Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Yellow-billed Cuckoo Surveys in Conservation Areas on the Lower Colorado River and Bill Williams River

2019 Annual Report

April 2020

Work conducted under LCR MSCP Work Task D7

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

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

Arizona Participant Group

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

Other Interested Parties Participant Group

QuadState Local Governments Authority
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Wildlife
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
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Nevada Participant Group

Colorado River Commission of Nevada
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Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

Conservation Participant Group

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

Lower Colorado River Multi-Species Conservation Program

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ACRONYMS AND ABBREVIATIONS

ac	acre(s)
AHY	after hatching year
AOU	American Ornithologists' Union
BLCA	Beal Lake Conservation Area
Bill Williams River NWR	Bill Williams River National Wildlife Refuge
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
CO	confirmed breeding territory
cuckoo	western distinct population segment of yellow-billed cuckoos (*Coccyzus americanus*)
CVCA	Cibola Valley Conservation Area
F	female
ft	foot/feet
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
M	male
m	meter(s)
Mg	magenta
mi	mile(s)
MP3	MPEG-3 coding format for digital audio
n =	number equals (sample size)
NA	not applicable
Nature Trail	Cibola National Wildlife Refuge Unit #1 Conservation Area Nature Trail

PO	possible breeding territory
PR	probable breeding territory
PVER	Palo Verde Ecological Reserve
Reclamation	Bureau of Reclamation
spp.	species (plural)
SSRS	Southern Sierra Research Station
USFWS	U.S. Fish and Wildlife Service
YEW	Yuma East Wetlands

Symbols

°C	degrees Celsius
°F	degrees Fahrenheit
>	greater than
<	less than
≤	less than or equal to
#	number
%	percent

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EXECUTIVE SUMMARY

Following large-scale water diversion and subsequent loss of riparian habitats over the previous century, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was created in 2005, in compliance with the Endangered Species Act, to balance legal water resource use and the conservation of threatened and endangered species and their habitats along the lower Colorado River (LCR). The western distinct population segment of yellow-billed cuckoos (*Coccyzus americanus*; cuckoo) was listed as threatened under the Endangered Species Act in 2014 and is 1 of 27 species covered under the program. The Bureau of Reclamation (Reclamation) contracted the Southern Sierra Research Station to continue surveys and determine the breeding status of cuckoos in conservation areas along the LCR between Needles, California, and Yuma, Arizona, and along the Bill Williams River between Planet Ranch and Lake Havasu (the study area) from 2019 to 2022.

Six conservation areas managed by the LCR MSCP were surveyed by the Southern Sierra Research Station in 2019, including the Beal Lake Conservation Area (BLCA), the Palo Verde Ecological Reserve (PVER), the Cibola Valley Conservation Area (CVCA), the Cibola National Wildlife Refuge Unit #1 Conservation Area (Cibola NWR Unit #1), the Laguna Division Conservation Area, and Yuma East Wetlands (YEW). A stretch of suitable habitat within the Bill Williams River National Wildlife Refuge (Bill Williams River NWR), Bill Williams River East and Bill Williams River West, was also surveyed. Reclamation surveyed two other LCR MSCP conservation areas, Planet Ranch and Hunters Hole, reported separately. One other LCR MSCP conservation area, the Dennis Underwood Conservation Area, will be surveyed under this contract in future years.

Generally, the same sites were surveyed in 2019 as in 2018, though the delineation of some sites changed in 2019, in some cases to reflect what could reasonably be surveyed by an individual in a morning. This resulted in previously large sites being broken into smaller sites, and some small sites merging into one survey site. Following the current survey protocol, from June 17 to August 9, 2019, 41 sites ranging from 9 to 212 hectares (ha) totaling approximately 2014 ha were surveyed. All sites were surveyed four times, except for one at Bill Williams River East (Cougar Point), which was dropped after the first survey due to a lack of suitable habitat. Overall, 263 survey detections were recorded, including 2 at the BLCA, 19 at Bill Williams River East, 2 at Bill Williams River West, 116 at the PVER, 35 at the CVCA, 54 at Cibola NWR Unit # 1, 31 at the Laguna Division Conservation Area, and 4 at YEW.

During or after surveys, followup visits were conducted in areas of activity to determine breeding status and to resight banded birds. A total of 77 breeding territories were estimated in the study area, including 32 possible, 25 probable, and 20 confirmed breeding territories.

A main objective of resighting was to locate up to seven cuckoos previously fitted with Global Positioning System (GPS) tags in 2014 and 2015 that have not yet been recaptured. If a GPS-fitted bird was positively resighted, two capture attempts were permitted to recapture the bird. If no birds carrying GPS tags were resighted, an alternative option was to capture two birds at a site without previous capture attempts in order to provide information on site fidelity and dispersal. Eight cuckoos banded in previous years were positively resighted in 2019; none were GPS tagged. In lieu of resighting and recapturing a GPS-tagged bird, two adults were captured and banded at the YEW South site in 2019.

Prior to 2016, intensive nest searching and monitoring were included in the scope of work in order to detect changes in reproductive performance and assess the health of the LCR cuckoo population. After 2015, nest searching and monitoring were removed, although field activities, such as surveys and followup visits, to determine breeding status or to resight banded adults sometimes led to nests being found. The nests were not typically monitored; however, some monitoring occurred to determine the banded status of adults, and some monitoring occurred at nests of conservation interest. Without regular nest monitoring, the fates of most nests remain unknown, and nest results are not comparable across years due to unequal yearly effort involved in nest searching and monitoring.

During surveys and followup visits in 2019, 18 nests were found in the study area: 1 at Bill Williams River East, 6 at the PVER, 3 at the CVCA, 7 at Cibola NWR Unit #1, and 1 at YEW. Nest fates were not determined for most nests, though some fates were discovered during resight attempts. Through this activity, five nests were known to have failed, including two nests abandoned with their entire clutches unhatched. Birds may abandon nests due to several factors, including non-viability of eggs from inbreeding, infertility, exposure to extreme temperatures, low humidity, or other environmental causes, or due to perceived threats, disturbance, predators, or human activity. Successful recruitment of as many young as possible each year is important for the recovery of imperiled populations.

Chapter 1 – Introduction and Project Background

YELLOW-BILLED CUCKOO HISTORY ON THE LOWER COLORADO RIVER

The Bureau of Reclamation (Reclamation) has been conducting surveys for yellow-billed cuckoos (*Coccyzus americanus*, cuckoo) along the lower Colorado River (LCR) since 1998. The western distinct population segment of cuckoos was listed as threatened under the Endangered Species Act on November 3, 2014 (Federal Register 2014). From 1975 to 1979, 242 cuckoos were estimated along the LCR, with an additional 208 at the Bill Williams Delta (Rosenberg et al. 1991). By 1986, the estimate for the LCR had declined to 18 cuckoos and 50–60 at the Bill Williams River Delta (Rosenberg et al. 1991). Other reports describe population changes based on surveys conducted annually since 2006 (Halterman 2009; Johnson et al. 2008; McNeil and Tracy 2013; McNeil et al. 2010, 2011, 2012, 2013). In 2016, there were no survey detections on the Bill Williams River, and most cuckoos currently on the LCR were in Lower Colorado River Multi-Species Conservation Program (LCR MSCP) conservation areas (Parametrix, Inc., and Southern Sierra Research Station 2015, 2016a, 2016b, 2018, 2019). A major factor for the decline of cuckoos in the west, including along the LCR, has been habitat loss within riparian systems (Gaines and Laymon 1984; Rosenberg 1991). A draft survey protocol (the protocol) and survey detection forms have been issued by the U.S. Fish and Wildlife Service (USFWS) (Halterman et al. 2016), with instructions revised in 2019 (USFWS and Reclamation 2019).

LOWER COLORADO RIVER MULTI-SPECIES CONSERVATION PROGRAM

The LCR MSCP is a multi-stakeholder Federal and non-Federal partnership responding to the need to balance the use of water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. The LCR MSCP is a 50-year plan to conserve at least 27 species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through the implementation of a Habitat Conservation Plan (HCP) (LCR MSCP 2004a).

Past reports on cuckoo monitoring efforts in the study area since 2006 can be found on the LCR MSCP website (www.lcrmscp.gov). These reports provide information on sites previously surveyed under contract with Reclamation. The locations to be surveyed under this contract include the Beal Lake Conservation Area (BLCA), the Bill Williams River National Wildlife Refuge (Bill Williams River NWR) (middle section of the refuge), the Cibola National Wildlife Refuge Unit #1 Conservation

Area (Cibola NWR Unit #1), the Cibola Valley Conservation Area (CVCA), the Palo Verde Ecological Reserve (PVER), the Dennis Underwood Conservation Area, the Laguna Division Conservation Area (LDCA), and Yuma East Wetlands (YEW) (see figures 1–6; see tables 1 and 2).

PROJECT SCOPE OF WORK

The purpose of the current study is to monitor the status of western cuckoos in LCR MSCP conservation areas from 2019 to 2022. Objectives are to conduct presence surveys and determine the breeding status of western cuckoos at LCR MSCP conservation areas along the LCR between Needles, California, and Yuma, Arizona, including a stretch of the Bill Williams River between Mineral Wash and Lake Havasu (see figure 1). Surveys and followup visits will be conducted for 4 years. In 2023, a summary report will be prepared showing the results of the previous 4 years. All services will be conducted in accordance with the LCR MSCP's Habitat Conservation Plan (LCR MSCP 2004a), the associated biological opinion (File Number: 02-21-04-F-0161) (USFWS 2005a) and Section10(a)(1)(a) permit (TE-086834-0) (USFWS 2005b), and the Lower Colorado River Multi-Species Conservation Program Final Programmatic Environmental Impact Statement/ Environmental Impact Report (LCR MSCP 2004b).

Chapter 2 – Study Area and Site Descriptions

STUDY AREA AND SITE SELECTION

Surveys of potential and previously occupied cuckoo habitat were conducted at sites spanning approximately 300 kilometers (km) (186 river miles) of the LCR and tributaries, from the Havasu National Wildlife Refuge (Havasu NWR) near Needles, California, to Yuma, Arizona (the study area, figure 1). Sites that a cuckoo would potentially use were defined in the LCR MSCP Habitat Conservation Plan as at least 10 ha (25 acres [ac]) of contiguous riparian vegetation containing Fremont cottonwood-Goodding's willow (*Populus fremontii-Salix gooddingii*) (hereafter cottonwood-willow) of structural types I–III (an overstory averaging > 4.6 meters (m) or 15 feet [ft] tall) (Anderson and Ohmart 1984; LCR MSCP 2004a). Occasionally, smaller patches of habitat were surveyed depending on their location, perceived quality, and previous survey history. However, most nesting occurs in patches 20 ha 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 western cuckoos from 2009 to 2012 (McNeil et al. 2013), and no nests have been found in the study area in patches smaller than about 20 ha (50 ac). Thus, most small, isolated patches are unlikely to support breeding. All LCR MSCP conservation areas at least 2 years old and containing suitable habitat were surveyed by the Southern Sierra Research Station (SSRS), except for Planet Ranch (Hannon et al. 2018) and Hunters Hole (Miller et al. 2019), which were surveyed by Reclamation and are reported separately. In 2019, 41 sites were surveyed (see table 1).

A Global Positioning System (GPS) unit was used to determine the boundaries of potential breeding habitat within each site defined under this system. Where boundaries were inaccessible, georeferenced aerial imagery was used to estimate the boundaries. Once potential breeding habitat was identified within a site, survey transects were established (described in chapter 3).

SITE DESCRIPTIONS

Sites surveyed in 2019 are described by geographic area from north to south and alphabetically within each area. The results of some adjacent sites are presented together as one site, such as at the Cibola National Wildlife Refuge Unit #1 Conservation Area's Nature Trail (Nature Trail) and Mass Transplanting, and CW-North and Cottonwood Genetics (see table 1). All conservation areas are described in more detail in annual reports and restoration development plans available at https://lcrmscp.gov/steer_committee/ technical_reports.html. Survey detections and estimated territories are included for each site surveyed in 2019. All detections summarized in the following site descriptions were assessed by spatial location, observed behaviors, and associated dates

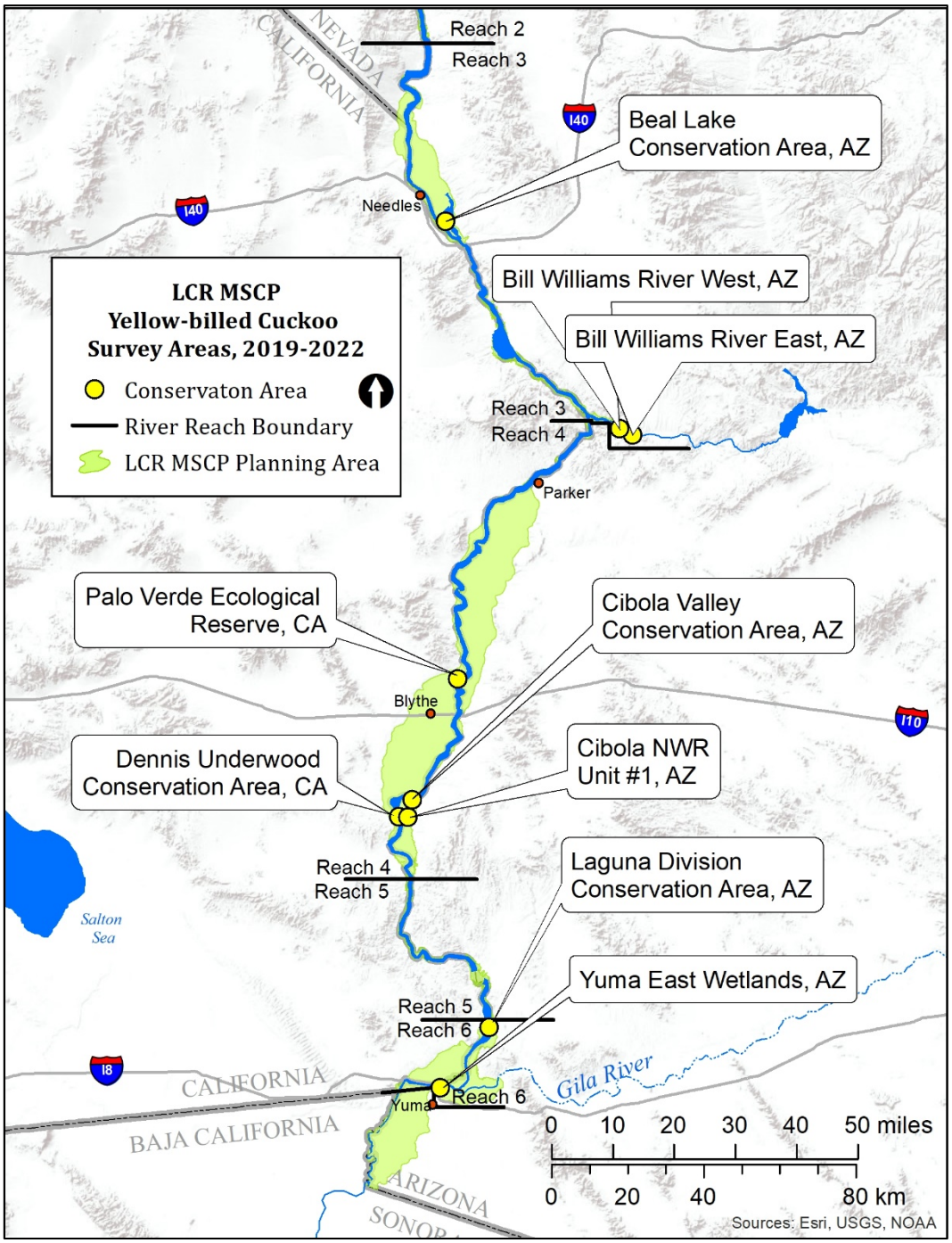

Figure 1.—LCR MSCP cuckoo survey areas, 2019–22.

and used to categorize the breeding status for each occupied patch as a possible (PO), probable (PR), or confirmed (CO) breeding territory (following Halterman et al. 2016; USFWS and Reclamation 2019) (see table 4). Due to the Federal listing of this species, and for the protection of nesting birds, site maps showing specific nesting areas are not included in this report. The results of all detections are also listed in table 5.

Havasu National Wildlife Refuge

San Bernardino, California, and Mohave County, Arizona

The Havasu NWR was established in 1941 to protect the largest remaining natural riparian forest in the lower Colorado River valley. It included parts of the Bill Williams River until 1993, when it was separated to form the Bill Williams River NWR (see below). The Havasu NWR currently encompasses over 48 km (30 river miles) along the LCR and adjacent lands from Needles, California, to Lake Havasu City, Arizona. Cuckoo habitat within the refuge occurs almost entirely within the Topock Marsh area, a historical river meander east of the main river channel currently managed for wildlife. Water levels are seasonally manipulated to benefit wildlife and recreation. One area within the Havasu NWR was surveyed in 2019, the BLCA (figure 2). The BLCA was created in partnership with Reclamation and the USFWS to create a haven for native fishes and to test methods for establishing native plant communities (LCR MSCP 2011a).

Area: Beal Lake Conservation Area (BLCA)

Mohave County, Arizona

Site: Beal

35.5 ha (87.8 ac)
Section: C1507

Beal lies approximately 3 km (1.9 miles [mi]) south of Topock Platform between Beal Lake and Topock Marsh (figure 2) and contains one survey site, previously listed as two sites: Site 1505 and Site 1506 (Parametrix, Inc., and SSRS 2019). Beal has consistently drawn a small number of breeding cuckoos (LCR MSCP 2010a; Parametrix, Inc., and SSRS 2019). The site consists of a mosaic of native trees planted in the historical floodplain of the Colorado River. Approximately 43 ha (106 ac) were planted from 2003 to 2005 (LCR MSCP 2008a, 2010a). Of those, 35.5 ha (87.8 ac) were surveyed for cuckoos in 2019. Multiple access roads cross the sites and define the perimeters, though many roads have now been blocked off with large boulders. The site is irrigated throughout the nesting season via pipes and irrigation canals bordering the southeastern edge, which connects Beal Lake to the southwest, with Topock Marsh to the northeast.

In 2019, there were two survey detections and one PO territory at this site.

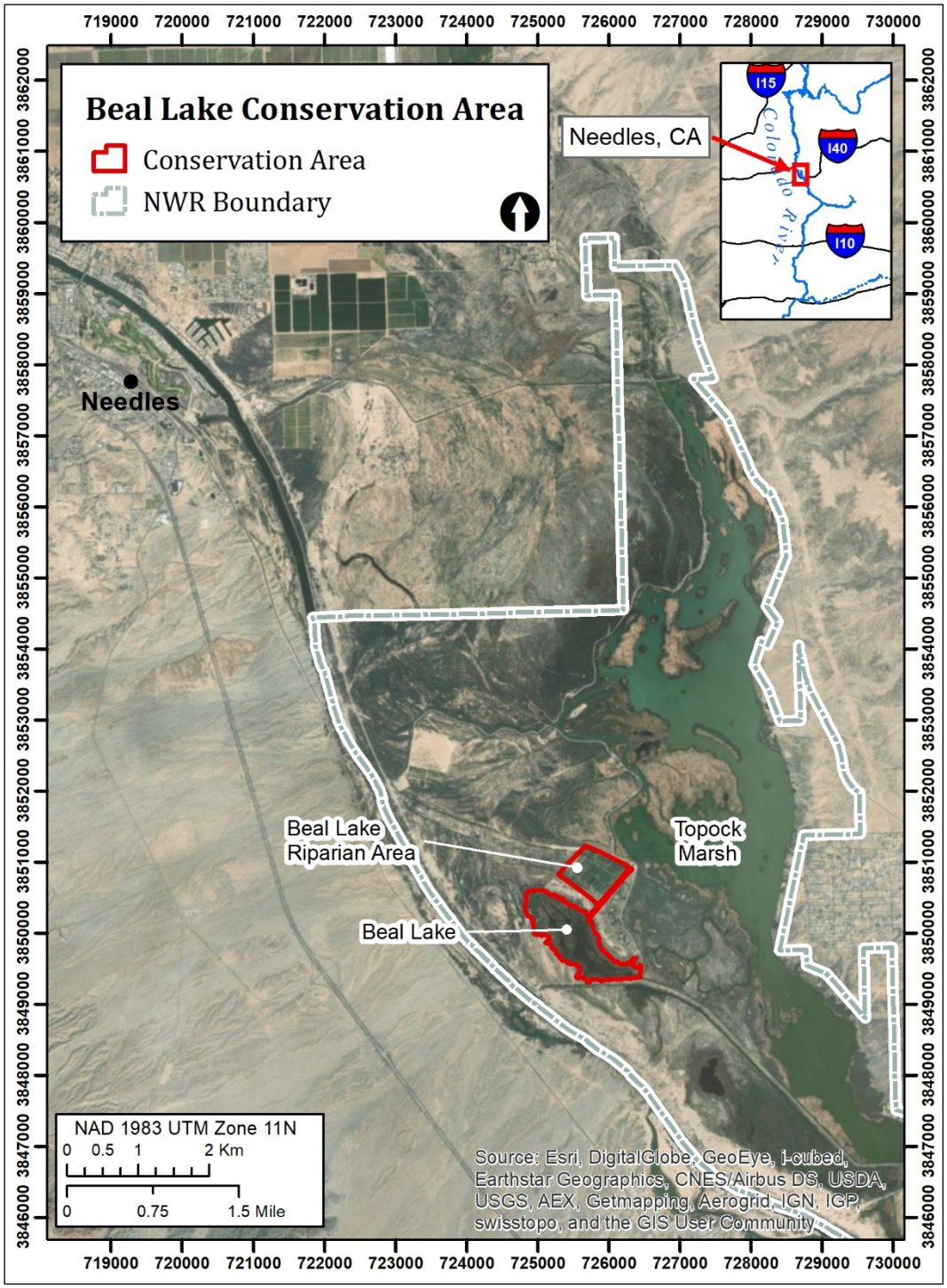

Figure 2.—The BLCA within the Havasu NWR.

Bill Williams River National Wildlife Refuge

La Paz and Mohave Counties, Arizona

The Bill Williams River East and Bill Williams River West areas are within the Bill Williams River NWR (figure 3). This refuge was established in 1993 and was formerly part of the Havasu NWR (see above). 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 river miles), and it has historically supported some of the most extensive and productive cuckoo breeding habitat in the watershed (Johnson et al. 2008; Rosenberg et al. 1991). Portions of the river contain perennial surface water. Prior to the completion of Alamo Dam in 1968, the historical hydrologic regime enabled overbank flooding necessary for natural regeneration of native vegetation and persistence of cottonwood-willow forest. In the more recent past, occasional winter releases from Alamo Dam resulted in some natural riparian forest regeneration. The last significant flood releases were in the winter of 2004–05 and March 2018. On March 19, 2018, water was released from Alamo Dam to conduct maintenance and repairs to the 50-year-old, 86.26-m (283-ft) earthen structure (U.S. Army Corps of Engineers 2018). Designed to mimic a late winter storm, its highest flow occurred March 23, 2018, and slowly subsided by April 1, 2018 (Central Arizona Project 2018). The flow spurred some regeneration of native trees lining the narrow stream, though most sites continued to experience die-off with ongoing drought conditions and the more recent colonization by tamarisk beetles (*Diorhabda* spp.). Non-native tamarisk (*Tamarix* spp.) shrubs have spread widely throughout riparian systems in the Western United States, with many detrimental ecological impacts (DeLoach et al. 2003). However, whether many of these impacts are due to tamarisk per se or the altered hydrological regime is debated (Shafroth et al. 2010). The northern tamarisk beetle (*D. carinulata*) was introduced into North America from China for biocontrol. It was first released in 2001 in six Western States and later released across other western sites (DeLoach et al. 2003). The beetle is effective in reducing the tamarisk populations due to its ability to damage large stands through repeated defoliation. Its ability to evolve its seasonal timing of diapause has enabled it to establish well beyond its purported geographic limit (Bean et al. 2012), and it is now found in every Western State, including the Colorado River Basin (Bloodworth et al. 2016). In 2011 the U.S. Department of Agriculture ceased releasing tamarisk beetles due to concern for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*). Beetles were reported as not present in 2016 at the Bill Williams River (Bloodworth et al. 2016); however, elf owl (*Micrathene whitneyi*) surveyors at the Bill Williams River noted abundant tamarisk beetles that year (Parametrix, Inc., and SSRS 2019). By 2018, the beetles were noted to have declined along with the tamarisk (Parametrix, Inc., and SSRS 2019).

The vegetation composition and structure in the eastern half of the refuge significantly differs downstream from Gibraltar Rock in the western half. East of Gibraltar Rock, shallow underground bedrock and cliffs bordering the riparian area

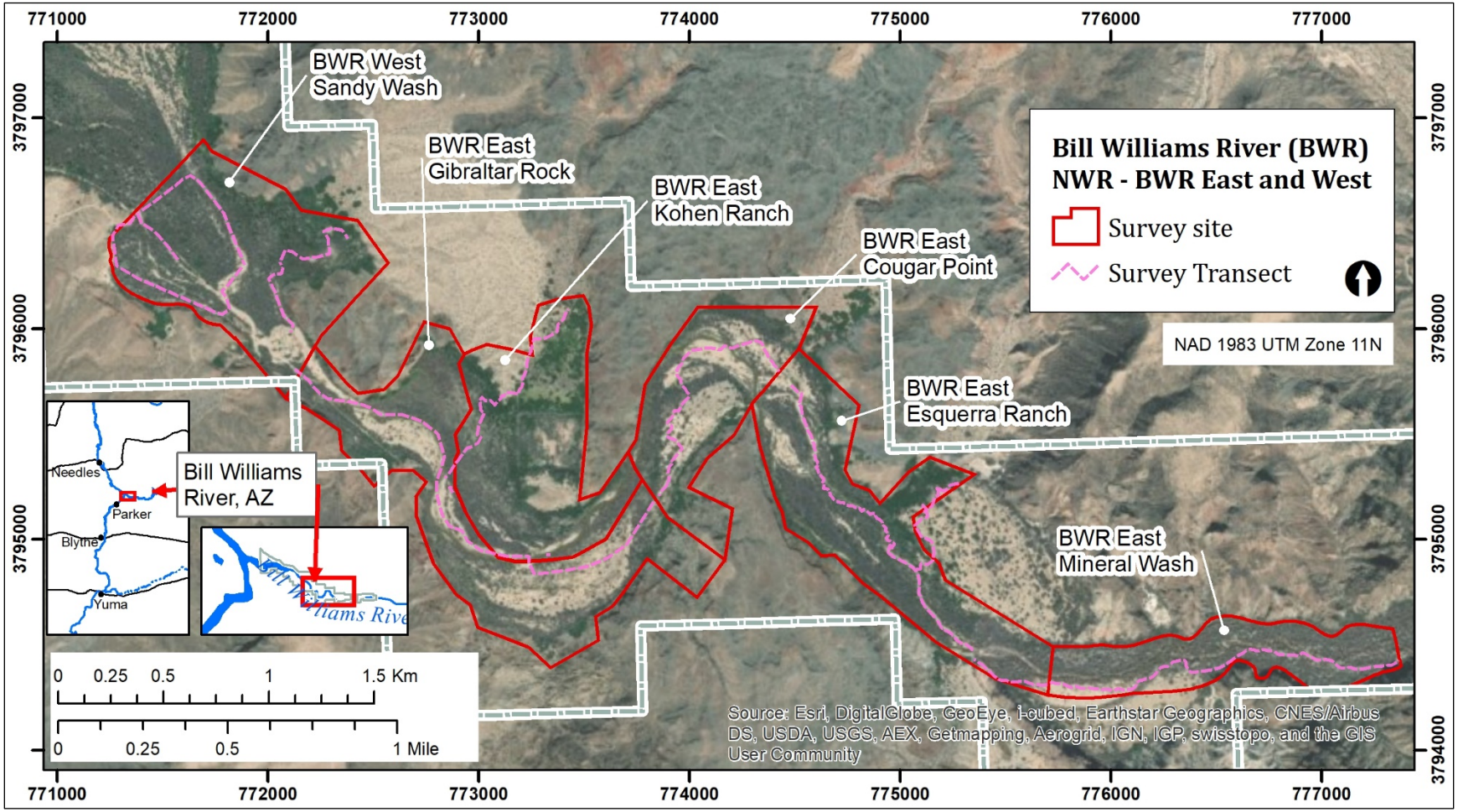

Figure 3.—Bill Williams River East and Bill Williams River West areas, showing sites and transects surveyed in 2019.
Cougar Point was dropped after one survey.

increase perennial flows and surface water. West of Gibraltar Rock, the river channel widens into a sandy, broad floodplain that persists to the western edge of the refuge at its interface with Lake Havasu.

Sites previously surveyed in the Bill Williams River East and Bill Williams River West areas were removed from the study area after 2015 due to a reduced scope of work, with Bill Williams River sites falling outside of LCR MSCP conservation areas. With the addition of Planet Ranch to the LCR MSCP in 2016, portions of the Bill Williams River NWR, referred to as the Middle Bill Williams River National Wildlife Refuge by the LCR MSCP, became creditable acres under the program (LCR MSCP 2004a). Thus, in 2017, the stretch of riparian forest between Mineral Wash (Bill Williams River East) and Sandy Wash (Bill Williams River West) were included again in the surveys. This stretch of the river was surveyed in 2019.

Many survey routes and trails previously used for cuckoo surveys were unusable or not found in 2019 due to the large amount of downfall across the trails. Areas of previously suitable habitat also became unsuitable due to long-term drought. Therefore, before surveys began, SSRS crews spent several days evaluating habitat and creating new trails and survey routes. Changes, such as dropped or added transects, are discussed in each site description below. Five sites at the Bill Williams River NWR were surveyed in 2019, and one other previously surveyed site (Cougar Point) was removed after the first survey due to a lack of suitable habitat.

Area: Bill Williams River East

Mohave and La Paz Counties, Arizona

Site: Esquerra Ranch

73.9 ha (182.6 ac)
Section: C1935

This site lies between the Mineral Wash and Cougar Point sites and begins near the confluence of Mineral Wash and the Bill Williams River (see figure 3). 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 cottonwoods and Goodding's willow snags, with scattered live tamarisk creating a tangled understory. The Bill Williams River was dry here from 2014 to 2017. In 2019, a trickle of water flowed through the site, and young cottonwoods and Goodding's willows lined the narrow riverbed. Some understory persists, including honey mesquite (*Prosopis glandulosa*), tamarisk, and arrowweed (*Pluchea sericea*). Deadfall has washed downstream, creating large log dams, which make surveying difficult.

In 2019, there were four survey detections and two PO territories at this site.

Site: Gibraltar Rock

90.1 ha (222.7 ac)
Section: C1936

This site is located between Cougar Point and Sandy Wash, south of Kohen Ranch (see figure 3). 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. Some water flowed in 2019 along the main riverbed during two surveys, and some young cottonwoods and Goodding's willows persist.

In 2019, there were two survey detections and no territories estimated at this site.

