Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2008 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
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Multi-Species Conservation Program

Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries, 2008 Annual Report

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Cover: Yellow-billed cuckoo on nest, Cibola Valley Conservation Area, 2008. Photo by Eric Enbody.

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EXECUTIVE SUMMARY

The Yellow-billed Cuckoo (*Coccyzus americanus*) has experienced dramatic population declines in the western United States over the last hundred years, and is currently a candidate for Federal endangered status. It is a riparian obligate in the western United States, which requires extensive tracts of habitat for successful reproduction and maintenance of healthy populations. This makes the species a valuable gauge of the health of riparian habitat, and thus an important indicator of the success of the riparian restoration goals of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP).

In 2008 the Southern Sierra Research Station (SSRS) conducted comprehensive call-playback surveys for Yellow-billed Cuckoos, within the LCR MSCP region in potentially suitable habitat. Cuckoos were detected 156 times during surveys, which were estimated to represent 43 potential breeding pairs. Successful breeding was confirmed at two locations – the Bill Williams River National Wildlife Refuge (three nests), and Cibola Valley Conservation Area (two nests), a 3-year-old LCR MSCP habitat restoration project initiated in 2005. This finding shows that as little as three years are necessary for a newly created habitat patch to become suitable for breeding.

Occupancy status was assigned to habitat patches (plots) based on survey and follow-up data, in order to better understand the factors driving Yellow-billed Cuckoo nest and breeding site selection. Habitat at these plots (n=135) and at nest sites (n=5) was characterized by measuring vegetation, microclimate and insect variables. This preliminary analysis found that nest plots were significantly cooler and more humid than other plots measured. Similar to previous research, occupied plots were slightly cooler and more humid than unoccupied plots. As more data are collected over the next four years, a more complete understanding of breeding habitat requirements will enhance the success of future habitat restoration projects.

INTRODUCTION

THE LOWER COLORADO RIVER MULTI-SPECIES CONSERVATION PROGRAM

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a coordinated, comprehensive, long-term multi-agency effort with the goal of developing and implementing a plan that will: "conserve habitat and work toward the recovery of threatened and endangered species, as well as reduce the likelihood of additional species being listed; accommodate present water diversions and power production and optimize opportunities for future water and power development, to the extent consistent with the law; as well as provide a basis for incidental take authorizations" (LCR MSCP 2004a). MSCP participants and stakeholders created this document in part to establish a long-term framework for compliance with the Endangered Species Act for ongoing and future projects (LCR MSCP 2004a).

Developed between 1996 and early 2005, the plan for this 50-year effort includes the goal of creating more than 3278 hectares (ha) (8,100 acres, ac) of riparian, marsh and backwater habitat for six listed species and 21 other species native to the lower Colorado River. Implementation of the program began in October 2005 with the signing of a Record of Decision by the Secretary of the Department of the Interior (LCR MSCP 2004a). The implementation activities include adaptive management principles, which allow program conservation measures to be adjusted over time, based on monitoring and research. The US Bureau of Reclamation (Reclamation), in consultation and partnership with a steering committee made up of representatives from the 56 participating entities, is the primary implementing agency for this activity.

The MSCP covers areas up to and including the full-pool elevations of Lakes Mead, Mohave, and Havasu in addition to the historical floodplain of the Colorado River from Lake Mead to the United States-Mexico Southerly International Boundary, a distance of about 400 river miles (LCR MSCP 2004a). In addition to providing millions of people with drinking water, irrigation, recreational opportunities, and electricity, the Colorado River provides important migration stopover and breeding habitat for neotropical migrant land birds such as the Yellow-billed Cuckoo.

The goals of the MSCP include habitat creation for the 27 covered species, including at least 1,639 ha (4,050 ac) for the Yellow-billed Cuckoo (LCR MSCP 2004a). These riparian habitat restoration efforts need to be guided by parameters that reflect specific Yellow-billed Cuckoo site selection requirements. Part of this process requires surveys to monitor cuckoo populations, occupancy and habitat use at restoration sites.

Yellow-billed Cuckoo Biology and History

Western cuckoo populations have declined dramatically over the last 100 years due to loss of available habitat (Gaines and Laymon 1984, Halterman et al. 2001, Hughes 1999, Laymon and Halterman 1987). In 1907, approximately 160,000-200,000 ha (400,000-500,000 ac) of alluvial floodplain was estimated to occur between Fort Mohave and Yuma (Mearns 1907), densely wooded throughout (Grinnell 1914). By 1980, 32,678 ha (80,749 ac) of riparian woodland remained in the lower Colorado River Valley (Hunter et al. 1988). Currently, approximately 50,990 ha (126,000 ac) of woody riparian vegetation is estimated to occur within the LCR MSCP boundary, of which 18% is native (LCR MSCP 2004b).

There has been some debate about the taxonomic status of eastern and western cuckoo populations; some research indicates two distinct subspecies (Ridgeway 1887, Franzreb and Laymon 1993, Pruett et al. 2001), while other research opposes separate subspecies status (e.g. Banks 1988, Fleischer 2001). In 2001 the United States Fish and Wildlife Service (USFWS) determined that the western birds represent a Distinct Population Segment (DPS), and they became a candidate for listing (USFWS 2001). In 2002, the listing was determined to be warranted but precluded by higher priority listing actions due to resource limitations (USFWS 2002a). The Yellow-billed Cuckoo is listed as endangered in California (California Department of Fish and Game 1978), a species of special concern in Arizona (Arizona Game and Fish Department 1988) and a sensitive species on US Forest Service lands within Arizona and New Mexico (USDA 1988).

Cuckoos begin arriving in Arizona in late May, and in California in late May-early June (Bent 1940, Hughes 1999). Nesting activities usually take place between late June and late July, but can begin as early as late May, and continue to late September (Hughes 1999). Nest building takes one to two days. Incubation begins as soon as the first egg is laid, and lasts 9-11 days (Hughes 1999). Clutch size averages just over two eggs, and may be as high as four (Laymon et al. 1997). Young hatch asynchronously and are fed large food items such as katydids, tree frogs, large caterpillars and cicadas (Laymon et al. 1997). After fledging at five to seven days, young are dependent on adults for at least three weeks (Laymon and Halterman 1985).

Suitable breeding habitat within the range of western cuckoos primarily consists of riparian forests and associated bottomlands dominated by native vegetation. The two dominant nesting tree species are Goodding's willow (*Salix gooddingii*) and Fremont cottonwood (*Populus fremontii*). Other species are also used, including species of mesquite (*Prosopis spp.*) and tamarisk (*Tamarix spp.*) (Halterman et al. 2001, Halterman 2009).

While variation exists in plant species composition and structure across their western range, cuckoo presence has been shown to be correlated to patch size (Halterman 1991). On the Sacramento River in California, cuckoos were estimated to require 10-40 ha of habitat (Gaines 1974, Laymon 1980). There is speculation that overstory cover, understory density, and the presence of water are also important. Nest site selection may be influenced by temperature, humidity, and prey base (Westmoreland et al. 2007, Koenig and Leibhold 2005). Collecting vegetation and microclimate variables for comparison between areas with varying cuckoo population densities may provide important insight and direction for restoration efforts.

Insects have previously been observed to have a major impact on avian communities on the lower Colorado River (Andersen 1994). Yellow-billed Cuckoo populations in hardwood forests of the northeastern United States have been observed to fluctuate greatly in response to fluctuating cicada abundance (Koenig and Liebhold 2005). During hundreds of observation hours at cuckoo nests on the Bill Williams River National Wildlife Refuge (BWR NWR), over 90% of prey items delivered to nestlings were Apache cicadas (*Diceroprocta apache*) and katydids (family *Tettigoniidae*) (Halterman 2000). It is possible that food availability is an important factor in cuckoo distribution and occupancy of habitat patches, and may be more limiting than availability of appropriate nest sites.

Previous Research

Personnel of the Southern Sierra Research Station (SSRS) conducted Yellow-billed Cuckoo surveys and research on western cuckoo populations from 1985-2007. This research included conducting surveys, testing the current survey methodology, studying breeding biology, and sexual dimorphism. The United States Geological Service (USGS), Colorado Plateau Field Station conducted cuckoo surveys on the lower Colorado River from 2005-2007 (Johnson et al. 2006, 2007, 2008). Some of these data were used to interpret the results of the 2008 surveys.

Objectives

The objectives of this work are as follows:

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

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

3. Evaluate the effectiveness of the current breeding season survey methodology (Halterman et al. 2007) and refine it to use over the term of the MSCP.

METHODS

SURVEY SITE SELECTION

During April and May 2008, riparian habitat patches within the study region were assessed. A habitat patch is defined as an area of potentially suitable cuckoo habitat 2 ha (4.9 ac) or greater in extent, that is separated from another patch of potentially suitable habitat by at least 300 meters (m) of non-habitat. A survey site is defined as part of a patch, an entire patch, or a collection of patches of potentially suitable habitat that is treated as one site. Sites were selected based on past cuckoo detections, patch size, plant species composition, and habitat structure. A vegetation type map of the LCR, following Anderson and Ohmart (1976) and based on 2004 aerial photographs (BIO-WEST, Inc. 2006), was also consulted when locating suitable survey sites. Sites surveyed in 2006 and 2007 were surveyed in 2008 unless significant habitat changes were observed, such as flooding or fire.

Large stands of monotypic tamarisk were not considered suitable habitat unless they were in close proximity to native habitat, riparian restoration sites, or were interspersed with native cottonwoods and/or willows. No cuckoos were found in areas dominated by tamarisk during 1977 cuckoo surveys of the lower Colorado River (Gaines and Laymon 1984). Low densities (2.4% of all occurrences) were found in tamarisk stands on the lower Colorado during avian surveys in 1980, contrasting with the relatively high densities (43.5% of all occurrences) observed in tamarisk along the middle Pecos River, Texas (Hunter et al. 1988). They suggested reduced cuckoo densities were due to increased temperatures as elevation dropped from east to west.

All survey sites were delineated by walking their boundaries with a GPS unit. Where site boundaries were inaccessible (such as areas of BWR NWR), boundaries were estimated in ArcGIS 9.3 using geo-referenced 2004 aerial photography. Size in hectares, length, average width of riparian habitat (size/length), and contiguous patch size for each site were estimated using ArcGIS 9.3.

After all surveys were completed, a site occupancy status (occupied or unoccupied) was assigned to each survey site. Following Johnson et al. (2008), sites were categorized as occupied if cuckoos were detected on at least two surveys. The distance from each site to the nearest known occupied site (not counting the site itself) was estimate using ArcGIS 9.3.

For each site, the specific location, unique site characteristics, plant species composition, canopy height, vegetation classification, percent saturated soil/standing water, distance to surface water, and level and causes of disturbance were visually estimated. Site names from the 2006-7 LCR cuckoo surveys were used. Vegetation classifications were defined as follows:

Native: Sites containing >75% native tree species
Mixed Native: Sites containing 51-75% native tree species
Mixed Exotic: Sites containing 51-75% exotic tree species
Exotic: Sites containing >75% exotic tree species

Yellow-billed Cuckoo Surveys

Cuckoo surveys were conducted following Halterman et al. (2007). This standardized survey methodology requires four complete surveys of each site during the field season (early June to early September). Sequential surveys were spaced 12 to 20 days apart and took place between sunrise and 12:00, or until temperatures reached 40° C (104° F). Call-playback, described by Johnson et al. (1981) and Gaines and Laymon (1984), was used to increase the probability of cuckoo vocalization.

A survey detection is defined as an individual cuckoo that is seen or heard during a survey. A non-survey or incidental detection occurs when an individual cuckoo is encountered any time other than during a cuckoo survey. An individual cuckoo detected more than once during a single survey is counted as one survey detection.

Using a GPS unit, stops were made every 100 m along the edge of or within riparian habitat. The location of each point was recorded, as were survey date, start and stop times. Basic weather data, including temperature, wind, and cloud cover were also recorded.

When surveyors arrived at a survey point they waited for a one-minute listening period. This was followed by broadcasting the cuckoo contact call (the "kowlp" call) once per minute over a five minute period using an MP3 player with a hand-held speaker. Five seconds of calling was followed by a 55-second listening/observation period. At each survey point, playback ceased once a cuckoo was detected. After recording all pertinent data, the surveyor moved 300 m from the detection point before resuming the survey. Crews of one to three surveyors worked together during surveys. For example, one surveyor broadcast the calls while another recorded data; if a detected cuckoo was suspected of breeding, one surveyor stayed behind to nest-search while another continued the survey.

Standardized forms were used and completed during surveys (Appendix 1). For each detection, the surveyor estimated the distance and compass bearing to the cuckoo, time of detection, behavior, vocalizations (if any), vegetation type the bird was observed in, presence of other cuckoos, their behavior and interactions, and presence or absence of leg bands. Breeding evidence was recorded if observed. This included carrying food or nesting material, copulation, presence of a juvenile, or a nest. If cuckoos were located >300 m apart during a single survey, they were counted as separate individuals.

All geospatial data were projected to the North American Datum of 1983 (NAD83), UTM Zone 11 projection for storage. Survey data was entered into an MS Access© 2007 database. Locations and details of all survey points were incorporated into an ArcGIS 9.3 geodatabase, using DNRGarmin® v5.03 (Minnesota Department of Natural Resources 2001), MS Access© 2007 and ArcGIS 9.3 software. Estimated distance/bearing lines were stored in the geodatabase as a separate feature class and overlayed with geo-referenced 2004 aerial photographs of the LCR. These maps were used to assess survey detections and update the number of individuals detected during a survey if necessary (i.e. if two separate detections indicated the same area, they were changed to a single detection).

Surveys were conducted on foot, by kayak, or motorized boat. Where feasible, survey transects were conducted 200 m apart through habitat patches. Surveys were conducted either from adjacent roads, or through the habitat patch. The primary advantage of surveying from roads was greater visibility, potentially increasing the probability of detecting non-vocal cuckoos.

TESTING THE SURVEY METHODOLOGY

Yellow-billed Cuckoos are quiet and secretive birds, making it difficult to accurately estimate their populations (Hughes 1999, Laymon et al. 1997, Halterman et al. 2009). Additionally, they cannot be reliably sexed in the field (Pyle and Howell 1997), nor is it possible to rely on behavior or vocalizations to determine mating status (Hughes 1999, Laymon et al. 1997, Halterman et al. 2009). One of the objectives of this study is to test the effectiveness of the current survey methodology and refine it to use over the term of the MSCP.

To test cuckoo detection probability, a modified version of the double-observer method (Nichols et al. 2000) was used. The original method requires two surveyors working together on a point count. The primary observer records detections, sharing these with the second observer. The second observer records the primary observer's detections plus additional birds not detected by the primary observer. Because call playback is required for cuckoo surveys, this technique was modified so the second surveyor begins the route an hour after the first (Halterman 2009). Three observers (a single observer followed by two others) covered seven routes on the Bill Williams River NWR.

Detection probabilities were calculated based on equations from Nichols et al. (2000) for double-observer data, modified for two independent observers:

$$\hat{p}_1 = (x_{11} x_{22} - x_{12} x_{21}) / (x_{11} x_{22} + x_{22} x_{21}) \qquad (2)$$

$$\hat{p}_2 = (x_{11}x_{22} - x_{12}x_{21}) / (x_{11}x_{22} + x_{11}x_{12}) \quad (3)$$

$$\hat{p} = 1 - (x_{12}x_{21} / x_{22}x_{11}) \quad (4)$$

where $\hat{p}_1$ estimates detection probability for the first observer, $\hat{p}_2$ estimates detection probability for the second observer, and $\hat{p}$ is the overall probability of detection. The value of x_{ij} is the number of cuckoos detected by surveyor i (i = 1, 2) when observer j was the first surveyor (j = 1, 2). The number of cuckoos detected by the first surveyor is x_{11}, and x_{12} is the number of birds seen by surveyor one that were missed by observer two.

The estimate obtained by the above method was then compared to detection probability estimates calculated using the software program PRESENCE v2.3 (Hines 2006). By repeated surveying of sites, the probability of detecting a species can be estimated (MacKenzie et al. 2002). Information from individuals detected at least one time provides probability of detection estimates, which can be used to account for individuals not detected. Survey data were converted to presence/absence for each survey at each site. The program was modified to use the same definition of occupancy used in other analysis, i.e. cuckoo detections during at least two survey periods (the default is to consider sites occupied if a species is detected once).

Breeding Status

Although estimates of breeding activity can be important tools for making informed management decisions, a reliable method for estimating breeding pairs of this secretive species has not been clearly defined. Current survey methodologies record total detections across the season. To aid in reporting estimated cuckoo numbers more concisely, breeding terms are used throughout this report, defined as follows.

Breeding status includes *possible breeding (POB)*, *probable breeding (PRB)*, and *confirmed breeding (COB)*. One or more cuckoo detected in an area during at least two survey periods was considered a *possible breeding pair*. Cuckoos observed carrying food, traveling as a pair, or exchanging vocalizations were considered *probable breeding pairs*. A breeding pair was only *confirmed* when copulation, a nest, or a fledgling was observed. Estimates of breeding status presented in this report are based on follow-up visits in addition to surveys. Follow-up visits include nest searching, mist netting efforts, and incidental detections. The term *potential breeding area* is used to describe an area where *possible*, *probable* or *confirmed breeding* was observed.

NEST SEARCHING AND MONITORING

Nest searching was done by two methods. The first method follows Martin and Geupel (1993) and took place during surveys. All cuckoos detected during surveys were located visually, if possible, and vegetation in the vicinity of the cuckoo was examined. Cuckoos may respond to survey calls from the nest, and if they are close enough to the surveyor it is possible to locate the nest. While this method works in fairly open habitats, it performs poorly in dense and structurally complex habitats.

The second method takes advantage of the fact that members of a cuckoo pair share incubation duties. Male cuckoos incubate overnight (Payne 1997, 2005). The female exchanges place with the male shortly after sunrise, and both members of the pair often vocalize during the exchange (Halterman 2009). Additionally, some individuals call when they come to the nest to feed young. One or more researchers would wait in a location where cuckoos were recently detected and suspected of nesting. When cuckoos called, researchers repositioned themselves to triangulate on the calling locations. When a nest was located, a GPS reading was taken 10 m from the nest. A more accurate GPS reading was taken after nesting activities ceased.

Nests were monitored every 2-5 days. Cuckoo nestlings leave the nest in as little as five days and are very quiet shortly after fledging (Hughes 1999), thus an interval of more than five days would likely result in missing fledging events. Nest contents were checked using a mirror pole when adults were not present. Estimated nest initiation date, number of eggs, nestlings, nest success and fledglings per nest were recorded.

Nestlings were banded when accessible (less than 6 m high). Each chick was banded with a USGS aluminum band and a striped color band. A stopped wing rule was used to measure wing and tail. Tarsus, bill length and bill width were measured with calipers. Weight was measured using a 30 gram Pesola® scale. Blood and feather samples were taken for genetic analysis. Blood was extracted using either radial or femoral vein puncture techniques. Samples were sent to Avian Biotech International in Florida for genetic sexing.

TARGET MIST NETTING

A targeted mist net technique modified from Sogge et al. (2001) was used to attempt to capture adult cuckoos for radio telemetry, in order to locate nests, and observe cuckoo habitat use at restoration and non-restoration sites. Two double-stacked 60-mm mist nets, ranging from 6-12 m in length, were placed in a 'V' pattern near low vegetation. One person played a variety of cuckoo calls using CD players connected by 15 m wires to two speakers placed 1 m high in a tree. Capture efforts typically began just after dawn. If no cuckoos displayed interest after approximately 45 minutes, the nets were moved to another site. Attempts ceased when temperatures reached 40° C (104° F).

HABITAT CHARACTERIZATION MEASUREMENT

Plot Site Selection

Habitat characterization plots were established throughout the study region. Sampling plots were spaced approximately 300 m apart along established survey routes within potentially suitable habitat. By distributing vegetation plots evenly throughout patches, plots can either be averaged to compare at the site level, or treated independently to target small scale habitat characteristics.

Individual plot centers were located at a randomly selected distance (0-50 m) in one of two randomly chosen directions perpendicular to the survey route from a known survey point. If this direction placed the survey plot in unsuitable habitat (such as upland scrub vegetation) the plot was established in the opposite direction.

A plot occupancy status was calculated based on cuckoo detections within 150 m of each plot center: a 150 m radius circle was drawn around each plot using ArcGIS 9.3. A plot was occupied ("1") if a cuckoo detection (adjusted for estimated distance/direction from observer) fell within the circle during at least two survey periods; otherwise the plot was unoccupied ("0").

Plot Design

Vegetation sampling methods used in 2008 (Appendices 2 & 3) were modified from the BBIRD Field Protocol (Martin et al. 1997), and similar to those used to describe Yellow-billed Cuckoo habitat by Johnson et al. (2008). Plots consisted of two circles centered on the same point: a 5 m radius circle nested within an 11.3 m radius circle. The inner circle was used to determine ground cover estimates and counts of small trees, shrubs, and saplings. The larger circle was used to describe canopy layers and counts of large trees and snags. Plots were laid out with two 22.6 m ropes marked at 1 m increments. Ropes were centered and laid out in the cardinal directions, dividing the plot into four equal quadrants.

VEGETATION SAMPLING

Detailed methods for collecting each of the parameters are outlined in Appendix 3. Variables collected at plots are summarized in Table 1. In addition to general plot information (site code, site name, vegetation plot number, UTM location, date and surveyors), vegetation characterization data fell into four general categories: vegetation density estimates (distance to nearest shrub, sapling and tree); structural characteristics of the habitat (canopy height, cover, composition); ground cover characteristics (ground cover, litter depth); and plant species composition and abundance.

Table 1. Vegetation parameters collected in 2006, 2007 and 2008.

Parameter	2006	2007	2008
Location Information	X	X	X
High Canopy Dominant and Co-dominant Species and Percent of High Canopy	X	X	X
Distance to Water	X	X	X
Aspect and Slope	X	X	X
Total Canopy: Average Ht/Dominant Species/Cover* (Densiometer Reading)	X*	X	X
High Canopy: Average Ht/Dominant Species/Cover* (Visual Estimate)	X*	X	X
Main Canopy Cover: Average Ht/Dominant Species/Cover (Visual Estimate)		X	X
Sub-Canopy Cover: Average Ht/Dominant Species (Visual Estimate)		X	X
Nearest Live Shrub in each quadrant: Species/Distance/Height/Crown Width	X	X	X
Nearest Live Tree in each quadrant: Species/Distance/Height/DBH/Crown Width/Canopy Cover	X	X	X
Nearest Snag: Species/Distance/Height/DBH	X	X	
Litter Depth: Average of 12 readings within 5 m plot	X	X	X
Percent Ground Cover (sum to 100%): Grass/Leaf Litter/Downed Logs/Bare Ground/Standing Water	X	X	X
Percent Ground Cover: All Green/Shrub/Forb/Sedge/Marsh Vegetation/Brush	X	X	X
Shrub or Sapling: Species/Number <2.5cm DBH/Number > 2.5cm and <8cm DBH	X	X	X
Small Trees**: Species/Number <8cm DBH/Number>8 and <23cm DBH	X	X	X
Large Trees: Species/Number>23cm and <38cm DBH/Number >38cm DBH	X	X	X
Snags: Species/Number >8cm and <12cm DBH/Number >12cm DBH	X	X	X

***In 2006 Average canopy height was not recorded for Total or High Canopy cover.**
****In 2006 these data were collected in the larger 11.3 m circle. In 2007 and 2008 they were collected in the 5 m circle only.**

Comparison of 2008 Vegetation Data with 2004 LCR Vegetation Type Map

Vegetation plots in 2008 were compared to the LCR vegetation type map of the LCR following Anderson and Ohmart (1976), based on 2004 aerial photography (BIO-WEST, Inc. 2006), to determine if this map could be used for further vegetation analysis. A simple vegetation type (ignoring structural class) was assigned to each vegetation plot based on dominant species at each plot (either high canopy dominant species, or total canopy dominant species if no high canopy was present). This was compared to the 2004 vegetation classification.

Nest Site Habitat Characterization

When nests became inactive, detailed vegetation measurements were recorded. Each nest was characterized using the habitat measurement characteristics outlined above. Additionally, a survey of vegetation structure was conducted on 0.1 ha (0.25 ac) circular plots centered on nest sites (Ralph et al. 1993). The species, height, diameter at breast height (DBH), average foliage radius, height at first foliage and tree condition for each tree in a plot were recorded. Visual estimates were made of the percent of the nest concealed by foliage cover in a 25 cm sphere centered on the nest, from a distance of 1 m above (overhead cover), below, and from the sides (side cover), in each of the 4 cardinal directions. Additionally, visual estimates were made of percent tree cover, grass cover, forb cover, brush cover, and bare ground. Canopy cover measurements were taken using a spherical densiometer at 10 points on the plot: two points at the center, four points at 5 m

and four points at 10 m from the center in the four cardinal directions. A foliage height profile was taken at 50 points; 12 to 13 points at 1 m intervals in each of the four cardinal directions. The presence or absence of foliage determined foliage height profile, measured in 1 m intervals above the ground. Total vegetation volume (TVV) was estimated as TVV=H/10p, where H is the total number of hits (presence of vegetation) summed over all layers at all points measured, and p is the number of points at which vegetation volumes were measured (Mills et al. 1991). The information on individual trees on each plot was converted to mean DBH, mean height, basal area/ha, mean foliage volume, foliage volume/ha, trees/ha, and trees/acre by species.

Microclimate Measurement

Temperature and Humidity

Thermocron™ i-Buttons® (model #DS1923) were used to measure temperature and relative humidity (RH) hourly at a subset of the 140 vegetation characterization plots. Units were placed at all plots on the BWRNWR, and about a third of the restoration plots. They were wrapped in a three inch square of nylon mesh, and tied 2 m high on a branch in a shaded location. The data loggers were centered on the plots, with the majority placed early to mid July and retrieved in mid September. I-Buttons® were also placed directly below Yellow-billed Cuckoo nests one to two days after their discovery.

Readings were uploaded with a Dual i-Button® receptor interface cable and high speed USB interface adapter (SK-IB-R Connectivity Kit made by Embedded Data Systems LLC). I-Buttons® were launched and read using 1-Wire® Viewer software. Units were synchronized and programmed to record temperature to the nearest 0.5° Fahrenheit (F) and RH to 0.6%.

Hourly data were averaged to estimate diurnal and nocturnal highs, lows and means for each day. These averages were used to determine overall average high, low, and mean readings for each plot. Plot averages were stored for future analysis to detect differences in Yellow-billed Cuckoo nest sites, occupancy and broad scale habitat characteristics.

Soil Moisture

A correlation between soil moisture and cuckoo presence was suggested by Rosenberg et al. (1991). Soil moisture is an important factor for other listed riparian species including the southwestern Willow Flycatcher (USFWS 2002b, McLeod et al. 2008). This data was collected, along with vegetation characteristics, to detect any relationship between soil moisture and Yellow-billed Cuckoo presence.

Two soil moisture units were used to collect Volumetric Water Content (VWC) data: a Hydrosense™ (Campbell Scientific, Australia), and a Fieldscout® TDR 100/200 (Spectrum Technologies). The Fieldscout® TDR 100/200 measured VWC to a resolution of 0.1%, while the resolution of the Hydrosense™ unit was 1%. Field tests showed <1.0% difference between these two types of probes when 13 readings were averaged (n=5 replicates). Twelve centimeter (cm) (4.7 inch) insertion rods were used for both types of soil moisture probe. Readings were taken at the center of the plot, and one, two and three meters from

the center, in each of the four cardinal directions. These thirteen readings were averaged for each plot.

INSECT SAMPLING

The Apache cicada has been estimated to contribute up to 1.3 cm of water annually to the upper soil layers (Anderson 1994). Cicada exuviae densities are thought to be correlated with percent canopy cover of riparian trees (Glinski and Ohmart 1984, Ellingson and Anderson 2002), which has been shown to be greater in cuckoo nesting habitat (Laymon 1998). In order to determine relationships between cicada abundance, soil moisture, and cuckoo presence, cicadas were sampled using three methods.

For the first method, sound levels (decibels, db) of droning cicadas were measured using a decibel meter. Readings were taken in two ranges, High (65-130 db) and Low (35-100 db), and two frequency weighted readings ("A" and "C"). Although "A" weighted frequencies are typically used for environmental monitoring, "C" weighted readings were also collected for comparison because the "C" weighting is generally used for the analysis of machines having a flat, mechanical quality (such as cicada droning). Readings were taken at each vegetation plot along with the date and time.

The second method required recording an index of live cicada abundance at survey points. Cicada numbers were indexed as follows: 1 = 0-1 cicadas; 2 = 2-5 cicadas; 3 = 5-10 cicadas, 4 = 11-19 cicadas; 5 = 20+ cicadas.

Cicada exuvia (exoskeleton) abundance data were recorded at all habitat characterization plots, following Ellingson and Andersen (2002). Exuviae were counted within 1x1 m quadrats placed at the plot center, and at the nearest vertical woody vegetation in each cardinal direction. The five counts were averaged for analysis. Start and end times were recorded for each search. At BWR NWR vegetation plots, exuvia abundance was measured twice during the season to monitor changes in numbers.

DATA ANALYSIS

Preliminary data analysis was performed using SAS JMP® 7.0 (SAS Institute), MS Access© 2007, and MS Excel© 2007. Analyses of variance (ANOVA) were performed to explore potential differences between nest, occupied and unoccupied plots, and between occupied and unoccupied sites. Simple linear regressions were performed to explore correlations between pairs of continuous variables collected at each plot.

AVIAN MONITORING

During surveys all avian species detected were recorded. Relative abundance of each species was noted. Numbers of individuals detected were recorded for species of interest to the LCR MSCP, AGFD and USFWS. These species include, but are not limited to, Willow Flycatcher (*Empidonax traillii)*, Summer Tanager (*Piranga rubra*), Vermilion Flycatcher (*Pyrocephalus rubinus*), Yellow Warbler (*Dendroica petechia*), Gilded Flicker

(*Colaptes chrysoides*) and Yellow-breasted Chat (*Icteria virens*). Species lists can be found in Appendix 4 (north sites), Appendix 5 (Bill Williams River NWR), Appendix 6 (sites near Blythe) and Appendix 7 (Yuma area sites).

SITE DESCRIPTIONS

Sites are described based on geographic area, with the most northerly sites presented first. A map of the 2008 survey locations is shown in Figure 1. A total of 40 routes, comprising just over 1,000 ha (2,471 ac) of riparian habitat were surveyed (Table 2).

PAHRANAGAT NATIONAL WILDLIFE REFUGE

Lincoln County, NV (White River Drainage)

Pahranagat NWR is owned and managed by the USFWS. The Refuge is approximately 145 kilometers (km) north of Las Vegas on U.S. Highway 93 near the town of Alamo. Within the Refuge there are four water impoundments managed as habitat for migratory birds. Water levels are kept highest during the winter for waterfowl. By early July 2008, upper Pahranagat Lake was drained almost completely. The inlet and outlet of upper Pahranagat Lake (the northernmost impoundment) are lined with mature Fremont cottonwood and Goodding's willow. Two sites along the perimeter and immediately below upper Pahranagat Lake were surveyed for cuckoos in 2008.

Upper Pahranagat Lake North (PAHNTH) *Elevation: 1020 m, 16.8 ha*

Upper Pahranagat Lake North consists of a contiguous patch of native habitat surrounding the inlet of Pahranagat Creek, as well as a narrow string of native habitat following the perimeter of the northern end of the lake (Figure 2). Mature Fremont cottonwood and Goodding's willow dominate the high canopy while a dense layer of yerba mansa (*Anemopsis californica*) and milkweed (*Asclepias speciosa*) provide a thick ground cover. Along Pahranagat Creek upstream of the site, extensive fields used for grazing extend up the valley toward the creek's water source, Pahranagat Springs. Adjacent upland vegetation is characteristic of the Mojave Desert in the region, dominated by creosote bush (*Larrea tridentata*) and Joshua trees (*Yucca brevifolia*).

Upper Pahranagat Lake South (PAHSTH) *Elevation: 1020 m, 17.4 ha*

The southern portion of Upper Pahranagat Lake has a narrow stringer of native riparian vegetation along the south and west shores of the lake, and the first 900 m of the outlet channel downstream from the dam (Figure 3). Mature Fremont cottonwood makes up about 95% of the overstory; the remainder is Goodding's willow. Young cottonwoods and willows make up the sparse understory. Cattails (*Typha sp.*) line the western edge of the riparian habitat near the southern outlet to Pahranagat Lake. Areas downstream of the survey stretch are drier and more typical of Mojave Desert vegetation.

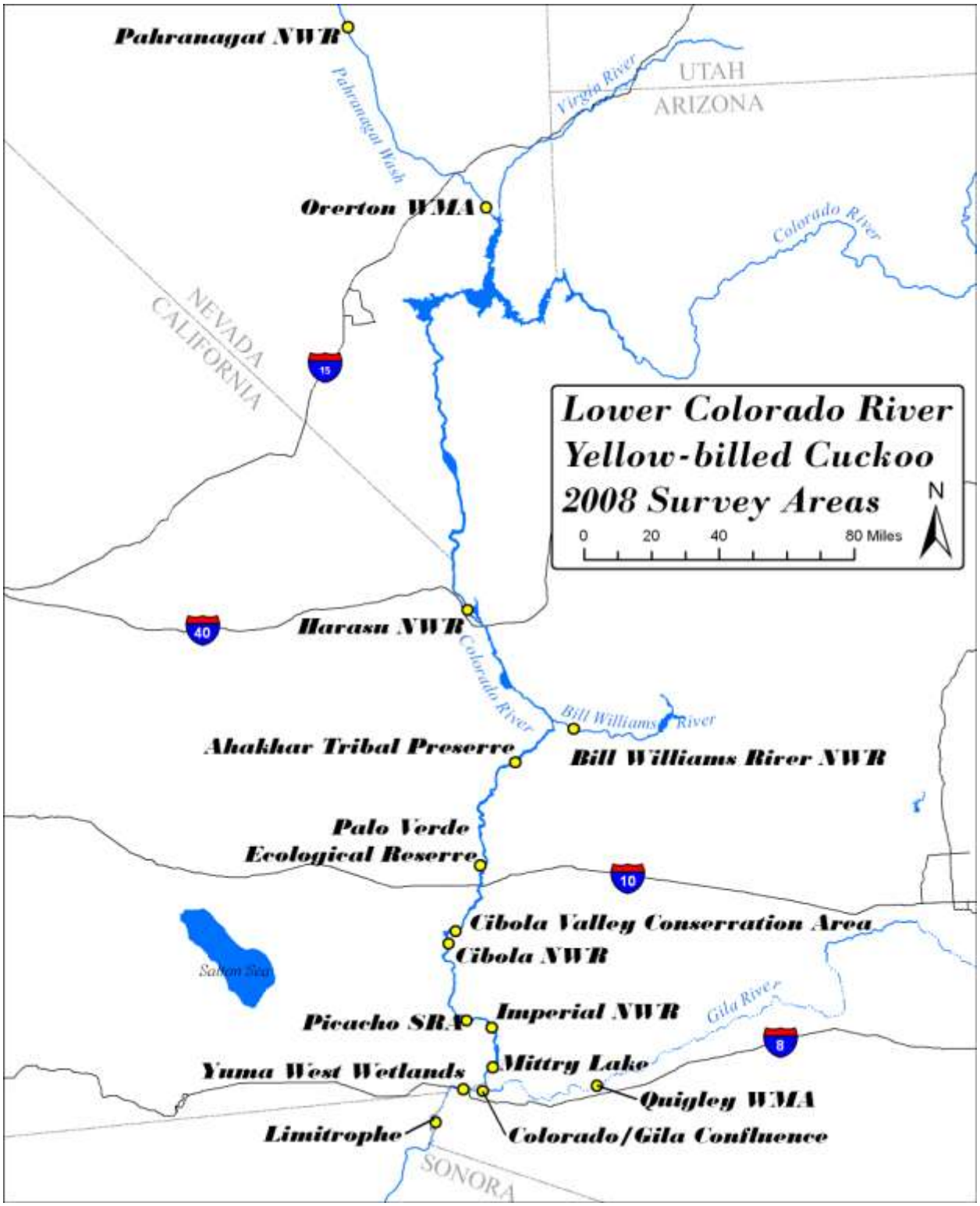

Figure 1. Overview map of the lower Colorado region 2008 cuckoo survey areas.

Table 2. Yellow-billed Cuckoo sites surveyed within the LCR watershed in 2008.

Site Code	Site Name	Veg. Classification	Patch Size (ha)	Number of Veg. Plots
PAHNTH	Pahranagat North	Native	17	0
PAHSTH	Pahranagat South	Native	17	0
OVRHP	Overton Honeybee Pond	Mixed Native	4.1	0
OVRW	Overton Wildlife	Mixed Exotic	3.5	0
HAVPS[1]	Pintail Slough	Native	12	6
HAVND[1]	North Dike	Native	3.9	3
HAVRH	Havasu River Highway	Mixed native	3.9	2
HAVTPR[1]	Topock Platform	Native	8.9	4
HAVBR[1]	Beal Restoration	Native	17	4
BWCW	Cave Wash	Native	57	5
BWCP	Cottonwood Patch	Native	23	2
BWHB	Honeycomb Bend	Native	29	8
BWMW	Mineral Wash	Mixed Native	51	6
BWBB	Big Bend	Mixed Native	84	9
BWKC	Kohen Cliff	Mixed Native	33	1
BWGR	Gibraltar Wash	Mixed Native	47	6
BWSW	Sandy Wash	Mixed Native	46	4
BWFW	Fox Wash	Exotic	62	7
BWMF	Mosquito Flats	Mixed Exotic	29	5
BWNB	North Burn	Mixed Exotic	26	5
BWSS	Saguaro Slot	Mixed Native	14	3
BWMA	Bill Williams Marsh	Mixed Native	19	0
CRIT[1]	Ahakhav Tribal Preserve	Native	54	10
PVER[1]	Palo Verde Eco. Reserve	Native	8.3	3
CVCA[1]	Cibola Valley Conservation	Native	37	6
CIBNTH[1]	Cibola North Plantation	Native	7.5	2
CIBCNT[1]	Cibola Nature Trail	Native	18	2
CIBEUC[1]	Cibola Eucalyptus	Native	29	2
CIBSTH[1]	Cibola South Restoration	Native	5.3	3
PICSRA[1]	Picacho SRA	Native	5.4	3
IMP20A[1]	Imperial NWR 20A	Native	1.6	1
IMPSTH[1]	Imperial South	Native	3.1	3
MLPR[1]	Mittry Lake/Pratt Rest.	Native	5.7	3
GRQP[1]	Quigley WMA	Mixed Native	11	4
YUCC	Yuma/Colorado Confluence	Mixed Exotic	68	3
GRGC	Gila/Colorado Confluence	Mixed Exotic	78	4
YUWW[1]	Yuma West Wetlands	Mixed Native	17	3
LIMNTH	Limitrophe North	Mixed Exotic	51	4
LIMSTA	Limitrophe South (A)	Native	8.3	1
LIMSTB	Limitrophe South (B)	Mixed Native	8.1	3

[1]Site is entirely or at least in part being restored with native species. Some are naturalized and no longer dependent on active irrigation whereas others require continued irrigation to persist.

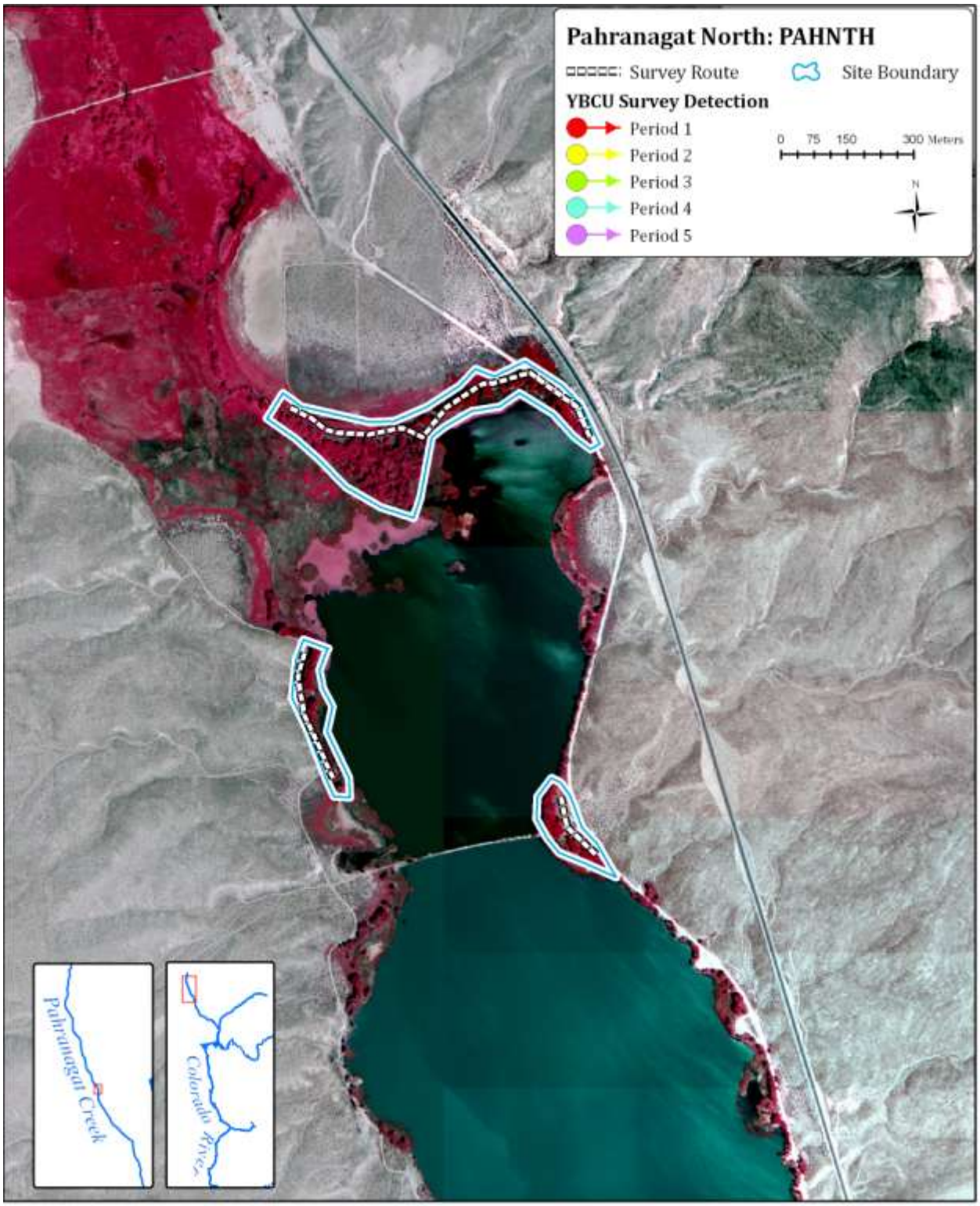

Figure 2. Map of Pahranagat North Yellow-billed Cuckoo survey route, 2008.

