010, McNeil et al. 2011) to compare with those generated from using territory-based sample units. The following estimates are not discussed further, beyond drawing conclusions about the switch from site-based to territory-based sample units.

The probability of detecting cuckoos at the site scale exceeded those observed for the smaller, territory-based scale for all survey periods across all sites (Figure 1-3, Table 1-13). However, the trends in cuckoo detectability across surveys one through five were markedly similar between the two sampling scales.

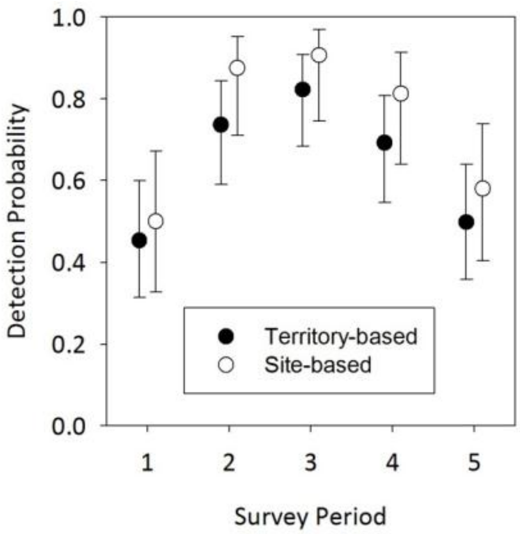



Figure 1-3. Comparison of 2011 site-based vs. territory-based sample unit detection probabilities from all areas. Data is also displayed in Table 1-13.

Table 1-13. Comparison of 2011 site-based vs. territory-based sample unit detection probabilities from all areas. Data is also displayed in Figure 1-3.

| Survey Period | Detection Probability Estimates | | | |
|---|---|---|---|---|
| | Territory-based (CI) | | Site-based (CI) | |
| 1 | 0.453 | (0.314 - 0.599) | 0.500 | (0.328 - 0.671) |
| 2 | 0.736 | (0.590 - 0.843) | 0.875 | (0.710 - 0.952) |
| 3 | 0.822 | (0.683 - 0.908) | 0.906 | (0.745 - 0.969) |
| 4 | 0.692 | (0.546 - 0.808) | 0.812 | (0.640 - 0.913) |
| 5 | 0.498 | (0.358 - 0.639) | 0.580 | (0.404 - 0.738) |

Using site-based sample units, t-tests revealed that mean site size was significantly greater ($P = 0.04$) at natural areas (32.6 ha, S.D = 21.3) compared to restoration areas (22.5 ha, S.D = 19.1), and that occupied sites (33.0 ha, S.D = 21.0) were significantly larger than unoccupied sites (16.8 ha, S.D = 14.9, P = 0.001). At natural sites, site occupancy (65.2%) exceeded territory-based occupancy (52.4%). In contrast, restoration area occupancy remained largely unchanged when measured using site-based (63.0%) or territory-based sample units (62.5%). The proportion of sites occupied in Reach 3 (Bill Williams River NWR, 87.5%), Reach 4 (Parker to Cibola, 80.0%), and Reach 5-6 (Imperial to Yuma, 50.0%) exceeded the proportion of territory-based sample units occupied in these same Reaches (Table 1-14). Occupancy at Reach 3 (Havasu NWR) remained unchanged because sites and territory-based sample units were the same. Thirty-four percent of sites (17 of 50) were deemed unoccupied by breeding cuckoos: six sites had no detections and eleven had detections during only one survey visit. The probability that a site deemed unoccupied actually held cuckoos that remained undetected on two or more visits was estimated to be 0.001% (S.D. = 0.0008%, n=17).

Table 1-14. 2011 LCR cuckoo occupancy rate by river reach based on territory-based sample units compared to previously used site-based sample units.

| River Reach | Occupancy | |
|---|---|---|
| | Territory-based | Site-based |
| Reach 3 (Havasu NWR) | 40.0% | 40.0% |
| Reach 3 (Bill Williams River NWR) | 54.3% | 87.5% |
| Reach 4 (Parker to Cibola) | 67.9% | 80.0% |
| Reach 5-6 (Imperial to Yuma) | 42.9% | 50.0% |

## Discussion

We found that three surveys conducted during the peak of cuckoo activity, during July on the LCR, were more efficient in assessing an area for breeding cuckoo occupancy than those conducted at other times (June and August). This was mainly due to the greater probability of detecting cuckoos at this time, but also because cuckoo dispersal patterns make July survey detections inherently better suited to identify breeding birds. Cuckoos detected in July were more likely to breed at the site where they were detected. Birds detected in June or August have a greater likelihood to be transient; cuckoos detected in June may be northbound migrants using a site as a stop-over to refuel, and those detected in August may have already begun their post-breeding dispersal (McNeil et al. 2010). However, June and August surveys are still important, as they contribute towards identifying occupied areas and can be used to identify migratory stopover areas which are important to the species even though the habitat may not be used for breeding.

In addition to the benefits of the added third July survey, the increase in peak-season survey frequency yielded unintended consequences. The extra July survey created an opportunity cost, by impacting the frequency with which we could conduct other peak-season research activities (e.g. follow-up visits, mist netting, telemetry, and nest searching). Furthermore, by not conducting late August surveys we were limited in our ability to determine if cuckoos remained at breeding sites into early September at the onset of dove hunting season. A review of the value of the added July survey will be a part of the 2012 summary project methodology review.

We found the territory-based sample units to be an improvement over the former use of sites as sample units for estimating occupancy and detection probability. When using site-based sample units, comparisons of occupancy (or detection probability) across survey areas (Table 1-14) or between natural and restoration habitat are likely confounded by the disparity in site size, whereas the use of a standardized, territory-based sample unit controls for the effect of sample unit size and eliminates these confounding effects (Williams et al. 2002). Moreover, cuckoos may only use a small portion of the habitat within a large site-based sample unit. As a result, territory-based sample units are more versatile, because in addition to measuring occupancy within an area, they increase the ability to interpret the occupancy estimate as a proportion of habitat used within an area. For example at the Bill Williams River NWR, substantial areas of surveyed riparian habitat are not used by cuckoos. Survey sites at the Refuge are relatively large, and 88% were occupied, but the territory-based occupancy estimate of 54% enables a more accurate estimate of the actual habitat used within the Refuge.

As observed in previous years, the ability to detect cuckoos is not constant throughout the breeding season (McNeil et al. 2010, 2011). In 2011, cuckoo detection probabilities were comparable to those observed in the past, with a peak in July and lower detectability in June and August. In 2011, Neotropical migrants across the western US (AZFO 2011), including cuckoos on the LCR, arrived at their breeding grounds weeks later compared to previous years. And in August, at the end of their breeding season, the lower detectability revealed that cuckoos were less vocal during the tail end of their breeding season and/or they had already dispersed from the area (McNeil et al. 2011); both behaviors have been observed. During this time, we have occasionally located cuckoos near their nest which were not detected during nearby survey broadcast calls. The decline in detectability in August can also be attributed to dispersion from breeding areas, which has been observed to start in early August on the LCR (McNeil et al. 2011, Chapter 3 this report).

Relative to the total number of survey detections, occupancy estimates are more easily compared between areas within one season, and from year to year, because they account for imperfect detection and annual variation in the number of detections between survey periods (MacKenzie et al. 2006, Henneman 2009). Using the territory-based sampling scale, the proportion of restoration habitat occupied by cuckoos (62.5%) exceeded that at the remnant natural habitat patches (52.4%). Habitat occupancy in the Parker to Cibola Reach (67.9%)

exceeded that of Havasu NWR (40.0%), Bill Williams River NWR (54.3%) and Imperial to Yuma Reaches (42.9%). Many restoration sites newly occupied in 2010 were again used by cuckoos in 2011. These included Pintail Slough in Havasu NWR, CVCA Phase 2, PVER Phases 3 and 4, and Mittry Lake/Pratt Restoration. With the exception of Pintail Slough and Mittry Lake/Pratt, these restoration sites are relatively young and in just a few years their vegetation successfully progressed from short, low canopy cover plantings to dense habitat supporting nesting cuckoos.

Along with greater occupancy at restoration areas, maximum breeding pair estimates were also greater at restoration sites compared to natural sites. Overall, we saw possible declines in cuckoo breeding activity at Havasu NWR and Bill Williams River NWR, a possible small increase in breeding activity in the Imperial to Yuma Reaches, and a dramatic increase in breeding activity in the Parker to Cibola Reach. Havasu NWR saw the estimated maximum territory estimate decline from five to three territories. However, the confirmed number of nests at Havasu NWR between 2010 and 2011 remained constant at one. Bill Williams River NWR declined from an estimated maximum of 31 territories in 2010 to 23 maximum territories in 2011. This decline was also mirrored in the year-to-year drop observed in survey detection trends across all survey periods between the two years. In contrast, the maximum pair estimates in the Parker to Cibola Reach more than doubled, from 16 in 2010 to 34 in 2011 (primarily driven by increases at PVER and CVCA). In Reaches 5-6 (Imperial to Yuma), the detection history suggests that most cuckoos detected were migrants. At these sites the number of confirmed breeding territories did not change from zero between 2010 and 2011, but the estimated maximum pair estimates increased from four to six.

In conclusion, we saw cuckoo occupancy at restoration areas exceed that at natural areas and for the first time during this study, the Bill Williams River NWR was eclipsed by restoration areas and did not support the majority of confirmed breeding and estimated cuckoo pairs. Reach 4, in particular the Blythe area (PVER and CVCA), surpassed the Bill Williams River in detections, occupancy, territory density, and number of confirmed and estimated maximum breeding territories. However, at this time it is unclear if the observed increases 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 the Bill Williams River NWR, or elsewhere within the species' breeding range. Either scenario is possible. Researchers speculate that declines in their range indicate that cuckoos may be choosing other breeding locations (Dettling and Howell 2011), 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 restoration efforts in these areas appear successful in attracting high breeding cuckoo densities. 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 assess changes in cuckoo occupancy as these restoration sites mature. Additional details of occupancy and breeding evidence are described in Chapter 2 and Appendix B.

# Chapter 2. 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 enables us to measure demographic trends across breeding populations, and guide the creation of landscapes that support ongoing viable populations. Objectives of this five-year project include identifying key yellow-billed cuckoo breeding habitat characteristics to use as a basis for future habitat restoration. By locating a substantial number of nests in the study area over the past three seasons, we have been able to identify key determinants of cuckoo nest-site selection, such as patch size, small native tree density, canopy cover, and microclimate (Chapter 4, McNeil et al. 2011). In 2011, we continued monitoring the progress of current LCR restoration efforts through intensive nest-searching and monitoring, concentrating our efforts at LCR MSCP restoration sites and the Bill Williams River (BWR) NWR.

## Methods

We used a number of techniques to search for nests during the breeding season. During surveys, we located all detected cuckoos visually if possible, and searched vegetation in the vicinity for nests (following 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 researchers waited before dawn in the area of a suspected nest; triangulation was then used to locate calling birds. 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 3). 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 directly below the nest.

After locating a nest, we recorded the GPS location approximately 10 m from the nest; a more accurate reading was taken after nesting activity ceased. We recorded nest site characteristics such as nest tree species, tree height and nest height, stage, and the banded status of adults if known. We used telescoping mirror poles to monitor nests every 2-5 days, recording nest contents and any observed behaviors. Nestlings were banded at 3-6 days when accessible (Chapter 3). 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 two 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 or destroyed, with large egg shell fragments or remains, or empty before the earliest possible fledge date with no further activity detected nearby. Adult cuckoos are known to move further average distances after nest failure than after success (Halterman 2009). Nests were considered deserted if intact eggs or chicks were present and no further parental activity was observed.

We used a Fuhrman Diversified black-and-white time lapse video camera system to monitor a subset of nests. The system comprised a small video camera with both diurnal and nocturnal visibility. We secured the camera to a branch by a series of adjustable clamps placed approximately 1 m from the nest. The camera was connected by a cable to a VCR unit, which we placed approximately 18 m away from the nest to prevent further nest site disturbance. The system was powered by a 12-volt battery, which along with the VCR tape was replaced every 24 hours. We camouflaged the camera, cable, VCR, and battery with vegetation or tarps. After camera installation, we observed the nest through the attached VCR monitor until we saw an adult returning to the nest. If an adult failed to return to the nest within one hour, we removed the camera and observed from a distance until we saw an adult returning to the nest. We reviewed all tapes and recorded key activities such as nest exchanges, food delivery, and nest fate.

We continued to assess the relationship between relative cicada abundance and cuckoo fledging activity by site type (McNeil et al. 2011), by recording an index of relative live cicada abundance at all survey points during cuckoo surveys (0). We recorded cicada indices prior to playing survey broadcast calls, and counted cicadas observed on vegetation, flying, and those heard calling in the area around each survey point. Cicada counts 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 graphed relative cicada abundance against cuckoo fledging dates at all restoration and natural sites with breeding cuckoos.

Habitat selection analyses include a wide range of variables describing vegetation structure, plant species composition, and abiotic factors (See McNeil et al. 2011 for a four-year [2006-2010] cuckoo breeding habitat selection summary). In 2011, we collected habitat data at nest locations to compare with available habitat, following new 2011 Reclamation Post-development Habitat Monitoring Field Methods (Bangle 2011). Data were collected within plots centered at nests, and at random locations within available habitat. Each plot consisted of a nested set of three plot types: one primary 10x40 m plot; one secondary 5x15 m plot; and four tertiary 0.5x2 m plots, plus five points within the primary plot. Measurements included tree density, shrub density, height, and tree diameter at breast height (DBH), crown closure, vegetation hits to pole, distance to large gaps, and ground and foliar cover. The majority of the 2011 non-nest habitat data were collected separately by Reclamation contractors and was not available to be included for comparison with cuckoo nests at the time of this report. A multi-year habitat assessment will be presented in the 2012 summary report.

## Results

Between July 2 and August 15, 2011, we found 29 yellow-billed cuckoo nests at five locations, from Havasu NWR to Cibola NWR (Table 2-1). Eleven nests were found at PVER (Phases 2 to 4), nine at CVCA (Phases 1 and 2), seven at BWR NWR (east half), and one each at Havasu NWR (Beal) and Cibola NWR (Crane Roost). We confirmed a total of 28 breeding territories (nests, fledglings, or copulations) and estimated up to 67 possible breeding pairs within the surveyed sites based on the timing and duration of all activity during the season (Appendix B). Nests were found at several previous nesting locations, including Havasu NWR Beal, BWR NWR, PVER (Phase 2 and 3), and CVCA (Phase 1 and 2). We also found nests at two sites for the first time: PVER Phase 4 and Cibola NWR Crane Roost. Detailed accounts of all nests are provided in Appendix C.

Table 2-1. Yellow-billed cuckoo nests found on the LCR, 2011.

| Nest | Date Found | Ad.1[1] | Ad. 2 | Tree Sp.[2] | # Eggs | 1st Egg[3] | Fate[4] | End Date[5] | Est. Fledge Date[6] | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| HAVBR-N1 | 7-10 | UNB | UNB | POFR | 3 | 7-8 | F1+ | 7-27 | | |
| BWCW-N1 | 7-14 | UNK | UNK | SAGO | 4 | 7-10 | F3 | 7-26 | | |
| BWHB-N1 | 7-24 | UNK | UNK | TASP | 3 | 7-10 | F3 | 7-26 | | |
| BWHB-N2 | 7-24 | UNK | UNK | SAGO | 2 | 7-13 | F2 | 7-29 | | |
| BWHB-N3 | 8-09 | AF | UNB | TASP | 2 | 8-02 | F1 | 8-20 | | AF=ASY banded 2010 |
| BWMW-N1 | 7-12 | UNK | UNK | TASP | 3 | 7-05 | F2 | 7-21 | | |
| BWPT-N1 | 7-13 | UNK | UNK | POFR | 2 | 7-08 | F2 | 7-24 | | too high to check |
| BWPT-N2 | 7-21 | UNK | UNK | SAGO | 2 | 7-11 | F2 | 7-27 | | |
| PVER2-N1 | 7-14 | BUT | UNK | SAGO | 2 | 7-13 | F2 | 7-29 | | |
| PVER2-N2 | 7-26 | UNK | UNK | SAEX | 3 | 7-21 | X D | 7-29 | 8-06 | 3 eggs depredated (1 punc.) |
| PVER2-N3 | 8-02 | UNK | UNK | POFR | 1* | 8-02 | X D | 8-02 | 8-18 | 1 punctured ybcu, 1 dove egg |
| PVER3-N1 | 7-18 | UNB | UNK | POFR | 3 | 7-14 | F3 | 7-30 | | |
| PVER3-N2 | 7-25 | UNK | UNK | POFR | 2+ | 7-24 | F1+ | 8-10 | | too high to check |
| PVER4-N1 | 7-14 | UNK | UNK | SAGO | 1* | 7-14 | X D | 7-14 | 7-28 | 1 punctured dove, 1 ybcu egg |
| PVER4-N2 | 7-22 | HAY | UNK | POFR | 2 | 7-18 | F2 | 8-02 | | fledgling recaptured |
| PVER4-N3 | 7-22 | MRD | UNK | POFR | 3 | 7-20 | X D | 8-02 | 8-05 | depredated |
| PVER4-N4 | 7-24 | EOW | UNK | SAGO | 3 | 7-23 | X D | 8-05 | 8-08 | chicks eaten by king snake |
| PVER4-N5 | 7-29 | UNB | UNK | POFR | 2+ | 7-12 | F2+ | 7-28 | | found after fledged |
| PVER4-N6 | 8-15 | UNK | UNK | POFR | 3 | 8-12 | X DE | 8-20 | 8-28 | deserted with 3 eggs |
| CVCA1-N1 | 7-02 | UNK | UNK | SAGO | 3 | 6-30 | X W | 7-03 | 7-16 | failed – weather (storm) |
| CVCA1-N2 | 7-08 | BA | UNK | POFR | ? | 7-08 | X D | 7-13 | 7-23 | empty 7-13, no egg shells |
| CVCA1-N3 | 7-12 | ROB | MM | SAGO | 4 | 7-09 | F3 | 7-26 | | +1 egg unhatched |
| CVCA1-N4 | 7-23 | UNK | UNK | SAGO | 4 | 7-15 | F2 | 8-02 | | +2 unhatched (1 punctured) |
| CVCA1-N5 | 8-04 | BA | UNK | POFR | 2 | 7-27 | F2 | 8-12 | | BA renest (bands re-sighted) |
| CVCA1-N6 | 8-10 | CBR | SY | SAGO | 2 | 8-10 | X D | 8-15 | 8-26 | SY = lG/Go banded 2010; nest empty >Tamarisk cleared |
| CVCA2-N1 | 7-15 | DG | GRE | SAGO | 5 | 7-15 | F4 | 7-30 | | +1 unhatched |
| CVCA2-N2 | 7-21 | FJR | UNK | SAGO | 4 | 7-20 | X | 8-05 | 8-05 | 4 ybcu+2 dove eggs 3 ybcu hatched 0 fledged |
| CVCA2-N3 | 8-01 | DUM | LJ | POFR | 2 | 7-30 | F2 | 8-14 | | LJ=ATY re-sighted at nest |
| CIBCR-N1 | 8-12 | MON | UNK | PRGL | 3 | 8-09 | X DE | 8-20 | 8-25 | deserted with 3 eggs |
| Total (Mean) | | | | 74 (2.84 ±0.8)* | | | F39+ (62% nest success, 1.52 per nest) | | | |

1. Adult: UNK=unknown, UNB=unbanded, or banded bird (Chapter 3). 2. Tree sp.: POFR=*Populus fremontii*, PRGL=*Prosopis glandulosa*, SAEX=*Salix exigua*, SAGO=*S. gooddingii*, TASP=*Tamarix ramosissima*. 3. Estimated date first egg laid (based on 10-day incubation). 4. Fate: F=fledged (number of fledglings), X=failed, D=depredated, DE=deserted, W=failure due to weather. *Mean clutch size based on nests with known clutch size. Fledged young average calculated without ybcu-dove nests. 5. Date first fledged or failed. 6. Estimated first fledge date of failed nests based on 10-day incubation + 6-day nesting period.

Overall nesting activity peaked July 22-28 (Figure 2-1) but peaked earlier at the BWR NWR (July 8-21). Similar to our previous findings (McNeil et al. 2011), fledging dates were related to temporal relative cicada abundance (recorded during cuckoo surveys) at the BWR NWR, whereas at restoration sites, cicada activity was consistently low throughout the season and unrelated to fledging (Figure 2-2).

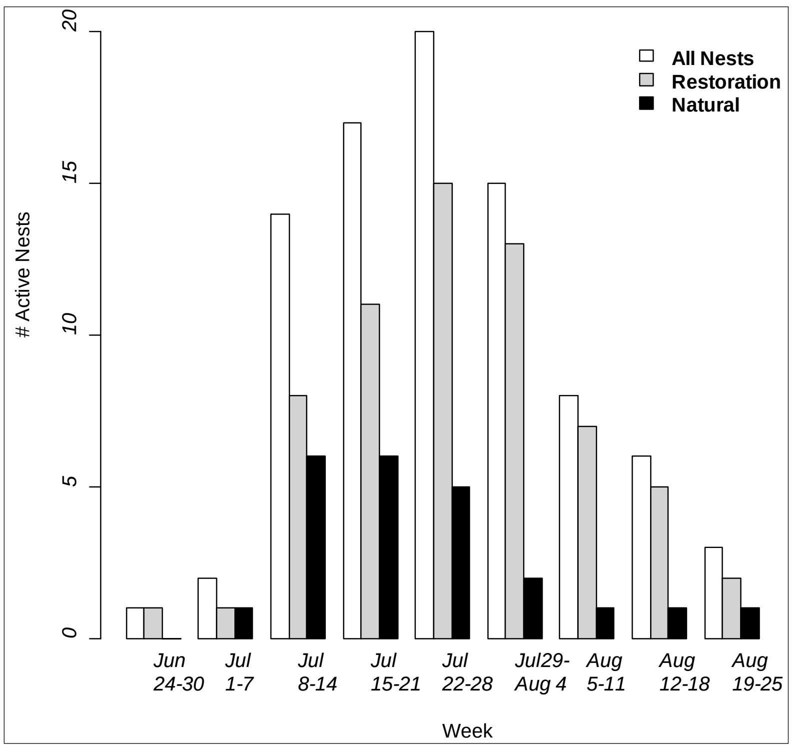


Figure 2-1. Active nests (all sites, restoration sites, and natural sites) by week, LCR 2011.

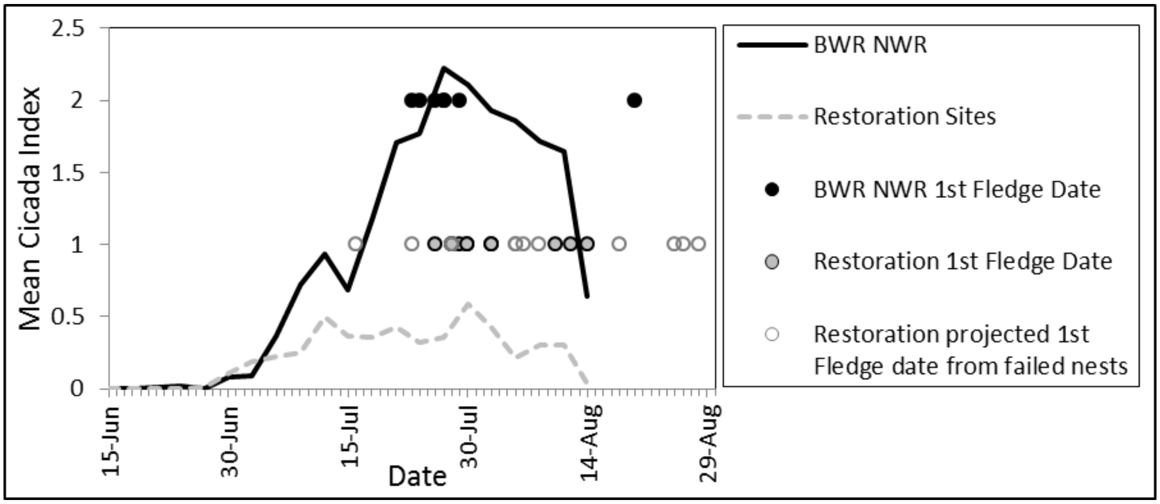



Figure 2-2. Cicada activity and fledging dates at natural and restoration sites, LCR 2011. Cicada abundance was greater at natural sites (black lines) compared to restoration sites (dashed gray lines). Cuckoo fledging dates were closely tied to peak cicada activity at natural sites but not restoration sites.

Almost all restoration site nests were in Fremont cottonwood (*Populus fremontii*, 11 nests) or Goodding's willow (*Salix gooddingii*, 9 nests, Figure 2-3). One nest each was in a honey mesquite (*Prosopis glandulosa*) and coyote willow (*S. exigua*, the first nest we have found in this species). The BWR nests were in tamarisk (*Tamarix ramosissima*, 3 nests), Goodding's willow (3 nests) and cottonwood (1 nest). Nests were found in a wide range of tree heights and diameters (Figure 2-4). Nest height ranged from 1.1 m to 13 m above ground with a median height of 3.4 m. Cover immediately above all nests averaged 87%, and overall canopy cover at nests averaged 98%.


Figure 2-3. Nest tree species for 29 yellow-billed cuckoo nests (all sites, restoration sites, natural sites), LCR 2011.

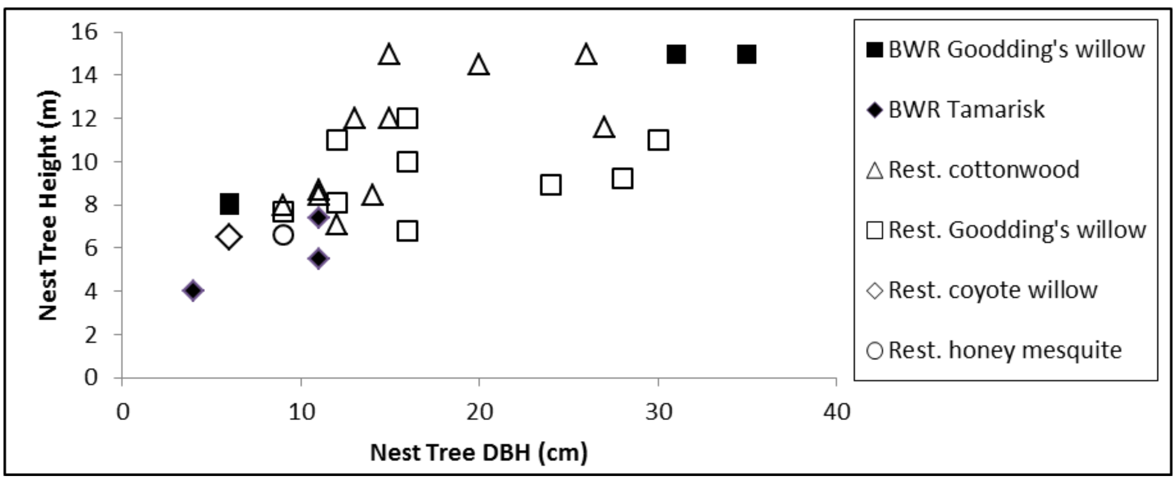



Figure 2-4. Nest tree height by DBH and by tree species for 29 yellow-billed cuckoo nests at the Bill Williams River NWR (black) and restoration sites (hollow), LCR 2011.

Clutch size (the number of eggs per nest) ranged from 2 to 5 and averaged 2.84 ±0.8 (n=25). Apparent nest success (the proportion of nests fledging at least one young) was 62% overall (Table 2-1), but differed markedly between BWR (100%) and restoration nests (50%). Nest productivity averaged 1.46 young fledged per nest (35 young from 24 nests of known outcome). BWR NWR nest productivity averaged 2.14 fledged per nest, whereas restoration sites averaged 1.25 fledged per nest (2.5 per successful nest). Average egg success (the proportion of eggs that hatched and fledged) was 54% (84.5% at BWR, 41.5% at restoration sites). Nest depredation occurred in 63% of all failed nests. Causes of failure included depredation by unknown predators (three nests), egg puncture by unknown avian egg predators (three nests), desertion of eggs (two nests), depredation by a California king snake (*Lampropeltis getula californiae*, one nest), desertion of young (unknown cause, one nest), and weather (one nest).

We found three nests containing both cuckoo and dove eggs, indicating interspecific nest parasitism (egg dumping) had occurred (Table 2-2). Two of these nests (PVER4 Nest 1 and PVER2 Nest 3) were depredated and inactive when found; the PVER2 nest contained one punctured cuckoo egg and one intact dove egg, while the PVER4 nest had one punctured dove egg and one intact cuckoo egg. The third parasitized nest (CVCA2 Nest 2) was found with two cuckoo and two dove eggs, attended by a pair of cuckoos. We suspected these three nests were all built by doves due to their somewhat bulkier construction and/or more open placement. We also observed large gaps in egg-laying dates at three nests (CVCA1 Nest 4, CVCA2 Nest 1, and CVCA2 Nest 2), suggesting the occurrence of intraspecific parasitism (female cuckoos laying eggs in other female cuckoos' nests). All anomalous nests were found at either PVER or CVCA (Table 2-2).

Table 2-2. Anomalous nests displaying evidence of intra- or interspecific brood parasitism at LCR MSCP sites, 2011.

| Nest | Anomaly type | Date found | Pre-dumping contents | Date dumped | Cuckoo egg found status | Dove egg found status | Nest fate |
|---|---|---|---|---|---|---|---|
| PVER4N1 | Inter | 7-14 | Unknown | unknown | 1 intact | 1 punctured | Failed |
| PVER2N3 | Inter | 8-02 | Unknown | unknown | 1 punctured | 1 intact | Failed |
| CVCA2N2 | Inter | 7-21 | Unknown | unknown | 2 intact | 2 intact | Failed |
| CVCA1N4 | Intra | 7-23 | 2 ybcu eggs (est. lay dates 7/15,7/16) | 7-24, 7-25 | 2 intact | | Fledged 2 |
| CVCA2N1 | Intra | 7-23 | 4 ybcu eggs (est. lay dates 7/12-7/15) | 7-18 to 7-20 | 1 Intact | | Fledged 4 |
| CVCA2N2 | Intra | 7-21 | 3 ybcu eggs (est. lay dates 7/21 to 7/22), 2 dove eggs | 7-30 | 1 intact | | Failed |

Two nest cameras were placed successfully, at nests PVER4 N4 and CVCA2 N2. Two additional camera placement attempts were made at CVCA2 N1 (removed after 45 minutes) and CVCA1 N3 (removed after 50 min); adults returned to both nests soon after camera removal and both subsequently fledged young.

PVER4 Nest 4 was found with three eggs and all hatched by August 4. On August 5, a California king snake was recorded on video swallowing all three nestlings. Though unsuccessful, the adult vigorously defended the nest, raising its wings to appear larger, while the snake struck at the adult several times. This was the first time in this study we positively identified a nest predator or observed nest predator defense.

CVCA2 Nest 2 was found with two dove eggs and two cuckoo eggs, being incubated by a cuckoo pair. The nest appeared to be a dove nest but it is unknown if the cuckoos added nesting material, laid the eggs in an abandoned dove nest or evicted the doves, or if the eggs were instead dumped by doves (Bent 1940, Baskett 1992). No doves were ever observed at the nest and neither dove egg hatched. An additional cuckoo egg was laid by July 23 and another (probable egg-dumping) on July 30 which did not hatch. Unusually, three chicks all hatched within a 24-hour time frame (suggesting more than one female may have laid the first three eggs). We witnessed at least one adult experiencing difficulty feeding the nestlings, repeatedly attempting to feed large insects to the begging young and then eating or flying away with the food. The smallest chick (2 days old) jumped from the nest on August 2 and was found dead and partially eaten by ants. The remaining two chicks appeared stunted and weighed 35–46% below average mass for their age (4-5 days); one of these appeared deformed with an upper mandible shorter than the lower mandible. Both remaining chicks also jumped prematurely from the nest; the smaller of the two was eaten by ants on the ground. The larger chick was found alive on the ground. After observing the nest from a distance and detecting no further parental activity by 5 pm that day we determined the nest had been deserted. Additional details of all nests are provided in Appendix C.

## Discussion

This year, average clutch size was higher than we have ever recorded in this study (2.84 eggs per nest), including our first observations of four- and five-egg clutches. Before 2011, we had only observed clutches of one to three eggs on the LCR (an average of 2.3 ±0.6 from 2008-2010, n=22). Most of the larger clutches were at restoration sites; CVCA averaged 3.1 (n=9) and PVER averaged 2.7 (n=7), compared to 2.5 (n=7) at BWR NWR which included just one four-egg clutch. Laymon (1998) noted clutches greater than three eggs had never been found at BWR NWR. Clutch size has been found to be correlated to food abundance and seasonal insect outbreaks in both yellow-billed cuckoos (Fleischer et al. 1985, Laymon et al. 1997, Payne 2005) and other species (Lack 1947, Jetz et al. 2008). Cuckoos are indeterminate egg layers, able to increase their final clutch size to take advantage of abundant food (Nolan and Thompson 1975).