Site: Kohen Ranch

68.5 ha (169.3 ac)
Section: C1937

Kohen Ranch covers areas of natural regeneration that occurred following prolonged flooding in 2005 plus a restored honey mesquite bosque area added to the survey site in 2019 (see figure 3). This restored area north and east of the original site boundary includes approximately 15 ha (37 ac) of abandoned agricultural fields planted by the USFWS in 2009 to increase mesquite bosque habitat and to enhance terrace avian communities (USFWS 2011). 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 mature senescing cottonwood forest with a honey mesquite bosque edge and an understory of honey mesquite, tamarisk, and seep willow (*Baccharis salicifolia*). The route then extends north to cover the now-suitable restored mesquite bosque, and a transect previously following the main river channel to the south was removed due to the death of most riparian trees there.

In 2019, there were seven survey detections with one PO territory and one PR territory at this site.

Site: Mineral Wash

41 ha (101.3 ac)
Section: C1901

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 floodplain (see figure 3). It is

comprised of a cottonwood-willow overstory with a honey mesquite bosque edge and an understory of mesquite and tamarisk. Arborescent Sonoran Desert scrub lines the cliffs to the north and south, and saguaro (*Carnegiea gigantea*) and creosote bush (*Larrea tridentata*) 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. The river flowed during the spring and summer in 2018 and also during cuckoo surveys in 2019. Young cottonwoods and Goodding's willows line the edge of the river. A few large cottonwoods persist in the outer ecotone area.

In 2019, there were six survey detections and one CO (nest) territory at this site.

Area: Bill Williams River West

Mohave and La Paz Counties, Arizona

Site: Sandy Wash

80.8 ha (199.6 ac)
Section: C1938

This site connects Gibraltar Rock to the southeast, Fox Wash to the north, and Cross River to the northwest (the latter two sites were last surveyed in 2015; Parametrix, Inc., and SSRS 2019) (see figure 3). This section of the refuge gradually widens into a floodplain laced with dry river channels. It has a cottonwood-willow overstory with a honey mesquite bosque edge and an understory of mesquite and tamarisk. The main transect loops around the eastern end of the broad floodplain, which follows an old river channel and an old road. Most trees along the road have died due to prolonged drought. In 2019, a transect was added in the northeast to cover an area where a higher water table supports a sizeable patch of healthy cottonwood-willow forest. Arborescent Sonoran Desert scrub lines the cliffs to the north and south. Hikers and researchers use this easily accessible site. In 2018, the Bill Williams River flowed during spring and again in mid-July. In 2019, the wash was dry, except in the east section, which had some ponding.

In 2019, there were two survey detections and one PO territory at this site.

Palo Verde Valley

Riverside County, California

Area: Palo Verde Ecological Reserve (PVER)

The PVER is located 12 km (7.5 mi) north of Blythe, California (figure 4). The 547-ha (1,352-ac) area was acquired by the State of California in 2004. Reclamation implemented riparian restoration within former agricultural fields in eight phases,

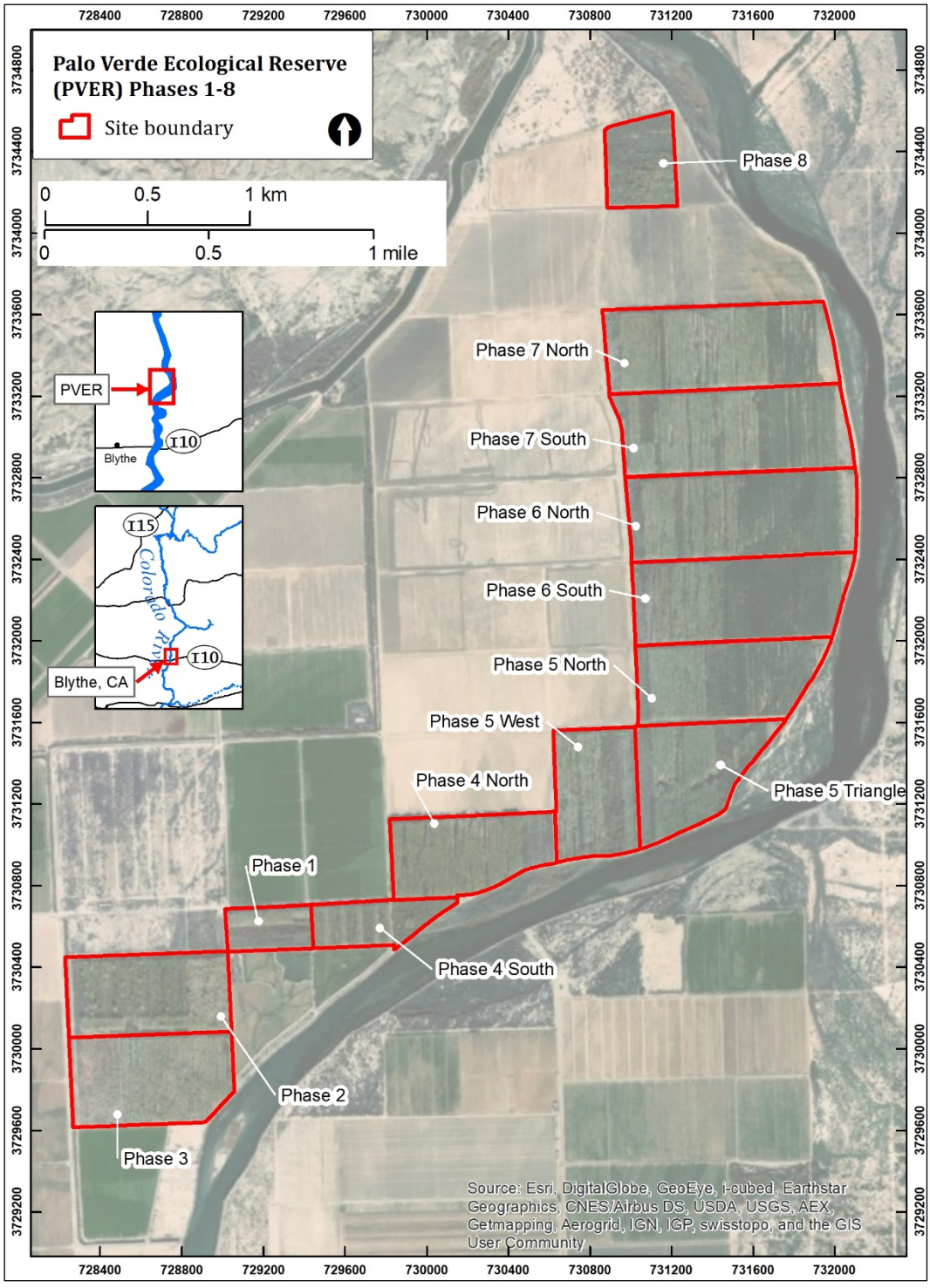

Figure 4.—PVER Phases 1–8, showing sites surveyed in 2019.

with public use and hunting managed by the California Department of Fish and Wildlife (CDFW). Public use includes jogging, dog walking, hunting, fishing, boating, swimming, and wildlife viewing. Each phase of the PVER is described in annual reports and restoration development plans that are available at https://lcrmscp.gov/steer_committee/technical_reports.html). The main goal for the PVER is to create and manage as much riparian habitat as possible for southwestern willow flycatchers, cuckoos, and other covered LCR MSCP species over a 50-year period. The species composition and density were planted to mimic a natural riparian landscape when fully mature. Over 1.8 million riparian trees and shrubs were planted over an 8-year period, concluding in 2013 with the planting of Phase 8. The area surveyed for cuckoos includes approximately 414 ha (1,023 ac) of near-contiguous irrigated riparian forest spanning 5 linear km (3.1 mi) adjacent to the river. The phases were surveyed as they became suitable breeding habitat, with Phase 1 first surveyed in 2008, Phase 7 first surveyed completely in 2014, and Phase 8 first surveyed in 2016. Changes to survey sites in 2019 included the division of larger sites into smaller survey sites: Phase 5 is now surveyed as North, Triangle, and West; and Phases 4, 6, and 7 are each surveyed and reported as two sites, North and South. All eight phases were surveyed in 2019.

Adjacent farming activity that may negatively affect breeding cuckoos includes regular overhead crop dusting as well as noisy tractors and harvesting equipment. The edges receive overspray of chemicals from the crop dusting as well as applications from tractor spray. During the breeding season, farm equipment travels along the main road and in some perimeter and interior roads both night and day. In 2019, a new irrigation team was brought in, and heavy equipment plowed and furrowed the perimeter of the site, with some activity on interior roads. During the first session of dove hunting from September 1 to 15, all PVER phases experienced hunting-related disturbance, such as increased road traffic, people, dogs, and loud and erratic gunshots.

Many trees throughout the PVER appear to be weeping with reddish sap, possibly from insect infestations. Trees also began dropping yellow leaves early in 2019 during the breeding season.

Site: Phase 1

25.0 ha (61.8 ac)
Section: C2363

The eastern section of Phase 1 was planted in 2006 (LCR MSCP 2006a, 2006b) (see figure 4). Mature cottonwoods and Goodding's willow are present and at the southern edge is a dense patch of coyote willow (*Salix exigua*). The western section was sparsely planted with honey mesquite, and cuckoos have not been documented using it. 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. During the early years after planting, the tree canopy was dense with a wide

spreading canopy (LCR MSCP 2006b). The trees in this area are now tall, of large diameter and low canopy cover. Most *Baccharis* spp. and coyote willow understory present in past years has been shaded out, except along the road edges. The adjacent coyote willow area has always attracted a large number of nesting birds, including red-winged blackbirds (*Agelaius phoeniceus*), which sometimes make surveying this area difficult due to the raucous noise.

In 2019, there were four survey detections and one CO territory (copulation) at this site.

Site: Phase 2

31.6 ha (78.0 ac)
Section: C2361

Phase 2 was planted in 2007 (LCR MSCP 2006c, 2009a) (see figure 4). The eastern third contains a small field of seeded cottonwoods. The understory in this plot is now dense, with many tall dead or dying trees. The remaining area of Phase 2 now has large-diameter trees present. The entire site is difficult to move through due to the many fallen trees and limbs. The site is bordered on all sides by dirt access roads and irrigation canals on the west, north, and south.

In 2019, there were six survey detections and one PO territory at this site.

Site: Phase 3

34.0 ha (84.0 ac)
Section: C2362

Phase 3 was planted in 2008 and 2009 (LCR MSCP 2007a, 2010b) (see figure 4). The site now consists of tall, large-diameter cottonwood and Goodding's willow trees. Fallen trees and branches make this site difficult to walk and approach birds stealthily for resight or observations. The 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.

In 2019, there were six survey detections and one CO (nest) at this site.

Sites: Phase 4 North and Phase 4 South

41.2 ha (101.8 ac)
Sections: C2372, C2371

Phase 4 was planted in 2009 (LCR MSCP 2009b, 2013, see figure 4). It is bordered by actively farmed agriculture fields to the north and west. Dirt access roads

surround the perimeter, and irrigation canals are present on the north and west edges. Both sections east and west of the road now contain large-diameter trees, with many dead or downed trees and limbs. The saltbush (*Atriplex* spp.) on the edges are large and dense, but many large honey mesquite are now dead or dying, as are the cottonwoods bordering this area to the south. Due to its large size, this phase is surveyed as two sites: Phase 4 North and Phase 4 South, with the south site surveyed along with Phase 1.

In 2019, there were eight detections, one CO territory (copulation), and two PO territories in Phase 4 North and six detections and one PO territory in Phase 4 South.

Sites: Phase 5 North, Phase 5 Triangle, and Phase 5 West

87.4 ha (216.1 ac)
Sections: C2366, C2364, C2365

Phase 5 was planted in 2010, and a full description of the planting can be found at https://lcrmscp.gov/steer_committee/technical_reports.html (LCR MSCP 2009c, 2010c) (see figure 4). This site is slightly different from other the PVER phases due to a more open canopy, several meadows, grassy ground cover, and a shorter average height of cottonwoods and Goodding's willows. The Phase 5 North, West and Triangle sites are all similar in species composition. The site is bordered by agricultural fields to the north and west and the LCR to the east. Dirt roads surround the perimeter, and an irrigation canal is on the western boundary.

In 2019, there were 6 survey detections and 1 PR territory in Phase 5 North; 9 detections, 1 PO territory, and 1 PR territory in Phase 5 Triangle; and 11 detections, 1 PO territory, 1 PR territory, and 1 CO (nest) territory in Phase 5 West.

Sites: Phase 6 North and Phase 6 South

89.0 ha (219.9 ac)
Sections: C2369, C2368

Phase 6 was planted in 2011 (LCR MSCP 2010d, 2019) (see figure 4). The phase is surveyed as Phase 6 North and Phase 6 South due to its large size, but both sites are similar in plant composition. The sites are bordered by agricultural fields, an irrigation canal to the west, and the LCR to the east. Dirt access roads surround the perimeter. Small areas of native grasses and honey mesquite on the southern and northern boundary appear stressed.

In 2019, there were 20 survey detections, 3 PO territories, 1 PR territory, and 1 CO (nest) territory in Phase 6 North and 15 detections, 3 PO territories, 3 PR territories, and 1 CO (nest) territory in Phase 6 South.

Sites: Phase 7 North and Phase 7 South

91.6 ha (226.3 ac)
Sections: C2369, C2370

Phase 7 was planted in 2012 (see figure 4). The eastern and western end plots are planted with honey mesquite and native grasses (LCR MSCP 2011b, 2012a). The sites are 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. PVER 7 shows similar habitat site changes as described in the PVER 6 section, with yellowing and stressed mesquite along the eastern and western borders. Due to its large size, this phase is surveyed as two sites: Phase 7 North and Phase 7 South.

In 2019, there were 12 detections, 1 PO territory, 1 PR territory, and 2 CO (nests) territories in Phase 7 North site and 11 detections, 2 PO territories, and 1 PR territory in Phase 7 South.

Site: Phase 8

14.6 ha (36.1 ac)
Section: C2335

Phase 8 is 500 m (1,640 ft) north of Phase 7 North and separated by an agricultural field (see figure 4). It was planted with honey mesquite and alkali sacaton (*Sporobolus airoides*) in 2013, and scattered cottonwoods have naturally colonized (LCR MSCP 2012a, 2012b). The cottonwoods and mesquite are growing well and appeared healthy and green during the cuckoo breeding season. The site is bordered by agricultural fields to the south, the LCR to the east, and disturbed scrubland to the north and west. Dirt access roads surround the perimeter. In 2019, warning signs adjacent and west of Phase 8 indicated the use of dangerous pesticides, which may negatively impact covered species.

In 2019, there were two survey detections and no estimated territories at this site.

Cibola Valley

La Paz County, Arizona

Area: Cibola Valley Conservation Area (CVCA)

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 5). Each phase of the CVCA is described in annual reports and restoration development plans that are available at https://lcrmscp.gov/steer_committee/teccibolahnical_reports.html. Reclamation

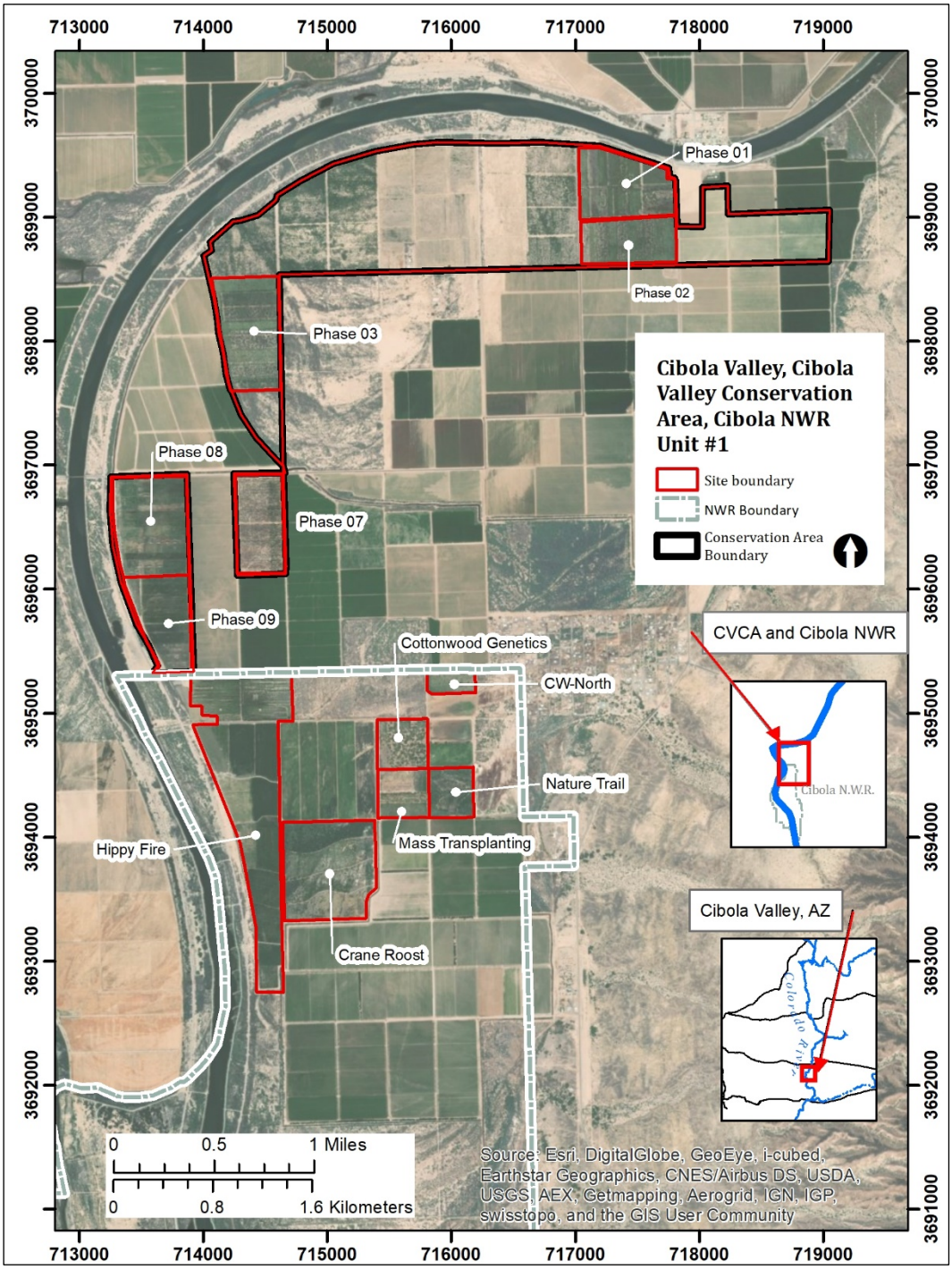

Figure 5.—The CVCA and Cibola NWR Unit #1, showing sites surveyed in 2019.

has implemented restoration activities on 412.4 ha (1,019 ac) of land, with hunting and public access managed by the Arizona Game and Fish Department. A mosaic of cottonwoods, Goodding's willows, and honey mesquite was planted to mimic the riparian communities historically present. Trees were planted in nine phases from 2006 to 2017; six of these phases were surveyed for cuckoos in 2019. The CVCA is now experiencing an increase in cuckoo detections, which in prior years was declining. This is likely due to the addition of new young habitat in Phases 7, 8, and 9.

Sites: Phase 1 North and Phase 1 South

37.2 ha (91.9 ac)
Sections: C2547, C2548

The CVCA Phase 1 site consists of six fields planted in 2006 (LCR MSCP 2007b, 2008b (see figure 5). The LCR flows approximately 100 m (328 ft) from the northern edge of the site. The dominant tree species include cottonwoods, Goodding's willows, and coyote willows. 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. In 2019, this site had many dying, downed, and stressed trees. The southeast corner of this plot suffered from a fire in 2014, which impacted much of the cottonwood and willow habitat at this site. Many Goodding's willows are now resprouting from the burned trunks. This phase was surveyed as two sites: Phase 1 North and Phase 1 South.

In 2019, Phase 1 North had no detections, and Phase 1 South had seven detections and two PO territories.

Site: Phase 2

27.5 ha (67.9 ac)
Section: C2528

Phase 2 was planted in 2006 (LCR MSCP 2007c, 2010e) (see figure 5) to create an additional 80 ac (approximate) of additional riparian habitat that shall be managed for covered species listed in the LCR MSCP Habitat Conservation Plan. The site is immediately 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. As in Phase 1, trees appear stressed, with many downed trees and limbs. The dense cottonwoods bordering the east and south of the site still appear green and healthy. Farm fields are located to the east and south, and Highway 78 is directly east. A regularly visited fenced yard used to store farm equipment is located just south of the southeast corner.

In 2019, there was one survey detection at this site.

Site: Phase 3 North and Phase 3 South

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, 670 m (2,198 ft) north of Phase 7, and 0.4 km (0.25 mi) east of the LCR (see figure 5). The site was planted in 2007 (LCR MSCP 2007d, 2010f). By 2019, most patches of coyote willows appeared water stressed and were dying or dead. The site has low canopy cover, except for the dense plantings of cottonwoods along the western border, which appear healthy. Dirt access roads line the perimeter and bisect the plantings, agricultural fields are located to the west, and restored or native vegetation surround the other three sides. This phase was divided in 2019 into Phase 3 North and Phase 3 South survey sites. The phase may have benefited by its proximity to the newly planted Phases 7 to 9.

In 2019, there were three survey detections and one PO territory in Phase 3 South and three detections and two PO territories in Phase 3 North.

Site: Phase 7

29.3 ha (72.3 ac)
Section: C2539

Phase 7 is located 670 m (2,198 ft) south of Phase 3, 400 m (1,312 ft) east of Phase 8, and 1.2 km (0.75 mi) east of the Colorado River (see figure 5). Plantings in 2015 converted the area from active agricultural fields to honey mesquite and cottonwoods, which along with earlier phases was designed to create a mosaic of native vegetation (Stegmeier et al. 2018a, 2018b).

In 2019, there were five survey detections, one PO territory, and two CO (one nest each in the cottonwood and honey mesquite plots) territories at this site.

Site: Phase 8

46.6 ha (115.2 ac)
Section: C2542

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 (see figure 5). 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 for bird and bat species covered under the LCR MSCP (Stegmeier et al. 2018c, 2018d). Phase 8 was first surveyed in 2018.

In 2019, there were nine survey detections, one PO territory, one PR territory, and one CO territory (nest) territory at this site.

Site: Phase 9

31.2 ha (77.2 ac)
Section: C2546

Phase 9 was planted in 2017 (Stegmeier et al. 2018d, 2018e) (see figure 5). It includes honey mesquite in east-west sinuous rows as well as cottonwoods, coyote willows, and baccharis. Phase 9 is immediately south of Phase 8. Halfway through the 2018 season, vegetation in the northeast corner of the site became suitable for cuckoo breeding, and a nest was found. The entire phase was first surveyed in 2019.

In 2019, there were seven survey detections, two PO territories, and one PR territory at this site.

Area: Cibola National Wildlife Refuge Unit #1 Conservation Area (Cibola NWR Unit #1)

La Paz County, California

Cibola NWR Unit #1 is 29.8 km (18.5 mi) south of Blythe, California, within the historical floodplain of the Colorado River (see figure 5). 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 historical channel still receives irrigation, and portions are maintained as wildlife habitat, while the new channel carries the main flow of the Colorado River and is extensively levied. Within the refuge, agricultural fields border tamarisk- and honey mesquite-dominated uplands. Most cuckoo habitat on the refuge is in conservation areas receiving varying degrees of irrigation. Eight sites were surveyed for cuckoos in 2019, including two sites previously reported each as two sites (Cottonwood Genetics/CW-North, and Mass Transplanting/Nature Trail), and two sites previously reported as one site (Crane Roost North and Crane Roost South). In addition, Hippy Fire is surveyed as three sites: Upper, Middle, and Lower. Each phase of Cibola NWR Unit #1 is described in annual reports and restoration development plans that are available at https://lcrmscp.gov/steer_committee/technical_reports.html.

Site: Cottonwood Genetics/CW-North

24.6 ha (60.9 ac)
Section: C2741

Cottonwood Genetics was planted in 2005 with about 1,000 trees propagated at a research greenhouse at Northern Arizona University for an university project conducted in association with Reclamation (Nelson 2007) (see figure 5). Researchers used the plantings to assess the influence of stand-level genetic diversity on communities and ecosystem processes. The site is a park-like grove of mature cottonwoods with an open understory. It is bordered by an agricultural field to the east, North 160 to the west, and Mass Transplanting to the south.

In 2019, there were seven survey detections and one PO territory found. It is surveyed together with CW-North.

CW-North is a small, open, structurally homogeneous plot planted in 2002 (see figure 5). It consists of a mostly cottonwood overstory and ground cover dominated by Bermudagrass (*Cynodon dactylon*). The plot is bordered on the north by Baseline Road and agricultural fields. Fallow fields of sparse tamarisk, arrowweed, and quailbush (*Atriplex lentiformis*) extend east and west. Cottonwood Genetics is 200 m (656 ft) to the southwest, separated by an agricultural field. The Nature Trail is 580 m (1,903 ft) to the south, separated by three agricultural fields. All sites were later incorporated into Cibola NWR Unit #1(LCR MSCP 2009d, 2009e; Stegmeier et al. 2018c, 2019).

There were no survey detections at CW-North.

Site: Crane Roost North

30.0 ha (74.0 ac)
Section: C2744

Crane Roost is surveyed as two sites, Crane Roost North and Crane Roost South (see figure 5). The North site incorporates an older plot originally planted in 2005, consisting of tall emergent cottonwoods and a grove of dense honey mesquite, mule-fat (*Baccharis salicifolia*), and tamarisk. To the south is a younger plot planted in 2009, consisting of cottonwoods, Goodding's willows, and coyote willows (LCR MSCP 2009d, 2009f).

In 2019, there were seven detections, one PR territory, and one CO (nest) territory at this site.

Site: Crane Roost South

27.4 ha (67.6 ac)
Section: C2743

Crane Roost South comprises more recently planted fields. Plantings from west to east, as in Crane Roost North, include coyote willows, Goodding's willows, cottonwoods, and honey mesquite (LCR MSCP 2009d) (see figure 5). The site contains surface salt deposits, resulting in shorter, more sparsely distributed trees, with several grassy meadows. The site is bordered by agricultural fields to the east, scrub vegetation to the south, and Lower Hippy Fire to the west. Trees in this area appear stressed, and some willows have defoliated tops but are resprouting from the base.

In 2019, there were six survey detections and two CO (nests) territories at this site.

Site: Upper Hippy Fire

37.9 ha (93.5 ac)
Section: C2745

Hippy Fire was developed in 2013 to create habitat for southwestern willow flycatchers, cuckoos, and other LCR MSCP covered species (LCR MSCP 2012c; Miller et al. 2017) (see figure 5). This site grew rapidly and was intermittently checked for cuckoos in 2014. It was first surveyed in 2015.

In 2019, there were seven survey detections, one PR territory, and one CO territory (nest, the first one found at this site) at this site.

Site: Middle Hippy Fire

49.3 ha (121.7 ac)
Section; C2746

Active agricultural land here was converted in 2017 to riparian forest to benefit LCR MSCP covered species (Stegmeier et al. 2018e, 2019) (see figure 5). The site is bordered by Upper Hippy Fire to the north and Lower Hippy Fire to the south. Several gravel and dirt roads surround the site, and an irrigation ditch borders the site to the east and north, with honey mesquite plantings and the LCR on the western border. The site was first surveyed in 2019.

In 2019, there were 12 survey detections, 1 PR territory, and 2 CO territories (nests) at this site.

Site: Lower Hippy Fire

49.6 ha (122.6 ac)
Section: C2747

Planted in 2016, the development of Lower Hippy Fire resulted in additional habitat to benefit the southwestern willow flycatcher, cuckoo, and other species covered in the HCP (Stegmeier et al. 2018f, 2018g) (see figure 5). The site is bordered by dirt and gravel access roads, an irrigation canal and Crane Roost to the east, the LCR to the west, and Middle Hippy Fire to the north.

In 2019, there were 11 survey detections and 3 PR territories at this site.

Site: Mass Transplanting/Nature Trail

22.7 ha (56 ac)
Section: C2742

This site combines two areas previously treated as two sites but typically surveyed by one surveyor in the same morning. Mass Transplanting, west of and adjacent to the Nature Trail, was planted in 2005 and 2006 and consists of cottonwoods and Goodding's willow, with open grassy areas (LCR MSCP 2007e) (see figure 5). Some open areas have been invaded by non-native Johnsongrass (*Sorghum halepense*).

The Nature Trail was first planted in 1999 (LCR MSCP 2007b) (see figure 5). The transect follows a gravel trail winding through the habitat. Species composition and height vary across the site, creating structural diversity. Cottonwoods dominate the higher canopy over 30% of the site. The understory includes Goodding's willows, honey mesquite, and screwbean mesquite (*Prosopis pubescens*). Much of the surrounding area is agricultural, and bordering the site north and east are seasonally flooded fields for wintering waterfowl. The site is invaded with Johnsongrass, and many willows and understory trees are dead or stressed.

In 2019, there were four survey detections, one PR territory, and one CO (nest) territory at this site. This was the first confirmed breeding noted in Mass Transplanting since surveys began here in 2008.

Yuma

Yuma County, Arizona

Area: Laguna Division Conservation Area (LDCA)

Yuma County, Arizona

The LDCA is located on Reclamation withdrawn lands along the LCR within the Laguna Division section of Reach 6 (see figure 1; figure 6). The LDCA is downstream from Imperial Dam and upstream of Laguna Dam and encompasses approximately 585 ha (1,200 ac). Each phase of the LDCA is described in annual reports and restoration development plans available at https://lcrmscp.gov/steer_committee/technical_reports.html. Prior to restoration, the area consisted of a mix of saltcedar (*Tamarisk* spp.) and mesquite (*Propospis* spp.) and wetlands along the abandoned river channel between the Laguna Settling Basin and the Mittry Lake Wildlife Area. The restoration project created a mosaic of riparian areas consisting of open water/marsh and trees planted from 2013 to 2015 (Chavez et al. 2019). Several meandering channels were constructed, and the hydrology of the site is managed to create and sustain the cottonwood-willow and honey mesquite land cover types in order to meet LCR MSCP conservation criteria for target species as outlined in the HCP (LCR MSCP 2004a). Baseline surveys in the remnant riparian areas from 2009 through 2012 (McNeil et al. 2013) detected a few migrant cuckoos using the area. Reach 1 was first surveyed in 2016, with Reach 2 added in 2018.

