Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Yellow-billed Cuckoo Surveys on the Lower Colorado River and Tributaries

2014 to 2018 Summary Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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National Park Service
Bureau of Land Management
Bureau of Indian Affairs
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Desert Wildlife Unlimited

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Lower Colorado River
Multi-Species Conservation Program

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2014 to 2018 Summary Report

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ACRONYMS AND ABBREVIATIONS

ac	acre(s)
Ag	gold
AGFD	Arizona Game and Fish Department
AHY	after hatching year
AIC	Akaike's information criterion
AOU	American Ornithologists' Union
ASY	after-second-year
ATY	after third year
Bk	black
BLCA	Beal Lake Conservation Area
Bill Williams River NWR	Bill Williams River National Wildlife Refuge
BWR-East	Bill Williams River-East
BWR-West	Bill Williams River-West
CDFW	California Department of Fish and Wildlife
Cibola NWR	Cibola National Wildlife Refuge
Cibola NWR Unit #1	Cibola National Wildlife Refuge Unit #1 Conservation Area
COB	confirmed breeding
CRIT	Colorado River Indian Tribes
CVCA	Cibola Valley Conservation Area
DNA	deoxyribonucleic acid
DPS	distinct population segment
ESA	Endangered Species Act
F	female
ft	foot/feet
g	gram(s)
GPS	Global Positioning System
ha	hectare(s)
Havasu NWR	Havasu National Wildlife Refuge
HCP	Habitat Conservation Plan
km	kilometer(s)

LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LDCA	Laguna Division Conservation Area
Lv	lavender
M	male
m	meter(s)
mB	mid-blue
MDB	Microsoft Access database
MEFF	mobile electronic field form
Mg	magenta
mi	mile(s)
MHz	megahertz
n =	number equals (sample size)
Nature Trail	Cibola National Wildlife Refuge Unit #1 Conservation Area Nature Trail
NAU	Northern Arizona University
NMB	neotropical migratory bird
oz	ounce(s)
Parametrix	Parametrix, Inc.
POS	possible breeding
PRB	probable breeding
PVER	Palo Verde Ecological Reserve
R	red
Reclamation	Bureau of Reclamation
S	silver
SD	standard deviation
SR	State Road
SSRS	Southern Sierra Research Station
SY	second year
UAGC	University of Arizona Genetics Core
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
V	violet
VIF	variance inflation factor
Y	yellow
YBCU	yellow-billed cuckoo (*Coccyzus americanus*)
YEW	Yuma East Wetlands

Symbols

©	copyright
°C	degrees Celsius
°F	degrees Fahrenheit
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
μ	mean
#	number
%	percent
±	plus or minus
®	registered trademark symbol
–	to

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EXECUTIVE SUMMARY

The western distinct population segment (DPS) of yellow-billed cuckoos (*Coccyzus americanus occidentalis*, YBCUs) has declined dramatically over the past century, following extensive loss of riparian forests, and was listed as threatened in 2014 (U.S. Fish and Wildlife Service 2014). In 2005, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was created to protect, maintain, and create breeding habitat for YBCUs and other threatened and near-threatened species occurring within the historical flood plain of the lower Colorado River (LCR MSCP 2004a). This report details a 5-year study (2014–18) to monitor the response of YBCUs to ongoing LCR MSCP habitat creation and helps inform future habitat restoration for YBCUs in the region.

After plantings in LCR MSCP conservation areas began in 2006, the initial YBCU response was monitored from 2008 to 2013 (McNeil and Tracy 2013; McNeil et al. 2013a). Within the planted areas, YBCU detections and territories increased from 25 survey detections (2.95/20 hectares [ha]) (49.4 acres [ac]) and 3 confirmed territories in 2008 to 130 detections (5.89/20 ha [49.4 ac]) and 29 confirmed territories in 2012. The increasing trend continued in 2013, with 262 survey detections (8.9/20 ha [49.4 ac]) in LCR MSCP conservation areas. Following these initial YBCU monitoring projects (2008–13), in 2014 work began on a new 5-year study. Objectives of this study included:

1. Assisting the Bureau of Reclamation (Reclamation) in documenting and standardizing data collected for the YBCU project

2. Documenting the presence of YBCUs in suitable habitat within the LCR MSCP region

3. Monitoring and documenting population parameters, such as nest success, breeding density, productivity, and survival rates, which can be used to assess habitat quality.

After 2015, the scope of work was reduced. For the remaining 3 years, field work continued within LCR MSCP conservation areas only, and population monitoring was removed from the objectives. To assist Reclamation in data documentation and standardization, new mobile electronic field forms were tested in 2014 and implemented for the remainder of the project to ensure consistent data collection (detailed in Chapter 1).

To document the presence of YBCUs within the LCR MSCP study area, YBCU surveys continued from 2014 to 2018 in selected LCR MSCP conservation areas, including the Beal Lake Conservation Area (BLCA), Palo Verde Ecological Reserve (PVER), Cibola Valley Conservation Area (CVCA), Cibola National Wildlife Refuge Unit #1 Conservation Area (Cibola NWR Unit #1), Laguna Division Conservation Area (LDCA), and Yuma East Wetlands (YEW), each described in Chapter 2. Areas surveyed in 2014 and 2015 also included non-

LCR MSCP conservation areas (or areas since removed from the project) within the study area, including the Muddy River (Overton Wildlife Management Area), Topock (within the Havasu National Wildlife Refuge), Bill Williams River-East (BWR-East) and Bill Williams River-West (BWR-West), the ʻAhakhav Tribal Preserve, the Picacho National Wildlife Refuge, the Imperial National Wildlife Refuge, and Laguna (Mittry). Following the reduction in scope of this project, surveys continued in LCR MSCP conservation areas from 2016 to 2018, and a portion of the Bill Williams River National Wildlife Refuge (Bill Williams River NWR) from 2017 to 2018. Also, due to a change in survey protocols, from 2014–15, five surveys were completed at all sites, and from 2016 to 2018, four surveys were completed per site. To account for the inconsistent annual effort, results from the first four surveys only were used in annual comparisons.

Between 2014 and 2018, 23 to 42 sites (approximately 953 to 1690 ha [2,355 to 4176 ac]) were surveyed annually, resulting in 212 to 301 survey detections, or 2.97 to 6.20 detections/20 ha (49.9 ac). Survey detections increased from 2014 (3.55/20 ha [49.4 ac], 286 detections) to 2016 (6.20/20 ha [49.4 ac], 293 detections), fell considerably in 2017 to 2.97/20 ha (49.4 ac) (212 detections) – their lowest level for the 5-year period – and rose in 2018 to 3.02/20 ha (49.4 ac) (255 detections). Annual detection counts were driven by results from one conservation area, the PVER, which contributed an average of 64–71% of all annual detections. At the Bill Williams River NWR, continued lower total detections and detections/20 ha coincided with a reduced survey effort, from 16 sites surveyed in 2014 (BW Marsh to Cave Wash), to no sites surveyed in 2016, and 6 sites surveyed in 2017–18 between Sandy Wash and Mineral Wash. Within this section of the refuge, survey detections declined from 0.79/20 ha (15 detections) in 2014, to no detections in 2017, and 0.58/20 ha (49.4 ac) (11 detections) in 2018. With areas planted under the LCR MSCP since 2006 maturing over the years, and planting finished in some areas (including the PVER), the effects of habitat age on YBCU detections from 2008 to 2018 were also explored, including site size, which has previously been found to affect YBCU occupancy. As predicted, younger and larger sites were associated with increased detections in LCR MSCP planted habitat; thus, the recent decline in detections observed within these sites may be related to the older average age of the current habitat matrix. Another likely cause for the overall declining trend includes the prolonged drought currently impacting the entire Southwestern United States/Mexico region, further discussed below. Survey results are detailed in Chapters 3 and 4.

Original objectives of this project included using population parameters to assess whether YBCUs are increasing as a result of LCR MSCP habitat creation activities and to provide a reference for the status of YBCUs using created habitat. Following the reduction in the scope of this project, this objective was removed after 2015. Banding and resighting efforts occurred to some degree each year from 2014 to 2018, adding to 6 years (2008–13) of banding and resighting data previously gathered for the study area. A target canopy mist net technique was

used to capture birds throughout the breeding season. All newly captured YBCUs were given a Federal band on one leg and a pinstriped aluminum band on the other leg to form a unique color combination. A small amount of blood was extracted from the brachial vein of each newly captured YBCU for deoxyribonucleic acid (DNA) sexing. In 2014 and 2015, a subset of the captured YBCUs were fitted with radio transmitters to assist in locating nests; additionally, in 2014 and 2015, seven captured YBCUs per year were fitted with lightweight Global Positioning System (GPS) tags to track their life cycle outside of the breeding period.

Attempts were made during all field work to resight previously banded YBCUs by observing (with binoculars or photographing) the legs of all detected YBCUs. Resighting efforts were limited to 50 days each in 2017 and 2018. For resighted second year YBCUs (returning young banded the previous year), the natal dispersal distance was calculated as the distance between the bird's natal nest and its (assumed first) nesting location. For returning after-second-year YBCUs, the breeding dispersal distance was calculated as the distance between the successive nests associated with each bird between years. If no nest was found, the bird's capture site was used to estimate the distance dispersed. Within-season dispersal distances were calculated for birds nesting more than once per season as the distance between each successive nest.

Population parameters measured in 2014–15 included nest survival and productivity. In these years, intensive nest searching occurred in all areas of YBCU activity to try to confirm breeding and measure nest survival and productivity. From 2016 to 2018, nest searches only occurred in areas where breeding had not been previously confirmed, which included the LDCA and YEW. Other nests were found incidentally or opportunistically during or after surveys, or during attempts to resight GPS-fitted YBCUs. Nests in 2014–15 were monitored every 2 to 4 days to determine stage, contents, and fate. A telescoping mirror or small Wi-Fi camera mounted on a pole was used to check nest contents. Nestlings were opportunistically banded when they were 3 to 6 days old if the nest was accessible. Nests were judged successful if at least one young fledged, which was determined by detecting an adult or fledgling near the nest within 2 days of the estimated fledge date. Nests were considered to have failed if they were found damaged or destroyed, if large eggshell fragments or remains were present, or the nest was observed to be empty before the earliest possible fledge date (approximately 6 days after hatching) with no further activity detected nearby. Nests were considered deserted if intact eggs or live chicks were present with no further parental activity observed nearby. Apparent nest success was calculated as the observed number of successful nests divided by the number of successful plus unsuccessful nests found. Mayfield survival (Mayfield 1975) was also calculated to account for nests that failed before being found. Productivity was estimated as the average of the minimum number known of young to have fledged and the maximum possible young fledged from each nest (all young, minus any young known not to have fledged). Clutch size was the observed total number of eggs in each nest.

Between June and August 2014–18, 233 YBCUs, 108 adults and 125 young, were newly captured in the study area. Most birds were captured at the PVER (n = 192), followed by Cibola NWR Unit #1 (n = 30), CVCA (n = 5), BWR-East (n = 4), and the BLCA (n = 2). Of the captured adults, 53 (49%) were DNA-sexed male, 54 (50%) were female, and one was unsexed. Seventy of 125 young banded were sexed female (56%), 52 were sexed male (41.6%), and 3 (2.4%) were unsexed. There were also 53 recaptures and 50 resights from 2014 to 2018 of YBCUs previously banded in the study area. Of 231 birds newly banded from 2014 to 2017, 47 (20.3%) were recaptured or resighted in subsequent years. Of banded adults, 27.4% were resighted – higher than the proportion of banded young resighted (14.5%). From banding resight data collected from 2008 to 2018, 155 dispersal events were recorded for 95 individual YBCUs. These included 31 natal, 82 breeding, and 42 within-season movements. YBCUs of all ages showed high site fidelity; 87% of the resighted young returned to their natal area, and 90% of adults returned to their previous nesting area. Twelve individuals dispersed away from their capture or previous breeding area, seven (58.3%) involving movements into the PVER from the CVCA, the Cibola National Wildlife Refuge (Cibola NWR), and BWR-East. The recorded dispersal of a male that nested at BWR-East in 2012 (McNeil et al. 2013b) and was then resighted at the PVER in 2016 suggests that some declines observed at the Bill Williams River NWR may be due to dispersal into LCR MSCP conservation areas. Natal dispersal distances averaged slightly greater than breeding dispersal distances (median = 0.78 kilometers [km], range 0.07 – 36.7 km versus 0.51 km, range 0.05 – 157.5 km) (0.49 miles [mi] versus 0.33 mi). All adults observed nesting more than once in a season nested within the same conservation area through the season (median = 150 m [492 ft], range 14–971 m [56–3,186 ft] between successive nests). In 2018, one banded YBCU was observed to nest twice in the same nest, which is previously undocumented in this species.

A banded male aged 8+ years resighted at Crane Roost in 2017 became the oldest documented YBCU to date. The resight verifies the utility of long-term, mark-resight programs. It also suggests a relatively low probability of resighting banded YBCUs. This YBCU was banded 7 years prior to being resighted for the first time in 2017. This individual may have been present in the study area, possibly at the same site each year since 2010, yet remained undetected due to the difficulty of resighting YBCU color bands. Apart from contributing to longevity and site fidelity estimates for this population, continued resight data can improve knowledge regarding survival for this population.

Continued declines in populations of neotropical migratory birds have demonstrated the need for a full life-cycle approach to their conservation (Faaborg et al. 2010). Conservation of habitat and resources in the breeding grounds may not stabilize these populations if birds face high mortality along their migratory routes or on their wintering grounds; however, ecology and behavior outside of the breeding season are poorly understood for most populations. Thus, an understanding of the habitat used by birds during migration

and wintering is essential to make a complete life-cycle assessment of threats and conservation needs (Rosenberg et al. 2016). Migration data from two western YBCUs collected via light-level geolocators (McNeil et al. 2015; Sechrist et al. 2012) gave much insight into the pre- and post-breeding movements, migration paths, and wintering grounds for this DPS, with limitations. Both birds appeared to winter within the Gran Chaco Forest of Bolivia, Paraguay, and Argentina, but their migration routes and pre- and post-breeding movements were less clear, and despite the plethora of data generated by this technology, the high (> 200 km or 124 mile) average spatial error per point prevents actual locations of any individual to be determined. To gain a better understanding of non-breeding habitat use and threats for western YBCUs, lightweight GPS tags were attached to a subset of YBCUs annually captured in the study area in 2014 and 2015. Six females and one male each year were fitted with PinPoint-10 GPS tags (Lotek Systems Inc., Ontario, Canada). Due to the observed site fidelity of many breeding YBCUs, those confirmed or suspected to be breeding were targeted for GPS attachment to increase the likelihood of recapture over the following years of the project. The GPS tags were attached to lower-back, leg-loop harnesses (Rappole and Tipton 1991) weighing 2.0 grams [0.07 ounces] with the harness (≤ 3% total body mass). Added netting efforts continued in 2016 in an attempt to recapture as many of the GPS-fitted birds as possible. After 2016, up to two capture attempts were permitted per year to retrieve any remaining GPS tags.

Of the 14 YBCUs (12 females, 2 males) captured at the PVER and fitted with GPS tags in 2014 and 2015, 7 females were recaptured: 3 in 2015, 3 in 2016, and 1 in 2017. All were examined and appeared in good health. Five of the YBCUs were nesting when recaptured, and the discovery of their nests often facilitated recapture. One was unmated when recaptured, but nested later in the season, and one YBCU's breeding status was unknown. Another YBCU had lost its harness and GPS tag before recapture. For the six YBCUs recaptured with their harnesses still on, the harnesses still appeared to be in good condition, with no sign of wear. Thirty-seven points were downloaded from the 6 retrieved GPS tags – 31 during migration, 3 from the wintering grounds, and 3 recorded at the PVER breeding site. Of 34 points recorded during migration or wintering, 22 (67%) fell on private land outside of formal protection, and 12 (33%) fell within conservation areas. The GPS tags provided much more accurate data compared to light-level geolocator data, in particular providing exact fall and spring migration stopover locations. Although few data points were collected on the wintering grounds, they all fell within the Gran Chaco Forest of central South America, agreeing with that suggested by the geolocator data. The migration data indicates that this population follows a loop migration pattern, flying along the Pacific Coast of Mexico and Central America during fall and using a more eastern path during spring. During spring, YBCUs appear to pass through the more humid Caribbean coast. See Chapter 6 for further details of the migration study.

Between 2014 and 2018, 165 YBCU nests were found in the study area within 6 conservation areas: BLCA (n = 1), BWR-East (n = 4), PVER (n = 140), CVCA (n = 4), Cibola NWR Unit #1 (n = 15), and YEW (n = 1). No nests were detected at the LDCA. Nests were located in Fremont cottonwood (*Populus fremontii*, n = 95, 57.5%), Goodding's willow (*Salix gooddingii*, n = 49, 29.7%), honey mesquite (*Prosopis glandulosa*, n = 13, 7.9%), tamarisk (*Tamarix* spp., n = 5, 3.0%), coyote willow (*S. exigua*, n = 2, 1.2%), and seep willow (*Baccharis salicifolia*, n = 1, 0.7%). Known nesting activity began mid- to late June each year and ended mid-September in 2014 and late August in 2015. From 2016 to 2018, field work generally ended before nesting activity finished. YBCU clutches in 2014 and 2015 averaged 2.80 and 2.88 eggs (range 2–4, n = 30 [2014] and 33 [2015] nests with known clutch size). From 2016 to 2018, nests were not monitored to determine clutch size or fate; however, in 2016, one nest was incidentally observed with six eggs (PVER Phase 6, Nest 5), the largest YBCU clutch recorded in the study area and at least twice the typical YBCU clutch size of 2–3 eggs. Also, at least three different YBCUs (two banded, one unbanded) were observed at this nest during resight attempts, and given the unusually high egg count and extra adults observed at the nest, the eggs were assumed to have been laid by more than one female. Also during resight attempts at the nest, an unbanded adult was observed twice picking up a nestling and flying away with it, before the nest eventually failed.

Apparent and Mayfield nest success rates were 67 and 55% (n = 33), respectively, in 2014, and 56 and 43% (n = 39), respectively, in 2015. Productivity in 2014 and 2015 averaged 1.6 and 1.2 fledged per nest, respectively. The number of young fledged from nests monitored in 2014 and 2015 were 50 to 60 and 44 to 49 young, respectively. The results indicate that although more nests were found with more eggs in 2015 compared to 2014, due to the lower average nest survival in 2015, average and total productivity declined from 2014 to 2015. In both these years, at least three nests failed to hatch any eggs despite both adults incubating long past the normal 10-day period. This was also incidentally observed at one nest each in 2017 and 2018, and another five nests in 2018 were observed abandoned with full clutches. The ongoing hotter and drier conditions impacting the study area may have begun to exceed the limits tolerable to nesting YBCUs in this study area. Excessive temperatures can cause embryonic death, and nestlings cannot survive temperatures exceeding 41 degrees Celsius (°C) (107 degrees Fahrenheit [°F] due to dehydration and stress caused by prolonged heat (Cunningham et al. 2013). Parental fitness may also be affected, as adults spend more time cooling nests from extreme temperatures up to 49 °C (120 °F) and less time foraging or feeding the nestlings, further impacting the nestlings (Richards 1970). During this project, nesting YBCUs were often observed shading nests with their wings and reducing their body temperature by gular fluttering. The birds may be regulating egg temperatures below lethal levels by high nest attentiveness and nest placement in cooler areas with high canopy cover (McNeil et al. 2013a). Given the measured decline in productivity of YBCU nests in 2015, along with the

apparent increase in the number of eggs failing to hatch in the study area, continuing nest monitoring in the study area is merited. Population monitoring is further detailed in Chapter 5.

Since before 2008 and throughout the entire period of monitoring YBCUs in the LCR MSCP study area, the Southwestern United States and Mexico were experiencing a period of prolonged drought that continued through the end of the field season in 2018. The period from 2000 to 2014 was the driest 15-year timespan ever recorded in the Colorado River Basin, with local tree-ring data showing 2000–15 was the driest 16-year period for the study area in the last 100 years, and among the driest in the last 1,200 years (Udall and Overpeck 2017). Colorado River flows from 2000 to 2014 were 19% below the 1906–99 average, and a third of the reduced flow was explained by above-average temperatures (0.9 °C [1.6 °F] above the 1906–99 average) (Udall and Overpeck 2017). Historic drought conditions continued throughout the study area from 2015 to 2018 (National Oceanic and Atmospheric Association 2018).

During this period, the Bill Williams River NWR, historically a regional YBCU stronghold, received no significant flooding between two managed dam releases in 2005 and 2018, and the YBCU population fell from the peak observed in 2010 (McNeil et al. 2013a, 2013b), to no YBCUs detected in 2017, recovering slightly after the flood release in 2018. Although no breeding activity has been confirmed at the refuge since 2015, it is possible that breeding occurred during this time. A gradual decline in the health of the riparian community within the refuge was noted – large cottonwoods, Gooding's willows and coyote willows largely succumbing to the impacts of the drought by 2017, and the overall riparian bird community also appeared to decline in numbers over the 5-year period. Additionally, drone footage of the refuge taken in April 2018 (Brennan 2018) to document the effects of the managed release revealed extensive impacts to vegetation quality from the ongoing drought.

Meanwhile, under these regional drought conditions, breeding YBCUs were observed to successfully occupy the planted LCR MSCP sites since monitoring began in 2008. It is possible that the regular flood irrigation occurring throughout each breeding season in the planted LCR MSCP sites has largely buffered the YBCU population against the harshest effects of the drought, enabling the population to persist. With this warmer, drier trend predicted to continue in the Southwestern United States through this century (Seager and Vecchi 2010; Woodhouse et al. 2010), over the lifetime of the LCR MSCP, this program and the successful adaptive management of YBCU breeding habitat may be crucial to the short-term viability of the regional population.

Chapter 1

INTRODUCTION AND PROJECT BACKGROUND

Lower Colorado River Multi-Species Conservation Program

In 2005, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was created "to balance the use of Colorado River water with the conservation of native species and their habitats" (LCR MSCP 2004a). This coordinated, comprehensive, long-term, multi-agency effort focuses on conserving habitat, working toward the recovery of threatened and endangered species, and reducing the likelihood of additional species being listed (LCR MSCP 2004a). The Bureau of Reclamation (Reclamation) is the implementing agency of the LCR MSCP.

The LCR MSCP encompasses areas within the historical flood plain of the Colorado River from Lake Mead to the United States-Mexico International Boundary, a distance of about 644 kilometers (km) (400 miles [mi]) along the river (LCR MSCP 2004a). A Habitat Conservation Plan (HCP) was designed to provide Endangered Species Act (ESA) compliance over the 50-year period of the program (LCR MSCP 2004b).

Developed between 1996 and early 2005, the LCR MSCP includes the creation of more than 3,278 hectares (ha) (8,100 acres [ac]) of riparian, marsh, and backwater habitat for six federally listed species protected under the ESA. In addition, 20 other covered species that are "… included under the Endangered Species Act (ESA) incidental take authorization and are either currently listed or proposed for listing as threatened or endangered under the ESA or are protected under Arizona, California, or Nevada law; or may become listed during the 50 year LCR MSCP term that are affected by covered activities" (see https://www.lcrmscp.gov/publications/hcp_volii_dec04.pdf.

Yellow-billed Cuckoo Biology and History

The yellow-billed cuckoo (*Coccyzus americanus occidentalis*, YBCU) was listed as endangered in California (California Department of Fish and Game[1] 1978), as a species of special concern in Arizona (Arizona Game and Fish Department [AGFD] 1988), and a U.S. Forest Service sensitive species in Arizona and New Mexico (U.S. Department of Agriculture 1988). In 2014, the U.S. Fish and

[1] Now the California Department of Fish and Wildlife.

Wildlife Service (USFWS) listed the western distinct population segment (DPS) of YBCUs as threatened (USFWS 2014). The LCR MSCP will refer to the western DPS of the YBCU as YBCU or western YBCU in this report.

Western YBCUs are riparian obligate birds that migrate between their breeding grounds in the United States and wintering areas in South America (McNeil et al. 2015; Sechrist et al. 2012; USFWS 2014). They are among the last neotropical migrants to arrive in Arizona and California to breed, beginning to arrive in late May (Bent 1940). During the breeding season, their diet consists primarily of large insects, such as grasshoppers, katydids, caterpillars, mantids, and cicadas, and can include tree frogs and small lizards (Bent 1940; Hamilton and Hamilton 1965; Hughes 2015; Nolan and Thompson 1975). Breeding of western YBCUs often coincides with the availability of large insects (Ehrlich et al. 1992). The population of this species has declined mainly due to the loss of their preferred riparian breeding habitat (USFWS 2014).

Western YBCUs usually nest between late June and late July but can begin nesting as early as late May and continue until late September (Hughes 2015). In the lower Colorado River (LCR) region, their nesting period primarily occurs from late June to late August, peaking in mid- to late July. Western YBCUs at the PVER, located north of Blythe, California, have been documented nesting into September (McNeil and Tracy 2013; McNeil et al. 2013a; Parametrix, Inc., [Parametrix] and Southern Sierra Research Station [SSRS] 2015), and adults tending young may remain until mid-October (Halterman et al. 2016).

Riparian tree species primarily used by YBCUs for nesting in this study area include Goodding's willow (*Salix gooddingii*), Fremont cottonwood (*Populus fremontii*, hereafter cottonwood), and tamarisk (*Tamarix* spp.). Other trees or large shrubs used include honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*P. pubescens*), mule-fat (*Baccharis salicifolia*, also known as seep willow), and coyote willow (*S. exigua*) (McNeil et al. 2013a).

Nests are built by both sexes and consist of a loose platform of sticks. Clutch sizes typically range from one to five (Payne 2005), typically two to three eggs (Hughes 2015; Laymon 1998). In the LCR MSCP study area, the average clutch size was 2.8 from 72 nests monitored between 2008 and 2012 (McNeil et al. 2013a). Eggs are generally laid daily until clutch completion (Jay 1911). Incubation begins once the first egg is laid and lasts for 9 to 11 days (Hughes 2015; Potter 1980, 1981). Both sexes incubate, with males tending the nest overnight (Halterman 2009). Young hatch asynchronously and are fed mostly large insects (Halterman 2009; Laymon and Halterman 1985; Laymon et al. 1997). After fledging at 5 to 9 days, young YBCUs may be dependent on adults for up to 3 weeks (Laymon and Halterman 1985; McNeil et al. 2013a). Fall migration begins in August, and most birds have left by mid-September (Hughes 2015; McNeil et al. 2013a).

YBCU History in the Study Area

Historically, an estimated 160,000 to 200,000 ha (395,369 to 494,211 ac) of heavily wooded flood plain (Grinnell 1914) occurred within the Lower Colorado River Valley between Fort Mohave and Yuma (Mearns 1907). During that time, YBCUs were thought to be fairly common, though few early records of YBCUs exist (Gaines and Laymon 1984). Beginning with the removal of mature cottonwood to fuel steamboats by the 1890s (Ohmart et al. 1988), followed by the construction of major dams, such as the Laguna (1907), Hoover (1935), Imperial and Parker (1938), and Davis Dam (1951), much of the existing LCR flood plain was converted to agriculture and urban settlement (Ohmart and Anderson 1982; Phillips et al. 1964), and an extensive range reduction of YBCUs was noted (Grinnell and Miller 1944). In the 1970s, the regional YBCU population was estimated at 358 individuals: 244 between Davis Dam and the Mexican border, and 114 at the mouth of the Bill Williams River (Gaines and Laymon 1984). By 1980, just 32,678 ha (80,749 ac) of riparian woodland was estimated remaining in the Lower Colorado River Valley (Hunter et al. 1988).

Between 1993 and 2001, several YBCU surveys were conducted at the Bill Williams River National Wildlife Refuge (Bill Williams River NWR) (Halterman 1998, 2001; Halterman and Laymon 1994, 1995), which by then supported the most extensive remaining riparian forest in the LCR MSCP study area. These surveys recorded pairs rather than individuals, and estimates fluctuated between 6 and 30 pairs. Surveys from 2001 through 2004 recorded between 34 and 78 individuals detected (Halterman 2002, 2003, 2004). Surveys conducted in 2005 along the lower Colorado and Gila Rivers recorded 33 detections, 78% of which were at the Gila River confluence and Limitrophe (Johnson et al. 2006). Surveys conducted in 2006, which included the Bill Williams River NWR, recorded 180 detections, 65% of which were at the Bill Williams River NWR (Johnson et al. 2007). Surveys in 2007 recorded 163 detections in the study area, 85% of which were at the Bill Williams River NWR (Johnson et al. 2008).

In 2006, planting and flood irrigation of cottonwood, Gooding's and coyote willow, and mesquite began in LCR MSCP conservation areas to create habitat for YBCUs and other riparian species. Beginning 2 years post-planting at each site, the response by YBCUs was monitored through surveys and other field work conducted from 2008 through 2012 (McNeil et al. 2013a). The population of YBCUs within planted LCR MSCP areas steadily increased from 28 survey detections and 3 breeding territories in 2008 to 131 survey detections and 29 breeding territories in 2012 (McNeil et al. 2013a). YBCUs typically began nesting in the newly planted areas 2 years post-planting. Over the same timeframe, the population within the Bill Williams River NWR fluctuated from a high of 142 detections in 2010, to a low of 73 detections in 2012, showing a steady decline over the 5 years (McNeil et al. 2013a). Surveys continued in 2013, with 274 survey detections and 16 territories identified in LCR MSCP

conservation areas, while survey detections at the Bill Williams River NWR further declined to 41 as the dry conditions and lack of flooding there continued (McNeil and Tracy 2013).

Project Scope of Work

Objectives of the 5-year study during 2014 to 2018 included:

1. Assisting Reclamation in documenting and standardizing data collected for the YBCU project, which would be accomplished by implementing standardized mobile electronic field forms (MEFFs) and creating data dictionaries, metadata, and quality assurance/quality control processes following completion of field work (after the 2014 field season, all data will be collected electronically when feasible).

2. Documenting the presence of YBCUs in suitable habitat within the LCR MSCP region in 2014 and 2015. From 2016 to 2018, the scope of work for this project was reduced, and YBCU surveys were conducted only within LCR MSCP conservation areas, as 10 years of system-wide data had been collected and sufficient numbers of YBCUs were occupying conservation areas to inform LCR MSCP habitat management questions.

3. Monitoring and documenting population parameters that could be used to assess habitat quality, such as nest success, breeding density, productivity, and survival rates in 2014 and 2015. After 2015, this objective was removed from the scope of work, as 8 years of data were available that documented nest success, breeding density, and productivity.

Data Standardization and Documentation

In 2013, Reclamation instituted a three-tiered naming convention to be used for all projects conducted under the LCR MSCP (table 1). The area encompassed by the LCR MSCP boundary was divided into standardized areas, sites, and sections, with areas covering the largest geographic extent and sections covering the smallest. Several projects may be ongoing within these areas during the same breeding season; therefore, section boundaries were delineated by Reclamation based on the needs of various projects occurring within those locations, and they may not entirely encompass all YBCU habitat. For the YBCU project, a Global Positioning System (GPS) unit was used to determine the boundaries of potential breeding habitat within each section. Where boundaries were inaccessible, georeferenced aerial imagery was used to estimate the boundaries. Once potential breeding habitat was identified within each site, survey transects were established (as described below).

Table 1.—Naming conventions for the YBCU project under the LCR MSCP

Term	Definition
Study area	Potential YBCU breeding habitat within the LCR MSCP boundary, along a 603-km (375-mi) stretch of the LCR and tributaries from the Muddy River (Nevada) to Yuma, Arizona.
River reach (reach)	A discrete watershed segment used for the analysis of impacts and conservation measures (LCR MSCP 2004a). Survey results are grouped by each river reach in this report.
Survey area (area)	A collection of clustered monitored sites.
Survey site (site)	At least 20 ha (49 ac) of potential breeding habitat that contains cottonwood and Goodding's willow of structural types I–III (sites with an overstory averaging > 4.6 meters (m) [15 feet (ft)] tall) (Anderson and Ohmart 1984) that can be monitored in one morning. For full coverage of the area, one or more linear transects are traversed.
Section	A spatially explicit location that may include transects, survey points, plots, net lanes, and trap lines used for different projects under the LCR MSCP.
Transect	Spatially explicit trails spaced 200 to 250 m (656 to 820 ft) throughout potential breeding habitat from which YBCU surveys are conducted.
Survey point (point	Spatially explicit location where YBCU call broadcasts are played to elicit responses. Points are spaced 100 m (328 ft) apart along transects (Halterman et al. 2016).

To address data standardization and meet objective 1 listed above under "Project Scope of Work," data collected during YBCU field work under the LCR MSCP transitioned from paper to electronic data collection. Prior to 2014, data were recorded in the field on paper data forms, with spatial data recorded on Garmin GPS units. Following daily field work, the GPS points were imported into Microsoft Access database (MDB) forms along with other data transcribed from the paper data forms at the project field houses. Paper data forms continued to be used in 2014, in conjunction with entering data while in the field into MEFFs created with TerraSync™ version 5.41 loaded onto Trimble® Juno 3B GPS units (Trimble Navigation, Ltd., Sunnyvale, California). GPS Pathfinder Office version 5.6 (Trimble Navigation, Ltd., Sunnyvale, California) was used to transfer, differentially correct, review, and address any additional errors identified in MEFF data files, which were then exported to MDB files. The MEFFs were tested and evaluated, with changes made iteratively until the forms were satisfactory. Each data file was named following a standardized LCR MSCP naming convention, all fields were checked for accuracy, and the vertical precision of every point was checked, with explanations added if points had less than 15-meter (m) (49-foot [ft]) precision. Metadata was created for all data fields. All changes made to data files after initial upload were documented and uploaded to a Reclamation SharePoint site.

Beginning in 2015, all paper data forms were eliminated, and field data were entered into MEFFs on Juno 3B GPS units and processed with GPS Pathfinder Office. Data were entered while in the field whenever possible. If field conditions interfered with electronic data collection, the data were first entered into field notebooks, and spatial locations were recorded with Garmin GPS units if necessary, and then transferred into MEFFs later at a field house. In 2016, the MEFFs were revised to address issues identified in 2015 (Parametrix and SSRS 2016b). A single MEFF was created to enter data for all field tasks, to streamline data entry, and to allow increased time for observation. The MEFFs were simplified (e.g., all field tasks were combined into a single MEFF rather than one MEFF per field task, and fewer data were recorded) due, in part, to the reduced scope of work. The simplification of the MEFFs also enabled easier data management within a central MDB, allowing for faster review of all data as they were being collected.

YBCU Presence and Population Monitoring

To document the presence of YBCUs in suitable habitat within the LCR MSCP study area (objective 2; see "Project Scope of Work," above), standardized YBCU surveys (Halterman et al. 2016) continued from 2014 to 2018 in survey areas and sites within the study area as described in Chapter 2. Results of these surveys are detailed in Chapters 3 and 4. Objective 3, population monitoring, is discussed in Chapters 5 and 6. These chapters provide an assessment of the regional YBCU population and provide information for Reclamation's ongoing adaptive management of riparian areas in the study area.

Chapter 2

STUDY AREA AND SITE DESCRIPTIONS

Study Area and Site Selection

Surveys of potential and previously occupied YBCU habitat were conducted at sites spanning approximately 603 km (375 mi) of the LCR and tributaries, from the Muddy River in southern Nevada, to Yuma, Arizona (the study area, figure 1). Sites that YBCUs would potentially use in the study area were defined in the LCR MSCP Habitat Conservation Plan as at least 10 ha (25 ac) of contiguous riparian vegetation containing cottonwood and Goodding's willow of structural types I–III (an overstory averaging > 4.6 m or 15 ft tall) (Anderson and Ohmart 1984; LCR MSCP 2004a). Occasionally, smaller patches of habitat were also surveyed depending on their location and perceived quality. However, almost all nesting occurs in patches 20 ha (50 ac) or more in extent (Halterman et al. 2016). Additionally, territory sizes (95% kernel density estimates) in this study area averaged approximately 20 ha (50 ac), based on observations of 77 radio-tracked YBCUs from 2009 to 2012 (McNeil et al. 2013a), and no nests have been found in this study area in patches smaller than about 20 ha (50 ac). Thus, most small, isolated patches are unlikely to support breeding. Between 2014 and 2018, 23 to 42 sites were surveyed annually (table 2).

Sites were initially surveyed annually if one or more potential breeding territories were reported during either of the previous two breeding seasons. In addition, all LCR MSCP conservation areas at least 2 years old and containing suitable habitat were surveyed annually. In 2016, Reclamation reduced the scope of this project to include surveys of sites only within LCR MSCP conservation areas, as 10 years of system-wide data had been collected and sufficient numbers of YBCUs were occupying conservation areas to inform LCR MSCP habitat management questions.

As discussed in Chapter 1, Reclamation instituted a three-tiered naming convention to be used for all projects conducted under the LCR MSCP (table 2). A GPS unit was used to determine the boundaries of potential breeding habitat within each section defined under this system, and where boundaries were inaccessible, georeferenced aerial imagery was used to estimate the boundaries. Once potential breeding habitat was identified within a section, survey transects were established (as described in Chapter 4). Sites are clustered within survey areas and are listed in table 2.

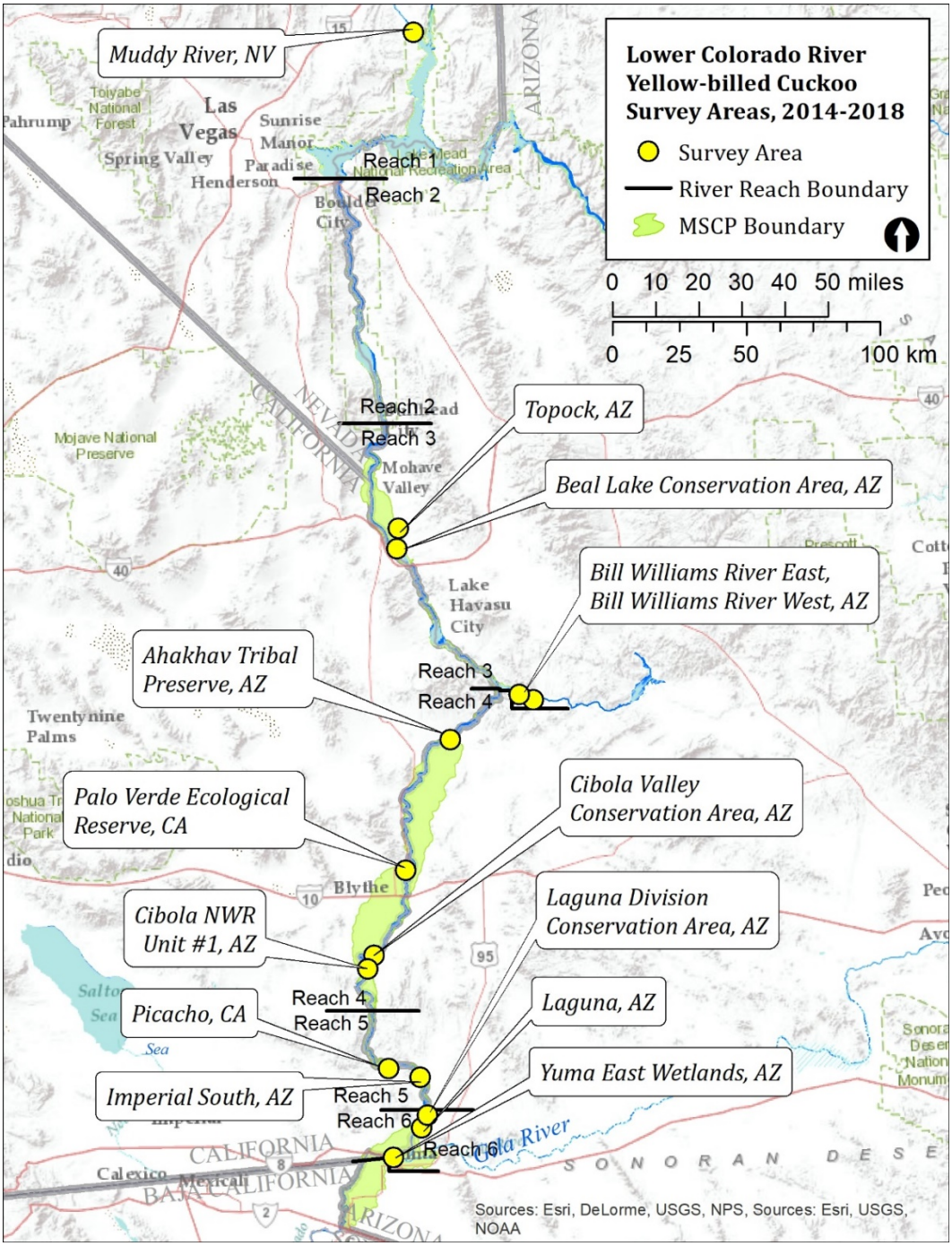

Figure 1.—The 2014 to 2018 LCR MSCP yellow-billed cuckoo study area and survey areas.

Table 2.—Sites surveyed for YBCUs in the LCR MSCP study area between 2014 and 2018

Geographic area	LCR MSCP study areas	Site name	Hectares	Acres	2014[1]	2015[1]	2016[1]	2017[1]	2018[1]	Note
Overton Wildlife Management Area, Nevada[2]	Muddy River (Reach 1)	Overton Wildlife	40.00	98.84	1	1	0	0	0	
Havasu National Wildlife Refuge, Arizona	BLCA[2] (Reach 3)	CPhase 05	19.67	48.60	1	1	1	1	1	Reported together
		CPhase 06	15.84	39.14	1	1	1	1	1	
	Topock (Reach 3)	Pintail Slough	22.31	55.13	1	1	0	0	0	
		Topock Platform	9.33	23.05	1	1	0	0	0	
Bill Williams River National Wildlife Refuge, Arizona	BWR-East (Reach 3)	Cave Wash	44.91	110.97	1	1	0	0	0	
		Cougar Point	49.73	122.88	1	1	0	1	1	
		Esquerra Ranch	73.89	182.58	1	1	0	1	1	
		Gibraltar Rock	90.14	222.74	1	0	0	1	1	
		Honeycomb Bend	24.85	61.40	1	1	0	0	0	
		Kohen Ranch	43.45	107.36	1	1	0	1	1	
		Mineral Wash	40.99	101.29	1	1	0	1	1	
	BWR-West (Reach 3)	Borrow Pit	37.75	93.28	1	1	0	0	0	
		BW Marsh	18.37	45.39	1	1	0	0	0	
		Cross River	50.51	124.81	1	1	0	0	0	
		Fox Wash	90.85	224.49	1	0	0	0	0	
		Middle Delta	39.21	96.89	1	0	0	0	0	
		Mosquito Flats Site 12	35.29	87.20	1	1	0	0	0	Reported together
		Mosquito Flats Site 13	23.61	58.34	1	1	0	0	0	
		North Burn	42.14	104.13	1	1	0	0	0	
		Sandy Wash	80.78	199.61	1	1	0	1	1	

Table 2.—Sites surveyed for YBCUs in the LCR MSCP study area between 2014 and 2018

Geographic area	LCR MSCP study areas	Site name	Hectares	Acres	2014[1]	2015[1]	2016[1]	2017[1]	2018[1]	Note
Blythe, California	'Ahakhav Tribal Preserve (Reach 4)	CRIT 09	62.54	154.54	1	1	0	0	0	
	PVER[3] (Reach 4)	Phase 1	25.02	61.82	1	1	1	1	1	
		Phase 2	31.57	78.01	1	1	1	1	1	
		Phase 3	34.00	84.01	1	1	1	1	1	
		Phase 4	41.25	101.93	1	1	1	1	1	
		Phase 5	87.45	216.09	1	1	1	1	1	
		Phase 6	88.95	219.80	1	1	1	1	1	
		Phase 7	91.64	226.44	1	1	1	1	1	
		Phase 8	14.59	36.05	0	0	1	1	1	
Cibola Valley, Arizona	CVCA[4] (Reach 4)	Phase 1	37.17	91.85	1	1	1	1	1	
		Phase 2	27.47	67.88	1	1	1	1	1	
		Phase 3	43.87	108.40	1	1	1	1	1	
		Phase 4	24.44	60.39	0	0	0	1	0	
		Phase 7	30.25	74.75	0	0	0	0	1	
		Phase 8	46.61	115.17	0	0	0	0	1	
	Cibola NWR Unit #1[5] (Reach 4)	Cottonwood Genetics	16.47	40.70	1	1	1	1	1	
		Crane Roost	57.31	141.61	1	1	1	1	1	
		CW-North	7.25	17.91	1	1	1	1	1	
		Hippy Fire	58.77	145.22	0	1	1	1	1	
		Mass Transplanting	16.16	39.93	1	1	1	1	1	
		Nature Trail	14.50	35.83	1	1	1	1	1	

Table 2.—Sites surveyed for YBCUs in the LCR MSCP study area between 2014 and 2018

Geographic area	LCR MSCP study areas	Site name	Hectares	Acres	2014[1]	2015[1]	2016[1]	2017[1]	2018[1]	Note
Yuma, Arizona	Imperial South (Reach 5)	Fishers Landing	34.00	84.01	1	1	0	0	0	
	Picacho (Reach 5)	Lago Tres	14.80	36.57	0	1	0	0	0	
	Laguna (Reach 6)	Mittry	12.19	30.12	1	1	0	0	0	
	LDCA[6] (Reach 6)	Reach 1	225.82	558.00	0	0	1	1	1	
		Reach 2	211.71	523.14	0	0	0	0	1	(140 ha [346 ac])
	YEW[7] (Reach 6)	A North Channel	8.17	2.47	0	0	0	1	1	Reported together
		J	18.63	20.19	0	0	0	1	1	
		I	17.97	46.03	1	0	1	1	1	Reported together
		South AC	9.08	44.40	1	0	1	1	1	
		South C	13.57	22.44	1	0	1	1	1	
		Total	**2,316.83**	**5724.89**	**42**	33.53	**23**	**32**	**34**	

[1] Value of “1” indicates the site was surveyed that year, “0” indicates no survey that year.
[2] BLCA = Beal Lake Conservation Area.
[3] PVER = Palo Verde Ecological Reserve.
[4] CVCA = Cibola Valley Conservation Area.
[5] Cibola NWR Unit #1 = Cibola National Wildlife Refuge Unit #1 Conservation Area.
[6] LDCA = Laguna Division Conservation Area.
[7] YEW = Yuma East Wetlands.

Site Descriptions

Sites surveyed at any time between 2014 and 2018 are described below, from north to south by geographic area, and alphabetically within each area. In this report, results of some adjacent sites are presented together as one site, including two sites at the Beal Lake Conservation Area (BLCA) presented as one site and five sites at Yuma East Wetlands (YEW) presented as two sites (see the "Note" column in table 2). Site descriptions were recorded in the years the sites were surveyed and may not reflect current conditions. Vegetation height and cover measures were based on visual estimates made during site visits before or after surveys.

Survey detections and estimated territories are included for each site and year surveyed. Note that detection totals here include results from all survey visits, which included up to five visits for 2014–15 surveys and four visits for 2016–18 surveys. All detections summarized in the following site descriptions were assessed by spatial location, observed behaviors, and associated dates, and used to categorize the breeding status for each occupied patch as a possible (POS), probable (PRB), or a confirmed (COB) breeding territory (following Halterman et al. 2016) (see table 13 in Chapter 4).

Overton Wildlife Management Area

Nevada

Area: Muddy River

Clark County, Nevada

This area lies within the Muddy River Basin in Moapa Valley, about 3.2 km (1.9 mi) south of Overton on State Road (SR) 169. The Nevada Department of Wildlife manages the Overton Wildlife Management Area as wildlife habitat, and it consists of 7,145 ha (17,657 ac) of Mojave Desert upland and riparian flood plain where the Muddy River flows into the Overton arm of Lake Mead. Within the flood plain, 66 ha (165 ac) of agricultural crops, including barley (*Hordeum vulgare*) and alfalfa (*Medicago sativa*), are grown for migrating and wintering waterfowl. Most riparian habitat not managed for waterfowl has been invaded by tamarisk. There is little suitable habitat within the Overton Wildlife Management Area, and part of one site was surveyed in 2014 and 2015. The sites were not surveyed after 2015.

Site: Overton Wildlife (MROW) ***40 ha (99 ac)***

Section: Overton Wildlife

The Overton Wildlife site included small patches of remnant Goodding's willow with a tamarisk understory along the main channel of the river. Dominant trees were Goodding's willow lining the main channel and scrubby tamarisk forming a dense understory; a narrow stringer of cottonwoods lined the perimeter of the

agricultural fields. The survey followed a line of cottonwoods between an access road, a seasonally flooded pond, and fallow fields, and continued along the flood plain of the Muddy River. Several fields to the west were dry during the breeding season and flooded in winter for waterfowl. Upstream to the north, east, and south, patches of tamarisk lined the main fork of the Muddy River. Adjacent to the riparian vegetation are Mojave Desert uplands dominated by creosote bushes (*Larrea tridentata*). There were two survey detections here in 2014 and one detection in 2015. This site was not surveyed after 2015.

Havasu National Wildlife Refuge

San Bernardino, California, and Mohave County, Arizona

The Havasu National Wildlife Refuge (Havasu NWR) was established in 1941 and encompasses over 48 km (30 mi) of the LCR and adjacent land from Needles, California, to Lake Havasu City, Arizona. YBCU habitat within the refuge is almost entirely within the Topock Marsh area, a historical river meander east of the main river channel currently managed as wildlife habitat. Water levels are seasonally manipulated to benefit wildlife and recreation. Two areas within the refuge were surveyed in 2014 and 2015: BLCA and Topock. Only the BLCA area was surveyed after 2015.

Area: Beal Lake Conservation Area

Mohave County, Arizona

Sites: CPhase 05, CPhase 06 (BLBL) ***35.5 ha (87.7 ac)***

Sections: C1505, C1506

The BLCA lies approximately 3 km (1.9 mi) south of Topock Platform between Beal Lake and Topock Marsh, and contains two sites surveyed together. The sites consist of a mosaic of native trees planted in the historical Colorado River flood plain. Approximately 43 ha (106 ac) were planted from 2003 to 2005 (LCR MSCP 2008a, 2010). Of those hectares, 35.5 (83 ac) were surveyed for YBCUs from 2014 through 2018. Multiple access roads cross the sites and define the perimeters. The sites are irrigated throughout the nesting season via an irrigation ditch bordering the southeastern edge, which connects Beal Lake to the southwest, with Topock Marsh to the northeast. There were 6 survey detections here in 2014; 7 detections, 1 PRB, and 1 COB territory (1 nest) in 2015; 10 detections and 1 PRB territory in 2016; 3 detections and 1 POS territory in 2017; and 8 detections and 1 COB territory (based on a copulation observed) in 2018.

Area: Topock

Mohave County, Arizona

Site: Pintail Slough (TKPS) ***22.3 ha (55.3 ac)***

Sections: North Dike, Pintail Slough

At the time of surveys in 2014 and 2015, the North Dike section was a mature restoration plot along the north dike of Topock Marsh, with an overstory of cottonwood and Goodding's willow and an understory of mule-fat and honey mesquite. An agricultural field to the north separated habitat in this section from Pintail Slough. The section is surrounded by access roads, with a cement-lined irrigation canal along the western edge. The historical flood plain lies south and west and is dominated by honey mesquite and tamarisk. The Pintail Slough section consists of a single row of large cottonwoods lining the slough, a restored field of cottonwoods and willows 250 m (820 ft) to the south, and another stand of cottonwoods and willows 300 m (984 ft) southeast. The slough supports cattails (*Typha* sp.), and the surrounding understory is a mix of tamarisk, arrowweed (*Pluchea sericea*), and quail bush (*Atriplex lentiformis*). The southeast habitat is dominated by cottonwoods that established naturally following flooding of nearby wintering waterfowl habitat. The southern planted field had a sparse overstory of cottonwoods and a dense groundcover of non-native Johnsongrass (*Sorghum halepense*). A system of access roads intersects the section. There were three survey detections at this site in both 2014 and 2015, with one POS territory estimated in 2015. This site was not surveyed after 2015.

Site: Topock Platform (TKTP) ***9.3 ha (23 ac)***

Section: Topock Platform

Topock Platform was first planted with cottonwood and Goodding's willow in the late 1990s as nursery stock for other restoration efforts. The trees were rarely cut, and additional trees were planted or grew voluntarily. It now includes 9.3 ha (23 ac) of restored native habitat located next to fields formerly flooded in winter for waterfowl habitat. The understory, which came in voluntarily, increased the diversity of the vegetation over the years. However, the USFWS no longer irrigates this site, and at the time of the last surveys in 2015, it was in severe decline, with many dead and dying cottonwoods and Goodding's willows present. During summer, this habitat patch was dry and supported a healthy cicada population. There was one survey detection at this site in 2014 and three detections and one POS territory in 2015. This site was not surveyed after 2015.

Bill Williams River National Wildlife Refuge

La Paz and Mohave Counties, Arizona

The BWR-East and BWR-West areas are within the Bill Williams River NWR (figure 2). This site was established in 1993 and was formerly part of Havasu NWR, which was established in 1941, to protect the largest remaining natural riparian forest in the Lower Colorado River Valley. It is located 14.3 km (8.9 mi) south of Lake Havasu City, Arizona, and consists of 2,430 ha (6,000 ac) of river drainage managed by the USFWS. The refuge extends from Lake Havasu upstream along the Bill Williams River for about 16 km (10 mi), and it has historically supported some of the most extensive and productive YBCU breeding habitat in the watershed (Johnson et al. 2008). Portions of the river contain perennial surface water. The managed hydrologic regime historically enabled overbank flooding necessary for natural regeneration of native vegetation and persistence of Fremont cottonwood-Goodding's willow (hereafter cottonwood-willow) forest. In the past, occasional winter releases from Alamo Dam resulted in some natural riparian forest regeneration. According to the U.S. Army Corps of Engineers, the release of Alamo Dam water was needed to conduct maintenance and repairs to the 50-year-old, 86.26-m (283-ft) earthen structure. During 2018, some survey sites still retained low surface-water flows, as listed in site descriptions below.

Drone video footage of the refuge recorded in April 2018 (Brennan 2018) shows that most sites along the river are currently parched, with extreme die-off of riparian trees due to ongoing drought, which also limited flood releases, and tamarisk defoliation by the tamarisk beetle (*Diorhabda* spp.). The last significant flood release was in the winter of 2004–05. On March 19, 2018, a small release occurred that was designed to mimic a late-winter storm. The highest flow occurred March 23, 2018, and slowly subsided by April 1, 2018.

Tamarisk is considered to be a high priority noxious weed in many areas throughout the Western United States. Public support for tamarisk control has increased over the past decade, and Public Law 109320, Salt Cedar and Russian Olive Control Demonstration Act, was passed by the Congress in 2006 garnering Federal and State support for control projects. Tamarisk beetles were introduced in 2001 by the U.S. Department of Agriculture to help manage tamarisk (RiversEdge West 2018). This species is effective in reducing the population of this noxious weed, due to its ability to damage tamarisk through repeated leaf defoliation. Tamarisk beetles have now been recorded in every State of the Southwestern United States (RiversEdge West 2018). Since 2007, tamarisk beetle distribution maps have been generated to help monitor the beetle's distribution in the Southwest (RiversEdge West 2018). The tamarisk beetle and its larvae feed on the leaves of the tamarisk, which does not kill the tree immediately, so affected tamarisk can resprout along their stems. Due to this resprouting, 5 to 7 years of beetle infestation may be required for tamarisk stands to succumb to this defoliation process (RiversEdge West 2018). In 2016, elf owl (*Micrathene*

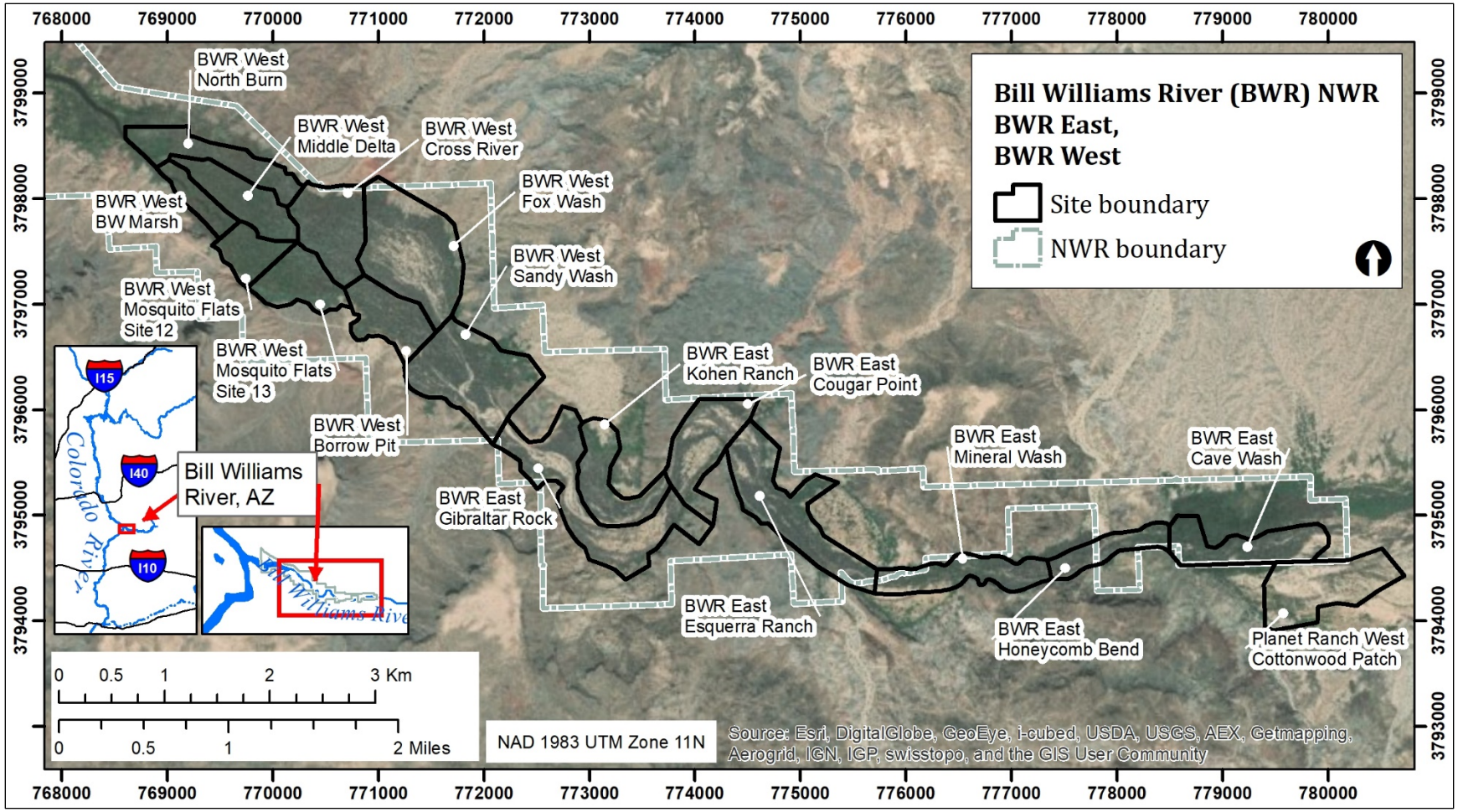

Figure 2.—BWR-East and BWR-West areas, showing sites surveyed between 2014 and 2018.

whitneyi) surveyors at the BWR-East and BWR-West sites noted that tamarisk beetles were abundant, but in 2018, YBCU surveyors noted that as the tamarisk have declined along the Bill Williams River, the tamarisk beetle numbers have also declined (Arcidiacono 2018, personal communication).

The vegetation composition and structure in the eastern half of the Bill Williams River NWR significantly differs from that found downstream from Gibraltar Rock in the western half of the refuge. East of Gibraltar Rock, shallow underground bedrock and cliffs bordering the riparian area increase perennial flows and surface water. West of Gibraltar Rock, the river channel widens into a sandy, broad flood plain that persists to the western edge of the refuge at its interface with Lake Havasu.

Sites previously surveyed in the BWR-East and BWR-West areas were removed from the study after 2015 due to the reduced scope of work, with Bill Williams River sites falling outside of the LCR MSCP conservation areas. With the addition of Planet Ranch to the LCR MSCP in 2016, portions of the Bill Williams River NWR became creditable acres under the program (LCR MSCP 2004b). Thus, in 2017, the stretch of riparian forest between Mineral Wash (BWR-East) and Sandy Wash (BWR-West) were included again in the surveys. Fifteen sites were surveyed here in 2014, 12 in 2015, 0 in 2016, and 6 in 2017 and 2018.

Area: Bill Williams River-East
Mohave and La Paz counties, Arizona

Site: Cave Wash (BECW) ***44.9 ha (111 ac)***
Section: Cave Wash

This site is in the flood plain of the Bill Williams River at the eastern end of the refuge. This portion of the refuge consists of a broad riparian area with both historical and recently formed river channels. There were extensive areas of dense tamarisk in 2014 and 2015, although the vegetation was predominately native. Water was seasonally present in some side channels and perennial in the main channel. The main channel was lined with young cottonwood, Goodding's willow, and tamarisk, averaging 10 m (32 ft) high, surrounding dense marsh. There was one survey detection at this site in 2014 and no detections in 2015. This site was not surveyed after 2015.

Site: Cougar Point (BEPT) ***49.7 ha (122.8 ac)***
Section: Cougar Point

This site lies between the Esquerra Ranch and Gibraltar Rock sites, and is the western section of the pre-2009 Big Bend route. It follows the river bend around

Cougar Point and has a cottonwood-Goodding's willow overstory with a honey mesquite bosque edge and an understory of honey mesquite and tamarisk. Arborescent desert scrub lines the cliffs to the north and south. The north includes an area of previous forest regeneration that followed flooding in 2005. The southern part skirts older forest along the old river channel. In spring and summer 2018, water ran in the riverbed where some young cottonwoods and willows now grow. Very few live, mature cottonwoods were observed by 2018, and all mature willows observed were dead. Large amounts of deadfall has washed downstream, leaving open sandy beaches along the riverbed. There were no survey detections at this site in 2014, 2015, 2017, or 2018. This site was not surveyed in 2016.