Large clutch sizes can also result from instances of intraspecific brood parasitism (discussed below).

In 2011, apparent nest success was 100% at the Bill Williams River, but only 50% at the restoration sites. High apparent nest success (≥70%) has been previously observed in cuckoos (Laymon et al. 1997, Halterman 2009, McNeil et al. 2011), and in the LCR region it tends to be higher at BWR than restoration sites: from 2008 to 2010 we have observed 100% apparent nest success at BWR NWR (n=13), and 70% at restoration sites (n=17). Despite low average nest success at restoration sites in 2011, the minimum number of young we observed fledge from these sites still increased by a third over the two seasons (from 18 to 24), due to the increased number of nests and larger clutches in 2011.

Three restoration site nests (at CVCA1, CVCA2, and PVER3) first fledged young between August 10-14 (Table 2-1). Based on family groups remaining at sites for at least three weeks post-fledging (Chapter 3), these birds likely remained at their breeding site until at least the first week of September. An additional three nests (at PVER4, CVCA1, and Cibola NWR) were estimated to have first fledged young during August 25-28 (Table 2-1) had they not failed. If these nests had successfully fledged young, the birds may still have been present at their respective breeding sites at least until September 15-18, over two weeks after the start of dove hunting season (previously discussed in McNeil et al. 2011).

We observed interspecific and probable intraspecific brood parasitism for the first time. Unlike most cuckoo species, yellow-billed cuckoos usually build their own nest and raise their own young. However, they are facultative brood parasites, occasionally practicing both intra- and interspecific brood parasitism (Bent 1940). Brood parasitism by yellow-billed cuckoos is most prevalent during years of high food abundance (Nolan and Thompson 1975, Hughes 1999) and thought to be uncommon most years (Nolan and Thompson 1975). Yellow-billed cuckoo eggs have been found in the nests of at least 12 other species (including mourning doves *Zenaidura macroura*) (Bendire 1895, Jay 1911, Bent 1940). In some cases, the nests have already been abandoned when appropriated (Jay 1911, Payne 2005), which may have been the case for the three anomalous cuckoo/dove nests we found. Brood parasitism may also occur after accidental nest loss during the laying period, prompting the female to lay the remainder of her clutch in another nest (Bendire 1895, Laymon et al. 1997). This may have occurred after severe storms when we incidentally noted increased nest failure and building (e.g. after a storm on the night of July 2 that apparently destroyed one nest).

Intraspecific nest parasitism occurs more frequently than assumed (Yom-Tov 1980, Rohwer and Freeman 1989) and genetic analyses have shown that clutches with mixed parentage are not infrequent (Johnsgard 1997). Yellow-billed cuckoo clutches laid by more than one female have been confirmed molecularly at the Kern River, CA (Fleischer 2001), and Kansas (Fleischer et al. 1985). In many bird species, female (unmated) floaters that do not obtain nests or mates of their own may settle as secondary females (copulating with already-mated males), and may enhance their reproductive success by engaging in intraspecific brood parasitism (Sandall and Diemer 1999). However, it is increasingly found that the layers can also be mated females that simultaneously tend a nest of their own, with intraspecific parasitism enhancing their reproductive success (Gibbons 1986, Kendra et al. 1988, Jackson 1993). We suspect that unpaired and paired female cuckoos may be doing the same. Our telemetry observations revealed some females in close proximity to nests that were not their own, and we witnessed a possible egg dumping on video (see Appendix C for details).

Several results suggest high food abundance in 2011, particularly at PVER and CVCA 1-2, including evidence of interspecific and suspected intraspecific nest parasitism, large clutches, and high breeding densities and overlapping home ranges among radio-tracked cuckoos (Chapter 3). We again recorded low relative cicada abundance in restoration sites, but we know cuckoos eat a variety of insects at these sites (McNeil et al. 2011). We did not measure non-cicada insect abundance at the sites (although loud nocturnal insect calling [mainly crickets and katydids] was incidentally noted at CVCA 1-2 during evening telemetry observations in July), and we cannot verify high insect abundance at these sites. Food abundance has been previously linked to yellow-billed cuckoo nesting decisions. Anders and Post (2006) found over three times the number and biomass of lepidopteran larvae (a primary food resource) in eastern yellow-billed cuckoo nesting territories compared to occupied territories in which nesting was not attempted. Given the general evidence that irrigation increases arthropod productivity, mostly from increased vegetation biomass (Kirchner 1977, Frampton et al. 2000), humidity (Chapman 1969), leaf water or leaf nitrogen content (Weisenborn and Pratt 2008), it seems likely that the well-irrigated conditions at PVER and CVCA are enabling high insect productivity and thus high nesting densities at these sites.

At natural sites, cuckoos time their nesting to cicada activity (Rosenberg et al. 1982, McNeil et al. 2011), which in the past two years peaked during the final week of July. Of note, cuckoos (and many other US neotropical migrant birds) arrived to the region later than expected in 2011 (AZFO 2011). Their late arrival led to a compressed time period to prepare for nesting, but did not appear to cause a disjunction in the timing between fledging and the peak in their primary food. This, however, is a concern, as global climate change has the potential to disrupt the timing between a species and its food resources (Visser and Both 2005). Eastern cuckoo declines have also been linked to global climate patterns causing warmer winters, which reduced prey biomass the following summer (Anders and Post 2006).

Nest predation was high this year, and we were able to identify one predator (from video) as a king snake. We have previously observed several king snakes at CVCA, including one in the process of eating a dove chick. Eggs and nestlings may be taken by birds, mammals, or snakes (Nolan 1963, Potter 1980), and in some areas nest depredation may account for failure to fledge young from 80% of nests (Nolan 1963, Nolan and Thompson 1975). Other potential nest predators we have observed in LCR MSCP restoration sites include common ravens (*Corvus corax*), Cooper's and red-tailed hawks (*Accipiter cooperii*, *Buteo jamaicensis*), bobcats (*Lynx rufus*), and grey foxes (*Urocyon cinereoargenteus*). Restoration decisions such as irrigation levels, tree species composition, tree spacing, edge amount, water features, and site placement may affect the suite of predators found at each site. The amount of edge and site fragmentation can affect depredation rates by snakes as well as other animals (Weatherhead and Blouin-Demers 2004). Proximity to agricultural areas may increase depredation by human-adapted species (Hartley and Hunter 1998, Bui et al. 2010), and as sites change in structure and composition, new predator suites may evolve.

Punctured eggs were discovered in four nests this year. Nesting birds are known to puncture eggs of nearby nests thereby reducing interspecific resource competition (Picman et al. 1996). Nest punctures may also be caused by avian brood parasites (Peer 2006) which may cause the host to abandon its nest (Sealy 1992). Potential avian egg predators photographed at artificial LCR MSCP nests included yellow-breasted chats (*Icteria virens*), Bullock's orioles (*Icterus bullockii*), and Bewick's wrens (*Thryomanes bewickii*) (Theimer et al. 2010). We observed all of these species except wrens at PVER and CVCA in 2011.

This year, three nests were deserted during egg and nestling stages. Clutch or offspring desertion is a widespread behavior, often varying in frequency within populations (Szekely et al. 1996). There are numerous potential causes of nest desertion including: parasites (King et al. 1977); poor egg/nestling health due to genetics, extreme incubation temperatures (see Chapter 4 for further discussion), low food resources, or pesticides; nest disturbance by predators or researchers (Halterman 1998); skewed sex ratios (Forsgren et al. 2004); genetic desertion propensities (Pogany et al. 2008); and sexual conflicts (Parker 2005). However, at the two mid-August nests, the causes of desertion seem most likely related to their late seasonality when both food resources (as shown in Figure 2-2) and breeding adult body mass had likely waned (Wiggins et al. 1994). In general, most birds experience a decline in reproductive value across the season, manifesting as decreased adult body mass (Merila and Wiggins 1997), parental effort, growth, and survival of offspring (Perrins 1970). We can also speculate other factors having possibly played a role, such as high mosquito density at Cibola Crane Roost (regularly noted at this site, correlated to albatross nest desertion [Anderson and Fortner 1988]), or disturbance from farming activities near PVER4. We also cannot rule out adult mortality. Raptors may be an important cause of mortality during migration or on arrival to wintering grounds (Hector 1985). They have also attacked incubating cuckoos (Hughes 1999), and in August this year, we discovered the remains of a probable raptor-killed adult cuckoo at BWR NWR in a known Cooper's hawk territory.

One nest desertion was captured on video (CVCA2 Nest 2), but there were so many confounding factors at this nest, the true causes for failure may never be known. Possible causal factors include lack of parental experience (Pogany et al. 2008; at least one adult was a first-time breeder, and the parents apparently didn't build their own nest [nesting in a dove nest; see

CVCA2 N2 account in Appendix C], nest disturbance (both inter- and intraspecific parasitism), poor nestling health (possibly also related to parental inexperience; all three chicks had stunted growth, all fell or jumped out of the nest), and loss of young (two chicks died before desertion). The chicks' stunted growth, possible deformity and premature death also suggests possible inbreeding depression. Offspring of highly related parents often show reduced fitness (Szulkin and Sheldon 2007) which manifests in slower growth rates, higher physical abnormalities, and nestling mortality (Kelly and Ash 1976). Another potential factor is pesticide poisoning, as many restoration sites are adjacent to active agriculture. Laymon (1980) observed two fledglings falling from trees unable to maintain balance after pesticide spraying in a nearby orchard. Agricultural pesticides may reduce prey availability (Laymon and Halterman 1987), cause abnormal embryo development including bill deformities and incomplete ossification (Hoffman and Albers 1984, Geisy et al. 1994, Kuiken et al. 1999, Harding et al. 2004), directly poison birds, reduce nest attendance, and cause egg shell thinning (Hughes 1999).

This year was an informative field season, and through intensive nest searching and monitoring (including the use of telemetry and nest video cameras) we gained valuable new information including our first observations of nest parasitism by cuckoos in the study area. We continued to confirm increased breeding in the study area over the past four years of this project (from 5 nests in 2008, 9 in 2009, 17 in 2010, to 29 in 2011). Three sizeable breeding subpopulations are now evident in this region; at BWR NWR, PVER (10-17 pairs), and CVCA (7-11 pairs estimated). PVER especially saw dramatic increases in breeding evidence; maximum breeding estimates increased from 6 to 17 pairs over two years. Each year more planted habitat has become suitable in this area, and in 2011 the maturation of Phase 4 to suitable breeding habitat increased the total amount of contiguous breeding habitat at PVER to 91 ha, making it the second largest contiguous suitable habitat patch in the study area behind the BWR NWR. It is therefore not surprising that it now supports the second largest number of estimated breeding territories.

# Chapter 3. Mist Netting, Color Banding, and Telemetry

## Introduction

Yellow-billed cuckoo breeding populations in the western United States are restricted to small and isolated riparian habitat fragments comprising 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 et al. 2006, Martín et al. 2008, Ortego et al. 2008). It is therefore important to measure current dispersal patterns among western yellow-billed cuckoo populations. Identifying limits to dispersal between breeding sites can guide the restoration of riparian landscapes towards supporting a more viable population, and can be achieved through long-term color banding efforts. Long-term color banding can also provide information on natal and breeding dispersal patterns, as well as other poorly understood key traits such as survivorship, mate and site fidelity, breeding behavior and morphology, and population demography and genetic structure.

Cuckoos are difficult to observe due to their furtive behavior, and their bands can be even more difficult 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 such as the effects of habitat characteristics 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 (McNeil et al. 2011); thus, it is often unclear whether breeding has occurred in an area.

Telemetry improves breeding pair estimates by increasing the likelihood of confirming both breeding and transiency. Another benefit of radio-tracking is the ability to measure actual response and detection rates of known-location birds, improving survey protocol assessment (detailed in 0).

Over the past three seasons of color-banding and re-sighting cuckoos on the LCR, we have confirmed that both males and females breed in their second year (the following breeding season after hatching). We have also observed male natal philopatry (the return of males to their natal territory to breed), a female natal dispersal event of 33 km (between CVCA and PVER), and male breeding site fidelity. However, these results are based on very few returns and much more data is required. Additionally, home range estimates can be impacted by many sources of natural and human-caused variation. It is therefore important to obtain enough data on a sufficient number of individuals at all breeding stages to gain a better understanding of the factors affecting home range variation. In 2011, we continued banding, re-sighting, and radio-tracking cuckoos in LCR study sites, to increase our sample sizes for dispersal, home ranges, and nests, as well as to determine migratory versus breeding status, and track individual movements and behaviors at LCR MSCP restoration sites throughout the breeding season.

## Methods

### Mist Netting

We attempted to capture 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 was observed flying towards the broadcast, we found a suitable net lane and used a target mist net technique modified from Sogge et al. (2001): we attached three or four stacked (totaling 7.8 to 10.4 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 during each attempt, including temperature, number of cuckoos in the area, and which vocalizations elicited a response. If no cuckoos displayed interest after approximately one hour, we moved the set-up to another location. We ceased our attempts when temperatures reached 40° C (104° F).

## Color Banding

We banded all captured cuckoos with an anodized blue Federal aluminum band and a pin-striped color aluminum band 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 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 MAPS protocol). We extracted a small amount of blood from each bird by brachial vein puncture, placed on PermaCode™ cards and/or in EDTA-treated buffer. Genomic DNA was extracted from the buffered blood and sexed using a PCR-based method following Han et al. (2009) to amplify sex-specific DNA fragments of the CHD gene located on the avian sex chromosomes (W and Z). Accuracy of the sexing results should be verified by another molecular method and on known-sex birds (Robertson and Gemmell 2006, Casey et al. 2009) which will be completed for the summary 2012 report.

We attempted to re-sight all banded birds present at all sites by observing with binoculars the legs of all detected cuckoos. For re-sighted second-year (SY) birds (returning chicks from

2010), we calculated natal dispersal distance as the distance between the bird's natal nest and its (assumed first) nesting location (calculated in ArcGIS Desktop). For returning after-second-year (ASY) birds, breeding dispersal distance was calculated as the distance between each year's known nests associated with the bird.

### 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 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. All transmitters were operational for 6 to 8 weeks. We stitched the 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 (following Bray and Corner 1972, Pitts 1995, Woolnough et al. 2004). We used three types of telemetry receivers (Wildlife Materials TRX48S, Communications Specialists Model R1000, Advanced Telemetry Systems R410) and three types of directional antennae (AF Antronics model F151-3FB, Communications Specialists RA-150 Folded Yagi, Lotek AN-3FX 150) to monitor the marked birds. We attempted to record at least two accurate positions per hour. Vocalizations, intra-specific interactions, movements, behaviors, and habitat characteristics were recorded for each location. If an observer thought that their presence was disturbing the bird, they moved away from the bird and used triangulation of two or three bearings 90 ± 30° apart taken within five minutes of each other to estimate the bird's location (Springer 1979). We also attempted to confirm the breeding status of all radioed birds by witnessing the birds at nests, or by observing other breeding behaviors. 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 small distances (averaging 66 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 all sites along the LCR. At sites near Blythe, we also used a vehicle-mounted null-peak antenna system (Advanced Telemetry Systems) to search for lost birds. 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 imported telemetry points into ArcGIS 9.3 (shifted based on distance-bearing and triangulation estimates) and used Hawth's Analysis Tools (Beyer 2004) to estimate home ranges for each cuckoo. Three home range estimates were calculated: minimum convex polygons (MCP), and 95% and 50% kernel density estimators (KDE, Silverman 1986). MCP and 95% KDE estimates 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, MCP is extremely sensitive to data outliers, often over-estimating 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 performed nonparametric ANOVAs (using SAS 9.3) to assess differences in average home range sizes based on gender, breeding status, site, habitat patch size, number of points, and number of days tracked. A more thorough home range analysis of our complete telemetry data set (2009-2012) will be included in our summary 2012 report.

We also fitted eight cuckoos that we knew (based on nest observations) or assumed to be breeding (based on proximity to a known nest, or duration of residency) with Mk20 ASLT geolocators (British Antarctic Survey) weighing 1.1 g total (0.9 g geolocator + 0.2 g cord attachment, 1.5-1.9% of total bird mass). Geolocators are archival tags capable of measuring and storing data for up to 12 months (British Antarctic Survey 2010). Daily sunrise and sunset times (based on light level) are stored and standard astronomical equations are used to determine the bird's approximate latitude and longitude. We attached the geolocators with lower-back leg-loop harnesses using 1 mm elastic cord, Kevlar thread, and cyanoacrylate glue to secure the knots (following Rappole and Tipton 1991, J. Sechrist pers. comm.). The successful recapture of any of these birds in 2012 will provide valuable information on fall/spring migration routes and non-breeding ranges.

## Results

### Mist Netting

We made 87 mist netting attempts over 42 days between June 11 and August 23 in 2011, resulting in 34 captures of 29 adults and one juvenile (Table 3-1). Our mean capture rate was 38% per attempt. Nets were open an average of 72 minutes per attempt. The average capture took approximately 25 minutes, although some birds were captured in less than 5 minutes. Temperatures during attempts ranged from 22° to 36° C (average 27° C).

Table 3-1. Yellow-billed cuckoo capture rate by area, 2011.

| Area | #Attempts | #Captures | #Females/#Males | Capture rate |
|---|---|---|---|---|
| Havasu NWR | 4 | 1 | 1/0 | 25% |
| Bill Williams River NWR | 8 | 0 | - | 0% |
| CRIT | 6 | 2 | 2/0 | 33% |
| PVER | 17 | 9[1] | 3/5 | 53% |
| CVCA | 29 | 14[2] | 5/6 | 48% |
| Cibola NWR | 13 | 6[3] | 4/1 | 46% |
| Picacho SRA | 1 | 1 | 1/0 | 100% |
| Imperial NWR | 1 | 0 | - | 0% |
| Mittry Lake Pratt | 1 | 0 | - | 0% |
| Quigley WMA | 3 | 1 | 1/0 | 33% |
| Total | 87 | 34 | 17/12 | 38% |

1. Eight adults, one juvenile captured. 2. Eleven individual adults captured; three captured twice in 2011. 3. One adult captured twice.

## Color Banding and Re-sights

Between June 12 and August 23 2011, we captured and color-banded 27 adults, recaptured two previously banded birds, and positively re-sighted four birds previously banded in 2010 (Table 3-2 and Table 3-4). We captured most adults (76%) between July 2 and July 29. We also banded 35 hatch-year birds (Table 3-3). We recorded 28 re-sights total, however just twelve (43%) were seen well enough to determine the full band combination and eight (29%) were able to be identified to individual. All between-year recaptures and full re-sights were of birds previously captured or banded in 2010, giving an annual re-sight rate of 11.8% (7 of 51 banded in 2010). These returns gave us four new dispersal records (three breeding and one natal, Table 3-4). Four banded adult males all returned to their previous breeding sites (three at CVCA and one at BWR NWR). One returning CVCA bird (LJ) was first banded as an adult in 2009, who returned for the third consecutive year. BA had two nests in 2011, 228 m and 26 m from his 2010 nest. TGB was re-sighted carrying food 150 m from his 2010 nest, though a nest was not found in the area and he was only seen once. The returning BWR NWR male (AF) was first banded as an adult in 2010 near Planet Ranch 1,800 m upstream of where he nested in 2011.

We re-sighted three of 24 young banded in 2010 (all at CVCA or PVER), giving a LCR SY return rate of 12.5%, and a Blythe-area SY return rate of 19%. One returning SY male (FJR) returned to CVCA2 and nested approximately 200 m from his natal nest. The other two returning SY birds were not able to be individually identified, as they were two of seven chicks from three 2010 nests (PVER3, CVCA1, CVCA2) that were given the same color band combination. We also recaptured a 27-day-old fledgling 175 m from its nest, accompanied by an adult and another fledgling, and re-sighted a 26-day-old fledgling 400 m from its natal nest, observed with two adults (Table 3-4).

Table 3-2. Yellow-billed cuckoos captured on the LCR, 2011.

| # | Site Code | Date captured | YBCU ID | Band # | Sex | Code [1] | Age[2] | Color bands[3] | Att[4] | Breeding evidence |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CVCA1 | 6-12 | BA | 1212-13743 | M | R | ASY | W R/Bk Go | - | Nests CV1-2, -5 |
| 2 | PVER4 | 6-24 | BOO | 1222-90523 | F | N | AHY | Bl/W-Bl-W | T | - |
| 3 | CRIT | 6-28 | VTI | 1222-90501 | F | N | AHY | Bl/R-Y | T | - |
| 4 | HAVPS | 6-30 | AP | 1222-90521 | F | N | AHY | Bl-W-Bl/Bl | T | - |
| 5 | CIBCR | 7-2 | NUR | 1222-90530 | M | N | AHY | Bl/G-Bk-G | T | - |
| 6 | PVER4 | 7-2 | MRD | 1222-90522 | F | N | AHY | Bl/Y-Bk-Y | T | Nest PV4-3 |
| 7 | CRIT | 7-2 | SCM | 1222-90502 | F | N | AHY | Bl/G-W-G | T | - |
| 8-1 | CVCA2 | 7-4 | DG | 1222-90524 | M | N | AHY | Bl/Y-Bl-Y | T | Nest CV2-1 |
| 9 | CVCA2 | 7-4 | JE | 1222-90525 | F | N | AHY | Bl/G-O-G | T | - |
| 10 | CIBIPM | 7-8 | ND | 1222-90526 | F | N | AHY | Bl/Y-G-Y | T | - |
| 11 | CVCA1 | 7-9 | SME | 1222-90527 | M | N | AHY | Bl/R-G | T | - |
| 12 | PICSRA | 7-10 | YS | 1222-90531 | F | N | AHY | Bl/Bl-Y-Bl | - | - |
| 13 | CVCA1 | 7-12 | CD | 1222-90528 | M | N | AHY | Bl/Bk-G-Bk | T | - |
| 14 | CVCA1 | 7-12 | FJR | 1212-13785 | M | R | SY | W R-Bl/Go | T | Nest CV2-2 |
| 15 | PVER4 | 7-14 | EOW | 1222-90529 | M | N | AHY | Bl/G-Y-G | T | Nest P4-4 |
| 16 | PVER4 | 7-14 | ARA | 1222-90540 | M | N | AHY | Bl/R-Bk | T | - |
| 17 | GRQP | 7-14 | ANG | 1222-90532 | F | N | AHY | Bl/Y-Bl | T | - |
| 18-1 | CVCA2 | 7-15 | GRE | 1713-67913 | F | N | AHY | No Band | T | Nest CV2-1 |
| 19-1 | CVCA2 | 7-15 | CBR | 1222-90541 | F | N | AHY | Bl/Go-Bl-Go | T | |
| 20 | CVCA2 | 7-15 | DUM | 1222-90542 | F | N | AHY | Bl/O-W-O | T | Nest CV2-3 |
| 21 | CIBCR | 7-21 | MON | 1222-90534 | F | N | AHY | Bl/G-Y | - | Nest CIBCR-1 |
| 19-2 | CVCA2 | 7-23 | CBR | 1222-90541 | F | R | AHY | Bl/Go-Bl-Go | T | Nest CV1-6 |
| 22 | PVER4 | 7-24 | GUL | 1222-90535 | M | N | AHY | Bl/Lv-W | G | Nest PV4-2? |
| 23 | CIBCR | 7-25 | TIN | 1222-90538 | F | N | AHY | Bl/O-Bk | T | - |
| 24-1 | CIBCR | 7-25 | RIS | 1222-90537 | F | N | AHY | Bl/No Band | T | - |
| 25 | PVER2 | 7-26 | BUT | 1222-90539 | M | N | AHY | Bl/G-Bk | G | Nest PV2-1 |
| 26 | CVCA1 | 7-28 | ROB | 1222-90557 | M | N | AHY | Bl/G-Lv-G | G | Nest CV1-3 |
| 27 | CVCA1 | 7-28 | MM | 1222-90558 | F | N | AHY | Bl/O-G-O | G | Nest CV1-3 |
| 18-2 | CVCA2 | 7-29 | GRE | 1713-67913 | F | R | AHY | S/No Band | G | Nest CV2-1 |
| 8-2 | CVCA2 | 7-29 | DG | 1222-90524 | M | R | AHY | Bl/Y-Bl-Y | - | Nest CV2-1 |
| 28 | PVER4 | 8-03 | HAY | 1222-90569 | M | N | AHY | Bl/Bl-Lv | G | Nest PV4-2 |
| 24-2 | CIBCR | 8-05 | RIS | 1222-90537 | F | R | AHY | Bl/No Band | G | - |
| 29 | PVER4 | 8-07 | PRI | 1222-90578 | F | N | AHY | Bl/Lv-Y | G | Nest PV4-4? |
| 30 | PVER4 | 8-23 | HJR | 1222-90567 | U | N | HY | Bl-O-Bl/Bl | - | NA |

1. N=new capture, R=recapture. 2. AHY=after hatching year, SY=second year, ASY=after second year. 3. (Top to bottom, left/right): Bk=black, G=green, Go=gold, Lv=lavender, Bl= blue, O=orange, R=red, S=silver, W=white, Y=yellow. '-' between colors indicates split band. 4. T=Transmitter, G=Geolocator.

Table 3-3. Hatch-year yellow-billed cuckoos banded on the LCR, 2011.

| Date | Site Code | Nest # | Chick # | Parent(s)[1] | Federal Band # | Band combo.[2] |
|---|---|---|---|---|---|---|
| 7-20 | BWMW | 1 | 1 | | 1222-90503 | G-W/Bl |
| 7-20 | BWMW | 1 | 2 | | 1222-90504 | Y-Bk/Bl |
| 7-24 | BWMW | 1 | 3 | | 1222-90505 | R-Bl-R/Bl |
| 7-26 | BWPT | 2 | 1 | | 1222-90506 | O-Bl/Bl |
| 7-26 | BWPT | 2 | 2 | | 1222-90507 | O-Bk-O/Bl |
| 7-27 | BWHB | 2 | 1 | | 1222-90508 | Bk-O-Bk/Bl |
| 7-27 | BWHB | 2 | 2 | | 1222-90509 | G-O/Bl |
| 7-27 | BWHB | 1 | 1 | | 1222-90510 | R-Bk-R/Bl |
| 7-27 | BWHB | 1 | 2 | | 1222-90511 | W-Bk-W/Bl |
| 7-27 | BWCW | 1 | 1 | | 1222-90514 | Bk-R-Bk/Bl |
| 7-27 | BWCW | 1 | 2 | | 1222-90515 | Bk-Y/Bl |
| 7-27 | BWCW | 1 | 3 | | 1222-90516 | Bk-G/Bl |
| 7-24 | CVCA1 | 3 | 1 | ROB, MM | 1222-90536 | O-Y/Bl |
| 7-26 | CVCA1 | 3 | 2 | ROB, MM | 1222-90543 | O-Y/Bl |
| 7-26 | CVCA1 | 3 | 3 | ROB, MM | 1222-90544 | Y-Bl/Bl |
| 7-29 | CVCA2 | 1 | 1 | DG, GRE | 1222-90545 | O-Bl-OBl/ |
| 7-29 | CVCA2 | 1 | 2 | DG, GRE | 1222-90546 | Bl-W-Bl/Bl |
| 7-29 | CVCA2 | 1 | 3 | DG, GRE | 1222-90547 | Bl-Y/Bl |
| 7-29 | CVCA2 | 1 | 4 | DG, GRE | 1222-90548 | Bl-W/Bl |
| 7-26 | PVER2 | 1 | 1 | BUT | 1222-90555 | R-Go/Bl |
| 7-26 | PVER2 | 1 | 2 | BUT | 1222-90556 | Bk-Y-Bk/Bl |
| 7-29 | PVER3 | 1 | 1 | | 1222-90562 | W-R-W/Bl |
| 7-29 | PVER3 | 1 | 2 | | 1222-90563 | W-Y-W/Bl |
| 7-29 | PVER3 | 1 | 3 | | 1222-90564 | W-G-W/Bl |
| 7-31 | CVCA1 | 4 | 1 | | 1222-90565 | Bk-W-Bk/Bl |
| 7-31 | CVCA1 | 4 | 2 | | 1222-90566 | lB-O/Bl |
| 8-2 | PVER4 | 2 | 1 | HAY | 1222-90567 | Bl-O-Bl/Bl |
| 8-2 | PVER4 | 2 | 2 | HAY | 1222-90568 | Bl-G-Bl/Bl |
| 8-4 | CVCA2 | 2 | 1 | FJR | 1222-90570 | lB-Bl/Bl |
| 8-4 | CVCA2 | 2 | 2 | FJR | 1222-90571 | W-Bk/Bl |
| 8-12 | CVCA2 | 3 | 1 | DUM, LJ | 1222-90572 | Y-W/Bl |
| 8-12 | CVCA2 | 3 | 2 | DUM, LJ | 1222-90573 | Y-G/Bl |
| 8-18 | BWHB | 3 | 1 | ABE | 1222-90512 | Bk-R/Bl |

1. See Table 3-2 and Table 3-4 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 3-4. Yellow-billed cuckoo re-sights, recaptures and dispersal distances, LCR 2011.

| Dispersal type | ID | Band color | Sex[1] | 2011 Age[2] | 2011 Re-sight Date | 2011 Recap Date | Re-sight Site | Site first banded | Date banded | Distance moved |
|---|---|---|---|---|---|---|---|---|---|---|
| Breeding | BA | R W/Bk Go | M | ASY | 7/09 | 6/12 | CVCA1 | CVCA1 | 6/23/10 | 228 m |
| | | | | | 8/1 | 6/12 | CVCA1 | CVCA1 | 6/23/10 | 26 m |
| | TGB | Bk W/W Go | M | ASY | 7/14 | | CVCA2 | CVCA1 | 6/24/10 | 150 m |
| | AF | Bl W/R Go | M | ASY | 8/02 | | BWHB | BWCP | 7/04/10 | 1.3 km[3] |
| | LJ | W Go/W O | M | ATY | 8/04 | | CVCA2 | CVCA1 | 7/11/09, 6/23/10 | 48 m |
| Natal | FJR | W R-Bl/Go | M | SY | | 7/12 | CVCA2 | CVCA2 | 8/03/10 | 204 m |
| | SY1[4] | Lg/Go | U | SY | 8/02 | | PVER1 | PVER3 | 8/14/10 | 650 m |
| | | | | | | | | or CVCA1 | 8/09/10 | 33 km |
| | | | | | | | | or CVCA2 | 7/29/10 | 33 km |
| | SY2[4] | Lg/Go | U | SY | 8/08 | | CVCA1 | CVCA1 | 8/14/10 | 214 m |
| | | | | | | | | or CVCA2 | 8/09/10 | 422 m |
| | | | | | | | | or PVER3 | 7/29/10 | 33 km |
| Post-fledging | HJR | Bl-O-Bl/Bl | U | HY-27d | | 8/23 | PVER4 | PVER4 | 8/04/11 | 175 m |
| | HY2 | Bk-Y-Bk/Bl | U | HY-29d | 8/21 | | PVER2 | PVER2 | 8/02/11 | 400 m |

1. Sex: M=male by DNA, F=female by DNA, U=not sexed. 2. HY=hatching year (juvenile), SY=second year, ASY=after second year, ATY=after third year. 3. Distance between 2011 nest and 2010 copulation (nest was not found in 2010). 4. In 2010 seven nestlings at PVER and CVCA were banded with the same color combination (Lg/Go) and two of the seven were re-sighted in 2011 (one at PVER1, one at CVCA1). Without capturing and reading the individual band numbers of these two SY birds, their identity and natal site are unknown. Therefore we included the three possible natal dispersal distances for each bird.

## Telemetry

We attached radio transmitters to 20 adult cuckoos, and followed each bird between 0 and 18 days (averaging 133.5 points per bird, 16 points per bird per day, Table 3-5). No movements between non-contiguous sites were observed, and birds that left their capture site were never relocated despite intensive searching. The longest movement recorded was of a bird (VTI) at Ahakhav Tribal Preserve that moved 1.3 km from its banding location at the Preserve to an isolated honey mesquite, later returning to the Preserve for a few days before leaving again. One migrating bird apparently left his capture site (CVCA) on the night of July 15; the signal was located at the site at 8:20 pm but by 9:40 pm the signal was gone.