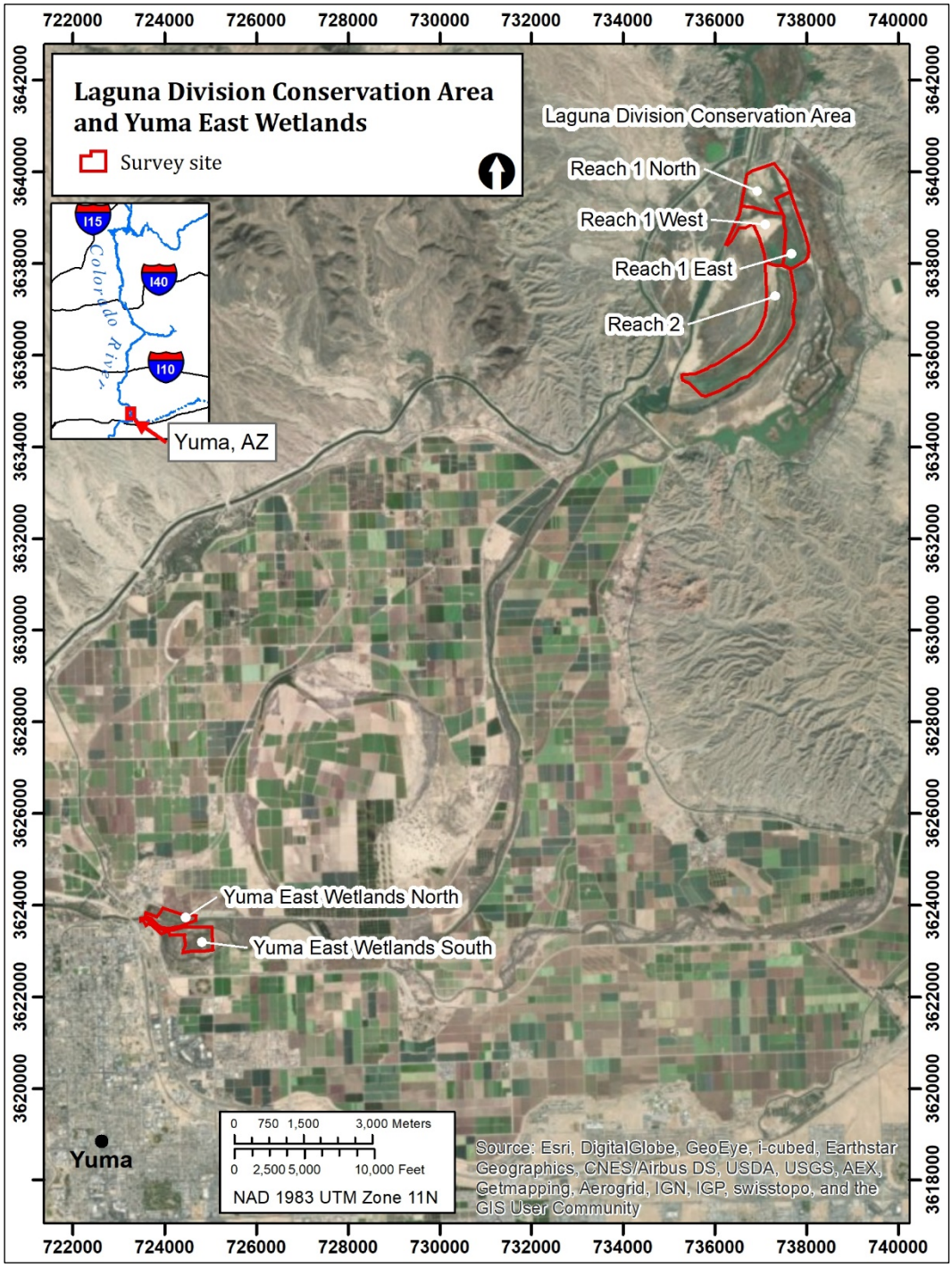

Figure 6.—The LDCA and YEW, showing sites surveyed in 2019.

Sites: Reach 1 East, Reach 1 North, Reach 1 West

225.8 ha (558.0 ac)
Sections: C4965, C4964, C4966

All planting in Reach 1 of the LDCA (see figure 6) was completed in April 2014. The plantings were stratified along a flowing channel to represent wetland, wetland transition, and upland riparian species (LCR MSCP 2012d). In 2019, the 5-year-old planted cottonwoods, Goodding's willows, and coyote willows in Reach 1 were still generally sparse and spindly, with intermittent dense and healthier patches. Several larger healthy patches skirt the open marsh areas. Cuckoos have been observed foraging in both the tall, denser cottonwoods and large honey mesquite plots. The site is difficult to survey due to dense marsh vegetation, islands, changing water levels, and tributaries of deep marsh and open water areas. This site is divided into three survey routes, Reach 1 East, Reach 1 West, and Reach 1 North, to ensure full survey coverage.

In 2019, Reach 1 East had six detections, one PO territory, and one PR territory; Reach 1 North had seven detections, one PO territory, and one PR territory; and Reach 1 West had five detections and one PO territory.

Site: Reach 2

211.7 ha (523.1 ac)
Section: C4963

Reach 2, planted in 2015 (LCR MSCP 2012d), is at an earlier successional stage than Reach 1 (see figure 6). The site is long and linear, and a thin ring of short cottonwoods abut the marshes. Some interior areas that line the deeper internal waterway contain taller and healthier-appearing cottonwoods and Goodding's willows. This site is difficult to survey due to changing water levels, marsh vegetation, and deep-water channels. It was previously surveyed from the road only, and in 2019, a second transect was added in the wet interior along lines of large trees.

In 2019, there were 13 survey detections and 2 PO territories at this site.

Area: Yuma East Wetlands (YEW)

Yuma County, Arizona

The YEW area is located along the banks of the LCR in the city of Yuma, Arizona (see figure 6). Until planting began in 2003, the area was a mix of exotic plants, trash dumps, and squatter camps. YEW is part of the Yuma Crossing Natural Heritage Area and is jointly managed by the City of Yuma, the Quechan Tribe, the Arizona Game and Fish Department, and private ownership. A mosaic of the marsh, cottonwood-willow, and honey mesquite land cover types were created from 2001 to 2014 (Brooks et al. 2018). Each phase of YEW is described in annual reports and restoration development plans that are available at

https://lcrmscp.gov/steer_committee/technical_reports.html. The Colorado River divides the area from east to west with YEW North and YEW South sites, which are surveyed separately. It is promoted as a recreation area with trails, a swimming area, picnic tables, and restrooms. The area is highly managed, with new plantings, vegetation clearing, and frequent irrigation. Site workers, vehicles, joggers, cyclists, and dog walkers are regular visitors. Noise disturbance can be high due to a diesel irrigation system, associated vegetation management, railroad traffic, and vehicular traffic on Interstate 8 to the west. This site is managed for LCR MSCP covered species, including riparian and marsh birds. During the breeding season from July to August, regular chain sawing and wood chipping were encountered near the 2018 nest site and near the new nest found in 2019.

Site: YEW North

26.8 ha (66.2 ac)
Sections: C4713

This site is immediately east of the Ocean-to-Ocean Bridge north of the LCR (see figure 6). The cottonwood-dominated area (previously Site J) to the north parallels the river and is connected to a small wetland area and Sunrise Park to the west. A large concrete drainage ditch runs through the mostly cottonwood and honey mesquite plantings. The irrigation system is powered by a noisy diesel irrigation pump. The site is bounded by a large leveed gravel road to the north and Quechan Tribal lands containing mixed exotic species. Squatter camps are nearby, and individuals are sometimes encountered on the road or as they come to collect water from the river. 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. This area is popular in the early morning with sunning birds and raptors perching on the dead trees. The river channel here is clogged with Giant Salvinia (*Salvinia molesta*).

In 2019, there were no survey detections at this site.

Site: YEW South

40.6 ha (100.3 ac)
Section: C4714

This site is east of the Ocean-to-Ocean Bridge south of the LCR (see figure 6) and consists of a mosaic of cottonwoods, Goodding's willows, and honey mesquite mixed with open areas. During the breeding season from July to August, chain sawing and wood chipping occurred near the 2018 nest site and near the new nest found in 2019. It is possible there was a second nest to the south in 2019 (several survey detections), but management activities hampered followup attempts.

In 2019, there were four survey detections, one PR territory, and one CO (nest) territory at this site.

Chapter 3 – Surveys

INTRODUCTION

Objectives of this project include documenting the presence of yellow-billed cuckoos in suitable habitat within the LCR MSCP study area and determining the breeding status in areas of activity. Standardized surveys and territory estimates continued in 2019 in six LCR MSCP conservation areas and in a stretch of the Bill Williams River NWR from Mineral Wash to Sandy Wash.

METHODS

Survey Sites

Sites surveyed in 2019 include all sites surveyed in 2018, except Cougar Point, which was removed after the first survey due to lack of suitable habitat, plus two new sites added in 2019 after becoming suitable at 2 years old: CVCA Phase 9 and Middle Hippy Fire (table 1; see chapter 2 for detailed descriptions of each site). Survey transects were added to Sandy Wash and Kohen Ranch. Additionally, some larger sites were divided into smaller sites beginning in 2019 to reflect what is able to be surveyed by an individual in a morning. This also reflects how the sites were surveyed in the past, with data from multiple surveyors previously combined for reporting now reported separately. PVER Phases 4, 6, and 7, CVCA Phases 1 and 3, and Crane Roost were each divided into two sites (Crane Roost North and Crane Roost South), and PVER Phase 5, LDCA Reach 1, Cibola NWR Unit #1, and Hippy Fire were each divided into three sites. In other cases, small sites typically surveyed by one person in a morning were sometimes combined to form larger sites (e.g., Mass Transplanting + Nature Trail and Cottonwood Genetics + CW-North are each now reported as one site.

Surveys

Four surveys were conducted per site in 2019 (Halterman et al. 2016), following the dates shown in table 2. Surveys were conducted on foot 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.

Table 1.—Sites surveyed for cuckoos in the LCR MSCP study area, 2019

Area	Site	Hectares	Acres
BLCA	Beal	35.5	87.8
Bill Williams River NWR East	Esquerra Ranch	73.9	182.6
	Cougar Point*	49.7	122.9
	Mineral Wash	41.0	101.2
	Kohen Ranch	68.5	169.3
	Gibraltar Rock	90.1	222.7
Bill Williams River NWR West	Sandy Wash	80.8	199.6
PVER	Phase 1	8.9	21.9
	Phase 2	31.6	77.9
	Phase 3	34	84.0
	Phase 4 North	28.4	70.2
	Phase 4 South	12.8	70.3
	Phase 5 North	33.7	83.3
	Phase 5 Triangle	28.3	70.2
	Phase 5 West	25.3	62.5
	Phase 6 North	46.7	115.5
	Phase 6 South	42.2	104.3
	Phase 7 North	45.5	112.6
	Phase 7 South	45.0	111.2
	Phase 8	44.7	110.5
CVCA	Phase 1 North	17.7	43.8
	Phase 1 South	19.5	48.0
	Phase 2	27.5	67.9
	Phase 3 North	21.9	54.3
	Phase 3 South	21.8	54.0
	Phase 7	29.3	72.3
	Phase 8	44.7	111.5
	Phase 9	31.2	77.2
Cibola NWR Unit #1	Mass Transplanting/ Nature Trail	22.6	55.9
	Cottonwood Genetics/ CW-North	24.6	60.9
	Crane Roost North	29.9	74.0
	Crane Roost South	27.3	67.6
	Lower Hippy Fire	49.6	122.6
	Middle Hippy Fire	49.3	121.7
	Upper Hippy Fire	37.8	93.5
LDCA	Reach 1	65.0	160.8
	Reach 1	78.1	193.0
	Reach 1	82.6	204.2
	Reach 2	211.7	523.1
YEW	YEW North	26.8	66.2
	YEW South	40.6	100.3

Table 2.—Cuckoo survey dates for the LCR MSCP study area, 2019

Survey period	Survey number	Survey dates
1	1	June 17 to June 30
2	2	July 1 to July 14
2	3	July 15 to July 28
3	4	July 29 to August 9

Surveys were conducted along one or more parallel transects spaced approximately 200 m (650 ft) apart, with survey points spaced every 100 m (328 ft) along transects. Survey points 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 ran along edges, such as on adjacent roads, for greater visual detectability or if the interior was inaccessible. Surveyors used Samsung Galaxy S8+ phones (Android operating system) with Collector for ArcGIS™ version 18.0.3, build 1033 (Esri) to locate survey points and record field data. During all field work, surveyors also recorded the presence of other LCR MSCP avian focal species (table 3). After field data collection each morning, data were synchronized to ArcGIS Online for processing.

Table 3.—Avian focal species monitored during field work in the LCR MSCP study area, 2019, referenced using American Ornithologists' Union (AOU) nomenclature

Scientific Name	Common Name	AOU code recorded
Empidonax traillii extimus	Southwestern willow flycatcher	WIFL
Coccyzus americanus[1]	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[2]	Sonoran yellow warbler	YEWA[2]
Piranga rubra	Summer tanager	SUTA
Rallus obsoletus yumanensis	Ridgway's rail[3]	CLRA
Laterallus jamaicensis coturniculus	California black rail	BLRA
Ixobrychus exilis hesperis	Western least bittern	LEBI
Micrathene whitneyi	Elf owl	ELOW

[1] Referred to as *Coccyzus americanus occidentalis* in the HCP (LCR MSCP 2004a).
[2] Referred to as *Dendroica petechia sonorana* (YWAR) in the HCP (LCR MSCP 2004a).
[3] Referred to as Yuma clapper rail in the HCP (LCR MSCP 2004a).

At each survey point, surveyors recorded the location, time, and presence of live cicadas. They then listened and watched for cuckoos for 1 minute. If a cuckoo was not detected, surveyors used an MP3 player and hand-held speaker to broadcast a 5-second cuckoo contact call (the "kowlp" call [Hughes 2015]) at approximately 70 decibels calibrated with a decibel meter before each survey, 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 cuckoo was detected, surveyors immediately discontinued call-playback and 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. Surveyors also recorded any observed breeding evidence, including carrying food or nesting material, copulations, juveniles, or nests. 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 cuckoo visually observed or heard during a survey, including any detected while traveling between survey points, was recorded as a new 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, although surveyors used their judgment to determine whether multiple detections within 300 m (984 ft) were of the same individual. It is usually difficult to tell individual cuckoos apart by call or appearance; however, individuals exhibiting unique calls or behaviors may be recognized by 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 high-density nesting areas has resulted in undercounting individuals and territories (Parametrix, Inc., 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 found ≤ 200 m (656 ft) apart during the season. Individuals detected 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) and were used to help determine breeding status.

Breeding Territory Estimates

Habitat patches were considered occupied if detections occurred in an area (generally < 100 m apart) during two or more surveys (i.e., at least 12 days apart). All survey detections were assessed by spatial location, observed behaviors, and dates to determine initial territories and categorize the breeding status for each territory as a possible (PO), probable (PR), or confirmed (CO) breeding territory (Halterman et al. 2016) (table 4). Fledglings or juveniles detected that could have come from a territory already counted were not counted as new territories.

Table 4.—Definitions for cuckoo breeding territory estimation

Term	Definition
Possible breeding territory (PO)	Detections within a 300–500 m area during at least two surveys and 12–14 days apart.
Probable breeding territory (PR)	Detections within a 300–500 m area during at least three surveys and 12–14 days apart, or PO territory plus purposeful food carry (single observation, bird does not eat food), stick carry (single observation), multiple incidents of alarm calls in same area, or PO territory plus pair exchanging multiple kowlp or alarm calls (not coos) within 100 m of one another.
Confirmed breeding territory (CO)	Observation of active nest (or multiple stick carries to nest being built), copulation, fledgling (unable to fly) with adult, or PR plus multiple food carries to same area, or distraction display (dropped wing).

Note that PO, PR, and CO counts estimate the number of breeding territories and not the number of breeding pairs, with each territory representing two adults typically associated with a single nest. Apart from the fact that many breeding territories are missed due to the cryptic nature and rapid nesting cycle of the species, other 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 one or both adults renesting following a successful or failed nest. The number of actual territories represents the number of pairs assuming two birds tend each nest and all pairs nest exactly once in a season. The true breeding population will be less than twice the number of territories if individuals nest more than once per season.

Breeding territory estimates were calculated based on PO, PR, and CO territory counts (see table 4). The CO territory count is the most conservative estimate of breeding territories. PR territories are based on solid observations and a sound definition (Halterman et al. 2016; McNeil et al. 2013) and, when summed with CO

territories, provides a reasonable estimate of breeding territories. The sum of all PO, PR, and CO territories provides the maximum estimate and likely overestimates the true number of breeding territories.

Followup Visits

After surveys, and on days in between survey visits, followup visits were conducted in areas of previous activity, both to determine breeding status and to resight seven cuckoos previously GPS-tagged in the study area that may still be wearing their harness with the attached GPS tag (see Parametrix, Inc., and SSRS 2019). Observations made during these followup visits were used to refine the breeding status of estimated territories, such as upgrading a PO to a PR or CO territory of breeding evidence was observed. A total of 233 followup visits were conducted.

RESULTS

From June 17 to August 9, 2019, 177 survey visits were conducted at 41 sites, yielding 263 survey detections (table 5). Overall detections peaked during survey 2 (early to mid-July), including at the PVER, the CVCA, and the LDCA (table 5). Detections peaked on survey 3 at the Bill Williams River NWR and the Cibola National Wildlife Refuge (Cibola NWR). A total of 77 estimated and confirmed breeding territories were recorded in the study area, including 31 PO, 26 PR, and 20 CO territories. Maps showing survey detections, estimated territories, and nests are in a separate document due to the confidentiality of breeding location data related to federally listed species.

Table 5.—Yellow-billed cuckoo survey results and breeding territory estimates, LCR MSCP study area, 2019

Area	Site	Detections by survey					Territories[A]		
		1	2	3	4	Total	PO	PR	CO
BLCA	Beal	0	1	0	1	2	1	0	0
	BLCA total	**0**	**1**	**0**	**1**	**2**	**1**	**0**	**0**
Bill Williams River East	Cougar Point	0	NA	NA	NA	NA	NA	NA	NA
	Esquerra Ranch	0	1	3	0	4	2	0	0
	Gibraltar Rock	0	0	2	0	2	0	0	0
	Kohen Ranch	0	3	2	2	7	1	1	0
	Mineral Wash	1	2	2	1	6	0	0	1
	Bill Williams River East total	**1**	**6**	**9**	**3**	**19**	**3**	**1**	**1**
Bill Williams River West	Sandy Wash	1	0	1	0	2	1	0	0
	Bill Williams River West total	**1**	**0**	**1**	**0**	**2**	**1**	**0**	**0**
PVER	Phase 01	1	1	1	1	4	0	0	1
	Phase 02	2	3	1	0	6	0	1	0
	Phase 03	2	0	2	2	6	0	0	1
	Phase 04 North	3	1	2	2	8	0	2	1
	Phase 04 South	0	3	2	1	6	1	0	0
	Phase 05 North	1	2	0	3	6	0	1	0
	Phase 05 Triangle	3	3	2	1	9	1	1	0
	Phase 05 West	2	4	3	2	11	1	1	1
	Phase 06N	7	5	4	4	20	3	1	1
	Phase 06S	1	5	5	4	15	3	3	1
	Phase 07N	4	3	2	3	12	1	1	2
	Phase 07S	3	4	3	1	11	2	1	0
	Phase 08	0	2	0	0	2	0	0	0
	PVER total	**29**	**36**	**27**	**24**	**116**	**12**	**12**	**8**

Table 5.—Yellow-billed cuckoo survey results and breeding territory estimates, LCR MSCP study area, 2019

Area	Site	Detections by survey					Territories[A]		
		1	2	3	4	Total	PO	PR	CO
CVCA	Phase 01 North	0	0	0	0	0	0	0	0
	Phase 01 South	1	4	2	0	7	2	0	0
	Phase 02	0	1	0	0	1	0	0	0
	Phase 03	2	3	1	0	6	3	0	0
	Phase 07	0	1	2	2	5	1	0	2
	Phase 08	2	2	3	2	9	1	1	1
	Phase 09	0	2	2	3	7	2	1	0
	CVCA total	**5**	**13**	**10**	**7**	**35**	**9**	**2**	**3**
Cibola NWR Unit #1	Cottonwood Genetics/CW-North	1	2	3	1	7	1	0	0
	Crane Roost North	3	0	2	2	7	0	1	1
	Crane Roost South	0	1	3	2	6	0	0	2
	Lower Hippy Fire	2	3	4	2	11	0	3	0
	Middle Hippy Fire	3	2	3	4	12	0	1	2
	Mass Transplanting/Nature Trail	1	1	1	1	4	0	1	1
	Upper Hippy Fire	1	3	2	1	7	0	1	1
	Cibola NWR Unit #1 total	**11**	**12**	**18**	**13**	**54**	**1**	**7**	**7**
LDCA	Reach 01 East	1	2	1	2	6	1	1	0
	Reach 01 North	2	4	0	1	7	1	1	0
	Reach 01 West	0	2	2	1	5	1	0	0
	Reach 02	2	5	4	2	13	2	0	0
	LDCA total	**5**	**13**	**7**	**6**	**31**	**5**	**2**	**0**
YEW	YEW North	0	0	0	0	0	0	0	0
	YEW South	0	1	1	2	4	0	1	1
	YEW total	**0**	**1**	**1**	**2**	**4**	**0**	**1**	**1**
All sites	**Grand total**	**52**	**82**	**73**	**56**	**263**	**31**	**26**	**20**

[A] PO = possible breeding territory, PR = probable breeding territory, and CO = confirmed breeding territory.

Chapter 4 – Nests, Resights, and Banding

INTRODUCTION

Prior to 2016, intensive nest searching and monitoring were included in the scope of work to detect changes in reproductive performance, assess population health, and create solutions to species decline (DeSante et al. 2005; Hemmings et al. 2012a, 2012b). After 2015, nest searching and monitoring were removed from the project, although field activities such as surveys and followup visits to determine breeding status or to resight adults can sometimes lead to nests being found. These nests are not typically monitored; however, some nest monitoring may occur to determine the banded status of adults, and some monitoring occurred at nests of conservation interest, such as nests incubated long past their estimated hatching date. Without regular nest monitoring, nest fate and parentage of most nests remain unknown, and results may not be comparable over previous years.

METHODS

Nests

All field work adhered to the Ornithological Council's Guidelines to the Use of Wild Birds in Research (Fair et al. 2010). Field personnel were trained in safe and effective techniques for approaching potential cuckoo nests, emphasizing safety and minimization of disturbance to breeding birds. Yellow-billed cuckoos 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 after at least 30 minutes to revisit the site. Observers checked for predators before visiting a potential nest and minimized time spent at nests. Flagging may increase predation risk and was used sparingly, placed at least 10 m (32.8 ft) away from nests when possible. To confirm breeding evidence, followup visits were made in areas with survey detections on the same or another day.

Field crews searched for nests at sites where breeding had not previously been documented. As cuckoos may respond to broadcast survey calls from the nest, during or after surveys all accessible suitable vegetation surrounding detections was briefly searched (Martin and Geupel 1993). Another technique used the fact that nesting pairs share incubation duties and often vocalize during nest exchanges (Hughes 2015; Halterman 2009; Potter 1980). Localized activity or behavioral clues were also followed up on (e.g., food and stick carries, and alarm calls). Cuckoo nests were confirmed by stick nests containing one or more bluish eggs or cuckoo chicks. Recently used cuckoo nests were identified by the presence of small bluish egg fragments in or below the nest. After locating a nest, flagging was placed at least

10 m (32.8 ft) away so observers could relocate or avoid the nest, and a Global Navigation Satellite System location with distance and direction to the nest was recorded. A more accurate position was sometimes recorded after nesting activity had ceased. Nest site characteristics such as nest substrate height, species, and nest height, stage, and the banded status of adults were also recorded if known. All observations made near active nests were completed as quickly as possible to limit disturbance to nesting birds.

Because banded cuckoos are typically easiest to resight while feeding nestlings, observers sometimes monitored nests to determine nest stage and to resight banded adults. To determine nest stage, observers watched nests through binoculars or a spotting scope. If nests were low enough (below 7 m [23 ft]), experienced personnel sometimes used a telescoping mirror pole to check nest contents. Most nest contents were not observed, and nests were typically not monitored to determine fate. Nestlings were banded opportunistically at 3–6 days if accessible (see below, "Banding"). Nests were judged successful if at least one young fledged, determined by detecting an adult or fledgling near the nest ≤ 2 days from the estimated fledge date. Nests were considered failed if found damaged or destroyed, with large eggshell fragments or remains, or empty before the earliest possible fledge date (approximately 6 days after hatching) with no further activity detected nearby. Nests were considered deserted or abandoned if intact eggs or live chicks were present with no further parental activity detected. Multiple females' eggs in one nest was suggested by the appearance of two eggs in one 24-hour period during laying, or the appearance of a new egg three or more days after laying had apparently ceased (MacWhirter 1989), based on observations that cuckoos typically lay one egg per day until clutch completion (Jay 1911; Potter 1980).

Resights

Field crews attempted to resight previously banded cuckoos by observing, with binoculars or photographing the legs of, all cuckoos detected during field work. The main objective was to resight up to seven cuckoos previously fitted with GPS tags in 2014 and 2015 and not yet recaptured (Parametrix, Inc., and SSRS 2019). If a band color combination suggested a GPS-tagged bird, a crew immediately visited the area to locate the bird. If a GPS bird was positively resighted, a banding crew would visit the area as soon as possible to attempt to recapture it (see below).

Banding

In 2019, up to two netting attempts per year were included in the scope of work to recapture cuckoos previously fitted with GPS tags. If a GPS-tagged bird was resighted, up to two attempts would be made to recapture the bird to remove the GPS device and download the data. If no birds carrying GPS tags were resighted or

captured, other options were proposed, one being the capture of two birds at a site with no previous capture attempts. If no GPS-tagged birds were resighted, and no capture attempts were made in 2019, these attempts would carry over into upcoming years. For example, two unused capture attempts in 2019 would carry over into 2020, when four attempts could be made.

To capture adult cuckoos, a suitable net lane, such as a gap in the vegetation, was found or created, and a modified target mist net technique was used (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). Recorded vocalizations were sometimes broadcast from speakers on either side of the mist net to lure a cuckoo into the net. Capture attempts ceased when temperatures reached 40 °C (104 °F) or when cuckoos became unresponsive.

Unbanded cuckoos newly captured in 2019 were banded with a silver 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 (3.5-ounce) Pesola® or 400-gram (14.1-ounce) 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. 2015). For future sexing of birds, a small amount of blood was extracted from the brachial vein of each newly captured cuckoo, placed on filter paper, and dried.

RESULTS

Nests

Between June 18 and August 5, 18 yellow-billed cuckoo nests were found in the study area (table 6), including 1 nest at Bill Williams River East (Mineral Wash), 6 at the PVER (1 in Phase 3, 1 in Phase 5 West, 1 in Phase 6 North, 1 in Phase 6 South, 2 in Phase 7 North), 3 at the CVCA (2 in Phase 7, 1 in Phase 8), 7 at Cibola NWR Unit #1, 1 in Crane Roost North, 2 in Crane Roost South, 2 in Middle Hippy Fire, 1 in Upper Hippy Fire, 1 in Mass Transplanting), and 1 at the YEW South site. Four nests were found directly after surveys; the rest were found during followup visits while attempting to resight birds or determine breeding status. Known nesting activity began June 28 at PVER Phase 6 and ended on August 6 at Bill Williams River East (Mineral Wash). Most nests were located in cottonwoods (n = 11), followed by Goodding's willow (n = 5) and honey mesquite (n = 3).

Table 6.—Yellow-billed cuckoo nests found in the LCR MSCP study area, 2019

Area	Site	Nest #	Date found	Tree sp.[A]	Tree height (m)	Nest height (m)
Bill Williams River East	Mineral Wash	1	August 6	SALGOO	10	5
PVER	Phase 3	1	July 9	POPFRE	22	16.8
	Phase 5 West	1	July 27	SALGOO	9.5	4.3
	Phase 6 North	1	June 28	POPFRE	16	10.6
	Phase 6 South	1	July 30	POPFRE	17	8.2
	Phase 7 North	1	July 25	SALGOO	13	9
	Phase 7 North	2	July 26	PROGLA	5.5	2.8
CVCA	Phase 7	1	July 11	POPFRE	14	4
	Phase 7	2	August 5	PROGLA	5	2
	Phase 8	1	July 5	POPFRE	9	3.9
Cibola NWR Unit #1	Crane Roost North	1	July 18	PROGLA	7	4
	Crane Roost South	1	July 23	SALGOO	9	2.4
	Crane Roost South	2	July 30	POPFRE	16	6.4
	Mass Transplanting	1	July 29	POPFRE	13	9.3
	Middle Hippy Fire	1	July 8	POPFRE	8	2.8
	Middle Hippy Fire	2	July 18	POPFRE	11	5.3
	Upper Hippy Fire	1	July 1	SALGOO	7.4	3.4
YEW	YEW South	1	August 1	POPFRE	10	8

[A] SALGOO = Goodding's willow, POPFRE = Fremont cottonwood, and PROGLA = honey mesquite.

Nest fate was not determined for most nests, though some fates were discovered during attempts to resight nesting adults; 5 of the 18 nests found were known to have failed. In two nests, CVCA 8 Nest 1 and PVER 7 Nest 2, the entire clutch failed to hatch. These nests were found with full clutches, and after the normal incubation period of 10–11 days, they were found abandoned. Two other nests, Mass Transplanting and PVER 6 North Nest 1, were too high to check but were suspected to have been abandoned before hatching, due to a lack of any evidence of hatching (such as broken egg shells below the nest or food carries to the nest), and nest abandonment before the projected fledge date. At one other failed nest, CVCA 7 Nest 1, whole crushed eggs were found below the nest, either due to a predator or strong winds (see below). Seven nests were known to have fledged at least one young: PVER 5 West Nest 1, CVCA 7 Nest 2, Crane Roost North Nest 1, Middle Hippy Fire Nests 2 and 3, and Upper Hippy Fire Nest 1. Ten chicks were opportunistically banded from six low nests (see above, "Banding").

Notable Nests

CVCA7 Nests 1 and 2

CVCA Phase 7 was planted in 2015 with honey mesquite in the west section and cottonwoods in the east section. As in the previous year, cuckoos were observed using both vegetation types for foraging, and in 2019, one nest was found in each vegetation type. Nest 1, the first cuckoo nest found at this site, was found on July 11 in an approximately 14-m-high cottonwoods on the eastern edge of the plot, around 4 m high. At that time, two eggs were visible through the flimsy stick nest. The nest failed sometime between July 14 and 19, when two broken eggs were found below the nest. The area had experienced recent high winds.

Nest 2 was found on August 5 near the western edge of the site, 2 m high in a small honey mesquite. One or more adults from Nest 1 may have renested at Nest 2, as there were 17 days between Nest 1 failing and the finding of Nest 2, though no adults were ever resighted. Nest 2 contained a newly hatched chick (N1) and two eggs (figure 7, taken 4 days later), one (E1, figure 8) with a small hole assumed to be an emerging hatchling. The nest was revisited on August 9, and it contained three eggs. E1 appeared to be in the same stage and, on closer inspection, was found to contain a dead chick. The single nestling fledged, and the other two eggs never hatched. The two whole eggs were candled (a weak light source was held behind the egg to observe the developmental stage of the embryo), and both appeared undeveloped. The adults left the area soon after the chick fledged.