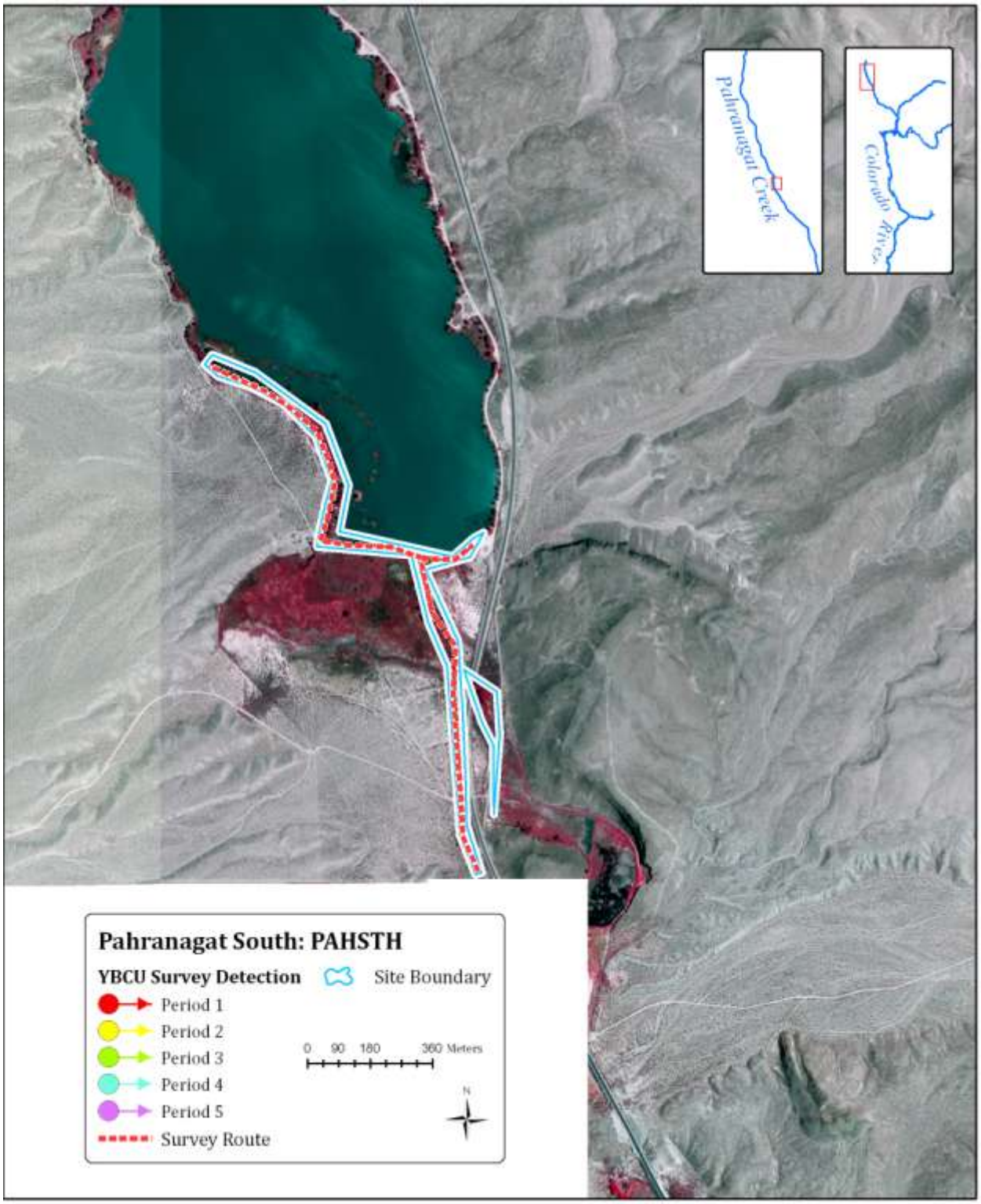

Figure 3. Map of Pahranagat South Yellow-billed Cuckoo survey route, 2008.

Overton Wildlife Management Area

Clark County, NV (Muddy River Drainage)

The Overton Wildlife Management Area (WMA) lies in the Moapa Valley about 3.2 km south of the town of Overton on SR 169. The WMA consists of 7,145.5 ha (17,657 ac) of Mojave Desert upland and riparian floodplain where the Muddy River flows into the Overton arm of Lake Mead. Nevada Department of Wildlife (NDOW) manages this area as wildlife habitat. Within the floodplain, 66 ha (165 ac) of agricultural crops including barley (*Hordeum vulgare*) and alfalfa (*Medicago sp.*) are grown to enhance habitat for migrating and wintering waterfowl.

Most riparian habitat not managed for waterfowl has been invaded by tamarisk. There are small patches of remnant Goodding's willow overstory with tamarisk understory along the main channel of the Muddy River. There is a narrow stringer of habitat consisting of Fremont cottonwoods on the perimeter of the agricultural fields. Two sites within the riparian areas of the WMA were surveyed during the 2008 breeding season.

Overton Honeybee Pond (OVRHP) *Elevation: 370 m, 4 ha*

Potential cuckoo habitat here includes a patch of mixed native riparian forest below the levee south of Honeybee Pond (Figure 4). The overstory is dominated by Goodding's willow, tamarisk, and California fan palm (*Washingtonia filifera*). The dense understory has a diverse species composition including common reed (*Phragmites australis*), cattail, arrowweed (*Pluchea sericea*), tamarisk and Goodding's willow.

A public accessible levee road borders the northern perimeter of the site, and Honeybee Pond extends to the north. Dense cattails grow around the reservoir perimeter. To the south of the site are open fields that were dry and fallow during the survey season.

Overton Wildlife (OVRW) *Elevation: 365 m, 3 ha*

The survey route follows a stringer of young Fremont cottonwoods between an access road and fallow fields, continuing along the floodplain of the Muddy River. Dominant trees are tamarisk and Goodding's willow (Figure 5). Goodding's willow lines the main channel, while tamarisk provides a dense understory. Potential cuckoo habitat at this site is composed of a scattered mosaic of young cottonwood, willow and tamarisk.

Several fields to the west are flooded in the winter to provide waterfowl habitat. These fields are dry during the cuckoo breeding season. Upstream to the north, east, and south patches of young tamarisk line the main fork of the Muddy River. Adjacent to the riparian vegetation are creosote bush-dominated Mojave Desert uplands.

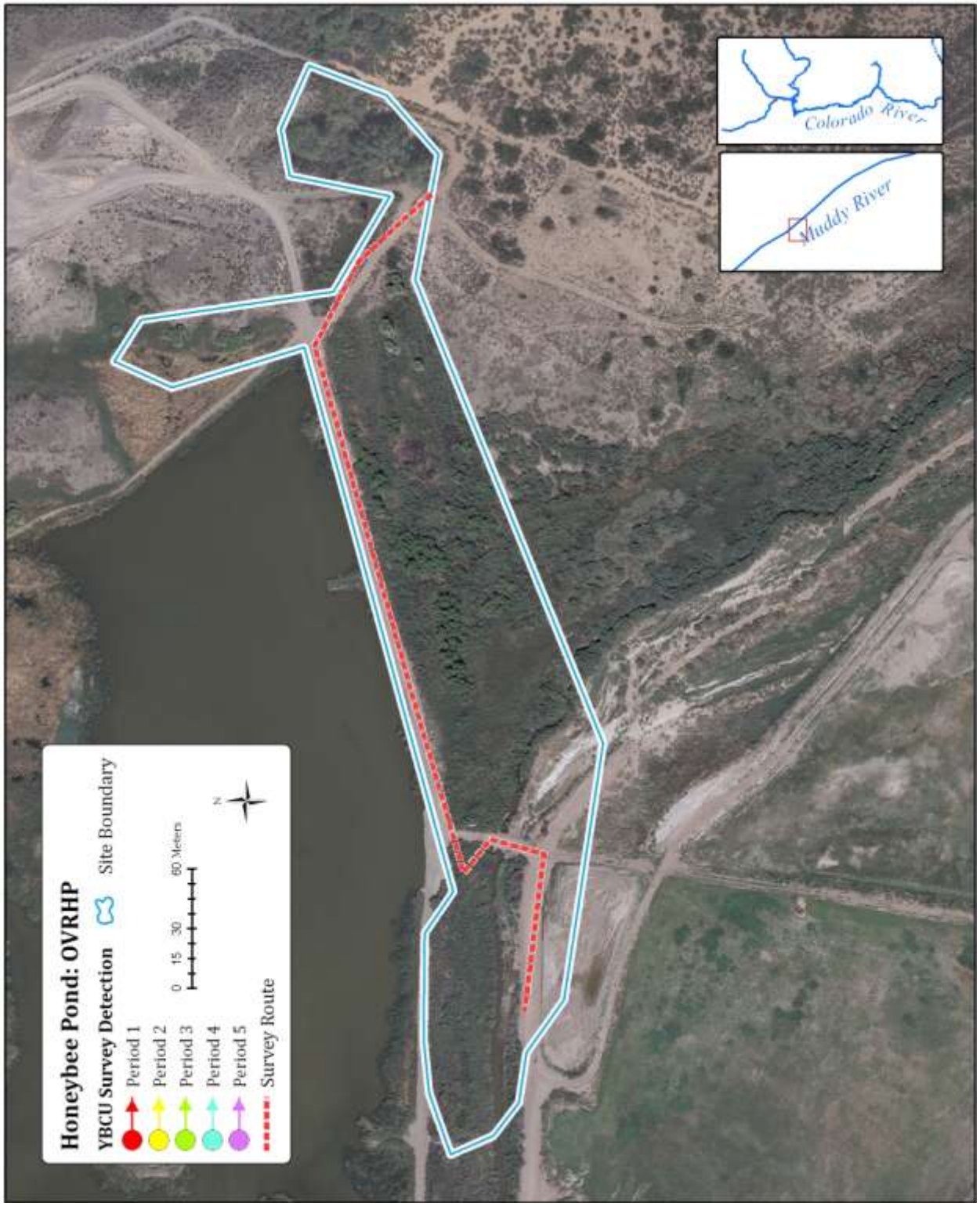

Figure 4. Map of Honeybee Pond Yellow-billed Cuckoo survey route, 2008.

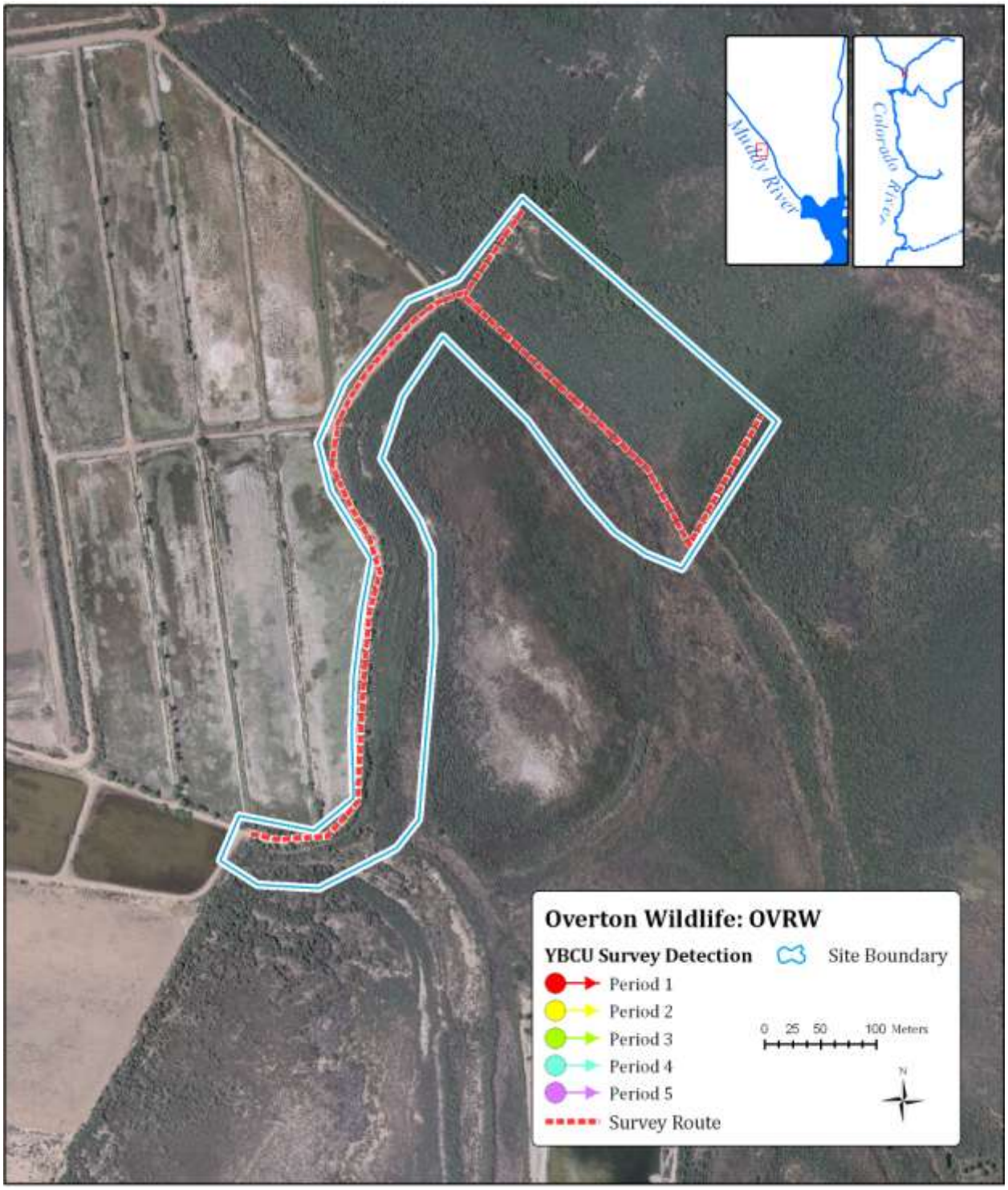

Figure 5. Map of Overton Wildlife Yellow-billed Cuckoo survey route, 2008.

HAVASU NATIONAL WILDLIFE REFUGE

Mohave County, AZ (Colorado River Drainage)

Established in 1941, Havasu National Wildlife Refuge encompasses more than 30 river miles of the Colorado River and adjacent land area from Needles, California to Lake Havasu City, Arizona. Yellow-billed Cuckoo habitat within the refuge is almost entirely within the Topock Marsh area, a historic river meander east of the main river channel currently managed as wildlife habitat. Water levels are increased in the early spring to benefit Southwestern Willow Flycatchers (*E. t. extimus*) and gradually lowered during the fall.

Five sites were surveyed here in 2008 (Figure 6); four restoration sites, and a fifth site along the main channel of the Colorado River dominated by Goodding's willow, tamarisk, and mesquite. Two sites are on the north end of the marsh, separated by 350 m (Pintail Slough, North Dike), while the other sites are approximately 6 km to the southwest, between the main channel of the Colorado River and Topock Marsh (Havasu River Highway, Beal, Topock Platform).

Pintail Slough (HAVPS) *Elevation: 140 m, 2 ha*

Pintail Slough consists of a narrow patch of mature cottonwoods (50-60 cm DBH) lining the slough, and a restoration patch 300 m to the southeast (Figure 7). A system of access roads intersects the site. The slough is lined with cattails and the surrounding understory is a mix of tamarisk, arrowweed and quailbush (*Atriplex sp.*). The southeast patch is planted with cottonwoods spaced 2-5 m apart, forming a short sparse overstory. Non-native Johnson grass (*Sorghum halapense*) forms a dense ground cover. Water was present at this site throughout the season. The habitat is interspersed among fields planted for wildlife habitat enhancement.

North Dike (HAVND) *Elevation: 140 m, 8 ha*

This site has two patches: a mature restoration patch along the north dike of Topock Marsh, and a field restored with young cottonwoods adjacent to a strip of dense tamarisk and mesquite (Figure 8). These sites were regularly irrigated through the spring and summer. The mature patch has an overstory of Fremont cottonwood and Goodding's willow and an understory of mulefat (*Baccharis salicifolia*) and honey mesquite (*Prosopis glandulosa*). The second patch consists of sparse cottonwoods interspersed with Goodding's willow, mulefat, and honey mesquite. There are no exotics in the overstory or mid-canopy on these sites.

An agricultural field borders the site to the north. The site is surrounded by access roads, with a cement-lined irrigation canal along the western edge. To the south and west is a historic floodplain dominated by mesquite and tamarisk. There was extensive hunting activity observed here late in the field season, and feral pig sign was abundant throughout the site.

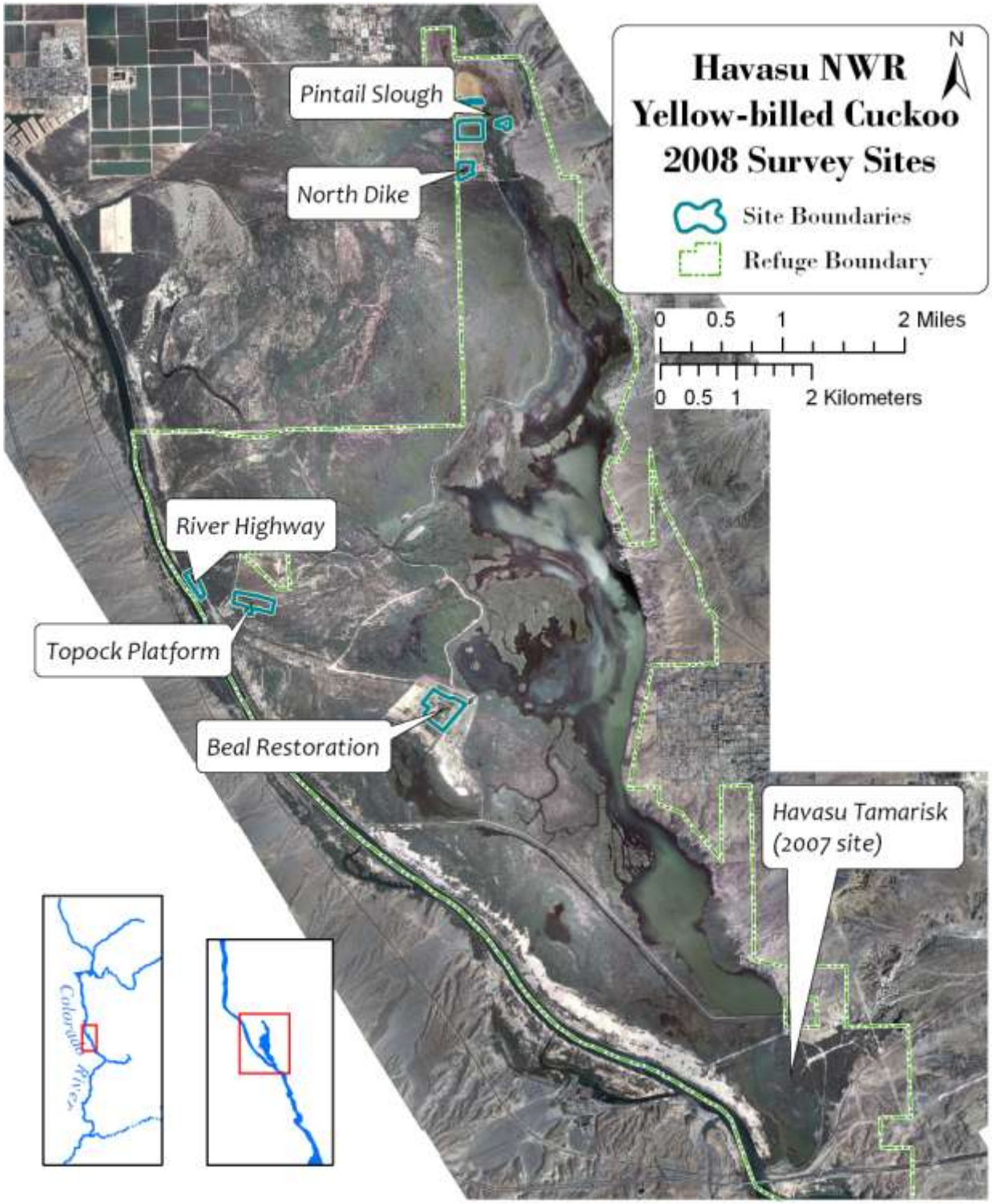

Figure 6. Overview map of 2008 Yellow-billed Cuckoo survey sites on Havasu NWR.

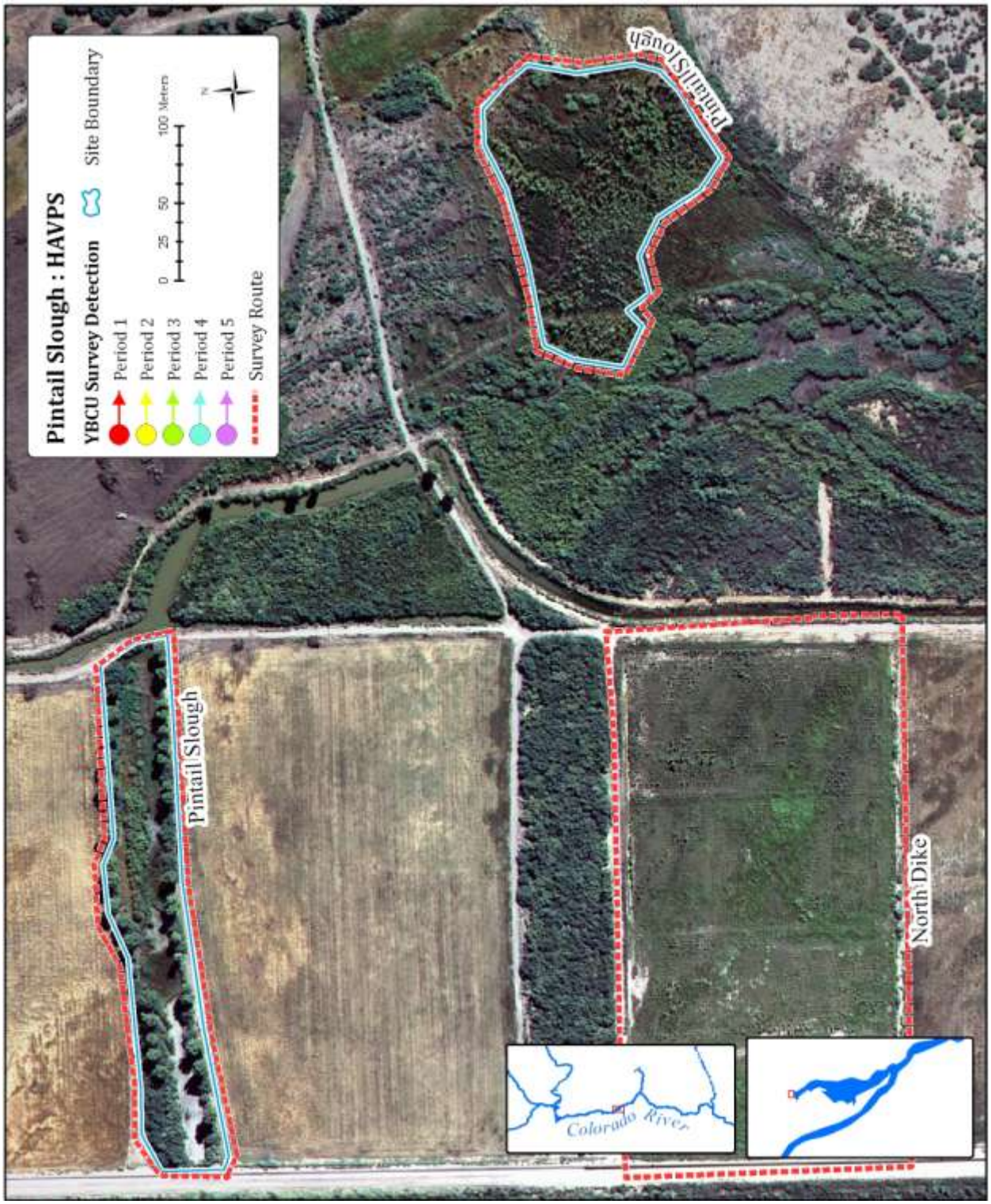

Figure 7. Map of Pintail Slough Yellow-billed Cuckoo survey route, 2008.

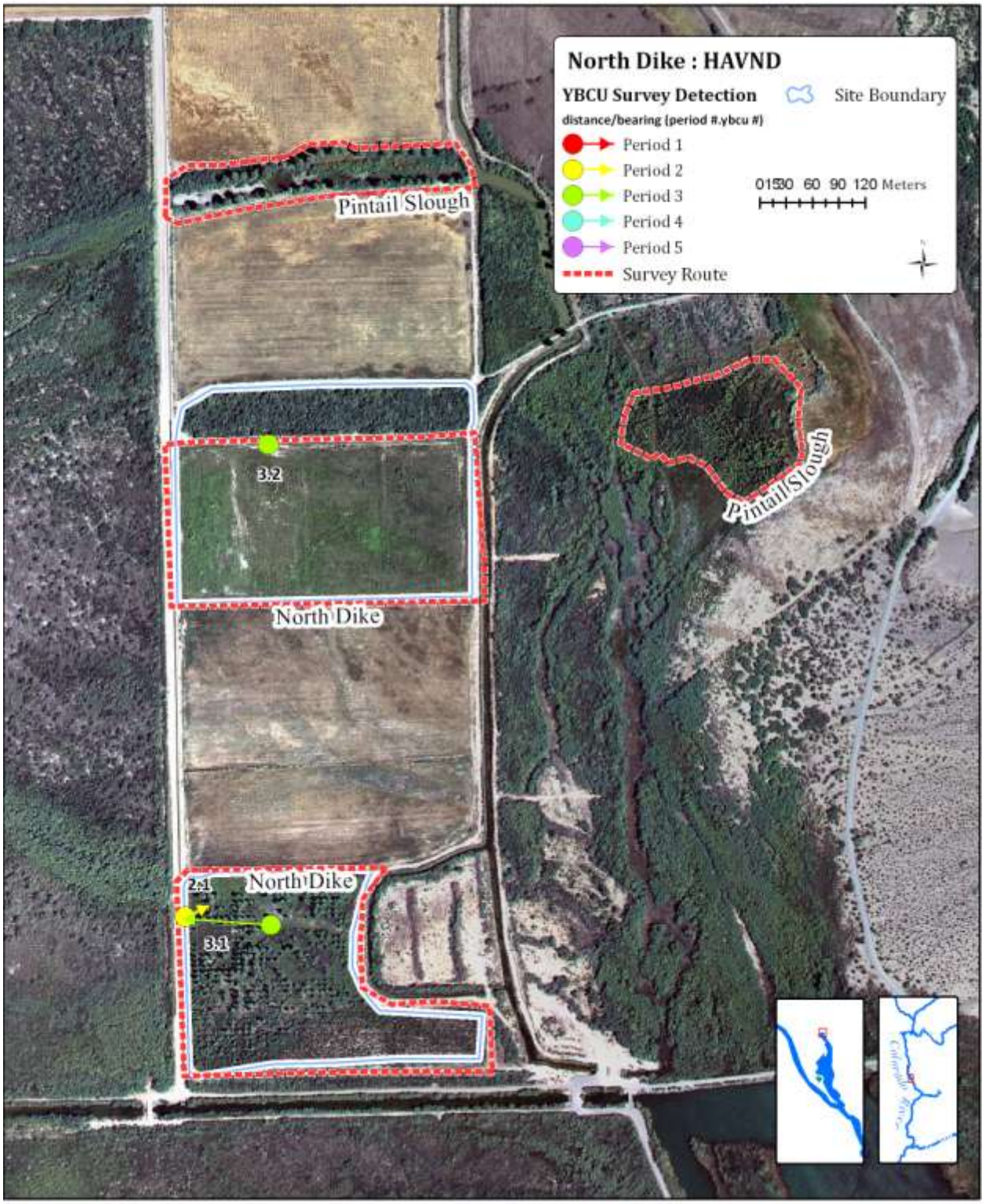

Figure 8. Map of Havasu NWR North Dike Yellow-billed Cuckoo survey route and detections, 2008.
Circle indicates observer location, arrow indicates estimated distance/bearing from observer to bird.

Havasu River Highway (HAVRH) *Elevation: 143 m, 4 ha*

The Havasu River Highway site is composed of a thin stringer of remnant riparian habitat between the levee road and the Colorado River, 350 m northwest of Topock Platform (Figure 9). This small patch of mixed native habitat has a sparse overstory of Goodding's willow, tamarisk and mesquite. The main canopy height ranges from 4-6 m and has an average canopy cover of 20%. Arrowweed and baccharis provide a nearly impenetrable understory 1-3 m high, covering 95% of the site. The Colorado River to the west experiences heavy motorized boat traffic.

Topock Platform (HAVTPR) *Elevation: 141 m, 9 ha*

The Topock Platform site includes 8.8 ha (21.7 ac) of restored native habitat, located next to fields flooded in winter for waterfowl habitat (Figure 10). Three distinct habitat areas make up this site. The section adjacent to the public access parking and Topock Platform is 4.0 ha (9.9 ac) of six-year-old Fremont cottonwoods and Goodding's willow with tall (8-14 m) and dense canopy cover. This area was planted as a nursery site for other restoration efforts. The understory is open, with 20% cover of 1-5 m high screwbean mesquite (*Prosopis pubesens*), Goodding's willow and Fremont cottonwood. To the east is a 4.2 ha (10.4 ac) stand of shorter and more sparsely planted three year old cottonwoods and willows. Along the southern edge there is a small (0.6 ha, 1.48 ac) stand of dense mesquites. Bermuda grass (*Cynodon sp.*) dominates the ground cover throughout the site.

This site is named for the large wildlife viewing platform on the northwest corner of the site. The landscape to the south and east is dominated by extensive stands of quailbush, arrowweed and dense tamarisk with a few remnant willows and mesquites.

Beal Restoration (HAVBR) *Elevation: 137 m, 17 ha*

Beal Restoration lies approximately 3 km south of Topock Platform, between Beal Lake and Topock Marsh (Figure 11). This site is a mosaic of 81 ha (200 ac) of native trees planted in the historic floodplain of the Colorado River. Of the 43.38 ha (107.2 ac) planted from 2003 to 2005 as part of Phases 1 and 2 (LCR MSCP 2006a), 16.75 ha (41.4 ac) were surveyed for cuckoos in 2008. The survey route follows suitable patches within the site.

This site consists of nearly 5 ha (12.3 ac) of Fremont cottonwood as well as 4 ha (9.8 ac) of mixed Goodding's willow and mesquite. The remaining area is relatively open with a sparse native overstory and an understory of arrowweed, screwbean mesquite and coyote willow. The overstory ranges from 3-7 m high, with 10% canopy closure. The understory vegetation ranges from 1-3 m, and covers about 40% of the area.

Multiple access roads cross the site and define the perimeter. There is year-round water in an irrigation ditch bordering the southeastern edge of the site. This ditch connects Beal Lake on the southwest with Topock Marsh to the northeast. This site was frequently flood irrigated during the 2008 breeding season.

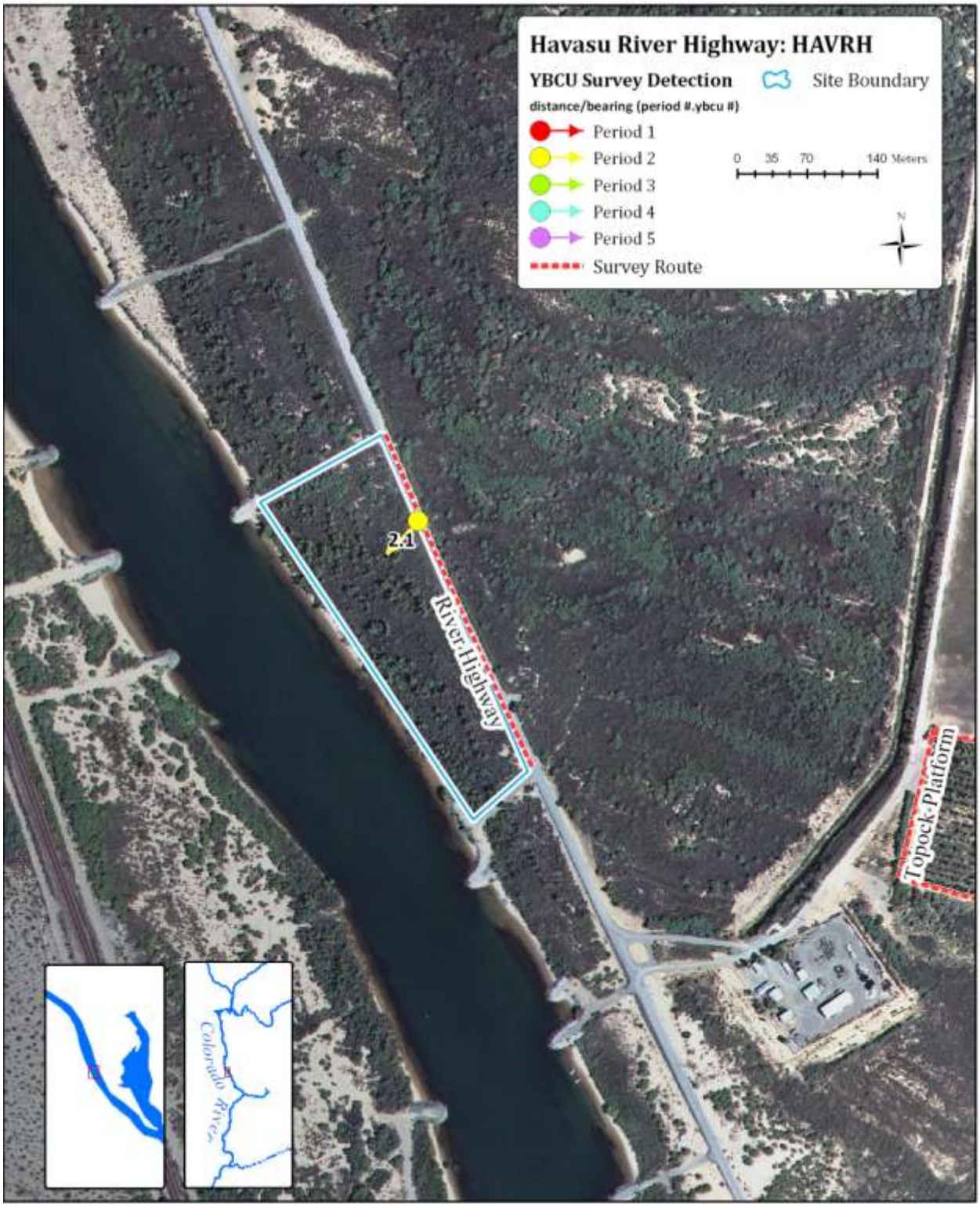

Figure 9. Map of Havasu River Highway Yellow-billed Cuckoo survey route and detections, 2008.

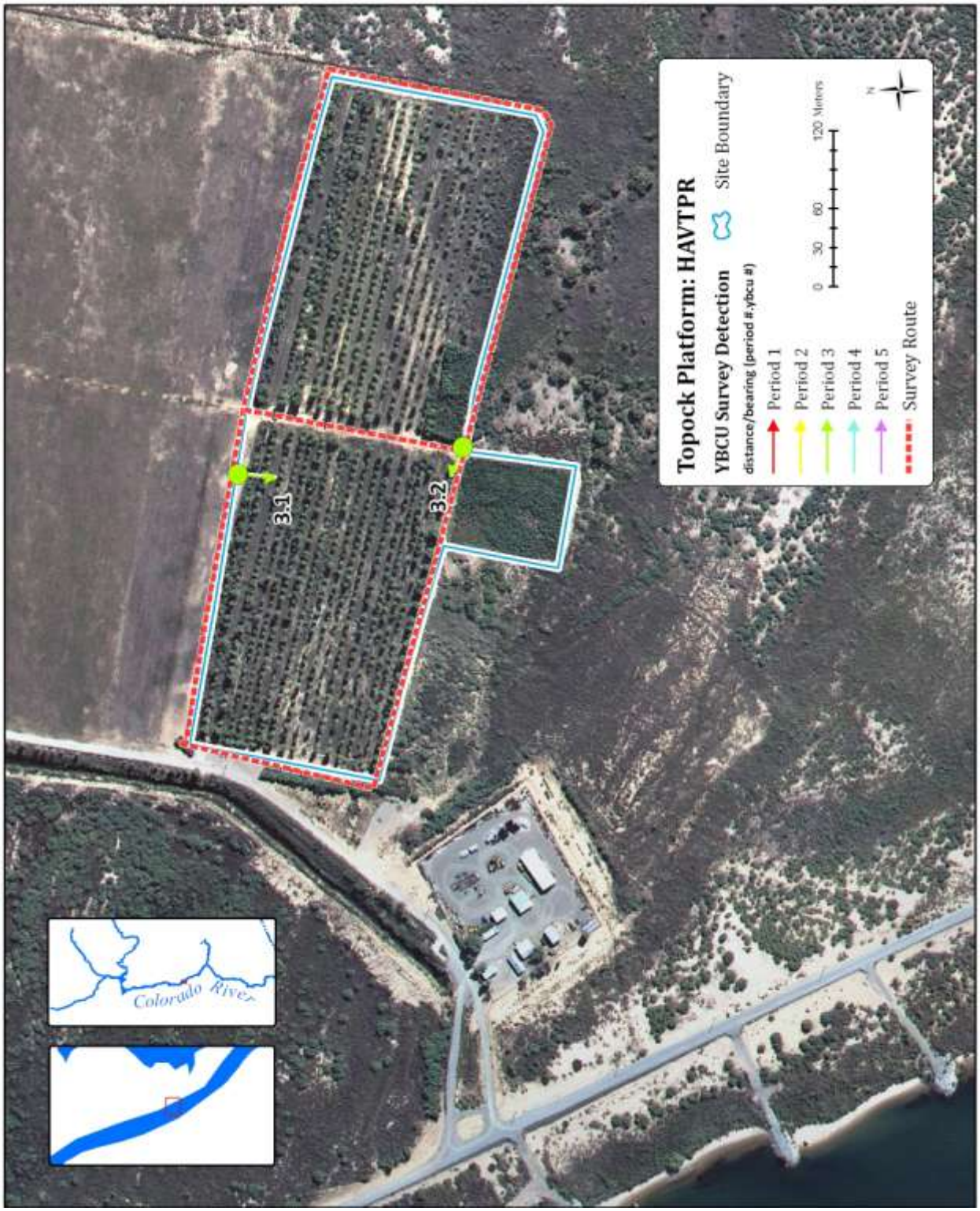

Figure 10 . Map of Topock Platform Yellow-billed Cuckoo survey route and detections, 2008.

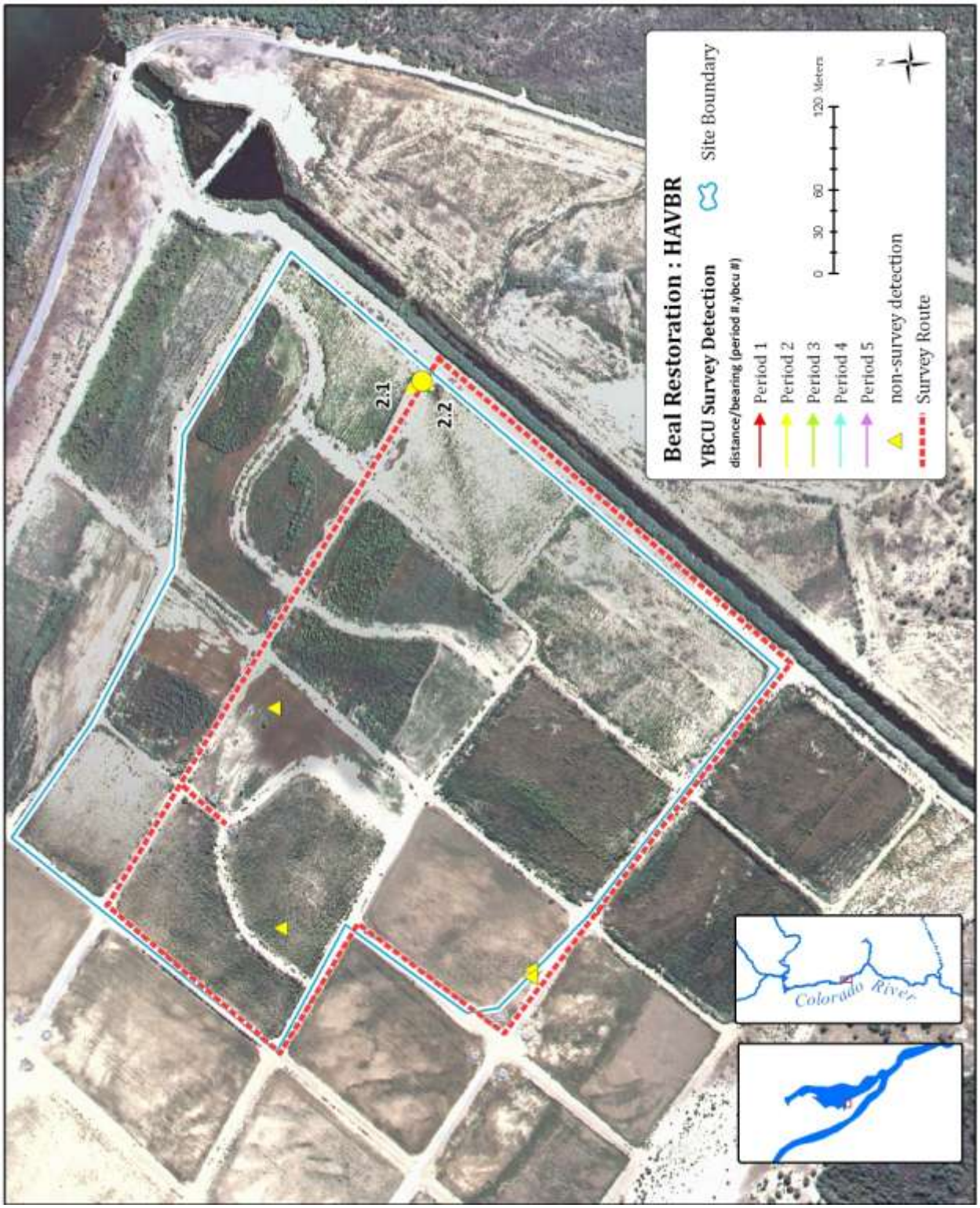

Figure 11. Map of Beal Restoration Yellow-billed Cuckoo survey route and detections, 2008.

BILL WILLIAMS RIVER NATIONAL WILDLIFE REFUGE

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

Bill Williams River NWR is located 14.3 km south of Lake Havasu City, AZ. It consists of 2,430 ha (6,000 ac) of the BWR drainage managed by the USFWS to protect the largest remaining natural riparian habitat in the lower Colorado River Valley. Established in 1941, this Refuge extends from Lake Havasu upstream on the Bill Williams River for 16 km, and contains the most extensive and productive Yellow-billed Cuckoo habitat in the LCR watershed. Part of the Bill Williams River has perennial surface water, and a managed hydrologic regime allows overbank flooding necessary for persistence of cottonwood and willow gallery forests. Large releases from Alamo Dam during the winter of 2005 have resulted in the natural regeneration of large areas of riparian habitat.