Site: Esquerra Ranch (BEER) ***73.9 ha (183 ac)***
Section: Esquerra Ranch

This site lies between Mineral Wash and Cougar Point and begins near the confluence of Mineral Wash and the Bill Williams River. The transect runs along the river channel to a bend known as Cougar Point. It is bounded by a steep cliff on the southwest and broad dry uplands (the site of the historical Esquerra Ranch house) to the northeast. It is currently open, with many fallen cottonwood and Goodding's willow snags, with scattered live tamarisk creating a tangled understory. The Bill Williams River was dry here from 2014 to 2017. Water flowed from the managed release from Alamo Dam in March 2018, during the spring and summer months. Young cottonwood and Goodding's willows line the riverbed, and deadfall has washed downstream, creating large dams. There were three survey detections at this site in 2014, two detections and one POS territory in 2015, no detections in 2017, and two detections and one POS territory in 2018. This site was not surveyed in 2016.

Site: Gibraltar Rock (BEGR) ***90.1 ha (222.6 ac)***
Section: Gibraltar Rock

This site is located between Cougar Point and Sandy Wash, south of Kohen Ranch. The eastern portion is generally xeric and open, with patches of large native trees and a dense understory of tamarisk. The western half is dry, with small patches of large native trees and a dense understory of tamarisk, traversing the old refuge road near the Gibraltar Rock cliff formation. One 2-ha (5-ac) patch of live honey mesquite, tamarisk, and cottonwood persists, with most riparian vegetation dead. Following the managed release in March 2018, the Bill Williams River flowed during the spring and summer months. Young cottonwoods and willows line the riverbed. There were no survey detections at this site in 2014, no detections in 2017, and one detection in 2018. This site was not surveyed in 2015 or 2016.

Site: Honeycomb Bend (BEHB) ***24.8 ha (61 ac)***
Section: Honeycomb Bend

This transect follows the Bill Williams River, connecting Cave Wash to the east and Mineral Wash to the west. It follows the Bill Williams River through some of the best riparian forest on the refuge. Tall cottonwoods and Goodding's willows with a dense understory of Goodding's willows, arrowweed, and tamarisk dominate the multi-structured forest. The river is perennial, and beaver dams have created ponds lined with dense willows, cattails, and tamarisk. The riparian area is restricted by surrounding cliffs, with intermittent overbank flooding. The surrounding Sonoran Desert vegetation includes saguar cacti (*Carnegiea gigantea*) and creosote bushes. Perennial water flows through this site, and seasonal flooding occurs during winter and summer rains. A public access road follows Mineral Wash, and there is some recreational activity where the road terminates at the river. There were seven survey detections, one POS, and one COB territory at this site in 2014, and two detections with two POS and one PRB territory estimated in 2015. This site was not surveyed after 2015.

Site: Kohen Ranch (BEKR) ***43.4 ha (107.2 ac)***
Section: Kohen Ranch

Kohen Ranch covers areas of natural regeneration that occurred following prolonged flooding in 2005. The route begins at the historical Kohen Ranch and heads northeast following the northern edge of the riparian corridor paralleling the Gibraltar Rock route. The route passes through a mature cottonwood forest with a honey mesquite bosque edge and an understory of honey mesquite and tamarisk. Arborescent desert scrub lines the cliffs to the south and a restoration area, in which 8 ha (20 ac) of abandoned agricultural fields were planted by the USFWS in 2009 to increase honey mesquite bosque habitat and to enhance terrace avian communities, is located at the northern edge.

The densest and tallest forest is in the immediate Bill Williams River corridor. The majority of riparian vegetation is dead due to drought and the lack of flowing water in previous years, and a 12-ha (30-ac) section hosts 90% of live plants onsite. In 2018, the Bill Williams River flowed during the spring and summer months. Young cottonwoods and Goodding's willows line the riverbed. There were two survey detections at this site in 2014, no survey detections in 2015, and no survey detections in 2017. In 2018, there were five detections and two POS territories estimated here. This site was not surveyed in 2016.

Site: Mineral Wash (BEMW) ***41 ha (101 ac)***
Section: Mineral Wash

This linear site is located toward the eastern end of the Bill Williams River NWR between Honeycomb Bend and Esquerra Ranch, following the river channel from a restricted canyon bordered by cliffs to an open flood plain. It is comprised of a cottonwood-Goodding's willow overstory with a honey mesquite bosque edge and an understory of honey mesquite and tamarisk. Arborescent Sonoran Desert scrub lines the cliffs to the north and south, and saguaro cacti and creosote bushes are present. Seasonal flooding typically 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. The densest and tallest forest exists in the immediate Bill Williams River corridor. In 2018, the Bill Williams River flowed during spring and summer. Young cottonwoods and Goodding's willows line the edge of the river. A few large cottonwoods grow in the outer ecotone area. There were nine survey detections and three COB territories (two nests, one fledgling) at this site in 2014, six detections with three POS and two COB territories in 2015, no detections in 2017, and two survey detections in 2018. This site was not surveyed in 2016.

Area: Bill Williams River-West
Mohave and La Paz Counties, Arizona

Site: Borrow Pit (BWBP) ***37.8 ha (93 ac)***
Section: Borrow Pit

This site connects Cross River to the west and Sandy Wash to the east, following a trail along an old river channel paralleling the west-end refuge access road. The survey was conducted from the dry river channel and bluffs overlooking the site. At the time of the last survey in 2015, the southern half contained mature cottonwood-willow forest with a dense tamarisk understory. The northern half includes extensive areas of dense tamarisk with occasional dense stands of cottonwood and willow. There were two survey detections here in 2014 and no detections in 2015. This site was not surveyed after 2015.

Site: BW Marsh (BWMA) ***18.4 ha (45.5 ac)***
Section: BW Marsh

This site was surveyed by kayaks. This route provided access to habitat within the broad western flood plain by following the main channel of the Bill Williams River upstream of Lake Havasu. The channel floods seasonally from upstream waters and is periodically inundated by fluctuating lake levels. In 2014 and 2015, the vegetation consisted of cottonwoods and willows with a dense understory of

tamarisk. The shore was lined with cattails. Regular boating and fishing activities occur here. There were no survey detections at this site in 2014 and two detections and one POS territory in 2015. This site was not surveyed after 2015.

Site: Cross River (BWCR) ***50.5 ha (124.8 ac)***
Section: Cross River

This site bisects the river delta approximately 1 km (0.6 mi) upstream of Lake Havasu. It connects Borrow Pit to the south and North Burn to the north and in 2014 was mostly comprised of tall cottonwoods and willows with a mixed native and dense tamarisk understory. There were also smaller patches of younger cottonwood-willow and occasional monotypic dense tamarisk. There are multiple historical river channels within this site. There were two survey detections here in 2014. This site was not surveyed after 2014.

Site: Fox Wash (BWFW) ***90.8 ha (224.4 ac)***
Section: Fox Wash

This site is north of Sandy Wash, following the main channel of the Bill Williams River, and ending in a wide flood plain to the west. At the time of the last surveys in 2014 and 2015, scattered dense bands of tall cottonwoods and willows lined the main channel, and narrower and more open native vegetation lined several historical channels. The interior was open with patches of scrubby tamarisk, while narrow patches of marsh vegetation surrounded remnant pools along the main channel. Groundcover was sparse and mostly bare sand. There were two survey detections at this site in 2014. This site was not surveyed after 2014.

Site: Middle Delta (BWMD) ***39.2 ha (96.9 ac)***
Section: Middle Delta

This site traverses an extensive patch of mature, mixed exotic vegetation extending upstream of the river delta between the BW Marsh and North Burn sites. It also connects to Cross River and North Burn. In 2014, the eastern (upstream) end had extensive patches of mature cottonwood overstory with an open understory. To the west, the overstory consisted of patches of mature willows, which became sparse closer to Lake Havasu. The understory was dominated by dense tamarisk. The western end of this site is bordered by two forks of the Bill Williams River Delta. There was one survey detection at this site in 2014. This site was not surveyed after 2014.

Sites: Mosquito Flats Site 12, Site 13 (BWMF) ***58.9 ha (145.5 ac)***
Sections: Site 12, Site 13

The riparian forest at the western end of the refuge spreads across a wide flood plain. In 2014, the original Mosquito Flats site was separated into two sites – Site 12 (West) and Site 13 (East) – to more adequately survey both the interior and exterior areas of the original site, though both are similar in composition. There is minimal visitor use in summer and some vehicle traffic on the main road to the south. The water table can be high here, indicated by standing ponds and water-filled side channels during high water events. There were three survey detections at the site in 2014 and seven detections in 2015, including one PRB territory. This site was not surveyed after 2015.

Site: North Burn (BWNB) ***42.1 ha (104 ac)***
Section: North Burn

Much of the North Burn site burned in 2005 and regenerated with tamarisk, quail bush, and a few native trees. The survey route lies within the habitat rather than along the edge and is reached by the Cross River trail. The site can also be reached by kayak. There were no survey detections at this site in 2014 and two detections in 2015. This site was not surveyed after 2015.

Site: Sandy Wash (BWSW) ***80.8 ha (199.7 ac)***
Section: Sandy Wash

This site connects Gibraltar Rock to the southeast, Fox Wash to the north, and Cross River to the northwest (the latter two were surveyed in 2014 and 2015 only). This section of the Bill Williams River NWR gradually widens into a flood plain laced with dry river channels. The transect loops around the eastern end of the broad flood plain, which follows an old road and river channel. It has a cottonwood-willow overstory with a mesquite bosque edge and an understory of honey mesquite and tamarisk. Arborescent desert scrub lines the cliffs to the north and south. Hikers and researchers frequently use this easily accessible site. In 2018, the Bill Williams River flowed during spring and again in mid-July. The majority of trees here are dead due to drought. There were four survey detections at this site in 2014 and two survey detections in 2015, including one POS territory. By 2017, most riparian trees were dead due to drought. There were no survey detections in 2017 and one detection in 2018. This site was not surveyed in 2016.

Colorado River Indian Tribes' Lands

Area: 'Ahakhav Tribal Preserve
La Paz County, Arizona

The 'Ahakhav Tribal Preserve lies along the Colorado River on Colorado River Indian Tribes' (CRIT) lands approximately 3.5 km (2.1 mi) southwest of Parker, Arizona. Established in 1995, the preserve comprises 507 ha (1,253 ac) of mixed native forest, restored river channels, and a park. The site is bordered by Mojave Road to the south and agricultural fields to the east and west.

Site: CRIT 09 (AKC9) ***62.5 ha (154.4 ac)***
Section: CRIT 09

Over 54 ha (133 ac) of riparian forest have been restored at this site since 2001. Periodic revegetation in some previously restored areas has resulted in multi-layer patches of varying canopy height. In 2014 and 2015, species composition consisted of 45 ha (111 ac) of mosaic plantings of cottonwood and Goodding's willow and approximately 15 ha (37 ac) of honey and screwbean mesquite. Groundcover was sparse, with little understory and sandy soil. There was generally no standing water observed during site visits. The survey route follows roads around the perimeter and interior of this site. There were four survey detections at this site in 2014 and three detections in 2015. This site was not surveyed after 2015.

Palo Verde Valley
Riverside County, California

Area: Palo Verde Ecological Reserve

The PVER is located 12 km (7.5 mi) north of Blythe, California (figure 3). The 547-ha (1,352-ac) area was acquired by the State of California in 2004. Riparian restoration activities were implemented in phases by Reclamation, with public use and hunting managed by the California Department of Fish and Wildlife (CDFW). Planting concluded in 2013. The details of planting and management are outlined in the Palo Verde Ecological Reserve Restoration Development Plan: Overview (LCR MSCP 2006), including the specific development plans for each phase (see www.lcrmscp.gov). The PVER is comprised of approximately 414 ha (1,023 ac) of near-contiguous irrigated riparian forest spanning 5 linear km (3.1 mi) bordering the LCR. Farming activity, including overhead crop dusting, occurs regularly in adjacent fields, which can also be noisy during crop planting and harvesting of the fields. The edges of the area may receive overspray of chemicals from crop dusting and tractor spray. Farm equipment travels along the main road and some perimeter and interior roads during the breeding season.

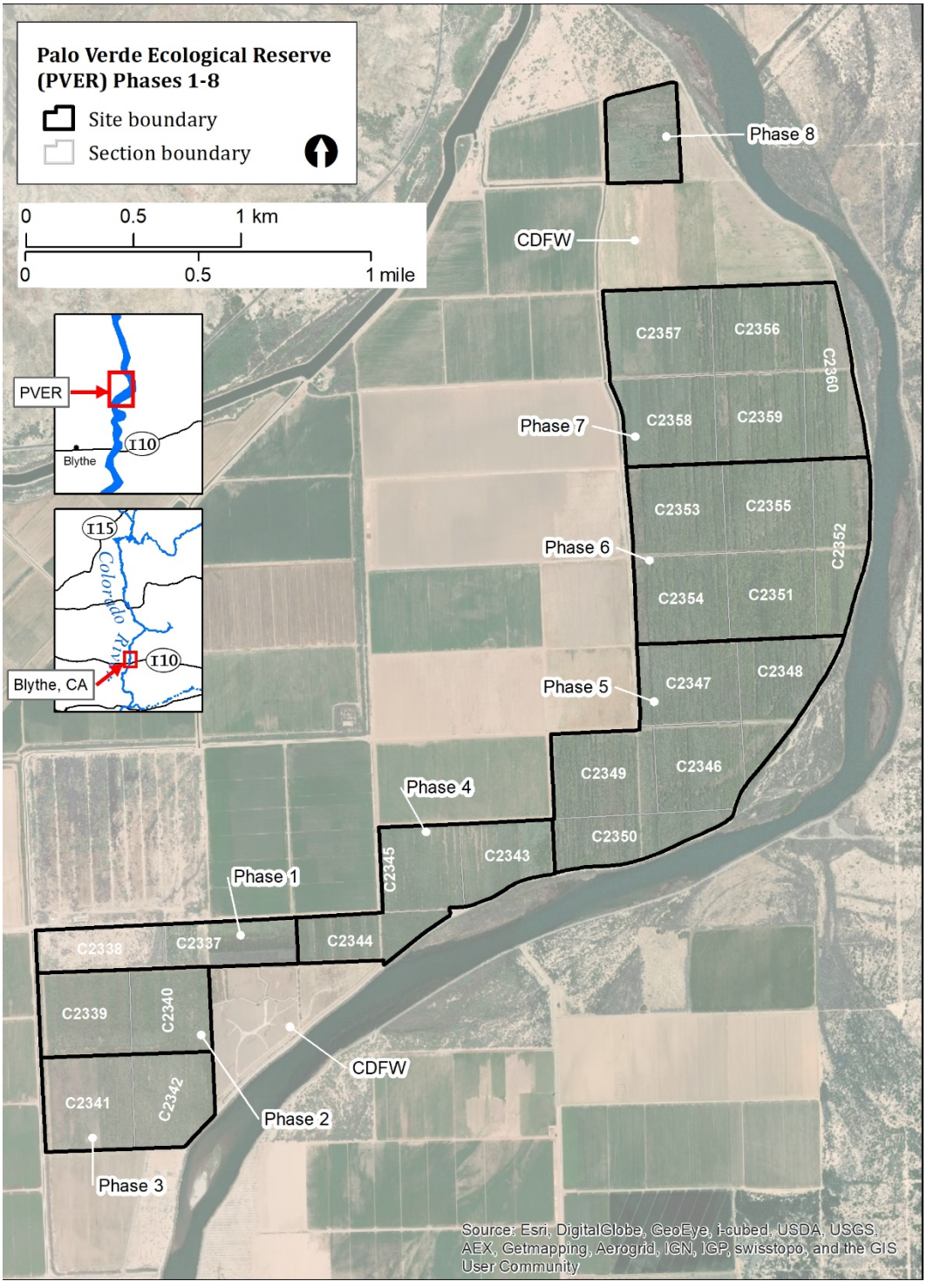

Figure 3.—PVER Phases 1–8, showing sites surveyed between 2014 and 2018.

During the first session of dove hunting from September 1 to 15, all phases (phased restoration sites) experience hunting-related disturbance. The phases at the PVER were surveyed as they became suitable breeding habitat, with Phase 7 first surveyed completely in 2014 and Phase 8 in 2016.

Site: Phase 1 (PVP1) ***25.0 ha (61.8 ac)***
Sections: C2337, C2338

Section C2337 was planted with mainly cottonwood and Goodding's willow in 2006 as a nursery plot. The southern edge includes a dense planting of coyote willow. Section C2338 was planted with honey mesquite on 6-m (20-ft) centers and has not been documented to be used by YBCUs yet. The site is bordered by dirt access roads on all sides. An agricultural field borders the north, and an open area managed by the CDFW lies to the south of Section C2337. There was one survey detection at this site in 2014, four detections and one POS territory in 2015, two detections and one POS territory in 2016, no detections in 2017, and six detections and one POS territory in 2018.

Site: Phase 2 (PVP2) ***31.6 ha (78.0 ac)***
Sections: C2339, C2340

Phase 2 was planted in 2007. This site consists mostly of alternating Goodding's willow, coyote willow, and cottonwood plantings, and it was designed to maximize the amount of edge between Goodding's willow and coyote willow, which is considered preferred habitat for the southwestern willow flycatcher (*Empidonax traillii extimus*) (LCR MSCP 2006). The eastern half of Section C2340 contains a small field planted with genetically diverse cottonwood trees (the remaining plantings within Phase 2 were planted from nursery pole cuttings). The site is bordered on all sides by dirt access roads and irrigation canals on the west, north, and south. There were 7 survey detections at this site in 2014; 14 detections, 2 POS, 2 PRB, and 2 COB territories (2 nests) in 2015; 11 detections and 3 POS territories in 2016; 6 detections and 1 POS territory in 2017; and 13 detections, 2 POS, 1 PRB, and 1 COB territory (1 nest) in 2018.

Site: Phase 3 (PVP3) ***34.0 ha (84.0 ac)***
Sections: C2341, C2342

Phase 3 was planted with stands of cottonwood and Goodding's willow for southwestern willow flycatcher habitat in 2008 and 2009. The species composition and density was planted to mimic a natural riparian landscape when fully mature. This site is bordered by dirt access roads on all sides and to the east by the LCR and an open area managed by the CDFW. The southern edge is

bordered by a large cleared and partially constructed housing development. There were 3 survey detections at this site in 2014; 11 detections in 2015, including 1 COB territory (1 nest); 2 detections and 1 POS territory in 2016; 7 detections and 1 POS, 1 PRB, and 1 COB territory (1 nest) in 2017; and 13 detections, 2 POS, and 1 PRB territory estimated at this site in 2018.

Site: Phase 4 (PVP4) ***41.2 ha (101.8 ac)***
Sections: C2343, C2344, C2345

Phase 4 was planted with cottonwood and Goodding's willow stands in 2009. It is bordered by actively farmed agriculture fields to the west and north. Dirt access roads surround the perimeter, and irrigation canals are present on the west and north sides. There were 23 survey detections and 4 nests found at this site in 2014; 24 detections, 1 POS, 2 PRB, and 5 COB territories (4 nests and 1 fledgling) in 2015; 23 detections, 2 POS, 2 PRB, and 4 COB territories (4 nests) in 2016; 7 detections, 1 POS, 1 PRB, and 1 COB territory (1 nest) in 2017; and 19 detections and 4 PRB territories estimated at this site in 2018.

Site: Phase 5 (PVP5) ***87.4 ha (216.1 ac)***
Sections: C2346, C2347, C2348, C2349, C2350

Phase 5 was planted with cottonwood and Goodding's willow stands in 2010. This site is slightly different from other PVER phases, which have more contiguous canopy cover, and there are several open meadows. It is bordered by agricultural fields to the west and the LCR to the east. Dirt access roads surround the perimeter, and an irrigation canal is on the western boundary. There were 78 survey detections and 10 COB territories (five nests) in 2014; 43 detections, 6 POS, 1 PRB, and 5 COB territories (3 nests) in 2015; 45 detections, 7 POS, 5 PRB, and 9 COB territories (8 nests) in 2016; 25 detections, 1 POS, 3 PRB, and 2 COB territories (2 nests) in 2017; and 30 detections, 4 POS, 1 PRB, and 6 COB territories (3 nests) at this site in 2018.

Site: Phase 6 (PVP6) ***88.9 ha (219.9 ac)***
Sections: C2351, C2352, C2353, C2354, C2355

Phase 6 was planted in 2011 with cottonwood, Goodding's willow, *Baccharis* spp., and open areas of native grasses, quailbush, and honey mesquite. The site is bordered by agricultural fields, an irrigation canal to the west, and the LCR to the east. Dirt access roads surround the perimeter. There were 86 survey detections and 25 COB territories, including 13 nests, in 2014; 72 detections, with 8 POS, 7 PRB, and 16 COB territories, including 11 nests found, in 2015; 59 detections

and 8 POS, 2 PRB, and 21 COB territories (17 nests) in 2016; 47 detections and 4 POS, 4 PRB, and 9 COB (6 nests) territories in 2017; and 37 detections and 4 POS and 13 COB territories (10 nests) at this site in 2018.

Site: Phase 7 (PVP7) ***91.6 ha (226.3 ac)***
Section: Phase 7

Phase 7 was planted with cottonwood, Goodding's willow, coyote willow, *Baccharis* spp., and open areas of native grasses, quailbush, and honey mesquite in 2012. This site is bordered by agricultural fields to the west and north, the LCR to the east, and Phase 6 to the south. Dirt access roads surround the perimeter.

There were 52 survey detections and 10 COB territories, including 7 nests in 2014; 55 detections, 5 POS, 4 PRB, and 12 COB territories (12 nests) in 2015; 67 detections, 17 POS, 6 PRB, and 16 COB territories (12 nests) in 2016; 40 detections, 5 POS, 1 PRB, and 12 COB territories (9 nests) in 2017; and 39 detections, 3 POS, 1 PRB, and 6 COB territories (4 nests) at this site in 2018.

Site: Phase 8 (PVP8) ***14.6 ha (36 ac)***
Section: Phase 8

Phase 8 is 500 m (1,640 ft) north of Phase 7 and separated by an agricultural field. It was planted with honey mesquite and alkali sacaton (*Sporobolus airoides*) in 2013, and scattered cottonwoods have naturally colonized. The site is bordered by agricultural fields to the south, the LCR to the east, and disturbed areas to the north and west. Dirt access roads surround the perimeter. This site was first surveyed in 2016, with no detections. There were two detections and one POS territory in both 2017 and 2018.

Cibola Valley

La Paz County, Arizona

Area: Cibola Valley Conservation Area

The Cibola Valley Conservation Area (CVCA) is located 24.2 km (15 mi) south of Blythe, California; south and east of the LCR and the California State line; and immediately north of Cibola NWR Unit #1 (figure 4). Within Cibola Valley, 412.4 ha (1,019 ac) of land owned by the Mohave County Water Authority were identified for riparian restoration as outlined in the Cibola Valley Conservation Area Restoration Development Plans (LCR MSCP 2007a-d, 2009). Restoration

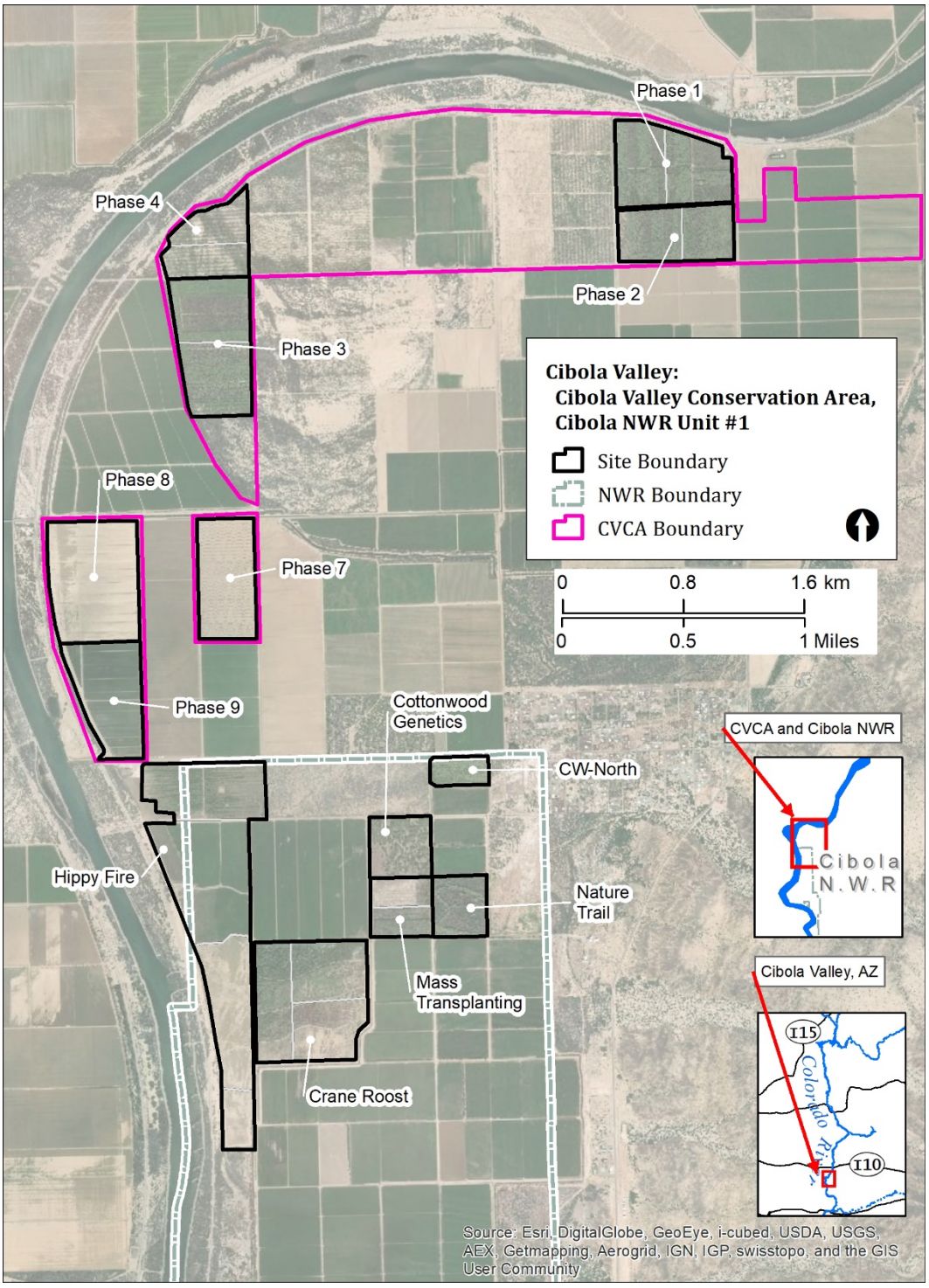

Figure 4.—The CVCA and Cibola NWR Unit #1 showing sites surveyed between 2014 and 2018.

has been implemented by Reclamation, with hunting and public access managed by the AGFD. From 2006 to 2017, trees were planted in nine phases; seven of these phases were surveyed for YBCU between 2014 and 2018. Phases 1–3 were surveyed every year, Phase 4 was surveyed in 2017 only, and Phases 7, 8, and part of 9 were first surveyed in 2018.

Site: Phase 1 (CVP1) ***37.2 ha (91.9 ac)***
Sections: C2525, C2526

The CVCA Phase 1 site consists of six fields planted in 2006 (LCR MSCP 2007b). The LCR flows approximately 100 m (328 ft) from the northern edge of the site. The dominant tree species include cottonwood, Goodding's willow, and coyote willow. River Road, Highway 78, and several dirt access roads define the perimeter of Phase 1, and additional interior dirt roads cross the site. The northern, southern, and western boundaries have cement-lined irrigation canals.

There were 8 survey detections at this site in 2014; 9 detections and 3 POS territories in 2015; 12 detections, 1 POS, 1 PRB, and 1 COB territory (1 nest) in 2016; 4 detections and 1 POS territory in 2017; and 7 detections and 2 POS territories estimated at this site in 2018.

Site: Phase 2 (CVP2) ***27.5 ha (67.9 ac)***
Sections: C2527, C2528

Phase 2 was planted in 2008 (LCR MSCP 2007c). The site is adjacent to, and south of, Phase 1, separated by a dirt access road and a concrete-lined irrigation ditch. Cottonwoods and Goodding's willows are the co-dominant trees. Farm fields are located to the east and south, and Highway 78 is directly to the east.

There were 3 survey detections and 1 COB territory (1 nest) in 2014; 10 detections and 2 POS territories in 2015; 5 detections and 2 POS territories in 2016; 8 detections, 1 POS territory, and 1 PRB territory estimated in 2017; and 2 survey detections and 1 POS territory at this site in 2018.

Site: Phase 3 (CVP3) ***43.9 ha (108.4 ac)***
Sections: C2529, C2530

Phase 3 is located 2.6 km (1.6 mi) west of Phases 1 and 2, and 400 m (1,312 ft) east of the LCR. The site was planted in 2007 with cottonwood, Goodding's willow, and coyote willow (LCR MSCP 2007d). Dirt access roads line the perimeter and bisect the plantings, restored or native vegetation surrounds three sides of the site, and an agricultural field is located to the west. There were no

detections at this site in 2014, two detections and no territories in 2015, five detections and one POS territory estimated in 2016, three detections and no territories in 2017, and no detections in 2018.

Site: Phase 4 (CVP4) ***24.4 ha (60.4 ac)***
Sections: C2531, C2532

This site is immediately north of CVCA Phase 3 and planted primarily with honey mesquite and quailbush (LCR MSCP 2008b). One test survey was conducted at this mesquite plot in 2014 after a YBCU was incidentally detected there in 2013. Though several bird species have been recorded using this site, the habitat was determined not yet to be suitable for breeding YBCUs. Additional mesquite plots were planted at Phase 5 in 2010 and Phase 6 in 2011 (LCR MSCP 2009, 2011). There were no survey detections at this site in 2014 or in 2017. This site was not surveyed in 2015, 2016, or 2018.

Site: Phase 7 (CVP7) ***30.2 ha (75 ac)***
Sections: C2356, C2357, C2358, C2359, C2360

Phase 7 is located 670 m (2,198 ft) south of Phase 3, 400 m (1,312 ft) east of Phase 8, and 1,200 m (3,937 ft) east of the Colorado River. Planting in 2015 converted the area from active agricultural fields to honey mesquite and cottonwood, which, along with earlier phases, was designed to create a native vegetation mosaic (LCR MSCP 2018a). The design included 3,000 honey mesquite trees planted in the western half of the site and 1,728 cottonwoods planted in the eastern half of the site. The soil is sandy with high transmissivity (LCR MSCP 2018a). There was one survey detection at this site in 2018. Subsequent followup visits found at least one YBCU roosting overnight in the cottonwoods and foraging in the honey mesquite.

Site: Phase 8 (CVP8) ***46.6 ha (115.2 ac)***
Section: Phase 8

Phase 8 is located 670 m (2,198 ft) south of Phase 3, 400 m (1,312 ft) west of Phase 7 across from a farm field, immediately north of Phase 9, and 200 m (656 ft) east of the LCR. Plantings in 2016 converted the area from farm fields to low- to high-density cottonwood-willow and honey mesquite communities. These plantings were designed to recreate historical plant and insect communities on the LCR for bird and bat species covered under the LCR MSCP (LCR MSCP 2018b). Phase 8 was first surveyed in 2018. Most of Phase 9 was not suitable at the

beginning of surveys in 2018, but half way through the season, a patch in the northeast section was surveyed with Phase 8. There were seven survey detections and two COB territories (two nests; one each in Phases 8 and 9).

Site: Phase 9 (CVP9) ***31.2 ha (77.2 ac)***
Section: Phase 9

Phase 9 is located immediately south of Phase 8, and at just 1 year after planting in 2017, was too young to survey in 2018. Half way through the season, vegetation in the northeast corner of the site became suitable for breeding YBCU, and three survey points were added to the Phase 8 survey (see above) to cover the newly available habitat. Therefore, this information is not reported in the tables with the regularly surveyed areas.

Area: Cibola National Wildlife Refuge Unit #1 Conservation Area
La Paz County, California

The Cibola NWR is 29.8 km (18.5 mi) south of Blythe, California, within the historical flood plain of the Colorado River. The refuge, covering more than 6,475 ha (16,000 ac), was created in 1964, and includes both the historical river channel and a channel constructed in the late 1960s. The historic channel still receives irrigation, and portions are maintained as wildlife habitat, while the new channel carries the main Colorado River flow and is extensively levied. Within the refuge, agricultural fields border tamarisk- and mesquite-dominated uplands. Most YBCU habitat on the Cibola NWR is in conservation areas receiving varying degrees of irrigation. Five sites were surveyed from 2014 to 2018, with a sixth site (Hippy Fire), added in 2015.

Site: Cottonwood Genetics (CNCG) ***16.5 ha (40.7 ac)***
Section: Cottonwood Genetics

This site was planted in 2005 with about 1,000 trees propagated at a Northern Arizona University (NAU) research greenhouse for an NAU project conducted in association with Reclamation (Nelson 2007). The plantings were used to assess the influence of stand-level genetic diversity on communities and ecosystem processes. The site is a park-like grove of mature cottonwood with an open understory. There were two survey detections here in 2014 and 2015, three detections and one POS territory estimated in 2016, and one detection in both 2017 and 2018.

Site: Crane Roost (CNCR) ***57.3 ha (141.5 ac)***
Sections: C2726, C2727, C2728

Two sections of this site (C2726 and C2727) are similar and encompass an older area in the north originally planted in 2005, consisting of tall emergent cottonwood, a grove of dense honey mesquite, mule-fat, and tamarisk. To the south, both sections include a younger plot planted beginning in 2009, which consists of cottonwood, Goodding's willow, and coyote willow. Section C2726 is bordered on the north by an access road and an agricultural field. Section C2727 is bordered on the west by an access road and irrigation canal, next to Hippy Fire Section 30. Section C2728 comprises more recently planted fields (LCR MSCP 2009) of cottonwood and willow just south of C2726 and east of C2727. The section contains surface salt deposits with shorter, sparsely distributed trees. There were 28 survey detections, 1 POS, 2 PRB, and 3 COB territories (3 nests) at this site in 2014; 33 detections, 1 POS, 1 PRB, and 4 COB territories (3 nests) in 2015; 27 detections, 5 POS, 1 PRB, and 2 COB territories (4 nests) in 2016; 22 detections, 3 PRB, and 1 COB territory (1 nest) in 2017; and 20 detections, 1 POS, 1 PRB, and 1 COB territory (1 nest) in 2018.

Site: CW-North (CNCWN) ***7.3 ha (18 ac)***
Section: CW-North

CW-North is a small, open, structurally homogeneous site with a cottonwood overstory and groundcover dominated by Bermudagrass (*Cynodon dactylon*). The site is bordered on the north by Baseline Road and agricultural fields. Fallow fields of sparse tamarisk, arrowweed, and quailbush extend east and west. The Cottonwood Genetics site is 200 m (656 ft) to the southwest, separated by an agricultural field. The Cibola National Wildlife Refuge Unit #1 Conservation Area Nature Trail (Nature Trail) is 580 m (1,903 ft) to the south, separated by three agricultural fields. There was one survey detection here in 2014 and no detections in 2015 through 2018.

Site: Hippy Fire (CNHF) ***58.8 ha (145.2 ac)***
Sections: 20 and 30

Hippy Fire was developed to create habitat for southwestern willow flycatchers, YBCUs, and other LCR MSCP-covered species. In 2013, approximately 29 ha (72 ac) of active agricultural fields (Section 20) were converted to cottonwood, Goodding's willow, coyote willow, honey mesquite, mule-fat, saltgrass (*Distichlis spicata*), and alkali sacaton (LCR MSCP 2013). First surveyed in 2015, a 30-ha (74-ac) section just west of Crane Roost was added to surveys in 2017, with additional points added in 2018 as trees matured.

This site grew rapidly and was intermittently checked for YBCUs in 2014. There were 3 detections and 1 POS territory in 2015; 6 detections and 1 POS territory estimated in 2016; 16 detections, 2 POS, 1 PRB, and 1 COB (1 nest) territory in 2017; and 19 detections, 1 POS, 1 PRB, and 4 COB territories (2 nests, 2 fledglings) at this site in 2018.

Site: Mass Transplanting (CNMT) ***16.2 ha (40 ac)***
Section: Mass Transplanting

This site west of and adjacent to the Nature Trail was planted in 2005 and 2006 with cottonwood and Goodding's willow, with some open grassy areas. Approximately 1,821 seedlings/ha (4,500 per ac) were planted to inhibit the growth of non-native species, although some open areas have been invaded by non-native Johnsongrass. There were no survey detections here in 2014 or 2015, two detections in 2016, and no detections in 2017 or 2018.

Site: Nature Trail (CNNT) ***14.5 ha (35.8 ac)***
Section: Nature Trail

This site was first planted in 1999. The transect follows a gravel trail winding through the habitat. Species composition and height vary across the site, creating structural diversity. Over half of the site was planted with screwbean mesquite. Cottonwoods dominate the higher canopy over 30% of the site. The understory includes Goodding's willow, honey and screwbean mesquite, mule-fat, and coyote willow. Much of the surrounding area is agricultural, and bordering the site north and east are seasonally flooded fields for wintering waterfowl. The site is heavily invaded with Johnsongrass. There were three survey detections and one COB (one nest) here in 2014, three detections and one POS territory in 2015, six detections and two POS territories in 2016, three detections and one POS territory in 2017, and no detections at this site in 2018.

Trail construction and associated noise disturbance occurred at this site early in the 2018 breeding season, coinciding with the first time during this project that no YBCUs were detected here.

Imperial National Wildlife Refuge

Yuma County, Arizona

Area: Imperial South

The Imperial National Wildlife Refuge was established in 1941 and encompasses 10.43 ha (25.77 ac) of riparian area and associated Sonoran Desert uplands. The headquarters is 40.3 km (25 mi) north of Yuma, Arizona, off Martinez Lake Road. The refuge follows 48.3 km (30 mi) of the LCR, including some of the last remaining unchannelized stretches. Refuge management activities include protecting backwater lakes, managing marshes, farming crops for wintering waterfowl, and restoring wetlands and riparian vegetation. One site, Fisher's Landing, was surveyed in 2015.

Site: Fisher's Landing (ISFL) ***24.4 ha (60.3 ac)***

Sections: Imperial 20A, Imperial 50, Imperial Nursery, Imperial NW

Imperial 20A was planted in 1995, 560 m (1,837 ft) from the main body of Martinez Lake. Stunted cottonwoods form a sparse canopy, averaging 20% cover. The overstory varies from 4 to 14 m (13 to 45.9 ft) high and is interspersed with mesquite. A thick groundcover of saltgrass, Bermudagrass, and common reed (*Phragmites australis*) provides 90% cover. This site is bordered by seasonally flooded wildlife ponds to the north, mixed native marshland to the east, and agricultural fields to the south and west.

Imperial 50 (4.2 ha, 10.4 ac) was planted in 2010. It consists of densely planted cottonwood and mesquite and a dense quailbush perimeter. It is surrounded on three sides by agricultural fields and on one side by restored marsh. A gravel road and two dirt roads surround the perimeter, with an irrigation canal to the north. It is approximately 200 m (656 ft) southwest of Imperial 20A.

Imperial Nursery (13 ha, 32 ac) consists of a small native nursery planted in 1994 and a band of 5- to 15-m (16.4- to 49-ft) tall cottonwood and Goodding's willow, and mesquite lining a finger of Martinez Lake, with approximately 60% canopy closure. There is a low, sparse (about 5% cover) understory of cottonwood, mesquite, arrowweed, common reed, mule-fat, and tamarisk. Surrounding vegetation includes an open field, impoundment ponds, and a mix of tamarisk, Goodding's willow, and a marsh to the north. The survey follows perimeter roads and tamarisk-willow to the north. There were two detections at Imperial Nursery in 2015, the only year of surveys at this site.

Picacho State Recreation Area

Imperial County, California

Area: Picacho

The Picacho State Recreation Area is at the site of a historical gold-mining town owned and managed by the California State Parks Department. It is 38.6 km (24 mi) north of Winterhaven, California, on the LCR. It was surveyed in 2015 only.

Site: Lago Tres (POLT) ***14.8 ha (36.6 ac)***

Section: Lago Tres

Lago Tres is a restoration site situated at the confluence of Picacho Wash and the LCR. The structurally diverse vegetation planted after tamarisk clearing in 1996 appears naturalized and is not irrigated. Cottonwood, Goodding's willow, and honey and screwbean mesquite dominate the 6- to 17-m tall canopy, averaging 30% cover. A diverse understory of arrowweed, quailbush, blue palo verde (*Parkinsonia florida* also known as *Cercidium floridum*), mule-fat, honey and screwbean mesquite, Goodding's willow, and cottonwood provides approximately 50% cover. This site is bordered by mature tamarisk trees at the Picacho State Recreational Campground and adjacent Sonoran Desert uplands to the west, and the river to the east. There was one survey detection at this site in 2015, the only year of surveys here.

Yuma

Yuma County, Arizona

Area: Laguna

The Laguna area includes the Mittry Lake Wildlife Management Area, managed by the AGFD for wildlife habitat and outdoor recreation. The area is 24.2 km (15 mi) northeast of Yuma, between the Laguna and Imperial Dams on the LCR, and is composed of open water, marsh, and planted riparian vegetation. One site here was surveyed in 2014 and 2015.

Site: Mittry (MLPR) ***12.2 ha (30.1 ac)***
Section: Pratt Restoration

Pratt Restoration is a small cooperative restoration site first planted in 1999 on a Bureau of Land Management agricultural lease. The overstory consists of cottonwood and Goodding's and coyote willows. There is an understory of mule-fat, Goodding's willow, mesquite, cottonwood, and tamarisk. Active farm fields border the north and east sides of the site, and a younger restoration patch abuts the southeastern edge. Fires regularly impact the surrounding tamarisk-dominated vegetation. The site is partly protected by surrounding roads, concrete canals, and firefighting efforts. There was one survey detection here in 2014 and three detections in 2015 during the first survey. YBCUs were likely using the site as a stopover only. It was not surveyed after 2015.

Area: Laguna Division Conservation Area
Yuma County, Arizona

The Laguna Division Conservation Area (LDCA) is located on Reclamation withdrawn lands along the LCR within the Laguna Division section of Reach 6. The LDCA is downstream from Imperial Dam and upstream of Laguna Dam, and it encompasses approximately 585 ha (1,200 ac). Prior to restoration, the area consisted of tamarisk-mesquite scrub and wetlands along the abandoned river channel between the Laguna Settling Basin and the Mittry Lake Wildlife Management Area. The restoration project created a mosaic of riparian areas consisting of open water/marsh, cottonwood, Goodding's willow, coyote willow, and honey mesquite planted from 2013 to 2015. Several meandering channels were constructed, and the hydrology of the site is managed to create and sustain four specific land cover types (cottonwood-willow, honey mesquite, marsh, and backwater) that meet LCR MSCP conservation criteria for target species as outlined in the LCR MSCP Habitat Conservation Plan (LCR MSCP 2004a). Baseline surveys in the remnant riparian areas from 2009 through 2012 (McNeil et al. 2013a) detected a few migrant YBCUs using the area. Reach 1 was first surveyed in 2016, with Reach 2 added in 2018.

Site: Reach 1 (LDR1) ***225.8 ha (558.0 ac)***
Section: Reach 1

In 2018, the 4-year-old planted cottonwoods, Goodding's willows, and coyote willows in Reach 1 were still generally sparse, spindly, yellow, and stunted, with intermittent denser patches. Several larger, greener patches skirt the open marsh areas. YBCUs have been observed foraging in the large mesquite bordering the site. There were three survey detections and one POS territory estimated at this

site in 2016; nine detections and two POS territories in 2017, and six detections and one PRB territory (with food carry) at this site in 2018, although no birds were detected again during a subsequent followup or survey visit to this area.

Site: Reach 2 (LDR2) ***211.7 ha (523.1 ac)***
Section: Reach 2

Reach 2 is generally at an earlier successional stage than Reach 1. A thin ring of stressed cottonwoods abut the marshes, while other interior areas contain taller and healthier-appearing trees. There were six detections and one POS territory estimated at this site in 2018. The POS territory was based on detections in the same location during two surveys that appeared to be a YBCU roosting in the same tree. One cooing bird was observed moving from Reach 1 to Reach 2.

Area: Yuma East Wetlands
Yuma County, Arizona

The YEW area is located along the banks of the LCR in the city of Yuma, Arizona. Until planting began in 2003, the area was a mix of exotic plants, trash dumps, and squatter camps. Before becoming part of the LCR MSCP, YEW was part of the Yuma Crossing Natural Heritage Area and was jointly managed by the city of Yuma, the Quechan Tribe, the AGFD, and private ownership. Planting at YEW began in the winter of 2003–04. The site is promoted as a recreation area with trails and restrooms. The site is highly managed, with new plantings, clearing, and frequent irrigation. Site workers, hikers, bicycle riders, and homeless people are encountered often here. Noise disturbance in this area can be high due to irrigation pumping and associated farming practices, railroad traffic, and vehicular traffic on Interstate 8 west of YEW. Only sites south of the river were surveyed in 2014 and 2015. In 2018, the first nest was found here.

Sites: A North Channel, J ***26.8 ha (66.2 ac)***
Sections: C4708, C4703

These sites are immediately east of the Ocean-to-Ocean Bridge north of the LCR. The cottonwood-dominated Site J to the north parallels the river and is connected to a small wetland area and park to the west. Some mixed native riparian vegetation recently burned to the east of the site and on a small adjacent island, but resprouting and some new restoration has occurred in these areas. No surveys were conducted here in 2014 or 2015. There was one survey detection in 2016, four detections and one PRB territory in 2017, and two detections in 2018.

Sites: I, South AC, South CI ***40.6 ha (100.3 ac)***
Sections: C4702, C4710, C4711

These sites are east of the Ocean-to-Ocean Bridge south of the LCR. The South AC site parallels the Colorado River and consists of a mosaic of plantings of cottonwood, Goodding's willow, and honey mesquite. Farther south and east, several rectangular patches of mixed-species plantings are found in sites South C and I. There was one survey detection here in 2014, no surveys in 2015, four detections and one PRB territory in 2016, two detections and one POS territory in 2017, and six detections and one COB territory (one nest) in 2018. The nest was the first found in this area since surveys began in 2009 and was located after the third survey in a dense stand of coyote willows and honey mesquite in site South C. There were five follow up visits to YEW in 2018.

Chapter 3

2018 SUMMARY

Introduction

In 2018, the fifth and final year of YBCU surveys were conducted for this project. Through these repeated surveys, the annual status of the population can be assessed. A 5-year summary of surveys and other field work conducted in the study area from 2014 to 2018 are described in Chapters 4–6.

Methods

All field work conducted in 2018 followed methods stated in Chapters 4 and 5. Any changes from these general methods are noted below.

Site Selection

All sites surveyed in 2017 (Parametrix and SSRS 2018) were again surveyed in 2018 (figure 5, table 3), with the exception of CVCA Phase 4, which was not surveyed due to lack of suitability and to enable newly suitable planted sites (2 or more years post-planting) to be surveyed. Three sites were surveyed for the first time: CVCA Phase 7 (planted 2015), CVCA Phase 8 (planted 2016), and LDCA Reach 2 (planted 2015). For the last two surveys, CVCA Phase 8 surveys included three points in the adjacent CVCA Phase 9 (planted 2017), as it became suitable during the season (cottonwood-willow type III; LCR MSCP 2004a). Descriptions of all sites surveyed in 2018 are in Chapter 2.

Surveys

The current YBCU survey protocol (Halterman et al. 2016) was followed in 2018, with four standardized YBCU call-broadcast surveys (table 4) conducted at each of 34 sites. Detailed survey methods are described in Chapter 4, and the current survey protocol is provided as attachment 1.

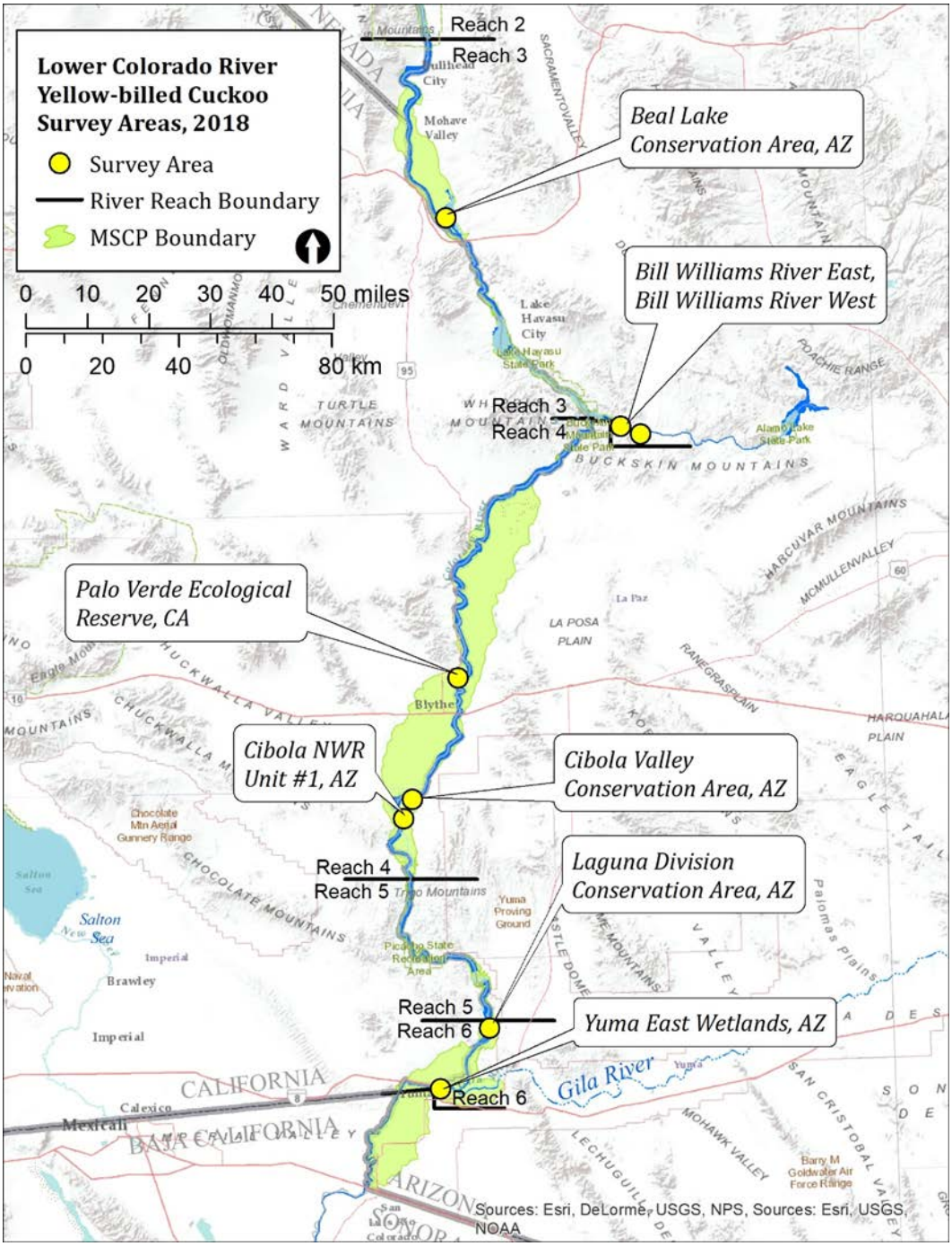

Figure 5.—The LCR MSCP yellow-billed cuckoo study area from Reach 2 to 6, 2018. Sites are clustered within survey areas.

Table 3.—LCR MSCP yellow-billed cuckoo survey areas and sites, 2018

Geographic area	LCR MSCP conservation area	LCR MSCP site code	Pre-2014 site code[1]	Site name	Size (ha)
Needles, Arizona	BLCA (Reach 3)	BLBL	HAVBR	CPhase 05[1]	19.7
		BLBL	HAVBR	CPhase 06[1]	15.8
Parker, Arizona	BWR-East (Reach 3)	BEPT	BWPT	Cougar Point	49.7
		BEER	BWER	Esquerra Ranch	73.9
		BEGR	BWGR	Gibraltar Rock	90.1
		BEKR	BWKR	Kohen Ranch	43.4
		BEMW	BWMW	Mineral Wash	41.0
	BWR-West (Reach 3)	BWSW	BWSW	Sandy Wash	80.8
Blythe, California	PVER (Reach 4)	PVP1	PVER1	Phase 1	25.0
		PVP2	PVER2	Phase 2	31.6
		PVP3	PVER3	Phase 3	34.0
		PVP4	PVER4	Phase 4	41.2
		PVP5	PVER5	Phase 5	87.4
		PVP6	PVER6	Phase 6	89.0
		PVP7	PVER7	Phase 7	91.6
		PVP8	PVER8	Phase 8	14.6
Cibola, Arizona	CVCA (Reach 4)	CVP1	CVCA1	Phase 1	37.2
		CVP2	CVCA2	Phase 2	27.5
		CVP3	CVCA3	Phase 3	43.9
		CVP7	CVCA7	Phase 7	30.2
		CVP8	CVCA8	Phase 8	46.6
	Cibola NWR Unit #1 (Reach 4)	CNCG	CIBGEN	Cottonwood Genetics	16.5
		CNCR	CIBCR	Crane Roost	57.3
		CNCWN	CIBNTH	CW-North	7.3
		CNHF	N/A	Hippy Fire	58.8
		CNMT	CIBMT	Mass Transplanting	16.2
		CNNT	CIBCNT	Nature Trail	14.5

Table 3.—LCR MSCP yellow-billed cuckoo survey areas and sites, 2018

Geographic area	LCR MSCP conservation area	LCR MSCP site code	Pre-2014 site code[1]	Site name	Size (ha)
Yuma, Arizona	LDCA (Reach 6)	LDR1	N/A	Reach 1	225.8
		LDR2	N/A	Reach 2	211.7[2]
	YEW (Reach 6)	YWANC	YUEW	A North Channel[3]	8.2
		YWJ	YUEW	J[3]	18.6
		YWI	YUEW	I[4]	18.0
		YWSAC	YUEW	South AC[4]	9.1
		YWC	YUEW	South C[4]	13.6
				Total	**1,689.7**

[1] Sites CPhase 05 and 06 surveyed and reported together.
[2] 140 ha of Reach 2 surveyed.
[3] Sites A North Channel and J (north of the Colorado River) surveyed and reported together.
[4] Sites I, South AC, and South C (south of the Colorado River) surveyed and reported together.

Table 4.—YBCU survey period dates for the LCR MSCP study area, 2018

Survey period	Survey number	Dates
1	1	June 15 to June 29
2	2	June 30 to July 13
2	3	July 14 to July 27
3	4	July 28 to August 10

Breeding Territory Estimates

Habitat patches were considered occupied if detections occurred in that area during two or more survey visits (at least 12 days apart). All survey detections were assessed by spatial location, observed behaviors, and associated dates to determine initial territories and categorize the breeding status for each territory as a possible (POS), probable (PRB), or a confirmed (COB) breeding territory (following Halterman et al. 2016) (see table 13 in Chapter 4). Additionally, observations made during 50 followup visits were used to refine the breeding status of the estimated territories, such as upgrading a POS to a PRB or COB territory. Any fledglings or juveniles detected that could have come from a territory already counted were not included as new territories.

Note that these counts estimate breeding territories and not breeding pairs, with each territory representing one nest but not necessarily two adults. Factors that complicate pair estimation include polyandrous females renesting with another male after leaving an active nest (Halterman 2009), polygyny/multiple maternity of nests (McNeil 2015), and either or both adults renesting following a successful or failed nest. Relative to the number of breeding birds in the study area, the number of territories can be understood to represent the number of pairs, assuming that two birds are associated with each nest, and that all pairs nest exactly once in a season. Given the nature of YBCUs, the true breeding population size is probably smaller than twice the number of territories.

Proportion of Habitat Occupied

To estimate the proportion of habitat occupied (≥ two survey detections at least 12 days apart), similarly sized sample units were created to control for the variation in site size (Williams et al. 2002). For sites sized < 30 ha (74 ac), site boundaries were used as sample units. At sites ≥ 30 ha (74 ac), section boundaries were used as sample units if present; otherwise, a continuous grid of 1-ha (2-ac) hexagons across the site was created in ArcGIS, with adjacent hexagons combined to form sample units sized 15–21 ha (37.11–51.9 ac) (as in McNeil et al. 2013a). This resulted in 88 sample units averaging 18.2 ha (45.0 ac, range 8.2–25.0 ha [20.3–61.8 ac]). The proportion of habitat occupied within each conservation area was calculated as the number of occupied sample units divided by the total number of sample units surveyed.

Captures and Resights

Up to two mist net attempts were scheduled in 2018 in case one of seven remaining GPS-tagged YBCUs was resighted in the study area during the field season (see Chapter 6). Capture methods are described in Chapter 5.

Nests

Searches for nests occurred in 2018 in areas where breeding had not yet been confirmed (LDCA and YEW). See Chapter 5 for detailed nest searching and monitoring methods. Nests incidentally found during field work were monitored to determine the identities of the nesting adults, in case a GPS-tagged YBCU was present (see Chapter 6).

Results

Surveys

From June 16 to August 10, 2018, 4 surveys each were conducted at 34 sites, yielding 255 survey detections (figure 6, table 5). Detections were highest at the PVER sites throughout the season, with 159 total detections, representing 62% of all survey detections and 24.5% of the surveyed area in 2018. Detections peaked during survey visit 3 (mid- to late July) at the PVER, Cibola NWR, and BWR-East areas, and peaked in most other areas during survey visit 2 (early to mid-July) (table 5). YEW detections remained stable and low (n = 2) across all survey visits. Focal avian species encountered during 2018 field work are shown in table 6. A list of incidental sightings of focal species from 2014 to 2018 is provided in attachment 2, and detailed maps of all survey sites are provided in attachment 3. Maps showing detection locations are provided in a separate document due to the confidential nature of locational data related to federally listed species.

Breeding Territory Estimates

Based on the timing, location, and persistence of all detections (survey and non-survey), 26 POS, 11 PRB, and 35 COB territories were estimated in the study area (table 5). The most common evidence of breeding were nests found (n = 24) (see Chapter 5, “Population Monitoring”). The other 11 confirmed territories were based on observed fledglings or copulations.

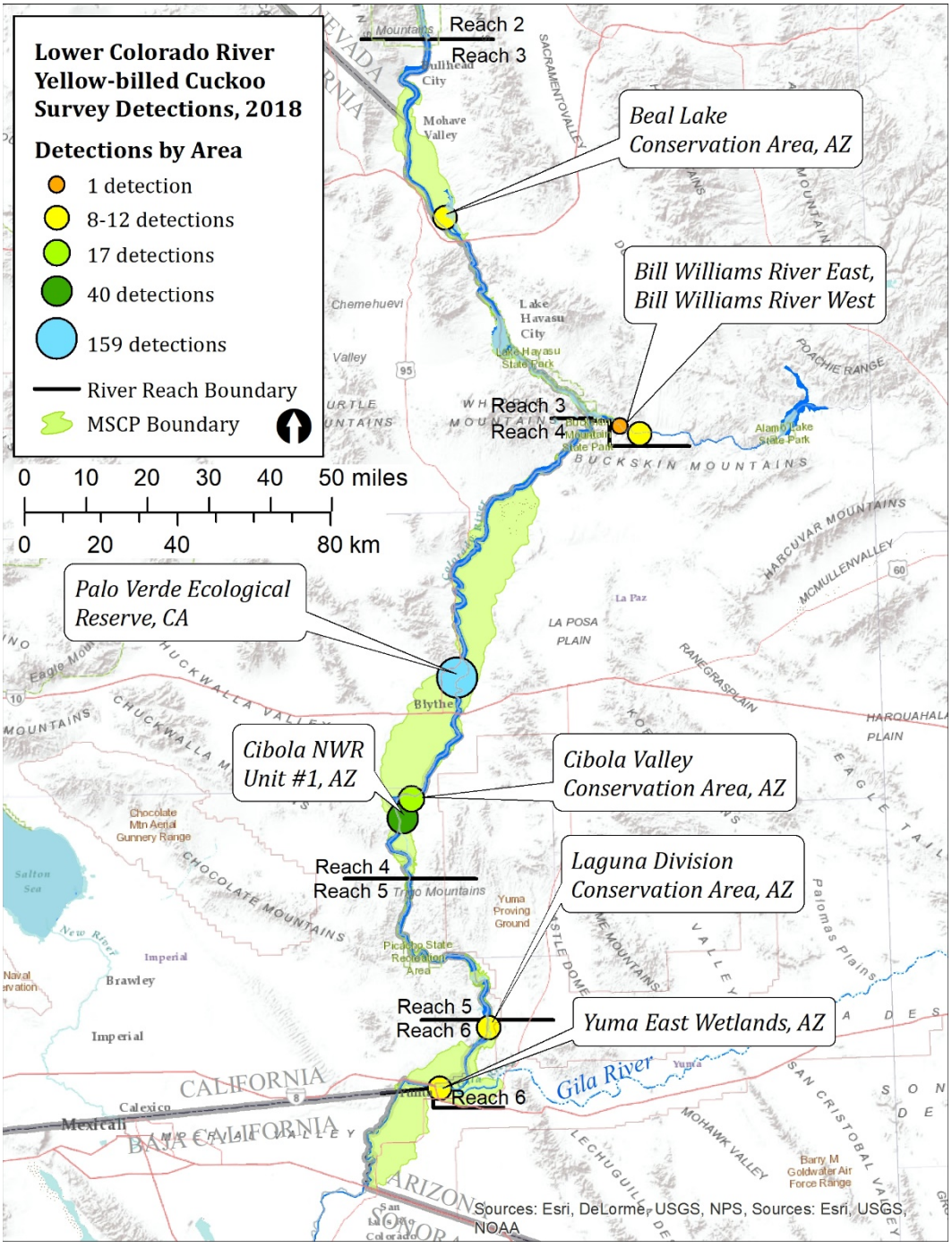

Figure 6.—Map of LCR MSCP study area showing YBCU survey results by area, 2018.