Figure 7.—CVCA 7 Nest 2, nestling and three eggs, August 9, 2019.
Egg 1 (E1) chick died in shell; Eggs 2 and 3 never hatched. (Photo by D. Tracy.)

Figure 8.—CVCA7 Nest 2 Egg 1 (E1), chick in shell.
(Photo by S. McNeil.)

Yuma East Wetlands South

This site was planted with a mix of cottonwoods, honey mesquite, and baccharis. It is managed as a recreation area, and some sections are away from the river where the roads are not regularly used. The first cuckoo nest here was found in 2018 (Parametrix, Inc., and SSRS 2019). The 2019 nest (figure 9) was < 100 m west of the 2018 nest. The cottonwood nest tree was in a small grove of cottonwoods, mesquite, and baccharis near a large opening. It was found after a survey, after birds had been detected in the area on two surveys. The nest was determined successful when a fledgling was heard away from the nest during a followup visit. The following day the nest was found to contain one small and one large chick. The adults were captured and banded at the request of Reclamation (see above, "Banding"). This may provide information on site fidelity and dispersal from this site.

During the cuckoo breeding season, July and August 2019, regular chain sawing occurred in the area near the 2018 and 2019 nests (figure 10). A supervisor spoke directly to the workers about the potential disturbance and reported this to Reclamation. When the surveyors returned for the next survey, they found the disturbance had continued and now included the chipping of cut vegetation (figures 11 and 12).

Figure 9.—YEW Nest 1 (red circle marks nest location).
Nest is in a small cottonwood with a honey mesquite/ baccharis understory. (Photo by S. McNeil.)

Figure 10.—Chainsaw crew at YEW South cutting in an area of survey detections.
(Photo by D. Tracy.)

Figure 11.—Piles of vegetation cleared and stacked along roads and canals at YEW South.
(Photo by D. Tracy.)

Figure 12.—Chipping of cut vegetation at YEW South.
(Photo by S. McNeil.)

Abandoned Nests

Two nests, PVER Phase 7 Nest 2 and CVCA Phase 8 Nest 1, were found to have been abandoned with unhatched eggs after a 10+ day incubation period. Both nests appeared to have sufficient canopy cover. The CVCA nest in a cottonwood was found July 5, with two eggs being incubated. It appeared abandoned by July 19, still with two eggs, with no further activity detected in the area.

The PVER nest was found in a honey mesquite with three eggs in the incubation stage on July 25 (figure 13). The nest, still with three eggs, was abandoned by August 1, and no adults were detected in the area again.

Figure 13.—CVCA 8 Nest 1 with two abandoned eggs.
(Photo by S. McNeil.)

Failed, Unknown Cause

PVER 6 Nest 1 was found on June 26 in a cottonwood too high to determine the contents, though the nest tree was easy to access next to a dirt road. The nest was first monitored by scope on June 29 to identify the adults and stage (incubation). On July 13, after the projected hatch date of July 5 had long passed with no feeding observed, the nest was again monitored with the scope. The male and female both brought insects to the nest, but no chicks were ever seen to respond, and the parents eventually ate the insects and flew away. The nest appeared abandoned the next day, July 14, at 19 days.

Mass Transplanting Nest 1 was the first nest found at this site, and the site has had few survey detections over the years. The site has a relatively open canopy, with sunlight allowing grass to grow as a ground cover. Two birds were heard calling in the area after the July 26 survey, and on July 29, the nest was found 13 m (43 ft) high in a tall, bowed cottonwood. The adults were only observed incubating, with no evidence of hatching or feeding. By August 9, the nest appeared to be abandoned, with leaves seen in the nest and no birds detected in the area. No evidence of predation or hatching was observed.

PVER 5 Nest 1 was found on July 27 in a Goodding's willow, containing two eggs. Just one egg hatched, and on August 5, the chick was opportunistically banded. It appeared below normal size and weight for a 5-day-old. On August 6, the nest was empty, and because the chick was considered old enough to fledge and both adults were detected near the nest, it was considered successful.

Resights

Eight cuckoos banded in previous years were positively resighted in 2019 (table 7). Of note was a sixth-year (6Y) female originally banded as a chick from PVER Phase 6 and resighted at Crane Roost North. It was the first resight of this bird since being banded. No GPS-tagged cuckoos were positively resighted in 2019.

Table 7.—Cuckoos resighted in the LCR MSCP study area, 2019

Resight site	Resight date	Bird ID[a]	Color bands[b]	Age[c]	Sex[d]	Original capture site	Original capture date
Crane Roost North	July 3	JAG	Lv-Bk/R	6Y	F	PVER Phase 6 South	July 24, 2014
Crane Roost North	July 3	GMW	mB-lB/R	4Y	F	Crane Roost South	July 26, 2016
PVER Phase 7 North	July 7	FRL	S/Lv-Ag-Lv	A5Y	M	PVER Phase 7 South	July 3, 2015
PVER Phase 6 South	July 10	HOT	S/lB-mB	A5Y	M	PVER Phase 7 North	July 20, 2015
PVER Phase 6 North	July 10	SER	S/W-Lv-W	A7Y	M	PVER Phase 5 North	July 12, 2013
PVER Phase 6 South	July 17	CHC	S/lB-G	A5Y	F	PVER Phase 7 North	July 29, 2015
PVER Phase 7 South	July 25	ACO	R/O-V	A4Y	F	PVER Phase 6 South	July 10, 2016
PVER Phase 6 South	July 29	VBO	S/Ag-Y	ASY	F	PVER Phase 7 South	July 31, 2017

[a] Bird ID: unique three-character identifier of the individual cuckoo.
[b] Color bands (left / 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, W = white, Y = yellow, A hyphen (-) indicates a split band consisting of two or three colors.
[c] Age: 4Y = fourth year, 6Y = sixth year, ASY = after second year, A4Y = after fourth year, A5Y = after fifth year, and A7Y = after seventh year.
[d] Sex (confirmed by DNA test): F = female, and M = male.

Banding

As no GPS-tagged cuckoos were positively resighted in 2019, the option was exercised to band birds at a site with no previous banding, and two nesting adults at YEW were captured and banded near the nest on August 8 (table 8). Additionally, 10 chicks were opportunistically banded from low nests (table 8).

Table 8.—Cuckoos newly banded in the LCR MSCP study area, 2019

Date banded	Site	Age[A]	Band number	Bird ID[B]	Color bands[C]
August 8	YEW South	AHY	1212-27570	ALT	S/mB-R-mB
August 8	YEW South	AHY	1713-67975	VER	S/Lv-G-Lv
July 8	Upper Hippy Fire	L	1202-68092	N1 C1	W-O-W/S
July 8	Upper Hippy Fire	L	1202- 68091	N1 C2	G-R-G/S
July 8	Upper Hippy Fire	L	1202- 68093	N1 C3	Lv-mB-Lv/S
July 8	Middle Hippy Fire	L	1202-68094	N2 C1	Lv/S
July 29	Middle Hippy Fire	L	1212-27566	N3 C1	lB-R/S
July 29	Middle Hippy Fire	L	1212-27567	N3 C2	G-Lv/S
July 29	Middle Hippy Fire	L	1212-27568	N3 C3	Lv –Bk/S
July 28	Crane Roost South	L	1202-68097	N1 C1	R-W-R/S
July 29	Crane Roost South	L	1212-27565	N1 C2	O/S
August 9	PVER Phase 5 West	L	1212-12757	N1 C1	R-mB-R/S
August 9	CVCA Phase 7	L	1212-12758	N1 C1	mB-Y/S

[A] Age: AHY = after hatching year (adult), and L = local (locally hatched young).
[B] Bird ID: unique three-character identifier of adult or nest (N) and chick (C) number of young.
[C] Color bands (left/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, Y = yellow. A hyphen (-) indicates a split band consisting of two or three colors.

DISCUSSION

Changes in annual survey detections and estimated territories could be related to several factors, including changes in data collection methods in 2015 and again in 2019, and a late contract award causing the hiring of less-experienced surveyors. Declines in survey detections, which are collected with the same level of effort and following a standardized protocol, may point to waning habitat suitability, particularly at older planted sites (Parametrix, Inc., and SSRS 2019). Dying and stressed Goodding's and coyote willows, cottonwoods, and honey mesquite, reducing the amount of available breeding habitat, were observed in 2019 at the PVER, the CVCA, and Cibola NWR Unit #1. Yellowing of trees and early leaf drop in cottonwoods observed at the PVER could be a sign the trees are experiencing stress, such as from insects or disease (U.S. Department of Agriculture 1975). Reduction of leaf mass or canopy cover would limit the high canopy cover desired by nesting cuckoos (McNeil et al. 2013). Cottonwoods have declined throughout the West due to a fungal disease and likely exacerbated by drought (Trouillas and Gubler 2016). These changes may also affect insect productivity and biomass.

Speculation that birds previously nesting or born at the PVER might be drawn to the large acreage of younger habitat now available at CVCA Phases 7–9 and at the Cibola NWR (Parametrix, Inc., and SSRS 2019) received some validation when a chick banded at the PVER in 2014 was resighted at the Cibola NWR in 2019. With the removal of banding from the scope of work after 2016 and the subsequent reduction in sightings of banded birds, it will not be possible to determine if this is occurring regularly.

Abandoned nests and unhatched eggs remain a concern. Nests abandoned with whole clutches were also observed in 2014 (three nests, Parametrix, Inc., and SSRS 2015), 2015 (three nests, Parametrix, Inc., and SSRS 2016a), 2017 (one nest, Parametrix, Inc., and SSRS 2018), and 2018 (five nests, Parametrix, Inc., and SSRS 2019). Unlike in 2015 when canopy cover above the abandoned nests were atypically low, both nests abandoned in 2019 appeared to have sufficient cover. Birds may abandon nests due to perceived threats, predators, or human disturbance (Halterman et al. 2016). Embryos may also die, and eggs may not hatch due to many reasons, including infertile eggs, exposure to extreme heat (radiant or ambient temperature), and low humidity (Parametrix, Inc., and SSRS 2019). Embryonic death can occur early during organ formation or immediately before hatching. Common causes include inbreeding, nutritional deficiencies, incubation problems (too cool or hot), and bacterial or viral infection (Rideout 2012). Embryonic death at the end of incubation may occur after a chick has created a small pip hole to breath external air. Low humidity or high ambient temperature causes the egg and shell to harden and dry (Rideout 2012). The chick becomes exhausted and dehydrated, dying a quarter to halfway out of the shell as it sticks to the membrane. This might be what happened to the partially hatched egg at CVCA Phase 7 Nest 2.

One or both adults may leave a nest once they realize the eggs will not hatch, in which case abandonment is due to the non-viability of eggs, through inbreeding or environmental causes. Changes to the sites, such as less food or less suitable habitat, may cause adults to be off nests longer to maintain their own breeding condition, leaving the nest exposed to extreme environmental conditions. Temperatures at sites typically reach lethal levels to bird eggs (40.5 to 44 °C [104.9 to 111.2 °F]) (Conway and Martin 2000; Webb 1987). Adults may also spend more time and energy to keep eggs or nestlings from overheating by providing shade or gular panting. This may also have been the case in a third nest (CVCA 7 Nest 2) where three of four eggs never hatched.

The proportion of eggs failing to hatch in wild bird populations was estimated to be 12% in house sparrows (*Passer domesticus*) (Stewart and Westneat 2012), 12% in 64 species (Morrow et al. 2002), and 11% in 99 species (Spottiswoode and Møller 2004). Higher non-hatching rates may indicate an underlying problem warranting investigation (Rideout 2012). Reduced hatching is a common characteristic of threatened species with a small population size (Hemmings et al. 2012a, 2012b; Jamieson and Ryan 2000). Most hatching failures (88–100%) result from early embryonic death, an expected outcome of inbreeding depression (Hemmings et al.

2012a, 2012b), and in some cases, hatching failure can be attributed to inbreeding, due to a positive correlation with mean relatedness between breeding pairs (Spottiswoode and Møller 2004). Infertility may also be an inherent result of conflict over fertilization between the sexes in polyandrous species such as the cuckoo, either from excess sperm entering the egg or over-efficient barriers to such fertilizations (Morrow et al. 2002). The current lack of understanding of the evolution of infertility suggests it may result from complex interactions among several factors (Morrow et al. 2002), and more research would be needed to understand cuckoo hatching failures. The successful hatching and recruitment of as many young as possible in the LCR region will be important for the recovery of this threatened population.

Regarding the disturbance at YEW, considering both adults and young often return to their previous breeding or natal site (Parametrix, Inc., and SSRS 2019), any disturbance to sites during the breeding season may impact site fidelity. Noise can also interfere with breeding vocalizations and pair bonding (Goodwin 2009). Cuckoo nests are frequently found on edges of clearings, including along canals, trails, and roads. To minimize adverse impacts to nesting and young birds, it is recommended that vegetation crews refrain from activities in the area from May to September and that major cutting occurs in winter.

LITERATURE CITED

Anderson, B.W. and R.D. Ohmart. 1984. Vegetation Type Maps: Lower Colorado River. Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada.

Bean, D.W., P. Dalin, and T.L. Dudley. 2012. Evolution of critical day length for diapause induction enables range expansion of *Diorhabda carinulata*, a biological control agent against tamarisk (*Tamarix* spp.). Evolutionary Applications 5:511–523.

Bloodworth, B.R., P.A. Shafroth, A.A. Sher, R.B. Manners, D.W. Bean, M.J. Johnson, and O. Hinojosa-Huerta. 2016. Tamarisk Beetle (*Diorhabda* spp.) in the Colorado River Basin: Synthesis of an Expert Panel Forum. Scientific and Technical Report No 1. Colorado Mesa University. https://www.researchgate.net/publication/292135370_Tamarisk_beetle_Diorhabda_spp_in_the_Colorado_River_basin_synthesis_of_an_expert_panel

Brooks, J., B. Raulston, and B. Blasius. 2018. Yuma East Wetlands, 2017 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2017/e28_annrep_2017.pdf

Central Arizona Project (CAP). 2018. Alamo Dam Release. March 2018. https://www.cap-az.com/departments/water-operations/alamo-releases

Chavez, A., C. Dodge, B. Blasius, and J. Knowles. 2019. Laguna Division Conservation Area, 2018 Annual Report. Prepared for the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2018/e27_annrep_2018.pdf

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

DeLoach, C.J., P.A. Lewis, J.C. Herr, R.I. Carruthers, J.L. Tracy, and J.L. Johnson. 2003. Host specificity of the leaf beetle, *Diorhabda elongata deserticola* (Coleoptera: Chrysomelidae) from Asia, a biological control agent for saltcedars (*Tamarix*: Tamaricaceae) in the western United States. Biological Control 27:117–147.

DeSante, D.F., M.P. Nott, and D. Kaschube. 2005. Monitoring, modeling, and management: why base avian monitoring on vital rates and how should it be done? Pages 795-804 *in* C.J. Ralph and T.D. Rich (editors). Bird Conservation Implementation and Integration in the Americas. General Technical Report PSW-GTR-191. U.S. Department of Agriculture, U.S. Forest Service, Albany, California..

DeSante, D.F., K.M. Burton, P. Velez, D. Froehlich, and D. Kaschube. 2015. Monitoring Avian Productivity and Survivorship (MAPS) Manual, 2015 Protocol. The Institute for Bird Populations, Point Reyes Station, California. http://www.birdpop.org/docs/pubs/DeSante_et_al_MAPS_Manual_2015.pdf

Fair, J., E. Paul and J. Jones. 2010. Guidelines to the Use of Wild Birds in Research. Washington, D.C.: Ornithological Council. www.nmnh.si.edu/BIRDNET/guide

Federal Register. 2014. Volume 79, No. 192 / Friday, October 3, 2014 /Proposed Rules.

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

Goodwin, S.E. 2009. Patch landscape, and soundscape effects on the forest bird community in the national parks of the National Capital Region. Thesis. University of Delaware, Newark.

Halterman, M.D. 2000. Population Status of the Yellow-billed Cuckoo at the Bill Williams River NWR, Alamo Dam, Arizona, and Southern Nevada: Summer 2000. Report submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada.

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

Halterman, M.D., M.J. Johnson, J.A. Holmes, and S.A. Laymon. 2016. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of Yellow-billed Cuckoo: U.S. Fish and Wildlife Techniques and Methods. 45 p.

Hannon, K., B. Raulston, C.J. Ronning, and B. Blasius. 2018. Planet Ranch Conservation Area, 2017 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2017/e21_annrep_2017.pdf

Hemmings, N.L., J. Slate, and T.R. Birkhead. 2012a. Inbreeding causes early death in a passerine bird. Nature Communications 3:863.

Hemmings, N.L., West, N., and T.R. Birkhead. 2012b. Causes of hatching failure in endangered birds. Biology Letters 8: 964–967. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3497133/

Hughes, J.M. 2015. Yellow-billed cuckoo (*Coccyzus americanus*) *in* A. Poole and F. Gill (editors). The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. https://birdsna.org/Species-Account/bna/species/418/articles/introduction

Jamieson, I.A. and C.J. Ryan. 2000. Increased egg infertility associated with translocating inbred takahe (*Porphyrio hochsteetteri*) to island refuges in New Zealand. Biological Conservation 94:107–114. https://www.otago.ac.nz/threatenedbirdgroup/Publications_files/Jamieson&Ryan_2000.pdf

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

Johnson, M.J., S.L. Durst, C.M. Calvo, L. Stewart, M.K. Sogge, G. Bland, and T. Arundel. 2008. Yellow-billed Cuckoo Distribution, Abundance, and Habitat Use Along the Lower Colorado River and its Tributaries, 2007 Annual Report. U.S. Geological Survey Open-File Report 2008-1177.

Lower Colorado River Multi-Species Conservation Program. 2004a. Lower Colorado River Multi-Species Conservation Program, Volume II: Habitat Conservation Plan, Final. December 17 (J&S 00450.00). Sacramento, California. https://www.lcrmscp.gov/publications/hcp_volii_dec04.pdf

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

_____. 2006a. Palo Verde Ecological Reserve Restoration Development Plan: Phase 1. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e04_phase1_2006.pdf

_____. 2006b. Palo Verde Ecological Reserve Annual Report 2006. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e04_annrep_2006.pdf

_____. 2006c. Palo Verde Ecological Reserve Restoration Development Plan: Phase 2. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e04_phase2_2006.pdf

_____. 2007a. Palo Verde Ecological Reserve Development Plan: Phase 3. 2007. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e04_phase3_2007.pdf

_____. 2007b. Cibola Valley Conservation Area Restoration Development Plan: Phase 1. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e05_phase1_2007.pdf

_____. 2007c. Cibola Valley Conservation Area Restoration Development Plan: Phase 2. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e05_phase2_2007.pdf

_____. 2007d. Cibola Valley Conservation Area Restoration Development Plan: Phase 3. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e05_phase3_2007.pdf

_____. 2007e. Mass Transplanting Demonstration 2005–2006, Final Report 2007. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e07_finrep_2005-2006.pdf

_____. 2008a. Beal Riparian and Marsh Restoration, 2006 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e01_annrep_2006.pdf

_____. 2008b. Cibola Valley Conservation Area, Fiscal Year 2006. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2006/e05_annrep_2006.pdf

_____. 2009a. Palo Verde Ecological Reserve, Annual Report 2007. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e04_annrep_2007.pdf

_____. 2009b. Palo Verde Ecological Reserve Development Plan: Phase 4. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2009/e04_phase4_2009.pdf

_____. 2009c. Palo Verde Ecological Reserve Restoration Development and Monitoring Plan: Phase 5. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2009/e04_phase5_2009.pdf

_____. 2009d. Cibola National Wildlife Refuge Unit 1 Conservation Area Restoration Development and Monitoring Plan: Phase 1. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2009/e24_phase1_2009.pdf

_____. 2009e. Cibola NWR Unit 1 Conservation Area, 2007 Annual Monitoring Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e24_annrep_2007.pdf

_____. 2009f. Cibola NWR Unit 1 Conservation Area, 2009 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2009/e24_annrep_2009.pdf

_____. 2010a. Beal Riparian and Monitoring Restoration Plan: Overview. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2010/e01_dev_mon_2010.pdf

_____. 2010b. Palo Verde Ecological Reserve, Annual Report 2008. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2008/e04_annrep_2008.pdf

_____. 2010c. Palo Verde Ecological Reserve, 2010 Annual Report. Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2010/e04_annrep_2010.pdf

_____. 2010d. Palo Verde Ecological Reserve Development Plan: Phase 6. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2010/e04_phase6_2010.pdf

_____. 2010e. Cibola Valley Conservation, 2008 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2008/e05_annrep_2008.pdf

_____. 2010f. Cibola Valley Conservation, Area 2007 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2007/e05_annrep_2007.pdf

_____. 2011a. Beal Lake Conservation Area, 2011 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2011/e01_annrep_2011.pdf

_____. 2011b. Palo Verde Ecological Reserve Development and Monitoring Plan: Phase 7. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2011/e04_phase7_2011.pdf

_____. 2012a. Palo Verde Ecological Reserve, 2012 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2012/e04_annrep_2012.pdf

_____. 2012b. Palo Verde Ecological Reserve Restoration Development and Monitoring Plan: Phase 8. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2012/e04_phase8_2012.pdf

_____. 2012c. Cibola National Wildlife Refuge Unit 1 Conservation Area Restoration Development and Monitoring Plan: Upper Hippy Burn. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2012/e24_dev_mon_hippy_2012.pdf

_____. 2012d. Laguna Division Conservation Area Restoration Development and Monitoring Plan. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2012/e27_dev_mon_2012.pdf

_____. 2013. Palo Verde Ecological Reserve, 2009 Annual Report. Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2009/e04_annrep_2009.pdf

_____. 2019. Palo Verde Ecological Reserve, 2011 Annual Report. Bureau of Reclamation 019, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2011/e04_annrep_2011.pdf

MacWhirter, R.B. 1989. On the rarity of intraspecific brood parasitism. The Condor 91:485–492.

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

McNeil, S.E. 2015. Population genetic diversity and structure in yellow-billed cuckoos across a fragmented landscape. Thesis. University of Arizona, Tucson. https://arizona.openrepository.com/arizona/handle/10150/595973

McNeil, S.E. and D. Tracy. 2013. Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2013 Annual Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by Southern Sierra Research Station. https://www.lcrmscp.gov/reports/2013/d07_annrep_2013.pdf

McNeil, S.E., D. Tracy, J.R. Stanek, J.E. Stanek, and M.D. Halterman. 2010. Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2010 Annual Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by Southern Sierra Research Station. https://www.lcrmscp.gov/reports/2010/d07_annrep_2010.pdf

McNeil, S.E., D. Tracy, J.R. Stanek, and J.E. Stanek. 2011. Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2011 Annual Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by Southern Sierra Research Station. https://www.lcrmscp.gov/reports/2011/d07_annrep_2011.pdf

_____. 2012. Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2012 Annual Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by Southern Sierra Research Station. https://www.lcrmscp.gov/reports/2012/d07_annrep_2012.pdf

_____. 2013. Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2008–2012 Summary Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by Southern Sierra Research Station. https://www.lcrmscp.gov/reports/2012/d07_sumrep_2008-2012.pdf

Miller, D., A. Calvert, and S. Kokos. 2017. Cibola National Wildlife Refuge Unit #1 Conservation Area, Fiscal Year 2013 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2013/e24_annrep_2013.pdf

Miller, D., C. Dodge, S. Kokos, and B. Blasius. 2019. Hunters Hole, 2014 Annual Report. Prepared for the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2014/e31_annrep_2014.pdf

Morrow, E.H., G. Arnqvist, and T.E. Pitcher. 2002. The evolution of infertility: does hatching rate in birds coevolve with female polyandry? Journal of Evolutionary Biology 15:702–709. http://www.arnqvist.org/jeb2002.pdf

Nelson, L. 2007. Roots of Understanding: Unearthing the Hidden Power of the Tree Gene. Horizons, Northern Arizona University. https://www.lcrmscp.gov/publications/e6_nau_horizons_07.pdf

Parametrix, Inc., and Southern Sierra Research Station. 2015. Yellow-billed Cuckoo Surveys and Population Monitoring on the Lower Colorado River and Tributaries, 2014 Annual Report. Submitted to the Bureau of Reclamation, Boulder City, Nevada, by S.E. McNeil and D. Tracy, Southern Sierra Research Station, Weldon, California, and J. Lisignoli and T. Hurt, Parametrix, Inc., Albuquerque, New Mexico. https://www.lcrmscp.gov/reports/2014/d07_annrep_2014.pdf

_____. 2016a. Yellow-billed Cuckoo Surveys and Population Monitoring on the Lower Colorado River and Tributaries, 2015 Annual Report. Prepared by D. Tracy and S.E. McNeil, Southern Sierra Research Station, Weldon, California, and Parametrix, Inc., Albuquerque, New Mexico. Submitted to the Bureau of Reclamation, Boulder City, Nevada. February 2016. https://www.lcrmscp.gov/reports/2015/d07_annrep_2015.pdf

_____. 2016b. Yellow-billed Cuckoo Surveys and Population Monitoring on the Lower Colorado River and Tributaries, 2016 Annual Report. Prepared by D. Tracy and S.E. McNeil, Southern Sierra Research Station, Weldon, California, and J. Lisignoli, Parametrix, Inc., Albuquerque, New Mexico. https://www.lcrmscp.gov/reports/2016/d07_annrep_2016.pdf

_____. 2018. Yellow-billed Cuckoo Surveys on the Lower Colorado River, 2017 Annual Report. Prepared by S.E. McNeil and D. Tracy, Southern Sierra Research Station, Weldon, California, and J. Lisignoli, Parametrix, Inc., Albuquerque, New Mexico. https://www.lcrmscp.gov/reports/2017/d07_annrep_2017.pdf

_____. 2019. Yellow-billed Cuckoo Surveys on the Lower Colorado River and Tributaries, 2014 to 2018 Summary Report. Submitted to the Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, by S.E. McNeil, D. Tracy, J. Lisignoli, and J.R. Stanek under Reclamation contract No. R14PD0004. https://www.lcrmscp.gov/reports/2018/d07_sumrep_2014-2018.pdf

Potter, E.F. 1980. Notes on nesting yellow-billed cuckoos. Journal of Field Ornithology 51:17–29.

Reclamation (see Bureau of Reclamation).

Rideout, B.A. 2012. Investigating embryo deaths and hatching failure. Veterinary Clinic Exotic Animals 15:155–162. https://www.vetexotic.theclinics.com/article/S1094-9194(12)00007-2/pdf

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River. 1991. The University of Arizona Press, Tucson, Arizona.

Shafroth, P.B., C.A. Brown, and D.M Merritt (editors). 2010. Saltcedar and Russian Olive Control Demonstration Act Science Assessment. U.S. Geological Survey Scientific Investigations Report 2009–5247. 143 p.

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

Spottiswoode, C. and A.P. Møller. 2004. Genetic similarity and hatching success in birds. Proceedings of the Royal Society of London B. 271, 267_272. https://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC1691583&blobtype=pdf

Stegmeier, J., B. Raulston, and B. Blasius. 2018a. Cibola Valley Conservation Area Restoration Development and Monitoring Plan: Phase 7. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2018/e05_phase7_2018.pdf

Stegmeier, J., C. Dodge, S. Kokos, and B. Blasius. 2018b. Cibola Valley Conservation Area, 2015 Annual Report. Prepared for the Lower Colorado River Multi-Species Conservation Program by the Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2015/e05_annrep_2015.pdf

Stegmeier, J., B. Raulston, and B. Blasius. 2018c. Cibola Valley Conservation Area Restoration Development and Monitoring Plan: Phases 8 and 9. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2018/e05_phase8-9_2018.pdf

Stegmeier, J., B. Raulston, B. Blasius, and J. Knowles. 2018d. Cibola Valley Conservation Area, 2017 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2017/e05_annrep_2017.pdf

Stegmeier, J., B. Sabin, and B. Blasius. 2018e. Cibola National Wildlife Refuge Unit #1 Conservation Area Restoration Development and Monitoring Plan: Middle Hippy Fire. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada.

Stegmeier, J., B. Sabin, B. Blasius, and J. Knowles. 2018f. Cibola National Wildlife Refuge Unit #1 Conservation Area, 2016 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2016/e24_annrep_2016.pdf

Stegmeier, J., B. Sabin, and B. Blasius. 2018g. Cibola National Wildlife Refuge Unit #1 Conservation Area Restoration Development and Monitoring Plan: Lower Hippy Fire. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2018/e24_dev_mon_lhippy_fire_2018.pdf

Stegmeier, J., B. Sabin, and B. Blasius. 2019. Cibola National Wildlife Refuge Unit #1 Conservation Area, 2017 Annual Report. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada. https://www.lcrmscp.gov/reports/2017/e24_annrep_2017.pdf

Stewart, I.R.A. and D.W. Westneat. 2012. Patterns of hatching failure in the house sparrow *Passer domesticus*. Journal of Avian Biology 43:1–11. http://udel.edu/~istew/Stewart%20&%20Westneat%202012%20Hatching%20failure%20in%20the%20House%20Sparrow.pdf

Trouillas, F.P. and W.D. Gubler. 2016. Crypotosphaeria dieback of Fremont cottonwood caused by *Crypotosphaeria pullmanensis* and *C. multicontinentalis* in California. Plant Disease 100:777–783. https://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-09-15-0972-RE

U.S. Army Corps of Engineers. 2018. Alamo Dam Flushing Flow Release Final Environmental Assessment. https://www.cap-az.com/documents/departments/water-operations/alamo-dam-release/Alamo-Dam-EA-and-FONSI-with-Appendices.pdf

U.S. Department of Agriculture. 1975. Insects and Diseases of Cottonwoods. Forest Service General Technical Report SO-8. https://www.srs.fs.usda.gov/pubs/gtr/gtr_so008.pdf

U.S. Fish and Wildlife Service (USFWS). 2005a. Biological and Conference Opinion on the Lower Colorado River Multi-Species Conservation Program, Arizona, California, and Nevada. Phoenix, Arizona.

_____. 2005b. Federal Fish and Wildlife Permit Number TE-086834-0.

_____. 2011. Final Restoration Plan and Environmental Assessment and Restoration Program at the Bill Williams River National Wildlife Refuge, Mohave and La Paz County, Arizona. U.S. Department of the Interior, U.S. Fish and Wildlife Service. https://www.fws.gov/southwest/es/arizona/Documents/ECReports/TexmoRP_EA FINAL Nov 2011.pdf

U.S. Fish and Wildlife Service (USFWS) and Bureau of Reclamation (Reclamation). 2019. Draft addendum to appendices 1 to 3 for yellow-billed cuckoo survey protocol in Arizona, New Mexico, and Texas *in* M.D. Halterman, M.J. Johnson, J.A. Holmes, and S.A. Laymon. 2016. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: Draft. U.S. Fish and Wildlife Techniques and Methods. Prepared by Susan Sferra, Vicky Ryan, and Meghan White for USFWS, Southwest Region, Albuquerque, New Mexico, and Bureau of Reclamation, Denver Technical Center, Denver, Colorado. https://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/YellowBilledCuckoo/Instructions for completing YBCU Survey Summary Forms July 2019 v3.pdf

USFWS (see U.S. Fish and Wildlife Service).