Thirteen routes within the BWR NWR covering over 518 ha (1279 ac) of potential Yellow-billed Cuckoo habitat were surveyed in 2008 (Figure 12). The Kohen Cliff survey route was added in 2008 to encompass some of this new habitat. Teepee Trail was surveyed in 2007, but was considered unsuitable during 2008. The thirteen sites surveyed in 2008 were considered occupied this season, and are described from upstream (east) to downstream (west).

Cottonwood Patch (BWCP) *Elevation: 180 m, 23 ha*

Cottonwood Patch is situated in the floodplain of the Bill Williams River, at the eastern end of the Refuge. This site is adjacent to Planet Ranch, which is owned and managed by the City of Scottsdale, AZ. A patch of young cottonwoods was established on area previously used for agriculture following flooding in 2005. The site is dominated by dense patches of regenerating cottonwoods surrounded by large open areas. Ground cover is predominantly Bermuda grass. The survey route is linear, winding through the widest parts of the habitat (Figure 13). The soil is sandy gravel, with intermittent water flow through river meanders. The upland side is composed of old agricultural fields, and the route is separated from the main stream of the Bill Williams River by a 200-400 m open sandy wash with scattered tall cottonwoods.

Cave Wash (BWCW) *Elevation: 175 m, 57 ha*

This site is in the floodplain of the Bill Williams River (Figure 14). This section of the refuge consists of a wide riparian area with both old, and recently formed, river channels. Although the vegetation is primarily native, there are extensive areas of tamarisk. Water is seasonally present in some side channels, and perennial in the main channel. The main channel is lined with young cottonwoods, willows, and tamarisk averaging 4 m high, with dense marsh vegetation in the main channel. The survey route follows two old river channels. The riparian area is mature, wide and multi-structured. Little ground cover is present, and there is a large expanse of sandy gravel.

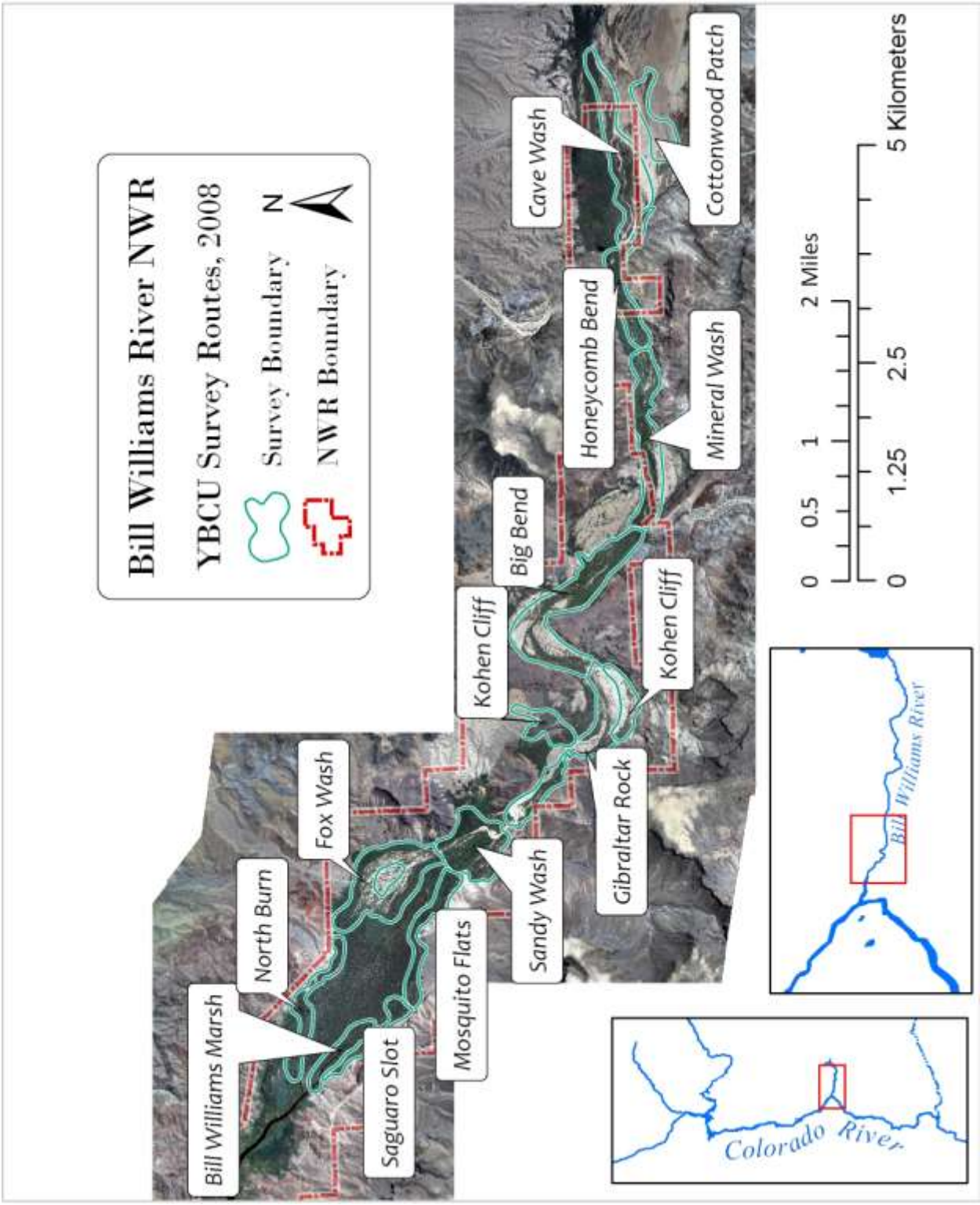

Figure 12. Map of Yellow-billed Cuckoo survey routes on the Bill Williams River NWR, 2008.

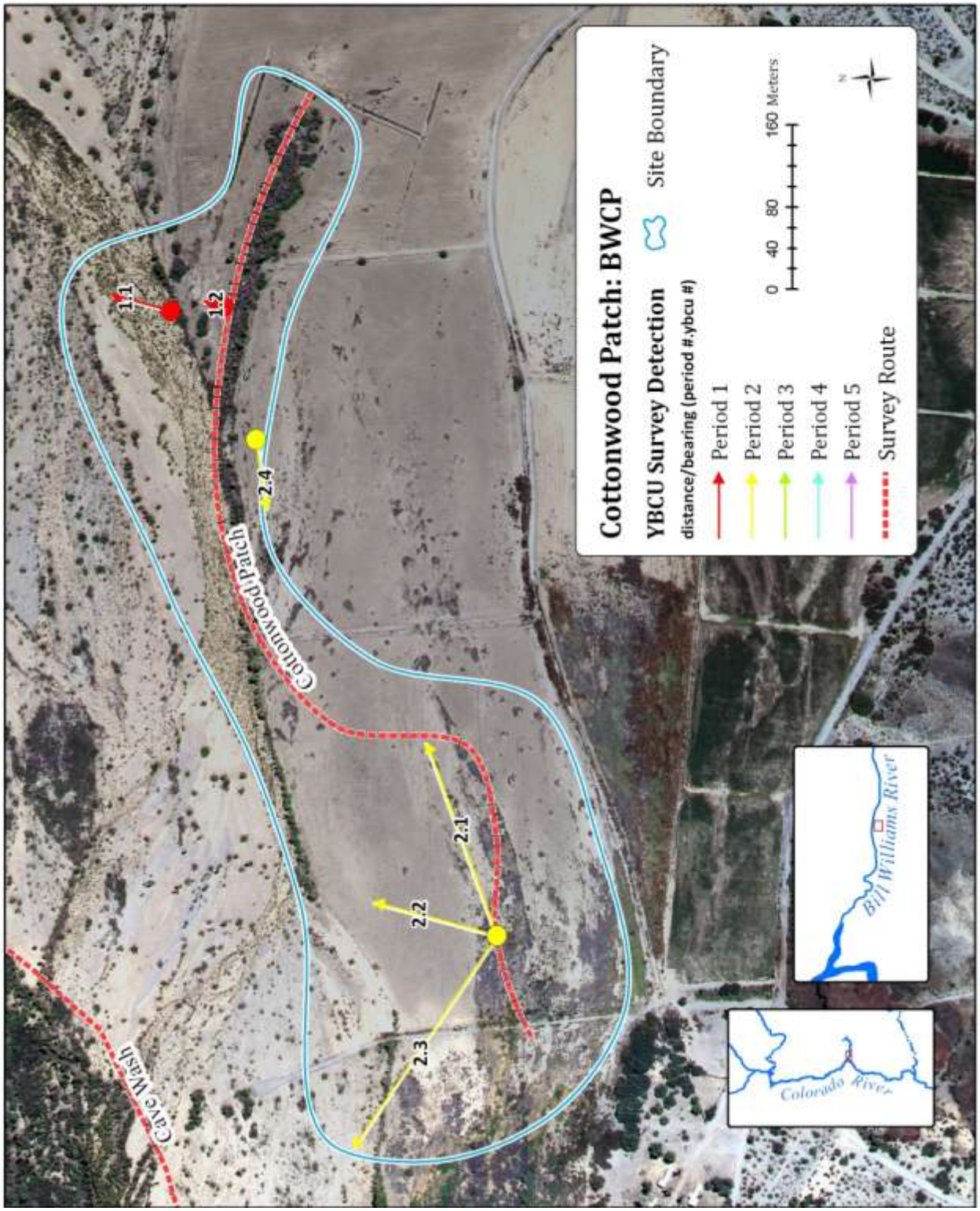

Figure 13. Map of Cottonwood Patch Yellow-billed Cuckoo survey route and detections, 2008.

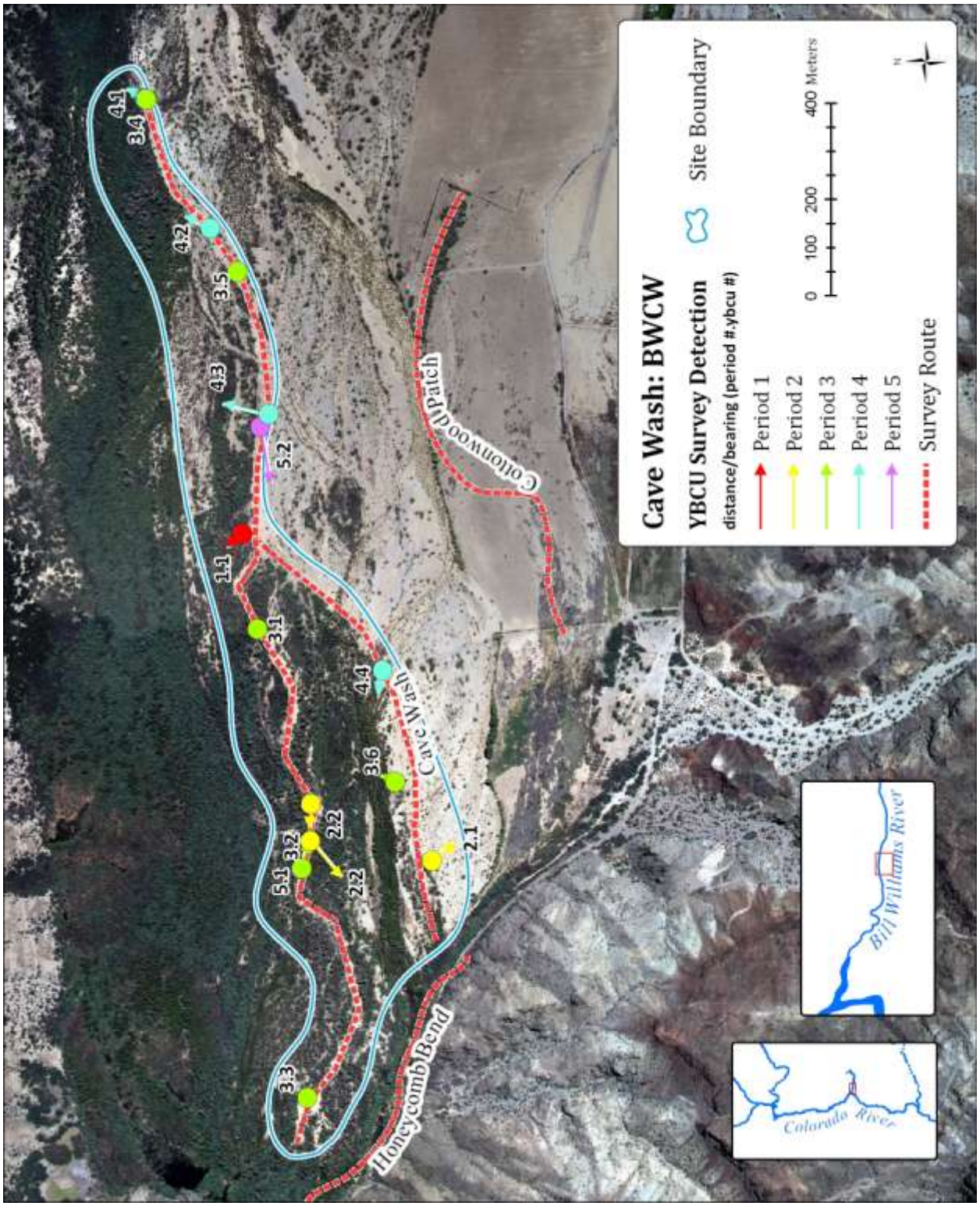

Figure 14. Map of Cave Wash Yellow-billed Cuckoo survey route and detections, 2008.

Honeycomb Bend (BWHB) *Elevation: 170 m, 29 ha*

This route follows the Bill Williams River, connecting with Cave Wash to the east and Mineral Wash to the west (Figure 15). Tall cottonwoods and willows, with a dense understory of willow, arrowweed and tamarisk dominate the multi-structured habitat. The river is perennial, and multiple beaver dams have created ponds lined with dense willows and cattails. The riparian area is restricted by the surrounding cliffs as the river passes through a narrows. There is intermittent flooding at the site, and little ground cover.

Mineral Wash (BWMW) *Elevation: 165 m, 51 ha*

This route is located between the Honeycomb Bend and Big Bend routes. It is a linear route following the river channel from a restricted canyon bordered by cliffs to a more open floodplain (Figure 16). The river is lined with bands of tall dense willows, large cottonwoods, and an understory of willows, tamarisk, arrowweed and mesquite. There is a riparian restoration effort within the floodplain at the west end of the route, though few plants appear to be alive. Extensive marsh vegetation and cattails line the river channel. The route is bordered by old agricultural fields. The surrounding Sonoran Desert vegetation includes Saguaros and creosote bush.

Perennial water flows through the site, while seasonal flooding occurs during winter and summer rains. A public access road follows Mineral Wash, and there is some human recreational activity where the road terminates at the river.

Big Bend (BWBB) *Elevation: 165 m, 84 ha*

This site lies between the Mineral Wash and Gibraltar Rock routes. The route begins at the intersection of Mineral Wash road and the Bill Williams River. The first half of the survey route follows the old (pre-2005) river channel, bends around the Big Bend (also known as Cougar Point), and follows the riparian edge along an old road (Figure 17). Several of the meanders contain perennial water and the river channel is lined with cottonwoods, willows and a dense understory of tamarisk and arrowweed. The western portion of the route winds between riparian areas, mesquite bosque, steep hills and cliffs. Flooding in 2005 resulted in natural regeneration of many young native trees. Dense cattails blocked access to part of the route surveyed in 2006 and 2007, and the route was modified in 2008.

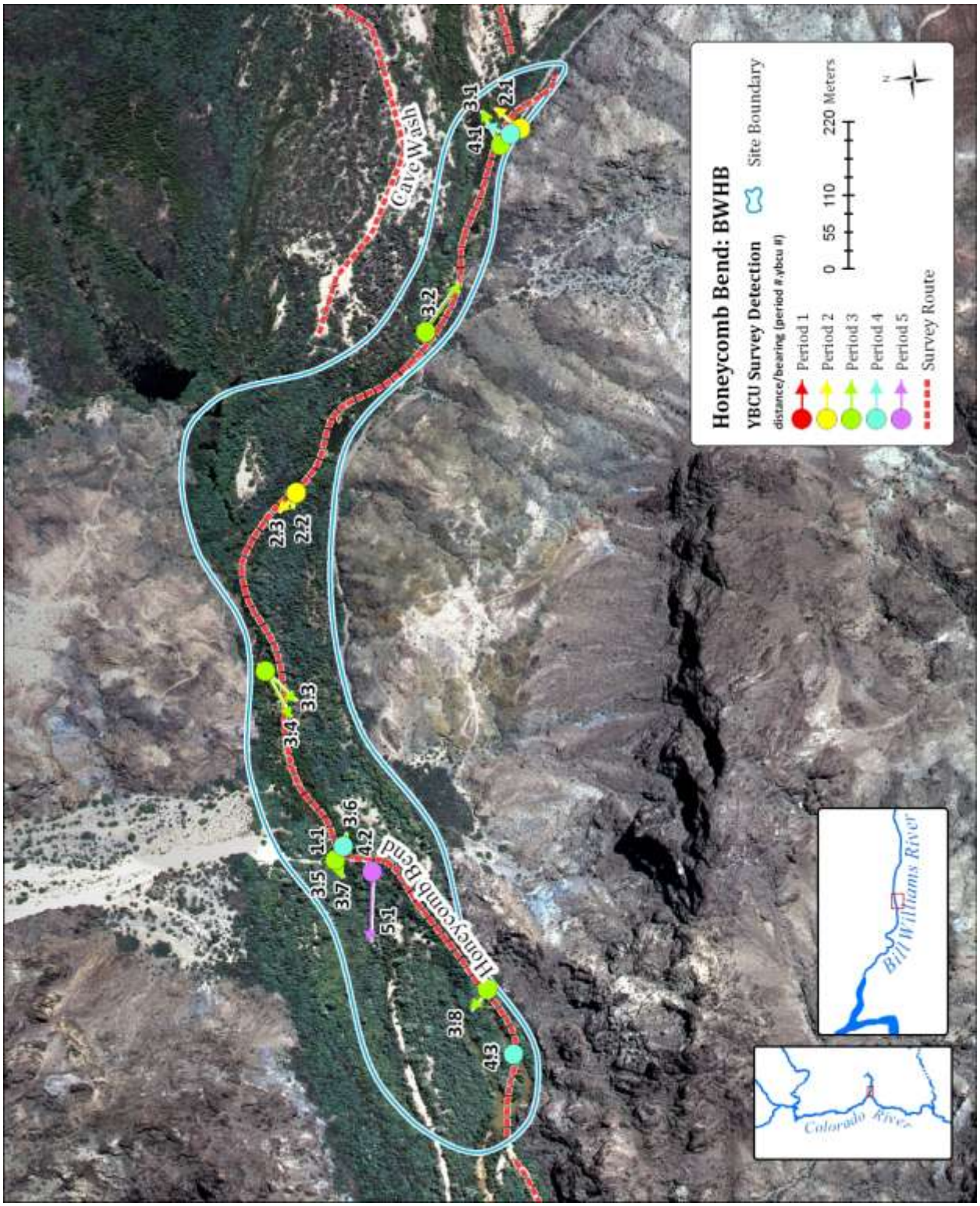

Figure 15. Map of Honeycomb Bend Yellow-billed Cuckoo survey route and detections, 2008.

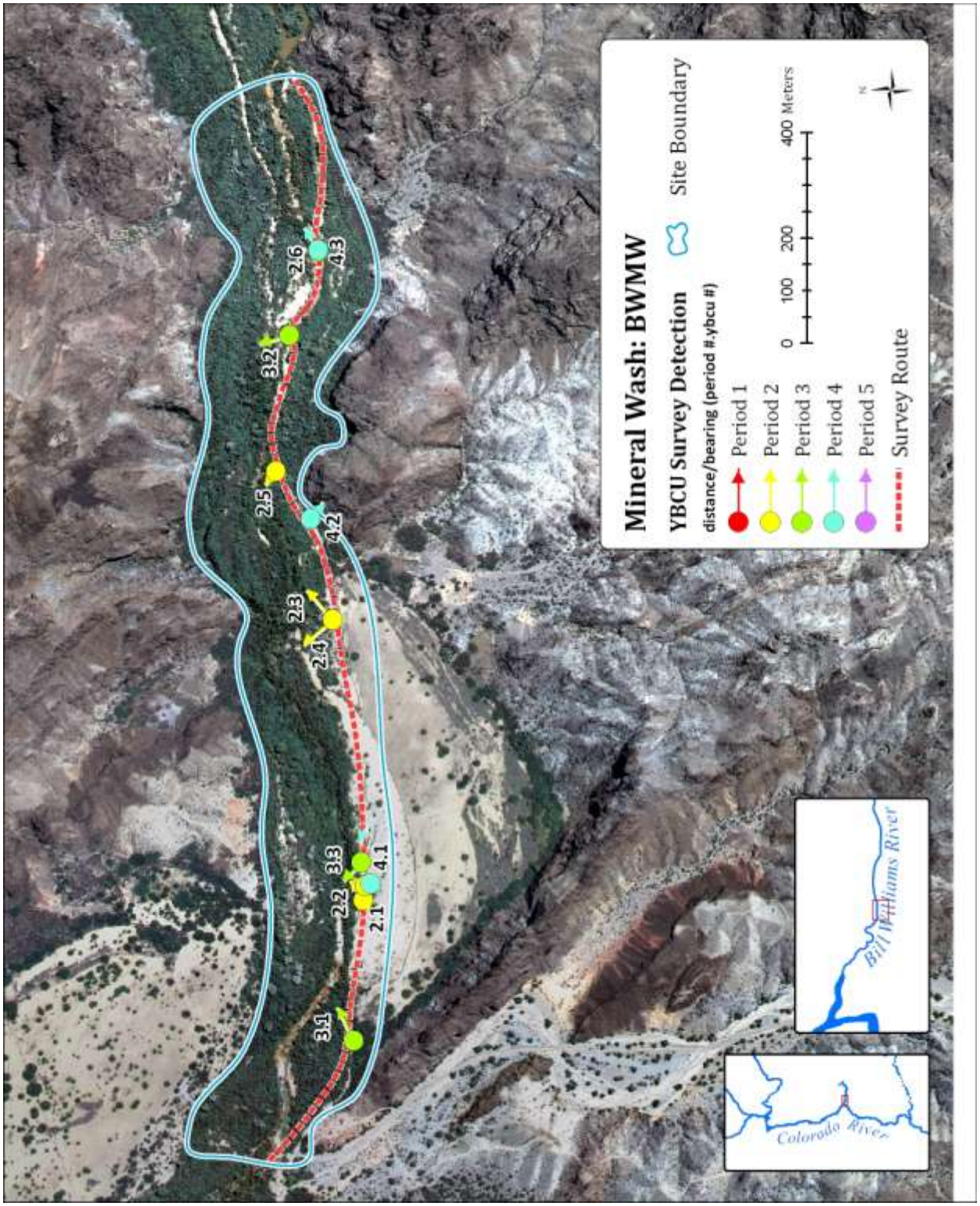

Figure 16. Map of Mineral Wash Yellow-billed Cuckoo survey route and detections, 2008.

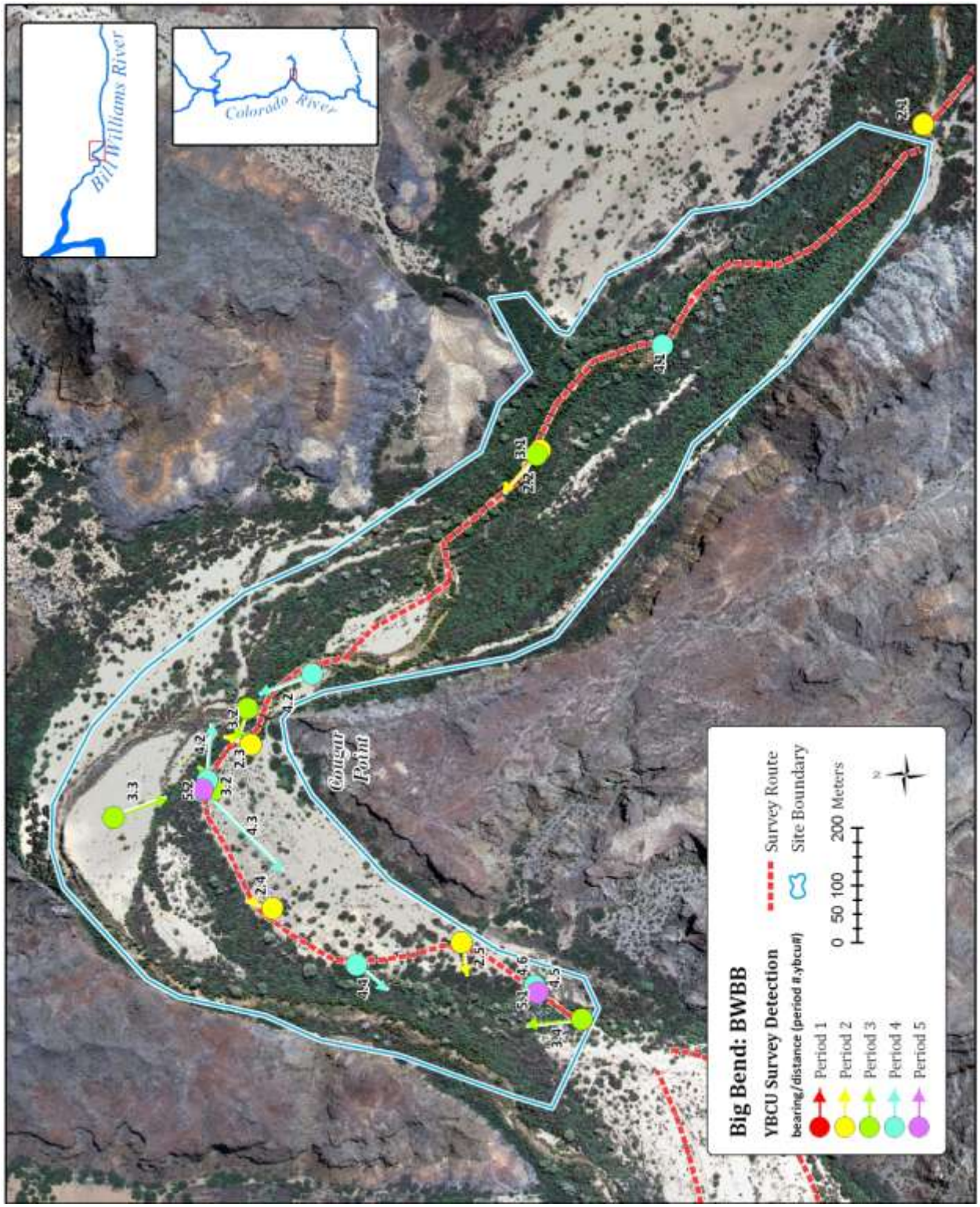

Figure 17. Map of Big Bend Yellow-billed Cuckoo survey route and detections, 2008.

Kohen Cliff (BWKC) *Elevation: 145 m, 33 ha*

This site was added in 2008 during survey period two. Extensive natural regeneration of riparian habitat occurred following extensive and prolonged flooding during 2005-2006. This route consists of two separate parts, and begins at the intersection of Big Bend and Gibraltar Rock routes. It then follows a cliff to the south, crosses the river and goes through the old Kohen Ranch (Figure 18). The route passes through two old oxbows containing mixed native riparian vegetation. In places both oxbows have a mix of park-like vegetation, with a high cottonwood overstory and Bermuda grass ground cover. A 50 m band of dense, mature mesquite follows the base of the cliffs, while the Kohen Ranch section contains young, dense cottonwoods and willows scattered with mesquite.

Kohen Cliff experiences seasonal flooding. There have been past restoration efforts on the downstream oxbow. This site has the lowest percentage of tamarisk when compared to all other Bill Williams River NWR sites surveyed this season.

Gibraltar Rock (BWGR) *Elevation: 145 m,* 47 ha

Located between the Big Bend and Sandy Wash routes (Figure 19), Gibraltar Rock follows an old road and the largely dry river channel. Water was present early in the season but the main channel was completely dry by early July. The eastern part of the route parallels the main river channel, passing through dense high-canopy cottonwood/ willow areas, dense stands of mesquite, and scattered open cottonwood/mesquite savannah. The western half of the route is drier, with large native trees and a dense understory of tamarisk. The route passes through a gap in the cliffs. West of this gap the floodplain widens and is dominated by tamarisk. This site experiences some flooding and recreational activity from hikers. There are numerous research projects in this area.

Sandy Wash (BWSW) *Elevation: 145 m, 45.5 ha*

This route connects with Gibraltar Rock to the east and Fox Wash to the west (Figure 20). This section of the Refuge gradually widens into a floodplain laced with dry river channels. The route makes a loop through and around the eastern end of the broad floodplain, following the old road for part of the route. There is an overstory of tall cottonwoods and willows, with a tamarisk-dominated understory. Although the cottonwood/willow stands are dense in places, they are quite narrow, often only a few trees wide. The rest of the habitat is mature tamarisk. No standing water was present at this site during the field season. Hikers and researchers frequently utilize this easily accessible route.

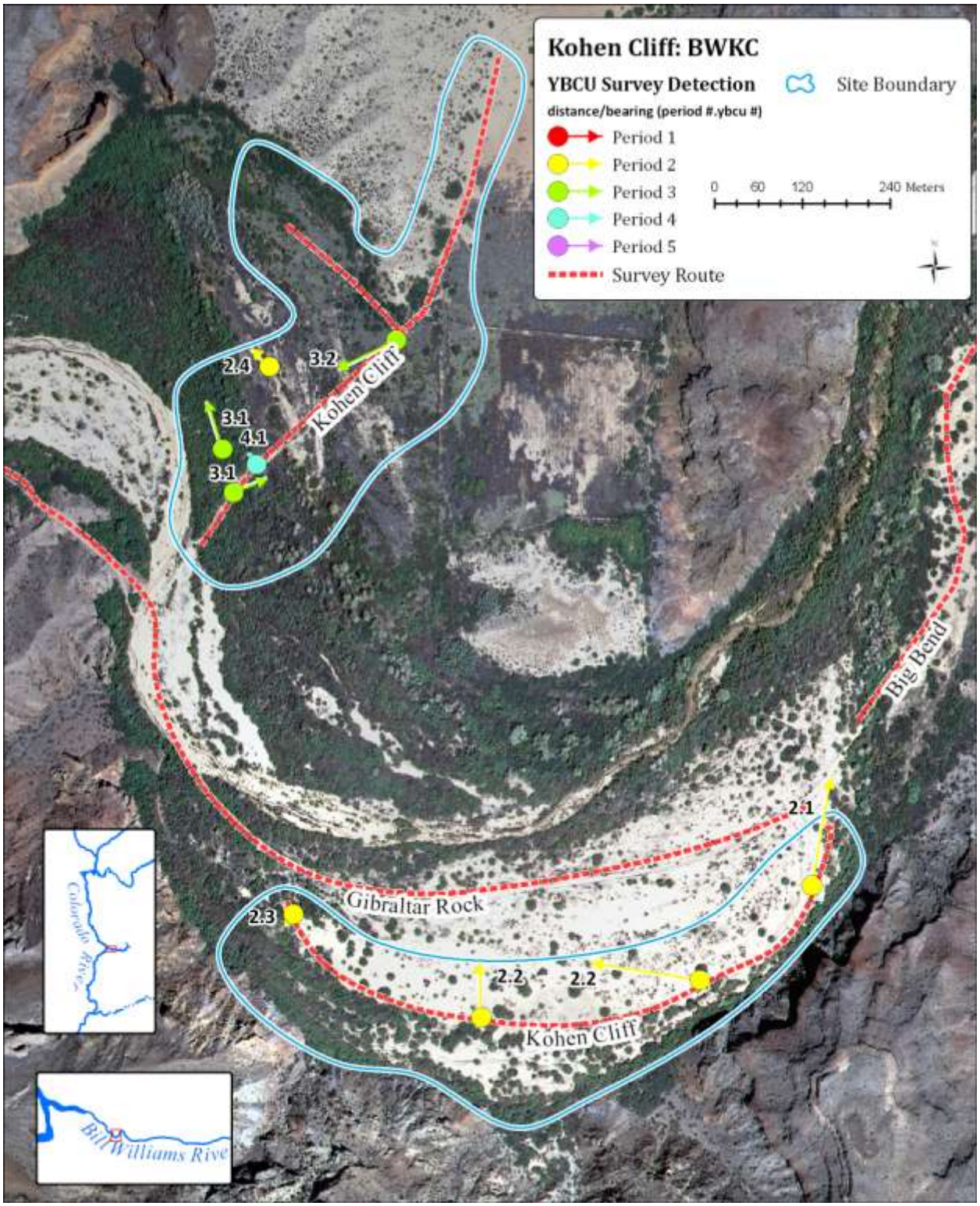

Figure 18. Map of Kohen Cliff Yellow-billed Cuckoo survey route and detections, 2008.

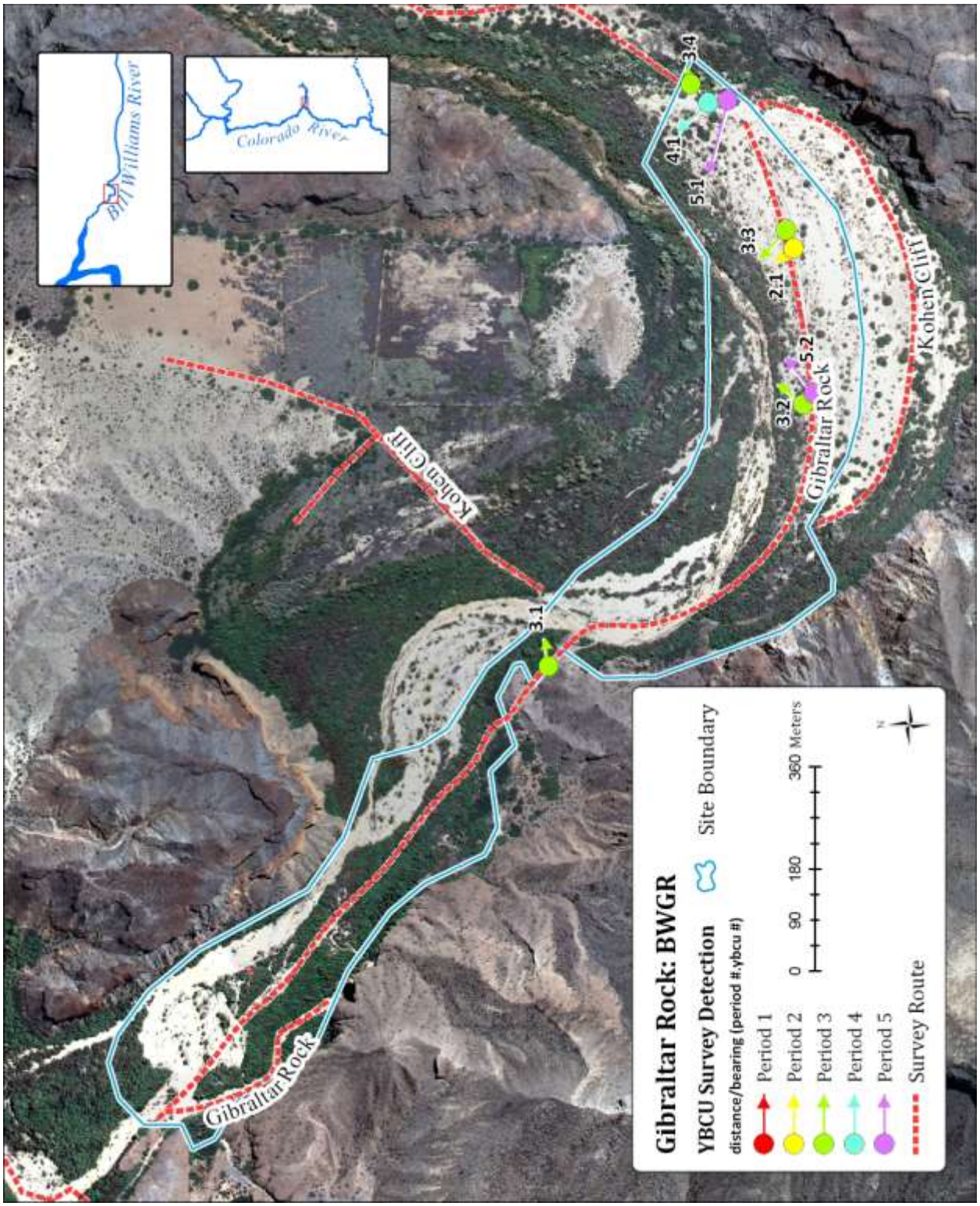

Figure 19. Map of Gibraltar Rock Yellow-billed Cuckoo survey route and detections, 2008.

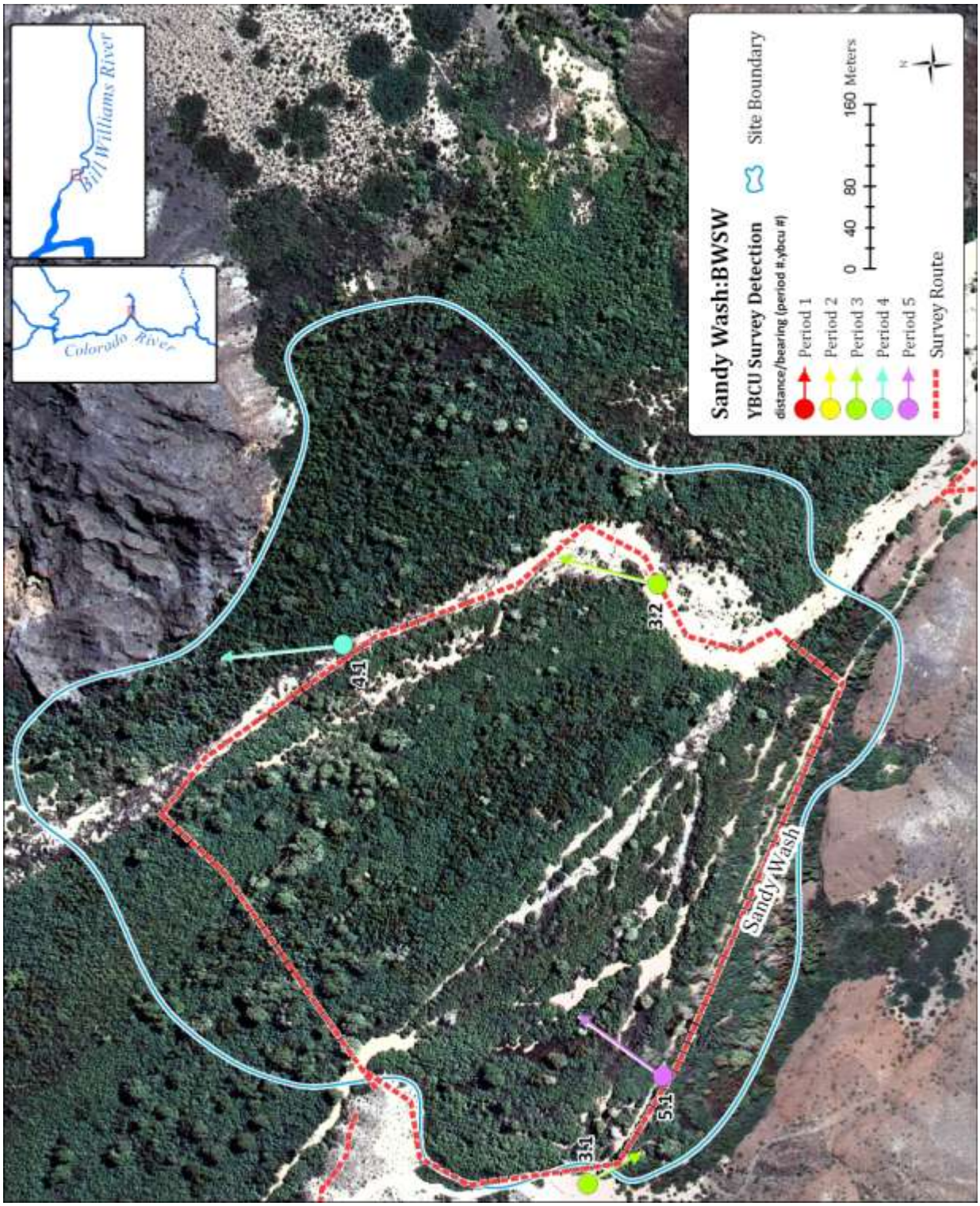

Figure 20. Map of Sandy Wash Yellow-billed Cuckoo survey route and detections, 2008.

Fox Wash (BWFW) *Elevation: 140 m, 62 ha*

This route lies north of Sandy Wash, along the main channel of the Bill Williams River, and ends in a wide floodplain to the west (Figure 21). Dense stringers of tall cottonwoods and willows line the main channel. Narrower and more open stringers of native vegetation line several of the older channels. The interior is open, with patches of dense tamarisk, while narrow bands of marsh vegetation surround remnant pools along the main channel. Mature cottonwoods and mesquites are interspersed throughout the site.

Mosquito Flats (BWMF) *Elevation: 140 m, 29 ha*

The riparian habitat at the western end of the refuge spreads out into a wide floodplain. The route follows the southern edge of the habitat (Figure 22), connecting to the Sandy Wash route on the east and Saguaro Slot on the west. The habitat along the eastern half of the route contains mature riparian cottonwood/willow forest with a dense tamarisk understory. This area is surveyed from an old river channel, and bluffs overlooking the habitat. The western half of the route drops into a wide desert wash, skirts the edge of the riparian, and then winds through a desert riparian area (desert willow, mesquite, arrowweed and palo verde). Recreational activity takes place along the main access road paralleling the site. No standing water was observed during the field season.

North Burn (BWNB) *Elevation: 133 m, 25 ha*

The North Burn route begins at the northern branch of the Bill Williams River slough and continues along the channel of the river for approximately 800 m before following the eastern edge of the river floodplain (Figure 23). The overstory ranges from 8-18 m high and provides around 70% cover, while the understory is 2-8 m, providing around 75% cover. The route encompasses three distinct habitat types. The first is surveyed from a boat and includes small clusters of mature willows surrounded by tamarisk and cattails. The second part to the south and west is a mixed native forest, with a mature willow/cottonwood overstory. The third, northeastern, part is dominated by tamarisk.

The habitat burned in 2005, and is regenerating with tamarisk and quailbush. The site is surrounded by tamarisk-dominated floodplain and Sonoran Desert upland habitat to the north and east. The area to the south and west has more native-dominated habitat extending up the Bill Williams River. Standing water was observed throughout the season.