Table 5.—YBCU survey results, LCR MSCP study area, 2018

Area	Site	Survey 1 detections	Survey 2 detections	Survey 3 detections	Survey 4 detections	Total survey detections	POS	PRB	COB	Hectares (ha)	Detections per ha/20 ha	Territories per ha/20 ha
BLCA	Beal CPhase 05, 06	2 (6/22)	3 (7/6)	2 (7/19)	1 (8/2)	8	0	0	1	35.51	0.23 / 4.51	0.03 / 0.56
	BLCA total:	**2**	**3**	**2**	**1**	**8**	**0**	**0**	**1**	**35.51**	**(0.23 / 4.51)**	**(0.03 / 0.56)**
BWR-East	Cougar Point	0 (6/27)	0 (7/11)	0 (7/25)	0 (8/8)	0	0	0	0	49.73	0 / 0	0 / 0
	Esquerra Ranch	1 (6/20)	0 (7/3)	1 (7/17)	0 (7/31)	2	1	0	0	73.89	0.03 / 0.54	0 / 0
	Gibraltar Rock	0 (6/25)	0 (7/9)	1 (7/23)	0 (8/6)	1	0	0	0	90.14	0.01 / 0.22	0 / 0
	Kohen Ranch	0 (6/19)	0 (7/2)	2 (7/16)	3 (7/30)	5	2	0	0	43.45	0.12 / 2.3	0 / 0
	Mineral Wash	2 (6/21)	0 (7/4)	0 (7/18)	0 (8/1)	2	0	0	0	40.99	0.05 / 0.98	0 / 0
	BWR-East total	**3**	**0**	**4**	**3**	**10**	**3**	**0**	**0**	**298.19**	**(0.03 / 0.60)**	**(0 / 0)**
BWR-West	Sandy Wash	0 (6/28)	1 (7/12)	0 (7/26)	0 (8/9)	1	0	0	0	80.78	0.01 / 0.25	0 / 0
	BWR-West total	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**80.78**	**(0.01 / 0.25)**	**(0 / 0)**
PVER	PVER Phase 1	2 (6/19)	2 (7/5)	1 (7/19)	1 (8/2)	6	1	0	0	25.02	0.24 / 4.80	0 / 0
	PVER Phase 2	1 (6/20)	4 (7/5)	5 (7/20)	3 (8/2)	13	2	1	1	31.57	0.41 / 8.24	0.03 / 0.63
	PVER Phase 3	3 (6/20)	4 (7/5)	3 (7/20)	3 (8/2)	13	2	1	0	34.00	0.38 / 7.65	0 / 0
	PVER Phase 4	3 (6/19)	4 (7/5)	8 (7/19)	4 (8/2)	19	0	4	0	41.25	0.46 / 9.21	0 / 0
	PVER Phase 5	9 (6/18)	8 (7/4)	8 (7/18)	5 (8/1)	30	4	1	6	87.45	0.34 / 6.86	0.07 / 1.37
	PVER Phase 6	6 (6/17)	9 (7/3)	13 (7/17)	9 (7/31)	37	4	0	13	88.95	0.42 / 8.32	0.15 / 2.92
	PVER Phase 7	10 (6/16)	8 (7/2)	12 (7/16)	9 (7/30)	39	3	1	6	91.64	0.43 / 8.51	0.07 / 1.31
	PVER Phase 8	1 (6/19)	0 (7/5)	1 (7/20)	0 (8/3)	2	1	0	0	14.59	0.14 / 2.74	0 / 0
	PVER total	**35**	**39**	**51**	**34**	**159**	**17**	**8**	**26**	**414.5**	**(0.38 / 7.67)**	**(0.06 / 1.25)**

Table 5.—YBCU survey results, LCR MSCP study area, 2018

Area	Site	Survey 1 detections	Survey 2 detections	Survey 3 detections	Survey 4 detections	Total survey detections	POS	PRB	COB	Hectares (ha)	Detections per ha/20 ha	Territories per ha/20 ha
CVCA	CVCA Phase 1	1 (6/27)	4 (7/11)	2 (7/25)	0 (8/8)	7	2	0	0	37.17	0.19 / 3.77	0 / 0
	CVCA Phase 2	0 (6/27)	1 (7/11)	1 (7/25)	0 (8/8)	2	1	0	0	27.47	0.07 / 1.46	0 / 0
	CVCA Phase 3	0 (6/28)	0 (7/12)	0 (7/26)	0 (8/9)	0	0	0	0	43.87	0 / 0	0 / 0
	CVCA Phase 7	0 (6/28)	0 (7/12)	1 (7/26)	0 (8/10)	1	0	0	0	30.25	0.03 / 0.66	0 / 0
	CVCA Phase 8	1 (6/28)	3 (7/12)	2 (7/26)	1 (8/10)	7	0	0	2	46.61	0.15 / 3.00	0.04 / 0.86
	CVCA total	**2**	**8**	**6**	**1**	**17**	**3**	**0**	**2**	**185.40**	**(0.09 / 1.83)**	**(0.01 / 0.22)**
Cibola NWR Unit #1	Cottonwood Genetics	1 (6/26)	0 (7/10)	0 (7/24)	0 (8/7)	1	0	0	0	16.47	0.06 / 1.21	0 / 0
	Crane Roost	5 (6/25)	4 (7/9)	7 (7/23)	4 (8/6)	20	1	1	1	57.31	0.35 / 6.98	0.02 / 0.35
	CW-North	0 (6/26)	0 (7/10)	0 (7/24)	0 (8/7)	0	0	0	0	7.25	0 / 0	0 / 0
	Hippy Fire	2 (6/25)	8 (7/9)	8 (7/23)	1 (8/6)	19	1	1	4	58.77	0.32 / 6.47	0.07 / 1.36
	Mass Transplanting	0 (6/26)	0 (7/10)	0 (7/24)	0 (8/7)	0	0	0	0	16.16	0 / 0	0 / 0
	Nature Trail	0 (6/26)	0 (7/10)	0 (7/24)	0 (8/7)	0	0	0	0	14.50	0 / 0	0 / 0
	Cibola NWR total	**8**	**12**	**15**	**5**	**40**	**2**	**2**	**5**	**170.5**	**(0.23 / 4.69)**	**(0.03 / 0.59)**
LDCA	Reach 1	2 (6/27)	3 (7/12)	1 (7/26)	0 (8/9)	6	0	1	0	225.82	0.03 / 0.53	0 / 0
	Reach 2	2 (6/30)	4 (7/13)	0 (7/27)	0 (8/10)	6	1	0	0	211.71	0.03 / 0.57	0 / 0
	LDCA total:	4	7	1	0	12	1	1	0	437.5	(0.03 / 0.55)	(0 / 0)
YEW	A North Channel, J	1 (6/26)	1 (7/11)	0 (7/25)	0 (8/8)	2	0	0	0	26.80	0.07 / 1.49	0 / 0
	Sites I, South AC, and South C	1 (6/26)	1 (7/11)	2 (7/25)	2 (8/8)	6	0	0	1	40.61	0.15 / 2.95	0.02 / 0.49
	YEW total	2	2	2	2	8	0	0	1	67.41	(0.12 / 2.37)	(0.01 / 0.3)
All sites total (average)		**56**	**72**	**81**	**46**	**255**	**26**	**11**	**35**	**1,689.73**	**(0.15 / 3.02)**	**(0.02 / 0.41)**

Table 6.—Detection counts of focal avian species[1] by site, LCR MSCP study area, 2018

Area code	Site	Arizona Bell's vireo	California black rail	Yuma clapper rail	Elf owl	Gilded flicker	Gila woodpecker	Summer tanager	Vermilion flycatcher	Willow flycatcher	Sonoran yellow warbler
BLCA	Beal CPhase 05, 06	5					4	3			4
Bill Williams RiverE	Cougar Point	2					4				
Bill Williams RiverE	Esquerra Ranch	7					9	2			3
Bill Williams RiverE	Gibraltar Rock	3					8				
Bill Williams RiverE	Kohen Ranch	4					4				
Bill Williams RiverE	Mineral Wash	8			2		9	4			2
Bill Williams RiverW	Sandy Wash	1					4				
PVER	PVER Phase 1										
PVER	PVER Phase 2										
PVER	PVER Phase 3							1			
PVER	PVER Phase 4							10			1
PVER	PVER Phase 5							4			1
PVER	PVER Phase 6							11		1	7
PVER	PVER Phase 7							19	1		2
PVER	PVER Phase 8										
CVCA	CVCA Phase 1										
CVCA	CVCA Phase 2										
CVCA	CVCA Phase 3										
CVCA	CVCA Phase 7										
CVCA	CVCA Phase 8										
CNWR1	Cottonwood Genetics										
CNWR1	Crane Roost										1
CNWR1	CW-North										
CNWR1	Hippy Fire										1
CNWR1	Mass Transplanting										
CNWR1	Nature Trail	1									
LDCA	Reach 01										
LDCA	Reach 02		1								
YEW	A North Channel, J										
YEW	Sites I, South AC, and South C										

[1] Species: Arizona Bell's vireo (*Vireo bellii arizonae*), California black rail (*Laterallus jamaicensis coturniculus*), Yuma clapper rail (*Rallus longirostris yumanensis* [also known as Yuma Ridgway's rail = *R. obsoletus yumanen*sis]), elf owl (*Micrathene whitneyi*), gilded flicker (*Colaptes chrysoides*), Gila woodpecker (*Melanerpes uropygialis*), summer tanager (*Piranga rubra*), vermilion flycatcher (*Pyrocephalus rubinus*), willow flycatcher (*Empidonax traillii*), and Sonoran yellow warbler (*Dendroica petechia sonorana* = *Setophaga petechia sonorana*).

Proportion of Habitat Occupied

The overall proportion of habitat occupied by YBCUs in 2018 was 58% (51 of 88 sample units surveyed). By conservation area, the proportion of habitat occupied was:

- 100% at the BLCA (2 of 2 sample units)
- 23.1% at BWR-East (3 of 13 sample units)
- 0% at BWR-West (0 of 3 sample units)
- 100% at the PVER (24 of 24 sample units)
- 41.7% at the CVCA (5 of 12 sample units)
- 80% at Cibola NWR Unit #1 (8 of 10 sample units)
- 31.6% at the LDCA (6 of 19 sample units)
- 60% at YEW (3 of 5 sample units)

Captures and Resights

One capture attempt was made on August 7, 2018, after a potentially GPS-tagged bird was seen near PVER Phase 6, Nest 10. Two adults were captured near the nest and found to be unbanded (table 7). The first YBCU captured (SIM) was determined to be male based on observed overnight incubation, and the second (NAL) was assumed to be female. No other recapture attempts occurred. Eighteen previously banded YBCUs were resighted and identified to individual in 2018 (table 8). No GPS-tagged YBCUs were resighted in 2018 (see Chapter 6). Ten resighted YBCUs were observed at nests (see the "Nests" section below), and another five were confirmed to be breeding, based on observed copulations.

Table 7.—New YBCU captures, LCR MSCP study area, 2018

Date	Site	Bird ID[1]	Band number	Color bands[2]	Age[3]	Sex[4]	Note
August 7	PVER Phase 6	SIM	1212-27555	S / V-W-V	AHY	M	Male from Nest 10
August 7	PVER Phase 6	NAL	1713-67966	S / G-lB-G	AHY	F	Female from Nest 10

[1] Bird ID: unique two-to-three-character identifier of the individual YBCU.
[2] Color bands (left to right, top to bottom): G = green, lB = light blue, S = silver, V = violet, and W = white, . A hyphen (-) indicates a split band consisting of two or three color stripes.
[3] Age: AHY = after hatching year.
[4] Sex (confirmed by DNA test): F = female, and M = male.

Nests

Between June 26 and August 6, 2018, 24 YBCU nests were found in the study area (table 9), including the first nest confirmed at YEW. Eighteen nests were found at the PVER (Phases 2, 5, 6, and 7), two at the CVCA (one each in Phases 8 and 9), and three at Cibola NWR Unit #1 (one at Crane Roost and two at Hippy Fire). Eleven other breeding territories were confirmed in the study area: one at Beal, eight at the PVER (Phases 5 to 7), and two at Cibola NWR Unit #1 (Hippy Fire).

Nests were constructed in cottonwoods (n = 14, 58.3%), Goodding's willows (n = 7, 29.2%), honey mesquite (n = 2, 8.3%), and coyote willows (n = 1, 4.2%). Documented nesting activity in 2018 began June 16 at PVER Phase 7 (copulation) and continued until August 25, when the last known nest was abandoned and the field season ended.

Nests were observed, when detected, to determine the identities of nesting adults in case a GPS-tagged YBCU was present (see Chapter 6). The identities of 12 nesting birds were confirmed; the banded status of all other nesting birds was either unbanded or unknown (table 9). During resight attempts, nine nests were found to have failed due to weather or depredation, and another five were observed to be abandoned before egg hatching (table 9).

Double-clutching was confirmed for two pairs (three banded birds) in 2018. The first nest of YBCU pairs, SER and NIP (PVER Phase 6, Nest 2), was found July 4 and failed by July 11. The same pair nested again at PVER Phase 6, Nest 8, which was found July 28 and failed by August 2. A second banded male (TAS) made two nesting attempts with an unbanded female (PVER Phase 6, Nests 1 and 9, described below).

Nest Highlights/Noteworthy Observations

PVER Phase 6, Nest 1 and PVER Phase 6, Nest 9: The same nest

PVER Phase 6, Nest 1 (figure 7) found on July 2 was high in a cottonwood, and the contents of the nest were unknown. During several early morning visits to determine the banded status of the adults, incubating was assumed (no feeding observed). A returning after-fourth-year male (TAS) banded at PVER Phase 6 in 2015 was resighted, and the female mate was unbanded. On July 15, the nest was inactive, with no egg shells found on the ground. As the nest was not monitored, the fate was unknown.

On July 30, during attempts to resight birds in the same area, a YBCU was seen sitting on the same nest as PVER Phase 6, Nest 1. This was the first time YBCUs have been observed to use a nest more than once in a season. The male at the nest was eventually confirmed to be TAS, again nesting with an unbanded female.

Table 8.—Banded YBCUs resighted in the LCR MSCP study area, 2018

Site code	Date	YBCU ID[1]	Color bands[2]	Age[3]	Sex[4]	Original capture site	Original capture date	Previous capture/resight site	Note
PVP1	July 5	ZUN	V-O-V / S	4Y	M	PVP6	July 27, 2015		Paired
PVP6	July 28	DAE	mB-Bk-mB / S	SY	F	PVP6	August 5, 2017		Resighted at nest
PVP6	June 12	LEA	S / Y-Lv	A6Y	F	PVP6	July 15, 2013	PVP5	Confirmed breeding
PVP6	July 29	NIP	S / R-lB-R	ATY	F	PVP7	August 23, 2016	PVP5	Resighted at nest
PVP6	July 11	PEN	S / R-O-R	ATY	M	PVP7	July 1, 2016	PVP7	Confirmed breeding
PVP6	June 29	SER	S / W-Lv-W	A6Y	M	PVP6	July 12, 2013	PVP5; PVP6	Resighted at nest
PVP6	July 2	SIE	mB-R-mB / R	5Y	F	PVP5	July 14, 2014	PVP7	Resighted at nest
PVP6	July 5	TAS	S / W-G-W	A4Y	M	PVP6	June 19, 2015	PVP5; PVP6	Resighted at nest
PVP6	June 20	VES	S / Lv-Bk	ATY	M	PVP7	June 9, 2016		Resighted at nest
PVP7	July 29	ACO	R / O-V	ATY	F	PVP6	July 10, 2016		
PVP7	June 30	ANA	S / V-G	ATY	F	PVP7	August 2, 2016	PVP5; PVP6	Resighted at nest
PVP7	June 17	ANT	V-Y-V / S	4Y	M	PVP7	July 19, 2015	PVP6	
PVP7	July 11	ARC	S / R-Lv	ASY	F	PVP7	August 1, 2017		Resighted at nest
PVP7	June 12	DEV	W-Ag-W / R	5Y	F	CVP2	August 1, 2014	PVP7	
PVP7	June 20	IRO	R-W / R	TY	F	PVP7	July 9, 2016	PVP7	
PVP7	July 11	MRS	S / lB-W	A4Y	M	PVP6	June 30, 2015		Resighted at nest
PVP7	July 16	RIP	lB-V-lB / S	4Y	F	PVP7	August 7, 2015	PVP7	Confirmed breeding
PVP7	July 1	TAM	W-lB-W / R	5Y	F	PVP6	July 28, 2014		Resighted at nest

[1] Bird ID: unique two-to-three-character identifier of the individual YBCU.
[2] Color bands (left to right, top to bottom): Bk = black, G = green, lB = light blue, Lv = lavender, mB = mid blue, O = orange, R = red, S = silver, V = violet, W = white, and Y = yellow. A hyphen (-) indicates a split band consisting of two or three color stripes.
[3] Age: ASY = after 2nd year, ATY = after 3rd year, A4Y = after 4th year, A6Y = after 6th year, SY = 2nd year, TY = 3rd year, 4Y = 4th year and 5Y = 5th year.
[4] Sex (confirmed by DNA test): F = female, and M = male.

Table 9.—YBCU nests found in the LCR MSCP study area, 2018

Area/site	Nest #	Adult[1]	Adult[1]	Date found	Tree species[2]	Tree height	Nest height	Note
PVER Phase 2	1	UB	UB	July 20	SALGOO	15	8	
PVER Phase 5	1	UB	UB	July 16	SALGOO	10.4	4.1	Failed/abandoned
PVER Phase 5	2	UB	ANA	July 18	SALGOO	9	6.8	Failed/abandoned
PVER Phase 5	3	VES?	SIE?	July 19	SALGOO	6	4.2	Failed/abandoned
PVER Phase 6	1	TAS	UB	July 2	POPFRE	18	14	
PVER Phase 6	2	SER	NIP	July 4	POPFRE	17	15	Failed
PVER Phase 6	3	UB	UB	July 17	POPFRE	19	8	Failed
PVER Phase 6	4	UB	UB	July 18	SALGOO	11	9	Failed
PVER Phase 6	5	UK	UK	July 20	POPFRE	14	12.5	Failed
PVER Phase 6	6	UB	DAE	July 22	POPFRE	16	12	
PVER Phase 6	7	UK	UK	July 24	SALGOO	15	13	Failed
PVER Phase 6	8	SER	NIP	July 28	POPFRE	17.5	14	Failed
PVER Phase 6	9	TAS	UB	July 30	POPFRE	18	14	Failed/abandoned
PVER Phase 6	10	SIM	NAL	July 30	POPFRE	13	5.6	Failed
PVER Phase 7	1	UB	TAM	June 26	POPFRE	18	14	
PVER Phase 7	2	MRS	ARC	July 3	SALGOO	11	9	
PVER Phase 7	3	UB	UB	July 13	POPFRE	16	9.8	
PVER Phase 7	4	UB	UB	July 16	PROGLA	6	2.3	
CVCA Phase 8	1	UB	UK	July 16	POPFRE	9	2.2	
CVCA Phase 9	1	UK	UK	July 23	POPFRE	5.6	2.7	Failed/abandoned
CNWR Crane Roost	1	UK	UK	July 9	SALEXI	8	2.4	Failed
CNWR Hippy Fire	1	UB	UK	July 23	POPFRE	5.3	2.1	Failed
CNWR Hippy Fire	2	UB	UK	August 6	POPFRE	12	2.6	Found after fledged
YEW	1	UK	UK	July 25	PROGLA	5	2	Fledged

[1] Two-to-three-character unique identifier of the banded nesting male or female: UB = unbanded, UK = unknown, and ? indicates both adults were banded but not confirmed beyond a doubt. VES and SIE were resighted together several times before the nest was found. The nest failed before their identities could be confirmed.
[2] Nest substrate species: POPFRE = Fremont cottonwood, PROGLA = honey mesquite, SALEXI = Coyote willow, and SALGOO = Goodding's willow.

During resight attempts between August 1 and 12, the nest was visited regularly; the birds appeared to be incubating with only twigs and no food brought to the nest (figure 8). The estimated latest hatch date of August 9 (based on 10 days incubation) passed with no sign of hatching. Both adults tended the nest, with the nest always occupied when visited between July 30 and August 23. On August 24, for the first time, no bird was observed on the nest when visited, and two adults were heard nearby. One returned near the nest without food, eventually leaving, and no birds returned to the nest. On August 25, the nest appeared to have finally been abandoned. Over the next 2 days during early morning visits, no overnight incubation was observed, and both adults appeared to have left the immediate area.

Figure 7.—Adult incubating at PVER Phase 6, Nest 1, July 4, 2018.
(Photo by C. Squibb, SSRS).

Figure 8.—Adult incubating at PVER Phase 6, Nest 9, August 1, 2018.
(Photo by C. Squibb, SSRS).

First Nest Found at YEW

YBCUs have been detected during surveys at YEW since 2010 (McNeil et al. 2013a); however, no breeding evidence has been observed since surveys began, and just one PRB territory was previously estimated, in 2017 (Parametrix and SSRS 2018). YBCUs were detected during the first two surveys of 2018. During a predawn visit before the third survey on July 28, a "kowlp" was heard in site South C in the same area identified in previous surveys. A YBCU called from a thick stand of coyote willows north of the mature cottonwoods in site I (Section C4702). One technician continued the survey while a second stayed to listen and observe. The area was pinpointed with additional calls, and soon the nest was located in a honey mesquite growing within and at the edge of the coyote willow stand. After the adult flushed off the nest, the nest was mirrored to reveal three eggs. The nest was constructed from honey mesquite and coyote willow twigs with a lining of mesquite leaves. It was revisited on August 1, with photos taken of three chicks (figure 9) and the surrounding vegetation (figure 10). By the fourth survey on August 8, the nest was empty; at least one young fledged based on an adult seen carrying food from the high cottonwoods into the low coyote willow thicket.

Figure 9.—Three chicks in nest at YEW, August 1, 2018.
(Photo by S. McNeil, SSRS).

Figure 10.—Yuma nest on edge of opening in a honey mesquite within a dense thicket of coyote willows, August 1, 2018.

Chapter 4

SURVEYS 2014 TO 2018

Introduction

The objectives of this 5-year study include documenting the presence of YBCUs in suitable habitat within the LCR MSCP study area. After plantings in LCR MSCP conservation areas began in 2006, the initial YBCU response was monitored from 2008 to 2013 (McNeil et al. 2013a; McNeil and Tracy 2013). Within the planted areas, YBCU detections and territories dramatically increased, from 25 survey detections (2.95/20 ha) (49.4 ac) and 3 confirmed territories in 2008, to 130 detections (5.89/20 ha [49.4 ac]) and 29 confirmed territories in 2012. The trend continued in 2013, with 262 survey detections (8.9/20 ha [49.4 ac]) in LCR MSCP conservation areas. YBCUs typically began nesting in the newly created habitat as soon as 2 years after planting. One conservation area, the PVER, became a main driver of the increasing detection trend. With almost 400 ha (988 ac) of YBCU habitat planted and irrigated between 2006 and 2012, the PVER had become the largest contiguous area of planted managed riparian forest in the study area. Over the same period, survey detections at the Bill Williams River NWR fluctuated from a high in 2010 of 142 detections (4.5/20 ha [49.4 ac]) to a low in 2013 of 41 detections (1.39/20 ha [49.4 ac]). YBCUs previously breeding at the Bill Williams River NWR were suspected to have gradually dispersed into the new LCR MSCP plantings or to other areas, though this was not documented.

Surveys within the study area from 2014 to 2018 are presented here to provide a multi-year assessment of the population and to identify trends in the response by YBCUs to habitat planted under the LCR MSCP.

During the previous 5-year study, as planted LCR MSCP sites aged, it was noted that fewer YBCUs appeared to use the sites (McNeil et al. 2013a). The effects of habitat size, vegetation characteristics, and microclimate (temperature and humidity) on YBCUs have previously been documented (Laymon and Halterman 1989; Laymon et al. 1997; McNeil et al. 2013a; Parker et al. 2005), but the importance of the prey base, flood irrigation regimes, and habitat age are less understood. Given the positive association found previously between the density of young (8–23 centimeters in diameter) native trees and the odds of nest placement in the study area (McNeil et al. 2013a), increasing site age was predicted to negatively affect YBCU occupancy. Based on the available standardized survey data collected within LCR MSCP conservation areas since 2008, age and size factors predicted to influence YBCU territory density within the study area were assessed.

Methods

Survey Schedule

See Chapter 2 for detailed descriptions of all sites surveyed between 2014 and 2018. The descriptions include areas and years surveyed, yearly results, and any circumstances leading to changes in the surveys. Between 2014 and 2018, 23 to 42 sites were surveyed annually (table 10). Prior to 2016, surveys were conducted annually if one or more potential breeding territories were reported during either of the previous two breeding seasons throughout the study area. In addition, all LCR MSCP conservation areas at least 2 years old that contained suitable structure and vegetation types were also surveyed. In 2016, Reclamation reduced the scope of this project and removed sites outside LCR MSCP conservation areas, including sites at the Bill Williams River NWR. With the addition of Planet Ranch to the LCR MSCP (LCR MSCP 2016), portions of the Bill Williams River NWR became creditable acres under the program, and in 2017, the stretch of riparian forest between Sandy Wash (BWR-West) and Mineral Wash (BWR-East) was placed back into the areas surveyed. For this report, some adjacent sites are presented as one site, including two sites at the BLCA and five sites at YEW.

Surveys

Each year, the most current YBCU survey protocol was used. The main change over the years was a change in the number of surveys per site each year; five surveys were conducted per site from 2014 to 2015 (Halterman et al. 2011), and four surveys were conducted per site from 2016 to 2018 (Halterman et al. 2016) (table 11). Surveys were conducted on foot, and some sites were accessed by kayaks prior to 2018, between sunrise and 11:00 a.m., or until temperatures reached 40 degrees Celsius (°C) (104 degrees Fahrenheit [°F]). When possible, adjacent sites were surveyed on the same day to minimize double counting the same individual. Radios were used to communicate among surveyors when adjacent patches were surveyed at the same time.

Surveys were conducted along one or more parallel transects spaced approximately 200 to 250 m (650 to 820 ft) apart, with survey points spaced every 100 m (328 ft) along transects (mean 883 m [2,900 ft], range 150–3,700 m [492–12,140 ft]). Surveys were assumed to cover 100 to 125 m (328 to 410 ft) of habitat on either side of each transect. Most transects traversed through the habitat; however, some transects ran along edges, such as on adjacent roads, for greater visual detectability or because the interior was inaccessible. Trimble Juno 3B GPS units (±15 m [49 ft] horizontal accuracy) were used to locate survey points. At each point, surveyors recorded the location, time, and any LCR MSCP avian focal species detected (table 12).

Table 10.—Sites surveyed (including number of surveys) between 2014 and 2018, LCR MSCP study area

Geographic area	Conservation area	Site	Hectares	2014	2015	2016	2017	2018
Overton Wildlife Management Area, Nevada	Muddy River (Reach 1)	Overton Wildlife	40.00	5	4	–	–	–
Havasu NWR, Arizona	BLCA (Reach 3)	CPhase 05[1]	19.67	5	5	4	4	4
		CPhase 06[1]	15.84	5	5	4	4	4
	Topock	Pintail Slough	22.31	5	4	–	–	–
		Topock Platform	9.33	5	5	–	–	–
Bill Williams River NWR	BWR-East (Reach 3)	Cave Wash	44.91	5	4	–	–	–
		Cougar Point	49.73	4	4	–	4	4
		Esquerra Ranch	73.89	5	5	–	4	4
		Gibraltar Rock	90.14	5	–	–	4	4
		Honeycomb Bend	24.85	5	5	–	–	–
		Kohen Ranch	43.45	5	4	–	4	4
		Mineral Wash	40.99	5	5	–	4	4
	BWR-West (Reach 3)	Borrow Pit	37.75	5	4	–	–	–
		BW Marsh	18.37	4	5	–	–	–
		Cross River	50.51	5	4	–	–	–
		Fox Wash	90.85	4	–	–	–	–
		Middle Delta	39.21	4	–	–	–	–
		Mosquito Flats Site 12[2]	35.29	5	4	–	–	–
		Mosquito Flats Site 13[2]	23.61	5	4	–	–	–
		North Burn	42.14	4	5	–	–	–
		Sandy Wash	80.78	5	5	–	4	4
Parker, Arizona	‘Ahakhav Tribal Preserve	CRIT 09	62.54	5	5	–	–	–
Blythe, California	PVER (Reach 4)	Phase 1	25.02	5	5	4	4	4
		Phase 2	31.57	5	5	4	4	4
		Phase 3	34.00	5	5	4	4	4
		Phase 4	41.25	5	5	4	4	4
		Phase 5	87.45	5	5	4	4	4
		Phase 6	88.95	5	5	4	4	4
		Phase 7	91.64	5	5	4	4	4
		Phase 8	14.59	–	–	4	4	4

Table 10.—Sites surveyed (including number of surveys) between 2014 and 2018, LCR MSCP study area

Geographic area	Conservation area	Site	Hectares	2014	2015	2016	2017	2018
Cibola, Arizona	CVCA (Reach 4)	Phase 01	37.17	5	5	4	4	4
		Phase 02	27.47	5	5	4	4	4
		Phase 03	43.87	5	5	4	4	4
		Phase 04	24.44	–	–	–	4	–
		Phase 07	30.25	–	–	–	–	4
		Phase 08	46.61	–	–	–	–	4
	Cibola NWR Unit #1 (Reach 4)	Cottonwood Genetics	16.47	4	5	4	4	4
		Crane Roost	57.31	5	5	4	4	4
		CW North	7.25	5	5	4	4	4
		Hippy Fire	58.77	–	5	4	4	4
		Mass Transplanting	16.16	5	5	4	4	4
		Nature Trail	14.50	5	5	4	4	4
Yuma, Arizona	Imperial South	Fisher's Landing	34.00	–	4	–	–	–
	Picacho	Lago Tres	14.80	–	3	–	–	–
	Laguna	Mittry	12.19	4	4	–	–	–
	LDCA (Reach 6)	Reach 1	225.82	–	–	4	4	4
		Reach 2	211.71[3]	–	–	–	–	4
	YEW (Reach 6)	A North Channel[4]	8.17	–	–	–	4	4
		J[4]	18.63	–	–	–	4	4
		I[5]	17.97	4	–	4	4	4
		South AC[5]	9.08	4	–	4	4	4
		South C[5]	13.57	4	–	4	4	4
Total area (ha), annual sites surveyed			**2,316.84**	**42**	**38**	**23**	**32**	**34**

[1] Sites CPhase 05 and 06 reported together.
[2] Mosquito Flats Site 12 and 13 reported together.
[3] Approximately 140 ha of Reach 2 was surveyed.
[4] Sites A North Channel and J reported together.
[5] Sites I, South AC, and South C reported together.

Table 11.—Approximate YBCU survey dates for the LCR MSCP study area, 2014 to 2018

Survey period	Survey number	Dates
1	1	June 15 to June 29
2	2	June 30 to July 13
2	3	July 14 to July 27
3	4	July 28 to August 10
4	5	August 11 to August 31 **(2014–15 only)**

Table 12.—Avian focal species monitored during field work in the LCR MSCP study area, 2014 to 2018, referenced using American Ornithologists' Union (AOU) nomenclature

Scientific name	Common name	AOU[1] code recorded
Empidonax traillii extimus	Southwestern willow flycatcher	WIFL
Coccyzus americanus2	Yellow-billed cuckoo	YBCU
Colaptes chrysoides	Gilded flicker	GIFL
Melanerpes uropygialis	Gila woodpecker	GIWO
Pyrocephalus rubinus	Vermilion flycatcher	VEFL
Vireo bellii arizonae	Arizona Bell's vireo	BEVI
Setophaga petechia sonorana (also known as *Dendroica petechia sonorana*)	Sonoran yellow warbler	YEWA[3]
Piranga rubra	Summer tanager	SUTA
Rallus obsoletus yumanensis (also known as Yuma clapper rail [*R. longirostris yumanensis*])	Ridgway's rail[4]	CLRA
Laterallus jamaicensis coturniculus	California black rail	BLRA
Ixobrychus exilis hesperis	Western least bittern	LEBI
Micrathene whitneyi	Elf owl	ELOW

[1] AOU codes referred to in table 3.
[2] Referred to as *Coccyzus americanus occidentalis* in the HCP (LCR MSCP 2004b).
[3] Referred to as *Dendroica petechia sonorana* (YWAR) in the HCP (LCR MSCP 2004b).
[4] Referred to as Yuma clapper rail in the LCR MSCP Habitat Conservation Plan (LCR MSCP 2004b).

At each survey point, surveyors listened and watched for YBCUs for 1 minute. If a YBCU was not detected, an MP3 player and hand-held speaker were used to broadcast a 5-second YBCU contact call (the "kowlp" call [Hughes 2015]) at approximately 70 decibels (calibrated with a decibel meter before each survey) (Halterman et al. 2016) once per minute for 5 minutes. During the 5-minute period, each 5-second call was followed by 55 seconds of active listening. If a YBCU was detected, call-playback was immediately discontinued, and surveyors recorded the true bearing and estimated distance from the surveyor to the bird, time of detection, number of calls broadcast, response type, behavior, vocalizations, and presence and color combinations of any leg bands observed. Any observed breeding evidence was recorded, including individuals carrying food or nesting material, copulation, a juvenile, or a nest. Surveyors then progressed along the transect 300 m (984 ft) from the estimated location of the detected bird to avoid additional disturbance and the potential for repeat detections of the same individual.

An individual YBCU visually observed or heard during a survey, including any detected while traveling between survey points, was recorded as a survey detection. If the same individual was presumed to have been detected more than once during a single survey (such as when an individual appeared to follow a surveyor), only the initial detection was counted toward the detection total.

Detections > 300 m (984 ft) apart during a single survey were generally counted as separate individuals and separate survey detections, although surveyors used their judgment to determine whether multiple detections within 300 m (984 ft) were the same individual. It is usually difficult to tell individual YBCUs apart by call or appearance; however, individuals exhibiting unique calls or behaviors may be recognized when they follow observant surveyors. The distance between separate individuals of 300 m (984 ft) is somewhat arbitrary; however, it is reasonable for most areas because it corresponds to the typical minimum distance found between active nests based on previous field data collected. In recent years, using 300 m (984 ft) to separate territories in higher-density nesting areas (e.g., PVER Phases 6 and 7 during this project) resulted in undercounting individuals and territories (Parametrix and SSRS 2015). To compensate for this undercounting, the distance used to separate individuals and territories was reduced to approximately 200 m (656 ft) at known high-density sites (confirmed by active nests ≤ 200 m [656 ft] apart). Detections of one individual observed more than once were considered repeat detections, and detections occurring before or after surveys were classified as incidental survey detections. Data collected for repeat detections were the same as that collected for survey detections (e.g., estimated distance and bearing, behavior, and vocal codes).

Breeding Territory Estimates

Habitat patches were considered occupied if detections occurred in that area during two or more survey visits (at least 12 days apart). All survey detections

were assessed by spatial location, observed behaviors, and associated dates to determine initial territories and categorize the breeding status for each territory as a POS, PRB, or COB breeding territory (Halterman et al. 2016) (table 13). Any fledglings or juveniles detected that could have come from a territory previously counted were not included as new territories. Additionally, in between survey visits, followup visits were sometimes conducted in areas of activity. Observations made during followup visits were used to refine the breeding status of the estimated territories, such as upgrading a POS to a PRB or COB territory. Followup effort was variable over the 5 years: from 2014 to 2016, followup visits occurred regularly in areas of activity, every 2–5 days (in 2016 primarily to resight GPS-tagged YBCUs). In 2017 and 2018, followup visits were limited to 50 total, to confirm breeding in LCR MSCP conservation areas and to resight GPS-tagged YBCUs.

Table 13.—Definitions for YBCU breeding territory estimation

Estimation type	Term	Definition
Breeding territory estimation	Possible breeding (POS) territory	Two or more total detections in an area during two survey periods and at least 12 days apart. For example, within a certain area, one detection made during survey period 2 coupled with another detection made 12 days later during survey period 3 warrant a POS territory designation.
	Probable breeding (PRB) territory	Three or more total detections in an area during at least three survey periods and at least 12 days between each detection, or POS plus YBCUs observed carrying food (single observation), carrying a stick (single observation), traveling as a pair, or exchanging vocalizations.
	Confirmed breeding (COB) territory	Observation of copulation, stick carry (multiple observations), food carry (multiple observations), distraction display, an active nest, or confirmed fledgling.
Population estimation	Minimum territory estimate	The observed number of confirmed breeding territories (COB).
	Territory estimate	The sum of the observed number of confirmed (COB) and probable (PRB) breeding territories.
	Maximum territory estimate	The sum of the observed number of confirmed (COB), probable (PRB), and (POS) territories. This represents an estimate of the highest possible number of breeding pairs, assuming two birds per nest, and all pairs nest once during the season. The true breeding population size is probably lower due to individuals nesting more than once in a season and transient YBCU activity misidentified as breeding.

Note that the POS, PRB, and COB counts estimate the number of breeding territories and not the number of breeding pairs, and each territory represents two adults typically associated with a single nest. Factors that complicate pair estimates include polyandrous females that renest with another male after leaving an active nest (Halterman 2009), polygyny/multiple maternity of nests (McNeil 2015), and one or both adults renesting following a successful or failed nest. Relative to the number of breeding birds in the study area, the number of territories can be understood to represent the number of pairs, assuming there are two birds associated with each nest, and all pairs nest exactly once in a season. Given the nature of YBCUs, the true breeding population size will be less than twice the number of territories if individuals nest more than once in a season.

Breeding territory estimates were calculated based on the POS, PRB, and COB territory counts (see table 13). The COB territory count provides the minimum and most conservative estimate of breeding territories. Identification of PRB territories are based on solid observations and a sound definition (Halterman et al. 2016; McNeil et al. 2013a) (see table 13) and, when summed with COB territories, provides the most reasonable estimate of breeding territories. The sum of all POS, PRB, and COB territories provides the maximum estimate and likely over-estimates the true number of breeding territories. Due to differences in site sizes, survey results were standardized by calculating the number of survey detections and breeding territories per 20 ha (49 ac), the average size of a YBCU territory in this study area (McNeil et al. 2013a).

Survey Detections – Site Age/Size Model

To explore the effects of site age and size on YBCU survey detections, a mixed regression model was fit to survey data from the PVER (Phases 1–8), CVCA (Phases 1–3), and the Cibola NWR (Crane Roost and Hippy Fire sites) from 2008 to 2018 (2008 to 2013 data from McNeil and Tracy 2013 and McNeil et al. 2013). The Crane Roost and Hippy Fire sites were planted in different years and split accordingly for this analysis (figure 11). CVCA Phase 7, CVCA Phase 8, and Hippy Fire (south) were excluded from the analysis because only 1 or 2 years of survey data were obtained, which is too few to include as random effects in the model. The response variable was square-root transformed survey detections (survey visits 1–4). The predictor variables were site age in years since planted and site size in hectares. To account for the non-independence of repeated spatial observations and annual influences on YBCU detections, random effects of site and year were included in the model (Crawley 2013). The reported random effect standard deviation (SD) was used to measure the site and year variability around the model intercept. The model was fit to 105 observations across 14 sites and 11 years (ages 2 to 12).

Prior to applying models, an exploratory data analysis was performed to identify any potential violations of statistical assumptions (Zuur et al. 2010); boxplots

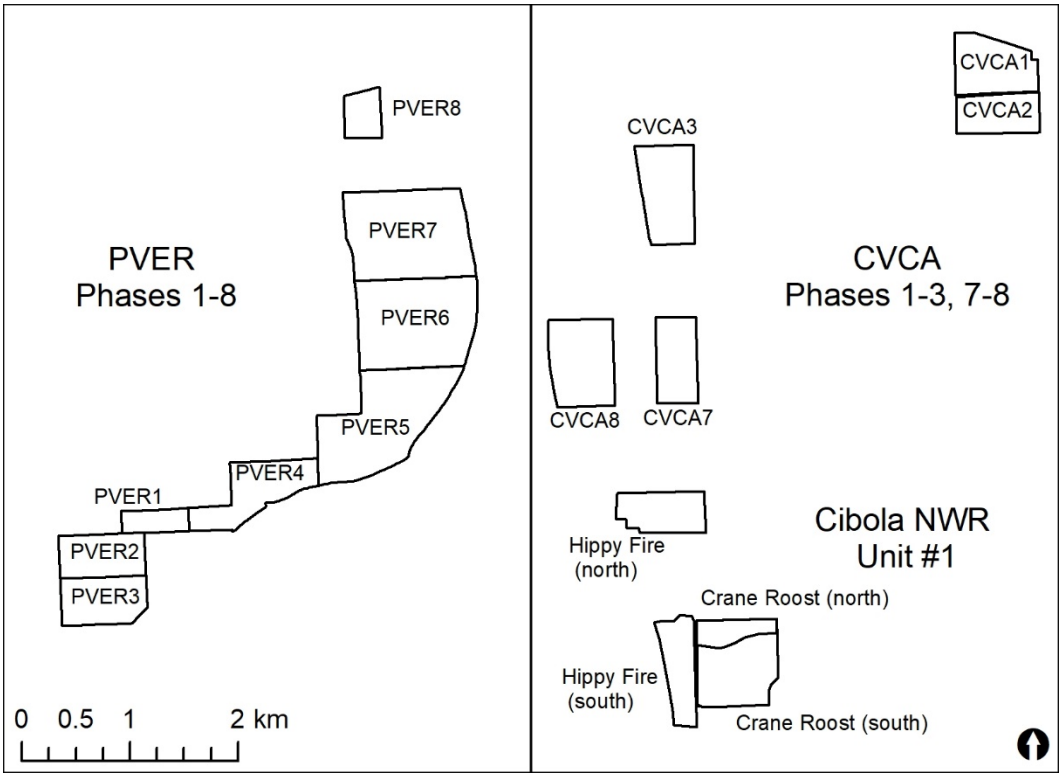

Figure 11.—Sites used in YBCU detection site age/size model (PVER Phases 1–8, CVCA Phases 1–3, Crane Roost, and Hippy Fire [north]).

and histograms were created to detect outliers in response covariates, and relationships between each continuous covariate and response variable were assessed with scatterplots. Collinearity among covariates was calculated with variance inflation factors (VIFs) to exclude collinear variables from the model (Belsley et al. 1980). An Analysis was conducted in R version 3.3.2 (R Core Team 2014) as implemented in R package lme4 (Bates et al. 2014).

Results

Surveys Summary

From 2014 through 2018, between 23 and 42 sites were surveyed per year, resulting in 212 to 301 annual survey detections (table 14), or 2.67 to 5.56 detections/20 ha. With the variation in the number of sites surveyed per year, and with sites not surveyed a fifth time from 2016 to 2018, results from the optional fifth surveys conducted mid- to late August 2014–15 were not included in the annual detection totals and comparisons across years. Overall, most detections were made in July during survey period 2 (visits 2 and 3); August surveys had the fewest detections.

Table 14.—Annual YBCU survey detections by survey visit at LCR MSCP sites ("All Sites" on figure 12), 2014 to 2018

Year	Number of sites surveyed	Survey visit					Detection total (surveys 1–4)	Hectares (ha) surveyed	Average detections/20 ha	Detection ratio visit 4 : visit 2
		1	2	3	4	5				
2014	42	49	81	78	78	62	286	1609.27	3.55	0.96
2015	38	58	81	88	74	29	301	1416.49	4.25	0.91
2016	23	87	81	71	54	-	293	945.68	6.20	0.67
2017	32	59	58	55	40	-	212	1425.61	2.97	0.69
2018	34	56	72	81	46	-	255	1689.73	3.02	0.64
Mean	**33.8**	**62**	**75**	**75**	**58**	**45**	**269**	**1417.36**	**4.00**	**0.77**

Overall, annual survey detections peaked in 2015, detections/20 ha peaked in 2016, and both detections and detections per 20 ha reached their lowest levels in 2017, a 52% decline in detections/20 ha from the peak observed in 2016 (see table 14). When grouped by river reach (table 15; see figure 13), most detections were made in Reach 4, particularly at the PVER. Relatively few detections were made in the remaining reaches surveyed (Reaches 1, 3, 5, and 6). Reach 2 had no surveys due to a lack of habitat. A comparison of the annual ratio of detections between survey visits 4 and 2 showed a decline after 2015, indicating that YBCUs may have changed the way they used the habitat during this period, particularly at sites outside of the PVER area (see table 14; figure 12).

In Reach 1 (table 15), the Overton Wildlife site surveyed in 2014 and 2015 had one to two detections per year (mean [μ] = 1.5 detections per year, SD = 0.71, total detections [n] = 3).

At the Havasu NWR in Reach 3 (table 15), annual detections at BLCA sites CPhase 05 and CPhase 06 (2014–18: μ = 6.8, SD = 2.59, n = 34; 2014–15: μ = 6.8, SD = 0.5, n = 13) exceeded those recorded at other sites within the Havasu NWR (Pintail Slough and Topock Platform) (2014–15: μ = 2.5, SD = 1, n = 10, surveyed 2014 and 2015). Reach 3 (BWR-East and BWR-West sites) (table 15) (figure 13) exhibited a shallow declining detection trend from 2014 to 2018 (2014: μ = 1.9 detections, SD = 1.8, n = 29; 2018: μ = 1.7 detections, SD = 1.2, n = 10).

Table 15.—Annual detection totals for YBCU surveys, LCR MSCP, 2014 to 2018

River reach	LCR MSCP conservation area	Site name	Site size (ha)	Annual survey detection total[1]					Annual survey detections/20 ha[1]				
				2014[2]	2015[2]	2016	2017	2018	2014[2]	2015[2]	2016	2017	2018
1	Muddy River	Overton Wildlife	40.00	2	1	-	-	-	1.00	0.50	-	-	-
3	BLCA	CPhase 05, 06	35.51	6	7	10	3	8	3.38	3.94	5.63	1.69	4.51
	Topock	Pintail Slough	22.31	3	3	-	-	-	2.69	2.69	-	-	-
		Topock Platform	9.33	1	3	-	-	-	2.14	6.43	-	-	-
		Total Topock		**10**	**13**	**10**	**3**	**8**	**2.36**	**2.38**	**5.63**	**1.69**	**4.51**
	BWR-East	Cave Wash	44.91	1	0	-	-	-	0.45	0.00	-	-	-
		Cougar Point	49.73	0	0	-	0	0	0.00	0.00	-	0.00	0.00
		Esquerra Ranch	73.89	2	2	-	0	2	0.54	0.54	-	0.00	0.54
		Gibraltar Rock	90.14	0	-	-	0	1	0.00	-	-	0.00	0.22
		Honeycomb Bend	24.85	4	2	-	-	-	3.22	1.61	-	-	-
		Kohen Ranch	43.45	2	0	-	0	4	0.92	0.00	-	0.00	1.84
		Mineral Wash	40.99	7	6	-	0	2	3.42	2.93	-	0.00	0.98
		Total BWR-East		**16**	**10**	**0**	**0**	**9**	**1.22**	**0.85**	**-**	**0.00**	**0.72**
	BWR-West	Borrow Pit	37.75	2	0	-	-	-	1.06	0.00	-	-	-
		BW Marsh	18.37	0	2	-	-	-	0.00	2.18	-	-	-
		Cross River	50.51	2	0	-	-	-	0.79	0.00	-	-	-
		Fox Wash	90.85	2	-	-	-	-	0.44	-	-	-	-
		Middle Delta	39.21	1	-	-	-	-	0.51	-	-	-	-
		Mosquito Flats	58.90	2	7	-	-	-	0.68	2.38	-	-	-
		North Burn	42.14	0	2	-	-	-	0.00	0.95	-	-	-
		Sandy Wash	80.78	4	2	-	0	1	0.99	0.50	-	0.00	0.25
		Total BWR-West		**13**	**13**	**0**	**0**	**1**	**0.56**	**1.00**	**-**	**0.00**	**0.25**

Table 15.—Annual detection totals for YBCU surveys, LCR MSCP, 2014 to 2018

River reach	LCR MSCP conservation area	Site name	Site size (ha)	Annual survey detection total[1]					Annual survey detections/20 ha[1]				
				2014[2]	2015[2]	2016	2017	2018	2014[2]	2015[2]	2016	2017	2018
4	‘Ahakhav Tribal Preserve	CRIT 09	62.54	4	3	-	-	-	1.28	0.96	-	-	-
	CVCA	Phase 1	37.17	8	9	12	4	7	4.30	4.84	6.46	2.15	3.77
		Phase 2	27.47	3	10	5	8	2	2.18	7.28	3.64	5.83	1.46
		Phase 3	43.87	0	2	5	3	0	0.00	0.91	2.28	1.37	0.00
		Phase 4	24.44	-	-	-	0	-	-	-	-	0.00	-
		Phase 7	30.25	-	-	-	-	1	-	-	-	-	0.66
		Phase 8	46.61	-	-	-	-	7	-	-	-	-	3.00
		Total CVCA	**185.36**	**11**	**21**	**22**	**15**	**17**	**2.16**	**4.35**	**4.13**	**2.34**	**1.78**
	PVER	Phase 1	25.02	1	4	2	0	6	0.80	3.20	1.60	0.00	4.80
		Phase 2	31.57	6	13	11	6	13	3.80	8.24	6.97	3.80	8.24
		Phase 3	34.00	3	11	2	7	13	1.76	6.47	1.18	4.12	7.65
		Phase 4	41.25	18	22	23	10	19	8.73	10.67	11.15	4.85	9.21
		Phase 5	87.45	66	40	45	25	30	15.09	9.15	10.29	5.72	6.86
		Phase 6	88.95	69	60	59	47	37	15.51	13.49	13.27	10.57	8.32
		Phase 7	91.64	41	48	67	40	39	8.95	10.48	14.62	8.73	8.51
		Phase 8	14.59	-	-	0	2	2	-	-	0.00	2.74	2.74
		Total PVER	**414.47**	**204**	**198**	**209**	**137**	**159**	**7.91**	**9.23**	**7.57**	**5.07**	**7.04**
4	Cibola NWR Unit #1	Cottonwood Genetics	16.47	2	1	3	1	1	2.43	1.21	3.64	1.21	1.21
		Crane Roost	57.31	19	29	27	22	20	6.63	10.12	9.42	7.68	6.98
		CW-North	7.25	1	0	0	0	0	2.76	0.00	0.00	0.00	0.00
		Hippy Fire	58.77	-	3	6	16	19	-	1.02	2.04	5.45	6.47
		Mass Transplanting	16.16	0	0	2	0	0	0.00	0.00	2.47	0.00	0.00
		Nature Trail	14.50	3	3	6	3	0	4.14	4.14	8.27	4.14	0.00
		Total Cibola NWR	**170.47**	**25**	**36**	**44**	**42**	**40**	**3.19**	**2.92**	**5.06**	**3.08**	**2.44**

Table 15.—Annual detection totals for YBCU surveys, LCR MSCP, 2014 to 2018

River reach	LCR MSCP conservation area	Site name	Site size (ha)	Annual survey detection total[1]					Annual survey detections/20 ha[1]				
				2014[2]	2015[2]	2016	2017	2018	2014[2]	2015[2]	2016	2017	2018
5	Imperial South	Fisher's Landing	24.40	-	2	-	-	-	-	1.64	-	-	-
	Picacho	Lago Tres	14.80	-	1	-	-	-	-	1.35	-	-	-
6	Laguna	Mittry	12.43	1	3	-	-	-	1.61	4.83	-	-	-
	LDCA	Reach 1	225.82	-	-	3	9	6	-	-	0.27	0.80	0.53
		Reach 2	211.71	-	-	-	-	6	-	-	-	-	0.57
		Total LDCA	**437.53**	**-**	**-**	**3**	**9**	**12**	**-**	**-**	**0.27**	**0.80**	**0.54**
	YEW	A North Channel, J	26.80	-	-	-	4	2	-	-	-	2.99	1.49
		Sites I, South AC, and South CI	40.61	0	-	5	2	6	0.00	-	2.46	0.98	2.95
		Total YEW	**67.41**	**0**	**-**	**5**	**6**	**8**	**0.00**	**-**	**2.46**	**1.98**	**2.22**

[1] A dash (-) indicates the area was not surveyed.
[2] 2014 and 2015 survey totals do not include results of the fifth survey conducted in these years.

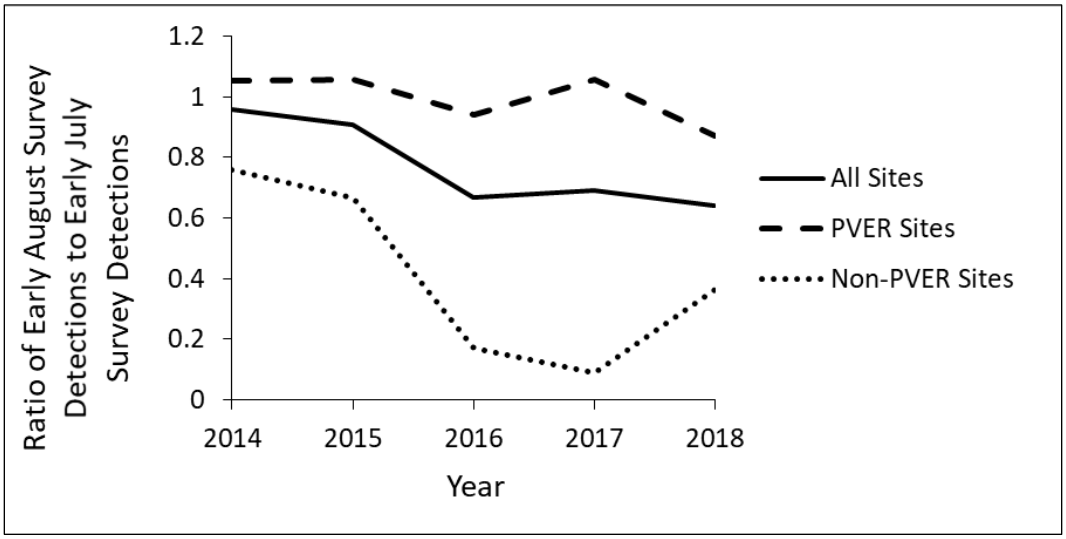

Figure 12.—Ratio of early August (visit 4) to early July (visit 2) survey detections for all sites, PVER sites, and non-PVER sites, 2014 to 2018.

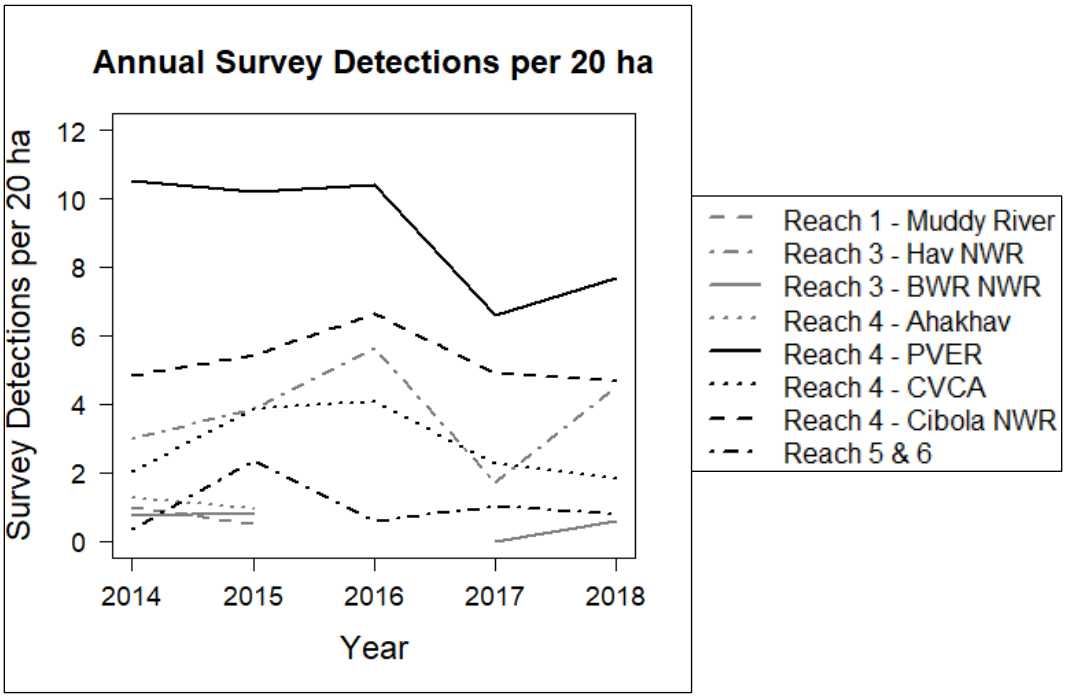

Figure 13.—Survey detections per 20 ha from survey visits 1 to 4, 2014 to 2018, by survey area/reach.

Reach 4 includes three LCR MSCP conservation areas, PVER, CVCA, and Cibola NWR Unit #1, and one other restoration site, the ‘Ahakhav Tribal Preserve (see table 15). Annual detection totals at ‘Ahakhav Tribal Preserve were three and four in 2014 and 2015 ($\mu = 3.5$ per year, SD = 0.1, n = 7). CVCA (six sites, Phases 1–3, 4, 7–8) had a moderately fluctuating total detection count from 2014 to 2018 (11, 21, 22, 15, 17), with relatively low to moderate average detection counts from 2014 to 2018 ($\mu = 4.8$ per year, SD = 3.6, n = 86). From 2014 to 2018, detections at the PVER (eight phases) fluctuated over the period, with the highest counts in the first 3 years (204, 198, 209, 137, 159), and annually contributed 63 to 71% of all survey detections (see table 15; see figure 13). It experienced a 24% decline in detections from 2016 to 2018 (2016: $\mu = 26.1$, SD = 25.4, n = 209; 2018: $\mu = 19.9$, SD = 13.1, n = 159). Cibola NWR Unit #1 (six sites) (see table 15) had relatively high annual detection totals at two sites; Crane Roost detections peaked in 2015 and then declined over 2016–18 ($\mu = 23.4$, SD = 4.4, n = 117), while Hippy Fire saw an increasing trend ($\mu = 11.0$, SD = 7.7, n = 44). The remaining Cibola NWR sites (Nature Trail, Cottonwood Genetics, CW-North, and Mass Transplanting) had few detections per year ($\mu = 1.3$, SD = 1.6, n = 26).

River Reach 5 sites, Lago Tres and Fisher’s Landing, were surveyed in 2015 and had one and two detections, respectively (see table 15). Reach 6 sites, Mittry, LDCA, and the YEW sites, had consistent but few annual detections ($\mu = 4.3$, SD = 2.5,n = 43) (see table 15). Mittry was surveyed 2014–15 with one and three detections respectively. Reaches 1 and 2 at the LDCA had three to nine detections annually in the years surveyed (2016–18). In 2014, the YEW sites south of the river (Sites I, South AC, and South CI) had no detections. The area was not surveyed in 2015; cuckoos were detected in the southern sites again in 2016 and at sites both north and south of the river in 2017 and 2018.

A closer examination of the highly influential PVER conservation area showed that after standardizing for varying site size by calculating detections per 20 ha for each phase, several trends emerged (figure 14). In 2014, the largest phases had the greatest density relative to the smallest phases. However, by 2018, all but the two smallest phases (Phase 8 and Phase 1) had converged to a similar detection density of 6.8 to 9.2 annual detections/20 ha.

Breeding Territory Estimates

Annual breeding territory estimates are summarized by survey area on figure 15 and table 16. Reach 1 sites had no confirmed breeding territories in 2014 or 2015. Muddy River had one POS territory in 2014 and was unoccupied in 2015. From 2014 to 2018 in Reach 3, the BLCA had territories each year, including confirmed breeding in 2015 and 2018 (figure 15; see table 16). The Topock sites (Pintail Slough and Topock Platform, surveyed in 2014 and 2015) had zero to one POS territory per year and no confirmed breeding.