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

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ATTACHMENT 1

Maps of Survey Sites and Transects, Lower Colorado River Multi-Species Conservation Program Study Area, 2019

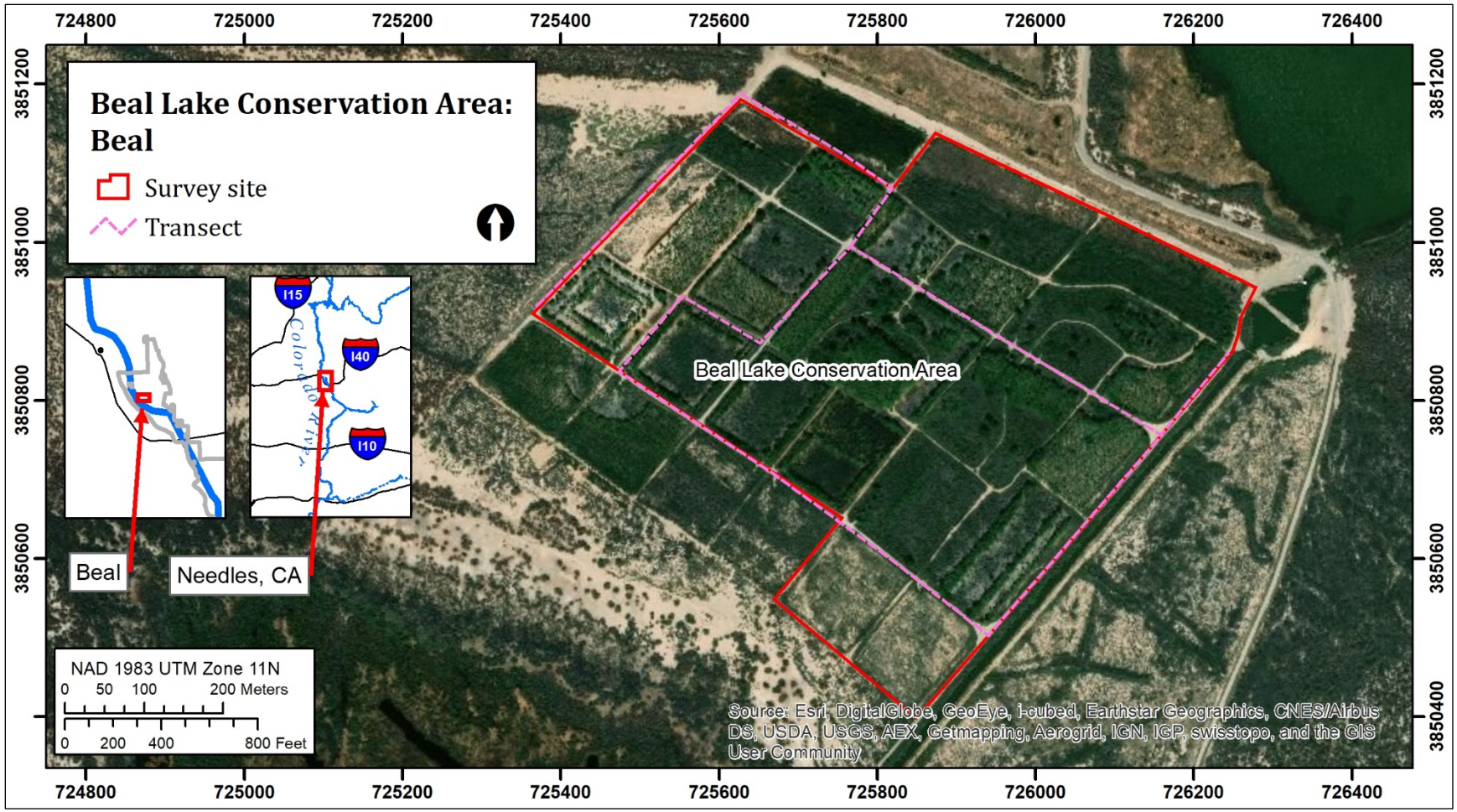

Figure 1-1.—Beal Lake Conservation Area, yellow-billed cuckoo survey sites showing transects, 2019.

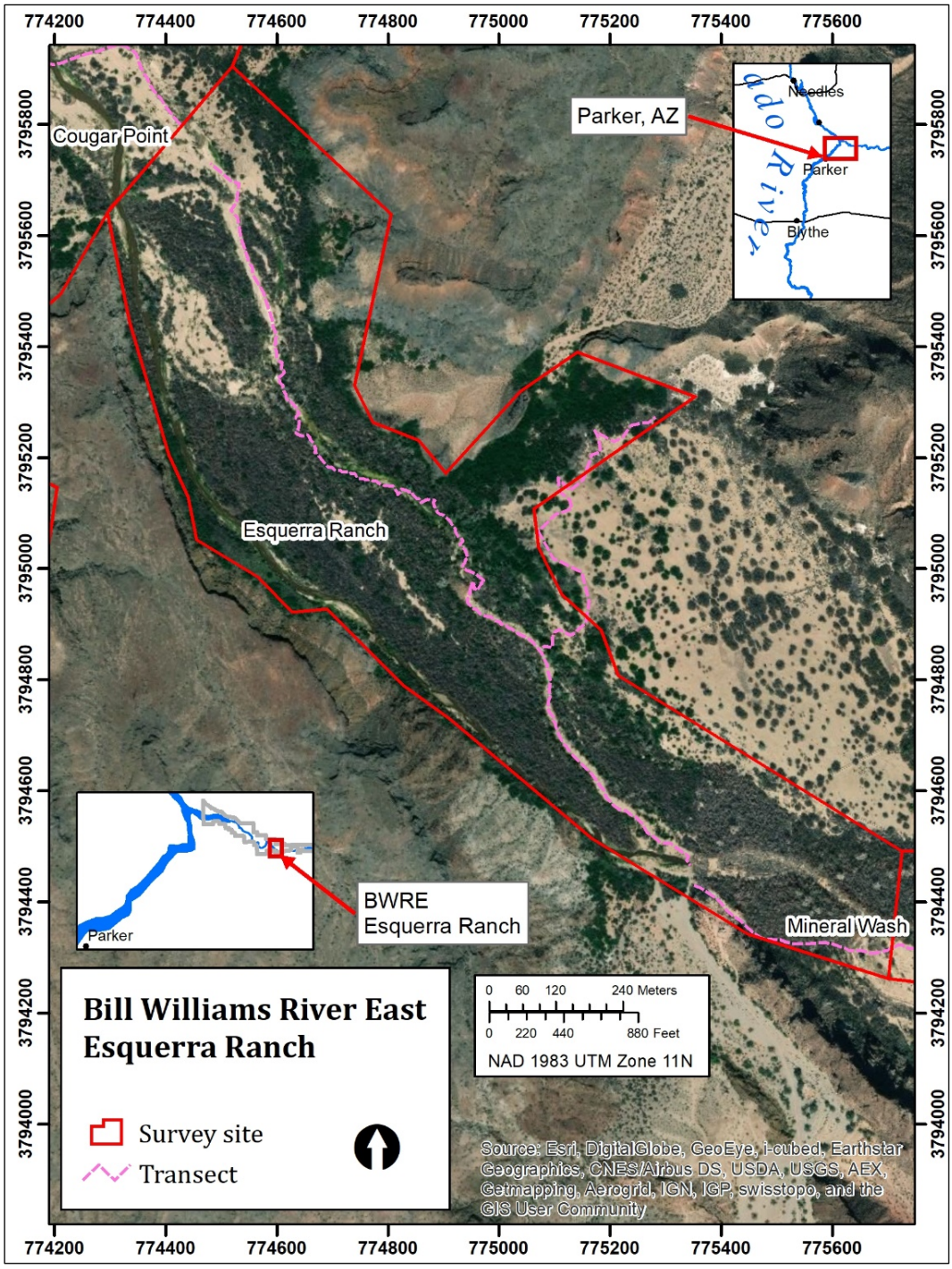

Figure 1-2.—Bill Williams River East-Esquerra Ranch yellow-billed cuckoo survey site showing transect, 2019.

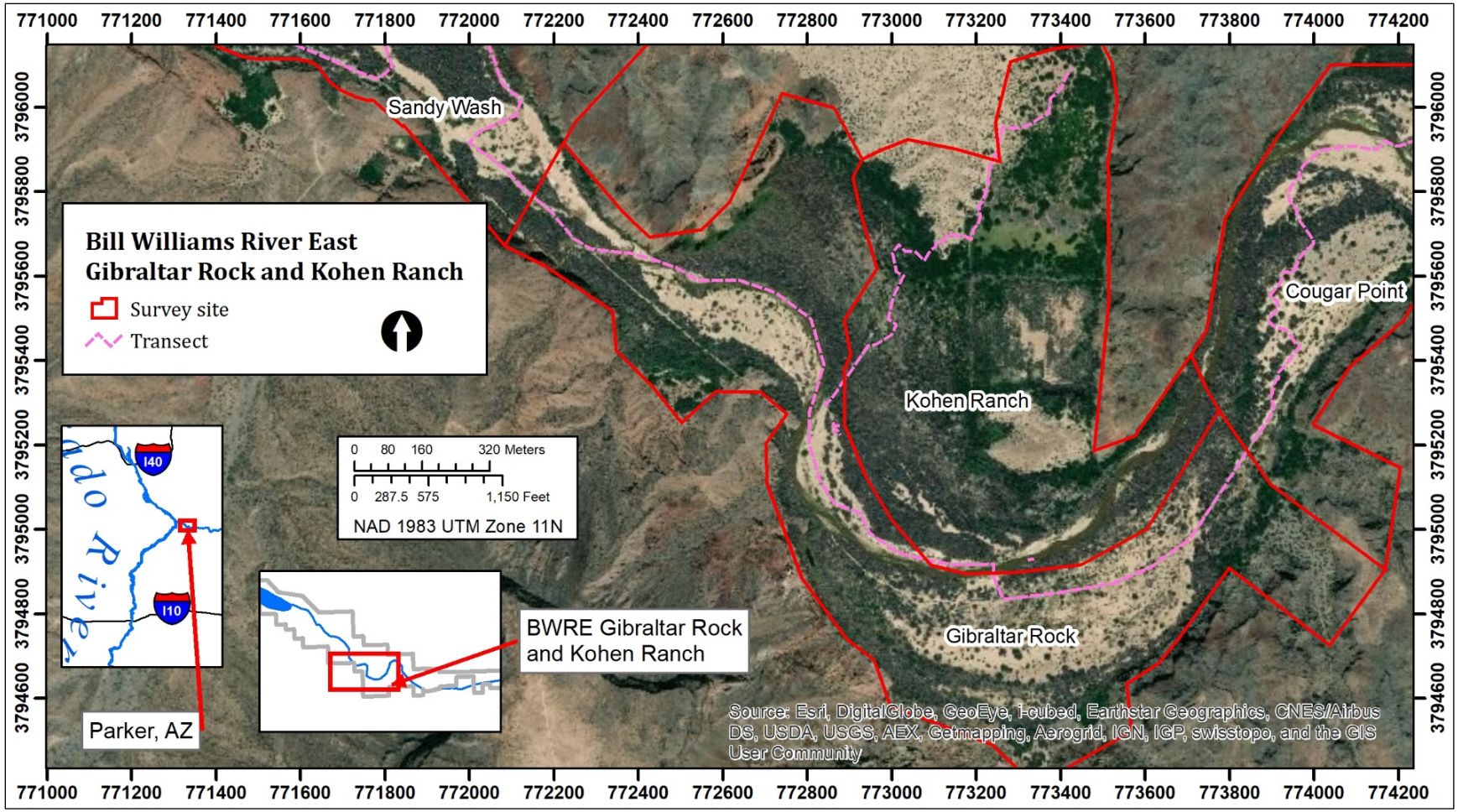

Figure 1-3.—Bill Williams River East-Gibraltar Rock and Kohen Ranch yellow-billed cuckoo survey sites showing transects, 2019.

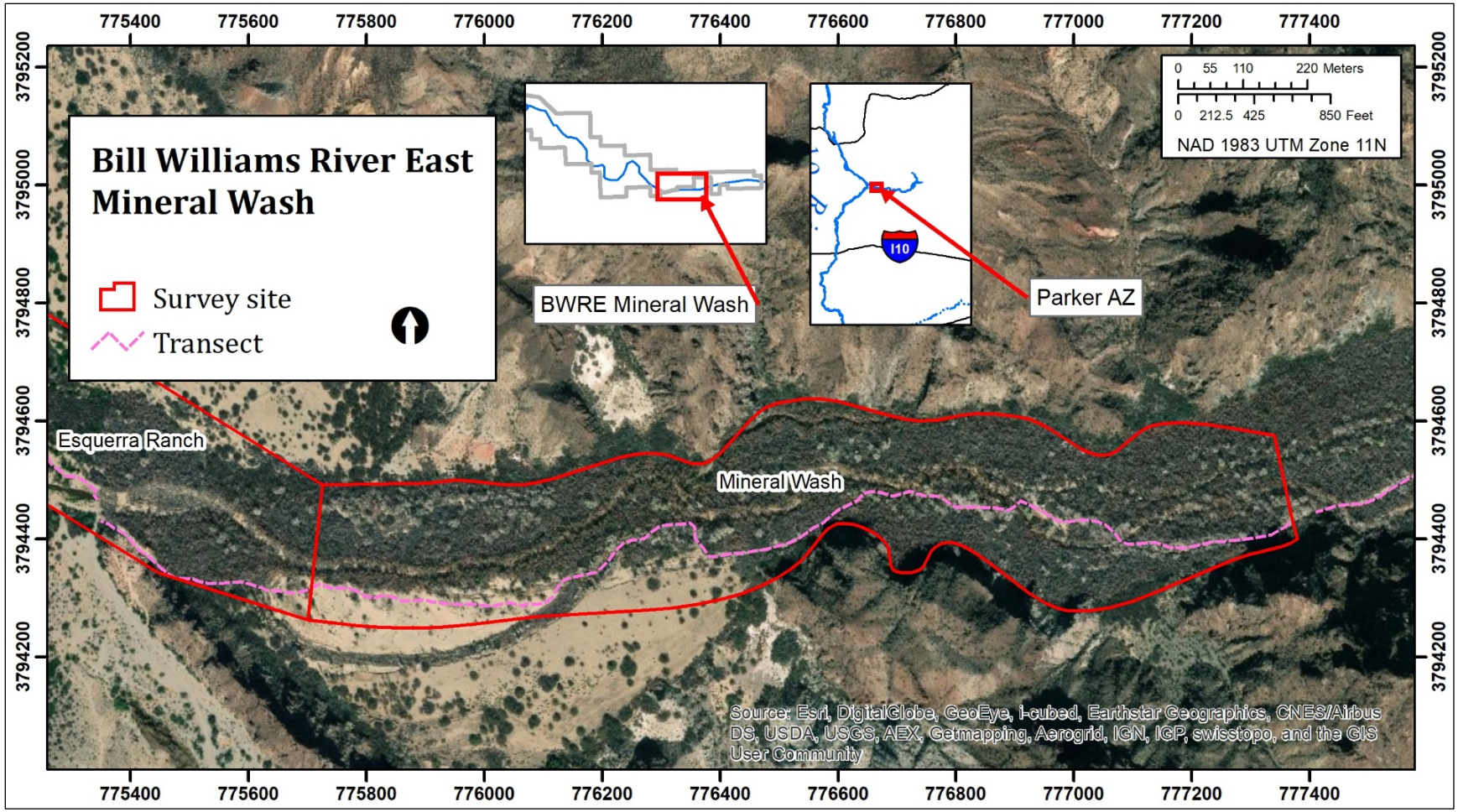

Figure 1-4.—Bill Williams River East-Mineral Wash yellow-billed cuckoo survey site showing transect, 2019.

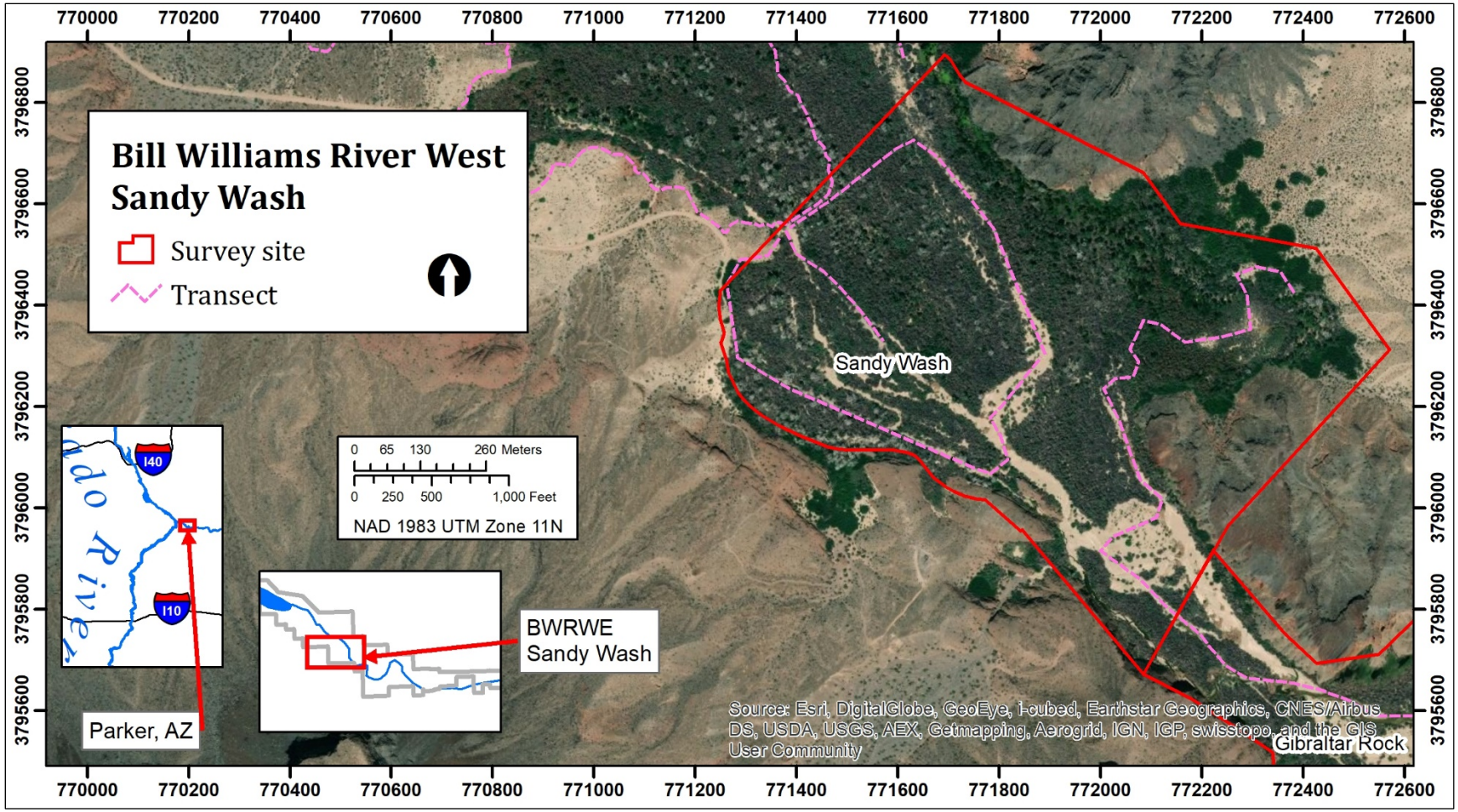

Figure 1-5.—Bill Williams River West-Sandy Wash yellow-billed cuckoo survey sites showing transects, 2019.

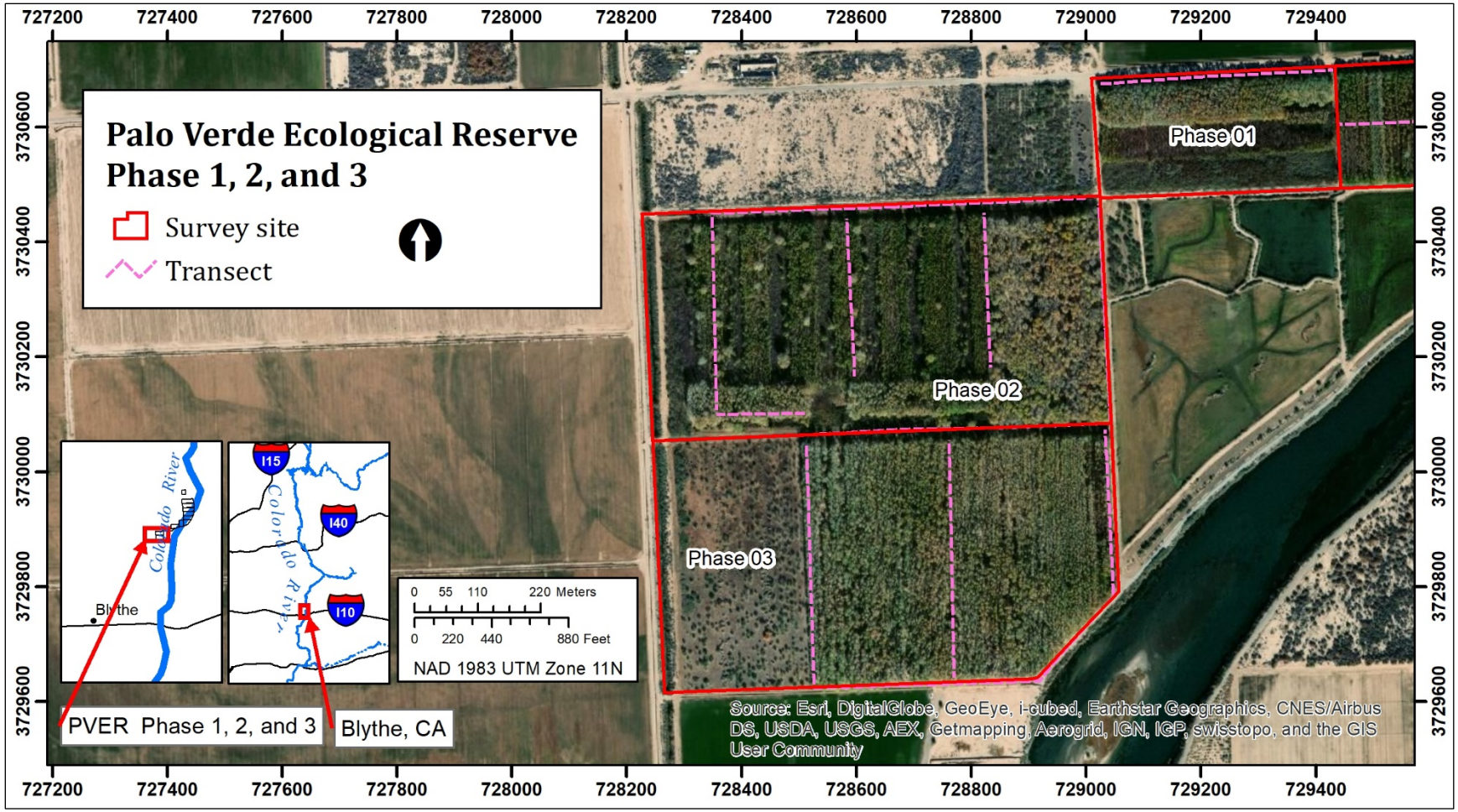

Figure 1-6.—Palo Verde Ecological Reserve Phase 1, 2, and 3 yellow-billed cuckoo survey sites showing transects, 2019.

Figure 1-7.—Palo Verde Ecological Reserve Phase 4 yellow-billed cuckoo survey site showing transects, 2019.

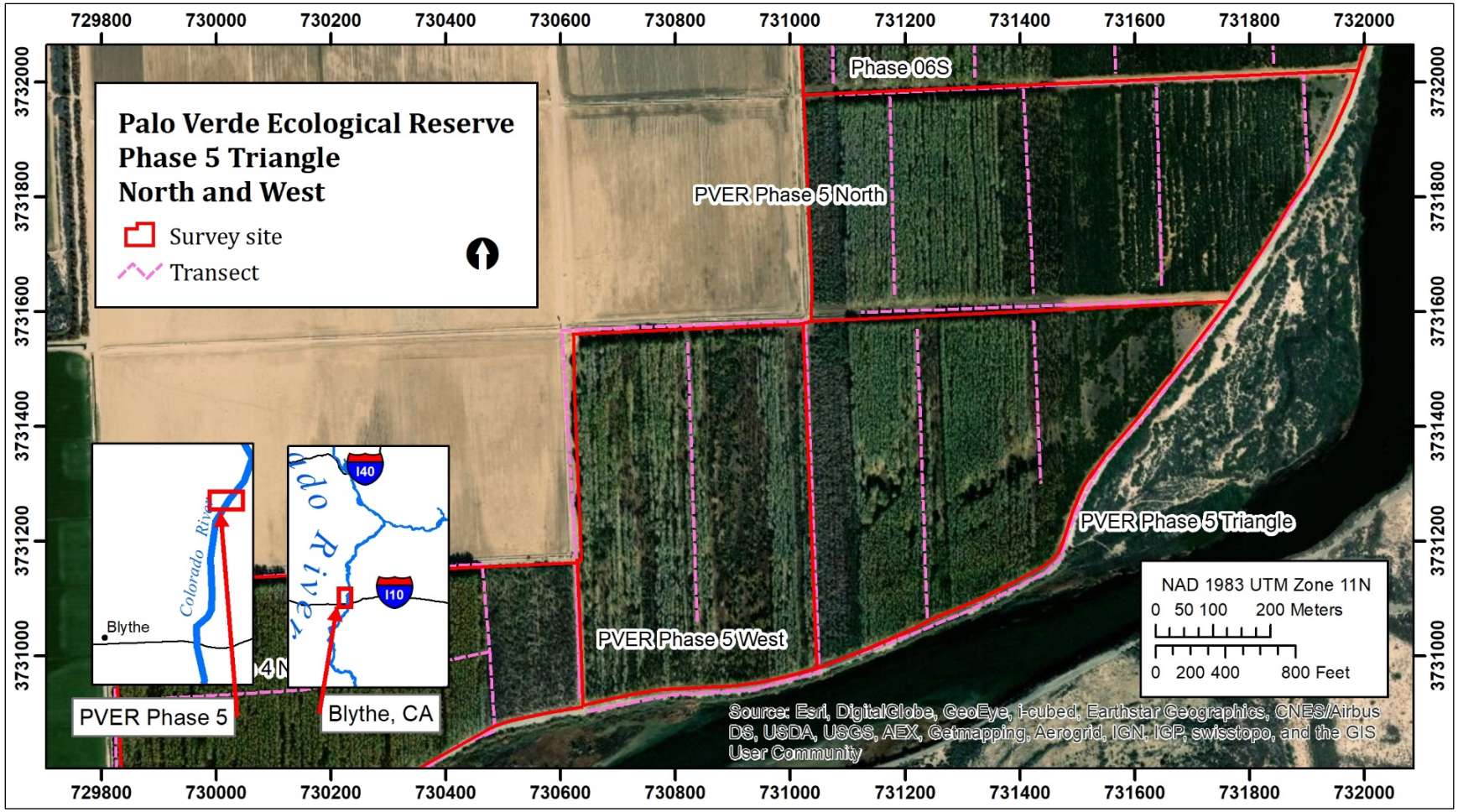

Figure 1-8.—PVER Phase 5 yellow-billed cuckoo survey site showing transects, 2019.

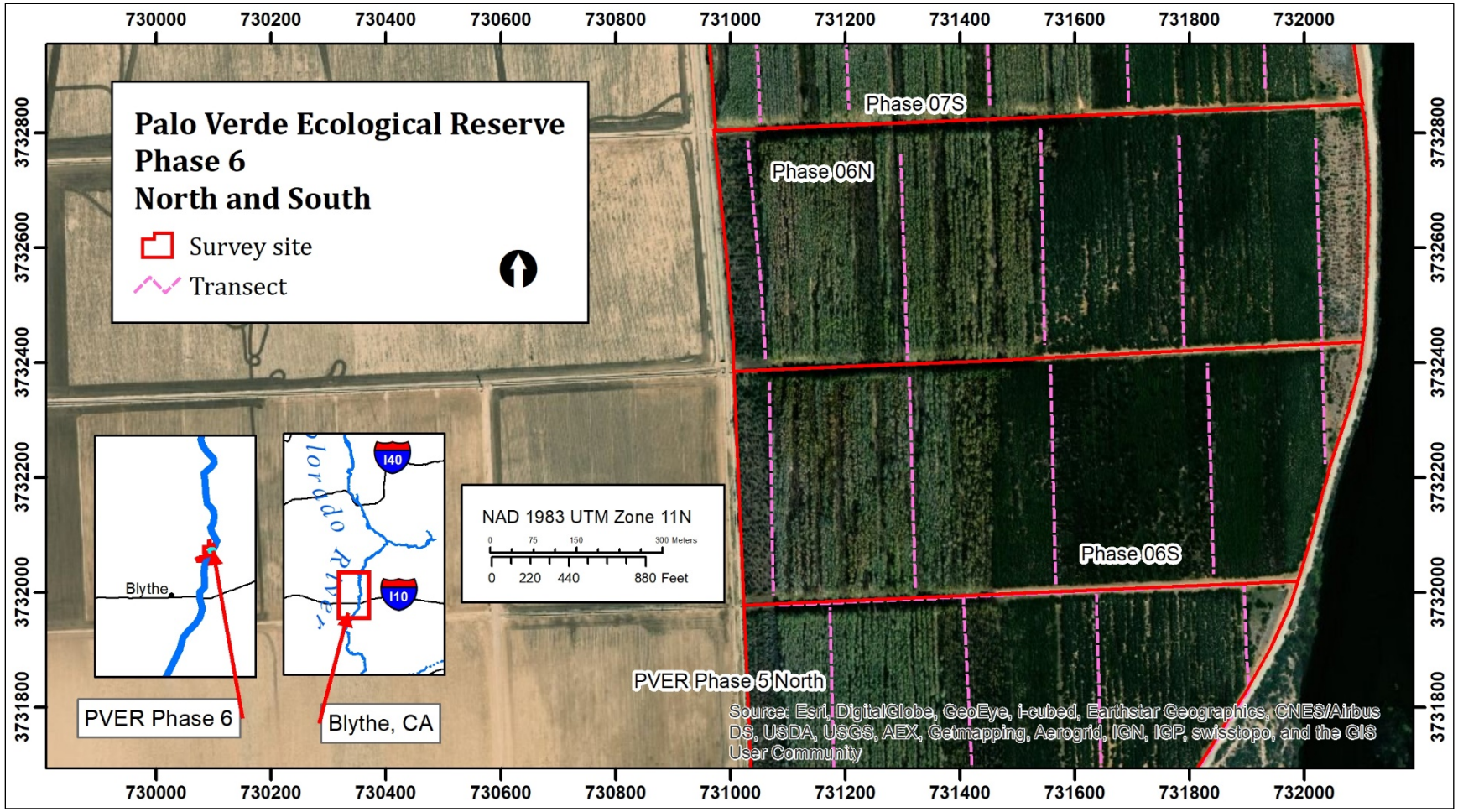

Figure 1-9.—Palo Verde Ecological Reserve Phase 6 yellow-billed cuckoo survey site showing transects, 2019.

