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, 2009 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

June 2010

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Lower Colorado River Multi-Species Conservation Program

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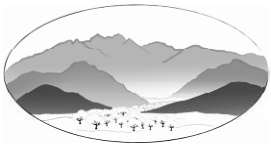

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Research for Conservation of Biological Diversity

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Contents

List of Tables

List of Figures

LIST OF APPENDICES

1

EXECUTIVE SUMMARY

In 2009, Southern Sierra Research Station (SSRS) conducted call-playback surveys for Yellow-billed Cuckoos (*Coccyzus americanus*) at 58 sites within the lower Colorado River Basin, under the Lower Colorado River Multi-Species Conservation Program. Cuckoos were detected 178 times during surveys. The estimated survey detection probability was 59% overall. This varied throughout the season, and was highest in July (84%) and lowest after mid-August (19%). Cuckoo detections were correlated with cicada abundance throughout the season, with cuckoo detections peaking two weeks before peak cicada abundance. Based on survey and incidental detections, 42 potential breeding pairs were estimated to occur in the region, with breeding confirmed at four locations: the Bill Williams River National Wildlife Refuge, Palo Verde Ecological Reserve, Cibola Valley Conservation Area, and Cibola National Wildlife Refuge. Similar to previous research, nest plots in 2009 were significantly cooler and more humid than other plots, while occupied plots were slightly cooler and more humid than unoccupied plots. Ten cuckoos were mist-netted and color-banded during the season, including nine at restoration sites. One of these was a recapture of a banded nestling, giving the first recorded Yellow-billed Cuckoo natal dispersal distance of 33 km. Six cuckoos were outfitted with radio transmitters at restoration sites and followed for 5 or more days. Their mean home range estimates were 21.6 ±8.8 hectares (95% kernel density) and 27.6 ±15.0 hectares (minimum convex polygon). As more data are collected over the next three years, a more complete understanding of breeding habitat requirements within this region should enhance the success of future riparian habitat restoration projects.

INTRODUCTION

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 goals including habitat conservation, recovering threatened and endangered species, and preventing the listing of additional species (LCR MSCP 2004a). The MSCP covers areas within the historical floodplain of the Colorado River from Lake Mead to the United States-Mexico Southerly International Boundary, a distance of about 400 river miles (LCR MSCP 2004a). Developed between 1996 and early 2005, the LCR MSCP includes the creation of more than 3,278 hectares (ha) (8,100 acres, ac) of riparian, marsh and backwater habitat for six listed species and 21 other species native to the lower Colorado River, including at least 1,639 ha (4,050 ac) of habitat for the riparian obligate Yellow-billed Cuckoo (LCR MSCP 2004a).

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). Mearns (1907) estimated approximately 160,000-200,000 ha (400,000-500,000 ac) of alluvial floodplain between Fort Mohave and Yuma, densely wooded throughout (Grinnell 1914). By 1980, only 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 supports two distinct subspecies (Ridgeway 1887,

Franzreb and Laymon 1993, Pruett et al. 2001), while other research finds no basis for separate subspecies status (e.g. Banks 1988, Fleischer 2001). In 2001, the United States Fish and Wildlife Service (USFWS) determined that western Yellow-billed Cuckoos represent a Distinct Population Segment (DPS), and that this population was 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 U.S. Forest Service lands within Arizona and New Mexico (USDA 1988).

Cuckoos begin arriving in Arizona and California in late May (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). Nests take one to two days to build, and are often at the edge of openings (Hamilton and Hamilton 1965). 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 may be 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 mesquite (*Prosopis* spp.) and tamarisk (*Tamarix* spp.) (Halterman et al. 2001).

While variations exist in plant species composition and structure across their western range, cuckoo presence has been shown to be correlated with patch size (Halterman 1991). In a meta-analysis of edge effect studies, cuckoos demonstrated an avoidance of small patches, and affinity for edges (Parker et al. 2005). Cuckoos were estimated to require 10-40 ha of habitat on the Sacramento River in California (Gaines 1974, Laymon 1980), while mean home range estimates of radio-tracked cuckoos on the San Pedro River in Arizona were 39 to 51 ha (Halterman and Oring 2009a). There are currently no home range estimates from marked cuckoos within the LCR.

Insects have previously been observed to have a major impact on avian communities on the lower Colorado River (Andersen 1994), and prey base may influence nest site selection (Westmoreland et al. 2007, Koenig and Liebhold 2005). In particular, Apache cicadas (*Diceroprocta apache*) are a significant food source for many western riparian breeding birds (Rosenberg et al. 1982). Of three cuckoo nests monitored in Arizona and California, Apache cicadas accounted for over 45% of all food items brought to the nestlings (Halterman 1998). Eastern Yellow-billed Cuckoo populations have been found to fluctuate greatly in response to periodical cicada abundance (Koenig and Liebhold 2005). Food availability may be 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 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 (LCR) from 2005-2007 (Johnson et al. 2006, 2007, 2008). SSRS conducted cuckoo surveys on the LCR in 2008 (Halterman et al. 2009b). Some of these data were used to interpret the results of the 2009 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. 2008) and refine it to use over the term of the MSCP.

METHODS

Survey Site Selection

During April and May 2009, riparian habitat patches within the study region were assessed. A habitat patch was defined as an area of potentially suitable cuckoo habitat 2 ha (4.9 ac) or greater in extent, that was separated from another patch of potentially suitable

habitat by at least 300 meters (m) of non-habitat. A survey site was defined as part of a patch, an entire patch, or a collection of patches of potentially suitable habitat that was treated as one site. Sites were selected based on past cuckoo detections, patch size, plant species composition, and habitat structure. Sites surveyed in 2008 were surveyed in 2009 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 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 the boundaries with a GPS unit. Where site boundaries were inaccessible (such as areas of BWR NWR), boundaries were estimated in ArcGIS 9.3 using geo-referenced 2004 aerial photography. Each site's size (ha), length, average width of riparian habitat (size divided by length), and contiguous patch size (ha) were estimated using ArcGIS 9.3.

After all surveys were completed, a site occupancy status (occupied or unoccupied) was assigned to each survey site. In 2008 a site was considered occupied if one or more cuckoos were detected at the site during more than one survey period (Halterman et al. 2009b). This was modified in 2009 such that a site was considered occupied only if there

were two or more cuckoo detections, a minimum of 16 days apart (the minimum number of days from egg laying to fledging). This change ensured that transient cuckoos did not warrant occupancy. The distance from each site to the nearest known occupied site (not counting the site itself) was estimated 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 types of disturbance were visually estimated. 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.

In 2009, woody riparian land cover vegetation classification (Anderson and Ohmart 1984) was recorded for sites, plots, and survey points. This classification includes plant community cover type (Table 1) and structure of the vegetative cover (Table 2). An additional classification was added in 2009 to describe average cover of the dominant vegetation: Open (25% or less cover), Medium (26% to 74% cover), and Closed (75% or more cover). This was added as there was considerable variation in cover between sites which otherwise had the same classification.

Table 1. Woody Riparian Land Cover Types and Characteristics Used in Classification.

Habitat Type	Code	Characteristics
Cottonwood-willow	CW	*Salix gooddingii* and *Populus fremontii* (the latter usually in low densities) constituting at least 10 percent of total trees (remaining trees are usually saltcedar).
Saltcedar	SC	*Tamarix* spp. constituting 80–100 percent of total trees.
Honey mesquite	HM	*Prosopis glandulosa* constituting 90–100 percent of total trees.
Saltcedar–honey mesquite	SHM	*Prosopis glandulosa* constituting at least 10 percent of total trees; rarely found to constitute more than 40 percent of total trees.
Saltcedar–screwbean mesquite	SSM	*Prosopis pubescens* constituting at least 20 percent of total trees.
Arrowweed	AW	*Pluchea sericea* constituting 90–100 percent of total vegetation in area.
Atriplex	ATX	*Atriplex lentiformis, A. canescens* and/or *A. polycarpa* constituting 90–100 percent of total vegetation in area.

Source: Anderson and Ohmart 1984.

Table 2. Description of Woody Riparian Land Cover Structural Types.

Type I	Mature stand with distinctive overstory more than 4.6 meters (m) (15 feet) tall; intermediate class is 0.6–4.6m (2–15 feet) tall and understory is 0–0.6m (0–2 feet) tall.
Type II	Overstory is more than 4.6m (15 feet) tall and constitutes more than 50% of the trees; little or no intermediate class present.
Type III	Largest proportion of trees is 3.05–6.1m (10–20 feet) tall; few trees above 6.1m (20 feet) or below 1.5m (5 feet) tall.
Type IV	Few trees above 4.6m (15 feet) tall; 50% of the vegetation is 1.5–4.6m (5–15 feet) tall and 50% is 0.3–0.61m (1–2 feet) tall.
Type V	60–70% of the vegetation is 0–0.61m (0–2 feet) tall; the remainder is 1.5–4.6m (5–15 feet) tall.
Type VI	75–100% of the vegetation is 0–0.61m (0–2 feet) tall.

Source: Anderson and Ohmart 1984.

Yellow-billed Cuckoo Surveys

Cuckoo surveys were conducted following Halterman et al. (2008). Four or five complete surveys of each site were performed during the field season (mid 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 detection.

A survey detection was defined as an individual cuckoo that was seen or heard during a survey. A non-survey or incidental detection occurred when an individual cuckoo was encountered any time other than during a cuckoo survey. An individual cuckoo detected more than once during a single survey was 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 date, start and stop times, and basic weather data such as temperature, wind, and cloud cover.

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. When a cuckoo was detected at a survey point, playback ceased, and 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. 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 were 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 overlaid with geo-referenced 2004 aerial photographs of the LCR. Survey detection maps were created for all sites, with the surveyor's location represented by a circle, and the distance/bearing of the detection represented by an arrow. These maps (Appendix 5) 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.

DETECTION PROBABILITY

The probability of detecting a species can be estimated from repeated surveys of a site (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. Estimates were calculated using the software program PRESENCE v2.4 (Hines 2006). Survey data were converted to presence/absence for each survey at each site. The program was modified to use the definition of occupancy described above, i.e. at least two detections, at least 16 days apart (the default is to consider a site occupied if a species is detected once). Overall detection probability was calculated, as well as for each survey period, for all sites, and for restoration and natural sites separately.

Breeding Status

Yellow-billed Cuckoos are quiet and secretive birds, making it difficult to accurately estimate their populations (Laymon et al. 1997, Halterman et al. 2009a). They can have large home ranges and vocalize infrequently (Hamilton and Hamilton 1965, Halterman et al. 2009a, Halterman and Oring 2009a), and may abandon their nest due to nest-searching activity (Halterman 1998). Confirming breeding can therefore be time-consuming and invasive, and relatively few nests are typically found during a season. Alternate methods for estimating breeding populations are therefore required. All detections were assessed by location, observed behaviors and detection dates. Breeding probability in each detection area was then categorized as *possible*, *probable*, or *confirmed*. One or more cuckoos detected in an area at least 16 days apart warranted a *possible breeding pair* (POB). Cuckoos observed carrying food, traveling as a pair, or exchanging vocalizations were considered a *probable breeding pair* (PRB). Breeding was only *confirmed* (COB) when a copulation, stick carry, nest, or fledgling was observed. Estimates of breeding status were based on all detections, including incidental, survey, and follow-up. Follow-up visits included nest searching, mist netting, telemetry, and other site visits. The term potential

breeding area was 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 mated pairs share incubation duties. Male cuckoos incubate overnight (Payne 1997, 2005). The female changes place with the male shortly after sunrise, and both members of the pair often vocalize during the exchange. Additionally, some individuals call prior to arriving at the nest to feed young. One or more researchers waited in a location where cuckoos were recently detected and suspected of nesting. When cuckoos called, researchers repositioned to triangulate on the calling locations. When a nest was located, a GPS reading was taken approximately 10 m from the nest. A more accurate GPS reading was taken after nesting activities ceased.

Nests were monitored every 2-5 days. Nest contents were checked using a telescoping 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 (i.e. nest less than 6 m high). Each chick was banded with a USGS aluminum band and a Darvic 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 (g) Pesola® scale. Blood and feather samples were collected for genetic analysis. Blood was extracted from either a radial or femoral vein puncture.

Target Mist Netting

A targeted mist net technique modified from Sogge et al. (2001) was used to capture adult cuckoos for radio telemetry, to locate nests, and observe cuckoo habitat use at restoration and non-restoration sites. Two methods were used. In the first method, two double-stacked 60 mm mist nets, ranging from 6-12 m in length, were placed in a 'V' pattern near low vegetation. In the second method, two 12 m tall poles and a pulley system were used with 4-stacked (10.4 m high) mist nets. This net set-up was placed in a vegetation gap. With both methods one person played a variety of cuckoo calls using a CD or MP3 player and two speakers placed 1 m high in a tree on each side of the net. Capture efforts typically began just after dawn. If no cuckoos displayed interest after approximately 45 minutes, the nets were moved to another location. Attempts ceased when temperatures reached 40° C (104° F).

All unbanded cuckoos captured were banded with a USGS gold anodized aluminum band and a unique combination of three Darvic color bands. 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 100 g Pesola® scale or 400 g Acculab digital scale. Blood was extracted by brachial vein puncture and placed on PermaCode™ cards for genetic analysis. No other species captured during netting efforts were banded.

Blood samples were sent to Avian Biotech International for DNA sexing. Birds unable to be sexed through DNA were sexed behaviorally or morphologically as follows: nesting birds observed incubating at night were male (Payne 1997, 2005); nesting birds that did not incubate at night were female. Additional behaviors were used to tentatively sex birds unable to be sexed through incubation time: birds observed giving the 'coo' call were more likely to be female (Halterman et al. 2009a), and birds observed to be the sole fledgling caregiver were more likely to be male (Halterman and Oring 2009b). Additionally, birds presenting a distinct cloacal protuberance (CP) were male (Pyle 1997).

Radio Telemetry

Captured birds were fitted with a Holohil BD-2g transmitter (Holohil LTD), weighing 1.95 grams and transmitting for 60 days. Transmitters were either back-mounted with cyanoacrylate, or attached to the base of the tail with dental floss. To back-mount the transmitter, feathers were first trimmed to 5 mm in a small patch on the bird's back, and the transmitter was glued in place using cyanoacrylate (following Mong and Sandercock 2007). Transmitters were held in place gently for at least one minute while the glue dried. Transmitters that were attached to the tail were tied or stitched through the two central rectrices and secured at the base of the bird's tail with dental floss (Bray and Corner 1972, Pitts 1995, Woolnough et al. 2004).

Radio-marked cuckoos were monitored using one of two types of telemetry receiver (Wildlife Materials TRX48S and Communications Specialists Model R1000), and one of two types of directional antennae (AF Antronics model F151-3FB and Communications Specialists RA-150 Folded Yagi). Receivers were tuned to broadcast at 148-152 megahertz. To record behavioral data as well as locations for habitat use, observers attempted to sight

the bird once every 30 to 60 minutes. Vocalizations, intra-specific interactions, movements, breeding behaviors and habitat characteristics were recorded for each location. If it was determined that observer presence was affecting a bird's movements or behavior, locations were recorded using triangulation. Two observers took simultaneous bearings 10-60 degrees apart (Springer 1979) and later mapped the bearings to determine the bird's actual location.

Telemetry points were imported into ArcGIS 9.3, and home ranges were calculated for each cuckoo using Hawth's Analysis Tools (Beyer 2004). Three methods were used to estimate home ranges: minimum convex polygons (MCP), and 50% and 95% kernel density estimators (KDE, Silverman 1986). MCP and 95% KDE estimates are commonly used to represent an animal's home range, while the 50% KDE is used to describe an animal's core range (Laver and Kelly 2008). MCPs are obtained by connecting all outer data points to form a convex hull (following Mohr 1947). While popular due to its simplicity, the MCP is extremely sensitive to data outliers, often over-estimating the animal's true home range (Worton 1995). KDEs determine the probability of locating the bird in an area at any given time, and are less biased towards outliers (Seaman and Powell 1996). The user determines the desired probability level (e.g. 95%), and the smallest area covering that percentage of all data points is calculated. A fourth estimate ("clipped KDE") was also calculated, with agricultural areas removed from the 95% KDE, to eliminate areas known to be unused.

Habitat Characterization

Plot Site Selection

Habitat characterization plots were established throughout the study region. One project objective was to determine microclimate differences between occupied and

unoccupied cuckoo habitat. Because only minor microclimate differences have been found between occupied and unoccupied plots in previous years (Halterman et al. 2009b), a new method was used to place the data loggers. Using detection data from the previous 3 years (2006-2008), areas both occupied and unoccupied for each of the past 3 years were determined using ArcGIS 9.3, and loggers were placed at the centers of these areas. Logger placement was stratified by occupancy status (occupied or unoccupied) and restoration status (restoration site or natural). Loggers were also placed at cuckoo nest locations from 2007 and 2008, and at nests found during 2009. Loggers at historic nest locations were hung as close to the recorded UTM location as possible. Loggers placed below current nests were deployed within five days of finding the nest. A plot occupancy status was determined at the end of the season based on the current year's detections. A plot was considered occupied if a cuckoo was detected within 50 m of each plot center. This distance was chosen to separate plots with spatially dependent (proximally close) detections from plots with no dependent detections, while ensuring a sufficient number of occupied plots for analysis.

Plot Design

Vegetation sampling methods (Appendix 2) 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 2. Variables collected at plots are summarized in Table 3. In addition to general plot information (site code, site name, vegetation plot number, UTM location, date and surveyors), four general categories of vegetation data were collected: 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 3. Vegetation parameters collected 2006-2009.

Parameter	2006	2007	2008	2009
Location Information	X	X	X	X
High Canopy Dominant and Co-dominant Species and Percent of High Canopy	X	X	X	X
Distance to Water	X	X	X	X
Aspect and Slope	X	X	X	X
Total Canopy: Average Ht/Dominant Species/Cover* (Densiometer Reading)	X*	X	X	X
High Canopy: Average Ht/Dominant Species/Cover* (Visual Estimate)	X*	X	X	X
Main Canopy Cover: Average Ht/Dominant Species/Cover (Visual Estimate)		X	X	X
Sub-Canopy Cover: Average Ht/Dominant Species (Visual Estimate)		X	X	X
Nearest Live Shrub in each quadrant: Species/Distance/Height/Crown Width	X	X	X	X
Nearest Live Tree in each quadrant: Species/Distance/Height/DBH/Crown Width/Canopy Cover	X	X	X	X
Nearest Snag: Species/Distance/Height/DBH	X	X		
Litter Depth: Average of 12 readings within 5 m plot	X	X	X	X
Percent Ground Cover (sum to 100%): Grass/Leaf Litter/Downed Logs/Bare Ground/Standing Water	X	X	X	X
Percent Ground Cover: All Green/Shrub/Forb/Sedge/Marsh Vegetation/Brush	X	X	X	X
Shrub or Sapling: Species/Number <2.5cm DBH/Number > 2.5cm and <8cm DBH	X	X	X	X
Small Trees**: Species/Number <8cm DBH/Number>8 and <23cm DBH	X	X	X	X
Large Trees: Species/Number>23cm and <38cm DBH/Number >38cm DBH	X	X	X	X
Snags: Species/Number >8cm and <12cm DBH/Number >12cm DBH	X	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 2007-09 they were collected in the 5 m circle only.

Nest Site Vegetation Sampling

When nests became inactive, detailed vegetation measurements were recorded. Each nest was characterized using the habitat methods 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 within 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

Temperature and Humidity

Two models of Thermocron iButton® (Embedded Data Systems LLC) were used to measure temperature (DS1921G and DS1923), and one model (DS1923) was used to measure relative humidity (RH) at sites during the 2009 breeding season. IButtons® were programmed and the data was uploaded using a dual iButton® receptor interface cable and high speed USB interface adapter (SK-IB-R Connectivity Kit made by Embedded Data Systems LLC) and One Wire Viewer© software (Maxim Integrated Products). Units were set to record temperature and humidity once each hour, on the hour. Units were synchronized and programmed to record temperature to the nearest 0.5° Celsius (C) and to 0.6% RH.

A stainless steel wire was glued to each data logger with epoxy before being suspended from a 5.1 cm X 5.1 cm X 1 cm plastic container which provided shade to the

unit. The containers were painted light beige and suspended with wire 2 m above the ground in a shaded area at the center of vegetation characterization plots (Figures 1 and 2).

Figure 1. iButton® hung at 2 m in the center of a plot.

Figure 2. iButton® and shade assembly.

Hourly data were averaged to estimate diurnal (05:00:01-19:00:00) and nocturnal (19:00:01-05:00:00) highs, lows and means for each day. These averages were used to determine overall average high, low, and mean readings for each plot to detect plot scale differences in cuckoo occupancy. Plots were also averaged across each site to look for differences at the landscape scale.

Soil Moisture

Soil moisture is an important factor for some listed riparian species including the southwestern Willow Flycatcher (*Empidonax traillii extimus*) (USFWS 2002b, McLeod et al. 2008). Rosenberg et al. (1991) has suggested a correlation between soil moisture and cuckoo presence. To detect any relationships between soil moisture and cuckoo occupancy, Volumetric Water Content (VWC) was recorded at all vegetation plots using Fieldscout®

TDR 100/200 units with 12 centimeter (4.7") insertion rods. These units measured VWC to a resolution of 0.1%. VWC was measured at the center, as well as at one, two and three meters from the center in each of the four cardinal directions for each plot. This was done at each vegetation sampling plot once during each of four or five survey periods. At plots where loggers were hung later in the season (e.g. at nests) soil moisture was taken fewer than five times. The average VWC at each plot was used for analysis.

Insect Sampling

The Apache cicada (*Diceroprocta apache*) is estimated to contribute up to 1.3 cm of water annually to the upper soil layers of some riparian ecosystems through excretion of moisture obtained from feeding on the xylem of roots and stems (Andersen 1994). To determine if relationships exist between cicada abundance, soil moisture, and cuckoo presence, cicadas were sampled using two methods: live cicada counts and exuviae counts.

Live Cicada Counts

An index of the estimated number of cicadas seen or heard at each survey point was recorded during surveys, prior to playing the YBCU call broadcast. These included live cicadas seen on vegetation, flying away as the surveyor approached the survey point, or heard calling. Cicada counts were indexed as follows: 1=0-1 cicadas, 2=2-5 cicadas, 3=6-10 cicadas, 4=11-19 cicadas, and 5=20+ cicadas.

Exuviae Counts

Apache cicada nymphs emerge from the soil, climb nearby vegetation, and shed their nymphal exoskeleton (exuviae) which is left on or near the ground, attached to vegetation. These exuviae were counted in late August or early September concurrent with vegetation sampling. Exuviae were counted within five 1x1 m sampling grids at each

vegetation plot. The first sampling grid was placed at the center of each vegetation sampling plot with the sides of the grid oriented with the cardinal directions (Figure 3). The subsequent four grids were placed at the nearest vertical vegetation that was more than five meters from the center of the vegetation sampling plot, in each of the four cardinal directions. Observers spent as much time as needed (no less than three minutes) to thoroughly search each of the five sampling grid locations.

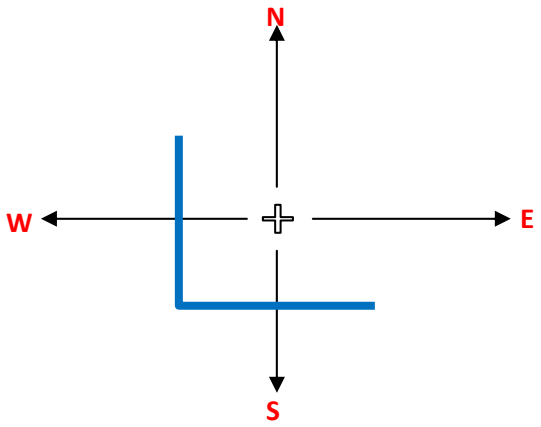

Figure 3. Orientation of 1x1m cicada exuviae counting grids.

Data Analysis

Preliminary data analysis was performed using JMP® 7.0 (SAS Institute), MS Access© 2007, MS Excel© 2007, and R version 2.10.0 (R Development Core Team 2005). 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. 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*). An alphabetic list of site names and codes is given in Appendix 3.1. Species lists can be found in Appendix 4.1 (north sites), Appendix 4.2 (Bill Williams River NWR), Appendix 4.3 (sites near Blythe) and Appendix 4.4 (Yuma area sites).

SITE DESCRIPTIONS

Sites are described by geographic area, with the most northerly sites presented first. The sites are listed alphabetically by site code in Appendix 3.1. A map of the 2009 survey locations is shown in Figure 4. A total of 58 sites, comprising 1,465 ha (3620 acres) of riparian habitat was surveyed. Twenty three routes were added or expanded in 2009. This includes 14 new sites, and the expansion of 9 sites previously surveyed, giving 440 additional ha of survey coverage in 2009. Overview maps of areas with multiple survey sites are included in the following section. Maps of individual sites, showing routes and locations of cuckoos detected during the 2009 surveys, are in Appendix 5.

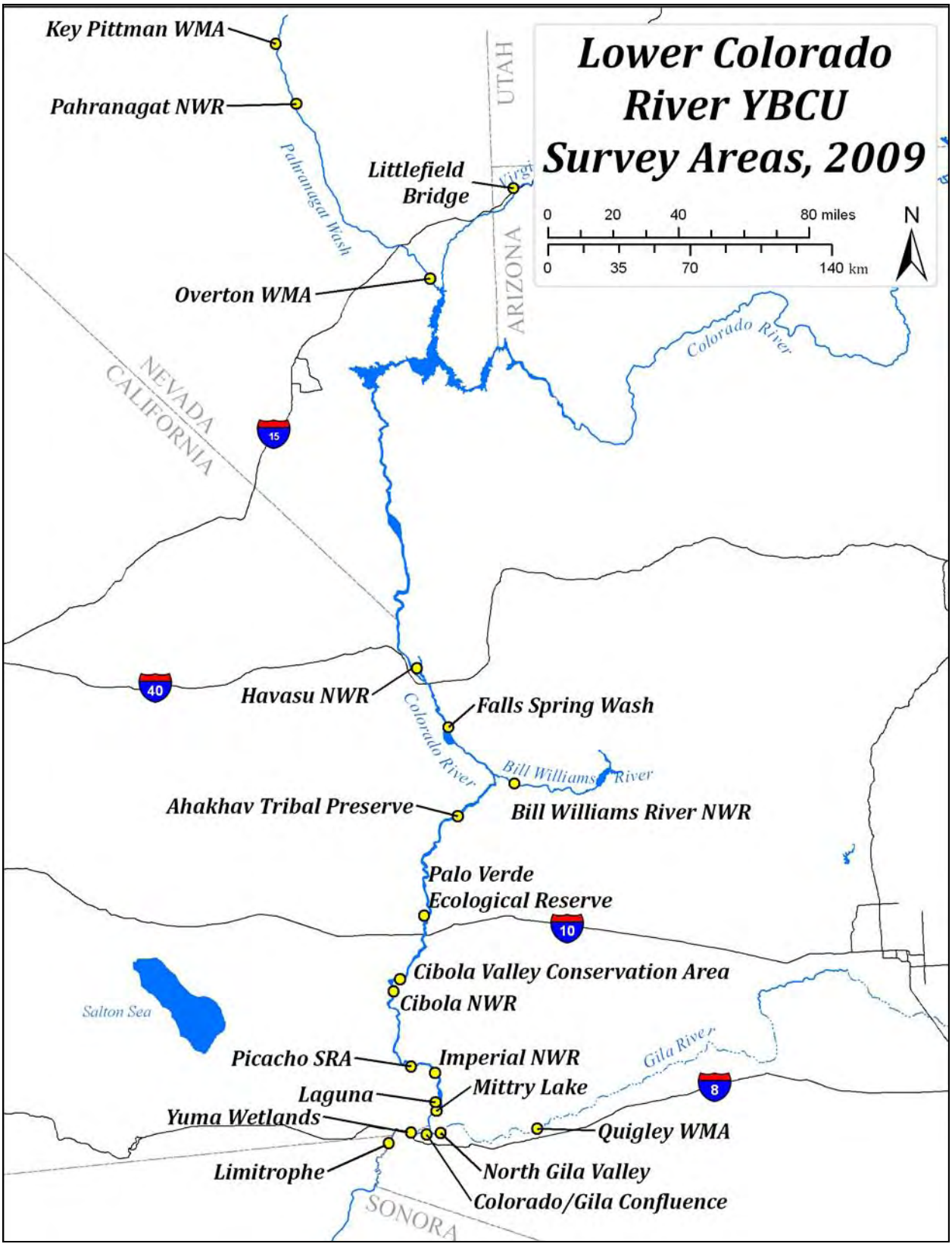

Figure 4. Overview map of the lower Colorado River region 2009 cuckoo survey areas.

Key Pittman Wildlife Management Area
Lincoln County, NV (White River Drainage)

Key Pittman Wildlife Management Area (WMA) is in the Pahranagat Valley between the Pahranagat Range to the west and the Hiko Range to the east. It includes two lakes (Nesbit and Frenchy) approximately 180 km north of Las Vegas near the town of Hiko, Nevada. The WMA comprises about 146 ha (362 ac) of wetlands and aquatic habitats, and 283 ha (700 ac) of adjacent uplands associated with the historic outflow of Hiko Spring. This habitat is currently managed by the Nevada Department of Wildlife (NDOW) for farming, grazing, fishing and wildlife. A few mature Fremont cottonwoods line portions of the shoreline of both Nesbit and Frenchy lakes. Southwestern Willow Flycatchers nest in the few dense patches of coyote willow surrounding Nesbit Lake. One native-dominated site was surveyed for cuckoos within the WMA during the 2009 breeding season.

Key Pittman WMA (KEYPIT) *Elevation: 1168 m, 1.9 ha*

A single 2008 incidental cuckoo detection by SWCA initiated the 2009 survey effort. The habitat surveyed in 2009 consists of a small patch of mature cottonwoods with an open understory at the southern end of Nesbit Lake, as well as multiple dense patches of coyote willow along the lake's western shore. Adjacent to these isolated habitat patches there are extensive emergent wetlands which transition to alkali desert scrub. One cuckoo was detected during 2009 surveys (Appendix 5.1, Table 4).

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. The inlet and outlet of upper Pahranagat Lake 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 2009.

Upper Pahranagat Lake North (PAHNTH) *Elevation: 1020 m, 9.0 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 (Appendix 5.2). 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, 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 Mohave yucca (*Yucca schidigera*). For 2009 surveys two points on this route were moved from the edge to the interior of the habitat, providing better coverage. One cuckoo was detected during surveys in 2009 (Table 4).

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 (Appendix 5.3). 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. No cuckoos were detected in 2009 (Table 4).

Littlefield Bridge
Mohave County, AZ (Beaver Wash)

Beaver Wash crosses county Hwy 91 approximately 1.2 km north of Interstate 15 at Littlefield Bridge, in the town of Littlefield. From its confluence with the Virgin River, upstream for more than 2 km, the floodplain of Beaver Wash consists of structurally diverse native dominated riparian vegetation. One site was surveyed at Littlefield Bridge during the 2009 breeding season.

Littlefield Bridge (LITBR) *Elevation: 565 m, 39.9 ha*

Continuous native-dominated riparian habitat both upstream and downstream of Littlefield Bridge was surveyed during the 2009 season (Appendix 5.4). Extensive recruitment of young cottonwoods and willows was evident, while mature cottonwoods lined the edges of, and were interspersed within the floodplain at this site. Water was present at this site throughout the breeding season. Beaver Wash is used for off-road recreation, and people were camping at the site for much of the season. Adjacent upland use includes a golf course, residential and commercial areas, as well as grazing along the NE border of the riparian habitat. No cuckoos were detected in 2009 (Table 4).

Overton Wildlife Management Area
Clark County, NV (Muddy River Drainage)

Overton Wildlife Management Area (WMA) lies in the Moapa Valley about 3.2 km south of Overton on SR 169. The WMA consists of 7,145.5 ha (17,657 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. A narrow stringer of Fremont cottonwoods lines the perimeter of the agricultural fields. Three sites within riparian areas of the WMA were surveyed during the 2009 breeding season.

Overton Honeybee Pond (OVRHP) *Elevation: 370 m, 3.6 ha*

Potential cuckoo habitat includes a patch of mixed native riparian forest below the levee south of Honeybee Pond (Appendix 5.5). The overstory is dominated by Goodding's willow, tamarisk, and California fan palm (*Washingtonia filifera*). The dense and diverse understory includes common reed (*Phragmites australis*), cattail, arrowweed (*Pluchea sericea*), tamarisk and Goodding's willow. A 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. No cuckoos were detected in 2009 (Table 4).

Overton Residential (OVRR) *Elevation: 365 m, 2.8 ha*

This route consists of two survey points near residences along the western edge of the WMA (Appendix 5.6). The habitat consists of a narrow patch of mature cottonwoods with an understory of hackberry and saltbush (*Atriplex* sp.) between an alfalfa field, a

residence, and a private plantation. There is a Great Blue Heron rookery in one of the larger cottonwoods. No cuckoos were detected during surveys at this site in 2009, however there were incidental detections reported at Wilson Pond to the south, representing a possible breeding pair (Table 4).

Overton Wildlife (OVRW) *Elevation: 365 m, 10.1 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 (Appendix 5.7). 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. No cuckoos were detected during surveys in 2009 (Table 4).

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. Seven sites were surveyed here in 2009 (Figure 5), including two new areas, Farm Ditch Road and Glory Hole. Four of the seven are restoration sites. Two sites are on the north end of the marsh, separated by 350 m (Pintail Slough, North Dike), while the other sites are 5 to 7 km to the southwest, between the main channel of the Colorado River and Topock Marsh (Havasu Levee Road, Topock Platform, Farm Ditch Road, Glory Hole, Beal).

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

This site consists of a narrow stand of mature cottonwoods (50-60 cm DBH) lining the slough, a restored field 250 m to the south, and another stand 300 m southeast (Appendix 5.8). The slough is lined with cattails and the surrounding understory is a mix of tamarisk, arrowweed and quailbush. The southeast habitat is dominated by cottonwoods, which established naturally following flooding of nearby wintering waterfowl habitat (Pers. comm. Jack Allen, Refuge biologist). The southern area is a planted field with a sparse overstory of cottonwoods, and a dense ground cover of Johnson grass (*Sorghum halapense*). Water was present at the site throughout the season. A system of access roads intersects the site. No cuckoos were detected at this site in 2009 (Table 4).

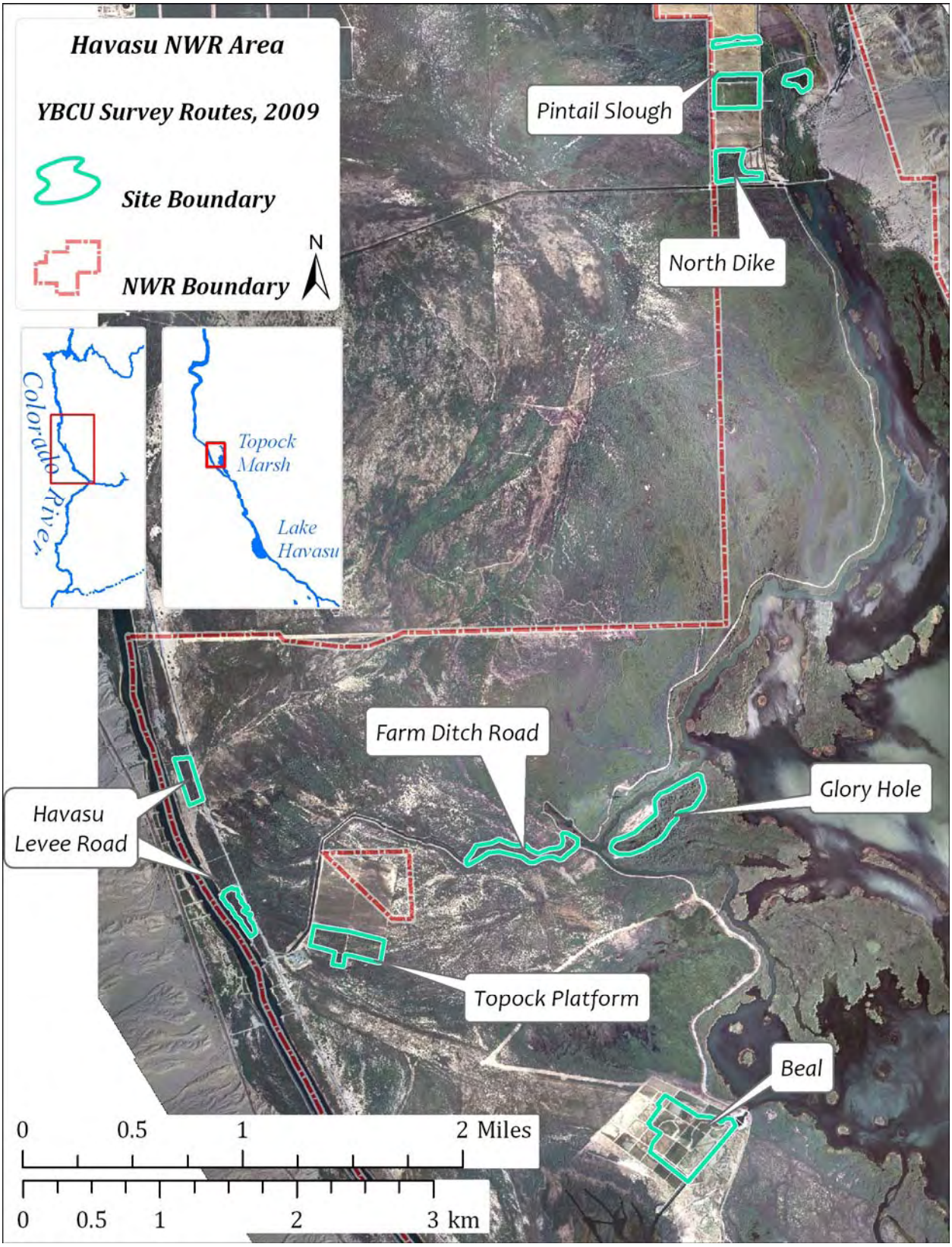

Figure 5. Map of 2009 Yellow-billed Cuckoo survey sites, Havasu NWR.

North Dike (HAVND) *Elevation: 140 m, 5.1 ha*

This is a mature restoration site along the north dike of Topock Marsh (Appendix 5.9). The patch has an overstory of Fremont cottonwood and Goodding's willow and an understory of mulefat (*Baccharis salicifolia*) and honey mesquite (*Prosopis glandulosa*). An agricultural field borders the site to the north. The site is surrounded by access roads, with a cement-lined irrigation canal along the western edge. To the south and west is a historic floodplain dominated by mesquite and tamarisk. There was hunting activity here late in the field season. No cuckoos were detected at this site in 2009 (Table 4).

Havasu Levee Road (HAVLR) *Elevation: 143 m, 3.2 ha*

This site (called Havasu River Highway in 2008) is composed of a thin stringer of remnant riparian habitat between the levee road and the Colorado River, 350 m northwest of Topock Platform (Appendix 5.10). 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 about 20%. Arrowweed and mulefat provide a nearly impenetrable understory 1-3 m high, covering approximately 95% of the site. The Colorado River to the west experiences heavy motorized boat traffic. No cuckoos were detected at this site in 2009 (Table 4).

Glory Hole (HAVGH) *Elevation: 139m, 13.2 ha*

This mixed native site is on an island bounded by channels along the eastern shore of Topock Marsh (Appendix 5.11). Suitable cuckoo habitat includes a mosaic of willow and tamarisk patches interspersed with marsh vegetation. The overstory covers less than 10% of the site while the understory is quite dense. No cuckoos were detected during surveys in 2009 (Table 4).

Farm Ditch Road (HAVFDR) *Elevation: 139m, 6.9 ha*

This site consists of a narrow patch of mixed native vegetation following an irrigation ditch opposite Farm Ditch Road (Appendix 5.12). A sparse overstory of Goodding's willow and honey mesquite grows above a dense understory of coyote willow, tamarisk, screwbean mesquite and quailbush. The irrigation ditch contains water throughout the season, and is lined with bulrush, cattails, and horsetail (*Equisetum* sp.). Adjacent vegetation is low, dense and dominated by tamarisk and quailbush. No cuckoos were detected at this site in 2009 (Table 4).

Topock Platform (HAVTPR) *Elevation: 141 m, 9.3 ha*

The Topock Platform site includes 8.8 ha (21.7 ac) of restored native habitat, located next to fields flooded in winter for waterfowl habitat (Appendix 5.13). 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 about 20% cover of 1-5 m high screwbean mesquite (*Prosopis pubescens*), 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 is a small (0.6 ha, 1.48 ac) stand of dense mesquites. Bermudagrass (*Cynodon* sp.) dominates the ground cover throughout the site. The landscape to the south and east is dominated by extensive stands of quailbush, arrowweed and dense tamarisk with a few remnant willows and mesquites. One cuckoo was detected during surveys in 2009 (Table 4).

Beal Restoration (HAVBR) *Elevation: 137 m, 21.3 ha*

Beal Restoration lies approximately 3 km south of Topock Platform, between Beal Lake and Topock Marsh (Appendix 5.14). 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 2009. The survey route follows suitable habitat 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 approximately 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. One cuckoo was detected during surveys in 2009 (Table 4). Based on observations during follow-up visits, this was classified as a possible breeding pair.

Lake Havasu City
Mohave county, AZ

Falls Spring Wash (LHCFSW) *Elevation: 137 m, 6.8 ha*

This site is within Lake Havasu City limits along the eastern shore of the lake, just north of the Mesquite Bay recreation access, Havasu National Wildlife Refuge (Appendix 5.15). Mixed native habitat lines the lake shore within the floodplain of Falls Spring Wash. A sparse Goodding's willow, cottonwood, mesquite and tamarisk overstory stands between the bulrush marsh along the edge of the lake, and extensive arrowweed, *Acacia* and creosote uplands to the east. No cuckoos were detected at this site in 2009 (Table 4).

Havasu City Willow Patch (LHCWP) *Elevation: 137m, 1.0 ha*

This site is within Lake Havasu City along the eastern shore of the lake, just south of Mesquite Bay recreation access, within Havasu National Wildlife Refuge (Appendix 5.16). It consists of a small, dense patch of coyote willow bordered to the west by bulrush, and Mohave Desert upland to the north, south, and east. Dense arrowweed creates an understory that borders the thick coyote willow overstory. No cuckoos were detected at this site in 2009 (Table 4).

Desilt Wash
San Bernardino County, CA

Desilt Wash flows into the Colorado River 0.8 km below Parker Dam, between the towns of Parker and Lake Havasu City. The Metropolitan Water District operates Gene Pumping Station immediately upstream of the potential cuckoo habitat. Desilt Wash and the surrounding uplands are owned by the County of San Bernardino, and public access is restricted. The wash between the Colorado River and Gene Pumping Station was surveyed for cuckoos in 2009.

Desilt Wash (DSWA) *Elevation: 140 m, 3.4 ha*

Potentially suitable cuckoo habitat at this site includes approximately 800 m of narrow riparian vegetation along Trails End Camp Road/MWD Road (Appendix 5.17). California fan palms dominate the overstory of the upstream portion of the route, with Fremont cottonwood stands above an understory of tamarisk, palo verde and arrowweed downstream. Water was present at this site throughout the season. No cuckoos were detected at this site in 2009 (Table 4).

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. Portions of the Bill Williams River have perennial surface water. The hydrologic regime is managed to allow overbank flooding necessary for natural regeneration of native vegetation, and for persistence of cottonwood-willow forest. Large releases from Alamo Dam during the winter of 2005 resulted in the natural regeneration of large areas of riparian habitat.

Sixteen routes within the BWR NWR, covering over 680 ha (1680 ac) of potential Yellow-billed Cuckoo habitat were surveyed in 2009 (Figure 6). Three new routes were added in 2009 at the western end of the refuge: Middle Delta, Cross River, and Borrow Pit. Four routes were modified in 2009 for extended coverage of the habitat: Kohen Cliff, Big

Bend (split into Esquerra Ranch and Cougar Point), Sandy Wash, and Mosquito Flats. The sixteen sites surveyed in 2009 are described from upstream (east) to downstream (west).

Cottonwood Patch (BWCP) *Elevation: 180 m, 38.2 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, and is owned and managed by the City of Scottsdale, AZ. A patch of young cottonwoods was established 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 (Appendix 5.18). 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. There were six survey detections in 2009, and one confirmed breeding pair (Table 4).

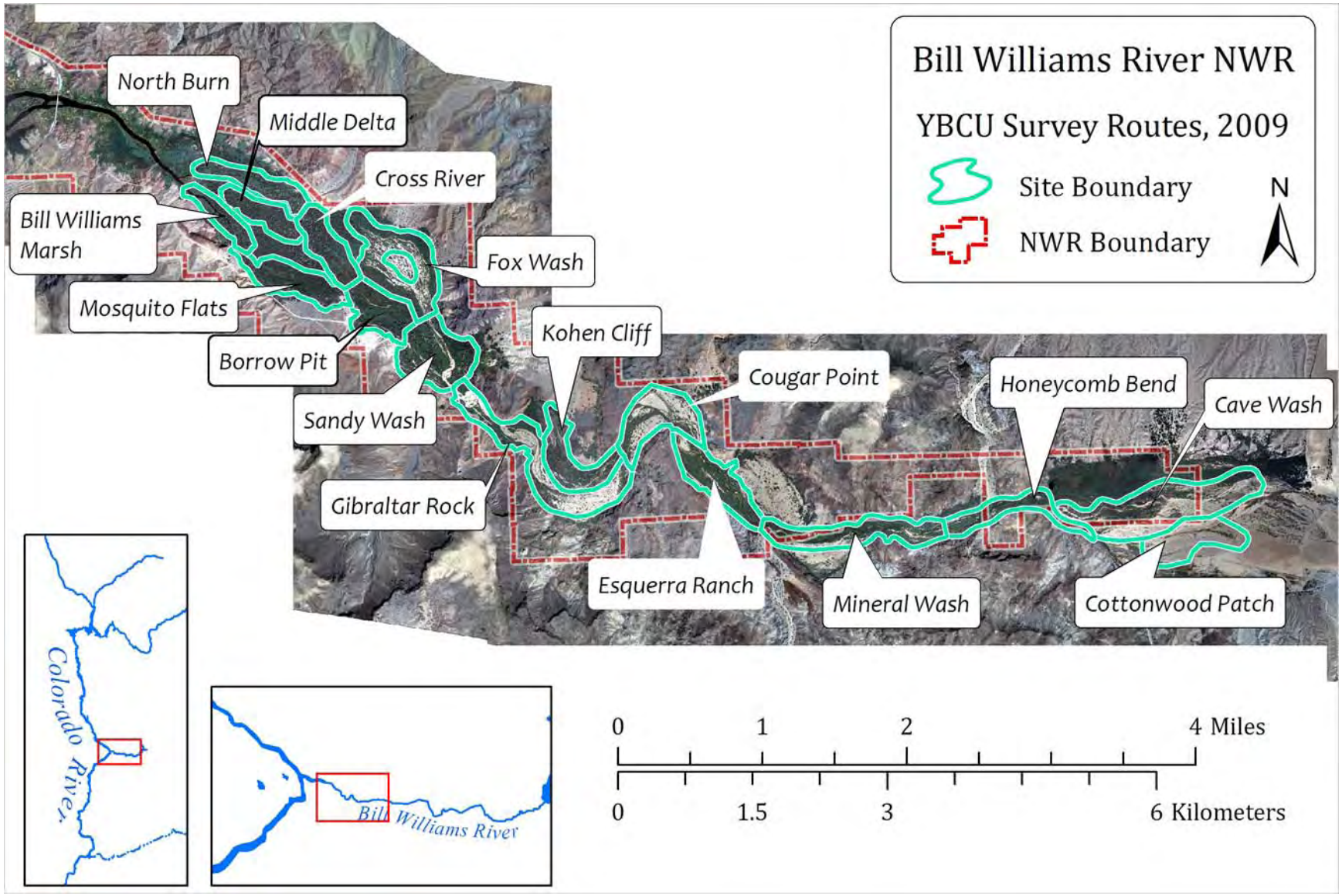

Figure 6. Map of Yellow-billed Cuckoo survey routes on the Bill Williams River NWR, 2009.

Cave Wash (BWCW) *Elevation: 175 m, 88.1 ha*

This site is in the floodplain of the Bill Williams River (Appendix 5.19). This section of the refuge consists of a broad riparian area with both historic, 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 and multi-structured. There were 15 survey detections in 2009, representing one confirmed, two possible, and one probable breeding pair (Table 4).

Honeycomb Bend (BWHB) *Elevation: 170 m, 29.6 ha*

This route follows the Bill Williams River, connecting with Cave Wash to the east and Mineral Wash to the west (Appendix 5.20). 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 overbank flooding at the site, and little ground cover. In the late part of the season the river became impassible in places due to the water depth behind beaver dams. The survey route was modified accordingly during the last two survey rounds to bypass the river, but remained within 50 m of the original route. There were 14 survey detections in 2009, representing one confirmed breeding pair (nest), and two possible breeding pairs (Table 4).

Mineral Wash (BWMW) *Elevation: 165 m, 49.8 ha*

This route is located between the Honeycomb Bend and Esquerra Ranch routes. It is a linear route following the river channel from a restricted canyon bordered by cliffs to a more open floodplain (Appendix 5.21). 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 site 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 (less common) summer rains. A public access road follows Mineral Wash, and there is some human recreational activity where the road terminates at the river. There were 13 survey detections in 2009, representing one confirmed and two possible breeding pairs (Table 4).

Esquerra Ranch (BWER) *Elevation: 165 m, 40.2 ha*

This site is the eastern section of the 2008 Big Bend route, which was split to increase coverage of the habitat, and lies between Mineral Wash and Cougar Point routes (Appendix 5.22). The new route name was chosen after consulting with Refuge personnel, who do not use the name "Big Bend". The route begins at the intersection of Mineral Wash road and the Bill Williams River. The route is a loop downstream along the current river channel to a big bend (also known as Cougar Point), then upstream along an old (pre-2005) river channel. Both channels contain perennial water and are lined with cottonwoods, willows and a dense understory of tamarisk and arrowweed. The route is bounded by a

steep cliff on the southwest and a broad dry upland area (the former Esquerra Ranch) to the northeast. There were two survey detections in 2009, but no evidence of breeding (Table 4).