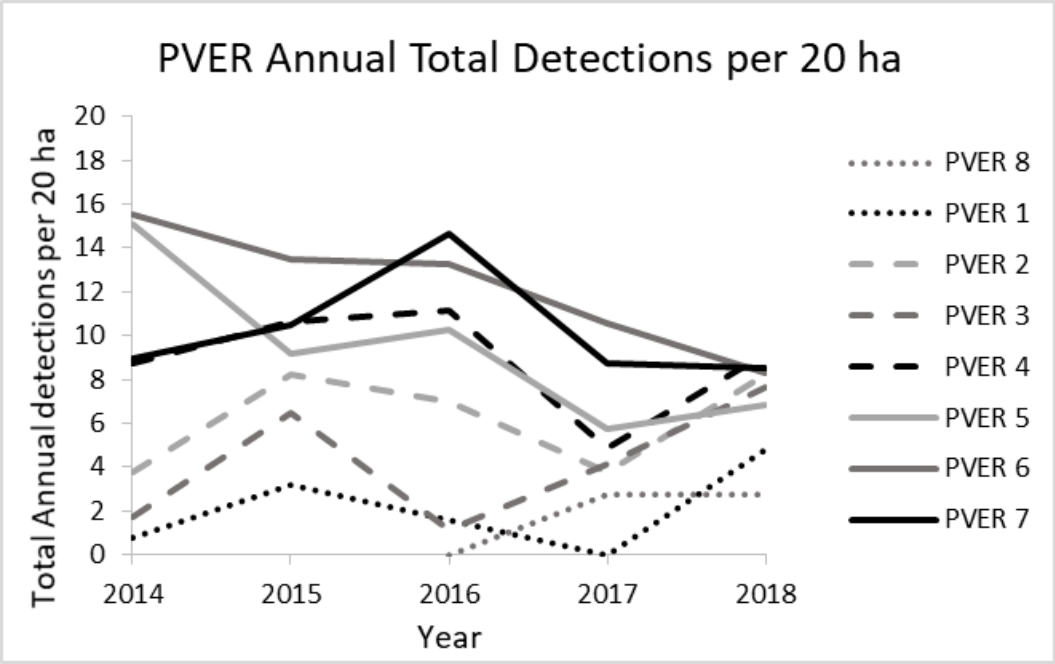

Figure 14.—Annual total detections for 2014 to 2018 at the PVER, where most detections occurred.
Survey detections per 20 ha are shown for PVER Phases 1–8. Sites smallest to largest are depicted by a shading and line pattern, dotted and light (Phase 8, 14.6 ha [49 ac]) to solid and dark (Phase 7, 91.6 ha [226 ac]).

The Bill Williams River NWR supported few territories annually and experienced a decline in the number of estimated territories from 2014 to 2018 (figure 15; see table 16). Occupancy of surveyed sites varied between 0 and 50% (see table 17), and COB territories were found only at Honeycomb Bend (2014) and Mineral Wash (2014 and 2015). PRB territories were observed at Honeycomb Bend (2015) and Mosquito Flats (2015). Occupied sites with POS territories were observed in 2014 (n = 6), 2015 (n = 7), and 2018 (n = 3). Sample unit occupancy averaged 24%, the lowest of all survey areas (see table 18). The refuge was not surveyed in 2016, and no detections occurred in 2017.

Most sites surveyed for YBCUs were within Reach 4, and most had COB territories. The ‘Ahakhav Tribal Preserve averaged 0.5 territory per year (range 0–1 POS) and was unoccupied in 2015 (figure 15; see tables 16 and 17).

The PVER exceeded all other LCR MSCP conservation areas in annual COB territories (μ = 38.2, range 25–50), and 5-year total COB territories (n = 191) (figure 15; see tables 16 and 17). From 2014 to 2018, 92% of the sites on average were occupied with breeding territories, with all sites occupied in 2015 and 2018 (see table 17).

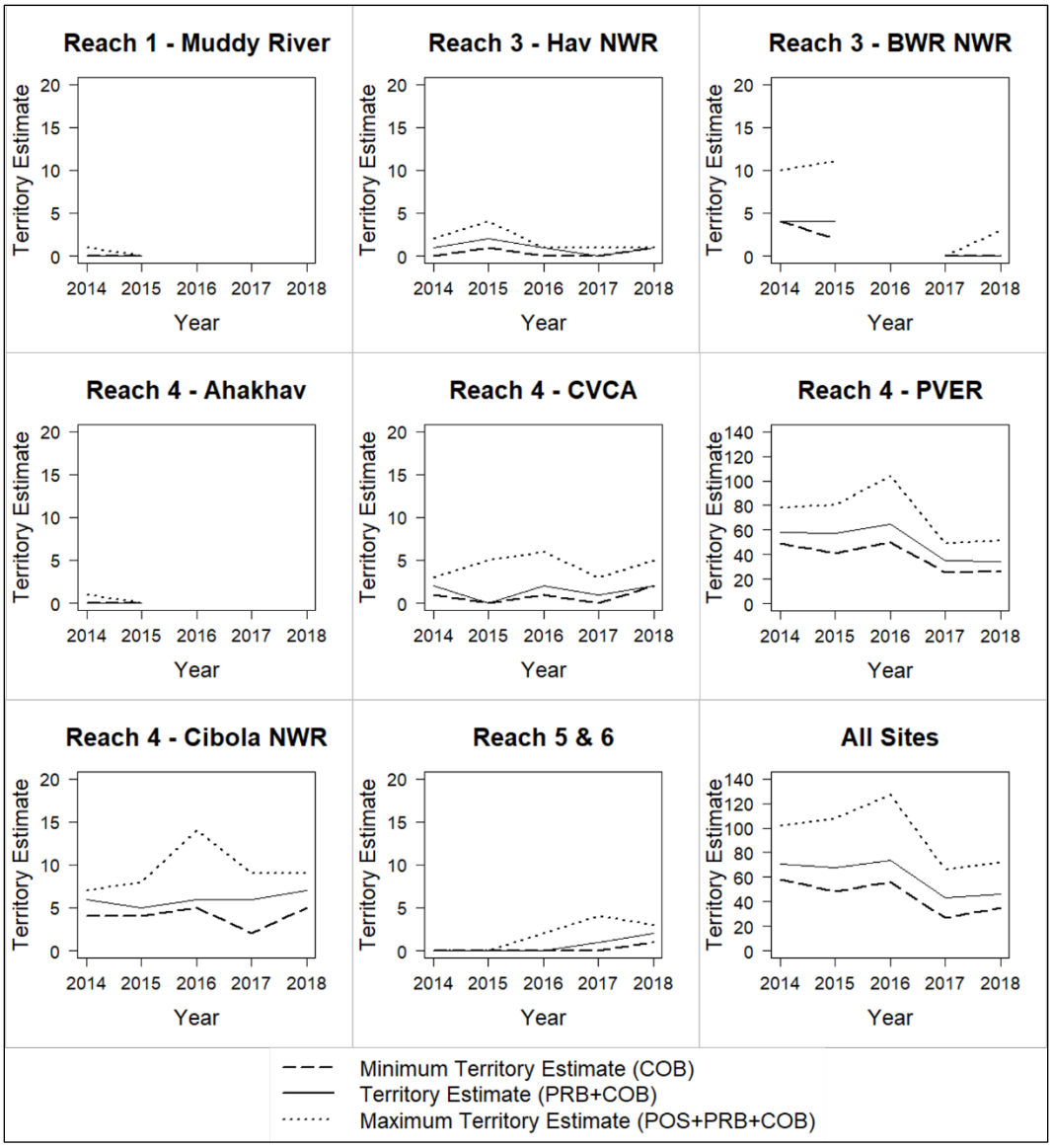

Figure 15.—Annual breeding territory estimates by survey area, and all sites combined, LCR MSCP study area, 2014 to 2018.
Note the variation in the scale of y-axis. Territory estimates are also displayed in table 16.

Table 16.—Minimum breeding territories, estimated breeding territories, and maximum breeding territory estimates by survey area, 2014 to 2018

River reach	Site	Year	POS[1]	PRB[2]	COB[3]	Minimum territory estimate[4]	Territory estimate[5]	Maximum territory estimate[6]
1	Muddy River	2014	1	0	0	0	0	1
		2015	0	0	0	0	0	0
3	Havasu NWR	2014	1	0	0	0	0	1
		2015	2	0	0	0	0	2
	BLCA	2014	0	1	0	0	1	1
		2015	0	1	1	1	2	2
		2016	0	1	0	0	1	1
		2017	1	0	0	0	0	1
		2018	0	0	1	1	1	1
4	‘Ahakhav Tribal Preserve	2014	1	0	0	0	0	1
		2015	0	0	0	0	0	0
	Bill Williams River NWR	2014	6	0	4	4	4	10
		2015	7	2	2	2	4	11
		2017	0	0	0	0	0	0
		2018	3	0	0	0	0	3
	CVCA	2014	1	1	1	1	2	3
		2015	5	0	0	0	0	5
		2016	4	1	1	1	2	6
		2017	2	1	0	0	1	3
		2018	3	0	2	2	2	5
	PVER	2014	20	9	49	49	58	78
		2015	23	16	41	41	57	80
		2016	39	15	50	50	65	104
		2017	14	10	25	25	35	49
		2018	17	8	26	26	34	51
	Cibola NWR	2014	1	2	4	4	6	7
		2015	3	1	4	4	5	8
		2016	8	1	5	5	6	14
		2017	3	4	2	2	6	9
		2018	2	2	5	5	7	9
5	Reach 5	2014	0	0	0	0	0	0
		2015	0	0	0	0	0	0

Table 16.—Minimum breeding territories, estimated breeding territories, and maximum breeding territory estimates by survey area, 2014 to 2018

River reach	Site	Year	POS[1]	PRB[2]	COB[3]	Minimum territory estimate[4]	Territory estimate[5]	Maximum territory estimate[6]
6	Mittry	2014	0	0	0	0	0	0
		2015	0	0	0	0	0	0
	LDCA	2016	1	0	0	0	0	1
		2017	2	0	0	0	0	2
		2018	1	1	0	0	1	2
	YEW	2014	0	0	0	0	0	0
		2016	1	0	0	0	0	1
		2017	1	1	0	0	1	2
		2018	0	0	1	1	1	1

[1] POS – Two or more total detections in an area during two surveys and at least 12 days apart.
[2] PRB – A POS territory, plus YBCUs observed in pairs, exchanging vocalizations or other breeding behavior.
[3] COB – Observation of copulation, multiple stick or food carries, nest, fledgling.
[4] Minimum territory estimate = sum of all COB territories.
[5] Territory estimate = sum of all PRB + COB territories.
[6] Maximum territory estimate = sum of all POS, PRB, and COB territories.

The CVCA had up to 22 territories over the 5 years ($\mu = 4.4$ territories per year, range 3–6), with 0 to 2 confirmed territories per year (see figure 15; see table 16). From 2014 to 2018, the CVCA territory and detection totals mildly fluctuated, with no significant increase or decrease. The proportion of CVCA sample units occupied from 2014 to 2018 (40%, 66.7%, 83.3%, 42.9%, and 41.7%) peaked in 2016 and dropped to below 50% occupancy in 2017 and 2018 (see table 18).

Cibola NWR Unit #1 had 20 confirmed breeding territories from 2014 to 2018, 14 at Crane Roost (3 in 2014, 4 in 2015, 5 in 2016, 1 in 2017, and 1 in 2018), 5 at Hippy Fire (1 in 2017 and 4 in 2018), and 1 at Nature Trail (in 2014) (see figure 15; see table 16). This area had the second highest COB territories per year, with an average of four confirmed per year (annual range two to eight POS, one to four PRB, two to five COB). On average, 73% of Cibola NWR sample units (range 60–87%) were occupied annually (see table 18).

Table 17.—Proportion of sites occupied with POS, PRB, or COB territories by survey area, 2014 to 2018

Survey area	Proportion of sites occupied (with breeding territories)[1]										
	2014		2015		2016		2017		2018		Mean
Muddy River	100%	1/1	0%	0/1	-	-	-	-	-	-	50%
Havasu NWR	67%	2/3	100%	3/3	100%	1/1	100%	1/1	100%	1/1	93%
Bill Williams River NWR	47%	7/15	50%	6/12	-	-	0%	0/6	33%	2/6	33%
‘Ahakhav Tribal Preserve	100%	1/1	0%	0/1	-	-	-	-	-	-	50%
CVCA	50%	2/4	67%	2/3	100%	3/3	50%	2/4	60%	3/5	65%
PVER	86%	6/7	100%	7/7	88%	7/8	88%	7/8	100%	8/8	92%
Cibola NWR	40%	2/5	50%	3/6	67%	4/6	50%	3/6	33%	2/6	48%
Imperial South-Yuma	0%	0/2	0%	0/3	100%	2/2	100%	3/3	75%	3/4	55%

[1] A dash (-) indicates the area was not surveyed.

Table 18.—Proportion of sample units occupied by survey area, 2014-2018

Survey area	Proportion of sample units occupied[1]										
	2014		2015		2016		2017		2018		Mean
Muddy River	100%	2/2	0%	0/2	-	-	-	-	-	-	50%
Havasu NWR	40%	2/5	75%	3/4	100%	2/2	50%	1/2	100%	2/2	67%
Bill Williams River NWR	35%	12/34	26%	7/27	-	-	0%	0/16	19%	3/16	24%
‘Ahakhav Tribal Preserve	100%	2/2	0%	0/2	-	-	-	-	-	-	50%
CVCA	40%	2/5	67%	4/6	83%	5/6	43%	3/7	42%	5/12	53%
PVER	100%	21/21	92%	22/24	92%	22/24	92%	23/25	100%	24/24	95%
Cibola NWR	80%	4/5	63%	5/8	88%	7/8	60%	6/10	80%	8/10	73%
Imperial South-Yuma	0%	0/4	0%	0/2	24%	4/17	24%	4/17	38%	9/24	27%

[1] A dash (-) indicates the area was not surveyed.

Two Reach 5 areas surveyed in 2015 (Imperial South and Picacho) had no breeding territories estimated. In Reach 6, one breeding territory was confirmed at YEW (site South AC) in 2018, the first breeding territory confirmed for this conservation area (see Chapter 3).

Survey Detections – Site Age/Size Model

Table 19 summarizes the results of the mixed regression model of survey detections and site age and size. The random effects integral to the sampling design were > 0 and were retained in the model (Site: SD = 0.658, Year: SD = 0.229). Correlation and VIF values indicated no collinearity in model covariates, and no over-dispersion was observed. Model parameter estimates with 95% predictive intervals (figure 16) showed a strong interaction between site size and age, with larger sites experiencing a steeper decline in survey detections as they aged compared to smaller sites. Overall, young habitat started with proportionally higher detection counts in larger sites compared to smaller sites. However, by age 10–12 years, detections in the larger sites had become similar to those in smaller sites. Sites 20 ha or less showed low counts across all ages. The overall amount of planted YBCU habitat compared to the proportion of habitat less than 6 years old within LCR MSCP conservation areas from 2008 to 2018 is shown on figure 17.

Table 19.—Summary of mixed model results of survey detections (2008 to 2018) by site age, size, and age x size interaction

Model variable	Estimate	Standard error	P
Model Intercept	0.306	0.493	0.539
Site size (ha)	0.100	0.011	< 0.001
Site age	0.121	0.066	0.073
Site age:size interaction	-0.006	0.002	< 0.001

Discussion

Throughout the entire period of monitoring YBCUs in the LCR MSCP study area (since before 2008), the Southwestern United States and Mexico were experiencing a period of prolonged drought that continued through the end of the field season in 2018. The years 2000 to 2014 was the driest 15-year period ever recorded in the Colorado River Basin (Udall and Overpeck 2017), with local tree ring data showing 2000–15 was the driest 16-year period for the study area in the last 100 years, and among the driest in the last 1,200 years (Udall and Overpeck 2017).

Figure 16.—Predicted survey detections versus site age for sites sized 20, 50, and 80 ha.
95% predictive intervals are shown by grey shading around each line.

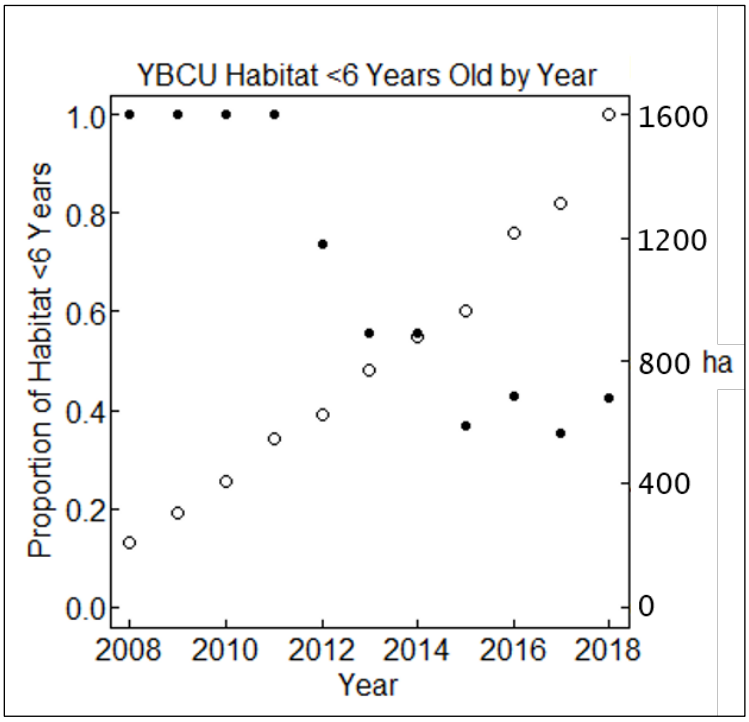

Figure 17.—Hectares of planted YBCU habitat (open circles) and proportion of habitat < 6 years old (black circles) by year, LCR MSCP sites, 2008 to 2018.

Colorado River flows from 2000 to 2014 were 19% below the 1906–99 average, and a third of the reduced flow was explained by above-average temperatures (0.9 °C [1.6 °F] above the 1906–99 average (Udall and Overpeck 2017). Historic drought conditions continued throughout the study area from 2015 to 2018 (National Oceanic and Atmospheric Administration 2018).

During this same period, the Bill Williams River NWR, historically a regional YBCU stronghold (Johnson et al. 2008) received no significant flooding since 2005, and the YBCU population fell from the peak observed in 2010 (McNeil et al. 2013a) to no YBCUs detected in 2017, increasing slightly after a small flood release in 2018 to 10 detections and 3 POS territories. Although no breeding activity has been confirmed at the refuge since 2015, it is possible that breeding occurred during this time. Sites only surveyed from 2014 to 2015, including Honeycomb Bend and Cave Wash, may have supported breeding YBCUs from 2016 to 2018; however, a gradual decline in the health of the riparian community was also observed within the refuge, with large cottonwoods and willows largely succumbing to the impacts of prolonged drought by 2017. Additionally, drone footage of the refuge taken in April 2018 (Brennan 2018) to document the effects of the managed release captured extensive impacts to vegetation quality from the ongoing drought.

Meanwhile, under these regional drought conditions, breeding YBCUs were observed to successfully occupy the planted LCR MSCP sites since monitoring began in 2008 (McNeil and Tracy 2013; McNeil et al. 2013a; this report). It is possible that the regular flood irrigation occurring throughout each breeding season in the planted LCR MSCP sites has largely buffered the YBCU population against the harshest effects of the drought, enabling the population to persist. With this warmer, drier trend predicted to continue in the Southwestern United States. through this century (Seager and Vecchi 2010; Woodhouse et al. 2010), over the lifetime of the LCR MSCP, this program and the successful adaptive management of YBCU breeding habitat may be crucial to the short-term viability of the regional population.

During this 5-year period, fewer and fewer detections occurred in early August. The decline in the ratio of detections between survey visits 4 and 2 (early August versus early July) suggest changes in habitat use and possibly habitat quality. At the PVER, August detections dropped only slightly in 2018, but overall remained relatively high, suggesting that these birds were asynchronously breeding, attempted multiple clutches, and remained in this area through August, similar to that observed previously (McNeil et al. 2013a). In contrast, steep declines in August detections observed at sites outside of the PVER suggests that birds increasingly departed these sites earlier in the latter years of this study. Earlier departure, especially prior to August, may indicate that overall habitat quality at these sites may have declined in breeding suitability. While changes in detection probability may be related to their breeding stage phenology (McNeil

et al. 2013a), the scarcity of probable and confirmed breeding observations at the majority of sites suggests that many birds increasingly departed these sites earlier in the latter years of this study.

The flat or declining detection counts in the study area fit within the greater long-term regional population declines, local extirpations, and range contractions observed over the last century (Gaines and Laymon 1984; Halterman et al. 2001; Laymon and Halterman 1987; Stanek 2017). Throughout California, the YBCU meta-population may have largely collapsed. At the Sacramento River, which once supported the largest population in the State with 60 to 96 pairs estimated in 1972 (Gaines and Laymon 1984) YBCU sightings are now exceptionally rare (Dettling et al. 2015; Sullivan et al. 2009). It is unknown when the last confirmed breeding occurred there, though it likely predates the widespread surveys conducted from 2012 to 2013, when no nesting activity was observed (Dettling et al. 2015). The Kern River Valley population, formerly considered the second largest in California behind the LCR population, has not had confirmed breeding since 2015 (Stanek and Stanek 2015), and in 2018, just one PRB and one POS territory were estimated (Stanek 2018). While YBCUs are still detected on the Sacramento and South Fork Kern Rivers, their uncertain long-term viability increases the importance of the closest substantial population, currently in the LCR MSCP study area.

Detection densities suggest that habitat quality may also be changing. Density in the largest sites (41–92 ha [101–227 ac]) appeared to decline, potentially resulting in sizable losses relative to the densities observed in the recent past. The results of the survey detections–site age/size model agrees with results from the study of YBCU nest site selection from 2008 to 2012 in the study area (McNeil et al. 2013a), which indicated that YBCUs preferred large stands of riparian forest with (cool, humid) patches of dense young native trees for nesting. With the overall planted habitat in the study area aging (see figure 17), if future results remain consistent with this trend, stand age may be important to consider in adaptive management to support YBCU occupancy over the long term.

Chapter 5

POPULATION MONITORING

Introduction

Objectives from the Yellow-billed Cuckoo Monitoring Statement of Work in 2014 included using population parameters to (1) assess whether YBCUs are increasing due to LCR MSCP habitat creation activities and (2) provide a reference for the status of YBCUs using created habitat. This objective was removed from the scope of this contract after 2015. In general, wildlife population status and trends should be defined in terms of site- and habitat-specific measures of productivity, density, and survival (Van Horne 1983). Annual productivity can be measured by finding and monitoring nests, while population density can be estimated from a combination of surveys (see Chapter 4) plus intensive nest searching and monitoring. In 2014 and 2015, population parameters measured included density, nest survival, and productivity. Banding and resight data were previously collected in the study area between 2008 and 2013, prior to this project (McNeil and Tracy 2013; McNeil et al. 2013a). These efforts continued from 2014 to 2018, with variable annual effort (described below). The combined years of banding and resight data comprise 11 years of data.

Methods

Target Mist Netting

Annual netting effort varied over the course of this project. In 2014 and 2015, attempts were made to capture most birds throughout the season, with up to four banding crews active on a given morning. In 2016, netting effort remained high in order to try to recapture as many GPS-fitted birds as possible. After 2016, up to two attempts per year were included in the scope of work in case a GPS-fitted YBCU was resighted.

The health and welfare of wild birds is paramount, and the guidelines for safety of the birds recommended in North American Bird Banding Techniques, Volume II (Canadian Wildlife Service and USFWS 1977) and the Guidelines to the Use of Wild Birds in Research, Third Edition (Fair et al. 2010) were followed in this project. Mist netting is a safe, common, and effective means of capturing adult birds (Spotswood et al. 2011), and all netting and banding was conducted by experienced, federally permitted banders or subpermittees. All banders and banding assistants attended western YBCU survey training as well as specialized mist net setup and banding training. Given the potential for temperatures to be

lethal to bird eggs (40.5 to 44 °C [104.9 to 111.2 °F]) (Conway and Martin 2000; Webb 1987), care was taken not to deter adults from incubating, and all field activities ceased when the ambient temperature reached 40 °C (104 °F).

Adult YBCUs were captured each year during the breeding season between mid-June and mid-August. A responsive YBCU was first located by using recorded YBCU vocalizations or listening for an unsolicited YBCU call. A suitable net lane, such as a gap in the vegetation, was found or created, and a modified target mist net technique was used to capture the birds (Sogge et al. 2001). Two to four stacked nets 7.8 to 15 m (25.6 to 49.2 ft) high, ranging in length from 9 to 18 m (29.5 to 59 ft) were attached between two canopy poles (Bat Conservation and Management, Inc., Carlisle, Pennsylvania) and placed in the designated vegetation gap of similar canopy height. Recorded vocalizations were broadcast from speakers on either side of the mist net to lure YBCUs into the net. Capture attempts ceased when temperatures reached 40 °C (104 °F) or when YBCUs became unresponsive.

Color Banding

To increase the number of unique leg band color combinations available, the Federal aluminum bands were color anodized with different colors used over the years of the banding conducted in this study area: gold (Ag) from 2008 to 2010, mid-blue (mB) in 2011, magenta (Mg) from 2012 to 2013 (McNeil and Tracy 2013; McNeil et al. 2013b), red (R) in 2014 (Parametrix and SSRS 2015), and red or unanodized silver (S) from 2015 to 2018 (Parametrix and SSRS 2016a, 2016b, 2018). All newly captured (unbanded) YBCUs were given a Federal band on one leg and a pinstriped (two- or three-striped) aluminum band on the other leg to form a unique color combination. Non-targeted species were immediately released from nets without being banded.

A wing rule was used to measure wing and tail length, calipers were used to measure bill length, and a 100-gram (g) (3.5-ounce [oz]) Pesola® or 400-g (14.1-oz) Acculab digital scale was used to weigh the birds. For adults, molt, feather wear, orbital ring color, cloacal protuberance score, and brood patch score were also recorded following the Monitoring Avian Productivity and Survivorship protocol (DeSante et al. 2014).

Although females average slightly larger than males (Pyle 1997), individuals cannot be reliably sexed by morphology. To sex birds, a small amount of blood was extracted from the brachial vein of each newly captured YBCU and placed on filter paper and dried (2014–17). Deoxyribonucleic acid (DNA) was extracted from dried blood samples at the University of Arizona Genetics Core (UAGC), and the DNA samples were sexed by S. McNeil, SSRS Avian Biologist, at the University of Arizona Culver Laboratory of Conservation Genetics (see McNeil 2015).

During the field season, field crews attempted to resight previously banded YBCUs by observing birds (with binoculars or photographing) the legs of YBCUs visually detected, as designated by the scope of work for this project. Resighting and nest-searching attempts were limited to 50 followup visits total in 2017 and 2018 due to changes in the scope of work for the final years of the project. Resight data were recorded in a field notebook and transferred into a MEFF on a Juno unit once the color combination was confirmed or the banded bird was no longer seen by the observers.

Dispersal

For resighted second year (SY) birds (returning chicks banded the previous year), natal dispersal distance was calculated as the distance between the bird's natal nest and its (assumed first) nesting location (calculated in ArcGIS 10.6 (ESRI 2018). For returning after-second-year (ASY) or older birds, breeding dispersal distance was calculated as the distance between the successive nests associated with birds each year. If no nest was found, the bird's capture site was used to estimate the distance dispersed. Within-season dispersal distances were also calculated for birds nesting more than once per season as the distance between each successive nest.

Telemetry

In 2014 and 2015, a subset of captured adults was equipped with one of two types of radio transmitters: Holohil BD-2 (Holohil Systems, Ltd., Carp, Ontario, Canada) weighing 1.47 to 1.51 g and broadcasting at 151.5 to 152 megahertz (MHz); and Lotek Biotrack Radio PIP AG 393 (Lotek Wireless, Inc., Newmarket, Ontario, Canada) weighing 1.09 to 1.24 g and broadcasting at 151.0 to 151.49 MHz. Transmitters were operational for 6 to 8 weeks. Transmitters were stitched near the base of the two central rectrices with dental floss or Kevlar thread, and the knots were secured with a small drop of cyanoacrylate glue (Bray and Corner 1972; Pitts 1995; Woolnough et al. 2004) (figure 18).

Radio receivers (Communications Specialists Model R1000) and three-prong directional Yagi antennae (AF Antronics model F151-3FB and Communications Specialists RA-150 Folded Yagi) were used to monitor the birds every 1 to 3 days for up to 4 hours per session. Vocalizations, movements, and behaviors including intraspecific interactions, and signs of breeding were recorded during telemetry sessions. If an observer thought that their presence was disturbing the bird, they moved away and continued tracking from a distance. Breeding by tracked birds was confirmed by witnessing the birds at nests or exhibiting other breeding behaviors. If a bird's signal was no longer detected at its capture site, the signal was searched for on foot or by vehicle for the remainder of the season. A lack of signal with no additional resights of a bird was assumed to be due to the bird leaving the area, although transmitter failure was also possible.

Figure 18.—YBCU fitted with tail-mounted radio transmitter, July 8, 2014, at PVER Phase 7.

Nests

In 2014 and 2015, nest searches occurred in all areas of YBCU activity to try to confirm breeding. All field work adhered to the Ornithological Council's guidelines for the use of wild birds in research (Fair et al. 2010). Field personnel were trained in safe and effective techniques for approaching potential YBCU nests, emphasizing safety and minimization of disturbance to breeding birds. YBCUs may be subtle in their distress signals and can abandon nests if disturbed (Halterman 2000). If a bird showed repeated alarm calls or distraction displays for over 5 minutes, observers moved at least 100 m (328 ft) away, returning cautiously and quietly after a minimum of 30 minutes to revisit the site. Observers checked for predators before visiting nests and minimized the time spent at nests. Because flagging may increase predation risk, it was used sparingly and placed at least 10 m (32.8 ft) away from nests when possible.

YBCUs may call or respond to call-playback from their nest. Therefore, during and after surveys, nests were searched for in all accessible woody vegetation surrounding survey detections (Martin and Geupel 1993). Additionally, observers watched and listened in areas where two YBCUs exchanged vocalizations, which may indicate a nest (Halterman 2009; Hughes 2015; Potter 1980). Other behavioral clues were also used, such as food and stick carries, alarm calls, or

distraction displays, with efforts directed in these areas until a nest was located. Additionally, radio telemetry was used in 2014 and 2015 to locate nests. Used, inactive YBCU nests were distinguished from similar stick nests of other species such as doves if bluish egg fragments were found in or directly below the nest.

After locating a nest, the GPS location was recorded a few meters from the nest; a more accurate reading was taken after YBCU activity ceased. Nest site characteristics, such as nest substrate species, estimated tree height, nest height, stage, and the banded status of adults were recorded, if known. All observations made near active nests were completed as quickly as possible to reduce the potential to disturb nesting birds. Sometimes data were recorded in a field notebook first and then entered into a MEFF at a later time when observers were away from the nest.

During 2014 and 2015, nests were monitored every 2 to 4 days to determine stage, contents, and fate. A telescoping mirror or small Wi-Fi camera mounted on a pole was used to check nest contents, and any observed behaviors or resighted bands were noted. Nestlings were opportunistically banded when they were 3 to 6 days old whenever the nest was accessible. Nests were judged successful if at least one young fledged, which was determined by detecting an adult or fledgling in the vicinity within 2 days of the estimated fledge date. Young YBCU leave the nest before they can fly and climb or hop onto nearby branches, where they may remain close to the nest site for several days. Nests were considered to have failed if they were found damaged or destroyed, when large eggshell fragments or remains were present, or when the nest was determined to be empty before the earliest possible fledge date (approximately 6 days after hatching) with no further activity detected nearby. Nests were considered deserted if intact eggs or live chicks were present with no further parental activity observed near the nest. Possible egg dumping (more than one female YBCU laying eggs in a nest) was suspected if two eggs were laid in one 24-hour period during laying or a new egg appeared 3 or more days after laying had ceased (McWhirter 1989).

For nests found in 2014 and 2015, apparent nest success was calculated as the observed number of successful nests divided by the number of successful plus unsuccessful nests found. To account for nests that failed before being found, Mayfield nest success (Mayfield 1975) was also calculated:

$$\text{Nest survival} = [(\text{total exposure days} - \text{failed nests})/\text{total exposure days}]^{\text{nesting period}}$$

This calculation assumed constant daily survival and used 18 days as the average length of the nesting period. Exposure days were calculated using the midpoint method for nests of known fate and the last known active date for nests of unknown fate.

Because the exact number of young fledged from each nest was not usually known, to estimate nest productivity, the average of the minimum (includes only

known young fledged) and the maximum possible young fledged from each nest (includes all young minus any young known not to have fledged) was used. Clutch size was the total number of known eggs laid in each nest.

From 2016 to 2018, after the removal of population monitoring from the objectives of the project's scope of work, nest searches were only conducted in areas where breeding had not been previously confirmed, including the LDCA and YEW. Additional nests were found incidentally or opportunistically during or after surveys and during attempts to resight GPS-fitted birds.

Results

Target Netting, Color Banding, Recaptures, and Resights

Between June and August 2014 to 2018, 233 YBCUs, 108 adults and 125 young, were newly captured in the study area (summarized in table 20, all captures are listed in attachment 4). Most birds were banded at the PVER (n = 192), followed by Cibola NWR Unit #1 (n = 30), CVCA (n = 5), BWR-East (n = 4), and the BLCA (n = 2). Of the captured adults, 53 (49%) were DNA-sexed male, 54 (50%) were female, and 1 was unsexed. Seventy of the 125 young (56%) were sexed female, 52 (41.6%) were sexed male, and 3 (2.4%) were unsexed. There were also 53 recaptures and 50 resights of birds previously banded in the study area (attachment 4; see table 20 for summary). Of 231 birds newly banded from 2014 to 2017, 47 (20.3%) were recaptured or resighted in subsequent years. The proportion of adults resighted (27.4%) was higher than young resighted (14.5%).

Dispersal

Between 2008 and 2018, a total of 155 dispersal events were recorded for 95 individual YBCUs in the study area. These included 31 natal, 82 breeding, and 42 within-season movements (figure 19, table 21). Of the returning banded birds, 87% of young returned to their natal area, and 90% of adults returned to their previous nesting area. Twelve banded birds dispersed away from their capture or previous breeding area (see circles at bottom right of plot on figure 19): eight adults dispersed to new breeding areas, and four young birds dispersed away from their natal areas (table 22). Seven of the 12 dispersal events (58.3%) involved movements into PVER (table 22). Natal dispersal distances averaged slightly farther than breeding dispersal distances (median 788 m [2,585 ft] versus 513 m [1,683 ft]). All YBCUs observed nesting more than once in a season remained within one conservation area through the season (median = 150 m [492 ft] between successive nests). For the first time documented, one banded YBCU (or pair of YBCUs – the female was unbanded both nesting attempts) nested twice in the same nest in 2018 (see Chapter 3, figures 7 and 8).

Table 20.—Summary of YBCUs captured, recaptured, or resighted in the LCR MSCP study area, 2014 to 2018

Area	Year	Age[1]	New captures	Recaptures	Resights	Mortality	Total
BLCA	All years	All ages	2		2		4
	2015	All ages	2		2		4
		Adult			2		2
		Juvenile	2				2
BWR-East	All years	All ages	4				4
	2014	All ages	2				2
		Juvenile	2				2
	2015	All ages	2				2
		Juvenile	2				2
Cibola NWR	All years	All ages	30	3	4	1	37
	2014	All ages	10	1			11
		Adult	3	1			4
		Juvenile	7				7
	2015	All ages	10	2		1	12
		Adult	6				6
		Juvenile	4	2		1	6
	2016	All ages	10		2		12
		Juvenile	10		2		12
	2017	All ages			2		2
		Adult			1		1
		Juvenile			1		1
CVCA	All years	All ages	5		1		6
	2014	All ages	5				5
		Adult	3				3
		Juvenile	2				2
	2017	All ages			1		1
		Juvenile			1		1
PVER	All years	All ages	192	50	43	1	285
	2014	All ages	53	12	1		66
		Adult	26	7			33
		Juvenile	27	5	1		33
	2015	All ages	57	12	2	1	71
		Adult	26	8	2	1	36
		Juvenile	31	4			35
	2016	All ages	67	23	3		93

Table 20.—Summary of YBCUs captured, recaptured, or resighted in the LCR MSCP study area, 2014 to 2018

Area	Year	Age[1]	New captures	Recaptures	Resights	Mortality	Total
PVER		Adult	38	15	2		55
		Juvenile	29	8	1		38
	2017	All ages	13	3	19		35
		Adult	4	2	13		19
		Juvenile	9	1	6		16
	2018	All ages	2		18		20
		Adult	2		10		12
		Juvenile			8		8
All sites	All years	All ages	233	53	50	2	336
		Adult	108	33	30	1	171
		Juvenile	125	20	20	1	165

[1] Age when initially captured.

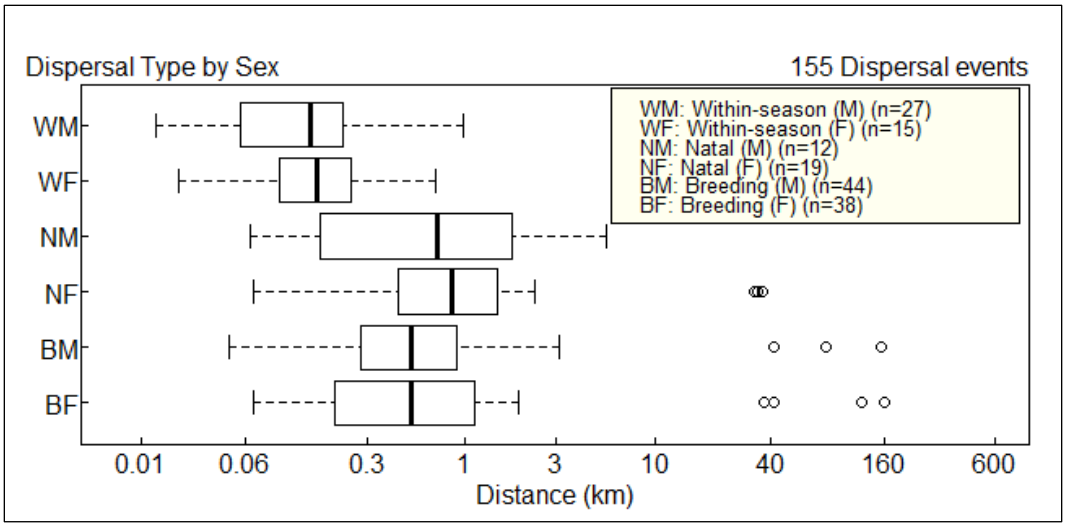

Figure 19.—Boxplots of dispersal distances by type and sex, LCR MSCP study area, 2008 to 2018.

Table 21.—Summary of dispersal events by type and sex, LCR MSCP study area, 2008 to 2018

Dispersal type	Sex	Number of dispersal events	Return to previous site	Dispersal to new site	Distance dispersed (km)			
					Minimum	Median	Mean	Maximum
Breeding	Female	38	33 (86.8%)	5 (13.2%)	0.068	0.512	10.955	157.494
	Male	44	41 (93.2%)	3 (6.8%)	0.048	0.513	6.808	151.981
	Total	**82**	**74 (90.2%)**	**8 (9.8%)**	**0.048**	**0.513**	**8.730**	**157.494**
Natal	Female	19	16 (84.2%)	3 (15.8%)	0.068	0.843	6.166	36.678
	Male	12	11 (91.7%)	1 (8.3%)	0.065	0.717	1.314	5.487
	Total	**31**	**27 (87.1%)**	**4 (12.9%)**	**0.065**	**0.788**	**4.288**	**36.678**
Within-season	Female	15	15 (100%)	0	0.022	0.159	0.201	0.689
	Male	27	27 (100%)	0	0.014	0.145	0.170	0.971
	Total	**42**	**42 (100%)**	**0**	**0.014**	**0.150**	**0.181**	**0.971**

Table 22.—Details of 12 dispersals away from a natal or previous breeding area, LCR MSCP study area, 2008 to 2018

Dispersal type	Bird ID	Sex	Area 1	Year 1	Area 2	Year 2	Distance dispersed (km)
Natal	ODY	F	CVCA	2008	PVER	2009	33.3
	JER	M	CVCA	2008	CNWR	2015	5.5
	DEV	F	CVCA	2014	PVER	2017	36.7
	BAT	F	PVER	2016	CVCA	2017	34.2
Breeding	CA	F	CRIT	2009	BWR-East	2010	37.4
	NUR	M	CNWR	2011	PVER	2013	41.8
	KIM	M	CVCA	2012	BLCA	2015	152.0
	LLL	F	CNWR	2012	PVER	2015	42.0
	FMF	M	BWR-East	2012	PVER	2016	78.4
	NIL	F	CNWR	2014	BLCA	2015	157.5
	SAL	F	CNWR	2015	PVER	2016	41.8
	NIL	F	BLCA	2015	PVER	2016	119.5

Two mortalities of banded YBCUs were recorded during this project. A banded adult initially captured at the PVER on July 14, 2015, was radio tracked until it left the site by July 29, 2015. It was reported dead August 4, 2015, after it was found on a porch in Chino Valley, Yavapai County, Arizona (Bird Banding Laboratory, 2015, personal communication). Also in 2015, an 18-day-old juvenile banded from a nest at Crane Roost was found dead in a dove nest, 300 m (984 ft) from its natal nest. No YBCUs banded any year during other projects outside this study area were ever resighted or recaptured in the study area between 2014 and 2018.

Nests

Between 2014 and 2018, 165 YBCU nests were found in the study area within 6 conservation areas: BLCA (n = 1), BWR-East (n = 4), PVER (n = 140), CVCA (n = 4), Cibola NWR Unit #1 (n = 15), and YEW (n = 1) (table 23). All nests found are listed in attachment 5. In 2014 and 2015, 74 nests were found, almost half of them (n = 36, 48.6%) located by telemetry. Known nesting activity began mid- to late June each year and ended mid-September in 2014 and late August in 2015. From 2016 to 2018, field work generally ended before nesting activity had finished.

Nests were located in cottonwoods (n = 95, 57.5%), Goodding's willows (n = 49, 29.7%), honey mesquite (n = 13, 7.9%), tamarisk (n = 5, 3.0%), coyote willows (n = 2, 1.2%), and mule-fat (n = 1, 0.7%) (table 24). Nest substrates ranged in height from 2.5 m (8.2 ft) to 25.0 m (82 ft) (mean = 12.3 m [40.4 ft]). Nest heights ranged from 1 m (3.3 ft) to 20 m (66 ft) (mean = 7.6 m [24.8 ft]).

Nest Monitoring

Of 74 nests monitored in 2014 and 2015 in all areas, at least one young successfully fledged from 44 (61%) nests, and 28 (39%) nests failed (table 25). Fate was unknown for two nests (3% of nests [2014–15]). Overall Mayfield nest success was 48%. Apparent and Mayfield success were 67 and 55 % (n = 33), respectively, in 2014, and 56 and 43% (n = 39), respectively, in 2015. The PVER was the only area with at least 20 nests found between 2014 and 2018; apparent and Mayfield success for the PVER was 57 and 49% (n = 53), respectively. Apparent Mayfield success at the PVER was 61 and 48%, respectively, in 2014 and 56 and 42%, respectively, in 2015.

YBCU clutch size in 2014 and 2015 averaged 2.8 and 2.87, respectively (range 2–4, n = 30 [2014] and 33 [2015] nests with known clutch size, table 25). From 2016 to 2018, nests were not monitored to determine clutch size or fate; in 2016, however, one nest was incidentally observed with six eggs (PVER Phase 6, Nest 5), the largest YBCU clutch recorded in the study area and at least twice the

Table 23.—Summary of nests located in the study area, 2014 to 2018

Area	Site	Nests found by year[1]						
		2014	2015	2014–15	2016	2017	2018	2014–18
BLCA	CPhase 5	–	1	1	–	–	–	1
BWR-East	Mineral Wash	2	2	2	ns	–	–	4
PVER	Phase 2	–	2	2	–	–	1	3
	Phase 3	–	1	1	–	1	–	2
	Phase 4	4	4	8	4	1	–	13
	Phase 5	5	3	8	8	2	3	21
	Phase 6	13	11	24	17	6	9	56
	Phase 7	7	12	19	12	9	5	45
	Total	**29**	**33**	**62**	**41**	**19**	**18**	**140**
CVCA	Phase 1	–	–	–	1	–	–	1
	Phase 2	1	–	–	–	–	–	1
	Phase 8	ns	ns	ns	ns	ns	1	1
	Phase 9	ns	ns	ns	ns	ns	1	1
	Total	1	–	–	1	–	2	4
Cibola NWR Unit #1	Crane Roost	3	3	3	4	1	1	12
	Hippy Fire	ns	–	–	–	1	2	3
	Total	**3**	**3**	**3**	**4**	**2**	**3**	**15**
YEW	South C	–	–	–	–	–	1	1
	Year total	**35**	**39**	**74**	**46**	**21**	**24**	**165**

[1] – = no nest found; ns = not surveyed.

Table 24.—YBCU nest substrate heights and nest heights by species, mean ± SD (minimum-maximum), LCR, 2014 to 2018

Nest substrate species	Count	Percent	Substrate height (m)	Nest height (m)
Cottonwood	95	57.58	14.88 ± 4.86 (5–25)	9.13 ± 4.29 (1.5–20)
Goodding's willow	49	29.70	10.32 ± 3.08 (4–18)	6.2 ± 2.93 (1–15)
Honey mesquite	13	7.88	4.78 ± 1.61 (2.5–9)	2.94 ± 1.63 (1.5–7)
Tamarisk	5	3.03	5.54 ± 1.78 (3–7.5)	4.14 ± 1.23 (2.5–5.5)
Coyote willow	2	1.21	9.5 ± 0.71 (9–10)	8.5 ± 4.95 (5–12)
Mule-fat	1	0.61	2.90	1.50
Total	**165**	**100.00**	**12.31 ± 5.3 (2.5–25)**	**7.57 ± 4.21 (1–20)**

Table 25.—Clutch size, productivity, and fates of 74 YBCU nests monitored in the LCR MSCP study area, 2014 and 2015

Year	Area	Number of nests	Mean clutch size	Total eggs minimum	Total eggs maximum	Total hatched minimum	Total hatched maximum	Total fledged minimum	Total fledged maximum	Mean productivity (known)	Mean productivity (estimated)	Number success	Number failed	Number unknown	Percent success
2014	All areas	35	2.80	93	99	61	72	50	60	1.37	1.59	22	11	2	0.67
	BWR-East	2	2.00	4	4	4	4	2	4	2.00	2.00	1	0	1	1.00
	Cibola NWR	3	4.00	9	11	7	9	6	7	3.00	2.17	3	0	0	1.00
	CVCA	1	2.00	2	2	2	2	2	2	2.00	2.00	1	0	0	1.00
	PVER	29	2.80	78	82	48	57	40	47	1.25	1.50	17	11	1	0.61
2015	All areas	39	2.87	103	118	66	84	44	49	1.08	1.19	22	17	0	0.56
	BLCA	1	3.00	3	3	2	3	2	2	2.00	2.00	1	0	0	1.00
	BWR-East	2	2.50	5	5	3	4	2	2	1.00	1.00	1	1	0	0.50
	Cibola NWR	3	2.67	8	8	5	7	4	4	1.33	1.33	2	1	0	0.67
	PVER	33	2.91	87	102	56	70	36	41	1.03	1.17	18	15	0	0.55
All years	**All areas**	**74**	**2.84**	**196**	**217**	**127**	**156**	**94**	**109**	**1.21**	**1.38**	**44**	**28**	**2**	**0.61**

typical YBCU clutch size of two to three eggs. Also, at least three different YBCUs (two banded, one unbanded) were observed at the nest during resight attempts, and given the unusually high egg count and extra adults observed at the nest, the eggs were assumed to have been laid by more than one female. Also during resight attempts at this nest, an unbanded adult was twice observed picking up a nestling and flying away with it before the nest eventually failed (cause unknown).

Productivity in 2014 and 2015 averaged 1.6 and 1.2 fledged per nest, respectively (see table 25). The numbers of young fledged from nests monitored in 2014 and 2015 were 50 to 60 and 44 to 49 young, respectively. These totals indicate that more nests were found with more eggs in 2015, but due to the lower average nest survival in 2015, average and total productivity was lower in 2015 than in 2014.

In 2014, successful double brooding was confirmed at PVER Phase 7 when a radio-tracked adult was monitored at two successful nests. Five other radio-tracked YBCUs renested after initial nest failures. Of those, three successfully renested on their second or third attempt. In 2015, double brooding by an individual banded YBCU was observed at Cibola NWR Unit #1, Crane Roost, and PVER Phase 4 to Phase 7, although no individuals were known to have successfully nested more than once.

At least two pairs successfully nested into mid-September in 2014 at the PVER, both fledging at least one young. In addition, while collecting nest attributes at inactive nests, five contact calls were played to determine if parents or juveniles were still in the area. Between August 26 and September 14, 2014, 17 detections were recorded near previous nest areas, suggesting that adults with juveniles or nests were still at the sites well into September. Two known nests were initiated in mid-August of 2015 (fledge dates August 16 and August 24), suggesting that adults with young were still present at the sites in 2015 at the start of the dove hunting season on September 1.

Depredation was the assumed cause of most nest failures in 2014 and 2015 (5 in 2014 and 10 in 2015), although the identities of predators were never known for any failed nests during this project. Potential predators incidentally observed during field work included king snakes (*Lampropeltis getula californiae*), Cooper's hawks (*Accipiter cooperii*), and common ravens (*Corvus corax*). A white-nosed coati (*Nasua narica*) was observed first by SWCA Environmental Consultants personnel at PVER Phase 2 on June 10, 2014 (A. Pellegrini 2015, personal communication), and on this project on July 30, 2015, near a recently failed nest in PVER Phase 6. Weather (wind and rainstorms) caused four other nest failures (two each in 2014 and 2015). In both 2014 and 2015, at least three nests failed to hatch eggs despite both adults incubating long past the normal 10-day period (Parametrix and SSRS 2016a). This was also incidentally observed at

one nest each in 2017 (Parametrix and SSRS 2018) and 2018 (see Chapter 3 this report). Additionally, another five nests abandoned with full clutches were incidentally observed in 2018 (see Chapter 3 for details of nests found in 2018).

Discussion

Banding

Although population monitoring was removed from the scope of work after 2015, the banding that continued throughout the project, despite the variable annual effort, is still informative. Recapture and resight data gave an apparent return rate over the 5 years of 27.4% for adults and 14.5% for young. This large difference, young returning at just over half the rate of adults, is typical for most species of birds. Juveniles tend to disperse farther away from their natal areas, often outside the area being studied (Greenwood 1980). Therefore, the probability of resighting SY birds is usually lower than returning ASY birds, causing juvenile survivorship to be underestimated (Grzybowski 2005). Lastly, the young may not be surviving the non-breeding season as well as the adults (Newton 2003), either during migration or wintering. In many migratory species, the highest mortalities occur during migration. For example, in a study of willow flycatchers (*Empidonax trailii*), migration accounted for 62% of the annual mortality despite the migration period lasting no more than a quarter of the annual cycle (Paxton et al. 2017).

A banded male aged 8+ years resighted at Crane Roost in 2017 is now the oldest documented YBCU to date. Apart from contributing to longevity and site fidelity estimates for this population, continued resight data can improve knowledge regarding survival estimates and varying detection probabilities of individuals. This detection also suggests the low apparent probability of resighting banded YBCUs. This YBCU was banded 7 years prior to being resighted for the first time in 2017. This individual may have been present in the study area, possibly at the same site each year since 2010, yet remained undetected due to the difficulty of resighting YBCU color bands.

Most birds observed over more than 1 year showed high site fidelity, although with just 20% of banded birds resighted, it is unknown whether the other 80% never seen again were in fact present at the sites and remained undetected, dispersed to new areas, or died. Of note, a male that nested at BWR-East in 2012 (McNeil et al. 2013b) was resighted at the PVER in 2016. The YBCU population at the Bill Williams River NWR declined over the years of this project, likely due to the prolonged drought conditions throughout the region (see Chapter 4). Some YBCU that previously nested at the Bill Williams River may have dispersed to flood-irrigated sites such as the PVER or other LCR MSCP conservation areas, though there are still large, unsurveyed areas along the Bill Williams River where YBCU may breed.

Nests

Although only 2 years of nest monitoring data were collected, the results are informative. Nest survival in 2015 (43% Mayfield) was lower than previous estimates in the study area in 2008 to 2012 (59% Mayfield survival overall and 52% at the PVER) (McNeil et al. 2013a) and in 2014 (55% overall and 47.9% at the PVER) (Parametrix and SSRS 2015). Correspondingly, average productivity per nest in 2015 (1.2 fledged young) was lower than previous years (averaging 1.6 in 2008–12 and 2014). Despite more nests being found with more eggs in the study area in 2015, productivity was lower than in 2014 or previous years due to the lower average nest survival in 2015. Previously, higher average clutch sizes in 2011–12 compared to 2008–10 did not lead to increased productivity (McNeil et al. 2013a). Larger broods may have experienced greater predation, given the increased parental activity, which tends to increase the risk of nest predation (Martin et al. 2000). However, the causes of most failed nests are unknown, so whether this occurred cannot easily be evaluated. It is unknown whether these results from 2015, the last year nests were formally monitored, are related to annual variation in resources or predators, habitat maturation, or impacts from prolonged regional drought, or if they portend the start of a downward trend.

Unhatched eggs are usually assumed to be infertile, potentially caused by insufficient or defective sperm, male health, condition, age, toxins (Birkhead et al. 2008), or incompatibility between a male's sperm and female's ovum (Zeh and Zeh 1997). Fertilized eggs may also fail to hatch, with various causes of embryo death, including low humidity, microbial infection, poor female condition, or inbreeding (Birkhead et al 2008; Grant 1982). Another causal factor is rising atmospheric temperatures, which also impacts humidity. The hotter and drier conditions experienced throughout the Southwestern United States region during this entire study period (see discussion in Chapter 4) may have begun to exceed the limits tolerable to nesting YBCUs.

High temperatures can cause embryonic death – the temperature of incubated eggs generally increasing with increasing ambient temperature (Grant 1982). Additionally, nestlings cannot survive temperatures exceeding 41 °C (107 °F) due to dehydration and stress caused by prolonged heat (Cunningham et al. 2013). Parental fitness may also be affected, as adults spend more time cooling the nest from extreme temperatures up to 49 °C (120 °F) and less time foraging or feeding nestlings, further impacting the nestlings (Richards 1970). Nesting YBCU during this project were often observed shading nests with their wings and reducing their body temperature by gular fluttering. The birds may also be regulating egg temperatures below lethal levels by high nest attentiveness and nest placement in cooler areas with high canopy cover. An analysis of microclimate data collected from 87 YBCU nests monitored in the study area from 2008 to 2012 showed the odds of nest placement within occupied sites increased 23.8% for every degree (°C) decrease in average ambient diurnal temperature, and increased 4.6% for every 1% increase in average diurnal relative humidity (McNeil et al. 2013a). Loss of fitness over a number of nests and individuals can significantly impact a

population. The current increase in observed temperatures, predicted to continue over this century (Woodhouse et al. 2010), likely constitutes an important selective force on avian reproduction and physiology (Griffith et al. 2016). Lower hatch rates and productivity are a concern in threatened populations and may provide important research topics in the future.

Chapter 6

MIGRATION STUDY, 2014 TO 2016

Introduction

Continued declines in populations of neotropical migratory birds (NMBs) have demonstrated the need to take a full life-cycle approach to their conservation (Faaborg et al. 2010). Conservation of habitat and resources on breeding grounds may not stabilize these populations if birds face high mortality along their migratory routes or on their wintering grounds. However, ecology and behavior outside of the breeding season are poorly understood for most NMBs. This knowledge gap comprises a major barrier to designing conservation strategies that will protect these birds during the non-breeding season. Thus, an understanding of the habitat used by birds during migration and wintering is essential to enable a complete life cycle assessment of their threats and conservation needs (Rosenberg et al. 2016).

Migration data from two western YBCUs, collected via light-level geolocator data (McNeil et al. 2015; Sechrist et al. 2012) provided insight into the migration paths and wintering grounds for this DPS, with limitations. Both birds appeared to winter within the Gran Chaco Forest of Bolivia, Paraguay, and Argentina, with the majority of winter points collected forming a dense cloud of data points centered on this region. The migration routes and pre- and post-breeding movements of these two birds were less clear. Both birds appeared to undergo a "loop migration" (spring and fall migration following different paths), but their routes appeared to be reversed from each other. Additionally, large movements between the breeding grounds and Mexico pre- and post-breeding were noted. However, a high average error was also noted in both studies (averaging > 200 km [124 mi] per point) [McNeil et al. 2015]. Thus, despite the great number of data points generated (two points per day estimated from light levels measured every second), actual locations of any individual could not be determined because of the high error present in this type of data, and the ability to determine a finer assessment is lacking.

To gain a better understanding of non-breeding habitat use and threats for western YBCUs, lightweight GPS tags were attached to a subset of birds annually captured in the study area during the breeding seasons of 2014 and 2015. The GPS tags are electronic data loggers capable of measuring high-accuracy geographical location points for up to 12 months, including areas a YBCU may migrate to or overwinter. Data within the loggers remain indefinitely, but the YBCUs must be recaptured to retrieve the data. The loggers store latitude and longitude on pre-designated dates, averaging 10-m (33-ft) accuracy in open areas and up to 50-m (164-ft) accuracy under dense canopy cover. This can provide

highly accurate information on pre- and post-breeding movements, migration routes and wintering locations, and may identify areas within the full range of this population that may benefit from management or protection.

Methods

In 2014 and 2015, 14 YBCUs captured at the PVER (6 females and 1 male each year; see Chapter 5 for capture methods), were fitted with PinPoint-10 GPS tags with built-in radio transmitters to assist in tag relocation (Lotek Systems Inc., Ontario, Canada). The expected average accuracy per point was 10 m (33 ft) in open areas and up to 50 m (164 ft) under dense canopy cover. At the time of this study, PinPoint-10 tags stored approximately 10 points each before battery failure. PinPoint-50 tags stored approximately 50 points but were considered too heavy to attach for the safety of the birds, as they exceeded 5% of their body mass. Due to the observed site fidelity of many breeding YBCUs, those confirmed or suspected to be breeding were targeted for GPS attachment to increase the likelihood of recapture over the following years of the project.

The GPS tags were attached to lower-back, leg-loop harnesses made of 1-millimeter elastic cord, fitted to each YBCU, and secured with Kevlar thread and cyanoacrylate glue on the knots (Rappole and Tipton 1991). The GPS tags weighed 1.1 grams (g) (0.04 ounces [oz]), and the transmitters weighed 0.7 g (0.02 oz), totaling 1.8 g (2.0 g [0.07 oz] with harness, $\leq$ 3% total body mass). After attachment, each harness was thoroughly examined to ensure proper fit. Birds were monitored for up to 30 minutes after release to confirm acceptance of the harness and resumption of normal behavior and flight. Banding crews were instructed that should any bird appear agitated by the harness or seem unable to fly, they should immediately try to recapture the bird and remove the attachment. This was never an issue during the duration of this project.

Pinpoint Host version 2.1.0.15 software (Fowler 2014) was used to charge and program the GPS tags to record locations on up to 20 specific dates outside the peak breeding season (September to early June). To increase the chance the birds were stationary at stopover or wintering locations (i.e., resting or foraging) rather than flying when GPS points were recorded (YBCUs being nocturnal migrants; Crawford and Stevenson 1984), GPS points were programmed to record around noon each day, taking into account the assumed general location of the birds based on previous geolocator data (McNeil et al. 2015). To aid in relocation, the built-in radio transmitters were programmed to activate on June 30 of the following year, when most birds should have returned to their breeding grounds and still be responsive to playback calls used to lure the birds into mist nets. On activation, the transmitters were pre-programmed to emit a radio signal for 7 to 14 days.

During the years following GPS attachment (2015–18), if a GPS-fitted YBCU was resighted (by observation of color bands or antennae) or suspected to be in an area, mist netting attempts were made (up to two attempts only in 2017 and 2018) to recapture the bird. Following recapture, the harness with the GPS tag was removed, and the area of attachment was thoroughly examined for any sign of injury or abrasion. Pinpoint Host software (Fowler 2014) version 2.12.0.15 was used to recharge the GPS tags and download the stored spatial data to a text file, and ArcMap™ version 10.6 (© Esri) was used to map the locations. Google Earth was used to estimate the land status of each GPS location and whether they occurred on private, unprotected land, or within a public or private park or reserve.

Results

Of the 14 YBCUs captured at the PVER and fitted with GPS tags in 2014 and 2015, 7 females were recaptured, all at the PVER: 3 in 2015, 3 in 2016, and 1 in 2017 (table 26). All were examined and appeared in good health. Five were nesting when recaptured, the discovery of their nests often facilitating recapture. One was unmated when recaptured and nested later in the season, and one YBCU's breeding status was unknown. Six of the birds still had their harnesses attached; one had lost its harness and GPS tag before recapture. The six recovered harnesses still appeared to be in good condition, with no sign of wear.

Table 26.—Details of seven YBCUs fitted with GPS tags at the PVER, 2014 to 2015, and recaptured in 2015 to 2017

Bird ID	Date deployed	Date recaptured	Number of GPS points	Breeding status	Note
BRO	7/29/2015	7/31/2017	1	Unknown	GPS tag failed after one fall point recorded
CHC	7/29/2015	8/12/2016	–	Nesting	Harness/GPS tag lost – no longer attached
ELE	7/29/2014	7/24/2015	10	Nesting	Fall and spring points recorded
JWZ	8/4/2014	6/30/2015	7	Unmated	Fall and spring points recorded
ONY	8/15/2015	7/22/2016	9	Nesting	Fall and winter points recorded
PUS	8/11/2014	8/7/2015	2	Nesting	GPS tag failed after two fall points recorded
WWW	8/17/2015	7/11/2016	8	Nesting	Fall and winter points recorded
Total			**37**		

In 2015, no radio signals from GPS-fitted birds were detected presumably because the signals were too weak or the transmitters had failed. In 2016, radio signals from two GPS-fitted birds (ONY and WWW) were detected after their transmitters activated on June 30; they were both tracked to nests and recaptured.