Table 3-5. Home range estimates of yellow-billed cuckoos radio-tracked at LCR restoration sites, 2011.

| Site | Habitat size (ha) | YBCU ID | Sex[1] | Capture date | Breeding stage | #days tracked | # points | Average pts/day | MCP[2] (ha) | 95% KDE[3] (ha) | 50% KDE[3] (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Havasu Pintail Slough | 12 | AP | F | 6/30 | No breeding evidence | 0 | - | - | - | - | - |
| Ahakhav Tribal Preserve | 60 | SCM | F | 7/2 | No breeding evidence | 7 | 96 | 13.7 | 16.9 | 13.9 | 2.9 |
| | | VTI | F | 6/28 | No breeding evidence | 7 | 112 | 16 | 108.3[4] | 48.9 | 9.2 |
| PVER Phases 1-4 | 91 | EOW | M | 7/14 | Pre- to post-nesting | 11 | 143 | 13 | 14.5 | 16.1 | 2.5 |
| | | BOO | F | 6/24 | No breeding evidence | 10 | 129 | 12.9 | 50.6 | 36.5 | 8.9 |
| | | MRD | F | 7/2 | Pre-nesting | 7 | 80 | 11.4 | 14.0 | 15.0 | 3.5 |
| | | ARA | M | 7/14 | No breeding evidence | 1 | 7 | 7 | 6.3 | 10.5 | 2.4 |
| CVCA Phases 1-2 | 64 | CBR | F | 7/15 | Pre- to post-nesting | 20 | 212 | 10.6 | 18.9 | 23.5 | 5.1 |
| | | DUM | F | 7/15 | Pre- to post-nesting | 15 | 162 | 10.8 | 16.6 | 17.9 | 3.1 |
| | | DG | M | 7/4 | Pre-nesting, nesting | 13 | 165 | 12.7 | 12.2 | 15.3 | 3.3 |
| | | FJR | M | 7/12 | Pre- to post-nesting | 11 | 119 | 10.8 | 16.2 | 21.8 | 5.0 |
| | | GRE | F | 7/15 | Nesting | 7 | 89 | 12.7 | 8.9 | 12.3 | 2.4 |
| | | SME | M | 7/9 | No breeding evidence | 4 | 64 | 16 | 16.4 | 20.5 | 3.8 |
| | | JE | F | 7/4 | No breeding evidence | 3 | 44 | 14.7 | 17.0 | 21.8 | 4.7 |
| | | CD | M | 7/12 | No breeding evidence | 0 | - | - | - | - | - |
| Cibola NWR Crane Roost | 48 | TIN | F | 7/25 | No breeding evidence | 6 | 44 | 7.3 | 7.0 | 10.4 | 1.9 |
| | | NUR | M | 7/2 | No breeding evidence | 5 | 61 | 12.2 | 22.3 | 24.9 | 4.3 |
| | | RIS | F | 7/25 | No breeding evidence | 4 | 49 | 12.3 | 11.1 | 16.8 | 3.6 |
| Cibola NWR Perri Marsh | 70 | ND | F | 7/8 | No breeding evidence | 4 | 59 | 14.8 | 40.3 | 21.1 | 5.0 |
| Quigley WMA | 10 | ANG | F | 7/14 | No breeding evidence | 5 | 47 | 9.4 | 7.5 | 9.8 | 2.3 |
| Overall Mean (± SD)[4] | 41.8 | | | | | 10.1 | 133.5 | 16.1 | 17.5 ±11.6 | 19.8 ±9.7 | 4.1 ±2.1 |

1. Sexed by DNA. 2. MCP=minimum convex polygon. 3. KDE=kernel density estimate. 4. MCP mean excluded outlier data from VTI which significantly affected the estimate.

The average home range size (95% KDE) of 18 birds radio tracked at LCR restoration sites was 19.8 ±9.7 ha (MCP 17.5 ±11.6 ha, Table 3-5). Females and non-breeding birds tended to have larger average home ranges with greater variability compared to males and breeding birds respectively (Table 3-6). Of seven confirmed breeding birds that were followed for at least seven days, the average 95% KDE was 17.4 ±4.0 ha, slightly smaller and 41% less variable than the overall average. The home range of 11 birds showing no breeding evidence was 21.4 ±12.0 ha. The core range (50% KDE) averaged 4.1 ±2.1 ha overall. For nesting birds the core range averaged 3.5 ±1.1 ha (equivalent to a circle of radius 106 ±59 m) that usually surrounded the nest. (The one nesting bird whose nest did not overlap its 50% KDE was mostly tracked before nesting, and the nest failed early). 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, or number of days tracked ($P > 0.05$ for all tests).

Table 3-6. Average home ranges ± standard deviation (SD) by gender, breeding status, and site.

| | | Home range estimate (mean ±SD) | | |
|---|---|---|---|---|
| Factor | Group (n) | MCP | 95% KDE | 50% KDE |
| Gender | Male (n=6) | 14.65 ±5.29 | 18.19 ±5.20 | 3.55 ±1.00 |
| | Female (n=12) | 26.24 ±28.99 | 20.66 ±11.49 | 4.38 ±2.43 |
| Breeding Status | Non-breeding (n=11) | 27.61 ±30.23 | 21.38±12.04 | 4.47 ±2.48 |
| | (n=10; excluding 1 outlier) | (19.54 ±14.81) | | |
| | Breeding (n=7) | 14.47 ±3.25 | 17.42 ±3.98 | 3.53 ±1.09 |
| Site | Cibola Crane Roost (48 ha, n=3) | 13.47 ±7.92 | 17.38 ±7.27 | 3.26 ±1.23 |
| | Cibola Perri Marsh (70 ha, n=1) | 40.30 | 21.09 | 5.05 |
| | CRIT (60 ha, n=2) | 62.60 ±64.63 | 31.42 ±24.76 | 6.09 ±4.45 |
| | CVCA (64 ha, n=7) | 15.17 ±3.42 | 19.02 ±4.06 | 3.90 ±1.06 |
| | GRQP (10 ha, n=1) | 7.50 | 9.75 | 2.27 |
| | PVER (91 ha, n=4) | 21.35 ±19.86 | 19.53 ±11.55 | 4.33 ±3.06 |

Telemetry observations indicated that birds stayed at their capture sites 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 their eventual breeding status. Confirmed breeders spent significantly more days at their capture site (average 37.4 days) than birds that left before breeding was confirmed (average 11.4 days, Table 3-7). Departure of birds from the sites was steady throughout the season (Figure 3-1). Birds leaving sites in the first half of the season (<July 23) stayed 4 to 19 days (average 11.4 days, n=9) with no breeding evidence, and were assumed to be migrating through the sites. Conversely, birds that left later in the season remained at their capture site longer (12 to 64 days, average 31.2, n=11), including eight confirmed breeders.

Table 3-7. Number of days at sites post-capture by breeding status, LCR 2011.

| | | Days at site | |
|---|---|---|---|
| Status | n | Range | mean |
| Early departure (<July 23) | 10 | 1 - 19 | 10.4 ±6.1 |
| No breeding confirmed | 13 | 1 - 19 | 11.4 ±5.8 |
| Later departure (≥July 23) | 11 | 12 - 64 | 31.2 ±16.7 |
| Confirmed breeding | 8 | 27 - 64 | 37.4 ±13.9 |

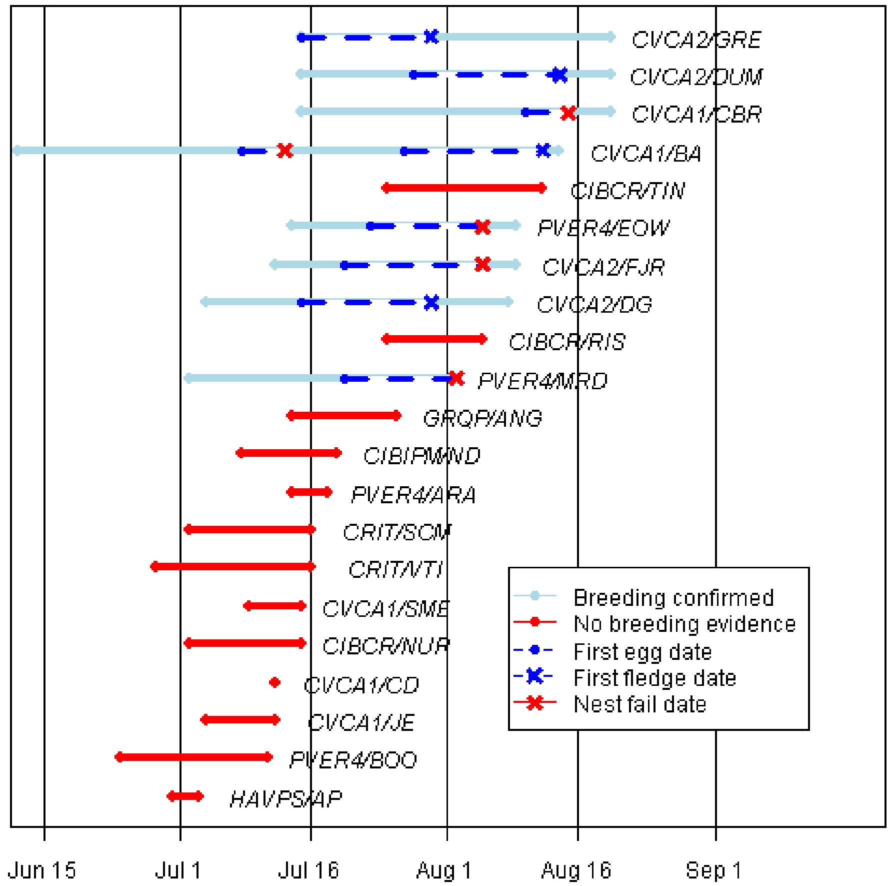



Figure 3-1. Capture, last known presence and nesting dates of banded yellow-billed cuckoos, LCR 2011. The first circle in represents date of capture, last circle = date last detected at site (the following birds either dropped their transmitter or had their transmitter removed on site, so for these birds the last date is the date the bird was last re-sighted: GRE, DG, RIS, MRD). Birds are ordered by last known date at site to show the regular departure of birds throughout the season. All birds here were radio-tracked except BA, who was included due to being recaptured early and subsequently re-sighted several times during the 2011 season.

## Discussion

Prior to 2011, our banding and re-sight results led us to speculate that both natal and breeding cuckoo dispersal may be female-biased (McNeil et al. 2010). This year we observed four adult males all return to their 2010 breeding sites, three at CVCA and one at BWR NWR, as well as a returning SY male to CVCA (though these sexes still need to be verified). Of our few returns, males have returned to their natal and breeding sites, while two females (one ASY, one SY) dispersed 33-38 km to other sites (the only long-distance dispersal events we have recorded to date). Avian natal dispersal is predominantly female-biased (Greenwood 1980), with females breeding further average distances from their natal site than males. Migratory species tend to average higher natal dispersal distances than resident species, though the majority of birds still breed relatively near to (i.e. within a few km of) their natal site (Paradis et al. 1998). Laymon (pers. comm. in Bennett and Keinath 2001) also observed males but not females returning to their natal areas at the Kern River during subsequent years, suggesting that natal site fidelity is less prevalent in female cuckoos. Breeding dispersal tends to involve shorter distances than natal dispersal in most species (Paradis et al. 1998), however, while more return data and sexing verification is still needed, our 2011 results continue to support female bias (and male philopatry) in both natal and breeding dispersal at these sites.

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 populations (e.g. 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. Another potential sign of reduced dispersal is the relatively high re-sight rate of 12.5% among returning 2010 chicks. Re-sight rates from a selection of avian studies averaged 5%, whereas at isolated sites they averaged 10.5% (Weatherhead and Forbes 1994). Breeding habitat within the LCR region consists of isolated patches of varying sizes and levels of isolation (e.g. Havasu NWR to BWR = 71 km, BWR to PVER = 79 km, PVER to CVCA = 32.5 km), and distances to the next closest breeding populations outside the LCR are much greater. Our limited study area may however be insufficient to fully measure dispersal, and we may be missing long-distance dispersal events among our banded cuckoos, which is a common problem with dispersal studies (van Noordwijk 1984, Paradis et al. 1998, Fagan and Lutcher 2006). Additional research over a wider geographic area is needed to determine if ecological constraints such as increased dispersal distances may be impeding cuckoo population recovery and persistence.

Young cuckoos have been observed receiving parental care for at least two weeks (Laymon 1998) to three weeks (Laymon and Halterman 1985) after fledging. This year we re-sighted two fledglings that had moved 175 m and 400 m from their respective nests, 21 and 24 days post-fledging (Table 3-4). Both were accompanied by one or two adults, and one was with another fledgling (assumed to be its sibling). Even three to three and a half weeks after fledging, the parents and juveniles were still together within or near the breeding territory. Additional information on post-fledging dispersal may help guide future management decisions such as September dove hunting at LCR MSCP breeding sites (previously discussed in McNeil et al. 2011).

Based on our telemetry results, after cuckoos arrived at a site, they remained in one area (averaging ~20 ha) over the length of their stay, whether they nested or not. This suggests that cuckoos establish both breeding and foraging territories (as opposed to randomly moving throughout the available habitat). Similar to our 2010 results (McNeil et al. 2011), over half the birds we tracked (especially during the first half of the season) left their capture site within two weeks, before breeding was confirmed. It is likely that these birds were migrating through the area and stopping at the sites long enough to replenish nutrients (Chernetsov 2006). Due to the high number of transients captured, it is likely that the LCR is an important migration route for other western cuckoo subpopulations.

Previous telemetry-based yellow-billed cuckoo home range (95% kernel density) estimates include 38.6 ±42.2 ha on the San Pedro River (n=23, Halterman 2009), 56.3 ±58.1 ha on the Rio Grande (n=10, Sechrist et al. 2009), and our estimates at LCR restoration sites of 21.6 ±8.8 ha in 2009 (n=6, McNeil et al. 2010) and 21.7 ±10.4 ha in 2010 (n=19, McNeil et al. 2011). This year our home range estimates at LCR restoration sites of 19.8 ±9.7 ha were close to our previous estimates at these sites. Among breeding cuckoos tracked at CVCA and PVER they were even less variable in 2011 (17.4 ±4.0 ha).

At CVCA we estimated 7–11 breeding pairs over 64 ha (0), or 5.8–9.1 ha/pair. Similarly at PVER the breeding density was 11–17 pairs/91 ha, or 5.4–8.3 ha/pair. The average nesting cuckoo home range at these sites was 17.4 ha, therefore the breeding pairs at these sites shared space by overlapping their home ranges by an average of 52%/pair. Our LCR home range estimates are also considerably smaller than previous estimates from the San Pedro and Rio Grande, and may indicate differences in habitat area, quality, or prey densities. Unfortunately, we have experienced low capture rates at the BWR (mainly due to taller canopy) so we cannot yet compare home ranges between natural and restored LCR habitat. However, the BWR is comparable to the large intact riparian forests of the Rio Grande and San Pedro Rivers so home ranges are expected to be greater at the BWR than restoration sites.

Galli et al. (1976) found birds with large area requirements including yellow-billed cuckoos were most likely to be non-passerine insectivores, which suggests that small habitat patches may be food limited for these species. Habitat patch size has previously been correlated with cuckoo occupancy (Gaines 1974, Galli et al. 1976, Halterman 1991, Parker et al. 2005, Girvetz and Greco 2009, McNeil et al. 2011). Female cuckoos lay the largest eggs of any bird relative to body mass (Payne 2005), requiring high energy resources over a short period, and many habitat fragments are likely too small to support a sufficient biomass of large prey items required for cuckoo reproduction.

Continued color-banding, re-sighting, and telemetry at LCR breeding sites has enabled us to assess annual responses to habitat creation of varying patch sizes, connectivity, and quality, and may confirm or refute the existence of physical limits to dispersal among these subpopulations. We will continue our attempts to band and re-sight a significant proportion of LCR yellow-billed cuckoos in 2012, and recommend continued long-term banding of these as well as other western cuckoo breeding subpopulations.

# Chapter 4. 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 a determinant 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 (D'Alba et al. 2009, Hoekman et al. 2002, Robertson 2009). These studies found that small-scale temperature and/or humidity differences affected reproductive outcomes. However, few studies have specifically addressed avian nest site selection due to differences in microclimate in extreme desert riparian habitats, where temperature and humidity likely have a strong influence on nest site selection and reproductive success.

In 2010, our results showed that microclimate at yellow-billed cuckoo nests had lower diurnal and nocturnal temperatures compared to available habitat (McNeil et al. 2011). Correspondingly, nests were also more likely to have higher diurnal and nocturnal relative humidity (McNeil et al. 2011). No significant differences in humidity or temperature (diurnal or nocturnal) were found between occupied and unoccupied sites, or between natural and restored sites (McNeil et al. 2011). To further our understanding of microclimate influences on yellow-billed cuckoo distribution on the lower Colorado River, we continued to monitor microclimate in 2011 at nests and available habitat. We also monitored microclimate at occupied and unoccupied breeding territories.

## 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 2011 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° Celsius (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 between 15 June and 18 July. From early-July and mid-August when nests were most active, 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.

Data logger locations were randomly distributed at sites throughout the study region. Because many of our sites are relatively large (>30 ha) they were subdivided into "cuckoo territory-sized" sample units (see 0). At MSCP restoration sites, data loggers were placed at a subset of vegetation plots previously established by Reclamation. For most sample units at Bill Williams River NWR and Havasu NWR, three or four data loggers were hung at random locations at least 100 meters apart. Temperature and RH data loggers were placed at 186 locations (160 random locations and 26 nests) within 46 sample units; 57 loggers recorded temperature only. Three loggers failed to record data or were lost.

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 for each day. We used these averages to determine microclimate differences between nests and available habitat within occupied sample units, and between occupied and unoccupied sample units (for a description of sample units and occupancy see 0). For this analysis we truncated the data to between July 8 and August 20, when nests were active. We also compared microclimate between natural and restoration sites.

We used logistic regression mixed-effects models to analyze temperature and humidity on our repeated measures dataset (measurements through time). To account for latitudinal temperature differences and variation in the size of sites, we blocked our data by sample unit. We used odds ratios from the output of the logistic regression to evaluate the influence of microclimate on territory (sample unit) occupancy and nest placement versus availability. An odds ratio > 1 indicates a positive relationship whereas an odds ratio < 1 signifies a negative relationship (Ott and Longnecker 2001). We performed separate analyses for nocturnal and diurnal RH and temperature due to high multicollinearity among these four variables. To substantiate our results, we also performed a paired t-test comparing the mean difference between nest and available habitat. We used the R statistical package 2.11.1 for all data analyses (R Development Core Team 2010).

## Results

Microclimate averages are displayed in Figure 4-1 and Table 4-1. Both temperature and humidity showed temporal variation (Figure 4-1). As expected, temperature and RH were highly negatively correlated, both diurnally ($r_{121}$ = -0.925, $r^2$ = 0.856, P <0.001) and nocturnally ($r_{121}$ = -0.939, $r^2$ = 0.882, P <0.001). We found no differences in diurnal and nocturnal temperatures or RH between site types (restoration or natural, Table 4-2) or territory occupancy (occupied vs. unoccupied territories, Table 4-3).

Table 4-1. Microclimate averages and standard deviations at restored and natural sites, occupied and unoccupied territories (sample units), and nest habitat compared to available habitat.

| | Temperature ($^0$C) | | Humidity (%RH) | |
|---|---|---|---|---|
| Status[1] | Diurnal | Nocturnal | Diurnal | Nocturnal |
| Restoration Site | 32.66 ±3.14 (n=81) | 26.05 ±3.29 (n=81) | 48.40 ±14.98 (n=67) | 61.30 ±16.68 (n=67) |
| Natural Site | 33.22 ±2.69 (n=74) | 26.35 ±3.43 (n=74) | 50.78 ±12.78 (n=55) | 63.09 ±15.50 (n=55) |
| Occupied Territory | 32.46 ±2.76 (n=114) | 25.91 ±3.23 (n=114) | 52.20 ±13.75 (n=89) | 64.54 ±15.62 (n=89) |
| Unoccupied Territory | 34.51 ±3.03 (n=41) | 26.94 ±3.59 (n=41) | 41.45 ±12.33 (n=33) | 55.01 ±15.89 (n=33) |
| Nest Habitat | 30.22 ±2.02 (n=25) | 25.27 ±2.49 (n=25) | 59.16 ±11.75 (n=22) | 68.66 ±14.00 (n=22) |
| Available Habitat | 32.24 ±2.67 (n=114) | 25.66 ±3.16 (n=114) | 52.28 ±13.31 (n=89) | 65.39 ±15.51 (n=89) |

[1]Occupied and unoccupied means calculated by first averaging data from all data loggers within each sample unit (SU), then averaging the occupied and unoccupied SUs. Site type (restoration and natural) means also calculated this way. Nest habitat means calculated by averaging data recorded from each data logger in occupied SUs when nests were active. Available habitat means used data from non-nest data loggers in occupied SUs.

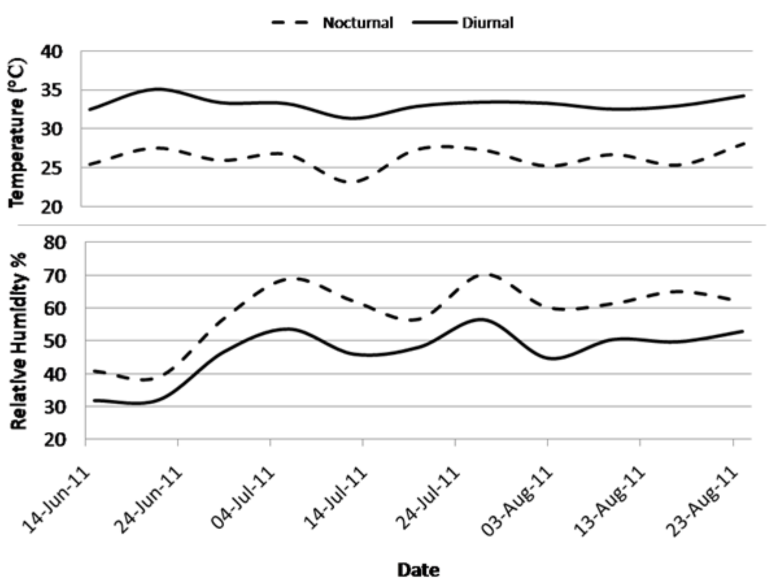



Figure 4-1. Average diurnal and nocturnal temperature ($^0$C) and relative humidity (%) averaged by week during the 2011 survey season.

Table 4-2. Site type (restoration versus natural) results of logistic regression mixed-effects models for diurnal and nocturnal temperature and humidity, LCR 2011. No significant results (P <0.05).

| Microclimate Variable | Odds Ratio | Estimate | Standard Error | P-Value |
|---|---|---|---|---|
| Diurnal Temperature | 1.034 | 0.034 | 2.278 | 0.988 |
| Nocturnal Temperature | 0.986 | -0.014 | 1.448 | 0.992 |
| Diurnal Relative Humidity | 0.997 | -0.003 | 0.490 | 0.995 |
| Nocturnal Relative Humidity | 1.073 | -0.071 | 0.433 | 0.870 |

Table 4-3. Territory occupancy (occupied sample units compared to unoccupied sample units) results of logistic regression mixed-effects models for diurnal and nocturnal temperature and humidity, LCR 2011. No significant results (P <0.05).

| Microclimate Variable | Odds Ratio | Estimate | Standard Error | P-Value |
|---|---|---|---|---|
| Diurnal Temperature | 0.838 | -0.177 | 2.236 | 0.937 |
| Nocturnal Temperature | 0.943 | -0.058 | 1.832 | 0.975 |
| Diurnal Relative Humidity | 1.044 | 0.043 | 0.516 | 0.934 |
| Nocturnal Relative Humidity | 1.025 | 0.025 | 0.454 | 0.957 |

We found that microclimate was different at nests compared to available habitat (Figure 4-2, Figure 4-3). These differences were significant when controlling for latitude and repeated measurements (Table 4-4). Nest sites were more likely to be located in areas with lower diurnal temperatures and higher diurnal RH. Our results show a 59.8% increase in the odds of nest placement for every degree (C) decrease in average diurnal temperature, and a 4.6% increase in the odds of nest placement for every one percent increase in average diurnal humidity. We did not find a significant relationship between nest placement and nocturnal temperature or nocturnal RH (Table 4-4). The paired t-test supported these results (Table 4-5), however the t-test mean difference estimates should not be interpreted directly because of the small sample sizes and large standard deviations.

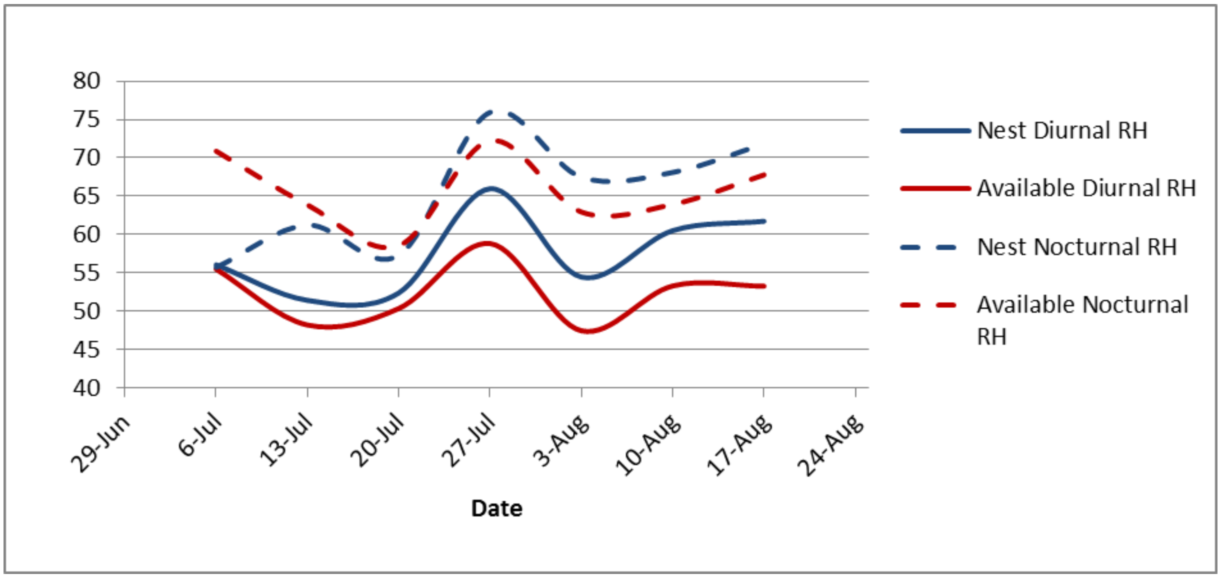



Figure 4-2. Average diurnal and nocturnal relative humidity (%) at nest habitat and available habitat (within occupied sample units only) during the 2011 survey season.

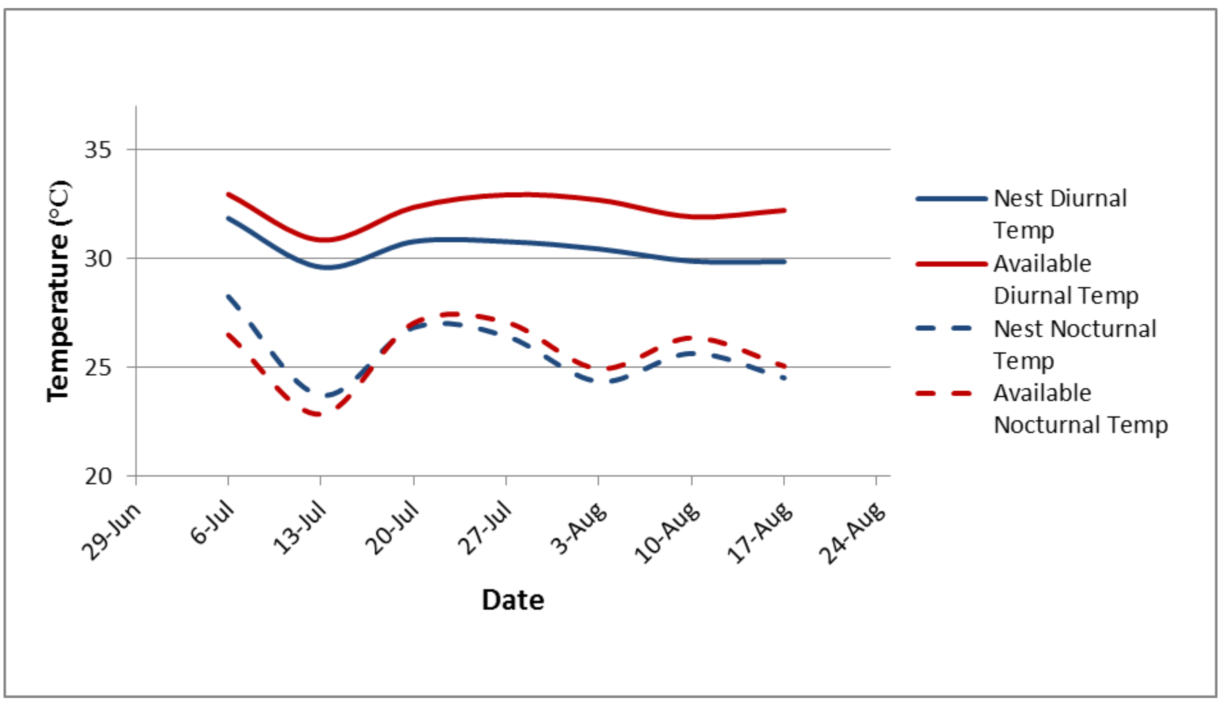



Figure 4-3. Average diurnal and nocturnal temperature (°C) at nest habitat and available habitat (within occupied sample units only) during the 2011 survey season.

Table 4-4. Nest site selection results of logistic regression mixed-effects models for diurnal and nocturnal temperature and humidity, LCR 2011. 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. Significant results are denoted with an asterisk (*).

| Microclimate Variable | Odds Ratio | Estimate | Standard Error | P-Value |
|---|---|---|---|---|
| Nest Diurnal Temperature | 0.598 | -0.515 | 0.037 | <0.001* |
| Nest Nocturnal Temperature | 1.025 | -0.025 | 0.026 | 0.338 |
| Nest Diurnal Relative Humidity | 1.046 | 0.045 | 0.007 | <0.001* |
| Nest Nocturnal Relative Humidity | 0.992 | -0.009 | 0.006 | 0.141 |

Table 4-5. Mean differences, standard deviation, and paired t-test results for microclimate at paired nest habitat versus available habitat within occupied sample units. Significant results are denoted with an asterisk (*).

| | Temperature Difference ($^{o}$C) | | Humidity Difference (%RH) | |
|---|---|---|---|---|
| Comparison | Diurnal | Nocturnal | Diurnal | Nocturnal |
| Nest habitat vs. available habitat | 1.64 ± 1.28 (N=12) $t_{11} = 4.43, P = 0.001$* | -0.12 ± 0.90 (N=12) $t_{11} = -0.45, P = 0.658$ | -5.52 ± 7.14 (N=12) $t_{11} = -2.53, P = 0.028$* | -0.31 ± 7.46 (N=12) $t_{11} = -0.15, P = 0.887$ |

## Discussion

We found no significant differences in humidity or temperature (diurnal or nocturnal) between occupied and unoccupied territories, or between natural and restoration sites. The lack of association between territory occupancy and microclimate suggests that cuckoos are not selecting breeding territories based on temperature and humidity alone. This can be inferred because our sample units are based on average territory size.

Similar to our results in 2009 and 2010, our 2011 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 lower Colorado River 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 lower Colorado River 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.

# Chapter 5. Summary of Results and Recommendations

- Through repeated standardized surveys throughout the study area, the annual status of the LCR cuckoo subpopulation can be assessed by examining spatial and temporal distribution and occupancy patterns. Analysis of annual survey datasets has enabled the identification of cuckoo responses to maturing LCR MSCP habitat restoration, such as greater occupancy of restored compared to natural habitat in 2011 (62.5% vs. 52.4%), stressing the importance of habitat restoration for cuckoo recovery in this region. We recommend five surveys conducted from mid-June to mid-August, with an additional late-August survey at confirmed breeding sites potentially impacted by dove hunting. Surveys conducted during the peak of cuckoo activity, in July on the LCR, are the most cost-effective for identifying habitat occupancy. June and August surveys are important in their ability to identify the annual variability in arrival and departure of cuckoos to and from their breeding grounds, in addition to their contribution to habitat occupancy analysis.

- Cuckoo breeding and cicada abundance are correlated in natural systems, but less is known about prey base at the restoration sites. We recommend additional research on prey communities across sites, emphasizing large arthropod species richness and abundance. Ideally these should be conducted pre- to post-breeding to assess temporal density changes over time, which may affect breeding densities, temporal nest productivity, and juvenile survivorship. Soil moisture and irrigation practices should also be examined, as our 2010 results (McNeil et al. 2011) showed cicada abundance was negatively correlated with soil moisture.