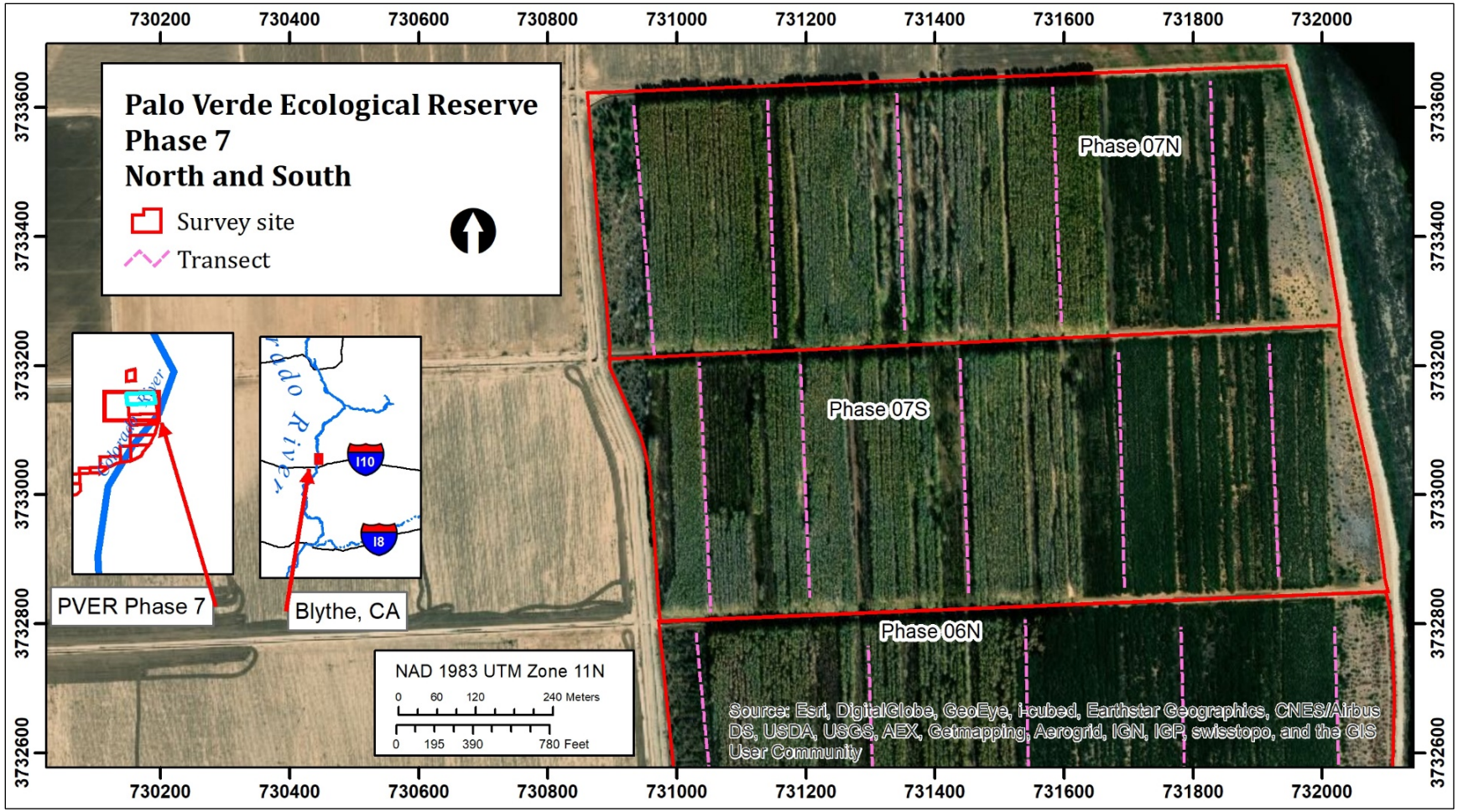

Figure 1-10.—Palo Verde Ecological Reserve Phase 7 yellow-billed cuckoo survey site showing transects, 2019.

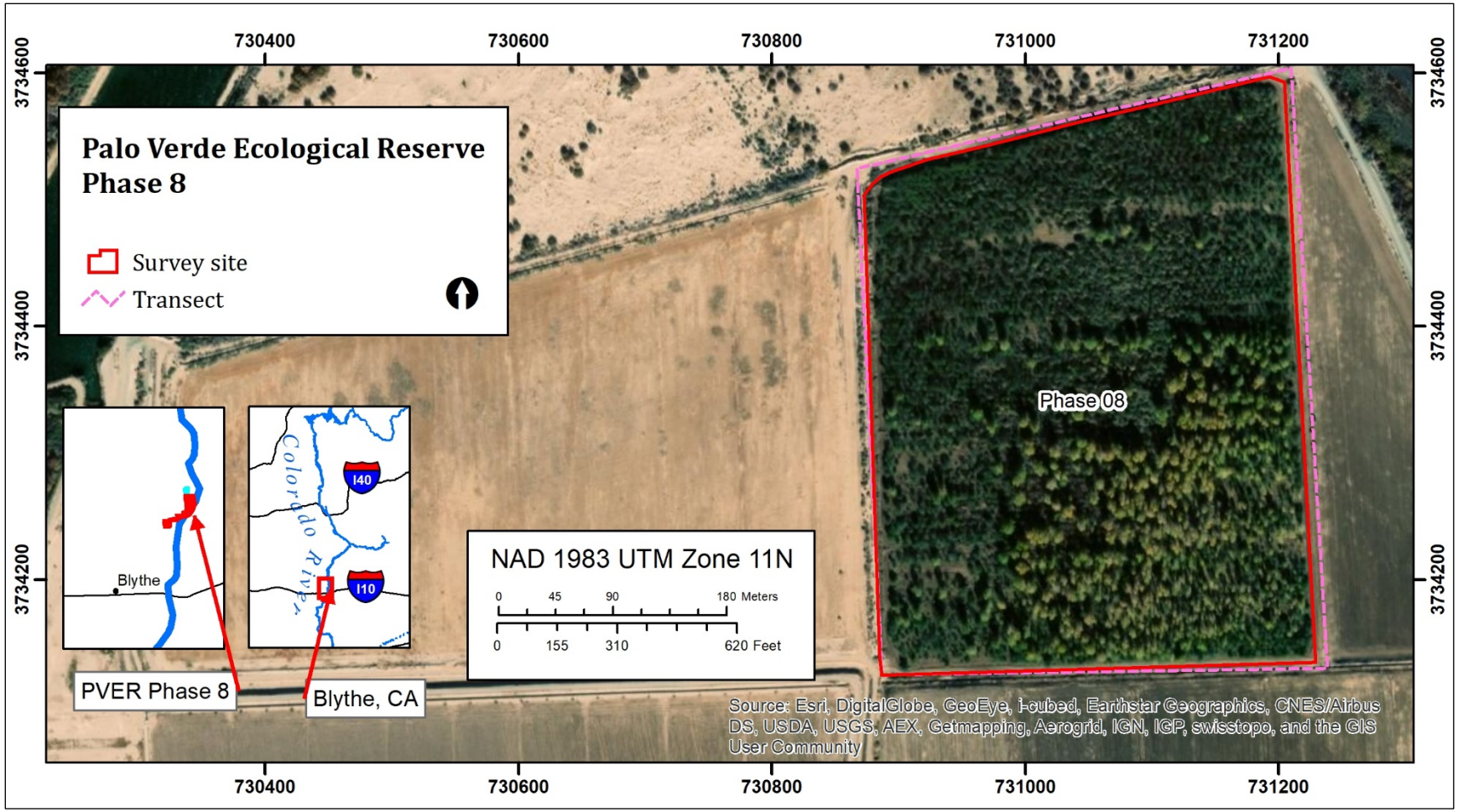

Figure 1-11.—Palo Verde Ecological Reserve Phase 8 yellow-billed cuckoo survey site showing transects, 2019.

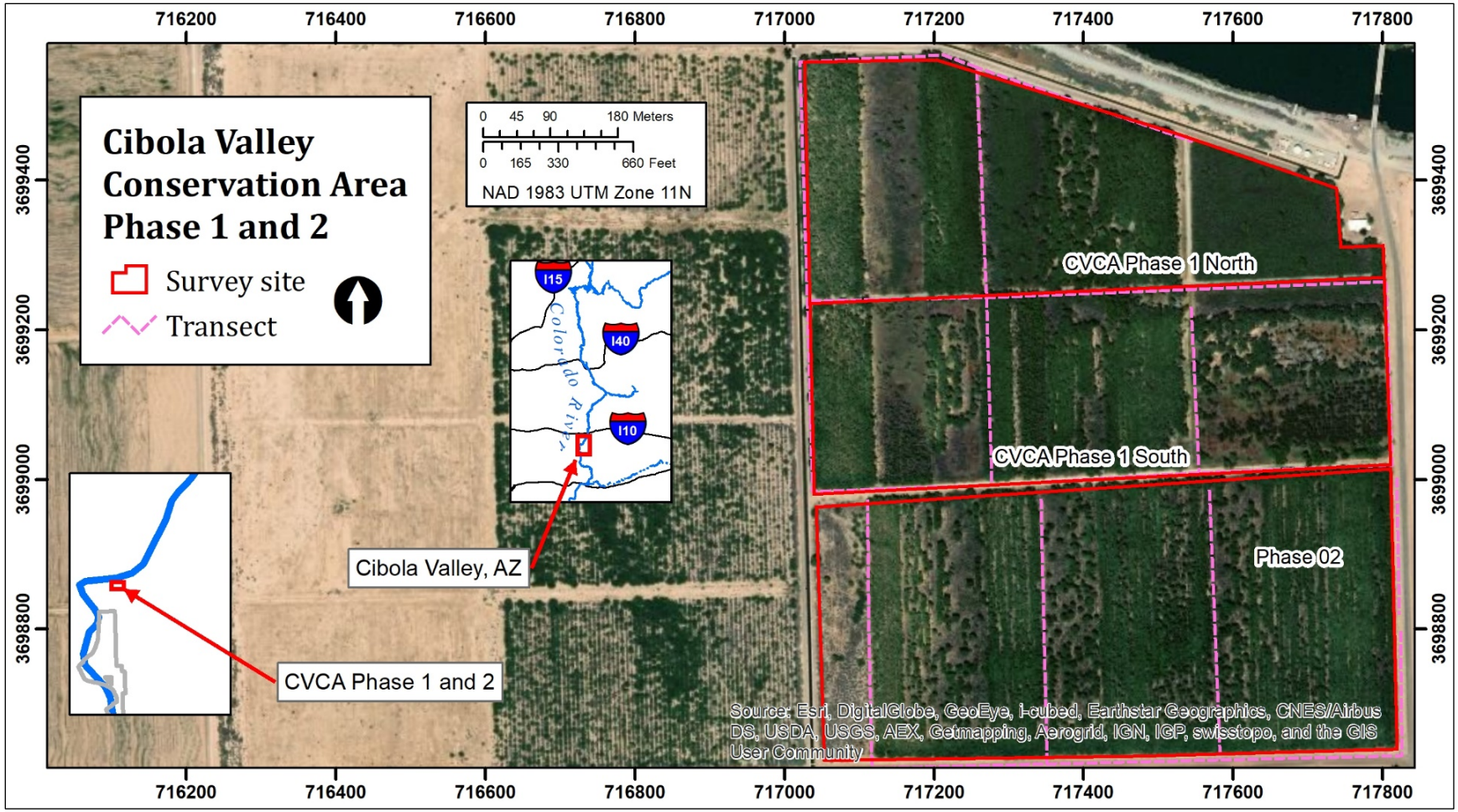

Figure 1-12.—Cibola Valley Conservation Area Phase 1 and 2 yellow-billed cuckoo survey sites showing transects, 2019.

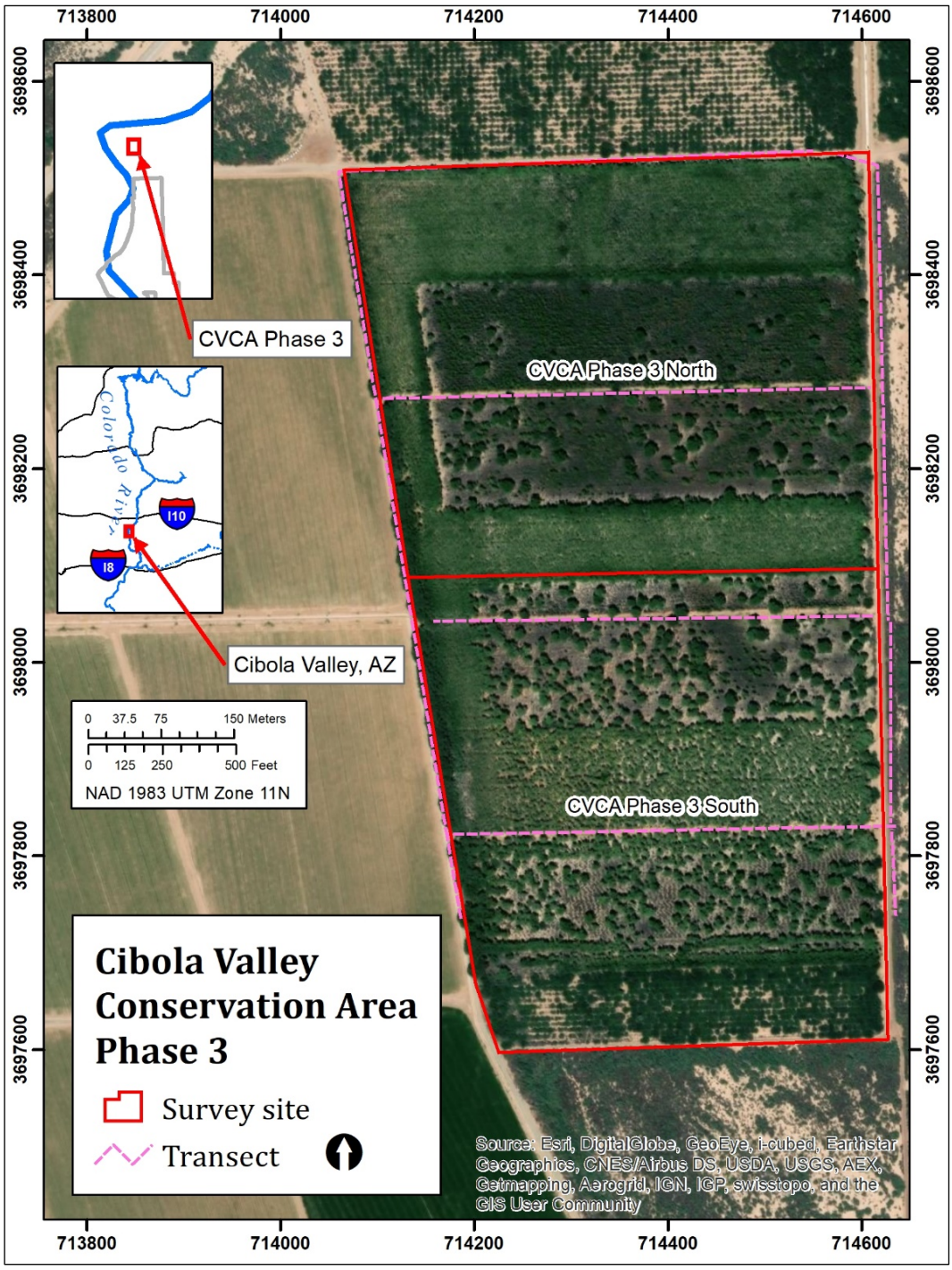

Figure 1-13.—Cibola Valley Conservation Area Phase 3 yellow-billed cuckoo survey site showing transects, 2019.

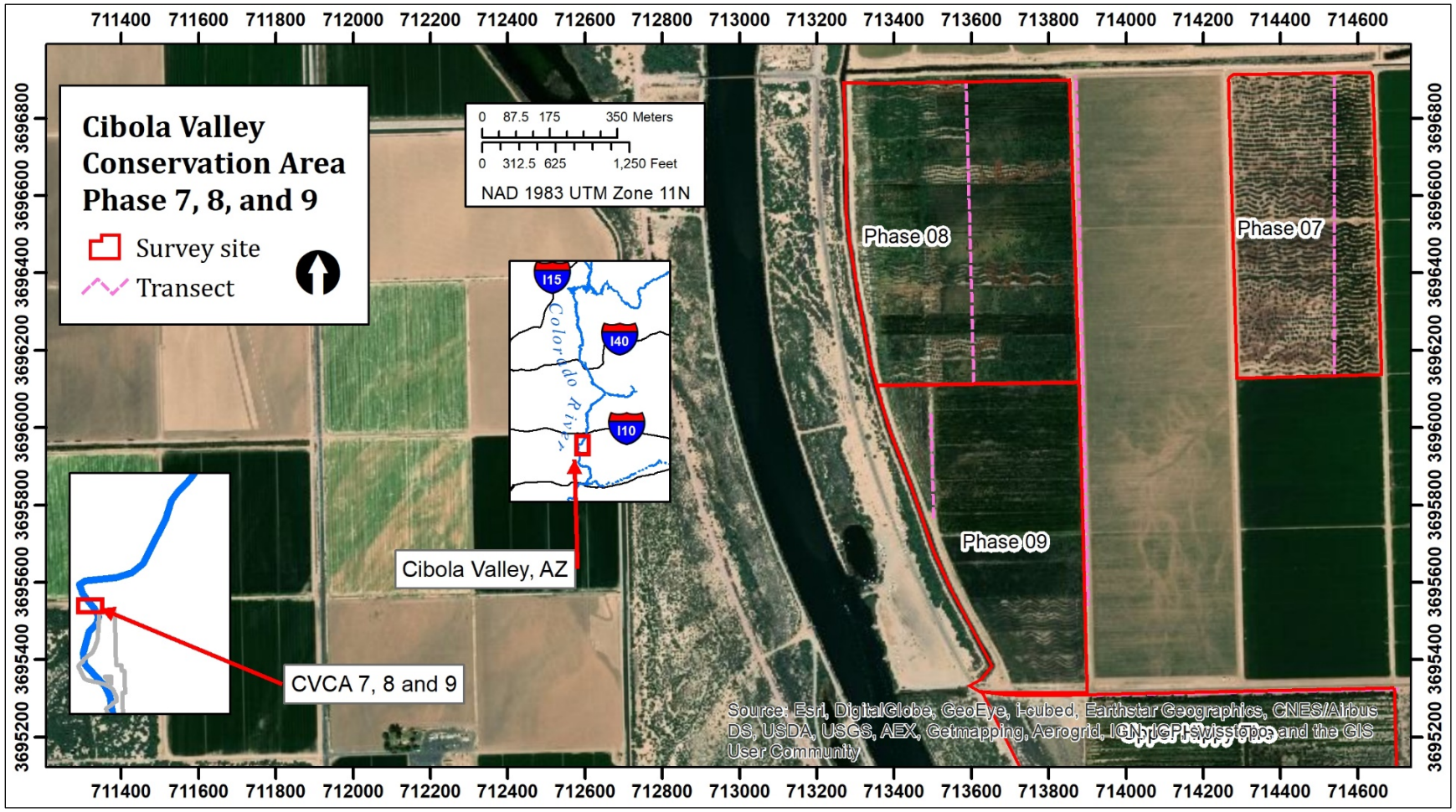

Figure 1-14.—Cibola Valley Conservation Area Phases 7, 8, and 9 yellow-billed cuckoo survey sites showing transects, 2019.

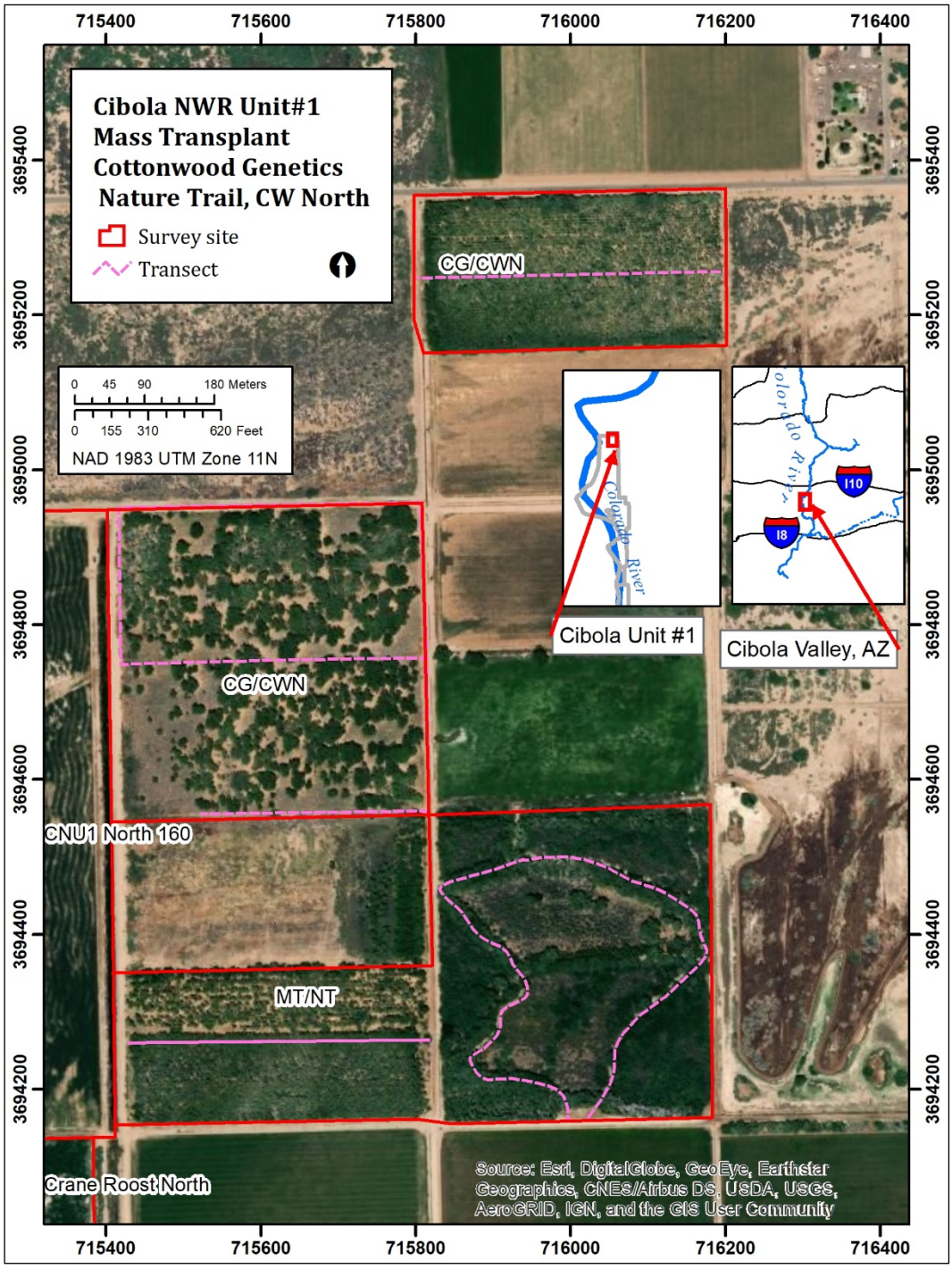

Figure 1-15.—Cibola National Wildlife Refuge Unit #1 Conservation Area-CW-North, Cottonwood Genetics, Mass Transplanting, and Nature Trail yellow-billed cuckoo survey sites showing transects, 2019.

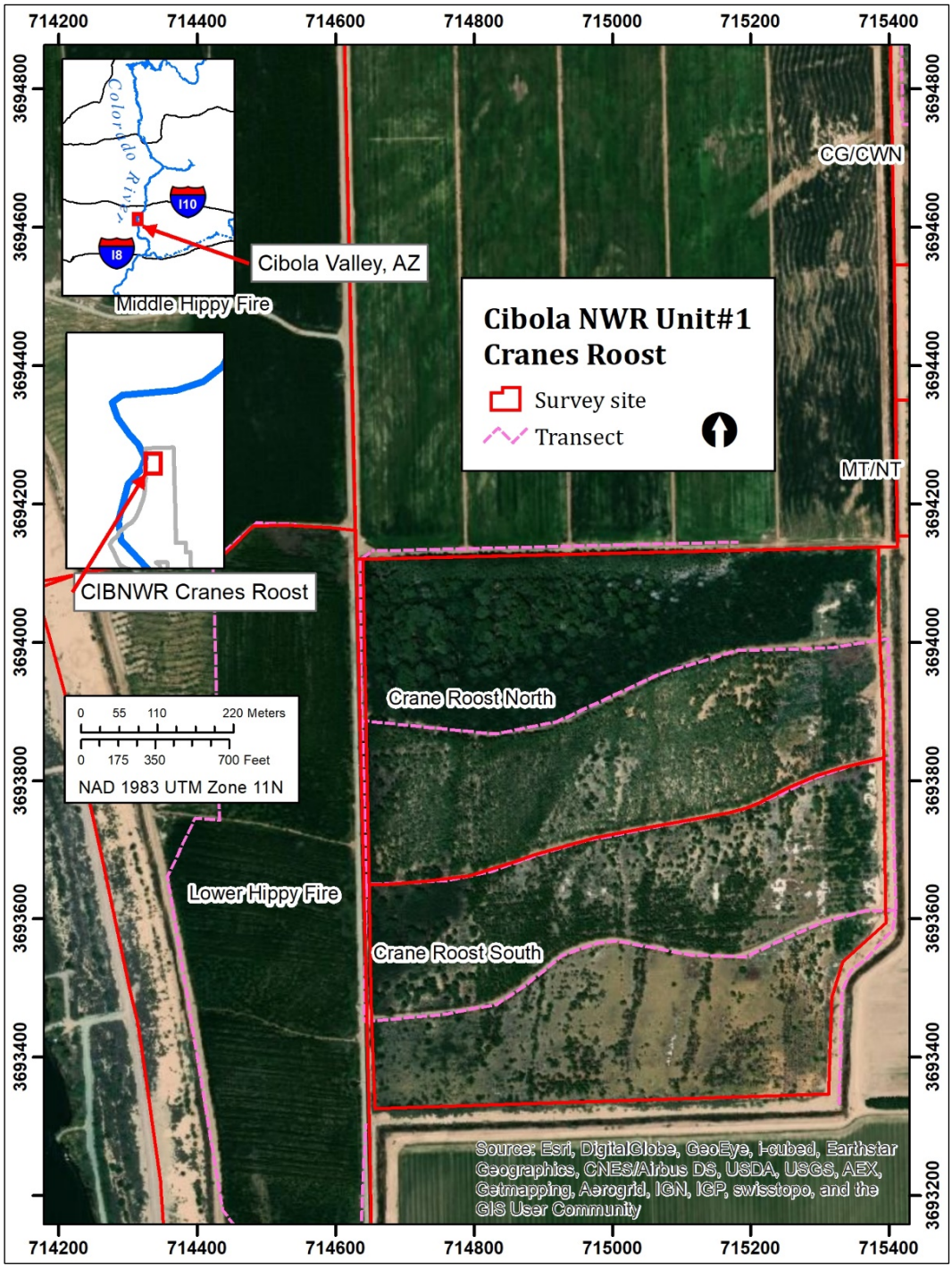

Figure 1-16.—Cibola National Wildlife Refuge Unit #1 Conservation Area Crane Roost yellow-billed cuckoo survey sites showing transects, 2019.

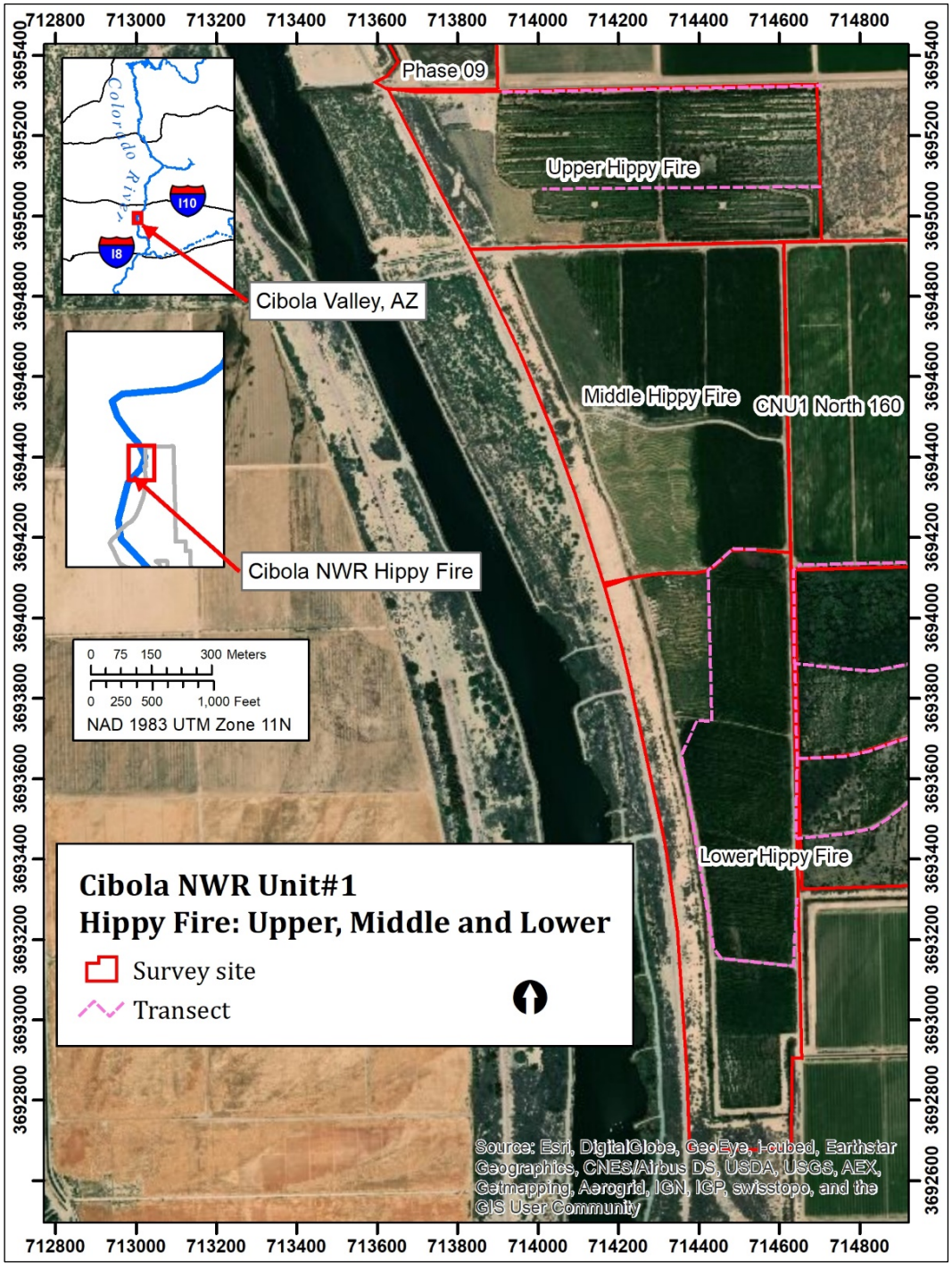

Figure 1-17.—Cibola National Wildlife Refuge Unit #1 Conservation Area-Upper, Middle, and Lower Hippy Fire yellow-billed cuckoo survey sites showing transects, 2019.