Thirty-seven points were downloaded from six retrieved GPS tags (figure 20, table 27). The data were successfully downloaded from 4 tags, containing 7 to 10 points each. Two units experienced technical issues and recorded one or two points before failure. The harness and GPS tag were no longer attached to one YBCU when recaptured. Of the 37 points, 30 were migrating, 3 were wintering, and 3 were at the PVER breeding site. Due to a bug identified in the firmware after deployment in 2014, not all locations were recorded on the programmed dates that year, including wintering data. This fault was corrected in the tags deployed in 2015; however, those tags depleted their batteries earlier than expected due to repeated unsuccessful attempts to connect to satellites on the wintering grounds. Therefore, no spring migration data were collected for birds tracked in 2015 to 2016. They did, however, provide wintering points not able to be collected during the previous deployment (see table 26).

Of the 33 points recorded during migration and wintering, 22 (67%) fell on private land outside of formal protection and 12 (33%) fell within conservation areas such as biosphere reserves, national parks, and wildlife refuges (table 27).

Fall Migration

Stopovers during fall migration were in a variety of vegetation and land cover types, including desert washes, tropical dry forest, cow pastures, steep mountain slopes, and mangrove forests. Early fall stopovers (late August and September) were in desert washes in southern Arizona (Cabeza Prieta National Wildlife Refuge) and Sonora, Mexico (figure 21). Dominant trees at the point in Cabeza Prieta National Wildlife Refuge were ironwood (*Olneya tesota*) and palo verde (*Parkinsonia* spp.). Further south, most fall migration stopovers through Mexico and Central America were in tropical dry forest within approximately 140 km (87 mi) of the Pacific Ocean. On September 16–22, six YBCUs (three birds in 2014, three in 2015) were in Mexico, two for at least a month. ONY was in Sonora on September 1, 2017, and Michoacán on October 1, 2017. JWZ was in Sonora on September 17, 2017, and in Michoacán on October 15, 2017. Points recorded by all six YBCU indicated they had stopped in the same 660-km (410-mi) stretch from Nayarit to Michoacán. Five stopped during September 15–22 (two in 2014, three in 2015) and one on October 14, 2014. All fall stopover locations in Mexico occurred on private land.

The equipment on four birds recorded stopovers during October in Nicaragua (two in 2014, two in 2015). Two points were located in tropical dry forest, one in

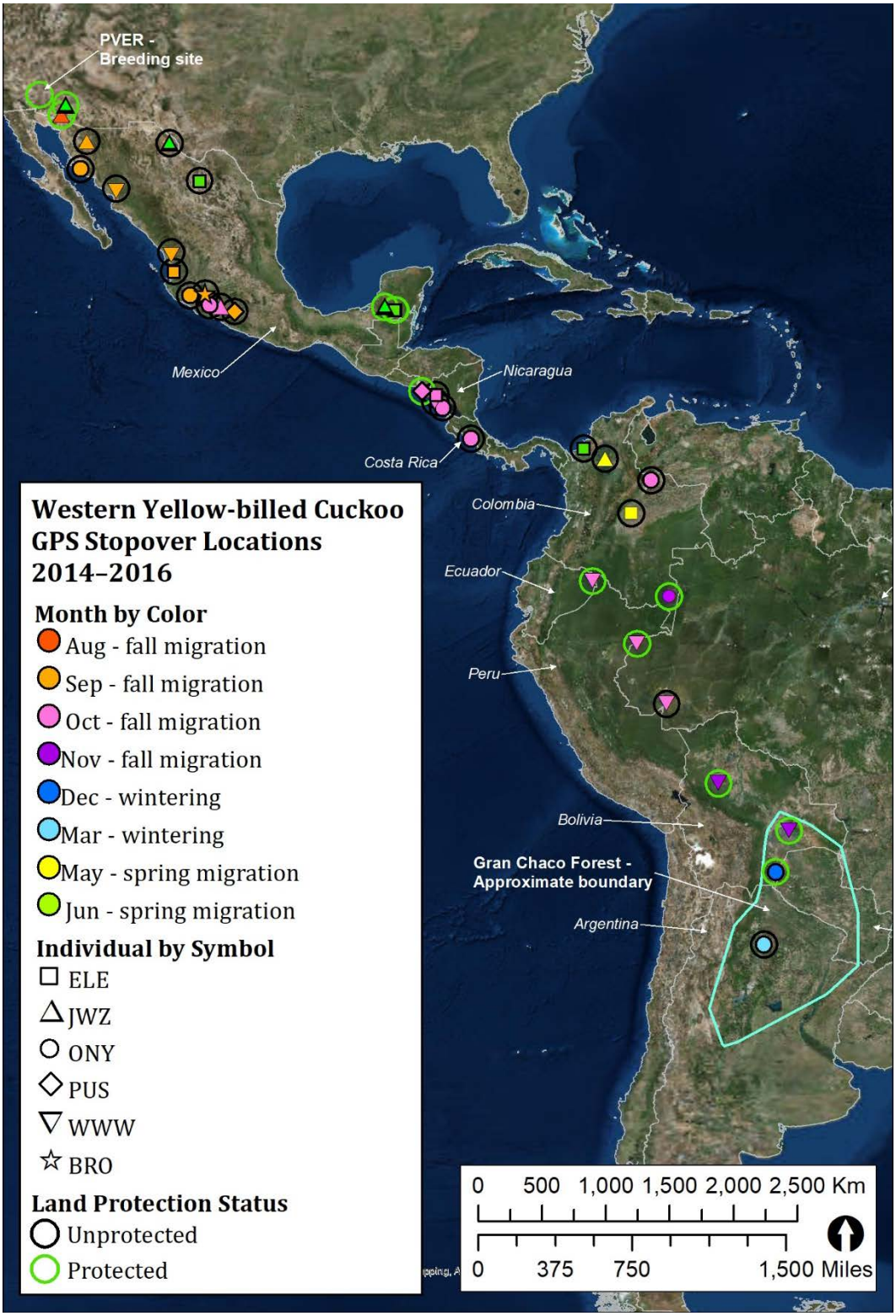

Figure 20.—Map of stopover locations recorded by six YBCUs GPS tracked between the PVER and South America, 2014 to 2016.

Table 27.—Details of GPS points of six YBCUs tracked between the PVER and South America, 2014 to 2016

Date	Period	YBCU ID	State	Country	Land Protected?[1]	Comment
8/20/14	Fall	JWZ	Arizona	USA	Yes	Cabeza Prieta National Wildlife Refuge, Ajo
9/1/15	Fall	ONY	Sonora	Mexico	No	South of Kino Bay
9/2/15	Fall	WWW	Sonora	Mexico	No	South of Presa Mocuzarit
9/15/15	Fall	ONY	Jalisco	Mexico	No	Near Sierra de Manantlán Biosphere Reserve
9/19/14	Fall	PUS	Michoacán	Mexico	No	Near Characharando
9/16/15	Fall	WWW	Nayarit	Mexico	No	Near El Barranco – dry oak forest
9/17/14	Fall	ELE	Nayarit	Mexico	No	West of Compostela
9/17/14	Fall	JWZ	Sonora	Mexico	No	South of Santa Ana
9/22/15	Fall	BRO	Jalisco	Mexico	No	52 km south of Lake Chapala Guadalajara
10/1/15	Fall	ONY	Michoacán	Mexico	No	Near Acatlán
10/2/15	Fall	WWW	Managua	Nicaragua	No	Dry forest – charcoal pits
10/16/15	Fall	WWW	Sucumbios	Ecuador	Yes	Cuyabeno Wildlife Reserve
10/14/14	Fall	JWZ	Michoacán	Mexico	No	North of Presa Infiernillo
10/14/14	Fall	PUS	Chinandega	Nicaragua	Yes	Protected area – mangroves
10/15/15	Fall	ONY	Granada	Nicaragua	No	Open forest/cattle pasture
10/15/14	Fall	ELE	León	Nicaragua	No	Near Santa Maria – cattle ranch
10/22/15	Fall	ONY	Puntarenas	Costa Rica	No	Humid tropical forest
10/23/15	Fall	WWW	Amazonas	Brazil	Yes	Reserva Indígena Vale Do Javari
10/30/15	Fall	WWW	Acre	Brazil	No	Purus River
10/29/15	Fall	ONY	Arauca	Colombia	No	52 km E of Parque Nacional Natural El Cocuy
11/6/15	Fall	WWW	Beni	Bolivia	Yes	Beni Biological Station Biosphere Reserve
11/5/15	Fall	ONY	Vaupés	Colombia	Yes	Parque Nacional Natural Río Puré
11/13/15	Winter	WWW	Santa Cruz	Bolivia	Yes	Kaa-Iya del Gran Chaco National Park
12/1/15	Winter	ONY	Tarija	Bolivia	Yes	El Corbalan Reserve – private
3/15/16	Winter	ONY	S. del Estero	Argentina	No	Remote cattle ranching villages
5/15/15	Spring	JWZ	Bolívar	Colombia	No	East of Nechí
5/15/15	Spring	ELE	Meta	Colombia	No	Rio Meta
6/10/15	Spring	ELE	Córdoba	Colombia	No	Monteria
6/10/15	Spring	JWZ	Campeche	Mexico	Yes	Reserva de la Biósfera Calakmul
6/21/15	Spring	ELE	Campeche	Mexico	Yes	Reserva de la Biósfera Calakmul

Table 27.—Details of GPS points of six YBCUs tracked between the PVER and South America, 2014 to 2016

Date	Period	YBCU ID	State	Country	Land Protected?[1]	Comment
6/21/15	Spring	JWZ	Chihuahua	Mexico	No	Chihuahuan Desert – mesquite oasis
6/26/15	Spring	JWZ	Arizona	USA	Yes	Sonoran Desert National Monument Gila Bend
6/26/15	Spring	ELE	Campeche	Mexico	Yes	Reserva de la Biósfera Calakmul
7/1/15	Spring	ELE	Coahuila	Mexico	No	Chihuahuan Desert – mesquite oasis
6/30/15	Breeding	JWZ	California	USA	Yes	PVER
7/6/15	Breeding	ELE	California	USA	Yes	PVER
8/19/14	Breeding	ELE	California	USA	Yes	PVER

[1] Land protection status: No = point is on private land; Yes = point falls within a park or reserve identified in Google Earth.

a windrow on a cattle ranch, and one in young mangrove forest, which was the only protected stopover location recorded in Nicaragua. One October point was also recorded in Costa Rica in 2015. The next fall points recorded for these YBCUs were in Colombia and Ecuador; a straight-line path was recorded by one YBCU (WWW) flying from Ecuador on October 16, through western Brazil on October 23–30, into Bolivia on November 6, and ending on November 13 in the Kaa-Iya del Gran Chaco National Park in Bolivia (see the "Wintering Grounds" section below). The other YBCU providing late-fall migration points (ONY) appeared to take a more easterly path south from central Colombia on October 29, 2015, to southern Colombia on November 5, 2015. This was the last fall point recorded for this YBCU.

Wintering Grounds

Three wintering points were recorded in the Gran Chaco Forest in southeastern Bolivia (Santa Cruz and Tarija Provinces) and northern Argentina (Santiago del Estero Province). All points were within large remote forested areas, two in protected areas and one in a low-populated area with small-scale cattle ranching and farming operations gradually moving into the forest. The Gran Chaco is a hot semi-arid region of the Rio de Plata Basin, consisting of 250,000 square miles divided between eastern Bolivia, western Paraguay, northern Argentina, and a small portion of Brazil (figure 21). It contains the second-largest forest type in the world after the Amazon, and its diverse forests range from dry thorn forest to humid seasonally flooded savannas.

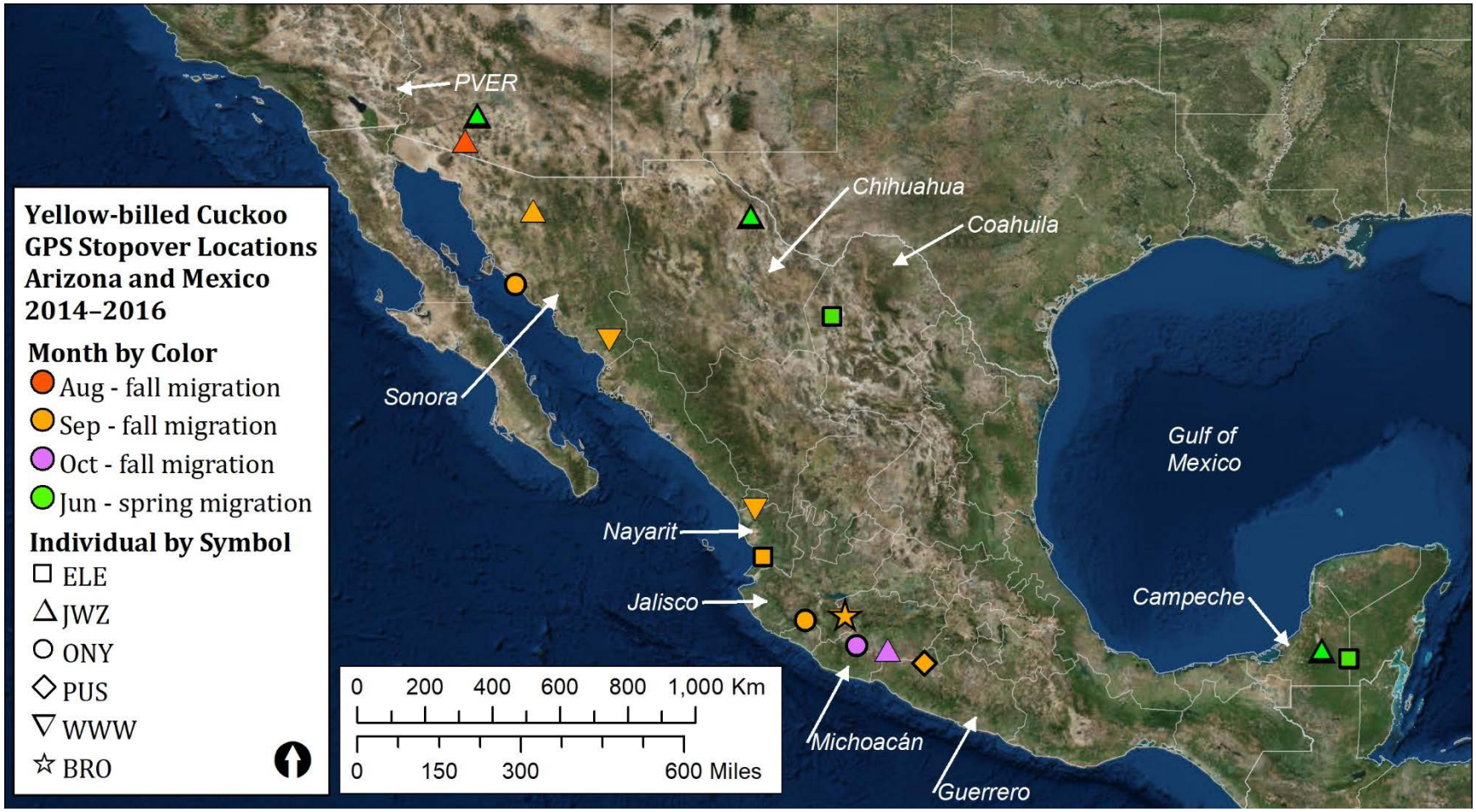

Figure 21.—Stopover locations in southern Arizona and northern Mexico recorded by six YBCUs tracked between the PVER and South America, 2014 to 2016.

Spring Migration

Nine spring migration points were recorded by two birds tracked in 2014–15 (ELE and JWZ). Both birds returned through Colombia in May and June in lowland dry tropical forest, with one (ELE) remaining from at least May 15 to June 10 (2015). All spring points north of Colombia were in Mexico, farther east compared to the fall migration points. The birds both stopped in the Yucatan Peninsula, in the Calakmul Biosphere Reserve, Campeche, on June 10 (JWZ) and 21–26 (ELE) (2015), approximately 78 km (48.47 mi) apart. Both were then recorded in the Chihuahuan Desert, each stopping in small thickets of mesquite woodland surrounded by the Chihuahuan Desert, one in Chihuahua (JWZ, June 21) and the other in Coahuila (ELE, July 1). On June 26, JWZ stopped in the Sonoran Desert National Monument near Gila Bend, Arizona. Both birds arrived back to the PVER breeding site by June 30 – July 6 (2015), 5 to 9 days after leaving Campeche. Both started nesting by July 12 (JWZ) and July 15 (ELE) (2015).

Migration Stopover Photographs

The following photographs are of migration stopover points in Arizona, Mexico, and Colombia, and wintering grounds in Bolivia visited during 2017 and 2018. They include fall and spring stopovers in Arizona (figures 22 and 23), fall stopovers in Mexico (figure 24) and Nicaragua (figure 25), wintering ground in the Gran Chaco Forest in Bolivia (figures 26, 27, and 28), and a spring stopover in Chihuahua, Mexico (figure 29). Figure 30 shows Finca Las Palmeras in northern Colombia, over two dates in 2018 (from figure 11 in Bayly 2018). This private, bird-friendly cattle ranch is a major spring stopover site for YBCUs and other neotropical migrants. The two contrasting images show the rapid greening of the tropical dry forest with the advent of spring rains.

Discussion

The GPS tags provided much more accurate data compared to data from the light-level geolocators (McNeil et al. 2015; Sechrist et al. 2012), particularly for the fall and spring migration stopover locations. The wintering data, though few, were all within the Gran Chaco Forest of central South America, conforming generally with the geolocator data (McNeil et al. 2015; Sechrist et al. 2012).

The migration data collected from light-level geolocators and GPS tags indicate that the western YBCU (DPS) follows a loop migration pattern flying down the Pacific Coast during fall and using a more eastward path during spring. This is not surprising given that the Pacific Coast in Mexico and Central America is greener and wetter during late summer/fall compared to spring (the dry season). Thus, their prey are likely in greater abundance during this time period. During spring, YBCUs appear to follow a more easterly pattern along the more humid

Figure 22.—JWZ fall stopover point (August 20, 2014) in a desert wash, Cabeza Prieta National Wildlife Refuge, Arizona.
(Photo by D. Tracy, SSRS, September 2016).

Figure 23.—JWZ spring stopover point (June 26, 2015) in an open desert wash, Sonoran Desert National Monument, Arizona.
(Photo by D. Tracy, SSRS, September 2016).

Figure 24.—WWW fall stopover point (September 16, 2015), in a dry oak forest near El Barranco, Nayarit, Mexico.
(Photo by D. Tracy, SSRS, February 2017).

Figure 25.—ONY fall stopover (October 15, 2015) in an open tropical dry forest/cattle pasture, Granada, Nicaragua.
(Photo by D. Tracy, March 2017).

Figure 26.—Wintering YBCU at the El Corbalán Reserve, Tarija Province, Bolivia.
(Photo by S. McNeil, SSRS, April 2018).

Figure 27.—Gran Chaco dry thorn forest wintering grounds near the El Corbalán Reserve, Tarija Province, Bolivia.
(Photo by D. Tracy, SSRS, April 2018).

Figure 28.—Gran Chaco dry thorn forest wintering grounds, El Corbalán Reserve, Tarija Province, Bolivia.
(Photo by S. McNeil, SSRS, April 2018).

Figure 29.—ELE spring stopover site (July 1, 2015) in a mesquite patch, Chihuahuan Desert, Coahuila, Mexico.
(Photo by S. McNeil, SSRS, April 2017).

Figure 30.—Spring stopover site for YBCUs at Finca Las Palmeras, Córdoba, Colombia (figure 11 in Bayly 2018).
(Photos by Nick Bayly, SELVA, 2018).

Caribbean coast and perhaps Pacific highlands. For example, in Colombia, large numbers of YBCUs are known to use a tropical dry forest spring stopover site on the Caribbean side of Colombia right after the area greens up in late winter (Bayly 2018). Again, YBCUs appear to arrive during a time period when insect abundance increases.

During fall migration, the predominant ecosystem type used by all tracked birds was Pacific tropical dry forest through Mexico (especially Jalisco to Michoacán) and Central America, with most recorded stopovers falling outside of formal protection areas. This forest type has been reduced to less than 0.1% of its original expanse and is among the most endangered ecosystems in the lowland tropics (Janzen 1988). Additionally, a large drop in precipitation is projected for Pacific dry forests of Central America in the dry season and the Yucatan region in the wet season (Karmalkar et al. 2011), where both YBCUs tracked during spring migration stopped. On the wintering grounds, the Gran Chaco Forest is one of South Americas' last frontiers due to its challenging environment, which has kept much of the land from development. It has become a haven for some of the last indigenous hunter-gatherer tribes, and over 608 bird species (Herzog and Kessler 2002). Over the last few decades, the Gran Chaco has experienced large-scale conversion of over 7.4 million acres of forest for expanding cattle and soybean production (Berbery et al. 2006; Veit and Sarsfield 2017), representing the greatest loss of forest cover globally this century (Hansen et al. 2013). A deeper assessment of the current and future threats of this entire region should be a focus of U.S. agencies responsible for recovery of this species.

The recapture of seven GPS-fitted YBCUs also enables an assessment of the harness attachment used. All harnesses appeared in good shape upon recapture, almost as pliable as the day they were fitted. From other accounts (Streby et al. 2015), it was assumed the material would degrade and cause the harnesses to break after a year or two, but instead they were apparently protected from ultraviolet degradation, perhaps by the birds' feathers or high canopy cover. Given the recapture of one bird in 2016 without its harness, it is possible that the harnesses have fallen off the other seven birds not recaptured; however, it is recommended that field researchers continue to look out for the remaining seven GPS-fitted birds in case any still wear their harnesses. A careful review of attachment methods is warranted before more tags are deployed (Streby et al. 2015), though it is possible that a reluctance to publish negative data may explain the lack of information on tag attachment longevity or failures (McKinnon and Love 2018).

The development of light-level geolocators and GPS tags has enabled the determination of stopover and wintering sites for many long-distance migrants (Bridge et al. 2013; McKinnon et al. 2013). This study of a sample of LCR yellow-billed cuckoo breeding migrants has added much-needed precision to the knowledge of migration stopover and wintering grounds of western YBCUs,

though gaps still exist due to the small number of points that were collected with the current technology. Future tracking of YBCUs across their entire range may further reveal the migratory connectivity of western and eastern YBCUs and the most pressing threats facing the western DPS through their full life cycle.

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Cover Photographs (adult YBCU – Alicia Arcidiacono; chicks and unhatched egg in nest – Shannon McNeil).

ATTACHMENT 1

Current Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Protocol (Halterman et al. 2016)

A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo

DRAFT May 2016

Cover: Western Yellow-billed Cuckoo. Photograph taken by Murrelet Halterman

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A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo.

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A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo

By Murrelet D. Halterman, Independent Researcher; Matthew J. Johnson and Jennifer A. Holmes, Colorado Plateau Research Station, Northern Arizona university; and Stephen A. Laymon, US Fish and Wildlife Service

Purpose

Our intent is to detail the current standard survey protocol and survey data interpretation for the western Distinct Population Segment (DPS) of Yellow-billed Cuckoos (*Coccyzus americanus*). It is intended to determine if a habitat patch contains one or more Yellow-billed Cuckoos, and is not designed to establish the exact distribution and abundance of cuckoos at a site. This protocol is intended to maximize detectability and efficiency; determining precise Yellow-billed Cuckoo numbers, locations, and breeding status requires many more visits and additional observation. This survey protocol also does not address issues and techniques associated with nest monitoring or other cuckoo research activities, but we discuss basic natural history and nest searching information in order to enhance surveyor understanding. This document is not intended to provide comprehensive coverage of that information. For more information on Yellow-billed Cuckoo biology see Hughes (1999), the final listing rule (79 FR 59992) and proposed critical habitat rule (79 FR 48547) for the species, and reports cited in this document.

Background

As early as 1944 the species was noted to be declining in California due to habitat loss and alteration (Grinnell and Miller 1944). The western population of the Yellow-billed Cuckoo was petitioned for listing as a federally endangered species in 1999 (USFWS 2001). In 2002 the western DPS was determined to be warranted but precluded for listing by higher priority species. On October 3, 2013 the proposed rule to list the western DPS of the Yellow-billed Cuckoo as a Threatened species was published in the Federal Register (78 FR 61621) and on October 3, 2014 the final listing rule was published (79 FR 59992) and the listing went into effect November 3, 2014.

At the time of the initial petition in 1999, little was known of the extent of the western population outside of California. Since then there has been additional research on distribution, ecology, and habitat use of the Yellow-billed Cuckoo in the western United States. We now have information on the population distribution in most of the western states, although there are still many areas that have not been thoroughly surveyed.

Breeding populations exist in California in the Sacramento Valley along the Sacramento River and some tributaries (although recent surveys found no evidence of breeding (Dettling and Howell 2011)), the South Fork Kern River, and restoration sites near Blythe on the lower Colorado River (Figure 1; Halterman et al 2001, McNeil et al 2013, Stanek and Stanek 2012). In Arizona, cuckoos are known to breed primarily within the Bill Williams, Big Sandy , Agua Fria,

Verde River, Gila River, Santa Cruz and San Pedro river watersheds, as well as multiple restoration sites along the lower Colorado River (Corman and Magill 2002, Halterman 2009, Johnson et al. 2010, McNeil et al. 2013). In New Mexico they breed on the Gila River and the middle Rio Grande (Stoleson and Finch 1998, Woodward et al. 2002, Ahlers and Moore 2012). In Colorado there are small numbers along the Colorado River and upper Rio Grande (Beason 2010). There are no known breeding populations in Oregon (Marshall et al. 2003). In Idaho there is reported breeding on the Snake River (Cavallaro 2011). In Nevada they may occasionally breed on the Carson, Virgin and Muddy Rivers (Halterman 2001, McKernan and Braden 2002, Tomlinson 2010, McNeil et al. 2013).

Figure 1. Range of the western Distinct Population Segment of the Yellow-billed Cuckoo.

In order to advance our understanding of the distribution of Yellow-billed Cuckoos, we need an effective and standardized survey protocol and uniform reporting of survey results. Cuckoos seldom call on their own and have a relatively low level of responsiveness to playback (Halterman 2009), and thus can be difficult to detect, making it difficult to accurately track populations. This document is intended to provide clear guidelines to agencies, consultants, volunteers, and researchers, to monitor Yellow-billed Cuckoo populations and determine habitat

occupancy. Because of the similarity of habitat use and survey techniques, some information was borrowed with permission from the SWFL protocol (Sogge et al. 2010).

Section 1. Natural History

Breeding Range and Taxonomy

Western Yellow-billed Cuckoos historically bred throughout riparian systems of western North America from southern British Columbia to northwestern Mexico (Hughes 1999). They inhabited the deciduous riparian woodlands once lining most rivers and streams. Since at least the 1850s, Yellow-billed Cuckoo populations have declined dramatically (Roberson 1980, Gaines and Laymon 1984, Laymon and Halterman 1987) and breeding cuckoos have been extirpated over much of the western range, including British Columbia, Oregon, and Washington (Hughes 1999). Although the western Yellow-billed Cuckoo has been described as a subspecies called the California Cuckoo (*Coccyzus americanus occidentalis*) (Ridgeway 1887, AOU 1956), there has been debate about its taxonomic status. There is research that both supports (Franzreb and Laymon 1993, Pruett et al. 2001), and refutes subspecies status (Banks 1988 and 1990, Fleischer 2001). The range of the Distinct Population Segment of the Yellow-billed Cuckoo is essentially the same as the range of the subspecies.

Migration and Winter Range

The Yellow-billed Cuckoo is a Neotropical migrant bird that winters in South America east of the Andes, primarily south of the Amazon Basin in southern Brazil, Paraguay, Uruguay, eastern Bolivia, and northern Argentina (78 FR 61621). The winter range and migration routes of the western Yellow-billed Cuckoo are poorly known. Eastern and western cuckoos may intermingle on the wintering grounds and in migration, or they may have separate wintering grounds and migration routes. Geolocator data is available from one single cuckoo captured during the breeding season on the middle Rio Grande River in New Mexico (Sechrist et al. 2012). This data indicates that the bird spent five months, from late November through April, in eastern Bolivia, southwestern Brazil, Paraguay, and northeastern Argentina. This cuckoo traveled south to southern Sonora, Mexico, in late July, then back to the Rio Grande before migrating southeast through Texas and eastern Mexico in August and September, and Honduras, Panama, and Columbia in October, and the upper Amazon basin in November. In the Spring it followed a different migration route through Brazil, Columbia, Venezuela, the Caribbean, the Yucatan Peninsula in Mexico, to the lower Rio Grande, then to the Conchas River in Chihuahua, Mexico, then back to the Rio Grande near its original capture point in early July (Sechrist et al. 2012, 78 FR 61621). There's little additional information on the western Yellow-billed Cuckoo's migration routes. Research indicates that the San Pedro River, and the lower Colorado River and its tributaries are migratory corridors (Halterman 2009) and a migrating flock was recorded by Miller (1950) in the Cape region of Baja California Sur in late May or early June (78 FR 61621).

Breeding Habitat

Breeding western Yellow-billed Cuckoos are riparian obligates and currently nest almost exclusively in low to moderate elevation riparian woodlands with native broadleaf trees and shrubs that are 20 hectares (ha) (50 acres (ac)) or more in extent within arid to semiarid

landscapes (Hughes 1999, 79 FR 59992). They are most commonly associated with cottonwood–willow–dominated vegetation cover, but the composition of dominant riparian vegetation can vary across its range. In California, habitat often consists of willows (*Salix* spp) mixed with Fremont cottonwoods (*Populus fremontii*) and, in other portions of its range, narrow-leaf cottonwood (*Populus augustifolia*) and mesquite (*Prosopis* spp.) are important habitat components. In Arizona, habitat may also contain box elder (*Acer negundo*), Arizona alder (*Alnus oblongifolia*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), oak (*Quercus* spp.), netleaf hackberry (*Celtis reticulata*), velvet ash (*Fraxinus velutina*), Mexican elderberry (*Sambuccus mexicanus*), tamarisk (*Tamarix* spp.), and *Baccharis* ssp.; (Corman and Magill 2000, Corman 2005, Johnson et al. 2010). Occupancy rates (the percent of patches surveyed with at least one cuckoo detection) in Arizona were highest in cottonwood/willow/ash/ mesquite habitat (70.7% occupancy), cottonwood/willow/ash/mesquite/with less than 75% tamarisk habitat (60.7% occupancy), and mesquite bosque/hackberry habitat (60.0% occupancy). Yellow-billed Cuckoos were much less common in sycamore/cottonwood habitat (46.2% occupancy), sycamore/alder/willow/ash/walnut habitat (33.3% occupancy), and habitat comprised of greater than 75% tamarisk cover (33.3% occupancy; Johnson et al. 2010).

At the landscape level, the amount of cottonwood–willow-dominated vegetation cover and the width of riparian habitat influence western Yellow-billed Cuckoo breeding distribution (Gaines and Laymon 1984, Halterman 1991, Holmes et al. 2008, Givertz and Greco 2009, Johnson et al. 2012, 79 FR 59992). Riparian patches used by breeding cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. Yellow-billed Cuckoos mainly nest in patches that are as large as 80 ha (several hundred ac); for example, San Pedro River, Arizona or Elephant Butte Reservoir, New Mexico, but they will nest in areas as small as 20 ha (Beal Lake Conservation Area at Havasu National Wildlife Refuge in Arizona (McNeil et. al. 2013). They have not been found nesting in isolated patches 0.4–0.8 ha (1-2 ac) or narrow, linear riparian habitats that are less than 10-20 meters (m) (33-66 ft) wide, although single birds have been detected in such isolated patches or linear habitats during migration or the early breeding season (mid-late June). In California, Yellow-billed Cuckoos are most likely to be found in patches of willow–cottonwood riparian habitat greater than 80 ha (200 ac) in size. Yellow-billed Cuckoos rarely used smaller patches of habitat (under 20 ha in size), particularly when patches were distant from other patches of riparian habitat (Laymon and Halterman 1989). In Arizona, on the lower Colorado River, Yellow-billed Cuckoos used large patches of habitat (> 20 ha) and areas with dense canopy closure for nesting (McNeil et al. 2013), and habitat modeling identified several important features associated with cuckoo breeding habitat: (1) a 4.5 ha (11.1 ac) core area of dense cottonwood-willow vegetation and (2) a large (72 ha/178 ac) native forest surrounding the core (Johnson et al 2012). The odds of cuckoo occurrence decreased rapidly as the amount of tamarisk cover increased or when cottonwood-willow vegetation was scarce (Johnson et al. 2012). On the Verde River in Arizona, sites occupied by cuckoos were at least 100 m (330 feet) wide; 79% of occupied sites were over 200 m (650 ft) wide, and 92% had at least 5 ha (12 ac) of mesquite in the uplands bordering the riparian patch. On average, occupied sites were larger than unoccupied sites (mean riparian patch width of occupied sites was 253 m (830 ft), and 134 m (440 ft) for unoccupied sites (Holmes et al. 2008).

At large spatial scales, cuckoos have been observed using newly formed sapling stands of riparian vegetation, first documented on the Sacramento River (Halterman 1991). Since then, cuckoos have been recorded using flood irrigated, fast-growing, restoration habitat that was less than a year old for foraging, and less than two years old for nesting (McNeil et al. 2013). Ahlers et al. (2014) found increasing numbers of cuckoos on the middle Rio Grande River in NM, likely in response to an increase of young riparian habitat through natural regeneration. The same was found on the Kern River where the majority of detections and all of the nests were found within the relatively younger habitat (Stanek and Stanek 2012). Johnson et al. (2008) found cuckoos nesting at a newly formed site, with three years old willows, on the Lake Mead/ Colorado River Delta, over 100 km from the nearest known breeding population. Although the mechanisms driving these fluctuations are unknown, it seems likely that availability of suitable breeding habitat and prey abundance are driving factors behind these changes (Greco 2012, Koenig and Leibhold 2005, Barber at al. 2008, Johnson et al. 2008, McNeil et al. 2013).

Yellow-billed Cuckoo habitat can be characterized and quantified in a number of ways, depending on the objectives of the observers. For the purposes of this protocol, we use a relatively simple approach, similar to that used in the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) protocol (Sogge et al. 2010), that can be used to broadly describe and classify survey sites based on woody plant species composition and habitat structure. As described above, these, along with patch size and connectivity, have been documented as important components of cuckoo habitat, but they are likely not the only ones. Measuring other potentially important aspects of cuckoo habitat such as food availability, predators, hydrology, and environmental factors such as temperature and humidity, are beyond the scope of this protocol.

The general categories used to characterize cuckoo habitat in this protocol are based on the composition of the tree/shrub vegetation at the site: native broadleaf (>75% of cover from native trees/shrubs); exotic/introduced (>75% of cover from exotic trees/shrubs); mixed native/exotic-mostly native (51% - 75% cover from native trees/shrubs); and mixed native/exotic-mostly exotic (51% - 75% cover from exotic trees/shrubs). Each site's canopy and understory canopy height, canopy and understory canopy cover, and the cover of particular dominant plant species in the canopy and understory canopy are also recorded.

The native broadleaf tree/shrub category for breeding sites within the Western Yellow-billed Cuckoo range are described above, and often have a distinct overstory of willow, cottonwood, or other broadleaf trees, with recognizable sub-canopy layers and an understory of mixed species trees and shrubs, including tamarisk. Sites are classified as native broadleaf if greater than 75% of the cover is contributed by native broadleaf species. Exotic/introduced are sites where exotic/introduced trees/shrubs contribute 75% or greater of the vegetation cover. These sites are typically dominated by tamarisk or Russian olive (*Elaeagnus angustifolia*). Mixed native/exotic sites ("mixed exotic native-mostly native" and "mixed exotic native-mostly exotic) include mixtures of native broadleaf trees and shrubs mixed with exotic/introduced species such as tamarisk and Russian olive. The exotics are primarily in the understory canopy, but may be a component of the canopy, and the native/exotic components may be dispersed throughout the habitat or concentrated as a distinct patch within a larger matrix of habitat. If a particular site is dominated primarily by natives (i.e. 51% - 75% native) it is classified as mixed exotic native-

mostly native. If it is dominated primarily by exotics/introduced species (i.e. 51% - 75% exotic) it is classified as mixed exotic native-mostly exotic.

The ultimate measure of habitat suitability is not simply whether or not a site is occupied. Habitat suitability occurs along a gradient from high too poor to unsuitable; the best habitats are those in which cuckoo reproductive success and survivorship result in a stable or growing population. Some occupied habitats may be acting as population sources, while others may be functioning as population sinks (Pulliam 1988). Therefore, it can take extensive research to determine the quality of any given habitat patch. Not all unoccupied habitat is unsuitable; some sites with suitable habitat may be geographically isolated or newly established, such that they are not yet colonized by breeding cuckoos. Small habitat patches may also provide critical stopover sites for refueling and resting during migration. There also may not be enough cuckoos in a given area, particularly at the periphery of its current range, to fill all available habitat.

Breeding Chronology and Biology

Western Yellow-billed Cuckoos are late spring migrants. In Arizona and California, a few individuals occasionally arrive in mid- to late May, but the majority do not arrive until mid-June, with late migrants straggling into early July (Corman 2005; Laymon 1998a). Nesting typically occurs between late June and late July, but may occasionally begin as early as late May, and continue into September. Cuckoos have been observed in California as late as mid-September (M. Halterman, pers. obs., McNeil and Tracy 2013, Parametrix and SSRS 2015) and mid-October in southeastern Arizona (Corman 2005). In southeastern Arizona (and possibly in other parts of the southwest), nesting may regularly continue into September, with some birds occasionally noted feeding older fledglings into early October (Corman and Magill 2000, Halterman 2002).

Nests and Eggs

Both adults build the nest, incubate the eggs, and brood and feed the young. Nest building may take as little as half a day, with additional material added to the nest as incubation proceeds (Halterman 2009). Nests are typically well-concealed in dense vegetation (Halterman 2002; Laymon et al. 1997; McNeil et al 2013). Typical clutch size varies from two to four eggs, but exceptionally one and five egg clutches have been observed. Larger clutches are likely the result of conspecific parasitism (Hughes 1999; Laymon et al 1997; Laymon 1998a; McNeil et al. 2013). Eggs, which are a pale bluish-green, are usually laid every second day, but the interval may be variable (Hughes 1999). Eggs are incubated from 9-11 days (Hughes 1999) and young cuckoos fledge five to eight days after hatching, with six days being typical (Laymon and Halterman 1985, Halterman 2009). Males incubate the eggs at night, and both sexes alternate incubation and nestling care during the day (Halterman 2009, Payne 2005). Males appear to be the primary caregiver of the young post-fledging (Halterman 2009).

Typically Western Yellow-billed Cuckoos have one brood per year (Ehrlich et al 1988). In California at the South Fork Kern River, in years of abundant food resources, two and even three broods have successfully fledged. Double brooding was observed in less than half of the 12 years of study there and triple brooding was observed only once (Laymon 1998a). Double broods have been regularly observed on the upper San Pedro River (Halterman 2009) and on the lower

Colorado and Bill Williams rivers (McNeil et al. 2013). Triple broods have occasionally been observed at these sites.

Fledglings continue to be dependent on the adults for approximately 14-21 days, seeking food from adults by giving short "cuk-cuk-cuk" calls. At approximately 14 days, fledglings give louder calls, but appear to lack the full range of adult vocalizations. The fledglings may continue to be dependent on the adults until they are 28-32 days old (Halterman 2009, McNeil et al. 2013). Young birds can be distinguished for several weeks post-fledging by the paler yellow coloration on the bill, and a shorter tail with slightly paler coloration (dark gray instead of black; Pyle 1997). It is very difficult to see these subtleties in the field, however, and aging fully-grown juveniles can be problematic for all but the most experienced observers (Halterman 2008).

Vocalizations

Cuckoos call infrequently, with an unsolicited vocalization rate of one call/hour (Halterman 2009). Their vocalizations are described by Hughes (1999) and others (Bent 1940, Hamilton and Hamilton 1965, Potter 1980). Common calls include variations of the contact call. This is a series of "kuk" notes with or without "kowlp" notes, given by both sexes (Halterman 2009; Hughes 1999). Also commonly heard is the "coo" call, apparently given primarily by females (Halterman 2009). A very soft "coo" call seems to be given by adults to nestlings. Adults also give an alarm consisting of a low "wooden knocking" call, continued until the threat leaves the area. This call is typically given in the vicinity of a nest or fledgling. Calls are described in detail in the Survey Protocol Section, Yellow-billed Cuckoo Identification, below.

Food and Foraging

Cuckoos eat a wide variety of prey items. These are primarily large arthropods such as cicadas, katydids, grasshoppers, and caterpillars, but may also include small lizards, frogs, spiders, tent caterpillars, and a variety of other insects. There is evidence to suggest that population levels and breeding may be closely tied to abundance of certain food items (Clay 1929, Bent 1940, Preble 1957, Hamilton and Hamilton 1965, Nolan and Thompson 1975, Laymon 1980, Koenig and Liebhold 2005, Halterman 2009, McNeil et al. 2013). Cuckoos typically perch inconspicuously while visually searching nearby vegetation for prey (Hamilton and Hamilton 1965, Stiles and Skutch 1989). This foraging method contributes to the difficulty of detection. They may venture out into surrounding low vegetation (flooded fields, younger habitat, sacaton (*Sporobolus* sp.) grassland) after observing prey items while perched in the riparian (Halterman 2002; McNeil et al. 2013).

Site Fidelity and Local Population Fluctuations

Little is known about population substructure, dispersal of young and post-breeding adults, juvenile and adult site fidelity, or the factors influencing breeding site detection and selection. Research indicates that the San Pedro River, lower Colorado River and tributaries are migratory corridors, in addition to being breeding areas (Halterman 2009). Cuckoos were captured and equipped with transmitters in suitable nesting habitat on these rivers; and many of these birds left the area before breeding. A small number of birds that left their banding location were detected

in the same season at other riparian sites. These within-season movements varied from 1 km to nearly 500 km (Halterman 2002, McNeil et al. 2013). Additional research is needed at other sites, particularly with more northern populations, to determine if these movements occur range wide.

Between-year fluctuations in estimated populations have been observed at multiple locations throughout the range. From 1997 to 2004, the estimated population on the Bill Williams River fluctuated between 6 and 28 pairs (20 to 78 survey detections/year; Halterman 2008). The estimated population of the South Fork Kern River fluctuated from less than 5 pairs to more than 20 pairs over a 12 year period (Laymon et al. 1997). The population on the San Pedro River fluctuated greatly from 2001 to 2007, with numbers halving from 2003 to 2006, then apparently doubling from 2006 to 2007 (Halterman 2008). Populations on the Sacramento River have shown year-to-year fluctuations (Halterman 1991) and decade-to-decade fluctuations (Laymon and Halterman 1987, Halterman et al. 2001, Dettling and Howell 2011).

The methods used to estimate population size varied between studies, but it is clear that Yellow-billed Cuckoo populations increase or decrease locally well beyond the expected fluctuations of a closed population. These studies indicate a species that is not only capable of, but likely adapted to, locating and utilizing resources that are highly variable in time and space. Multiple years of surveying are therefore required to obtain a reasonable estimation of occupancy, habitat use, and distribution.

Little is known about survivorship of Yellow-billed Cuckoos, though the Institute for Bird Populations reports an estimated annual survival probability of 50% (NBII/MAPS Avian Demographics Query Interface). Limited data from the San Pedro River, Arizona, with color-banded birds, indicates that a small percentage of the population (about 5%) returns to the breeding sites each year (Halterman 2009). On the lower Colorado River, primarily in LCR-MSCP habitat creation sites, about 10% of the banded birds were recaptured in the area one or more years after initial capture (McNeil et al. 2013). Returning birds on the San Pedro were re-sighted approximately 25 m (80 ft) and over 2 km (1.2 miles) from their banding location (Halterman 2009). Returning birds banded as adults on the lower Colorado River were re-sighted between approximately 25 m (80 ft) and 40 km (25 miles) from their banding location (McNeil et al. 2013). Returning birds banded as nestlings/fledglings on the Lower Colorado River were re-sighted between ~30 m (100 ft) to ~80 km (50 miles) from their banding location (McNeil et al. 2013). Breeding pairs of banded cuckoos at this site were found using the same territory for up to three years (Laymon 1998a).

Threats to the Cuckoo and Habitat

The decline of the western Yellow-billed Cuckoo is primarily the result of riparian habitat loss and degradation. Within the three states with the highest historical number of Yellow-billed Cuckoos, past riparian habitat losses are estimated to be about 90 to 95 percent in Arizona, 90 percent in New Mexico, and 90 to 99 percent in California (Ohmart 1994, USDOI 1994, Noss et al. 1995) Many of these habitat losses occurred historically, and although habitat destruction continues, many past impacts have ramifications that are ongoing and affect the size, extent, and quality of riparian vegetation within the range of the western Yellow-billed Cuckoo. Principal causes of riparian habitat destruction, modification, and degradation in the range have occurred

from alteration of hydrology due to dams, water diversions, management of river flow that differs from natural hydrological patterns, channelization, and levees and other forms of bank stabilization that encroach into the floodplain (79 FR 48547). These losses are further exacerbated by conversion of floodplains for agricultural uses, such as crops and livestock grazing. In combination with altered hydrology, these threats promote the conversion of existing primarily native habitats to monotypic stands of non-native vegetation, reducing the suitability of riparian habitats for the cuckoo.

Because of the absence or near absence of nesting by Yellow-billed Cuckoos in monotypic stands of tamarisk and other nonnative vegetation, the available literature suggests that conversion of native or mixed (native and non-native) riparian woodlands to nearly monotypic stands of tamarisk and other non-native vegetation, coupled with the inability of native vegetation to regenerate under altered hydrological conditions, is a significant threat to the western Yellow-billed Cuckoo now and in the future (79 FR 48547). Non-native vegetation occurs across most of the range; its establishment can be caused by altered hydrology or other disturbances, which are widespread throughout the range. Non-native vegetation is expected to increasingly modify and decrease habitat for the western Yellow-billed Cuckoo within a majority of its range in the United States and northern Mexico. Other threats to riparian habitat include long-term drought and climate change.

Section 2. Survey Protocol

This basic protocol has changed little since it was first written in 1998 (Laymon 1998) and expanded in 1999 (Halterman 1999). There have been a number of refinements as research has increased our knowledge of this elusive species. The greatest change is in interpretation of results. Previous versions of this protocol have been used effectively to survey hundreds of sites in the western United States.

Yellow-billed Cuckoos are challenging to survey for a number of reasons. They have a low unsolicited calling rate, averaging about one call/hour making standard point count surveys particularly ineffective (Halterman 2009). They have large home ranges, with average 95% kernel home ranges varying from 19.5 ha (48.2 ac) to 42.3 ha (104.5 ac), depending on location, breeding status, and gender of the individual (Halterman 2009, McNeil et al. 2013, Sechrist et al. 2009). This brevity of peak of activity, along with the potential for double and triple brooding, further complicates complete survey coverage. The peak of cuckoo nesting activity lasts only about one month, with breeding activity of the western DPS of the Yellow-billed Cuckoo peaking in July (Laymon et al. 1997, Halterman 1991, 2009; McNeil et al. 2013), but in some years breeding can start in May and end in September. Detection rates also peak during July and drop off dramatically after mid-August regardless of breeding status (Laymon et al 1997, Halterman 2008, Ahlers 2012, McNeil et al. 2013). Males and females are sexually monomorphic in appearance and in many behaviors (Halterman 2009). Breeding can only be confirmed by finding an active nest, seeing fledglings, distraction or alarm displays, or copulation. These render interpretation of survey results problematic. Given these challenges, no methodology can assure 100% detection rates. This protocol does provide an effective tool for detecting cuckoos when surveys are conducted by trained surveyors.

The secretive and sometimes subtle life history characteristics of this species influence how Yellow-billed Cuckoo surveys should be conducted and form the basis upon which this protocol was developed. This protocol is based on the use of repeated call-playback surveys during pre-determined periods of the breeding season, to confirm presence or to derive a high degree of confidence regarding cuckoo absence at a site. Such species-specific survey techniques are necessary to collect reliable presence/absence information for this and other rare and secretive species (Johnson et al 1981, Sogge et al. 1997, Conway and Simon 2003).

The primary objective of this protocol is to provide a standardized survey technique to detect Yellow-billed Cuckoos, estimate breeding status, and facilitate consistent and standardized data reporting. The survey technique will, at a minimum, help determine presence of the species in the surveyed habitat for that breeding season. Ultimately, the quality of the survey that is conducted will depend on the experience, preparation, training, and in-the-field diligence of the individual surveyor.

This protocol is designed for use by persons who are non-specialists with Yellow-billed Cuckoos or who are not expert birders. However, surveyors must have sufficient knowledge, training, and experience with bird identification and surveys to visually distinguish Yellow-billed Cuckoos from similar species, and be able to distinguish Yellow-billed Cuckoo calls from similar vocalizations of other species. Visual sightings of cuckoos are relatively rare and often fleeting, and surveyors experienced with bird identification and behavioral observations of nesting birds will be best able to understand these brief observations. A surveyor's dedication and attitude, willingness to work early hours in dense, rugged and wet habitats, and ability to remain alert and aware of cues also are important. Surveys conducted improperly or by unqualified, inexperienced, or complacent personnel may lead to inaccurate results and unwarranted conclusions.

Surveys conducted by qualified personnel in a consistent and standardized manner will enable continued monitoring of general population trends at and among sites, and among years. Annual or periodic surveys in cooperation with State and Federal agencies should aid resource managers in gathering basic information on cuckoo status and distribution at various spatial scales. Identifying occupied and unoccupied sites will assist resource managers in assessing potential impacts of proposed projects, avoiding impacts to occupied habitat, identifying suitable habitat characteristics, developing effective restoration management plans, and assessing species recovery.

Like previous versions, this revised protocol is based on call-playback techniques. However, it includes changes in the timing of surveys to increase the probability of detecting cuckoos and to help determine if detected cuckoos are breeders or migrants. A detailed description of surveys and timing is discussed in the section "Timing and Number of Visits." The current survey data sheets are easier to use and submit than previous versions, and allow reporting all site visits within a single year on one form. The new survey forms also are formatted such that they are comparable to the current and widely used Southwestern Willow Flycatcher (SWFL) survey forms.

This protocol is intended to determine if a habitat patch contains Yellow-billed Cuckoos, and is not designed to establish the location of nests or the exact distribution and abundance of cuckoos at a site. Determining precise cuckoo numbers and locations requires many more visits and additional time observing behavior. This survey protocol also does not address issues and techniques associated with nest monitoring or other cuckoo research activities. Those efforts are beyond the scope needed for most survey purposes, and require advanced levels of experience and skills to gather useful data and avoid potential negative effects to cuckoos. If nest monitoring is a required component of your study, personnel experienced with and permitted for nest searching and monitoring must be included in the project. We provide general information on nest searching so surveyors will recognize the behavior of cuckoos near a nest, and thus avoid unnecessary disturbance around a nest that might cause nest abandonment or predation.

Biologists who are not expert birders or specialists with Yellow-billed Cuckoos can effectively use this protocol. However, please note that prior to conducting any surveys, all surveyors are required to attend or have attended a U.S. Fish and Wildlife Service (USFWS)-approved Yellow-billed Cuckoo survey training workshop, and have knowledge and experience with bird identification, survey techniques, avian breeding behavior, and ecology sufficient to effectively apply this protocol.

Non-Protocol (Exploratory) Surveys

Under special circumstances, it may be permissible to use call-playback in a way that does not follow the protocol. They are intended to assess whether an area merits full protocol surveys, and to increase general distribution knowledge. These exploratory surveys will allow agency personnel (or others working with their approval) to survey 1-3 times at sites that are not scheduled for regular surveys. These exploratory surveys are not intended to be conducted in project areas. These surveys are not intended to estimate the distribution and abundance of cuckoos at the site, and can only be conducted by individuals with all appropriate State and Federal permits and permissions.

Permits

Federal endangered species 10(a) 1(A) recovery permits are required to conduct surveys for Yellow-billed Cuckoos in all USFWS regions where the western Yellow-billed Cuckoo DPS breeds. State permits may also be required, and both federal and state permits may take several months to obtain so please plan ahead. Permits or permission are often required to access potential survey locations. The level of permitting will depend on the applicant's expertise in observing and handling cuckoos and attending a USFWS-approved Yellow-billed Cuckoo survey protocol workshop.

Permits will cover a range of activities, and will depend on the applicants experience level and needs. Permits are required for the following activities: surveys, nest searching and monitoring, banding adults and nestlings, attaching transmitters to cuckoos, radio telemetry, and blood and feather sample collection.

Pre-Survey Preparation

Pre-survey preparation is essential to conducting efficient, quality surveys. It is often overlooked, but can prove to be one of the more important aspects in achieving high-quality survey results. All surveyors are required to attend a USFWS-approved, survey protocol workshop prior to conducting surveys and should carefully study the Yellow-billed Cuckoo Identification section, below. It is especially critical for surveyors to be familiar with Yellow-billed Cuckoo vocalizations before going in the field. Surveyors should study calls, songs, drawings, photographs, and videos (if available) of Yellow-billed Cuckoos. An excellent source of vocalizations is the xeno-canto website (www.xeno-canto.org). This site is a community shared bird-sound database.

Surveyors should also become familiar with cuckoo habitat. If possible, visit as many known Yellow-billed Cuckoo breeding sites as possible and study photos of cuckoo habitat. Such visits are usually part of the Yellow-billed Cuckoo survey protocol workshops. All visits should be coordinated with USFWS, State wildlife agencies, and the property manager/owner, and must avoid disturbance to cuckoos. While visiting these sites, carefully observe the habitat characteristics to develop a mental image of the key features of suitable habitat.

Prior to conducting any presence/absence surveys in your respective State or USFWS Region, contact the respective cuckoo coordinators to discuss the proposed survey sites and determine if the sites have been surveyed in prior years. If possible, obtain copies of previous survey forms and maintain consistency with naming conventions and site boundaries. Study the forms to determine if cuckoos have been previously detected at the site, record locations of any previous detections, and read the comments provided by prior surveyors. While surveying, be sure to pay special attention to any patches where cuckoos have previously been detected. However, please realize if it has been several years since a location has been surveyed, some habitat sections may have changed, for better or worse. As an example, newer riparian sections may have developed in size and density to become appropriate nesting/foraging areas.

Familiarity with the survey site prior to the first surveys is the best way to be prepared for the conditions you will experience. It is the individual surveyor's responsibility to survey all suitable habitat within the respective site. It's best to layout and walk transects in advance of the surveys. Determine the best access routes to your sites and always have a back-up plan available in the event of unforeseen conditions (for example, locked gates, weather, etc.). Know the local property boundaries and transect start and stop points (if previously surveyed), where the potential hazards may be, including deep water, barbed wire fencing, and difficult terrain. Be prepared to work hard and remain focused and diligent in a wide range of physically demanding conditions. At many sites, these include heat, cold, wading through flowing or stagnant water, muddy or swampy conditions, and quicksand, crawling through dense thickets, and exposure to rattlesnakes, skunks, and biting insects.

The day before conducting the survey, set a time for departure to the site. Surveying generally occurs in the early morning, beginning just before sunrise and continuing, depending on environmental factors (including noise levels), until 1100 or until temperatures reach 40C/104F whichever comes first. Know the directions to the survey site and estimate the time it will take to

get to the first point by driving and walking, possibly in the dark. If possible, preload you're GPS (or other navigation device) with survey transects and survey points. Your departure time for the following morning should ensure arrival at the starting point approximately one hour before sunrise. If the survey takes more than two hours, make an effort to start at the opposite end of the transect for each survey round, so that all points are surveyed in the earlier hours. This may not always be logistically possible.

It is imperative that all surveyors exercise safety first. Be aware of hazards and how to avoid them, and do not allow the need to conduct surveys to supersede common sense and safety. Inform your coworkers where you will be surveying and when you anticipate returning. Always take plenty of water and know how to effectively use your equipment, especially compass, Global Positioning System (GPS), and maps.

Equipment

Table 1. List of items for conducting Yellow-billed Cuckoo surveys.

Required Items	**Details**
USGS Map and/or aerial photo (orthorectified; color photocopies) of survey area	A marked copy is required to be attached to survey datasheets submitted at the end of the season. The survey site needs to be delineated and detections clearly marked. If the survey area differed between visits, individual surveys should be delineated.
Broadcast equipment (e.g., Audio device, and speakers) and batteries	Must be capable of broadcasting recorded calls 100 m without distortion (recommended speaker volume of 70 db). Having a fully charged device and extra batteries as well as back-up/extra broadcast equipment is highly recommended to avoid abandoning a survey due to equipment failure. Use only the provided contact call for broadcast.
Standardized survey form	Multiple copies for each survey.
Recorded contact/kowlp calls	Acquired by attending Yellow-billed Cuckoo protocol workshop.
Binoculars	A pair with 7-10 power that can provide crisp images in poor lighting conditions.
GPS device with extra batteries	With start and stop UTMs for previously surveyed areas. All surveyor locations at time of detection should be recorded as waypoints. The compass direction and distance to individual detections are recorded from the waypoint.
Compass	The compass bearing is taken, and distance to the detected cuckoo(s) is estimated, from the surveyor's waypoint. The compass feature on the GPS unit is often much more difficult to use in the field than a compass. A compass may also help surveyors navigate through the patch more easily than using the GPS.
Clipboard or electronic device	Survey results and observations should be recorded directly onto the survey data form to ensure that all required data is collected and recorded.
Pens, Pencils, and Sharpies	Take multiples of each.
Device to record time	Use the GPS unit, watch, or phone
Optional Items	**Details**
Cell phone/portable radio	For communication between surveyors and for safety.

Camera	Helpful for habitat photos of survey sites, especially where cuckoos are found.
Laser Rangefinder	For measuring distance to detections (if possible) and height of trees.
Hard copy of start/stop UTMs	Use as a back-up for the GPS unit.

Yellow-billed Cuckoo Identification

Yellow-billed Cuckoos are a slender, medium-sized bird, about 30 cm in length, and weighing about 60 grams. The upperparts are grey-brown, the underside is clean white, and the tail is long with white spots at the end of the central rectrices. A flash of bright rufous in the wings is usually visible in flight, and occasionally while perched. The legs are blue-gray, but are seldom visible since cuckoos typically perch so that the legs are hidden under the belly. The bill is long and slightly down-curved, with a mostly black upper mandible and lower mandible ranging from yellow to orange with a black tip. Flight is generally direct and agile. Sexes are similar, and although females average larger than males, this difference is seldom visible in the field (Pyle 1997, Halterman 2009). In general, look for a slender bird with a bright white chest, long tail, and grey-brown head contrasting with a white throat.

When seen clearly, this species is unmistakable. Often you will only have a fleeting glimpse of a bird, so you need to quickly assess what you've seen. Be sure to study all available photos and video of cuckoos. Familiarization with images of both cuckoos and similar species will aid in rapid and correct identification in the field. There are a number of species that can be mistaken for cuckoos when seen briefly. These include:

1. Ash-throated Flycatchers (*Myiarchus cinerascens*) are the most similar to cuckoos, with a slender build, rufous in the wings, a relatively long tail, and agile flight pattern. They often fly closer during cuckoo call playback. The breast typically appears gray, the head is "puffy", and there is no strong contrast between brown upperparts and white underparts. Look for the shorter bill and tail when this species is perched.
2. Mourning Doves (*Zenaida macroura*) are heavier, the breast appears tan/gray, the tail is pointed, and the flight is relatively heavy and direct.
3. White-winged Doves (*Zenaida asiatica*) are much larger, with tan/gray breast, and show a bold flash of white in the wings in flight.
4. Northern Mockingbirds (*Mimus polyglottos*) are slender with a relatively long tail tipped with white. Look for the large white wing patches and lack of strong contrast between the chest and back.
5. The rusty flash of a Northern Flicker's (*Colaptes auratus*) wings are reminiscent of the rufous flash in a cuckoo's wings, but either calls or subsequent views will aid in correct identification.
6. Brown-crested Flycatchers (*Myiarchus tyrannulus*) are also similar, but the bright yellow belly and the larger head facilitate correct identification.
7. Loggerhead Shrikes (*Lanius ludovicianus*) and both California (*Toxostoma redivivum*) and Crissal thrashers (*Toxostoma crissale*) may also look like cuckoos when seen fleetingly.

The majority of Yellow-billed Cuckoo detections are from birds that are heard but never seen (Halterman et al 2001; Halterman 2009, McNeil et al. 2013), so it is critically important to know

the calls of this species as well as similar species. There are two commonly heard calls, which can be given by males or females. Each call can be confused with calls of a number of other birds, especially when heard at a distance. We will discuss each in detail:

1. Contact call - also referred to as the "kowlp" call. This is a series of a variable number of "kuk" notes followed by a variable number of "kowlp" notes. This can be given at any time during the breeding season. Individuals may give calls with variable combinations of kuks and kowlps, and may omit one or the other of the notes altogether. Although distinctive when heard clearly, there are several species with similar calls, particularly when heard from a distance. The most similar species is the Yellow-breasted Chat (*Icteria virens*), which sometimes appears to give calls mimicking the cadence of cuckoo calls following playback. Chats also typically give a single diagnostic sharp "chuck". Familiarization with the calls of this species is critical to correct identification where the two co-occur. Pied-billed Grebe (*Podilymbus podiceps*) calls can also sound very similar to cuckoo calls; the fact that the call emanates from a wetland will usually help distinguish this species, though this call is loud, carries well, and the presence of a wetland may not be known. Less similar, but still worth learning, are most woodpecker and accipiter calls.

2. Coo call. This is given with greatest frequency in the early and middle part of the breeding season. It typically consists of a 5-8 evenly-pitched and evenly-spaced "coo" notes, ending with 1-3 notes on a lower pitch. The number of coo notes may vary from one or two notes to several minutes of continuous calling. Although diagnostic when heard clearly, there are a number of species with similar calls. The most similar is Greater Roadrunner (*Geococcyx californianus*); its call is a series of "coos" which drop in pitch with each note. Distant notes of both Mourning and White-winged dove calls can sound almost identical to cuckoo coos, but the pattern is very different, with only 1-3 coo notes heard. Both dove species typically repeat their calls, so the initially questionable coo can usually be identified with careful attention. Other sounds which, when heard from a distance and at the edge of hearing, could be (and have been) confused with the cuckoo coo call include noisy cows, barking dogs, and machinery.