- Through intensive nest searching we have discovered large increases in breeding territories at LCR MSCP sites, and this year we witnessed nest parasitism by cuckoos for the first time in the study area, as well as high apparent nest failure of restoration nests compared to Bill Williams River nests. We recommend the continuation of long-term nest monitoring to determine possible trends in LCR breeding subpopulations, including whether lower reproductive success in restoration compared to natural sites will continue. Nest-searchers should be experienced and trained to avoid disturbance and possible nest abandonment.

- During August 13-15 2011 we discovered a farm crew of five workers had chain sawed tamarisk throughout CVCA, including around the CVCA1 N6 nest area within 5 m of the nest. The nest failed during this period. It is highly likely the adults were disturbed by the clearing and noise, leaving the nest vulnerable to depredation. The crew also cut down a previous year's nest tree (CVCA1 N1 2010). Nest trees (especially from successful nests) should be retained, as adults or fledged young may return to nest in the same tree. Contractors should also exercise caution when conducting research in these areas and should not remove any vegetation during the avian breeding season.

- Video nest monitoring can provide still-lacking information on cuckoo nesting ecology. This year through telemetry, we identified several females at or near other females' nests. Color nest video cameras (to identify bands) may help us identify the nature of these interactions. Color video cameras can also assist with prey species identification, as well as predator identification which may provide information on nest depredation, the primary cause of nest failure at restoration sites (63% of all failed nests in 2011).

- High predation rates contributed to much lower average nest productivity at restoration nests (1.25 young fledged) compared to Bill Williams River nests (2.14 young fledged). Predation may cause up to 80% of all nest failures (Nolan 1963, Nolan and Thompson 1975), and in some fragmented habitats may be sufficient to reduce the productivity of nesting birds to well below that necessary to sustain populations (Robinson et al. 1995). Although research has been conducted on avian predators at real and artificial nests at some LCR MSCP sites (Theimer et al. 2010), we recommend the continuation of video nest monitoring over a number of years, as restoration habitat changes rapidly and over time a different suite of predators may develop.

- We know cuckoos choose cooler microhabitats in which to place their nests (McNeil et al. 2011, Chapter 4). Yet we still know little about the effects of high temperatures on breeding fitness at these sites. Temperatures above 40.5° C can affect egg viability, causing malformations and death (Conway and Martin 2000). At higher temperatures, females may stay on the nest and endure a negative energy balance (in which less energy [food] is taken in than expended in metabolism, resulting in a decrease in body weight) (Vleck 1981). Cuckoos nesting in this region may be expending more energy through both increased nest attentiveness and shading of eggs and young. Measuring thermoregulation at nests may help to explain differences in breeding outcomes, and direct restoration efforts to provide less hostile environments. To determine the effect of high temperatures on reproductive behavior, we recommend data loggers to be placed in and near selected nests to measure nest and ambient temperatures (e.g. following Conway and Martin 2000), coupled with video monitoring to record nest bouts and quantify other nest temperature reduction behaviors. Additionally, ensuring that restoration sites have high humidity and areas of dense canopy (which result in decreased relative temperatures) may increase the availability of suitable nesting locations for yellow-billed cuckoos.

- Birds from three successful nests were likely still present at their breeding sites during the first week of September, and an additional three failed nests were estimated to have remained at their breeding sites until September 15-18 had their nests not failed (Chapter 2). Given the above-mentioned multiple potential threats to reproductive success at these sites (including predators, extreme temperatures, pesticides, and human disturbance), and the relatively low nest success rate at restoration sites (50% compared to 100% at Bill Williams River NWR in 2011), it is important to reduce or remove any controllable threats where possible. As previously discussed (McNeil et al. 2011), September dove hunting has unknown impacts on cuckoos at these sites; we therefore continue to recommend delaying dove hunting at confirmed breeding sites until at least mid-September.

- Over the past four years of color-banding and re-sighting banded LCR cuckoos, we have begun to gather valuable data on dispersal, including evidence of strong male natal and breeding site fidelity. It is important to continue collecting this data over a long time period and wide geographic area, to gain a better understanding of the causes and consequences of dispersal patterns, as well as to assess juvenile and adult survival, demographic trends, and the extent of connectivity among the various breeding subpopulations. To build on our current knowledge we recommend the continuation of long-term color-banding of the LCR cuckoo subpopulation, as well as other western subpopulations.

- Radio-telemetry of cuckoos over the past three seasons has revealed important behavioral information that would not be possible through other means of study. For example, we have consistently obtained mean home range estimates close to 20 ha, for both breeding and transient cuckoos, which we can now use as a basis for habitat occupancy analyses at an appropriate spatial scale of sample unit. We have also discovered high transiency among LCR cuckoos throughout the breeding season, which also improves our occupancy analyses and breeding territory estimates. Through telemetry we located five nests in 2011 that may have been missed, including all CVCA2 nests found over the past two years. We also discovered overlapping home ranges among breeding territories at CVCA and PVER, and several females visiting nests of other females. We recommend the continuation of telemetry on a subset of LCR cuckoos to build on our understanding of cuckoo ecology (e.g. effects of habitat on home range, habitat use within territories, conspecific nest parasitism) and ongoing responses to habitat restoration.

- Farrell (2006) stated evidence of possible increased inbreeding in western compared to eastern cuckoos. We will not know the extent of inbreeding in western cuckoo subpopulations until additional genetic studies are completed. Though inbreeding has been studied in domestic populations, there is a paucity of population genetic studies from natural environments (Szulkin and Sheldon 2007). We recommend the funding of genetic analysis of samples that have already been collected, as well as the continuation of DNA sampling of both adults and juveniles, to establish a pedigree and measure gene flow and inbreeding coefficients among isolated breeding sites.

- We observed a nestling with a deformed beak and another with unossified bones, both from the same nest. The causes are unknown, although numerous factors are possible, including inbreeding depression, disease, nutrient deficiencies, extreme incubation temperatures, pesticides, and other environmental contaminants. Many restoration sites are surrounded by agricultural fields, where we have observed nearby aerial applications of unknown substances. Information should be gathered on herbicides, pesticides, and fertilizers applied either on or nearby the sites to determine whether chemicals are an issue.

- We fitted eight cuckoos with geolocators at LCR MSCP sites in 2011. The return and recapture of any of these cuckoos in 2012 will provide previously unknown information on fall migration and non-breeding range within this subpopulation. Though the destruction or reduction in quality of migration and non-breeding habitat is thought to be a factor in cuckoo decline and population viability (Terborgh 1980, Wiggins 2005), little information is currently known on cuckoo migration routes, stopovers, wintering distribution or ecology, and further research is needed (Bennett and Keinath 2003, Wiggins 2005). If we are able to recover at least one geolocator we recommend funding to assess the quality and threats to non-breeding habitat identified.

# Acknowledgements

Southern Sierra Research Station wishes to thank the following organizations and individuals for their support and assistance with this project: Bob Achee (AGFD), Jack Allen (USFWS), Joseph Barnett (USFWS), Sue Barney (California State Parks), Pam Beare (CDFG), Dianne Bangle (Reclamation), Kathleen Blair (USFWS), Allen Calvert (Reclamation), Stacey Crow (Reclamation), Jim Dice (California State Parks), Christopher Dodge (Reclamation), Mitch Ellis (USFWS), Dick Gilbert (USFWS), Robin Greene (California State Parks), Gail Iglitz (Reclamation), Elaine Johnson (USFWS), Joe Kahl (Reclamation), Amy Leist (GBBO), Jerry Mulcahy (CADFG), Linda Miller (USFWS), David Martinez (Ahakhav Tribal Preserve), Mike Oldham (USFWS), Theresa Olson (Reclamation), Barbara Raulston (Reclamation), Steven Rimer (USFWS), Ashlee Rudolph (Reclamation), Todd Shoaff (BLM), Bill Singleton (Reclamation), Joe Sims (Ahakhav Tribal Preserve), Jeff Young (BLM), and Brenda Zaun (USFWS). Funding was provided by the Bureau of Reclamation under the Lower Colorado River Multi-Species Conservation Program.

We also thank our 2011 field crew and personnel of the Southern Sierra Research Station: Alicia Arcidiacono, Leif Baieri, Sinéad Borchert, Alyson Brokaw, Pam Bullard, Anna Fasoli, Claire Hanson, Angela Johnson, Alex Lamoreaux, Samantha Lantz, Jazelle Mondeau, Amanda Proudman, David Rankin, Lindsey Smith, Andrew Van Lanen, Ben Zyla, Michelle Johnson, and Mary Whitfield.

# Literature Cited


Allan, G. J., R. Bangert, T. G. Whitham, S. Ferrier, and K. Kennedy. In prep. Restoration of riparian habitat on the LCR: implications of genetic and vegetation density factors on habitat properties of the southwestern willow flycatcher. Annual report submitted September 2011 to the U.S. Bureau of Reclamation, Lower Colorado River Multi-species Program, Boulder City, NV.

Anders, A. D., and E. Post. 2006. Distribution-wide effects of climate on population densities of a declining migratory landbird. Journal of Animal Ecology 75:221-227.

Anderson, B. W., and R. D. Ohmart. 1984. Vegetation type maps: lower Colorado River. U.S. BOR, Lower Colorado Region, Boulder City, NV.

Anderson, D. J., and S. Fortner. 1988. Waved albatross egg neglect and associated mosquito ectoparasitism. The Condor 90:727-729.

Arizona Field Ornithologists (AZFO). 2011. Arizona Seasonal Reports Database Spring 2011 Website. http://azfo.org/seasonalReports/SeasonalReportSpring2011.html

Arizona Game and Fish Department (AGFD). 1988. Page 17 *in* Threatened native wildlife in Arizona.

Bangle, D. 2011. MSCP Post-development habitat monitoring field methods, 2011 monitoring season, version 3. Unpublished report, U.S. Bureau of Reclamation, lower Colorado River Multi-species Conservation Program.

Bart, J. 2011, Sampling large landscapes with small-scale stratification—User's Manual: U.S. Geological Survey Open-File Report 2011-1247.

Banks, R. C. 1988. Geographic variation in the yellow-billed cuckoo. Condor 90:473-477.

Banks, R. C. 1990. Geographic variation in the yellow-billed cuckoo: corrections and comments. Condor 92:538.

Baskett, T. S. 1992. Ecology and management of the mourning dove. Wildlife Management Institute, Stackpole Books, Harris, Pennsylvania.

Bendire, C. 1895. Life histories of North American birds. Government Printing Office, Washington D.C.

Bennett, J., and D. Keinath. 2001. Distribution and status of the yellow-billed cuckoo (*Coccyzus americanus*) in Wyoming. Report prepared by Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY.

Bennett, J., and D. A. Keinath. 2003. Species assessment for yellow-billed cuckoo (*Coccyzus americanus*) in Wyoming. Report to the Bureau of Land Management, Cheyenne Office.

Bent, A. C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds, and their allies. United States National Museum Bulletin No. 167, Washington, D.C.

Beissinger, S. R., M. I. Cook, and W. J. Arendt. 2005. The shelf life of bird eggs: testing egg viability using a tropical climate gradient. Ecology 86:2164-2175.

Beyer, H. L. 2004. Hawth's Analysis Tools for ArcGIS. Available at http://www.spatialecology.com/htools.

Bray, O. E., and G. W. Corner. 1972. A tail clip for attaching transmitters to birds. Journal of Wildlife Management 36:640-642.

British Antarctic Survey. 2010. Geolocator manual v8. http://www.birdtracker.co.uk.

Bui, T. D., J. M. Marzluff, and B. Bedrosian. 2010. Common raven activity in relation to land use in western Wyoming: implications for greater sage-grouse reproductive success. The Condor 112:65-78.

Burgman, M. A., and J. C. Fox. 2003. Bias in species range estimates from minimum convex polygons: implications for conservation and options for improved planning. Animal Conservation 6:19-28.

California Department of Fish and Game (CDFG). 1978. At the crossroads, 1978: a report on California's endangered and rare fish and wildlife. CDFG, Nongame Wildlife Investigations Report, Project E-W-2, Job IV-1.

Casey, A. E., K. L. Jones, B. K. Sandercock, and S. M. Wisely. 2009. Heteroduplex molecules cause sexing errors in a standard molecular protocol for avian sexing. Molecular Ecology Resources 9:61–65.

Champlin, T. B., J. C. Kilgo, M. L. Gumpertz, and C. E. Moorman. 2009. Avian response to microclimate in canopy gaps in a bottomland hardwood forest. Southeastern Naturalist 8:107-120.

Chapman, R. F. 1969. The world of an insect. McGraw-Hill Book Co., New York.

Chernetsov, N. 2006. Habitat selection by nocturnal passerine migrants en route: mechanisms and results. Journal of Ornithology 147:185-191.

Conway C. J., and T. E. Martin. 2000. Effects of ambient temperature on avian incubation behavior. Behavioral Ecology 11:178-188.

D'Alba, L., P. Monaghan, and R. G. Nager. 2009. Thermal benefits of nest shelter for incubating female eiders. Journal of Thermal Biology 34:93-99.

DeSante, D. F., M. P. Nott, and D. R. Kaschube. 2005. Monitoring, modeling, and management: why base avian monitoring on vital rates and how should it be done? Pages 795-804 in C. J. Ralph, and T. D. Rich, editors. Bird conservation implementation and integration in the Americas. U.S. Forest Service General Technical Report PSW-GTR-191. http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/795-804.pdf

Dettling, M. D., and C. A. Howell. 2011. Status of the yellow-billed cuckoo along the Sacramento River in 2010. Report to California Department of Fish and Game. PRBO Contribution #1794.

Fagan, W. F., and F. Lutscher. 2006. Average dispersal success: linking home range, dispersal, and metapopulation dynamics to reserve design. Ecological Applications 16:820-828.

Farrell, L. L. 2006. Subspecies status of the western yellow-billed cuckoo (Cuculidae: *Coccyzus americanus occidentalis*): using cytochrome B to elucidate the enigma. Thesis, Lakehead University, Canada.

Fleischer, R. C., M. T. Murphy, and L. E. Hunt. 1985. Clutch size increase and intraspecific brood parasitism in the yellow-billed cuckoo. Wilson Bulletin 97:125-127.

Fleischer, R. C. 2001. Taxonomic and evolutionarily significant unit (ESU) status of western yellow-billed cuckoos (*Coccyzus americanus*). Report to the USGS and USFWS.

Forsgren, E., T. Amundsen , A. A. Borg, and J. Bjelvenmark. 2004. Unusually dynamic sex roles in a fish. Nature 429:551–554.

Frampton, G. K., P. J. Van Den Brink, and P. J. L. Gould. 2000. Effects of spring drought and irrigation on farmland arthropods in southern Britain. Journal of Applied Ecology. 37:865- 883.

Franzreb, K. E., and S. A. Laymon. 1993. A reassessment of the taxonomic status of the yellow-billed cuckoo. Western Birds 24:17-28.

Gaines, D. 1974. A new look at the nesting riparian avifauna of the Sacramento Valley, California. Western Birds 5:61-80.

Gaines, D., and S. A. Laymon. 1984. Decline, status and preservation of the yellow-billed cuckoo in California. Western Birds 15:49-80.

Galli, A. E., C. F. Leck, and R. T. T. Forman. 1976. Avian distribution patterns in forest islands of different sizes in Central New Jersey. The Auk 93:356-364.

Giesy, J. P., J. P. Ludwig, and D. E. Tillitt. 1994. Deformities in birds of the Great-Lakes region: assigning causality. Environmental Science Technology 28:128-135.

Gibbons, D. W. 1986. Brood parasitism and cooperative nesting in the moorhen, *Gallinulu chloropus*. Behavioral Ecology and Sociobiology 19:221-232.

Girvetz, E. H., and S. E. Greco. 2009. Multi-scale predictive habitat suitability modeling based on hierarchically delineated patches: an example for yellow-billed cuckoos nesting in riparian forests, California, USA. Landscape Ecology 24:1315-1329.

Greenwood, P. J. 1980. Mating systems, philopatry and dispersal in birds and mammals. Animal Behaviour 28:1140-1662.

Grinnell, J. 1914. An account of the mammals and birds of the lower Colorado Valley, with special reference to the distributional problems presented. University of California Publications. Zoology 12:97-110.

Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna No. 27, Cooper Ornithological Society.

Groschupf, K. 1987. Status of the yellow-billed cuckoo (*Coccyzus americanus occidentalis*) in Arizona and west Texas. USFW Service Report: 20181-86-00731. Phoenix, AZ.

Hagenauer, L. E., K. J. Kennedy, and R. K. Bangert. *In prep*. Fremont cottonwood genetics study. Final report submitted 30 September 2011 to the U.S. Bureau of Reclamation, Lower Colorado River Multi-species Program, Boulder City, NV.

Halterman, M. D. 1991. Distribution and habitat use of the yellow-billed cuckoo (*Coccyzus americanus occidentalis*) on the Sacramento River, California, 1987-1990. Thesis, California State University, Chico, USA.

Halterman, M. D. 2009. Sexual dimorphism, detection probability, home range, and parental care in the yellow-billed cuckoo. Dissertation, University of Nevada, Reno, USA.

Halterman, M. D. 1998. Population status, site tenacity, and habitat requirement of the yellow-billed cuckoo at the Bill Williams River, Arizona - Summer 1998. Final report submitted to The Bureau of Reclamation, Lower Colorado Regional Office, Boulder City NV and U.S. Fish and Wildlife Service Bill Williams River National Wildlife Refuge, Parker, AZ.

Halterman, M. D., D. S. Gilmer, S. A. Laymon, and G. A. Falxa. 2001. Status of the yellow-billed cuckoo in California: 1999-2000. USGS-BRD-WERC Final report submitted to USFWS, USBR May 2001.

Halterman, M. D., M. J. Johnson, and J. A. Holmes. 2008. Western yellow-billed cuckoo natural history summary and survey methodology. Unpublished draft report, Southern Sierra Research Station, P. O. Box 1316, Weldon, CA 93283.

Hamilton, W. J. III, and M. E. Hamilton. 1965. Breeding characteristics of yellow-billed cuckoos in Arizona. Proceedings of the California Academy of Sciences. Fourth Series 32:405-432.

Han, J.-I., J.-H. Kim, S. Kim, S.-R. Park, and K.-J. Na. 2009. A simple and improved DNA test for avian sex determination. The Auk 126:779-783.

Hansson, B., S. Bensch, and D. Hasselquist. 2004. Lifetime fitness of short- and long-distance dispersing great reed warblers. Evolution 58:2546-2557.

Hansson, B., S. Bensch, D. Hasselquist, and B. Nelson. 2002. Restricted dispersal in a long-distance migrant bird with patchy distribution, the great reed warbler. Oecologia 130:536-542

Harding, L. E., M. Graham, and D. Paton. 2004. Accumulation of Selenium and lack of severe effects on productivity of American dippers (*Cinclus mexicanus*) and spotted sandpipers (*Actitis macularia*). Archival Environmental Contaminant Toxicology 48:3414-3423.

Hartley,M. J., and M. L. Hunter Jr. 1998. A meta-analysis of forest cover, edge effects, and artificial nest predation rates. Conservation Biology 12:465-469.

Hector, D. P. 1985. The diet of the Aplomado Falcon (*Falco femoralis*) in eastern Mexico. Condor 87:336-342.

Henneman, C. 2009. Yellow-billed cuckoo surveys in the South Fork Kern River Valley in 2008. Report to the U.S. Fish and Wildlife Service, Sacramento Office.

Henson, M. S., L. M. Weldon, J. L. Hayward, D. J. Greene, L. C. Megna, and M. C. Serem. 2011. Coping behaviour as an adaptation to stress: post-disturbance preening in colonial seabirds. Journal of Biological Dynamics 6:17-37.

Hines, J. E. 2006. PRESENCE. Software to estimate patch occupancy and related parameters. USGS-PWRC. http://www.mbr-pwrc.usgs.gov/software/presence.html.

Hoekman, S., I. Ball, and T. Fondell. 2002. Grassland birds orient nests relative to nearby vegetation. Wilson Bulletin 114:450-456.

Hoffman, D. J., and P. H. Albers. 1984. Evaluation of potential embryotoxicity and teratogenicity of 42 herbicides, insecticides, and petroleum contaminants to mallard eggs. Archives of Environmental Contaminant Toxicology 137:15-27.

Howe, W. H. 1986. Status of the yellow-billed cuckoo (*Coccyzus americanus*) in New Mexico. N. M. Department of Game and Fish Report : 516.6-75-09, Santa Fe.

Hughes, J. M. 1999. Yellow-billed cuckoo (*Coccyzus americanus*). No 148 in A. Poole and F. Gill, editors. The Birds of North America, Inc. Philadelphia, PA. USA.

Hunter, W. C., R. D. Ohmart, and B. W. Anderson. 1988. Use of exotic saltcedar (*Tamarix chinensis*) by birds in arid riparian systems. Condor 90:113-123.

Jackson ,W. M. 1993. Causes of conspecific nest parasitism in the northern masked weaver. Behavioral Ecology and Sociobiology 32:119-126.

Jay, A. 1911. Nesting of the California cuckoo in Los Angeles County, California. Condor 13:69–73.

Jetz, W., C. H. Sekercioglu, and K. Bohning-Gaese. 2008. The worldwide variation in avian clutch size across species and space. Public Library of Science Biology 6:12.

Johnsgard, P. A. 1997. The avian brood parasites: deception at the nest. Oxford University Press Inc. New York, NY.

Johnson, R. R., B. T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recordings as a special avian censusing technique. Pages 69-75 in C. J. Ralph, and J. M Scott, editors:

Estimating numbers of terrestrial birds. Studies in Avian Biology. Allen Press Inc., Lawrence, KS, USA.

Johnson, M .J., J. A. Holmes, C. Calvo, I. Samuels, S. Krantz, and M. K. Sogge. 2007. Yellow-billed cuckoo distribution, abundance, and habitat use along the lower Colorado River and tributaries, 2006 annual report. U. S. Geological Survey Open-File Report 2007-1097.

Johnson, M. J., S. L. Durst, C. M. Calvo, L. Stewart, M. K. Sogge, G. Bland, and T. Arundel. 2008. Yellow-billed cuckoo distribution, abundance, and habitat use along the lower Colorado River and its tributaries, 2007 annual report. U.S. Geological Survey Open-File Report 2008-1177.

Kelly, J. F., and W. J. Ash. 1976. Abnormal feathers of the micromelic syndrome in white pekin ducks. Journal of Heredity 1:63-4.

Kendra, P. E., R. R. Roth, and D. W. Tallamy. 1988. Conspecific brood parasitism in the house sparrow. Wilson Bulletin 100:80-90.

King, K. A., D. R. Blankinship, and R. T. Paul. 1977. Ticks as a factor in the 1975 nesting failure of Texas brown pelicans. Wilson Bulletin 89:157-158.

Kirchner, T. B. 1977. The effects of resource enrichment on the diversity of plants and arthropods in a short grass prairie. Ecology 58:1334-1344.

Kuiken, T., G. A. Fox, and K. L. Danesik. 1999. Bill malformations in double-crested cormorants with low exposure to organochlorines. Environmental Toxicology and Chemistry 18:2908-2913.

LaRoe, E. T., G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac. 1995. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department Interior, National Biological Service, Washington, D.C.

Lack, D. L. 1947. The significance of clutch size, Parts 1 and 2. Ibis 89:302-352.

Laver, P. N., and M. J. Kelly. 2008. A critical review of home range studies. Journal of Wildlife Management 72:290-298.

Laymon, S. A. 1980. Feeding and nesting behavior of the yellow-billed cuckoo in the Sacramento Valley. California Department of Fish and Game, Wildlife Management Branch, Sacramento, CA. Administrative Report 80-2.

Laymon, S. A. 1998. Yellow-billed cuckoo (*Coccycus americanus*) in The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight.

Laymon, S. A., and M. D. Halterman. 1985. Yellow-billed cuckoos in the Kern River Valley: 1985 population, habitat use, and management recommendations. Report to the Nature Conservancy. Sacramento, CA.

Laymon, S. A., and M. D. Halterman. 1987. Can the western subspecies of the yellow-billed cuckoo be saved from extinction? Western Birds 18:19-25.

Laymon, S. A., and M. D. Halterman. 1989. A proposed habitat management plan for yellow-billed cuckoos in California. USDA Forest Service General Technical Report PSW-110:272-277.

Laymon, S. A., P. L. Williams, and M. D. Halterman. 1997. Breeding status of the yellow-billed cuckoo in the South Fork Kern River Valley, Kern County, California: Summary report 1985-1996. Prepared for USDA Forest Service, Sequoia National Forest, Cannell Meadow Ranger District.

Lower Colorado River Multi-Species Conservation Program. 2004a. Lower Colorado River Multi-Species Conservation Program, Volume II: Habitat Conservation Plan. Final December 17 (J&S 00450.00.). Sacramento California.

Lower Colorado River Multi-Species Conservation Program. 2004b. Lower Colorado River Multi-Species Conservation Program, Volume III: Biological Assessment. Final December 17. (J&S 00450.00.), Sacramento, CA.

Lower Colorado River Multi-Species Conservation Program. 2006a. Beal Riparian and Marsh Restoration 2006 Annual Report, August 2008. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV.

Lower Colorado River Multi-Species Conservation Program. 2006b. Palo Verde Ecological Reserve Restoration Development Plan: Phase 2, December 2006. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier, San Diego, USA.

Martín, C. A., J. C. Alonso, J. A. Alonso, C. Palacín, M. Magaña, and B. Martín. 2008. Natal dispersal in great bustards: the effect of sex, local population size and spatial isolation. Journal of Animal Ecology 77:326–334.

Martin, J., J. D. Nichols, W. M. Kitchens, and J. E. Hines. 2006. Multiscale patterns of movement in fragmented landscapes and consequences on demography of the snail kite in Florida. Journal of Animal Ecology 75:527-539.

Martin, T. E., and G. R. Geupel. 1993. Nest-monitoring plots: methods for locating nests and monitoring success. Journal of Field Ornithology 64:507-519.

McLeod, M. A., T. J. Koronkiewicz, B. T. Brown, W. J. Langeberg, and S. W. Carothers. 2008. Southwestern willow flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2003–2007. Five-year summary report submitted to Bureau of Reclamation, Boulder City, NV by SWCA Environmental Consultants, Flagstaff, AZ.

McNeil, S. E., M. D. Halterman, E. T. Rose, and D. Tracy. 2010. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2009. Annual report to the U.S. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV, by Southern Sierra Research Station. www.lcrmscp.gov/reports/2009/d7_rep_09.pdf

McNeil, S. E., D. Tracy, J. R. Stanek, J. E. Stanek, and M. D. Halterman. 2011. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2010. Annual report to the U.S. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV, by SSRS. www.lcrmscp.gov/reports/2010/d7_rep_10.pdf

Mearns, E. A. 1907. Mammals of the Mexican boundary of the United States: a descriptive catalogue of the species of mammals occurring in that region; with a general summary of the natural history, and a list of trees. U.S. National Museum Bulletin No. 56.

Merila, J., and D. A. Wiggins. 1997. Mass loss in breeding blue tits: the role of energetic stress. Journal of Animal Ecology 66:452-460.

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. American Midland Naturalist 37:223-249.

Nolan, V. N .Jr, and C. F. Thompson. 1975. The occurrence and significance of anomalous reproductive activities in two North American non-parasitic cuckoos *Coccyzus* spp. Ibis 117:496–503.

Nolan, V. N. 1963. Reproductive success of birds in deciduous scrub habitat. Ecology 44:305-313.

Ohmart, R. D., B. W. Anderson, and W. C. Hunter. 1988. The ecology of the lower Colorado River from Davis Dam to the Mexico-United States international boundary: a community profile. United States Fish and Wildlife Service Biological Report 85:1–296.

Ortego, J. O., J. M. Aparicio, P. J. Cordero, and G. Calabuig. 2008. Individual genetic diversity correlates with the size and spatial isolation of natal colonies in a bird metapopulation. Proceedings of the Royal Society 275:2039-2047.

Ott, R. L., and M. Longnecker. 2001. An introduction to statistical methods and data analysis, Fifth Edition. Wadsworth Group, Pacific Groove, CA, USA.

Paradis, E., S. R. Baillie, W. J. Sutherland, and R. D. Gregory. 1998. Patterns of natal and breeding dispersal in birds. Journal of Animal Ecology 67:518-536.

Parker, G. A. 2005. Sexual conflict over mating and fertilization: an overview. Philosophical Transactions Royal Society 361:235-250.

Parker, T. H., B. M. Stansberry, C. D. Becker, and P. S. Gipson. 2005. Edge and area effects on the occurrence of migrant forest songbirds. Conservation Biology 19:1157-1167.

Payne, R. B. 2005. The cuckoos. Oxford University Press. Oxford, UK.

Peer, B. D. 2006. Egg destruction and egg removal by avian brood parasites: adaptiveness and consequences. The Auk 123:16-22.

Perrins, C. M. 1970. The timing of birds' breeding seasons. Ibis 112:242–255.

Picman, J. , P. Stanislav, and A. K. Picman. 1996. The effect of intraspecific egg destruction on the strength of marsh wren eggs. The Auk 113:599-607.

Pitts, T. D. 1995. A tail-mounted radio transmitter for eastern bluebirds. North American Bird Bander 20:106-110.

Pogany, A., I. Szrentirmai, J. Komdeur, and T. Szekely. 2008. Sexual conflict and consistency of offspring desertion in Eurasian pendulie tit (*Remiz pendulinus*). Evolutionary Biology 8:42.

Potter, E. F. 1980. Notes on nesting yellow-billed cuckoos. Journal of Field Ornithology 51:17-28.

Potter, E. F. 1981. Effects of cool weather on nesting behavior and development in the yellow-billed cuckoo. Chat 45:15-16.

Pruett, C. L., D. D. Gibson, and K. Winker. 2001. Molecular 'cuckoo clock' suggests listing of western yellow-billed cuckoos may be warranted. Wilson Bulletin 113:228-231.

R Development Core Team. 2010. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Rappole, J. H., and A. R. Tipton. 1991. New harness designs for attachment of radio transmitters to small passerines. Journal of Field Ornithology 62:335-337.

Rich, T. D. 2002. Using breeding land birds in the assessment of western riparian systems. Wildlife Society Bulletin 30:1128-1139.

Rhodes, B., C. O'Donnell, and I. Jamieson. 2009. Microclimate of natural cavity nests and its implications for a threatened secondary-cavity-nesting passerine of New Zealand, the South Island saddleback. Condor 111:462-469.

Ridgeway, R. 1887. A manual of North American birds. Lippincott, Philadelphia.

Robertson, B. A. 2009. Nest site selection in a postfire landscape: do parents make tradeoffs between microclimate and predation risk? The Auk 126:500-510.

Robertson, B. C., and N. J. Gemmell. 2006. PCR-based sexing in conservation biology: Wrong answers from an accurate methodology? Conservation Genetics 7:267-271.

Robinson, S. K., F. R., Thompson III, T. M. Donovan, D. R Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of birds. Science 267:1987-1990.

Rohwer, F, C., and S. Freeman. 1989. The distribution of conspecific nest parasitism in birds. Canadian Journal of Zoology 67:239-253.

Rosenberg, K. V., R. D. Ohmart, and B. W. Anderson. 1982. Community organization of riparian breeding birds: response to an annual resource peak. The Auk 99:260-274.

Saltz, D. 1994. Reporting error measures in radio location by triangulation: a review. Journal of Wildlife Management 58:181-184.

Sandell, M. J., and M. Diemer. 1999. Intraspecific brood parasitism: a strategy for floating females in the European starling. Animal Behavior 57:187-202.

Sealy, S. G. 1992. Removal of yellow warbler eggs in association with cowbird parasitism. The Condor 94:40-54.

Sechrist, J., V. Johanson, and D. Ahlers. 2009. Western yellow-billed cuckoo radio telemetry study results, Middle Rio Grande, New Mexico 2007-2008. U.S.D.I. Bureau of Reclamation, Technical Services Center, Fisheries and Wildlife Resources Group, Denver, Colorado.

Seaman, D. E., and R. A. Powell. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. Ecology 77:2075-2085.

Silverman, B. W. 1986. Density estimation for statistics and data analysis. Chapman and Hall, London, UK.

Sogge, M. K., J. C. Owen, E. H. Paxton, S. M. Landgridge, and T. J. Koronkiewicz. 2001. A targeted mist net capture technique for the willow flycatcher. Western Birds 32:167-172.

Springer, J. T. 1979. Some sources of bias and sampling error in radio triangulation. Journal of Wildlife Management 43:926-935.

Stromberg, J. C. 2001. Restoration of riparian vegetation in the south-western United States: importance of flow regimes and fluvial dynamism. Journal of Arid Environments 49:17-34.