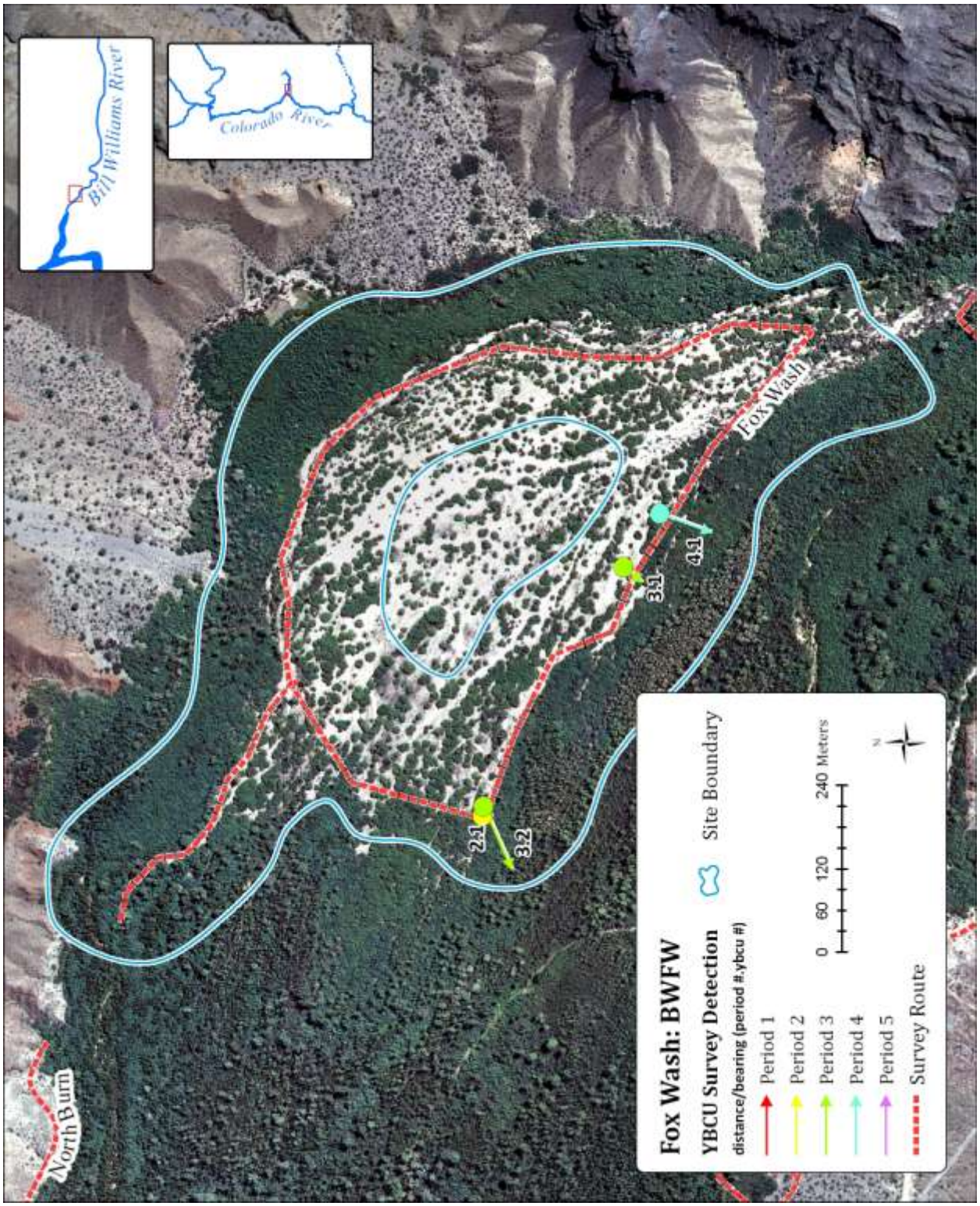

Figure 21. Map of Fox Wash Yellow-billed Cuckoo survey route and detections, 2008.

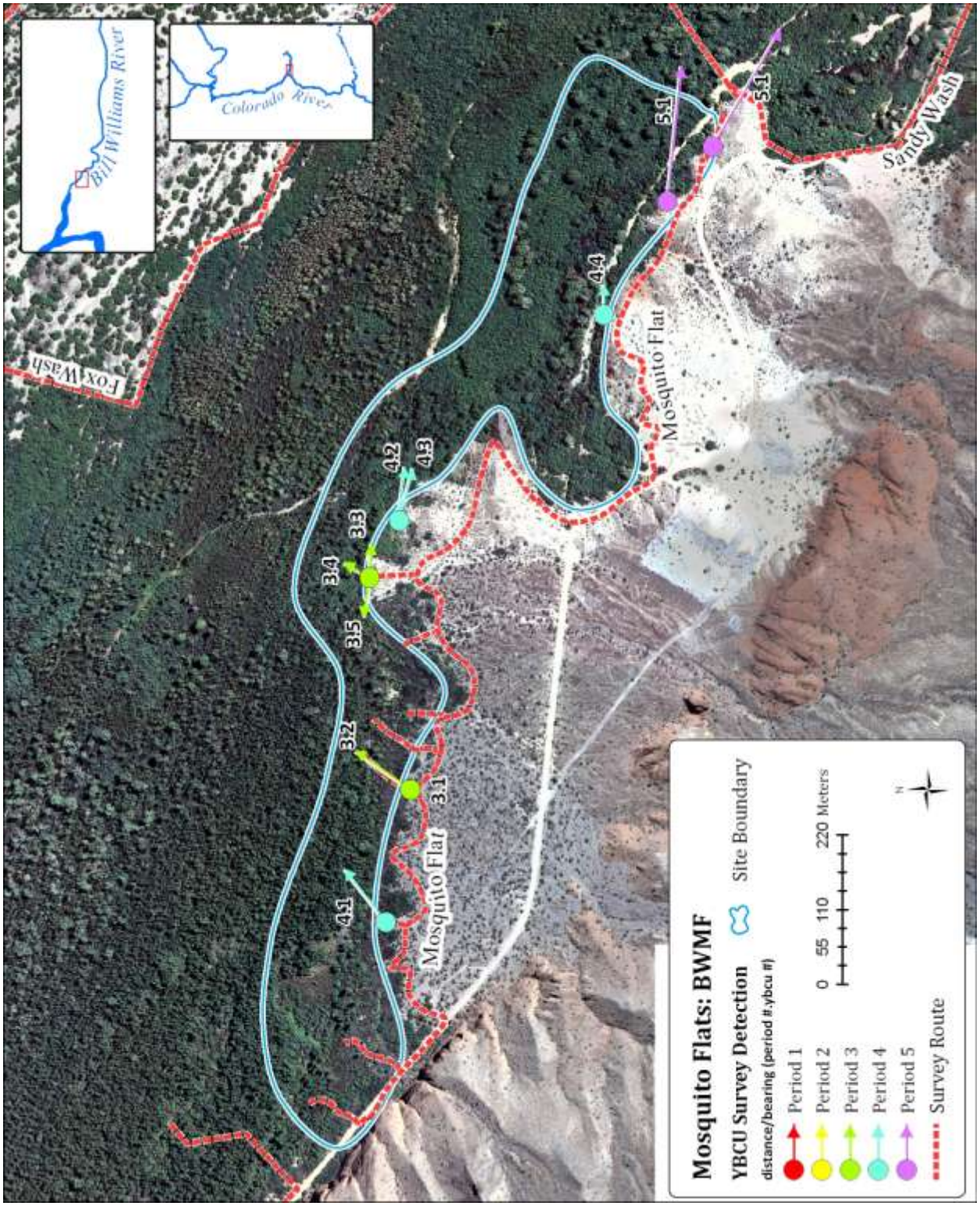

Figure 22. Map of Mosquito Flats Yellow-billed Cuckoo survey route and detections, 2008.

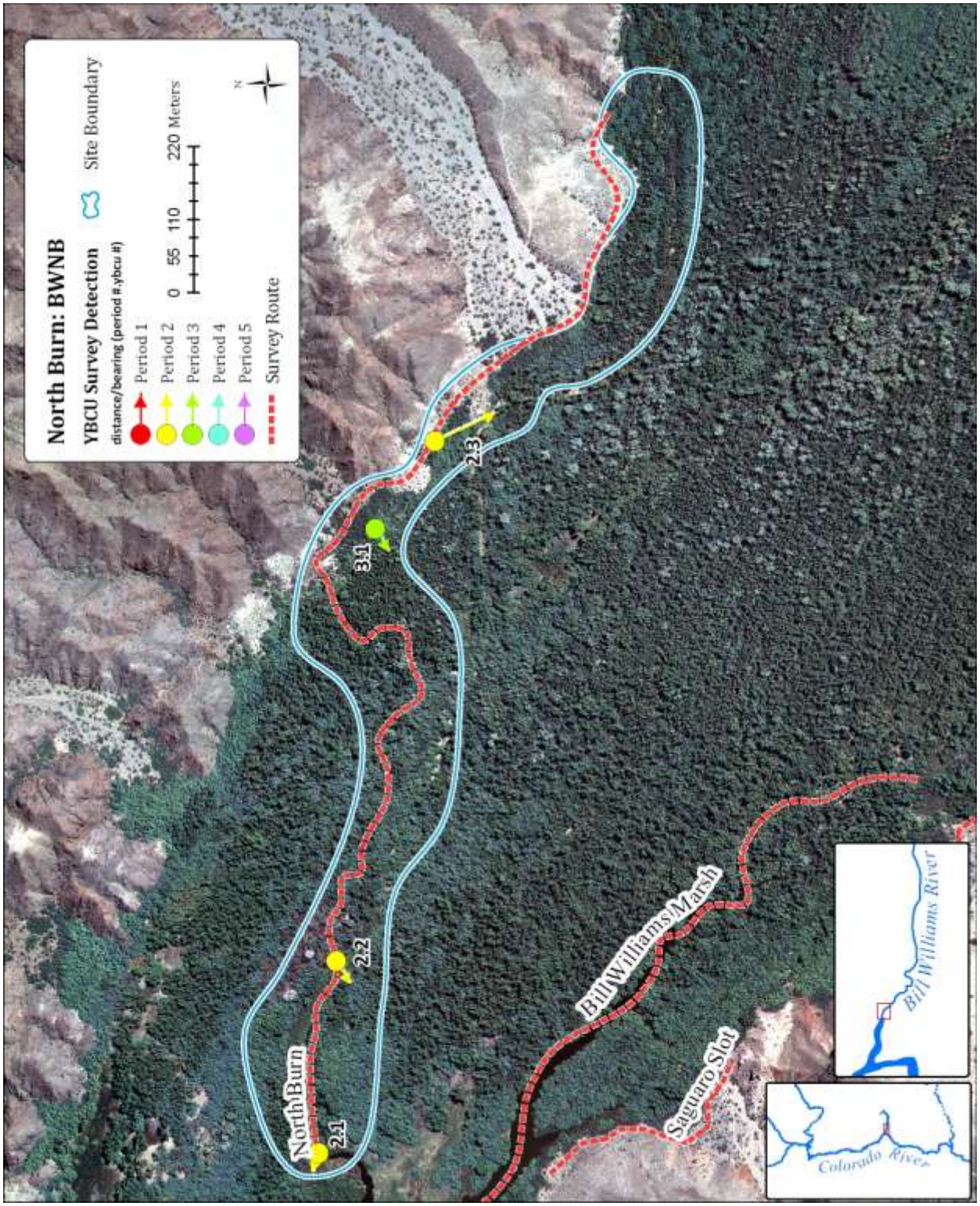

Figure 23. Map of North Burn Yellow-billed Cuckoo survey route and detections, 2008.

Saguaro Slot (BWSS) *Elevation: 143 m, 15 ha*

This route covers the western most riparian habitat accessible by land. It connects to Mosquito Flats on the east, and ends at cliffs on the west (Figure 24). For the most part the site is surveyed from bluffs overlooking the riparian habitat. The habitat consists of a dense mesquite/tamarisk understory, with an overstory of mature Goodding's willow and cottonwood. The western end of the broad floodplain is crossed by numerous river channels. Many of these have seasonal water and support nearly impenetrable cattails.

There is light visitor use in the summer, and some vehicle traffic on the main road, which parallels the route. Although there was no standing water on the vegetation plots, the water table appears to be high here, and there are several standing ponds and water-filled side channels on or near the route.

Bill Williams Marsh (BWMA) *Elevation: 133 m, 19 ha*

This route is accessed by kayak, and provides access to habitat within the broad western floodplain. The route follows the main channel of the Bill Williams River (Figure 25), which floods seasonally from upstream waters, and is periodically inundated by fluctuating lake levels. The riparian habitat consists of cottonwood/willow with a dense understory of tamarisk. The shore is lined with cattails. There is regular boating and fishing activity at this site.

AHAKHAV TRIBAL PRESERVE

Colorado River Indian Tribal Lands, AZ.

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

Ahakhav Tribal Preserve (CRIT) *Elevation: 108 m, 53 ha*

More than 54 ha (135 ac) of riparian habitat has been restored here since 2001. Periodic revegetation in some previously restored areas has resulted in multilayer patches with canopy heights ranging from to 2-16 m. Species composition consists of 40 ha of mosaic plantings of Freemont cottonwood and Goodding's willow, and approximately 14 ha (34.6 ac) of honey and screwbean mesquite. Ground cover is sparse, the soil is sandy and there is little understory. There was little standing water during visits. The survey route follows roads around the perimeter and interior of the site (Figure 26).

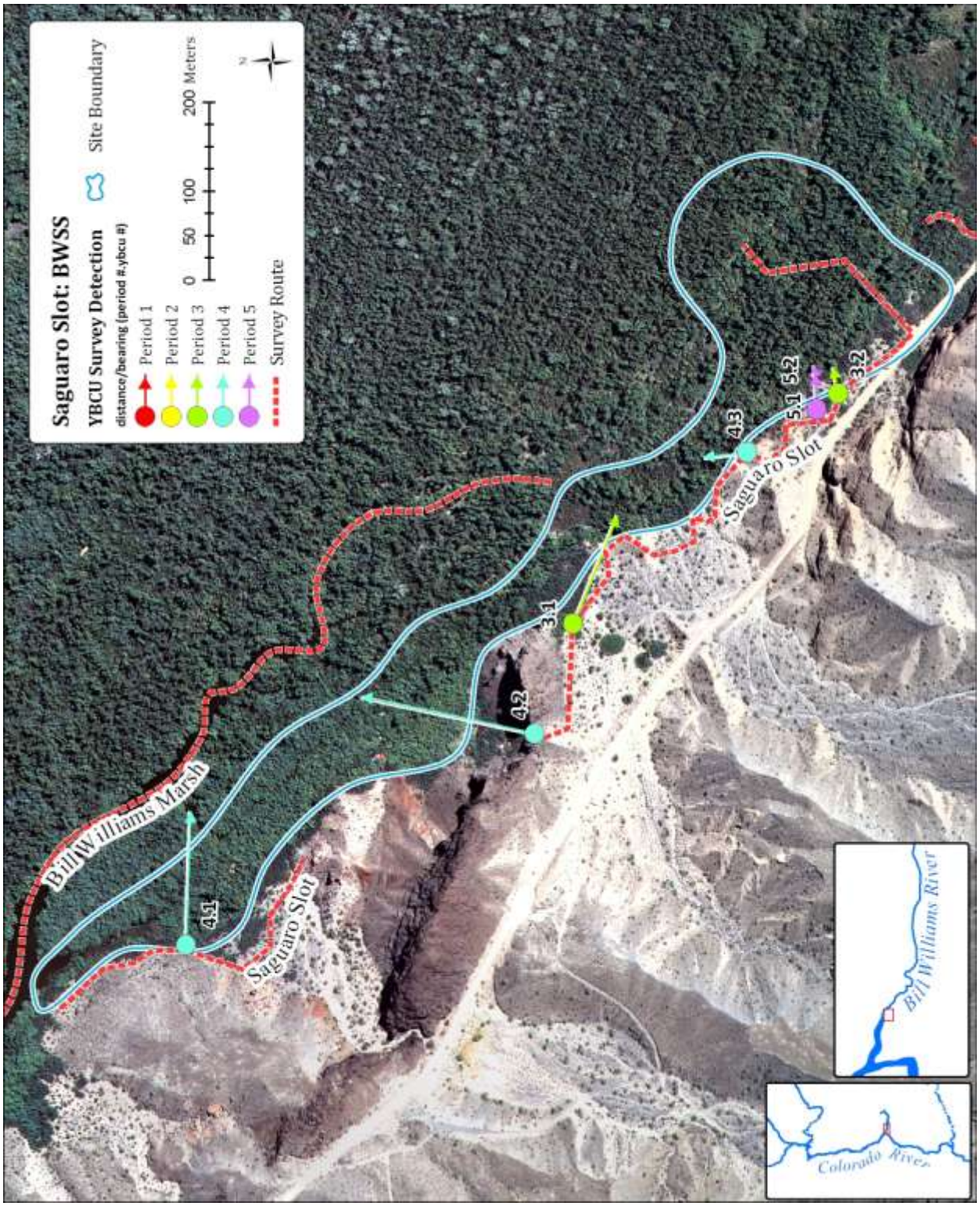

Figure 24. Map of Saguaro Slot Yellow-billed Cuckoo survey route and detections, 2008.

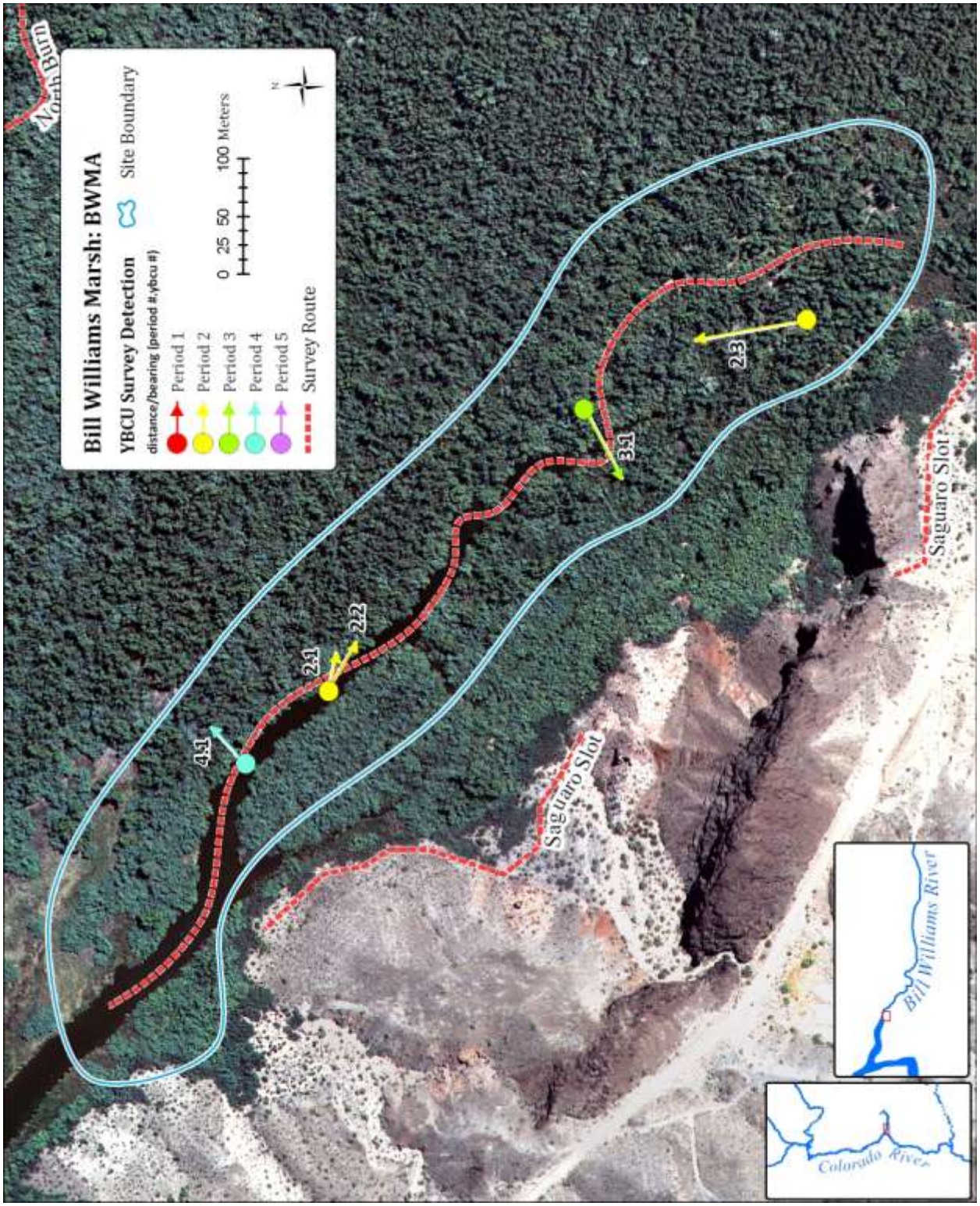

Figure 25**. Map of Bill Williams Marsh Yellow-billed Cuckoo survey route and detections, 2008.**

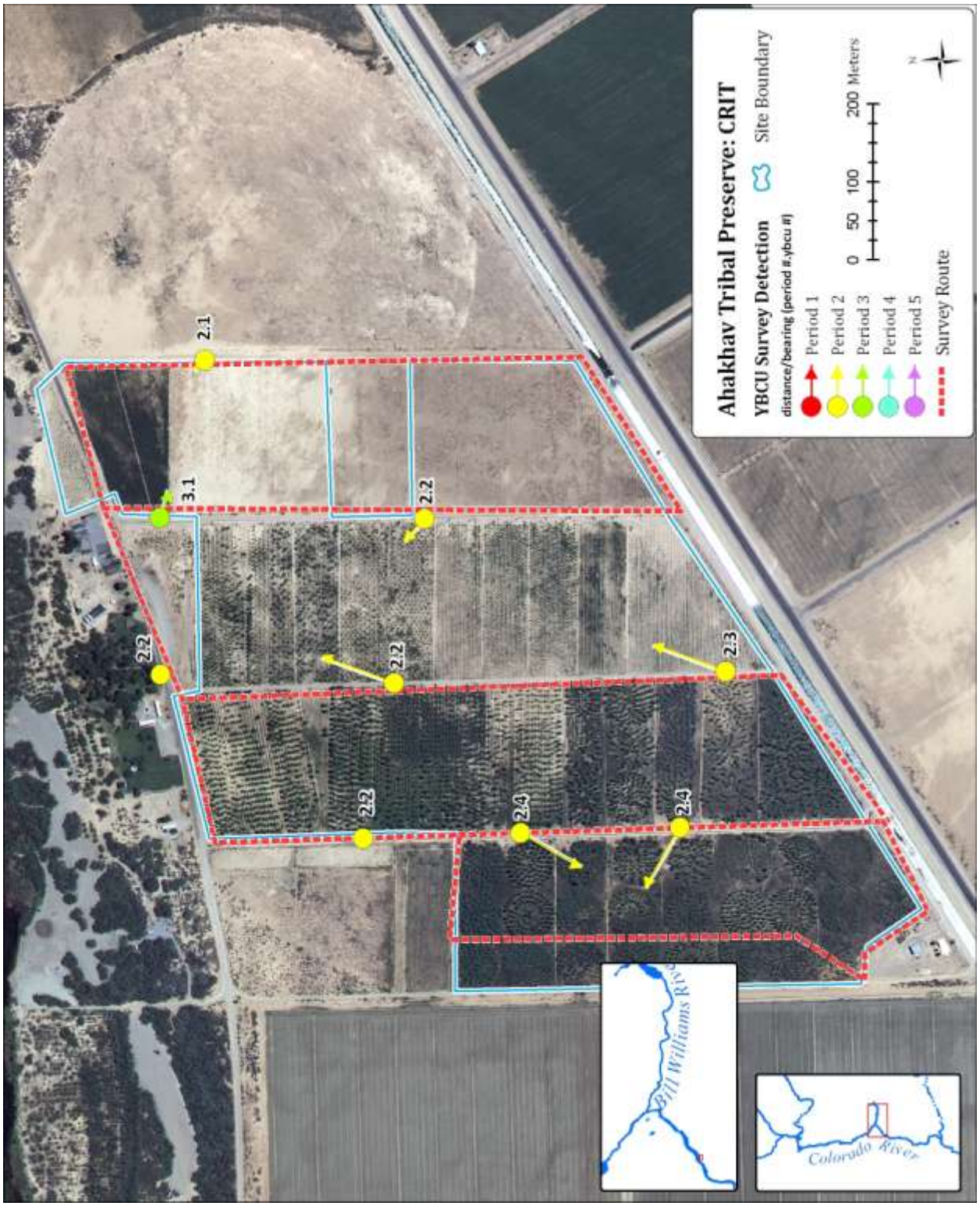

Figure 26. Map of Ahakhav Tribal Preserve survey route and cuckoo detections, 2008.

PALO VERDE ECOLOGICAL RESERVE

Riverside County, CA

Palo Verde Ecological Reserve (PVER) was acquired by the state of California in 2004 and consists of 547 ha (1351.1 ac) within the historic floodplain, north of Blythe. Portions of this Reserve have been identified for conversion from active agricultural lands to riparian habitat as part of the LCR MSCP. Planning and implementation of restoration activities within the reserve are a joint effort by Reclamation and the California Department of Fish and Game (CDFG), and are outlined in the Palo Verde Ecological Reserve Restoration Development Plan Overview (LCR MSCP 2006b). Within PVER, one site (Phase 1) was surveyed for the first time in 2008. This site was planted as a nursery, but may provide habitat for cuckoos. Agricultural fields border the site to the north and east. Restoration sites to the southwest (Phases 2 and 3) will be surveyed in future years.

Palo Verde Ecological Reserve (PVER) *Elevation: 86 m, 8.3 ha*

Phase 1 of PVER was planted in 2005. In 2008 during its fourth growing season, this native dominated restoration site had a cottonwood and willow overstory 3-8 m tall, providing 70% canopy cover. A dense mat of alfalfa inhibits the establishment of an understory. Because this section of the site is a nursery for cuttings, the planned lack of understory facilitates access for collection of plant materials. The site is bordered by roads, which were used to conduct the surveys (Figure 27).

CIBOLA VALLEY CONSERVATION AREA

La Paz County, AZ

Cibola Valley Conservation Area is 24.2 km south of Blythe, CA, southeast of a bend in the Colorado River near Cibola Bridge. Within Cibola Valley, 407.6 ha (1,019 ac) of land owned by the Mohave County Water Authority have been identified for riparian restoration activities, as outlined in the Cibola Valley Conservation Area Restoration Development Plan (LCR MSCP 2007). Figure 28 shows a map of the Cibola Valley area sites. Since 2006, 108 ha (266 ac) of native riparian trees have been planted in three phases. Phase 1 and 2 are located in adjacent fields and Phase 3 is approximately 2.6 km to the west. All five Phase 1 plantings were surveyed in 2008.

Figure 27. Map of Palo Verde Ecological Reserve Yellow-billed Cuckoo survey route and detections, 2008.

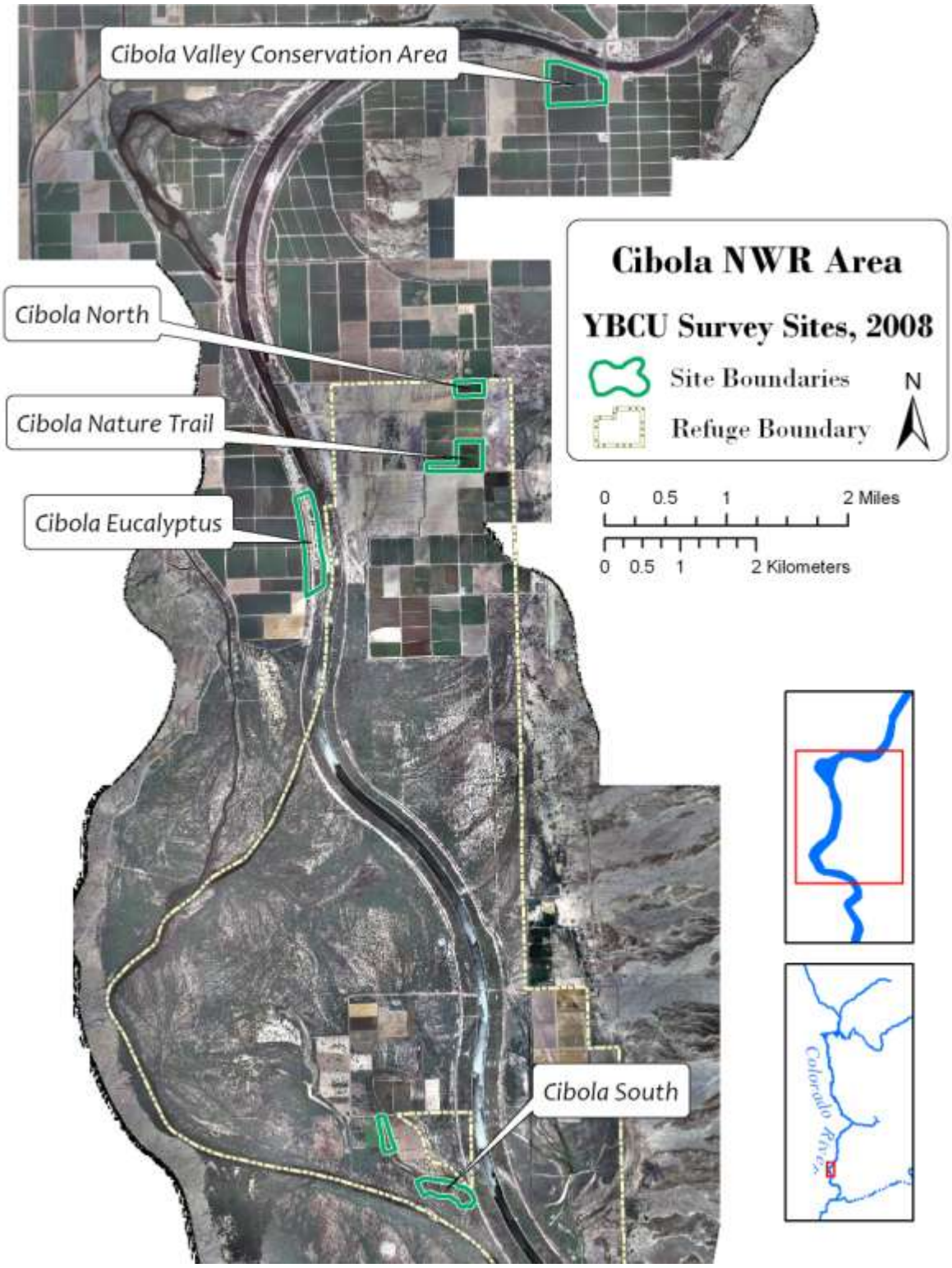

Figure 28. Map of Cibola NWR area Yellow-billed Cuckoo survey sites, 2008.

Cibola Valley Conservation Area (CVCA) *Elevation: 72 m, 37 ha*

Of the 108 ha (266 ac) planted during Phases 1-3, 37.4 ha (92 ac) were considered mature enough to be surveyed in 2008. This site consists of six fields planted in 2005, during Phase 1 of the CVCA restoration development (Figure 29). Goodding's willow, coyote willow, and Freemont cottonwood are the dominant tree species at the site. Field borders were planted with strips of *Atriplex* and baccharis. Canopy height ranges from 4-10 m with 80% canopy closure. The alfalfa ground cover has kept an understory from developing throughout much of the site. The site was laser-leveled prior to planting for even irrigation and was periodically flooded throughout the breeding season. The Colorado River is separated from the site by a levee and flows within 100 m of the northern edge of the restored area.

Access roads define the perimeter of CVCA. Several additional overgrown roads cross the sites, with a center road maintained for vehicle access. Surveys were conducted from these roads. Cotton (*Gossypium sp.*) and alfalfa fields dominate the surrounding area. This site had the highest ground cover of any site (90%), composed almost entirely of alfalfa. Cuckoo surveys were first conducted at CVCA in 2008. Two nests were found in the southwest corner of the site, and one juvenile was found in the eastern portion. These are discussed further in the nest results section.

CIBOLA NATIONAL WILDLIFE REFUGE

La Paz County, AZ (Colorado River Drainage)

Cibola NWR is 29.8 km south of Blythe, CA in the historic floodplain of the Colorado River. The Refuge, exceeding 6,475 ha (16,000 ac), was established in 1964 and is managed by the USFWS to preserve and protect wildlife habitat. The Refuge includes both the historic Colorado River channel as well as a new channel constructed in the late 1960's. The old channel still receives irrigation water and portions are maintained as wildlife habitat, while the new channel carries the Colorado River flow and is extensively levied. Within the Refuge fields of alfalfa and grain crops border extensive tamarisk and mesquite dominated uplands. Four sites at Cibola NWR were surveyed in 2008.

Cibola North Plantation (CIBNTH) *Elevation: 71 m, 7.5 ha*

Cibola North Plantation is a 7.5 ha (18.5 ac) restoration site with a cottonwood overstory. Cottonwoods at this site average 8 m high and provide 60% canopy closure. The ground cover is periodically mowed and dominated by Bermuda grass. No understory was present in 2008. This small site was surveyed by foot from the perimeter (Figure 30). Fallow fields dominated by sparse tamarisk, arrowweed, and *Atriplex* extend to the east and west of the site. The Cibola Nature Trail is 580 m to the south and is separated from this site by three agricultural fields. Two of these fields are planted with wildlife forage crops and a third is seasonally flooded to provide habitat for wintering waterfowl. The site is bordered on its northern edge by Baseline Road and agricultural fields.

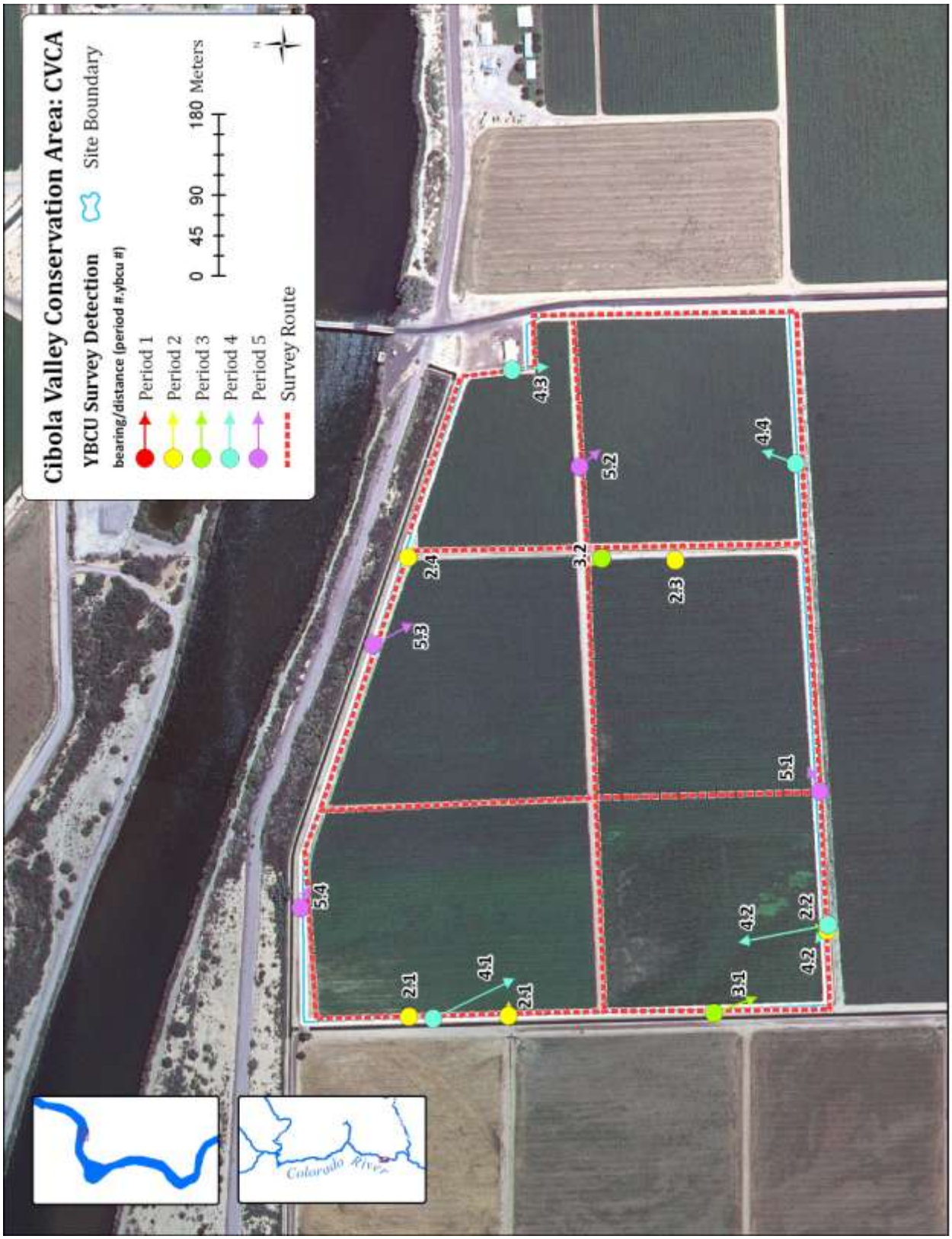

Figure 29. Map of CVCA Yellow-billed Cuckoo survey route and detections, 2008

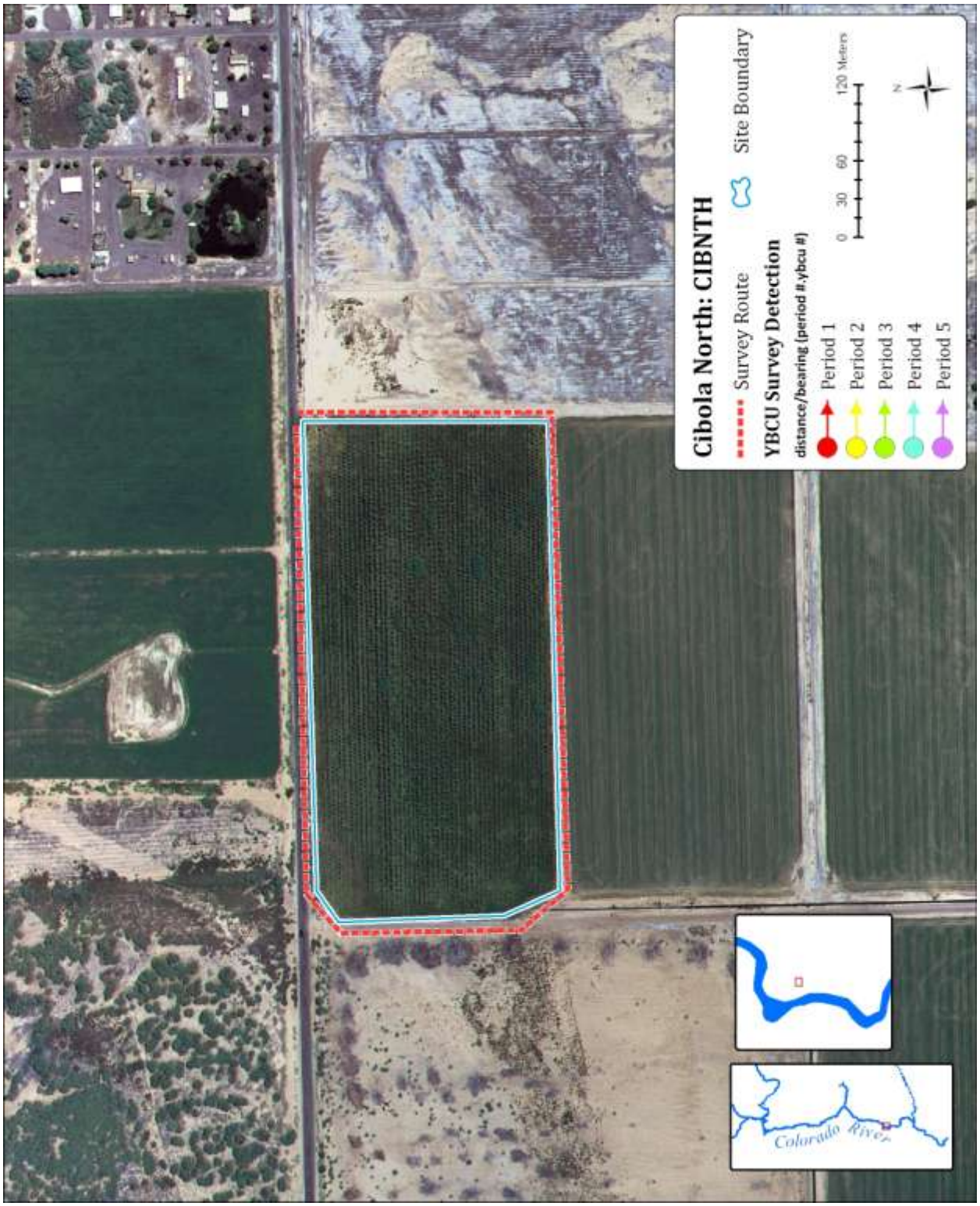

Figure 30. Map of Cibola North Yellow-billed Cuckoo survey route, 2008.

Cibola Nature Trail (CIBCNT) *Elevation: 75 m, 18 ha*

This restoration site was planted in 1999, converting a cornfield to a cottonwood/ willow forest. The route follows a well-maintained nature trail that winds through the habitat (Figure 31). Planted in a horseshoe shape, the species composition and height varies across the site, creating structural diversity. Cottonwoods dominate a 5-11 m tall canopy providing 40% canopy cover. The understory includes Goodding's willow, honey and screwbean mesquite, baccharis, coyote willow and young cottonwoods. Average understory measures 3 m with 50% cover. In 2008 this site was extended to include a 4.2 ha (10.4 ac) restoration patch extending to the west, bringing the site area to 18.4 ha (45.4 ac). This site was periodically flood irrigated during the survey season. Much of the surrounding area is agricultural fields planted with wildlife enhancement crops. A field seasonally flooded for wintering waterfowl borders the site to the north.

Cibola Eucalyptus Plantation (CIBEUC) *Elevation: 70 m, 29 ha*

Cibola Eucalyptus Plantation is a mixed native restoration site composed of a cottonwood and eucalyptus (*Eucalyptus sp.*) patch west of the levee road and a patch of cottonwood, tamarisk, willow and mesquite to the east. Overstory cover in the two patches is 10% and height varies from 3-12 m. The understory is mostly sparse with 30% cover. A mixed understory of arrowweed, quailbush, palo verde, tamarisk, mesquite and willow averages 3 m high. The surrounding area consists of winter wheat and alfalfa fields to the north, west, and south, and the Colorado River main channel to the east. The survey is conducted from the road bisecting the site (Figure 32).

Cibola South Restoration (CIBSTH) *Elevation: 65 m, 5.3 ha*

Cibola South Restoration combines a stringer of willows along an irrigation channel with a mature cottonwood-dominated restoration patch located in the island unit of Cibola NWR. This is a small site with 5.3 ha (13.1 ac) of potentially suitable native riparian habitat (Figure 33). Mature cottonwoods 4-8 m tall provide 25% cover in the southern part of this dry site. A sparse (25% cover) layer of mesquite, tamarisk and baccharis create an understory 1-4 m tall.