Cougar Point (BWPT) *Elevation: 165 m, 43.1 ha*

This site is the western section of the 2008 Big Bend route, and lies between the Esquerra Ranch and Gibraltar Rock routes (Appendix 5.23). The route follows a bend in the river (known as Cougar Point). The northernmost part goes through an area of extensive natural regeneration following 2005 flooding. The southern part skirts older forest along the main river channel, composed of cottonwoods, willows and a dense understory of tamarisk and arrowweed. Several meanders contain perennial water. There were 10 survey detections in 2009, representing one possible breeding pair and one probable breeding pair (Table 4).

Kohen Cliff (BWKC) *Elevation: 145 m, 37.2 ha*

This site was modified and expanded from the 2008 Kohen Cliff site. It covers areas of natural regeneration which occurred following prolonged flooding during 2005-2006 (Appendix 5.24). The route begins at the old Kohen Ranch and heads northeast, following the northern edge of the riparian and paralleling the Gibraltar Rock route. The route passes through mature cottonwood-willow forest as well as a mix of park-like vegetation, with a high cottonwood overstory and Bermuda grass ground cover. There is a 2009 FWS mesquite restoration site on the edge of this route, which may be included in future surveys. The Bill Williams River was flowing through the site at the start of the field season, but by August there was only water in the eastern section of the river. There were seven

survey detections in 2009, representing one confirmed and one possible breeding pair (Table 4).

Gibraltar Rock (BWGR) *Elevation: 145 m, 66.5 ha*

Located between Cougar Point and Sandy Wash routes (Appendix 5.25), Gibraltar Rock follows an old road and the river channel. Water was present early in the season but the main channel was completely dry by late June. 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 occasional winter flooding and recreational activity from hikers. There were three survey detections in 2009, but no evidence of breeding (Table 4).

Sandy Wash (BWSW) *Elevation: 145 m, 50.9 ha*

This route connects with Gibraltar Rock to the southeast and Fox Wash to the northwest. This section of the Refuge gradually widens into a floodplain laced with dry river channels. The route makes a loop through and around the eastern end of the broad floodplain, following the old road and river channel (Appendix 5.26). In 2009 approximately 1 km was added to access dense native-dominated habitat at the eastern part of the route. The site is diverse, with an overstory of tall cottonwoods and willows with a tamarisk-dominated understory on the southern edge, mature tamarisk in the central part, and tall dense native-dominated cottonwood/willow in the eastern part. There was standing water along the old river channel at the eastern part of the site during

the field season, but the rest is dry. Hikers and researchers frequently utilize this easily accessible route. There were 13 survey detections in 2009, representing one possible and two confirmed breeding pairs (Table 4).

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 (Appendix 5.27). 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 open to dense tamarisk, while narrow bands of marsh vegetation surround remnant pools along the main channel. Mature cottonwood and mesquite are interspersed throughout the site. There were four survey detections in 2009, representing one possible breeding pair (Table 4).

Borrow Pit (BWBP) *Elevation: 140 m, 33.6 ha*

This route is new for 2009 and includes the southeastern part of the 2008 Mosquito Flats route, and follows a new trail along an old river channel paralleling the west end access road (Appendix 5.28). The survey is conducted from an old river channel and bluffs overlooking the habitat. It connects with Cross River at the western boundary. The habitat along the southern half of the route contains mature riparian cottonwood/willow forest with a dense tamarisk understory. The northern half includes occasional dense stands of tall cottonwoods and willows and extensive dense tamarisk. No standing water was present on the site during 2009 surveys. There were six survey detections in 2009, representing two possible breeding pairs (Table 4).

Bill Williams Cross River (BWCR) *Elevation: 140 m, 31.5 ha*

This new approximately north-south survey route crosses the Bill Williams River delta approximately 1 km upstream from Lake Havasu (Appendix 5.29). It connects Borrow Pit to the south and North Burn to the north. This site is primarily composed of extensive tall cottonwoods and willows with a dense tamarisk understory. There are also smaller patches of younger cottonwood-willow forest and occasional monotypic patches of dense tamarisk. There are multiple old overgrown river channels within the site. This site is bordered both upstream and downstream by contiguous riparian habitat. There were eight survey detections in 2009, representing two possible breeding pairs (Table 4).

Mosquito Flats (BWMF) *Elevation: 140 m, 37.1 ha*

This route was significantly modified in 2009 to increase coverage of the extensive riparian forest at the western end of the refuge. It also incorporates the eastern section of the 2008 Saguaro Slot route. The riparian habitat at the western end of the refuge spreads out into a wide floodplain. The 2008 route followed the southern edge of the habitat, but in 2009 the route was moved to follow a new trail accessing more of the interior of the site (Appendix 5.30). The eastern two-thirds of the route passes through dense cottonwood/willow forest with occasional stands of tamarisk and scattered mesquite. The western third is surveyed from bluffs overlooking the riparian habitat, and skirts the edge of the riparian. 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. There were four survey detections in 2009, representing one possible breeding pair (Table 4).

North Burn (BWNB) *Elevation: 133 m, 30 ha*

This survey route was altered slightly in 2009 to conduct surveys from within the habitat rather than the edge, increasing the coverage area of potential habitat by almost 5 ha. The route begins at the northern branch of the Bill Williams River slough and continues along that channel (Appendix 5.31). 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, portion of the site is dominated by tamarisk. The area burned in 2005, and is regenerating with tamarisk and quailbush. The site is surrounded by tamarisk-dominated floodplain and Sonoran Desert upland habitat to the north and east. The area to the south and west has more native-dominated habitat extending up the Bill Williams River. Standing water was observed throughout the season. There were five survey detections in 2009, representing one possible and one probable breeding pair (Table 4).

Middle Delta (BWMD) *Elevation: 135 m, 25.2 ha*

This site was added in 2009, and traverses an extensive patch of mature, mixed exotic vegetation extending upstream from the Bill Williams River delta between the BWMA and BWNB sites (Appendix 5.32). It also connects to BWCR. The eastern (upstream) end of the route has extensive patches of mature cottonwood overstory with an open understory. To the west, the overstory consists of patches of mature willow, which become sparser closer to Lake Havasu. The understory is dominated by dense stands of tamarisk. Although no water was found within the site this season, the western end of the site is

bordered by two forks of the Bill Williams River delta. There were two survey detections in 2009, with no evidence of breeding (Table 4).

Bill Williams Marsh (BWMA) *Elevation: 133 m, 19.8 ha*

This route is surveyed by kayak, and provides access to habitat within the broad western floodplain. The route follows the main channel of the Bill Williams River (Appendix 5.33), 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. There were four survey detections in 2009, representing two possible breeding pairs (Table 4).

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 comprises 507 ha (1,253 ac) of mixed 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 at this site since 2001 (Appendix 5.34). 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 Fremont cottonwood and Goodding's willow, and approximately 14 ha (34.6 ac) of honey and screwbean mesquite. Ground cover is sparse, with little understory and sandy soil. There was little standing water

during visits. The survey route follows roads around the perimeter and interior of the site. There were nine survey detections in 2009, representing one possible and one probable breeding pair (Table 5).

Palo Verde Ecological Reserve
Riverside County, CA

Palo Verde Ecological Reserve (PVER) is located 12 km north of Blythe, CA. The 547 ha (1351 ac) site was acquired by the State of California in 2004. Restoration activities 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). Phases 1 and 2 were surveyed in 2009. Phase 3 was not surveyed, although cuckoos were observed foraging in the site for short periods.

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

Phase 1 of PVER was planted in 2005. In 2009 the cottonwood and willow overstory was 3-10 m tall, providing about 90% canopy cover. Groundcover is predominately alfalfa with mixed forbs. The site is bordered by dirt access roads, used to conduct the surveys (Appendix 5.35). Agricultural fields border the site to the north and east. There was a single survey detection at this site, and no evidence of breeding (Table 5).

Palo Verde Ecological Reserve Phase 2 (PVER2) *Elevation: 86 m, 24.2 ha*

PVER2 (Appendix 5.35) was planted in 2007 and first surveyed in 2009. Seventeen ha (42 acres) were mass planted in grids of Goodding's willow, coyote willow and Fremont cottonwood. These trees now range in height from 3 to 10 m with approximately 70% canopy cover. The plantings were designed to maximize the amount of edge between Goodding's willow and coyote willow, considered to be preferred habitat for the Southwest

Willow Flycatcher (LCR MSCP 2006b). An additional 7.2 ha (18 acres), used as a research area for Northern Arizona University, was less densely planted with a variety of genetic plant material. There were six survey detections in 2009, and two confirmed breeding pairs (Table 5), both with nests (Table 8).

Cibola Valley Conservation Area
La Paz County, AZ

Cibola Valley Conservation Area (CVCA) is located 24.2 km south of Blythe, CA, south and east of the Colorado River and the CA/AZ border. Within Cibola Valley, 407.6 ha (1,019 ac) of land owned by the Mohave County Water Authority have been identified for riparian restoration, as outlined in the Cibola Valley Conservation Area Restoration Development Plan (LCR MSCP 2007). Since 2006, 101 ha (250 ac) of native riparian trees have been planted in three phases. Phases 1 and 2 are located in adjacent fields, and Phase 3 is approximately 2.6 km to the west. Agricultural fields dominate the area surrounding the sites. All Cibola area sites are shown in Figure 7.

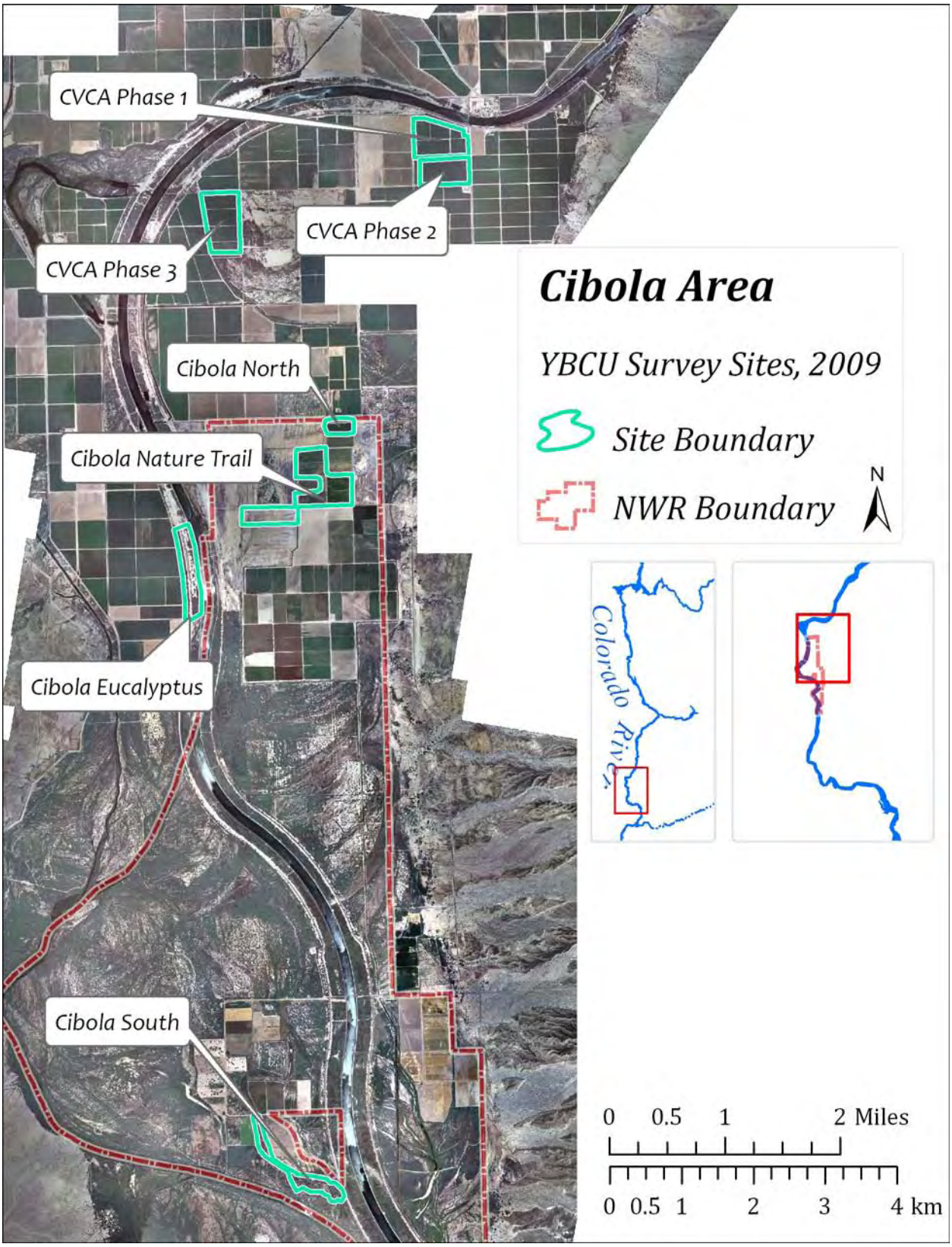

Figure 7. Map of Cibola area Yellow-billed Cuckoo survey sites, 2009.

Cibola Valley Conservation Area Phase 1 (CVCA1) *Elevation: 72 m, 35 ha*

This site consists of six fields planted in 2006 (Appendix 5.36). Fremont cottonwood, Goodding's willow, and coyote willow are the dominant tree species. Canopy height ranges from 5 to 16 m with about 90% canopy closure. There is little understory at the site (approximately 30%), groundcover consists of alfalfa and exotic grasses. The site was periodically flood-irrigated throughout the season. The Colorado River flows approximately 100 m from the northern edge of the site. River Road and several dirt access roads define the perimeter of CVCA1 and additional dirt roads cross the site. Cuckoo surveys were first conducted at CVCA1 in 2008. There were 12 survey detections and two confirmed breeding pairs with two nests (Table 5).

Cibola Valley Conservation Area Phase 2 (CVCA2) *Elevation: 72 m, 27.5 ha*

CVCA2 is adjacent and to the south of CVCA1, separated by a dirt access road and a concrete-lined irrigation ditch (Appendix 5.36). Together they form a contiguous habitat patch of 62.5 ha. Fremont cottonwood and Goodding's willow are the co-dominant trees, with heights ranging from 3 to 7 m, and canopy cover of approximately 90%. Phase 2 was surveyed for the first time in 2009. There were no survey detections at this site in 2009.

Cibola Valley Conservation Area Phase 3 (CVCA3) *Elevation: 72 m, 39 ha*

CVCA Phase 3 is located 2.6 km west of CVCA1 and CVCA2, and 400 m east of the Colorado River (Appendix 5.37). The site was planted in 2007 in eight vegetation grids of 4 to 5.2 ha (10 to 13 acres). The dominant species are Fremont cottonwood, Goodding's willow and coyote willow. Tree heights vary from 2 to 9 m and canopy cover averages 80%. Dirt access roads are found on all sides and between the plantings. Surveys were first

conducted at this site in 2009. There were six survey detections at this site in 2009 representing two possible breeding pairs (Table 5).

Cibola NWR
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 2009.

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

Cibola North is a 7.5 ha (18.5 ac) restoration site with a cottonwood overstory, averaging 8 m high and providing around 60% canopy closure (Appendix 5.38). The ground cover is dominated by Bermuda grass. Fallow fields dominated by sparse tamarisk, arrowweed, and quailbush (*Atriplex lentiformis)* 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. The site is bordered on its northern edge by Baseline Road and agricultural fields. There was a single survey detection in 2009, with no evidence of breeding (Table 5).

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

This restoration site was planted in 1999. The route follows a well-maintained walking trail that winds through the habitat (Appendix 5.38). The species composition and

height varies across the site, creating structural diversity. Cottonwoods dominate a 5-11 m tall canopy providing about 40% canopy cover. The understory includes Goodding's willow, honey and screwbean mesquite, baccharis, coyote willow and young cottonwoods. Average understory measures 3 m with approximately 50% cover. In 2008 this site was extended to include a 4.2 ha (10.4 ac) restoration patch to the west. This site was periodically flooded during the survey season. Much of the surrounding area is agricultural fields. There were three survey detections in 2009, and no evidence of breeding (Table 5).

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

Cibola Eucalyptus is a mixed native restoration site composed of cottonwood and *Eucalyptus* west of the levee road and a cottonwood, tamarisk, Goodding's willow and mesquite to the east (Appendix 5.39). Overstory cover in the two patches is approximately 10% and height varies from 3 to 12 m. The understory is mostly sparse with about 30% cover. A mixed understory of arrowweed, quailbush, palo verde, tamarisk, mesquite and Goodding's 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. There were two survey detections in 2009 representing one possible breeding pair (Table 5).

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 (Appendix 5.40). Mature cottonwoods 4-8 m tall provide 25% cover in the southern part of this dry site. A sparse (about 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, with a ground cover of cattails and Bermudagrass. The site is surrounded by historic Colorado River floodplain dominated by tamarisk, mesquite, arrowweed, quailbush, and agricultural fields used for wildlife enhancement crops. There were four survey detections at this site in 2009 (Table 5) and one confirmed breeding pair with a nest (Table 8).

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.

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

Picacho SRA (Appendix 5.41) 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 6-17 m tall canopy, averaging 30% cover. A diverse understory of arrowweed, quailbush, blue palo verde (*Cercidium floridum*), baccharis, mesquite, willow, and cottonwood provides about 50% cover. The site is bordered by the Picacho SRA campground and adjacent Sonoran Desert uplands to the west, and the river to the east. There was a single survey detection in 2009, with no evidence of breeding (Table 5).

Imperial National Wildlife Refuge
Yuma County, AZ (Colorado River Drainage)

Imperial NWR was established in 1941 and encompasses 10,307 ha (25,768 ac) of riparian area and associated Sonoran Desert uplands. The headquarters is 40.3 km north of Yuma, off Martinez Lake Road. The Refuge follows 48.3 km of the 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.

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 (Appendix 5.42). The nursery site comprises mature 5-14 m tall Fremont cottonwood, Goodding's willow, and mesquite, with approximately 60% canopy closure. There is a low, sparse (about 5% cover) understory of young cottonwood, mesquite, arrowweed, common reed, baccharis, and tamarisk. Surrounding habitat includes an open field, impoundment ponds, and wetlands to the north. There were four survey detections in 2009, and one probable breeding pair (Table 5).

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 (Appendix 5.43). Stunted Fremont cottonwoods form a sparse canopy (about 5% cover), planted 3-4 m apart. The overstory varies from 4 to 14 m high and is interspersed with mesquite. Mesquite, arrowweed, baccharis, and tamarisk form a sparse (approximately 10% cover) understory 1-4 m high. A thick ground cover of saltgrass (*Distichlis spicata*),

Bermudagrass and common reed provide about 90% ground cover. There were no detections in 2009 (Table 5).

Imperial AZ State Lands
Yuma County, AZ (Colorado River Drainage)

This site is on Arizona State Trust lands bordering Martinez Lake, and was identified in 2008 as potential cuckoo habitat due to its mature riparian vegetation and proximity to Imperial NWR (an occupied site). The area is near Fisher's Landing Resort, recreation cabins and camping areas on the nearby southern shore. Red Cloud Mine Road parallels the site to the east.

Imperial AZ State Lands (IMPAST) *Elevation: 61 m, 6.8 ha*

This site consists of a narrow, linear band of riparian vegetation bordering the lake, 1.2 km east of INWR (Appendix 5.44). The dominant species is Goodding's willow, with lesser amounts of Fremont cottonwood and tamarisk. Tree heights range from 6 to 13 m, with a canopy cover of approximately 20%. The site is bordered to the east by dense arrowweed and dry desert uplands. This site was first surveyed in 2009. There were no detections at this site in 2009 (Table 5).

Laguna
Imperial County, CA

Three sites are located on BLM-managed lands near Imperial Dam. The sites are made up of several small habitat patches.

Laguna 1-3 (LAG1-3) *Elevation: 50 m; 0.9, 3.9 & 3.8 ha*

The dominant tree at the three Laguna sites (Appendix 5.45) is Goodding's willow, providing an overstory 8-12 m high and canopy cover averaging 70%. A small amount of Fremont cottonwood and tamarisk are also present. The understory consists of tamarisk, cattails and arrowweed. The three sites are relatively close to each other; LAG2 is 645 m south of LAG1 and 500 m north of LAG3. LAG1 is separated from the other sites by a canal. LAG3 is bisected by Imperial Rd. These three sites were first surveyed in 2009. There were no detections at these sites in 2009 (Table 5).

Mittry Lake Wildlife Management 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 area is 24.2 km northeast of Yuma, between Laguna and Imperial dams on the Colorado River.

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

Pratt Restoration Project (Appendix 5.46) is a cooperative restoration effort planted in 1999 on a BLM agricultural lease. The overstory is 5-11 m with around 70% canopy cover, and comprises approximately 80% cottonwood and 20% Goodding's and coyote willow. There is about 30% understory cover (< 5 m) of 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. There were no detections at this site in 2009 (Table 5).

North Gila Valley/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. The Gila Confluence site was initially surveyed but dropped in 2009 due to poor habitat quality. It was replaced by two North Gila Valley sites.

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 (Appendix 5.47) creating a narrow 67.7 ha (167.2 ac) strip of potentially suitable cuckoo habitat. The sparse overstory (approximately 2% canopy cover) is about 98% tamarisk with isolated Goodding's willows and Fremont cottonwoods. The overstory ranges from 4 to 10 m tall. Tamarisk dominates the 1-3 m high understory, which covers approximately 30% of the site. Agricultural fields border the site opposite the river channel. This site was surveyed by kayak. There was a single survey detection at this site in 2009 and no evidence of breeding (Table 5).

North Gila Valley (GRNVA, GRNVB) *Elevation: 44 m; 3.6 & 4.77 ha*

These two sites are located in the North Gila Valley, Yuma, on the north side of the Gila River (Appendix 5.48), and consist of mature Goodding's willow and Fremont cottonwood. The overstory is 9-15 m high, and canopy cover averages 70%. Understory consists of dense tamarisk and arrowweed. The two sites are separated by about 680 m of this low shrubby habitat. Agricultural fields border the sites to the north. These sites were first surveyed in 2009. There were no detections at these sites in 2009 (Table 5).

Yuma Wetlands
Yuma County, AZ (Colorado River Drainage)

Yuma East and West Wetlands are restoration sites along the banks of the Colorado River near Yuma. The area was until recently a mixture of exotic plants, trash dumps, and squatter camps. Yuma West Wetlands is a 55 ha (135 acre) recreation and wildlife preserve managed by the Yuma Department of Parks and Recreation, while Yuma East Wetlands is part of the Yuma Crossing Natural Heritage Area, under joint management by the City of Yuma, the Quechan Tribe, AGFD, and private ownership. Planting at Yuma West began in 1999, while clearing and planting at Yuma East began in winter 2003-2004.

Yuma East Wetlands (YUEW) *Elevation: 36 m, 9 ha*

The site is immediately east of the Ocean to Ocean Bridge, and lies on both the north and south banks of the Colorado River, approximately 1.2 km upstream of Yuma West Wetlands (Appendix 5.49). The restored habitat consists of a mosaic of Fremont cottonwood, Goodding's willow, and mesquite species. Overstory at the site ranges from 3 to 9 m with 50% canopy cover. Surveys were conducted from the south side and by kayak. This site was added in 2009 after an incidental detection by AGFD in 2008. There were no survey detections in 2009 (Table 5).

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

The Yuma West Wetlands survey site (Appendix 5.50) includes 17.4 ha (43.0 ac) of restored riparian habitat. It is a diverse area, with a mosaic of Fremont cottonwood, Goodding's willow, and mesquite. Overstory at the site ranges from 6 to 12 m with an estimated 30% canopy cover. Arrowweed, saltbush, baccharis, mesquite, and 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. There were no survey detections in 2009 (Table 5).

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 exotic/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 (Appendix 5.51). 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 to 15 m tall that provides about 30% canopy cover. Tamarisk, arrowweed, baccharis, mesquite, willow, and cottonwood provide an understory 1-5 m high, with approximately 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. There were three survey detections in 2009, with no evidence of breeding (Table 5).

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. The site experiences heavy vehicular traffic from the U.S. Border Patrol. Limitrophe South (LIMSTH) surveyed in 2008 was dropped in 2009 due to poor habitat quality.

Limitrophe North (LIMNTH) *Elevation: 32 m, 164 ha*

The Limitrophe North site lies along the east bank of the Colorado River below Morelos Dam (Appendix 5.52). This 164 ha (405 acre) site of mixed exotic habitat is dominated by a 5-10 m tall overstory of Goodding's willow, Fremont cottonwood, and tamarisk, with approximately 15% canopy cover. The understory is dominated by tamarisk, arrowweed, willow and mesquite, providing about 45% cover. The site is bordered by an access road and a levee to the east, and the Colorado River to the west. In 2009, habitat surveyed in 2008 adjacent and north of Morelos Dam was cleared, and the new route is now entirely below the dam. There were three survey detections at this site in 2009 representing one possible breeding pair (Table 5).

RESULTS

Survey Results

A total of 274 surveys were conducted on 58 survey routes. Yellow-billed Cuckoos were detected during surveys on 178 occasions. Figure 8 shows a map of total survey detections within the study area. Summaries for all sites by region are given in Table 4 and Table 5. Two thirds of all survey detections were at Bill Williams River NWR. Other areas with a high number of detections included the Cibola Valley (CVCA and Cibola NWR).

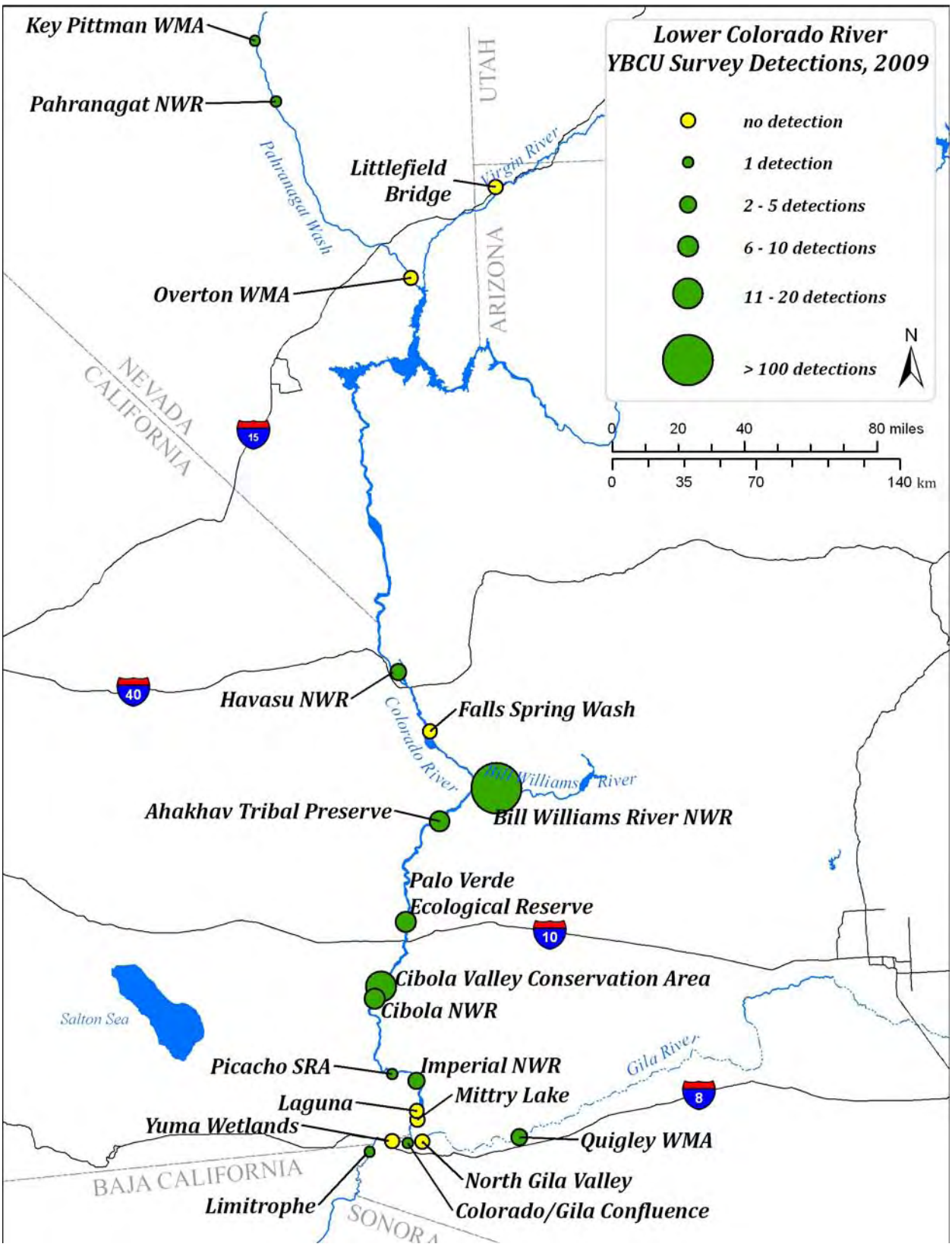

Figure 8. Map of YBCU survey detections in the lower Colorado River region, 2009.

Table 4. 2009 LCR YBCU survey results and breeding status, sites north of and at the Bill Williams River NWR.

Site Name	Survey Period and Dates (month/day)					Tot. Surv. Det.	Breeding Status*	Dist. to nearest occ. (km)[1]	Note
	1	2	3	4	5				
Sites North of Bill Williams River NWR									
Key Pittman	0 (6/20)	0 (7/9)	1 (7/21)	0 (8/6)	NA	1	NB	316.5 (HAVBR)	
Pahranagat Nth	1 (6/24)	0 (7/9)	0 (7/21)	0 (8/6)	NA	1	NB	290.1 (HAVBR)	
Pahranagat Sth	0 (6/24)	0 (7/9)	0 (7/21)	0 (8/6)	NA	0	NB	288.3 (HAVBR)	
Littlefield Bridge	0 (6/23)	0 (7/7)	0 (7/19)	0 (8/4)	NA	0	NB	242.3 (HAVBR)	
Honeybee Pond	0 (6/19)	0 (7/8)	0 (7/20)	0 (8/5)	NA	0	NB	195.4 (HAVBR)	
Overton Resid.	0 (6/19)	0 (7/8)	0 (7/20)	0 (8/5)	NA	0	NB	195.0 (HAVBR)	
Overton Wildlife	0 (6/19)	0 (7/8)	0 (7/20)	0 (8/5)	NA	0	NB	194.8 (HAVBR)	
Wilson Pond				0 (8/5)	NA	0	1 POB	194.0 (HAVBR)	3
Pintail Slough	0 (6/18)	0 (7/1)	0 (7/15)	0 (8/3)	0 (8/17)	0	NB	7.2 (HAVBR)	
North Dike	0 (6/18)	0 (7/1)	0 (7/15)	0 (8/3)	0 (8/17)	0	NB	6.7 (HAVBR)	
Levee Road	0 (6/17)	0 (7/2)	0 (7/17)	0 (8/1)	0 (8/18)	0	NB	3.5 (HAVBR)	
Glory Hole	0 (6/16)	0 (7/3)	0 (7/16)	0 (8/2)	0 (8/19)	0	NB	1.8 (HAVBR)	2a
Farm Ditch Road	0 (6/17)	0 (7/3)	0 (7/17)	0 (8/2)	0 (8/19)	0	NB	1.9 (HAVBR)	
Topock Platform	0 (6/17)	1 (7/2)	0 (7/16)	0 (8/1)	0 (8/18)	1	NB	2.3 (HAVBR)	
Beal Restoration	0 (6/15)	1 (7/2)	0 (7/16)	0 (8/1)	0 (8/18)	1	1 POB	67 (BWNB)	4
Falls Spring Wash	0 (6/23)	0 (7/8)	0 (7/22)	0 (8/12)	NA	0	NB	37.3 (BWNB)	
LHC Willow Patch	0 (6/23)	0 (7/8)	0 (7/22)	0 (8/12)	NA	0	NB	35.3 (BWNB)	
Desilt Wash	0 (6/24)	0 (7/10)	0 (7/24)	0 (8/7)	NA	0	NB	29 (BWMA)	
TOTAL	**1**	**2**	**1**	**0**	**0**	**4**	**2 POB**		
Sites at Bill Williams River NWR									
Cave Wash	2 (6/16)	4 (7/4)	6 (7/19)	0 (8/1)	2 (8/17)	14	2 POB, 1 PRB, 1 COB	0 (BWCP)	
Cottonwood Patch	0 (6/16)	4 (7/4)	2 (7/19)	0 (8/1)	0 (8/16)	6	1 COB	0 (BWCW)	
Honeycomb Bend	4 (6/22)	4 (7/14)	4 (7/31)	2 (8/15)	0 (9/9)	14	2 POB, 1 COB	0 (BWCW)	2b
Mineral Wash	4 (6/22)	3 (7/14)	3 (7/31)	3 (8/15)	0 (9/1)	13	2 POB, 1 COB	0 (BWHB)	
Esquerra Ranch	1 (6/21)	1 (7/5)	0 (7/30)	0 (8/15)	0 (8/28)	2	NB	0 (BWMW)	
Cougar Point	2 (6/21)	5 (7/7)	2 (7/30)	0 (8/15)	1 (8/27)	10	1 POB, 1 PRB	0 (BWKC)	
Kohen Cliff	0 (6/17)	1 (6/30)	4 (7/16)	1 (8/3)	1 (8/20)	7	1 POB, 1 COB	0 (BWPT)	
Gibraltar Rock	0 (6/15)	0 (6/30)	2 (7/16)	1 (8/3)	0 (8/18)	3	NB	0 (BWKC)	
Sandy Wash	2 (6/28)	5 (7/10)	5 (7/22)	1 (8/8)	0 (8/27)	13	1 POB, 2 COB	0 (BWFW)	
Fox Wash	0 (6/17)	0 (7/2)	3 (7/23)	1 (8/8)	0 (8/24)	4	1 POB	0 (BWSW)	
Borrow Pit	2 (6/23)	0 (7/10)	3 (7/22)	1 (8/5)	0 (8/19)	6	2 POB	0 (BWMF)	
Cross River	1 (6/19)	2 (7/13)	3 (7/27)	2 (8/9)	0 (8/19)	8	2 POB	0 (BWNB)	
Mosquito Flats	0 (6/23)	3 (7/13)	2 (7/24)	2 (8/12)	0 (8/27)	7	1 POB	0 (BWSW)	2c
North Burn	1 (6/22)	1 (7/9)	2 (7/29)	1 (8/14)	0 (8/27)	5	1 POB, 1 PRB	0 (BWMD)	
Middle Delta	0 (6/29)	0 (7/13)	2 (7/29)	0 (8/14)	0 (8/27)	2	NB	0 (BWNB)	
BW Marsh	1 (6/20)	2 (7/15)	0 (7/30)	1 (8/14)	0 (8/27)	4	2 POB	0 (BWNB)	
TOTAL	**20**	**35**	**43**	**16**	**4**	**118**	**18 POB, 3 PRB, 7 COB**		

*Breeding status based on all detections (survey and non-survey): POB (possible breeding pair) = ≥2 detections in an area ≥16 days apart; PRB (probable breeding pair) = POB + (food carry or traveling as a pair or vocalization exchange); COB (confirmed breeding pair) = copulation, stick carry, nest or fledgling. [1]Nearest known occupied site in parentheses. [2]Reported by SWCA; a=6/29.b=7/22,c=7/20. [3]Reported by B.Lund,7/9,7/16,7/23. [4]Reported by B. Raulston 7/9.

Table 5. 2009 LCR YBCU survey results and breeding status, sites south of the Bill Williams River.

Site Name	Survey Period and Dates (month/day)					Tot. Surv. Det.	Breeding Status*	Dist. to nearest occ. (km)[1]
	1	2	3	4	5			
Sites Near Blythe/Cibola Valley								
Ahakhav	2 (6/25)	5 (7/6)	2 (7/23)	0 (8/5)	0 (8/20)	9	1 POB, 1 PRB	29 (BWSS)
PVER 1	0 (6/15)	0 (7/1)	1 (7/15)	0 (8/1)	0 (8/15)	1	NB	0 (PVER2)
PVER 2	0 (6/15)	1 (7/1)	2 (7/15)	2 (8/1)	1 (8/15)	6	2 COB	38 (CVCA1)
CVCA 1	1 (6/16)	3 (7/5)	5 (7/17)	1 (8/5)	2 (8/18)	12	2 COB	2.5 (CVCA3)
CVCA 2	0 (6/21)	0 (7/2)	0 (7/17)	0 (8/5)	0 (8/18)	0	NB	0.03 (CVCA1)
CVCA 3	1 (6/21)	3 (7/6)	2 (7/16)	0 (8/6)	0 (8/19)	6	2 POB	2.5 (CVCA1)
Cibola North	0 (6/17)	0 (7/2)	1 (7/20)	0 (8/4)	0 (8/20)	1	NB	0.29 (CIBCNT)
Nature Trail	0 (6/17)	0 (7/2)	3 (7/20)	0 (8/4)	0 (8/20)	3	NB	0.87 (CIBEUC)
Cibola Euc.	0 (6/20)	1 (7/3)	0 (7/18)	1 (8/2)	0 (8/16)	2	1 POB	0.87 (CIBCNT)
Cibola South	1 (6/19)	1 (7/3)	2 (7/22)	0 (8/2)	0 (8/16)	4	1 COB	7 (CIBEUC)
Total	**5**	**14**	**18**	**4**	**3**	**44**	**4 POB, 1 PRB, 5 COB**	
Sites near Yuma								
Picacho SRA	0 (6/16)	1 (7/3)	0 (7/20)	0 (8/7)	0 (8/20)	1	NB	11 (IMPSTH)
Imperial 20A	0 (6/18)	0 (7/4)	0 (7/18)	0 (8/1)	NA	0	NB	1.3 (IMPSTH)
Imperial South	0 (6/18)	1 (7/4)	1 (7/18)	2 (8/1)	0 (8/18)	4	1 PRB	35 (CIBSTH)
Imperial AZ State	0 (6/18)	0 (7/4)	0 (7/18)	0 (8/1)	NA	0	NB	3.2 (IMPSTH)
Laguna 1	0 (6/17)	0 (7/2)	0 (7/16)	0 (8/5)	NA	0	NB	14.1 (IMPSTH)
Laguna 2	0 (6/17)	0 (7/2)	0 (7/16)	0 (8/5)	NA	0	NB	15 (IMPSTH)
Laguna 3	0 (6/17)	0 (7/2)	0 (7/16)	0 (8/5)	NA	0	NB	15.67 (IMPSTH)
Mittry Lake/ Pratt	0 (6/18)	0 (7/5)	0 (7/17)	0 (8/4)	0 (8/16)	0	NB	19 (IMPSTH)
Quigley WMA	0 (6/18)	3 (7/4)	0 (7/17)	0 (8/6)	0 (8/19)	3	NB	57.8 (IMPSTH)
Colorado Confluence	1 (6/19)	0 (7/6)	0 (7/23)	0 (8/9)	0 (8/23)	1	NB	17.5 (LIMNTH)
North Gila Valley A	0 (6/25)	0 (7/8)	0 (7/22)	0 (8/4)	NA	0	NB	26.9 (LIMNTH)
North Gila Valley B	0 (6/25)	0 (7/8)	0 (7/22)	0 (8/4)	NA	0	NB	26 (LIMNTH)
Yuma West	0 (6/15)	0 (7/1)	0 (7/15)	0 (8/3)	0 (8/15)	0	NB	11 (LIMNTH)
Yuma East	0 (6/19)	0 (7/6)	0 (7/23)	0 (8/9)	0 (8/23)	0	NB	1.3 (LIMNTH)
Limitrophe North	2 (6/20)	0 (7/7)	1 (7/21)	0 (8/6)	0 (8/21)	3	1 POB	41.4 (IMPSTH)
Total	**3**	**5**	**2**	**2**	**0**	**12**	**1 POB, 1 PRB**	
Total All Sites	**29**	**56**	**64**	**22**	**7**	**178**	**25 POB, 5 PRB, 12 COB**	

*Breeding status based on all detections (survey and non-survey): POB (possible breeding pair) = ≥2 detections in an area ≥16 days apart; PRB (probable breeding pair) = POB + (food carry or traveling as a pair or vocalization exchange); COB (confirmed breeding pair) = copulation, stick carry, nest or fledgling. [1]Nearest known occupied sites in parentheses.

SURVEY DETECTION PROBABILITY

Table 6 shows detection probabilities calculated by the program PRESENCE (Hines 2006). The overall probability of detection (p) for all sites was 0.59. Broken down by survey period, this changed throughout the season, and was highest in July, survey periods 2 (p=0.76) and 3 (p=0.84). Period 5 had the lowest probability of detection (p=0.19). There were some differences between restoration sites and natural sites when analyzed separately. Overall, natural sites had a 20% higher detection probability than restoration sites. In period 1, natural sites had a 73% higher detection probability than restoration sites. During period 4, natural sites had a 39% higher detection probability than restoration sites. The last survey period had very low detection probabilities for all sites. This pattern was also seen in detection rate/area by survey period throughout the season at all sites (Figure 9).

Table 6. Detection probabilities for each survey period, at restoration and natural sites, LCR 2009.

Survey period	Restoration p (±se), n=21	Natural p (±se), n=37	All Sites p (±se), n=58
1 (Jun 15-30)	0.3957 (±0.1544)	0.6857 (±0.1162)	0.5741 (±0.0971)
2 (Jul 1-14)	0.7915 (±0.1307)	0.7481 (±0.1088)	0.7654 (±0.0836)
3 (Jul 15-31)	0.7915 (±0.1307)	0.8727 (±0.0840)	0.8420 (±0.0724)
4 (Aug 1-14)	0.4947 (±0.1582)	0.6857 (±0.1162)	0.6123 (±0.0957)
5 (>Aug 14)	0.1979 (±0.1255)	0.1870 (±0.0974)	0.1913 (±0.0770)
Total	0.5272 (±0.0750)	0.6333 (±0.0553)	0.5933 (±0.0447)
(PSI)	0.4877 (±0.1120)	0.4353 (±0.0820)	0.4533 (±0.0661)

P=probability of detection, se=standard error, PSI=proportion of sites occupied.

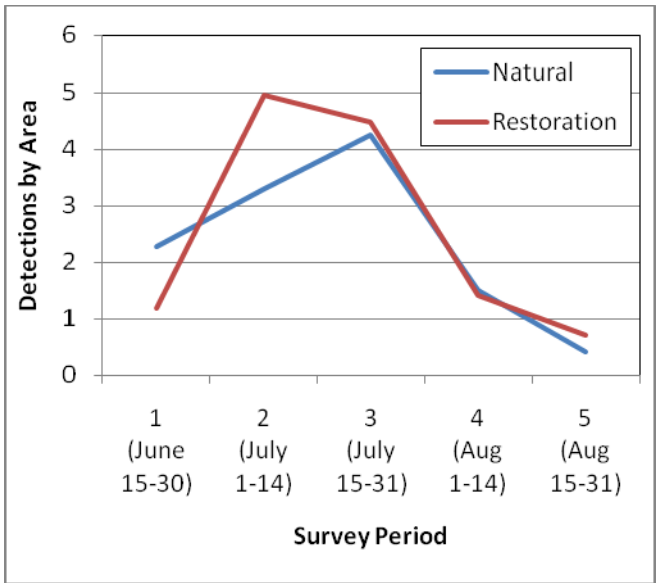

Figure 9. Lower Colorado River Yellow-billed Cuckoo survey detection rate by area for each survey period, 2009.

Breeding Evidence

Based on all detections, their timing, location and persistence, 42 potential breeding areas were estimated to occur within the survey region, including 25 possible (POB), 5 probable (PRB), and 12 confirmed (COB) breeding pairs (Table 7). A map of confirmed or suspected breeding and transient sites is shown in Figure 10. Approximately 85 calendar days were spent nest searching at all sites, not including time spent nest-searching during or following surveys About 35 days were spent nest searching at BWR NWR, 6 days at Beal and Ahakhav Tribal Preserve, 49 days at CVCA, PVER, Cibola Nature Trail, Cibola Eucalyptus and Cibola South, and 4 days at Imperial NWR. Nest checks were usually incorporated into other activities at a site, such as during surveys, nest-searching, or telemetry, and typically took no more than 10 minutes in order to minimize disturbance.

Table 7. Breeding evidence at all LCR survey sites, 2009.

Site	Visits to Site	First and Last Detection Dates	Total Days	Breeding Status*	Behaviors Observed*
Wilson Pond	1	6/19-7/23	1	1 POB	Detections in vicinity 6/19-7/23 (all incidental)
Beal Restoration	10	7/2-7/17	16	1 POB	Detections in vicinity 7/2-7/17, Two birds at site 7/3
Cave Wash	14	6/16-8/18	64	1 POB	Detections in vicinity 7/4- 8/17
				1 POB	Detections in vicinity 6/16-8/17
				1 PRB	Two birds exchanging vocalization 6/16, Detections in vicinity 6/16-7/20
				1 COB	Copulation seen 7/6
Cottonwood Patch	11	7/4-8/20	48	1 COB	Nest Found 7/21
Honeycomb Bend	13	6/22-8/15	55	1 POB	Detections in vicinity 6/22-8/15
				1 POB	Detections in vicinity 6/22-7/14
				1 COB	Fledgling found 7/22, Nest found 8/9, Juvenile Caught 8/20
Mineral Wash	10	6/22-8/16	56	1 POB	Detections in vicinity 6/22-8/15
				1 POB	Detections in vicinity 6/22-7/14
				1 COB	Juvenile observed 8/16
Cougar Point	15	6/21-8/27	68	1 POB	Detections in vicinity 6/21-8/27
				1 PRB	Three birds exchanging vocalizations 7/7, Detections in vicinity 6/21-8/16
Kohen Cliff	12	6/30-8/20	52	1 POB	Detections in vicinity 6/30-7/16
				1 COB	Juvenile birds heard 8/20
Sandy Wash	27	6/28-8/8	42	1 POB	Detections in vicinity 7/10-8/8
				1 COB	Adult feeding juvenile 7/22
				1 COB	Nest found 7/17, Fledged one or more
Fox Wash	8	7/23-8/8	17	1 POB	Detections in vicinity 7/23-8/8
Borrow Pit	12	6/23-8/5	44	1 POB	Detections in vicinity 6/28-8/5
				1 POB	Detections in vicinity 6/23-7/22
Cross River	8	6/19-8/9	52	1 POB	Detections in vicinity 7/13-8/9
				1 POB	Detections in vicinity 6/19-8/9
Mosquito Flats	18	6/30-8/13	45	1 POB	Detections in vicinity 6/30-8/13
North Burn	6	6/22-8/14	54	1 POB	Detections in vicinity 6/22-7/29
				1 PRB	Two birds together and a third vocalizing 7/9 Detections in vicinity 7/9-8/14
BW Marsh	5	6/20-8/14	56	1 POB	Detections in vicinity 6/20-7/15
				1 POB	Detections in vicinity 7/15-8/14
Ahakhav Tribal Preserve	17	6/25-7/30	36	1 POB	Detections in vicinity 7/6-7/28
				1 PRB	Two birds exchanging vocalizations 6/25, Detections in vicinity 6/25-7/28
PVER2	30	6/15-8/25	55	1 COB	Two birds with nest, 1+ fledgling
				1 COB	Two birds with nest
CVCA1	65	6/16-8/19	64	1 COB	Three birds with nest
				1 COB	Two birds with nest
CVCA3	20	6/21-7/16	26	1 POB	Two birds exchanging vocalizations 6/23, 3 birds 7/6
				1 POB	Detections in vicinity 6/21–7/16
Cibola Eucalyptus	16	7/3-8/4	31	1 POB	Detections in vicinity 7/3-8/4
Cibola South	19	6/19-8/4	47	1 COB	Two birds (one radio-tracked) with nest, 2 fledglings
Imperial South	12	7/4-8/5	33	1 PRB	Detections in vicinity 7/4-8/5, Two birds exchanging vocalizations and traveling as pair 8/1, 8/2, 8/5
Limitrophe North	6	6/20-7/22	33	1 POB	Detections in vicinity 6/20 -7/22
Total				**25 POB, 5 PRB,12 COB**	

*Breeding status definitions: POB (possible breeding pair) = ≥2 detections in an area ≥16 days apart; PRB (probable breeding pair) = POB + (food carry or traveling as a pair or vocalization exchange); COB (confirmed breeding pair) = copulation, stick carry, nest or fledgling.