Less commonly heard, but important to know, is the cuckoo alarm call, sometimes called the knocker call. This is a short series of soft wooden "kuk-kuk-kuk-kuk" notes. This is typically given near a nest or fledglings, but can be heard anytime a cuckoo is disturbed. The call typically is given multiple times, and at relatively close range. It is best to assume that the alarmed bird is near a nest or young, particularly in July and August, and leave the area to avoid further disturbance.

An excellent source of vocalizations of all these species is the xeno-canto website (www.xeno-canto.org). This site is a community shared bird-sound database.

Timing and Number of Visits

The timing of this protocol is intended to assess Yellow-billed Cuckoo presence, and potentially estimate abundance and distribution. Accurate population determination is beyond the scope of

this protocol, but conducting surveys during the peak of breeding activity will increase the probability of detecting any cuckoos that are present. This call-playback technique detects cuckoos that may otherwise be overlooked. Multiple surveys at each site are important, and with appropriate effort, avian biologists without extensive experience with cuckoos can find and verify Yellow-billed Cuckoo presence.

There are three survey periods. Surveys are conducted for the sole purpose of assessing whether Yellow-billed Cuckoos are present at a site. A minimum of four survey visits are required (Figure 2). Four surveys conducted during the three survey periods listed in Figure 2 will have an 80% probability of detecting an individual cuckoo (Carstensen et al. 2015, Halterman 2009) and a 95% probability of detecting cuckoos, when they are present at a site during the breeding season (McNeil et al. 2013, Carstensen et al. 2015).

Prior to the field season, we suggest developing a sampling schedule, based on the survey periods (Figure 2) and the number and extent of sites to be surveyed. Yellow-billed Cuckoo surveys should be scheduled to begin after a thorough training session (including attending a survey protocol workshop). Initiation of sampling is tailored to the phenology of the Yellow-billed Cuckoo in the study region, and is generally timed to begin after resident individuals have arrived, presumably to breed, within the region. Due to differences in breeding seasons across the western US, a survey window of ± 3 days is acceptable for the start and end of each survey period. Each survey site is visited a minimum of four times within the breeding season, with a minimum of 12 days and a maximum of 15 days between surveys at a particular site.

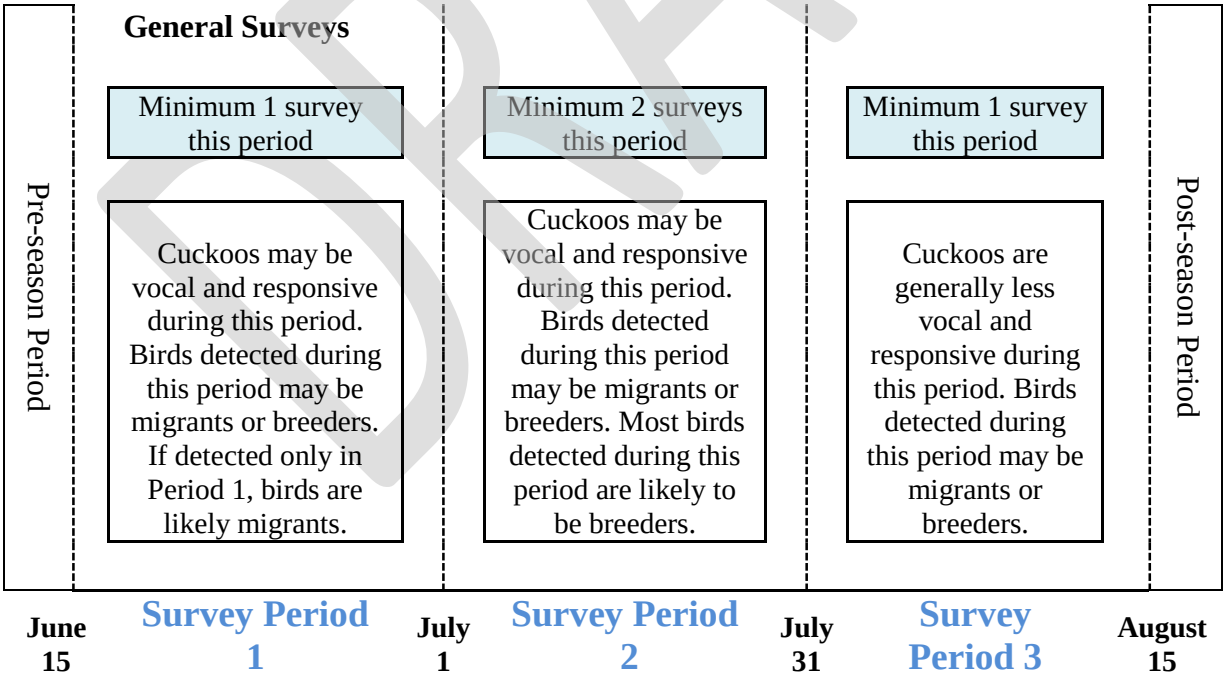

Figure 2. Recommended number and timing of visits during each survey period for Yellow-billed Cuckoo surveys.

If breeding confirmation is required, more visits will be needed and they must be conducted by surveyors permitted to search for nests. Even with additional effort, it may not be possible to verify breeding activity during a season. When developing a survey schedule for multiple surveyors, care should be given to scheduling so that multiple surveyors do not overlap areas, and the risk of a surveyor mistaking a broadcast call for a cuckoo is reduced. Additionally, if surveyors are working on adjacent plots, they should communicate both during and after surveys to avoid double counting.

Pre-season Survey Period: late May to June 14. No surveys required. This spans the earliest time that cuckoos may arrive on breeding grounds, but most cuckoos present during this period are likely migrants. However, cuckoos will occasionally begin breeding during this time.

Survey Period 1: June 15 to June 30. One survey is required. This survey occurs as migrating birds are passing through, and breeding birds arrive. Although many birds detected during this time may be migrants, surveys during this time will help with seasonal survey detection interpretation, and will also allow surveyors to familiarize themselves with all survey areas.

Survey Period 2: July 1 (+ or – 3 days) to July 31 (+ or – 3 days). Two surveys are required during this period. Cuckoos encountered during this time are mostly breeders, though migrants, wandering individuals, and young of the year may be encountered. This is the period when breeding activity is most likely to be observed (e.g. copulation, food carries, alarm calls). Extra time should be taken to cautiously observe all cuckoos encountered during this time, while avoiding disrupting potentially breeding birds.

Survey Period 3: August 1 to August 15. One survey is required, and most breeding birds are finishing breeding activities and departing. Cuckoos are typically much less vocal and responsive during this time than during Survey Period 2.

Post-breeding Period: August 16 through September. Cuckoos in the southwest may initiate nesting, build second or third nests, or provide care for fledglings in this period (Halterman 2009; McNeil et al. 2013). This is particularly true in southeastern Arizona where local conditions often allow for a lengthier breeding season. Surveys during this time will help clarify cuckoo use of the site, and length of time on the site. Birds encountered during this period may also be migrants. Cuckoos are less vocal during this time than during Survey Period 2.

The best way to confirm breeding status of cuckoos detected at a site is to do follow-up visits and observe cuckoo behavior at a distance. Careful notes should be taken during these visits. Playback calls should not be used during follow up visits, and great care must be taken in order to avoid disturbing nesting birds.

Reporting Requirements and Datasheets

Reporting requirements may vary by region and entity (Federal, State, and Private, for example). Check your permits and other information from permitting agencies for reporting requirements. Although these requirements vary, there is information that is required by any permitting agency, such as the location of the area surveyed and the location and number of cuckoo detections. For

your convenience we have provided three sample datasheets. These can be obtained from any of the following websites:

https://www.fws.gov/southwest/es/Documents/R2ES/YBCU_SurveyProtocol_FINAL_DRAFT_22Apr2015.pdf

https://www.fws.gov/southwest/es/arizona/Yellow.htm

https://www.facebook.com/groups/746657762142636/

1. Yellow-billed Cuckoo Survey Seasonal Summary Form. This form is meant to be completed at the end of the survey season, to summarize data collected across the survey periods. One form can be used for each site surveyed. If required, it can be filled out and submitted at the end of the season. There are three associated documents:
    a. PDF for printing.
    b. Excel file for data entry and electronic submission. This includes a formula to convert distance and direction from the observer to correct the estimated location (UTM) of a cuckoo detection.
    c. Yellow-billed Cuckoo Survey Summary Form Instructions (Appendix 1, this document).
2. Optional Yellow-billed Cuckoo Daily Datasheet. This form can be printed and used for each day's survey, and has room for notes and additional observations. It is not currently required in any Regions, and is provided as a convenience to surveyors.
    a. PDF for printing and field use.
    b. Optional Yellow-billed Daily Datasheet Instructions (Appendix 2, this document).
3. Site Description Form. This form can be used to describe the general characteristics of the site being surveyed. The intent is for one form to be filled out for each site surveyed. This form is included in the 2015 version of the Seasonal Summary Form, so you not need to complete this form separately if you are using the older form.
    a. PDF for printing and use in the field.
    b. Excel file for data entry and electronic submission.
    c. Site Description Form Instructions (Appendix 3, this document).

Survey Methods

The survey methods described below fulfill the primary objective of assessing the presence of Yellow-billed Cuckoos within a survey area during that breeding season. This protocol is primarily a call-back technique, a proven method for eliciting response from nearby Yellow-billed Cuckoos, when conducted as described below. This technique has also been used extensively to survey for Willow Flycatchers (Sogge et al. 2010) and increases the detectability of species that occur in low densities or in dense vegetation (Johnson et al. 1981, Sogge et al. 1997). The call-back technique simulates the presence of a cuckoo in the area, which may elicit a

response from a cuckoo (if there is one in the area), increasing its detectability. At each site, surveyors should broadcast a series of recorded Yellow-billed Cuckoo contact/"kowlp" calls, and look and listen for responses. In addition to maximizing the likelihood of detecting nearby cuckoos, this method also allows for positive identification by comparing the responding bird's vocalizations to the known Yellow-billed Cuckoo recording.

It is recommended that cuckoo surveys not be conducted at the same time as other state or federal permitted bird surveys. For example, it is preferable that a surveyor not conduct a cuckoo survey at the same time that they are conducting a Southwestern Willow Flycatcher survey or Least Bell's Vireo (*Vireo bellii pusillus*) survey. Doing so could negatively impact the detection of one or more species being surveyed and impair the ability to compare survey results to surveys where only one species was actively surveyed.

Begin surveys as soon as there is enough light to safely walk (just before sunrise) and continue, depending on the temperature, wind, rain, background noise, and other environmental factors, until 1100. Surveys should not be conducted after temperatures reach 40 degrees C (104 F). If the detectability of cuckoos is being reduced by environmental factors (e.g. excessive heat, cold, wind, or noise), surveys planned for that day should be postponed until conditions improve. Within a study area all potentially suitable habitat patches should be surveyed. A patch is defined as an area of riparian habitat 5 ha or greater in extent that is separated by at least 300 m from an adjacent patch of apparently suitable cuckoo habitat. The 5 ha is considered a typical minimum size for cuckoo occupancy, as no cuckoos have been detected attempting to nest in patches this size or smaller in Arizona or California (Halterman et al. 2001, Johnson et al. 2010). Suitable habitat falls into two types: 1. multi-layered riparian vegetation, with riparian canopy trees (at least a few within the patch) and at least one layer of understory vegetation; 2. mesquite and/or hackberry bosque, primarily in southeastern Arizona or when adjacent to habitat 1 above. Suitable breeding habitat often includes dense young riparian cottonwood/willow vegetation (Halterman 1991, Greco et al. 2002, McNeil et al. 2013).

Surveys can be conducted from the edge (within 10 m) when a patch is less than 200 m in width, provided the entire perimeter is surveyed. It is critical to survey all suitable habitat within an area. Small, linear patches may be thoroughly covered by a single transect along the perimeter. For larger sites, when suitable habitat exceeds 200 m in width, use a systematic survey path that assures complete patch coverage throughout the length and width of the site. Area with multiple, adjacent transects should be surveyed concurrently and in coordination (via text message or radio contact). This will help minimize duplicate detection of the same cuckoo, potentially on different transects/sites, and enable a more accurate territory estimation. The surveyor can skip over areas of unsuitable habitat (e.g. an extensive cobble bar) between patches, if the unsuitable habitat is at least 300 m in extent. Areas with small, narrow stringers of habitat, steep banks, and backwater sloughs can be surveyed by playback from a boat. It is the surveyor's responsibility to ensure all suitable habitat within the site is thoroughly surveyed.

The broadcast consists of five contact/kowlp calls, each spaced one minute apart. For consistency and comparability of the data, use only the call provided during the protocol training workshop (or from the authors). The recording should be played at approximately 70db. The standard survey forms can be obtained from http://www.fws.gov/southwest/es/. Negative data is

important, so complete the datasheet for all surveys conducted, regardless of detections. There are other forms which may be better suited to specific research needs. For those forms, it is best to contact specific researchers directly.

Arrive at the broadcast-point and wait at least one minute to listen for unsolicited cuckoo calls (i.e. cuckoos that may be calling before broadcast of the calls). Listen carefully for cuckoos, recognize and shift your attention from other bird species songs and calls, and focus on listening for cuckoos. The majority of responses occur after the first or second broadcast call, so surveyors need to be alert and prepared before beginning playback (McNeil et al. 2013, Carstensen et al. 2015).
If you do not hear any cuckoos during the initial listening period, begin the first broadcast. Listen and watch intently for responding cuckoos during and after each of the five broadcast calls. This includes watching for movement as silent birds may move closer to investigate. If no cuckoo is detected at the broadcast-point after five broadcast calls, continue 100 m along the transect and start a new broadcast as described above. Use additional datasheets for additional broadcast-points within the transect. Use the back of each datasheet to record observations and comments, linking the data by recording the "note #" in the right column of the survey data table on the front of the datasheet, and on the back of the datasheet along with the corresponding observations and comments.

Response to the broadcast call could take several forms. One or more Yellow-billed Cuckoos may move quietly (without calling) toward the surveyor, so it is critical to watch carefully for responding birds from any direction, including behind you. Cuckoos that fly silently toward the survey are difficult to detect and necessitate the full attention of the surveyor. In between broadcast calls, surveyors should be listening for cuckoos, and not be filling out the datasheet. Cuckoos may respond by calling from a distance, so listen for these responses. Cuckoos typically respond with the contact/kowlp call, but may also respond with a coo call or, rarely, an alarm call. When a cuckoo is detected, terminate the broadcast, as it may divert the bird from normal breeding activity or attract the attention of predators. Concentrate on observing the bird rather than immediately recording data. Several hundred cuckoos have been banded in the western United States over the last decade; carefully check cuckoos for leg bands, and carefully record the band color, combination and order.

After a cuckoo has been detected and appropriate data collected, move 300 m further along the transect before resuming the survey. This will minimize the likelihood of detecting the same cuckoo (Halterman 2009, McNeil et al 2013). While it is unusual for cuckoos to move 300 m after being detected by a surveyor, the surveyor should be aware of the possibility, attempt to track an individual's movements, and use their judgment to estimate if subsequent detections are separate individuals or the same individual. Please make note of all observations about individual movements and the reasoning used in determining number of individuals on the back of the data sheet.

When a cuckoo is encountered between broadcast points (i.e. an unsolicited detection is made while traveling to, from, or between broadcast points), stop and record all information in the same manner as if the detection was made during a broadcast. Do not broadcast calls. After making observations and recording information regarding the detection(s), move 300 m from the

point where the detection was made, along the transect. Continue with the procedures for conducting a survey broadcast.

Interpreting and Reporting Survey Results

This protocol is intended to be used to assess if a habitat patch contains a Yellow-billed Cuckoo. Therefore, the best way to interpret survey detections is a simple detection/non-detection determination. Determination of numbers and breeding status of cuckoos is more complex, and caution should be used when interpreting survey detection data. Because of the cuckoo's elusive and mobile nature, it is easy to both over- and under-estimate cuckoo populations. Over-estimation may occur when highly mobile individuals are detected on subsequent surveys hundreds of meters from their original detection and counted as "new" individuals (Halterman 2009, McNeil et al. 2013). Underestimation may occur because cuckoos vocalize infrequently, and respond and are detected less than half the time they are present during call playback (Halterman 2009).

The following information is one method of interpreting detection data, and should be used with caution. After the survey is completed, locations of cuckoos should be plotted as UTM coordinates on either USGS quad maps or in a GIS (geographic information system). Detection locations can be compared to estimate the total number of cuckoos detected at a site during a survey season. Separation of adjacent detections is based primarily on the distance between detections. If cuckoos are located greater than 300 m apart on the same survey, they are considered separate detections (Holmes et al. 2008, Halterman 2009, Henneman 2009). McNeil et al. (2013) and Ahlers et al. (2012) have developed similar methods for determining the number of Yellow-billed Cuckoo territories, and this should be consulted for a detailed interpretation of survey results.

Although it is difficult to accurately determine number of territories and breeding status, Holmes et al. (2008), and, later, the Southern Sierra Research Station developed a method of interpreting detections to estimate possible, probable, and confirmed breeding territories (Table 2). This determination is often only possible when follow-up visits are made to areas where cuckoos were detected during surveys. These visits may be part of nest searching or mist netting efforts. The following is from Holmes et al. (2008) and McNeil et al. (2013), and should be used, in addition to total detections, when reporting breeding status.

Table 2. Interpretation of results to estimate breeding status (from Holmes et al. 2008 and McNeil et al. 2013)

Estimation Type	Term	Definition
Breeding Territory Estimation	Possible breeding territory (PO)	Two or more total detections in an area during two survey periods and at least 10 days apart. For example, within a certain area, one detection made during Survey Period 2 coupled with another cuckoo detection made 10 days later, also during Survey Period 2, warrants a PO territory designation.
	Probable breeding territory (PR)	Three or more total detections in an area during at least three survey periods and at least 10 days between each detection. PO territory plus YBCUs observed carrying food (single observation), carrying a stick (single observation), traveling as a pair, or exchanging vocalizations.
	Confirmed breeding territory (CO)	Observation of copulation, stick carry to nest, carrying food (multiple observations), distraction display, nest, or fledgling.
Population estimation	Minimum breeding territory	The observed number of confirmed breeding territories (CO).
Occupancy estimation	Site occupancy	Occupancy is based on two or more total survey detections during two or more survey periods and at least 10 days apart. Multiple detections in an area over an extended period of time suggest that the area may have been used for breeding.

Section 3. Nest Searching

Nest searching

CAUTION: Because of the possibility of observer-induced nest abandonment, nest searching and monitoring should only be conducted when part of focused research activities. Special Federal and State permitting are required to conduct nest searching and monitoring. We provide general information on nesting activity and nest searching here so surveyors are familiar with the behaviors, and can avoid inadvertent use of these techniques.

Yellow-billed Cuckoos will nest in a wide variety of substrates, with placement height ranging from 1 m (3 ft) to 20 m (65 ft) (Hughes 1999). Nests are usually placed on either a fairly thin branch (horizontal or vertical) in larger trees or shrubs, or next to the trunk of a smaller diameter

at breast height (DBH) tree (Halterman 2002, 2008). Nests have been observed in a number of plant species including willow, cottonwood, alder, ash, mesquite, hackberry, seep willow (*Baccharis salicolifolia*) sycamore (*Plantanus* spp.), and tamarisk. There is usually a fairly high percentage of vegetation cover directly above the nest, and several meters around the nest (Laymon et al. 1997, Halterman 2005, McNeil et al. 2013).

Nesting cuckoos can be very sensitive to disturbance, especially during the pair formation and nest building stage. Nests located prior to the first egg are particularly susceptible to abandonment. At least five nests were abandoned during seven years of study on the Bill Williams River National Wildlife Refuge, possibly due, at least in part, to human disturbance (Halterman 2001, Halterman et al. 2009). Surveyors must be alert to cuckoos' behavioral signs of disturbance near a nest, which include alarm calls given repeatedly while watching the intruder, broken wing displays, or flying in with prey, then eating it instead of going to the nest. If these occur, the observer has been detected, the cuckoo is distressed, and the observer should move back. Recorded calls should not be used to elicit a response during nest searching and monitoring activities, as cuckoos have been observed leaving the nest in response to a recorded call.

Nest searching is done using two methods. Please use this information to avoid unintentionally searching for nests. When cuckoos make a nest exchange, typically one bird will call 10m or more from the nest, and the mate on the nest will answer (M. Halterman, unpublished data). The first method uses the observation of these behaviors. Two to three people will work together, triangulating on the vocalizations. The second method involves carefully searching all vegetation in the area where a cuckoo has vocalized several times, and a nest is suspected. Following the flight direction of cuckoos carrying food can also be used to locate nests.

If a nest is found, observers should leave the area after marking the general nest location with a GPS and making brief notes of the general description of the nest site (e.g., plant species used for nest substrate, approximate height of nest, and placement within the tree/shrub canopy). GPS readings should be taken no closer than 10 m from the nest, to avoid disturbance. A general description of the nest site should be completed soon after leaving the area. This information may be used for follow-up monitoring by an appropriately permitted individual.

Nest monitoring

If authorized to do so, surveyors can monitor active nests to determine nest fate. Nesting activity can be monitored and recorded by an observer sitting quietly 30-40 m from the nest for several hours. A blind or dense cover should be utilized for all nest monitoring and feeding observations. Signs of disturbance include an adult cuckoo giving a soft repetitive knocking call around the observer, and adults flying in with food, but not going to the nest. If these behaviors are observed for more than 20 minutes, the observer should leave the area. Also, because cuckoos are sensitive to disturbance at the nest, nest checks should only be conducted every 3-4 days (Halterman 2000). Both sexes incubate the eggs and care for the young (Nolan and Thompson 1975, Potter 1980, Payne 2005). Nest exchanges occur, on average, every two hours during incubation

(Halterman 2009). Nest exchanges increase when cuckoos are feeding nestlings, with up to 22 exchanges per day observed on the San Pedro River NCA (Halterman 2009).

Special Considerations

To avoid adverse impacts to Yellow-billed Cuckoos, follow these guidelines when performing all surveys:

1. Obtain all necessary Federal, State, and agency permits and permissions prior to conducting any surveys. Failure to do so leaves you liable for violation of the Endangered Species Act, various State laws, and prosecution for trespass.

2. Do not play the recording more than necessary or needlessly elicit vocal responses once Yellow-billed Cuckoos have been located. This may distract breeding birds from caring for eggs or young. If cuckoos are vocalizing upon arrival at the site, and your objective is to determine their presence or absence at a particular site—there is no need to play the recording. Excessive playing of the recording also may attract the attention of predators. Stop playing the survey recording as soon as you have confirmed the presence of a Yellow-billed Cuckoo, and do not play the recording again until you have moved 300 m from the estimated or known location of the previously detected cuckoo.

3. Proceed cautiously while moving through Yellow-billed Cuckoo habitat. Continuously check the area around you to avoid disturbance to nests of Yellow-billed Cuckoos and other species. Do not break understory vegetation, even dead branches, to create a path through the surveyed habitat.

4. Do not approach known or suspected nests. Nest searching and monitoring require specific State and Federal permits, have their own specialized methodologies (e.g. Martin and Geupel 1993), and are not intended to be a part of this survey protocol.

5. If you find yourself close to a known or suspected nest, move away slowly to avoid startling the birds or force-fledging the young. Avoid physical contact with the nest or nest tree, to prevent physical disturbance and leaving a scent. Do not leave the nest area by the same route that you approached. This leaves a "dead end" trail that could guide a potential predator to the nest/nest tree. If nest monitoring is a component of the study, but you are not specifically permitted to monitor the nest, store a waypoint with your GPS, affix a small flag at least 10 m away and hidden from view of the nest. Record the compass bearing to the nest on the flagging. Report your findings to an agency cuckoo coordinator or a biologist who is permitted to monitor nests.

6. If you use flagging to mark an area where cuckoos are found, use it conservatively and make certain the flagging is not near an active nest. Check with the property owner or land-management agency before flagging to be sure that similar flagging is not being used for other purposes in the area. Unless conducting specific and authorized/permitted nest monitoring,

flagging should be placed no closer than 10 m to any nest. Keep flagging inconspicuous from general public view to avoid attracting people or animals to an occupied site, and remove it at the end of the breeding season.

7. Watch for and note the presence of potential nest predators, particularly birds, such as Common Ravens (*Corvus corax*), American Crows (*Corvus brachyrhynchos*), jays, magpies, and accipiters. If such predators are in the immediate vicinity, wait for them to leave before playing the recording, or move on to the next broadcast-point.

8. Non-indigenous plants and animals can pose a significant threat to cuckoo habitat and may be unintentionally spread by field personnel, including those conducting cuckoo surveys. Simple avoidance and sanitation measures can help prevent the spread of these organisms to other environments. To avoid being a carrier of non-indigenous plants or animals from one field site to another, visually inspect and clean your clothing, gear, and vehicles before moving to a different field site. A detailed description on how to prevent and control the spread of these species is available by visiting the Hazard Analysis and Critical Control Point Planning for Natural Resource Management web site (http://www.haccp-nrm.org). Several non-native species of concern in survey locations are the tamarisk leaf beetle (*Diorhabda* spp.), quagga mussel (*Dreissena rostriformis bugensis*), cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), giant salvinia (*Salvinia molesta*), water milfoil (*Myriophyllum spicatum*), parrot's feather (*M. aquaticum*), and amphibian chytrid fungus (*Batrachochytrium dendrobatidis*).

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Appendix 1. Instructions for completing the Yellow-billed Cuckoo Survey Seasonal Summary Form.

NOTE- CHECK YOUR PERMIT – REPORTING REQUIREMENTS VARY BETWEEN REGIONS

These instructions are provided as guidance for completing the Survey Summary Form. It is important to complete all fields of the datasheet using a standardized format as described. Write clearly so that others can easily read the data. In addition to documenting sites with cuckoos, it is important to know areas where cuckoos were not detected; datasheets for these areas would have all information on the datasheet completed.

Attach the following: (1) copy of USGS quad/topographical map or similar (REQUIRED) of survey area, outlining survey site and location of cuckoo detections; (2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected cuckoos or their nests; (3) photos (if taken) of the interior of the patch, exterior of the patch, and overall site. Submit completed forms to both the appropriate state Yellow-billed Cuckoo coordinator and the US Fish and Wildlife Service (USFWS). Forms can also be completed digitally and submitted via email with attached or embedded topographic maps and photographs.

We recommend scanning or otherwise imaging data sheets immediately after the day's survey is completed. In the event of loss or damage to the data sheet, the information can be salvaged.

Page 1 of Survey Form

Site Name. Standardized site names are provided by the cuckoo survey coordinators for each state and should be consistent with the naming of other sites that might be in the area. If the site is new, work with your state or USFWS cuckoo coordinator to determine suitable site names before the beginning of the survey season. If the site was previously surveyed, use the site name from previous years (which can be obtained from the state or USFWS cuckoo coordinator). If you are uncertain if the site was previously surveyed, contact your state or USFWS cuckoo coordinator.

County. Record the county where the site is located.

State. Record the state where the site is located.

USGS Quad Name. Provide the full quad name, as shown on the appropriate standard 7.5-minute topographic maps.

Elevation. This can be obtained from a handheld GPS unit, USGS quad map, or a GIS elevation layer. Please use the most accurate information available. Please record data in meters.

Creek, River, Wetland, or Lake Name. Give the name of the riparian feature, such as the lake or watercourse, where the survey is being conducted.

Site Coordinates. Provide the start and end points of the survey, which will indicate the linear, straight-line extent of survey area, based on Universal Transverse Mercator coordinates (UTMs). If the start and end points of the survey changed significantly among visits, enter separate coordinates for each survey in the comments section on the back of the survey sheet. Note that we do not need the coordinates for the detailed path taken by the surveyor(s).

Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

Datum. For uniformity of data, please use NAD83.

Ownership. Circle the appropriate owner for the site (BLM, Reclamation, NPS, USFWS, USFS, Tribal, State, Private, or other (Municipal/County)).

Was site surveyed in previous year? Circle yes or no.

If yes, what site name was used? If the site was surveyed in the previous year, record the site name used in the previous year.

Survey Visit #. Survey 1 – 5. See the protocol for an explanation of the number of required visits for each survey period. Note: A survey is defined as a complete protocol-based survey that occurs over no more than 1 day. If a site is so large as to require more than a single day to survey, consider splitting the site into multiple sub-sites and use separate survey forms for each. Casual, pre-season, supplemental, or follow-up visits to check on the status of a territory should not be listed in this column, but should be documented in the comments section on page 2 or in the survey continuation sheet.

Observer(s). Record your first initial(s) and last name(s).

Date: Indicate the date that the survey was conducted using the format mm/dd/yyyy.

Start and Stop. Record the start and stop time of the survey, given in 24-hour format (e.g., 1600 hours rather than 4:00 p.m.).

Total hrs. Calculate the total hours, rounded to the nearest tenth (0.1) hour, based on time spent surveying the site and the number of surveyors. For single-observer surveys, or when multiple observers stay together throughout the survey, total the number of hours from survey start to end. If two or more observers surveyed different sections of one site concurrently and independently, sum the number of hours each observer spent surveying the site.

Total Number of YBCUs detected. Record the total number of unique individual adult/fledgling Yellow-billed Cuckoos detected during this particular survey. Do not count nestlings. (But do record whether nestlings or fledglings were found in the comments section.)

Detection Type. Record how the cuckoo was detected using two codes. First, record whether the detection was "Incidental" (with a code of "I") if the cuckoo not was detected during the 6 minutes of each call playback survey point. If the cuckoo was detected during a Call playback survey, record it as a "P". Second, record whether the detection was A = aural (you only heard a cuckoo), V = Visual (you only saw it), or B = both (you heard and saw it).

Vocalization Type. If the detection was aural, record the type of vocalization heard as "CON" = Contact/kowlp, "COO" = coo, "ALA" = alarm (soft knocker call) ,"OV" = other (and describe the "other" vocalization under notes section.

Playback Number (#). Record the number of times the 'kowlp' call was played before the cuckoo responded.

Behavior Code. Record the appropriate breeding behavior code(s), for the behavior observed using the following codes (listed on the datasheet).

Surveyor Detection Coordinates. Enter the UTM Easting (E) and Northing (N) for the location of the surveyor when the cuckoo was detected. The direction (compass bearing) and distance to the detected cuckoo are estimated from this point.

Distance. Estimate as accurately as possible, the distance in meters to the detected cuckoo.

Bearing. Estimate, as accurately as possible, the compass bearing in degrees to the detected cuckoo from the surveyor location. The compass declination should be set to the magnetic declination of the survey area. Magnetic declination values can be located on USGS 7.5 minute quad maps or can be found using an internet search for "your state" + magnetic declination.

Cuckoo Number (#). Record a sequential number, starting with the number 1 for the first observation of the survey, in the row pertaining to the broadcast - point in which the observation was made. Use this reference number for other note-worthy information in the note section on the datasheet - record the cuckoo number and detailed notes regarding your observations including breeding behavior.

Corrected Coordinates. The Yellow-billed Cuckoo location is calculated based on the surveyor's location, distance, and bearing. Use the provided "Yellow-Billed Cuckoo Survey Summary Form for electronic submission" datasheet, which will calculate these coordinates.

Survey Summary. At the end of the survey season, complete the survey summary on the front page of the datasheet, near the bottom. Record the total number of detections made (across all surveys at the site); the number of possible breeding territories (see interpreting and reporting survey results in the protocol); and the total number of survey hours (the sum of all hours spent surveying the site).

Notes. As described above, for each detection during which a cuckoo was observed, record the Note # followed by detailed notes describing the observation(s), or other note-worthy information. Attach additional pages or use the continuation sheet if needed.

Page 2: Yellow-billed Cuckoo Survey Seasonal Summary Form, continued

Yellow-billed Cuckoo survey and detection form, continued: Please use this form for additional detections, follow-up visits, and any other circumstance when more detail is needed. Please use the detailed instructions above for filling out the form.

Page 2 of Survey Form

Name of Reporting Individual. Indicate the full first and last name of the reporting individual.

Date Report Completed. Provide the date the form was completed in mm/dd/yyyy format.

Affiliation. Provide the full name of the agency or other affiliation (which is usually the employer) of the reporting individual.

Phone Number. Provide the reporting individual's phone number; include the area code.

E-mail. Provide the reporting individual's E-mail.

U.S. Fish and Wildlife Service (USFWS) Permit #. List the full number of the required federal permit under which the survey was completed.

State Permit #. If a State permit is required by the State in which the survey was completed, provide the full number of the State wildlife agency permit.

Site Name. Same as for page 1 of the survey form.

Length of area surveyed. Estimate the linear straight-line distance of the length of the area surveyed, in kilometers. This is not an estimate of the total distance walked throughout the survey site. Do not provide a range of distances.

Did you survey the same general area during each visit to this site this year? Yes/No. Circle Yes or No; if No, summarize in the comments below.

If site was surveyed last year, did you survey the same general area this year? Yes/No. Circle Yes or No; if No, record the reason and how the survey varied in the comments below.

Overall Vegetation Characteristics: This describes the overall vegetation characteristic for the site, namely which species predominantly comprise the tree/shrub layer. Check one of the following categories:

Native broadleaf plants - >75 % of the tree/shrub layer of the site is composed of native broadleaf plants.

Exotic/introduced plants - >75 % of the tree/shrub layer of the site is composed of exotic/introduced plants.

Mixed native and exotic plants (mostly native) – 51% -75% of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly exotic) – 51% -75% of the tree/shrub layer of the site is composed of exotic/introduced plants.

Average height of canopy. Provide the best estimate of the average height of the top of the canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate. Specify units used.

Estimated Canopy Cover. Estimate the percent canopy cover for the site.

Overstory Vegetation. Estimate the percent cover provided by the dominant overstory plant species at the site: cottonwood, tamarisk, Goodding's willow, Russian olive, coyote willow, and 'other". If other than the species listed, specify the species.

Average height of understory canopy. The understory canopy comprises a distinct layer (that does not have to be present throughout the site) below the overstory canopy. Provide the best estimate of the average height of the top of the understory canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate. Specify units used.

Estimated Understory Canopy Cover. Estimate the percent understory canopy cover for the site.

Understory Vegetation. Estimate the percent cover provided by the dominant understory plant species at the site: cottonwood, tamarisk, Baccharis, Goodding's willow, Russian olive, New Mexico olive, coyote willow, and 'other". If other than the species listed, specify the species.

Was surface water or saturated soil present at or within 300 meters of the site? Circle yes or no.

Was this true of all patches surveyed? Circle yes or no.
Comments. Provide comments regarding differences between survey patches within the site. For example, if the average canopy for the site is 30% cover, but within one patch it is 60%, describe this. Also note any significant differences between dominant overstory and understory vegetation among patches within the site. Document these differences with photographs whenever possible and reference comments to photos number whenever available. Note potential threats (e.g., livestock, ORV, hunting, etc.) to the site. If *Diorhabda* beetles are observed, contact your

USFWS and state cuckoo coordinator immediately. Attach additional pages or use the continuation sheet if needed.

Page 2 of Survey Summary Form

Yellow-billed Cuckoo survey and detection form, continued: Please use this form for additional detections, follow-up visits, and any other circumstance when more detail is needed. Please use the detailed instructions above for filling out the form.

Appendix 2. Instructions for Completing the OPTIONAL Yellow-billed Cuckoo Daily Datasheet

Total YBCU detections: at the end of the survey, record the total number of cuckoos detected during the survey. This is the actual number of detections. Interpretation of survey results (i.e. detections vs. number of cuckoos actually present) can be discussed in your report, but not here.

Page __ of __ : It is important to track number of pages, especially when datasheets are scanned.

Surveyor name: Record the first and last name of the primary surveyor.

Surveyor email: Record the best email address for the primary surveyor.

Surveyor phone number: Record the best phone number for the primary surveyor.

Site Code: Letter or alphanumeric code that denotes a particular site, intended to track sites throughout the season and across years. When applicable, you may use the same code identification as for Southwestern Willow Flycatcher sites.

Site Name: Write the full, unique name of the site to be surveyed. When applicable, you may use the same site name identification as for Southwestern Willow Flycatcher sites (Obtain these from your USFWS office).

Survey Period: The survey period in which the survey is being conducted (1-4), as defined in the protocol. Period 1 (one survey required): June 15-June 30. Period 2 (two surveys required): July 1 –July 31. Period 3 (one survey required): August 1-August 15.

Visit #: In many cases, this will be the same as the survey period, as most sites will be surveyed only once during a survey period. If more than one visit is conducted within one or more survey periods, number the visits sequentially, from the start of the survey season to the end. Such visits are typically for follow-up to determine breeding status.

Date: The month (mm) / day (dd) / year (yyyy) the survey is conducted.

Drainage: The name of the river, stream, or drainage where the site is located.

State, County: State two letter code (i.e. AZ); County full name (i.e. Coconino)

Additional Observers: First and last name of all additional surveyors.

Survey Start/End Time (hhmm): Write in the time of the start and end of the initial broadcast-point count (at the transect starting point) using the hour and minute format in military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Wind (0-5): Record wind measured with an anemometer. Alternatively, record the Beaufort wind code (0 through 5; Page 2 of form) as it applies to the strength of the wind during the survey. Record the average wind condition, not the maximum condition (e.g., periods of gusty winds). Do not survey if wind is greater than code 4.

Cloud Cover: Record cloud cover as: clear (C: <25%), partly overcast (PO: 25%-49%), mostly overcast (MO: 50-74%), or overcast (O: 75%+) If there are patches of clouds in different areas of the sky, try to visualize gathering all of them together into one part of the sky and recording what percent of cloud cover that would represent.

Precip (0-5): Record the appropriate code (0 through 5). Surveyors should not be surveying if rain is more than an intermittent drizzle. See chart on datasheet, Pg. 2.

Noise (0-3): Record the noise code (0-3) that applies to background noise conditions during the transect, as it relates to your ability to hear cuckoos. Record the average noise conditions, not the maximum condition. 0 = Quiet - no noise that interferes with bird detection. 1 = Faint Noise - slight noise that has only a minimal effect of bird detection. 2 = Moderate Noise - probably can't hear some birds beyond 100m. 3 = Loud Noise - Only the closest birds are detected. See chart on datasheet, Pg. 2.

Temperature: Record the ambient temperature; specify if collected in Fahrenheit or Celsius.

NAD: Surveyors should be using NAD 83.

UTM Start/Stop: Enter the UTM Easting (E) and Northing (N) for the transect starting point, and again for the end of the transect.

Start and Stop GPS Accuracy: The accuracy of the GPS reading for the UTMs, recorded in meters.

Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

<u>General survey data.</u>

Call Point Start Time (hhmm): Write in the time of the start of the individual broadcast-point count (when the surveyor first arrives at the point) using the hour and minute format using military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Survey Call Point UTM Coordinates: Enter the UTM Northing (N) and Easting (E) for the individual survey point.

Waypoint Number: Record this if you are saving them on your GPS unit.

<u>Yellow-billed Cuckoo detections:</u>

(Reminder: When a cuckoo is detected at a point, terminate the broadcast. **Do not continue to play the recording once a cuckoo is detected.)**

Detection #: When a cuckoo is detected, record a unique number for the detection. If it is the first detection of the survey visit, the detection number is "1". If more than one cuckoo is detected at the point, record the second detection in the next row on the data sheet, and record the detection number as "2". In the columns to the left (Point Start Time, UTM coordinates) record "" to denote that these values are the same as those in the row directly above. Also, if more than one cuckoo is detected at a point, be sure to thoroughly describe your observations under "Notes". If you think the same cuckoo is detected later at a different point during the survey or incidentally before or after the survey, give that bird a new detection number, but make a note of this. .

Time of Detection: Record the time that the cuckoo was detected, using the hour and minute format using military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Record how the cuckoo was detected. **I = Incidental** (between call broadcast points) or **P = Playback** (following broadcast calls).

Detection type: **A = Aural**, **V = Visual**, or **B = Both**. If the cuckoo was detected both by sight and sound (i.e., "B"), write in parenthesis the order in which the type of detections occurred. For example, "B (A/V), and describe the detection(s) under "Note #" as detailed below.

Compass Bearing (^{o}): Record the estimated compass bearing, in degrees, to the detected cuckoo. The compass declination should be set to zero.

Estimated Distance (m): Record the horizontal distance in meters between the broadcast point (where you are standing), and the location or presumed location of the cuckoo where you first detect it.

Accuracy of Estimate (Est. Accuracy): Indicate relative accuracy of your estimate using the codes shown in Table 1. Determine your pace by counting your steps per measured distance. Recalibrate your pace prior to and throughout the field season to ensure accuracy. Code reminders are on Pg. 2 of the datasheet.

Table 1. Codes for quantifying the degree of accuracy in estimating the distance to a detected cuckoo.

Accuracy Code	Explanation
1	Measured distance, using laser rangefinder or pacing, to a known location.
2	Measured distance, using laser rangefinder or pacing, to an estimated location.
3	Estimated location of detection and distance, feel confident it was within **25 m** of true location.
4	Estimated location of detection and distance, feel confident it was within **50 m** of true location.

5	Estimated location of detection and distance, feel confident it was within **100 m** of true location.
6	Little confidence in your estimate, a complete "guesstimate".

Vocal codes (Vocalization codes): Record the appropriate code (see Pg. 2, data sheet), or series of codes for any calls heard when you made the detection. Use more than one code, when appropriate.

Behavior/Breeding: Record the appropriate breeding behavior code(s), for the behavior observed using the codes on Pg. 2 data sheet. You may enter more than one code in this box. Note that if you use Vocal Exchange (VEX) you will enter data in 2 rows, one for each bird. Use more than one code, when appropriate.

Note #: To record observations of cuckoo detections, or other note-worthy information, first record a sequential number, starting with the number 1 for the first observation of the survey, in the row pertaining to the broadcast - point in which the observation was made. Use the space on the bottom of the data sheet to record detailed notes regarding your observations. Use the back of the data sheet if more space is needed.

***:** Two blank columns are provided so surveyors can record additional information that may be of interest, such as cicada presence, presence of other avian species of interest, etc.

Data Entry, Data Proof, Data Scan: These are provided for QA/QC of your data.

Review your federal and state permit requirements. Be sure to submit appropriate forms and reports on time to USFWS and other agencies. Retain a copy for your records.

Appendix 3. Instructions for Completing the Yellow-billed Cuckoo Survey Site Description Form

These instructions are provided as guidance for completing the Yellow-billed Cuckoo Survey Site Description Form. It is important to complete all fields of the datasheet using a standardized format as described. Type or write clearly so that others can easily read the data. Describe any unique habitat features in Comments.

We recommend scanning or otherwise imaging data sheets immediately after the day's survey is completed. In the event of loss or damage to the data sheet, the information can be salvaged.

Date report completed: Indicate the date that the survey was conducted using the format mm/dd/yyyy.

Site Name: Write the full, unique name of the site to be surveyed. When applicable, you may use the same site name identification as for Southwestern Willow Flycatcher sites (Obtain these from your USFWS office).

State. Record the state where the site is located.

County. Record the county where the site is located.

Name of Reporting individual: Record the first and last name of the primary surveyor.

Affiliation. Provide the full name of the agency or other affiliation (which is usually the employer) of the reporting individual.

Phone #: Record the best phone number for the primary surveyor.

Email: Record the best email address for the primary surveyor.

U.S. Fish and Wildlife Service (USFWS) Permit #. List the full number of the required federal permit under which the survey was completed.

State Permit #. If a State permit is required by the State in which the survey was completed, provide the full number of the State wildlife agency permit.

Site Coordinates. Provide the start and end points of the survey, which will indicate the linear, straight-line extent of survey area, based on Universal Transverse Mercator coordinates (UTMs). If the start and end points of the survey changed significantly among visits, enter separate coordinates for each survey in the comments section on the back of the survey sheet.

UTM Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

NAD: Surveyors should be using NAD 83.

USGS Quad Name(s). Provide the full quad name, as shown on the appropriate standard 7.5-minute topographic maps. Please list the names of all Quads covered by the survey site.
Length of area surveyed. Estimate the linear straight-line distance of the length of the area surveyed, in kilometers. This is not an estimate of the total distance walked throughout the survey site. Do not provide a range of distances.

Elevation. This can be obtained from a handheld GPS unit, USGS Quad map, or a GIS elevation layer. Please use the most accurate information available. Please record data in meters.

Name of nearest Creek, River, Wetland, or Lake. Give the name of the riparian feature, such as the lake or watercourse, where the survey is being conducted.

Ownership. Circle the appropriate owner for the site (BLM, Reclamation, NPS, USFWS, USFS, Tribal, State, Private, or Other (Municipal/County)).

Was site surveyed in previous year? Circle yes or no.

If yes, what site name was used? If the site was surveyed in the previous year, record the site name used in the previous year.

Did you survey the same general area during each visit to this site this year? Yes/No. Circle Yes or No; if No, summarize in the comments below.

If site was surveyed last year, did you survey the same general area this year? Yes/No. Circle Yes or No; if No, record the reason and how the survey varied in the comments below.

Native/Exotic:

Native broadleaf plants - >75 % of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly native) – 51% -75% of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly exotic) – 51% -75% of the tree/shrub layer of the site is composed of exotic/introduced plants.

Exotic/introduced plants - >75 % of the tree/shrub layer of the site is composed of exotic/introduced plants.

Overstory Vegetation. Provide the scientific names of the five most common species in the overstory, and the estimated percent cover provided each species. It is possible for there to be an overstory present with no understory. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Average height of canopy. Provide the best estimate of the average height, in meters, of the top of the canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate.

Estimated Overall Canopy Cover. Estimate the overall percent canopy cover for the site.

Understory Vegetation. The understory canopy comprises a distinct woody layer (that does not have to be present throughout the site) below the overstory canopy. For example, a cottonwood overstory might have a willow understory. It's also possible that there may only be an overstory, with no understory. Willow or mesquite, for example, may have no understory. Provide the scientific names of the five most common species in the understory, and the estimated percent cover provided each species. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Average height of understory canopy. Provide the best estimate of the average height, in meters, of the top of the understory canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate.

Estimated Overall Understory Cover. Estimate the percent understory cover for the site.

Describe adjacent habitat: Describe the types of habitat adjacent to the survey area. Include upland vegetation type, such as agricultural or residential areas, roads, and any other relevant information.

Adjacent Habitat. Provide the names of the five most common types of adjacent habitat, and the estimated percent cover provided each type. Alternatively, you can list up to five types of surrounding land use. For example: Fallow Ag field, 50%; suburb, 25%, Walnut orchard, 25%. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Was surface water or saturated soil present at or within 300 meters of the site? Circle yes or no.

Was this true of all patches surveyed? Circle yes or no.

Comments. Provide comments regarding differences between survey patches within the site. For example, if the average canopy for the site is 30% cover, but within one patch it is 60%, describe this. Also note any significant differences between dominant overstory and understory vegetation among patches within the site. Document these differences with photographs whenever possible and reference comments to photos number whenever available. Note potential threats (e.g.,

livestock, ORV, hunting, etc.) to the site. If *Diorhabda* beetles are observed, contact your USFWS and State cuckoo coordinator immediately. Attach additional pages or use the continuation sheet if needed.

PAGE 2. The first four sections are required in case pages become separated.

Site Name.

Name of Reporting Individual.

Phone Number.

E-mail.

Map: Attach the following: (1) copy of USGS quad/topographical map or similar (REQUIRED) of survey area, outlining survey site and location of cuckoo detections; (2) sketch or aerial photo showing site location, patch shape, openings, survey route, location of any detected cuckoos or their nests; (3) photos (if taken) of the interior of the patch, exterior of the patch, and overall site. Submit completed forms to both the appropriate State Yellow-billed Cuckoo coordinator and the US Fish and Wildlife Service (USFWS) as required by your permits. When required or recommended, forms should be completed digitally (Microsoft Word or Excel) and submitted via email with attached or embedded topographic maps and photographs.

OPTIONAL Yellow-Billed Cuckoo Daily Datasheet

Total YBCU Detections	

Page__1_ of ____

Surveyor name:														Surveyor email:														Surveyor Phone:													
Site Code:				Site Name:										Survey Period:										Visit #:				Date (mm/dd/yy):										Additional observers:	
Drainage:								State:						County:																									
Survey Start		Time:						Wind:						Cloud cover:										Precip:				Noise:										Temp:			
Survey End		Time:						Wind:						Cloud cover:										Precip:				Noise:										Temp:			
NAD:		Start Easting												Start Northing														Start GPS Accuracy (m):													
Zone:		Stop Easting												Stop Northing														Stop GPS Accuracy (m):													

Call Point Start Time	Survey Call Point UTM Coordinates													Waypoint Number	If a YBCU is detected, please provide the information below									Note #	*	*
	Easting						Northing								Detection # - separate line for each YBCU	Time of Detection	I=Incidental P=Playback	A=aural V=visual B=both	Compass Bearing (°)	Estimated Distance (m)	Est. Dist. Accuracy (use codes on pg. 2)	Vocal Code (you can use more than one code)	Behavior/ Breeding Code (you can use more than one)				

Notes:

	Date	Initials
Data Entry:		
Data Proof:		
Data Scan :		

*** Blanks provided for region-specific or project-specific data. Please define these fields in "Notes" or the space provided.**

OPTIONAL Yellow-Billed Cuckoo Daily Datasheet pg. 2

Site Code:	Site Name:	Survey Period:	Visit #:	Date (mm/dd/yy):	Page____ of ____

Wind		Precipitation		Noise codes		Dist Acc.		VOCALIZATION	CODE	BEHAVIOR	CODE	BEHAVIOR	CODE	BREEDING	CODE	CLOUD COVER
Calm	0	None	0	Quiet	0	1	exact	Contact	CON	No visual	NV	Catches Prey	CP	Copulation	COP	
Smoke drifts	1	Mist	1	Faint noise	1	2	estimate	Coo	COO	Sitting	ST	Carry Food	CF	Feeds Mate	FM	C < 25%
Felt on face	2	Drizle	2	Moderate:		3	±25m	Knock/Alarm	ALA	Foraging	FO	Eats Food	EF	Carry Nest Material	CN	PO 25-49%
Leaves move	3	Rain	3	detection radius ↓	2	4	±50m	Juvenile Calls	JUVC	Preening	PRE	At Nest	AN	Brooding/Incubating	BI	MO 50-75%
Small branches move	4	Heavy rain	4	Loud: Only		5	±100m	Other Vocaliz.	OV	Flying	FLY	Juvenile	JUV	Feeds Nestling	FN	O > 75%
Small trees move	5	Snow	5	closest birds detected	3	6	guess			Distraction Display	DD	Vocal Exchange	VEX	Feeds Fledgling	FF	

Point Start Time	Survey Call Point UTM Coordinates													Waypoint Number	If a YBCU is detected, please provide the information below									Note #	*	*
	Easting						Northing								Detection # - separate line for each YBCU	Time of Detection	I=Incidental P=Playback	A=aural V=visual B=both	Compass Bearing °	Estimated Distance (m)	Est. Dist. Accuracy (use codes on pg. 2)	Vocal Code (you can use more than one code)	Behavior/ Breeding Code (you can use more than one)			

Notes:

*** Blanks provided for region-specific or project-specific data. Please define these fields in "Notes" or the space provided.** (revised 06/03/2016)

Surveyor name:	Surveyor email:	Surveyor Phone:
Surveyor Affiliation (e.g. AGFD, BLM, etc.):	Please check your permits for reporting requirements and timing.	

Yellow Billed Cuckoo Survey Summary Form

Site Name: County: State:

USGS Quad Name: Elevation:

Creek, River, Wetland, or Lake Name

Site Coordinates: Start: E N UTM Zone:

Stop: E N Datum:

Ownership: BLM Reclamation NPS USFWS USFS Tribal State Private Other (Municipal/County)

Was site surveyed in previous year? Yes No Unknown If yes, what site name was used?

Survey # Observer(s) (Last Name, First Initial)	Date (m/d/y) Survey, Time, Total Hours	Total Number of YBCUs detected.	Time Detected (AM):	Detect Type: I=Incidental P=Playback A=aural V=visual B=both	Voc. Type: CN=Contact CO=coo AL=alarm OT=other (describe)	Playback #: Number of times 'Kowlp' call played before YBCU responded	Behavior code	Surveyor Detection Coordinates		Distance (m)	Bearing	Cuckoo #	Corrected Coordinates	
								UTM E	UTM N				UTM E	UTM N
Survey Period #1	Date:													
Observer(s):	Start:													
	Stop:													
	Total hrs:	Total:												
Survey Period #2	Date:													
Observer(s):	Start:													
	Stop:													
	Total hrs:	Total:												
Survey Period #3	Date:													
Observer(s):	Start:													
	Stop:													
	Total hrs:	Total:												
Survey Period #4	Date:													
Observer(s):	Start:													
	Stop:													
	Total hrs:	Total:												
Survey Period #5	Date:													
Observer(s):	Start:													
	Stop:													
	Total hrs:	Total:												
Survey Summary:	# Det	#PO	#PR	#CO		#Nests found		Total Survey Hours:						
Total YBCUs*														

Notes (refer to Cuckoo # associated with individual detections)

*Include justification for these designations.

VOCALIZATION	CODE
Contact	CON
Coo	COO
Knock/Alarm	ALA
Juvenile Calls	JUVC
Other Vocalization	OV

BEHAVIOR	CODE
No visual	NV
Sitting	ST
Foraging	FO
Preening	PRE
Flying	FLY
Distraction Display	DD

BEHAVIOR	CODE
Catches Prey	CP
Carry Food	CF
Eats Food	EF
At Nest	AN
Juvenile	JUV
Vocal Exchange	VEX

BREEDING	CODE
Copulation	COP
Feeds Mate	FM
Carry Nest Material	CN
Brooding/Incubating	BI
Feeds Nestling	FN
Feeds Fledgling	FF

NB = nest building, NE = active nest with unbroken eggs in it, NY = nest with young seen or heard in it, ON = occupied nest, US = used, inactive nest with blue-green eggshells.

Yellow-billed Cuckoo Survey Summary Form, continued

Name of Reporting Individual _____ Phone #_____

Affiliation_____ Email _____

Site Name_____

Survey # Observer(s) (Last Name, First Initial)	Date (m/d/y) Survey, Time, Total Hours	Time Detected (AM):	Detect Type: I=Incidental P=Playback A=aural V=visual B=both	Voc. Type: CN=Contact CO=coo AL=alarm OT=other (describe)	Playback #: Number of times 'Kowlp' call played before YBCU responded	Behavior code	Surveyor Detection Coordinates		Distance (m)	Bearing	cuckoo #	Corrected Coordinates	
							UTM E	UTM N				UTM E	UTM N

Notes - Continued (refer to Cuckoo # associated with individual detections)

ATTACHMENT 2

List of Incidental Sightings of Lower Colorado River Multi-Species Conservation Program Focal Bird Species, 2014 to 2018

	Bell's vireo					Black rail					Elf owl					Gila woodpecker					Gilded flicker					Least bittern				
Year	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Overton Wildlife	5	6	-	-	-	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-
CPhase 05, 06	4	10	5	4	5	0	0	0	0	0	0	0	0	0	0	2	4	0	0	4	0	0	0	0	0	2	0	0	0	0
Pintail Slough	9	15	-	-	-	0	0	-	-	-	0	0	-	-	-	6	7	-	-	-	0	0	-	-	-	0	0	-	-	-
Topock Platform	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	4	-	-	-	0	0	-	-	-	0	0	-	-	-
Cave Wash	5	6	-	-	-	0	0	-	-	-	0	0	-	-	-	5	22	-	-	-	2	0	-	-	-	0	1	-	-	-
Cougar Point	4	14	-	0	2	0	0	-	0	0	0	0	-	0	0	4	22	-	5	4	0	4	-	0	0	0	0	-	0	0
Esquerra Ranch	4	32	-	5	7	0	0	-	0	0	0	0	-	0	0	4	34	-	8	9	0	2	-	0	0	0	0	-	0	0
Gibraltar Rock	4	-	-	0	3	0	-	-	0	0	1	-	-	0	0	5	-	-	7	8	0	-	-	0	0	0	-	-	0	0
Honeycomb Bend	5	31	-	-	-	0	0	-	-	-	0	0	-	-	-	5	13	-	-	-	0	0	-	-	-	0	6	-	-	-
Kohen Ranch	5	21	-	4	4	0	0	-	0	0	0	0	-	0	0	5	34	-	4	3	0	0	-	0	1	0	0	-	0	0
Mineral Wash	5	26	-	6	8	0	0	-	0	0	0	1	-	0	2	5	21	-	8	9	1	0	-	0	0	0	0	-	0	0
Borrow Pit	4	14	-	-	-	0	0	-	-	-	0	0	-	-	-	5	21	-	-	-	0	0	-	-	-	0	0	-	-	-
BW Marsh	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	4	5	-	-	-	0	0	-	-	-	2	0	-	-	-
Cross River	4	2	-	-	-	0	0	-	-	-	0	0	-	-	-	5	5	-	-	-	0	0	-	-	-	0	0	-	-	-
Fox Wash	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	4	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Middle Delta	2	-	-	-	-	0	-	-	-	-	0	-	-	-	-	4	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Mosquito Flats	9	9	-	-	-	0	0	-	-	-	0	0	-	-	-	9	11	-	-	-	0	0	-	-	-	0	0	-	-	-
North Burn	3	4	-	-	-	0	0	-	-	-	0	0	-	-	-	4	4	-	-	-	0	0	-	-	-	0	0	-	-	-
Sandy Wash	5	9	-	0	1	0	0	-	0	0	0	0	-	0	0	5	38	-	4	4	1	0	-	0	0	0	0	-	0	0
CRIT 09	2	1	-	-	-	0	0	-	-	-	0	0	-	-	-	0	1	-	-	-	0	0	-	-	-	0	0	-	-	-
PVER Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 2	2	5	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 5	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 6	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 8	-	-	2	0	0	-	-	0	0	0	-	-	-	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0
CVCA Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0
CVCA Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CVCA Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
CVCA Phase 4	0	-	-	0	-	0	-	-	0	-	0	-	-	-	-	0	-	-	1	-	0	-	-	-	-	0	-	-	-	-
CVCA Phase 7	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
CVCA Phase 8	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
Cottonwood Genetics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Crane Roost	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CW-North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hippy Fire	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0		0	-	0	0	0	0	-	0	0	0	0
Mass Transplanting	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature Trail	3	7	2	3	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0
Lago Tres	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	3	-	-	-	0	0	-	-	-	0	0	-	-	-
Fishers Landing	0	2	-	-	-	0	3	-	-	-	0	0	-	-	-	0	12	-	-	-	0	0	-	-	-	0	2	-	-	-
Reach 1	-	-	2	5	0	-	-	1	0	0	-	-	-	0	0	-	-	1	0	0	-	-	-	0	0	-	-	2	0	0
Reach 2	-	-	-	-	0	-	-	-	-	1	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
Mittry	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	1	1	-	-	-	0	0	-	-	-	0	0	-	-	-
South AC, C, I	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	4	-	2	1	0	0	-	0	0	0	0	-	0	0	0

	Ridgway's rail					Summer tanager					Vermilion flycatcher					Willow flycatcher					Yellow warbler				
Year	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Overton Wildlife	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	1	1	-	-	-	5	10	-	-	-
CPhase 05, 06	0	1	0	0	0	5	4	5	5	3	0	0	0	0	0	0	0	0	0	0	4	9	3	4	4
Pintail Slough	0	0	-	-	-	3	3	-	-	-	0	2	-	-	-	0	0	-	-	-	2	5	-	-	
Topock Platform	0	0	-	-	-	1	2	-	-	-	0	1	-	-	-	1	0	-	-	-		0	-	-	
Cave Wash	0	0	-	-	-	5	8	-	-	-	0	0	-	-	-	0	0	-	-	-	2	1	-	-	
Cougar Point	0	0	-	0	0	3	7	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0
Esquerra Ranch	0	0	-	0	0	3	2	-	2	2	1	0	-	0	0	0	0	-	0	0	4	18	-	0	3
Gibraltar Rock	0	-	-	0	0	3	-	-	0	0	0	-	-	0	0	0	-	-	0	0	1	-	-	0	0
Honeycomb Bend	0	0	-	-	-	5	40	-	-	-	0	0	-	-	-	1	5	-	-	-	5	44	-	-	-
Kohen Ranch	0	0	-	0	0	5	6	-	0	0	0	0	-	0	0	0	0	-	0	0	3	4	-	0	0
Mineral Wash	0	0	-	0	0	4	14	-	3	4	0	0	-	0	0	1	0	-	0	0	4	14	-	3	2
Borrow Pit	0	0	-	-	-	4	3	-	-	-	0	0	-	-	-	0	0	-	-	-	1	4	-	-	-
BW Marsh	0	0	-	-	-	4	1	-	-	-	0	0	-	-	-	0	0	-	-	-	4	1	-	-	-
Cross River	0	0	-	-	-	4	2	-	-	-	0	0	-	-	-	0	0	-	-	-	5	2	-	-	-
Fox Wash	0	-	-	-	-	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	1	-	-	-	-
Middle Delta	0	-	-	-	-	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	4	-	-	-	-
Mosquito Flats	0	0	-	-	-	8	2	-	-	-	0	0	-	-	-	0	0	-	-	-	9	7	-	-	-
North Burn	0	0	-	-	-	2	1	-	-	-	0	0	-	-	-	0	0	-	-	-	4	3	-	-	-
Sandy Wash	0	0	-	0	0	5	8	-	0	0	0	0	-	0	0	0	0	-	0	0	0	3	-	1	0
CRIT 09	0	0	-	-	-	4	22	-	-	-	5	23	-	-	-	1	1	-	-	-	1	0	-	-	-
PVER Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PVER Phase 2	0	0	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
PVER Phase 3	0	0	0	0	0	2	1	0	4	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
PVER Phase 4	0	0	0	0	0	0	0	3	1	10	0	0	0	0	0	0	1	0	0	0	5	2	1	0	1
PVER Phase 5	0	0	0	0	0	0	2	1	4	4	0	1	0	0	0	1	1	0	0	0	2	3	2	3	1
PVER Phase 6	0	0	0	0	0	1	0	11	7	11	0	0	0	0	0	0	0	1	0	1	5	16	42	16	7
PVER Phase 7	0	0	0	0	0	0	0	4	21	19	0	0	0	0	1	1	1	0	0		1	3	9	8	2
PVER Phase 8	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0
CVCA Phase 1	0	0	0	0	0	0	3	3	2	0	0	0	0	0	0	0	0	0	0	0	1	1	4	5	0
CVCA Phase 2	0	0	0	0	0	0	1	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
CVCA Phase 3	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CVCA Phase 4	0	-	-	0	-	0	-	-	0	-	0	-	-	0	-	0	-	-	0	-	0	-	-	0	-
CVCA Phase 7	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
CVCA Phase 8	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
Cottonwood Genetics	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Crane Roost	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	3	2	2	0	1
CW-North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hippy Fire	-	0	0	0	0	-	0	0	1	0	-	0	0	0	0	-	0	0	0	0	-	1	0	1	1
Mass Transplanting	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature Trail	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
Lago Tres	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	1	-	-	-	0	0	-	-	-
Fishers Landing	0	8	-	-	-	0	3	-	-	-	0	0	-	-	-	0	0	-	-	-	0	1	-	-	-
Reach 1	-	-	1	2	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	1	2	0
Reach 2	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
Mittry	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-	1	1	-	-	-
South AC, C, I	0	-	0	0	0	0	-	0	0	0	1	-	0	0	0	2	-	0	0	0	2	-	1	1	0

ATTACHMENT 3

Maps of Survey Sites and Transects, LCR 2018

Figure page

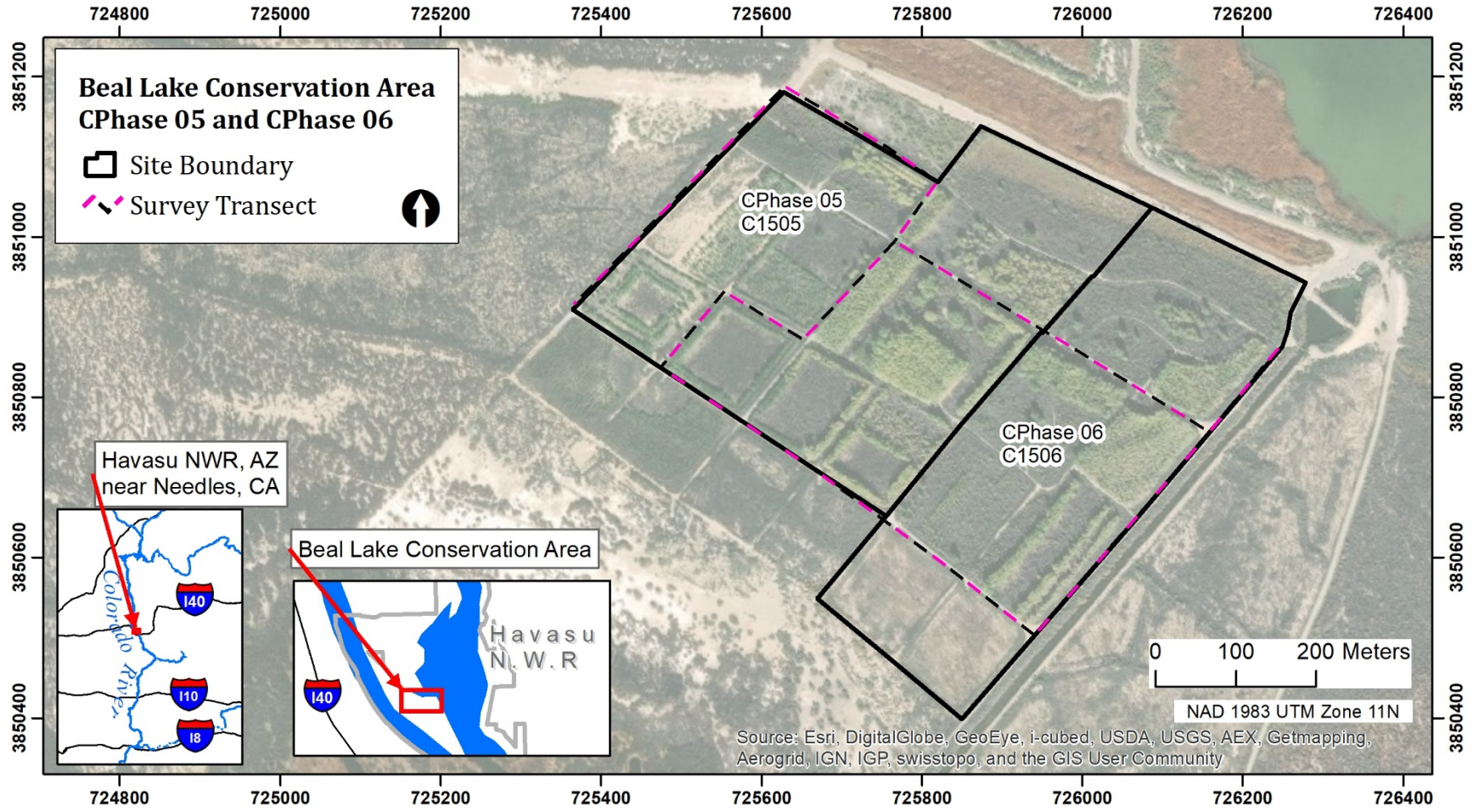

Figure 1.—Beal Lake Conservation Area CPhase 05 and CPhase 06 yellow-billed cuckoo (YBCU) survey sites and transects, 2018.