The northern portion of this site is composed primarily of a Goodding's willow overstory and an understory including mesquite, tamarisk and baccharis, and a ground cover of cattails and Bermuda grass. The site is surrounded by historic Colorado River floodplain dominated by tamarisk, mesquite, arrowweed, and *Atriplex*, and agricultural fields used for wildlife enhancement crops. These fields were fallow during most of the 2008 field season.

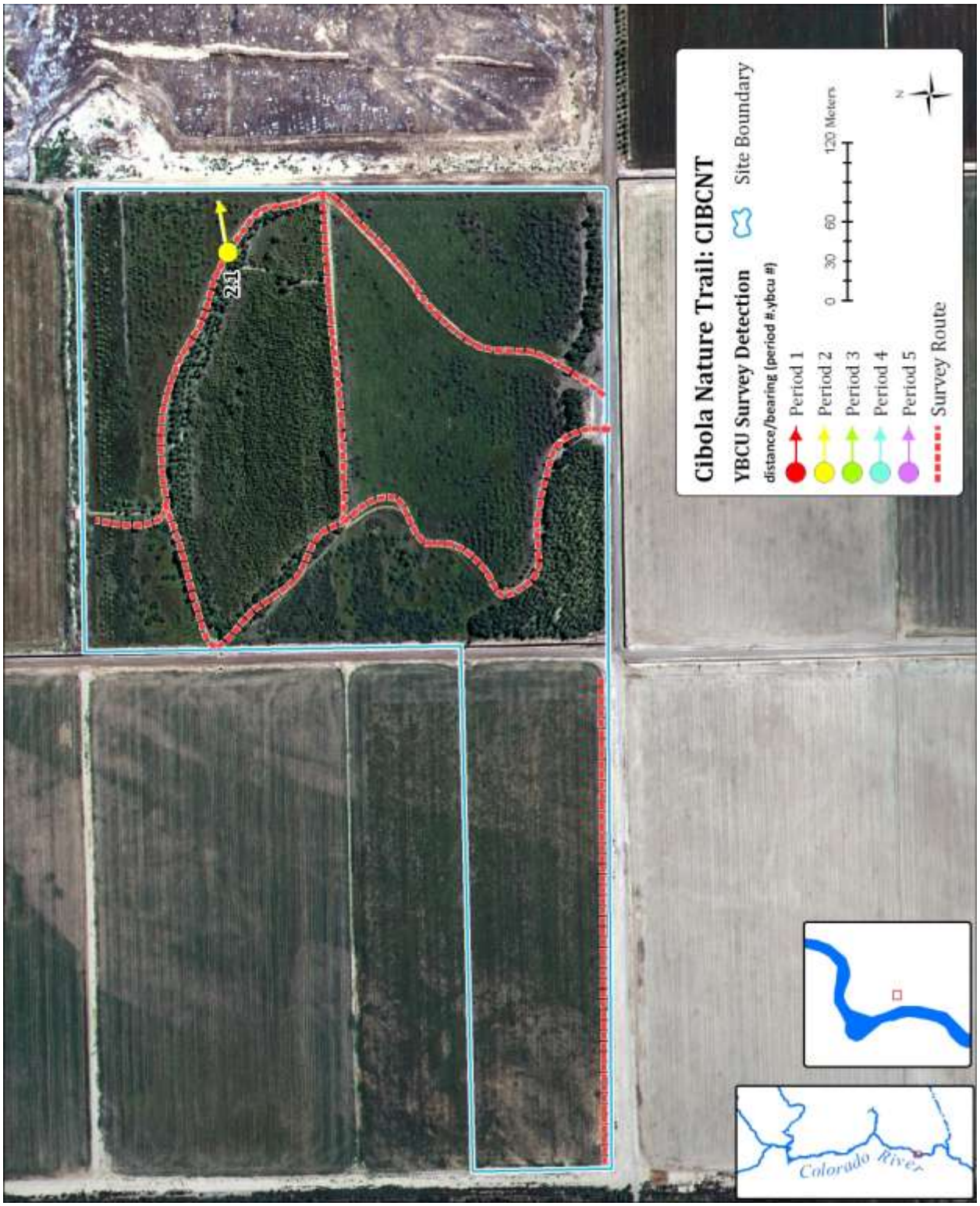

Figure 31. Map of Cibola Nature Trail Yellow-billed Cuckoo survey route and detections, 2008.

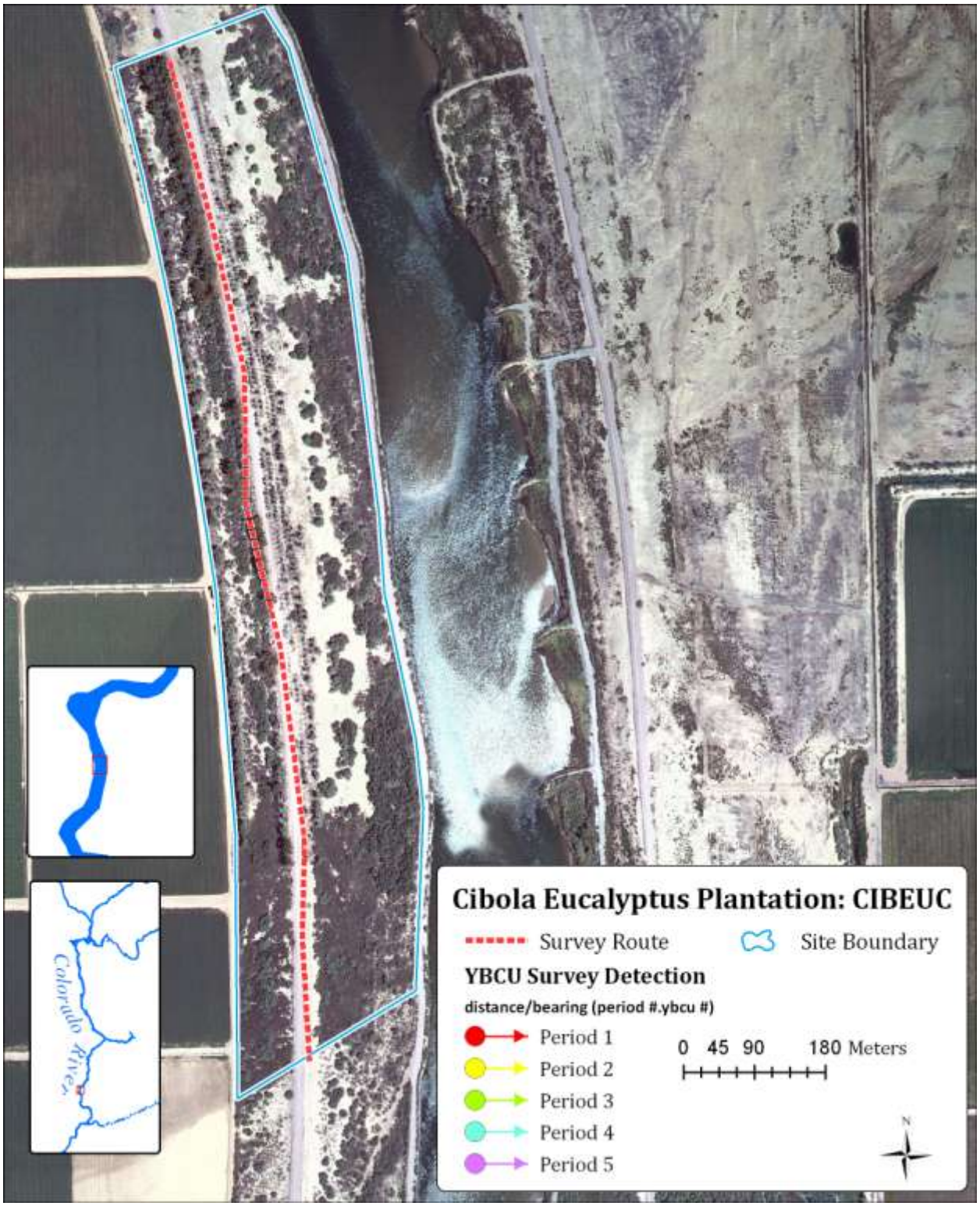

Figure 32. Map of Cibola Eucalyptus Yellow-billed Cuckoo survey route, 2008.

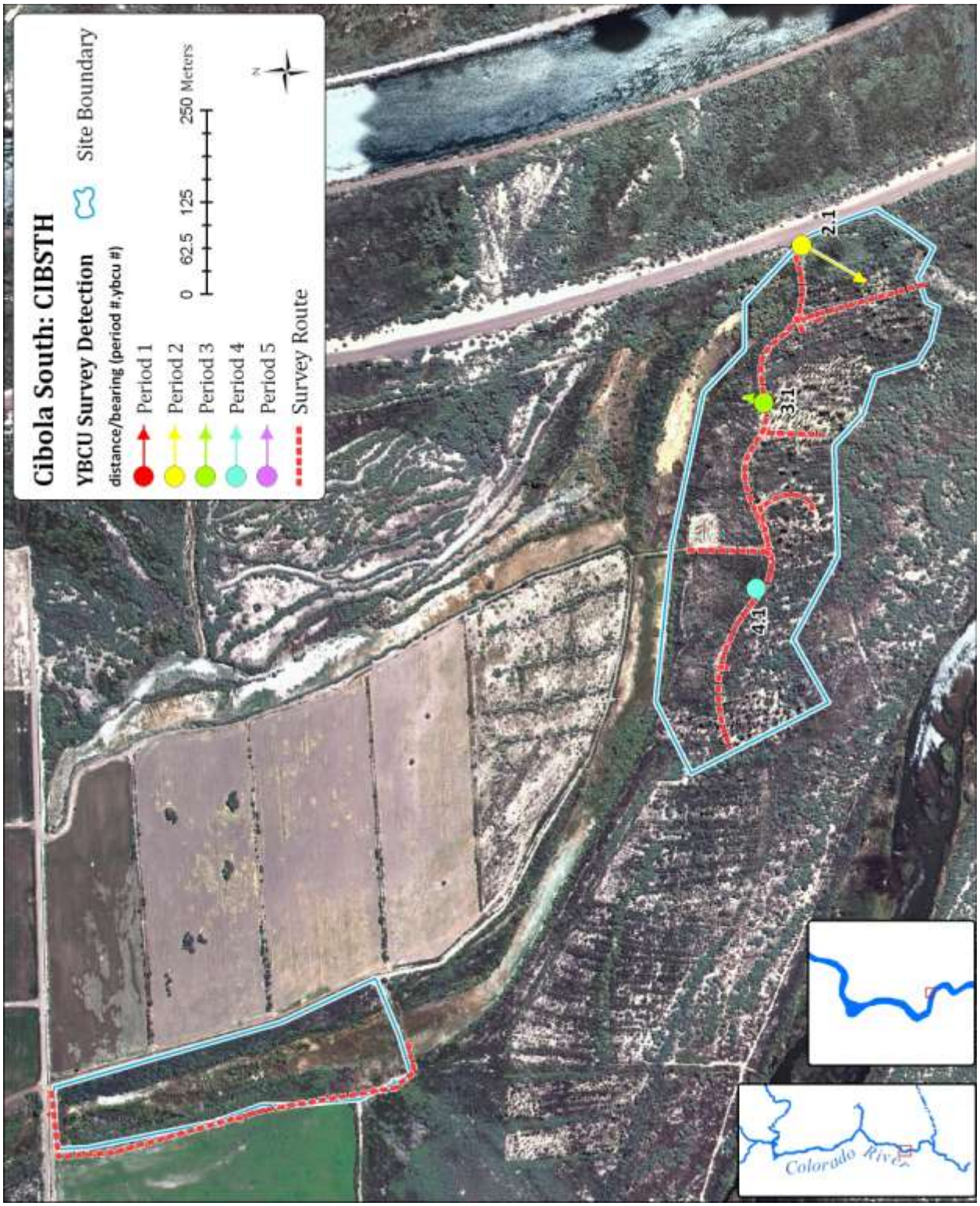

Figure 33. Map of Cibola South Yellow-billed Cuckoo survey route and detections, 2008.

PICACHO STATE RECREATION AREA

Imperial County, CA (Colorado River Drainage)

Picacho State Recreation Area (SRA) is a historic mining town site, currently state owned and managed by the California State Parks Department. It is 38.6 km north of Winterhaven, California, on the Colorado River. Restoration efforts within the park have enhanced remnant riparian vegetation.

Picacho State Recreation Area (PICSRA) *Elevation: 59 m, 5 ha*

Picacho SRA (Figure 34) is a cottonwood and willow dominated restoration site where Picacho Wash flows into the Colorado River. The vegetation at this restoration site appears naturalized and is structurally diverse. Fremont cottonwood, Goodding's willow, and honey and screwbean mesquite dominate the 6 to17 m tall canopy, averaging 30% cover. A diverse understory of arrowweed, *Atriplex*, blue palo verde (*Cercidium floridum*), baccharis, mesquite, willow and cottonwood provides 50% cover. The site is bordered by the Picacho SRA campground and adjacent Sonoran Desert uplands to the west, and the river to the east.

IMPERIAL NATIONAL WILDLIFE REFUGE

Yuma County, AZ (Colorado River Drainage)

Imperial NWR was established in 1941 and encompasses 10,307 ha (25,768 ac) of riparian area and associated Sonoran Desert uplands. The headquarters is 40.3 km north of Yuma, off Martinez Lake Road, and the Refuge follows 48.3 km of the lower Colorado River, including some of the last remaining unchannelized stretches. Management activities in the Refuge include protecting backwater lakes, managing marsh units, farming croplands to provide food for wintering waterfowl, and restoring wetlands and associated riparian vegetation. Two restoration sites within the Refuge were surveyed in 2008.

Imperial South Restoration (IMPSTH) *Elevation: 60 m, 3.1 ha*

Imperial South Restoration (INWR Forest) consists of a small native nursery planted in 1994, and a stringer of cottonwood and willow habitat lining a finger of Martinez Lake. The nursery site comprises mature 5-14 m tall Fremont cottonwood, Goodding's willow and mesquite, with 60% canopy closure. There is a low, sparse (5% cover) understory of young cottonwood, mesquite, arrowweed, *Phragmites*, baccharis and tamarisk. Surrounding habitat includes an open field (fallow during the field season), impoundment ponds, and wetlands to the north. The survey route follows perimeter roads (Figure 35).

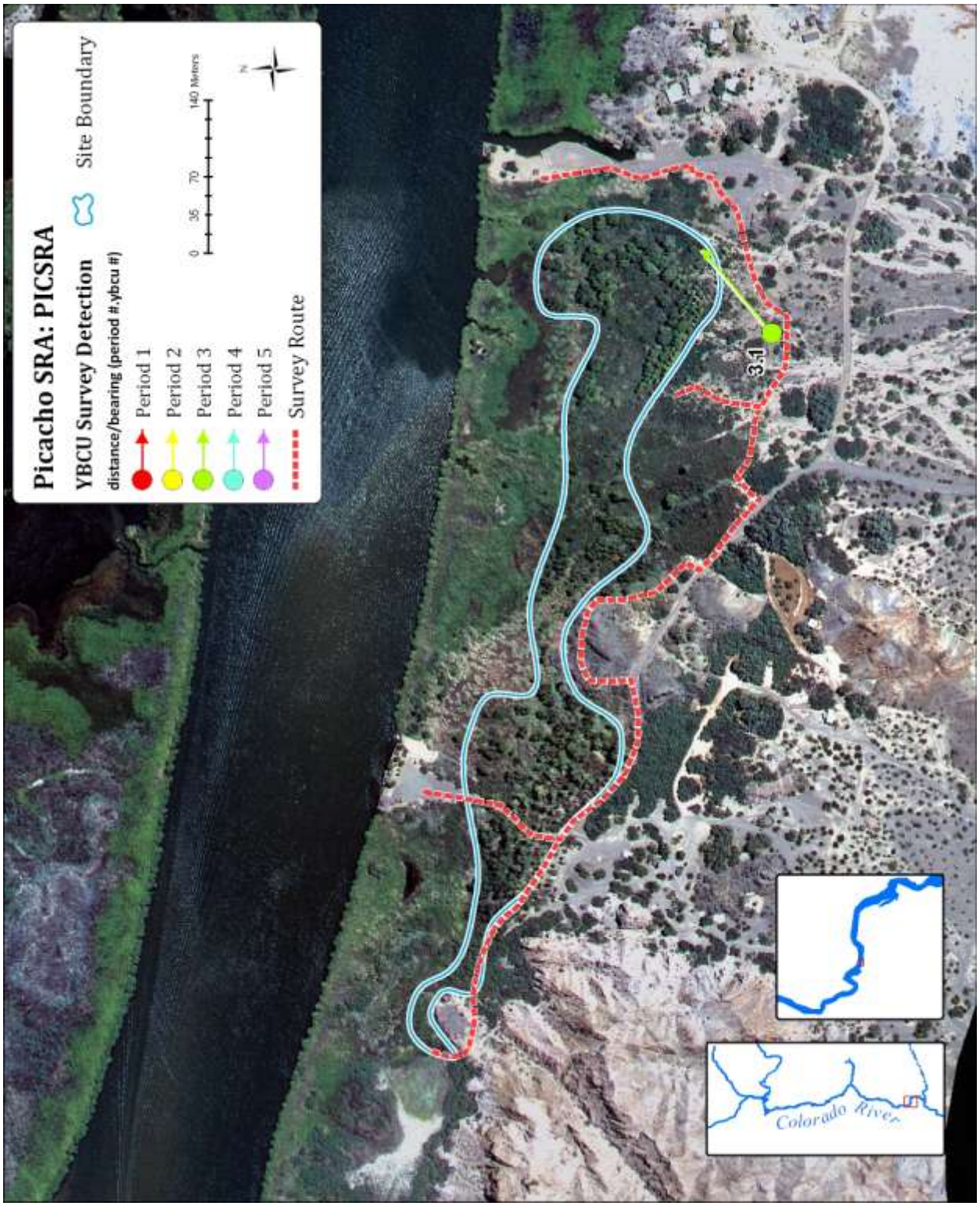

Figure 34. Map of Picacho State Recreation area Yellow-billed Cuckoo survey route and detections, 2008.

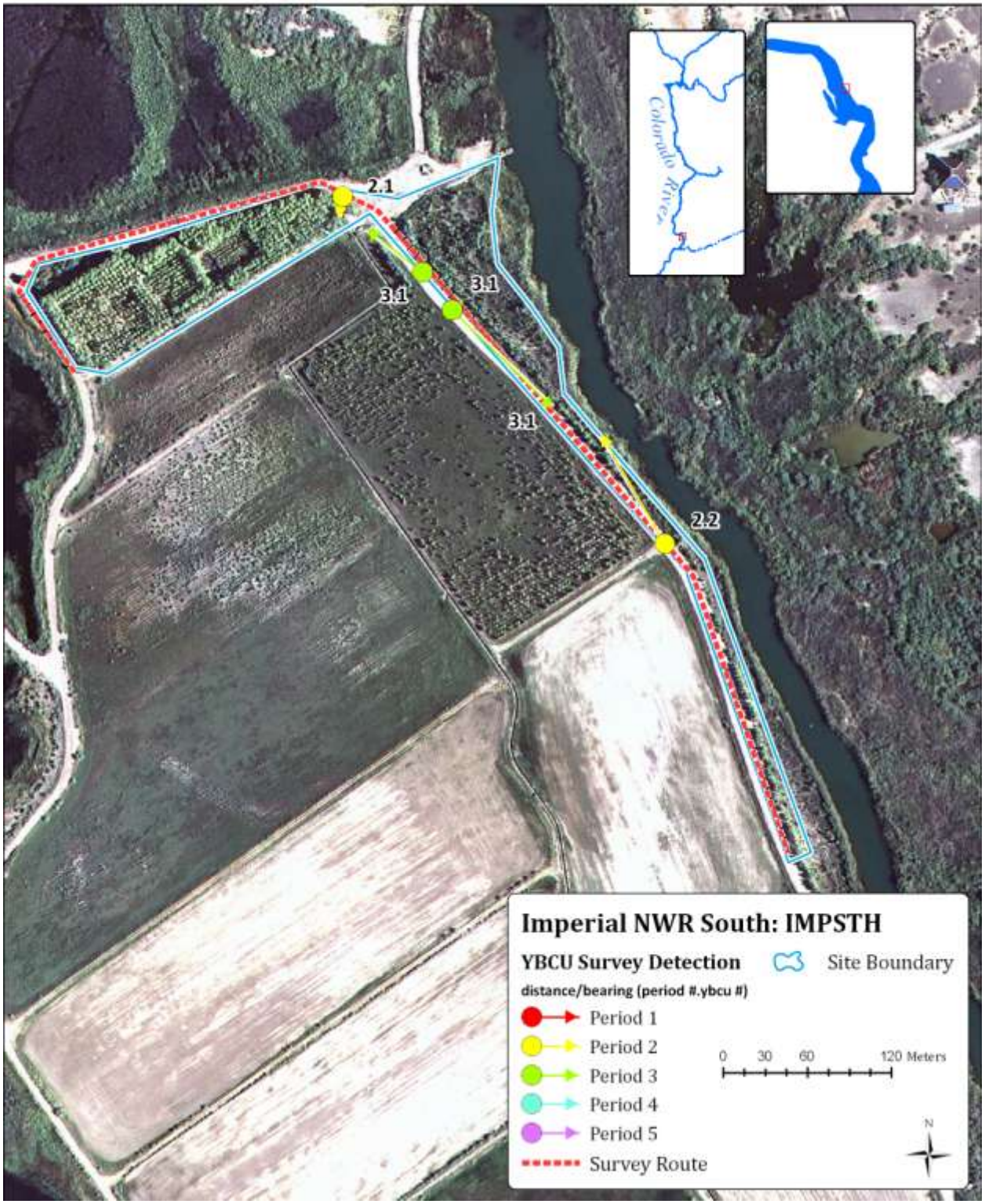

Figure 35. Map of Imperial NWR South Yellow-billed Cuckoo survey route and detections, 2008

Imperial 20A Restoration (IMP20A) *Elevation: 61 m, 2 ha*

Imperial 20A is a native restoration site 560 m from the main body of Martinez Lake. Stunted Fremont cottonwoods form a sparse canopy (5% cover) and are planted 4 m apart in rows spaced every 3 m. The overstory varies from 4-14 m high and is interspersed with mesquite. Mesquite, arrowweed, baccharis and tamarisk form a sparse (10% cover) understory 1-4 m high. A thick ground cover of saltgrass (*Distichlis spicata*), Bermuda grass and *Phragmites* provide 90% ground cover. This site was intermittently flood irrigated throughout the season. The site is bordered by seasonally flooded wildlife ponds to the north, mixed native marshland to the east, and exotic dominated fields to the south and west of the site. The survey route follows access roads through the restoration site (Figure 36).

Mittry Lake Wildlife Management Area/Betty's Kitchen Wildlife and Interpretive Area

Yuma County, AZ (Colorado River Drainage)

Mittry Lake WMA is managed by the Arizona Game and Fish Department (AGFD) for wildlife habitat and outdoor recreation. The adjacent Betty's Kitchen Wildlife and Interpretive Area is managed by the BLM and was designated a National Recreation Trail in 1992. The area is 24.2 km northeast of Yuma, between Laguna and Imperial dams on the lower Colorado River. It is composed of open water, marsh and desert riparian habitats. Several small patches of riparian habitat with a native overstory component exist throughout. In 2008 the only site in this vicinity assessed as suitable for cuckoos was the Pratt Restoration Project.

Pratt Restoration (MLPR) *Elevation: 40 m, 6 ha*

Pratt Restoration Project (Figure 37) is a cooperative restoration effort planted in 1999 on a BLM agricultural lease, using cottonwood and willow pole cuttings and locally collected seeds. The overstory is 5-11 m with 70% canopy cover, and comprises 80% cottonwood, and 20% Goodding's and coyote willow. There is 30% understory cover (< 5 m) of baccharis, willow, mesquite, cottonwood and tamarisk. Actively farmed alfalfa fields border the north and east sides of the site, while a young restoration site abuts the southeastern edge. Betty's Kitchen Nature Trail winds through a tall mature tamarisk and mesquite stand to the south and west of the site.

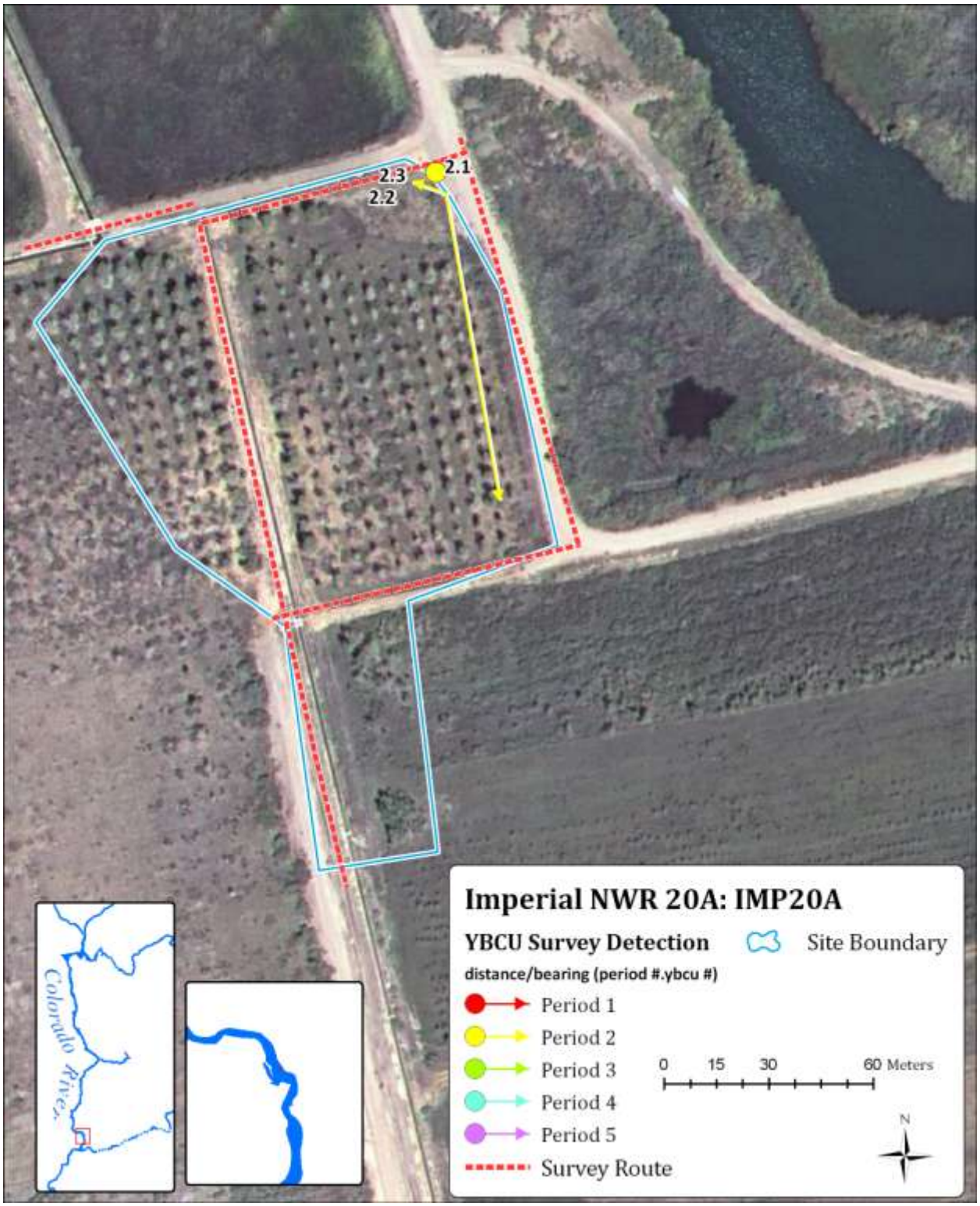

Figure 36. Map of Imperial NWR 20A Yellow-billed Cuckoo survey route and detections, 2008.

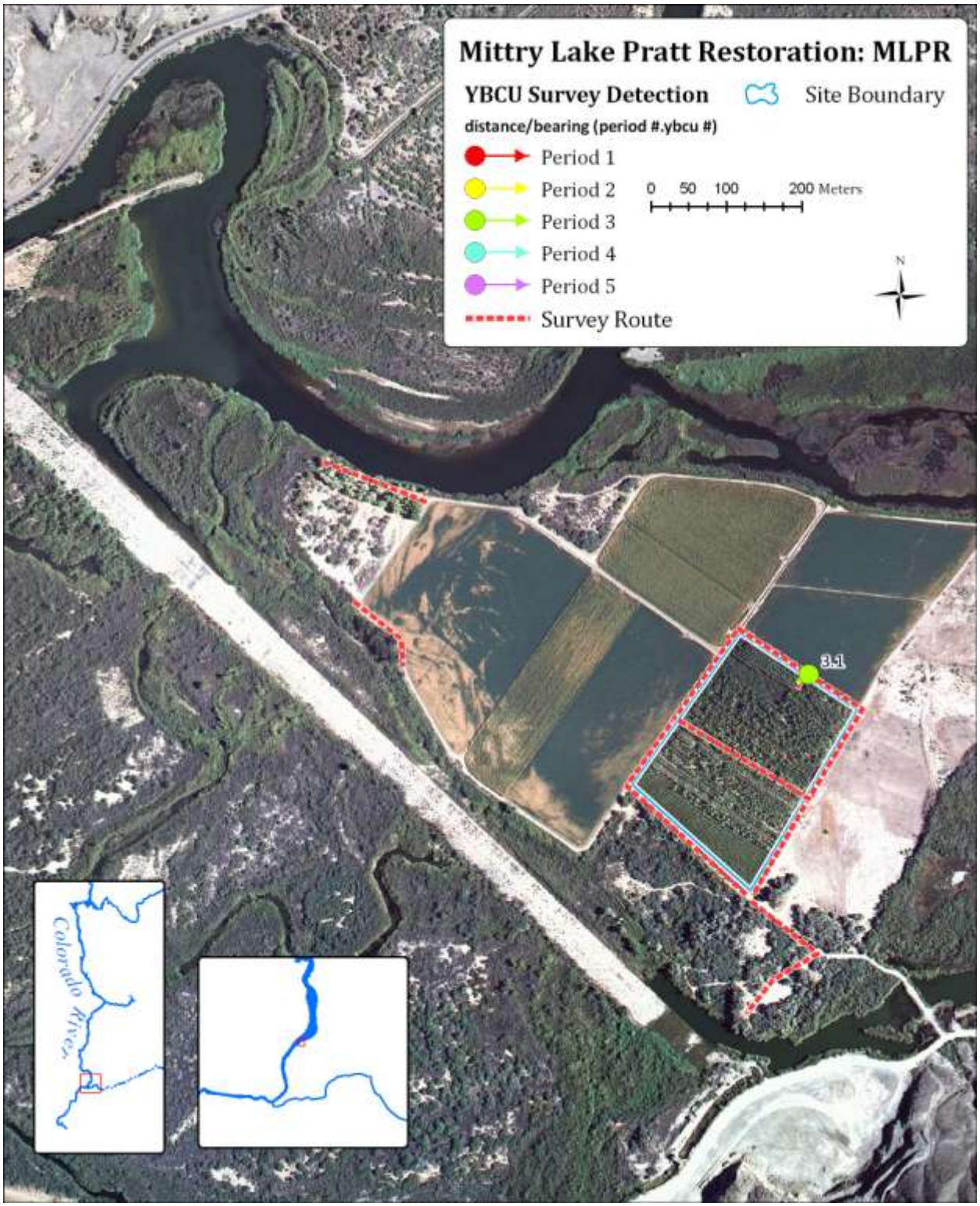

Figure 37. Map of Mittry Lake/Pratt Restoration Yellow-billed Cuckoo survey route and detections, 2008.

GILA RIVER/COLORADO RIVER CONFLUENCE

Yuma County, AZ (Colorado River Drainage)

Patches of riparian forest persist along the banks of both the Gila and Colorado Rivers near their confluence 6.5 km east of Yuma, Arizona. Ownership is divided between private parties and the BLM. Two sites were surveyed in this area during 2008.

Colorado Confluence (YUCC) *Elevation: 37 m, 68 ha*

Small patches of mixed exotic riparian vegetation line the main stem of the Colorado River immediately upstream of the Gila River confluence (Figure 38) creating a narrow 67.7 ha (167.2 ac) strip of potentially suitable cuckoo habitat. The sparse overstory (2% canopy cover) is 98% tamarisk with isolated Goodding's willows and Fremont cottonwoods. The overstory ranges from 4-10 m tall. Tamarisk dominates the 1-3 m high understory, which covers 30% of the site. Agricultural fields border the site opposite the river channel. This site was surveyed by kayak.

Gila Confluence (GRGC) *Elevation: 41 m, 78 ha)*

Patches of mixed exotic riparian habitat line the Gila River for 6.3 km, directly upstream of its confluence with the Colorado (Figure 39). This 78 ha (192.4 ac) site consists of a sparse tamarisk, Fremont cottonwood, and willow overstory 4 -10 m tall with 25% cover. An understory <4 m tall of tamarisk, arrowweed, willow and baccharis covers 60% of the site. The site is surrounded by extensive agricultural fields.

YUMA WEST WETLANDS PARK

Yuma County, AZ (Colorado River Drainage)

Yuma West Wetlands Park is a residential city park on the banks of the Colorado River, managed by the Yuma Department of Parks and Recreation. This area was used as a city dump as recently as 1970. Much of the park has been restored since planting began in 1999.

Yuma West Wetlands (YUWW) *Elevation: 36 m, 17 ha*

The Yuma West Wetlands survey site (Figure 40) covers 17.4 ha (43.0 ac) of restored native habitat. It is a diverse area, with a mosaic of Fremont cottonwood, Goodding's willow and mesquite. Overstory at the site ranges from 6-12 m with 30% canopy cover. Arrowweed, *Atriplex*, baccharis, mesquite, tamarisk, as well as young naturally regenerating willow and cottonwood make up a diverse understory. The Colorado River borders the northern edge of the site, and residential areas border the south, east, and west.

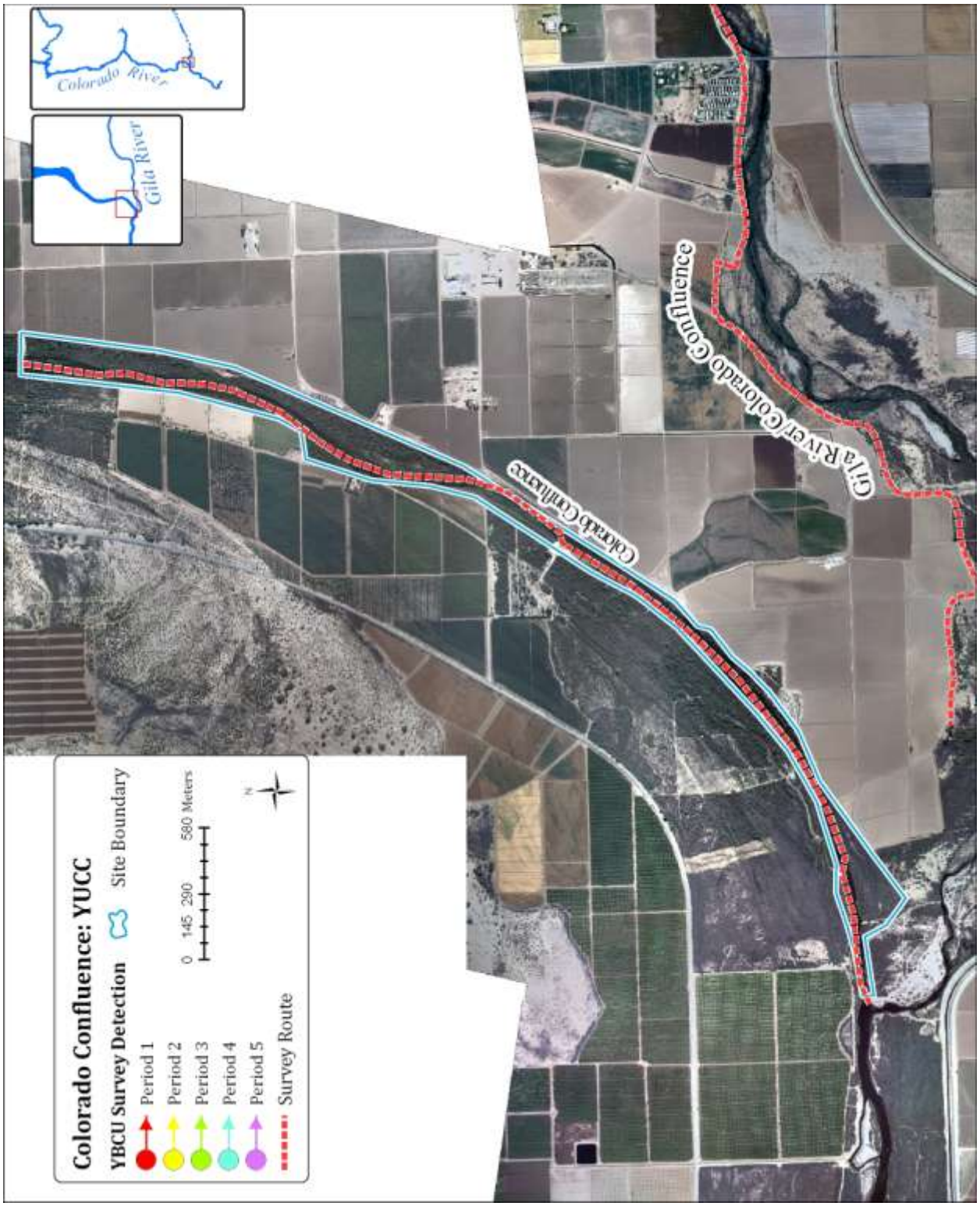

Figure 38. Map of Colorado Confluence Yellow-billed Cuckoo survey route and detections, 2008.

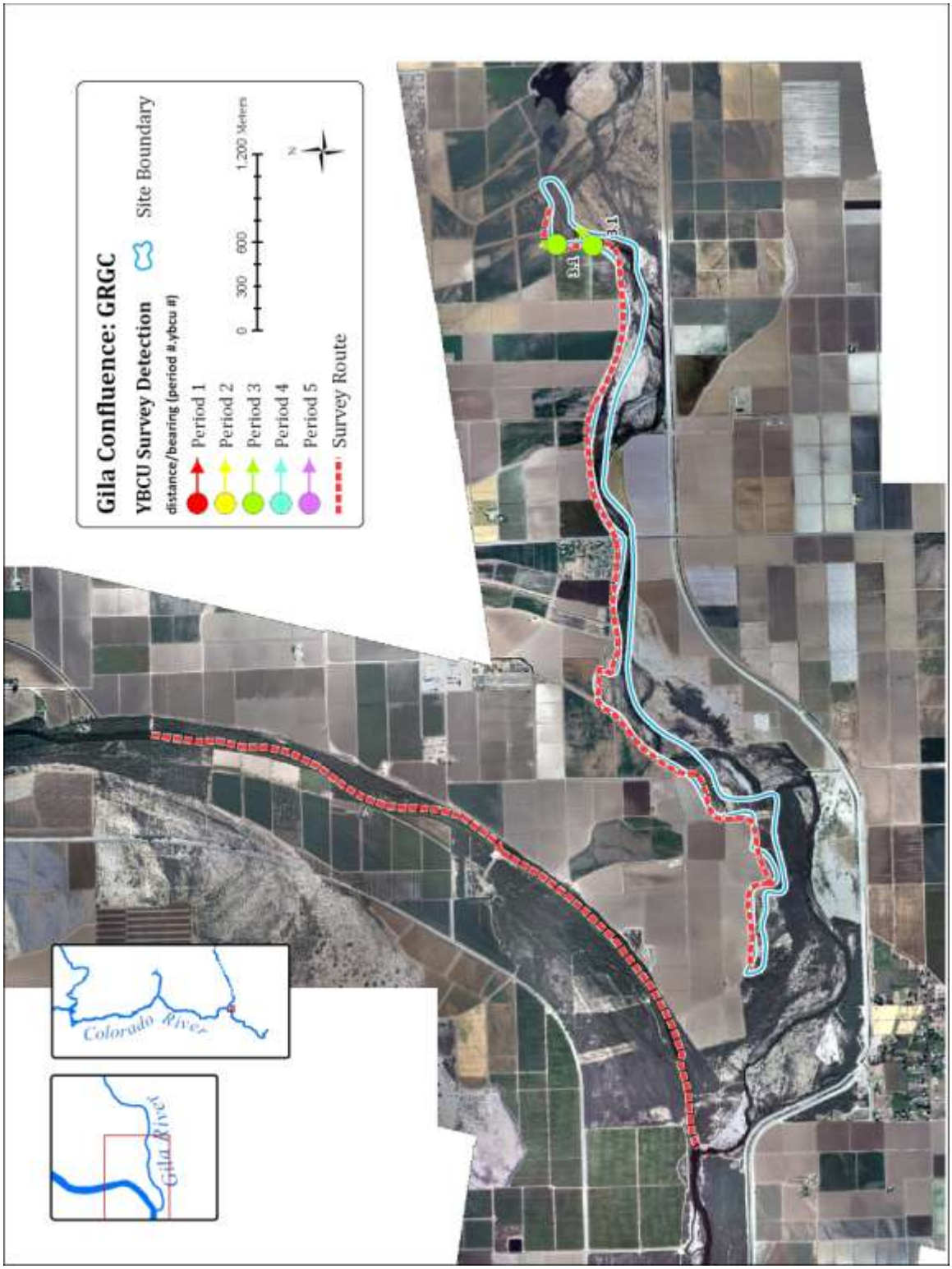

Figure 39. Map of Gila Confluence Yellow-billed Cuckoo survey route and detections, 2008.

Figure 40. Map of Yuma West Wetlands Yellow-billed Cuckoo survey route and detections, 2008.

Quigley Wildlife Management Area

Yuma County, AZ (Gila River Drainage)

Quigley WMA is 4.0 km north of Tacna, in the Gila River floodplain. This 244.8 ha (612 acre) WMA is owned and managed by AGFD for wildlife and recreation. Potentially suitable cuckoo habitat at this site includes mixed native historic floodplain and a native dominated restoration area.

Quigley WMA (GRQP) *Elevation: 75 m, 11 ha*

A native restoration plot and the adjacent mixed native habitat form the 11.2 ha (27.7 acre) Quigley Pond site. The restoration area contains a small, 1.7 ha (4.2 ac) plot of mature cottonwood, tamarisk, willow, and mesquites. This patch has an overstory ranging from 5-15 m tall that provides 30% canopy cover. Tamarisk, arrowweed, baccharis, mesquite, willow and cottonwood provide an understory 1-5 m high, with 70% canopy cover. The western mixed native section (9.3 ha, 22.9 ac) contains scattered, dead, and stressed cottonwoods and mesquites. The site is surrounded by agricultural fields on three sides and the dry Gila River floodplain to the west (Figure 41).