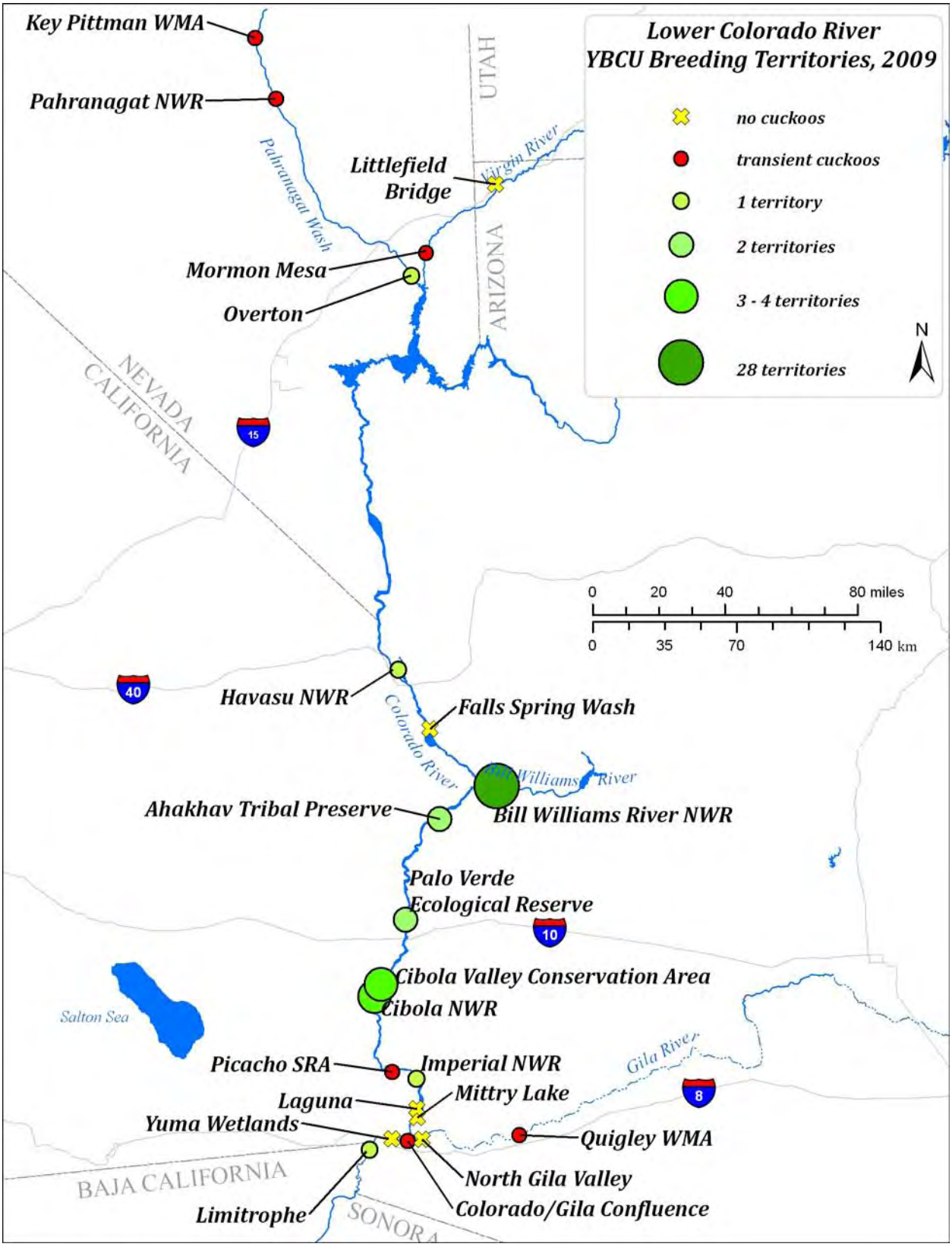

Figure 10. Map of confirmed or suspected YBCU breeding and transient areas, LCR 2009.

NESTS

Eight nests were found at four locations during the 2009 breeding season (Table 8); three at BWR NWR, two at PVER2, two at CVCA1, and one at Cibola NWR (CIBSTH). Two BWR NWR nests, one PVER2, and the CIBSTH nest were successful.

Table 8. Yellow-billed Cuckoo nests found on the lower Colorado River, 2009.

Nest	Location	# eggs	Fledged Successfully Y/N/UNK(#)	Date Found	Nest Tree Species	Tree Height (m)	Nest Height (m)
CVCA1_ N1_09	CVCA1	3	UNK	7/16	Fremont cottonwood	12.9	5.7
BWSW_ N1_09	Sandy Wash	UNK	Y	7/17	Fremont cottonwood	22	7.5
CVCA1_ N2_09	CVCA1	2	N	7/20	Goodding's willow	7.8	4.8
BWCP_ N1_09	Cottonwood Patch	2	UNK	7/21	Fremont cottonwood	11	5
PVER2_ N1_09	Palo Verde Ecological 2	1+	N	8/1	Goodding's willow	10.5	3.9
PVER2_ N2_09	Palo Verde Ecological 2	UNK	Y (1)	8/3	Goodding's willow	9	2.8
BWHB_ N1_09	Honeycomb Bend	UNK	Y(2)	8/9	Tamarisk	8.2	3.4
CIBSTH_ N1_09	Cibola South	UNK	Y (2)	7/24	Tamarisk	6.7	5.1

Mean nest height for the eight nests was 4.8 m, mean nest tree height was 11 m, and average nest tree DBH was 19.6 cm. Average cover directly above the nest was 79.3%, and 20.6% under the nest. Five of the nests had dense cover immediately adjacent on three sides, with much lower cover on the fourth side. The other three nests had dense cover on only one or two sides. Four of the five nests on restoration sites were within 3 m of an edge or vegetation transition area. Canopy cover throughout all nest plots averaged 76% in all directions, while ground cover averaged 63%. Ground cover was highly variable, and primarily driven by the presence of alfalfa at restoration sites.

Bill Williams River NWR

The three nests found at BWR NWR were at Sandy Wash, Cottonwood Patch, and Honeycomb Bend. Nest BWSW_ N1_09 was found on July 17 in a cottonwood tree. The nest contents could not be checked due to its height, but the nest was monitored to determine activity of the adults. The nest was considered successful due to continued activity in the immediate area after the nest had become inactive, with an unknown number of young fledged. The nest tree was in a large patch of tall cottonwoods with a sparse tamarisk understory. This dry sandy area was approximately 600 m from the nearest surface water. The second nest was found at Cottonwood Patch on July 21, and contained two small nestlings. The nest was still active on July 23, when an attempt was made to mist net an adult nearby. The nest was then checked on July 29; by this time there was no activity at the nest, and the nest fate is unknown. The nest was fairly exposed in a small stand of cottonwoods and willows, and approximately 300 m from the nearest surface water. The nest grove was separated from the main riparian by 8 m of dry sandy wash. The third nest was located post-fledging at Honeycomb Bend following a report from SWCA personnel of a recent fledgling. The nest was located in a tamarisk on the edge of the Bill Williams River, and was 30 m from a successful 2008 cuckoo nest.

Palo Verde Ecological Reserve

On August 1, two groups of cuckoos were heard calling from separate locations, and the first nest was found by following one of the calling birds. A cuckoo was discovered incubating, and the bird did not flush. The nest tree was in a grove of Goodding's willow, 3 m from the edge of a 4 m high coyote willow thicket. The nest was not visited on Aug 2. The nest was checked early on August 3, no cuckoos were in attendance, nor was there any

response to the observer's presence (such as alarm vocalizations). The nest was checked and one egg with a small dark mark on the end was visible. On August 4 the nest was re-checked with a ladder, and the egg was found to have a hole in the top with a dead chick inside. No other eggs or fragments were seen. The nest was possibly depredated on August 1 or 2 by a neighboring Yellow-breasted Chat. A dove egg was found nearby with a similar hole. Chats have been documented as depredating nests of Southwestern Willow flycatchers and other con-specifics (Peterson et al. 2004, T. Koronkiewicz pers. comm.). Although none have been observed depredating cuckoo nests in Arizona, this was observed in California in 1992 (M. Halterman pers. obs.).

The second PVER2 nest was found 200 m from nest 1 on August 3. The nest had recently fledged, with blue egg fragments found in the bottom and white excrement on the rim of the nest. A juvenile was heard calling within 10 m of the nest. Cuckoos were heard in this area for several more days and a juvenile was last heard in the area on August 13. The nest tree was in a shady grove of Goodding's willows similar to the first nest. The nest tree was centered in a strip of dense Goodding's willows approximately 11 m from a dense coyote willow grove.

Cibola Valley Conservation Area

CVCA1 nest 1 was found during telemetry observation on YBCU SLR (see telemetry section). The nest was within 5 m of a 2008 juvenile sighting and suspected nest site. The nest was less than 1 m from an edge between 13 m high cottonwoods and 5 m high coyote willows. The nest was well hidden by a thick whorl of leafy vegetation. Ground cover consisted of thick leaf litter interspersed with grass. Shrub cover was nonexistent on three sides of the nest tree while the fourth side abutted dense 5 m tall coyote willows. Three

cuckoos were observed in attendance at the nest, including two color-banded birds (SLR and LJ) and one unbanded cuckoo. SLR was identified as the primary male; LJ was also sexed as a male due to the presence of a distinct, enlarged CP (Pyle 1997). The third, unbanded bird was therefore female. Three adults have been observed feeding nestlings in approximately 30% of Yellow-billed Cuckoos nests (Laymon et al. 1997). Three nestlings were banded on July 28. On August 1, the nest was empty, and one adult was regularly heard in the area, although no juveniles or food carries were observed. There was no direct evidence of either predation or fledging, and the nest fate is unknown.

The second CVCA1 nest was also found through telemetry, of YBCU LBD, who was found incubating two eggs in a Goodding's willow on the edge of a coyote willow patch. On July 28, LBD was observed removing a dead, naked chick and flying with it away from the nest. The nest was then left unattended for 35 minutes and the observation ended. A re-visit two hours later found no cuckoo attending the nest, although one was heard calling nearby. The nest appeared undisturbed, and one broken egg fragment was found inside. Although infanticide by removal of the youngest nestling has been observed in Yellow-billed Cuckoos (Laymon et al. 1997, Halterman and Oring 2009b), from the adult's behavior and the chick's appearance it appeared to be dead when removed. The cause of nest failure is unknown.

Cibola South

The nest at Cibola NWR was found in a mesquite/tamarisk scrub thicket lining the eastern edge of the Perry Marsh restoration site (Cibola Island). The nest was in a mature tamarisk at the edge of the marsh, with a honey mesquite overstory. The presence of a nest had been suspected following observations of repeated food carries into the area and alarm

calls given when approached. On July 27, YBCU TF was captured 100 m south of the suspected nest, and radio-marked. The following day TF was discovered feeding two fledglings, which were heard calling in the tamarisk/mesquite thicket, within 3 m of each other. The nest, identified by the presence of blue eggshell fragments, was found on August 23, approximately 2 m from the fledglings' location.

Target Mist Netting

Forty days were spent attempting to capture cuckoos in 2009. Fourteen mist netting days were spent at Bill Williams River NWR, representing 20 net set-ups. One juvenile cuckoo was captured on the Cave Wash route. A total of 26 days were spent attempting to capture cuckoos on restoration sites. The majority of this effort occurred at sites near Blythe. Two adults were captured at CRIT, three at CVCA1, two at PVER2, and one each at Cibola South and Cibola Nature Trail (Table 9). Additional attempts took place at Havasu NWR's Beal Restoration, CVCA3, and Imperial NWR.

Table 9. Yellow-billed Cuckoos banded in 2009 on the lower Colorado River.

YBCU ID	Band Date	Site Code	Band #	Color Bands[1]	Age[2]	Sex	How Sexed[3]
CA	30-Jun	CRIT	121213729	R/Y; Gr/Ag	AHY	F	DNA
SLR	07-Jul	CVCA1	121213735	Bk/Y; R/Ag	AHY	M	Bhv (night incubation)
LJ	11-Jul	CVCA1	121213733	W/Ag; W/O	AHY	M	Morphology (CP)
DJ	18-Jul	CRIT	121213744	O/Bl, W/Ag	AHY	F	DNA
LBD	19-Jul	CVCA1	121213734	Gr/O; Bl/Ag	AHY	F	Bhv (day incubation)
MG	21-Jul	CIBCNT	121213732	R/Gr; W/Ag	AHY	F	DNA
TF	27-Jul	CIBSTH	121213731	Bl/Ag; O/W	AHY	M	Bhv (fledgling care)
nestling #1	29-Jul	CVCA1	121213737	Y	HY(5d)	U	
nestling #2	29-Jul	CVCA1	121213738	Y	HY(4d)	U	
nestling #3	29-Jul	CVCA1	121213739	Y	HY(3d)	U	
ODY	03-Aug	PVER2	121213724	R-Bl split; Ag	SY	F	Bhv (vocalizations-coos)
PF	03-Aug	PVER2	121213730	O/W; Bl/Ag	AHY	U	
POM	20-Aug	BWCW	121213745	BK/O, W/AG	HY	U	

[1]Band colors: Ag=Anodized Aluminum Gold (USGS metal);Darvic band colors: Bk=Black, Y=Yellow, R=Red, W=White, O=Orange, Gr=Green, Bl=Blue. [2]Age:AHY=after hatch year, HY=hatch year, SY=second year. [3]Bhv: tentatively sexed by behavior (see text).

Sexing

Of the nine adults captured in 2009, three were successfully sexed using DNA, two were behaviorally sexed through incubation timing, two were tentatively sexed through other behaviors, one was sexed by morphology (CP), and one could not be sexed. It is unclear why DNA sexing was not always successful, as all samples were collected using the same process with identical equipment. All blood cards were sent to a commercial lab that had previously sexed 52 cuckoos with a 94% success rate (Halterman et al. 2009a).

Two birds were sexed using incubation timing. SLR incubated overnight, a typical male behavior (Payne 1997, Payne 2005); LBD's nest was attended by a pair of cuckoos, and she was only observed incubating the nest during the day. One bird (TF) was tentatively sexed as a male as he was the sole fledgling caregiver (typically male, Halterman and Oring 2009b). ODY was tentatively sexed as a female, from repeated observations of this bird cooing (typically female, Halterman et al. 2009a).

Telemetry Observations

Six of the nine cuckoos captured at five restoration sites in 2009 were fitted with radio transmitters and followed for at least five days each, from early July to mid August 2009, for a total of 60 observation days. Table 10 gives a summary of telemetry results, including home range estimates and mated/gender status from telemetry observations and DNA analysis. Maps with home ranges of each cuckoo are shown in Figure 11. The smallest home range estimate was for an incubating female followed for 5 days, while the largest was for an unmated female followed for 13 days.

Table 10. Home range estimates, gender and mating status for cuckoos captured at LCR restoration sites, 2009.

Site	Site area (ha)	YBCU ID	#days data	# points	Gender	Mating/nesting status	MCP (ha)	95% KDE (ha)	Clipped 95% KDE (ha)	50% KDE (ha)
Ahakhav Tribal Preserve (CRIT)	53.5	DJ	5	81	Female	Unknown	30.4	29.3	25.3	6.7
		CA	0	-	Female	Unknown	-	-	-	-
Palo Verde Ecological Reserve (PVER)	48.5	ODY	13	274	Female*	Possibly PF's mate	29.8	22.2	14.9	3.8
		PF	0	-	Unk	Possibly ODY's mate	-	-	-	-
Cibola Valley Conservation Area (CVCA)	64.0	SLR	16	340	Male*	Nesting CVCA1_N1_09	20.3	17.6	16.4	3.6
		LBD	6	65	Female*	CVCA1_N2_09	4.4	8.7	6.0	2.0
		LJ	1	13	Male	Attended CVCA1_N1_09	-	-	-	-
Cibola Nature Trail (CIBCNT)	61.1	MG	13	166	Female	Unmated	50.5	32.4	21.9	4.0
Cibola South (CIBSTH)	66.6	TF	7	92	Male*	Post-nesting CIBSTH_N1_09	30.4	23.8	18.6	2.7
Mean	**56.6**		**10**	**170**			**27.6 ±15.0**	**21.6 ±8.8**	**17.8 ±6.7**	**3.8 ±1.6**

- Home range estimates not calculated due to lack of data. *Birds tentatively sexed by behavior.

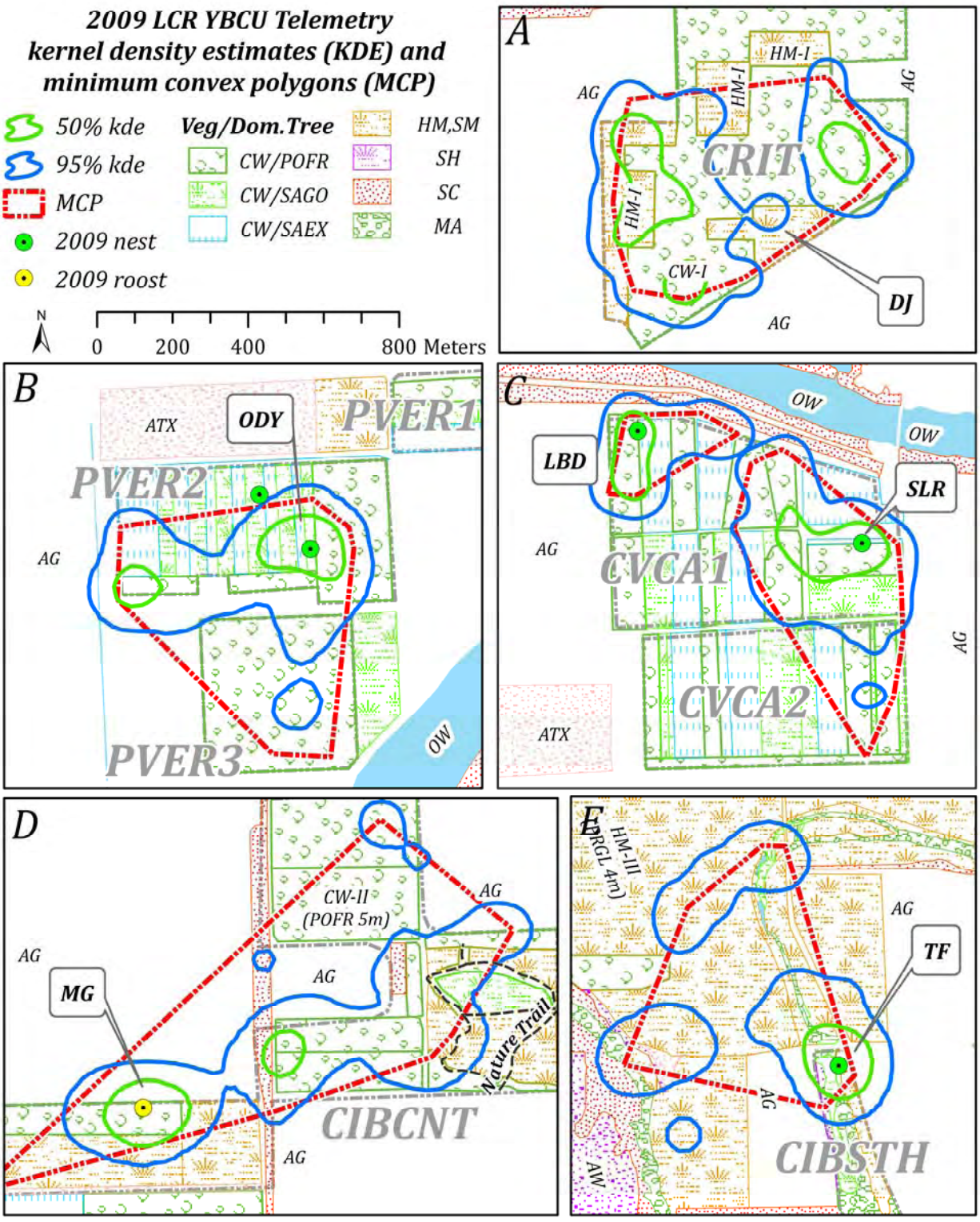

Figure 11. Home range maps of 6 cuckoos radio-tracked at LCR restoration sites in 2009.

A=Ahakhav Tribal Preserve (YBCU DJ), B=Palo Verde Ecological Reserve (YBCU ODY), C=Cibola Valley Conservation Area (YBCU SLR & LBD), D=Cibola Nature Trail (YBCU MG), E=Cibola South (YBCU TF). Vegetation layer updated from 2004 LCR vegetation types map (BIO-WEST 2006).

Ahakhav Tribal Preserve (CRIT)/CA

CA was caught on June 30 and released without a transmitter after two failed back-mounted attachment attempts. The bird immediately flew to a nearby mesquite, then slowly left the area. This bird was seen 260 meters from its capture location on July 6 (6 days after release) and was not seen again during the 2009 season.

Ahakhav Tribal Preserve (CRIT)/DJ

The second cuckoo caught at CRIT (DJ, Figure 11A) was captured on July 18. The transmitter was tail-mounted and remained fixed for the ten days she was observed at the site. Two other cuckoos were detected in the vicinity of DJ's capture, and during subsequent telemetry observations DJ was observed interacting with one or more cuckoos. DJ was seen flying toward other vocalizing cuckoos, heard responding vocally to other individuals, and seen carrying food. Despite this, DJ was not observed at a confirmed nest, or seen copulating with another bird. No juveniles were detected at the site, and DJ was observed moving large distances each day of telemetry. DJ was not detected after July 28, although one bird was detected at the site on July 30. No cuckoos were detected at the site after this date.

Palo Verde Ecological Reserve 2 (PVER2)/ODY

On August 3, two cuckoos were mist-netted at the same time. One of the cuckoos (ODY, Figure 11B) was a recapture, banded as a nestling at CVCA1 in 2008. A radio transmitter was tail-mounted to ODY. The second cuckoo (PF) was processed, color banded and released. DNA sexing was unsuccessful, and the data are insufficient to confidently determine the sex of either bird, however ODY was tentatively sexed as a female due to repeated cooing. After release, ODY spent the morning in a grove of Goodding's willows just

west of the capture site. During this time, ODY was in contact with at least one other cuckoo. ODY was occasionally observed flying from PVER2 to PVER3 to forage. On August 7, an unknown bird attempted to copulate with ODY near the capture location. On August 8 ODY was observed cooing throughout the day and in regular contact with at least one other cuckoo who responded to ODY's cooing with kowlp calls. After August 9, ODY was no longer observed interacting with other cuckoos. From August 13 – 24, ODY was observed mostly at the far southwestern corner of PVER2, only occasionally flying to and foraging in PVER3. On August 26 ODY's signal could not be found. The bird probably left the site between August 24 and 26.

Cibola Valley Conservation Area 1 (CVCA1)/SLR

On July 7 SLR was captured, color-banded and a transmitter back-mounted (Figure 11C). During the first day SLR sat for long periods in a low coyote willow thicket and generally stayed within 100 m of the capture location. SLR responded with contact calls to at least one other cuckoo and was observed copulating with a second cuckoo within 1 hour of release. SLR was observed carrying a stick on July 14, and again on July 16, when he flew to a nest (CVCA1 nest 1). During these telemetry observations, SLR was identified as a male (incubating overnight - Payne 1997, 2005) and appeared to be the primary nestling caregiver. SLR was followed until July 26, when the transmitter was found on the ground approximately 100 m from his nest. SLR retained his transmitter for a total of 18 days. He foraged primarily in cottonwood and Goodding's willow, and was in daily contact with several cuckoos. SLR was very vocal, giving contact calls when he flew to the nest and responding to other vocalizing cuckoos. SLR was observed carrying cicadas and katydids to the nest and to another adult. SLR was also observed in CVCA2, responding to a cuckoo and

foraging. From July 26 until his nest was no longer active (August 1) SLR was identified by glimpses of his color bands.

Cibola Valley Conservation Area 1 (CVCA1)/LJ

On July 11, approximately 100 m from SLR's capture location, LJ was captured, color banded and fitted with a back-mounted radio transmitter. LJ was identified as a male due to the presence of an enlarged cloacal protuberance (Pyle 1997). LJ spent much of the first morning near the capture site. He responded to a cuckoo calling from CVCA2, and then flew south into CVCA2 where he foraged in young cottonwoods and coyote willows. The next morning (July 12), LJ's transmitter was found on the edge of the plot, approximately 180 m from his capture site, and 40 m from SLR's nest (4 days before its discovery). LJ was identified later (by color bands) as one of three cuckoos associated with SLR's nest.

Cibola Valley Conservation Area 1 (CVCA1)/LBD

On July 19, LBD (Figure 11C) was mist-netted in the northwest corner of CVCA1, and equipped with a back-mounted radio transmitter. Following release, LBD moved 270 m from the capture location. The next morning (July 20), LBD was found in the northwest corner of the site, sitting on a nest in a Goodding's willow (CVCA1 nest 2). On July 23 the nest contained two eggs. Although DNA sexing was unsuccessful, LBD was identified as a female as she was never observed incubating the nest overnight, instead roosting nearby. On July 25 after a thunderstorm and heavy rain, the transmitter was found on the ground approximately 60 m from the nest. After the loss of the transmitter all observations of LBD were conducted at the nest area (See Nest CVCA1-02). LBD's daily movements centered at the nest area. LBD was not located again after nest failure.

Cibola Nature Trail (CIBCNT)/MG

MG was captured just west of Cibola Nature Trail on July 21 and fitted with a back-mounted radio transmitter. DNA sexing identified her as a female. MG was followed from July 21 until August 2, for a total of 13 days. MG's movements followed a predictable daily pattern, roosting west of the Nature Trail during the night, moving east towards the Nature Trail to forage each morning, then returning to her roost site during the heat of the day (see Figure 11D). During the mornings she cooed regularly. MG was observed with a second cuckoo from July 20-26. The two cuckoos roosted near each other; both regularly cooed and occasionally exchanged contact calls. After August 2 MG could no longer be located, and had probably left the area.

Cibola South (CIBSTH)/TF

On July 27 TF was mist-netted at Cibola Island (Perry Marsh), and fitted with a tail-mounted transmitter (Figure 11E). The morning after capture (July 28) TF was observed carrying food to a suspected nest (based on previous observations), and two fledglings were subsequently heard, calling approximately 3 m apart. For the next week he was observed foraging and carrying small lizards, cicadas, katydids and a caterpillar to the nest area. Although DNA sexing was unsuccessful, TF was suspected to be a male, as he was the sole fledgling caregiver observed. On July 31 TF's signal was not picked up from 5:40 until 7:45 am. He repeated this pattern on subsequent days, travelling 600 m or more through mesquite habitat both northeast and west of the nest area, and staying away from the nest area for long periods. TF was followed until August 3, when the signal could no longer be found in the area. The last cuckoo detection at the site occurred on August 4, when a juvenile was heard near the nest.

Vegetation Sampling

Vegetation characteristics were measured at 129 plots across 47 sites. Plots were classified as nest, 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 11. Mean canopy height and cover by occupancy status at restoration and non-restoration sites are also presented in Figure 12. Canopy cover was significantly higher at restoration than at natural plots (t=-3.46, p=0.00073, n=129), but not between occupied and unoccupied plots (t=-1.10, p=0.274, n=129). Total canopy cover at nest plots was similar to that at occupied and restoration plots.

Table 11. Vegetation canopy cover, height, and number of trees by size class at YBCU plots, LCR 2009.

	Vegetation Plots (n=129)									
	Nest (n=8)		Occupied (n=38)		Unoccupied (n=91)		Restoration (n=64)		Non-Restoration (n=65)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Total Canopy Cover %	84	50 - 98	82	40 - 98	78	27 - 99	83	40 - 99	74	27 - 99
Total Canopy Ht (m)	10	7 - 20	11	4 - 24	10	4 - 22	9	4 - 19	11	4 - 24
High Canopy Cover %	51	7 - 95	49	7 - 100	42	2 - 90	43	3 - 100	45	2 - 96
High Canopy Ht (m)	11	7.2-20	12	5 - 24	11	5-22	10	5 - 19	12	5 - 24
Main* Canopy Cover %	38	12 - 95	43	8 - 96	49	3 - 100	43	4 - 97	52	3 - 100
Main* Canopy Ht (m)	9	6 - 10	9	4 - 18	8	3 - 22	8	3 - 19	9	3 - 22
Sub Canopy Cover %	36	20 - 42	25	3 - 42	30	0 - 81	26	0 - 80	33	1 - 81
Sub Canopy Height (m)	5	3 - 6	4	0 - 10	4	0 - 7	4	1 - 7	4	0 - 10
Shrub/Sapling Cover %	10	2 - 26	12	0 - 43	19	0 - 100	13	0 - 73	21	0 - 100
Shrub Sapling Ht (m)	2	1 - 4	2	0 - 4	2	0 - 5	2	0 - 5	2	0 - 4
# Large Trees in 11.3 m	2	0 - 6	3	0 - 15	3	0 - 12	2	0 - 15	4	0 - 13
# Small Trees in 5 m	66	5 - 188	62	0 - 361	44	0 - 656	42	0 - 361	58	0 - 656
# Shrubs/Sapling in 5 m	51	0 - 163	39	0 - 187	64	0 - 1184	62	0 - 1184	50	0 - 313

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.*Main Canopy is where the majority of the canopy vegetation is found.

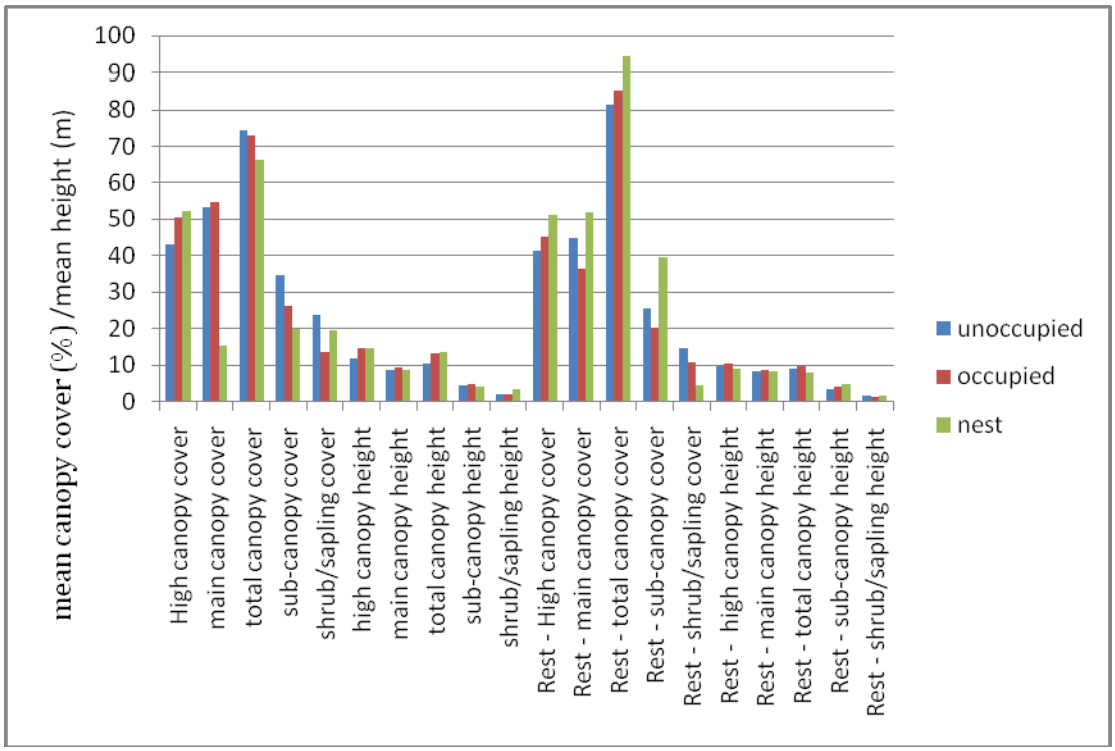

Figure 12. Mean canopy height (m) and cover (%), for nest sites, occupied sites, and unoccupied sites on the LCR, grouped by restoration status, 2009.

Microclimate

Temperature and Humidity

Microclimate data was recorded at 140 plots within 47 sites. Of these, 129 data loggers recorded both temperature and humidity (5 of which failed or were lost during the season), and 11 recorded temperature only. The number of iButtons®, mean temperature and humidity for each site with data loggers are given in Table 12 (northern sites) and Table 13 (southern sites). Fifty four percent of plots were at occupied sites (n=75), 46% were at unoccupied sites (n= 65). Natural sites made up 54% of these plots (n=75) while the remaining were at restoration sites (n=65).

Table 12. Summary of microclimate variable means for sites north of and at Bill Williams River National Wildlife Refuge, 2009.

Site Code	YBCU Status[1]	Mean Soil Moisture[2]	Mean Cicada Count[3]	# iButtons®	Diurnal Temp (C)	Nocturnal Temp (C)	Diurnal Humidity (RH)	Nocturnal Humidity (RH)
Sites North of BWR NWR								
PAHNTH	0	69.03 (n=2)	0 (n=2)	2	25.25	19.29	44.63	53.10
LITBR	0	44.97 (n=2)	0.63 (n=2)	2	29.05	23.52	*	*
OVRHP	0	22.74 (n=2)	0.13 (n=2)	2	32.15	25.26	37.57	50.35
OVRW	0	70.73 (n=3)	0 (n=2)	3	32.50	24.23	35.90	54.45
HAVPS	0	16.44 (n=2)	7.38 (n=2)	2	35.83	26.76	33.52	54.23
HAVND	0	29.05 (n=3)	2.17 (n=3)	3	35.24	24.30	39.05	65.98
HAVGH	0	42.15 (n=3)	0.17 (n=3)	3	30.49	24.21	55.24	68.01
HAVTPR	0	7.69 (n=3)	1.17 (n=3)	3	35.91	28.13	28.26	39.23
HAVBR	1	2.68 (n=3)	5.17 (n=3)	3	33.26	25.57	45.54	59.10
Mean (Tot)	**1**	**33.94 (n=23)**	**1.87 (n=22)**	**23**	**32.19**	**24.59**	**39.96**	**55.56**
BWR NWR Sites								
BWCW	4	1.75 (n=3)	32.5 (n=3)	3	32.26	25.51	42.14	56.69
BWCP	1	2.49 (n=2)	24.13 (n=2)	2	33.76	26.94	37.71	52.01
BWHB	3	7.43 (n=8)	32.69 (n=8)	8	30.35	24.95	54.10	64.26
BWMW	3	4.75 (n=4)	51.13 (n=4)	4	30.95	26.36	45.34	51.30
BWER	0	39.55 (n=4)	6.44 (n=4)	4	30.60	25.13	50.82	63.33
BWPT	2	37.44 (n=3)	23.13 (n=3)	3	29.98	24.84	54.40	63.87
BWGR	0	18.59 (n=7)	19.35 (n=5)	7	32.62	27.74	39.66	46.38
BWKC	2	7.69 (n=1)	76.75 (n=1)	1	31.94	27.09	43.50	49.67
BWSW	3	8.91 (n=8)	9.88 (n=8)	8	29.35	24.06	57.73	66.70
BWFW	1	30.17 (n=3)	31.42 (n=3)	3	29.12	23.90	60.76	71.98
BWBP	2	5.09 (n=1)	17 (n=1)	1	29.64	24.72	60.30	69.28
BWCR	2	72.02 (n=2)	2.75 (n=2)	2	30.06	24.17	60.52	73.05
BWMF	1	45.69 (n=4)	5.19 (n=4)	4	30.56	24.75	57.54	67.84
BWNB	2	58.64 (n=1)	0 (n=1)	1	28.01	21.77	77.32	90.26
BWMD	0	94.35 (n=2)	0 (n=2)	2	28.36	23.15	68.54	78.59
Mean(Tot)	**28**	**28.97 (n=53)**	**22.16 (n=51)**	**53**	**30.50**	**25.01**	**54.03**	**64.35**

[1]YBCU Status is an estimate of the total number of possible, probable or confirmed breeders at each site. [2]Mean soil moisture was averaged from 5 readings (taken during each of the 5 survey periods) for each site. N=the number of locations (vegetation plots) sampled from each site. [3] Cicada exuviae counts are the average of 5 counts done at each vegetation plot. N=the number of vegetation plots at a given site.

Table 13. Summary of microclimate variable means for sites south of Bill Williams River NWR, 2009.

Site Code	YBCU Status[1]	Mean Soil Moisture[2]	Mean Cicada Count[3]	# iButtons®	Diurnal Temp (C)	Nocturnal Temp (C)	Diurnal Humidity (RH)	Nocturnal Humidity (RH)
Sites South of BWR NWR								
CRIT	2	3.29 (n=6)	3.75 (n=6)	6	33.44	25.70	39.56	55.22
PVER1	0	52.57 (n=2)	1 (n=2)	2	28.05	24.68	*	*
PVER2	2	14.89 (n=4)	0 (n=4)	4	30.05	22.06	68.78	84.88
CVCA1	2	18.78 (n=6)	5.3 (n=5)	7	30.36	25.31	52.97	58.97
CVCA2	0	42.23 (n=1)	0 (n=1)	1	30.20	23.83	58.93	75.37
CVCA3	2	45.38 (n=3)	0 (n=3)	3	33.06	27.12	42.57	53.97
CIBNTH	0	10.44 (n=2)	12.88 (n=2)	2	33.97	28.76	36.75	41.52
CIBCNT	0	25.87 (n=4)	0.88 (n=4)	4	32.32	27.19	43.09	50.34
CIBEUC	1	8.23 (n=2)	0 (n=2)	2	35.12	31.75	29.47	31.09
CIBSTH	1	92.13 (n=4)	2.81 (n=4)	3	34.46	26.47	34.25	49.46
PICSRA	0	36.85 (n=2)	0 (n=2)	2	34.18	31.76	35.68	36.16
IMPSTH	1	17.82 (n=3)	3.33 (n=3)	3	34.35	29.82	39.29	47.73
IMP20A	0	30.89 (n=1)	3.25 (n=1)	1	33.96	28.18	41.13	49.23
IMPAST	0	94.15 (n=2)	0 (n=2)	1	31.94	25.73	43.02	58.24
LAG1	0	9.50 (n=1)	0.25 (n=1)	1	32.90	29.14	43.24	48.76
LAG2	0	71.93 (n=2)	0 (n=2)	2	32.38	28.32	46.69	49.05
LAG3	0	45.43 (n=3)	0 (n=3)	3	33.70	30.55	36.95	38.84
MLPR	0	42.77 (n=3)	1.92 (n=3)	3	34.77	28.88	34.66	43.61
GRQP	0	8.55 (n=3)	0 (n=3)	3	35.06	28.89	32.75	41.12
GRNVA	0	118.32 (n=1)	0 (n=2)	2	33.29	28.46	44.88	54.98
GRNVB	0	73.35 (n=1)	0 (n=1)	1	34.72	27.06	41.88	55.87
YUWW	0	43.48 (n=6)	0.04 (n=6)	6	34.67	29.36	36.41	44.47
YUEW	0	30.62 (n=2)	0 (n=2)	2	33.97	30.30	38.46	41.90
Mean(Tot)	12	40.76 (n=64)	1.54 (n=64)	64	33.08	27.80	41.88	50.49

[1] **YBCU** Status is an estimate of the total number of possible, probable or confirmed breeding pairs at each site. [2] Mean soil moisture was averaged from 13 readings taken during each of the 5 survey periods for each site. N=the number of locations (vegetation plots) that were sampled from each site. [3]Cicada exuviae counts are the average of 5 1x1 m subplots counted within each vegetation plot. N=the number of vegetation plots at the site.

Both temperature and humidity showed temporal (Figure 13) as well as latitudinal (Figure 14) variation across sites. Temperatures peaked in mid to late July, while humidity peaked in late August and early September. Overall temperatures increased and humidity decreased from north to south. Sites at BWR NWR were an exception to the latitudinal trend, with lower temperatures and higher humidity than other sites of similar latitude.

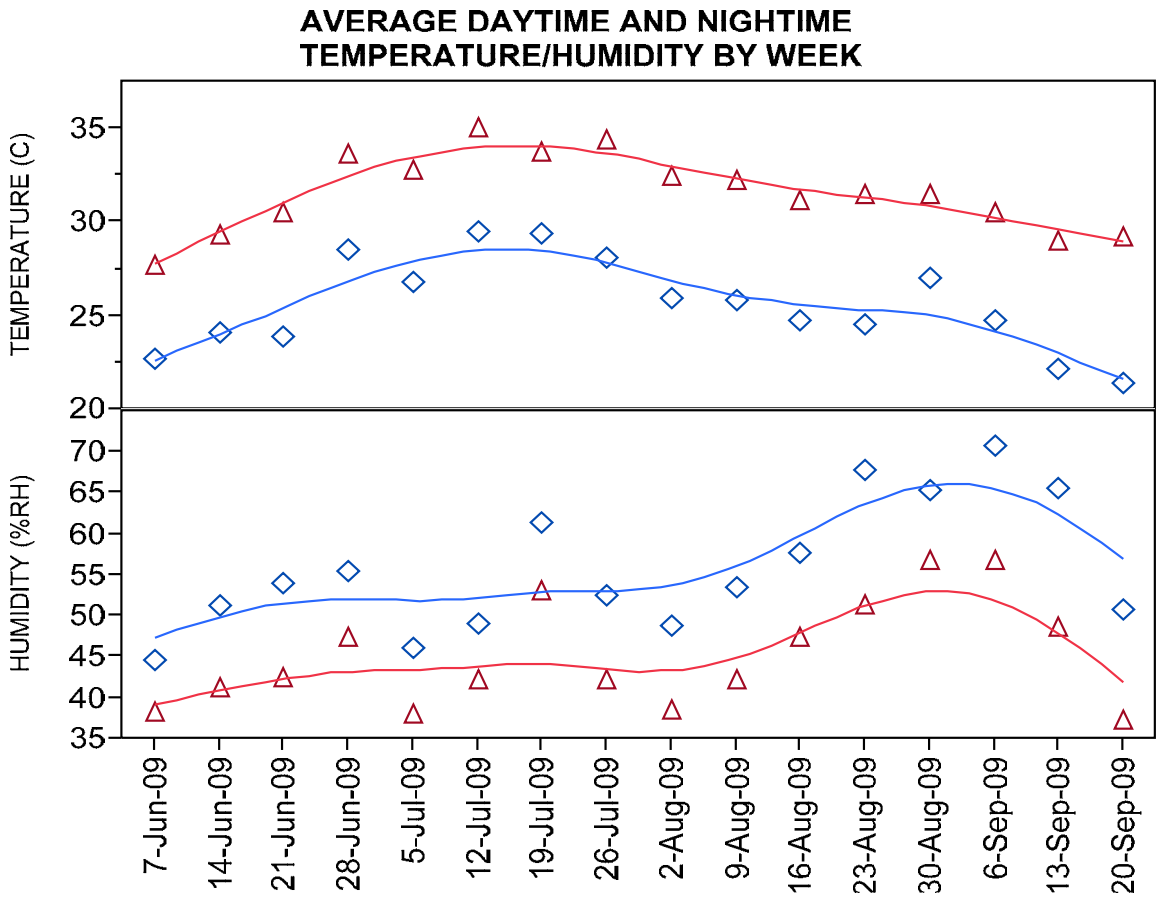

Figure 13. Average diurnal and nocturnal temperature (°C) and percent humidity (RH) for each week during the 2009 survey season. Date indicates the first day of the week (Sunday). Diurnal readings are represented by red triangles, nocturnal readings by blue diamonds and the trend by a solid line.

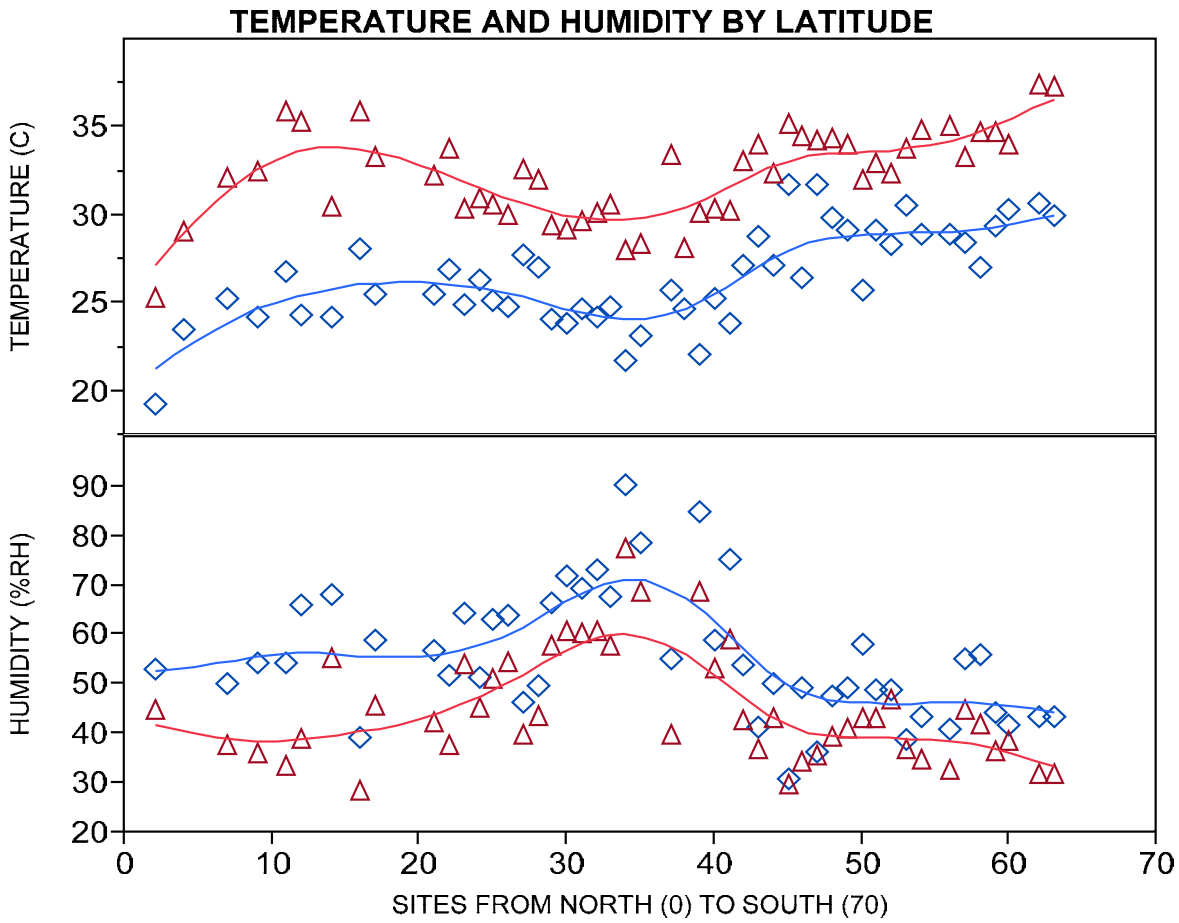

Figure 14. Diurnal (05:00:01-19:00:00) and nocturnal (19:00:01-05:00:00) temperatures (°C), and relative humidity (RH) by latitudinal gradient at LCR sites. Diurnal readings are represented by red triangles, nocturnal readings by blue diamonds and the trend by a solid line.

Mean temperature and humidity at occupied and unoccupied sites are presented in Table 14. Occupied sites had significantly higher diurnal and nocturnal humidity than unoccupied sites. Temperatures at occupied sites tended to be lower than at unoccupied sites, but results were not statistically significant. However, when average diurnal temperatures were compared by plot occupancy instead of site occupancy (i.e. treating plots with no detections within 50 m as unoccupied even if the site was considered occupied), the temperature difference was statistically significant (p=0.0489). Differences

between three-year (2006-2008) occupied and unoccupied plots showed even greater statistical significance (p=0.0151).

Table 14. Mean, standard deviation, and t-test results for microclimate variables at occupied and unoccupied sites and plots.

	Temperature (ºC)				Humidity (%RH)			
Status[1]	**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**	
Occupied site	31.50±2.02 (n=21)	t=-1.5018 p= 0.1402	25.74±2.26 (n=21)	t=-1.4014 p=0.1680	49.85±12.01 (n=21)	*t*=2.51 p=0.0166	60.37±13.38 (n=21)	t=2.1306 p=0.0394
Unoccupied site	32.53±2.67 (n=26)		26.79±2.89 (n=26)		41.86±9.07 (n=24)		52.20±11.45 (n=24)	
Occupied plot	31.48±2.34 (n=42)	t=-1.9997 p=0.0489	26.03±2.64 (n=42)	t=-0.7124 p=0.4784	48.50±12.05 (n=39)	t=1.7135 p=0.0912	57.41±14.58 (n=39)	t=0.6848 p=0.496
Unoccupied plot	32.36±2.39 (n=92)		26.37±2.42 (n=92)		44.63±10.84 (n=84)		55.58±11.71 (n=84)	
3-year Occupied plot	31.22±1.76 (n=28)	t=2.5148 p=0.0151	25.66±1.56 (n=28)	t=1.7647 p=0.0845	49.44±8.60 (n=28)	t=-3.3575 p=0.0014	59.49±8.82 (n=28)	t=-2.7545 p=0.0081
3-year unoccupied plot	32.65±2.50 (n=29)		26.70±2.77 (n=29)		41.73±8.57 (n=28)		52.29±10.65 (n=28)	

[1]Status: Site means were calculated by first averaging all plots within each site, then averaging the occupied and unoccupied sites. Plot data were based on plot occupancy, regardless of site occupancy. 3-year occupied/ unoccupied plots had detections/no detections for 3 consecutive years (2006-2008).

Mean temperature and humidity for vegetation plots with and without nests are presented in Table 15. To control for seasonal variation in temperature and humidity these data were compared only for July and August, the most active nesting period. This was necessary as some iButtons® were deployed later in the season than others. Although the sample size was small for iButtons® at 2009 nests (n=7), they had lower average temperatures (diurnal t=-2.230, p=0.032, nocturnal t=-2.657, p=0.017) and higher average humidity (diurnal t=2.174, p=0.035, nocturnal t=2.233, p=0.032) than those not at 2009 nest sites (n=130 for temperature, n=119 for humidity). When only occupied sites were considered, loggers at 2009 nests (n=7) had lower temperatures (t=-2.468, p=0.018) and higher humidity (t=2.272, p=0.027) than those not at nest sites (n=35).

Table 15. Mean, standard deviation, and sample size for microclimate variables at vegetation plots with and without nests, LCR 2009.

	Temperature (°C)		Humidity (%RH)	
Plot Type	**Diurnal**	**Nocturnal**	**Diurnal**	**Nocturnal**
Nest (2007-2009)[1]	30.87 ±2.23 (n=15)	25.21 ±2.25 (n=15)	52.81 ±11.60 (n=15)	63.19 ±13.33 (n=15)
Nest (2009)	30.38 ±2.98 (n=7)	24.11 ±2.79 (n=7)	56.93 ±14.97 (n=7)	69.10 ±16.76 (n=7)
No Nest Occupied (2009)	32.44 ±2.36 (n=35)	26.97 ±2.80(n=35)	45.59 ±10.46 (n=32)	53.78 ±13.10 (n=32)
No Nest Unoccupied (2009)	32.99 ±2.53 (n=92)	26.93 ±2.55 (n=92)	44.40±10.79 (n=84)	55.30 ±11.81 (n=84)
No Nest Combined (2009)	32.93 ±2.54 (n=130)	26.99 ±2.63 (n=130)	44.45 ±10.69 (n=119)	54.74 ±12.10 (n=119)

[1] Averages for 2009 iButtons® placed at plots where one or more cuckoo nest was found over the period 2007- 2009.

Soil Moisture

Volumetric water content (VWC) was collected at sites north of the BWR NWR and within BWR NWR (Table 12), and sites south of BWR NWR (Table 13). Soil moisture was highly variable both within and between plots. Occupancy was weakly correlated with soil moisture (Table 16), with lower soil moisture content at occupied sites. No difference in soil moisture was found between natural and restoration sites.

VWC showed a weak negative correlation with cuckoo survey detections (r^2=-0.108, p=0.0241) as well as cicada exuviae (r^2=-0.179, p=0.003) when averaged across all sites. A negative correlation between VWC and cicada exuviae (r^2=-0.111, P<0.0001) was also found at the plot scale.