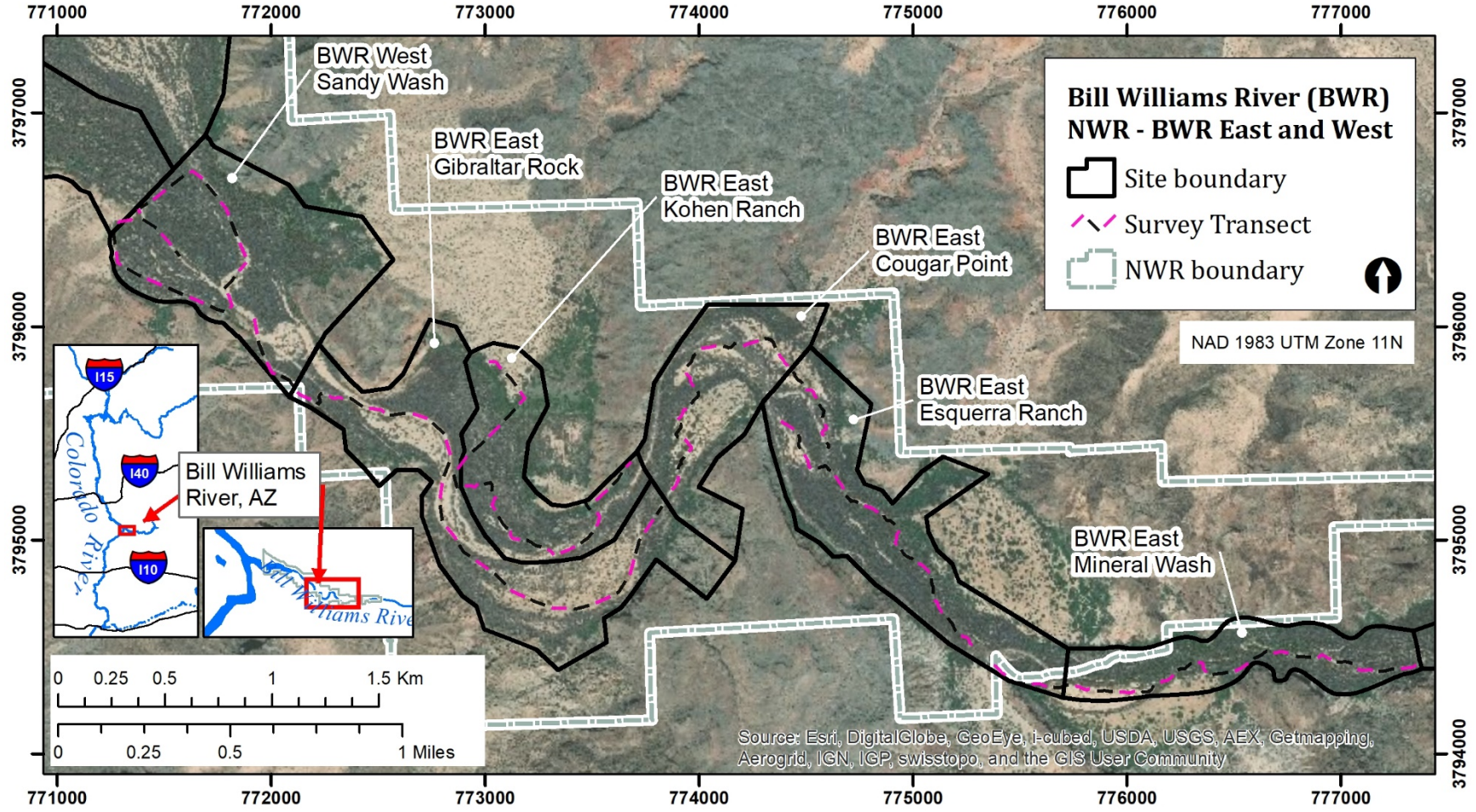

Figure 2.—Bill Williams River (BWR) East and BWR West YBCU survey sites and transects, 2018.

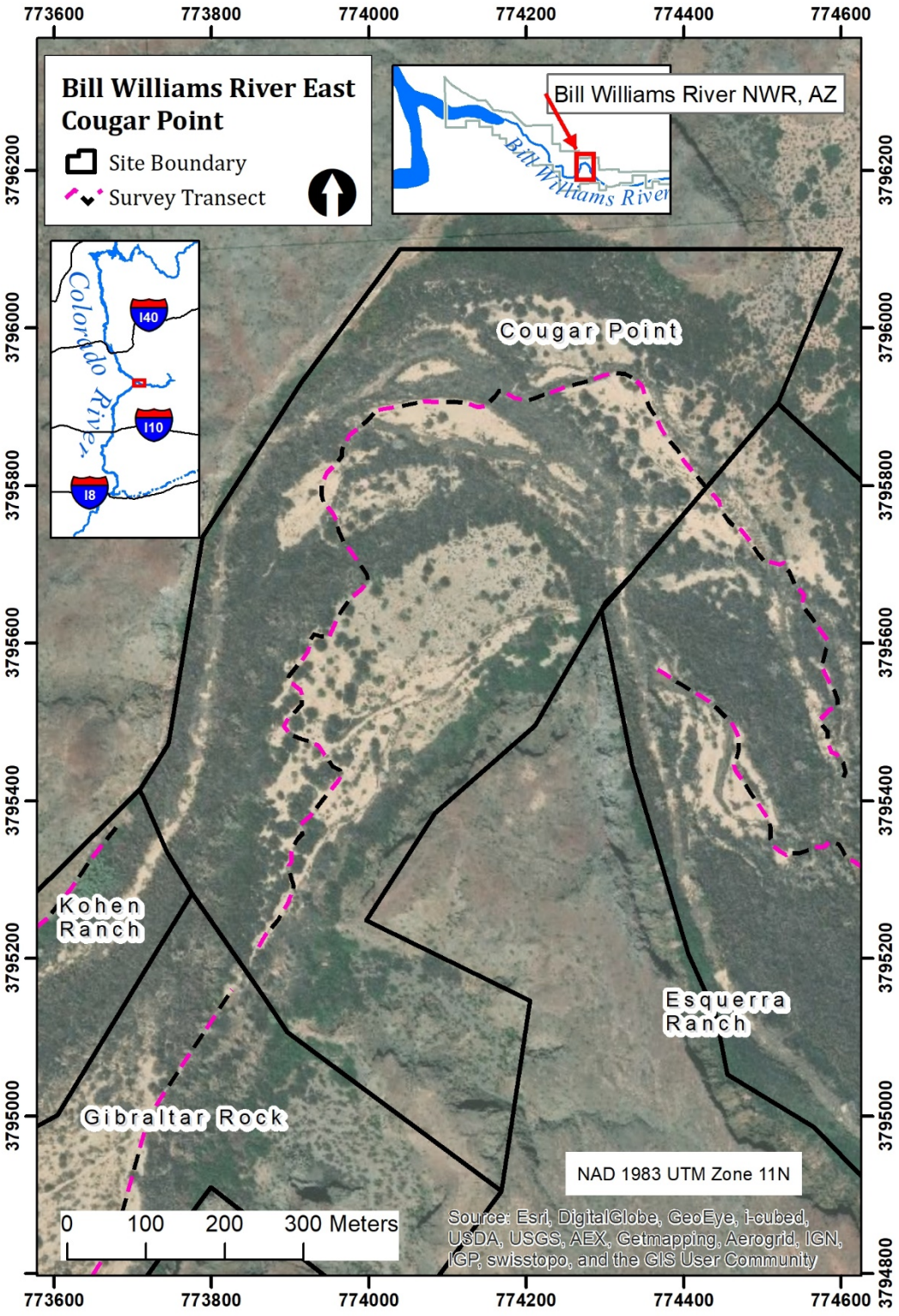

Figure 3.—BWR East Cougar Point YBCU survey site and transect, 2018.

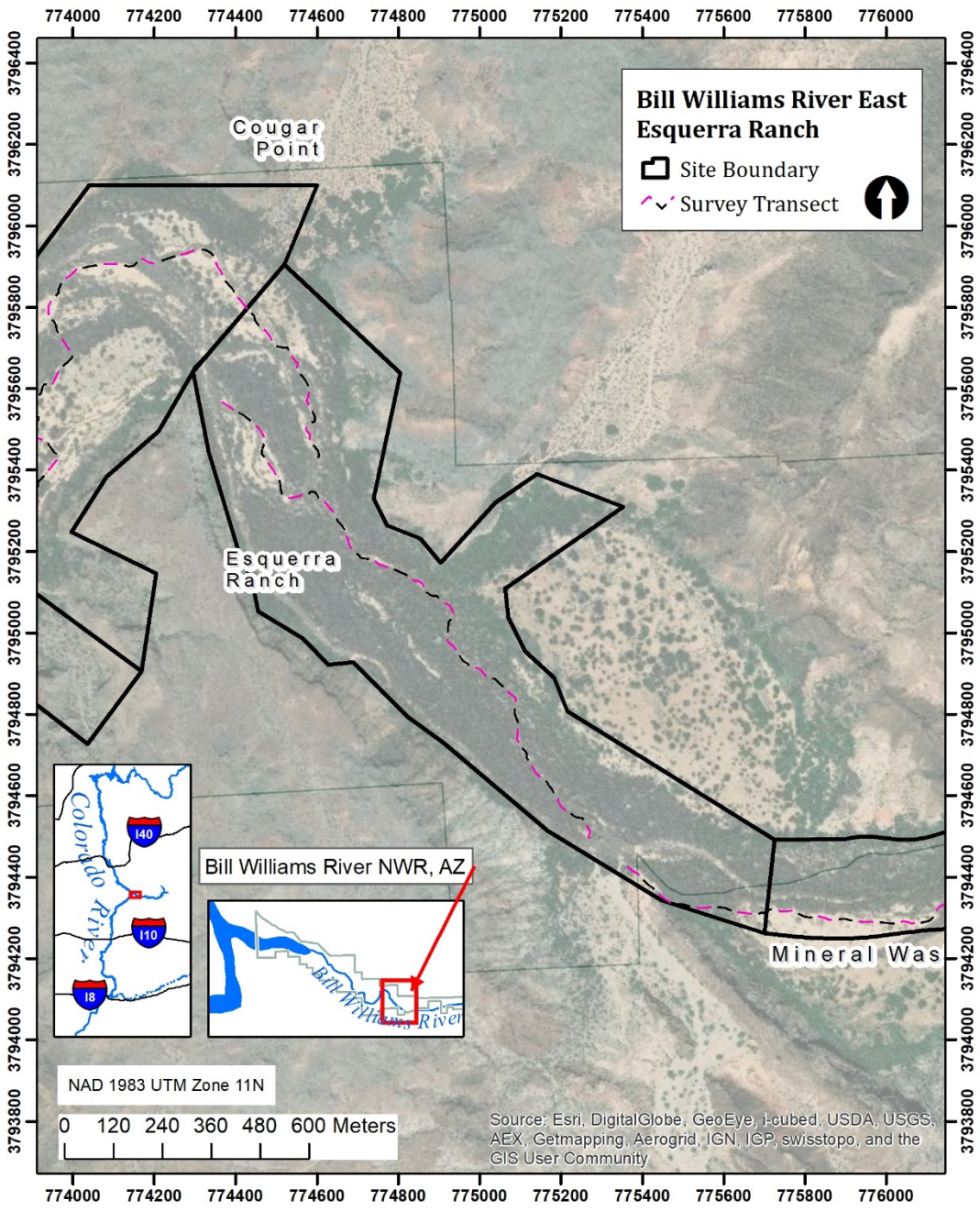

Figure 4.—BWR East Esquerra Ranch YBCU survey site and transect, 2018.

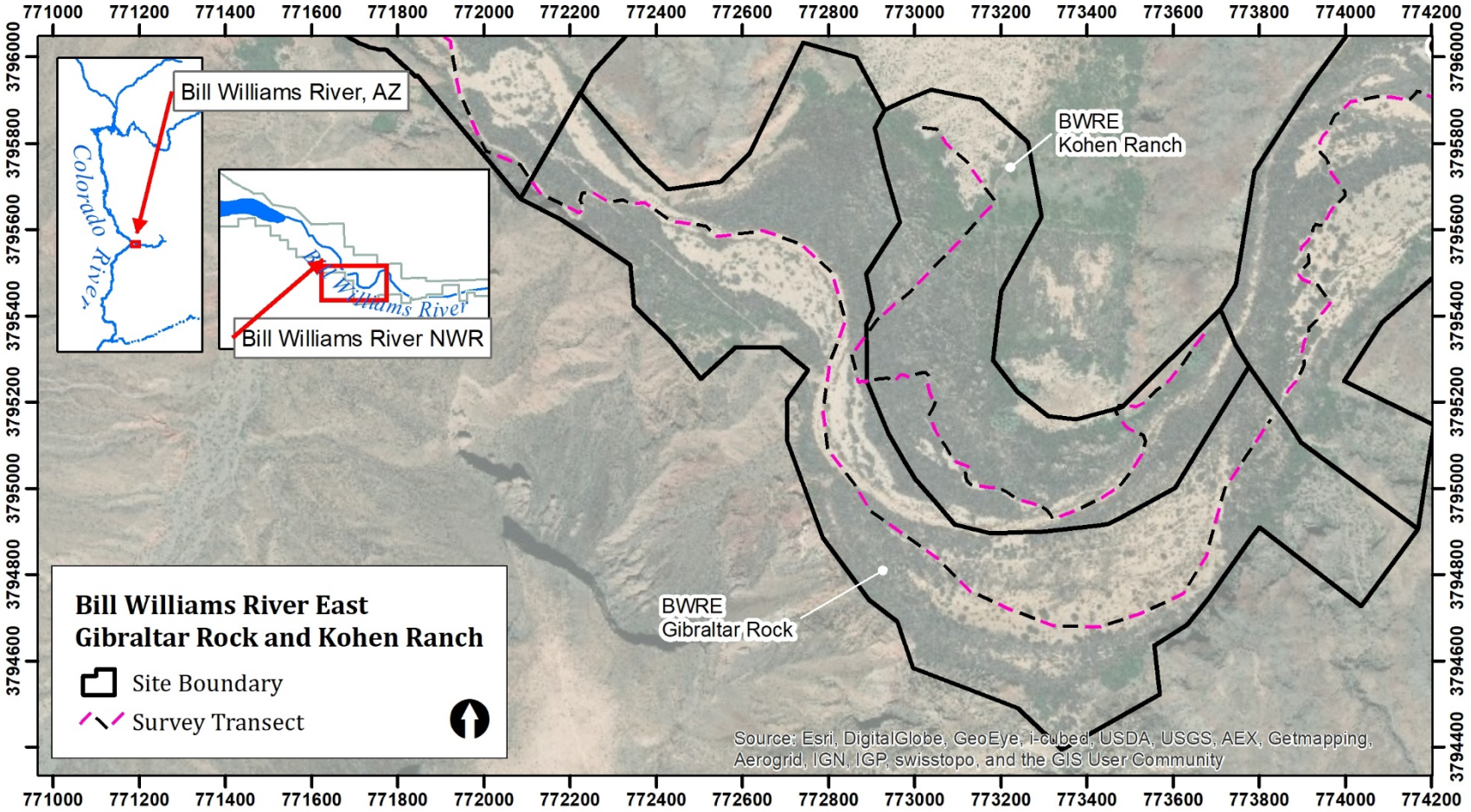

Figure 5.—BWR East Gibraltar Rock and Kohen Ranch YBCU survey sites and transects, 2018.

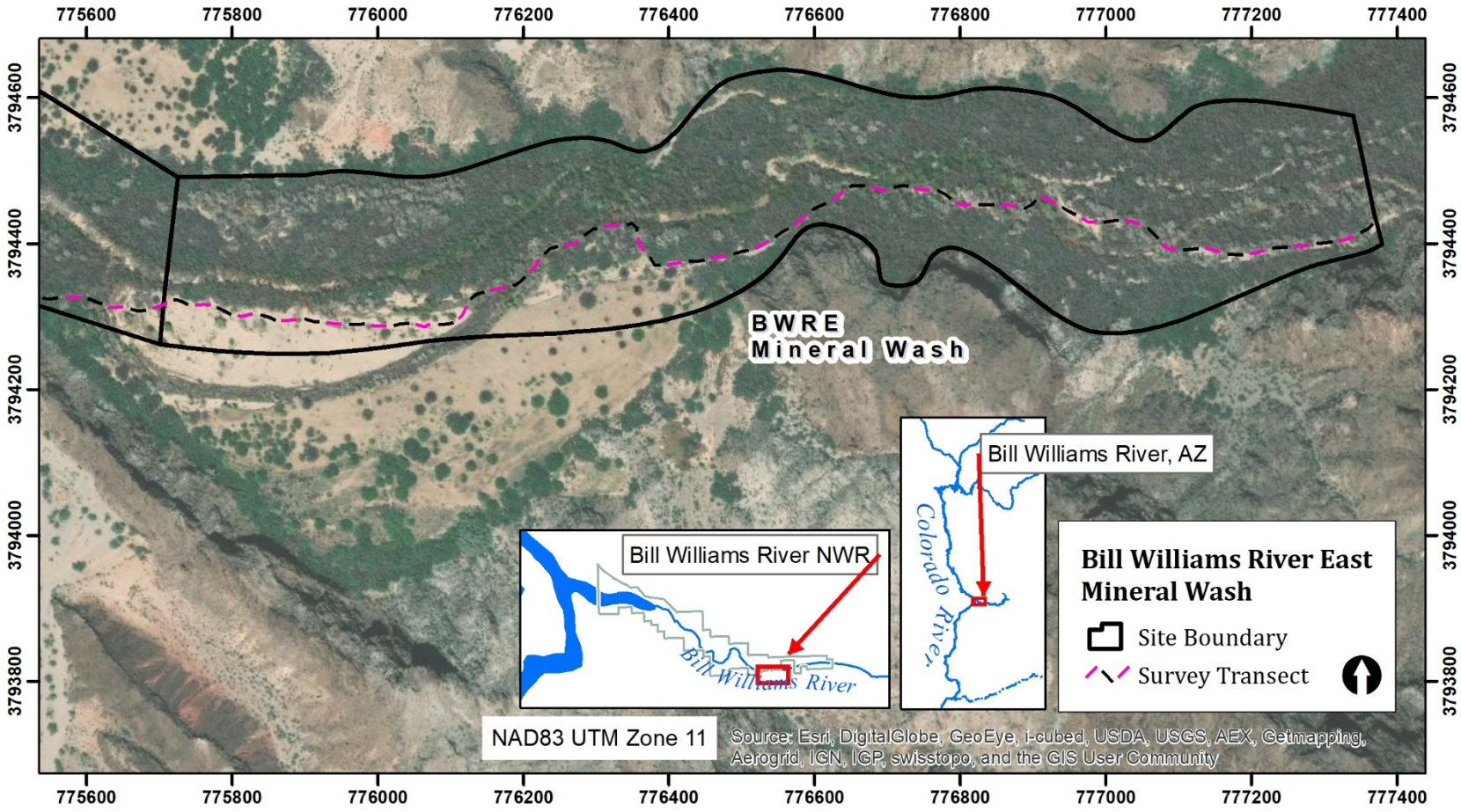

Figure 6.—BWR East Mineral Wash YBCU survey site and transect, 2018.

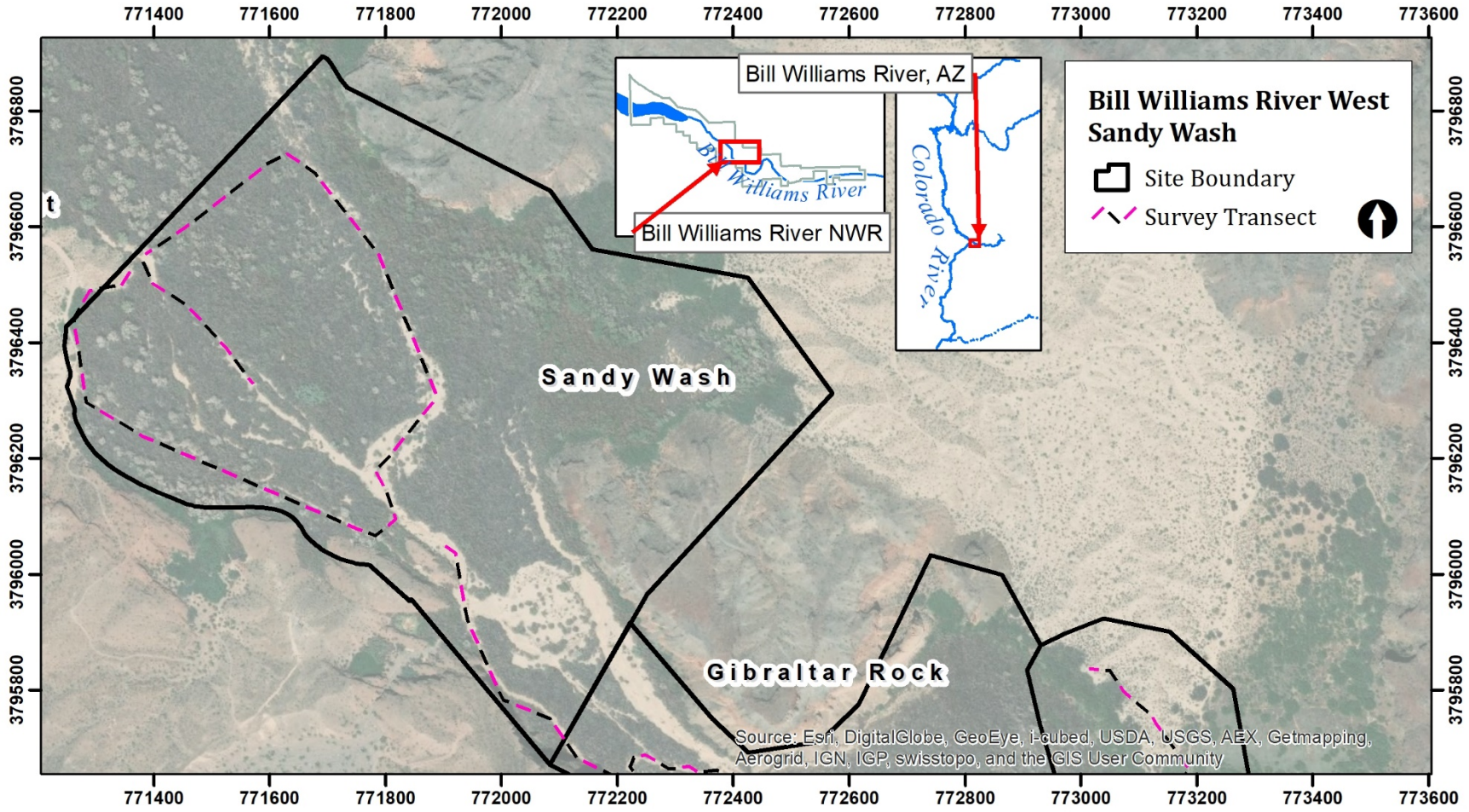

Figure 7.—BWR West Sandy Wash YBCU survey site and transect, 2018.

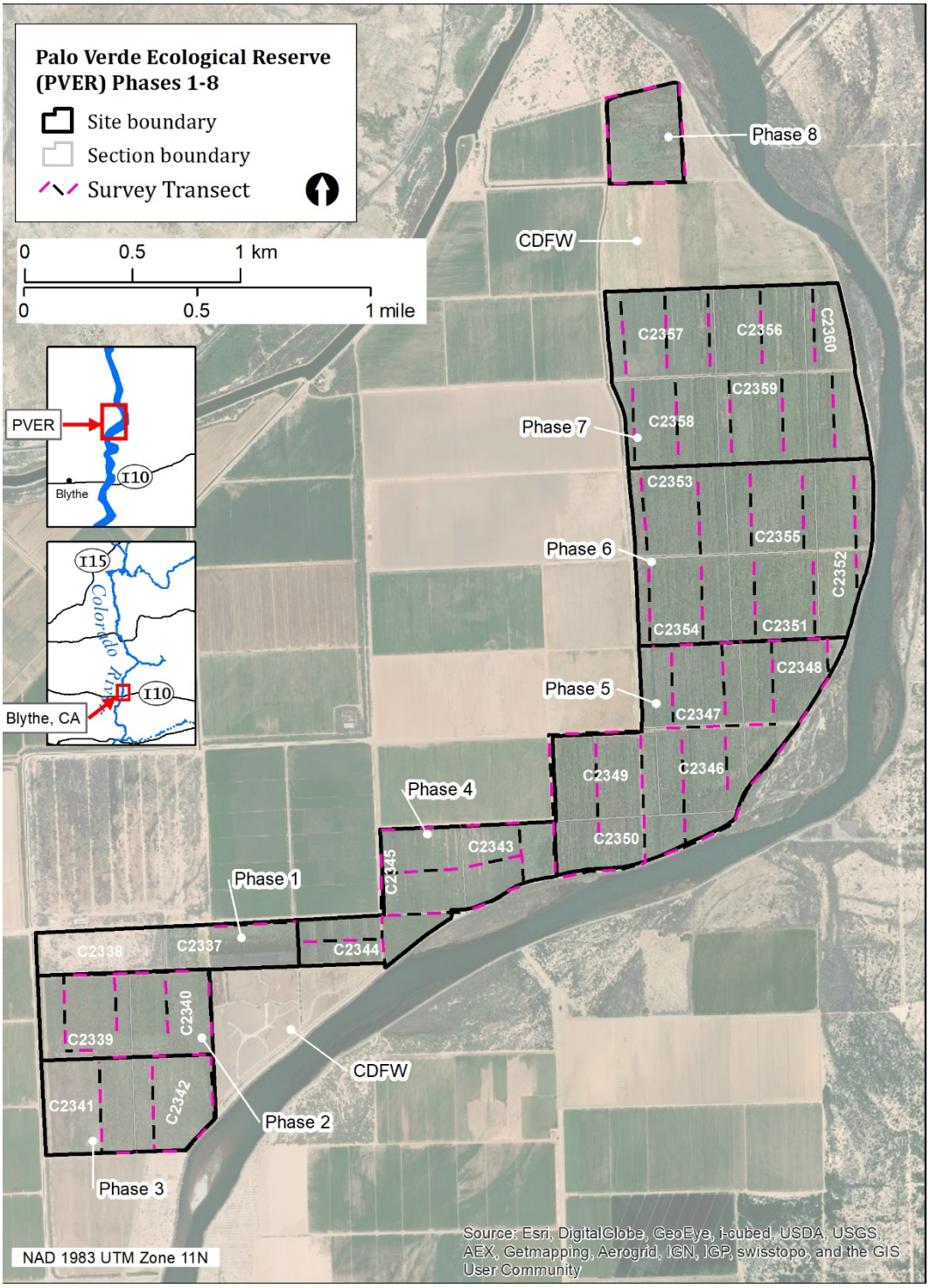

Figure 8.—Palo Verde Ecological Reserve (PVER) Phases 1-8 YBCU survey sites and transects, 2018.

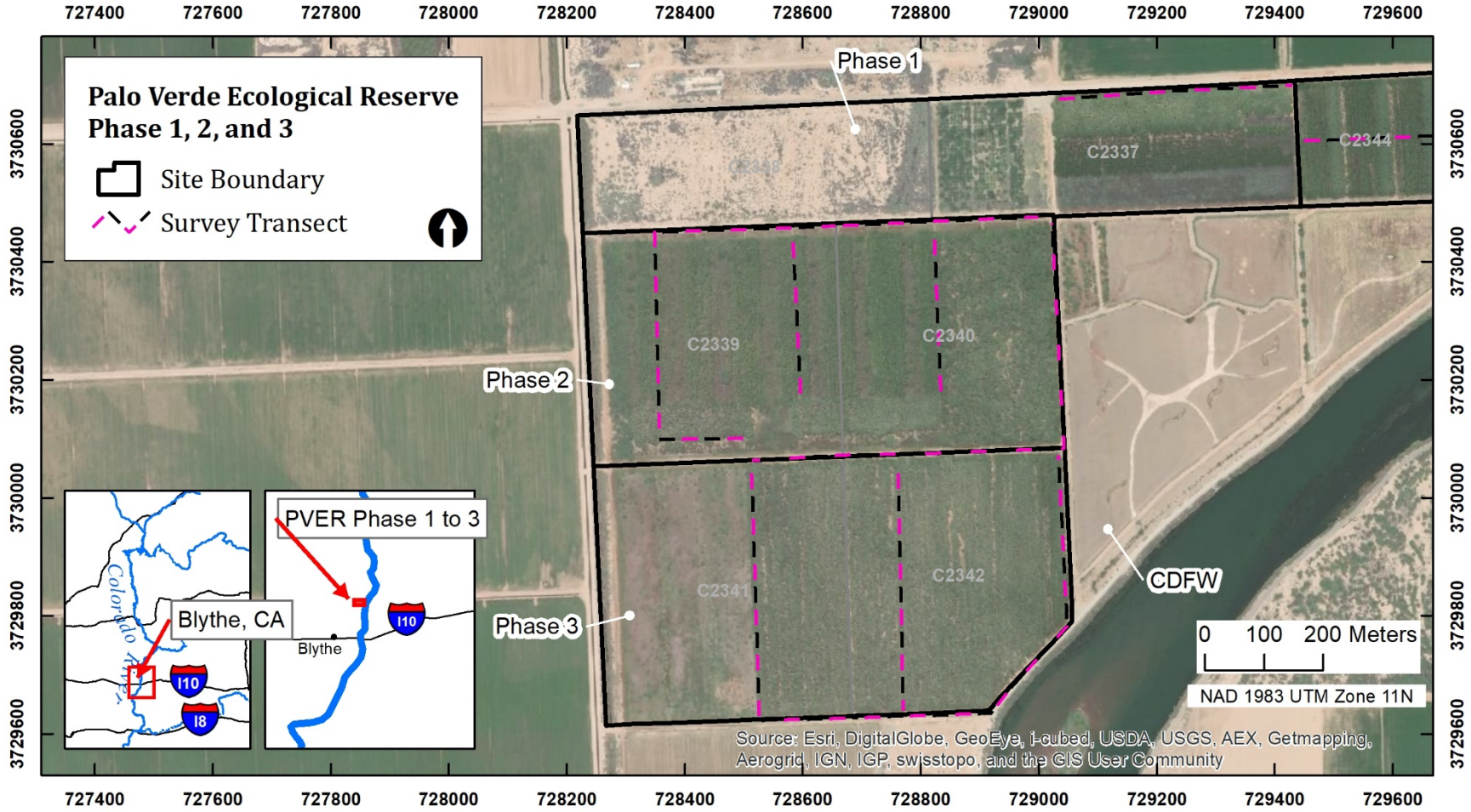

Figure 9.—PVER Phases 1, 2, and 3 YBCU survey sites and transects, 2018.

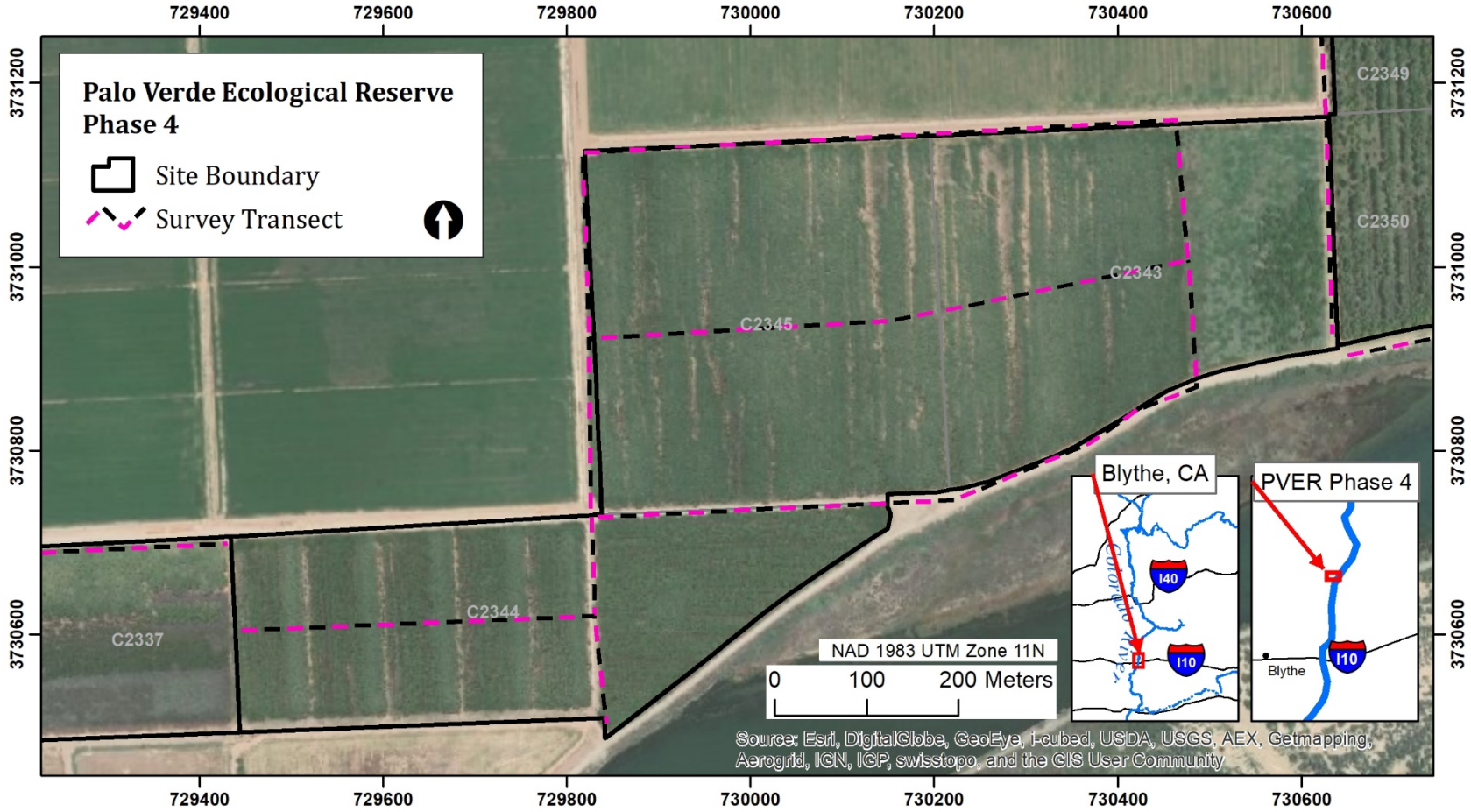

Figure 10.—PVER Phase 4 YBCU survey site and transects, 2018.

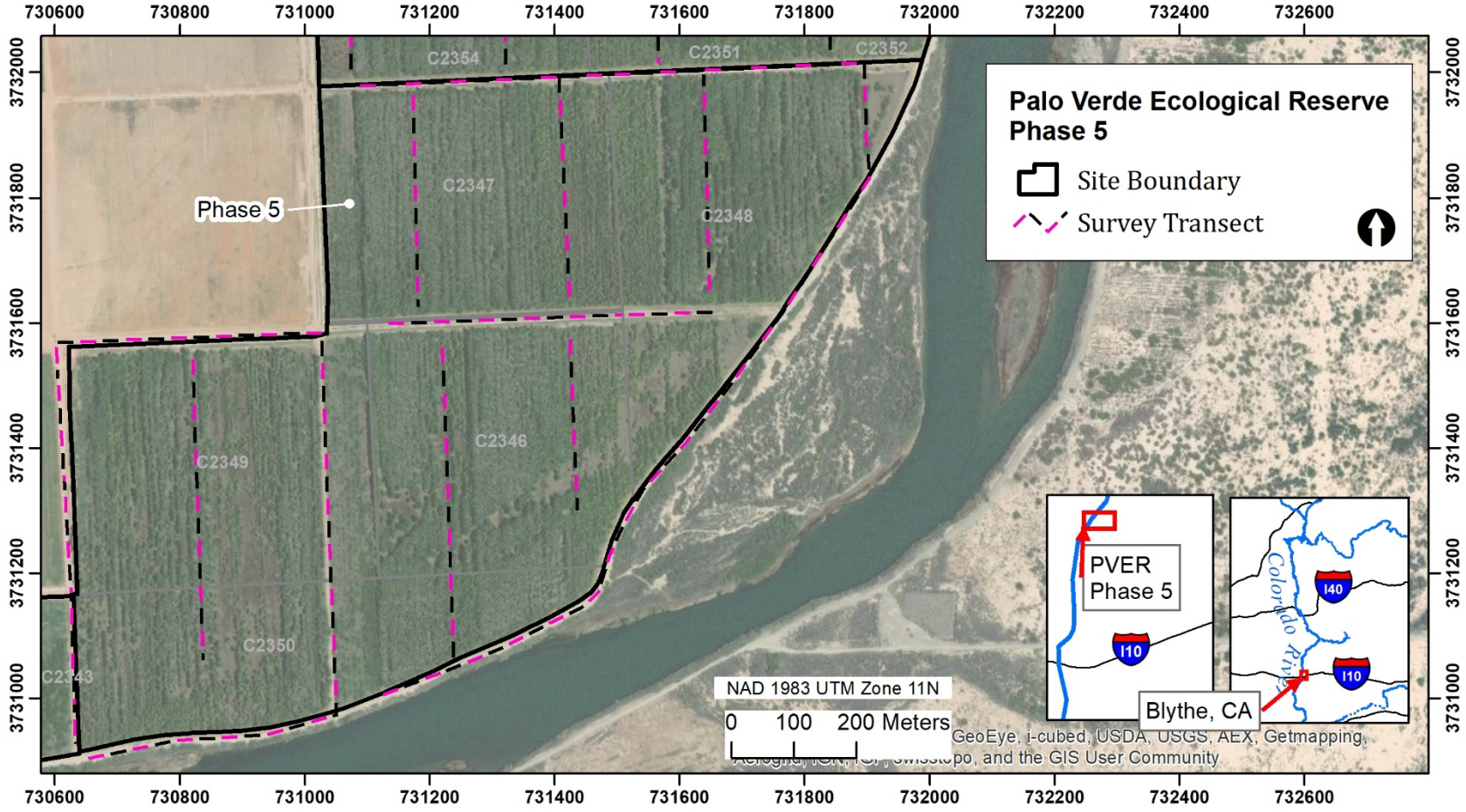

Figure 11.—PVER Phase 5 YBCU survey site and transects, 2018.

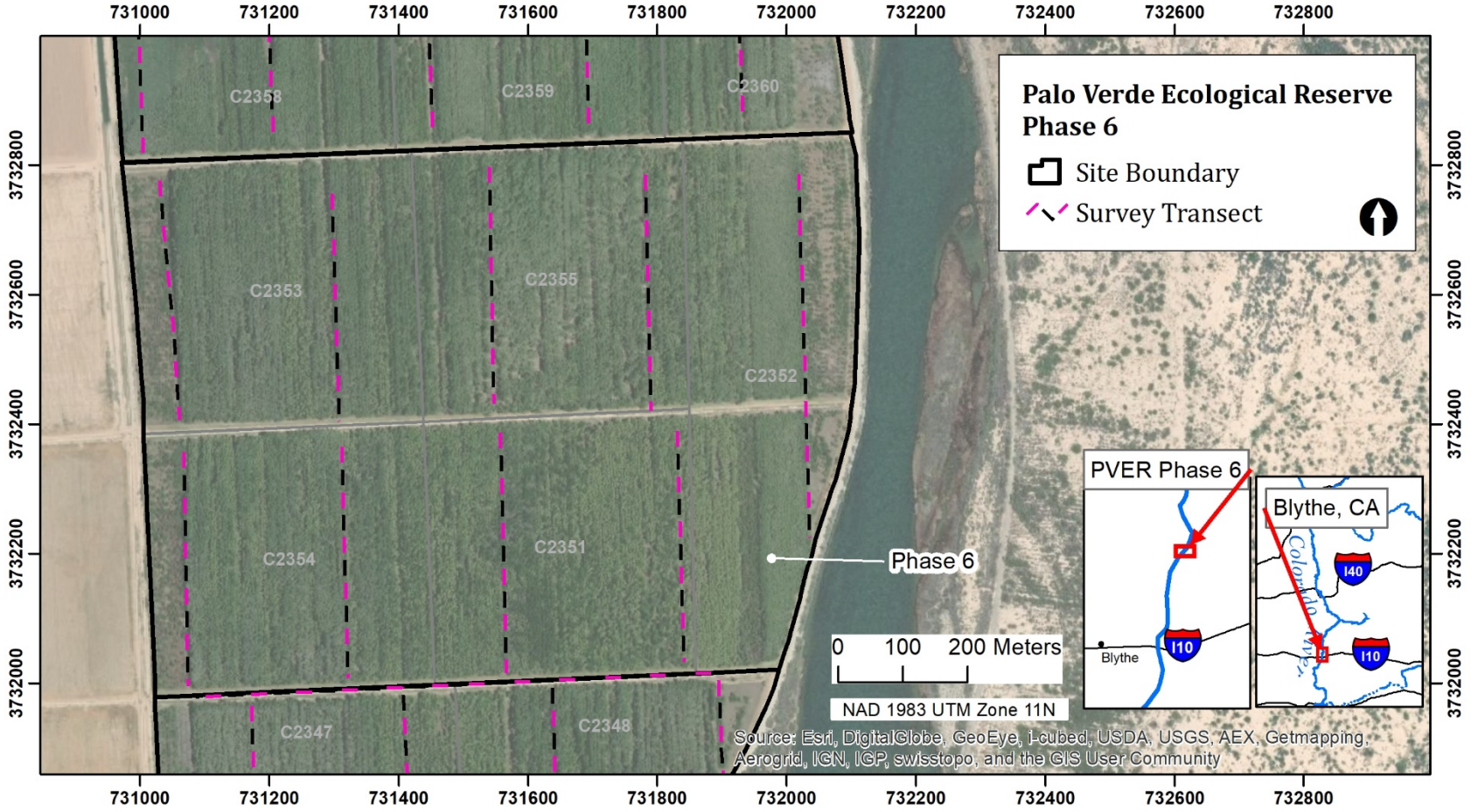

Figure 12.—PVER Phase 6 YBCU survey site and transects, 2018.

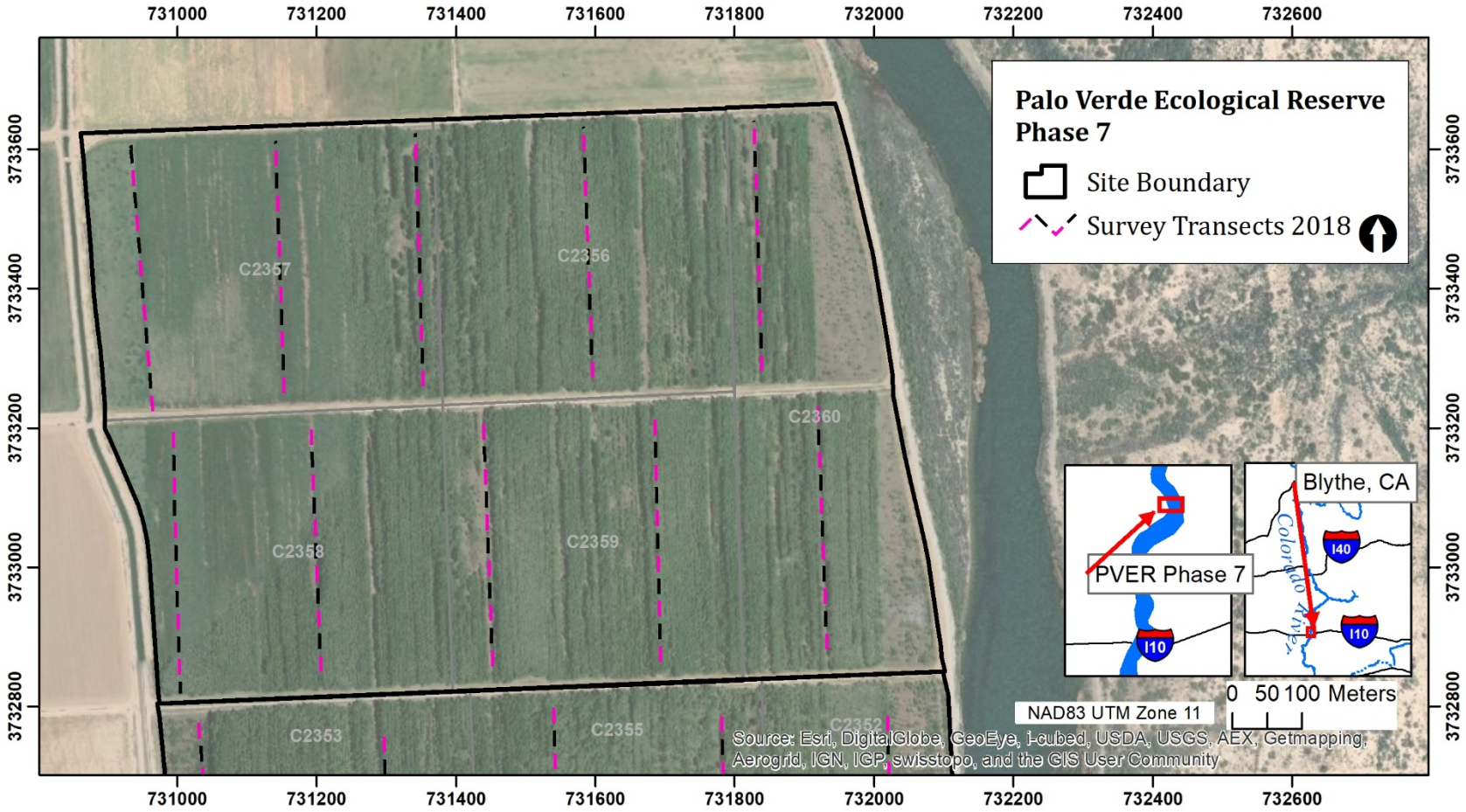

Figure 13.—PVER Phase 7 YBCU survey site and transects, 2018.

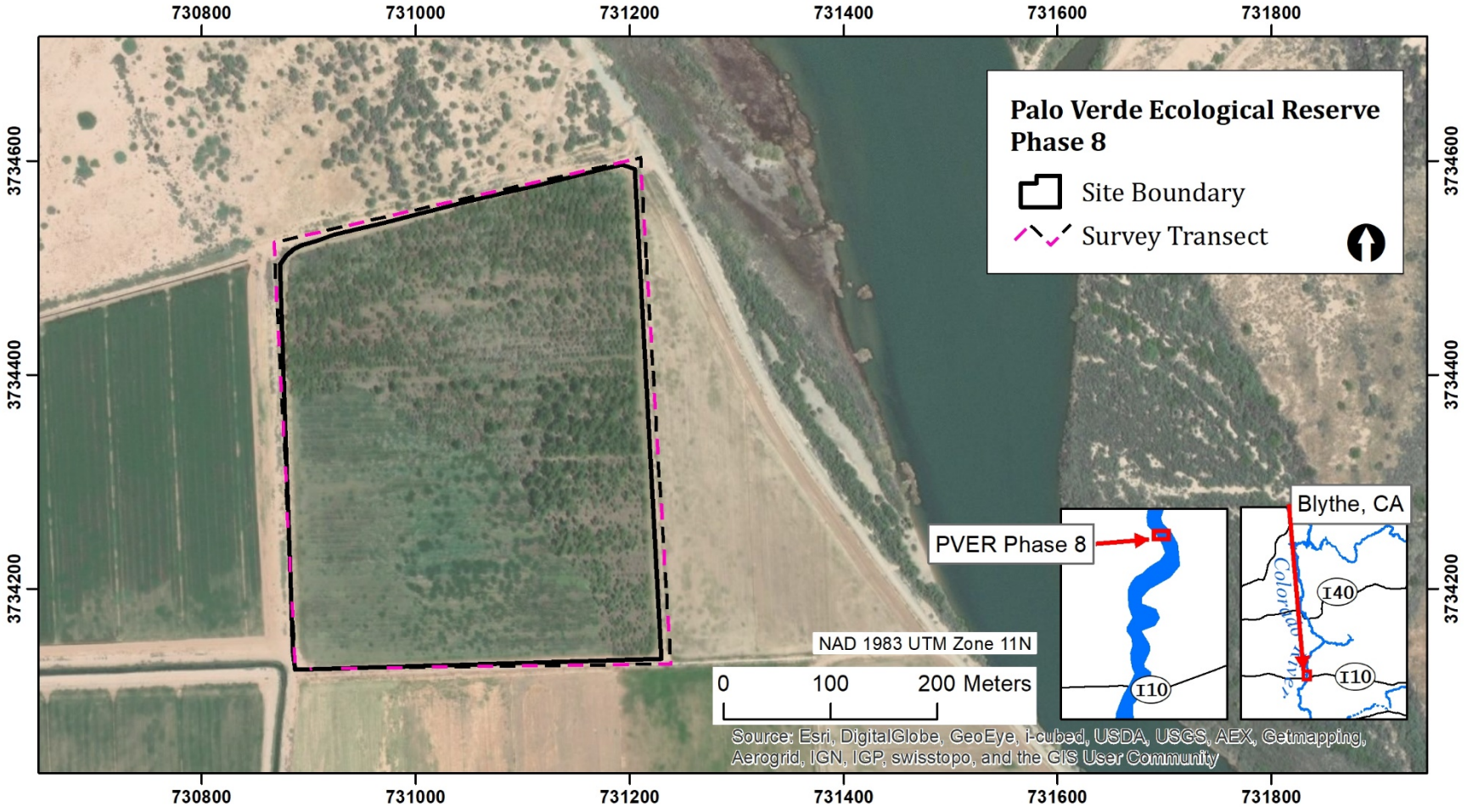

Figure 14.—PVER Phase 8 YBCU survey site and transects, 2018.

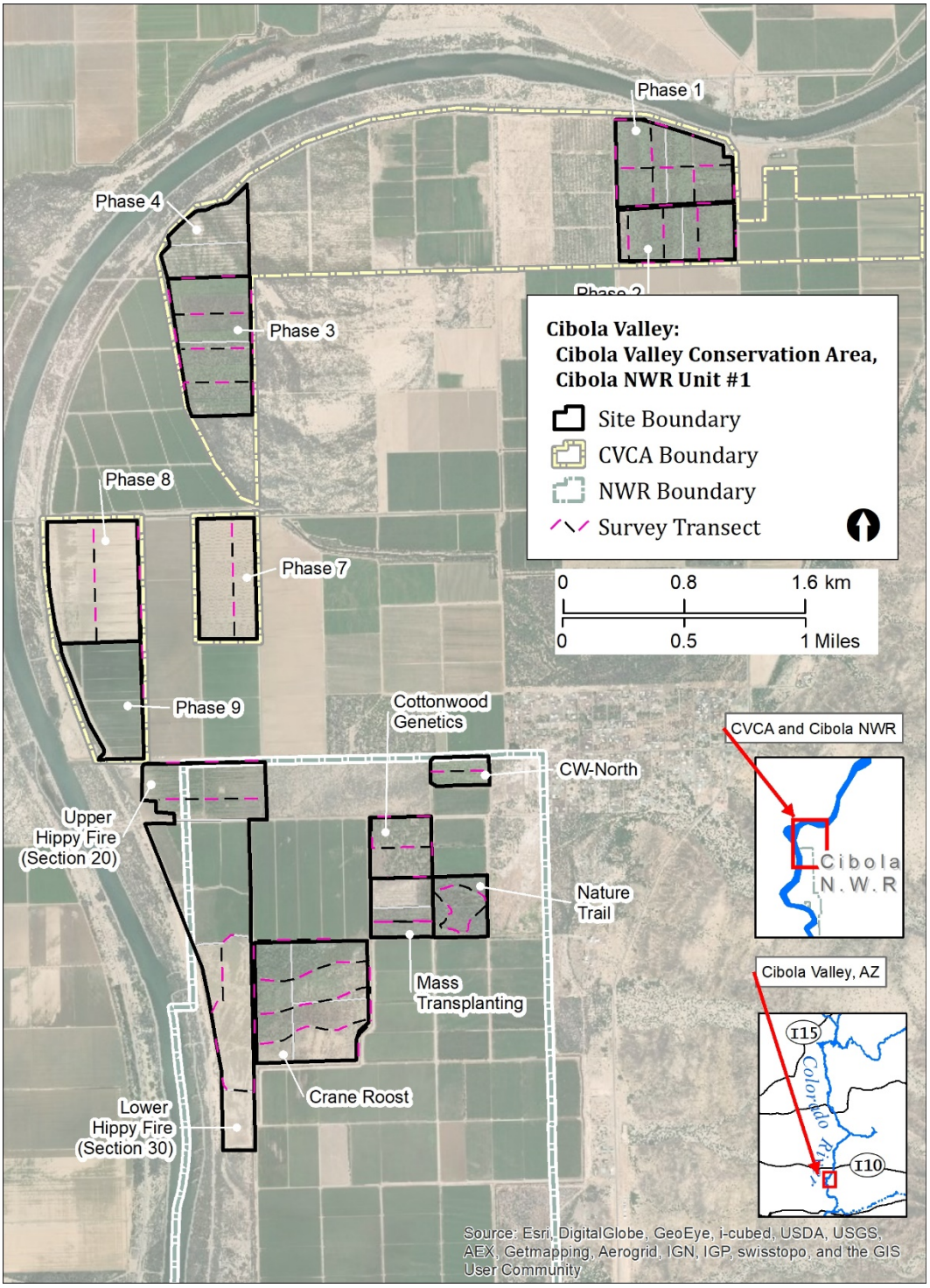

Figure 15.—Cibola Valley Conservation Area (CVCA) and Cibola NWR Unit #1 YBCU survey sites and transects, 2018.

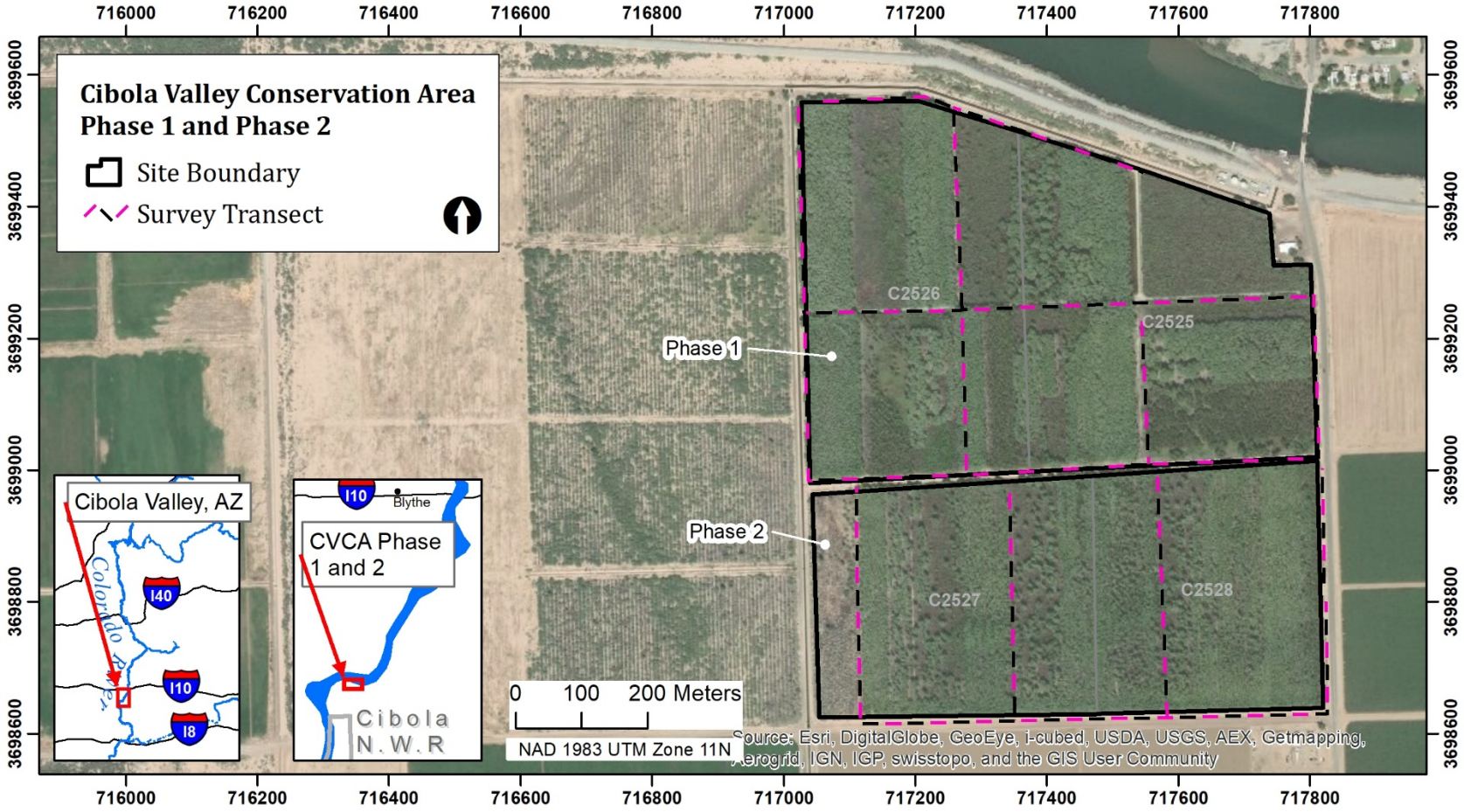

Figure 16.—CVCA Phases 1 and 2 YBCU survey sites and transects, 2018.