Székely T., J. N. Webb, A. I. Houston, and J. M. McNamara. 1996. An evolutionary approach to offspring desertion in birds. In: Nolan V Jr, Ketterson ED, editor. Current Ornithology 13:271–330. New York, Plenum Press.

Szulkin, M., and B. C. Sheldon. 2007. The environmental dependence of inbreeding depression in a wild bird population. Public Library of Science Biology 10:1027.

Terborgh, J. W. 1980. The conservation status of neotropical migrants: present and future. *In* Keast, A., and E. S. Morton (editors). Neotropics: ecology, behavior, distribution, and conservation. Smithsonian Institute Press, 1980, Washington, DC.

Theimer, T., M. A. McLeod, and T. Koronkiewicz. 2010. Real and artificial nest predation along the lower Colorado River, 2008-2009. Lower Colorado Multispecies Conservation Program.

U.S.D.A. Forest Service Region 3. 1988. Regional Forester's sensitive species list.

U.S. Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the yellow-billed cuckoo (*Coccyzus americanus*) in the western continental United States. Federal Register 66:38611-38626.

U.S. Fish and Wildlife Service. 2002. Yellow-billed cuckoo candidate listing on Endangered Species List. Federal Register 67:40657-40679.

U.S. Fish and Wildlife Service. 2011. Yellow-billed cuckoo candidate listing on Endangered Species List. Federal Register 76:66370-66439.

Van Noordwijk, A. J. 1984. Problems in the analysis of dispersal and a critique on its `heritability' in the great tit. Journal of Animal Ecology 53:533-544.

Visser, M. E., and C. Both. 2005. Shifts in phenology due to global climate change: the need for a yardstick. Proceedings: Biological Sciences 272:2561-2569.

Vleck, C. M. 1981. Energetic cost of incubation in the zebra finch (*Poephila guttata*). Condor 83:229-237.

Wachob, D. 1996. The effect of thermal microclimate on foraging site selection by wintering mountain chickadees. Condor 98:114-122.

Walsberg, G. E. 1986. Thermal consequences of roost-site selection: the relative importance of three modes of heat conservation. The Auk 103:1-7.

Weatherhead, P. J., and G. Blouin-Demers. 2004. Understanding avian predation: why ornithologists should study snakes. Journal of Avian Biology 35:185-190.

Weatherhead, P. J., and M. R Forbes. 1994. Natal philopatry in passerine Bird: genetic or ecological influences? Behavioral Ecology 5:426-433.

Webb, D. R. 1987. Thermal tolerance of avian embryos: a review. Condor 89:874-898.

Weisenborn, W. D., and G. F. Pratt. 2008. Selection of *Atriplex lentiformis* host plants by *Hesperopsis gracielae* (Lepidoptera: Hesperiidae). Florida Entomologist 91:192-197.

Whitfield, M. J., and J. R. Stanek. 2011. Yellow-billed cuckoo surveys in the South Fork Kern River Valley in 2010. Report to the US Fish and Wildlife Service, Sacramento Office.

Wiggins, D. A. 2005. Yellow-billed cuckoo (*Coccyzus americanus*): a technical conservation assessment. Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project.

Wiggins, D. A., T. Pirt, and L. Gustafsson. 1994. Correlates of clutch desertion by female collared flycatchers (*Ficedulaa lbicollis*). Journal of Avian Biology 25:93-97.

Williams, B. K., J. D. Nichols, and M. J. Conroy. 2002 . Analysis and management of animal populations: modeling, estimation, and decision making, Academic Press, San Diego.

Williams, J. B. 1996. Energetics of avian incubation. Pages 375-416 *in* C. Carey (editor). Avian energetic and nutritional ecology. Chapman Hall, New York.

Wilson, A., R. Fuller, C. Day, and G. Smith. 2005. Nightingales (*Luscinia megarhynchos*) in scrub habitats in the southern fens of East Anglia, England: associations with soil type and vegetation structure. Ibis 147:498-511.

Woolnough, A. P., W. E. Kirkpatrick, T. J. Lowe, and K. Rose. 2004. Comparison of three techniques for the attachment of radio transmitters to European starlings. Journal of Field Ornithology 75:330-336.

Worton, B. J. 1995. A convex hull-based estimator of home-range size. Biometrics 51:1206-1215.

Yoder, J. M., E. A. Marschall, and D. A. Swanson. 2004. The cost of dispersal: predation as a function of movement and site familiarity in ruffed grouse. Behavioral Ecology 15:469-476.

Yom-Tov, Y. 1980. Intraspecific nest parasitism in birds. Biological Reviews 55:93-108.

# Appendix A. Site Descriptions.

Sites are described beginning at the northern portion of the LCR MSCP covered area and appear in alphabetical order within each geographic area.

## Havasu National Wildlife Refuge

### Mohave County, AZ (Colorado River Drainage)

Havasu NWR was established in 1941 and encompasses over 30 river miles of the Colorado River and adjacent land from Needles, CA to Lake Havasu City, AZ. 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. Five sites were surveyed here in 2011 (Map d); four are restoration sites. Two sites are on the north end of the marsh, separated by 350 m (Pintail Slough, North Dike). The rest are 5-7 km southwest, between the main channel of the Colorado River and Topock Marsh (Topock Platform, Glory Hole, Beal).

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

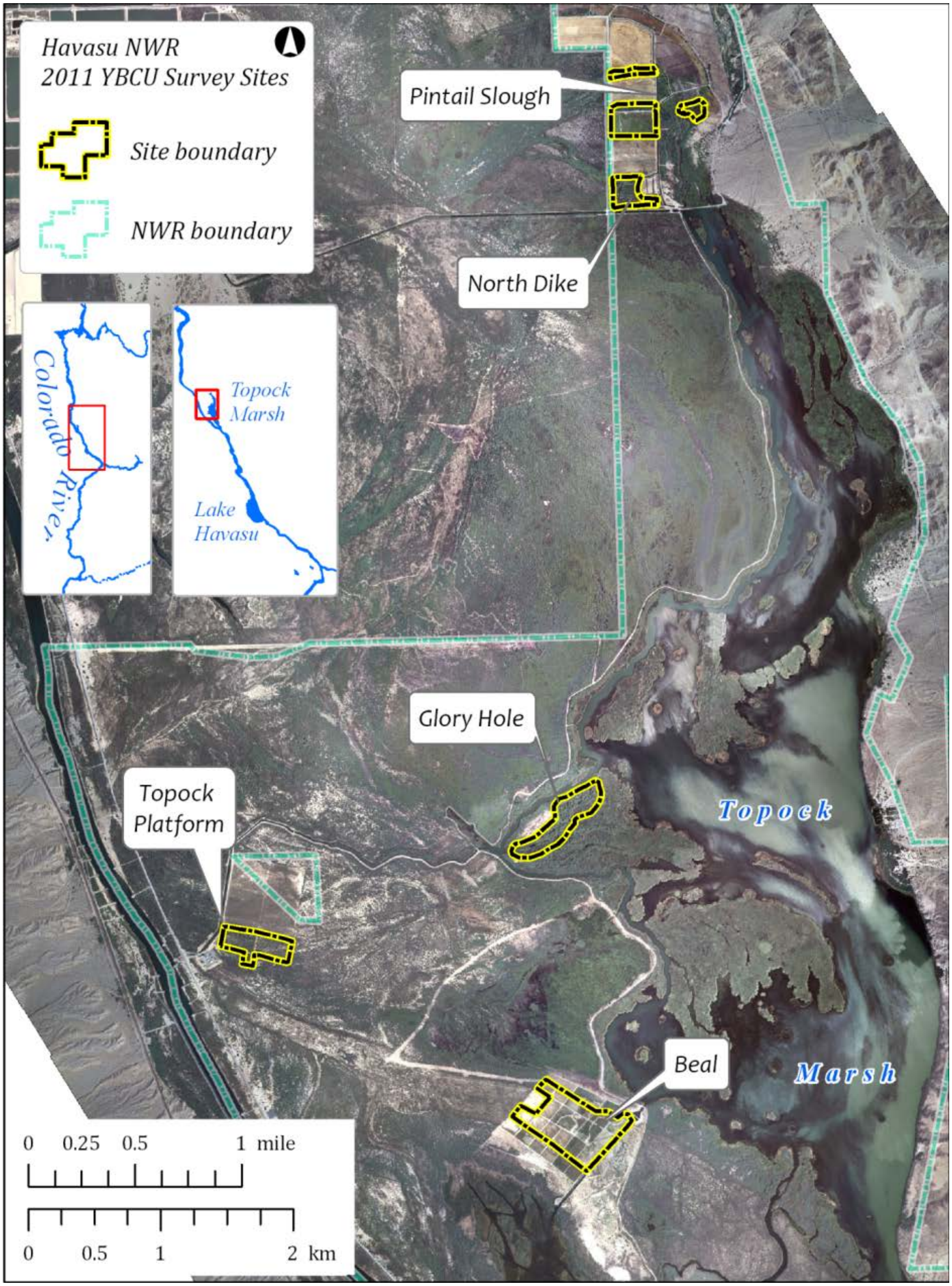
Beal lies approximately 3 km south of Topock Platform, between Beal Lake and Topock Marsh. The site consists of a mosaic of native trees planted in the historic floodplain of the Colorado River. Approximately 21.3 ha of the 43.4 ha planted from 2003 to 2005 as part of Phases 1 and 2 (LCR MSCP 2006a) were surveyed for cuckoos in 2011. 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, screwbean mesquite and coyote willow. 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. We had 7 detections during surveys in 2011 (Table 1-7, Map e) and one confirmed breeding pair (nest).

#### Glory Hole (HAVGH) Elevation 139 m; 13.2 ha

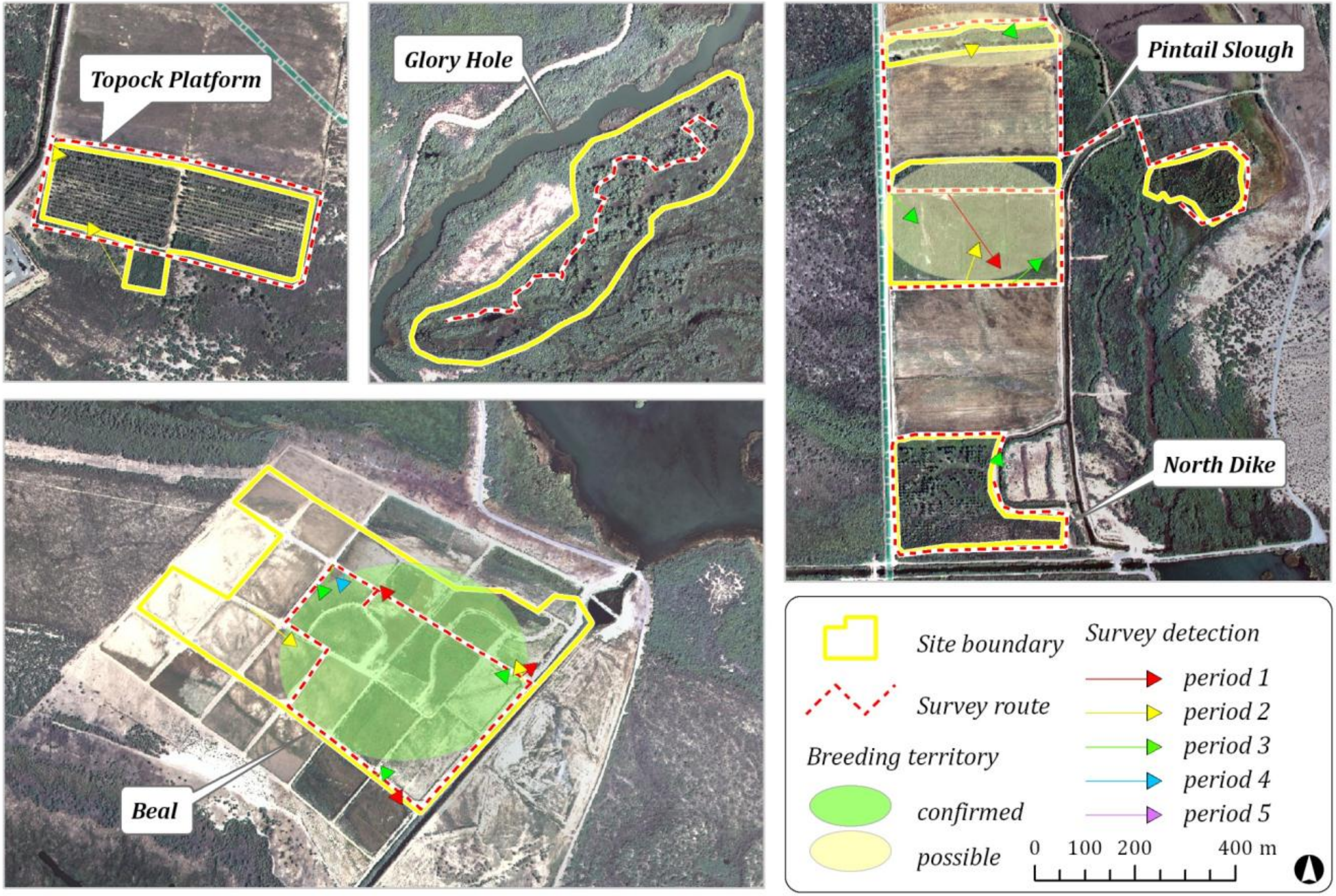
This mixed native site is on an island bounded by channels along the eastern shore of Topock Marsh. Suitable cuckoo habitat includes a mosaic of willow and tamarisk patches interspersed with marsh vegetation. The overstory covers less than 10% of the site while the understory is dominated by dense tamarisk. No cuckoos were detected during surveys in 2011 (Table 1-7, Map e).

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

This 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 floodplain dominated by mesquite and tamarisk. There was hunting activity here late in the field season. We had one cuckoo detection in 2011 (Table 1-7, Map e).




Map d. Havasu National Wildlife Refuge yellow-billed cuckoo survey sites, 2011.




Map e. Havasu National Wildlife Refuge YBCU survey detections and estimated breeding territories, 2011.

### Pintail Slough (HAVPS) Elevation 140 m; 11.7 ha

This site consists of a narrow stand of mature cottonwoods (50-60 cm DBH) 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 (*Tamarix ramosissima*), arrowweed (*Pluchea sericea*) and quailbush (*Atriplex lentiformis*). The southeast habitat is dominated by cottonwoods (*Populus fremontii*) which established naturally following flooding of nearby wintering waterfowl habitat (Jack Allen, Refuge biologist, pers. comm.). The southern planted field has a sparse overstory of cottonwoods and a dense ground cover of Johnson grass (*Sorghum halapense*). A system of access roads intersects the site. Water was present at the site intermittently through the season. A total of five cuckoo detections were made at this site from mid-June to mid-July in 2011 (Table 1-7, Map e). One adult cuckoo was captured and banded at this site. No nesting activity or breeding behaviors were observed.

### Topock Platform (HAVTPR) Elevation 141 m; 9.3 ha

The Topock Platform site includes 8.8 ha (21.7 ac) 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 this 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. This area was planted as a nursery site for other restoration efforts. The understory is open, with about 20% cover of 1-5 m-high screwbean mesquite (*Prosopis pubescens*), 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. In 2011, a single cuckoo was detected at the site, in early July (Table 1-7, Map e).

## Bill Williams River National Wildlife Refuge

### Mohave and Yuma Counties, AZ (Bill Williams River Drainage)

Bill Williams River NWR was established in 1941 and is located 14.3 km south of Lake Havasu City, AZ. It consists of 2,430 ha (6,000 ac) 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 currently contains the most extensive and productive yellow-billed cuckoo habitat in the LCR watershed. Portions of the Bill Williams River have 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 regeneration of large areas of riparian habitat. The habitat composition and structure in the western portion of the Refuge is significantly different from that found upstream of Gibraltar Rock in the eastern portion. East of Gibraltar Rock, shallow underground bedrock and cliffs bordering the riparian area create hydrologic conditions different from that west of Gibraltar Rock where the river channel widens into a sandy, broad and deep floodplain which persists to the western edge of the Refuge at its interface with Lake Havasu. Sixteen survey sites within the BWR NWR, covering over 700 ha (1680 ac) of potential cuckoo habitat were surveyed in 2011 (Map f).

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

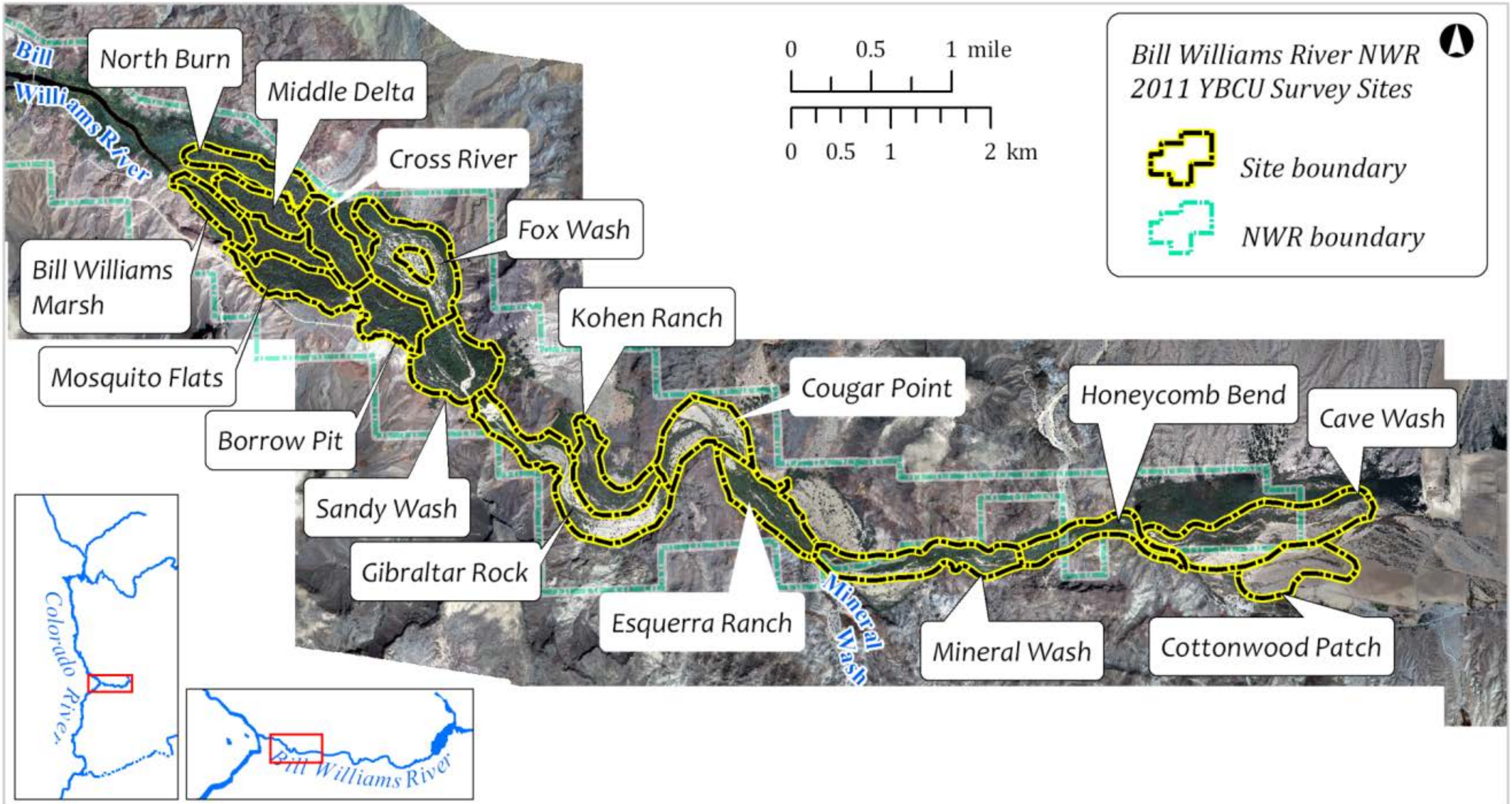
This route is surveyed by kayak, and provides access to habitat within the broad western floodplain. The route follows the main channel of the Bill Williams River, which floods seasonally from upstream waters, and is periodically inundated by fluctuating lake levels. The riparian habitat consists of 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 into one in 2010. Five cuckoo detections were made at this site in 2011, but no breeding activity was suspected at this site because most of the detections were attributed to an adjacent Mosquito Flats territory (Table 1-8, Map g).

**Borrow Pit (BWBP) Elevation 140 m; 33.6 ha**

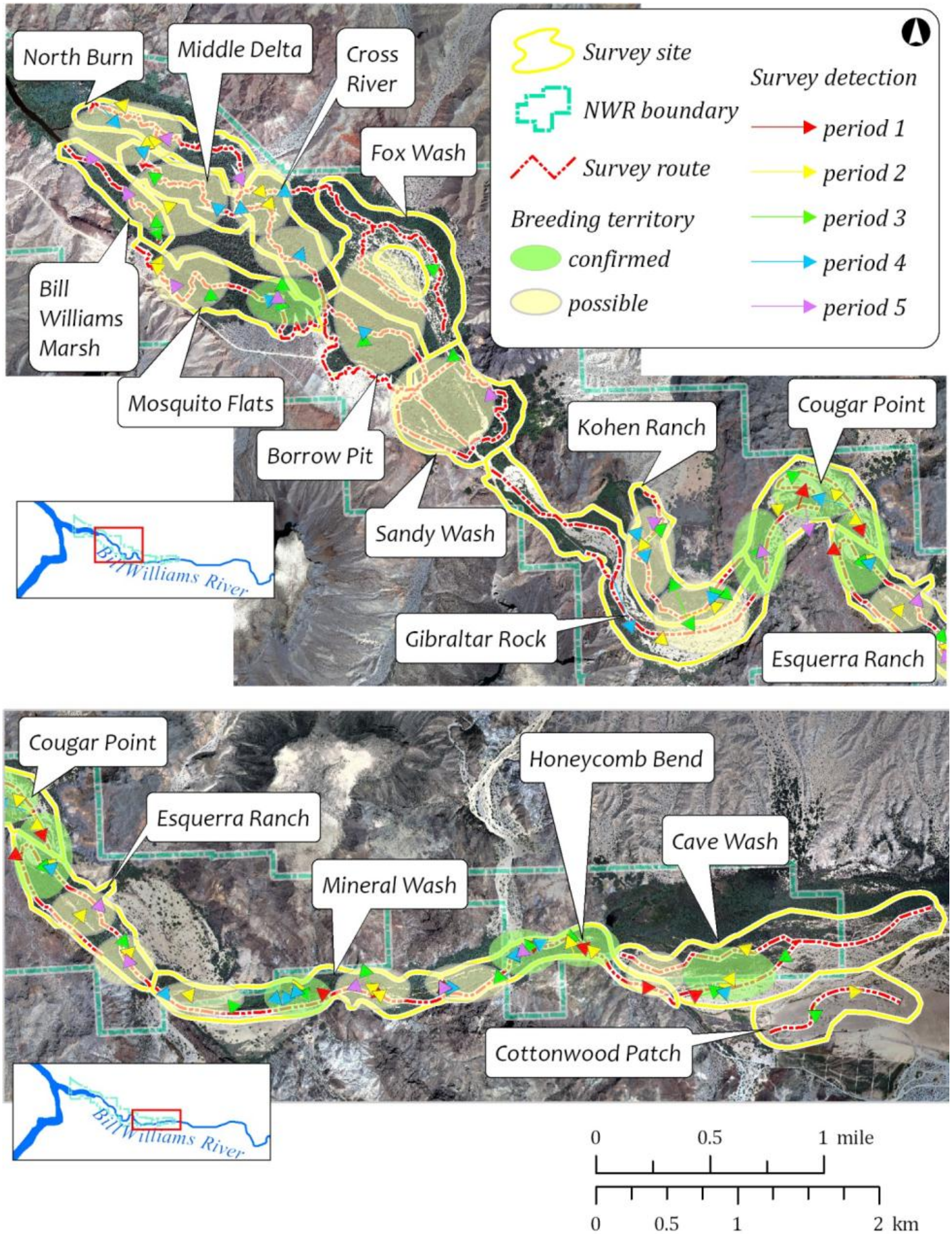
This route was created in 2009 and follows a trail along an old river channel paralleling the west end access road, and incorporates part of the former Mosquito Flats route. The survey is conducted from an old river channel and bluffs overlooking the habitat. It connects Cross River to the west and Sandy 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 two survey detections in 2011, representing one possible breeding territory (Table 1-8, Map g).

**Cave Wash (BWCW) Elevation 175 m; 88.1 ha**

This site is in the floodplain of the Bill Williams River at the eastern edge of the Refuge. The surveyed areas include Refuge lands and portions of Planet Ranch. This section of the Refuge consists of a broad riparian area with both historic and recently formed river channels. 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. In 2011 the western half of the site was dry while the eastern half held water in the main channel. The main channel is lined with young cottonwood, willow, and tamarisk averaging 8 m high, surrounding dense marsh vegetation. The survey route follows two river channels, one dry and one wet. There were 7 survey detections in 2011, and one confirmed breeding pair (Table 1-8, Map g).




Map f. Bill Williams River National Wildlife Refuge yellow-billed cuckoo survey sites, 2011.




Map g. Bill Williams River National Wildlife Refuge YBCU survey detections and estimated breeding territories, 2011.

**Cottonwood Patch (BWCP)** **Elevation 180 m; 38.1 ha**

This site is in the floodplain of the Bill Williams River at the eastern end of the Refuge, adjacent to Planet Ranch and currently owned and managed by the City of Scottsdale, AZ. The site is dominated by dense patches of cottonwoods established following flooding in 2005, surrounded by large open areas. Ground cover is predominantly Bermuda grass. The survey route winds through the widest parts of the habitat. The soil is sandy gravel, with intermittent water flow through river meanders. The upland side is composed of old agricultural fields, and the route is separated from the main stream bed of the Bill Williams River by a 200-400-m open sandy wash with scattered tall cottonwoods. There was only one survey detection here in 2011 (Table 1-8, Map g).

**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, composed of cottonwoods, willows, and a dense understory of tamarisk and arrowweed. Several meanders contain perennial water. There were 10 survey detections in 2011, and two confirmed breeding pairs (Table 1-8, Map g).

**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 from Lake Havasu. It connects Borrow Pit to the south and North Burn to the north. This site is primarily composed of extensive 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. There are multiple old meandering river channels within the site. This site is bordered both upstream and downstream by contiguous riparian habitat. There were five survey detections in 2011, representing two possible breeding territories (Table 1-8, Map g).

**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 Mineral Wash and Cougar Point routes. The Esquerra Ranch route name 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), 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 was nine survey detections in 2011, representing two possible and one confirmed breeding territory (Table 1-8, Map g).

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

This route lies north of Sandy Wash, along the main channel of the Bill Williams River, and ends in a wide floodplain 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 was one survey detection in 2011 and no evidence of breeding activity (Table 1-8, Map g).

**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 the 2011 field season, 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 discontinued western portion of the route traverses along the old refuge road under the 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. This site experiences winter flooding. Recreational use (hiking) is present but light. There were three survey detections in 2011 and no suspected breeding activity (Table 1-8, Map g).

**Honeycomb Bend (BWHB)** **Elevation 170 m; 29.6 ha**

This route follows 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. There were 13 survey detections in 2011, representing one probable and three confirmed breeding territories (Table 1-8, Map g).

**Kohen Ranch (BWKR)** **Elevation 145 m; 37.1 ha**

This site covers areas of natural regeneration which occurred following prolonged flooding during 2005-2006. The route begins at the historic Kohen Ranch and heads northeast following the northern edge of the riparian and paralleling the Gibraltar Rock route. 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 FWS 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. There were eleven survey detections here in 2011, representing two probable breeding pair (Table 1-8, Map g).

**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 from the Bill Williams River delta between the Bill Williams Marsh and North Burn sites. It connects to Cross River and North Burn. 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 this season, the western end of the site is bordered by two forks of the Bill Williams River delta. There were five survey detections in 2011, with one possible breeding pair (Table 1-8, Map g).

**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 and then an open floodplain. The river is lined with bands of tall dense willows, large cottonwoods, and an understory of willows, tamarisk, arrowweed, mesquite, and marsh vegetation. The route is bordered by old agricultural fields. The surrounding Sonoran Desert vegetation includes saguaros and creosote bush. Perennial water flows through the site, while 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. There were 19 survey detections in 2011, representing one confirmed and two possible breeding territories (Table 1-8, Map g).

**Mosquito Flats (BWMF) — Elevation 140 m; 37.1 ha**

This route was significantly modified in 2010. The eastern section which is surveyed from bluffs overlooking the riparian habitat, skirting along the edge of the riparian 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 floodplain. 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 2011. There is light visitor use in the summer, and some vehicle traffic on the main road to the south. Although there was no standing water on vegetation plots, the water table appears to be high here, and there were several standing ponds and water-filled side channels on or near the route. There were nine survey detections in 2011, representing one possible and on confirmed breeding territory (Table 1-8, Map g).

**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 willow/cottonwood overstory. The western two thirds of the site are dominated by tamarisk. The area burned in 2005, and is regenerating with tamarisk and quailbush. The site is surrounded by tamarisk-dominated floodplain and Sonoran Desert upland habitat to the north and east. The area to the south and west has more native-dominated habitat extending up the river. Standing water was observed until the middle of the breeding season. There were five survey detections in 2011, representing one possible breeding territory (Table 1-8, Map g).

**Sandy Wash (BWSW)** **Elevation 145 m; 50.9 ha**

This route connects with Gibraltar Rock to the southeast and Fox Wash to the northwest. This section of the Refuge gradually widens into a floodplain laced with dry river channels. The route makes a loop around the eastern end of the broad floodplain, 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 two survey detections in 2011, representing one possible breeding territory (Table 1-8, Map g).

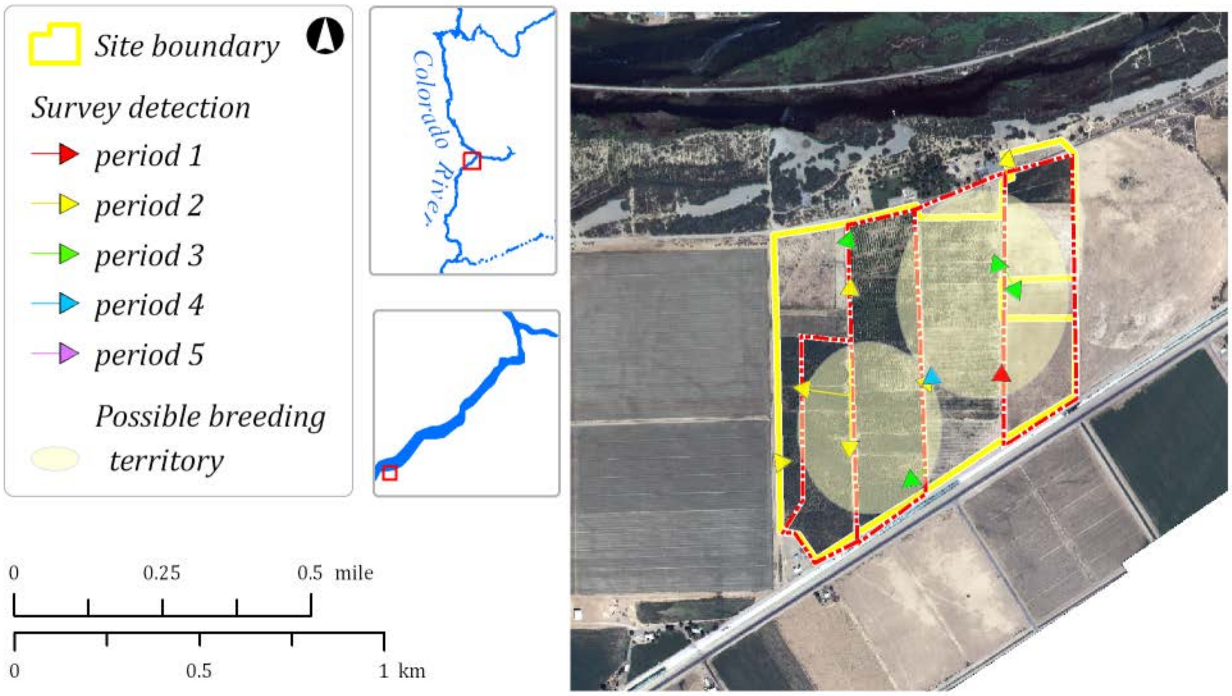
## Ahakhav Tribal Preserve

### Colorado River Indian Tribal Lands, AZ.

Ahakhav Tribal Preserve lies along the Colorado River approximately 3.5 km southwest of Parker, AZ. 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 ac) 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 multilayer 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 visits. The survey route follows roads around the perimeter and interior of the site. There were ten survey detections in 2011, representing two possible breeding territories (Table 1-9, Map h).