Table 16. Volumetric water content (VWC) distributions and χ^2 results for all plots, LCR 2009.

VWC	Occupied	Unoccupied	Test Results
0-25	55	27	**χ^2** = 15.039
26-50	9	16	**P** = 0.002*
51-75	4	11	**λ** = 0.079
>75	7	11	
VWC	**Natural**	**Restoration**	**Test Results**
0-25	41	41	**χ^2** = 4.973
26-50	13	12	**P** = 0.174
51-75	7	8	**λ** = 0.017
>75	4	4	

No relationship was found between soil moisture and humidity (diurnal, r^2=0.012, *p*=0.221; nocturnal, r^2=0.018, *p*=0.142) across 123 vegetation plots. The same was true for soil moisture and temperature (diurnal, r^2=0.014, *p*=0.170; nocturnal, r^2=0.004, *p*=0.475) across 133 plots.

Insect Sampling

Live Cicada Counts

Live cicada indices were recorded concurrently with cuckoo surveys at 50 sites along the lower Colorado River in 2009. These data show a seasonal synchrony between cicada abundance and cuckoo detections (Figure 15). Cuckoo detections peaked in week 28 (the second week in July), while cicada numbers peaked two weeks later, in week 30.

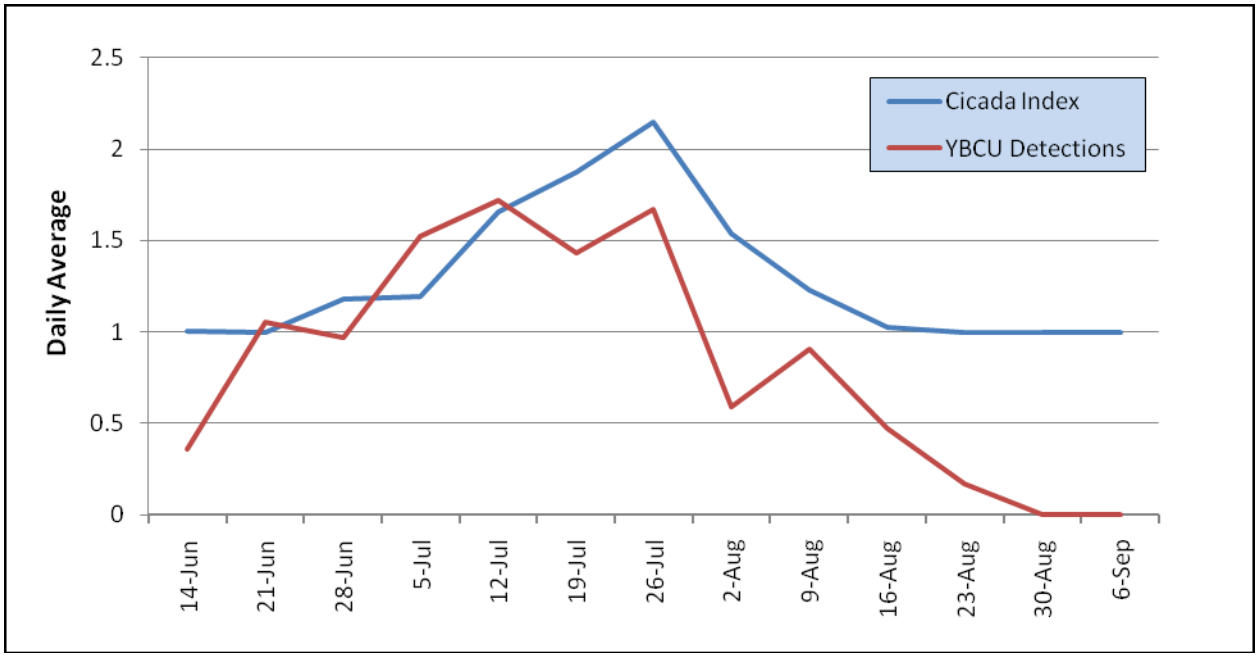

Figure 15. Average daily cicada index and YBCU detections by week for 2009 data.

Live cicada index data for both natural and restoration sites suggest a weak to moderate relationship between occupancy and cicada abundance (Table 17). When natural sites and restoration sites were combined, occupancy status was again related to the number of cicadas detected.

Table 17. Live cicada count distributions and χ^2 results at occupied and unoccupied sites.

	Live cicadas	Occupied	Unoccupied	χ^2
Natural	**0-1**	640	690	
	2-5	200	22	χ^2 = 185.069
	6-10	76	21	**P** < 0.0001*
	11-20	43	11	**λ** = 0.088
	>20	33	5	
Restoration	**0-1**	643	246	
	2-5	46	31	χ^2 = 47.735
	6-10	5	13	**P** < 0.0001*
	11-20	4	15	**λ** = 0.036
	>20	20	2	
Combined	**0-1**	1283	936	
	2-5	246	53	χ^2 = 89.74
	6-10	81	34	**P** < 0.0001*
	11-20	47	26	**λ** = 0.027
	>20	53	7	

Exuviae Counts

Cicada exuviae were counted at 137 plots, 73 at natural sites and 64 at restoration sites. Sixty-three of the plots were at unoccupied sites, while 74 were at occupied sites. Exuviae counts and cuckoo detections averaged across each site were positively correlated at natural sites (r^2=0.360, *p*=0.0012, n=26); no correlation was found at restoration sites (r^2=0.002, *p*=0.864, n=21). Similarly, exuviae numbers were correlated with the number of cuckoo pairs estimated for natural sites only (Figure 16). The mean exuviae count at known nest plots (mean=9.5 ±12.08, n=8)) was greater than that of unoccupied plots (mean=2.96 ±7.56, n= 63), but this was not statistically significant.

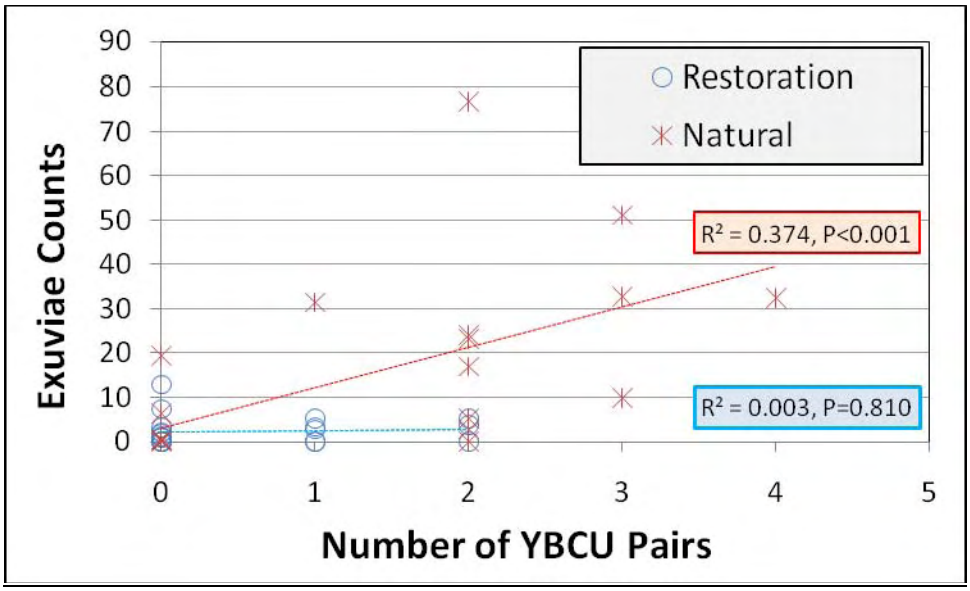

Figure 16. Exuviae counts by estimated number of breeding pairs at each site. The red line is the line of fit for natural sites, and the blue is the line of fit for restoration sites. Number of pairs is the total number of possible, probable or confirmed breeding pairs at each site.

Comparison of Methods (Live Cicada and Exuviae Counts)

Live cicada count averages were weakly correlated with exuviae counts across all sites (r^2=0.159, p=0.011, n=40); when two outliers were removed, the correlation was much stronger (r^2=0.466, p<0.001, n=38). Natural sites showed a stronger correlation between the two counts (r^2=0.567, p<0.001, n=20) when a single outlier was removed. The two count methods were not, however, strongly correlated at restoration sites (r^2=0.002, p=0.859, n=19).

Patch Size

Figure 17 shows total detections by size of area for each site. Sites with no detections were much smaller than sites where one or more cuckoos were detected (no detection: 12.1 ±16.5 ha, n=26, 1+ detection: 33.5 ±21.6 ha, n=32, t=-4.21, p<0.005). The mean size of occupied sites (37.3 ±19.5 ha, n=26) was almost three times as large as unoccupied sites (13.2 ±18.1 ha, n=32, t=-4.73, p<0.005).

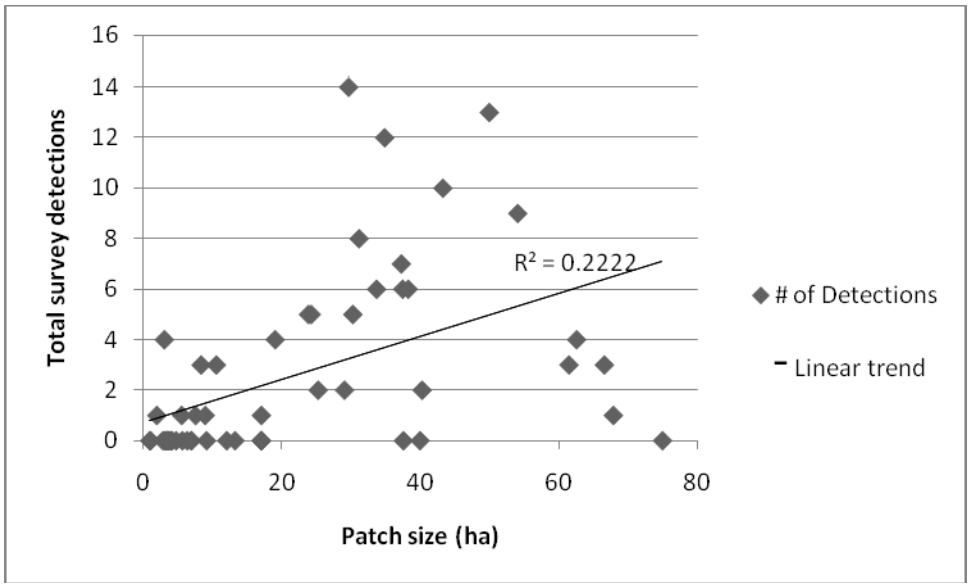

Figure 17. Total cuckoo detections by patch size (hectares), LCR survey sites 2009.

DISCUSSION

The current survey methodology (Halterman et al. 2008) requires a minimum of four surveys between mid-June and late August. The low detection probability estimated for surveys after August 15 (p=0.19) indicates that the majority of birds became less responsive, or left the sites, after this date. Of four birds leaving their site with transmitters attached, three left between July 29 and August 3, while the fourth left on August 24. This year's results suggest that at least for this region, July is the most productive period for detecting cuckoos, while surveys after mid-August may not reliably indicate site occupancy during the breeding season.

There was a strong relationship between cicadas and cuckoo detections in 2009, particularly at natural sites. At the Bill Williams River, Rosenberg et al. (1982) found peak cicada numbers coincided with fledging of young in cuckoos as well as seven other riparian bird species that prey heavily on cicadas. The strong cuckoo-cicada correlation found this

year did not extend to the restoration sites however, where there were lower numbers of cicadas.

Cicada colonization of new areas is subject to a number of factors. Arthropod community structure reflects the degree of fragmentation and isolation of forest ecosystems (Maleque et al. 2006). Cook et al. (2001) found that patch size and distance from emergence source both affected the colonization of an experimental forest by the 17 year cicada. They found an increase in cicada oviposition scars in larger patches and a decrease in scars with increasing distance from emergence source. Many of the restoration sites along the lower Colorado River are highly fragmented and far from established natural patches of habitat with large cicada populations. It may therefore take a long time for cicadas to fully colonize these areas.

Cuckoos appear to be adaptable and able to vary their diet based on locally abundant food resources (Hughes 1999). Rosenberg et al. (1982) found that besides cicadas, grasshoppers were an important food for cuckoos at the Bill Williams River. At some restoration sites (PVER and CVCA in particular) there may be different arthropod communities associated with the alfalfa-dominated understory. Stamp et al. (2002) found that black walnut stands had higher arthropod abundance and diversity among alleyways cropped with alfalfa rather than smooth brome grass or bare ground. Sampling large insects at restoration sites with and without alfalfa, and comparing the diets of cuckoos at natural compared to restoration sites, may shed some light on the differences between these habitats. Such a study could potentially be carried out on the Bill Williams River NWR and a subset of the restoration sites.

In 2009, this project expanded by capturing and radio-tracking cuckoos on LCR restoration sites. A bird captured at PVER2 was the first cuckoo banded as a nestling and subsequently recaptured. The natal dispersal distance, not previously documented for Yellow-billed Cuckoos, was 33 km for this individual. Of more than 100 cuckoo nestlings banded in Arizona and California over the last 20 years, none have previously been re-sighted (Laymon unpub. data, Halterman and Oring 2009a). Five nests were also found at three restoration sites in 2009, following the first confirmed nesting of cuckoos on an MSCP restoration site in 2008 (Halterman et al. 2008b). Cuckoos are successfully colonizing and breeding in these young sites (3 to 8 years old), and foraging in adjacent very young (1-2 year old) patches. Mean home range estimates within these restored sites (21.6 ha 95% KDE, 27.6 ha MCP) were about half the mean home ranges estimated by Halterman and Oring (2009a) from 28 cuckoos followed on the San Pedro River, southeast Arizona from 2001-2005, and about a third of the estimates from 10 cuckoos followed on the Middle Rio Grande, New Mexico from 2007-2008 (Sechrist et al. 2009). These large differences may be due to a number of factors, including differences in site characteristics (fragmented restoration sites compared to large expanses of contiguous habitat), sample size, number of observation days, breeding stage, sex, and mating status. More research is needed to better understand factors driving home range variation, as well as site fidelity, natal dispersal, and population dynamics of Yellow-billed Cuckoos within the region.

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Appendix 1.1. YBCU Survey and detection form, 2009.

Yellow-Billed Cuckoo (YBCU) Survey Detection Form **Page of**

Site Name: Site Code:		Survey Period	Visit Number	Date (m/d/y)
State: County:		Surveyor:		GPS #
START: Temp (°F)___ Hum (%)____Wind(Beaufort)___ Cloud Cover (%)___		STOP: Temp (°F)___Hum (%)___ Wind(Beaufort)____ Cloud Cover (%)____		
Start Time:	UTM Start: E N			Data Zone: Data Nad 83: Y N
Stop Time:	UTM Stop: E N			Data Entry: / / Data Proof: / /
Number of stops:	**Total YBCU Detected:**			

Time	Wpt Name	UTM East	UTM North	GPS #	Survey Pt. Name	Cicadas[1]	Bird # (1,2,3.., U)	Det. Type (A/V/B)[2]	Behaviors Observed[3]	Voc. Type[4]	Compass Bearing	Estimated Distance (m)	Habitat Type[5]	Structure Type[5]	Note #

[1] Count cicadas as survey point is approached and during survey. Enter number of cicadas detected (1=0-1 cicadas, 2=2-5 cicadas, 3=5-10 cicadas, 4=11-19 cicadas, 5=20+ cicadas).
[2] A=audio (heard), V-visual (seen), B=both heard and seen
[3] Include these behavior codes (for additional behaviors use notes): FC=flew closer, CO=copulation, SC=stick Carry, FC=food carry, VE=vocalization exchange, JU=juvenile seen or heard.
[4] Enter code of vocalization type given: V1=Contact Call, V2=Coo, V3=Knock, V4=Juvenile Voc. V5=Other (describe in notes).
[5] Use Habitat Type and Structure from Anderson and Ohmart (1984) provided on laminated card.

Notes:

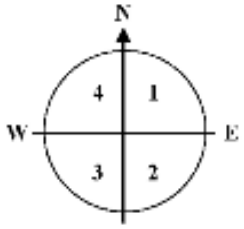
Appendix 2.1. Vegetation Plot Sampling Form, 2009.

2009 Vegetation Plot 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 2.2. **YBCU vegetation plot sampling methodology, 2009**.

2009 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. Filling out the Data Sheet

SITE CODE
Enter the survey site code.

VEG PLOT 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. This is generally the site code followed by a number, and should be the same number that is on the Veg. Plot Establishment Form.

UTM NAD
Enter the NAD used when marking points with GPS. This should be NAD 83.

UTM ZONE
Enter the appropriate zone.

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

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

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).

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.

HABITAT TYPE and %
Write the two or three letter code (Anderson and Ohmart) for the dominant habitat type present at the vegetation plot (See Habitat Card). If the Habitat type is Cottonwood-Willow (CW), include a percentage of cover (10-19%=**1**, 20-49%=**2**, 50-89%=**3**, 90-100%=**4**). This is the percentage of the plot that is shaded by this species when the sun is directly overhead.

STRUCTURAL TYPE
Record the Structural Type of the habitat at the vegetation plot (1-6, see Habitat Card).

OPENNESS
This number represents the amount of cover above the shrub layer (0-24%=Open, 25-74%=Medium, 75-100%=Closed). Record the Openness within the 11.3m plot. If >100m to the nearest change record >100.

DISTANCE TO HABITAT CHANGE
Measure the distance to the nearest 11.3 m radius (.1 acre) patch of habitat, which is a different Habitat Type or Structure Type (Anderson and Ohmart) than that at the center of the veg. plot (CW IV to SSM IV, or CW I to CW III). If we

DIST. TO WATER
Record the distance from the center of the plot to the nearest water. If you know there was water (present persistently throughout the season) nearby during June, July, or August record the distance to where this water was.

ASPECT
The direction the plot faces in degrees. Take a compass bearing, in degrees, from the highest point to the lowest point (of the 11.3m plot. (What direction would water run?)

SLOPE
Measure the slope across the 11.3m plot from the bottom to the top of the plot in degrees. Standing upright, look across the plot to something at eye-height, and read the left hand scale of the clinometer. Alternatively a compass with a slope measuring tool can be used. To do this, align the top edge of the compass with your eye and an object at the same height across the plot, then read the slope arrow.

TABLE I: DENSIOMETER COVER (0-96)

AVG Height-Using a range finder (or a clinometer and the tree height estimation sheet) determine the average height of the overall canopy cover. This is all canopy cover above 1.4m (all

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

How to use 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 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.

*****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. This layer does not overlap with the Shrub/Sapling Layer.
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 TREE ≥6.0cm DBH**
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. This measure should be taken regardless of its distance (do not leave blank if there is not a *live shrub/live tree/tree ≥6.0cm* within the plot). Divide the circle into quadrates along the cardinal compass directions. Within each quadrate, record the following information:

SPECIES, NEAREST ***LIVE SHRUB/LIVE TREE/TREE ≥6.0cm DBH***
Species name of closest *live shrub/live tree/tree ≥6.0cm DBH*, for each quadrate (1-4). For Table V count the closest tree that is larger than 6.0cm in diameter at breast height (1.4m) and ≥3m tall.

DISTANCE TO NEAREST ***LIVE SHRUB/LIVE TREE/TREE ≥6.0cm DBH***
The distance (in meters) from the center of the plot, to the selected *live shrub/live tree/tree ≥6.0cm DBH.*

HEIGHT OF NEAREST ***LIVE SHRUB/LIVE TREE/TREE ≥6.0cm DBH***
Height (in meters) of the selected *live shrub/live tree.*

MAX WIDTH OF NEAREST ***LIVE SHRUB***
The Max Width is the maximum crown width (in meters) of the selected *live shrub.*

PERP WIDTH OF NEAREST ***LIVE SHRUB***
The perpendicular width is the width of the *live shrub* measured at a right angle to the maximum width.

DIAMETER AT BREAST HEIGHT (DBH) OF NEAREST ***LIVE TREE/TREE ≥6.0cm DBH***
Record the diameter at breast height (measured in centimeters) of the closest *live tree/tree ≥6.0cm DBH* to the center of the plot in each of the four quadrates. If more than one stem/trunk, take the DBH of the largest.

CROWN WIDTH, NEAREST ***LIVE TREE/TREE ≥6.0cm DBH***

The Crown Width is the average width (in meters) of the crown (drip line to drip line), of the closest *live tree/tree ≥6.0cm DBH* to the center of the plot in each of the four quadrates. Measure the largest, and the smallest width of the crown, then estimate the average.

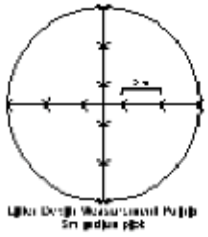
CANOPY COVER, NEAREST *LIVE TREE*
Standing under the selected tree, use the densiometer to measure the canopy cover of the closest tree.

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.

Table VI: 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 2m intervals along the ropes and within the 5m 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. 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.

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.

Table VII: Percent Ground Cover
These vegetation measurements, made within the 5m plots, are estimates of different types of ground cover. For each of the 4 quadrants in the 5m plot, make an ocular estimate of the percent of the ground covered from 50cm above ground, to ground level.

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 overlap with other low cover

types. Percent cover in low cover types (*Grass, Leaf Litter, Downed Logs, Bare Ground,* and *Water*) alone must sum to 100%, the remaining cover categories can sum to more than 100% because of vertical stratification of plant layers. However no single layer of *Shrub, Forb, Sedge, Marsh Vegetation,* or *Brush* can be greater than the value for *All Green Cover.*

% LEAF LITTER COVER

Percent *Leaf Litter* is the 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.

% GRASS COVER

The % *Grass Cover* is the percentage of the ground covered by grasses below 50 cm in height. 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 GRASS COVER EXAMPLE.

% DOWNED LOGS COVER

The % *Downed Logs* is the percent of ground covered by downed logs (logs >12cm 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 GRASS COVER EXAMPLE.

% BARE GROUND

The % *Bare Ground* is the percent of open ground not covered by leaf litter or any other low, dense cover. This value should be independent of taller, sparser vegetation, but dependent on low dense vegetation. SEE GRASS COVER EXAMPLE.

% WATER COVER

The % *Water Cover* is the percent of ground covered by standing water. This value should be independent of taller, sparser vegetation, but dependent on low dense vegetation. SEE GRASS COVER EXAMPLE.

% ALL GREEN COVER

The percent *All Green Cover* is the percentage of the ground covered by green vegetation that is below 50 cm in height. This includes grass, shrubs, forbs, and marsh vegetation.

% SHRUB COVER

The % *Shrub Cover* is the percentage of ground covered by woody perennial plants that are below 50 cm tall. This layer cannot be greater than the % *All Green Cover.*

% FORB COVER

The % *Forb Cover* is the percentage of ground covered by broad-leafed non-woody plants below 50 cm height. This layer cannot be greater than the % *All Green Cover.*

% MARSH VEGETATION

The % *Marsh Vegetation* is the percentage of ground covered by marsh vegetation (vegetation undifferentiated by species or type that is growing in water). This layer cannot be greater than the % *All Green Cover*.

% BRUSH COVER

The % *Brush Cover* is the percentage of ground covered by small dead woody vegetation (i.e. dead shrubs and bramble) less than 50 cm above the ground. This layer cannot be greater than the % *All Green Cover*.

Table VIII. Measuring Shrubs and Saplings within 5m Radius Circle

The following are the measurements to be taken within the 5m 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 5m plot at 10cm 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: < 2.5cm stem diameter at 10cm above ground
Large Size Class: > 2.5cm stem diameter at 10cm above ground

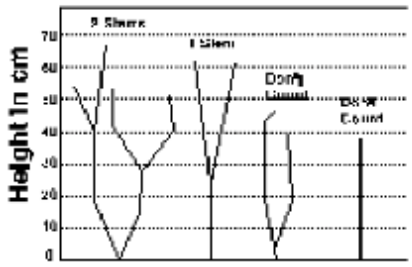
With a single central stem

Small Size Class: < 2.5cm DBH, or less than 1.4m tall
Large Size Class: 2.5 - 8.0cm 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:

Plants/stems less than 50cm (i.e. approximately knee height) high are not counted
Count the number of vertical stems at 10cm above the ground (ankle level), i.e if a stem branches above 10cm then it is counted as 1 (see figure, below).



SHRUB or SAPLING SPECIES
Enter the species name for each species encountered in the 5m plot, and 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".

Tables IX, X, and XI. Measuring Small /Large Tree/Snag Species
Small Trees are counted within the 5m circle only, and *Large Trees* and *Snags* are counted in the 11.3m 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. If you can accurately identify the species of snag, enter this, otherwise put unknown.

TREE SIZE CLASSES

Live Trees (measure the DBH for each species separately)	Small trees (within 5m circle): 8 -- 23cm Medium trees (within 11.3m circle): 23 -- 38cm Large trees (within 11.3m circle): >38cm
Snags (count within 11.3m circle)	Small snags: < 12cm DBH and > 1.4m tall Medium snags: > 12cm DBH and > 1.4m 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".

SMALL/ LARGE TREE/SNAG SPECIES
Record the species name for each species encountered on the large vegetation plot (11.3m radius circle). There is no specific order in which tree species must be presented. If you can accurately identify the species of snag, enter this, otherwise put unknown.

NUMBER OF STEMS (SMALL/ LARGE TREE/SNAG)
Count the total number of live stems for each size class, of each species within the large vegetation plot. Enter the total on the right of the tally marks.

RIPARIAN PLANTS OF THE LOWER COLORADO RIVER AND FOUR LETTER CODES

Common Name	Genus	Species	Code	Growth Form
Whitethorn Acacia	*Acacia*	*constricta*	ACCO	Shrub
Catclaw Acacia	*Acacia*	*gregii*	ACGR	Shrub
Giant Reed	*Arundo*	*donax*	ARDO	Grass
Arundo	*Arundo*	*sp.*	ARSP	Cane
Four Winged Saltbush	*Atriplex*	*canescens*	ATCA	Shrub
Desert Holly	*Atriplex*	*hymenelytra*	ATHY	Shrub
Alkalai Saltbush	*Atriplex*	*polycarpa*	ATPO	Shrub
Atriplex sp.	*Atriplex*	*sp.*	ATSP	Shrub
Quailbush or Big Saltbush	*Atriplex*	*lentiformis*	ATSP	Shrub
Emory Baccharis	*Bacchoris*	*emoryi*	BAEM	Shrub
Seep Willow/Mulefat	*Bacchoris*	*salicifolia*	BASAL	Shrub
Desert Broom	*Bacchoris*	*sarothroides*	BASAR	Shrub
Unspecified Baccharis	*Bacchoris*	*sp.*	BASP	Shrub
Blue Palo Verde	*Cercidium*	*floridum*	CEFL	Tree
Yellow Palo Verde	*Cercidium*	*microphyllum*	CEMI	Tree
Unspecified Palo Verde	*Cercidium*	*sp.*	CESP	Tree
Salt Grass	*Distichlis*	*spicata*	DISP	Grass
Russian Olive	*Elaeagnus*	*angustifolia*	ELAN	Tree
Unspecified Eucalyptus	*Eucalyptus*	*sp.*	EUSP	Tree
Alfalfa	*Medicago*	*sp.*	MESP	Forb
Common Reed	*Phragmites*	*australis*	PHAU	Grass
Arroweed	*Pluchea*	*sericea*	PLSE	Shrub
Fremont Cottonwood	*Populus*	*fremontii*	POFR	Tree
Honey Mesquite	*Prosopis*	*glandulosa*	PRGL	Tree
Screwbean Mesquite	*Prosopis*	*pubescens*	PRPU	Tree
Unspecified Mesquite	*Prosopis*	*sp.*	PRSP	Tree
Velvet Mesquite	*Prosopis*	*velutina*	PRVE	Tree
Coyote Willow	*Salix*	*exigua*	SAEX	Shrub
Gooding's Black Willow	*Salix*	*goodingii*	SAGO	Tree
Johnson Grass	*Sorghum*	*halapense*	SOHA	Grass
Tamarisk	*Tamarix*	*sp.*	TASP	Tree
Unknown Aster			UNAS	
Unknown			UNK	
California Fan Palm	*Washingtonia*	*filifera*	WAFI	Tree

Appendix 3.1. Yellow-billed Cuckoo sites surveyed within the LCR watershed in 2009.

Site Code	Site Name	Rest. status[2]	Veg. Classification	Patch Size (ha)	A-O[3] Veg. type - structure	Open-ness[4]
BWBP	Borrow Pit	N	Mixed Native	33.6	CW-1	M
BWCP	Cottonwood Patch	N	Native	38.2	CW-2	M
BWCR	Cross River	N	Native	31.1	CW-1	C
BWCW	Cave Wash	N	Native	88.6	CW-1	M
BWER	Esquerra Ranch	N	Mixed Native	40.2	CW-1	C
BWFW	Fox Wash	N	Exotic	62.5	SC-3	M
BWGR	Gibraltar Rock	N	Mixed Native	66.5	CW-1	C
BWHB	Honeycomb Bend	N	Native	29.6	CW-1	C
BWKC	Kohen Cliff	N	Mixed Native	37.2	CW-1	M
BWMA	Bill Williams Marsh	N	Mixed Native	19	CW-2	M
BWMD	Middle Delta	N	Mixed Native	25.2	CW-1	M
BWMF	Mosquito Flats	N	Mixed Exotic	37.2	CW-1	M
BWMW	Mineral Wash	N	Mixed Native	49.9	CW-1	M
BWNB	North Burn	N	Mixed Exotic	22.9	CW-4	M
BWPT	Cougar Point	N	Mixed Native	43.2	CW-1	O
BWSW	Sandy Wash	N	Mixed Exotic	50.9	CW-1	M
CIBCNT[1]	Cibola NWR Nature Trail	R	Native	61.4	CW-1	M
CIBEUC[1]	Cibola Eucalyptus	R	Mixed Native	29	CW-1	O
CIBNTH[1]	Cibola NWR North	R	Native	7.5	CW-2	M
CIBSTH[1]	Cibola NWR South	R	Native	23.8	HM-3	O
CRIT[1]	Ahakhav Tribal Preserve	R	Native	54	CW-1	M
CVCA1[1]	Cibola Valley Conservation Area P1	R	Native	34.8	CW-2	C
CVCA2[1]	Cibola Valley Conservation Area P2	R	Native	37.5	CW-3	C
CVCA3[1]	Cibola Valley Conservation Area P3	R	Native	37.4	CW-2	M
DSWA	Desilt Wash	N	Native	3.4	CW-1	O
GRNVA	North Gila Valley A	N	Mixed Native	3.6	CW-1	C
GRNVB	North Gila Valley B	N	Mixed Native	4.7	CW-1	M
GRQP[1]	Quigley WMA	R	Mixed Native	10.5	CW-1	M
HAVBR[1]	Beal Restoration	R	Native	17	CW-3	O
HAVFDR	Farm Ditch Road	N	Mixed Native	6.9	CW-3	O
HAVGH	Glory Hole	N	Mixed Native	13.2	CW-3	O
HAVLR	Havasu Levee Road	R	Mixed native	3.29	CW-3	O
HAVND[1]	North Dike	R	Native	3.9	CW-1	M
HAVPS[1]	Pintail Slough	R	Native	12	CW-1	O
HAVTPR[1]	Topock Platform	R	Native	8.9	CW-1	M
IMP20A[1]	Imperial NWR 20A	R	Native	1.6	CW-3	O
IMPAST	Imperial AZ State Trust	N	Native	5.6	CW-1	O
IMPSTH[1]	Imperial NWR South	R	Native	3.1	CW-1	C
KEYPIT	Key Pittman	N	Native	1.92	CW-2	O
LAG1-3	Laguna 1-3	N	Native	0.9	CW-1	O

Site Code	Site Name	Rest. status[2]	Veg. Classification	Patch Size (ha)	A-O[3] Veg. type - structure	Open-ness[4]
LHCFSW	Falls Spring Wash	N	Mixed Native	6.9	CW-4	M
LHCWP	Havasu Willow Patch	N	Native	1	CW-3	C
LIMNTH	Limitrophe North	N	Mixed Native	164	CW-1	O
LITBR	Littlefield Bridge	N	Native	39.9	CW-1	O
MLPR[1]	Mittry Lake/Pratt Restoration	R	Native	6.3	CW-1	M
OVRHP	Overton Honeybee Pond	N	Mixed Exotic	4.1	SC-4	M
OVRR	Overton Residential	N	Native	2.8	CW-1	O
OVRW	Overton Wildlife	N	Mixed Exotic	3.5	SC-3	O
PAHNTH	Pahranagat North	N	Native	17	CW-1	C
PAHSTH	Pahranagat South	N	Native	17	CW-2	O
PICSRA[1]	Picacho SRA	R	Native	5.5	CW-1	M
PVER1[1]	Palo Verde Ecological Reserve P 1	R	Native	8.3	CW-2	C
PVER2[1]	Palo Verde Ecological Reserve P 2	R	Native	24.2	CW-3	C
YUCC	Colorado Confluence	N	Mixed Exotic	67.8	SC-3	O
YUEW[1]	Yuma East Wetlands	R	Native	9.1	CW-3	O
YUWW[1]	Yuma West Wetlands	R	Native	17	CW-1	M

[1]Site is entirely or in part being restored with native species. Some are naturalized and no longer dependent on active irrigation whereas others require continued irrigation to persist. [2]Restoration status: R=restoration site, N=natural site. [3]Anderson-Ohmart Vegetation Classification/Type (see Table 1, Table 2). [4]Openness: C=closed (canopy cover ≥75%), M=Medium (canopy cover 26%-74%), O=Open (canopy cover ≤ 25%).

Appendix 4.1. Birds encountered during YBCU surveys, north of Bill Williams River, 2009.

Numbers indicate number of visits the species was detected.

Species Name	KEYPIT	HAVBR	HAVFDR	HAVGH	HAVLR	HAVND	HAVPS	HAVTPR	LHCFSW	LHCWP	LITBR	OVRHP	OVRR	OVRW	OVWP	PAHNTH	PAHSTH
Abert's Towhee		5	5	3	3	5	5	5	1	2	7	1	1	4			2
American Coot	1		1				1		4	4		1			1	4	
American Crow	1																
American Goldfinch							1										
American Kestrel							2								1	1	
American Robin													1				
American White Pelican	1																
Ash-throated Flycatcher	1	2	4		3	4	3	2			2					3	3
Barn Owl	1																
Bell's Vireo	1	5	2	2	2	5	4	4		3	1	1	1	3	1		2
Bewick's Wren	2			1				1						2			1
Black Phoebe	2	2	2	2	1	3	2	2	1	1		1		2		3	
Black Rail				1													
Black-chinned Hummingbird		1	1					1			5		1				1
Black-crowned Night-heron											2	2				2	
Black-headed Grosbeak								1									
Black-necked Stilt																2	
Black-tailed Gnatcatcher		5	3		2		2	1				1		1			1
Black-throated Gray Warbler		1															
Blue Grosbeak		4	3	1	3	4	5	3			5	1	1	3			1
Blue-gray Gnatcatcher						1							1				
Bronzed Cowbird		1															
Brown-crested Flycatcher	1		1	2		1	1	1			4					3	2
Brown-headed Cowbird	2	1	3	2	2	3	3	4	2	2	5	2	1	2		3	1
Bullock's Oriole	3	1				1	4	3	2		1			1		2	
Bushtit		1												1			
Canada Goose	2					1						4	1			1	3
Canyon Wren									1		1			1			
Clapper Rail				2										1			
Clarks Grebe			1	1					1								
Cliff Swallow		1									3						
Common Ground Dove						1											
Common Moorhen			3				1		2	1							
Common Raven							1	2		1	4	1		2		3	1

Species Name	KEYPIT	HAVBR	HAVFDR	HAVGH	HAVLR	HAVND	HAVPS	HAVTPR	LHCFSW	LHCWP	LITBR	OVRHP	OVRR	OVRW	OVWP	PAHNTH	PAHSTH
Common Tern						1						1					
Common Yellowthroat	2	4	4	5	1	4	5	1	3	2	5	5		2	1	4	2
Coopers Hawk							4				3					4	
Crissal Thrasher		2			1	1	2	1		1							
Eared Grebe									1	1							
Eurasian Collared Dove	1							1			5	1					
Gambel's Quail		5	2	1	1	3	5	5		2	5	2	3	2			1
Gila Woodpecker			1	3	1			1									
Great Blue Heron	2	1	1	2	2		5		2		2	3	1	2	1	3	
Great Egret		1				1	3		2			2		1	1	2	
Great Horned Owl			1			1	2	1							1	1	
Greater Roadrunner		4			1	1	4	1	1			1					
Great-tailed Grackle	1	6	5	4	5	5	5	3	3	4	5	3		4		3	
Green Heron	1	3	1	1			3		2		4	2					
Hooded Oriole		1			1			2			3		1			1	1
Horned Lark							1										
House Finch	2		1				2	1	1	1	3		1	1		2	2
House Wren	1															1	
Indigo Bunting		5	1		1	2	5	1			2	1					
Killdeer	1							1	1							2	
Ladder-backed Woodpecker		2	1	3	5			2	2	1							1
Least Bittern	1	1	1				1			1							
Least Tern						1											
Lesser Goldfinch			1								4		3			1	
Lesser Nighthawk		4	1	2	5	4	5	2	1								
Loggerhead Shrike	1	3	2	1		2	4	2						1			
Long-billed Curlew			1														
Lucy's Warbler		3		1		2	1	1						3			
MacGillivray's Warbler																1	
Mallard	2	1					1		1			3	2	1	1	4	1
Marsh Wren	1	1	2	4			1		4	1	3			1	1		1
Mourning Dove	2	5	5	3	4	5	5	5	4	3	5	5	4	3			2
Nashville Warbler		1	1	1													
Northern Flicker			1														
Northern Harrier								1									
Northern Mockingbird			2			2	1	1					3				3
Northern Rough-winged Swallow		3	4	1	1	3	2	2	1	1	5	5	2	4			2
Orange-crowned Warbler														1			

Species Name	KEYPIT	HAVBR	HAVFDR	HAVGH	HAVLR	HAVND	HAVPS	HAVTPR	LHCFSW	LHCWP	LITBR	OVRHP	OVRR	OVRW	OVWP	PAHNTH	PAHSTH
Peacock													2				
Phainopepla		1	1			1											
Pied-billed Grebe					1	1			3	1					1		
Red-shouldered Hawk											1						
Red-tailed Hawk							3				3	1	1			2	
Red-winged Blackbird	3	1	3	2		4	4	1	2	3	5	2	2	4		4	1
Rooster											2		2				
Ruddy Duck	2											1				2	
Rufous-winged Sparrow							1				4			4			
Say's Phoebe								1									
Sharp-shinned Hawk														1			
Short-billed Dowitcher							1										
Snowy Egret							1		1				2	2	1	1	
Song Sparrow	2		2	3	1	1	1	1	2		5	2		4		4	3
Spotted Sandpiper	2															4	
Summer Tanager		3	3	1		1		1			5					1	
Tree Swallow		1	1	1	1			1	1								
Turkey Vulture	1								3	1	5	3				4	2
Verdin		4	5	2	3	4	2	3	3		2	1		3			
Vermillion Flycatcher																	1
Violet-green Swallow	1	1							2	1							
Virginia Rail	1						1				1			2			
Warbling Vireo	1						1										
Western Flycatcher	1		1	1				1			1						
Western Grebe				1					3								
Western Kingbird	3	5	2	2	1	2	3	4			4		3	2	1	3	3
Western Sandpiper							1										
Western Tanager		1		1	1			1								1	
Western Wood-pewee			1														
White Tailed Kite																1	
White-faced Ibis		2	1				1		1					1		4	
White-winged Dove	1	5	5	3	5	5	5	4	4	3	2	4	3	3			2
Wild Turkey													1				
Willow Flycatcher	2		2	3							3			2		3	
Yellow Warbler	3	4	2	4	1	3	2	1	1		5	4	2	4		4	4
Yellow-billed Cuckoo	1	1						1								1	
Yellow-breasted Chat	1	5	5	2		5	4	4	3	2	5	5	1	3	1	3	4
Yellow-headed Blackbird	2		1		3		2		3	1			2		1	1	

Appendix 4.2. Birds encountered during YBCU surveys, Bill Williams River, 2009.

Numbers indicate number of visits the species was detected.

Species Name	BWBP	BWCP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKC	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Abert's Towhee	4	2	3	5	5	5	5	4	4	2	5	2	4	5	4	4
American Coot								1		3						
American Kestrel		1						2	1					2		
Anna's Hummingbird														1		
Ash-throated Flycatcher	3	1	3	3	5	2	3	2	4	3	1	2	4	3	2	2
Barn Owl								1								
Bell's Vireo	4	1	3	7	5	5	5	5	5	4	5	5	5	5	5	4
Belted Kingfisher										1			1			
Bewick's Wren	4		5	4	5	4	4		5	3	3	2	2	1	3	3
Black Phoebe	2		1		3	2	2	4	1	5			1		3	
Black Rail					3			1							1	
Black-chinned Hummingbird		1		2				1			1			2		
Black-crowned Night-heron											1			1		
Black-headed Grosbeak	2			1	1		1	2			1		1	2	1	1
Black-tailed Gnatcatcher	2		1	1		2	2	2	1			5	3	2	1	1
Black-throated Gray Warbler						1										
Black-throated Sparrow							1	1				1	1			
Blue Grosbeak	5	5	5	5	5	5	5	5	5	4	4	2	5	4	5	4
Blue-gray Gnatcatcher										1					1	
Bronzed Cowbird	1	1														
Brown Pelican											1					
Brown-crested Flycatcher	2	1	2	5	2	2	3	3	2			2	3	3	1	2
Brown-headed Cowbird	2	2	4	1	2	3	4	2	5	3	3	3	3	3	2	2
Bullock's Oriole		1		3	4		3	2					1	3	1	
Bushtit				1												
Cactus Wren													1	1		
Canada Goose					1										1	
Canyon Wren	4		3	1	5	2	4	5	5	4	5	3	4	5	3	4
Clapper Rail									1	1						
Clarks Grebe										2	1					
Cliff Swallow						1	2									
Common Ground Dove				3			1							2	2	
Common Moorhen										2					1	
Common Nighthawk															1	
Common Raven					2	2	1		1		1	1	1	1	2	1
Common Tern														1		
Common Yellowthroat	3	3	4	5	5	2	5	3	2	5	5	5	4	4	5	5
Coopers Hawk			1	2	5				1							1

Species Name	BWBP	BWCP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKC	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Crissal Thrasher			3		1	2	2					4	2	2	1	1
Curve-billed Thrasher															1	
Double Crested Cormorant										1						
Elf Owl								1								
Gambel's Quail	4	5	1	5	5	4	5	5	5			5	5	3	5	4
Gila Woodpecker	3	4	3	4	2	4	5	5	5	5	1	5	5	5	3	4
Gilded Flicker								1								
Great Blue Heron					1	3			2	4	1			1	1	
Great Egret				1						1						
Great Horned Owl								2					2			1
Greater Roadrunner	2	2	1	5	4	3	3	3	1	1		1	3	4	4	2
Great-tailed Grackle					2	1	3			3			4			
Green Heron					1	2	2	2		5			1	2	1	
Hairy Woodpecker													1			
Hooded Oriole					2					1			1		1	
House Finch	1	1		2			3	1	1			3	1			1
House Wren						1										
Indigo Bunting		1		3	2	1	1			1				4		
Killdeer				1												
Ladder-backed Woodpecker	2		4	5	4	3	4	2	3	4	4	3	3	5	3	2
Lark Sparrow													1			
Lazuli Bunting														2	1	
Least Bittern					2					2				1		
Lesser Goldfinch	1		1	4		2	1	2	2			1	2	3	2	2
Lesser Nighthawk	3	3	3	7		5	3	2	5	3		3	4	3	2	2
Loggerhead Shrike	2	3	1	4	3	3	5	3	3			2	4	2	3	2
Lucy's Warbler	2		1	1			1	2	1			1		1	1	2
MacGillivray's Warbler						1									1	
Mallard										2						
Marsh Wren					3			1						2	2	
Mourning Dove	5	4	3	5	5	5	5	3	5	3	4	4	4	5	5	5
Nashville Warbler						1						1			1	
Northern Flicker		1		1									1		1	
Northern Mockingbird									1					1		
Northern Rough-winged Swallow	1	1	3		5	3	3	1	1	4	4	1	1	1	1	
Orange-crowned Warbler						1										
Peregrine Falcon														1		
Phainopepla														2		
Pied-billed Grebe							2		1	3						

Species Name	BWBP	BWCP	BWCR	BWCW	BWER	BWFW	BWGR	BWHB	BWKC	BWMA	BWMD	BWMF	BWMW	BWNB	BWPT	BWSW
Red-shouldered Hawk																1
Red-tailed Hawk			1	1	3	3	3	1		3			2		1	1
Red-winged Blackbird				3	4		1	1	2	2	3		1	1	1	
Rock Wren															1	
Ruddy Duck														1		
Sage Sparrow								1								
Say's Phoebe	2	1			2		1		1				1			
Sharp-shinned Hawk														1		
Snowy Egret										1	1		1			
Solitary Vireo													1			
Song Sparrow	5		4	5	5	5	5	5	5	5	5	5	5	5	4	5
Sora													1			
Summer Tanager	4		1	5	3	2	2	3	2	1	2	5	3	3		4
Tree Swallow		1	1	1	2	1	1			1	1			2	1	
Turkey Vulture		1		1	4	1	5		1		1		1	1	1	1
Verdin	3		2	2	1	2	4	3	4	1	1	5	4	4	4	2
Violet-green Swallow														2		
Virginia Rail				1	3				1	1			1			
Warbling Vireo				1		1		1					3	1		
Western Flycatcher					3	1		3		1	1			1	1	
Western Grebe										1						
Western Kingbird	1				5	2	1	1	1	3			3	3	2	
Western Screech Owl							2				4	1			1	
Western Tanager		1	1	1	3		2		1		2		1		1	
Western Wood-pewee							1	1						1		
White Crowned Sparrow													1			
White-faced Ibis	1			1			1	1		2			1			
White-throated Swift							1	1		1			1		1	
White-winged Dove	4	5	3	5	5	5	5	5	5	4	5	4	5	5	5	4
Willow Flycatcher										1				1	2	
Wilson's Warbler								1				1		1		
Yellow Warbler	2		4	4	5	3	2	3	5	3	5	4	4	4	4	3
Yellow-billed Cuckoo	3	2	4	5	2	2	2	2	5	3	1	3	4	3	4	3
Yellow-breasted Chat	5	4	5	5	5	5	3	4	5	5	5	5	5	5	5	5
Yellow-headed Blackbird										1				2		

Appendix 4.3. Birds encountered during YBCU surveys, Blythe/Cibola area, 2009.

Numbers indicate number of visits the species was detected.