LIMITROPHE DIVISION

Yuma County, AZ (Colorado River Drainage)

The Limitrophe Division follows the lower Colorado River from Morelos Dam to the south, forming the international boundary between Mexico and the United States. This section contains little water as the majority of the flow is diverted into Mexico's Alamo Canal above Morelos Dam. The vegetation below the dam is dense and dominated by tamarisk. Three small patches of mixed native habitat were combined into two survey sites during the 2008 season. All sites experience heavy vehicular traffic from the US Border Patrol, whose management of this area includes burning and clearing of understory to improve visibility.

Limitrophe North (LIMNTH) *Elevation: 32 m, 60 ha*

The Limitrophe North site lies along the east bank of the Colorado River just above and below Morelos Dam (Figure 42). In 2007 the area surveyed was entirely below Morelos Dam. A fire prior to the 2008 season burned much of the southern portion of this site. The route was shifted to the north in 2008 to exclude burned areas. This 60 ha (148 acre) site of mixed exotic habitat is dominated by a 5-10 m tall overstory of Goodding's willow, Fremont cottonwood, and tamarisk, with 15% canopy cover. The understory is dominated by tamarisk, arrowweed, willow and mesquite which provide 45% cover. The site is bordered by an access road and a levee to the east, and the Colorado River to the west.

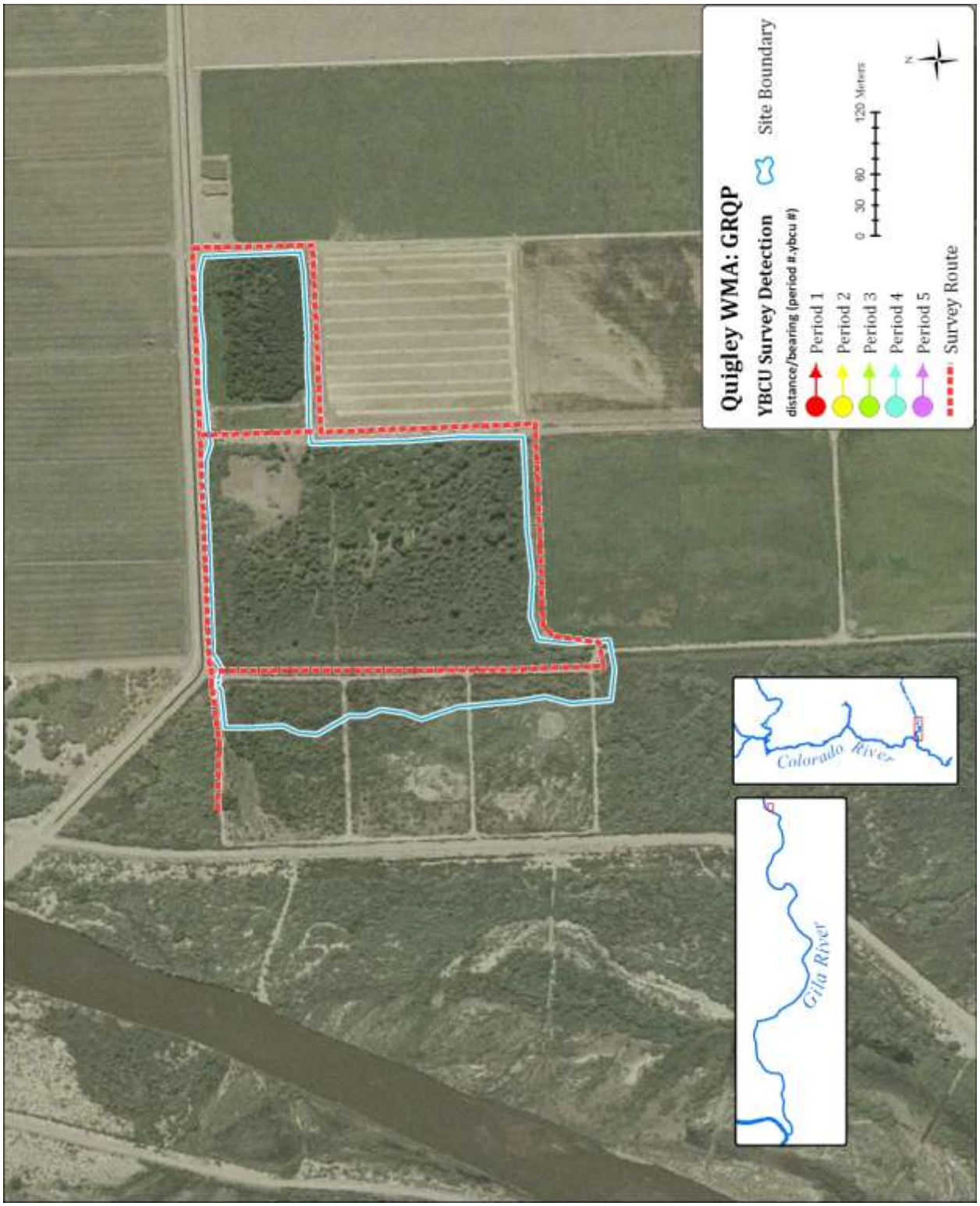

Figure 41. Map of Quigley Wildlife Management Area Yellow-billed Cuckoo survey route, 2008.

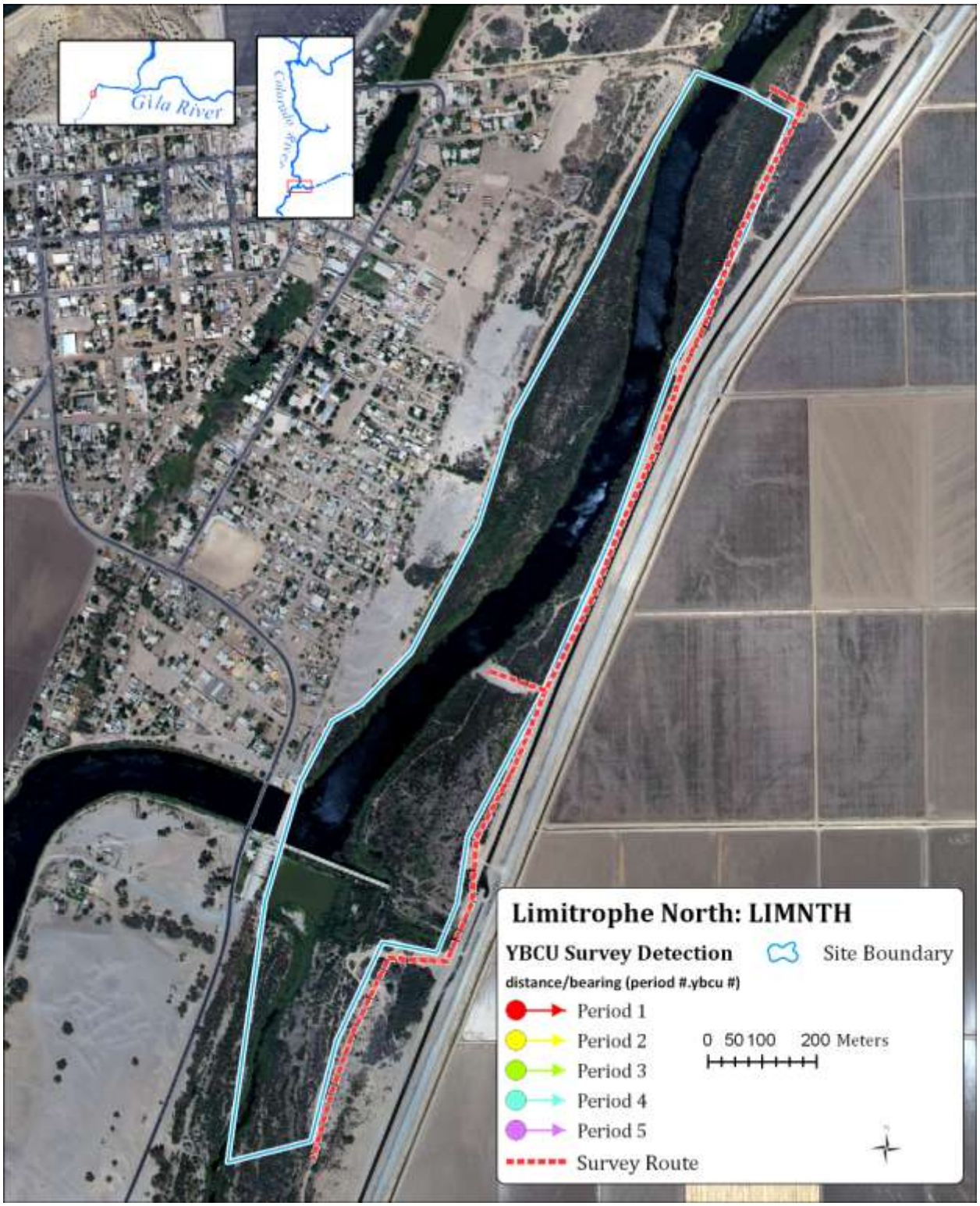

Figure 42. Map of Limitrophe North Yellow-billed Cuckoo survey route, 2008.

Limitrophe South (LIMST A/B) *Elevation: 27 m, 16 ha*

The Limitrophe South sites consists of two separate patches of habitat (A and B) (Figure 43) along the eastern edge of a large oxbow in the main channel of the Colorado River, about 16.1 km downstream of Morelos Dam. Area A is an 8.3 ha (20.6 ac), native-dominated patch with sparse cottonwoods 4-17 m tall, providing 55% overstory cover. This patch has an understory of willow, tamarisk, arrowweed, *Phragmites*, cottonwood and baccharis, providing 55% cover below 2 m high. Area B is 800 m south of A, and consists of 8 ha of willow, cottonwood, mesquite, and tamarisk in the river channel. Water was present throughout the season. The overstory varies from 3-10 m and provides 15% cover. A diverse understory of arrowweed, *Phragmites*, cattails, willow, and tamarisk provides 45% cover below 3 m high.

Both patches have actively farmed agricultural fields to the north and east, and the sparsely vegetated mixed exotic floodplain extends to the south and west. Limitrophe South surveys were shifted from the 2007 survey site after fire burned extensive sections of the site.

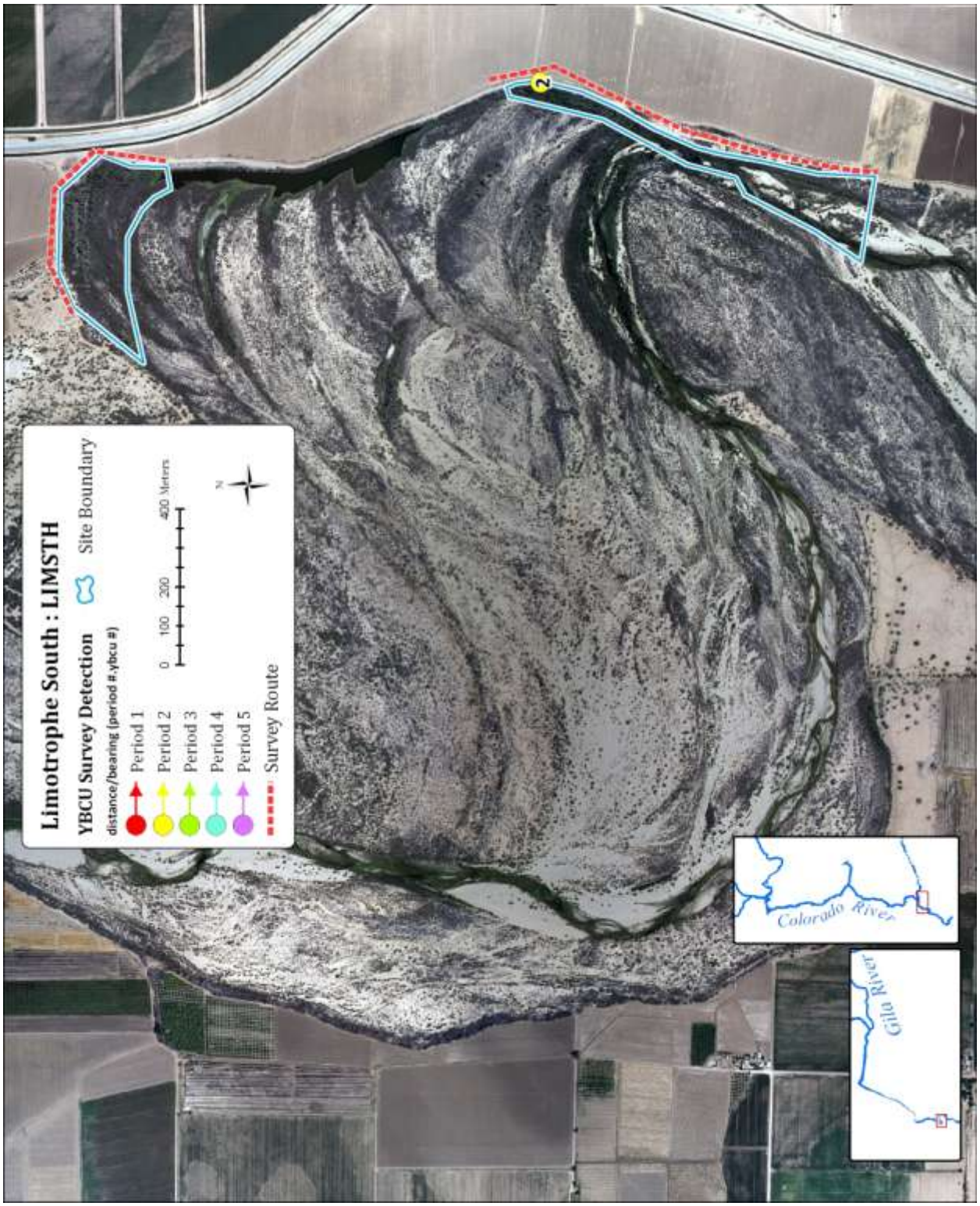

Figure 43. Map of Limitrophe South Yellow-billed Cuckoo survey route and detections, 2008.

Summary of Site Characteristics

Overall site characteristics were described early in the season during reconnaissance visits (Table 3). Overstory canopy cover averaged across all sites was 41%, while the understory cover was slightly greater, at 51%. Overstory canopy height ranged from 3-21 m and understory height ranged from 0-10 m. The dominant canopy species was Fremont cottonwood (35%), followed closely by tamarisk (31%). Goodding's willow (18%) was the only other dominant tree species. Approximately half the sites (21 of 40) were classified as native vegetation. Of these, all but three, which were on the BWR NWR, were restoration sites. Twelve of the remaining sites were mixed native vegetation, and six of these were mixed exotic. Only a single site was classified as exotic (Fox Wash was >75% tamarisk).

RESULTS

Survey Results

Yellow-billed cuckoo surveys were conducted at a total of 15 geographic areas in the Lower Colorado River MSCP study area. Dates of all surveys and follow up visits are shown in Table 4. All sites were surveyed four times, with most sites surveyed a fifth time. Two sites were only surveyed four times because they were added during the second survey period (Havasu River Highway and Kohen Cliff). Eight sites were not surveyed a fifth time for logistical reasons. Seven of the sites in this latter group had no detections on previous surveys; the eighth site had a single detection.

Table 3. Vegetation height and cover estimates from site descriptions at 2008 survey sites.

Site Code	Vegetation Classification	Overstory Height (m)	Overstory cover (%)	Understory height (m)	Understory cover %
BWBB	Mixed Native	5-20	50	0-5	65
BWCP	Native	4-8	60	1-3	20
BWCW	Native	4-18	25	1-5	65
BWFW	Exotic	3-15	15	1-4	45
BWGR	Mixed Native	4-15	30	2-4	55
BWHB	Native	4-20	60	2-6	65
BWKC	Mixed Native	4-18	50	1-5	60
BWMA	Mixed Native	4-20	60	2-5	75
BWMF	Mixed Exotic	10-18	30	2-10	60
BWMW	Mixed Native	5-20	40	0-5	60
BWNB	Mixed Exotic	8-18	70	2-8	75
BWSS	Mixed Native	5-14	70	1-4	70
BWSW	Mixed Native	5-20	35	2-6	70
CIBCNT	Native	5-14	40	0-5	50
CIBEUC	Native	3-12	10	0-3	30
CIBNTH	Native	8	60	.2	95
CIBSTH	Native	4-8	25	1-4	25
CRIT	Native	4-14	70	1-5	10
CVCA	Native	6	80	.75	90
GRGC	Mixed Exotic	4-10	25	0-4	60
GRQP	Mixed Native	5-15	30	1-5	70
HAVBR	Native	3-7	10	1-3	40
HAVND	Native	8-15	25	2-8	45
HAVPS	Native	14-16	8	1-8	40
HAVRH	Mixed Native	4-6	20	1-3	95
HAVTPR	Native	8-14	50	1-5	20
IMP20A	Native	4-14	5	1-4	10
IMPSTH	Native	5-14	60	1-5	5
LIMNTH	Mixed Exotic	5-10	10	0-5	45
LIMSTA	Native	4-17	55	0-2	55
LIMSTB	Mixed Native	3-10	15	0-3	45
MLPR	Native	5-11	70	0-5	30
OVRHP	Mixed Native	4-8	20	0-4	90
OVRW	Mixed Exotic	4-9	30	1-4	40
PAHNTH	Native	10-21	75	3-10	40
PAHSTH	Native	15	55	6-9	5
PICSRA	Native	5-17	30	0-6	50
PVER	Native	3-8	70	0-1	100
YUCC	Mixed Exotic	2-8	70	1-3	30
YUWW	Mixed Native	6-12	30	1-5	40

Table 4. Site visits during 2008 season listed alphabetically by site code.[1]

Site Code	Survey Dates	Follow-Up Dates[2]	Habitat Dates[3]	Total Visits
BWBB	6/4, 6/26, 7/17, 8/4, 8/24	7/9, 7/11, 7/24, 7/27, 7/29, 7/30, 7/31, 8/4, 8/12	7/5, 7/6, 7/9, 8/15, 8/17, 9/3, 9/8, 9/13, 9/14	23
BWCP	6/16, 6/28, 7/18, 8/6, 9/3	6/29, 7/11	7/9, 9/5	9
BWCW	6/15, 6/28, 7/15, 8/3, 9/2	6/29, 7/15, 7/18, 8/6	7/9, 7/11, 9/5	12
BWFW	6/6, 6/25, 7/18, 8/4, 9/1	7/4	7/7, 7/8, 8/24, 9/7, 9/9	11
BWGR	6/4, 6/23, 7/16, 8/1, 8/26	7/5, 7/14, 7/12, 7/30, 8/5	7/3, 7/5, 8/15, 8/16, 8/21, 9/8	16
BWHB	6/15, 6/28, 7/18, 8/3, 9/3	7/9, 7/18, 7/22, 7/24, 7/27, 7/28, 7/31, 8/3, 8/6, 8/22	7/6, 7/9, 8/25, 8/28, 9/6, 9/14	21
BWKC	6/27, 7/29, 7/30, 8/14, 9/1	7/1, 7/2, 7/22, 7/29	7/8, 9/4, 9/8	12
BWMA	6/17, 7/1, 7/22, 8/10, 9/1			5
BWMF	6/8, 6/24, 7/12, 8/6, 8/26	7/5, 7/13, 7/22, 8/6, 8/11, 8/20	7/3, 7/5, 8/15, 8/20, 8/27, 9/9, 9/19	18
BWMW	6/9, 6/30, 7/17, 8/7, 9/11	7/4, 7/14, 7/27, 8/7	7/4, 7/6, 8/19, 9/13, 9/14	14
BWNB	7/1, 7/23, 8/10, 8/27		7/9, 8/27, 9/2	7
BWSS	6/11, 6/24, 7/13, 8/8, 8/29	8/20, 8/29	7/8, 8/15, 8/20, 8/27, 9/8, 9/9	13
BWSW	6/6, 6/23, 7/15, 8/2, 8/26	7/3, 7/5, 7/7, 7/9, 7/10, 7/12, 7/13, 7/15, 7/23	7/3, 8/16, 8/27, 9/7, 9/19	19
CIBCNT	6/10, 6/25, 7/16, 8/7, 8/29		7/16, 8/18	7
CIBEUC	6/11, 6/25, 7/16, 8/7, 9/10		7/21, 8/18	7
CIBNTH	6/11, 6/25, 7/16, 8/7, 9/10		7/21, 8/15, 8/18, 8/29	9
CIBSTH	6/10, 6/24, 7/15, 8/7, 8/29	8/11	8/20	7
CRIT	6/15, 7/1, 7/22, 8/14, 9/10	7/1, 7/4, 7/14	7/4, 9/10, 9/15	11
CVCA	6/11, 6/24, 7/15, 8/6, 8/29	7/15-16, 7/20-21, 7/24, 7/29, 8/6, 8/8, 8/11	7/17, 8/8, 8/15-8/17, 8/19, 8/20	21
GRGC	6/8, 6/29, 7/20, 8/11, 9/8	7/21	8/8	7
GRQP	6/9, 6/27, 7/18, 8/9, 9/10		7/18, 9/10	7
HAVBR	6/10, 6/29, 7/19, 8/9, 9/4	6/19, 6/26	7/19, 9/17	9
HAVND	6/11, 6/30, 7/19, 8/9, 9/4	7/25-26	8/16	8
HAVPS	6/11, 6/30, 7/19, 8/9, 9/4	7/25-26	8/16	8
HAVRH	6/29, 7/19, 8/9, 9/4	7/25-26	8/17	7
HAVTPR	6/10, 6/29, 7/19, 8/9, 9/4	7/25-26	7/19, 9/17	9
IMP20A	6/5, 6/27, 7/17, 8/8, 9/4	7/16	8/4	7
IMPSTH	6/5, 6/27, 7/17, 8/8, 9/4	7/16	8/4	7
LIMNTH	6/6, 6/30, 7/21, 8/12		9/11, 9/12	6
LIMSTA	6/6, 6/30, 7/21, 8/12		8/11	5
LIMSTB	6/6, 6/30, 7/21, 8/12		8/11	5
MLPR	6/7, 6/29, 7/19, 8/10, 9/1	7/20	7/19, 9/1	8
OVRHP	6/7, 6/25, 7/16, 8/7		8/3	5
OVRW	6/7, 6/25, 7/16, 8/7			4
PAHNTH	6/8, 6/26, 7/17, 8/8			4
PAHSTH	6/8, 6/26, 7/17, 8/8			4
PICSRA	6/5, 6/26, 7/18, 8/9, 9/3		8/3	6
PVER	6/9, 6/26, 7/17, 8/6, 8/28	6/28, 7/24	8/21, 8/28	9
YUCC	6/8, 6/28, 7/21, 8/11	8/11	8/9	6
YUWW	6/7, 6/28, 7/19, 8/10, 9/2	7/20, 8/12	8/2	8

[1]A second entry for the same date is given when two or more teams were at the site on a given day.
[2]Follow-up dates include nest searching/monitoring and banding efforts.
[3]Habitat dates include all vegetation sampling, insect, soil moisture and microclimate data collection.

A total of 185 surveys were conducted on 40 survey routes. During surveys Yellow-billed Cuckoos were detected on 156 occasions. Summaries of detections per survey period are shown by geographic area (Table 5). Figure 44 shows a map of total survey detections within the study area. Summaries for all northern sites from Pahranagat to BWR NWR are given in Table 6; southern sites from Ahakhav to Yuma are in Table 7. The majority of detections (75%) were on the Bill Williams River NWR, most of these on the eastern section of the Refuge. The only other site with a relatively high number of detections was Cibola Valley Conservation Area.

Table 5. Yellow-billed Cuckoo survey detections and breeding classification on the lower Colorado River by region and period, 2008.

	Survey Period						Breeding Status*		
Region	1	2	3	4	5	Total	POB	PRB	COB
Bill Williams River NWR	4	34	40	28	11	117	22	7	5
North of Bill Williams River	0	4	4	0	0	8	2	0	0
Sites near Blythe/Cibola	0	7	4	4	4	19	3	0	2
South Sites – Yuma area	0	7	4	1	0	12	2	0	0
Total	4	52	52	33	15	156	29	7	7

* POB=possible breeding, PRB=probable breeding, COB=confirmed breeding (defined in Follow-up and Breeding Status section, Page 7).

Survey Method Test

Using the double-observer survey method a total of 38 cuckoos were detected; 32 by surveyor one and 22 by surveyor two. The probability of surveyor one detecting cuckoos present during the survey was estimated as 71%. The probability of surveyor two detecting cuckoos present during the survey was estimated as 47%. With two surveyors covering the same route on the same day, one hour apart, the overall probability of detecting cuckoos present at the time of the survey was 85%. Probability of detection estimated by PRESENCE (Hines 2006) at the BWR NWR during the same time periods, 3 and 4, were 66% and 59% respectively.

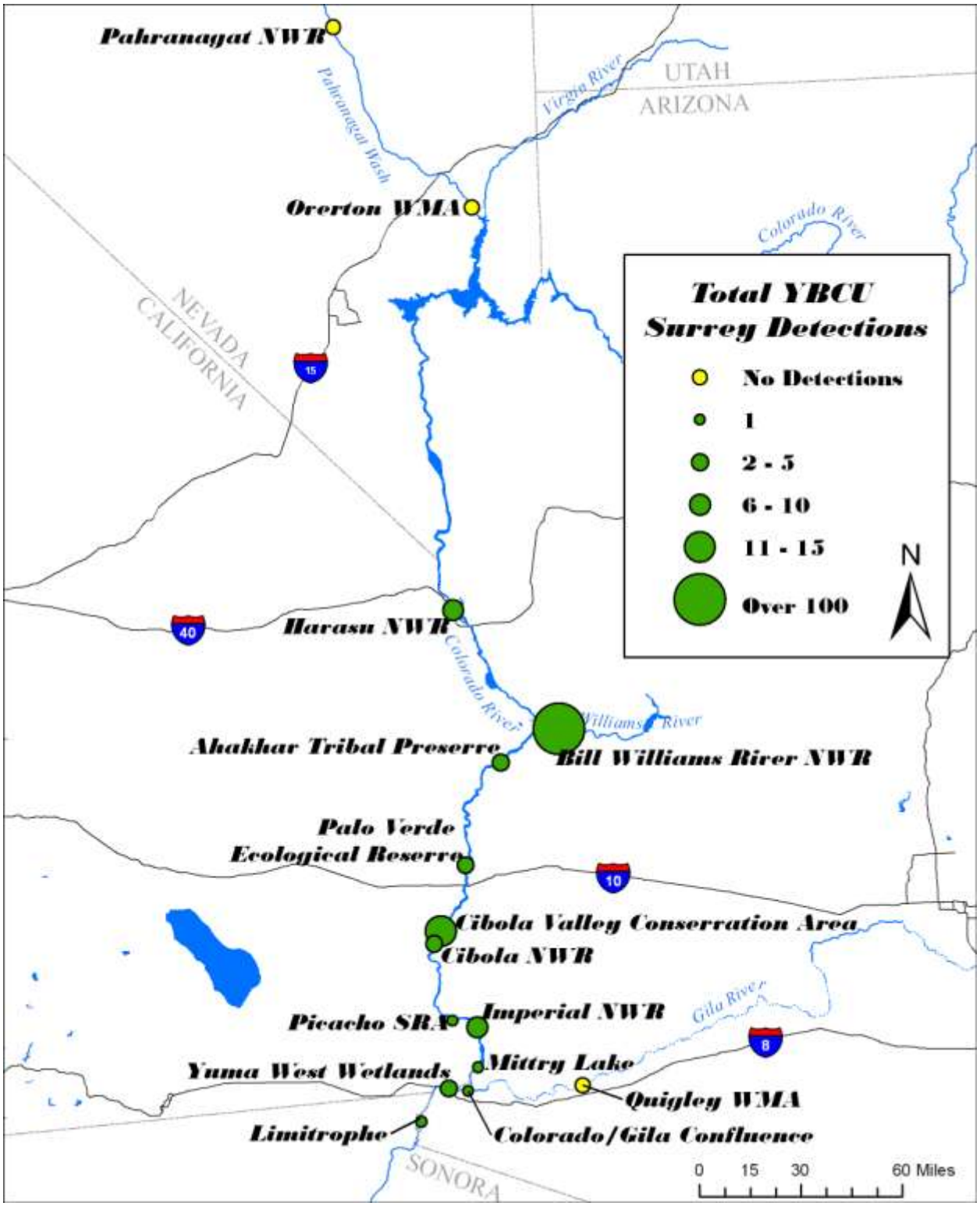

Figure 44. Map of YBCU detections in the lower Colorado River region, 2008 field season.

Table 6. 2008 Cuckoo detections, breeding status, and nearest occupied, for sites from Pahranagat to BWR NWR.

Sites Name	Survey Period and Dates (month/day)					Total Det.	Breeding Status*	Dist (km) to nearest occ.[1]	Reported Detections
	1	2	3	4	5				
Sites North of Bill Williams River NWR									
Pahranagat North	0 (6/8)	0 (6/26)	0 (7/17)	0 (8/8)	NA	0	NB	76[3]	1 (6/13)[4]
Pahranagat South	0 (6/9)	0 (6/26)	0 (7/17)	0 (8/8)	NA	0	NB	72[3]	
Honeybee Pond	0 (6/7)	0 (6/25)	0 (7/16)	0 (8/7)	NA	0	NB	32.8[3]	
Overton Wildlife	0 (6/7)	0 (6/25)	0 (7/16)	0 (8/7)	NA	0	NB	34.5[3]	
Pintail Slough	0 (6/11)	0 (6/30)	0 (7/19)	0 (8/9)	0 (9/4)	0	NB	0.35 (HAVND)	
North Dike	0 (6/11)	1 (6/30)	2 (7/19)	0 (8/9)	0 (9/4)	3	POB (1)	65 (BWNB)	
Havasu River Highway	NA	1 (6/29)	0 (7/19)	0 (8/9)	0 (9/4)	1	NB	6.2 (HAVND	
Topock Platform	0 (6/10)	0 (6/29)	2 (7/19)	0 (8/9)	0 (9/4)	2	NB	6.7 (HAVND)	
Beal Restoration	0 (6/10)	2 (6/29)	0 (7/19)	0 (8/9)	0 (9/4)	2	POB (1)	6.8 (HAVND)	2 (6/19, 6/26)[5]
TOTAL	**0**	**4**	**4**	**0**	**0**	**8**	**POB (2)**		
Sites at Bill Williams River NWR									
Cave Wash	1 (6/15)	3 (6/29)	6 (7/15)	4 (8/3)	2 (9/2)	16	POB (6)	0 (BWHB)	
Cottonwood Patch	2 (6/16)	4 (6/28)	0 (7/18)	0 (8/6)	0 (9/3)	6	POB (1)	0 (BWCW)	
Honeycomb Bend	1 (6/15)	3 (6/28)	8 (7/18)	3 (8/3)	1 (9/3)	16	POB (1), PRB (2), COB (2)	0 (BWCW)	
Mineral Wash	0 (6/9)	6 (6/30)	3 (7/17)	3 (8/7)	0 (9/11)	12	POB (1), PRB (2)	0 (BWHB)	
Big Bend	0 (6/4)	6 (6/26)	4 (7/17)	6 (8/4)	2 (8/24)	18	PRB (2), COB (2)	0 (BWMW)	
Kohen Cliff	NA	4 (6/27)	2 (7/29)	1 (8/14)	0 (9/1)	7	POB (1)	0 (BWBB)	
Gibraltar Rock	0 (6/4)	1 (6/23)	4 (7/16)	1 (8/1)	2 (8/26)	8	POB (2)	0 (BWKC)	
Sandy Wash	0 (6/6)	0 (6/23)	2 (7/15)	1 (8/2)	1 (8/26)	4	POB (2), COB (1)	0 (BWGR)	
Fox Wash	0 (6/6)	1 (6/25)	2 (7/18)	1 (8/4)	0 (9/1)	4	POB (2)	0 (BWSW)	
Mosquito Flats	0 (6/8)	0 (6/24)	5 (7/12)	4 (8/6)	1 (8/26)	10	POB (1), PRB (1)	0 (BWSW)	
North Burn	NA	3 (7/1)	1 (7/23)	0 (8/10)	0 (8/27)	4	POB (1)	0 (BWFW)	
Saguaro Slot[2]	0 (6/11)	0 (6/24)	2 (7/13)	1 (8/8)	2 (8/29)	5	POB (2)	0 (BWMF)	
Bill Williams Marsh[2]	0 (6/17)	3 (7/1)	1 (7/22)	3 (9/1)	0 (9/1)	7	POB (2)	0 (BWSS)	
TOTAL	**4**	**34**	**40**	**28**	**11**	**117**	**POB (22), PRB (7), COB (5)**		

*Breeding status criteria are defined in the *Follow-up Visits and Breeding Status* section, Page 7. Codes used include: NB=Non-breeding, COB=Confirmed breeding, PRB=Probable breeding, POB=Possible breeding. The number in parentheses is the number of birds for each status.

[1] Nearest known occupied site codes are given in parentheses.

[2] During the fourth survey period, two detections from BWSS (shown on Figure 24) were counted as BWMA detections based on estimated distance/bearing from observer to birds.

[3] The nearest known occupied site during the 2008 breeding season was Warm Springs Natural Area, NV (NDOW 2009).

[4] Detection reported by Tom Koronkiewicz, SWCA (pers. comm.).

[5] Detection reported by Joe Kahl (Wildlife Group, LCR Office of Reclamation).

Table 7. 2008 Cuckoo detections, breeding status, and nearest occupied, for sites from Ahakhav Tribal Preserve to the Limitrophe Division.

Sites Name	Survey Period and Dates (month/day)					Total Det.	Breeding Status*	Dist (km) to nearest occ.[1]	Reported Detections
	1	2	3	4	5				
Sites Near Blythe/Cibola Valley									
Ahakhav CRIT	0 (6/15)	4 (7/1)	1 (7/22)	0 (8/14)	0 (9/10)	5	POB (1)	29 (BWSS)	1 (6/23)[2]
Palo Verde Ecological	0 (6/9)	1 (6/26)	1 (7/17)	0 (8/6)	0 (8/28)	2	POB (1)	33 (CVCA)	
Cibola Valley	0 (6/11)	4 (6/24)	2 (7/15)	4 (8/6)	4 (8/29)	14	COB (2)	14 (CIBSTH)	
Cibola North Plantation	0 (6/11)	0 (6/25)	0 (7/16)	0 (8/7)	0 (9/10)	0	NB	3.7 (CVCA)	
Cibola Nature Trail	0 (6/10)	1 (6/25)	0 (7/16)	0 (8/7)	0 (8/29)	1	NB	4.5 (CVCA)	
Cibola Eucalyptus	0 (6/11)	0 (6/25)	0 (7/16)	0 (8/7)	0 (9/10)	0	NB	2.4 (CVCA)	
Cibola South Restoration	0 (6/10)	1 (6/25)	1 (7/15)	1 (8/7)	0 (8/29)	3	POB (1)	14 (CVCA)	
TOTAL	**0**	**11**	**5**	**5**	**4**	**25**	**COB (2), POB (3)**		
Sites Near Yuma									
Picacho SRA	0 (6/5)	0 (6/26)	1 (7/18)	0 (8/9)	0 (9/3)	1	NB	11 (IMPSTH)	
Imperial 20A	0 (6/5)	3 (6/27)	0 (7/17)	0 (8/8)	0 (9/4)	3	NB	1.3 (IMPSTH)	
Imperial South	0 (6/5)	2 (6/27)	1 (7/17)	0 (8/8)	0 (9/4)	3	POB (1)	33.8 (YUWW)	
Mitry Lake/ Pratt	0 (6/7)	0 (6/29)	1 (7/19)	0 (8/10)	0 (9/1)	1	NB	17.7 (YUWW)	
Quigley WMA	0 (6/9)	0 (6/27)	0 (7/18)	0 (8/9)	0 (9/10)	0	NB	64 (YUWW)	
Yuma/Colorado Conf.	0 (6/8)	0 (6/28)	0 (7/21)	0 (8/11)	NA	0	NB	6.8 (YUWW)	
Gila/Colorado Conf.	0 (6/8)	0 (6/29)	1 (7/20)	0 (8/11)	0 (9/8)	1	NB	6.8 (YUWW)	
Yuma West Wetlands	0 (6/07)	1 (6/28)	1 (7/19)	1 (8/10)	0 (9/2)	3	POB (1)	32 (IMPSTH)	
Limitrophe North	0 (6/6)	0 (6/30)	0 (7/21)	0 (8/12)	NA	0	NB	8.9 (YUWW)	
Limitrophe South	0 (6/6)	1 (6/30)	0 (7/21)	0 (8/12)	NA	1	NB	24 (YUWW)	
TOTAL	**0**	**7**	**5**	**1**	**0**	**13**	**POB (2)**		

*Breeding status criteria are defined in the *Follow-up Visits and Breeding Status* section, Page 7. Codes used include: NB=Non-breeding, COB=Confirmed breeding, PRB=Probable breeding, POB=Possible breeding. The number in parenthesis is the number of birds for each status.

[1]Nearest known occupied site codes are given in parentheses.

[2]Detection reported by Stephanie Hines, Ahakhav Tribal Preserve (personal communication).

[3]2008 was the first year of Yellow-billed Cuckoo surveys at this site.

BREEDING EVIDENCE

Based on all detections, their timing, location and persistence, 43 potential breeding areas were estimated to occur within the survey sites, including 29 possible, 7 probable, and 7 confirmed breeding pairs. Approximately thirty calendar days were spent nest searching on the Bill Williams River NWR, and 30 days nest searching at all other sites. North Dike, Ahakhav Tribal Preserve, Palo Verde Restoration, Cibola South Restoration, Imperial South Restoration, and Yuma West Wetlands all had one possible breeding pair, and two confirmed breeding pairs were at CVCA.

Thirty four potential breeding areas were found across all BWR NWR sites, including 22 possible, 7 probable and 5 confirmed. During follow-up visits, one or more, food carry, copulation, or stick carry was observed at three sites: Honeycomb Bend, Big Bend, and Sandy Wash. Juveniles were seen or heard at two of the sites, Honeycomb Bend (July 24th) and Sandy Wash (July 13th). At Honeycomb Bend, three nests were found, all less than 20 m from the river.

Although no breeding activity was observed at Ahakhav Tribal Preserve, birds were detected there from June 23rd to July 22nd. Similarly, cuckoos were detected during more than one survey period at North Dike, Palo Verde, Cibola South, Imperial South, and Yuma West Wetlands.

NESTS

Five nests were found at two locations during the 2008 breeding season (Table 8); three nests at the BWR NWR, and two at CVCA. All BWR NWR nests, and one of the two found at CVCA were successful.

Table 8. Yellow-billed Cuckoo nests found on the lower Colorado River, 2008 field season.

Nest	Location	# eggs	# fledg.	Date Found	Nestlings banded	Nest Tree Species	Tree Height (m)	Nest Height (m)	Tree DBH (cm)
CVCA-01-2008	CVCA	3	3	7/15/2008	3 (7/21/08)	Freemont cottonwood	10.5	2.7	10
CVCA-02-2008	CVCA	2	0	8/6/2008	0	Freemont cottonwood	9.3	2.7	8
BWHB-01-2008	Honeycomb Bend	2	2	7/22/2008	0	Goodding's willow	8	5.3	8.9
BWHB-02-2008	Honeycomb Bend	3	2	7/28/2008	2 (8/6/08)	Tamarisk	6.7	4.0	11.8
BWHB-03-2008	Honeycomb Bend	Unk.	2	7/24/2008	0	Goodding's willow	10	3.6	15

Mean nest height for the five nests was 3.6 m, mean nest tree height was 8.9 m, and average nest tree DBH was 10.8 cm. Average cover directly above the nest was 94%, and 36% under the nest. Although side cover immediately next to nests was variable, it was relatively dense in three cardinal directions (67%) and sparse in a fourth direction (23%).

Canopy cover throughout all nest plots averaged 80% in all directions from the nest, while ground cover averaged 25%. Soil moisture at nest plots varied from 3.6% to 26%.

Bill Williams River NWR

The three nests found at Bill Williams River NWR were on Honeycomb Bend survey route. Nest BWHB-01 was found with two eggs on July 22nd, towards the western end of the route. The nest was located in a Goodding's willow and successfully fledged two young. No young were banded from this nest. Two other nests were found at the eastern end of the route (BWHB-02 and BWHB-03). These nests were 75 m and three weeks apart, and may have been from one pair.

On July 24th, at least two adult cuckoos were observed flying multiple times into a dense tamarisk near a suspected cuckoo nest (BWHB-03). The same day, two juvenile vocalizations were heard in a tamarisk within 10 m of the suspected nest. Although BWHB-03 was found before BWHB-02, it was not confirmed until August 6th, when blue egg fragments were found in the nest.

BWHB-02 was found with three eggs on July 28th. This nest was located in a tamarisk, under the canopy of a Goodding's willow and a mature Fremont cottonwood. Two nestlings were banded on August 6th; no evidence was found of the third egg/nestling.

Cibola Valley Conservation Area

Two nests (CVCA-01, CVCA-02) were found in the southwestern corner of the site. In addition, a juvenile from a second pair was observed in the northeast corner of this site.

Information about the first nest (CVCA-01, cover photo) is as follows: A bird responded from the western boundary on the second survey. During the third survey on July 15th, a cuckoo responded from the same area. One surveyor then began a systematic search of the area, while the other continued the survey. A nest containing 3 eggs was found, approximately 3 m high in an 8.5 m tall cottonwood, abutting an irrigation berm. Although the tree was exposed to the east, the nest was well-hidden in a thick clump of leaves. Three nestlings, aged 3, 4, and 5 days old, were banded on July 21st, and blood samples were taken. One adult was heard within 100 m of the nest after the three nestlings had fledged, indicating that the birds were still present in the area.

Cuckoos were again detected during the fourth survey on August 6th in the vicinity of the first nest, and a systematic search of the area was undertaken. The second nest (CVCA-02) was found approximately 27 m from the first nest, with an adult quietly sitting. The bird flushed off the nest and two eggs were observed. This nest was initiated approximately two weeks after the first nest fledged. Two days after discovery, the nest was checked with a mirror pole; at that time one of the eggs appeared to have an unidentified black spot on it, possibly an insect, debris, or a hole in the shell. During this visit no adult was observed attending the nest. The adults' absence seemed unusual, since cuckoos begin incubation as soon as the first egg is laid, and typically leave the nest unattended only during the brief time required for a nest exchange. The nest was rechecked at dusk the same day and an adult was observed sitting on the nest. Three days later when the nest was checked, no adult was present, egg fragments were found on the

ground under the nest, and a single intact egg was in the nest. This indicates that an egg possibly hatched prior to the nest being abandoned. Evidence of predation, including dove feathers on the ground nearby, and observations of an *Accipiter* in the area indicate this may have been the cause of nest failure. The nest was rechecked several times later that day, and over the next two days. No adults were seen or heard in the area again.