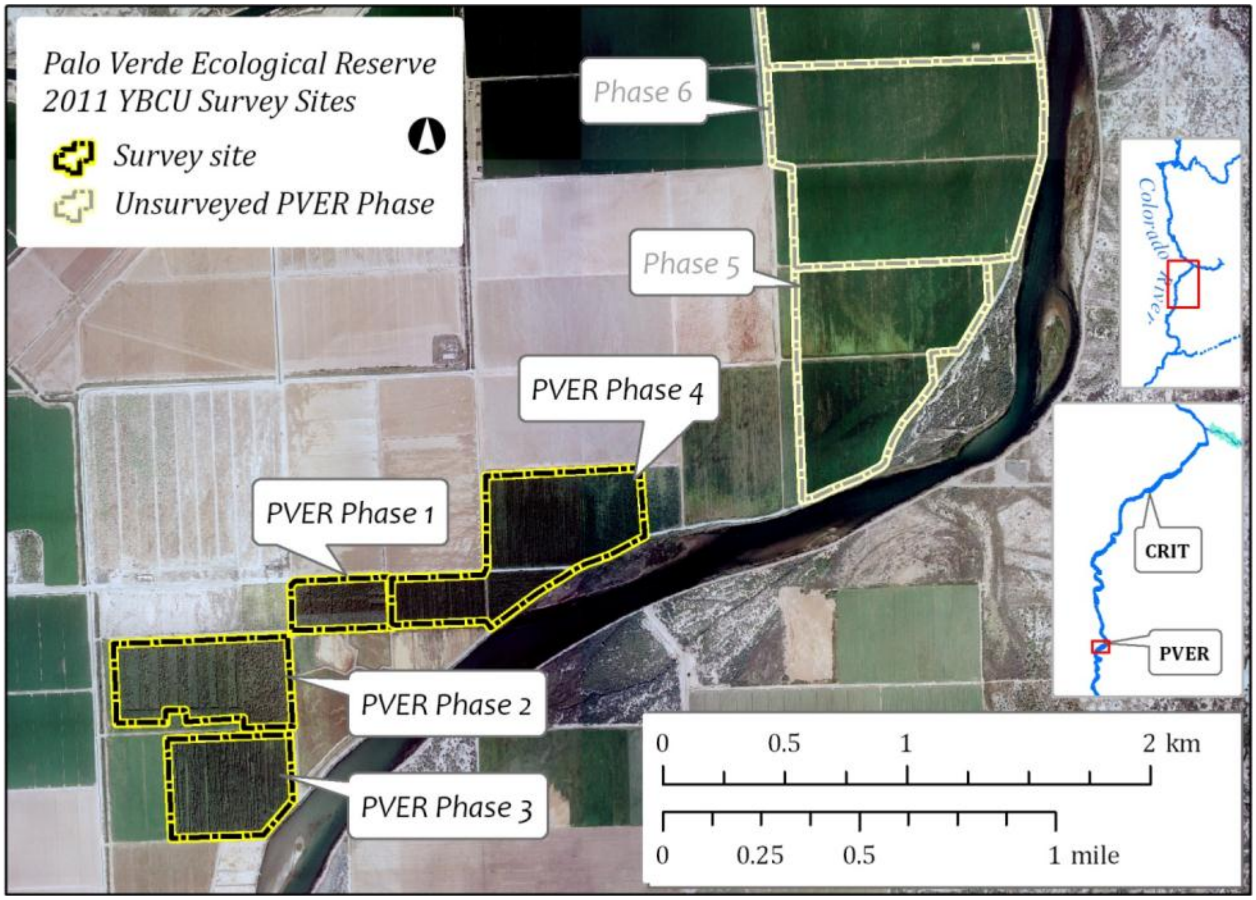



Map h. Ahakhav Tribal Preserve yellow-billed cuckoo survey detections and possible territories, 2011.

## Palo Verde Ecological Reserve

### Riverside County, CA

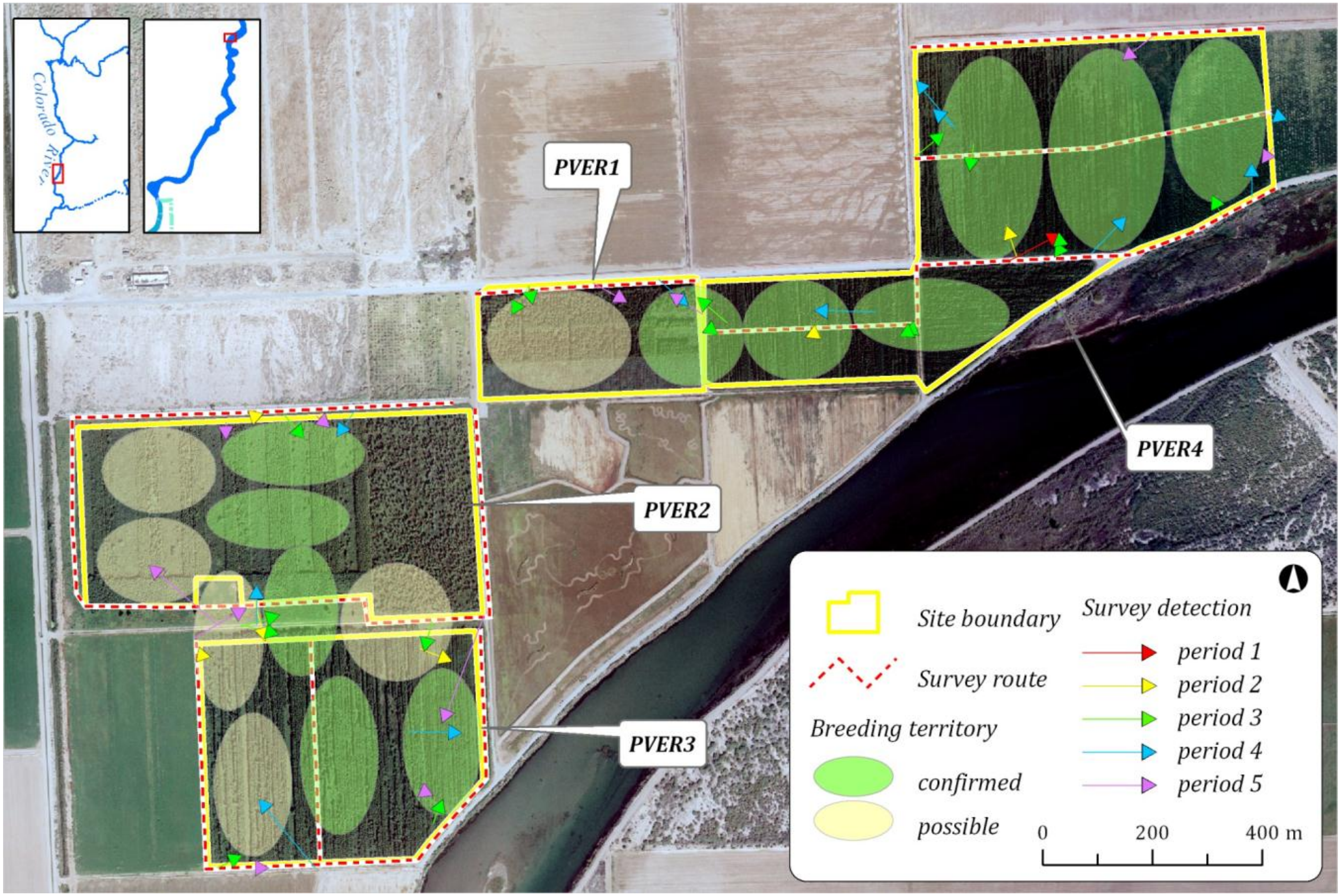
Palo Verde Ecological Reserve (PVER) is located 12 km north of Blythe, CA. The 547 ha (1351 ac) site was acquired by the State of California in 2004. Riparian restoration activities are being implemented by Reclamation, with public use and hunting managed by the California Department of Fish and Game (CDFG). 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. In 2010, Phases 1, 2, and 3 were fully surveyed, while Phase 4 received late-season surveys due to observed cuckoo activity. Phases 1-4 were fully surveyed in 2011 (Map i).




Map i. Palo Verde Ecological Reserve yellow-billed cuckoo survey sites, 2011.

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

PVER Phase 1 was planted in 2006. In 2011 the cottonwood and willow overstory was 3-15 m tall, with high canopy cover. Groundcover is predominantly alfalfa. The site is bordered by dirt access roads used to conduct the surveys. Agricultural fields border the site to the north and east. There were five survey detections at this site in 2011, and breeding behavior was observed (Table 1-9, Map j).




Map j. Palo Verde Ecological Reserve YBCU survey detections and estimated breeding territories, 2011.

**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 to 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). A Northern Arizona University research area to the east is less densely planted with a variety of genetic plant material (Allan et al. *in prep,* Hagenauer et al. *in prep*). There were ten survey detections in 2011, three confirmed breeding pairs (3 nests) and an additional two possible breeding pairs (Table 1-9).

**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 fully surveyed for cuckoos in 2009. Tree heights range from 4 to 14 m and canopy cover is high. There were ten detections in 2011, representing two confirmed breeding pairs (two nests), and another two possible and one probable breeding pair (Table 1-9).

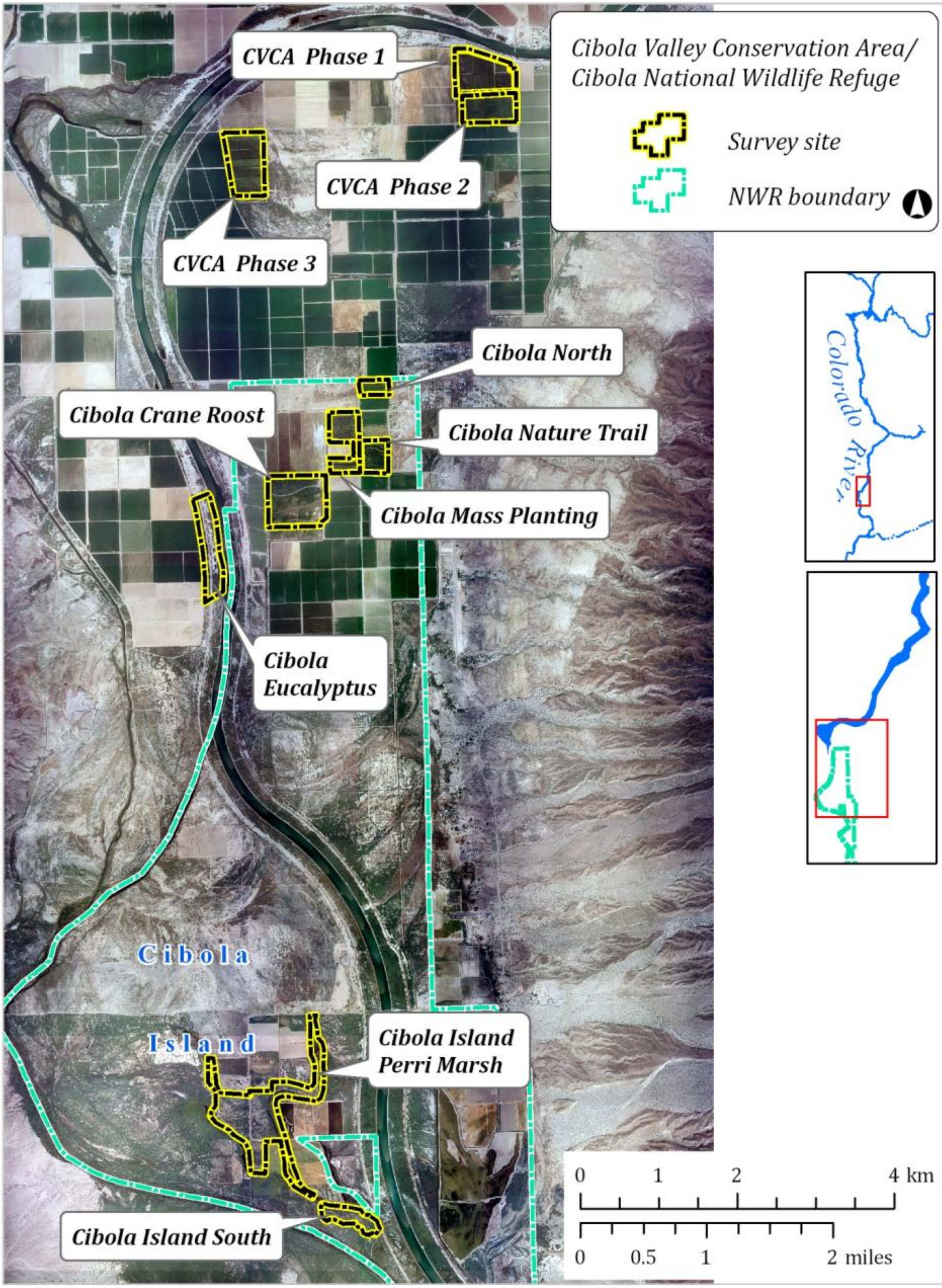
**Palo Verde Ecological Reserve Phase 4 (PVER4)** **Elevation 86 m; 35.8 ha**

Phase 4 was planted with cottonwood and willow strips in 2009. In 2010 the site was not surveyed until mid-season after activity was observed. In 2011 the site was fully surveyed. Tree heights range from 2 to 10 m and canopy cover is high. There were 18 detections, representing 5 confirmed breeding pairs (6 nests) and another possible breeding pair (Table 1-9).

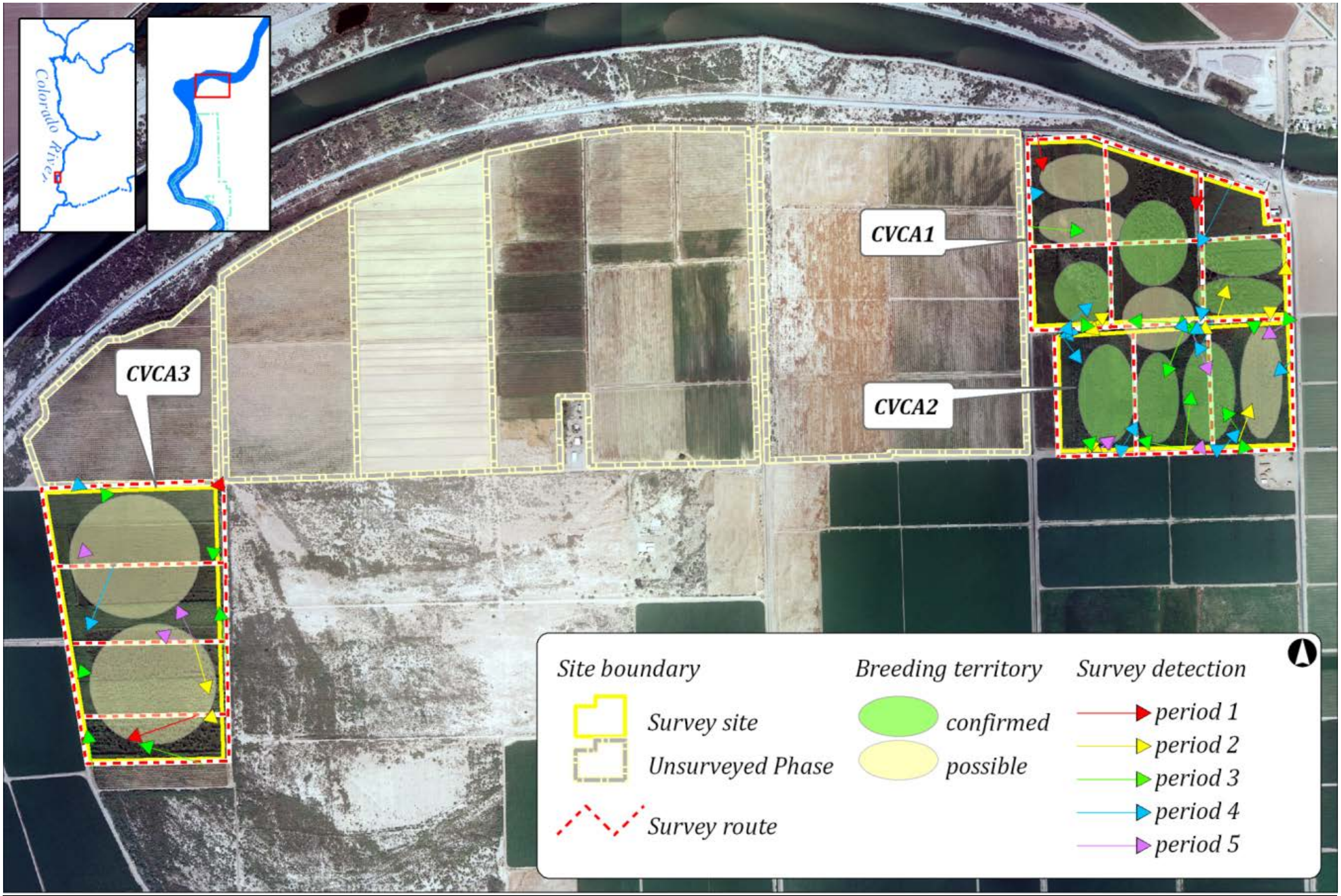
## Cibola Valley Conservation Area

### La Paz County, AZ

Cibola Valley Conservation Area (CVCA) is located 24.2 km south of Blythe, CA, south and east of the Colorado River and the CA/AZ border. Within Cibola Valley, 407.6 ha (1,019 ac) 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 2007-10). Riparian restoration has been implemented by Reclamation with hunting and public access managed by Arizona Game and Fish Department. Since 2006, 101 ha (250 ac) 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 k). Agricultural fields dominate the area surrounding the sites.




Map k. Cibola Valley Conservation Area and Cibola NWR yellow-billed cuckoo survey sites, 2011.




Map I. Cibola Valley Conservation Area YBCU survey detections and estimated breeding territories, 2011.

### 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 from the northern edge 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 2011 there were 18 survey detections and 4 confirmed breeding pairs (6 nests) with another one probable and two possible breeding pairs (Table 1-9, Map l).

### 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 3 to 11 m, with high canopy cover. Phase 2 was surveyed for the first time in 2009. In 2011 there were 27 survey detections, and three confirmed breeding pairs (3 nests) and one probable breeding pair (Table 1-9, Map l).

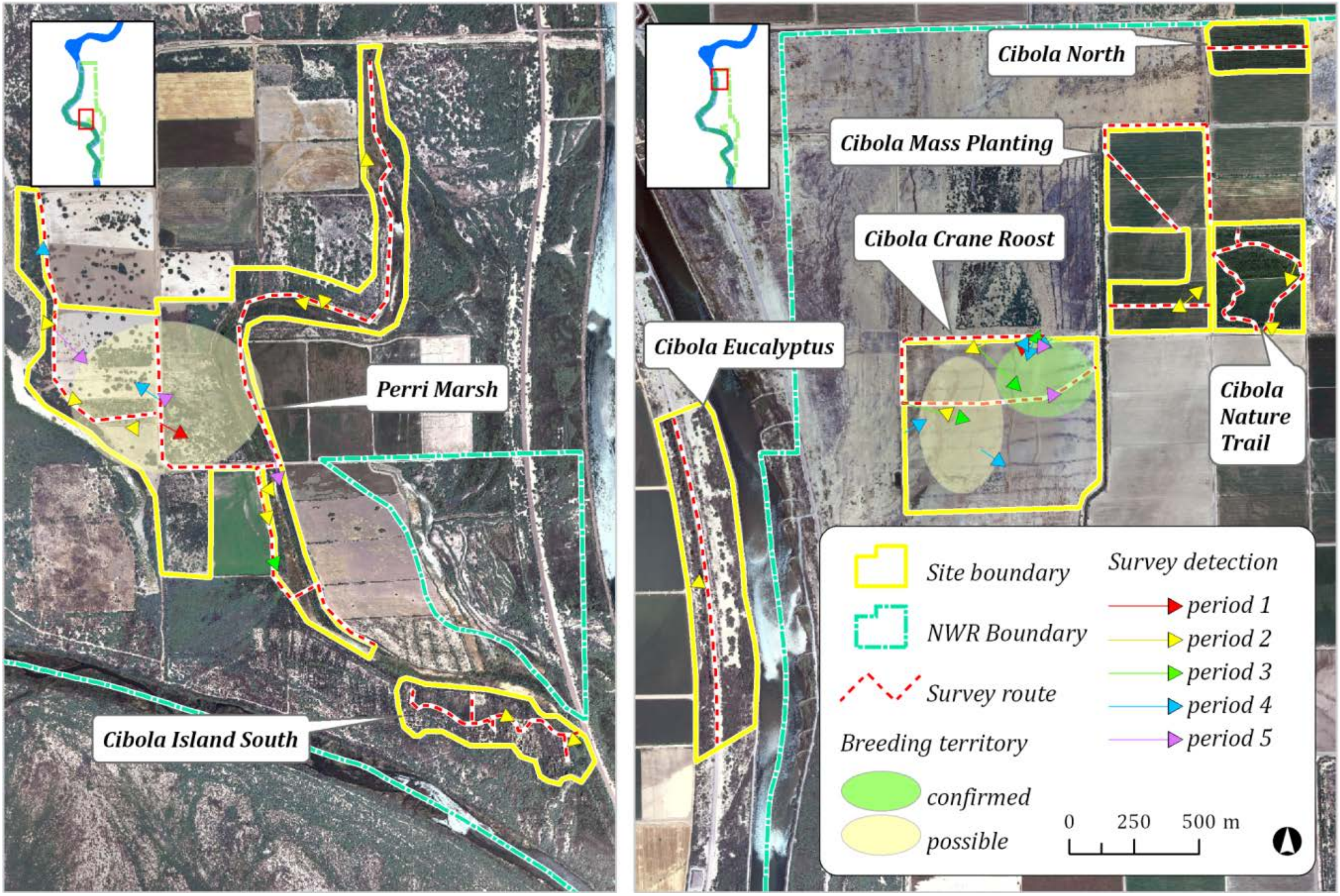
### Cibola Valley Conservation Area Phase 3 (CVCA3) Elevation 72 m; 37 ha

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 and coyote willow (and mesquite which is not yet suitable habitat for cuckoos). Tree heights vary from 5-12 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 2011, there were fourteen survey detections at this site, representing one possible breeding territory (Table 1-9, Map l).

## Cibola National Wildlife Refuge

### La Paz County, AZ (Colorado River Drainage)

Cibola NWR is 29.8 km south of Blythe, CA within the historic floodplain of the Colorado River. The Refuge, exceeding 6,475 ha (16,000 ac), 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. Seven sites at Cibola NWR were surveyed in 2011 (Map k).




Map m. Cibola National Wildlife Refuge YBCU survey detections and estimated breeding territories, 2011.

**Cibola Eucalyptus (CIBEUC)** **Elevation 70 m; 29.4 ha**

Cibola Eucalyptus is adjacent to the Refuge. It is a mixed native restoration site composed of 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 3-14 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 -5 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. There was one survey detection in 2011 (Table 1-9, Map m).

**Cibola Island Perri Marsh (CIBIPM)** **Elevation 65 m; 88.3 ha**

In 2011 the Cibola South site was broken up into two separate survey sites (Cibola Island: South and Perri Marsh) and expanded to cover additional mesquite habitat after radio tracking in 2010 revealed use of these areas by foraging cuckoos. Both sites are on the Island Unit of the Refuge connected by a meandering created channel, surrounded by historic Colorado River floodplain dominated by tamarisk, mesquite, arrowweed, and quailbush. The middle of the Perri Marsh site features a meandering channel with cottonwood and Goodding's willow overstory, an understory of mesquite, tamarisk and seep willow, and ground cover of cattails and Bermuda grass. Extensive mesquite plantings and agricultural fields used for wildlife enhancement surround the site. Cibola Island was damaged by a fire in late August 2011 and almost all riparian habitat was destroyed (B Zaun USFWS pers. comm.). In 2011 there were 15 survey detections and one possible breeding pair at Perri Marsh (Table 1-9, Map m).

**Cibola Island South (CIBSTH)** **Elevation 65 m; 13.8 ha**

Cibola Island South is an older restoration site located on the Island Unit. The mature cottonwoods 4-10 m tall provide 25% cover in the southern part of this dry site. A sparse (about 25% cover) layer of mesquite, tamarisk and seep willow create an understory 1-4 m tall. There were two survey detections here in 2011, both on July 7 (Table 1-9, Map m).

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

This area was previously surveyed as part of the Nature Trail survey (2009, 2010). A separate and expanded survey was conducted in this area 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 trees. The site had two survey detections in 2011 (Table 1-9, Map m).

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

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 structural diversity. Cottonwoods dominate a 5-11 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 fields. 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 was one survey detection here in 2011 (Table 1-9, Map m).

#### Cibola North (CIBNTH) Elevation 71 m; 7.2 ha

Cibola North is a more open, structurally homogeneous site with a cottonwood overstory averaging 10 m high and providing around 60% canopy closure. The ground cover is dominated by Bermudagrass. Fallow fields of sparse tamarisk, arrowweed, and quailbush extend to the east and west of the site. Cibola Nature Trail is 580 m to the south and is separated from this site by three agricultural fields. The site is bordered on its northern edge by Baseline Road and agricultural fields. There were no survey detections in 2011, and no evidence of breeding (Table 1-9, Map m).

#### Crane Roost (CIBCR) Elevation 75 m; 48 ha

<u>Phase 1:</u> Phase 1 was one of the first restoration plots planted at the refuge and consists of a block of dense 10-12 m-high cottonwoods, a grove of dense mesquites 5 m high, and a plot containing a mix of seep willow, mesquite, and tall emergent cottonwoods. Canopy cover at all plots is high. <u>Phase 2:</u> Several roads surround and dissect the recently planted fields of mixed cottonwoods and willows just south of the older Phase 1 plot. In 2011 the site was still sparse but contained a few patches of dense cottonwoods 3-4 m tall with high canopy cover. There were 13 survey detections here at Crane Roost, with one confirmed breeding pair (1 nest) and another possible breeding pair (Table 1-9, Map m).

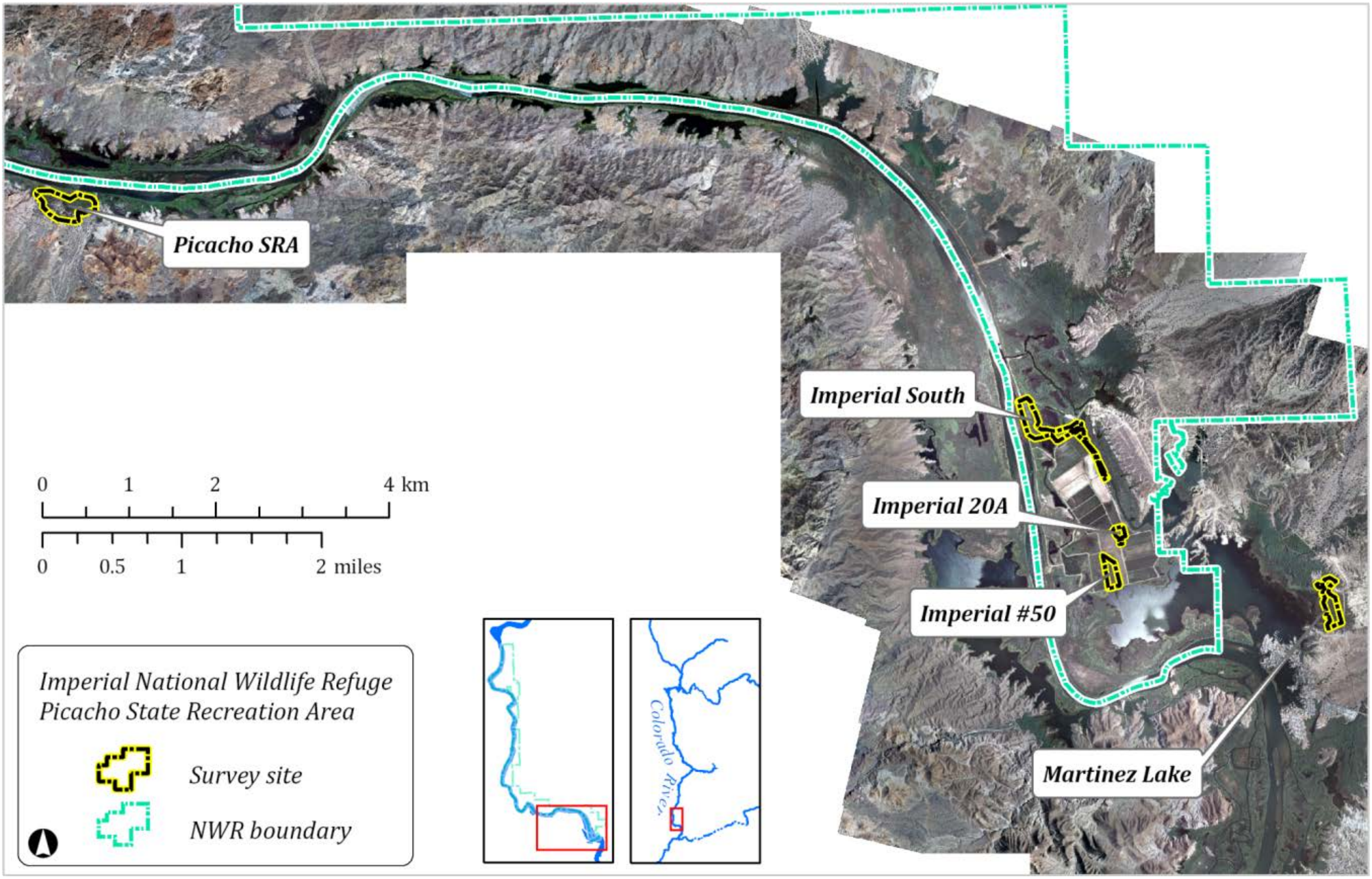
## Picacho State Recreation Area

### Imperial County, CA (Colorado River Drainage)

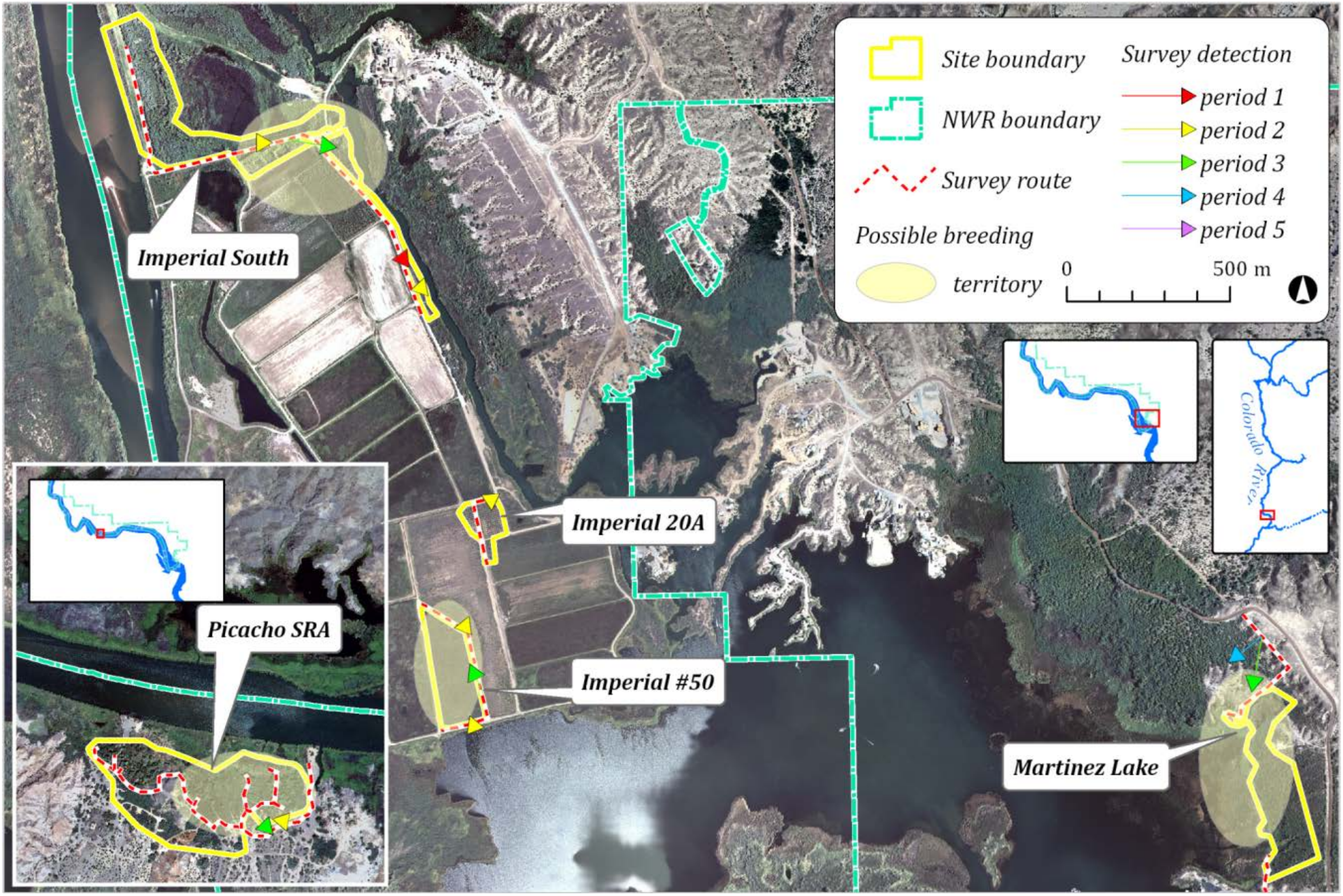
Picacho State Recreation Area (SRA) is a historic mining town site, currently state-owned and managed by the California State Parks Department. It is 38.6 km north of Winterhaven, California, on the Colorado River (Map n).