Bird Species	CIBCNT	CIBEUC	CIBNTH	CIBSTH	CRIT	CVCA1	CVCA2	CVCA3	DSWA	PVER1	PVER2
Abert's Towhee	4	5	2	5	5	5	4	4	4	4	4
American Kestrel	2	1	3	2	1	2	1	2			
Anna's Hummingbird	1	1	1		2				1		1
Ash-throated Flycatcher	5	4	4	5	4	2	1	1	2	3	3
Barn Owl	1				4	3		1		1	3
Bell's Vireo				1	3	2					1
Black Phoebe	4			3	5	4	1	2		2	2
Black-chinned Hummingbird	1		1		7	1	1	2	3	2	1
Black-crowned Night-heron					1					1	
Black-headed Grosbeak					4			1			
Black-tailed Gnatcatcher		2	1	5	4				4		1
Black-throated Gray Warbler								1			
Black-throated Sparrow			1								
Blue Grosbeak	4		4	3	5	5	5	5		5	5
Blue-gray Gnatcatcher						1					
Brown-crested Flycatcher					1				1		
Brown-headed Cowbird	4	2	2	3	5	4	4	3	2	4	4
Bullock's Oriole		1	3	3	3	4		1	1	1	2
Cactus Wren									2		
Canyon Wren									4		
Cliff Swallow	1			2		2	2	4		4	4
Common Ground Dove	5	1				1	2	1			
Common Raven	1	3			1	1	1	1	2		
Common Yellowthroat	3		1	3	1	4	1	1	3	5	5
Coopers Hawk			1	1							3
Crissal Thrasher	1			1							
Double Crested Cormorant				1						1	1
Eurasian Collared Dove	3	1	2	1	1	1	2				2
European Starling						2	2	1			
Gambel's Quail	5	4	5	5	5	5	1	5	4	4	4
Gila Woodpecker				1	3				1		
Gray Vireo					1						
Great Blue Heron	2	1		1	3						
Great Egret		1				1		1			
Great Horned Owl	1	4	2	1	5	5				2	2
Greater Roadrunner	2	1		1	5	2	1				
Great-tailed Grackle	2	1	3	1	5	2	2	2	1	1	1
Hooded Oriole					4						
Horned Lark						1	1				
House Finch	5	1	3	2	5	4	2	2	3	2	5
House Wren	1							1			

Bird Species	CIBCNT	CIBEUC	CIBNTH	CIBSTH	CRIT	CVCA1	CVCA2	CVCA3	DSWA	PVER1	PVER2
Indigo Bunting				2	3	3	1	2	1	2	3
Killdeer	4		2	1	2	3					1
Ladder-backed Woodpecker	1	3		4	4	1			3		
Lazuli Bunting										1	1
Lesser Goldfinch	1				3	1	1				
Lesser Nighthawk	4	3	3	2	5	4	2	3		3	3
Loggerhead Shrike	4	5	3	5	5	3	3	5	1	3	4
Lucy's Warbler					1	1		1		1	1
MacGillivray's Warbler	1				2						
Mallard				1							
Mourning Dove	5	5	5	5	5	5	5	5	2	5	5
Nashville Warbler					1						
Northern Harrier							1			2	3
Northern Mockingbird	1	2	1	2	5			2		3	2
Northern Rough-winged Swallow		1		1	3	4	3	3	2	3	3
Phainopepla								1			
Red-winged Blackbird	1	4	2	2	5	4	4	5		5	5
Rose-breasted Grosbeak		1				2					
Say's Phoebe				2	3						
Snowy Egret											1
Song Sparrow	1			4	2	4	3		1	4	5
Spotted Sandpiper						1					
Summer Tanager					5						
Tropical Kingbird					2						
Turkey Vulture	1	2		1	1	3		1			1
Unknown Hummingbird					2						
Verdin	3	4		5	7	2		2	4		1
Vermillion Flycatcher					5						
Warbling Vireo					2						
Western Flycatcher					1						
Western Kingbird	5	5	5	5	7	5	4	4		2	4
Western Tanager	1		1		3				1		
Western Wood-pewee	1		3		1					1	
White-faced Ibis	1			1	1	1		1		2	2
White-winged Dove	5	5	4	5	5	5	5	5	3	5	5
Wild Turkey			1								
Willow Flycatcher								1			
Wilson's Warbler	1				1			1			
Yellow Warbler	2			1	2	1			2		1
Yellow-billed Cuckoo	1	2	1	2	3	4	2	3		1	2
Yellow-breasted Chat	3	2		3	3	4	3		1	1	1
Yellow-headed Blackbird	1	1	1		3			2		5	1

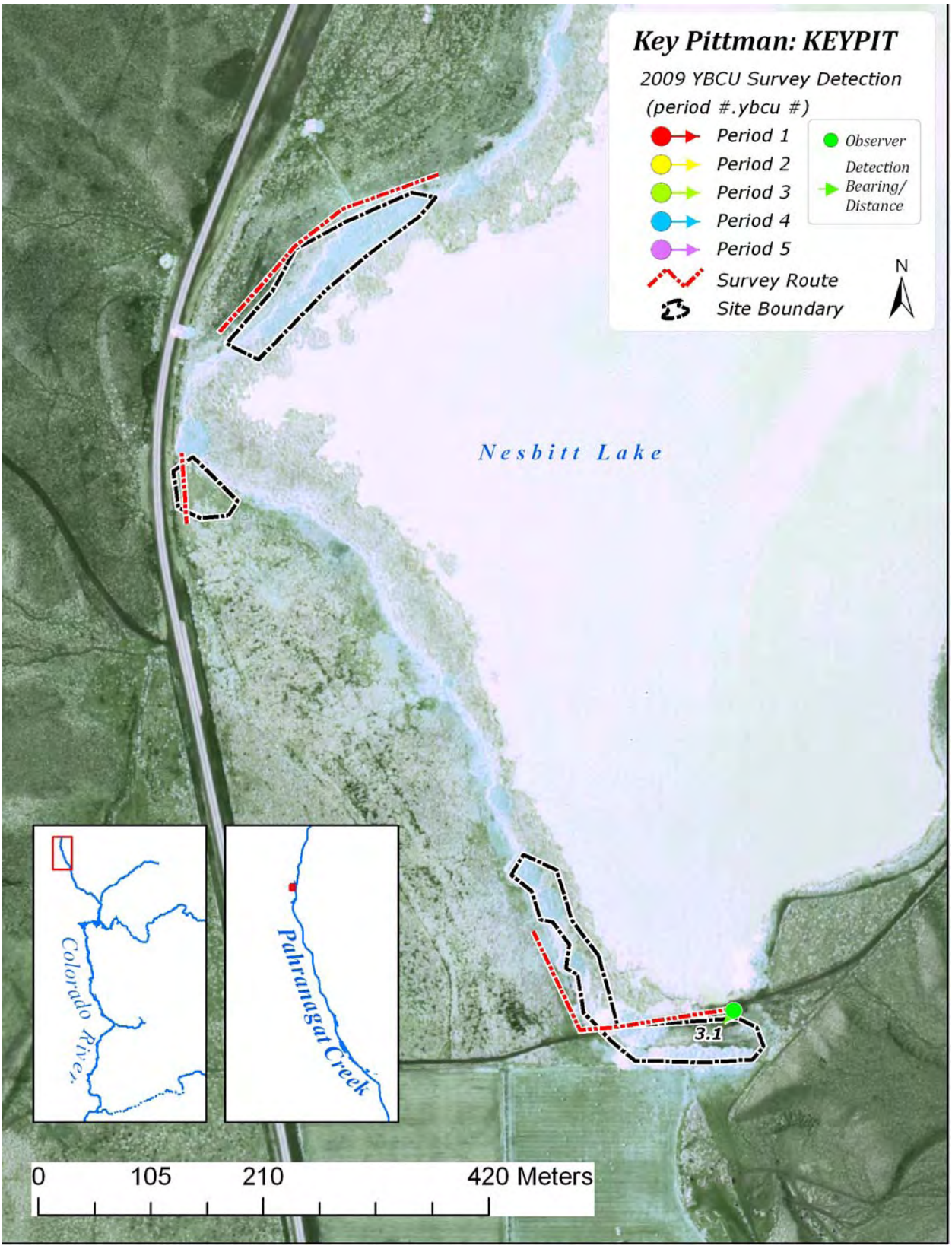
Appendix 4.4. Birds encountered during YBCU surveys, Yuma area, 2009.

Numbers indicate number of visits the species was detected.

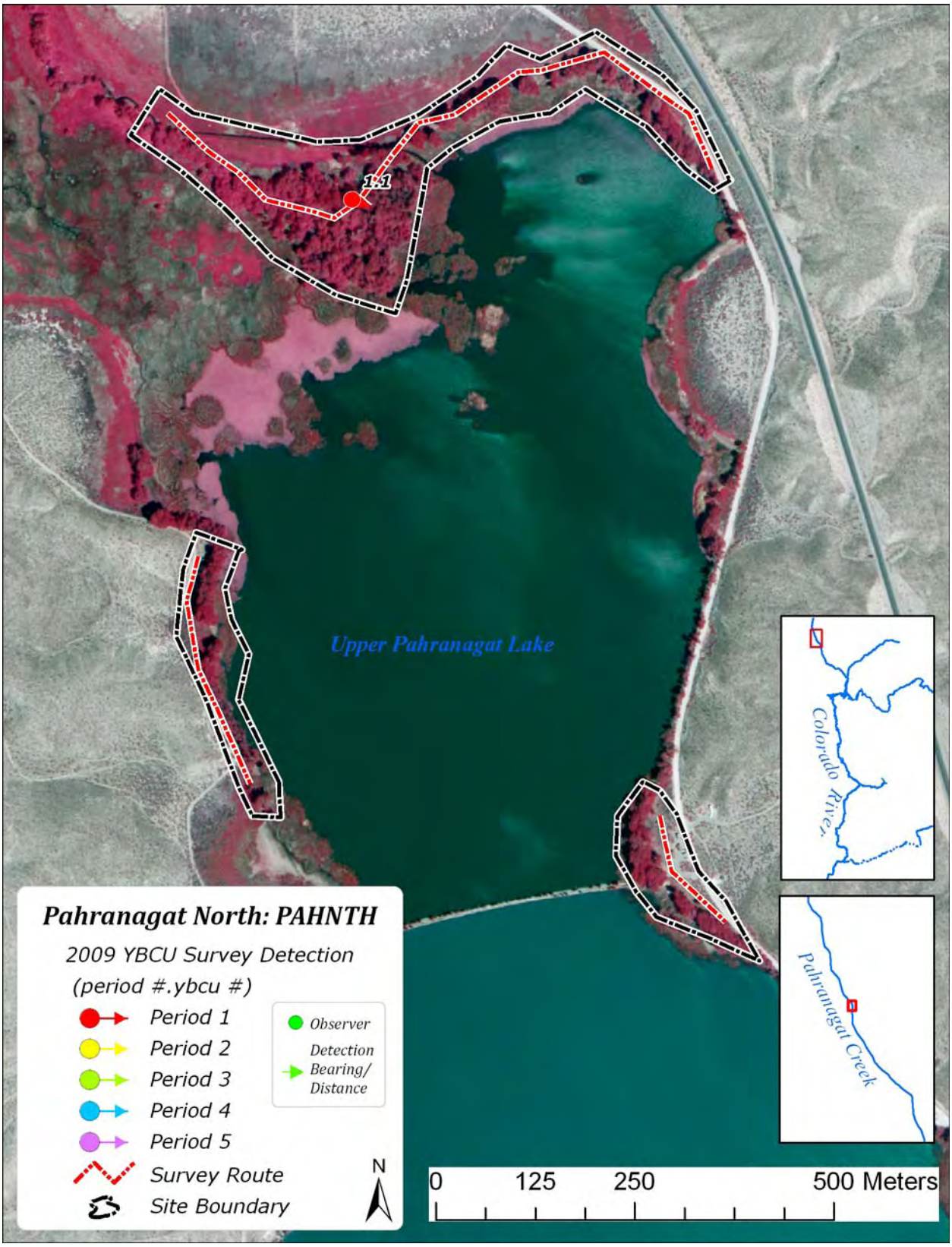
Species Name	GRNVA&B	GRQP	IMP20A	IMPAST	IMPSTH	LAG1	LAG2	LAG3	LIMNTH	MLPR	PICSRA	YUCC	YUEW	YUWW
Abert's Towhee	4	5	1	3	2	3	2	1	2	5	5	4	4	5
American Coot	1			1	3				3	2		2		
American Goldfinch	1											1		1
American Kestrel									1					
Anna's Hummingbird	2	2		1					1	1			2	5
Ash-throated Flycatcher	1	3	1	3	3	3	1	1	1	3	2	2		1
Barn Owl				1	1					1		1		1
Bell's Vireo									1		5			
Belted Kingfisher		1												
Black Phoebe		1			3				2	2		4	2	
Black Rail											1			
Black-chinned Hummingbird		2			1						1		2	5
Black-crowned Night-heron													1	
Black-headed Grosbeak		1												
Black-necked Stilt												3	1	
Black-tailed Gnatcatcher			1	2	1	1	1		1				2	1
Black-throated Gray Warbler														1
Blue Grosbeak	4	4		3	2	3		2	5	4	3	5	4	3
Blue Winged Teal					1									
Brown-crested Flycatcher		1			1						3			
Brown-headed Cowbird	4	4	1	3	1	1	1	2	4	3	2	5	3	2
Bullock's Oriole	2	3	1	1	1	1	1	1	1	2	2			2
Burrowing Owl									1					
Cactus Wren														1
Cattle Egret												2		
Cliff Swallow				1	1					1				
Common Ground Dove	1	3			1					1				1
Common Moorhen									1			2		
Common Nighthawk									1					
Common Raven		1												
Common Yellowthroat	4	1	2	4	5	1	2	2	4	4	4	5	5	4
Coopers Hawk														1
Costa's Hummingbird		1												
Crissal Thrasher									1				1	
Curve-billed Thrasher														3
Double Crested Cormorant					1	3								
Eurasian Collared Dove		2			2				1		3	1	1	2
European Starling			1											1
Gambel's Quail	3	4	2	3	4	3		1	3	3	5	3	3	5
Gila Woodpecker	1			1	4	3		1	3	1	4	2	1	5
Great Blue Heron					1				4			5		
Great Egret	1		1			1			3	1	1			

Species Name	GRNVA&B	GRQP	IMP20A	IMPAST	IMPSTH	LAG1	LAG2	LAG3	LIMNTH	MLPR	PICSRA	YUCC	YUEW	YUWW
Great Horned Owl		4		1	2							1		
Greater Roadrunner	1								4			1	2	3
Great-tailed Grackle	1	3	3	1	4	3			5	4	3	5	5	5
Green Heron	1				3	1			2			5	3	4
House Finch	1	4		1	1				2	2	2	2	3	2
House Wren		1								1				1
Hummingbird Species	1					1								
Indigo Bunting	1			1				1	1	3	1	2		1
Killdeer		1							2	1		5	3	
Ladder-backed Woodpecker	4	3		3	3	4	1	2	4	4	5	2	1	5
Lesser Goldfinch													1	1
Lesser Nighthawk	1	1	1	3	2	2	1	2	3	2	3		1	
Loggerhead Shrike	2	2	2	4	4	1		1	4	3	5		1	
Lucy's Warbler	1			1			1		1		1		1	
Mallard					1							1		
Marsh Wren	1									2		2		
Mourning Dove	4	5	3	4	3	3	1	1	5	5	3	5	4	5
Northern Flicker											1			
Northern Mockingbird				1									3	5
Northern Rough-winged Swallow	1	1		1			1	1	2	1		2	1	1
Osprey												1		
Phainopepla			1									1		
Pied-billed Grebe				2	3				1				1	
Red-tailed Hawk	1	1												
Red-winged Blackbird	2	3	2		3				3	1		5	1	1
Rock Pigeon									1			2	4	
Rooster	1	2							3					5
Ruddy Duck					2									
Say's Phoebe								1						
Sharp-shinned Hawk														1
Snowy Egret									2	1		4	2	2
Song Sparrow	3	1			2	1	2	1	2	3	2	1		
Sora	1													
Spotted Sandpiper												1		
Summer Tanager					2									
Tanager species					1					1				
Turkey Vulture		1			2	2			3		5	2		
Verdin	4	5	1	1	2	4	1	2	5	5	5	4	5	1
Vermillion Flycatcher		2												
Western Kingbird	2	4	3	2	4	2			2	3	2	2	1	
Western Tanager		1			1								2	
Western Wood-pewee	1	1						1	1		1			
White-faced Ibis					1					2				

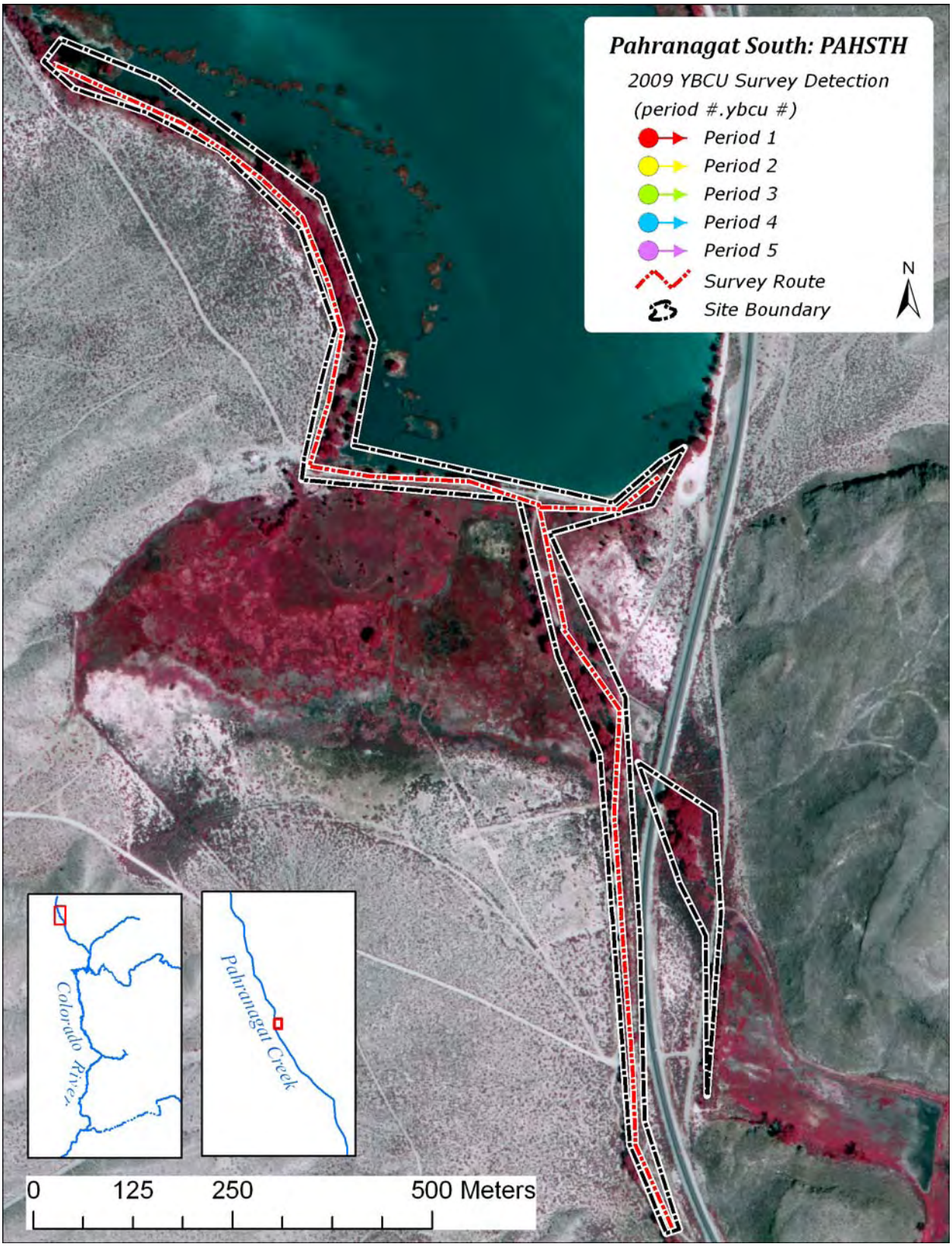
Species Name	GRNVA&B	GRQP	IMP20A	IMPAST	IMPSTH	LAG1	LAG2	LAG3	LIMNTH	MLPR	PICSRA	YUCC	YUEW	YUWW
White-winged Dove	4	5	3	4	4	3	2	2	5	4	3	5	5	2
Willow Flycatcher										1				
Wilson's Warbler													1	
Yellow Warbler	2	1									1			
Yellow-billed Cuckoo		1			2				2		1	1		
Yellow-breasted Chat	3			4	1	1	2	1		1	4			
Yellow-headed Blackbird	1	1	2						1		1	4		



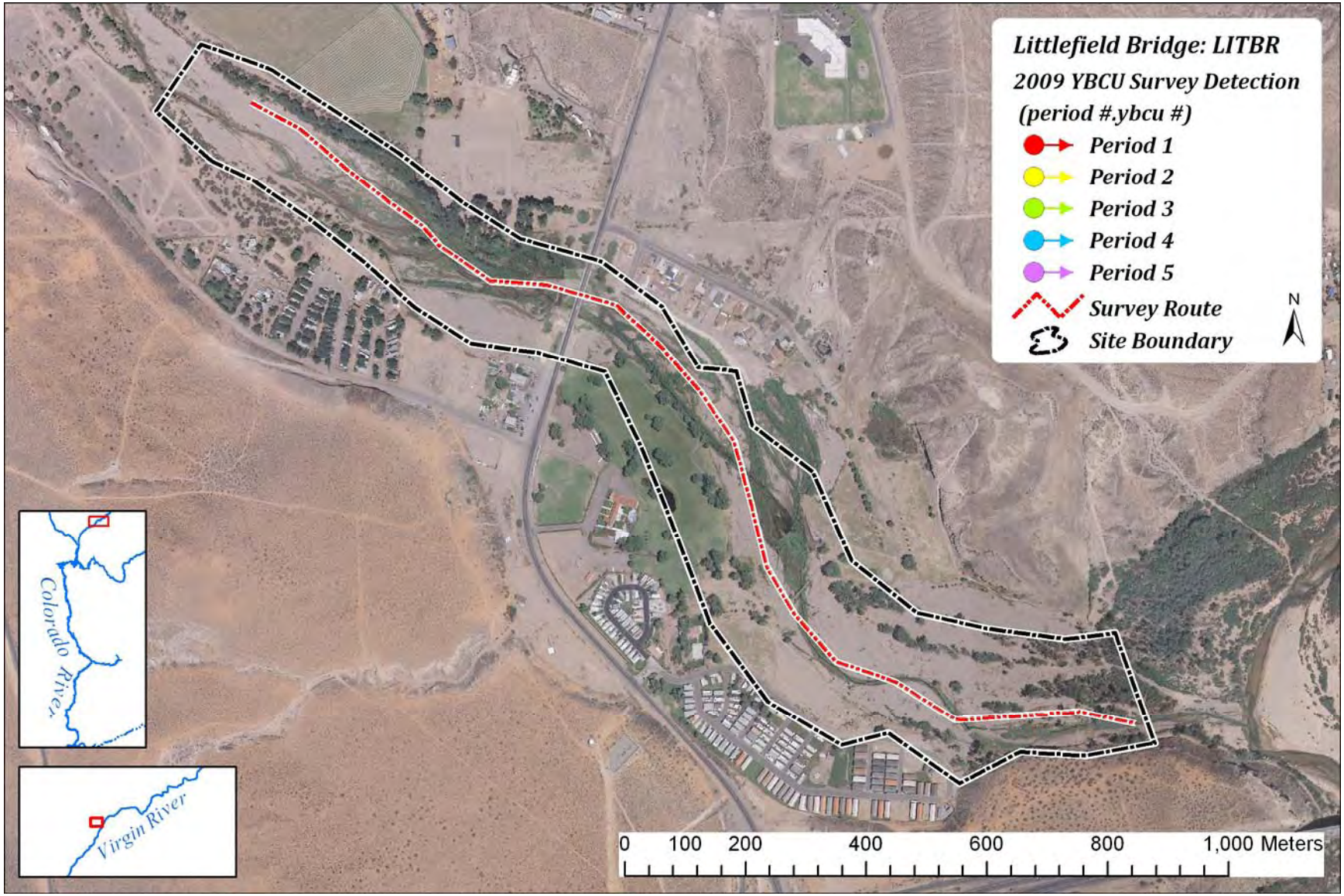
Appendix 5.1. Map of Key Pittman Yellow-billed Cuckoo survey route and detection, 2009.



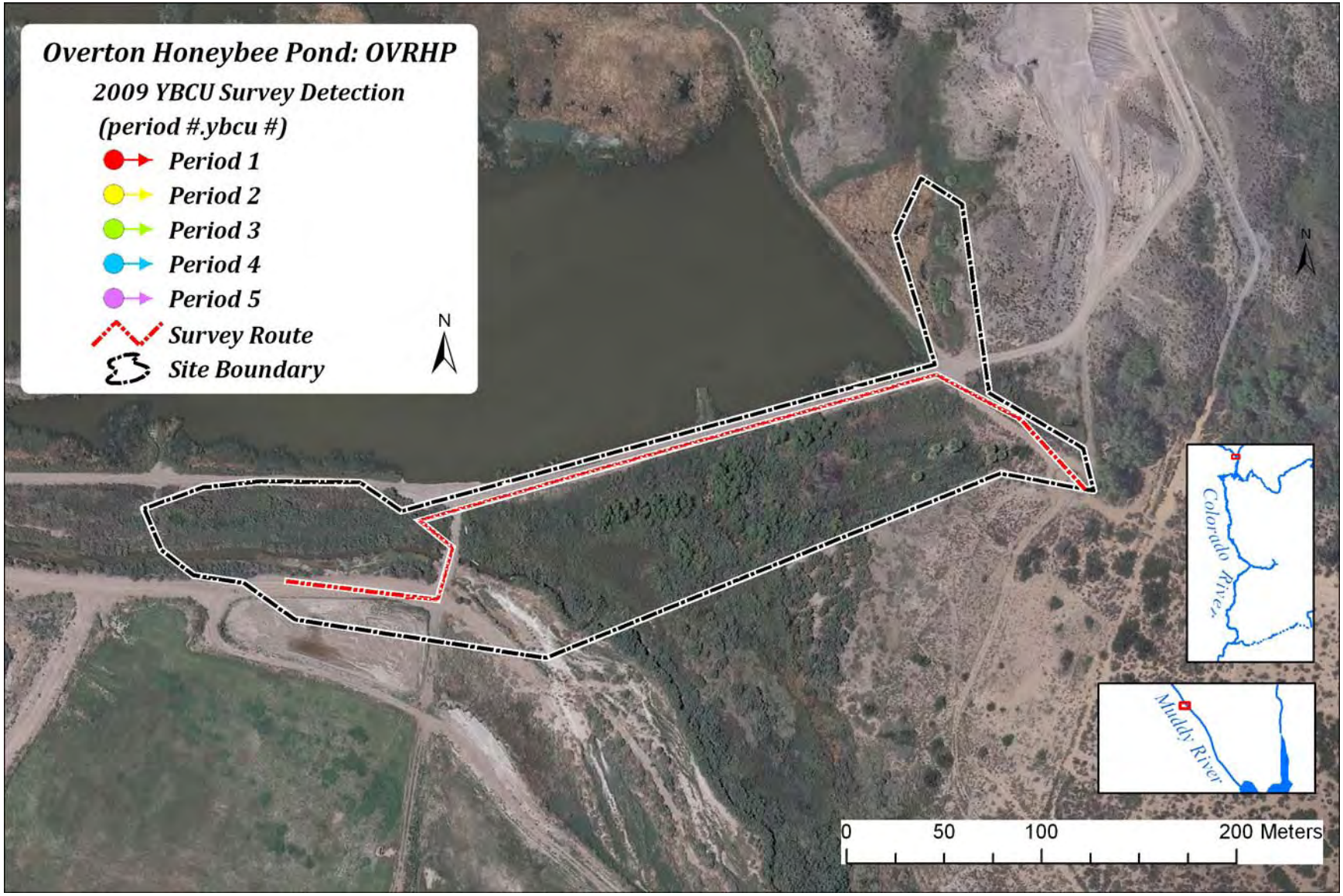
Appendix 5.2. Map of Pahranagat North Yellow-billed Cuckoo survey route and detection, 2009.



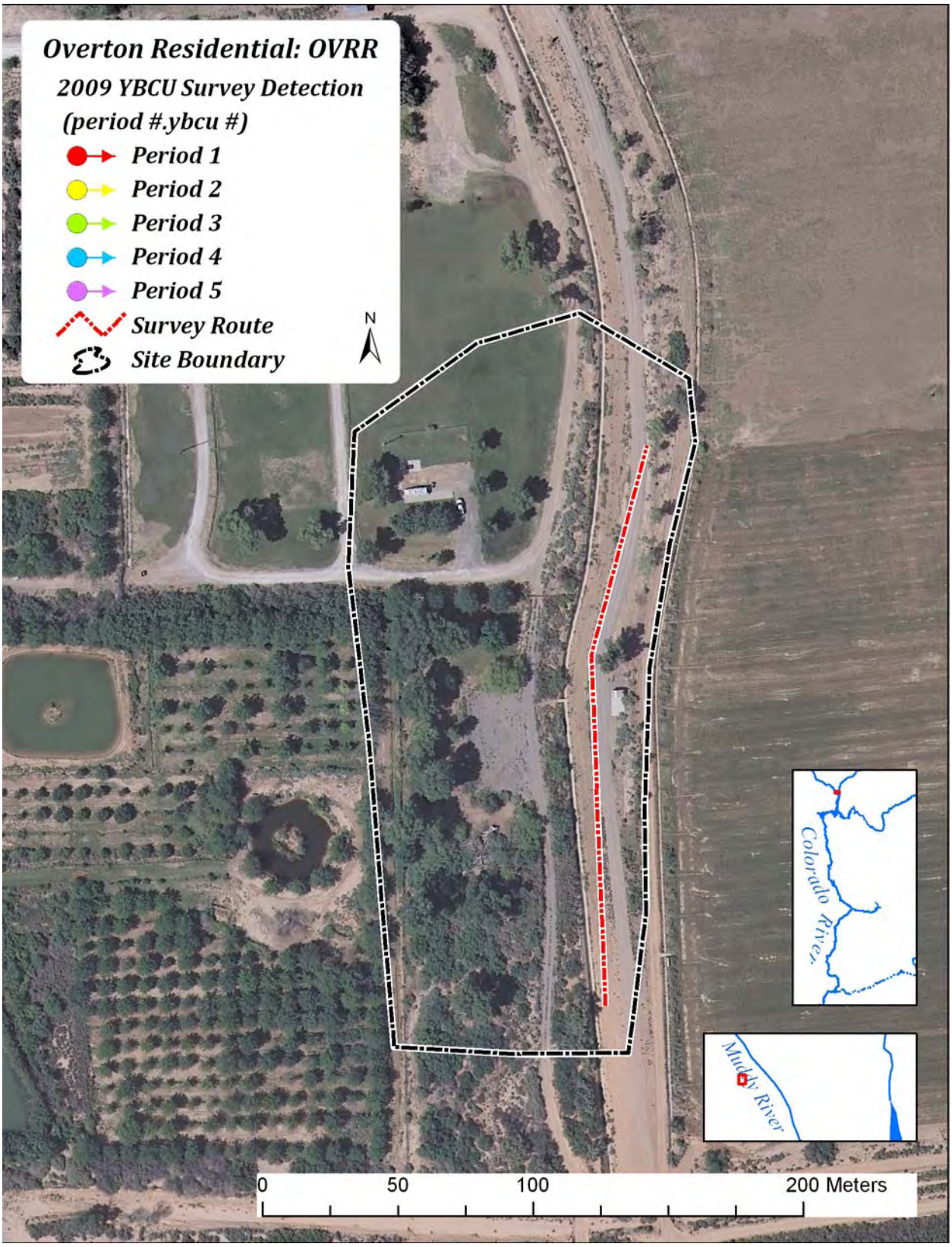
Appendix 5.3. Map of Pahranagat South Yellow-billed Cuckoo survey route, 2009.



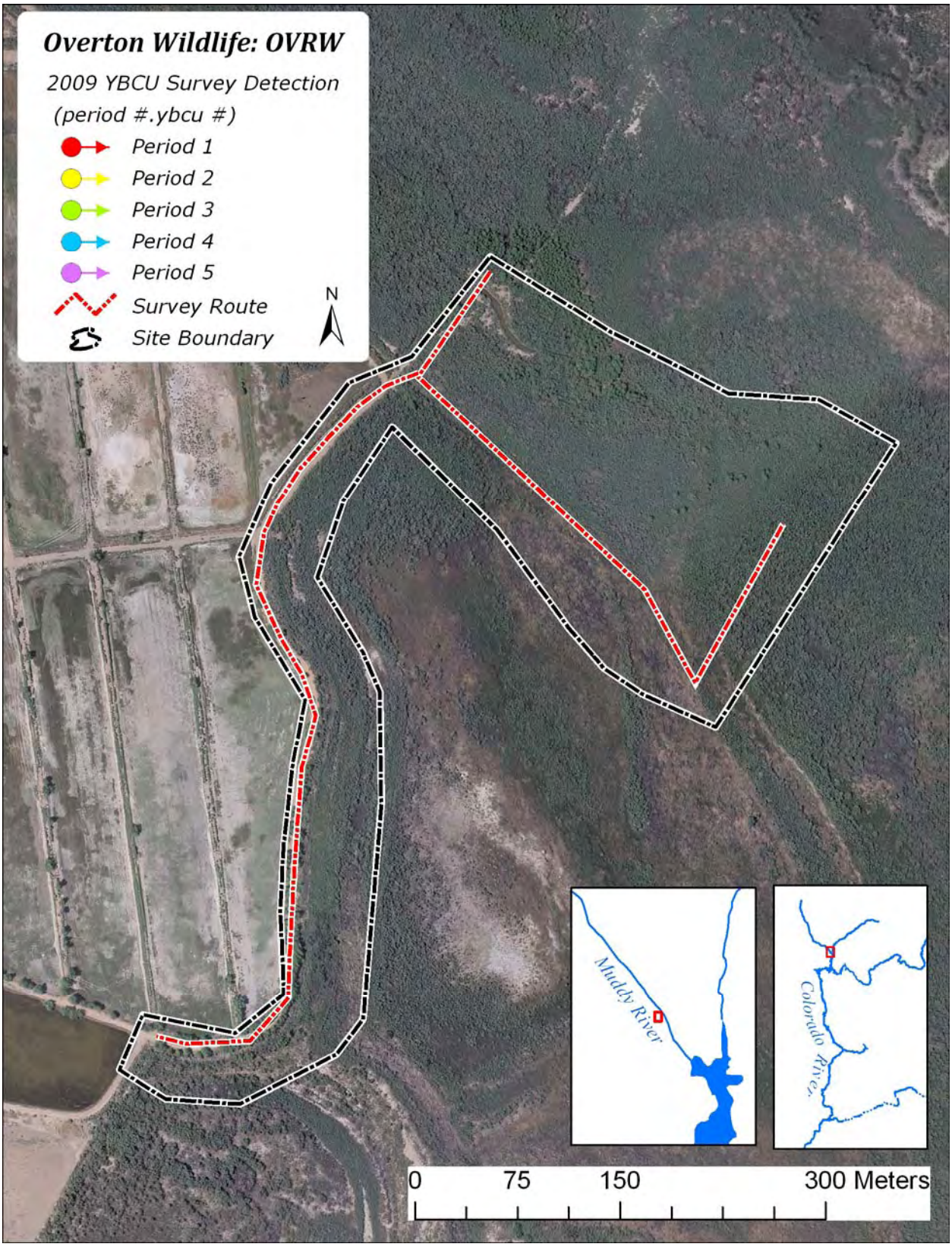
Appendix 5.4. Map of Littlefield Bridge Yellow-billed Cuckoo survey route, 2009.



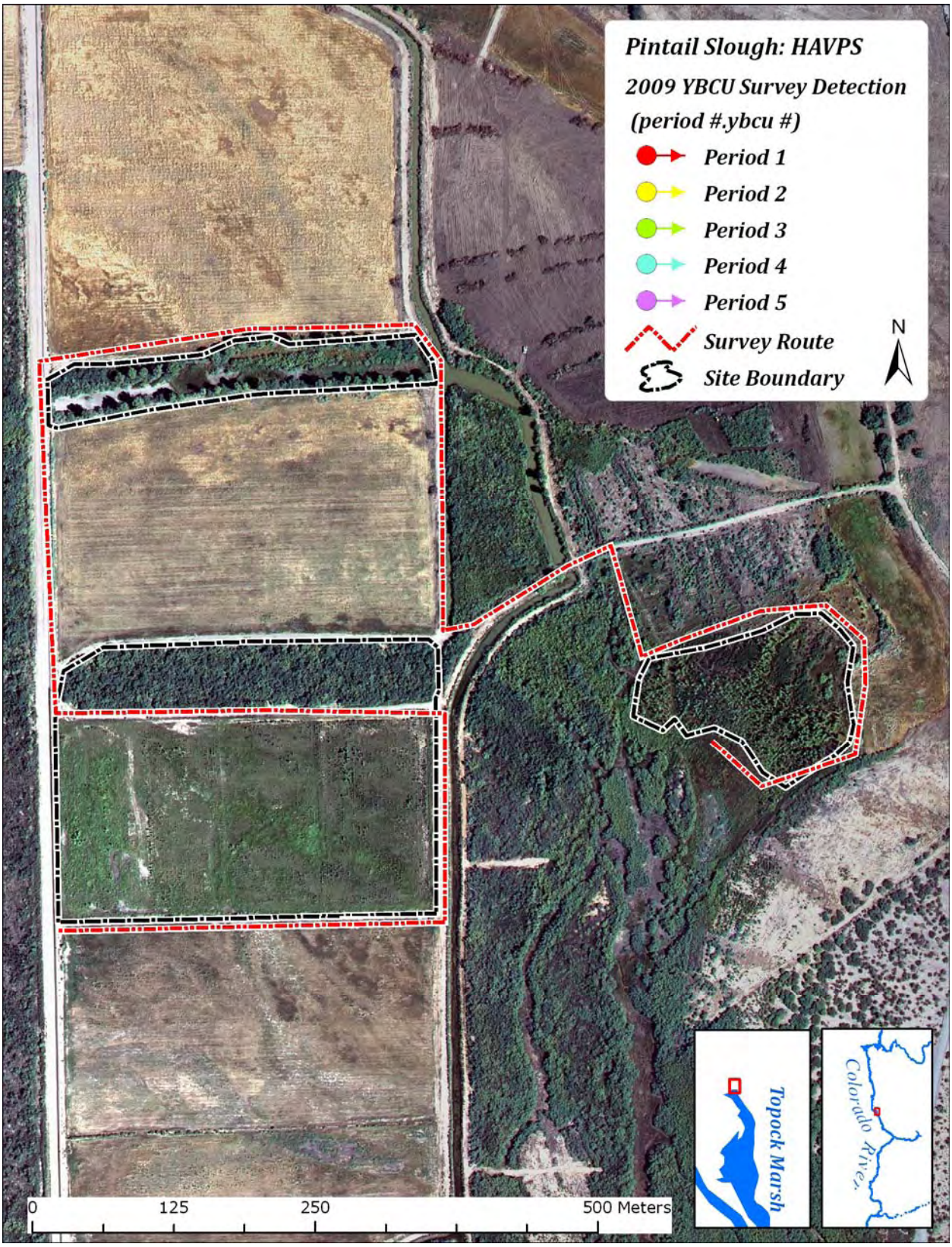
Appendix 5.5. Map of Honeybee Pond Yellow-billed Cuckoo survey route, 2009.



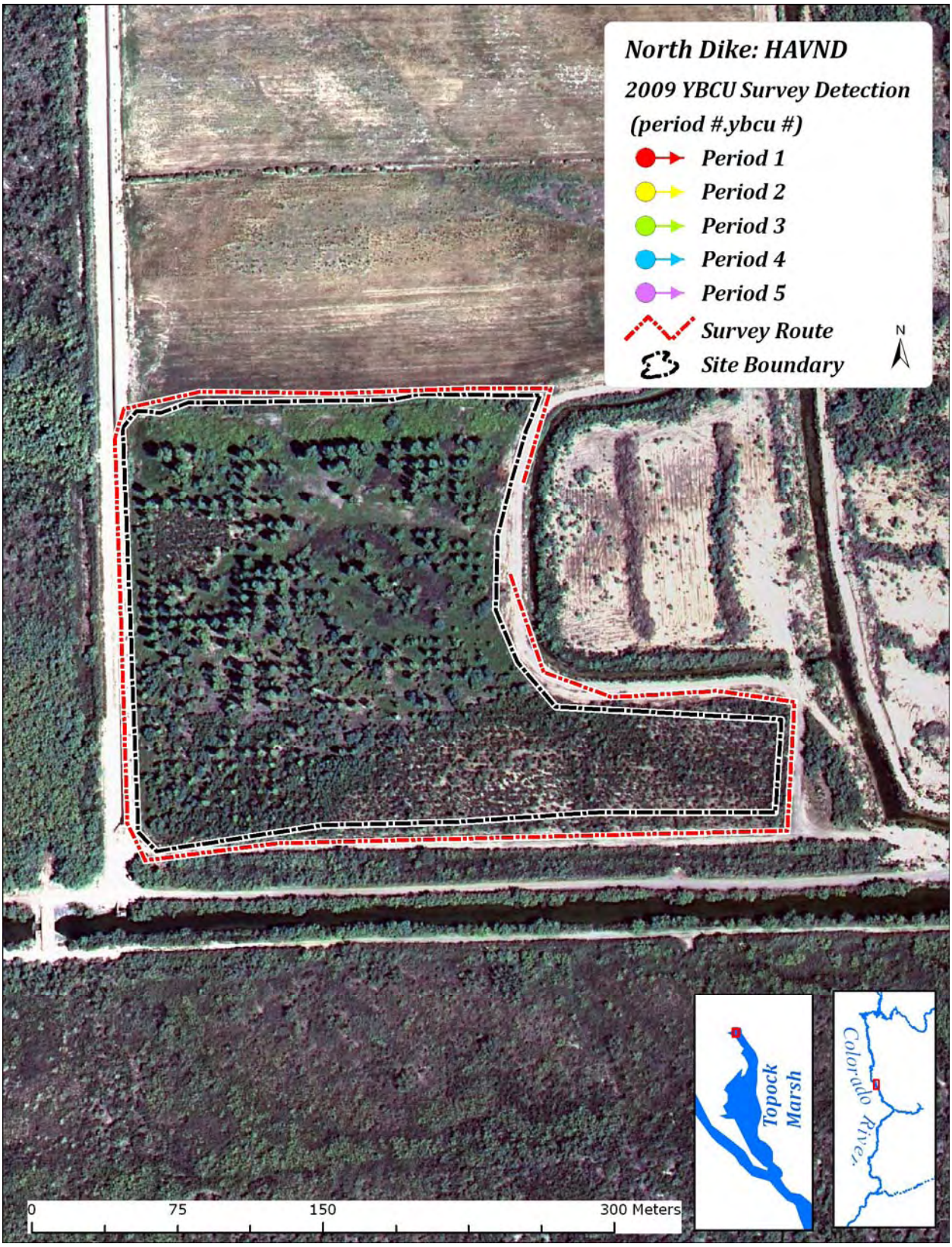
Appendix 5.6. Map of Overton Residential Yellow-billed Cuckoo survey route, 2009.



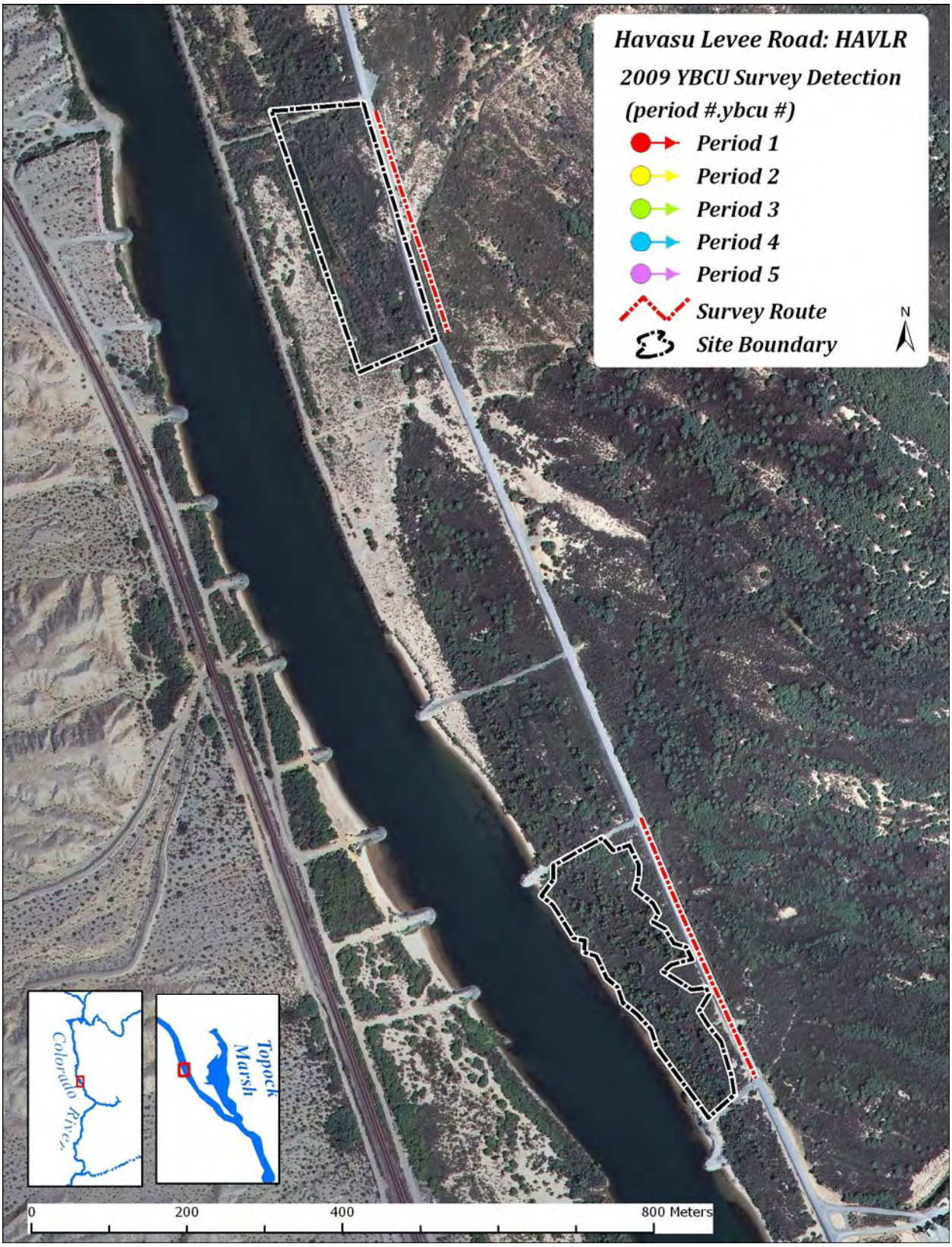
Appendix 5.7. Map of Overton Wildlife Yellow-billed Cuckoo survey route, 2009.



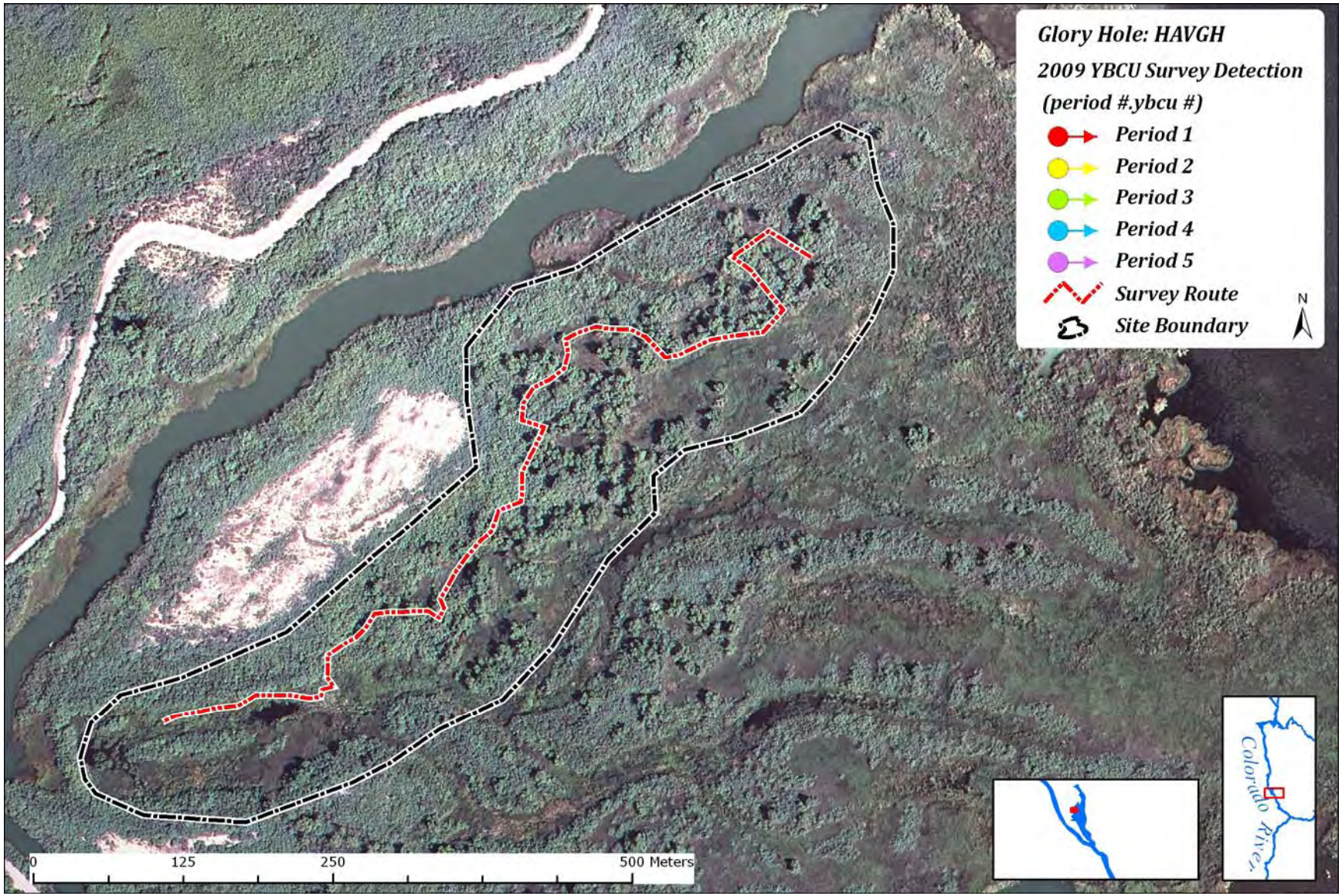
Appendix 5.8. Map of Pintail Slough Yellow-billed Cuckoo survey route, 2009.



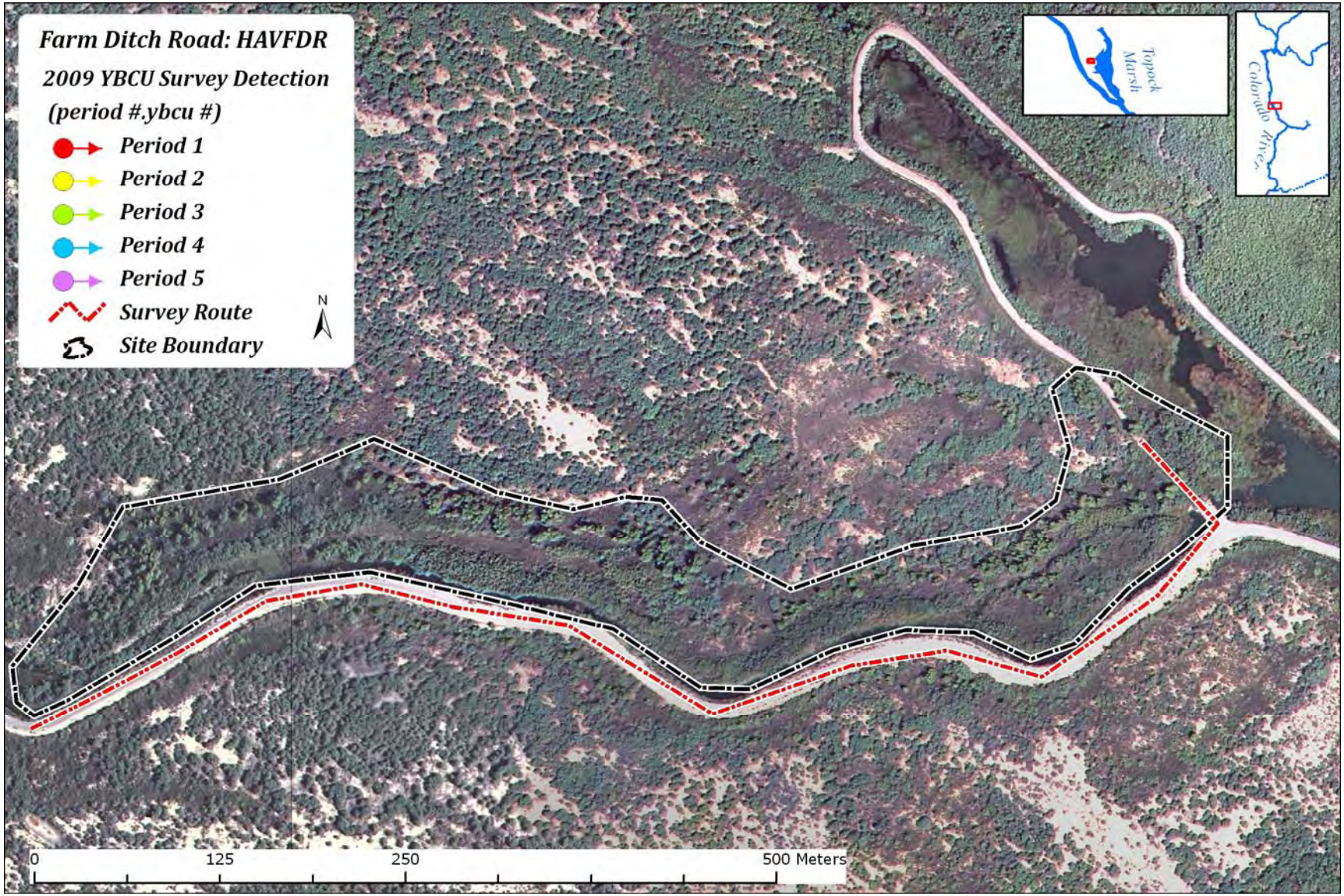
Appendix 5.9. Map of Havasu NWR North Dike Yellow-billed Cuckoo survey route, 2009.