A second pair of birds occupied the eastern portion of this site. They may have nested in the northeast corner, where an adult cuckoo was observed carrying food on August 9th. A juvenile was observed in the same area on August 13th. Target netting was attempted due to the increased cuckoo activity in the area, but was not successful.

Target Mist netting

Nine days were spent mist netting between Havasu Topock Platform, Kohen Cliff, Gibraltar Rock, Sandy Wash, Ahakhav Tribal Preserve, and CVCA. One or more net placement was made at or near a center of cuckoo activity. A single cuckoo flew into the net at CVCA but was not captured.

Vegetation

Vegetation characteristics were measured at 140 plots across 40 sites. Plots were classified as nest plots, occupied, or unoccupied plots. The mean canopy cover measures and height for five potential strata, along with the number of trees and shrubs for all plots, are presented in Table 9. Mean canopy height and cover by occupancy status at restoration and non-restoration sites are also presented in Figure 45. Nest plots tended to have greater total canopy cover (81% versus 64.5%, $p=0.0684$) than other plots, though no significant differences were found between plot types.

Table 9. Vegetation canopy cover, height, and number of trees by size class.

	Vegetation Plots (n=140)									
	Nest (n=5)		Occupied (n=42)		Unoccupied (n=98)		Restoration (n=62)		Non-Restoration (n=78)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Total Canopy Cover %	83	66-95	68	5-95	65	0-97	62	0-97	69	0-97
Total Canopy Height (m)	7.4	5-9.5	6.7	0-14	7.4	0-23	8.4	0-22	6.2	0-21
High Canopy Cover %	43	0-90	27	0-90	31	0-95	40	0-95	22	0-82
High Canopy Height (m)	8.3	6-11	8.7	0-23	8.6	0-25	9.2	0-22	8.2	0-23
Main Canopy Cover %	47	0-90	45	0-98	48	0-96	49	0-98	45	0-96
Main Canopy Height (m)	5.2	0-9	5.9	0-14	6.4	0-21	7.0	0-19	5.6	0-21
Sub Canopy Cover %	8	0-41	3	0-41	5	0-45	5	0-45	4	0-41
Sub Canopy Height (m)	2.0	0-6	1	0-11	1.2	0-8	1.4	0-8	1.0	0-11
Shrub/Sapling Cover %	14	0-50	13	0-65	13	0-78	10	0-72	15	0-79
Shrub Sapling Height (m)	1	0-2.5	1	0-5	1.2	0-4	1.0	0-4	1.4	0-5
# Large Trees in 11.3 m	1	0-3	2	0-15	2	0-23	2	0-11	2	0-15
# Small Trees in 5 m	27	17-38	48	0-528	44	0-623	40	0-520	51	0-623
# Shrubs/Sapling in 5 m	25	0-85	51	0-520	152	0-1547	6.4	0-80	135	0-1547

Canopy cover and heights represent the mean across all plots, including plots in which the canopy layer was absent (0). Sub canopy and shrub/sapling layers were frequently absent from the plots.

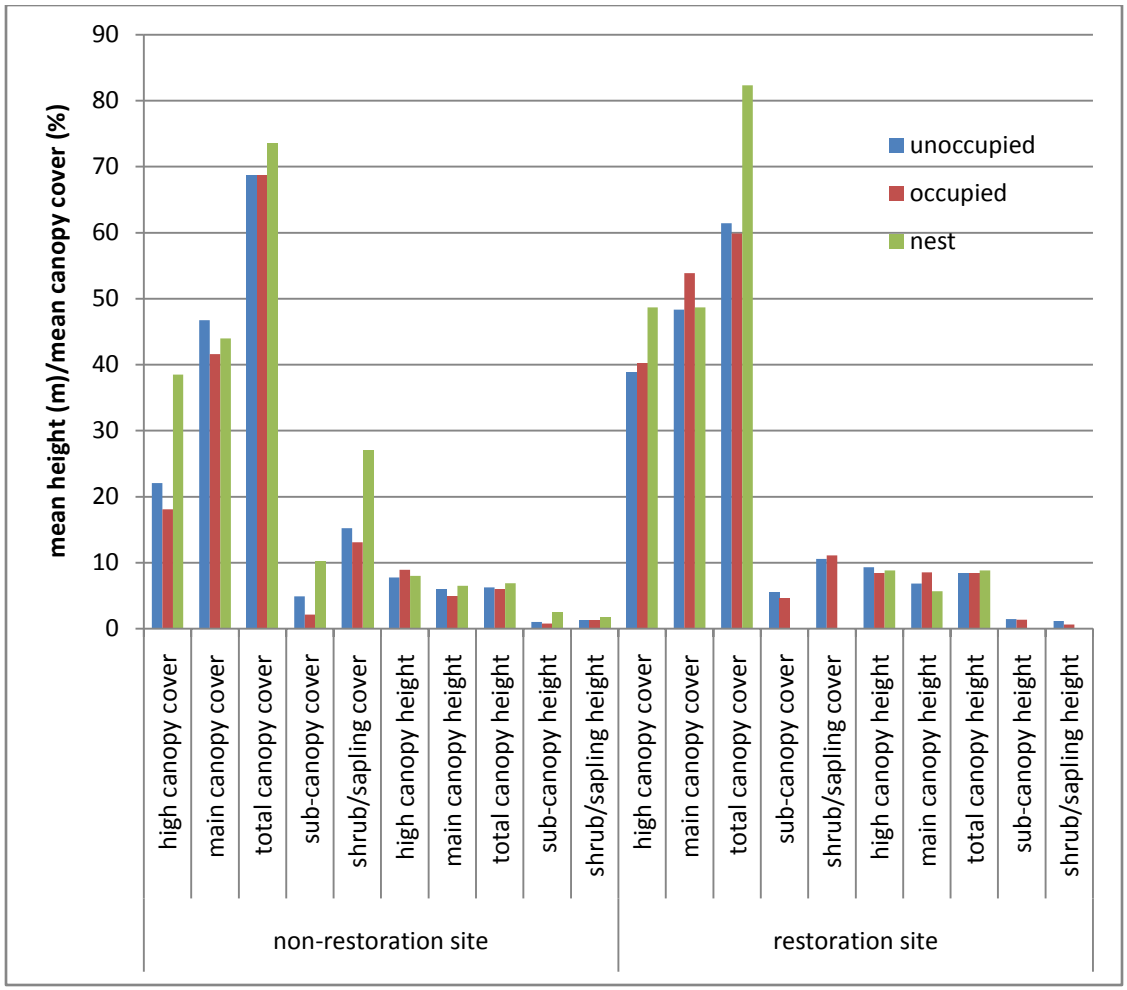

Figure 45. Mean canopy height (m) and cover (%), for nest sites, occupied sites, and unoccupied sites, grouped by restoration status.

While canopy measures (cover, height) were not found to be correlated with occupancy status, microclimate was significantly correlated to several canopy variables, shown in Table 10. A generalized linear model predicting mean diurnal temperature at plots, based on the 2008 vegetation data, explained 51% of the variation ($p<0.0001$): *mean diurnal temperature = 97.326 – 0.0664×main canopy cover + 0.1166×grass cover +0.045×bare ground cover – 0.064×green cover -0.008×site width - 0.012×contiguous patch size +0.0923×patch size.*

Table 10. Significant results of correlation matrix, microclimate by canopy.

Microclimate var.		Total canopy cover	Total canopy height	High canopy cover	High canopy height	Main canopy cover	Sub canopy cover	Mid canopy height
Min day temp	r^2	0.1	0.24	0.25	0.14		0.08	0.18
	p	0.0074	<0.0001	<0.0001	0.0013		0.0183	0.0002
Mean day temp	r^2	0.13				0.2		
	p	0.0019				0.0001		
Max day temp	r^2	-0.13				-0.09		
	p	0.0023				0.0106		
Min night temp	r^2	0.12	0.2	0.22	0.13			0.17
	p	0.0032	<0.0001	<0.0001	0.0018			0.0003
Mean night temp	r^2				0.06			
	p				0.0351			
Max night Temp	r^2	-0.07						
	p	0.0282						
Min day RH	r^2	0.08						
	P	0.0176						
Mean day RH	r^2	0.07				0.11		
	P	0.0196				0.0046		
Max day RH	r^2		-0.28	-0.03	-0.11			-0.07
	P		<0.0001	0.0017	0.0039			0.0282
Min night RH	r^2	0.06						
	P	0.0454						
Max night RH	r^2		-0.23	-0.11	-0.1	-0.08		
	P		<0.0001	0.0017	0.0055	0.0201		

Comparison of 2008 Vegetation with 2004 LCR Vegetation Type Map

The correct classification matrix between dominant vegetation in 2008 and 2004 is given in Table 11. Twenty seven percent (39/142) of the plots were correctly classified by the 2004-based data, including 66% (20/30) of tamarisk and 19% (19/100) of cottonwood/willow plots. None of the 2008 honey or screwbean mesquite plots were correctly classified. Thirty four of the 2008 CW plots had been classified as Agricultural, revealing the previous state of restoration sites; discounting these plots increased the correct classification rate to 36% (29% of CW plots). Forty one percent (27/66) of the remaining misclassified CW plots occurred on the Bill Williams River, and many of these

were likely affected by the 2005 flood. An updated classification layer based on new imagery should improve these results and enable further analyses.

Table 11. Correct classification matrix of 2004 and 2008 dominant vegetation at 2008 plots.

		2004 Classification (dominant vegetation)									
		AG – Agriculture	**AW - Arrow weed**	**BW – Back Water**	**CW I- VI – Cottonwood/willow**	**HM I-VI – Honey mesquite**	**NC – Not Classified**	**SC I- VI - Tamarisk**	**SM I- VI – Screwbean mesquite**	**UD - Undefined**	**Total**
2008 Classification	**CW I-VI - Cottonwood/willow**	34	2	1	19	3	4	34	3		100
	HM I- VI – Honey mesquite	2						4			6
	NC – Not Classified							1			1
	SC I- VI – Tamarisk	1	1		7			20		1	30
	SM I- VI – Screwbean mesquite	3				1	1				5
	Total	40	3	1	26	4	5	59	3	1	142

MICROCLIMATE

Temperature and Humidity

Microclimate data was recorded at 72 plots, including 4 nests, 27 occupied and 41 unoccupied plots. Average diurnal and nocturnal temperatures and relative humidity are given in Table 12. Average diurnal temperature was 12° F warmer than nocturnal temperature, and diurnal RH was 15% greater than nocturnal RH. The highest and lowest diurnal temperatures were both on the Bill Williams River NWR. The highest mean diurnal temperature was on the Cottonwood Patch route (100° F), and the lowest diurnal high temperature was on the Saguaro Slot route (84° F). Cibola Valley Conservation Area recorded the lowest mean diurnal temperature (87 ^{o} F) and highest mean diurnal relative humidity (70%).

Table 12. Cuckoo detections, diurnal and nocturnal average temperatures, and diurnal and nocturnal average relative humidity at survey sites, 2008.

Site Name	Cuckoo Detections	Average Temperature (F)		Average Relative Humidity	
		Day	Night	Day	Night
Beal Restoration	6	95.49	78.05	43.92	64.85
Topock Platform Restoration	2	96.81	79.60	32.66	53.07
Cottonwood Patch	3	100.04	84.27	33.85	50.07
Cave Wash	10	98.01	81.30	37.31	56.86
Honeycomb Bend	28	91.33	80.67	49.39	60.52
Mineral Wash	11	90.60	81.32	48.34	56.60
Big Bend	14	93.26	80.40	46.09	59.42
Kohen Cliff	5	97.56	81.12	38.72	58.34
Gibraltar Rock	4	97.76	85.96	34.69	45.80
Fox Wash	4	92.76	76.94	50.31	73.79
Sandy Wash	5	90.63	78.50	51.34	65.78
Mosquito Flats	13	91.98	78.87	51.50	68.01
Saguaro Slot	6	84.24	74.86	73.09	84.73
North Burn	3	89.40	75.99	59.29	78.83
Ahakhav	7	96.05	80.51	41.40	61.04
Palo Verde Ecological Reserve	2	90.37	74.92	61.01	77.20
Cibola Valley Conservation Area	14	87.09	77.95	70.21	75.72
Cibola Nature Trail	0	96.03	85.98	38.22	48.12
Eucalyptus Restoration	0	97.99	89.05	31.13	37.34
Quigley Pond	7	94.95	83.54	41.16	52.87
Mittry/Pratt Restoration	1	98.19	83.76	39.88	55.76
Yuma West Wetlands	1	93.78	83.24	46.73	61.52
Imperial South	4	92.23	86.16	44.74	52.37
Overall Averages		**93.76**	**81.00**	**46.30**	**60.81**

Many microclimate variables were strongly correlated with each other: four of these relationships are shown (Figure 46 - 49). Mean diurnal temperature was highly correlated with mean diurnal RH. Nest plots fell in the region of the graph indicating cool, humid conditions. Extreme temperatures (>130° F) shown in Figure 47 indicate some data loggers were exposed to direct sun during part of the day.

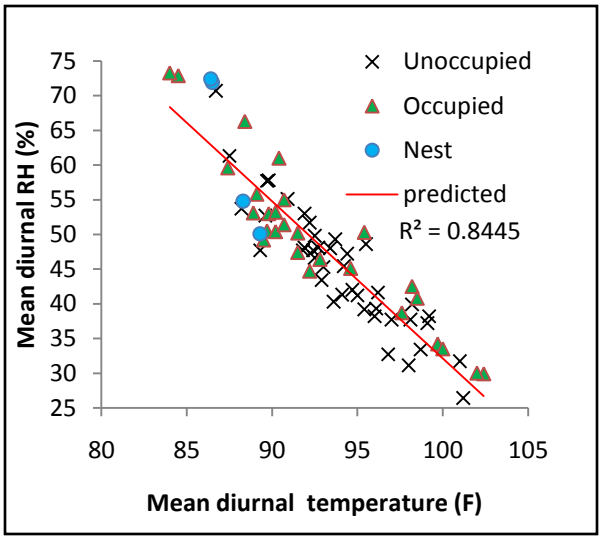

Figure 46. Mean diurnal RH by mean diurnal temperature.

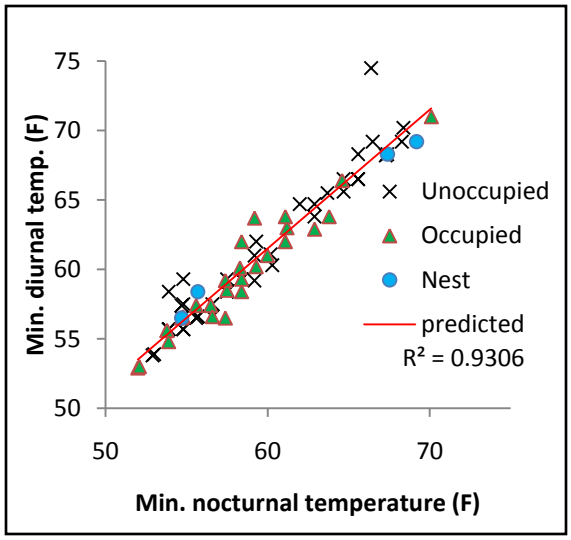

Figure 48. Minimum diurnal temperature by minimum nocturnal temperature.

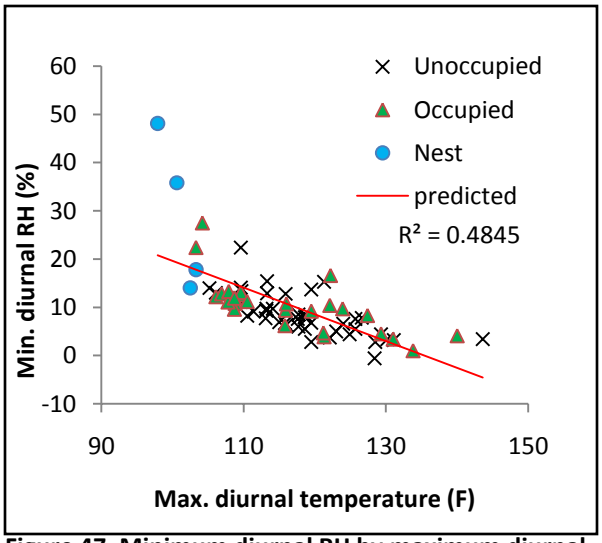

Figure 47. Minimum diurnal RH by maximum diurnal temperature.

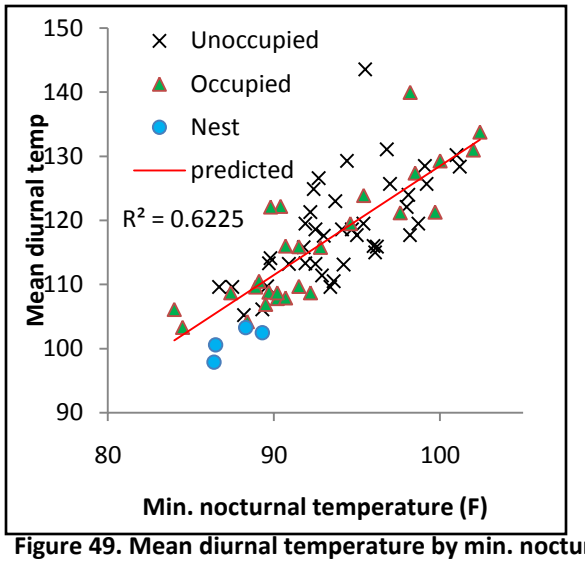

Figure 49. Mean diurnal temperature by min. nocturnal temperature.

Significant microclimate differences were found between plots (nest, occupied and unoccupied) (Table 13). At nest plots (n=4), diurnal temperatures averaged 5.8° F cooler, and maximum temperatures averaged 16.7° F cooler, than all other plots (occupied or unoccupied). Nest plot diurnal RH averaged 15.5% higher, minimum diurnal RH averaged 19.7% higher, and minimum nocturnal RH averaged 12.2% higher than all other plots. Occupied plots were also more humid during the day than unoccupied plots (mean=49.6% vs. 45%, p=0.0406). Occupied plots tended to be cooler than unoccupied plots, though the difference was not statistically significant.

Table 13. Comparison of microclimate data, nest, occupied and unoccupied plots (ANOVA).

	Plot Type							
	Nest		Occupied		Unoccupied			
	Mean n=4	Range	Mean n=27	Range	Mean n=41	Range	P*	P (Occ. vs. Unocc.)**
Diurnal temp. (F)	87.6	86.4-89.3	92.6	84-102.4	94.0	86.7-101.2	0.0113	0.1019
Max. diurnal temp	101.1	97.9-103.3	116.3	103.3 - 140	118.7	105.2-143.6	0.0009	0.1499
Max nocturnal temp	91.2	85.4-97.1	97.6	86.4-106	99.0	86.3-108.8	0.0079	0.1063
Diurnal RH%	62.3	50.1-72.4	49.6	29.9-73.3	45.0	26.4-70.7	0.0031	0.0416
Min diurnal RH%	28.9	14-48.1	10.5	1-27.5	8.4	-0.6-22.4	<.0001	0.0541

***Nests compared to all other plots.**

****Analysis repeated with nest plots excluded to compare occupied and unoccupied plots.**

Soil Moisture

Soil moisture was measured at 123 sites where habitat characterization plots were established. Readings were averaged for total, occupied, and unoccupied plots across sites (Table 14). The soil moisture readings were slightly correlated to mean diurnal RH, explaining approximately 3% percent of the observed variation (r^2=0.0343, n=69, p<0.0001, Figure 50). When 4 outliers with high soil moisture readings were removed from analysis, this increased to 26% (r^2=0.2634, n=65, p<0.0001, Figure 51).

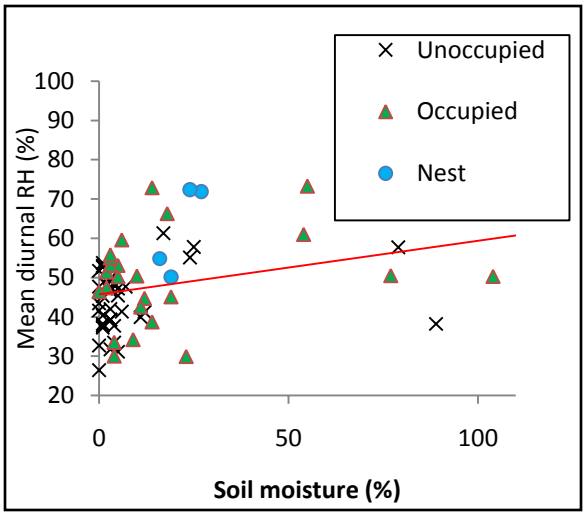

Figure 50. Soil moisture by mean diurnal RH.

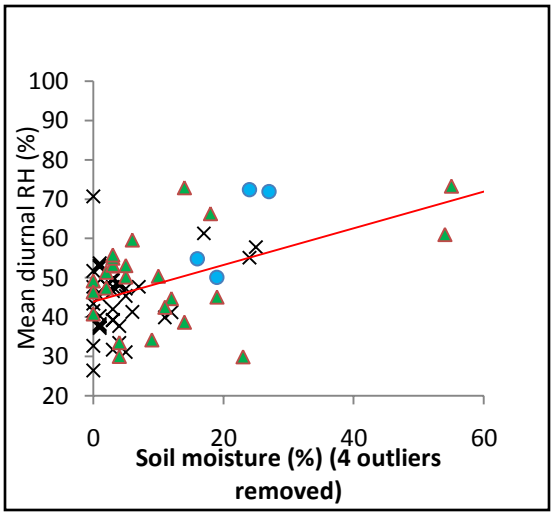

Figure 51. Soil moisture (with 4 outliers removed) by mean diurnal RH.

Table 14. Number of plots, and mean soil moisture readings at occupied and unoccupied sites.

	Total		Unoccupied		Occupied		
	# of Plots	Mean*	# of Plots	Mean*	# of Plots	Mean*	Sampling Dates
BWBB	9	24.6	3	1.7	6	11.2	8/17, 9/8, 9/13, 9/14
BWCP	2	4.1	1	4.5	1	3.8	9/5
BWCW	5	7.5	2	3.3	3	10.4	9/5
BWFW	7	6.1	5	7.5	2	2.7	8/24, 9/7, 9/9, 9/19
BWGR	6	11.7	5	9.2	1	22.6	7/3, 8/16, 8/21, 9/8
BWHB	7	8.6	0	NA	7	6.9	8/25, 8/28, 9/6, 9/14
BWKC	1	13.6	0	NA	1	13.6	9/8
BWMA	0	NA	NA	NA	NA	NA	NA
BWMF	5	27.7	3	1.7	2	18.9	9/9
BWMW	5	4.2	4	3.6	1	10.4	8/19, 9/13, 9/14
BWNB	3	39.9	3	22.0	0	NA	8/27, 9/2
BWSS	3	26.3	1	12.0	2	33.7	9/8, 9/9
BWSW	4	2.6	1	2.7	3	2.6	8/16, 8/27, 9/7, 9/19
CIBCNT	1	88.9	1	84.6	0	NA	8/18
CIBEUC	1	4.7	1	4.7	0	NA	8/18, 8/29
CIBNTH	1	*	1	*	0	NA	8/18
CIBSTH	0	NA	NA	NA	NA	NA	8/20
CRIT	10	1.3	9	1.4	1	0	9/10, 9/15
CVCA	3	22.9	0	NA	3	22.9	8/15, 8/16
GRGC	4	3.8	4	3.8	0	NA	9/8
GRQP	4	8.8	4	8.8	0	NA	9/10
HAVBR	4	3.4	4	3.4	0	NA	9/17
HAVND	3	11.7	1	*	2	11.7	9/16
HAVPS	5	29.1	5	21.8	0	NA	9/16
HAVRH	2	0.9	2	0.9	0	NA	9/17
HAVTPR	4	0.2	4	0.2	0	NA	7/19, 9,17
IMP20A	1	84.1	1	84.0	0	NA	9/4
IMPSTH	3	12.3	2	12.5	1	11.8	9/4
LIMNTH	4	18.0	4	23.5	0	NA	9/11, 9/12
LIMST	3	31.1	3	19.4	0	NA	9/11
MLPR	3	10.1	3	10.1	0	NA	9/1
OVRHP	0	N/A	N/A	N/A	N/A	N/A	N/A
OVRW	0	N/A	N/A	N/A	N/A	N/A	N/A
PAHNTH	0	N/A	N/A	N/A	N/A	N/A	N/A
PAHSTH	0	N/A	N/A	N/A	N/A	N/A	N/A
PICSRA	3	50.3	3	20.6	0	NA	9/3
PVER	1	54.5	0	NA	1	54.51	8/21
YUCC	3	10.7	3	10.7	0	NA	9/9
YUWW	3	4.4	3	4.4	0	NA	9/2
Total	**123**	**19.6**	**86**	**14.1**	**37**	**14.8**	

*Outlier readings (>100, or <0) were removed for calculating the mean.

INSECTS

Cicada excuviae abundance increased with occupancy status (occupied mean=6.2, unoccupied mean=3.4, p=0.0342). Five nest plots in 2008 tended to have more cicada excuviae than other plots (mean=11.2 vs. 4.2, t=1.7995, p=0.0741), although the sample size is too small to draw any conclusions. No relationship was found between total cuckoo detections and cicada abundance. There was also no relationship found between soil moisture and cicada excuviae abundance. Soil moisture was only measured once during the season at most sites, however, and there was incomplete overlap between timing of these measurements and cicada counts.

PATCH SIZE

Figure 52 shows total detections compared to size of area for each site. Sites with no detections were smaller (mean=19.5 ha, n=11, t=3.92, p<0.005) than sites where one or more cuckoos were detected (mean=28 ha, n=29). Average size of occupied sites (33.9 ha) was almost twice as large as unoccupied sites (18.2 ha, t=2.16, p=0.0187). Average site width was also greater at occupied sites (median=242 m) than unoccupied sites (median=196 m) (p=0.0279). (Medians were compared instead of means, as the data were not normally distributed.)

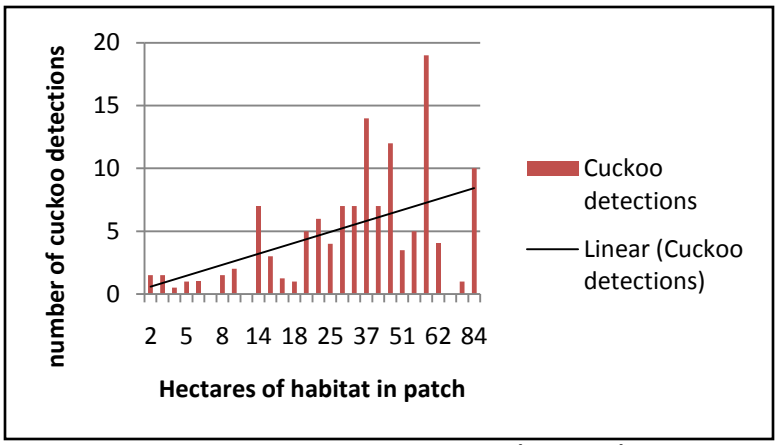

Figure 52. Total cuckoo detections by site size (hectares), LCR survey sites 2008.

DISCUSSION

There are two overarching goals of this long-term project. The first is to monitor Yellow-billed Cuckoo populations in the study area. The second is to determine factors influencing cuckoo occupancy of sites. The results from 2008 have provided some preliminary insights into factors influencing cuckoo distribution on the lower Colorado River.

The nests and fledglings found at CVCA are the first confirmed Yellow-billed Cuckoos breeding on an LCR MSCP restoration site. This is a promising result for cuckoo populations in the region. This site is among the largest restoration sites on the lower Colorado River. The trees are relatively tall (8-10 m) and densely planted, with sufficient habitat to support a small population of breeding cuckoos. As other phases of this restoration mature, the area should see increasing numbers of cuckoos.

Although only one possible breeding pair was estimated at Palo Verde Ecological Reserve, this site is expanding. There are currently 32.37 ha (80 ac) of trees at the Reserve that will be in their 3rd year during 2009 (LCR MSCP 2006c), and the site will be comparable in structure to CVCA during the 2008 season. By 2014, the area of restored habitat here is scheduled to cover up to 526 ha (1,300 ac) (LCR MSCP 2006b). As these consecutive plantings mature, they provide a valuable opportunity to investigate important questions regarding habitat age and structural characteristics required for breeding cuckoos.

Although nests were only found at BWR NWR and CVCA, breeding was suspected at a number of other sites. A total of 43 potential breeding areas were predicted based on survey and follow-up data. The following sites were identified as having possible breeding pairs, with at least one cuckoo detected at the same location during at least two survey periods: Havasu NWR, Ahakhav Tribal Preserve, PVER, Cibola NWR, Imperial NWR, and Yuma West Wetlands. The largest of these sites is Ahakhav Tribal Preserve (53.5 ha, 132 ac), which is also among the largest native dominated site outside of BWR NWR. Survey sites in other areas are not very large, but exist within a landscape of small habitat patches. The Imperial NWR sites are relatively small (approximately 2-3 ha), but numerous small patches of riparian habitat surround Lake Martinez, extending toward Picacho SRA. This network of marginal habitat may allow cuckoos to nest in stands of trees which may be too small if they were more isolated. This may partially explain why minimum patch size estimates are so variable for cuckoos.

Using the double-observer method, estimated probability of detection for the first surveyor was 71%. Surveyors following an hour later had a lower probability of detection (47%). There are several possible explanations for this result. Many species of birds vocalize most frequently at dawn, with vocalization rate declining during the day (Whitehead and Taylor 2002, Alberto and Peris 2008). During three years of work on San Pedro River in southeast Arizona, Halterman (unpub. data) found that 26% of detections during call playback surveys occurred in the first hour of the survey, just after dawn. The lower probability of detection for surveyor two may just be a factor of a temporal decrease

in responsiveness. Alternatively, studies of other avian species suggest that some individuals and/or species may become less responsive when surveyed too often (Forsman et al. 1977); it is possible that cuckoos rapidly habituate to call playback.

The probability of detection estimate for the first of the two surveyors is higher than the 57% probability of detection calculated using the same method on the San Pedro River in 2004 and 2005 (Halterman 2009). This difference may be due to higher population density on the San Pedro River, with consequent difficulty in separating individuals. Additional data will improve our understanding of individual observer and cuckoo variation, and how these affect population estimates.

Temperature and relative humidity data in 2008 were significantly correlated to several canopy variables. As canopy cover and canopy height increased, minimum temperatures increased, and maximum temperatures decreased; increases in total canopy also increased both minimum diurnal and nocturnal relative humidity. Similar relationships between canopy and microclimate have been found by Olfert et al. (2002). Preliminary analysis also showed a weak relationship between soil moisture and relative humidity. This is based on only a single year of data, however, and although this is worth further exploration, no conclusions can be drawn yet.

The four nest plots with microclimate measurements recorded were significantly cooler and more humid than all other plots. Occupied plots tended to be cooler than unoccupied plots, and were also more humid. Johnson et al. (2008) also found that occupied plots in 2006 and 2007 were slightly cooler and more humid than unoccupied plots. Hamilton and Hamilton (1965) suggested that cuckoos select nest sites based on specific microclimate conditions such as relative humidity, while Hunter et al. (1988) suggested high temperature as the cause of low cuckoo densities in tamarisk stands on the LCR. Because temperature and humidity are strongly correlated with each other, it is still not clear if one is more important than the other.

No cuckoos were detected during surveys north of Needles, CA. The loss of the Lake Mead National Recreation Area habitat may have negatively affected cuckoo occupancy at Pahranagat in 2007 and 2008. Cuckoos have not been detected here during surveys since 2006, when Johnson et al. (2008) had a single detection. It is a small site (two 17 ha patches), and remote from other cuckoo populations. This may also be the case for Overton WMA. At least five cuckoos were detected there in 2006, with none in 2007 (Johnson et al. 2008) or 2008. Breeding was not confirmed in 2006, though two cuckoos detected at the Overton Wildlife site were observed counter calling (Johnson et al. 2007). A marked population of cuckoos would be required to determine these movements.

A comparable number of cuckoos were detected on surveys at the Bill Williams River NWR in 2008 (n=117) as in 2006 (n=117) and 2007 (n=139). Detections per survey were also comparable to the previous two years. Although numbers of cuckoos detected have fluctuated over the years (Figure 53) there has been a population here every year surveyed. Large flood events in 2005 and 2006 resulted in a large amount of riparian regeneration in subsequent years. This survey effort will provide documentation of the

response of the cuckoo population on the Bill Williams River NWR to the maturing vegetation.

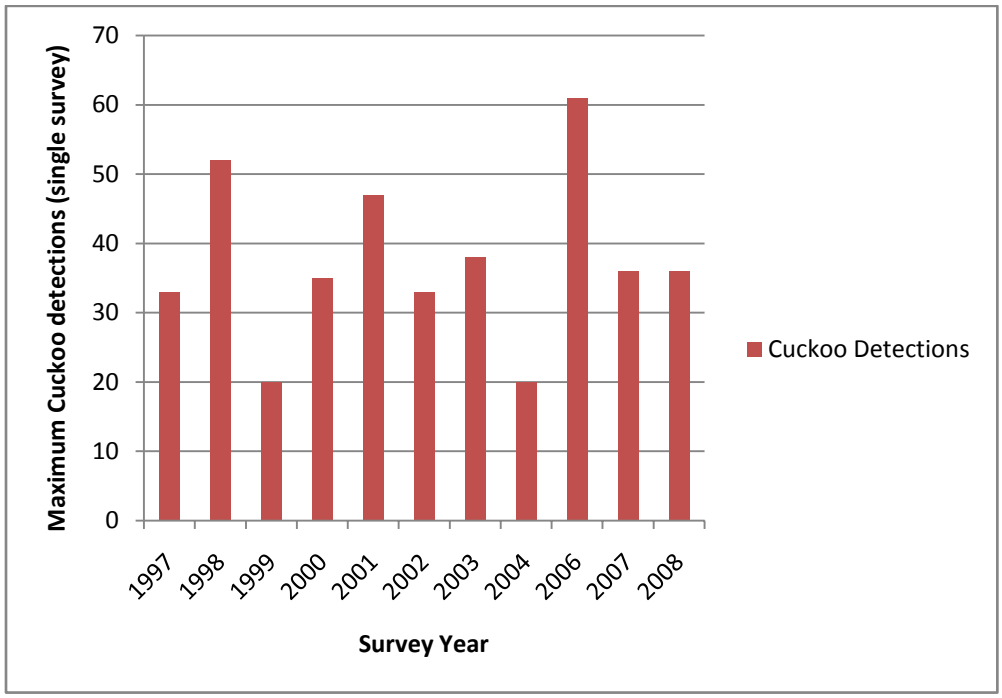

Figure 53. Maximum cuckoo detections during a single survey period at BWR NWR, 1997-2008 (excluding 2005).

The BWR NWR has historically been a stronghold for Yellow-billed Cuckoos and the majority of detections within the study region were expected to occur here. The Bill Williams River has a single control structure upstream, Alamo Dam. Although water levels behind the dam are managed for flood control and recreation, the US Army Corps of Engineers maintains a steady flow in the river throughout the year, thus ensuring sufficient water to support riparian vegetation. In addition to this flow, occasional large winter and monsoon floods occur, all of which sustain the healthy riparian ecosystem.

Successful restoration of riparian habitat for cuckoos requires a thorough knowledge of cuckoo breeding biology, resource use, and habitat requirements. It is important to determine how cuckoos use restoration sites, and the factors that promote breeding. In 2009 greater effort will be directed toward capturing cuckoos within restoration sites and equipping them with radio-transmitters in order to monitor movement, habitat use, feeding behavior, nest site selection, and nest success.

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LITERATURE CITED

Alberto, E.M. and S. Peris. 2008. Influence of time of day, duration, and number of point count sampling of birds in an Atlantic forest of Paraguay. Ornitologia Neotropical 19:229-242.

Andersen D.C. 1994. Are cicadas (*Diceroprocta apache*) both a keystone and a critical-link species in lower Colorado River riparian communities? Southwestern Naturalist 39:26-33.

Anderson, B.W. and R.D. Ohmart. 1976. Vegetation type maps of the lower Colorado River from Davis Dam to the southerly international boundary. U.S. Bureau of Reclamation, Boulder City, NV.

Arizona Game and Fish Department. 1988. Threatened native wildlife in Arizona. p.17.

Banks, R.C. 1988. Geographic variation in the Yellow-billed Cuckoo: Condor 90(2):473-477.

Bent, A.C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds, and their allies. U.S. Natl. Mus. Bull. 167, Wash., D.C. 244 pp. (Reprinted by Dover Publ., Inc., New York 1961).

BIO-WEST, Inc. 2006. 2004 Lower Colorado region vegetation type mapping, backwaters delineation, orthophotography, and GIS development. US Bureau of Reclamation, Boulder City, NV.

California Department of Fish and Game. 1978. At the crossroads, 1978: A report on California's endangered and rare fish and wildlife. Calif. Dept. of Fish and Game, Nongame Wildl. Investigations rep., Proj. E-W-2, Job IV-1.

Ellingson, A.R. and D.C. Andersen. 2002. Spatial correlations of *Diceroprocta apache* and its host plants: evidence for a negative impact from *Tamarix* invasion. Ecological Entomology 27:16-24.

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

Forsman, E.D., E.C. Meslow and M.J. Strub. 1977. Spotted owl abundance in young versus old-growth forest, Oregon. Wildlife Society Bulletin 5:43–47.

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

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

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

Glinski, R.L. and R.D. Ohmart. 1984. Factors of reproduction and population densities in the Apache cicada (*Diceroprocta Apache*). Southwestern Naturalist 29(1):73-79.

Halterman, M.D. 1991. Distribution and habitat use of the Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) on the Sacramento River, California, 1987–90. Masters' thesis, California State University, Chico. 49 pp.

Halterman M.D. 2009. Sexual dimorphism, detection probability, home range, and parental care in the Yellow-billed Cuckoo. PhD dissertation, University of Nevada, Reno.

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 USGS-BRD Dixon Field Station, 6924 Tremont Rd, Dixon, CA 95620.

Halterman, M.D., L.W. Oring and B.E. Raulston. 2009. Chapter 1. Sexual dimorphism, detection probability, home range, and parental care in the Yellow-billed Cuckoo. PhD dissertation, University of Nevada, Reno

Halterman, M.D., M.J. Johnson and J.A. Holmes. 2007. Western Yellow-billed Cuckoo natural history summary and survey methodology. Unpublished draft report, Southern Sierra Research Station, P.O. Box 1316, Weldon, CA 93283.

Hamilton, W.J. III and M.E. Hamilton. 1965. Breeding characteristics of the Yellow-billed Cuckoo in Arizona. Proceedings of the California Academy of Sciences, 4th Series, 32:405–432.

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

Hunter, W.C., R.D. Ohmart and B.W. Anderson. 1988. Use of exotic saltcedar (*Tamarix chinensis*) by birds in arid riparian systems. Condor 90(1): 113-123.

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.

Johnson, R.R., B.T. Brown, L.T. Haight and J.M. Simpson. 1981. Playback recordings as a special avian censusing technique, pp. 69-75 *In* Estimating numbers of terrestrial birds. (C.J. Ralph, and J.M Scott, eds.). Studies in Avian Biology, Allen Press, Inc, Lawrence, KS.

Johnson, M.J., J.A. Holmes, C. Calvo, I. Samuels, S. Krantz and M.K. Sogge. 2007. Yellow-billed Cuckoo distribution, abundance, and habitat use along the lower Colorado and tributaries, 2006 annual report: U.S. Geological Survey Open-File Report 2007-1097, 219 pp. http://pubs.usgs.gov/of/2007/1097/.

Johnson, M.J., J.A. Holmes, R. Weber and M. Dionne. 2006. Yellow-billed Cuckoo distribution, abundance and habitat use along the lower Colorado and Gila Rivers in La Paz and Yuma Counties, 2005. Report submitted to Arizona Game and Fish Heritage Program, Bureau of

Land Management, Bureau of Reclamation, and Northern Arizona University, Flagstaff. 112 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, 274 pp.

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. of Fish and Game, Wildlife Management Branch, Sacramento, CA, Admin. Rep. 80-2.

Laymon, S. A. 1998. Yellow-billed Cuckoo (*Coccyzuz americanus*). *In* The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/htmldocs/riparian_v-2.html.

Laymon, S.A., and M.D. Halterman. 1985. Yellow-billed Cuckoos in the Kern River Valley: 1985 population, habitat use, and management recommendations. Report to the Nature Conservancy. Sacramento, CA. 29 pp.

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

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

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

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

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

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

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

Lower Colorado River Multi-Species Conservation Program. 2007. Cibola Valley Conservation Area Restoration Development Plan: overview, July 2007. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83(8): 2248-2255.

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

Martin, T.E., C.R. Paine, C.J. Conway, W.M. Hochachka, P. Allen and W. Jenkins. 1997. BBIRD Field Protocol. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana.

McLeod, M.A., T.J. Koronkiewicz, B.T Brown, W.J. Langeberg, and S.W. Caruthers. 2008. Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2003-2007. Five-year summary report submitted to Bureau of Reclamation, Boulder City, NV by SWCA Environmental Consultants, Flagstaff, AZ. 206 pp.

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

Mills, G.S., J.B. Dunning Jr. and J.M. Bates. 1991. The relationship between breeding bird density and vegetation volume. Wilson Bulletin 103(3):468-479.

Minnesota Department of Natural Resources. 2001. DNRGarmin GPS Application, version 5.1.2600. http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html.

Nevada Department of Wildlife. 2009. Southwestern Willow Flycatcher and Yellow-billed Cuckoo survey and monitoring at select sites in southern Nevada, 2008 annual report.

Nichols, J.D., J.E. Hines, J.R. Sauer, F.W. Fallon, J.E. Fallon, and P.J. Heglund. 2000. A double-observer approach for estimating detection probability and abundance from point counts. Auk 117:393–408.

Olfert, O., G.D. Johnson, S.A. Brandt and A.G. Thomas. 2002. Use of arthropod diversity and abundance to evaluate cropping systems. Agronomy Journal 94:210-216

Payne, R.B. 1997. Cuculidae *in* Handbook of birds of the world, Vol 4. Lynx Edixions.

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

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

Pyle, P. and S.N.G. Howell. 1997. Identification guide to North American passerines: Part 1. Slate Creek Press, Bolinas, CA. 730 pages.

Ralph, C.J., G.R. Guepel, P. Pyle, T.E. Martin and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 pp.

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

Rosenberg, K.V., R.D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. Birds of the lower Colorado River Valley. University of Arizona Press. pp. 203-204.

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

US Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the Yellow-billed Cuckoo (*Coccyzus americanus*) in the western continental United States. Federal Register 66(143): 38611-38626.

US Fish and Wildlife Service. 2002a. Yellow-billed Cuckoo candidate listing on Endangered Species List. Federal Register 67(114).

US Fish and Wildlife Service. 2002b. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico. I-ix +210pp., Appendices A-O.