#### 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 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 Picacho SRA campground and adjacent Sonoran Desert uplands to the west, and the river to the east. There were two survey detection in 2011 and one possible breeding territory (Table 1-10, Map o).



Map n. Picacho State Recreation Area and Imperial National Wildlife Refuge YBCU survey sites, 2011.




Map o. Picacho State Recreation Area and Imperial National Wildlife Refuge YBCU survey detections and possible breeding territories, 2011.

# Imperial National Wildlife Refuge

## Yuma County, AZ (Colorado River Drainage)

Imperial NWR was established in 1941 and encompasses 10,307 ha (25,768 ac) 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 as food for wintering waterfowl, and restoring wetlands and associated riparian vegetation. This year one new survey site was added (Imperial 50, Map n).

### 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 site 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 four survey detections in 2011, and one possible breeding pair (Table 1-10, Map o).

### 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 of the site. There was only one survey detection in 2011 (Table 1-10, Map o).

### 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 has matured. It is surrounded on 3 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 SW of Imperial 20A. In 2011 there were three survey detections and one possible breeding territory (Table 1-10, Map o).

### Martinez Lake (IMPAST) — Elevation 61 m; 6.8 ha

This site consists of a narrow, linear band of riparian vegetation on AZ State Trust land bordering Martinez Lake, 1.2 km east of Imperial NWR. The dominant species is Goodding's willow, with lesser amounts of Fremont cottonwood and tamarisk. Tree heights range from 6-13 m, with a canopy cover of approximately 20%. The site is bordered to the east by dense arrowweed and dry desert uplands. There were two survey detections and one possible breeding territory in 2011 (Table 1-10, Map o).

## Laguna

### Imperial County, CA

Four new surveys were added on BLM-managed lands just below Imperial Dam. The sites were chosen to establish baseline measurements of cuckoo occupancy prior to planned riparian restoration in the area (Map p).

**Laguna Transect 'A' (LAGA)** **Elevation 50 m; 10.1 ha**

This transect was established along a rough bulldozed road known by Fred Phillips Consulting as 'Transect A'. Surrounding habitat consisted of mixed native and exotics including screwbean mesquite, arrowweed, and tamarisk. A few stunted remnant cottonwoods grow just to the west of the road. There was one survey detection here in 2011 (Table 1-10, Map p).

**Laguna Transect 'D' (LAGD)** **Elevation 50 m; 14.3 ha**

This transect follows a rough bulldozed road ending at a depression. It receives some water indicated by the presence of slightly taller trees (5 m) and singing common yellowthroats. Surrounding vegetation consists of mixed habitat of screwbean mesquite, tamarisk, quailbush and arrowweed. There were no survey detections here (Table 1-10, Map p).

**Laguna East (LAGE)** **Elevation 50 m; 13.9 ha**

This transect follows a small established dirt road along a small line of riparian vegetation, consisting of willows and cottonwoods. It then follows the edge of a marsh containing small pockets of riparian vegetation. The only cuckoo detected on Laguna surveys in 2011 flew from this site across the road and was detected on Transect A. There were no survey detections (Table 1-10, Map p).

**Laguna West (LAGW)** **Elevation 50 m; 1 ha**

Laguna West consists of a small remnant cottonwood-willow and marsh patch, just west of the planned restoration and east of the Colorado River. There were no survey detections in 2011 (Table 1-10, Map p).

## Mittry Lake Wildlife Management Area

### Yuma County, AZ (Colorado River Drainage)

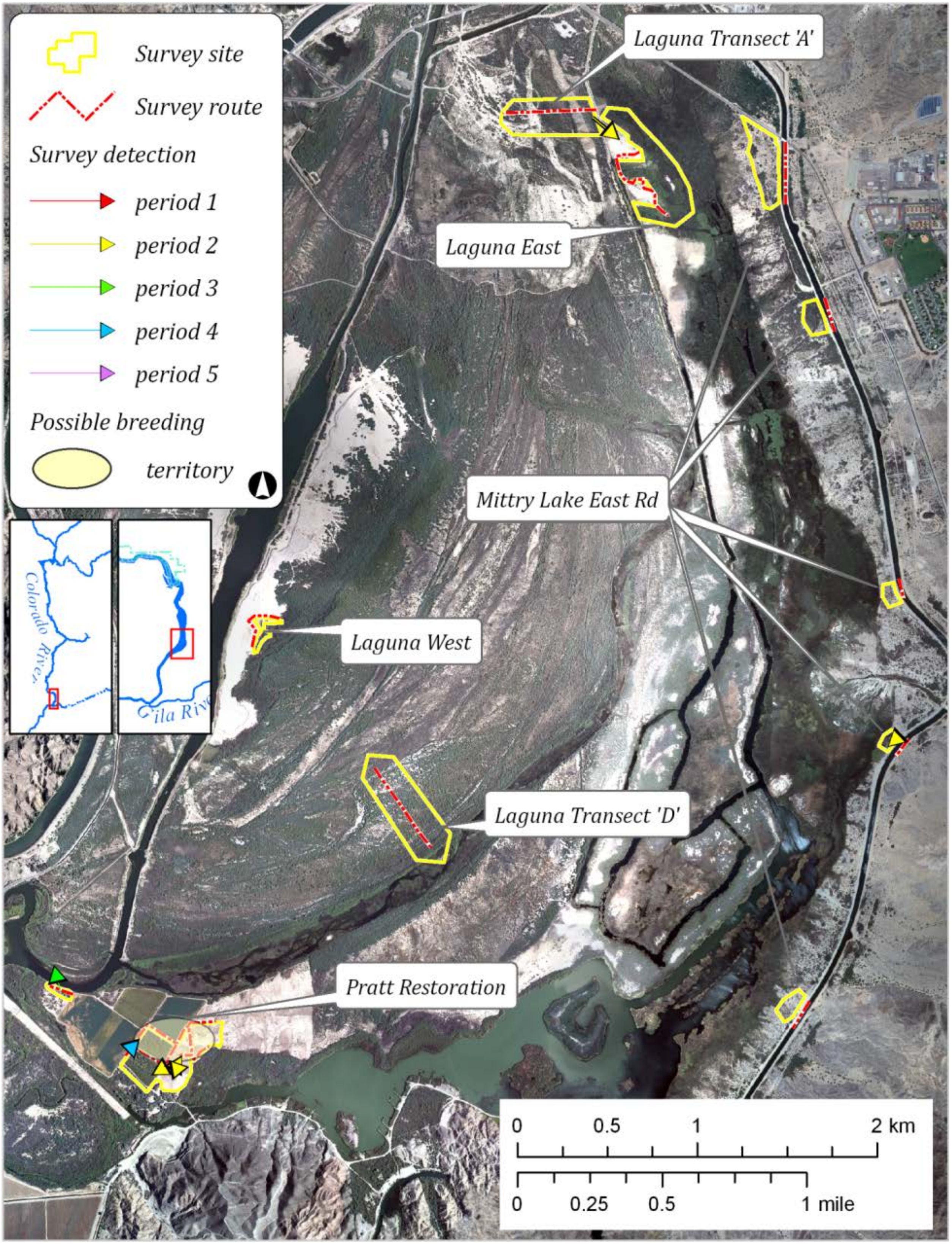
Mittry Lake WMA is managed by Arizona Game and Fish Department (AGFD) for wildlife habitat and outdoor recreation. The area is 24.2 km northeast of Yuma, between Laguna and Imperial Dams on the Colorado River (Map p).

#### Mittry Lake East Road (MLEA) — Elevation 40 m; 10.2 ha

This survey was added in 2011 along the gravel road leading to Laguna Dam to document pre-restoration occupancy below the dam. Habitat consists of marshland, cattails, tamarisk, arrowweed and a few pockets of native riparian trees. In 2011 one cuckoo was detected in a large solo cottonwood surrounded by dense arrowweed less than 20 m from the road (Table 1-10, Map p).

#### 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 large pre-season fire in 2011 destroyed most of the surrounding tamarisk-dominated vegetation at this site. The restorations sites were slightly damaged but mainly saved by the surrounding roads, concrete canals and firefighting efforts. There were five detections at this site in 2011, representing one possible breeding pair (Table 1-10, Map p).




Map p. Laguna, Mittry Lake yellow-billed cuckoo survey sites, detections and possible breeding territory, 2011.

# Yuma Wetlands

## Yuma County, AZ (Colorado River Drainage)

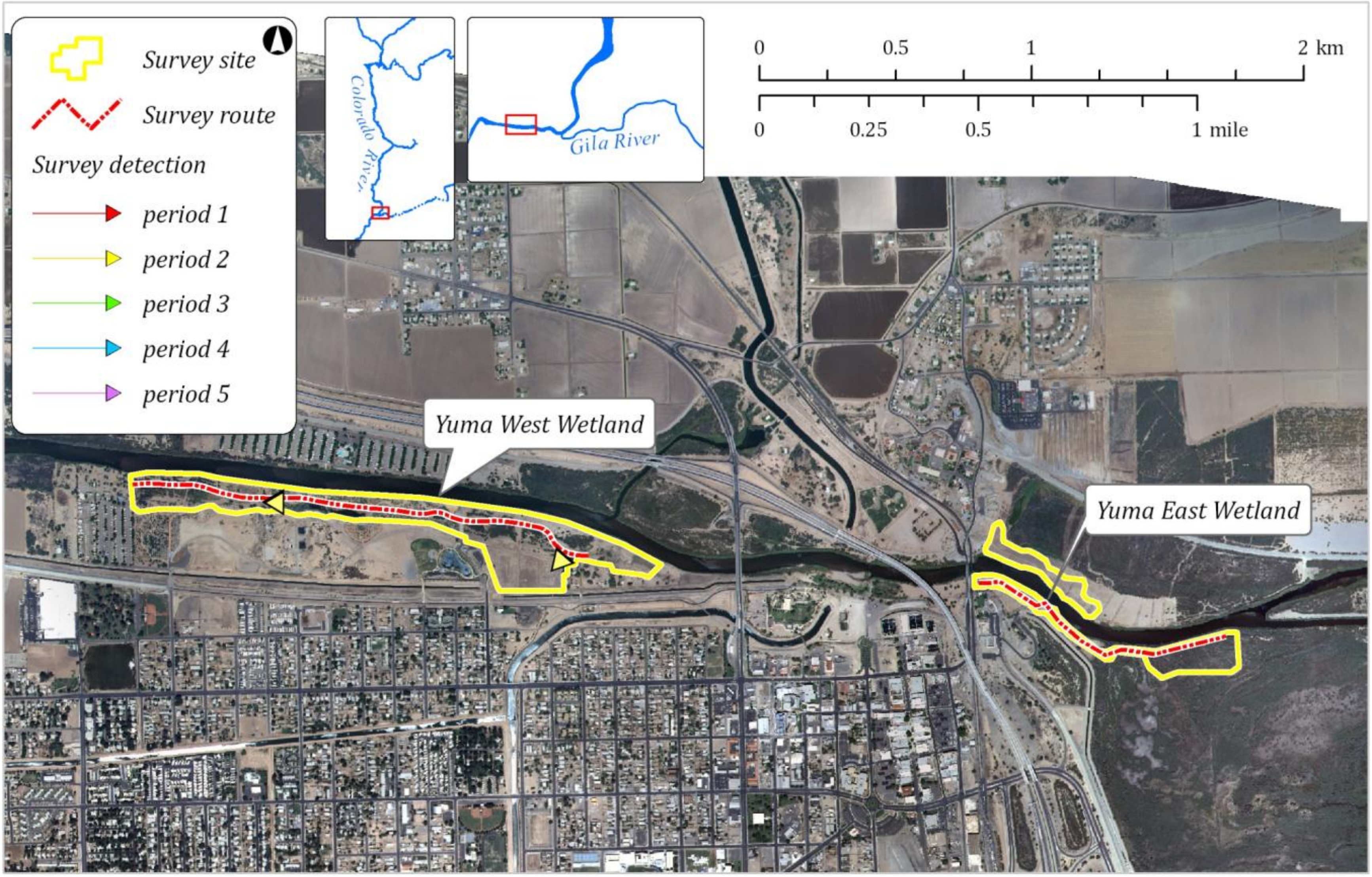
Yuma East and West Wetlands are restoration sites along the banks of the Colorado River in Yuma. Until recently the area was a mix of exotic plants, trash dumps and squatter camps. The West Wetlands is a 55 ha (135 acre) city park managed by the Yuma Department of Parks and Recreation. The East Wetlands is part of the Yuma Crossing Natural Heritage Area, 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 2003-2004 (Map q).

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

The 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 Wetlands. It was first surveyed in 2009. The planted habitat consists of a mosaic of Fremont cottonwood, Goodding's willow and mesquite spp. Overstory at the site ranges from 3-9 m with 50% canopy cover. Surveys were conducted from the south side. There were no survey detections in 2011 (Table 1-10, Map q).

### 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, and 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 were two survey detections in 2011 and no observed breeding activity (Table 1-10, Map q).




Map q. Yuma East and West Wetlands yellow-billed cuckoo survey sites and detections, 2011.

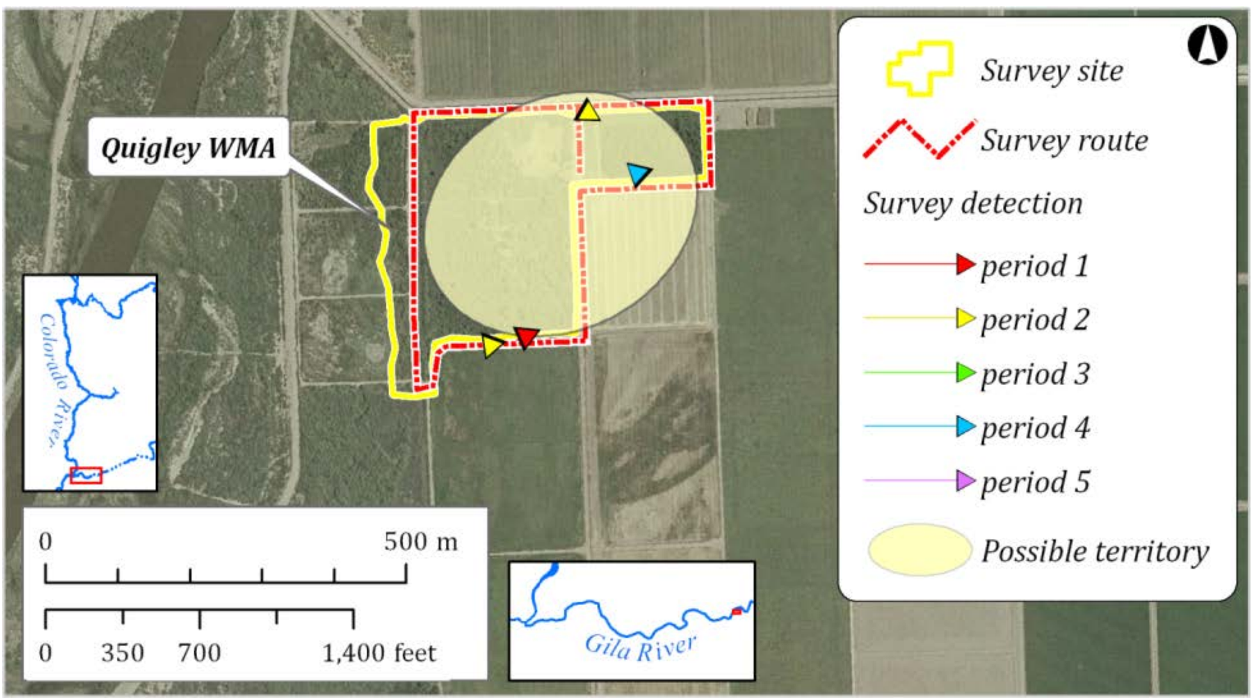
## Quigley Wildlife Management Area

### Yuma County, AZ (Gila River Drainage)

Quigley WMA is 4 km north of Tacna, in the historic Gila River floodplain. This 244.8 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 floodplain 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 were four survey detections in 2011, representing one possible breeding pair (Table 1-10, Map r).




Map r. Quigley Wildlife Management Area yellow-billed cuckoo survey detections, 2011.

# Appendix B. Breeding Evidence and Territory Estimates, LCR 2011.

| Site Code | #Visits | Breeding Status[2] | Behaviors Observed |
|---|---|---|---|
| HAVPS | 11 | 2 POS | Detections 6/20-7/02; Follow ups recorded no breeding behavior |
| HAVND | 10 | 0 | Detection 6/20 |
| HAVGH | 5 | 0 | No detections |
| HAVTPR | 8 | 0 | Detection 7/06 |
| HAVBR | 20 | 1 COB | One nest |
| BWCW | 17 | 1 COB | One nest |
| BWCP | 15 | 0 | Detections 7/6-7/19 |
| BWHB | 25 | 3 COB | Three nests |
| | | 1 PRB | Detections 6/21-7/30 |
| BWMW | 15 | 1 COB | One nest |
| | | 2 POS | Detections 6/21-8/08 |
| BWER | 12 | 1 COB | One nest |
| | | 1 POS | Detections 6/17-8/08 |
| BWPT | 17 | 2 COB | Two nests |
| BWKR | 18 | 2 PRB | Detections 7/03-7/11 |
| BWGR | 7 | 0 | Detections 7/03-7/25 attributed to Kohen Ranch |
| BWSW | 20 | 1 POS | Detections 7/11-8/01 |
| BWFW | 8 | 0 | Detection 7/19 |
| BWBP | 11 | 1 POS | Detections 7/06-7/29 |
| BWCR | 9 | 1 POS | Detections 7/05-7/22 |
| BWMF | 18 | 1 COB | Fledglings seen |
| | | 1 POS | Detections 7/02-8/05 |
| BWNB | 10 | 1 POS | Two detections 7/07 and 8/11 |
| BWMD | 8 | 1 POS | Two detections 7/09 and 7/27 |
| BWMA | 5 | 0 | Detections 7/06-8/11 attributed to adjacent site |
| CRIT | 18 | 0 | Detections 6/27-7/23 |
| CIBCNT | 10 | 0 | Two detections 7/05-7/12 – Follow ups recorded no breeding behavior |
| CIBEUC | 7 | 0 | Two detections 7/10 |
| CIBNTH | 5 | 0 | No detections |
| CIBSTH | 11 | 0 | Two detections 7/07 |
| CIBMP | 7 | 0 | Two detections 7/05-7/07 |
| CIBIMP | 12 | 1 POS | Detections in vicinity 7/07-8/09 – follow ups recorded no breeding behavior |
| CIBCR | 29 | 1 COB | One nest |
| | | 1 POS | Other birds besides nesters at site |
| CVCA1 | 46 | 4 COB | Six nests (four confirmed pairs - 2 probable renests) |
| | | 1 PRB | Food carries, activity in area 6/28-8/1 (+partial re-sight, possibly LBD (nesting female '09) |
| | | 2 POS | Detections in vicinity 7/2-8/20, nest 1,4 possibly different pairs |
| CVCA2 | 37 | 3 COB | Three nests |
| | | 1 PRB | Food carry/mate feed 7/14 (TGB returning nesting 2010 female) |
| CVCA3 | 15 | 1 POS | Detections in vicinity 6/16-8/05; follow ups observed no breeding behavior |
| PVER1 | 17 | 1 POS | Detections in vicinity 7/08-8/15; Twig carries 8/2, copulation 8/6 (but may have nested PVER4-N6 (found 8/14, 460 m east of copulation) |
| PVER2 | 29 | 3 COB | Three nests |
| | | 2 POS | Detections in vicinity 6/20-8/20 |
| PVER3 | 24 | 2 COB | Two nests |
| | | 1 PRB | Pair detections in vicinity 7/1-8/11, repeated probable food carries |
| | | 2 POS | Detections (including VEX) in vicinity 7/1-8/20, 7/11-8/11 |
| PVER4 | 40 | 5 COB | Six nests (in five separate territories) |
| | | 1 POS | The 6 nests may have been from 6 pairs |
| PICSRA | 5 | 1 POS | Detections 7/10-7/18 |
| IMPSTH | 8 | 1 POS | Detections in vicinity 6/21/-7/19 |
| IMP20A | 8 | 0 | Detection 7/08 |

| Site Code | #Visits | Breeding Status[2] | Behaviors Observed |
|---|---|---|---|
| IMP50 | 4 | 1 POS | Detections 7/08-7/16 |
| IMPAST | 6 | 1 POS | Detections 7/16-7/26 |
| MLPR | 14 | 1 POS | Detections 7/08-7/29 |
| MLEA | 4 | 0 | Detection 7/09 |
| LAGTA | 4 | 0 | Detection 7/09 |
| LAGTD | 4 | 0 | No detections |
| LAGE | 4 | 0 | No detections |
| LAGW | 4 | 0 | No detections |
| GRQP | 11 | 1 POS | Detections in vicinity 6/21-7/20 |
| YUWW | 8 | 0 | Detection 7/07 |
| YUEW | 5 | 0 | No detections |

# Appendix C. Nest Accounts.

## Havasu NWR

The Havasu NWR nest was the second we have found on the Refuge, and was again found at the Beal restoration site. Though this year's nest was within 160 m of the 2010 nest location, neither the nesting female (LB) nor the chick we banded here in 2010 were re-sighted in 2011, and both adults appeared to be unbanded (although they were never seen together). The nest was found on July 10 following a food carry, and contained 3 eggs. Two eggs hatched; the third egg disappeared from the nest July 16-20. The two chicks were banded on July 25 and 28, and the oldest fledged by July 28 and was seen sitting just below the nest. The second chick was assumed fledged (5 to 6 days old) as one parent was observed on July 30 sitting near the empty nest, alarm calling at the observer.

## Bill Williams River NWR

Seven nests were found at BWR NWR (all in the eastern half of the Refuge), including three at Honeycomb Bend, two at Cougar Point, and one each at Mineral Wash and Cave Wash. All nests were successful, fledging at least 13 young. Breeding was also confirmed at Mosquito Flats (fledglings), and overall we estimated up to 23 breeding territories within the BWR NWR in 2011 (see Appendix B).

BWCW N1 was found on July 14 and 3 eggs were observed on July 15. A fourth egg was laid sometime between July 16 and 19. The first chick fledged on July 27 and all fledged by July 30. The fourth egg never hatched.

BWHB N1 was found on July 24 after observing a nest exchange. When mirrored on July 25 it contained three nestlings. All three were fledged by July 27. One fledgling was captured in the nest tree, and the other 3 m from the nest. They were banded at eight and seven days old and returned to their original capture position.

BWHB N2 was also found on July 24. At this nest one of two researchers waiting for a dawn nest exchange was surprised by a mountain lion (*Puma concolor*) in the stream close to her sitting position. After a discussion the two brave nest searchers chose to continue waiting and the nest was located after the morning vocal exchange. The nest was mirrored the next day and contained two nestlings. The nest was difficult to access and monitor as it was high and over water. Nestlings were banded on July 27 at 3 and 4 days old. Three days later one banded fledgling was observed 10 m away from the nest and one adult was found near the nest as late as August 10.

BWHB N3 was found with two eggs on August 9. A copulation had been witnessed in the area (on August 2) and the male was re-sighted as AF (banded and seen copulating in 2010 1.3 km from the 2011 nest). One nestling fledged but the fate of the second was undetermined, as the nest was subsequently found partially destroyed and the second chick was never re-sighted.

BWMW N1 was found on July 12 and contained 3 eggs by July 14. Two fledged by July 24 and the third fledged shortly thereafter.

BWPT N1 was found on July 13. The nest was difficult to access or view due to the height and surrounding dense vegetation. Two eggs were observed on July 15, and chicks on July 21. Both chicks fledged by July 25.

BWPT N2 was also found on July 13 after adults were observed carrying nesting material. This nest was also difficult to access. Two nestlings were observed on July 25. The first fledged on July 28 and the second by August 1.

A nest at BWER was not found, but breeding evidence was observed on August 5; an unbanded adult was observed feeding several cicadas and one dragonfly to two fledglings.

## Palo Verde Ecological Reserve (CA)

Eleven nests were found at PVER; six in Phase 4, three in Phase 2, and two in Phase 3. Additionally, copulations and twig carries (mate offerings) were observed in Phase 1, involving a second year bird banded at either CVCA or PVER in 2010 (see Chapter 3). We estimated between 11 and 17 breeding territories occurred at PVER over the 2011 season. Nest success at PVER averaged 45%.

PVER2 N1 was found on July 14 containing two eggs. We banded both chicks, and fitted one parent with a geolocator. Both young fledged by July 29. One of the banded fledglings was subsequently re-sighted 23 days later 400 m west of the nest, still receiving parental care from both adults.

PVER2 N2 was found in a 6.5-m-high coyote willow (*Salix exigua*) on July 21 with three eggs, but was empty when checked three days later. A hollow egg with two small puncture marks was found on the ground below the nest. This is the first nest we have found in this tree species, found in a stand of coyote willows with a single Goodding's willow nearby.

At PVER2 N3, on August 2 an alarm-calling cuckoo drew the researcher to what appeared to be a dove nest, but when mirrored it contained one whole dove egg and one punctured YBCU egg. It was never observed active.

PVER3 N1 was found on July 18. When we brought a ladder on July 19 to check the nest contents we discovered a barn owl (*Tyto alba*) sitting on the nest branch within inches of the nest.

We flushed the owl and counted 3 eggs. The chicks were banded on July 29 and all three fledged by August 2.

PVER3 N2 was found on July 25 and was the highest nest found in 2011 (approximately 13 m). An egg was found on the ground below the nest the day it was found. The nest was too high to check and was monitored using binoculars, though adults were rarely seen. Feeding was observed on August 5. At least one chick fledged between August 5 and 10 (approximate age at least 5 to 6 days) and was heard near the nest area. Two adults were heard near the nest on August 11.

PVER4 N1 was found inactive on July 14. Previously high cuckoo activity was observed in the area. The nest was found with one intact cuckoo egg and one punctured dove egg.

PVER4 N2 was found on July 22 with two eggs, and fledged two by August 3. We fitted a geolocator to one of the adults (HAY) from this nest. On August 23 we recaptured the oldest fledgling from this nest (banded on August 2) at twenty seven days old. It had dispersed 175 m north of the nest and was with another juvenile (presumed sibling) and an adult (presumed parent).

PVER4 N3 was found with three eggs on July 22. One of the adults (MRD) had been captured, banded and radio-tagged on July 2, however she had dropped the transmitter by July18. MRD was later re-sighted at the nest near the dropped transmitter. The nest was found depredated with a single egg remaining on August 2.

PVER4 N4 was found July 24 with 2 eggs after the banded adult (EOW) was tracked to the nest. A third egg was laid on July 26. We placed a camera on the nest August 2, with parents returning after 10 minutes. Nestlings hatched on August 3, 4 and 5. The unbanded brooding adult was observed peering from the nest. A king snake was then seen approaching the nest as the adult left. The cuckoo returned and repeatedly tried to defend the nestlings, approaching the nest with wings outspread. The snake struck at the adult several times. Eventually the cuckoo fled but was seen agitated in the background. The king snake swallowed all three nestlings (1-3 days old) then circled the area looking for missed nestlings. The cuckoo never returned to the nest after the depredation event. The banded adult (EOW) later came to the nest with food, peered into the nest several times and then ate the food. It sat near the nest preening (a possible stress/coping behavior; Henson et al. 2011) before flying away.

PVER4 N5 was found on July 29 (confirmed by blue egg shell fragments in the nest) after adults were observed feeding at least two fledglings nearby. Previously a food carry was observed in the area.

PVER4 N6 was one of the last nests of the season and was found on August 14. It was active with three eggs on August 17, but deserted by August 20. The cause of desertion was not known, however it was late in the season, and the nest was close to the habitat edge near a road. Large farm machinery that passed close to the nest may have possibly disturbed the birds.

## Cibola Valley Conservation Area

We found nine nests at CVCA (Phases 1 and 2), five of them successfully fledging at least 13 young. We estimated between 7 and 11 breeding pairs; the nine nests were estimated to have been from seven pairs, as one or two of the six nests at CVCA1 were re-nests following failures early in the season (one confirmed by re-sighting a color-banded bird at two nests). We also estimated another four possible breeding pairs at the site (see breeding evidence table, Appendix B).

CVCA1 N1 was found on July 2, the first nest found in 2011. It was short lived as that night a severe storm passed through the area and destroyed the nest. The next morning broken tree branches were strewn across the site and the nest and three broken eggs were found on the ground below the nest. We believe this pair may have renested at CVCA1 N4 (described below).

CVCA1 N2 was found on July 8. The adult female at this nest was first banded at CVCA1 in 2010 (BA), returning in 2011 to nest approximately 225 m from her 2010 nest. Nest 2 was found in the same cottonwood as another 2010 nest and it is possible BA was also involved in that nest, though she was never observed here in 2010. BA was recaptured on June 12 this year in the same 2010 net lane. She was re-sighted carrying a stick to the nest tree on July 9, but by July 13 the nest was empty and assumed depredated, as no egg shells were found in the nest. She renested at Nest 5 (below).

CVCA1 N3 was found with four eggs on July 15. The eggs appeared somewhat brownish green in color. On July 23 we attempted to place a video camera near the nest, but we removed it after 50 minutes as the parents appeared reluctant to return to the nest. Three eggs hatched and fledged by July 28. Both adults at this nest were fitted with geolocators (MM, ROB, Chapter 3).

CVCA1 N4 was found on July 23 with two eggs, estimated to have been laid on July 16 and 17, and was a possible renest of the pair from Nest 1, 70 m away which failed July 2. Two additional eggs were laid on July 24-25, a week after the first eggs were laid and may represent intraspecific nest parasitism. The first two eggs hatched on July 26 and 27 and fledged by August 3. The adults abandoned the remaining two eggs and they were collected on August 6. One of the eggs had been punctured and an embryo was visible inside.

CVCA1 N5 was found on August 4 (initiated July 27). The female from CVCA1 N2 (BA, above) was re-sighted at the nest, which was in the same cottonwood stand and less than 20 m away from her 2010 nest. This nest was approximately 200 m from her first 2011 attempt. The nest was located high in a cottonwood and we were unable to access the nest. Two nestlings were observed by using a telescoping mirror and ladder. Both nestlings had fledged by August 13 and one was relocated approximately 50 m away on August 14, being fed by BA.

CVCA1 N6 was found by telemetry (CBR) on August 10, containing one egg. A second egg was laid the following day. On August 15 the nest was empty. During August 13-15 we discovered a farm crew of 5 workers had chain sawed tamarisk throughout the site, including around the nest area within 5 m of the nest. We believe the adults were disturbed by the clearing and noise, leaving the nest vulnerable to depredation. They also cut a previous nest tree (CVCA1 N1 2010). Nest trees (especially from successful nests) should be retained, as adults or fledged young may return to nest in the same tree.

CVCA2 N1 was found on July 15 (containing 4 eggs) by tracking a radio bird (DG) to the nest. An additional egg was laid 5 days later (possibly from intraspecific nest parasitism). On July 27 an attempt was made to place a camera at the nest. The camera was removed within 45 minutes after persistent knocking by one adult. The nest fledged four (the last egg remained unhatched) by August 2. Both adults (DG, GRE) at this nest were radio-tracked, with the female (GRE) later recaptured and fitted with a geolocator (Chapter 3).