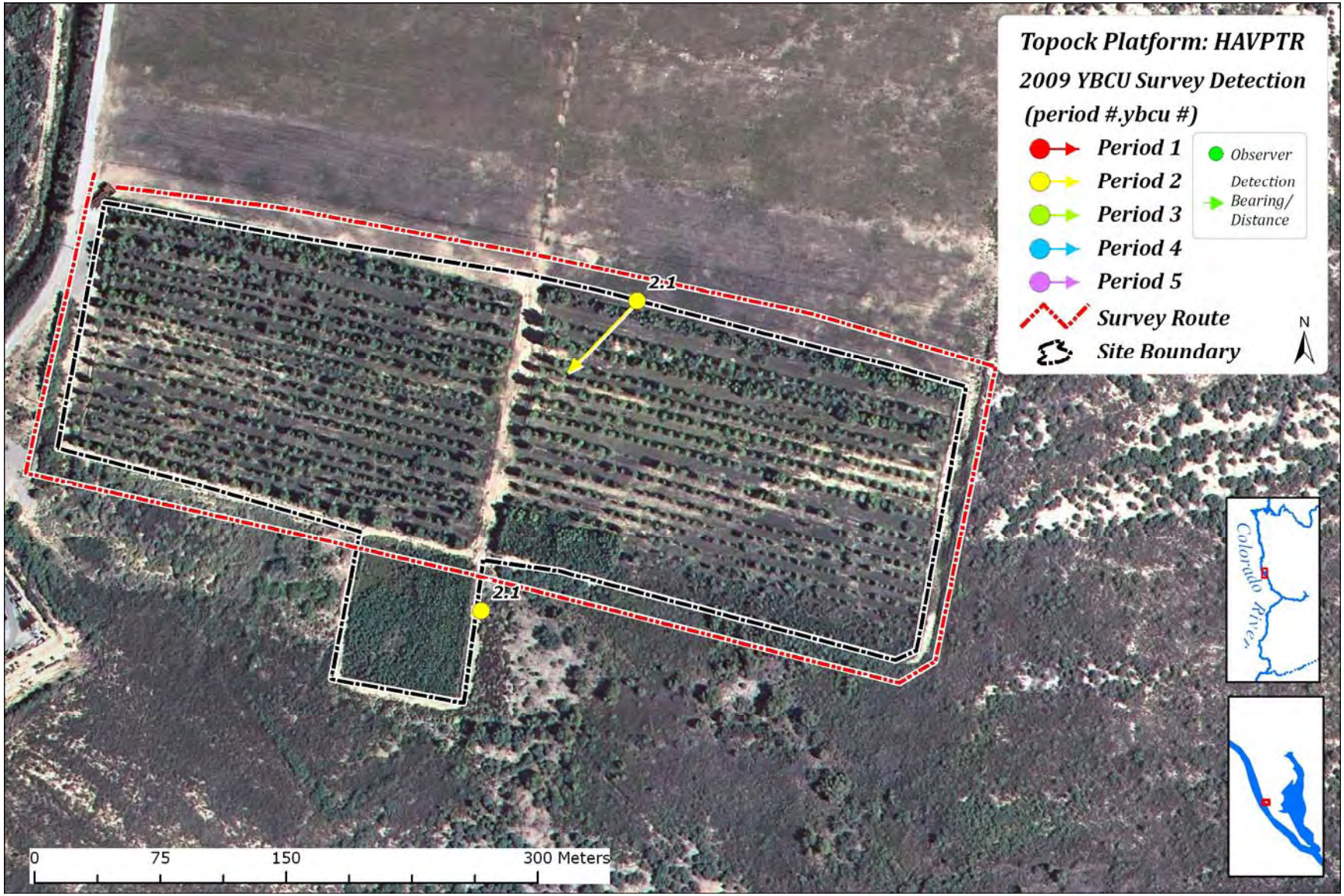
Appendix 5.10. Map of Havasu Levee Road Yellow-billed Cuckoo survey route, 2009.



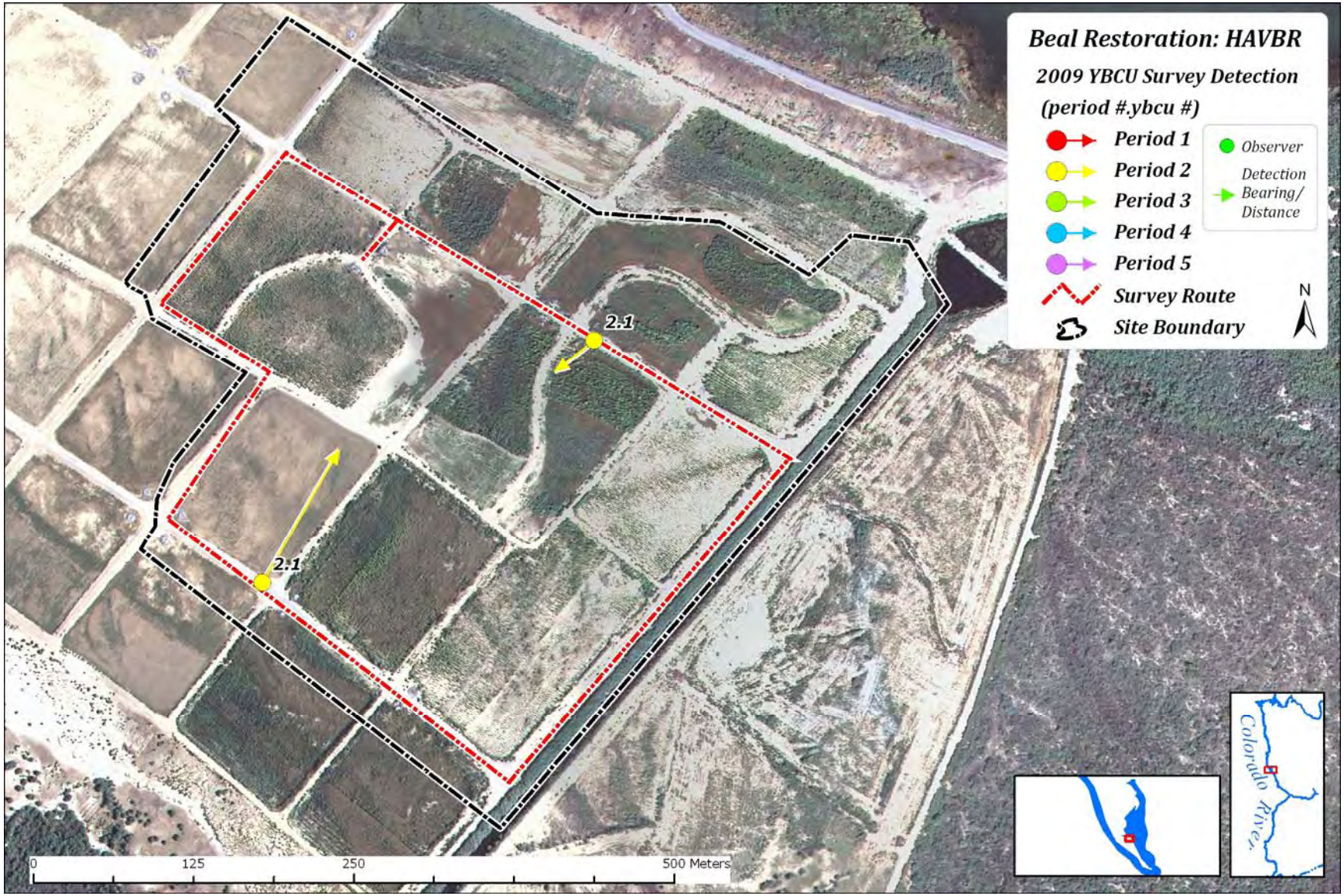
Appendix 5.11. Map of Havasu Glory Hole Yellow-billed Cuckoo survey route, 2009.



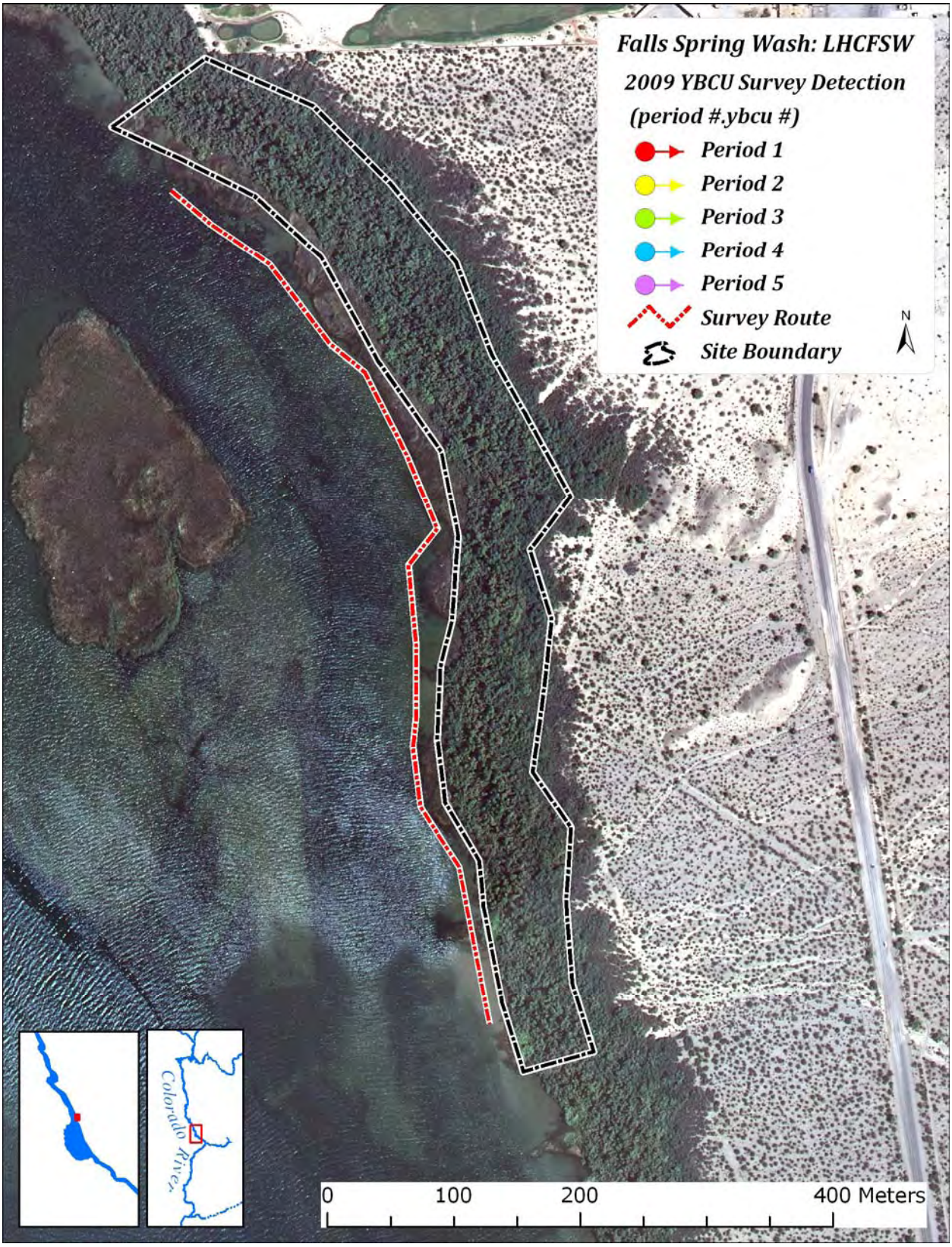
Appendix 5.12. Map of Farm Ditch Road Yellow-billed Cuckoo survey route, 2009.



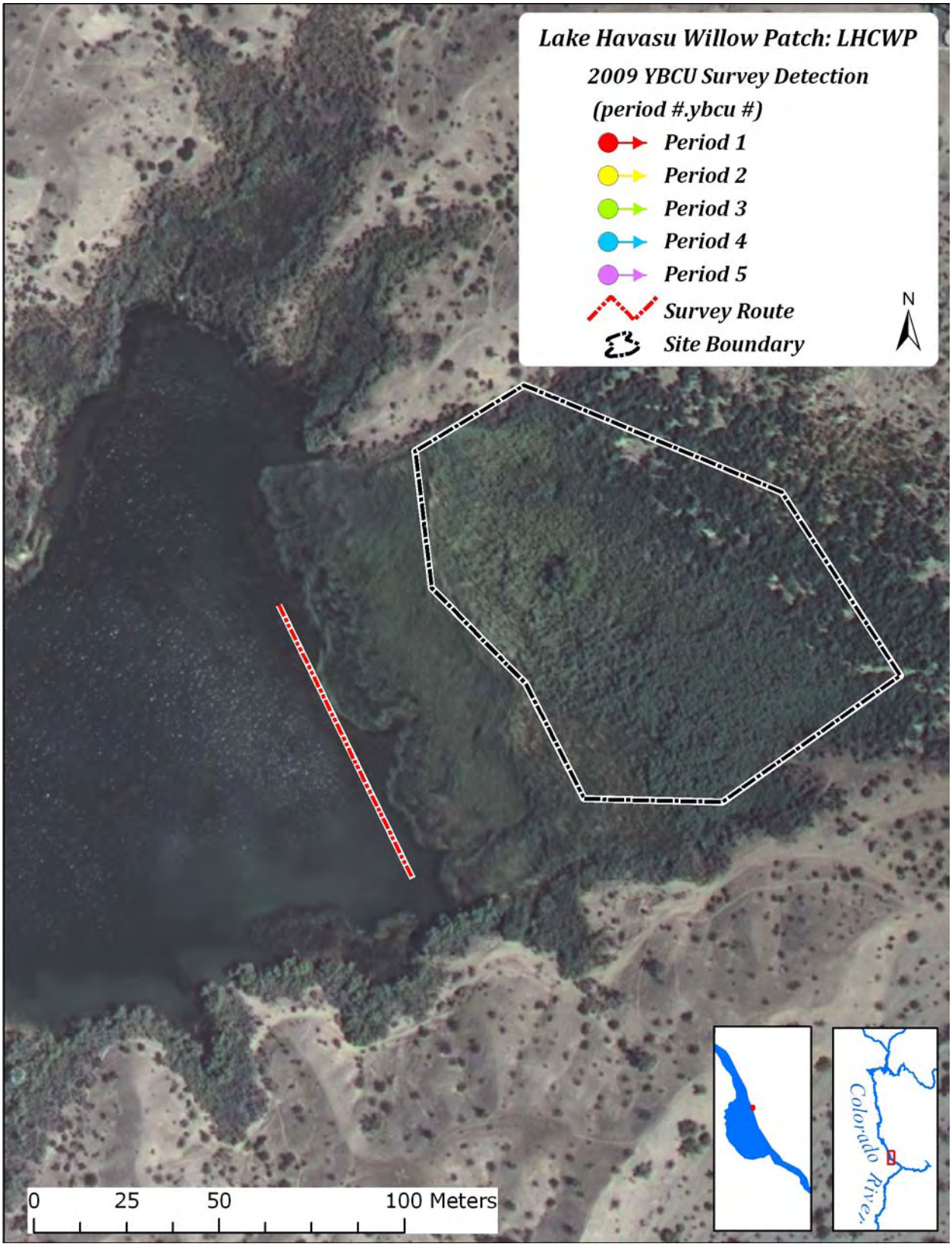
Appendix 5.13. Map of Topock Platform Yellow-billed Cuckoo survey route and detections, 2009.



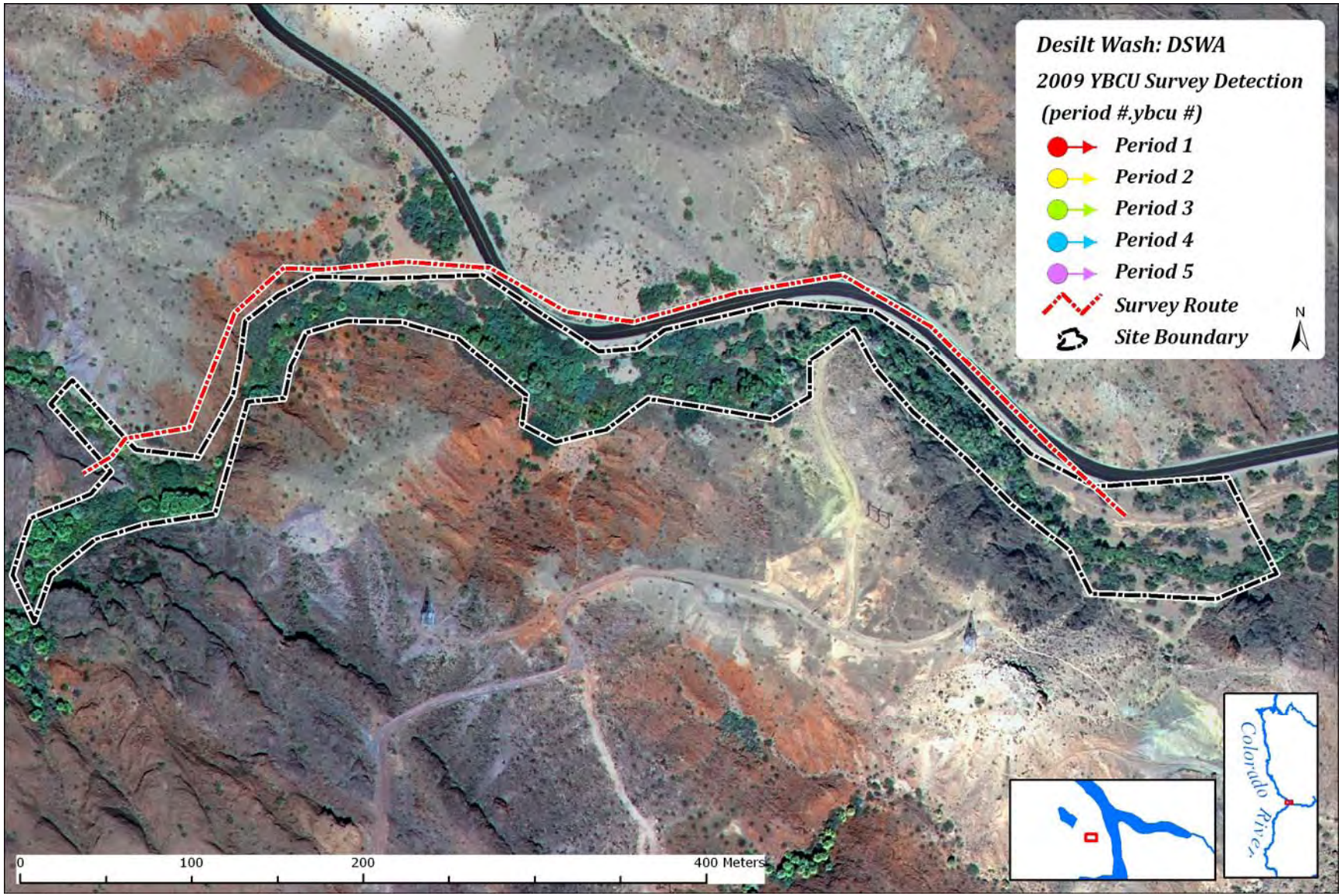
Appendix 5.14. Map of Beal Restoration Yellow-billed Cuckoo survey route and detections, 2009.



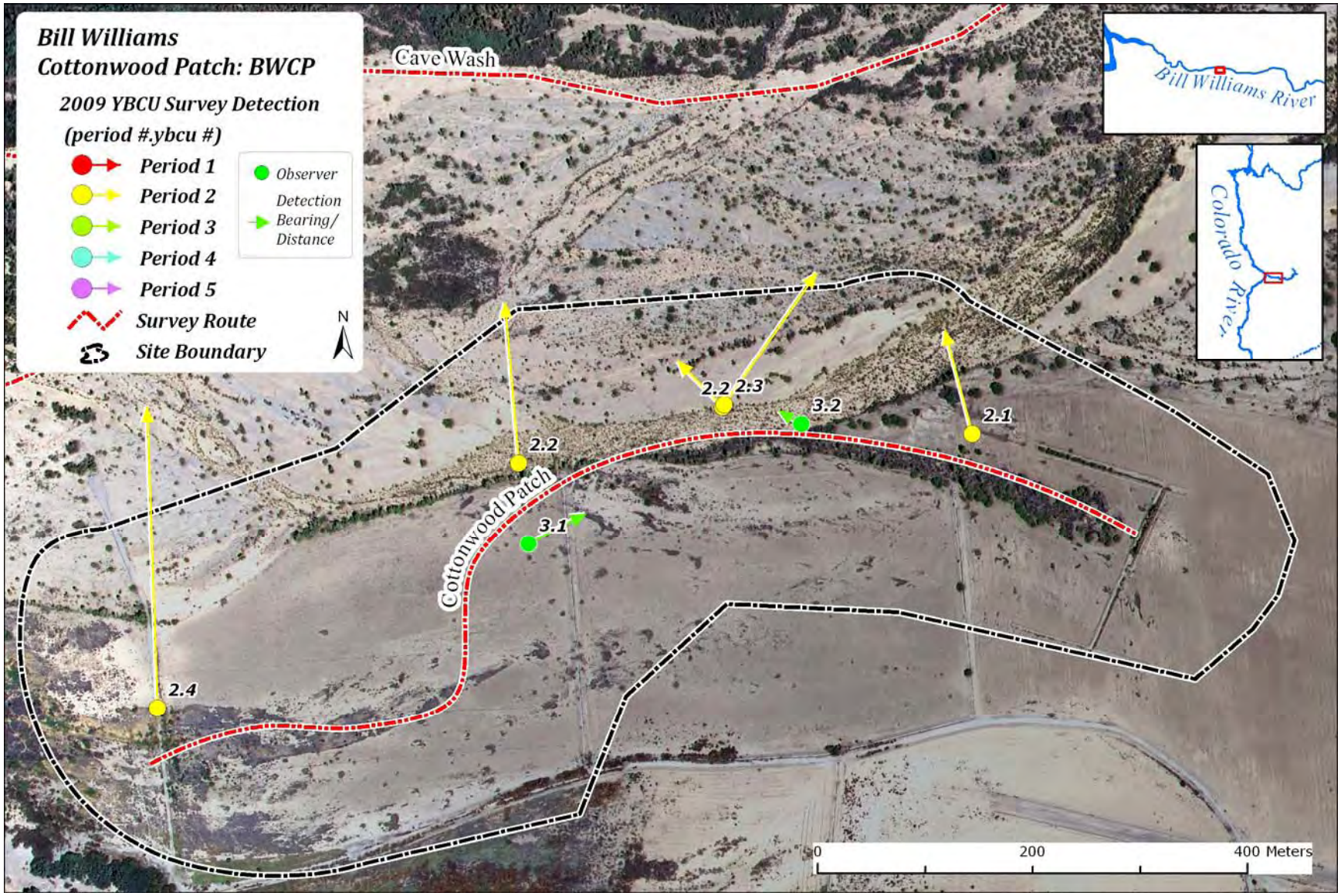
Appendix 5.15. Map of Falls Spring Wash Yellow-billed Cuckoo survey route, 2009.



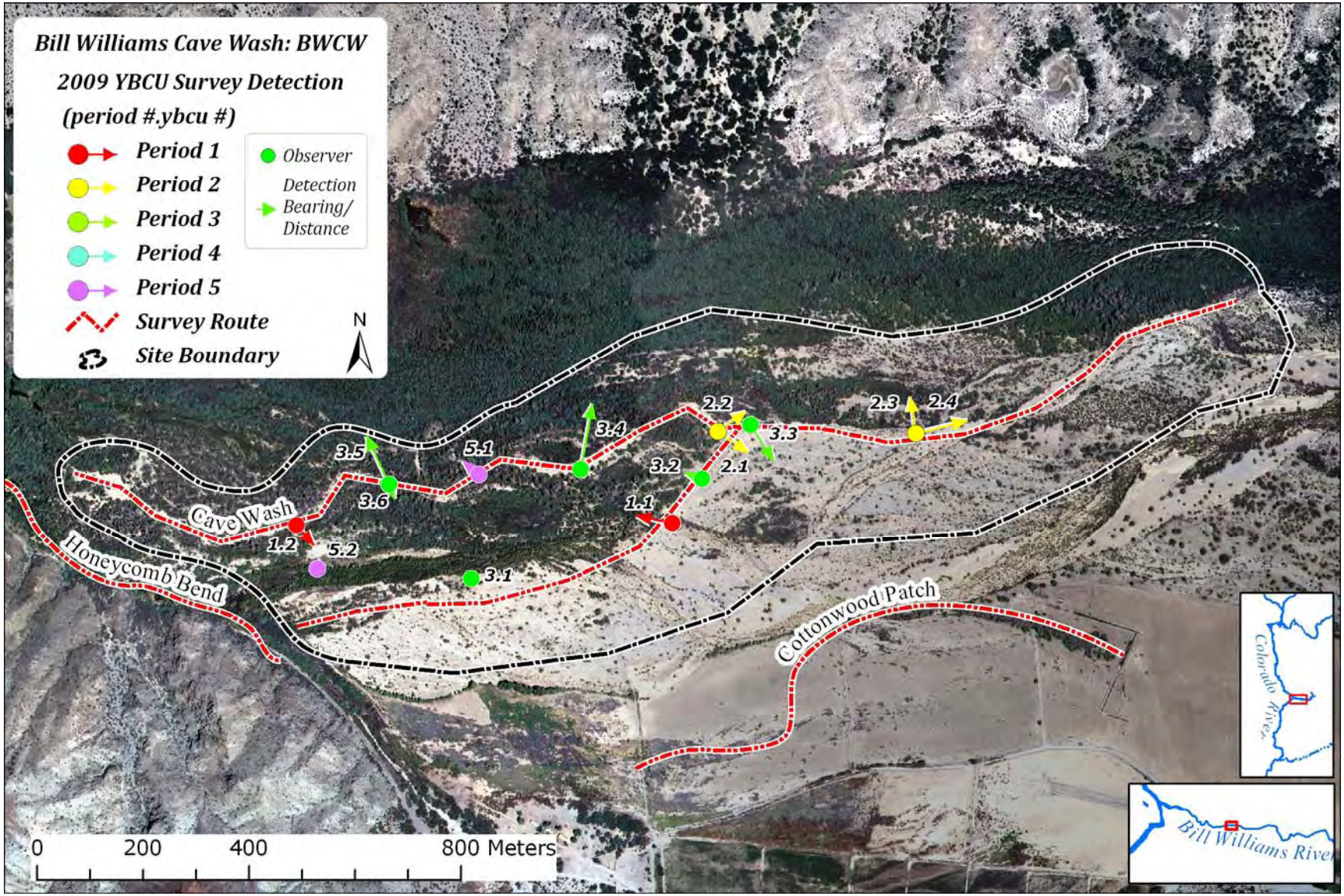
Appendix 5.16. Map of Havasu City Willow Patch Yellow-billed Cuckoo survey route, 2009.



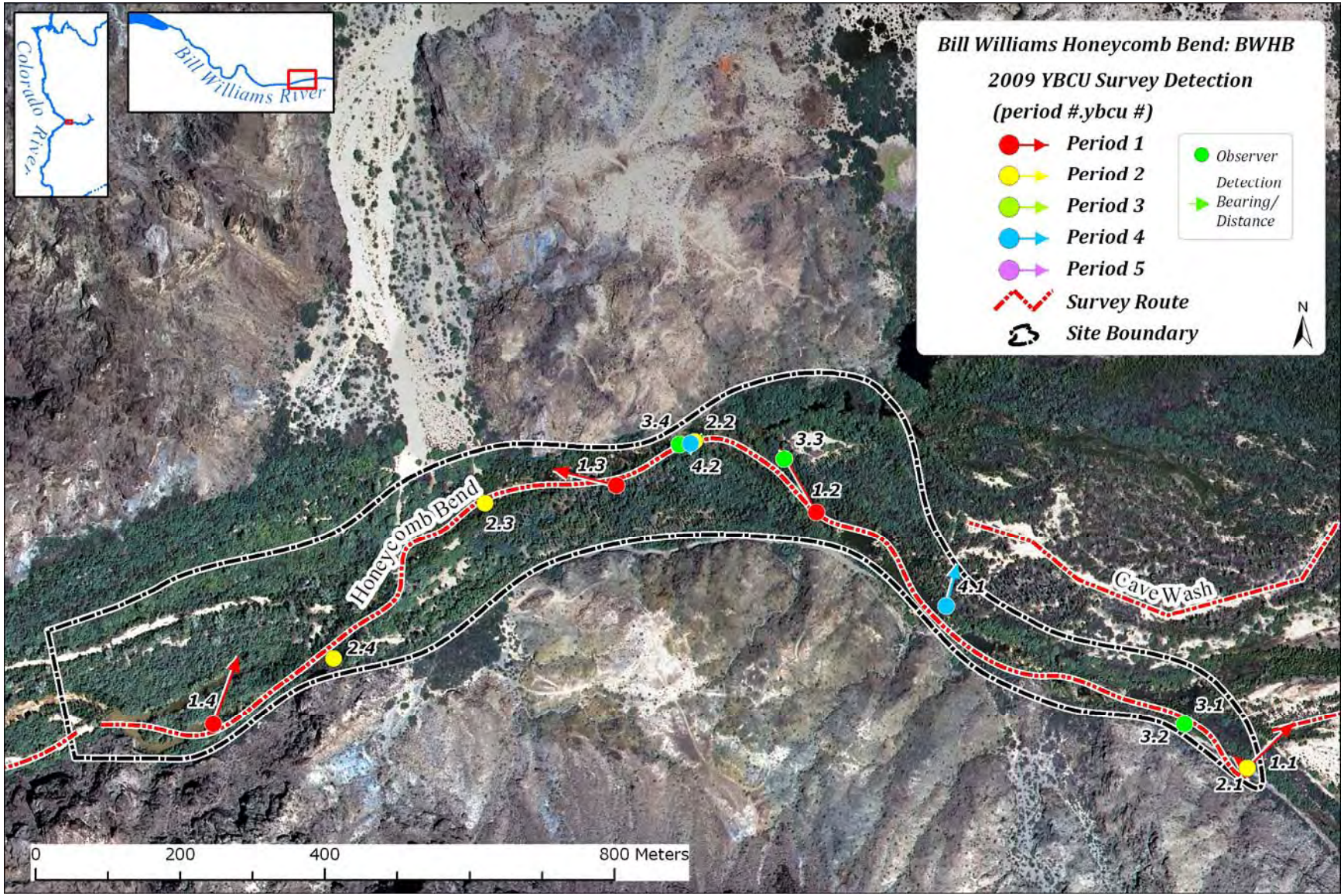
Appendix 5.17. Map of Desilt Wash Yellow-billed Cuckoo survey route, 2009.



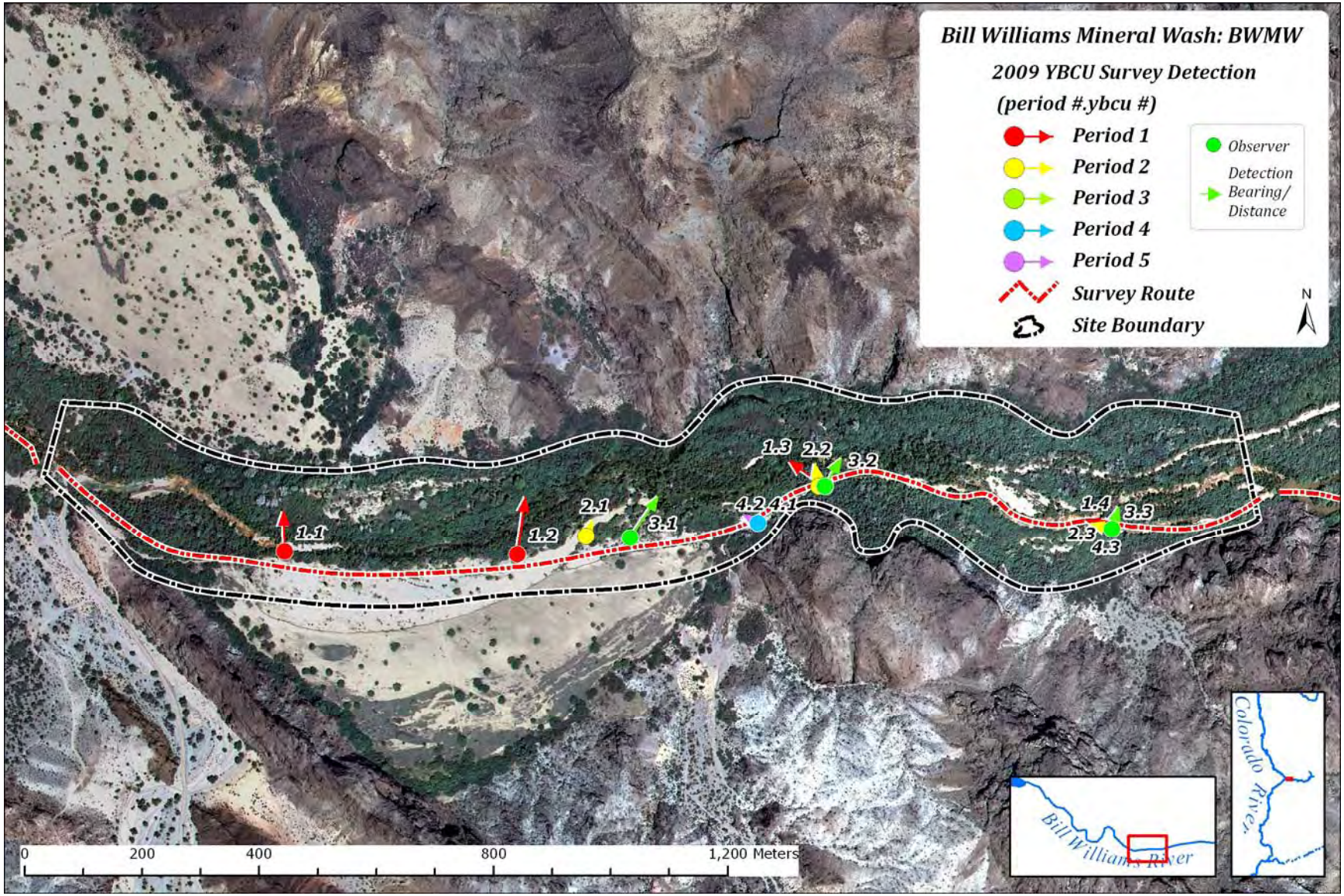
Appendix 5.18. Map of Cottonwood Patch Yellow-billed Cuckoo survey route and detections, 2009.



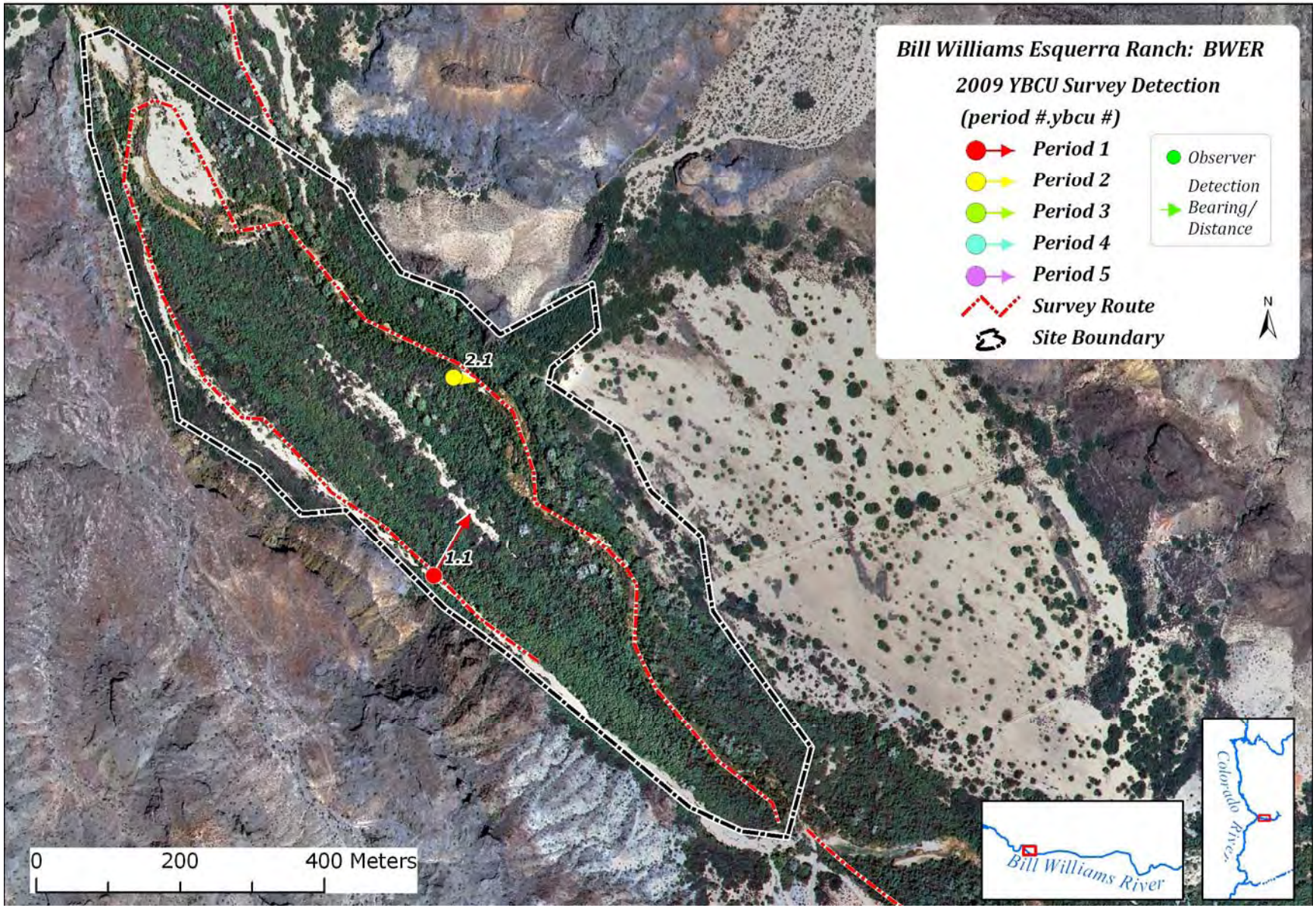
Appendix 5.19.Map of Cave Wash Yellow-billed Cuckoo survey route and detections, 2009.



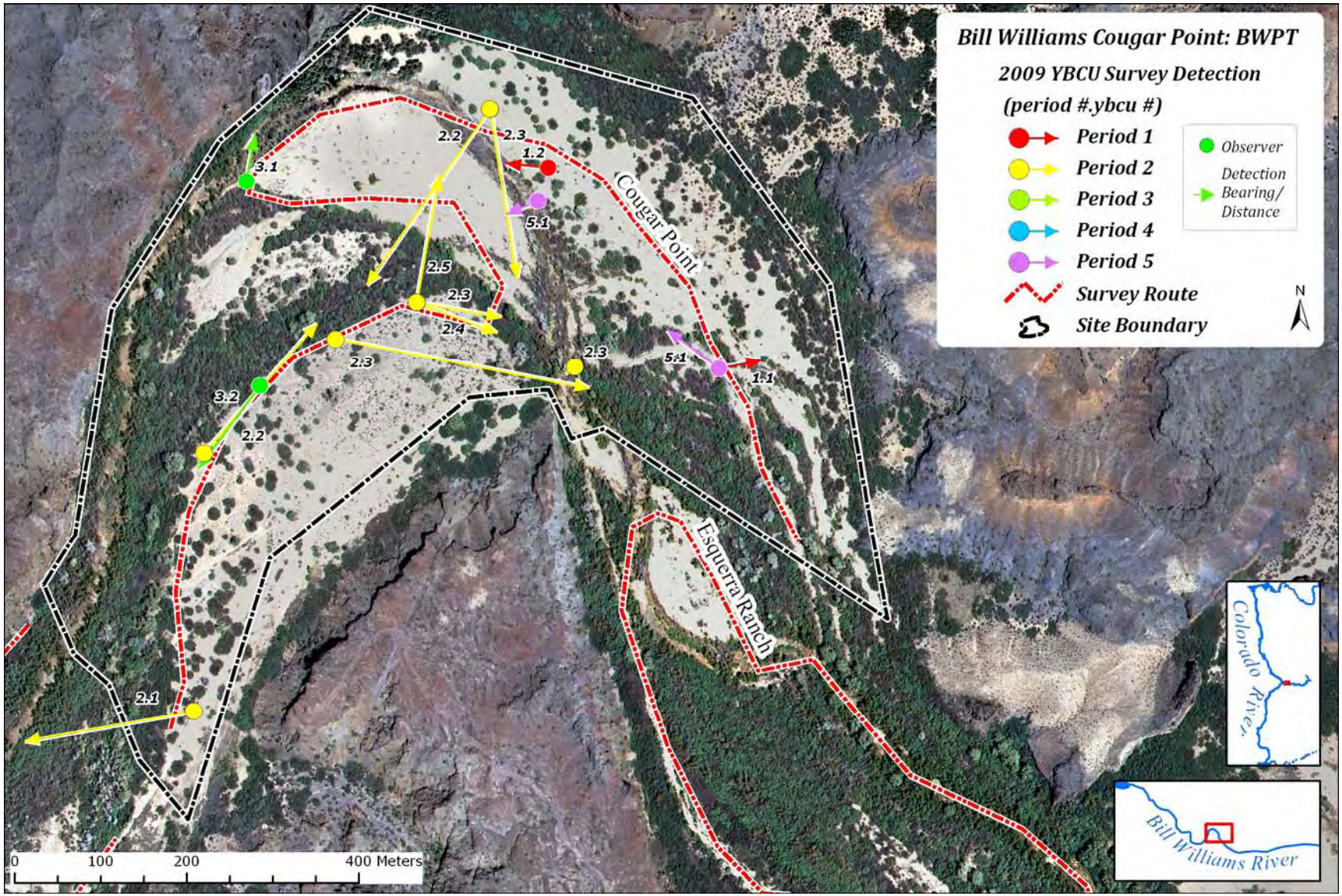
Appendix 5.20. Map of Honeycomb Bend Yellow-billed Cuckoo survey route and detections, 2009.



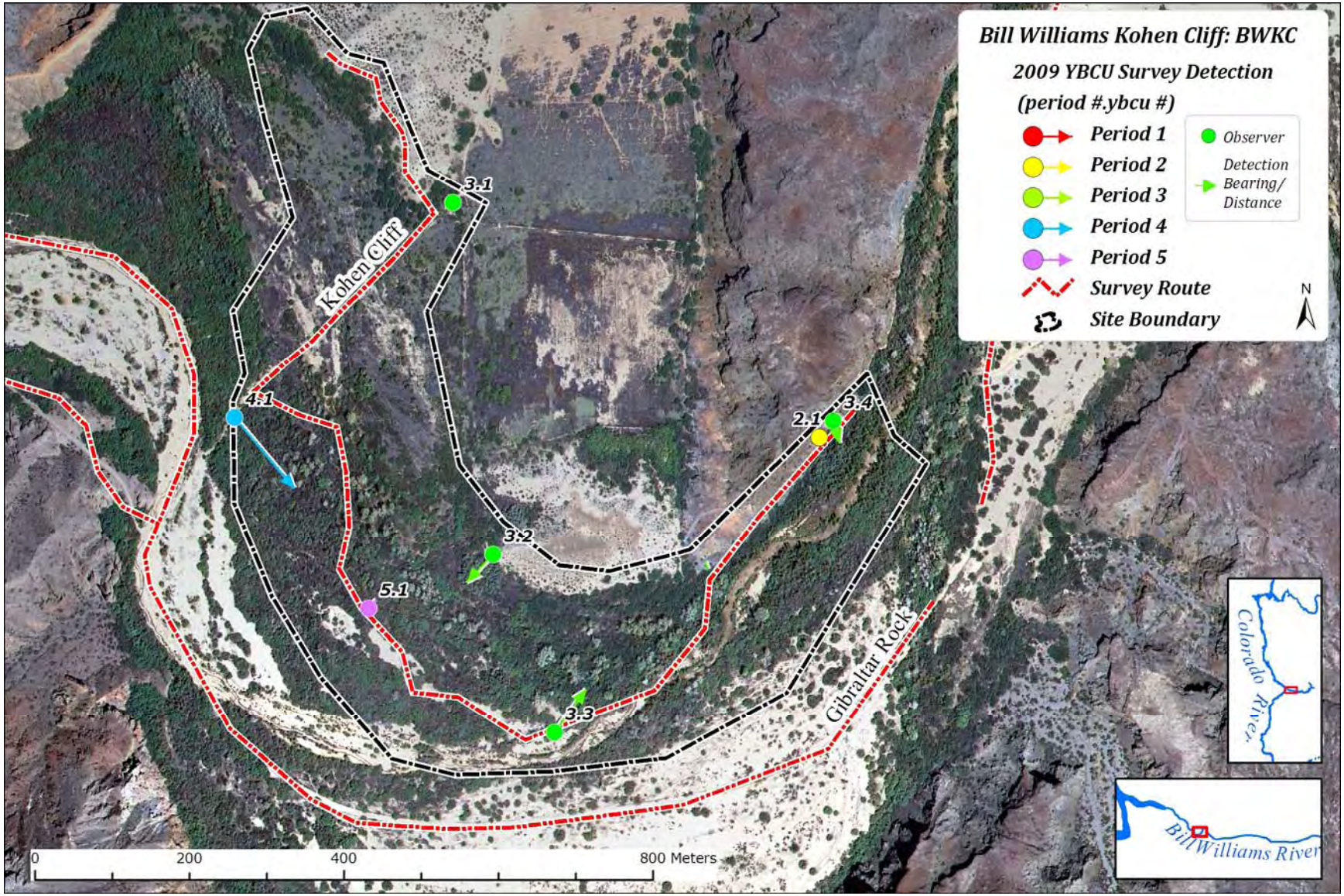
Appendix 5.21. Map of Mineral Wash Yellow-billed Cuckoo survey route and detections, 2009.



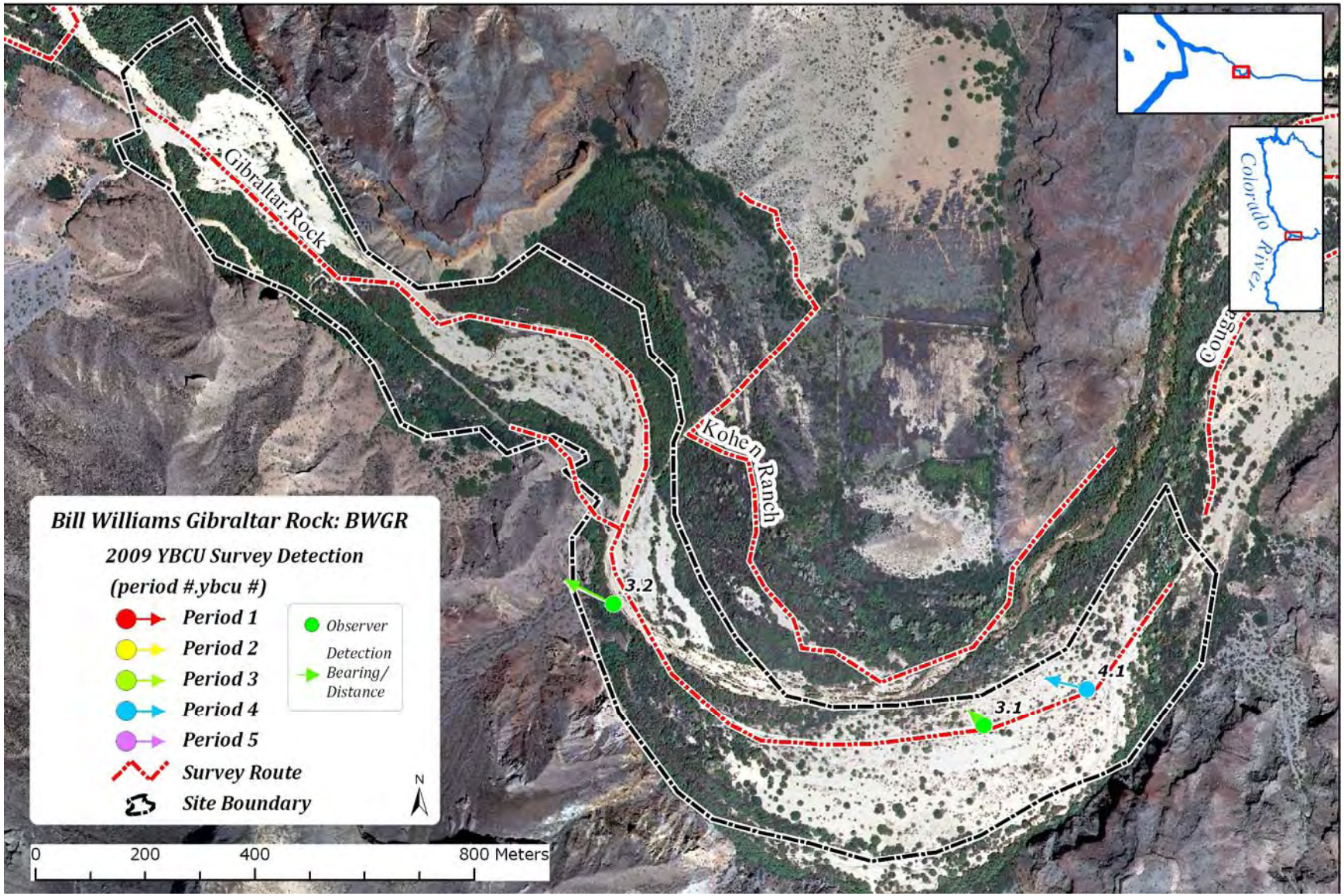
Appendix 5.22. Map of Esquerra Ranch Yellow-billed Cuckoo survey route and detections, 2009.