USDA, Forest Service Region 3. 1988. Regional forester's sensitive species list.

Westmoreland, D., M. Schmitz and K.E. Burns. 2007. Egg color as an adaptation for thermoregulation. Journal of Field Ornithology 78:176-183.

Whitehead, D.R. and T. Taylor. 2002. Acadian Flycatcher (*Empidonax virescens*). *In* The birds of North America, No. 148 (A. Poole and F. Gill, eds.). The Birds of North America, Inc. Philadelphia, PA.

Appendix 1. 2008 Yellow-billed cuckoo survey and detection form.

Yellow-Billed Cuckoo (YBCU) Survey and Detection Form | **Non Survey Detection (check box)** ☐ | **Page of**

Site Code:	Site Name:	Site Owner:	Survey Period	Visit Number	Date (m/d/y)
State:	County:		Surveyor:		GPS #
Drainage:			Geographic Area:		
START: Temp (°F)____ Hum (%)____ Wind(beaufort)____ Cloud Cover (%)____			STOP: Temp (°F)____ Hum (%)____ Wind(beaufort)____ Cloud Cover (%)____		
Start Time:	UTM Start:	E N	Start Time in Habitat:		Data Zone: Data Nad 83: Y N
Stop Time:	UTM Stop:	E N	End Time in Habitat:		Data Entry: / / Data Proof: / /

Number of stops:	**Total YBCU Detected:**

Point Name	Start Time	GPS Accuracy	UTM Coordinates	Cicadas Present (Y/N)	YBCU # Detected	# of Plays	Detection Type (A/V/B)**	Coo Voc. (Y/N)	Flew Closer (Y/N/U)	Compass Bearing	Estimated Distance (m)	Note #
			E N									
			E N									
			E N									
			E N									
			E N									
			E N									
			E N									
			E N									
			E N									
			E N									

Notes:

* For Yuma Clapper Rails, Southwestern Willow Flycatchers, and Common Blackhawks, take a UTM

**A=audio, V=visual, B=both

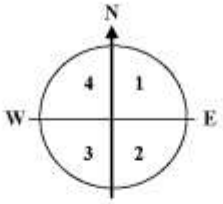
Appendix 2. Vegetation Plot Sampling Form, 2008.

2008 Patch Vegetation Sampling Form

SITE CODE_____ **SITE NAME**_____
VPN_____ **POINT NAME**_____ **DATE**_____
UTM: NAD____**ZONE**_____**ACCURACY**____**E**_____**N**_____
SURVEYORS_____ **Time Start**_____**Time Stop**_____

Cicada Excuviae:
Time Start_____
Center _____**NE**_____
SE_____**SW**_____
NW_____
Time Stop_____

Hydrosense Soil Moisture:
N:1m____**2m**____**3m**____
E:1m____**2m**____**3m**____
S:1m____**2m**____**3m**____
W:1m____**2m**____**3m**____
Center_____



High Canopy Dominant sp. (> 5 m_____**Percent of high canopy**_____
Co-dom sp. (> 40% cover of high canopy)_____ **Percent of high canopy** _____
Dist. To Water_____**ASPECT (within 5 m)**_____**SLOPE(within 5 m)**_____

Densiometer Cover (0-96)	AVG Ht.	Dominant Spp.	1_N	2_E	3_S	4_W
Total Canopy Cover						

Visual Cover Estimates (%)	AVG Ht.	Dominant Spp.	1_NE	2_SE	3_SW	4_NW
High Canopy Cover (>5m)						
Main Canopy Cover						
Sub Canopy Cover						
Shrub/Sapling Cover						

Nearest live shrub: from center point, within each of the quarters of the circle surrounding you:

Quad	Shrub Species	Distance	Height	Max Width	Perp. Width
1_NE					
2_SE					
3_SW					
4_NW					

Nearest live tree: from center point, within each of the quarters of the circle surrounding you:

Quad	Tree Species	Distance	Height	DBH	Crown Width	Can Cover
1_NE						
2_SE						
3_SW						
4_NW						

Site Description/Impacts/Cicadas/I-button/Notes:

_____
_____
_____
_____
_____
_____
_____

Photo Taken:_____

POINT NAME_____ **DATE**_____

Litter Depth: in mm:

1	2	3	4	5	6	7	8	9	10	11	12

Percent Cover: Looking at the 5 m circle, from 50cm above ground to ground level

	1 (NE)	2 (SE)	3 (SW)	4 (NW)
GRASS				
LEAF LITTER				
DOWNED LOGS (>12 cm diameter)				
BARE GROUND				
STANDING WATER				
Total of above:	**100%**	**100%**	**100%**	**100%**
ALL GREEN (below 50cm above ground level)				
SHRUB (woody perennials below 50 cm tall)				
FORB (broadleaf non-woody below 50 cm tall)				
SEDGE				
MARSH VEGETATION				
BRUSH (dead woody perennials below 50 cm tall)				

Shrubs and saplings (<1.4m tall): Within a 5 m radius circle:

Shrub or Sapling Species	0 to 2.5 cm				**Total**	2.5 to 8 cm				**Total**
	1(NE)	2(SE)	3(SW)	4(NW)		1(NE)	2(SE)	3(SW)	4(NW)	

Small Trees (>1.4m tall): Within a 5 m radius circle:

Live Tree Species	0 to 8 cm				**Total**	8 to 23 cm				**Total**
	1(NE)	2(SE)	3(SW)	4(NW)		1(NE)	2(SE)	3(SW)	4(NW)	

Large Trees: Within the 11.3 m Circle: Tally number of trees per species within the circle:

Live Tree Species	23 to 38 cm				**Total**	>38 cm				**Total**
	1(NE)	2(SE)	3(SW)	4(NW)		1(NE)	2(SE)	3(SW)	4(NW)	

Snags (completely dead trees > 1.4m tall): Within the 11.3 m Circle: Identify to species when able.

Snags (species or unknown)	**> 8cm and < 12 cm DBH**	**> 12 cm DBH**

Appendix 3. Vegetation Plot Sampling Methodology, 2008.

2008 VEGETATION SAMPLING INSTRUCTIONS

I. Setting up a Vegetation Plot

At a vegetation point, two sizes of circular plots are established:

1) A 5 meter radius plot is used to measure ground cover, count small trees, and count shrub and sapling stems.
2) An 11.3 m radius plot used to count the stems of trees.

The 5 m plot is nested within and centered on the same point as the 11.3 m plot.

Establish 4 quadrants to facilitate estimates and stem counting; then count stems in each quadrant separately.

II. Measurements

SITE CODE
Enter the survey site code.

SITE NAME
Write out the complete name for the survey site.

POINT NAME
This is a unique combination of letters and numbers. No other points in any of the survey areas or sites will have the same identification. Use the two letter site code in addition to the assigned veg. point number.

Measurements Made from the Center of Vegetation Plots

The following measures are taken while standing at the center of the plot (nest, or systematic vegetation sampling point).

UTM NAD
Enter the NAD used when marking points with GPS.

UTM ZONE
Enter the appropriate zone.

ACCURACY
Enter the GPS reading accuracy, in number of meters.

UTM N and E
Enter the northing and easting readings for the center of the circular plot.

AVERAGE TOP CANOPY HEIGHT
Choose a point in the canopy that represents the average height of the top of the canopy within 11.3 m of the center of the plot (i.e. ignore lone trees that emerge above the main canopy when taking this measure). Measure this height with a clinometer.

1

DOMINANT PLANT SPECIES IN CANOPY
Species name of plant species that dominates the high canopy. Species' dominance is determined by eye. Record the species name for any that accounts for at least 40% of the high canopy present. Leave blank if no single plant species represents > 40% of the high canopy present.

PERCENT OF DOMINANT CANOPY SPECIES
This is the percent of high canopy present that is occupied by the DOMINANT CANOPY SPECIES.

CO-DOMINANT PLANT SPECIES IN CANOPY
Species name of plant species that co-dominates the high canopy. Use this variable when there are 2 plant species that each represent > 40% of the high canopy present. Leave blank if there is not a second plant species that represents > 40% of the high canopy that is present.

PERCENT OF CO-DOMINANT CANOPY SPECIES
This is the percent of high canopy occupied by CO-DOMINANT CANOPY SPECIES.

DIST. TO WATER
Record the distance from the center of the plot to the nearest water.

ASPECT
The direction the 5 m plot faces in degrees. From the top of the 5 m plot face downhill and take a compass bearing in degrees. (What direction would water run?)

SLOPE
Measure the slope across the 5 m plot from the bottom to the top of the plot in degrees (LEFT HAND SCALE OF CLINOMETER). Measuring at eye-level aiming at a target also at eye-height the simplest way of taking this measurement.

TABLE I: DENSIOMETER COVER (0-96)

Dominant Species-Record the species that makes up the greatest percentage of the canopy cover.

AVG Height-Using a clinometer and the tree height estimation sheet, determine the average height of the tree species that dominates the overall canopy cover.

Total Canopy Cover- Using a spherical densiometer estimate the total canopy cover by standing at the center of the plot and recording cover in each of the four cardinal directions (N, E, S, W).

Using a spherical densiometer: Hold the densiometer in front of you at breast height. Imagine four equally spaced dots in each of the squares outlined on the mirror. Count the number of these imaginary dots covered by vegetation. Write the total number of dots covered by vegetation on the data sheet. This number should be between 0 and 96. This number divided by 96 then the result multiplied by one hundred will give us the percent canopy cover (We will do this once the data is entered).

TABLE II: VISUAL COVER ESTIMATES (%)
Visually estimate the percent cover for each vegetation layer within each quadrant. The observer must move around the plot to get a good feel for this.

2

*****For all visually estimated percent cover data record no cover as 0, <3% as 1, and for all other estimates round to the nearest 5 percent*****

High Canopy Layer- This layer is any canopy above 5 meters in height.
Main Canopy Layer- Can overlap with high canopy, but this layer provides the most cover/shade.
Sub Canopy Layer- Record this layer when there is a distinct canopy layer between the main and the shrub/sapling layer. This layer is often absent.
Shrub/Sapling Layer- this layer is composed of all shrubs and sapling species, as well as any tree species that is less than 1.4 meters in height.

Table III-V NEAREST LIVE SHRUB, LIVE TREE, AND SNAG

The next measurements are taken at all plots. These measures are all based on the point-centered quarter method of estimating densities of plants (e.g., Mueller-Dombois and Ellenberg 1974). For these measurements, stand at the center of the plot, and locate the nearest live tree, live shrub, or snag (dead tree) within each of the quarters of the circle surrounding you. Divide the circle into quadrates along the cardinal compass directions. Within each quadrate, record the following information:

SPECIES, CLOSEST SHRUB
Species name of closest shrub, for each quadrate (1-4).

DISTANCE TO SHRUB
The distance (in meters) from the center of the plot to the shrub

HEIGHT OF SHRUB
Height (in meters) of the selected shrub

MAX WIDTH
Maximum width (in meters) of selected shrub

PERP WIDTH
Width of the shrub measured at a right angle to the maximum width

SPECIES OF NEAREST TREE
Species name of closest tree code for each quadrate (1-4).

DISTANCE TO CLOSEST TREE
Distance (in meters) from the center of the plot to the closest tree within a quadrate

HEIGHT OF CLOSEST TREE
Height (in meters) of closest tree in quadrate # to the center of the plot

DIAMETER AT BREAST HEIGHT (DBH)
Diameter at breast height (in centimeters) of the closest tree to the center of the plot in each of the four quadrates.

CROWN WIDTH, CLOSEST TREE
Average width (in meters) of the crown of the closest tree to the center of the plot in each of the four quadrates. Measure the largest width, then estimate the average.

3

CANOPY COVER, CLOSEST TREE
Use the densitometer, standing under closest tree to measure canopy cover of closest tree.

Measurements Taken Within the Small (5 Meter) Plot

In each of the 5m plots we measure the depth of organic litter, ground cover of categories of ground cover, and counts of shrubs and saplings.

Measuring Litter Depth

Measure the depth of organic litter, using a stake or other tool (meter stick, ruler) to dig a small hole down to where individual leaf parts are no longer visible (leaf veins usually decompose last), to where the soil layer starts. We are interested in the depth of leaf litter and partially decomposed organic matter that accumulates on top of the mineral soil. Litter depth is measured at 2 m intervals along the ropes and within the 5 m plots. If any of these 12 points land on a log or a rock, move the meter stick slightly to a location where you are actually measuring litter depth.

LOCATIONS FOR LITTER DEPTH MEASUREMENTS

Organic litter depth (in mm) should be measured across the center of the plot parallel and perpendicular to the slope of the plot. Measures should be made at 12 points as shown in the figure, above.

Measuring Ground Cover

These vegetation measurements made within the 5 meter plots are estimates of ground cover, of several types. For each of the 4 quadrants in the 5 m plot, make an ocular estimate of: the percent of the ground covered by green vegetation from 50 cm above ground, to ground level. For each class of vegetation (shrub, grass, fern etc.), estimate a percent value independent of all other vegetation types (i.e. as if other vegetation types were absent). Vegetative cover categories can sum to more than 100% because of vertical stratification of plant layers. However, no single category of vegetative cover should be greater than the value for ALL GREEN COVER.

Notice that there are two types of ground cover that affect cover estimation rules: tall sparse cover that can overlap with low cover types, and low dense cover that cannot

4

overlap with other low cover types. Percent cover in high and low cover types can sum to more than 100%, but low cover types (low grass, bare ground, moss, low dense shrub, leaf litter, logs, etc.) alone must sum to 100% or less if there is bare ground.

The following are the variables to be measured within each 5 meter plot:

LITTER DEPTH
Litter depth is measured, in mm, at 12 points (see above) and the average of these 12 measurements is entered at the right side of the table.
We are measuring litter depth, not percent of ground covered by litter. Note if you are in an area covered in water, leave Litter Depth blank, and do not record litter depth as zero: there is litter...just not at the surface.

% ALL GREEN COVER
percentage of ground covered by green vegetation that is below 50 cm in height

% GRASS COVER
percentage of ground covered by grasses below 50 cm in height.

% SEDGE COVER
percentage of ground covered by sedge that is below 50cm in height. Also, see % MARSH VEGETATION, below.

% SHRUB COVER
percentage of gound covered by woody perrenial plants that are below 50 cm tall.

% BRUSH COVER
percentage of ground covered by small dead woody vegetation (i.e. dead shrubs and bramble) less than 50 cm above the ground

% FORB COVER
percentage of ground covered by broad-leafed non-woody plants below 50 cm height.

% LEAF LITTER COVER
percent of ground covered by leaf litter (including tamarisk needles). This value should be independent of taller, sparser vegetation (litter + tall sparse vegetation can sum to more than 100%), but is dependent on low dense vegetation (litter + low dense vegetation sum to 100% or less). Example: a plot with a layer of small shrubs/saplings covering 80% of the ground at 50 cm can have little plant cover at ground level so more than 20% of the ground could be leaf litter. However, a plot with 80% coverage of short, dense grass could have no more than 20% leaf litter cover.

% DOWNED LOGS COVER

percent of ground covered by downed logs (logs >12 cm diameter). This value should be independent of taller, sparser vegetation (can sum to more than 100%), but dependent on low dense vegetation (sum to 100% or less). SEE LEAF LITTER EXAMPLE.

% BARE GROUND
percent open ground not covered by leaf litter. This value should be independent of taller, sparser vegetation, but dependent on low dense vegetation. SEE LEAF LITTER EXAMPLE

% WATER COVER
percent of ground covered by standing water. This value should be independent of taller, sparser vegetation, but dependent on low dense vegetation. SEE LEAF LITTER EXAMPLE.

% MARSH VEGETATION
percentage of ground covered by marsh vegetation (vegetation undifferentiated by species or type that is growing in water). If sedges are not reported separate of other marsh vegetation (in % SEDGE COVER), then leave % SEDGE COVER blank instead of reporting a 0 cover for sedge.

Measuring Shrubs and Saplings within 5 m Radius Circle
The following are the measurements to be taken within the 5 meter radius plot. One measurement taken is a count of the numbers of stems of shrubs that exist within the plot circle. Stems of all saplings and shrubs should be counted by species within each 5 m plot at 10 cm above the ground. The number of stems of each species should be counted for each of two size classes (<2.5 cm diameter or >2.5 cm diameter). We make no distinction in the data between shrubs and saplings, but different criteria must be used to place shrubs (often having no main stem) and saplings (often having a single, main stem) in one of the two size classes into which we place shrubs (see below). Separate counts are made of the number of stems of each species of shrub/sapling within the plot. Please note: growth form and size class **do not** constitute 4 different categories. We are **only** categorizing stems as small or large, not as single stem small, multiple stem large, etc. Count the numbers of stems that fit any of these criteria:

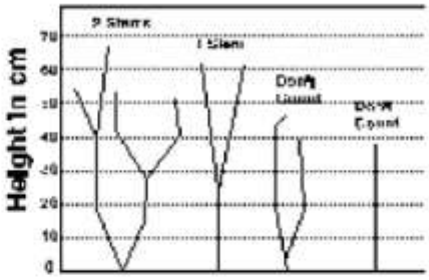
No single central stem at which DBH can be measured:
Small Size Class: < 2.5 cm stem diameter at 10 cm above ground
Large Size Class: > 2.5 cm stem diameter at 10 cm above ground

With a single central stem
Small Size Class: < 2.5 cm dbh, or less than 1.4 m tall
Large Size Class: 2.5 - 8.0 cm dbh

Many plant species break into multiple stems fairly close to the ground. In these situations, it is reasonable to assume that birds respond to stem densities rather than individual plant numbers. Therefore, we count vertical stems, not individual plants.

Rules for counting stems:
Don't count plants/stems less than 50 cm (i.e. approximately knee height) high.

Count the number of vertical stems at 10 cm above the ground (ankle level), i.e if a stem branches above 10 cm then it is counted as 1 (see figure, below).



The following are the variables recorded for each of the large diameter plots:

SHRUB or SAPLING SPECIES
Enter the species name for each species encountered in the 5 m plot, then tally the number of stems for each species, placing the tallies in the appropriate size class. Species do not have to be placed in any specific order. Use as many entries as necessary for the species of shrubs encountered. Rare species can be pooled into the group "OTHER".

Measurements Taken Within Larger (11.3 Meter) Vegetation Plots

The 11.3 meter radius plots are used to count the numbers of trees and snags within the 11.3 m circle. Live trees are separated into the size classes given in the table, below. Separate counts should be made for each species of tree in the plot. Snags (dead trees) taller than 1.4 m and >12 cm DBH are combined in a single category. If you can accurately identify the species of snag, enter this, otherwise put unknown.

TABLE: TREE SIZE CLASSES

Live Trees (measure each species separately)	Small trees: 8 -- 23 cm dbh Medium trees: 23 -- 38 cm dbh Large trees: >38 cm dbh
Snags (combine all species)	Small snags: < 12 cm dbh and > 1.4 m tall Medium snags: > 12 cm dbh and > 1.4 m tall

Use as many lines in the table as needed to record each species encountered in the large plot. Rare species can be pooled into the category "OTHER".

The following are the variables recorded for each of the large diameter plots:

TREE SPECIES
Species name entered for each species encountered on the large vegetation plot (11.3 m radius circle). There is no specific order in which tree species must be presented.

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NUMBER OF MEDIUM/LARGE STEMS
Total number of live stems of 23 -- 38 cm DBH, of each species within the large vegetation plot. Enter the total on the right of the tally marks.

NUMBER OF LARGE STEMS
Total number of live stems >38 cm DBH, of each species within the large vegetation plot. Enter the total on the right of the tally marks.

NUMBER OF SMALL SNAGS
Total number of snags between 8 and 12 cm dbh. If you can accurately identify the species of snag, enter this, otherwise put unknown.

NUMBER OF LARGE SNAGS
Total number of snags (all species combined) greater that 12 cm dbh. If you can accurately identify the species of snag, enter this, otherwise put unknown.

COMMON RIPARIAN PLANTS AND FOUR LETTER CODES

Common Name	*Genus*	*Species*	Code	Growth Form
Arroweed	*Pluchea*	*sericea*	PLSE	Shrub
Coyote Willow	*Salix*	*exigua*	SAEX	Shrub
Quailbush	*Atriplex*			Shrub
Seep Willow/Mulefat	*Baccharis*	*salicifolia*	BASA	Shrub
Freemont Cottonwood	*Populus*	*fremontii*	POFR	Tree
Goodings Willow	*Salix*	*goodingii*	SAGO	Tree
Honey Mesquite	*Prosopis*	*glandulosa*	PRGL	Tree
Screwbean Mesquite	*Prosopis*	*pubescens*	PRPU	Tree
Alfalfa	*Medicago*	*sp.*	MESP	Forb

*Trees can be treated as shrubs if less than 1.4 meters tall, but shrubs are always shrubs reguardless of height.
**if you know the genus but not the species the code will be the first two letters of the genus followed by sp.

8

Appendix 4. Bird abundance codes during YBCU surveys, north of Bill Williams River, 2008.
Relative abundance codes: 1=fewer than five detected during visit, 2=five to ten detected, 3=eleven to twenty detected, 4=more than twenty detected. Abundance codes were averaged for all site visits.

Species name	PAHNTH	PAHSTH	OVRHP	OVRW	HAVBR	HAVND	HAVPS	HAVTPR
Abert's Towhee			1.7	2.0	2.5	1.5	2.5	1.0
American Avocet	1.0							
American Coot			1.0		1.0	2.0		
American Crow	3.5							
American Gadwall	2.0							
American Kestrel	1.0	1.0	1.0	1.0				
American Pelican	3.0							
American Redstart							1.0	
American White Pelican		4.0				2.0		
Anna's Hummingbird							1.0	
Ash-throated Flycatcher	2.0	1.0			1.0			1.0
Barn Owl								
Bell's Vireo				1.0	1.5	1.0	1.0	1.0
Bewick's Wren	1.0	1.0						
Black Phoebe	1.0	1.0	1.0	1.0				1.0
Black Rail								
Black-chinned Hummingbird	1.0	1.0	1.0			1.0	1.0	
Black-crowned Night-heron				1.0				
Black-headed Grosbeak	1.5							
Black-necked Stilt	1.0							
Black-tailed Gnatcatcher				1.0				1.0
Black-throated Sparrow		1.0						
Blue Grosbeak	1.0	1.0	1.0	1.5	2.0	1.0	1.0	1.0
Blue Winged Teal	1.0							
Brown-crested Flycatcher	1.0	1.0			2.0			
Brown-headed Cowbird	3.0	1.0	2.7	3.5	3.0	1.5	1.5	1.5
Bullock's Oriole	1.0				1.0		1.0	1.5
Bushtit			3.0					
California Gull	3.0	1.0						
Canada Goose		3.0	1.0	3.0				
Canvasback				2.0				
Cassin's Kingbird								2.0
Cattle Egret				1.0				
Cinnamon Teal			1.0					
Clarks Grebe						1.0		
Cliff Swallow			1.0	2.0		2.0	4.0	
Common Ground Dove					1.0			
Common Raven		1.0	1.0					
Common Yellowthroat	4.0	2.7	1.7	2.3	3.5	2.5	2.0	1.0
Crissal Thrasher				1.0				
Double-crested Cormorant			1.0					
Eurasian Collared Dove		1.0		1.0				
Gadwall		1.0						
Gambel's Quail		3.0	1.3	2.0	1.5	2.0	1.5	3.5
Gray Catbird	1.0							
Great Blue Heron	1.0	1.0	1.0	1.0			1.0	
Great Egret		1.0	1.0			1.0	1.0	

Species name	PAHNTH	PAHSTH	OVRHP	OVRW	HAVBR	HAVND	HAVPS	HAVTPR
Great Horned Owl		1.0					1.0	
Greater Roadrunner				1.0	1.0	1.0	1.0	
Greater Yellowlegs								
Great-tailed Grackle		1.0	2.5	2.0	3.5	2.5	2.5	4.0
Green Heron				1.0	1.0	1.0	1.0	
Green-winged Teal		1.0						
House Finch	1.5	2.0			1.5	1.0	1.5	2.0
House Sparrow				1.0				
House Wren		1.0						
Killdeer	1.0	1.0		1.0	1.0			
Ladder-backed Woodpecker	1.0	1.0			1.0			1.0
Lazuli Bunting		1.0						
Lesser Goldfinch	1.0	1.0		2.0				1.0
Lesser Nighthawk					1.0	1.0	3.0	
Lucy's Warbler			1.0	1.0			3.0	
Mallard	2.0	2.0	1.0		2.0			
Marsh Wren			1.5					
Mourning Dove	3.5	2.0	2.3	1.7	3.0	2.5	4.0	3.5
Northern Flicker								1.0
Northern Harrier	1.0			1.0				
Northern Mockingbird	1.0	1.0		1.0	1.0		1.0	
Northern Pintail		3.0						
N. Rough-winged Swallow	1.0		1.7	4.0	1.0	3.0	2.5	
Osprey		1.0						
Peregrine Falcon			1.0					
Phainopepla				2.0				
Pied-billed Grebe			1.0		1.0			
Red-tailed Hawk		1.0						
Red-winged Blackbird	2.5		1.0	3.0	1.0	1.0	2.5	
Ring-neck Duck			1.0					
Say's Phoebe			1.0	1.0		1.0		
Snowy Egret			1.0	1.0			1.0	
Song Sparrow	4.0	1.7	2.0	2.0	3.0	2.0	1.0	
Spotted Sandpiper		1.0						
Spotted Towhee	2.0							
Summer Tanager		1.0					1.0	
Swainson's Hawk						1.0		
Turkey Vulture	1.5	2.0		1.0			1.0	
unknown Flycatcher						1.0		
Unknown Swallow sp.			1.0				1.0	
Verdin			1.0	1.0	1.0	1.0		1.0
Violet-green Swallow				1.0			1.0	
Virginia Rail			1.0					
Western Flycatcher	1.0	1.0						
Western Grebe			1.0		2.0	1.0		
Western Kingbird	2.5	1.0			1.0	1.0	1.0	
Western Tanager	1.0	1.0						
Western Wood-pewee	2.0							1.0
White-faced Ibis			2.0		1.0			
White-throated Swift			3.0	1.0				
White-winged Dove			3.0	2.0	1.5	2.5	4.0	3.0
Wild Turkey				3.0				

Species name	PAHNTH	PAHSTH	OVRHP	OVRW	HAVBR	HAVND	HAVPS	HAVTPR
Willow Flycatcher	1.5		1.0	1.0				
Wilson's Warbler	1.0							
Yellow Warbler	4.0	1.7	1.3	2.7	2.0	1.0		1.5
Yellow-billed Cuckoo					0.2	0.4		0.2
Yellow-breasted Chat	1.5	1.7	1.3	2.3	3.0	2.5	2.0	2.0
Yellow-headed Blackbird		2.0	1.5	1.0	1.0			

Appendix 5. Bird abundance during YBCU surveys, Bill Williams River NWR 2008.
Relative abundance codes: 1=fewer than five detected during visit, 2=five to ten detected, 3=eleven to twenty detected, 4=more than twenty detected. Abundance codes were averaged for all site visits.

Species name	BB	CW	FW	GR	HB	MF	MW	SS	SW
Abert's Towhee	2.0	7.0	2.0	1.5	1.0	3.0	1.0	1.0	3.0
American Kestrel					1.0				
Ash-throated Flycatcher	1.0	2.5	1.5	1.5	2.0	2.5	1.5	6.0	
Bell's Vireo	2.0	3.5	2.0	2.5	3.0	2.5	2.5	4.0	2.3
Bewick's Wren	1.0	1.0	1.0	1.0	1.0		1.0	1.5	1.5
Black Phoebe	1.0			1.0	3.0		1.0		
Black Rail	1.0	1.0		1.0	1.0	1.0			
Black-chinned Hummingbird			1.0	1.0	1.0	1.5		1.0	1.0
Black-crowned Night-heron			1.0					1.0	
Black-headed Grosbeak									2.0
Black-tailed Gnatcatcher	1.0	1.0		2.0	1.0			1.0	
Black-throated Sparrow									
Blue Grosbeak	1.0	2.5	1.0	1.5	1.0	2.0	1.0	1.0	2.0
Blue-gray Gnatcatcher			1.0			2.0	1.0	1.0	
Brown-crested Flycatcher	1.0	1.0	1.0	1.0	2.0	1.0	1.0	1.5	2.0
Brown-headed Cowbird	3.0	5.0	2.5	3.0	3.0	3.5	2.0	3.0	2.7
Bullock's Oriole	1.0	2.0		1.0	2.0	1.0	1.0		1.0
bunting species							1.0		
Bushtit								1.0	
Canyon Wren	1.0	3.0		1.5	2.0	2.0	1.0	3.7	1.0
Cliff Swallow	4.0		1.0	1.0	1.0				3.0
Common Ground Dove		1.0							1.0
Common Moorhen									
Common Raven	1.0	1.0		2.0	1.0		1.0		1.0
Common Yellowthroat	2.0	3.5	2.5	3.0	3.0	2.0	2.0	2.3	2.7
Coopers Hawk									1.0
Cordilleran Flycatcher									1.0
Crissal Thrasher	1.0	1.0	1.0				1.0	1.0	3.0
Flicker Sp.								1.0	
Gambel's Quail	4.0	7.0	3.0	3.0	2.0	4.0	3.5	8.0	2.7
Gila Woodpecker	2.0	4.0	1.0	2.0	2.0	3.0	2.0	3.7	2.3
Great Blue Heron	1.0		1.0	1.0				2.0	
Great Egret			1.0						
Great Horned Owl					1.0				
Greater Roadrunner						1.0	1.0		1.0
Greater Yellowlegs									
Great-tailed Grackle			1.0	2.0	1.0	2.0		3.0	2.0
Green Heron		1.0	1.0	1.0	2.0			1.0	
House Finch	1.0	1.0	1.0	1.0	3.0	1.5	1.0	1.0	1.0
Killdeer							1.0	1.0	
Ladder-backed Woodpecker	1.0	1.0	1.0	1.0	1.0	1.5	1.0	1.0	2.0
Lesser Goldfinch	2.0		2.0	1.0	4.0	2.0			1.0
Lesser Nighthawk	4.0	3.0	1.0	1.0	1.0	1.0	1.5		1.5
Lucy's Warbler		2.0			2.0	1.0	1.0	3.0	2.0
Mourning Dove	3.0	6.5	4.0	2.5	4.0	2.5	2.0	3.7	3.7
Northern Flicker					1.0		1.0		

Species name	BB	CW	FW	GR	HB	MF	MW	SS	SW
Northern Mockingbird	1.0	2.0		1.0			1.0		
N. Rough-winged Swallow					3.0	1.0	1.0		2.0
Pacific-slope Flycatcher	1.0	1.5	1.0	1.0			2.0	1.0	
Phainopepla	1.0					1.0	1.0		
Pied-billed Grebe		1.0						1.0	
Red-tailed Hawk		2.0		1.0	1.0		1.0		
Red-winged Blackbird	2.5	5.0			1.0			2.0	
Rock Wren						1.0		1.0	
Say's Phoebe						1.0		1.0	
Snowy Egret								1.0	
Song Sparrow	3.5	9.0	3.5	4.0	4.0	3.5	2.5	7.7	3.0
Summer Tanager	1.0	2.0	1.0		1.0	1.0	1.0	3.0	1.0
Tree Swallow			1.0						
Turkey Vulture	1.0	2.0		1.5	1.0	1.0	1.0	2.0	1.0
Verdin	1.5	3.0			1.0	3.5	1.0	4.0	1.0
Violet-green Swallow	2.0			1.0	2.0	1.0	1.0	1.0	
Virginia Rail									
Western Kingbird					1.0				
Western Screech Owl									1.0
Western Wood-pewee			1.0			1.0			
White-faced Ibis	4.0			4.0				4.0	4.0
White-throated Swift	1.0			1.0	1.0				
White-winged Dove	3.0	12.0	2.5	4.0	4.0	4.0	3.0	7.0	3.7
Willow Flycatcher							1.0		
Wood Duck			1.0						
Yellow Warbler	1.0	6.0	2.0	1.0	3.0	2.5	1.0	4.5	3.0
Yellow-billed Cuckoo	1.2	1.2	0.6	0.8	1.2	0.8	0.8	0.6	0.6
Yellow-breasted Chat	2.5	9.0	4.0	4.0	3.0	4.0	3.5	13.7	4.0

Appendix 6. Bird abundance during YBCU surveys near Blythe, 2008.
Relative abundance codes: 1=fewer than five detected during visit, 2=five to ten detected, 3=eleven to twenty detected, 4=more than twenty detected. Abundance codes were averaged for all site visits.

Species name	CRIT	PVER	CVCA	CIBCNT	CIBNTH	CIBEUC	CIBSTH	GRGC	GRQP
Abert's Towhee	3.0	2.0	1.7	1.5	1.0	1.0	1.0	2.0	2.3
American Coot								1.0	
American Kestrel		1.0		1.0					
Anna's Hummingbird	1.0				1.0			1.0	
Ash-throated Flycatcher	2.0	3.0	1.0	2.0		2.0	2.3	1.0	
Barn Owl	1.0	1.0							
Bell's Vireo									1.0
Black Phoebe							1.0		1.0
Black Rail									
Black-chinned Hummingbird	1.0	3.0	2.0	3.0				1.0	1.0
Black-crowned Night-heron									
Black-headed Grosbeak	1.0	3.0							
Black-necked Stilt									
Black-tailed Gnatcatcher		2.0				1.0	1.5	1.0	1.0
Black-throated Sparrow									
Blue Grosbeak	1.0	1.0	2.7	1.5	1.0		1.0	2.0	1.0
Bronzed Cowbird	1.0								
Brown-crested Flycatcher	1.0						1.0		
Brown-headed Cowbird		3.0	3.7	2.0	1.3	2.5	4.0	3.0	2.7
Bullock's Oriole	1.0		1.0	1.5	1.0	2.0	1.0	1.0	2.0
Canada Goose					1.0				
Cassin's Kingbird					2.0				
Cliff Swallow		4.0	4.0					3.0	
Common Ground Dove				1.0				1.0	1.0
Common Raven		1.0					1.0		
Common Yellowthroat	1.0		1.0	1.0	1.0		1.5	2.0	2.0
Eurasian Collared Dove			1.0		1.0	1.0		2.0	1.5
European Starling			2.0						
Gadwall									
Gambel's Quail	3.0	2.0		1.0	2.0	1.0	1.5	4.0	3.7
Gila Woodpecker							1.0		1.0
Great Blue Heron		1.0							
Great Egret	1.0	1.0					1.0	1.0	
Great Horned Owl	1.0	1.0				1.0	1.0	1.0	1.0
Greater Yellowlegs									
Great-tailed Grackle	2.0	2.5		1.0	2.3	1.0	4.0	2.0	2.0
Horned Lark	1.0								
House Finch	1.0	2.0	2.0	2.5	4.0	1.5	1.0		2.3
House Sparrow	1.0								
Indigo Bunting			2.0						1.0
Killdeer			2.0	2.5	1.0			1.0	
Ladder-backed Woodpecker						1.0	1.0	1.0	1.0
Lazuli Bunting							1.0		
Lesser Goldfinch	1.0		1.0						2.0
Lesser Nighthawk		3.0	1.0	2.0	1.5	1.0	2.0		1.0
Loggerhead Shrike		1.0				1.0	1.0	1.0	

Species name	CRIT	PVER	CVCA	CIBCNT	CIBNTH	CIBEUC	CIBSTH	GRGC	GRQP
Lucy's Warbler	2.0	1.0	3.0		1.0	1.0	1.0	1.0	
Mallard							1.0	1.0	1.0
Marsh Wren								1.0	
Mourning Dove	4.0	2.5	3.3	3.0	2.3	2.5	3.0	3.5	4.0
Northern Mockingbird	2.0	1.0	1.0	1.0		1.0	2.0	2.0	1.0
Northern Pintail									
N. Rough-winged Swallow	2.0	3.5	2.3	3.0	1.0	1.0	4.0	2.0	3.0
Pacific-slope Flycatcher									1.0
Phainopepla							1.0		
Pied-billed Grebe								1.0	
Red-tailed Hawk		1.0				1.0	1.0		1.0
Red-winged Blackbird	2.0	3.0	4.0	3.0	2.0	2.0	2.7	3.0	3.3
Ring-necked Pheasant								1.0	
Snowy Egret							1.0		
Song Sparrow			1.0	1.0			1.7	1.5	2.0
Turkey Vulture			1.0			1.0	1.0		
Unknown Egret			1.0						
unknown Flycatcher				1.0					
Unknown Gull		1.0							
Unknown Hummingbird		1.0	1.0					2.0	1.0
Verdin	1.0					1.0	1.3		1.5
Vermillion Flycatcher	2.0					1.0			
Western Flycatcher							1.0		
Western Grebe									
Western Kingbird	2.0	2.5	1.7	2.5	2.0	2.0	2.0	2.0	2.0
Western Meadowlark	1.0			1.0				1.0	
White-faced Ibis	4.0	2.0	4.0	4.0		3.0	4.0	3.0	
White-winged Dove	4.0	2.5	4.0	3.0	2.0	3.5	3.7	4.0	4.0
Wild Turkey					1.0				
Willow Flycatcher							1.0		1.0
Yellow Warbler			1.0				1.0	1.0	1.0
Yellow-billed Cuckoo	0.4	0.4	0.8	0.2			0.6	0.2	
Yellow-breasted Chat	2.0	1.0		1.5			2.3	1.0	1.0
Yellow-headed Blackbird		1.0	1.7	1.0			3.0	2.5	

Appendix 7. Bird abundance during YBCU surveys near Yuma, 2008.
Relative abundance codes: 1=fewer than five detected during visit, 2=five to ten detected, 3=eleven to twenty detected, 4=more than twenty detected. Abundance codes were averaged for all site visits.

Species name	PICSR	IMPSTH	IMP20A	MLPR	YUCC	YUWW	LIMNTH	LIMSTA	LIMSTB
Abert's Towhee	2.0	1.0		3.0	3.0	2.3	1.7	2.0	2.0
American Coot				1.0	1.0		1.0		
American Kestrel			1.0			1.0	1.0		
Anna's Hummingbird						1.0			1.0
Ash-throated Flycatcher	1.5	1.0	1.0	2.0		2.0	1.0		1.0
Bell's Vireo	1.0								
Belted Kingfisher	1.0								
Black Phoebe	1.0				2.0		1.0	1.0	
Black Rail									
Black-chinned Hummingbird					1.0	2.3	1.0		1.0
Black-crowned Night-heron					1.0				
Black-necked Stilt		1.0	1.0		1.5				
Black-tailed Gnatcatcher	1.0			1.0	1.0	1.0	2.0		1.0
Blue Grosbeak	1.0	1.0	1.0	1.0	2.5	1.0	2.0		1.0
Bronzed Cowbird						1.0			
Brown-headed Cowbird	1.5	2.0	2.0	3.0	3.0	3.0	3.0	2.0	2.5
Bullock's Oriole	1.0	1.0	2.0	1.0	1.0		1.0		
Burrowing Owl						1.0	1.0		
Bushtit	1.0								
Cattle Egret									1.0
Clapper Rail		1.0							
Cliff Swallow	3.0			4.0	4.0	4.0	1.0	4.0	4.0
Common Ground Dove					1.0	1.0			1.0
Common Moorhen				1.0	1.5		1.0		
Common Yellowthroat	2.0	1.0	2.0	1.0	3.0	1.5	1.3	2.0	2.0
Crissal Thrasher						1.0	1.0		
Eurasian Collared Dove		1.0		1.0	2.0		1.0	1.0	
European Starling						1.5			
Gambel's Quail	3.5	1.0	1.0	3.0	1.0	2.3	1.0	4.0	1.0
Gila Woodpecker	1.5	1.0		2.0	1.0	1.7	1.0		
Great Blue Heron		1.0			1.5	1.0	1.0		1.0
Great Egret		2.0				2.7			1.0
Great Horned Owl					1.0	1.0	1.0		
Greater Pewee						1.0			
Greater Roadrunner					1.0	1.0	1.0	1.0	
Greater Yellowlegs					1.0				
Great-tailed Grackle	2.0	2.0		3.0	2.0	3.7	3.0	3.0	1.5
Green Heron	1.0	1.0		1.0	2.0	1.0	1.0		1.0
House Finch	4.0	1.0		2.0	2.0	2.0	1.5	2.0	1.0
House Sparrow								2.0	
Inca Dove							1.0		
Killdeer		1.0		1.0	1.0	1.0	1.0		1.0
Ladder-backed Woodpecker	2.0	1.0		1.0	2.0	1.5	1.5		1.0
Least Bittern					1.0				

Species name	PICSR	IMPSTH	IMP20A	MLPR	YUCC	YUWW	LIMNTH	LIMSTA	LIMSTB
Lesser Goldfinch	1.0	1.0				1.0		1.0	
Lesser Nighthawk	1.0	1.0	1.0						
Loggerhead Shrike	1.0	1.0							
Lucy's Warbler		1.0			1.0	1.0	1.0	1.0	1.0
Mallard					1.0				
Marsh Wren		1.0		1.0	2.0			1.0	1.0
Mourning Dove	3.0	1.7	2.0	3.0	3.0	3.3	2.3	2.5	3.0
Northern Mockingbird						3.3	1.0	1.0	1.0
Northern Pintail									
N. Rough-winged Swallow	1.0		1.0	2.5	2.0	1.0	2.5	10.0	
Osprey					1.0		1.0		
Phainopepla						1.0			
Pied-billed Grebe			1.0	1.0	1.0		1.0		
Red-tailed Hawk	1.0								
Red-winged Blackbird	1.0	2.0	2.0	3.0	4.0	2.5	2.7	3.0	4.0
Ring-necked Pheasant					1.0			1.0	1.0
Rock Pigeon						3.0	1.5		
Semipalmated Plover					1.0				
Snowy Egret		1.0		1.0	1.0	1.0	1.0		1.0
Song Sparrow	3.0	1.0		2.0	2.5		1.0	1.0	1.5
Spotted Sandpiper					1.0				
Summer Tanager	1.0	1.0							
Turkey Vulture	4.0				1.0				
unknown blackbird								3.0	
Unknown Empid						1.0			
unknown Flycatcher									1.0
Unknown Hummingbird				1.0		4.0	1.0		
Verdin	1.5			1.0	1.0	2.0	1.3		1.0
Vermillion Flycatcher		1.0							
Western Kingbird	2.0	2.0	1.0	1.5	1.5	2.0	1.5	1.5	
Western Tanager		1.0							
White-faced Ibis	4.0	1.0		2.0			4.0		
White-throated Swift	2.0								
White-winged Dove	4.0	1.7	2.0	4.0	3.0	3.7	4.0	2.5	2.5
Willow Flycatcher	1.0		1.0			1.0		2.0	6.0
Yellow Warbler		1.0							
Yellow-billed Cuckoo	0.2	0.4	0.2	0.2		0.6			0.2
Yellow-breasted Chat	3.0			2.0	1.0	1.0	1.0		
Yellow-headed Blackbird					3.0		1.0		