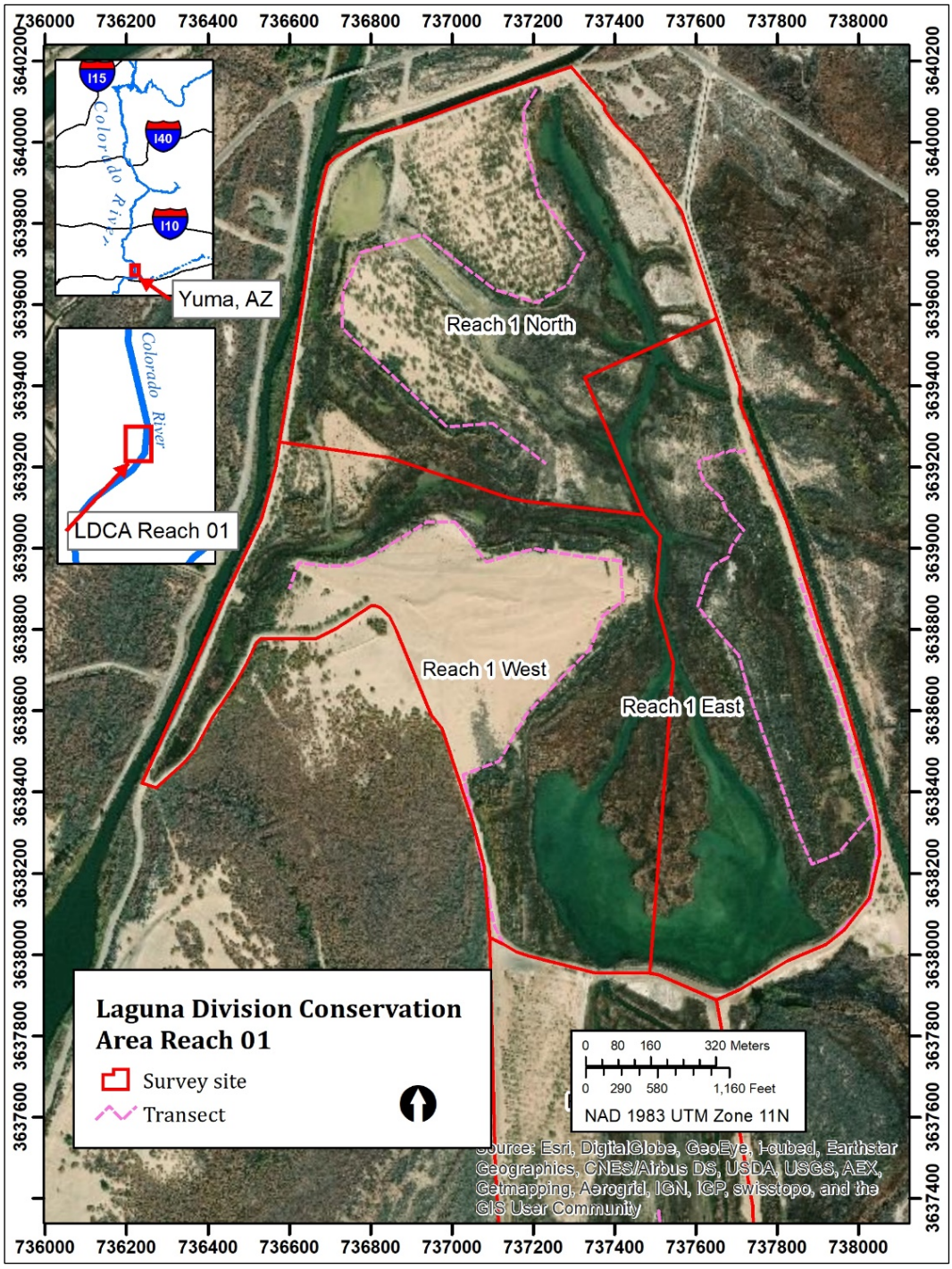

Figure 1-18.—Laguna Division Conservation Area-Reach 01 yellow-billed cuckoo survey site showing transects, 2019.

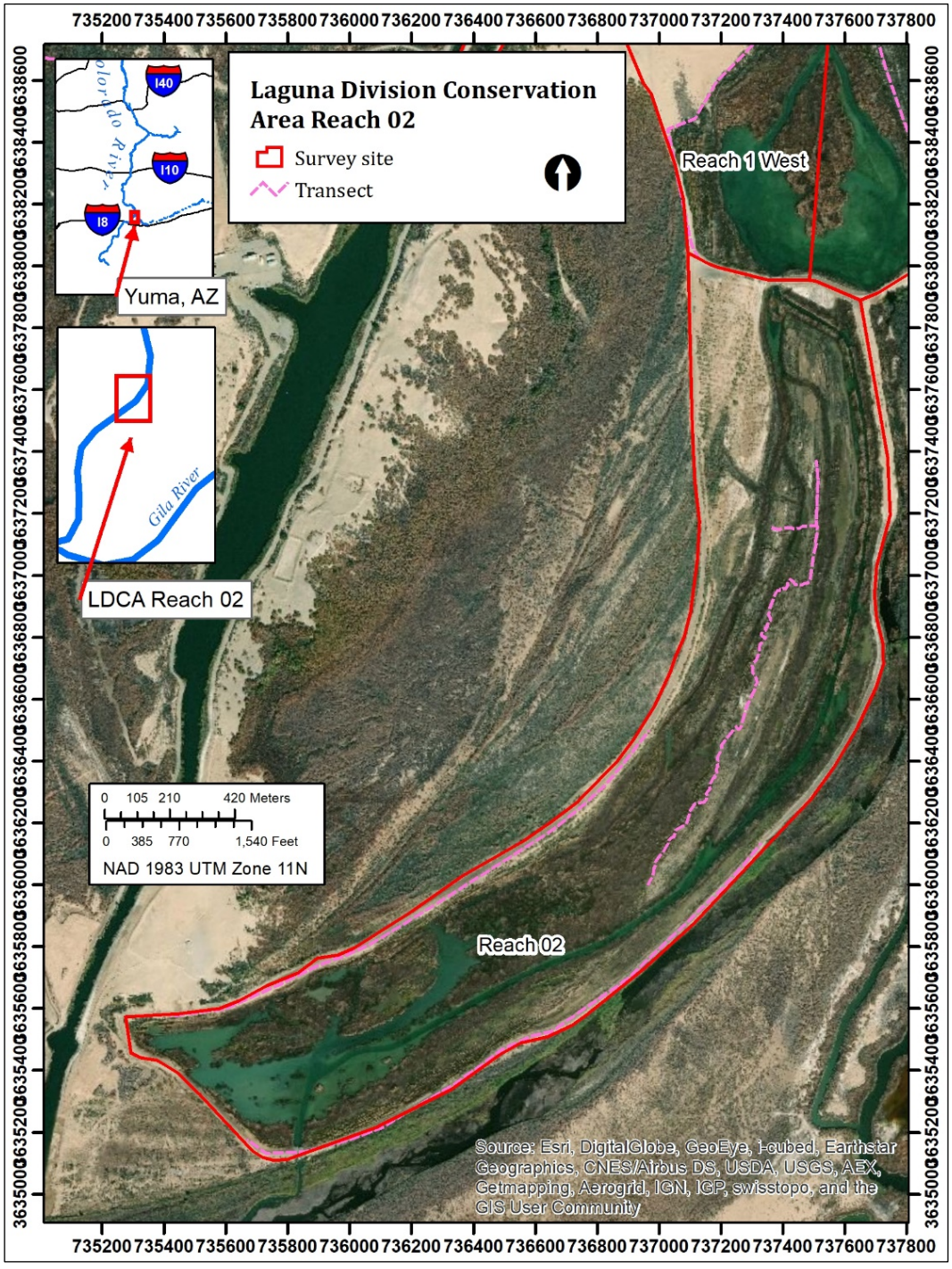

Figure 1-19.—Laguna Division Conservation Area-Reach 02 yellow-billed cuckoo survey site showing transects, 2019.

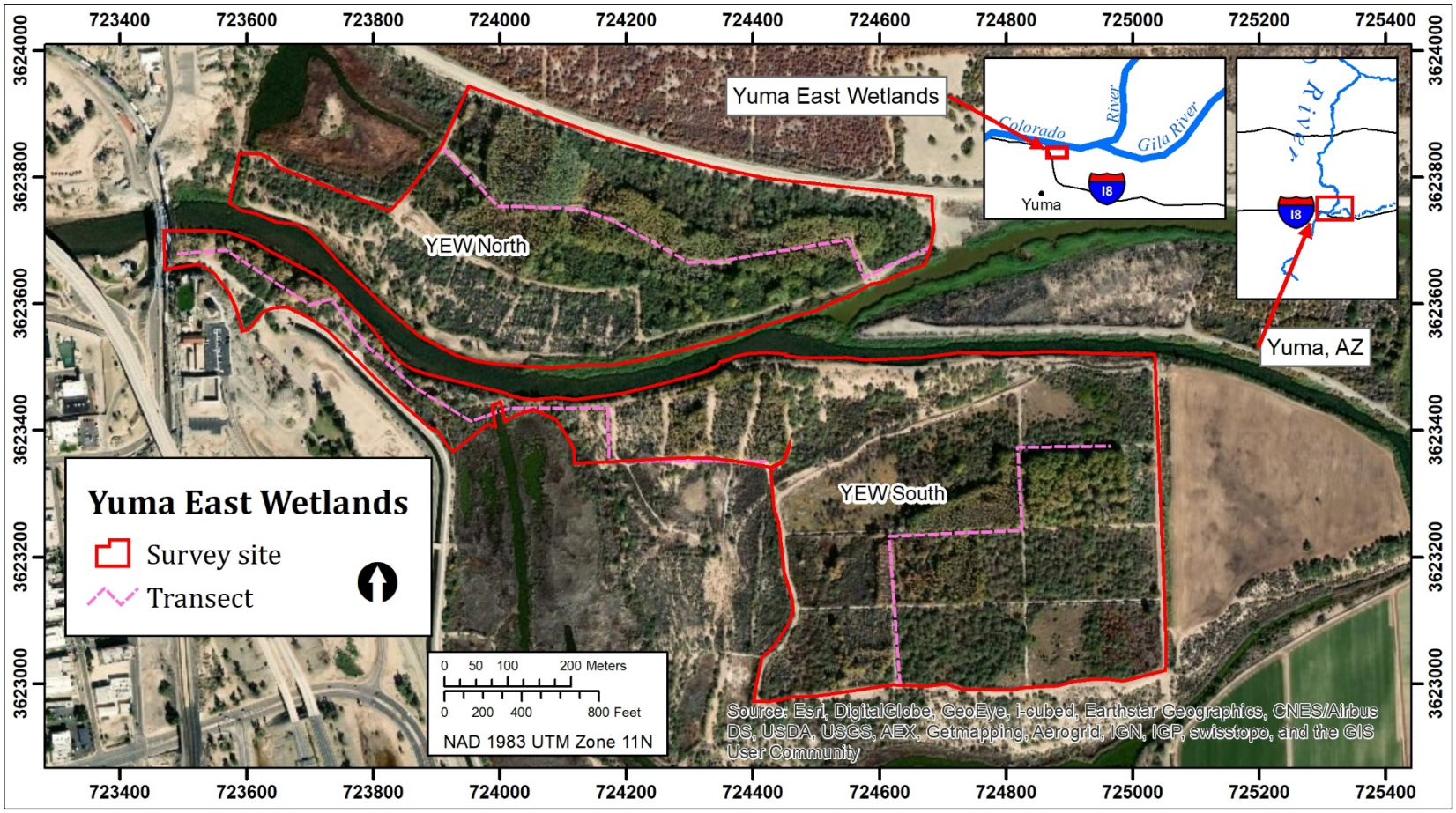

Figure 1-20.—Yuma East Wetlands yellow-billed cuckoo survey sites showing transects, 2019.

ATTACHMENT 2

A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*)

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.

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

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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.

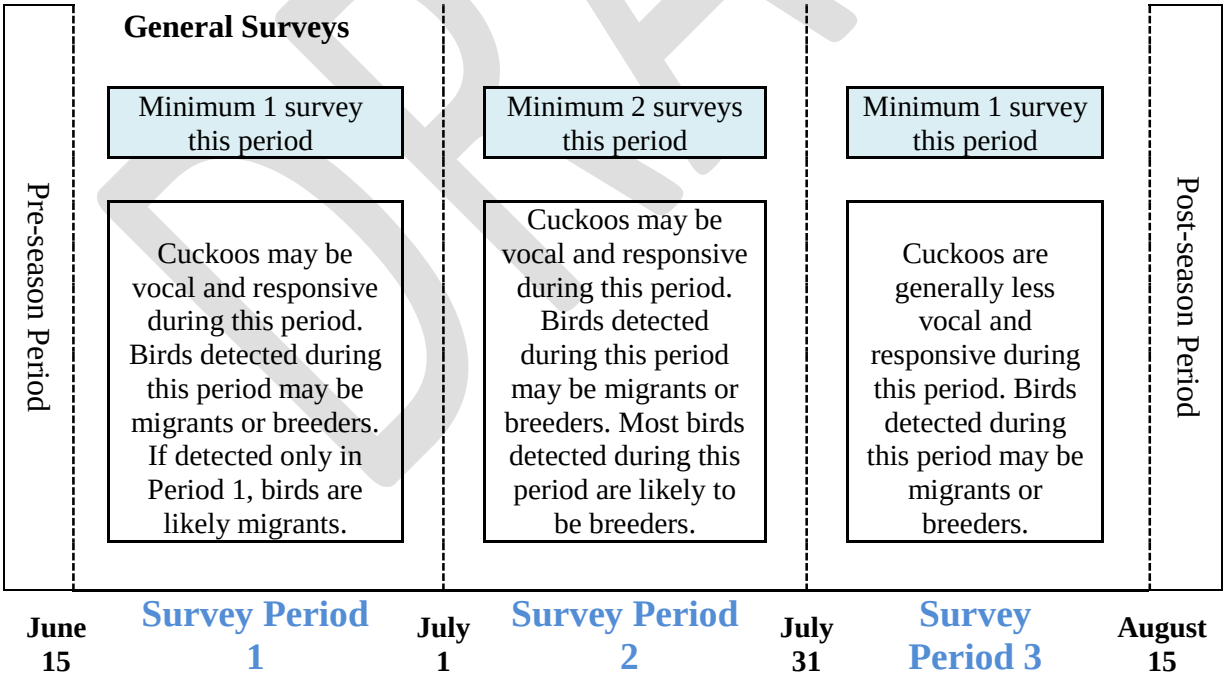

Figure 2. Recommended number and timing of visits during each survey period for Yellow-billed Cuckoo surveys.

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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References Cited

78 FR 61621. Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus); Proposed Rule. Federal Register / Vol. 78, No. 192 / Thursday, October 3, 2013 / Proposed Rules.

79 FR 48547. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo; Proposed Rule. Federal Register / Vol. 79, No. 158 / Friday, August 15, 2014 / Proposed Rules.

79 FR 59992. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus); Final Rule. Federal Register/ Vol. 79, No. 192 / Friday, October 3, 2014 / Rules and Regulations.

Ahlers, D., and D. Moore. 2012. Yellow-billed Cuckoo Study Results – 2011: Survey Results from the Middle Rio Grande, New Mexico. U.S. Bureau of Reclamation, Technical service Center, Denver, CO.

American Ornithologists' Union. 1957. Checklist of North American Birds. Fifth edition. American Ornithologists' Union, Washington, D.C.

Barber, N.A., R.J. Marquis, and W.P. Tori. 2008. Invasive prey impacts abundance and distribution of native predators. Ecology 89: 2678-2683.

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

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

Beason, J.P. 2010. Untitled summary report on distribution of yellow-billed cuckoos in Colorado and Wyoming, from Rocky Mountain Bird Observatory.

Bent, A.C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds, and their allies. Smithsonian Institution United States National Museum, Bulletin 176. 1989 reprint by Dover Publications, New York, NY.

Carstensen, D., D. Ahlers, and D. Moore. 2015. Yellow-billed Cuckoo Study Results – 2014: Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico. U.S. Bureau of Reclamation, Technical service Center, Denver, CO.

Cavallaro, R. 2011. Breeding Yellow-billed Cuckoo Survey and Inventory - Idaho Falls District, Bureau of Land Management - Interim Report. Prepared by Idaho Department of Fish and Game, Idaho Falls, Idaho. 52 pp.

Clay, M.B. 1929. The Yellow-billed Cuckoo. Bird-lore 31: 189–190.

Conway, C.J., and J.C. Simon. 2003. Comparison of detection probability associated with burrowing owl survey methods. Journal of Wildlife Management 67(3):501-511.

Corman, T.E. and R.T. Magill. 2000. Western yellow-billed cuckoo in Arizona: 1998 and 1999 survey report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Technical Report 150. 49 pp.

Corman, T.E. 2005. Yellow-billed Cuckoo (*Coccyzus americanus*) *in* Arizona Breeding Bird Atlas. T.E. Corman and C. Wise-Gervais (editors). Univ. of New Mexico Press, Albuquerque, NM, pp. 202-203.

Dettling, M.D., and C.A. Howell. 2011. Status of the Yellow-billed Cuckoo along the Sacramento River in 2010. Report to California Department of Fish and Game. PRBO Contribution #1794. 47 pp.

Fleischer, R.C. 2001. Taxonomic and evolutionarily significant (ESU) status of western yellow-billed cuckoos (*Coccyzus americanus*). Admin. Report to USGS and US Fish and Wildlife Service April 22, 2001. 25 pp.

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

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

Girvetz, E.H. and S.E. Greco. 2007. How to define a patch: a spatial model for hierarchically delineating organism-specific habitat patches. Landscape Ecology 22: 1131-1142.

Greco, S.E. 2012. Patch change and the shifting mosaic of an endangered bird's habitat on a large meandering river. River Research and Applications. DOI 10.1002/rra2568.

Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California. Cooper Ornithological Club, Berkeley, CA. 1986 reprint by Artemisia Press, Lee Vining, CA.

Halterman, M.D. 1991. Distribution and habitat use of the yellow-billed cuckoo (*Coccyzus americanus occidentalis*) on the Sacramento River, California, 1987-1990. Master's Thesis, California State University, Chico, CA. 49 pp.

Halterman, M.D. 1999. Draft Western Yellow-billed Cuckoo Natural History Summary and Survey Methodology. Southern Sierra Research Station, Weldon, CA.

Halterman, M.D. 2001. Population status of the yellow-billed cuckoo at the Bill Williams River NWR and Alamo Dam, Arizona, and Southern Nevada: summer 2000. Bureau of Reclamation, Lower Colorado River Division, Boulder City, NV. 45 pp.

Halterman, M.D. 2002. Surveys and life history studies of the yellow-billed cuckoo: summer 2001. Admin. Rept., Bureau of Reclamation, Lower Colorado Regional Office, Boulder City, NV and Bureau of Land Management, Sierra Vista, AZ. 37 pp.

Halterman, M.D. 2005. Surveys and life history studies of the yellow-billed cuckoo: summer 2004. Report to the Bureau of Reclamation, Lower Colorado Regional Office, Boulder City, NV and Bureau of Land Management, Sierra Vista, AZ. 32 pp.

Halterman, M.D. 2008. Final report for the 2006-2007 yellow-billed cuckoo project. Report to the Bureau of Reclamation, Lower Colorado Regional Office, Boulder City, NV.

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

Halterman, M.D., D.S. Gilmer, S.A. Laymon, and G.A. Falxa. 2001. Status of the yellow-billed cuckoo in California: 1999-2000. Report to the US Geological Survey, Dixon, CA. 73 pp.

Halterman, M.D., E.T. Rose, S.E. McNeil, and D. Tracy. 2009. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2008. Annual report to the U.S. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV, by Southern Sierra Research Station, Weldon, CA.

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

Henneman, C. 2009. Yellow-billed cuckoo surveys in the South Fork Kern River Valley in 2008. Admin. Rept. prepared for U.S. Fish and Wildlife Service, Sacramento Office by Southern Sierra Research Station, Weldon, CA.

Holmes, J.A., C. Calvo, and M.J. Johnson. 2008. Yellow-billed Cuckoo distribution, abundance, habitat use, and breeding ecology in the Verde River Watershed of Arizona, 2004-2005. Final Report to Arizona Game and Fish Department, Heritage Department, Phoenix, AZ. 34 pp.

Hughes, J.M. 1999. Yellow-billed Cuckoo (*Coccyzus americanus*). *In* The Birds of North America, No. 148 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA. 28 pp.

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

Johnson, M.J., R.T. Magill, and C. van Riper, III. 2010. Yellow-billed cuckoo distribution and habitat associations in Arizona, 1998-1999. Pp. 197-212, In: The Colorado Plateau IV: Integrating research and resources management for effective conservation (van Riper, C., III, B. F. Wakeling, and T. D. Sisk, Eds). University of Arizona Press, Tucson, AZ. 335 pp.

Johnson, MJ., J.R. Hatten, J.A. Holmes, and P.B. Shafroth. 2012. Development of a GIS-based model of yellow-billed cuckoo breeding habitat within the lower Colorado River Multi-Species Conservation Area, San Pedro River, and Verde River, AZ. Admin. Report to Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, NV. 53 pp.

Johnson, R.R., B.T. Brown, L.T. Haight, and J.M. Simpson. 1981. Playback recordings as a special avian censusing technique. In: Estimating numbers of terrestrial birds (C.J. Ralph, and J.M Scott, Eds.). Studies in Avian Biology 6:68-75.

Koenig, W.D., and A.M. Liebhold. 2005. Effects of periodical cicada emergences on abundance and synchrony of avian populations. Ecology 86:1873-1882.

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

Laymon, S.A. 1998. Yellow-billed Cuckoo survey and Monitoring Protocol for California. Unpublished.

Laymon, S.A. 1998a. Partners in Flight Bird Conservation Plan: Yellow-billed Cuckoo (Coccyzus americanus). (http://www.prbo.org/calpif/htmldocs/species/riparian/yellow-billed_cuckoo.htm)

Laymon, S.A. and M.D. Halterman. 1985. Yellow-billed cuckoos in the Kern River Valley: 1985 population, habitat use, and management recommendations. California Dept. of Fish and Game, Nongame Bird and Mammal Section Rep. 85–06.

Laymon, S.A. and M.D. Halterman. 1987. Distribution and status of the yellow-billed cuckoo in California: 1986-1987. Final Report to the California Department of Fish and Game, Nongame Bird and Mammal Section, Wildlife Management Division, Sacramento, CA.

Laymon, S.A. and M.D. Halterman. 1989. A proposed management plan for yellow-billed cuckoos in California. Pages 272-277 *in* D. Abell, Tech. Coord., Proceedings of the California Riparian Systems Conference: protection, management, and restoration for the 1990's. USDA Forest Service Gen. Tech. Rep. PSW-110, Berkeley, CA.

Laymon, S.A., P.L Williams, and M.D. Halterman. 1997. Breeding status of the yellow-billed cuckoo in the South Fork Kern River Valley, Kern County, California: Summary Report 1985-1996. Admin. Report USDA Forest Service, Sequoia National Forest, Cannell Meadow Ranger District, Challenge Cost-share Grant #92-5-13.

Marshall, D.B., M.G. Hunter, and A.L. Contreras. 2003. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR. 768 pp.

Martin, T.E., and G.R. Geupel. 1993. Methods for locating nests and monitoring success. Journal of Field Ornithology 64:438–449.

McKernan, R. L., and G. T. Braden. 2002. The status of Yuma clapper rail and yellow-billed cuckoo along portions of Virgin River, Muddy River, and Las Vegas Wash, Southern Nevada, 2001. Final Report to the U.S. Fish and Wildlife Service and Southern Nevada Water Authority, Las Vegas, prepared by San Bernardino County Museum, Redlands, California.

McNeil, S.E., D. Tracy, J.R. Stanek, and J.E. Stanek. 2013. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2008-2012 summary report. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV.

McNeil, S.E, D. Tracy, and C.D Cappello. (2015 in review). Loop migration and Chaco wintering by a Western Yellow-billed Cuckoo. Manuscript submitted for publication.

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

Noss, R.F., E.T. LaRoe III, and J.M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. U.S. Geological Survey, Biological Resources Division (National Biological Service), BSR no. 9501, Washington, DC.

Ohmart, R.D. 1994. The effects of human-induced changes on the avifauna of western riparian habitats. Studies in Avian Biology 15:273–285.

Parametrix, Inc. and Southern Sierra Research Station, 2015. Yellow-billed cuckoo surveys and population monitoring on the lower Colorado River and tributaries, 2014. Annual Report submitted to the Bureau of Reclamation, Boulder City, Nevada. Prepared by S.E. McNeil, and D. Tracy, Southern Sierra Research Station, Weldon, California, and Parametrix, Inc., Albuquerque, New Mexico. February 2015.

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

Potter, E.F. 1980. Notes on nesting yellow-billed Cuckoos. J. Field Ornithology 51:17-29.

Preble, N.A. 1957. Nesting habits of the yellow-billed cuckoo. American Midland Naturalist 57:474-482.

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

Pulliam, H.R. 1988. Sources, sinks, and population regulation. American Naturalist 132: 652–661.

Pyle, P. 1997. Identification guide to North American birds - part 1. Slate Creek Press, Bolinas, CA. 732 pp.

Ridgway, R. 1887. A manual of North American birds. Lippincott Press, Philadelphia, PA.

Roberson, D. 1980. Rare birds of the West Coast. Woodcock Publications, Pacific Grove, CA. 496 pp.

Sechrist, J., V. Johanson, and D. Ahlers. 2009. Western Yellow-billed Cuckoo Radio Telemetry Study Results – Middle Rio Grande New Mexico – 2007-2008. U.S. Bureau of Reclamation, Technical Service Center, Denver, CO.

Sechrist, J., Paxton, E. H., Ahlers, D., Doster, R. H., and Ryan, V. M. 2012. One year of migration data for a Western Yellow-billed Cuckoo. Western Birds 43:2–11.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbits. 1997. A southwestern willow flycatcher natural history summary and survey protocol. Technical Report NPS/NAUcprs/NRTR-97/12. 36 pp.

Sogge, M.K., D. Ahlers, and S.J. Sferra. 2010. A natural history summary and survey protocol for the Southwestern Willow Flycatcher: U.S. Geological Survey Techniques and Methods 2A-10. 38 pp.

Stanek, J. R., and J. E. Stanek. 2012. Yellow-billed Cuckoo Occupancy, Breeding, and Habitat Use in the South Fork Kern River Valley, 2012 Annual Report. Report to the US Fish and Wildlife Service, Sacramento Office, Sacramento, CA.

Stiles, F.G., and A.F. Skutch. 1989. A guide to the birds of Costa Rica. Cornell University Press, Ithaca, New York.

Stoleson, S., and D. Finch. 1998. Breeding bird activity along the Gila River in the Gila-Cliff valley. Unpublished data. USFS- Rocky Mountain Research Station, Albuquerque, NM.

Tomlinson, C. 2010. Yellow-billed cuckoo – Candidate Species Assessment – Coccyzus americanus, Nevada – April 14, 2010. Attachment in email to Karen Leyse, U.S. Fish and Wildlife Service, Sacramento, California. April 14, 2010. 12 pp

U.S. Department of Interior. 1994. The impact of Federal programs on wetlands, Vol. II, a report to Congress by the Secretary of the Interior, Washington, DC, March 1994.

United States Fish and Wildlife Service (USFWS). 2001. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the Yellow-billed Cuckoo (*Coccyzus*

americanus) in the Western Continental United States. Federal Register. 50 CFR Part 17:38611-626.

Woodward, H.D, S.H. Stoleson, and D.M. Finch. 2003. Yellow-billed cuckoos on the Gila National Forest: presence-absence, abundance, and habitat. Final report for the 2002 Field Season. US Dept. of Agriculture Forest Service, Rocky Mountain Research Station, Albuquerque, NM.

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.

General survey data.

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.

Yellow-billed Cuckoo detections:

(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	uckoo #	Corrected Coordinates	
							UTM E	UTM N				UTM E	UTM N

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

ATTACHMENT 3

Instructions for Completing the Revised Yellow-billed Cuckoo (*Coccyzus americanus*) Survey Summary Form (Draft Addendum to Appendices 1 to 3)

Instructions for completing the revised Yellow-billed Cuckoo Survey Summary Form
Draft Addendum to Appendices 1 to 3 for yellow-billed cuckoo survey protocol
in Arizona, New Mexico, and Texas: in Halterman et. al. (2016)
June, 2019

Suggested Citation:

U. S. Fish and Wildlife Service and U.S. Bureau of Reclamation. 2019. Draft Addendum to Appendices 1 to 3 for yellow-billed cuckoo survey protocol in Arizona, New Mexico, and Texas: in Halterman, M.D., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2016. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: Draft. U.S. Fish and Wildlife Techniques and Methods. Prepared by Susan Sferra, Vicky Ryan, and Meghan White for USFWS, Southwest Region, Albuquerque, New Mexico and U.S. Bureau of Reclamation, Denver Technical Center, Denver, Colorado.

Contacts for questions or comments: Susan Sferra at susan_sferra@fws.gov, Vicky Ryan at Vicky_ryan@fws.gov, or Meghan White at mwhite@usbr.gov.

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Introduction: These revised instructions are provided as guidance for completing the revised Yellow-billed Cuckoo (cuckoo) Survey Summary Form for Arizona, New Mexico, and Texas. The revised Excel Survey Summary data entry form automatically creates a database as data are entered. In addition to improvements in formatting and data storage, the instructions and form were revised to improve standardization of vegetation data and estimation of Possible, Probable, and Confirmed breeding territories.

To apply for a federal permit (USFWS Recovery Permit Application): To download a form for a federal permit: http://www.fws.gov/forms/3-200-55.pdf. If you have already applied for a federal permit, you may email *permitsR2ES@fws.gov* regarding the status of your application. Note that new federal permit applications submitted within the last few months may still be under review.