CVCA2 N2 was also found by radio telemetry (FJR, Chapter 3). It contained two cuckoo eggs and two dove eggs when found on July 21. The nest appeared to be a dove nest but it is unknown if the cuckoos added nesting material, laid the eggs in an abandoned dove nest or evicted the doves, or if the eggs were instead dumped by doves (Bent 1940, Baskett 1992). No doves were ever observed at the nest. A third egg was laid by July 23, and we placed a video camera near the nest. One dove egg disappeared on July 29. A fourth cuckoo egg was found on July 30. A review of the video tape showed a possible egg-dumping: the incubating adult left the nest as a second cuckoo approached. The second cuckoo flew to the nest but was soon displaced by the original adult, who then resumed incubating the eggs.

Unusually, all three chicks hatched within a 24-hour time frame (another indication of possible intraspecific nest parasitism). We witnessed at least one adult having difficulties feeding the three nestlings, repeatedly attempting to feed large insects to the begging young and then eating or flying away with the food. The smallest chick jumped from the nest prematurely at 2 days old and was found on the ground dead and partially eaten by ants. When the remaining two chicks were processed at 4-5 days old they appeared stunted, and were 35-46% below average mass for their age. One chick appeared deformed with an upper mandible shorter than the lower mandible. We found no indication of parasites (a possible cause for jumping). The smaller remaining nestling jumped at 4- 5 days and was entirely eaten by ants. The remaining chick also jumped from the nest at 5- 6 days. After the death of the two youngest nestlings and jumping by the third, one dove egg and one cuckoo egg remained. After observing the nest from a distance and detecting no further parental activity by 5 pm that day we determined the nest had been deserted. We took the orphaned chick to Liberty Wildlife Rescue where it lived for 16 days before dying on August 21. The autopsy showed that the bones had not fully ossified, however the cause of death was not determined.

CVCA2 N3 was found through telemetry on August 1 with 2 eggs. Both had fledged by August 15. The female (DUM) led us to the nest where we discovered the male was also banded (LJ). LJ was an after third year bird returning for the third consecutive year to nest here. LJ had previously nested in 2010 (CVCA2 N1) approximately 48 m away.

## Cibola NWR

In 2011 we found our first nest at the Cranes Roost site, the only nest found on the Refuge this year. We have previously found two nests at this Refuge, on the Island Unit in 2009, and at the Nature Trail in 2010. Several birds were captured and radio-tracked at the Crane Roost site though no other breeding was confirmed here.

CIBCR Nest 1 was one of two found late in the season, found on August 12 containing three eggs. The eggs were almost white in color and mottled. A female (MON) banded at the site on July 21 was re-sighted incubating the eggs. The nest was active at least until August 17, but by August 20 it was deserted with three eggs remaining. No cuckoos were observed in the area again.

# Appendix D. Birds encountered during YBCU surveys, Reach 3 (Havasu NWR), 2011.

The number of survey periods each species was detected is displayed. MSCP covered species are in **bold**.

| Species Name | HAVBR | HAVGH | HAVND | HAVPS | HAVTPR |
|---|---|---|---|---|---|
| Abert's Towhee | 4 | 4 | 5 | 5 | 5 |
| American Kestrel | | 1 | | 1 | 1 |
| Ash-throated Flycatcher | 1 | | 1 | 3 | 5 |
| Barn Owl | | 1 | 1 | | |
| **Bell's Vireo** | **5** | | **1** | **2** | |
| Bewick's Wren | 1 | 2 | | | |
| Black Phoebe | 1 | 1 | 2 | 1 | 1 |
| Black-chinned Hummingbird | | | 1 | 1 | |
| Black-tailed Gnatcatcher | 4 | 2 | 3 | 4 | 5 |
| Blue Grosbeak | 5 | | 2 | 5 | 5 |
| Brown-crested Flycatcher | 1 | 3 | 1 | | 2 |
| Brown-headed Cowbird | 4 | 4 | 3 | 2 | 3 |
| Bullock's Oriole | 1 | 1 | | 2 | 3 |
| Cliff Swallow | | | 3 | 3 | |
| Common Raven | | | | | 1 |
| Common Yellowthroat | 5 | 4 | 1 | 4 | 1 |
| Crissal Thrasher | 4 | | 2 | 2 | 3 |
| Gambel's Quail | 2 | 2 | 3 | 5 | 4 |
| **Gila Woodpecker** | | **5** | **1** | **1** | **4** |
| Great Blue Heron | | | | 3 | |
| Great Egret | | | | 1 | |
| Great Horned Owl | | 1 | 1 | 3 | 2 |
| Greater Roadrunner | 1 | | 2 | 3 | 1 |
| Great-tailed Grackle | 5 | 1 | 4 | 5 | |
| House Finch | | | 1 | | 1 |
| Indigo Bunting | 2 | | 1 | | 1 |
| Killdeer | | | | 1 | |
| Ladder-backed Woodpecker | 2 | 4 | 2 | 2 | 4 |
| Lesser Goldfinch | | | | | 2 |
| Lesser Nighthawk | 3 | 2 | 2 | 4 | 2 |
| Loggerhead Shrike | 1 | 2 | 1 | 4 | 2 |
| Lucy's Warbler | 4 | 1 | | | 1 |
| Mourning Dove | 5 | 4 | 4 | 5 | 4 |

| Species Name | HAVBR | HAVGH | HAVND | HAVPS | HAVTPR |
|---|---|---|---|---|---|
| Northern Mockingbird | | | | 1 | 1 |
| Northern Rough-winged Swallow | 1 | 1 | | 1 | 1 |
| Red-winged Blackbird | 1 | | | 1 | |
| Song Sparrow | 1 | 2 | 1 | | |
| **Summer Tanager** | **2** | **3** | | | **3** |
| Tropical Kingbird | | | | 1 | |
| Verdin | 3 | | 1 | 1 | 4 |
| Western Kingbird | 1 | | | | |
| Western Tanager | 1 | | | 3 | |
| White-winged Dove | 5 | 5 | 5 | 5 | 5 |
| **Yellow Warbler** | **3** | **3** | | | **2** |
| **Yellow-billed Cuckoo** | **4** | | **1** | **3** | **1** |
| Yellow-breasted Chat | 4 | 5 | 4 | 4 | 2 |

# Appendix E. Birds encountered during YBCU surveys, Bill Williams River NWR 2011.

The number of survey periods each species was detected is displayed. MSCP covered species are in **bold**.

| Species Name | BWBP | BWCP | BWCR | BWCW | BWER | BWFW | BWGR | BWHB | BWKR | BWMA | BWMD | BWMF | BWMW | BWNB | BWPT | BWSW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abert's Towhee | 5 | 4 | 5 | 3 | 5 | 5 | 4 | 4 | 4 | 2 | 5 | 5 | 2 | 4 | 5 | 5 |
| American Coot | 1 | | | | | | | | | | | | | | | |
| American Kestrel | | | | 2 | | 3 | | 1 | | | | | | 1 | 3 | |
| Anna's Hummingbird | | 1 | | | | | 1 | | 1 | | | | | | | |
| Ash-throated Flycatcher | 3 | 4 | 1 | 4 | 3 | 3 | 5 | 3 | 3 | 2 | 1 | 2 | 2 | | 5 | 1 |
| Barn Owl | | | | | | | | | | | | | 1 | | | |
| **Bell's Vireo** | **5** | **5** | **5** | **5** | **5** | **1** | **5** | **4** | **4** | | **1** | **4** | **5** | **5** | **5** | **5** |
| Bewick's Wren | 4 | 4 | 4 | 3 | 1 | 4 | 2 | 1 | 2 | 2 | 4 | 2 | 1 | 3 | 5 | 5 |
| Black Phoebe | 1 | | 1 | 1 | 2 | 1 | 2 | 3 | 4 | 4 | | | 4 | | 2 | |
| **Black Rail** | | | | **3** | | | | | | | | | | | | |
| Black-chinned Hummingbird | | 1 | | 3 | 1 | 2 | | 2 | | | | 1 | | 1 | 1 | |
| Black-headed Grosbeak | | 2 | 1 | | | | 1 | 1 | 1 | | | | | | 2 | |
| Black-tailed Gnatcatcher | 4 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 3 | 1 | 1 | 4 | 1 | 2 | 5 | 2 |
| Black-throated Sparrow | | | | | | | 1 | 1 | | | | | 1 | | 1 | |
| Blue Grosbeak | 5 | 5 | 3 | 4 | 5 | 5 | 4 | 4 | 3 | 1 | 1 | 2 | 3 | 5 | 5 | 4 |
| Brewer's Sparrow | | | | | | | | | | | | 1 | | | | |
| Brown Pelican | | | | | | | | | | 1 | | | | | | |
| Brown-crested Flycatcher | 3 | 2 | 3 | 2 | 4 | 3 | 1 | 2 | 3 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| Brown-headed Cowbird | 3 | 1 | 3 | 2 | 2 | 4 | 3 | 3 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 |
| Bullock's Oriole | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | | | | 1 | | 4 | |
| Cactus Wren | | 2 | | | | | | | | | | | | | | |
| Canyon Wren | 5 | 1 | 5 | 3 | 5 | 2 | 5 | 4 | 3 | 4 | 2 | 5 | 4 | 3 | 4 | 4 |
| Cliff Swallow | | 1 | | 1 | 1 | | 1 | 2 | 2 | | | | | | 1 | |
| Common Blackhawk | | | | | | | | | 1 | | | | | | 1 | |
| Common Ground-Dove | | | | 1 | | | | | | | | | 1 | | | |
| Common Moorhen | | | | 5 | | | | 4 | | | | | | | | |
| Common Raven | 1 | 1 | 1 | | 2 | 1 | 1 | | | | | | 1 | 1 | 4 | 1 |
| Common | 3 | 1 | 5 | 2 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 5 |

| **Species Name** | **BWBP** | **BWCP** | **BWCR** | **BWCW** | **BWER** | **BWFW** | **BWGR** | **BWHB** | **BWKR** | **BWMA** | **BWMD** | **BWMF** | **BWMW** | **BWNB** | **BWPT** | **BWSW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yellowthroat | | | | | | | | | | | | | | | | |
| Cooper’s Hawk | | | | 1 | | 2 | | 2 | | | | | | 2 | | 1 |
| Crissal Thrasher | 4 | 1 | | 1 | 1 | 4 | 1 | 1 | 3 | 1 | | 3 | | 1 | 5 | |
| Dusky Flycatcher | | | | | | | | | | | | 1 | | | | |
| **Elf Owl** | | | | | | | | | | | **1** | | **1** | | | **2** |
| Eurasian Collared Dove | | | | | | | | | | | | | 1 | | | |
| Gambel's Quail | 5 | 5 | 1 | 4 | 5 | 4 | 4 | 2 | 5 | | | 4 | 4 | 3 | 5 | 5 |
| **Gila Woodpecker** | **4** | **4** | **4** | **4** | **5** | **4** | **3** | **4** | **2** | **4** | **4** | **4** | **2** | **5** | **5** | **5** |
| **Gilded Flicker** | | **2** | | **2** | **1** | | | **1** | | | | | **1** | | **4** | |
| Great Blue Heron | | | | | 2 | | | 1 | 3 | | | | 3 | | 1 | |
| Great Horned Owl | | | | 1 | 1 | | | 4 | | 1 | | | 1 | | | |
| Greater Roadrunner | 3 | 2 | 1 | 5 | 3 | 5 | 4 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 4 | 4 |
| Greater Yellowlegs | | | | | | | | | | | | | | | 1 | |
| Great-tailed Grackle | | | | 1 | | | | 3 | 1 | | | | 2 | 3 | | |
| Green Heron | | | | 1 | 1 | 1 | 2 | 4 | 2 | 4 | | | 1 | | 2 | |
| House Finch | | 2 | | 2 | 1 | | 2 | 2 | 2 | | | | | | 2 | |
| Killdeer | | | | | | | | | 1 | | | | | | 1 | |
| Ladder-backed Woodpecker | 4 | 4 | 5 | 3 | 3 | 5 | 2 | 4 | 3 | 5 | 5 | 4 | 2 | 4 | 5 | 5 |
| Lazuli Bunting | | | | | | | | | 1 | | | | | | 1 | |
| Lesser Goldfinch | 2 | 3 | 1 | 1 | | 3 | 1 | 2 | 3 | 1 | | 1 | 1 | | 2 | |
| Lesser Nighthawk | 1 | 2 | 2 | 3 | 1 | 5 | 1 | | 1 | 1 | 1 | 2 | | 1 | 4 | 2 |
| Loggerhead Shrike | 1 | 4 | | 4 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 5 | |
| Lucy's Warbler | 2 | 3 | | 2 | 1 | 2 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | |
| Marsh Wren | | | | | | | | | | 2 | | | | | | |
| Mourning Dove | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 2 | 5 | 5 | 5 | 3 | 4 | 5 | 5 |
| Northern Mockingbird | | | | | | 1 | | | | | | | 1 | | | |
| Northern Rough-winged Swallow | | 2 | 1 | 1 | | 3 | 1 | 1 | 2 | 3 | 1 | 1 | | 1 | 4 | 2 |
| Phainopepla | | | | | | | | 1 | | | | | 1 | | | |
| Red-tailed Hawk | | | | | | | 1 | 2 | 1 | | | | 1 | | 4 | 1 |
| Red-winged Blackbird | | 1 | | | 2 | | | 2 | 2 | 1 | | | 2 | | | |
| Rock Wren | | | | | | | | | | | | | | | 2 | |
| Say's Phoebe | | 1 | | | | | 2 | 1 | 1 | | | | | | 1 | |
| Song Sparrow | 5 | 2 | 4 | 2 | 5 | 5 | 3 | 4 | 5 | 4 | 4 | 5 | 3 | 4 | 5 | 5 |
| Spotted Sandpiper | | | | | | | | | | | | | | | 2 | |
| **Summer Tanager** | **2** | **4** | **2** | **4** | **2** | **3** | | **4** | **3** | **3** | **1** | **4** | **1** | **4** | **4** | **4** |
| Swainson's Hawk | | | | | | | | | 1 | | | | | | | |

| Species Name | BWBP | BWCP | BWCR | BWCW | BWER | BWFW | BWGR | BWHB | BWKR | BWMA | BWMD | BWMF | BWMW | BWNB | BWPT | BWSW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkey Vulture | | 1 | | | 3 | | 2 | 1 | 1 | | | | 3 | | 4 | |
| Verdin | 4 | 4 | 3 | 2 | 1 | 1 | | 1 | 1 | 1 | | 3 | | | 4 | 2 |
| **Vermilion Flycatcher** | | | | | | | | | **1** | | | | | | | |
| Violet-green Swallow | | | | | 1 | | 1 | 1 | 1 | | | | | | 1 | |
| **Virginia Rail** | | | | | | | | **1** | | | | | | | **1** | |
| Warbling Vireo | | 1 | | | | 1 | | | 1 | | | | | 1 | | |
| Western Kingbird | | 2 | | 1 | | 1 | 1 | 2 | 2 | 1 | | | | | 2 | |
| Western Screech Owl | | | | | | | | 1 | | | | | 1 | | | |
| Western Tanager | 1 | | 2 | | | 1 | | 2 | 1 | 1 | 3 | | | | 1 | 1 |
| Western Wood-pewee | | | | | 1 | | | | 1 | | | | | | | |
| White-throated Swift | | | | | 1 | | 1 | | 1 | | | | | | 2 | |
| White-winged Dove | 4 | 5 | 5 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 4 | 4 | 3 | 4 | 5 | 4 |
| **Willow Flycatcher** | | | | | | | | | | **1** | | **2** | | | **2** | |
| **Yellow Warbler** | **4** | **1** | **5** | **4** | **4** | **2** | **2** | **4** | **3** | **4** | **4** | **5** | **2** | **3** | **5** | **4** |
| **Yellow-billed Cuckoo** | **2** | **1** | **2** | **4** | **5** | **1** | **3** | **5** | **4** | **3** | **3** | **4** | **5** | **3** | **5** | **2** |
| Yellow-breasted Chat | 5 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

# Appendix F. Birds encountered during YBCU surveys, Reach 4, 2011.

The number of survey periods each species was detected is displayed. MSCP covered species are in **bold**.

| Species Name | CIBCNT | CIBCR | CIBEUC | CIBIPM | CIBMP | CIBNTH | CIBSTH | CRIT | CVCA1 | CVCA2 | CVCA3 | PVER1 | PVER2 | PVER3 | PVER4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abert's Towhee | 5 | 5 | 3 | 5 | 5 | 2 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 1 | 5 |
| American Coot | | | | | 1 | | | 1 | | | | | | | |
| American Kestrel | 1 | 1 | 1 | 2 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | | 2 |
| American Redstart | 1 | | | | | | | | | | | | | | |
| American Robin | 1 | | | | | | | | | | | | | | 1 |
| Anna's Hummingbird | | | | | 1 | | | 4 | | | 1 | | 2 | 1 | 1 |
| Ash-throated Flycatcher | 3 | 2 | 5 | 5 | 1 | 4 | 5 | 5 | 3 | 4 | 3 | | 5 | | 3 |
| Barn Owl | | 1 | 1 | | | | | 1 | 2 | | | 1 | 2 | 3 | 2 |
| Barn Swallow | | 1 | | | | | | | | | | | | | 1 |
| **Bell's Vireo** | **1** | | | | | | | | | | | | **1** | | |
| Black Phoebe | 2 | 3 | | 4 | 2 | | 1 | | 2 | 1 | | 1 | 1 | 1 | 3 |
| Black-chinned Hummingbird | 2 | 1 | | 3 | 1 | 2 | | 5 | 3 | 1 | 1 | | 1 | | 1 |
| Black-crowned Night-heron | | | | | | | | | | | | 1 | | | |
| Black-headed Grosbeak | | | | | 1 | | | 1 | 1 | | | | | | |
| Black-necked Stilt | | | | 2 | | | | | | | | | | | |
| Black-tailed Gnatcatcher | 2 | 1 | 3 | 5 | 1 | | 5 | 2 | | | 1 | | | | |
| Blue Grosbeak | 5 | 5 | 3 | 5 | 4 | 3 | 1 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 |
| Brown-crested Flycatcher | | 1 | | | | 1 | | 1 | | | | | | | |
| Brown-headed Cowbird | 3 | 5 | 5 | 5 | 4 | | 4 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 |
| Bullock's Oriole | 2 | 1 | 5 | 5 | 4 | 1 | 3 | 5 | 5 | 2 | 3 | 1 | 3 | 1 | 4 |
| Burrowing Owl | 1 | | | | | | | | | | | | | | 1 |
| Cactus Wren | | | | 1 | | | | | | | | | | | |
| Cinnamon Teal | | | | | | | | | | | | | | | 1 |
| Cliff Swallow | | 3 | | 3 | 2 | | 1 | 2 | 2 | | 1 | | 2 | | 2 |
| Common Ground-Dove | 1 | 1 | 1 | | 1 | | | 1 | | | 1 | 1 | | | 1 |
| Common Peafowl | | | | | | | | | | | | | | 1 | |
| Common Raven | 1 | 1 | 3 | 3 | | | 1 | | 1 | | | | | | |
| Common Yellowthroat | 3 | 5 | | 5 | 4 | | 4 | 1 | 2 | 1 | | 3 | 5 | 4 | 5 |
| Cooper's Hawk | | | | | | | | | 1 | | | | | | |

| Species Name | CIBCNT | CIBCR | CIBEUC | CIBIPM | CIBMP | CIBNTH | CIBSTH | CRIT | CVCA1 | CVCA2 | CVCA3 | PVER1 | PVER2 | PVER3 | PVER4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crissal Thrasher | | 1 | 1 | 4 | | 1 | 4 | 5 | | | | | | | |
| Eurasian Collared Dove | 1 | 1 | 1 | | | | | | 1 | 1 | | 1 | | | 1 |
| European Starling | 1 | 2 | | 1 | 1 | 1 | | | 3 | | 1 | | | | |
| Gambel's Quail | 3 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 3 | 2 | 5 | 4 | 5 | 2 | 2 |
| **Gila Woodpecker** | **1** | | | **3** | | | **2** | | | | | | | | **1** |
| Great Blue Heron | 1 | 1 | | 3 | | | 1 | | | | | | | | |
| Great Egret | | | | | 1 | | | | | | | | | | |
| Great Horned Owl | 1 | 1 | 3 | 3 | | 1 | | 5 | 2 | | 1 | | 2 | | 2 |
| Greater Roadrunner | 1 | 2 | 1 | 3 | 2 | 2 | 1 | 5 | | 2 | 1 | | | | 1 |
| Greater Yellowlegs | | | | | 1 | | | | | | | | | | |
| Great-tailed Grackle | 2 | 2 | 1 | 5 | 4 | 3 | 2 | 5 | 4 | 1 | 1 | 1 | 1 | 3 | 4 |
| Green Heron | | | | 1 | | | | | | | | | | | |
| Hooded Oriole | | | | 2 | | | | | | | | | | | |
| Horned Lark | | | | | | | | 1 | | | | | | | |
| House Finch | 3 | 3 | 3 | 5 | 4 | 1 | | 5 | 3 | 2 | 3 | 3 | 5 | 1 | 5 |
| Indigo Bunting | | | | 1 | | | 1 | | 1 | | | 1 | 1 | | 3 |
| Killdeer | | 2 | | 4 | 1 | 3 | | | | | | | 1 | | |
| Ladder-backed Woodpecker | 1 | | 5 | 5 | 1 | | 5 | 5 | 3 | 1 | 3 | | 2 | 2 | 1 |
| Least Bittern | | 1 | | | | | | | | | | | | | |
| Lesser Goldfinch | | 1 | | | | | | 5 | 2 | | 1 | | 1 | | 2 |
| Lesser Nighthawk | 2 | 1 | 3 | 5 | 2 | 2 | 3 | 2 | 2 | | 2 | | 2 | 1 | 1 |
| Loggerhead Shrike | 3 | 5 | 5 | 5 | 4 | 4 | 5 | 3 | 4 | 3 | 5 | 1 | 3 | 1 | 3 |
| Long-billed Curlew | | 2 | | | 1 | | | | | | | | | | |
| Long-billed Dowitcher | | | | 1 | | | | | | | | | | | |
| Lucy's Warbler | 2 | 3 | 2 | 1 | | 1 | 1 | 4 | 1 | 1 | | 1 | 1 | | 2 |
| Mallard | | | | 1 | | | | | | | | | | | |
| Mourning Dove | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Northern Flicker | 1 | | | 2 | | | | | | | 1 | | | | |
| Northern Harrier | | 1 | | 1 | | | | | | | 1 | | | 1 | 1 |
| Northern Mockingbird | 1 | 1 | 4 | 5 | 3 | 2 | 3 | | 1 | 2 | 2 | | 1 | | |
| Northern Rough-winged Swallow | 1 | 1 | 1 | 3 | 1 | | 2 | | 2 | 1 | 2 | 1 | 3 | 1 | 2 |
| Pacific-slope Flycatcher | 1 | | | | 1 | | | | | | 1 | | | | |
| Peregrine Falcon | | | | 1 | | | | | | | | | | | |
| Phainopepla | | | | | | | 1 | | | | | | | | 1 |
| Pied-billed Grebe | | | | | | | | 2 | | | | | | | |
| Plumbeous Vireo | | | | | | | | | 1 | | | | | | |
| Prairie Falcon | | | | 1 | | | | | | | | | | | |
| Red-tailed Hawk | | | | | 1 | | | 3 | | | | 1 | 1 | 1 | |

| Species Name | CIBCNT | CIBCR | CIBEUC | CIBIPM | CIBMP | CIBNTH | CIBSTH | CRIT | CVCA1 | CVCA2 | CVCA3 | PVER1 | PVER2 | PVER3 | PVER4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red-winged Blackbird | 4 | 5 | 4 | 5 | 5 | 3 | 1 | 4 | 5 | 3 | 4 | 5 | 5 | 4 | 5 |
| Say's Phoebe | 1 | | | 1 | | | | 1 | | | | | | | |
| Song Sparrow | 1 | 4 | | 3 | 3 | | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 1 | 4 |
| **Summer Tanager** | | | | | | | | **5** | | | **1** | | | **1** | |
| Swainson's Hawk | | | | | | | | 1 | | | | | | | |
| Tree Swallow | | 1 | | | 1 | | | | | | | | | | 1 |
| Tropical Kingbird | | | | | | | | 1 | | | | | | | |
| Turkey Vulture | | 1 | 4 | | | | | 3 | 1 | 1 | | | 3 | 1 | 1 |
| Verdin | 2 | 1 | 2 | 5 | | 2 | 5 | 3 | 1 | | 2 | | 1 | | |
| **Vermilion Flycatcher** | | | | **1** | | | | **5** | | | | | | | |
| Violet-green Swallow | | | | | | | | 2 | | | | | | | |
| Western Flycatcher | | | | | | | 1 | 1 | | | | | | | |
| Western Kingbird | 4 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 5 | 4 | 5 |
| Western Meadowlark | 1 | 2 | | | 2 | | | 1 | | | | | | | |
| Western Tanager | | 2 | | | | 2 | 1 | | | | 1 | | | | 1 |
| White-eyed Vireo | | | | | | | | | 1 | | | | | | |
| White-faced Ibis | | 1 | 1 | 1 | 1 | | | | | | | | | | |
| White-tailed Kite | | | | | 1 | | | | | | | | | | 2 |
| White-throated Swift | | | | | | | | 1 | | | | | | | |
| White-winged Dove | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Willet | | | | | | | | | | | | | | | 1 |
| **Yellow Warbler** | **1** | | **1** | | | | | **1** | | **2** | | | | | **1** |
| **Yellow-billed Cuckoo** | **1** | **5** | **1** | **5** | **1** | | **1** | **4** | **5** | **4** | **5** | **3** | **4** | **4** | **5** |
| Yellow-breasted Chat | 4 | 4 | 1 | 5 | 3 | | 4 | 1 | 2 | 2 | 3 | 3 | 3 | | 3 |
| Yellow-headed Blackbird | | 2 | 1 | 4 | 3 | 1 | 1 | 1 | | | 1 | 1 | 3 | | 1 |

# Appendix G. Birds encountered during YBCU surveys, Reaches 5-6, 2011.

The number of survey periods each species was detected is displayed. MSCP covered species are in **bold**.

| Species Name | GRQP | IMP20A | IMPAST | IMP50 | IMPSTH | LAGA | LAGD | LAGE | LAGW | MLEA | MLPR | PICSRA | YUEW | YUWW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abert's Towhee | 1 | 2 | | 1 | 1 | | | | 4 | 1 | 3 | 3 | 4 | 2 |
| American Avocet | | | | | 1 | | | | | | | | | |
| American Coot | | | | | 1 | | | | 1 | | | | | |
| Anna's Hummingbird | 1 | | | 1 | 1 | | | | | | | 1 | 2 | 5 |
| Ash-throated Flycatcher | 4 | | 1 | 2 | 3 | 1 | | 2 | 3 | 3 | 5 | 5 | | |
| Barn Owl | 1 | | | | | | | | | | | | | |
| **Bell's Vireo** | | | | **1** | **1** | | | | | | | | | **1** |
| Black Phoebe | 1 | | | | 1 | | | | | | | | | |
| **Black Rail** | | | | | | | | **1** | | | | | | |
| Black-chinned Hummingbird | 1 | | | | 1 | | | | | | 1 | | 1 | 1 |
| Black-headed Grosbeak | | | | | 1 | | | | | | | | | |
| Black-necked Stilt | | | | | | | | | | | | 2 | | |
| Black-tailed Gnatcatcher | | 1 | | | 1 | 1 | 1 | | | 1 | 1 | | | |
| Blue Grosbeak | 1 | | | 1 | 1 | | | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| Brown-headed Cowbird | 5 | 2 | | 1 | 2 | 1 | | 3 | 2 | | 3 | 1 | 4 | 2 |
| Bullock's Oriole | 2 | | | | 1 | | | 1 | | 1 | | 1 | | |
| Cinnamon Teal | | | | | | | | | | | | 1 | | |
| **Clapper Rail** | | | | **1** | **1** | | | | | | | | **3** | |
| Cliff Swallow | | | | | | | | | | | | | 1 | |
| Common Ground-Dove | 1 | 1 | | | | | | | | | | | | 1 |
| Common Yellowthroat | | 4 | 3 | 2 | 5 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 5 | 5 |
| Crissal Thrasher | | 1 | | | | | | | | | | | 1 | 1 |
| Curve-billed Thrasher | | | | | | | | | | | | | 1 | |
| Eurasian Collared Dove | 1 | | | | | | | | | | | | | 2 |
| European Starling | | | | 1 | | | | | | | | | | 1 |
| Gambel's Quail | 5 | 1 | 1 | | | | 1 | 2 | 2 | 1 | 3 | 5 | 1 | 4 |
| **Gila Woodpecker** | | **1** | **1** | | | | | | **1** | **1** | **1** | **3** | | **4** |

| Species Name | GRQP | IMP20A | IMPAST | IMP50 | IMPSTH | LAGA | LAGD | LAGE | LAGW | MLEA | MLPR | PICSRA | YUEW | YUWW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Blue Heron | | | | | | 1 | 1 | | | | 1 | | | |
| Great Egret | | | | | 1 | | | | | | 1 | 1 | 2 | 1 |
| Great Horned Owl | 3 | | | | | | | | | | | | | 1 |
| Greater Roadrunner | | | | | | | | | | | | | 1 | 4 |
| Great-tailed Grackle | 1 | 1 | 1 | 3 | 3 | 2 | | | | 1 | 3 | 2 | 5 | 5 |
| Green Heron | | 1 | | | 1 | | | | | | | | | |
| House Finch | 5 | | 1 | 2 | 1 | | | 2 | 2 | 2 | 2 | 3 | 4 | 1 |
| House Sparrow | | | | | | | | | | | | | | |
| Inca Dove | | | | | | | | | | | | | | 1 |
| Killdeer | 1 | | | | 1 | | | | | | | 1 | 5 | |
| Ladder-backed Woodpecker | 1 | | | 1 | 2 | 1 | | | | | 2 | 1 | 1 | 2 |
| Lesser Goldfinch | 1 | | | | | | | | | | 1 | | | 1 |
| Lesser Nighthawk | 3 | 2 | 3 | 3 | 3 | 1 | 4 | 1 | 2 | 1 | 1 | 2 | | |
| Loggerhead Shrike | 5 | 3 | 3 | 4 | 5 | 3 | 3 | 4 | 3 | 2 | 4 | 5 | 2 | 2 |
| Lucy's Warbler | | | | | 1 | | | | | 1 | 1 | 2 | | |
| Marsh Wren | | | | | 1 | | | | 1 | | 1 | | | |
| Mourning Dove | 5 | 3 | 3 | 4 | 5 | 4 | 4 | 4 | 3 | 3 | 5 | 5 | 5 | 5 |
| Northern Mockingbird | | 1 | 1 | 1 | 1 | | | | 1 | | | | 4 | 5 |
| Northern Rough-winged Swallow | | | | | 1 | | | | 2 | | 2 | 3 | 1 | 1 |
| Phainopepla | | | | | 1 | | | | | | | | | |
| Pied-billed Grebe | | 2 | 1 | 1 | 2 | | 3 | 1 | | 2 | 5 | 3 | 1 | 1 |
| Red-tailed Hawk | 1 | | | | | | | | | | | | | |
| Red-winged Blackbird | 4 | 2 | 1 | 2 | 3 | | | 2 | 2 | | 3 | 2 | 3 | 1 |
| Rock Pigeon | | | | | | | | | | | | | 5 | |
| Ruddy Duck | | | | | | | | | | | | | 1 | |
| Say's Phoebe | | | | | 1 | | | | | | | | | |
| Song Sparrow | | | | | 2 | | | | 1 | | 2 | 1 | 1 | 1 |
| **Summer Tanager** | | | | | **1** | | | | | | | | | |
| Turkey Vulture | | | 1 | | 1 | | | | | 1 | 1 | 4 | | |
| Verdin | | 1 | | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 5 | 5 |
| **Vermilion Flycatcher** | **3** | | | | | | | | | | | | | |
| Warbling Vireo | | | | | 1 | | | | | | | | | |
| Western Kingbird | 3 | 3 | | 2 | 4 | | | | 1 | 2 | 4 | 2 | 2 | |
| Western Tanager | | | | | 1 | | | | | | 1 | | | |
| White-winged Dove | 5 | 3 | 2 | 3 | 4 | 4 | 3 | 4 | 4 | 2 | 5 | 5 | 4 | 5 |
| **Yellow-billed Cuckoo** | **3** | **1** | **2** | **2** | **3** | **1** | | | | **1** | **3** | **2** | | **1** |

| Species Name | GRQP | IMP20A | IMPAST | IMP50 | IMPSTH | LAGA | LAGD | LAGE | LAGW | MLEA | MLPR | PICSRA | YUEW | YUWW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yellow-breasted Chat | 1 | | 1 | | 2 | | | 3 | 3 | | 1 | 3 | | |
| Yellow-headed Blackbird | | 1 | | | 1 | | | | | | | | | |