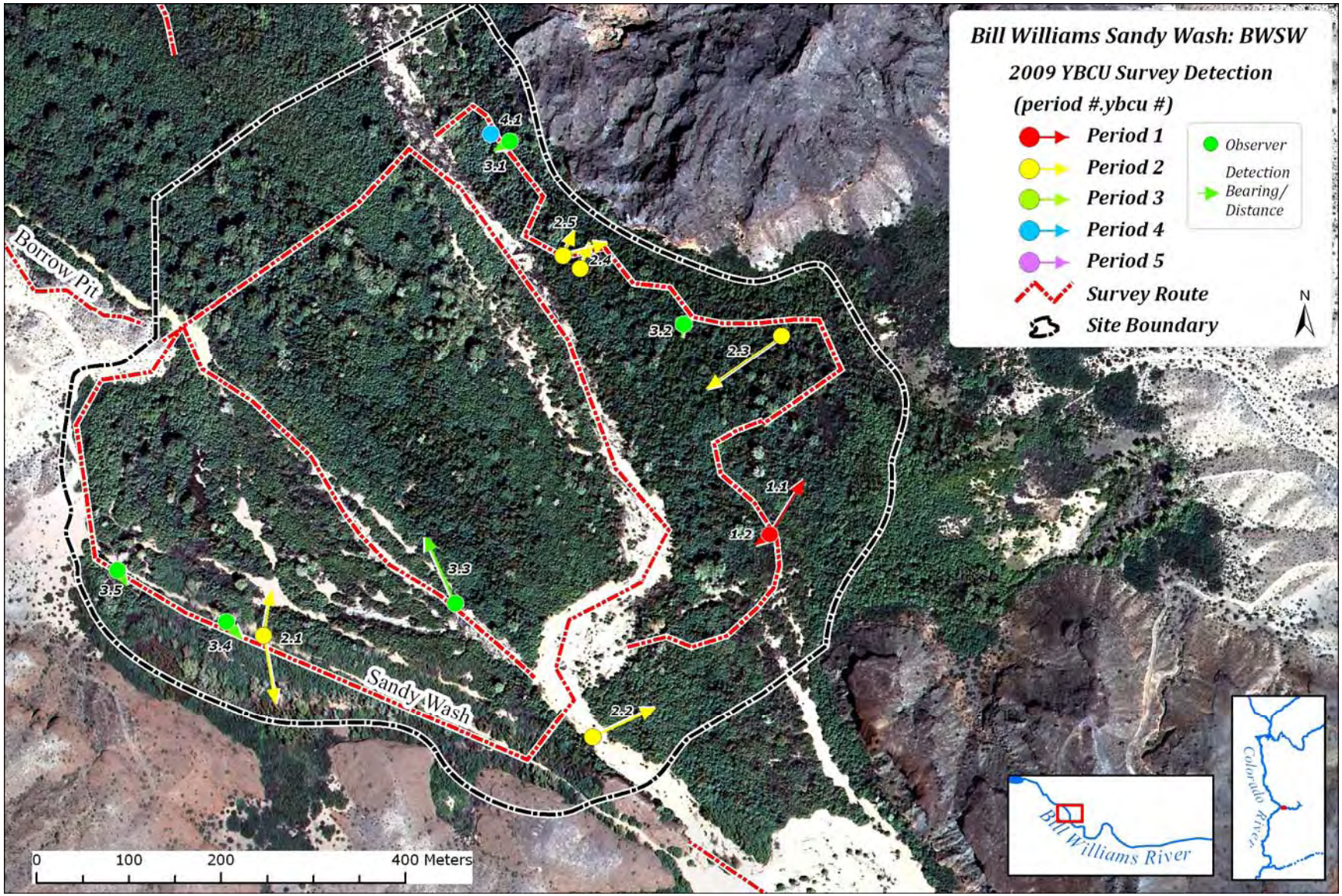
Appendix 5.23. Map of Cougar Point Yellow-billed Cuckoo survey route and detections, 2009.



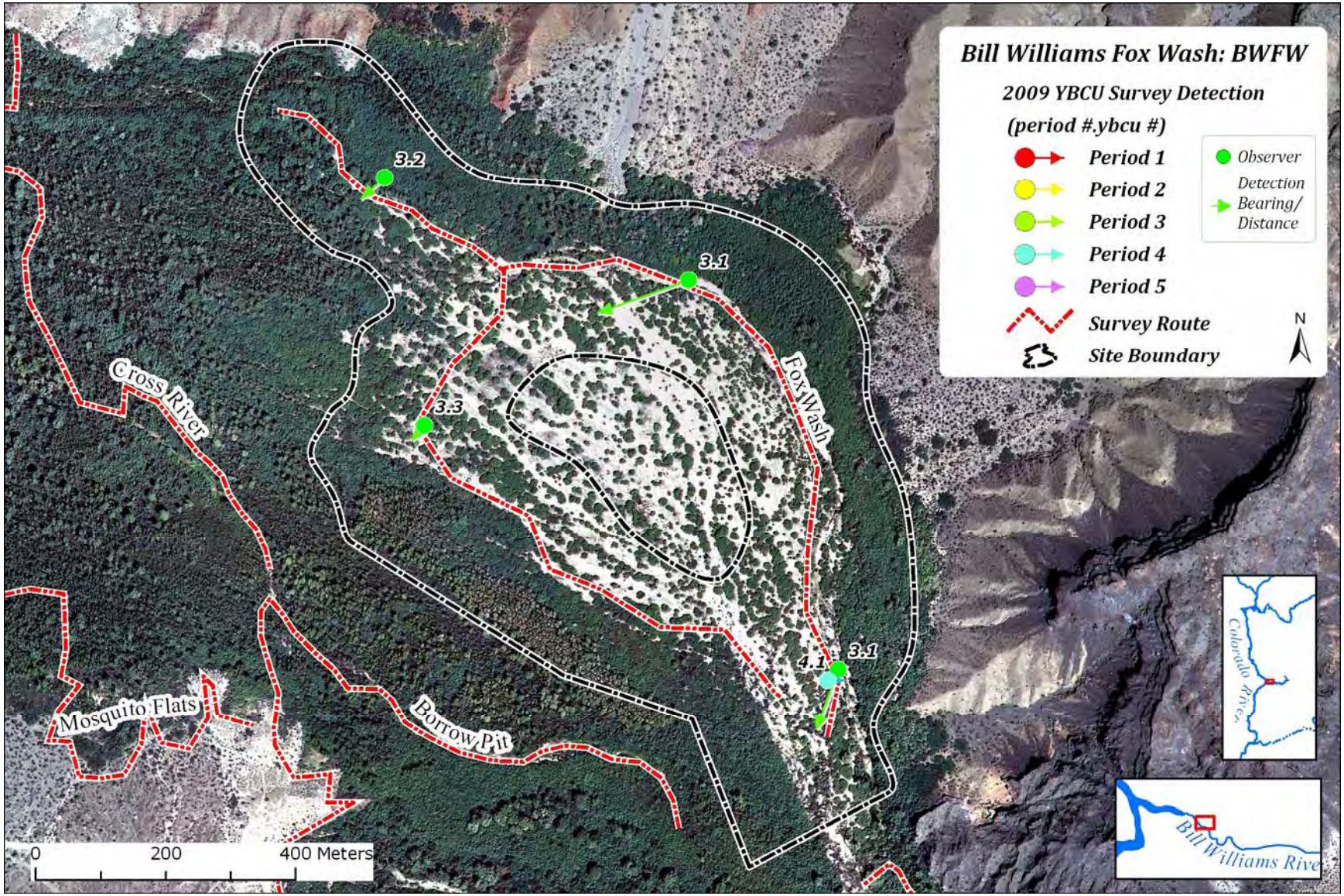
Appendix 5.24. Map of Kohen Cliff Yellow-billed Cuckoo survey route and detections, 2009.



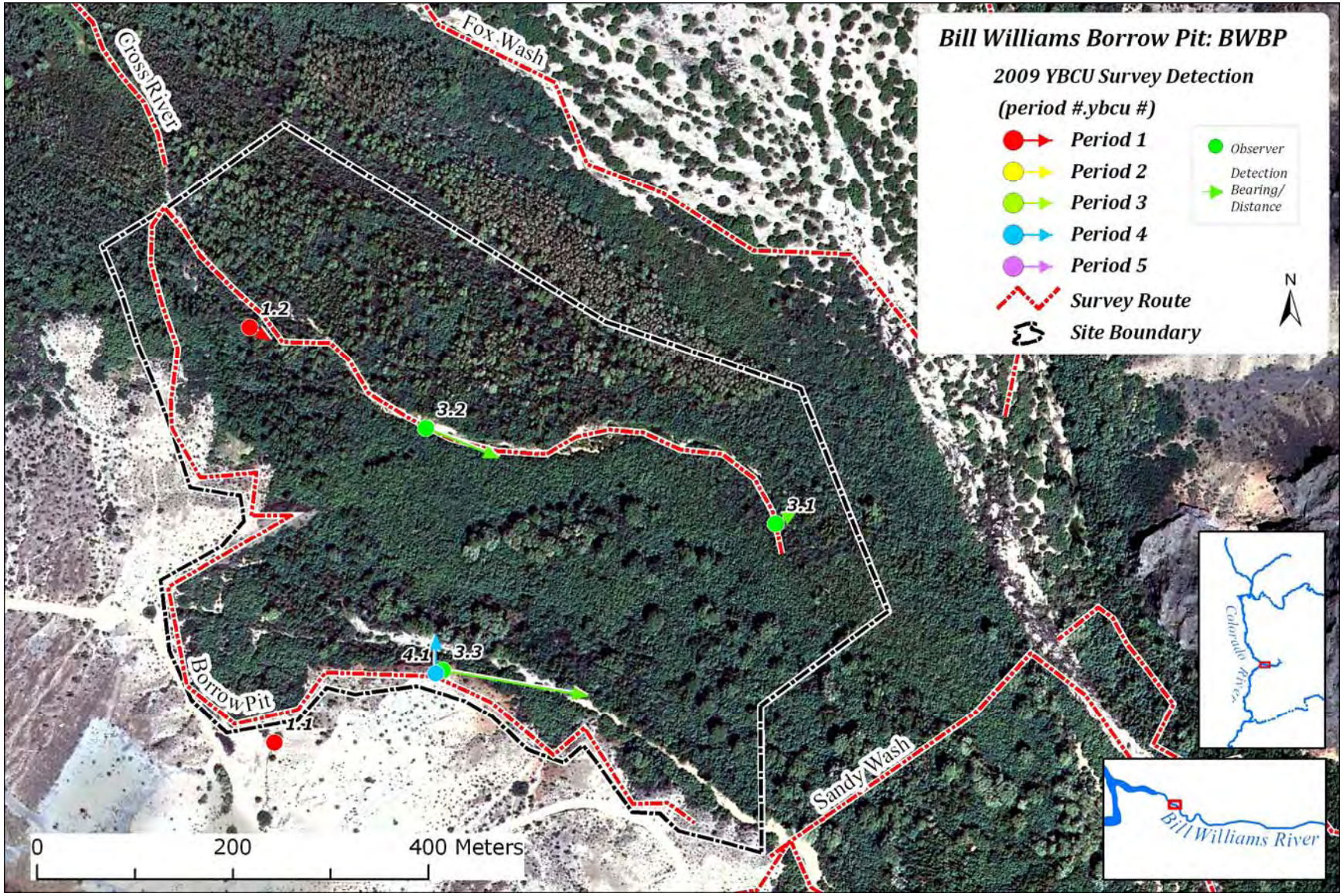
Appendix 5.25. Map of Gibraltar Rock Yellow-billed Cuckoo survey route and detections, 2009.



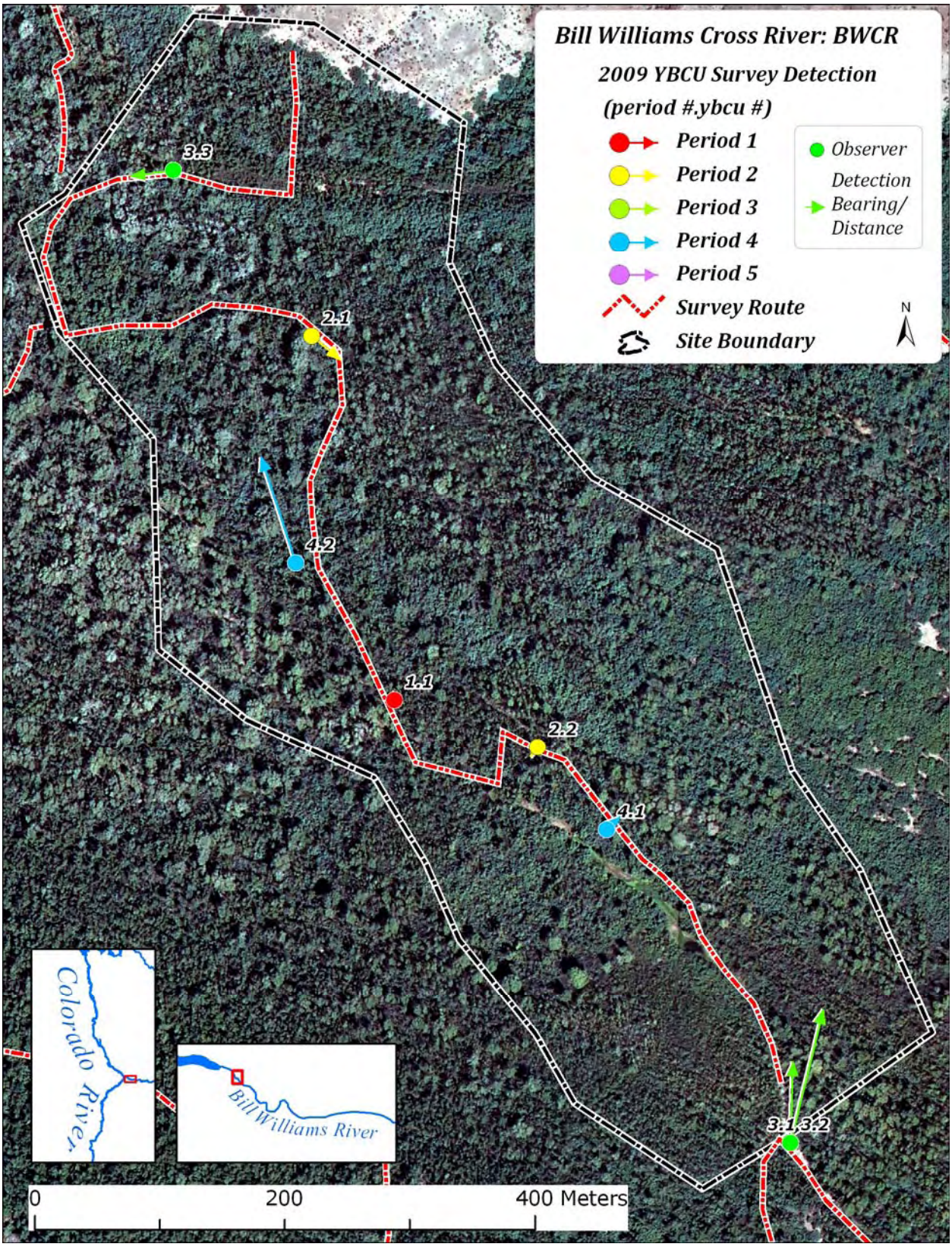
Appendix 5.26. Map of Sandy Wash Yellow-billed Cuckoo survey route and detections, 2009.



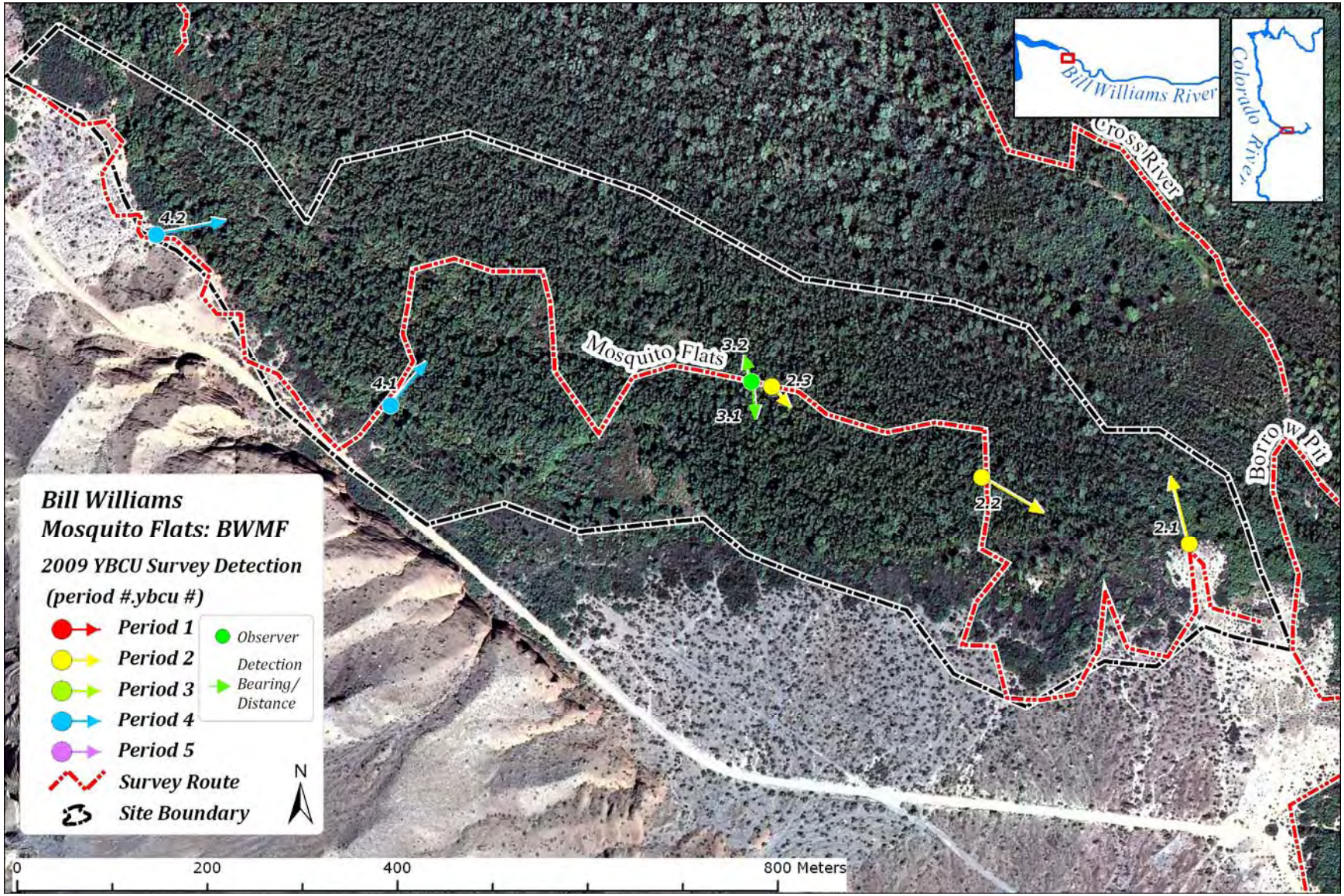
Appendix 5.27. Map of Fox Wash Yellow-billed Cuckoo survey route and detections, 2009.



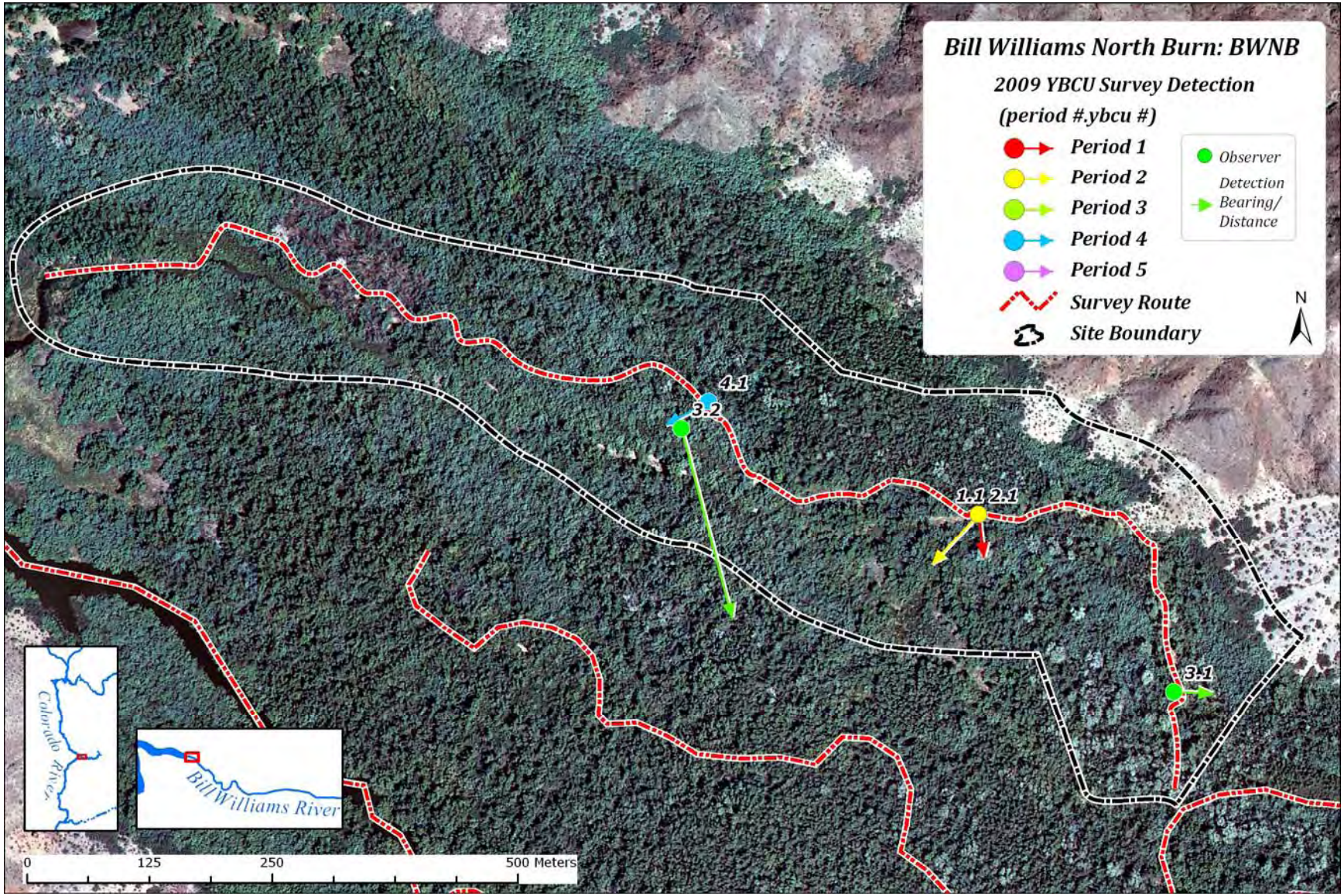
Appendix 5.28. Map of Borrow Bit Yellow-billed Cuckoo survey route and detections, 2009.



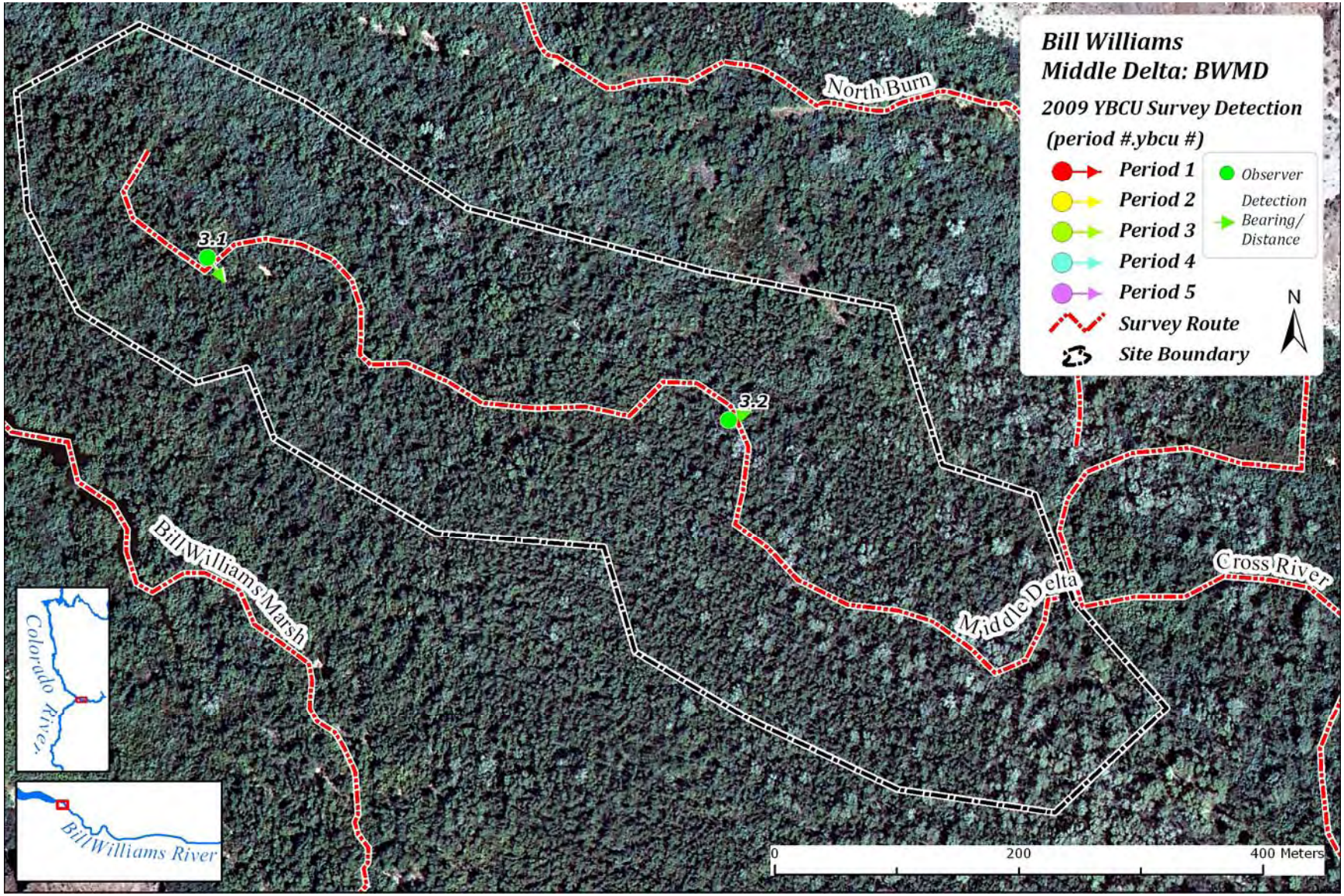
Appendix 5.29. Map of Cross River Yellow-billed Cuckoo survey route and detections, 2009.



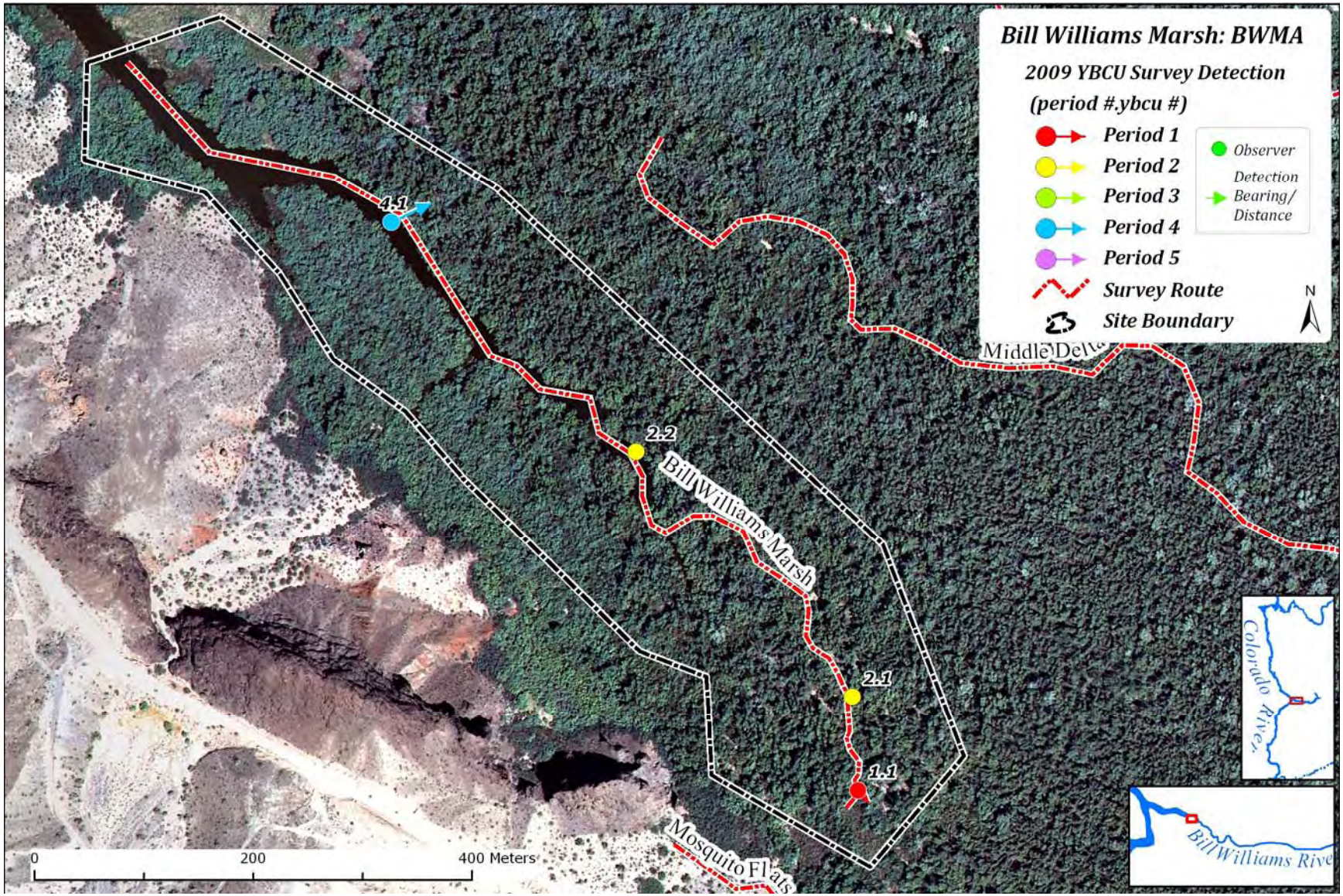
Appendix 5.30. Map of Mosquito Flats Yellow-billed Cuckoo survey route and detections, 2009.



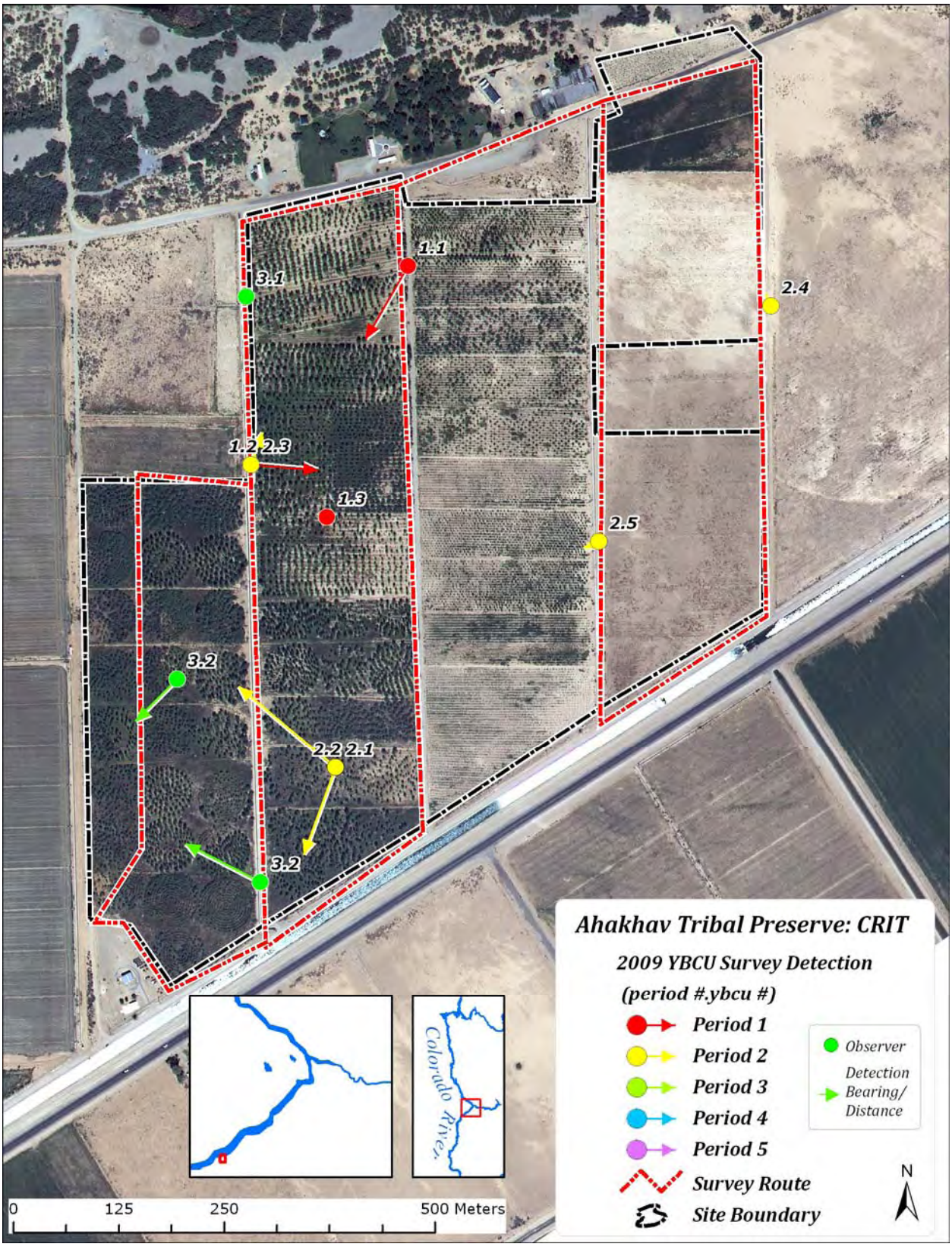
Appendix 5.31. Map of North Burn Yellow-billed Cuckoo survey route and detections, 2009.



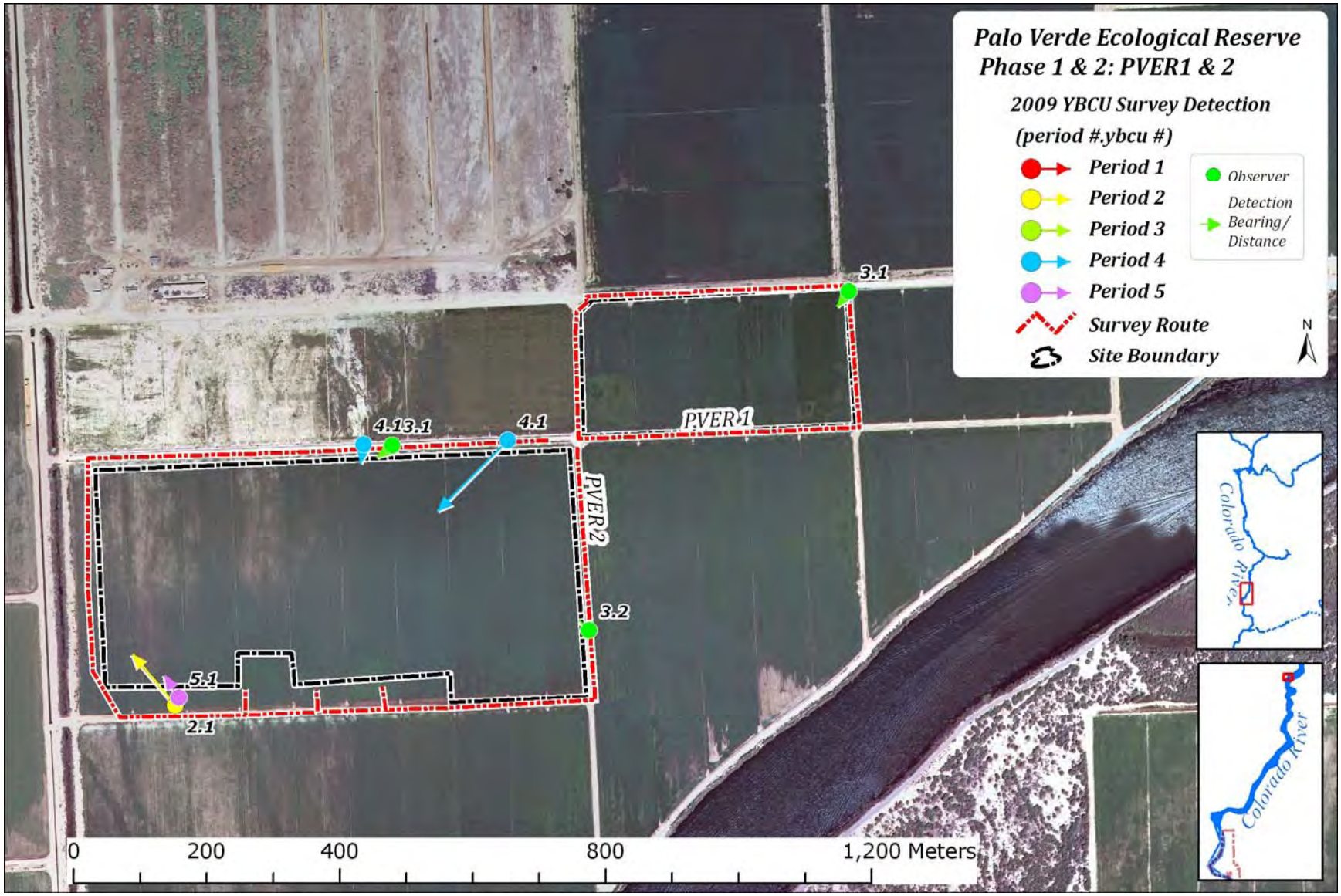
Appendix 5.32. Map of Middle Delta Yellow-billed Cuckoo survey route and detections, 2009.



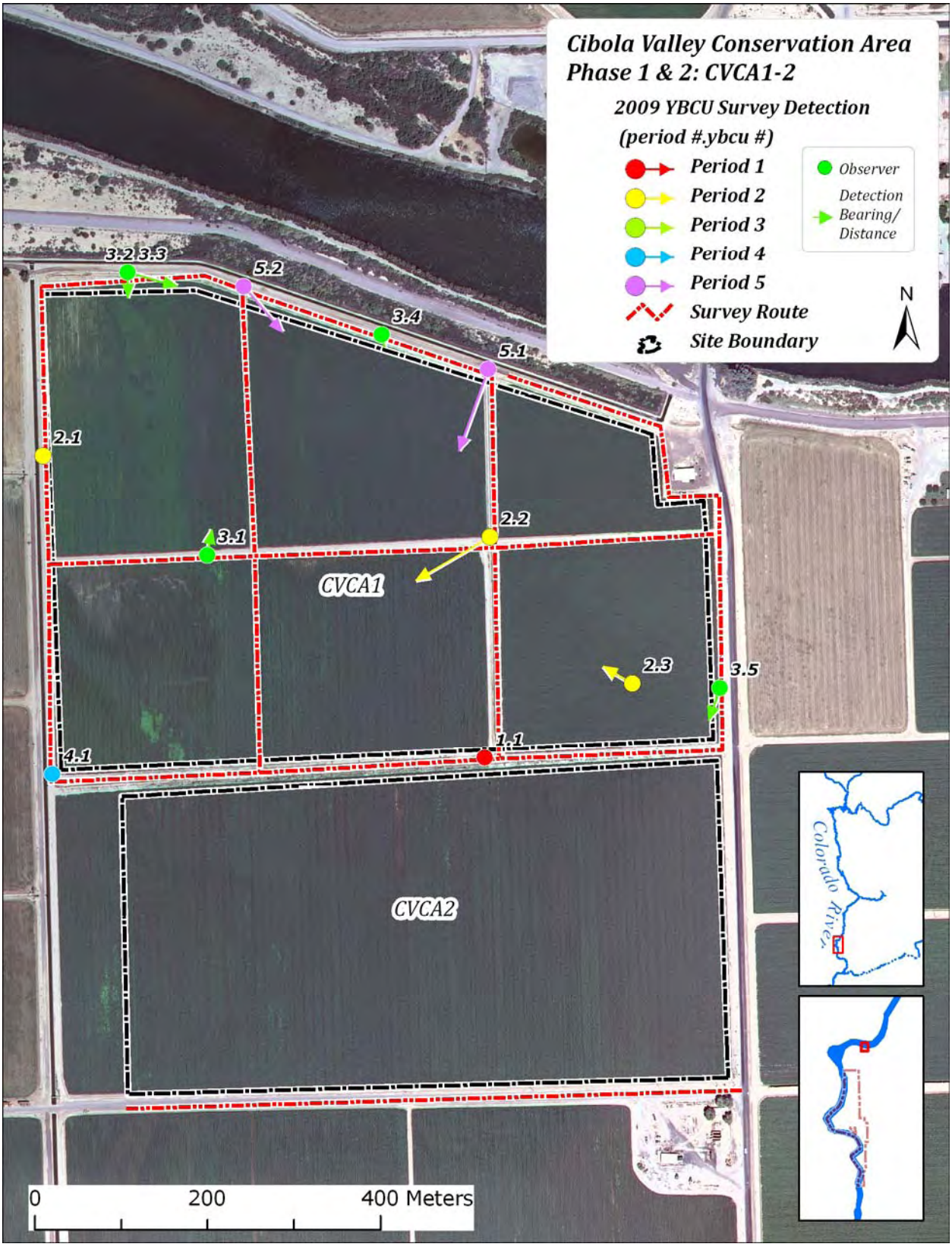
Appendix 5.33. Map of Bill Williams Marsh Yellow-billed Cuckoo survey route and detections, 2009.



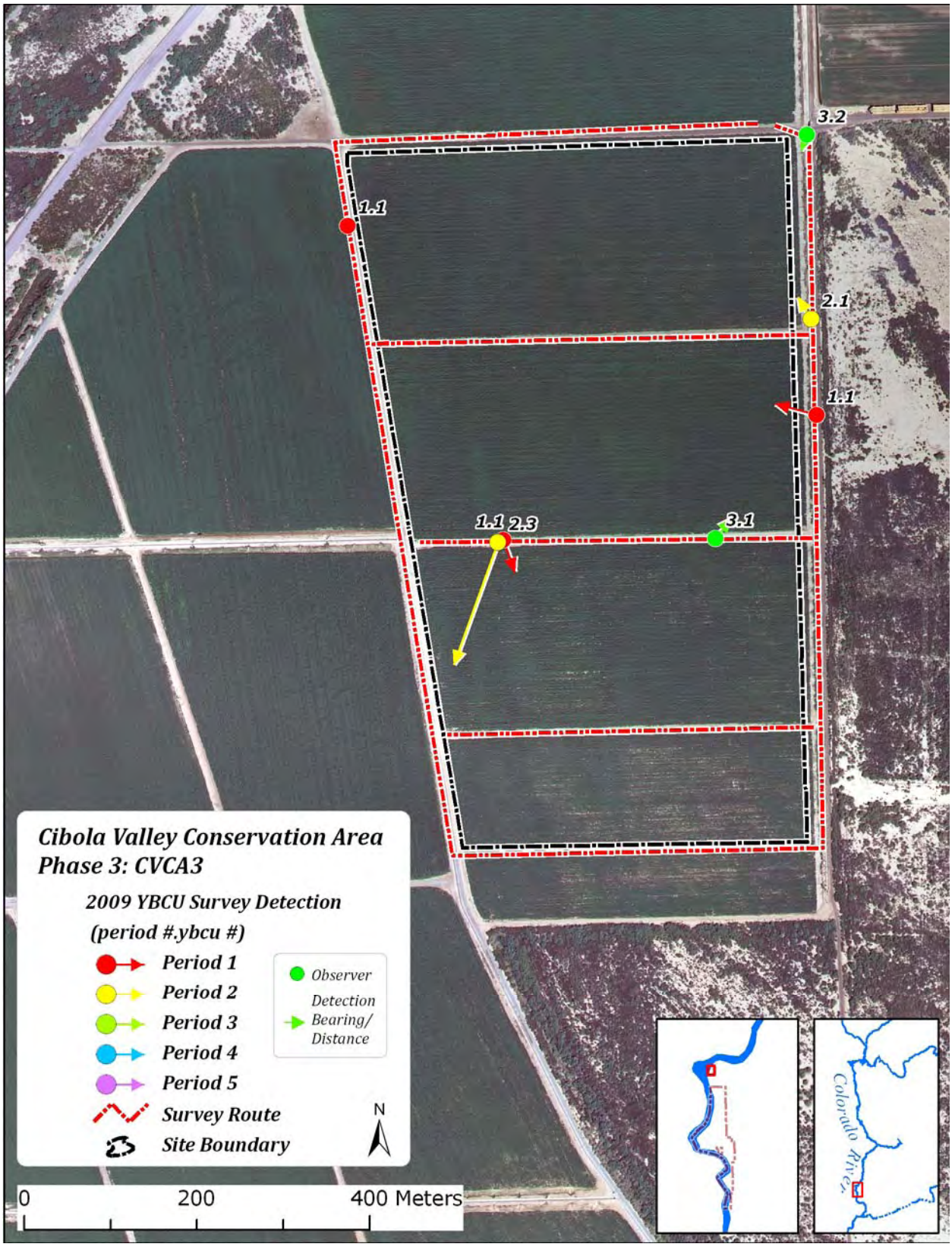
Appendix 5.34. Map of Ahakhav Tribal Preserve survey route and cuckoo detections, 2009.



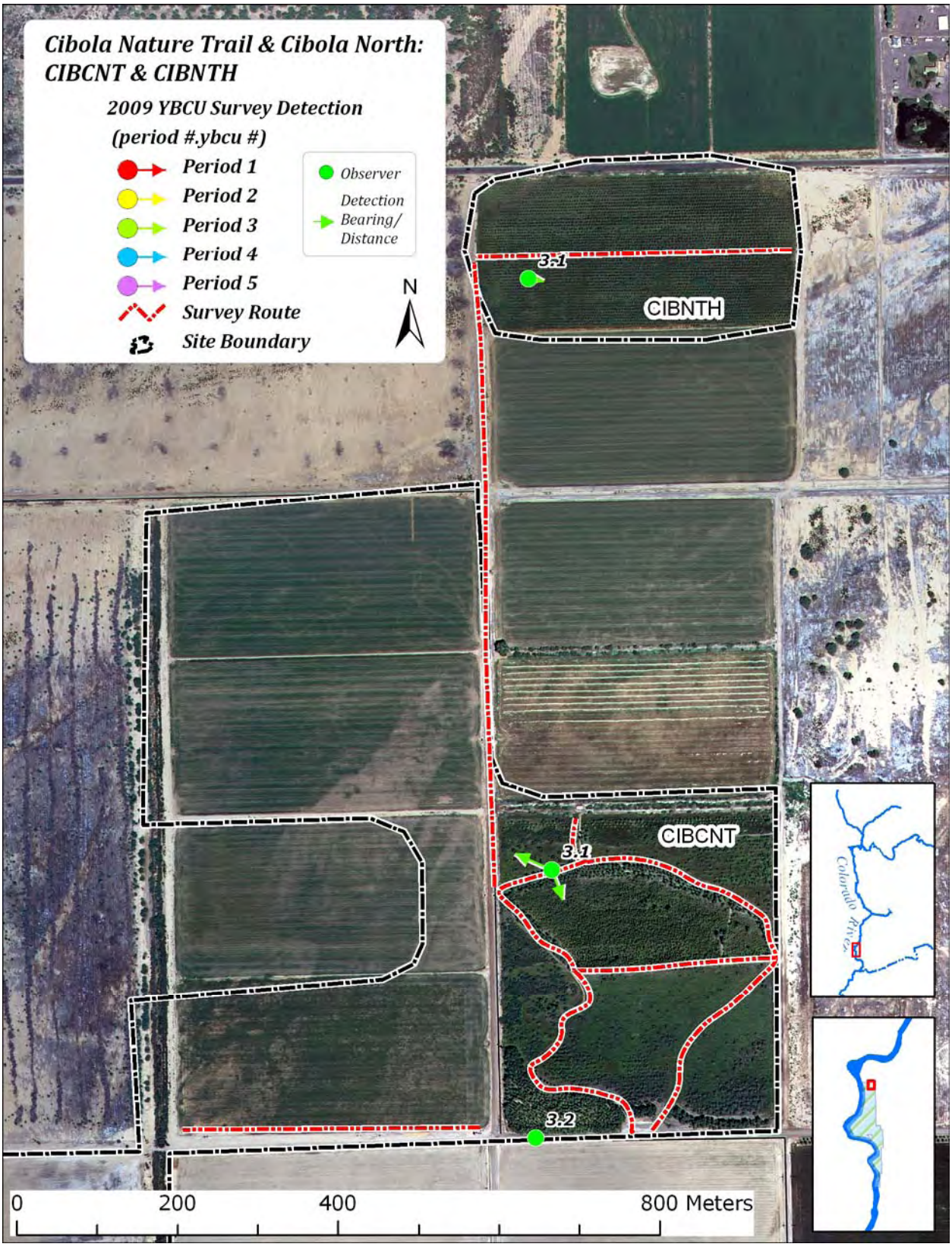
Appendix 5.35. Map of Palo Verde Ecological Reserve Phases 1 and 2 Yellow-billed Cuckoo survey routes and detections, 2009.