To apply for a state permit:
Each state has different permitting and reporting requirements. To survey in Arizona, in additional to your federal permit, you must apply for a scientific collecting license from the Arizona Game and Fish Department annually. A specific survey location is required at time of

submission. Expect up to 30 days for review and processing. Currently, there is no fee for this process. For more information and the application:
https://www.azgfd.com/license/speciallicense/scientificcollection/.
Email *scpermits@azgfd.gov* if you have questions.
No state permits are required for protocol surveys in New Mexico or Texas, but they are required for nest monitoring and handling cuckoos. Permit applications are available at: http://www.wildlife.state.nm.us/download/enforcement/scientific-educational/scientific/Scientific-Collection-Permit-Application-or-Renewal-Form.pdf. For any questions pertaining to New Mexico Department of Game and Fish permits, please email *dgf.permits@state.nm.us*. For any questions pertaining to Texas Park and Wildlife Division permits, please email *wpoffice@tpwd.state.tx.us*

Permit Reporting: The appropriate contacts in your State and Federal permits are usually the State and USFWS Ecological Services Field Office yellow-billed cuckoo leads and the State and Federal permits coordinators. Prior to conducting surveys, email the name of the area you intend to survey to your USFWS Ecological Service Field Office cuckoo lead. This information is needed to avoid duplication of effort. Survey field forms are posted at http://www.fws.gov/southwest/es/arizona/Yellow.htm. Complete data forms (spreadsheets) for all sites surveyed, regardless of whether or not cuckoos were detected.

CHECK YOUR PERMIT – REPORTING REQUIREMENTS VARY BETWEEN REGIONS AND STATES

For annual reports, Permittees in Arizona, New Mexico, and Texas are required to submit digitally:

(1) copies of all field data forms in Excel format (posted at http://www.fws.gov/southwest/es/arizona/Yellow.htm) with positive or negative survey results;
(2) copy of USGS quad/topographical map or similar of survey area, survey route, outline of survey site, location of cuckoo detections by survey number or date, nests (if any), and estimated territories;
(3) sketch or preferably an aerial photo showing survey area, survey route, outline of survey site location of cuckoo detections by survey number or dates, nests (if any), and estimated territories;
(4) photos (if taken) of the interior of the patch, exterior of the patch, and overall site (may be compiled in pdf);
(5) bird photos (if taken) (may be compiled in pdf); and
(6) if available, GIS files (i.e., shapefile, personal or file geodatabase) of #2 above.

Excel forms (spreadsheets) must be emailed in Excel format. Maps and photos may be compiled into a pdf. Results must be submitted by October 15, following each survey season. Permittees will be responsible for making sure that they submit the data to the appropriate USFWS Ecological Services Field Office and state in which surveys were conducted. Permittees (federal) must send a copy to landowner/land manager where surveyors were conducted.

Federal permits (send to): Arizona: *susan_sferra@fws.gov*, New Mexico: *vicky_ryan@fws.gov* and *clinton_smith@fws.gov*, Texas: *clayton_napier@fws.gov*,

vicky_ryan@fws.gov, and *clinton_smith@fws.gov*.

State permits (follow state reporting requirements; also send a copy of federal annual report): Arizona: *scpermits@azgfd.gov*. New Mexico: *nhnm@unm.edu*. Texas: Texas Parks & Wildlife Department, Wildlife Division – Wildlife Permitting Office, 4200 Smith School Road, Austin, Texas 78744.

We recommend scanning or otherwise imaging field 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 Summary Form for electronic submission

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.

Elevation (meters): 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. If elevation changed from start to finish, use the average elevation and include notes in the comments.

State: Record the state where the site is located.

USGS Quad Name: Provide the full quad name, as shown on the appropriate standard USGS 7.5-minute topographic maps. Please list the names of all USGS 7.5-minute topographic maps covered by the survey site. To find the name of the USGS map where a site is located, open the USGS 7.5-minute topographic map index at the following website: http://www.fws.gov/southwest/es/arizona/Yellow.htm.

Creek, River, Wetland, Canyon, or Lake Name: Provide the name of the riparian feature, such as the lake or watercourse (including ephemeral washes), where the survey is being conducted. If the drainage or canyon name is different than the riparian feature, use the name of the riparian feature. For example, Bonito River instead of Rio Grande.

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. Note that we do not need the coordinates for the detailed route taken by the surveyor(s) but see permit requirements for site outline and general survey route and associated geospatial files. A marked general survey route taken by the surveyor(s) on copies of a USGS quad/topographical map and aerial photo (or sketch if no aerial photo is available) will provide the needed information, especially for non-linear routes in wide expanses of habitat or side drainages. Surveyors may also provide additional points defining the area surveyed in the Comments section if the site is wide or nonlinear.

UTM 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, we prefer that you use NAD83.

Magnetic North Declination: The compass declination should be set to the magnetic declination of the survey area. Arizona ranges from 10-12º from east to west. New Mexico ranges from 9-10º from east to west within the range of the western yellow-billed cuckoo. Magnetic declination values can be located on USGS 7.5 minute quad maps, can be found using an internet search for "your state" + magnetic declination, or can be calculated on the following website at https://www.ngdc.noaa.gov/geomag/declination.shtml.

Was site surveyed in previous year? Click on drop down menu and select yes, no, or unknown.

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 #: Survey 1 – 5.
See the protocol for an explanation of the number of required visits (also known as surveys) for each survey period. Note: A single survey is defined as a complete protocol-based survey that occurs over no more than one 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. At least four surveys are required for completion of a full season of protocol-level surveys at any site. Although not required, we encourage additional surveys through September in Arizona and New Mexico, especially when conducting surveys for proposed projects. Cuckoo nests and fledglings have been documented as late as early October. Surveys conducted 12 - 14 days apart are recommended, based on a population study on the lower Colorado River (McNeil et al. 2013). If surveys are conducted only 10 days apart, only 40 days of the breeding season are covered. In addition some cuckoos may remain onsite for 10 days prior to leaving area and may be counted on two surveys. If surveys are conducted more than 16 days apart, an entire cuckoo breeding cycle may be missed. Surveys conducted 15 days apart are acceptable, but are not as ideal as 12-14 days apart if start date of a breeding cycle is unknown. Some extenuating circumstances such as wind, rainfall, flooding, and access may require some surveys to be only 10 days apart.

Protocol surveys require morning visits, but you may also conduct supplemental evening surveys if time permits. 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 or in the Additional Yellow-billed Cuckoo Detections section.

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 12-hour rather than 24-hour format (e.g., 4:00 am hours rather than 0400). You must use a semi-colon.

Total hrs: Calculate the total hours, rounded to the nearest quarter (0.25) 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 Cuckoos detected during this particular survey. When uncertain whether a detection represents a new individual, include comments on why you are uncertain (such as you were unsure whether the bird followed you or you were unsure whether the same bird was detected in different parts of the survey areas, or the bird was detected only briefly, or other cuckoo behavior). Do not count nestlings. (But do record whether nestlings or fledglings were found, in the Detection Comments section).

YBCU #: 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. Keep track of different cuckoos in the Detection Comments section using both Survey # and YBCU #. Document any information in the Detection Comments that may indicate whether a cuckoo is the same or a different bird than documented previously.

Time Detected: Time of cuckoo detection. Report time in 12-hour rather than 24-hour format (e.g., 8:00 am rather than 0800). You must use a semi-colon.

Detection Method: 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”.

Detection Type: 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 "CN" = Contact/kowlp,"CO" = coo, "AL" = alarm (soft knocker call), "OT" = other (and describe the "other" vocalization under Detection Comments section.

Number of 'kowlp' calls played prior to response: Record the number of times the 'kowlp' call was played before the cuckoo responded. A cuckoo vocalizing prior to playback or responding immediately after playback number 1 was likely already nearby and may be near or at the center of its territory. Surveyors should be especially vigilant for signs of breeding behavior. Cuckoos that do not respond until after several calls are broadcast may be present but silent, may be approaching from other areas, or may be following surveyors. Counting the number of broadcast calls also helps the surveyor pay attention to the survey.

Behavior Observed (refer to codes): If observed, record the appropriate behavior code provided at the bottom of the first sheet or see all codes provided at the end of this document in Addendum Appendix 1. Surveyors should be familiar with these behaviors to help in assessing territory and breeding status. More than one code may be used. If a nest is inadvertently found while conducting surveys, observers should 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. Surveyors are not authorized to monitor nests (repeated visits within 20 meters of nest tree) unless specifically stated in your State and Federal permits. Habitat density, nest height, surveyor noise, and surveyor visibility play a role in the level of disturbance to cuckoos. Surveyors must be alert to behavioral signs of disturbance near a cuckoo nest, which include alarm calls given repeatedly while watching the intruder, broken wing displays, or flying in with prey and eating the prey item instead of going to the nest. If these occur, the observer has been the cuckoo is distressed, and the observer should move back (Halterman et al. 2016).

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 (meters): Estimate as accurately as possible, the distance in meters to the detected cuckoo. Periodically, double check your distance estimation accuracy with a measuring tape in the same habitat type between surveys.

Bearing (in number degrees): Estimate, as accurately as possible, the compass bearing in numerical degrees to the detected cuckoo from the surveyor location (such as 360 degrees rather than North). See Magnetic North declination above.
Corrected Coordinates: The Cuckoo location is calculated based on the surveyor's location, distance, and bearing. You do not enter data into the Corrected Coordinates fields. This Excel data sheet contains a formula that will automatically calculate corrected coordinates and populate these fields.

Survey Summary (REQUIRED):

Surveyors MUST complete all fields in the Survey Summary section of the form. Surveyors have the best knowledge of the behavior, habitat, and location of birds detected on each survey visit, which are used to determine numbers of Possible, Probable, and Confirmed breeding territories. Guidance in estimating the numbers of breeding territories is provided in Table 1 below (updated and revised from Table 2 of the Survey Protocol). These estimates are important and are used by regulatory and land management agencies.

Table 1. Possible, Probable, and Confirmed breeding territory estimation using cuckoo detections. A site is occupied if at least one Possible breeding territory (PO), Probable breeding territory (PR), or Confirmed breeding territory (CO) is present. This table is revised and updated from Table 2 of the Survey Protocol, based on Holmes et al. (2008), McNeil et al. (2013), and Dillon et al. (2017).

Breeding Territory Estimation[1]	
Possible breeding territory (PO)	Detections within a 300 - 500 m area during at least 2 surveys and 12 - 14 days apart.
Probable breeding territory (PR)	Detections within a 300-500 m area during at least 3 surveys and 12-14 days apart; or PO territory plus purposeful food carry (single observation, bird does not eat food), stick carry (single observation), multiple incidents of alarm calls in same area, or PO territory plus pair exchanging multiple kowlp or alarm calls (not coos) within 100 m of one another.
Confirmed breeding territory (CO)	Observation of active nest (or multiple stick carries to nest being built), copulation, fledgling (unable to fly) with adult; or PR plus multiple food carries to same area; or distraction display (dropped wing).

[1] Surveys conducted 12 - 14 days apart are recommended, based on a population study on the lower Colorado River (McNeil et al. 2013). If surveys are conducted only 10 days apart, only 40 days of the breeding season are covered. In addition, some cuckoos may remain onsite for 10 days prior to leaving area and may be counted on two surveys. If surveys are conducted more than 16 days apart, an entire cuckoo breeding cycle may be missed. Surveys conducted 15 days apart are acceptable, but are not as ideal as 12-14 days apart if start date of a breeding cycle is unknown. Some extenuating circumstances such as wind, rainfall, flooding, and access may require some surveys to be only 10 days apart.

Total Survey Hours: The number of survey hours for the entire field season. The number of survey hours during each survey will be automatically summed and entered into this field.

Total Number of Detections: The number of individual cuckoos detected during each survey will be automatically summed and entered into this field. Example: If 3 cuckoos (unique individuals) were detected on the first survey, 2 cuckoos were detected on the 2nd survey, and no cuckoos were detected on surveys 3 and 4, the total number of cuckoo detections would be 5 even if the 2 cuckoos detected on the 2nd survey were 2 of the same individuals as on survey 1.

Number of PO Breeding Territories: Record the total number of Possible breeding territories following protocol guidelines and Table 1 (revised from Table 2 in the Survey Protocol, also summarized on form).

Number of PR Breeding Territories: Record the total number of Probable breeding territories following protocol guidelines and revised Table 1 (revised from Table 2 in the Survey Protocol, also summarized on form).

Number of CO Breeding Territories: Record the total number of Confirmed breeding territories following protocol guidelines and revised Table 1 (revised from Table 2 in the Survey Protocol, also summarized on form).

Number of Nests Found: Record total number of nests found (if any encountered). Surveyors are not authorized to monitor nests within 20 meters of the nest tree unless specifically stated in your State and Federal permits.

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

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

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

Name of Reporting Individual: Indicate the full first and last name of the reporting individual (preferably the primary surveyor).

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

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

Email: Provide the reporting individual's email.

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.

Ownership: Primary: Click on drop down menu and select from list.
(BLM, BOR, NPS, USFWS, USFS, Tribal, State, Private, or other (Municipal/County).

Did you survey the same general area during each visit to this site this year? Click on drop down and select Yes or No. If No, summarize in the comments section.

If site was surveyed last year, did you survey the same general area this year? Click on drop down and select Yes or No. If No, record the reason and how the survey varied in the comments section.

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

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 Overstory/Canopy (where playback calls were used):
Provide the scientific names of the five most common species in the overstory/canopy and proportion of overstory cover provided by each species in cuckoo breeding habitat (relative cover). Overstory may consist of more than one habitat type. For example, cottonwood/willow habitat bordered by mesquite may both be part of the breeding habitat. For relative percent cover, the total should equal 100%, even if more than five species are present. Appendix 2 at the end of this document and the dropdown menu on the form include most, but not all, of the species in southwestern cuckoo habitat. If one of the five most common species present is not

included, click on "Other" and include the scientific name of the species in the Comments section.

General Overstory/Canopy Characteristics:

Average Height (top of trees) of Overstory (meters; do not include a range): Provide the best estimate of the average height of the top of the overstory/canopy throughout the survey in meters. Although canopy height can vary, give only a single (not a range) overall height estimate.

Estimated Absolute (as opposed to relative) Canopy Cover (percent; may be < 100%): Estimate of the absolute percent overstory/canopy cover of the site. This measure of cover is not equal to the species relative covers previously recorded and may be less than 100% if canopy openings are present. The open streambed should not be included in the estimate.

Average Subcanopy (if present; where playback calls were used): Fill out this section if two distinctive tree layers are present and can be differentiated into an overstory/canopy and subcanopy layer (as opposed to overstory/canopy and understory layers). Provide the scientific names of the five most common species in the subcanopy and proportion of average subcanopy cover provided by each species in cuckoo breeding habitat (relative cover). For relative percent cover, the total should equal 100%, even if more than five species are present. Appendix 2 at the end of this document and the dropdown menu on the form include most, but not all, of the species in southwestern cuckoo habitat. If one of the five most common species present is not included, click on "Other" and include the scientific name of the species in the Comments section.

General Subcanopy Characteristics:

Average Height of Subcanopy (meters): Provide the best estimate of the average height of the top of the subcanopy throughout the survey in meters. Although subcanopy height can vary, give only a single (not a range) overall height estimate.

Estimated Absolute (as opposed to relative) Subcanopy Cover (percent; may be < 100%): Estimate the absolute percent overall subcanopy cover at the site. This measure of cover is not equal to the species relative covers previously recorded and may be less than 100% if subcanopy openings are present. The open streambed should not be included in the estimate.

Average Understory (if present; where playback calls were used): The understory comprises a distinct woody or herbaceous layer (that does not have to be present throughout the site) below the overstory canopy and subcanopy in cuckoo breeding habitat This is the shrub or ground cover layer, including tree regeneration, perennial shrubs, grasses, and/or annual herbaceous growth. For example, a cottonwood overstory might have shrub-sized young cottonwoods or willows and shrubs directly below, immediately

adjacent to, or in small patches in between the overstory. Or there may only be an overstory and subcanopy with no understory. List up to 5 species of understory and estimate proportion of understory cover of each species. Use scientific names. For percent cover the total should equal 100%, even if more than five species are present.

General Understory Characteristics:

Average Height (top) of Understory (meters; do not include a range): Provide the best estimate of the average height of the top of the understory throughout the site in meters. Although understory height can vary, give only a single (not a range) overall height estimate.

Estimated Absolute (as opposed to relative) Understory Cover (percent; may be < 100%): Estimate the absolute percent understory cover for the site. This measure of cover is not equal to the species relative covers previously recorded and may be less than 100% if openings are present. The open streambed should not be included in the estimate.

Immediate Adjacent Habitat Along Entire Transect (Outside of survey site): Categorize habitat adjacent to the survey area (e.g. rock outcrop, desert/scrub/thornscrub, urban/residential, agriculture/pasture, orchard, oak woodland, pinyon-juniper woodland, mixed conifer forest, grassland, marsh/wet meadow, open water, ditch/irrigation). Adjacent habitat should not be part of the breeding habitat. For example, if mesquite borders riparian habitat and contributes toward breeding habitat it is not considered adjacent habitat and should be included in the overstory and understory estimates. List up to 5 categories of adjacent habitat and estimate the proportion of percent cover (should equal 100%). If a category of adjacent habitat present is not included, click on "Other" and include the name of the adjacent habitat in the Comments section. Additional information on some of the adjacent habitat types:

- Desert/Scrub/Thornscrub is a broad category of habitat types that may contain creosote, cacti, arid-adapted shrubs, and thorny trees such as mesquite, acacia, and grey thorn. Tree cover, if present, is generally shorter and sparser than in breeding habitat. Examples: adjacent habitat along Agua Fria, Gila, lower San Pedro, Verde, Bill Williams, lower Colorado, Big Sandy, Santa Cruz rivers and tributaries in AZ and along ephemeral drainages in southeastern AZ.
- Orchard: pecan, almond, apple, pistachio. etc.
- Oak Woodland may include other trees and is primarily in the foothills and mountains of southeastern AZ. Example: Coronado National Forest.
- Mixed Conifer Forest. Example: Coronado National Forest.
- Grassland. Examples: along Gila R, Mimbres R, and Rio Grande in NM; Upper San Pedro R, Canelo Hills, and drainages in Buenos Aires National Wildlife Refuge, in AZ.

Is the survey area or adjacent area (within 300 meters) dominated by surface water or saturated soil during at least two surveys? Click on drop down menu and select Yes, No, or

Unknown. Provide information in the Comments section if surface water or saturated soil changed between surveys.

Perennial, intermittent, ephemeral drainage (or body of water): Click on drop down menu and select Perennial, Ephemeral, or Intermittent. We are interested in whether the drainage (or body of water) supporting vegetation used by cuckoos is perennial, intermittent, or ephemeral during the breeding season. Tanks, ponds, lakes, cienegas, irrigation ditches, irrigation system, etc. would be characterized by the frequency and duration the water source is available during the breeding season. See the descriptions below. Provide information in the comments section of any changes in hydrology.

Perennial - water flowing year-round, mostly from upstream waters or groundwater. Or a lake with water during the entire breeding season.

Intermittent - water flowing during certain times of the year mostly from upstream waters and groundwater. Examples: A streambed that contains pools of water in between dry reaches throughout the breeding season. In artificial systems, water may be delivered on a schedule, such as one day per week, with gradual drying in between deliveries. An irrigation ditch that contains water for two days every week. An irrigation system supporting revegetated riparian habitat.

Ephemeral - water present or flowing only after precipitation, such as during the summer monsoon. Examples: A wash that is temporarily moist or flowing from a summer rain. A tank that holds water temporarily after a summer rain.

Comments: Provide comments regarding differences between survey patches or where cuckoos were detected 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, subcanopy, 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 3 of Survey Summary Form for electronic submission

Yellow-Billed Cuckoo Survey Summary Form Page 3 (OPTIONAL). Please use this form for additional detections, follow-up visits, evening visits, and any other circumstance when more detail is needed.

Addendum to Literature Cited

Dillon, K., D. Moore, and D. Ahlers. 2017. Lower Rio Grande Yellow-billed Cuckoo Survey Results -2016. Selected Sites within the Lower Rio Grande Basin from Elephant Butte Dam, NM to El Paso, TX. Bureau of Reclamation, Technical Service Center, Fisheries and Wildlife Resources. Denver, CO.

Halterman, M.D., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2016. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: Draft. U.S. Fish and Wildlife Techniques and Methods, 45 p.

Holmes, J.A., C. Calvo, and M.J. Johnson. 2008. Yellow-billed cuckoo distribution, abundance, habitat use, and breeding ecology in the Verde River watershed of Arizona, 2004–2005. Final Report. Admin Rept. Arizona Game and Fish Dept. 34 pp.

McNeil, S.E., D. Tracy, J.R. Stanek, and J.E. Stanek. 2013. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2008–2012 summary report. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV, by SSRS. http://www.lcrmscp.gov/reports/2012/d7_sumrep_08-12.pdf.

McNeil, S.E. and D. Tracy. Yellow-billed Cuckoo Behavior Codes. Southern Sierra Research Station. Weldon, CA.

Appendix 1. Yellow-billed Cuckoo behavior codes (McNeil and Tracy 2019).

Behavior code	Description	Evidence of Breeding or Pair Activity? (0=No, S=suggestive-need more evidence, P=probable, C=confirms)	Note
CAP	Capture (e.g. in mist net)	0	For banding studies
DT	Dropped Transmitter (radio-tagged birds only)	0	For telemetry studies
FLC	Flies Closer (response to playback)	0	Added for response/detection study. Also useful to ID a catchable cuckoo (flies toward playback).
FLU	Flush (possibly off nest)	S	Flush, possibly off nest in response to surveyor. (Normally cuckoos avoid being seen up close. If a cuckoo flies right in front of you, often it's because you just flushed it (made it fly) off nest.
NOS	No Signal (radio-tagged birds only)	0	For telemetry studies
PA	Pair	S	Useful to hone in on territory centers
PN	Possible Nest	S	Useful to hone in on territory centers, and reduce excessive point-taking
RC	Repeat Call (from same location)	S	Useful to hone in on territory centers, and reduce excessive point-taking
RO	Roost Site (nocturnal)	S	Location of calling birds pre-dawn. Useful to locate nests (incubating males often call from nest pre-dawn)
RS	Resight band	0	For banding studies
MA	Mistnet Attempt	0	For banding studies
TD	Territorial Display	S	Useful to hone in on territory centers
NV	No Visual	0	

Behavior code	**Description**	**Evidence of Breeding or Pair Activity?** (0=No, S=suggestive-need more evidence, P=probable, C=confirms)	**Note**
BW	Bill Wipe	0-S	Sometimes indicates agitated behavior near a nest
FS	Fecal Sac Carry	C	
AN	At Nest	C	
US	Used Nest	C	Nests inactive when found (active earlier in season)
CP	Catches Prey	0	
EF	Eats Food	0	
FLY	Flying	0	
FO	Forages	0	
JUV	Juvenile	C (in area)	Older than fledgling, able to fly.
PRE	Preening	0-S	Sometimes indicates agitated behavior near a nest
ST	Sitting	0	Useful for band/resight QA (resighting bands usually requires sitting birds)
FY	Feeds Young	C	
BI	Brooding or Incubating	C	
CF	Carry Food	0-S	Suggests but does not confirm breeding. Other evidence needed
MAT	Carry Nest Material	P	Best to find the nest to confirm breeding
COP	Copulation	C	Best to find the nest to confirm breeding
DD	Distraction Display	C	Best to find the nest to confirm breeding
FLG	Fledgling	C	Indicates a nest nearby (fledgling = unable to fly)
FM	Feeds Mate	S	
FN	Feeds Nestling	C	
NB	Nest Building	C	
VEX	Vocal (kowlp) Exchange	S	

Appendix 2. Woody Plant Species List for Arizona, New Mexico, and Texas.

Veg Code	Common Name	Genus	Species
ABCO	White fir	*Abies*	*concolor*
ABSP	Fir species	*Abies*	species
ACSP	Acacia species	*Acacia/Senegalia*	species
ACGR	Catclaw acacia	*Senegalia* (old genus is Acacia)	*greggii*
ACSP	Acacia Species	*Acacia*	species
ACGL	Rocky Mountain Maple	*Acer*	*glabrum*
ACNE	Boxelder	*Acer*	*negundo*
ACSP	Maple species	*Acer*	species
ALIN	Thinleaf Alder	*Alnus*	*incana ssp. tenuifolia*
ALOB	Arizona alder	*Alnus*	*oblongifolia*
ALRH	White alder	*Alnus*	*rhombifolia*
ALSP	Alder species	*Alnus*	species
AMFR	Indigobush	*Amorpha*	*fructicosa*
APCA	Dogbane	*Apocynum*	*cannabinum*
ARXA	Texas madrone	*Arbutus*	*xalapensis*
ARSP	Manzanita	Arctostaphylos	species
BASP	Baccharis species	Baccharis	species
BAMBOO	Bamboo	Bamboo	species
Burned	Burned	Burned	Burned
CACTUS	Cactus species	Cactus	species
CAIL	Pecan	*Carya*	*illinoinensis*
CEEH	Desert hackberry Same species with 2 diff scientific names being used. Other name is Celtis pallida.	*Celtis*	*ehrenbergiana*
CELA	Sugar hackberry	*Celtis*	*laevigata*
CERE	Western hackberry Net-leafed hackberry Canyon hackberry	*Celtis*	*reticulata*
CESP	Hackberry species	*Celtis*	species
CRSP	Palo verde (2 species) Foothills Palo Verde (Cercidium microphyllum) or Blue Palo Verde (Cercidium floridum)	*Cercidium*	species

Veg Code	Common Name	Genus	Species
CHLI	Desert willow	*Chilopsis*	*linearis*
CONIFER	Conifer species	Conifer	species
COX	Dogwood species	*Cornus*	species
CUAR	Arizona cypress	*Cupressus*	*arizonica*
ELAN	Russian Olive	*Elaeagnus*	*angustifolia*
FONE	New Mexico Olive, Privet, New Mexican Forestiera	*Forestiera*	*neomexicana*
FOPU	New Mexico Olive, Stretchberry	*Forestiera*	*pubescens*
FOX	New Mexico Olive species	*Forestiera*	species
FREX	European ash	*Fraxinus*	*excelsior*
FRVE	Arizona Ash, Velvet Ash	*Fraxinus*	*velutina*
FRSP	Ash	*Fraxinus*	species
JGX	Walnut species	*Juglans*	species
JUMA	Arizona walnut	*Juglans*	*major*
JUNI	Black walnut	*Juglans*	*nigra*
JURE	English walnut	*Juglans*	*regia*
JUMO	One-seed juniper	*Juniperus*	*monosperma*
JUPA	Alligator Juniper	*Juniperus*	*pachyphloea*
JUSC	Rocky Mountain Juniper	*Juniperus*	*scopulorum*
JUSP	Juniper species	*Juniperus*	species
LYSP	Wolfberry species	*Lycium*	species
MAX	Apple tree species	*Malus*	species
MIMO	Mimosa	*Mimosa*	species
MOAL	White mulberry	*Morus*	*alba*
MOMI	Texas mulberry	*Morus*	*microphylla*
MOSP (AZ)	Mulberry	*Morus*	species
N	None	None	none
Other	Other	Other	Other
OTLE	Ironwood	*Olneya*	*tesota*
PASP	Palo Verde	*Parkinsonia*	species
PIEN	Engelmann's spruce	*Picea*	*engelmannii*
PIPU	Blue spruce	*Picea*	*pungens*
PISP	Spruce Species	*Picea*	species
PIED	Pinyon pine	*Pinus*	*edulis*
PIPO	Ponderosa pine	*Pinus*	*ponderosa*
PICE	Mexican Pinyon Pine	*Pinus*	*cembroides*
PISP	Pine	*Pinus*	species

Veg Code	Common Name	Genus	Species
PLWR	Arizona Sycamore	*Plantanus*	*wrightii*
POAN	Narrowleaf Cottonwood	*Populus*	*angustifolia*
PODE	Rio Grande Cottonwood, includes subspecies *wislizenii*	*Populus*	*deltoides*
POFR	Fremont Cottonwood	*Populus*	*fremontii*
POSP	Populus species	*Populus*	species
PRGL	Honey mesquite	*Prosopis*	*glandulosa*
PRPU	Screwbean mesquite	*Prosopis*	*pubescens*
PRSP	Mesquite	*Prosopis*	*species*
PRVE	Velvet Mesquite	*Prosopis*	*velutina*
PNSP	Fruit trees- domestic (almond, prune, etc.	*Prunus*	species
PRVI	Chokecherry	*Prunus*	*virginiana*
PSME	Douglas-fir	*Pseudotsuga*	*menziesii*
PTTR	Hoptree	*Ptelea*	*trifoliata*
QUGA	Gambel's oak	*Quercus*	*gambelii*
QUGR	Grey oak	*Quercus*	*grisea*
QULO	Valley oak	*Quercus*	*lobata*
QUMU	Chinaquapin oak	*Quercus*	*muehlenbergii*
QUSP	Oak species	*Quercus*	species
RHMI	Gray littleleaf sumac	*Rhus*	*microphylla*
RHSP	Sumac species	*Rhus*	species
RHTR	Three-leaf sumac	*Rhus*	*trilobata*
RONE	New Mexico locust	*Robinia*	*neomexicana*
ROWO	Wild rose	*Rosa*	*woodsii*
ROSP	Rose species	*Rosa*	species
ROAR	Arizona Rose	*Rosa*	*arizonica*
RUSP	Blackberry	*Rubus*	species
SAAM	Peachleaf willow	*Salix*	*amygdaloides*
SABE	Bebb willow	*Salix*	*bebbiana*
SABO	Red Willow (Bonpland)	*Salix*	*bonplandiana*
SAEX	Coyote willow/ Sandbar Willow	*Salix*	*exigua*
SAGE	Geyer Willow	*Salix*	*geyeriana*
SAGO	Tree willow, Goodding's willow, Black willow	*Salix*	*goodingii*

Veg Code	Common Name	Genus	Species
SAIR	Bluestem willow, Sandbar willow	*Salix*	*irrorata*
SALA	Arroyo willow	*Salix*	*lasiolepis*
SALE	red willow	*Salix*	*laevigata*
SALU	Yellow willow	*Salix*	*lutea*
SAMO	Park willow	*Salix*	*monticola*
SANI	Black willow	*Salix*	*nigra*
SATA	Yewleaf willow	*Salix*	*taxifolia*
SASP	Willow species	*Salix*	species
SAME	Mexican elderberry	*Sambucus*	*mexicana*
SASA	Soapberry	*Sapindus*	*saponaria*
SNAG	Snag (any species)	SNAG	SNAG
TAAP	Athel tamarisk	*Tamarix*	*aphylla*
TACH	Five-stamen saltcedar	*Tamarix*	*chinensis*
TAPE	Saltcedar	*Tamarix*	*pentandra*
TARA	Saltcedar	*Tamarix*	*ramosissiama*
TASP	Salt Cedar / Tamarisk (TACH, TARA, TAPE). Does not include athel tamarisk.	*Tamarix*	species *(chinensis / ramosissima/pentandra)*
ULPA	Chinese Elm	*Ulmus*	*parvifolia*
ULPU	Siberian elm	*Ulmus*	*pumila*
ULSP	Elm species	*Ulmus*	species
U	Unknown	Unknown	Unknown
ZIOB	Grey Thorn Old name is *Condalia lycioides*	*Ziziphus*	*obtusifolia*