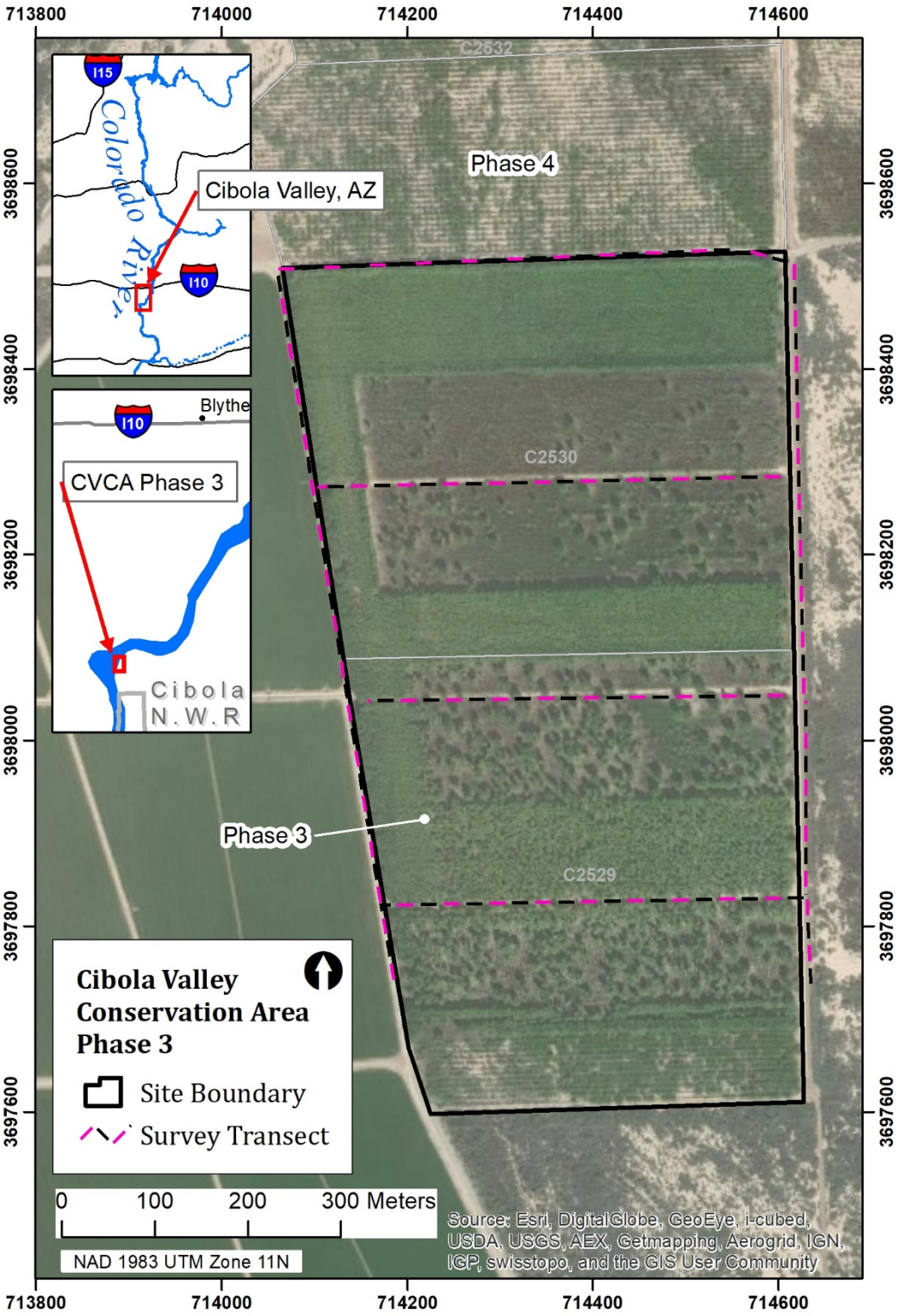

Figure 17.—CVCA Phase 3 YBCU survey site and transects, 2018.

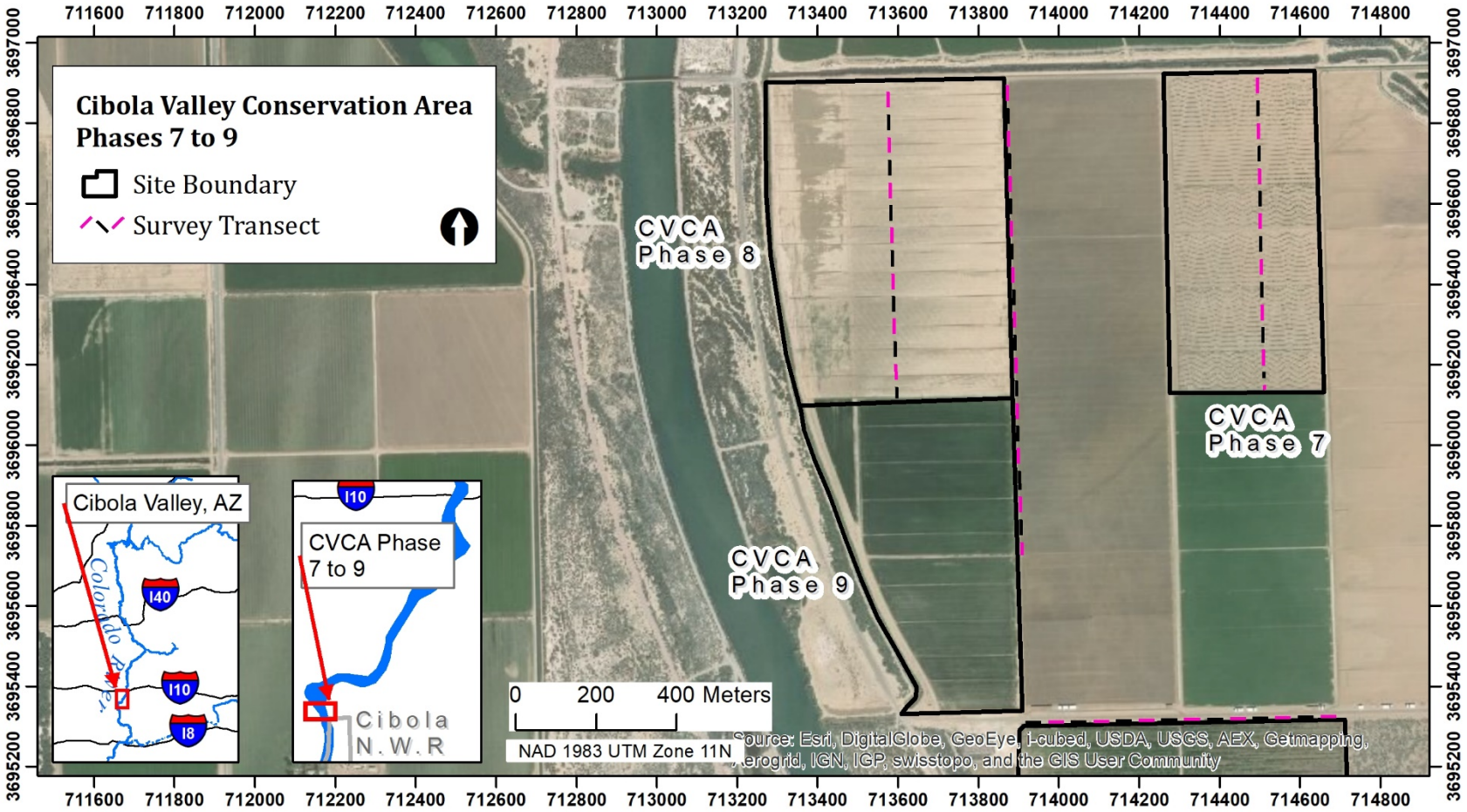

Figure 18.—CVCA Phases 7 to 9 YBCU survey sites and transects, 2018.

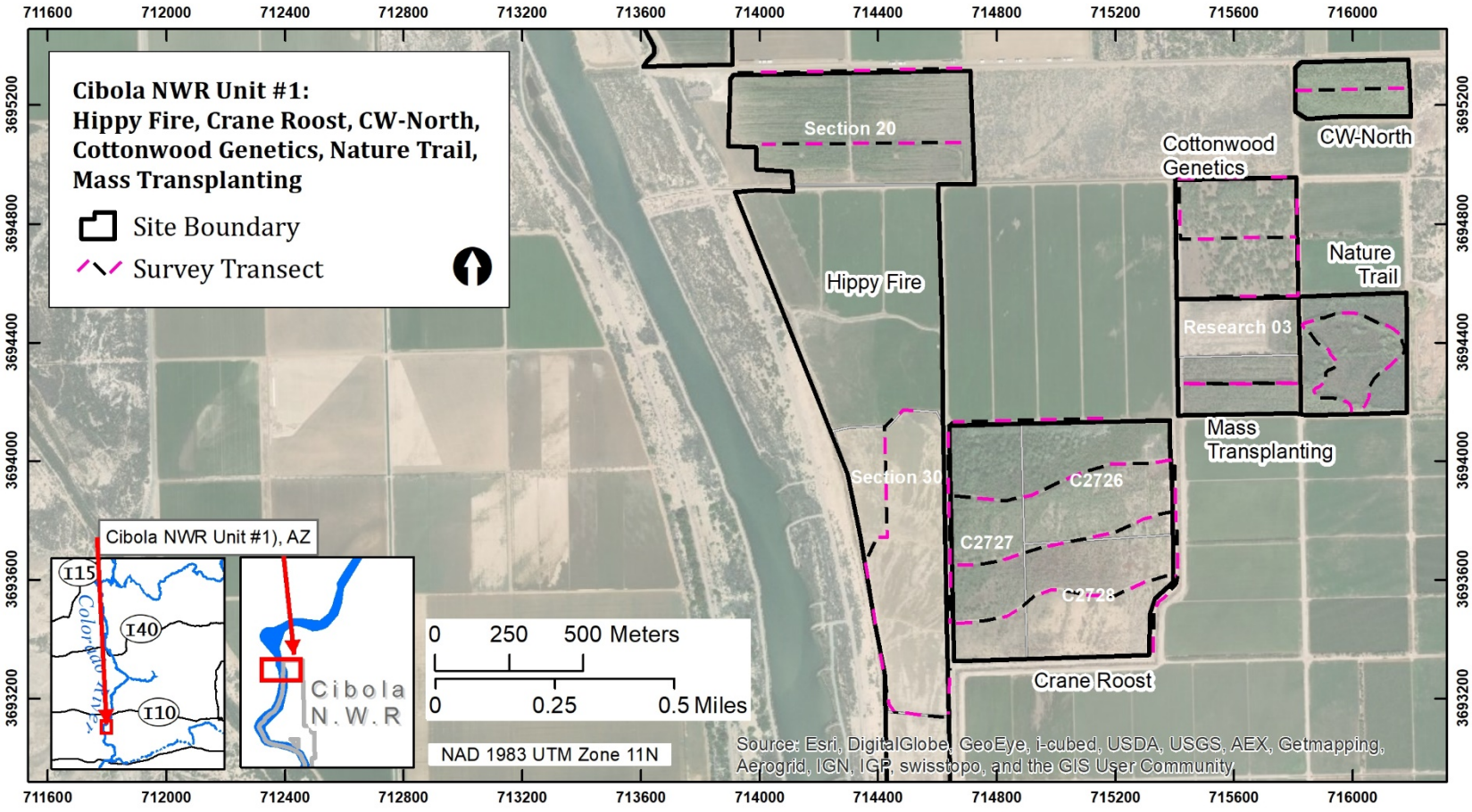

Figure 19.—Cibola NWR Unit #1 CW-North, Cottonwood Genetics, Mass Transplanting, Nature Trail, Hippy Fire, and Crane Roost YBCU survey sites and transects, 2018.

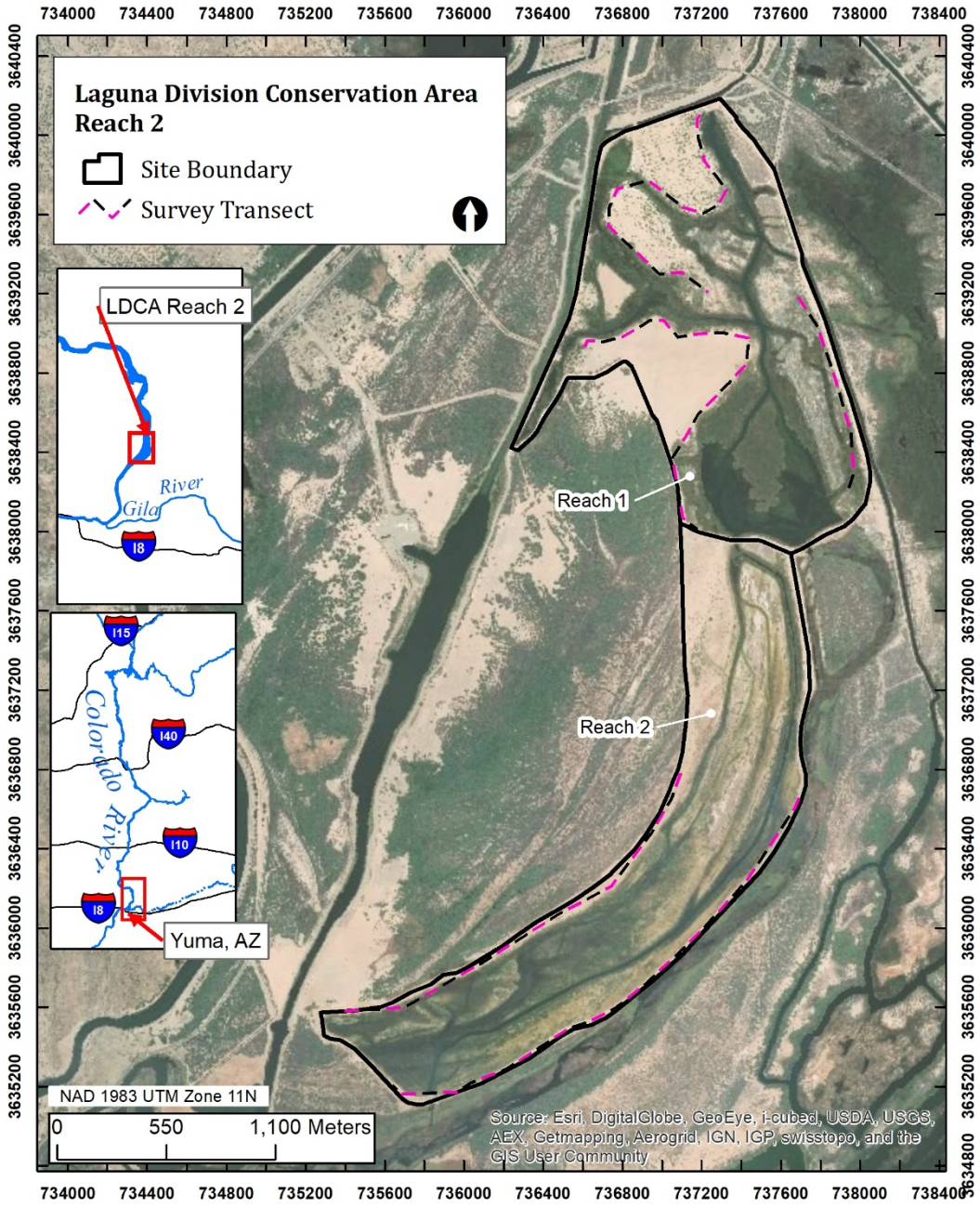

Figure 20.—Laguna Division Conservation Area Reach 1 and 2 YBCU survey sites and transects, 2018.

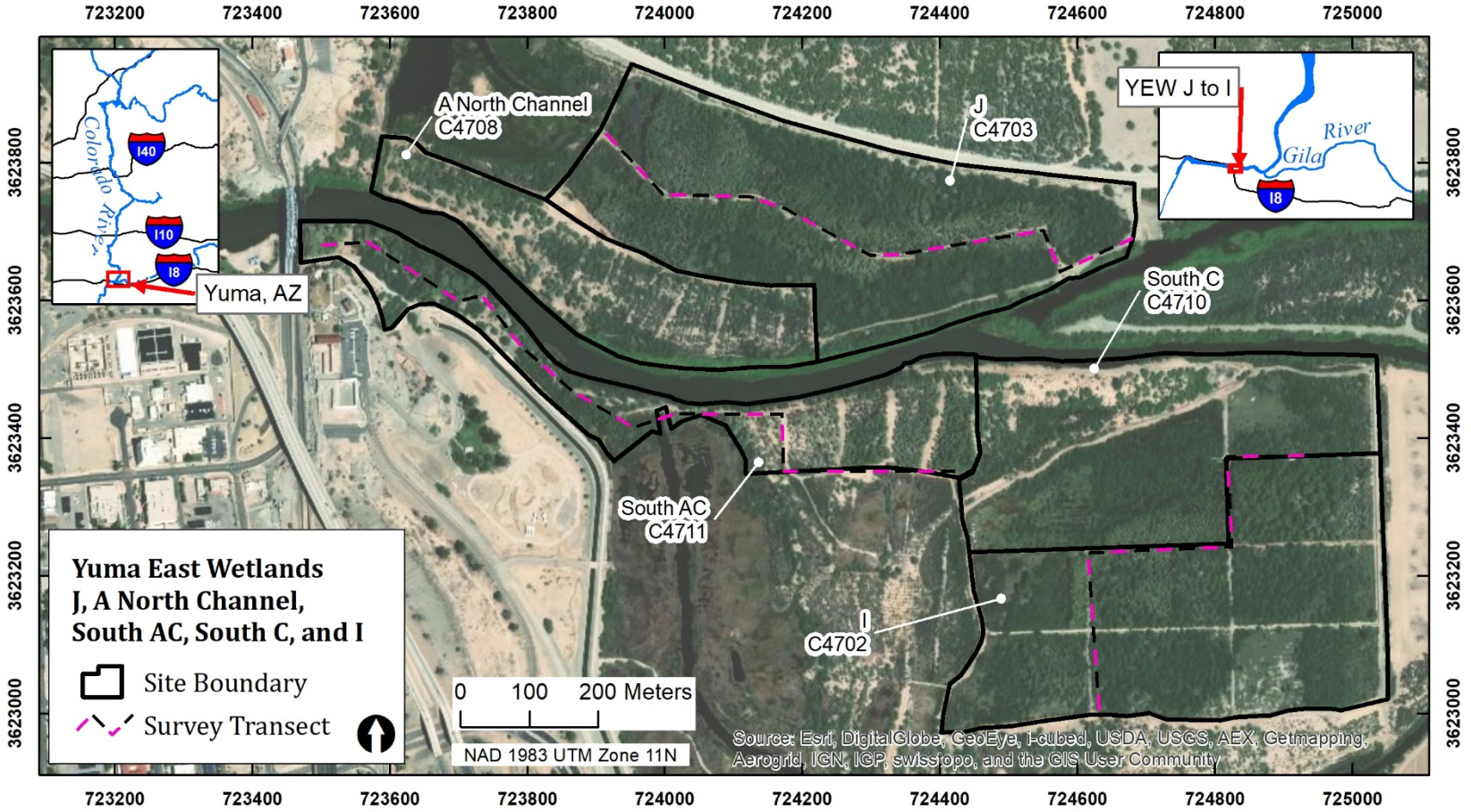

Figure 21.—Yuma East Wetlands J, A North Channel, South AC, South C, and I YBCU survey sites and transects, 2018.

ATTACHMENT 4

Yellow-billed Cuckoos (*Coccyzus americanus occidentalis*) Captured, Recaptured, or Resighted in the Lower Colorado River Multi-Species Conservation Program Study Area, 2014 to 2018

Table 4-1.–Yellow-billed cuckoos captured, recaptured, or resighted in the LCR MSCP study area, 2014-2018

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
HV	2015	BLCA	N	7/17	1352-59078	Lv-Ag-Lv/S	--	L	M	N	0
			N	7/17	1352-59077	lB-W-lB/S	--	L	F	N	0
			S	7/14	1222-90579	R/Ag-G-Ag	NIL	ASY	F	N	1
			S	7/23	1713-67912	Mg/Ag-R	KIM	A4Y	M	T	0
BW	2014	BEMW	N	7/9	1222-90549	lB-R/R	--	L	M	N	0
			N	7/9	1222-90550	lB-G/R	--	L	M	N	1
	2015	BEMW	N	7/24	1352-59093	V-lB/S	--	L	F	N	0
			N	7/24	1352-59092	Y-O-Y/S	--	L	M	N	0
PV	2014	PVP4	N	7/21	1222-90592	Bk-Ag/R	--	L	F	N	0
			N	7/21	1222-90593	lB-O-lB/R	--	L	M	N	0
		PVP5	N	6/23	1222-90517	R/Bk-W-Bk	LEC	AHY	M	N	0
			N	6/30	1222-90574	R/Bk-Y	CRU	AHY	M	T	1
			N	7/14	1222-90553	mB-R/R	RON	L	F	N	0
			N	7/14	1222-90552	mB-R-mB/R	SIE	L	F	N	1
			N	7/16	1222-90586	R/W-G	HAL	AHY	M	T	1
			N	7/18	1222-90588	R/O-G	BUL	AHY	F	T	0
		PVP6	N	5/30	1713-67933	R/lB-G-lB	SKE	AHY	M	N	0
			N	7/4	1222-90513	R/Bk-R-Bk	MOR	AHY	M	N	0
			N	7/17	1222-90587	R/R-mB	DST	AHY	M	T	0
			N	7/23	1222-90577	R/Lv-Bk-Lv	JBA	AHY	F	N	0
			N	7/24	1222-90597	lB-Bk/R	--	L	M	N	0
			N	7/24	1352-59015	Lv-Bk/R	--	L	F	N	0
			N	7/27	1352-59016	O-W/R	--	L	F	N	0
			N	7/28	1352-59022	Ag-Bk-Ag/R	--	L	F	N	0
			N	7/28	1352-59019	Lv-O-Lv/R	--	L	M	N	0
			N	7/28	1352-59021	Y-Y/R	--	L	F	N	0
			N	7/28	1352-59020	lB-mB-lB/R	--	L	M	N	0
			N	7/28	1352-59023	G-Ag-G/R	--	L	F	N	0
			N	7/28	1222-90580	R/lB	PUS	AHY	F	T	1
			N	7/28	1352-59017	Y-Lv-Y/R	TAC	L	M	N	1
			N	7/28	1352-59018	W-lB-W/R	TAM	L	F	N	1
			N	7/30	1352-59028	Bk-Ag-Bk/R	--	L	M	N	0
			N	7/30	1352-59030	lB-Y-lB/R	--	L	F	N	0
			N	7/30	1352-59029	O/R	ONY	L	F	N	1
			N	8/1	1222-90599	R/mB-W	DIC	AHY	M	T	0
			N	8/4	1352-59001	R/Ub[10]	JWZ	AHY	F	P	1
			N	8/5	1352-59002	R/O-mB	SMG	AHY	M	N	0
			N	8/11	1222-90583	R/W-Ag-W	PHD	AHY	F	T	0
			N	8/14	1352-59004	R/lB-Bk	MSO	AHY	M	T	1
			N	8/15	1352-59041	lB-R-lB/R	--	L	F	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2014	PVP6	N	8/15	1352-59042	Ag-lB-Ag/R	--	L	M	N	0
			N	8/19	1352-59043	R/mB-Ag	GOD	AHY	M	N	0
			N	8/31	1222-90584	G-Ag/R	--	L	U	N	0
			N	8/31	1352-59005	Ag-W/R	--	L	U	N	0
		PVP7	N	7/7	1222-90519	R/lB-O	FOX	AHY	F	T	0
			N	7/7	1222-90518	Y-W-Y/R	GAR	AHY	M	T	1
			N	7/8	1222-90520	R/Lv-Ag	VOL	AHY	M	T	0
			N	7/15	1222-90585	R/lB-Ag-lB	IVY	AHY	M	T	0
			N	7/28	1352-59024	Bk-O/R	--	L	M	N	0
			N	7/28	1352-59025	Ag-G-Ag/R	--	L	F	N	0
			N	7/28	1352-59026	G-mB-G/R	--	L	M	N	0
			N	7/28	1352-59027	G/R	KOZ	L	F	N	1
			N	7/29	1222-90581	R/Ub[10]	ELE	AHY	F	P	1
			N	7/30	1352-59031	Bk-Ag/R	--	L	M	N	0
			N	7/30	1222-90598	R/Bk-Y-Bk	BOR	AHY	M	T	0
			N	7/30	1222-90589	R/Ub	NAT	AHY	F	P	0
			N	8/6	1352-59003	R/lB-Y	STO	AHY	M	T	0
			N	8/6	1713-67937	R/G-R-G	VDR	AHY	M	T	0
			N	8/7	1222-90582	R/Ub	DUS	AHY	F	P	0
			N	8/8	1352-59044	Lv/R	--	L	M	T	0
			N	8/22	1713-67938	R/Ag-lB[10]	WWW	AHY	F	N	1
		PVP4	R	7/18	1202-68021	Mg/W-Bk	GMF	ATY	F	N	0
		PVP5	R	6/20	1212-13730	O W/Ag Bl	PF	A6Y	M	T	0
			R	6/30	1202-68014	lB-Bk-lB/Mg	SPM	SY	M	T	0
			R	7/16	1713-67926	Mg/O-lB	JTK	ASY	M	N	1
		PVP6	R	6/24	1713-67901	S/W-Lv[10]	SER	ASY	M	T	1
			S	7/17	1202-68048	O-lB/Mg	BGB	TY	M	N	0
			R	7/21	1202-68043	Lv-Y/Mg	HAG	SY	F	T	0
			R	7/30	1212-13752	Bl Ag/R G	AA	A5Y	M	T	0
			R	8/7	1202-68064	O-G/Mg	CHS	SY	F	T	0
			R	8/11	1222-90580	R/lB	PUS	AHY	F	P	1
		PVP7	R	7/17	1202-68018	Bk-G-Bk/Mg	JOF	SY	M	N	0
			R	8/6	1202-68043	Lv-Y/Mg	HAG	SY	F	TrP	0
			R	8/22	1352-59003	R/lB-Y	STO	AHY	M	TrP	0
	2015	PVP4	N	8/5	1352-59099	V-W-V/S	--	L	M	N	0
			N	8/6	1212-27505	O-Y-O/S	--	L	M	N	0
		PVP5	N	6/19	1713-67955	S/W-Ag	FLI	AHY	M	T	0
			N	6/30	1352-59050	S/lB-W	MRP	AHY	M	T	1
			N	7/6	1352-59056	S/mB-Y	CLE	AHY	F	T	0
			N	7/17	1352-59069	S/Bk-V	DUM	AHY	M	T	0
			N	7/31	1713-67949	S/Ub	BEL	AHY	F	P	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2015	PVP6	N	6/19	1713-67954	S/W-G-W	TAS	AHY	M	T	1
			N	7/13	1713-67947	S/V-O-V	MLS	AHY	F	T	0
			N	7/17	1352-59060	S/mB-lB	PIE	AHY	M	T	0
			N	7/18	1352-59080	Ag-mB/S	--	L	F	N	0
			N	7/18	1352-59084	Ag-W-Ag/S	--	L	F	N	0
			N	7/18	1352-59081	Ag-Lv-Ag/S	--	L	F	N	0
			N	7/18	1352-59083	Ag-lB/S	--	L	F	N	0
			N	7/27	1352-59096	mB-Ag-mB/S	--	L	M	N	0
			N	7/27	1352-59097	V-O-V/S	ZUN	L	M	N	1
			N	7/28	1713-67904	S/Ag-R-Ag	SNP	AHY	M	N	0
			N	8/3	1352-59072	S/Ub	PAT	AHY	F	P	0
			N	8/11	1212-27510	G-V-G/S	--	L	M	N	0
			N	9/10	1212-27513	Ub/S	--	L	F	N	0
		PVP7	N	6/22	1713-67956	S/R-W	TFU	AHY	M	T	0
			N	6/24	1352-59049	S/lB-R	DOR	AHY	M	T	0
			N	7/2	1352-59055	S/O-W	JKY	AHY	M	T	0
			N	7/3	1352-59052	S/Lv-Ag-Lv	FRL	AHY	M	T	1
			N	7/6	1352-59053	S/O-R	CHU	AHY	F	T	1
			N	7/9	1202-68072	O-R/Mg	--	L	F	N	0
			N	7/9	1202-68073	R-V/Mg	--	L	F	N	0
			N	7/9	1202-68075	V-W/Mg	HTO	L	F	N	1
			N	7/14	1352-59054	S/Ag-lB	TWK[8]	AHY	F	T	1
			N	7/18	1352-59085	Lv-Ag/S	--	L	F	N	0
			N	7/18	1352-59086	G-mB/S	ARI	L	F	N	1
			N	7/19	1352-59082	V-Y-V/S	ANT	L	M	N	1
			N	7/20	1352-59079	W-Lv-W/S	--	L	F	N	0
			N	7/20	1713-67958	S/Ag-Lv	GOG	AHY	F	T	0
			N	7/20	1352-59063	S/lB-mB	HOT	AHY	M	T	0
			N	7/21	1352-59070	S/R-O	AMS	AHY	F	T	0
			N	7/22	1352-59087	lB-mB/S	--	L	M	N	0
			N	7/22	1352-59089	S/lB-Lv	--	L	M	N	0
			N	7/26	1352-59095	lB-Lv-lB/S	--	L	M	N	0
			N	7/26	1352-59094	Y-R-Y/S	--	L	M	N	0
			N	7/28	1352-59098	mB-Ag/S	--	L	F	N	0
			N	7/28	1352-59100	lB-Ag-lB/S	--	L	M	N	0
			N	7/29	1713-67948	S/Bk-V-Bk	BRO	AHY	F	P	1
			N	7/29	1713-67959	S/lB-G	CHC	AHY	F	P	1
			N	7/29	1352-59062	S/V-Bk	STR	AHY	M	T	1
			N	7/30	1352-59071	S/Y-R	CHZ	AHY	M	T	0
			N	7/31	1352-59061	S/Y-lB	GOR	AHY	M	N	1
			N	8/4	1713-67950	S/Ub	PAN	AHY	M	P	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2015	PVP7	N	8/5	1713-67951	W-O/S	--	L	M	N	0
			N	8/5	1352-59074	W-mB/S	--	L	F	N	0
			N	8/5	1352-59073	S/R-V	BOO	AHY	F	T	1
			N	8/5	1713-67952	W-R/S	WHT	L	F	N	1
			N	8/7	1212-27507	V-lB-V/S	--	L	F	N	0
			N	8/7	1212-27506	lB-V-lB/S	RIP	L	F	N	1
			N	8/10	1212-27509	V-G-V/S	--	L	F	N	0
			N	8/10	1212-27508	lB-Ag/S	--	L	F	N	0
			N	8/20	1212-27512	V-R/S	--	L	M	N	0
		PVP2	S	7/13	1713-67906	S/Lv-O	GFK	A4Y	M	N	0
		PVP5	R	6/26	1713-67901	S/W-Lv[10]	SER	ATY	M	T	1
		PVP6	R	6/22	1713-67926	Mg/O-lB	JTK	ATY	M	N	0
			S	6/25	1713-67914	Mg/lB-mB-lB	LLL	A4Y	F	N	0
			R	6/29	1352-59017	Y-Lv-Y/R	TAC	SY	M	T	0
			R	7/9	1352-59029	O/R	ONY	SY	F	T	0
			R	7/28	1202-68016	G-Bk-G/Mg	PIS	TY	M	T	0
			R	8/7	1222-90580	R/lB	PUS	ASY	F	Pr	0
			R	8/15	1352-59029	O/R	ONY	SY	F	TrP	0
		PVP7	R	6/24	1222-90574	R/Bk-Y	CRU	ASY	M	T	1
			R	6/30	1352-59001	R/G-Ag-G	JWZ	ASY	F	PrT	0
			R	7/1	1222-90586	R/W-G	HAL	ASY	M	T	0
			R	7/24	1222-90581	R/V	ELE	ASY	F	Pr	1
			R	8/17	1713-67938	R/Ub[10]	WWW	ASY	F	P	1
	2016	PVP4	N	7/14	1212-27526	S/V-Y	--	L	F	N	0
			N	7/14	1212-27525	mB-O/S	SHA	L	M	N	0
			N	7/27	1352-59011	R-O-R/R	--	L	F	N	0
			N	7/27	1352-59010	R-O/R	--	L	M	N	0
			N	7/28	1212-27535	Y-V-Y/S	--	L	F	N	0
			N	7/28	1212-27542	O-V-O/S	BAT	L	F	N	1
		PVP5	N	6/14	1713-67932	R/V-Bk-V	COC	AHY	M	N	0
			N	7/28	1713-67978	S/W-lB-W	FUJ	AHY	M	N	0
			N	7/28	1713-67979	S/W-O	TRE	AHY	F	N	0
			N	7/29	1212-27541	V-Bk-V/S	--	L	F	N	0
			N	7/29	1212-27540	V-R-V/S	--	L	F	N	0
			N	8/8	1212-27514	Bk-mB/S	--	L	F	N	0
			N	8/8	1713-67982	S/G-Ag	DRK	AHY	F	N	0
			N	8/8	1713-67984	S/G-W	FRE	AHY	M	N	0
			N	8/10	1352-59068	lB-R-lB/S	--	L	M	N	0
			N	8/10	1212-27516	G-lB-G/S	--	L	M	N	0
			N	8/10	1212-27515	G-mB-G/S	--	L	M	N	0
			N	8/10	1713-67985	S/Bk-Ag	SAJ	AHY	F	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2016	PVP6	N	6/10	1713-67928	Ub /O-Lv-O[10]	ASC	AHY	F	N	0
			N	6/16	1713-67934	R/lB-V-lB	KIL	AHY	M	N	1
			N	7/1	1352-59045	W-Bk/R	SHT	AHY	M	N	0
			N	7/3	1713-67940	R/W-O-W	CHA	AHY	M	N	0
			N	7/8	1212-27524	S/V-O	LIL	AHY	M	N	0
			N	7/9	1352-59038	V/R	--	L	M	N	0
			N	7/10	1352-59037	R/O-V	ACO	AHY	F	N	1
			N	7/10	1352-59035	R/W-R	HUP	AHY	F	N	1
			N	7/11	1352-59036	R/Y-G	KAT	AHY	F	N	0
			N	7/13	1713-67946	R/Ag-W	LYM	AHY	F	N	0
			N	7/14	1713-67964	S/R-V-R	DAR	AHY	M	N	0
			N	7/15	1212-27520	V-G/S	--	L	M	N	0
			N	7/19	1212-27530	Bk-V/S	--	L	M	N	0
			N	7/19	1212-27531	Bk-V-Bk/S	CHM	L	M	N	0
			N	7/27	1212-27539	V-Bk/S	--	L	F	N	0
			N	7/27	1713-67976	S/V-G-V	BAL	AHY	M	N	0
			N	7/27	1713-67977	S/lB-Bk-lB	TET	AHY	F	N	1
			N	8/12	1212-27517	S/Ag-Bk-Ag	QUI	AHY	M	N	0
		PVP7	N	6/2	1713-67960	S/G	PAY	AHY	F	N	0
			N	6/9	1352-59066	S/Lv-Bk	VES	AHY	M	N	1
			N	6/11	1713-67927	R/Y-O-Y	DOO	AHY	M	N	1
			N	6/13	1352-59006	R/V-lB	CHI	AHY	F	N	0
			N	6/14	1713-67961	S/G-V-G	OLI	AHY	M	N	0
			N	6/20	1713-67962	S/O-R-O	KEA	AHY	F	N	0
			N	6/20	1352-59014	V-lB/R	LOA	AHY	M	N	0
			N	6/21	1713-67943	R/O-Y-O	RED	AHY	F	N	0
			N	6/22	1713-67939	R/Ag-mB	ALU	AHY	F	N	1
			N	6/28	1713-67944	R/O-V-O	KOF	AHY	F	N	1
			N	7/1	1713-67963	S/R-O-R	PEN	AHY	M	N	1
			N	7/8	1713-67935	mB-Lv-mB/R	--	L	F	N	0
			N	7/8	1352-59048	W-V/R	--	L	F	N	0
			N	7/9	1352-59047	W-Ag/R	--	L	M	N	0
			N	7/9	1352-59034	R-W/R	IRO	L	F	N	1
			N	7/12	1713-67945	R/Bk-O	HUM	AHY	M	N	0
			N	7/20	1212-27532	G-V /S	BRK	L	F	N	0
			N	7/20	1212-27533	G-lB/S	DOT	L	F	N	1
			N	7/22	1713-67971	O-lB-O/S	--	L	F	N	0
			N	7/24	1212-27536	Ub/S	--	L	M	N	0
			N	7/24	1212-27537	Y-V/S	--	L	F	N	0
			N	7/24	1212-27538	Ub/S	--	L	F	N	0
			N	7/24	1212-27534	Lv-lB/S	--	L	M	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2016	PVP7	N	8/2	1713-67981	S/V-G	ANA	AHY	F	N	1
			N	8/2	1713-67980	S/Y-Ag	KAL	AHY	F	N	1
			N	8/5	1713-67929	R/W-V-W	SIT	AHY	F	N	0
			N	8/8	1713-67930	R/Ag-lB-Ag	LAS	AHY	F	N	0
			N	8/13	1713-67931	R/Bk-Ag-Bk	PAW	AHY	F	N	1
			N	8/13	1713-67972	S/G-O	PER	AHY	F	N	1
			N	8/14	1212-27527	S/mB-O	LEM	HY	F	N	0
			N	8/23	1212-27519	S/R-lB-R	NIP	AHY	F	N	1
		PVP5	R	6/14	1713-67954	S/W-G-W	TAS	ASY	M	N	1
			R	7/4	1352-59053	S/O-R	CHU	ASY	F	N	1
			S	7/9	1202-68003	Mg/Bk-Lv-Bk	FMF	A5Y	M	N	0
			R	7/17	1352-59073	S/R-V	BOO	ASY	F	N	1
			R	7/18	1713-67901	S/W-Lv-W[11]	SER	A4Y	M	N	1
			R	8/10	1713-67903	S/Y-Lv	LEA	A4Y	F	N	1
			R	8/15	1222-90579	R/Ag-G-Ag	NIL	ATY	F	N	0
		PVP6	R	6/16	1352-59082	V-Y-V/S	ANT	SY	M	N	1
			R	6/23	1202-68065	W-Y/Mg	RIN	4Y	F	N	0
			R	6/23	1352-59058	S/mB-R	SAL	ASY	F	N	0
			S	6/24	1222-90518	Y-W-Y/R	GAR	ATY	M	N	0
			R	7/1	1202-68075	V-W/Mg	HTO	SY	F	N	1
			R	7/2	1713-67902	S/Y-Lv-Y	WAN	A4Y	F	N	1
			R	7/3	1352-59086	G-mB/S	ARI	SY	F	N	0
			R	7/8	1352-59027	G/R	KOZ	TY	F	N	0
			R	7/16	1352-59004	R/lB-Bk	MSO	ATY	M	N	0
			R	7/22	1352-59029	O/R	ONY	TY	F	Pr	0
			R	7/25	1713-67952	W-R/S	WHT	SY	F	N	1
			R	8/12	1713-67959	S/lB-G	CHC	ASY	F	Pl	1
		PVP7	R	6/29	1212-27506	lB-V-lB/S	RIP	SY	F	N	1
			R	7/11	1713-67938	R/Bk-Ag[11]	WWW	ATY	F	Pr	0
			R	7/15	1352-59052	S/Lv-Ag-Lv	FRL	ASY	M	N	1
			R	7/18	1222-90574	R/Bk-Y	CRU	ATY	M	N	1
			S	7/21	1222-90552	mB-R-mB/R	SIE	TY	F	N	1
			R	7/22	1352-59061	S/Y-lB	GOR	ASY	M	N	0
			R	7/22	1713-67928	R/Y-R-Y[11]	ASC	AHY	F	N	0
			R	8/5	1222-90581	R/V	ELE	ATY	F	N	0
	2017	PVP3	N	8/2	1352-59064	Ag-G/S	--	L	F	N	0
			N	8/2	1352-59065	lB-Bk/S	--	L	F	N	0
			N	8/2	1352-59075	lB-Y/S	--	L	F	N	0
		PVP5	N	8/3	1212-27521	O-G-O/S	--	L	M	N	0
			N	8/3	1212-27522	R-G-R/S	--	L	F	N	0
			N	8/3	1212-27523	Bk-W/S	--	L	M	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2017	PVP6	N	8/5	1352-59076	mB-Bk-mB/S	DAE	L	F	N	1
			N	8/5	1713-67965	S/mB-Lv	PIC	AHY	F	N	0
		PVP7	N	7/31	1713-67909	S/Ag-Y	VBO	AHY	F	N	0
			N	8/1	1713-67910	S/R-Lv	ARC	AHY	F	N	1
			N	8/1	1713-67941	R/mB-Lv	HOR	AHY	F	N	0
			N	8/3	1212-27528	mB-Y-mB/S	--	L	U	N	0
			N	8/3	1212-27529	Bk-Lv-Bk/S	--	L	F	N	0
		PVP5	S	7/29	1212-27519	S/R-lB-R	NIP	ATY	F	N	1
			S	8/1	1352-59053	S/O-R	CHU	ATY	F	N	0
		PVP6	S	6/19	1713-67902	S/Y-Lv-Y	WAN	A5Y	F	N	0
			S	7/7	1352-59082	V-Y-V/S	ANT	TY	M	N	1
			S	7/7	1212-27533	G-lB/S	DOT	SY	F	N	0
			S	7/9	1202-68075	V-W/Mg	HTO	TY	F	N	0
			S	7/9	1713-67934	R/lB-V-lB	KIL	ASY	M	N	0
			S	7/16	1352-59034	R-W/R	IRO	SY	F	N	1
			S	7/25	1352-59052	S/Lv-Ag-Lv	FRL	ATY	M	N	0
			S	7/25	1713-67972	S/G-O	PER	ASY	F	N	0
			S	7/25	1713-67977	S/lB-Bk-lB	TET	ASY	F	N	0
			S	7/31	1713-67931	R/Bk-Ag-Bk	PAW	ASY	F	N	0
			S	8/1	1713-67954	S/W-G-W	TAS	ATY	M	N	1
		PVP7	S	6/16	1222-90574	R/Bk-Y	CRU	A4Y	M	N	0
			S	6/29	1352-59033	W-Ag-W/R	DEV	4Y	F	N	1
			S	7/1	1212-27506	lB-V-lB/S	RIP	TY	F	N	1
			S	7/1	1713-67952	W-R/S	WHT	TY	F	N	0
			S	7/7	1713-67963	S/R-O-R	PEN	ASY	M	N	1
			S	7/24	1352-59062	S/V-Bk	STR	ATY	M	N	0
			R	7/31	1352-59073	S/R-V	BOO	ATY	F	N	0
			R	7/31	1713-67948	S/Bk-V-Bk	BRO	AHY	F	Pr	0
			S	8/5	1713-67959	S/lB-G	CHC	ATY	F	N	0
	2018	PVP6	N	8/7	1713-67966	S/G-lB-G	NAL	AHY	F		0
			N	8/7	1212-27555	S/V-W-V	SIM	AHY	M		0
		PVP1	S	7/5	1352-59097	V-O-V/S	ZUN	4Y	M	N	0
		PVP6	S	6/12	1713-67903	S/Y-Lv	LEA	A6Y	F	N	0
			S	6/20	1352-59066	S/Lv-Bk	VES	ATY	M	N	0
			S	6/29	1713-67901	S/W-Lv-W	SER	A6Y	M	N	0
			S	7/2	1222-90552	mB-R-mB/R	SIE	5Y	F	N	0
			S	7/2	1713-67954	S/W-G-W	TAS	A4Y	M	N	0
			S	7/11	1713-67963	S/R-O-R	PEN	ATY	M	N	0
			S	7/28	1352-59076	mB-Bk-mB/S	DAE	SY	F	N	0
			S	7/29	1212-27519	S/R-lB-R	NIP	ATY	F	N	0
		PVP7	S	6/12	1352-59033	W-Ag-W/R	DEV	5Y	F	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
PV	2018	PVP7	S	6/17	1352-59082	V-Y-V/S	ANT	4Y	M	N	0
			S	6/20	1352-59034	R-W/R	IRO	TY	F	N	0
			S	6/26	1352-59018	W-lB-W/R	TAM	5Y	F	N	0
			S	6/30	1713-67981	S/V-G	ANA	ATY	F	N	0
			S	7/3	1713-67910	S/R-Lv	ARC	ASY	F	N	0
			S	7/11	1352-59050	S/lB-W	MRP	A4Y	M	N	0
			S	7/16	1212-27506	lB-V-lB/S	RIP	4Y	F	N	0
			S	7/29	1352-59037	R/O-V	ACO	ATY	F	N	0
CV	2014	CVP1	N	7/1	1222-90575	R/R-Bk-R	DBL	AHY	F	T	0
			N	7/3	1222-90576	R/R-mB-R	URS	AHY	F	T	0
		CVP2	N	8/1	1352-59032	lB/R	--	L	F	N	0
			N	8/1	1352-59033	W-Ag-W/R	DEV	L	F	N	1
			N	8/4	1352-59040	R/R-mB	GWB	AHY	M	N	0
	2017	CVP1	S	7/11	1212-27542	O-V-O/S	BAT	SY	F	N	0
CN	2014	CNCR	N	7/12	1222-90551	G-Y-G/R	--	L	F	N	0
			N	7/17	1222-90590	R-G/R	--	L	F	N	0
			N	7/17	1222-90591	Ag-G/R	--	L	M	N	0
			N	7/17	1222-90554	lB-G-lB/R	--	L	M	N	0
			N	7/21	1713-67936	R/Ag-W-Ag	FRK	AHY	M	T	0
			N	7/23	1222-90595	Ag-R-Ag/R	--	L	F	N	0
			N	7/23	1222-90596	Lv-W/R	--	L	F	N	0
			N	7/23	1222-90594	mB-G/R	ORE	L	M	N	1
			N	7/24	1222-90579	R/Ag-G-Ag	NIL	AHY	F	T	1
		CNNT	N	6/25	9999-99999	Ub/Bk-lB-Bk	RUM	AHY	M	N	0
		CNCR	R	7/1	1713-67911	Mg/Lv-G	SMA	ATY	M	T	0
	2015	CNCR	N	6/17	1713-67953	S/W-lB	SCB	AHY	M	T	0
			N	6/23	1713-67957	S/Ag-Lv-Ag	CHE	AHY	M	T	0
			N	7/2	1352-59051	S/V-R	CHP	AHY	F	T	0
			N	7/7	1352-59057	S/lB-W	PEA	AHY	U	N	0
			N	7/13	1352-59059	S/Lv-lB	POP	AHY	F	T	0
			N	7/13	1352-59058	S/mB-R	SAL	AHY	F	T	1
			N	7/23	1352-59090	S/O-R-O	--	L	F	N	0
			N	7/23	1352-59091	V-O [10]/S [10]	--	L	F	N	0
			N	7/23	1352-59088	R-V-R/S	JJR	L	F	N	1
			N	8/13	1212-27511	W-V-W/S	--	L	M	N	0
			R	7/7	1222-90594	mB-G/R	ORE	SY	M	N	1
			R	6/25	1212-13725	lB-V/Ag[11]	JER	8Y	M	T	0
	2016	CNCR	N	7/2	1352-59046	Ag-Y/R	--	L	M	N	0
			N	7/2	1352-59039	Y-Ag/R	--	L	F	N	0
			N	7/2	1352-59013	V-O/R	--	L	M	N	0
			N	7/2	1352-59012	Y-V/R	--	L	M	N	0

Area[1]	Year	Site code	Band code[2]	Date	Band #	Color bands[3]	Bird ID[4]	Age[5]	Sex[6]	Att[7]	RS[8]
CN	2016	CNCR	N	7/26	1352-59007	Y-R/R	--	L	M	N	0
			N	7/26	1352-59009	mB-lB/R	--	L	F	N	0
			N	7/26	1352-59008	Lv-lB-Lv/R	--	L	F	N	0
			N	8/5	1212-27543	mB-G/S	--	L	F	N	0
			N	8/5	1212-27544	mB-G-mB/S	--	L	M	N	0
			N	8/5	1352-59067	mB-O-mB/S	--	L	M	N	0
			S	7/5	1352-59088	R-V-R/S	JJR	SY	F	N	0
			S	8/1	1222-90594	mB-G/R	ORE	TY	M	N	1
	2017	CNCR	S	6/28	1212-13740	W Ag/Bl O	RP	A8Y	M	N	0
		CNHF	S	7/13	1222-90594	mB-G/R	ORE	4Y	M	N	0
	2015	NA	X[8]	8/5	1352-59054	S/Ag-lB	TWK	AHY	F	U	0

[1] Area: HV=Havasu NWR, BW=Bill Williams River NWR, PV=PVER, CV=CVCA, CN=Cibola NWR, CH=Chino Valley
[2] Band code: N=new capture, R=recapture, RA=recapture, band added, Rm = same-year recapture, attachment added, S=resight, X=reported found dead
[3] Color bands (left to right, top to bottom): Ag = gold, Bk = black, G = green, lB = light blue, Lv = lavender, mB = mid blue, O = orange, R = red, S = silver, V = violet, Ub=no bandW = white, Y = yellow. A hyphen (-) indicates a split band consisting of two or three color stripes
[4] Bird ID: unique two-to-three-character identifier of the individual YBCU
[5] Age: AHY=after hatching year, ASY=after 2nd year, ATY=after 3rd year, A4Y=after 4th year, A6Y=after 6th year, L=young (locally hatched) SY=2nd year, TY=3rd year, 4Y=4th year, 5Y=5th year
[6] Sex (confirmed by DNA test): F = female, M = male, U=not sexed
[7] Attachment: N=none, T=transmitter, Tr=transmitter removed, P=Pinpoint GPS attached, Pr=Pinpoint GPS removed, U=unknown
[8] RS: Recapture or resight: Was recaptured or resighted during a subsequent year, 1=yes, 0=no
[9] YBCU 'TWK' captured PVER July 14 2015, reported found dead in Chino Valley, AZ Aug 4 2015
[10] Band changed on a subsequent recapture
[11] Band added

ATTACHMENT 5

Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Nests Found in the Lower Colorado River Multi-Species Conservation Program Study Area, 2014 to 2018

Table 5-1.–Yellow-billed cuckoo nests found in the LCR MSCP study area, 2014-2018

Area	Year	Site code	Nest #	TreeSp[1]	Adult 1[2]	Adult 2[2]	Date found
BLCA	2015	BLCA	1	PROGLA	KIM	Uk	7/14
BWR East	2014	BEMW	1	TAMARI	Ub	Ub	7/4
			2	TAMARI	Ub	Ub	8/15
	2015	BEMW	1	TAMSPP	Uk	Uk	7/10
			2	TAMSPP	Uk	Uk	7/16
PVER	2014	PVP4	1	POPFRE	Ub	Uk	7/2
			2	SALGOO	Ub	Uk	7/9
			3	POPFRE	Ub	Uk	8/5
			4	POPFRE	Ub	Uk	8/22
		PVP5	1	SALGOO	JTK	Ub	7/8
			2	POPFRE	Ub	FOX	7/18
			3	POPFRE	HAL	Ub	7/19
			4	POPFRE	Uk	Uk	7/22
			5	POPFRE	Ub	FOX	8/12
		PVP6	1	POPFRE	SER	Uk	7/4
			2	SALGOO	PF	Uk	7/5
			3	POPFRE	SPM	B	7/7
			4	SALGOO	Uk	Uk	7/11
			5	POPFRE	SPM	B	7/14
			6	SALGOO	AA	BGB	7/16
			7	SALGOO	SER	B	7/17
			8	POPFRE	DST	B	7/18
			9	POPFRE	Uk	Uk	7/18
			10	POPFRE	HAL	Uk	8/7
			11	POPFRE	SMG	PHD	8/12
			12	POPFRE	GOD	B	8/13
			13	POPFRE	HAL	Ub	8/29
		PVP7	1	POPFRE	CRU	Uk	7/14
			2	POPFRE	IVY	Uk	7/16
			3	POPFRE	Ub	BUL	8/1
			4	POPFRE	Ub	BUL	8/6
			5	POPFRE	DIC	DUS	8/8
			6	POPFRE	STO	WWW	8/20
			7	POPFRE	DIC	Uk	8/27
	2015	PVP2	1	SALGOO	GFK	Ub	7/13
			2	SALGOO	Ub	Uk	7/15

Area	Year	Site code	Nest #	TreeSp[1]	Adult 1[2]	Adult 2[2]	Date found
PVER	2015	PVP3	1	POPFRE	Uk	Uk	7/16
		PVP4	1	SALGOO	TAC	CLE	7/16
			2	POPFRE	TAC	CLE	7/24
			3	SALGOO	Uk	CHU	7/30
			4	POPFRE	TAC	CLE	8/6
		PVP5	1	POPFRE	DUM	BEL	7/21
			2	SALGOO	Uk	Uk	8/1
			3	POPFRE	DUM	BEL	8/11
		PVP6	1	POPFRE	SER	Ub	7/3
			2	POPFRE	TAS	Ub	7/6
			3	SALGOO	B	Uk	7/13
			4	POPFRE	PIE	PUS	7/15
			5	SALGOO	PIS	Ub	7/16
			6	SALEXI	Uk	JWZ	7/18
			7	PROGLA	SNP	Uk	7/24
			8	POPFRE	JTK	Uk	7/26
			9	POPFRE	TAS	Uk	7/31
			10	POPFRE	Ub	ONY	7/31
			11	SALGOO	PIE	PUS	8/1
		PVP7	1	SALGOO	FRL	Ub	7/6
			2	SALGOO	CRU	Ub	7/6
			3	POPFRE	HAL	WWW	7/9
			4	SALGOO	DOR	Uk	7/9
			5	POPFRE	MRP	Ub	7/10
			6	POPFRE	TFU	Ub	7/13
			7	POPFRE	JKY	BRO	7/20
			8	POPFRE	GOR	ELE	7/21
			9	POPFRE	STR	CHC	7/22
			10	POPFRE	PAN	BOO	8/1
			11	POPFRE	CHZ	Uk	8/3
			12	POPFRE	HAL	WWW	8/10
	2016	PVP4	1	SALGOO	B	Uk	7/7
			2	PROGLA	Uk	Uk	7/13
			3	SALGOO	Uk	Uk	7/18
			4	PROGLA	Ub	Uk	7/21
		PVP5	1	POPFRE	CHA	Ub	6/28
			2	SALGOO	Uk	Uk	7/6

Area	Year	Site code	Nest #	TreeSp[1]	Adult 1[2]	Adult 2[2]	Date found
PVER	2016	PVP5	3	SALGOO	SER	BOO	7/16
			4	SALGOO	B	B	7/20
			5	POPFRE	CHA	Ub	7/25
			6	POPFRE	FUJ	TRE	7/27
			7	POPFRE	Uk	Uk	7/29
			8	SALGOO	FRE	DRK	8/2
		PVP6	1	POPFRE	GAR	BOO	6/14
			2	POPFRE	Uk	Uk	6/26
			3	PROGLA	LIL	Ub	6/26
			4	SALGOO	Ub	Uk	6/27
			5	POPFRE	B	Ub	6/27
			6	POPFRE	SHT	HTO	6/30
			7	POPFRE	Uk	Uk	7/3
			8	SALGOO	MSO	SAL	7/9
			9	PROGLA	Uk	RED	7/9
			10	POPFRE	Uk	Uk	7/10
			11	POPFRE	DAR	ONY	7/14
			13	POPFRE	GAR	LYM	7/14
			12	POPFRE	ANT	ACO	7/17
			14	POPFRE	TAS	WHT	7/20
			15	SALGOO	BAL	TET	7/21
			16	POPFRE	QUI	CHC	8/2
			17	POPFRE	BAL	TET	8/24
		PVP7	1	POPFRE	Uk	KOF	6/21
			2	POPFRE	PEN	WWW	7/4
			3	SALGOO	HUM	Ub	7/7
			4	SALGOO	FRL	ALU	7/13
			5	POPFRE	CRU	KOF	7/13
			6	POPFRE	Uk	Uk	7/19
			7	POPFRE	GOR	ASC	7/19
			8	POPFRE	Uk	Uk	7/28
			9	SALGOO	ANT	LAS	8/2
			10	POPFRE	CRU	KOF	8/7
			11	POPFRE	Uk	Uk	8/9
			12	POPFRE	Ub	PER	8/12
	2017	PVP3	1	SALGOO	Ub	Ub	7/23
		PVP4	1	POPFRE	Ub	Ub	7/24

Area	Year	Site code	Nest #	TreeSp[1]	Adult 1[2]	Adult 2[2]	Date found
PVER	2017	PVP5	1	POPFRE	Ub	NIP	7/29
			2	SALGOO	Ub	CHU	8/1
		PVP6	1	SALGOO	ANT	DOT	7/5
			2	POPFRE	KIL	HTO	7/8
			3	POPFRE	FRL	TET	7/17
			4	POPFRE	Ub	BOO	7/19
			5	SALGOO	Uk	WHT	7/25
			6	POPFRE	Ub	Ub	7/29
		PVP7	1	POPFRE	CRU	DEV	6/27
			2	SALGOO	PEN	Ub	7/7
			3	SALGOO	B	Ub	7/7
			4	SALGOO	Uk	UK	7/7
			5	POPFRE	Uk	Uk	7/8
			6	SALGOO	STR	Ub	7/14
			7	SALGOO	Ub	IRO	7/17
			8	SALGOO	Ub	PER	7/22
			9	SALGOO	Uk	CHC	8/4
	2018	PVP2	1	SALGOO	Ub	Uk	7/20
		PVP5	1	SALGOO	Ub	Ub	7/16
			2	SALGOO	Ub	ANA	7/18
			3	SALGOO	VES	SIE	7/19
		PVP6	1	POPFRE	TAS	Ub	7/2
			2	POPFRE	SER	NIP	7/4
			3	POPFRE	Ub	Ub	7/17
			4	SALGOO	Ub	Ub	7/18
			5	POPFRE	Uk	Uk	7/20
			6	POPFRE	Ub	DAE	7/22
			7	SALGOO	Uk	Uk	7/24
			8	POPFRE	SER	NIP	7/28
			9	POPFRE	TAS	Ub	7/30
			10	POPFRE	SIM	NAL	7/30
		PVP7	1	POPFRE	Ub	TAM	6/26
			2	SALGOO	MRP	ARC	7/3
			3	POPFRE	Ub	Ub	7/13
			4	PROGLA	Ub	Ub	7/16
CVCA	2014	CVP2	1	SALGOO	GWB	DBL	7/20
	2016	CVP1	1	POPFRE	Uk	Uk	7/21

Area	Year	Site code	Nest #	TreeSp[1]	Adult 1[2]	Adult 2[2]	Date found
	2018	CVP8	1	POPFRE	Uk	Uk	7/16
		CVP9	1	POPFRE	Uk	Uk	7/23
Cibola NWR	2014	CNCR	1	BACSAL	FRK	Uk	7/9
			2	PROGLA	Uk	Uk	7/9
			3	TAMARI	SMA	Ub	7/11
	2015	CNCR	1	PROGLA	CHE	Uk	7/6
			2	PROGLA	JER	Uk	7/16
			3	POPFRE	CHE	SAL	8/3
	2016	CNCR	1	POPFRE	Uk	Uk	6/21
			2	PROGLA	Uk	Uk	7/26
			3	POPFRE	Uk	Uk	7/26
			4	SALGOO	Uk	Uk	7/26
	2017	CNCR	1	PROGLA	RP	Ub	6/27
		CNHF	1	POPFRE	ORE	Ub	7/13
	2018	CNCR	1	SALEXI	Uk	Uk	7/9
		CNHF	1	POPFRE	Ub	Uk	7/23
			2	POPFRE	Ub	Uk	8/6
Yuma East	2018	YWYW	1	PROGLA	Uk	Uk	7/25

[1] Nest substrate species: POPFRE = Fremont cottonwood, PROGLA = honey mesquite, SALGOO = Goodding's willow, SALEXI=coyote willow, TAMARI=tamarisk spp.

[2] Adult1, Adult 2: unique two-to-three-character identifiers of the nesting adults, Uk=unknown, Ub=unbanded, B=banded (identity unconfirmed)