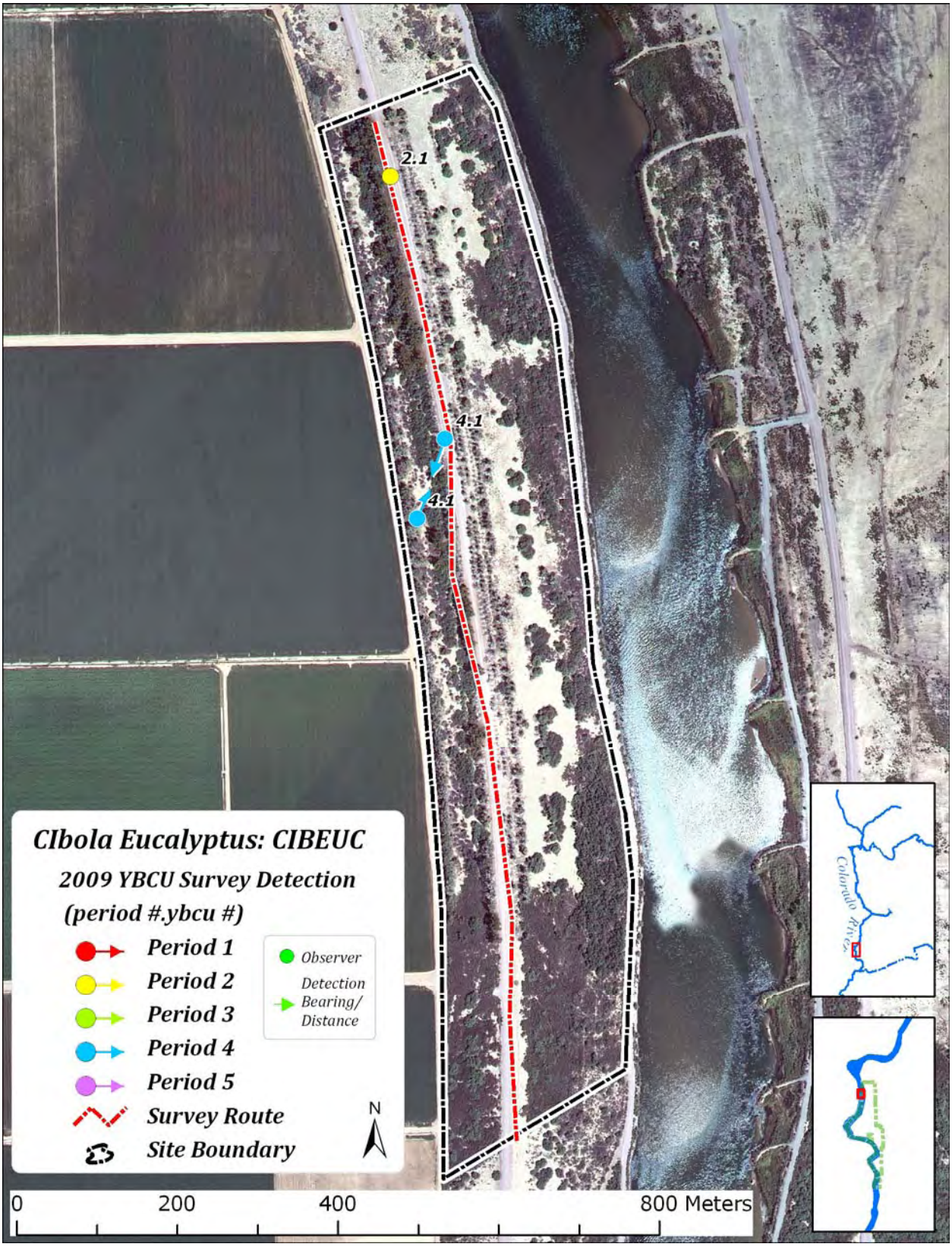
Appendix 5.36. Map of CVCA1-2 Yellow-billed Cuckoo survey route and detections, 2009.



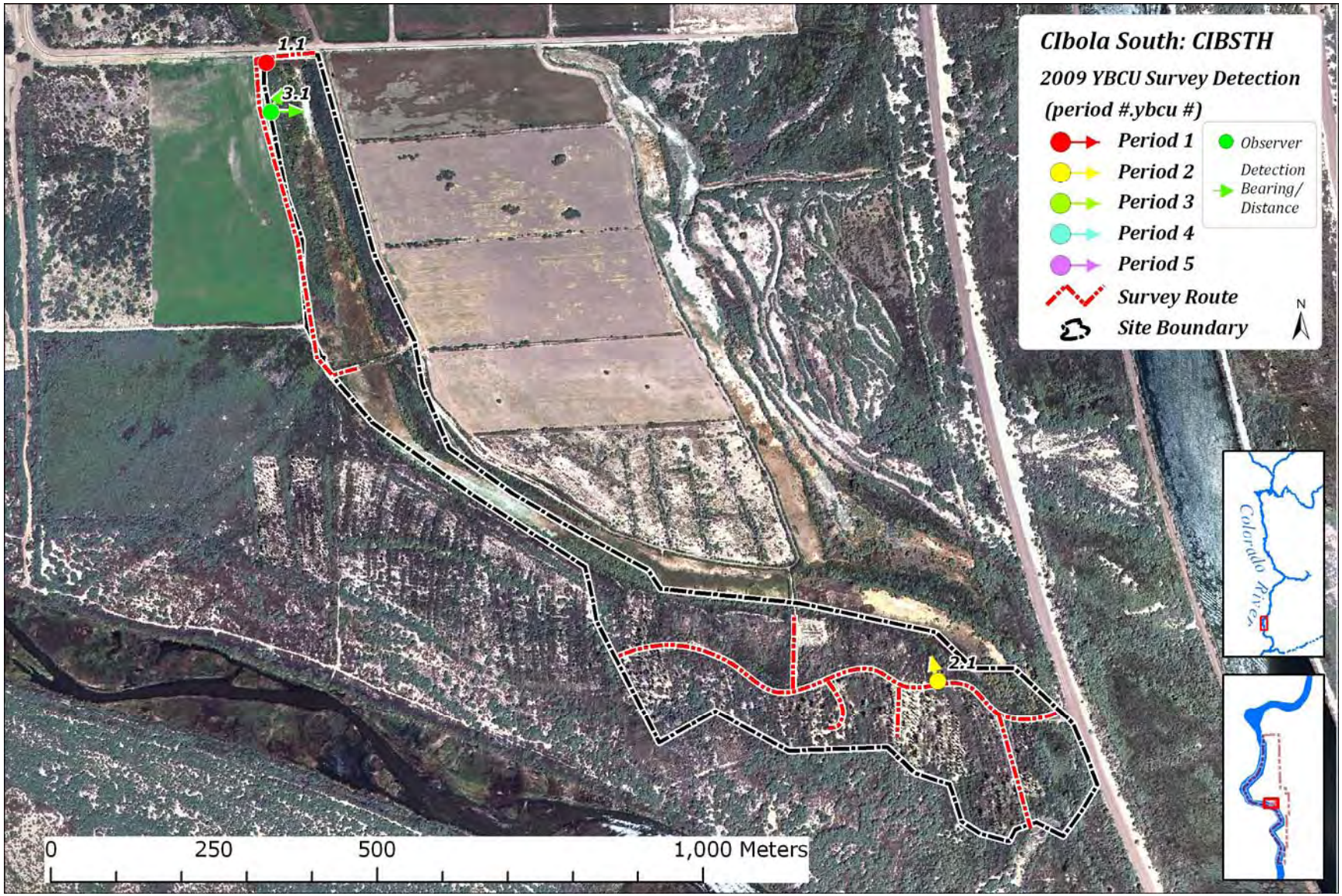
Appendix 5.37. Map of CVCA3 Yellow-billed Cuckoo survey route and detections, 2009.



Appendix 5.38. Map of Cibola North and Nature Trail Yellow-billed Cuckoo survey routes and detections, 2009.

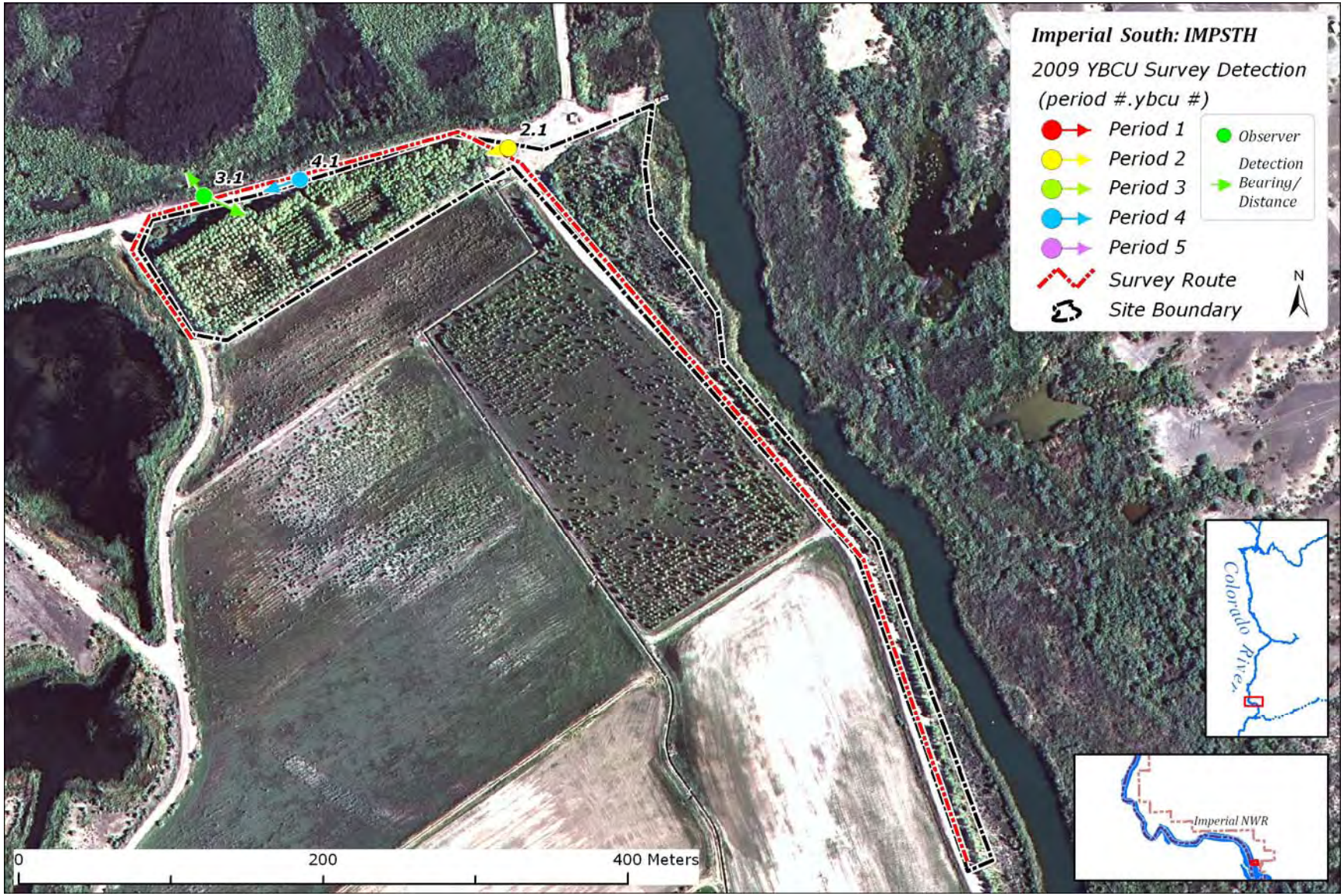


Appendix 5.39. Map of Cibola Eucalyptus Yellow-billed Cuckoo survey route and detections, 2009.

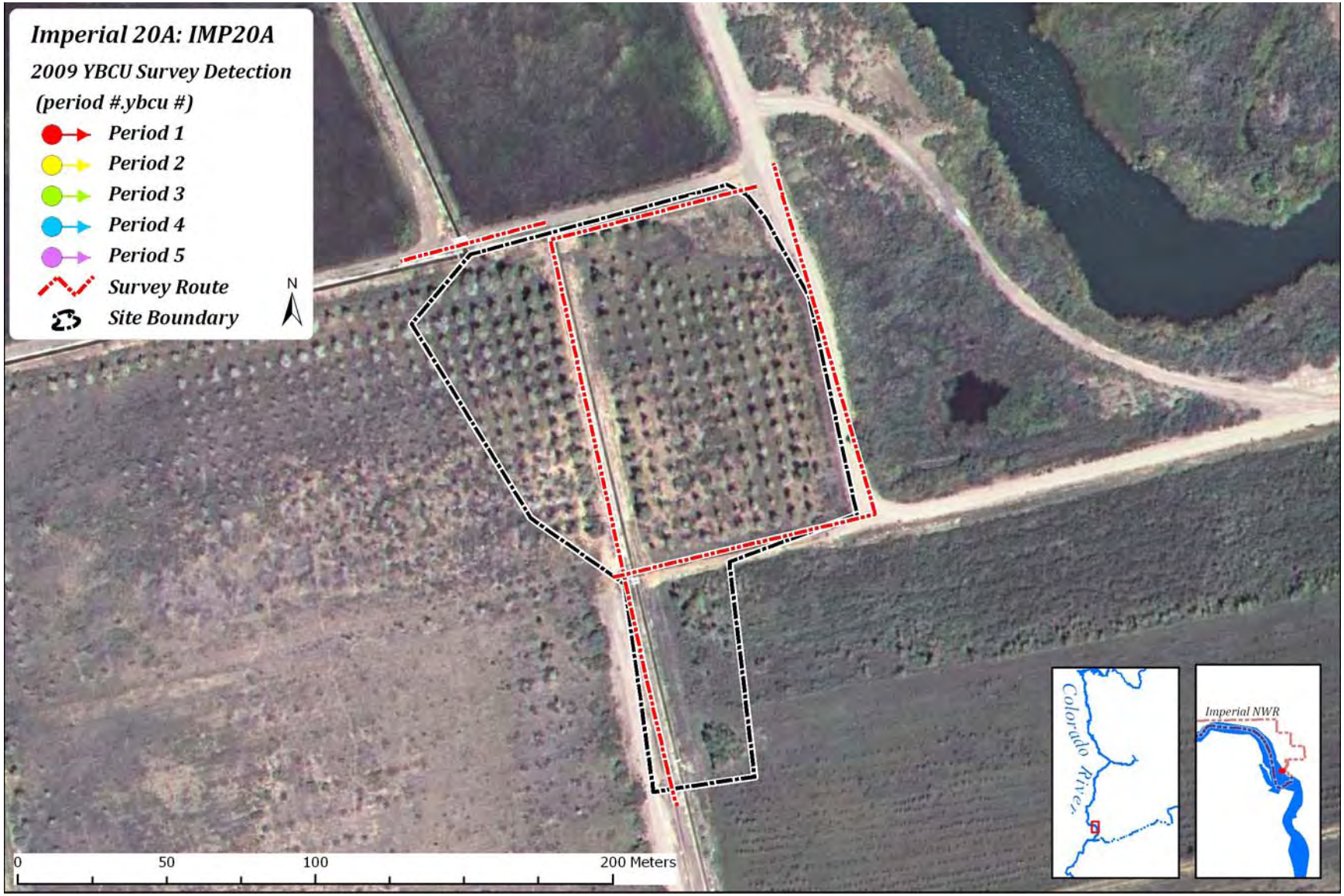


Appendix 5.40. Map of Cibola South Yellow-billed Cuckoo survey route and detections, 2009.

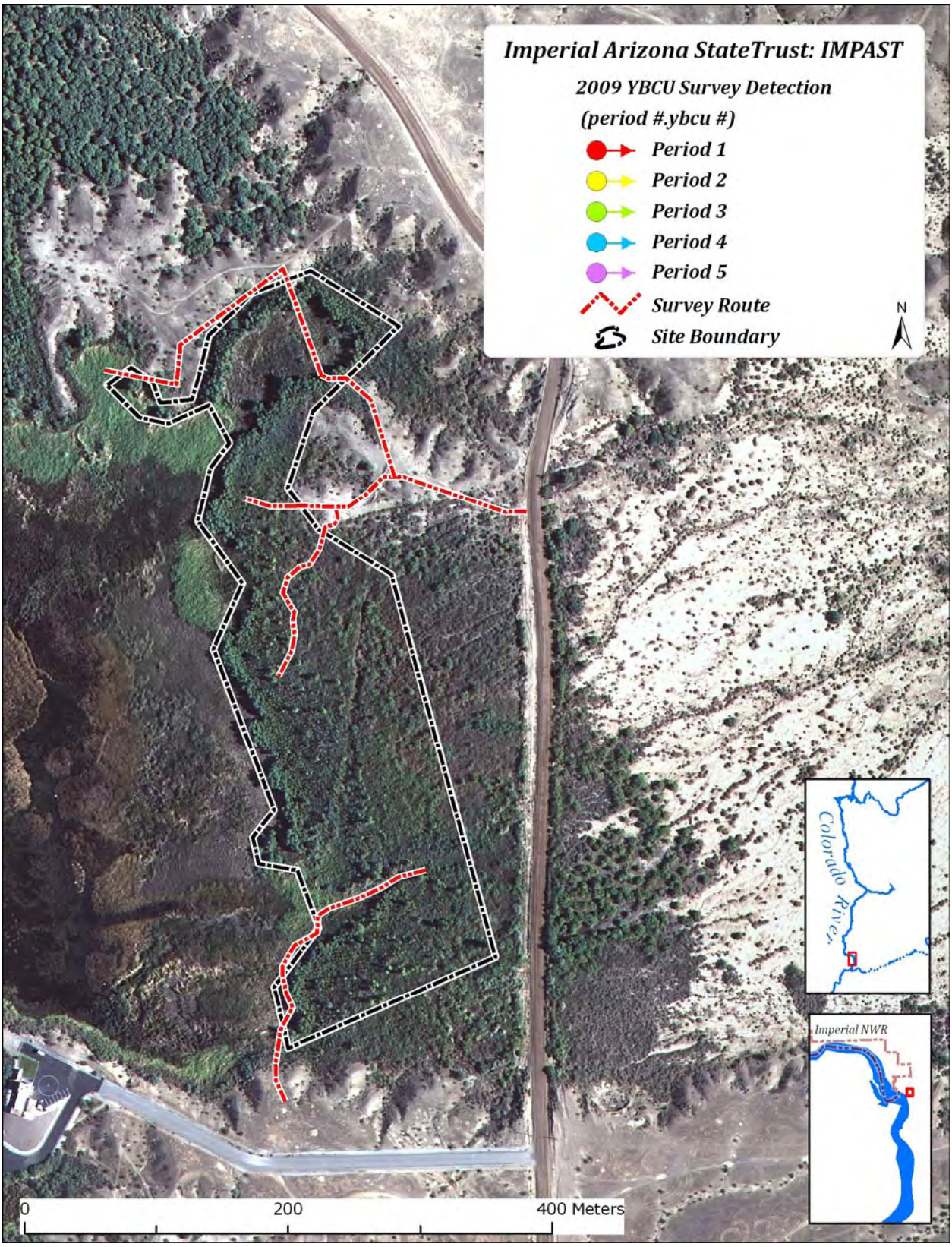
Appendix 5.41. Map of Picacho State Recreation area Yellow-billed Cuckoo survey route and detections, 2009.



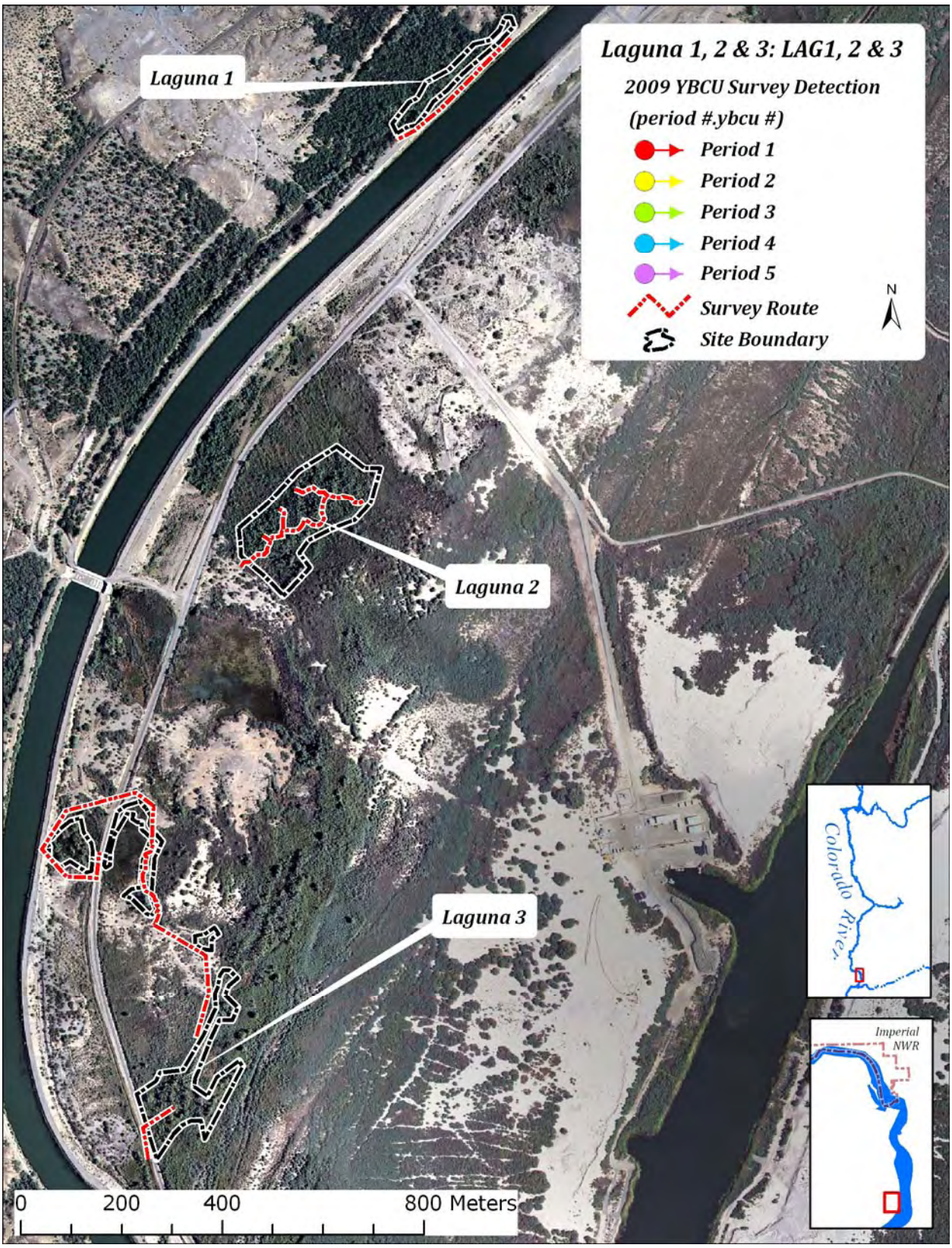
Appendix 5.42. Map of Imperial NWR South Yellow-billed Cuckoo survey route and detections, 2009.



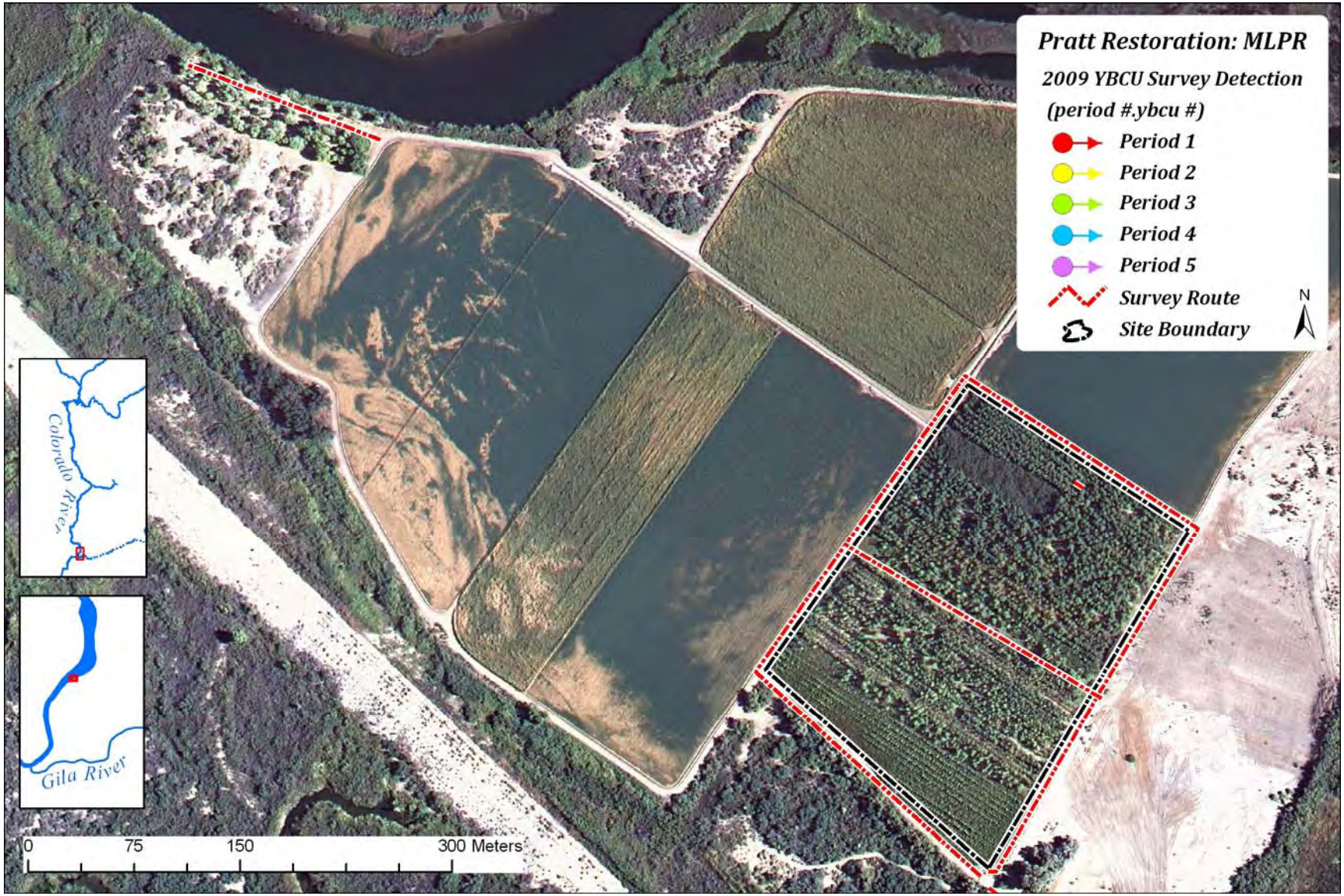
Appendix 5.43. Map of Imperial NWR 20A Yellow-billed Cuckoo survey route and detections, 2009.



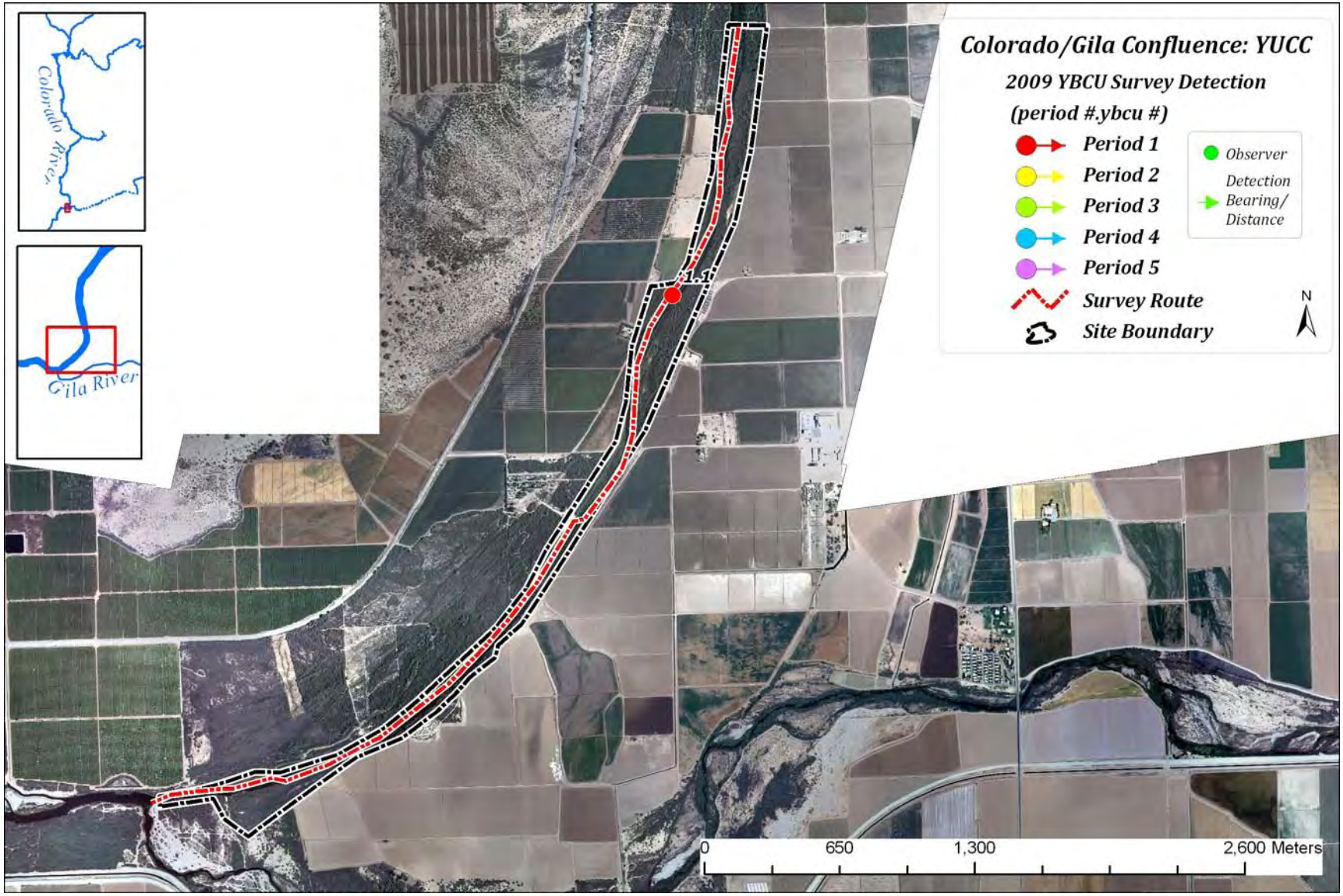
Appendix 5.44. Map of Imperial AZ State Trust Yellow-billed Cuckoo survey route and detections, 2009.



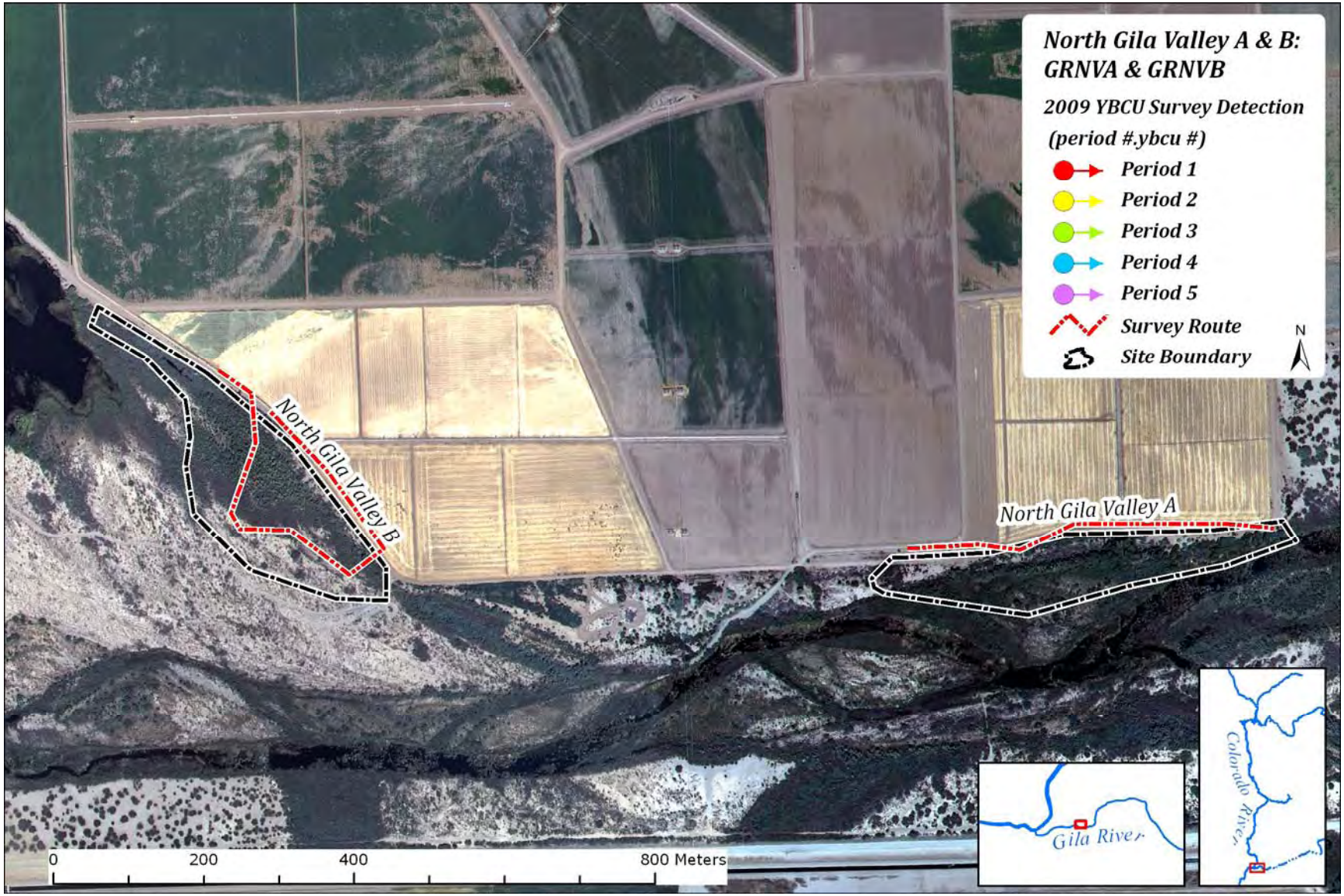
Appendix 5.45. Map of Laguna Yellow-billed Cuckoo survey routes, 2009.



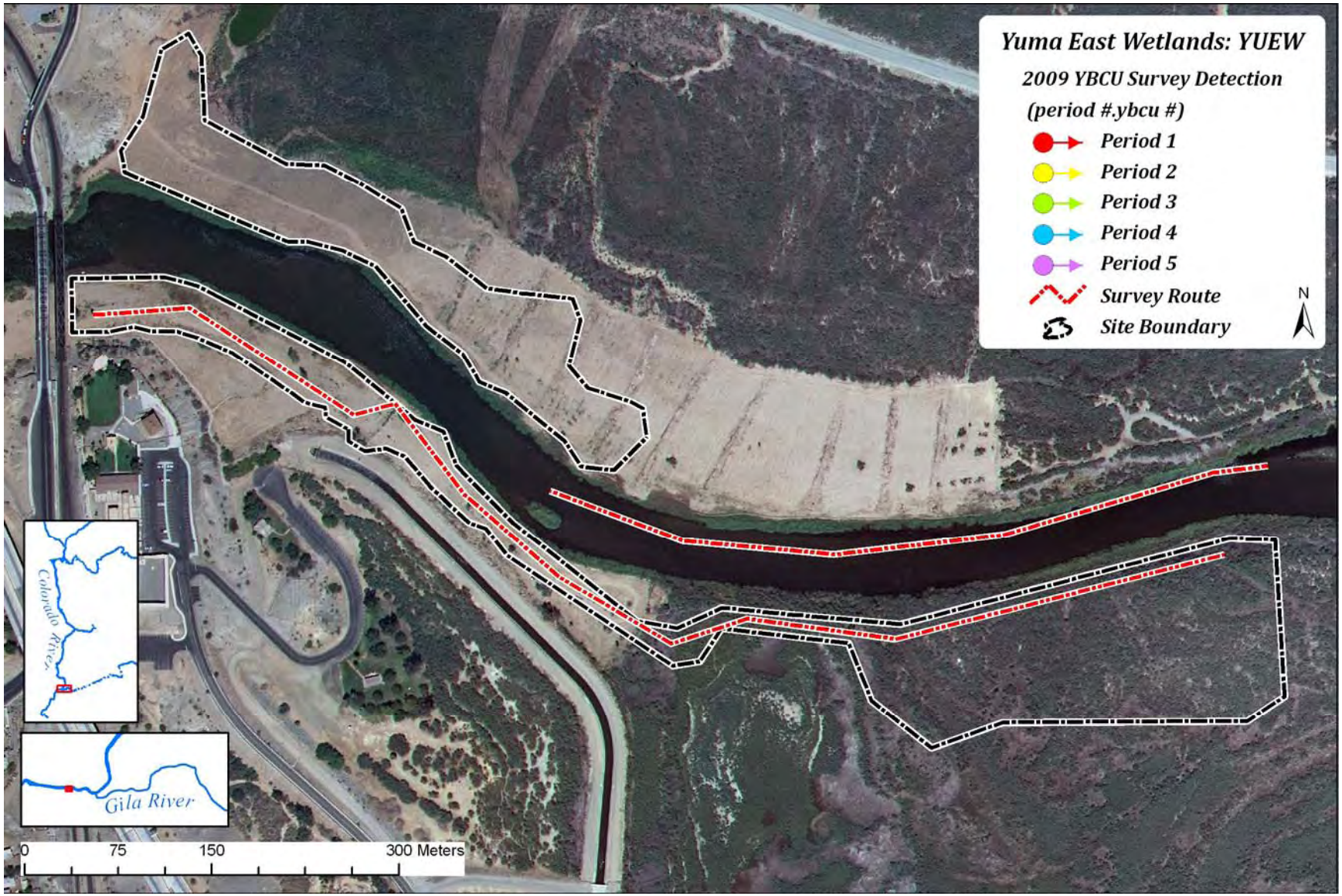
Appendix 5.46. Map of Mittry Lake/Pratt Restoration Yellow-billed Cuckoo survey route and detections, 2009.



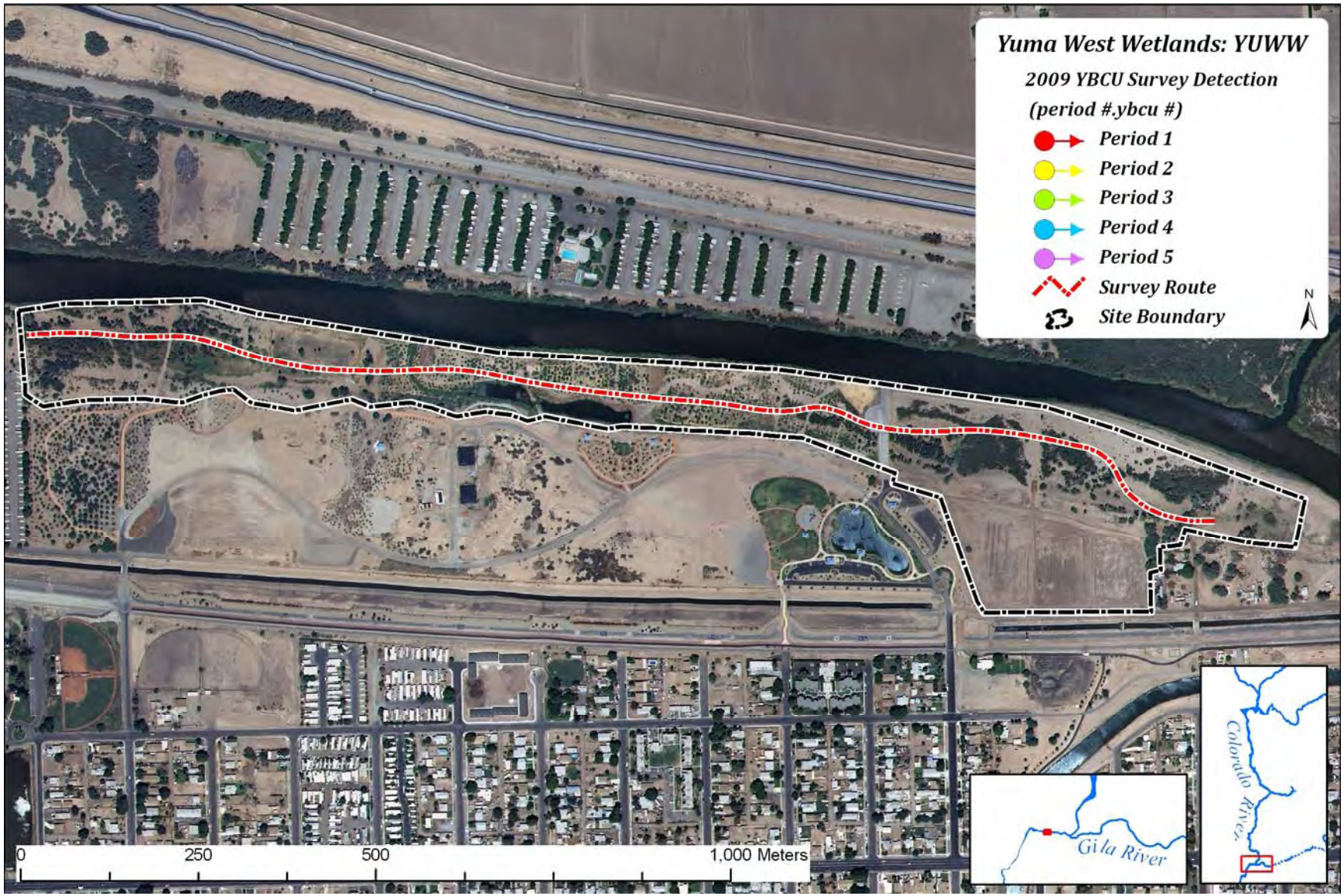
Appendix 5.47. Map of Colorado Confluence Yellow-billed Cuckoo survey route and detections, 2009.



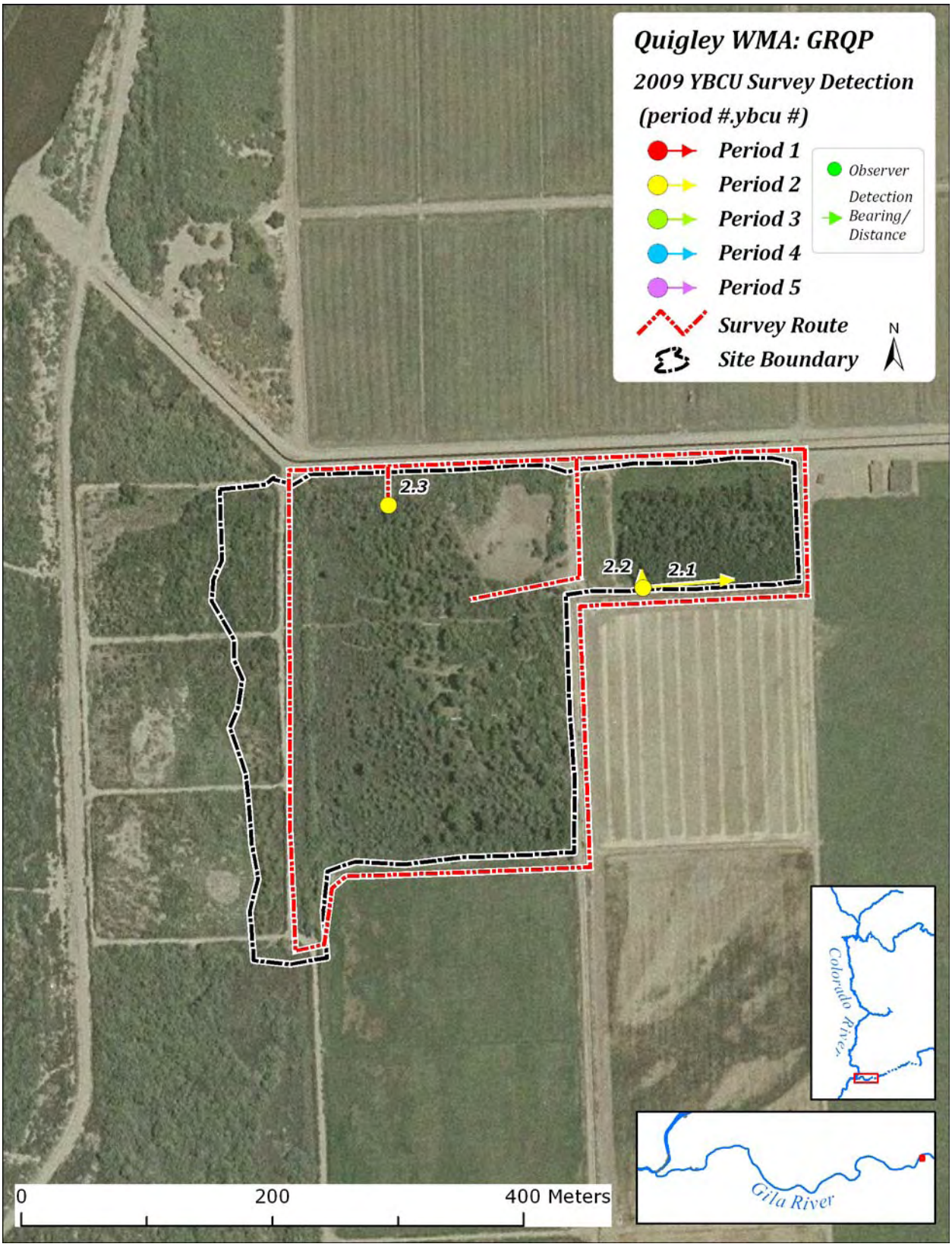
Appendix 5.48. Map of North Gila Valley Yellow-billed Cuckoo survey routes, 2009.



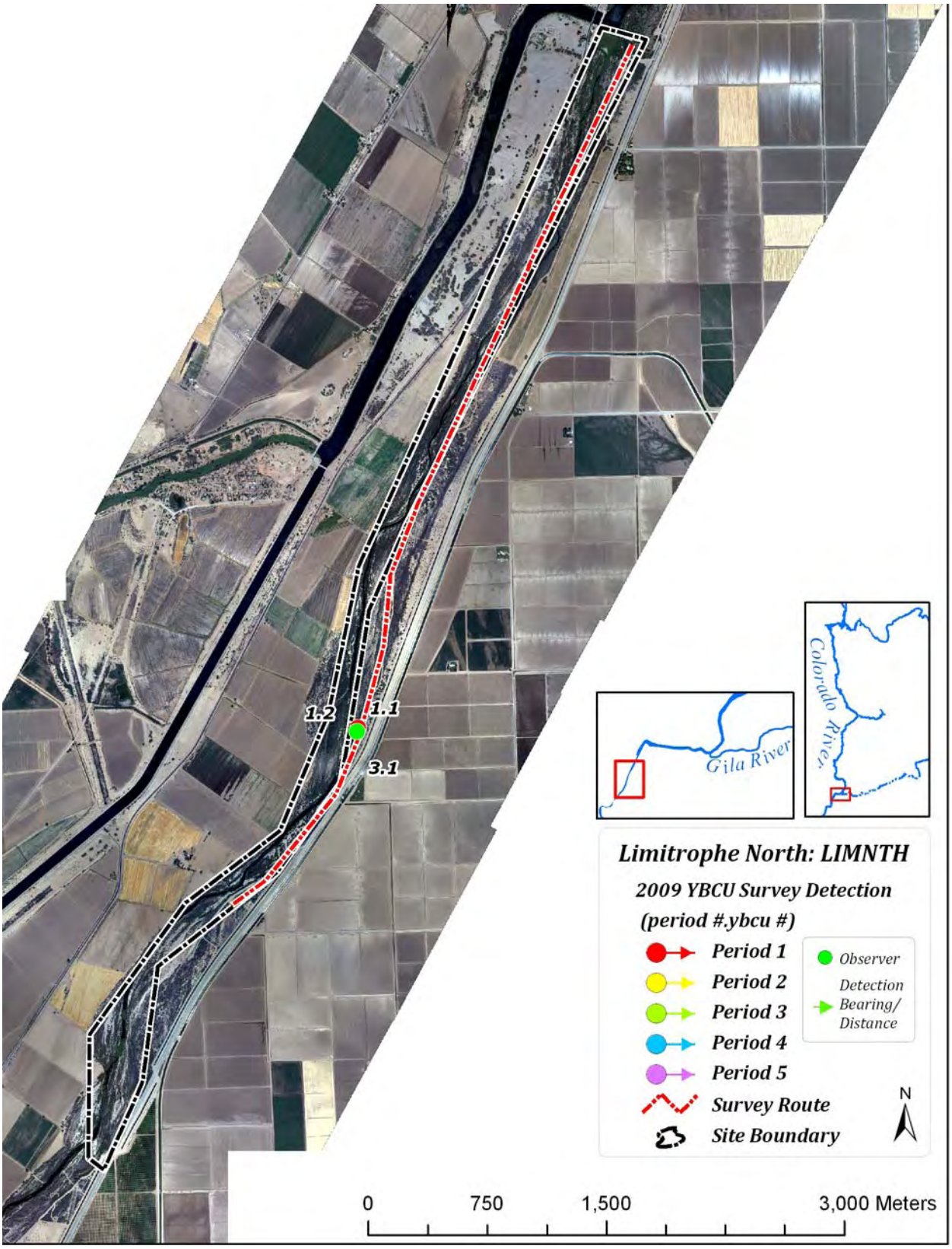
Appendix 5.49. Map of Yuma East Wetlands Yellow-billed Cuckoo survey route, 2009.



Appendix 5.50. Map of Yuma West Wetlands Yellow-billed Cuckoo survey route, 2009.



Appendix 5.51. Map of Quigley Wildlife Management Area Yellow-billed Cuckoo survey route, 2009.



Appendix 5.52. Map of Limitrophe North Yellow-billed Cuckoo survey route, 2009.