BUREAU OF RECLAMATION

Yellow-billed Cuckoo Breeding Habitat Use: Radio Telemetry on the Middle Rio Grande, New Mexico 2019

U.S. Department of the Interior **February 2020**

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Yellow-billed Cuckoo Breeding Habitat Use: Radio Telemetry on the Middle Rio Grande, New Mexico 2019

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Cover Photo: Radio-tagged Yellow-billed Cuckoo. (Reclamation/ K. Dillon)

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EXECUTIVE SUMMARY

A radio telemetry-based home range study was initiated in 2017 to determine breeding habitat composition and size requirements for the Western Yellow-billed Cuckoo along the Middle Rio Grande, New Mexico. In 2019, the third year of the study, 12 cuckoos (6 females and 6 males) were captured and instrumented along the Middle Rio Grande between San Acacia Dam and Highway 380. Datasets large enough to be included in the analysis ($n \geq 30$ location detections, >7 days of tracking) were obtained from 6 of the individuals instrumented with radio tags in 2019, with an average of 69 telemetry locations recorded per individual.

Core use areas for the 6 birds for which sufficient data was obtained averaged 5 hectares (ha) in size; the average size of the breeding and foraging area was 22 ha. In core use areas, 77 percent of the vegetation had a native species component and two thirds had overstory vegetation structure. Three nests were located and monitored in 2019, all associated with radio tagged individuals.

INTRODUCTION

The Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*, hereafter YBCU or cuckoo) is a riparian obligate species that breeds across the western United States. Historic breeding distributions in North America occurred from British Columbia to Mexico (Hughes 1999). However, the species is experiencing long term population decline (Halterman et al. 2000) and extirpation in much of its former range (Laymon and Halterman 1987). In 1998, the cuckoo was petitioned for listing under the Endangered Species Act (ESA) of 1973. It was determined that listing was warranted but precluded by higher priority species (USFWS 2001). Ongoing genetic studies were insufficient to determine full subspecies status for the cuckoo and in 2013, the western Distinct Population Segment of the Yellow-billed Cuckoo was proposed for listing under the ESA. The listing became effective in November 2014. The cuckoo is also listed as threatened, endangered, or sensitive by the states of California, Arizona, New Mexico, Colorado, and Utah.

Portions of major rivers in New Mexico and Arizona that still contain large tracts of contiguous native or mixed native and exotic riparian habitat are considered to be important strongholds for cuckoos (Hughes 1999, Lehman and Walker 2001), especially on the Middle Rio Grande, New Mexico (Johanson et al. 2006, 2007). Population estimates for this species on the Rio Grande during the breeding season are based on standardized call playback surveys.

The Bureau of Reclamation (Reclamation) has recorded casual detections of cuckoos on the Middle Rio Grande since 1998 and formal surveys were initiated in 2006. Cuckoos have large, undefended breeding territories and therefore little is known about the specifics of their breeding habitat size and vegetation composition requirements, either on the Rio Grande or elsewhere in their breeding range. This study used known cuckoo locations to attempt to capture, radio tag, and track cuckoos during the breeding season.

METHODS

Study Area

Cuckoos were captured along the Rio Grande from river mile 116 (San Acacia Dam) to river mile 87 (Highway 380) in 2019. The previous two years of the study concentrated on capturing cuckoos breeding in the receded pool of Elephant Butte Reservoir (Figure 1). This northward shift in capture effort was intended to examine potential variation in habitat use and home range size related to geographic variation in habitat characteristics and land use (e.g. natural floodplain versus agriculture). Riparian vegetation in this northern section of the Rio Grande is typically patchier and reduced in quantity due to agriculture and development than within the reservoir pool and supports a notably lower concentration of YBCUs (Dillon et al. 2019). Annual cuckoo survey results were used to select areas with consistent cuckoo detections for mist netting.

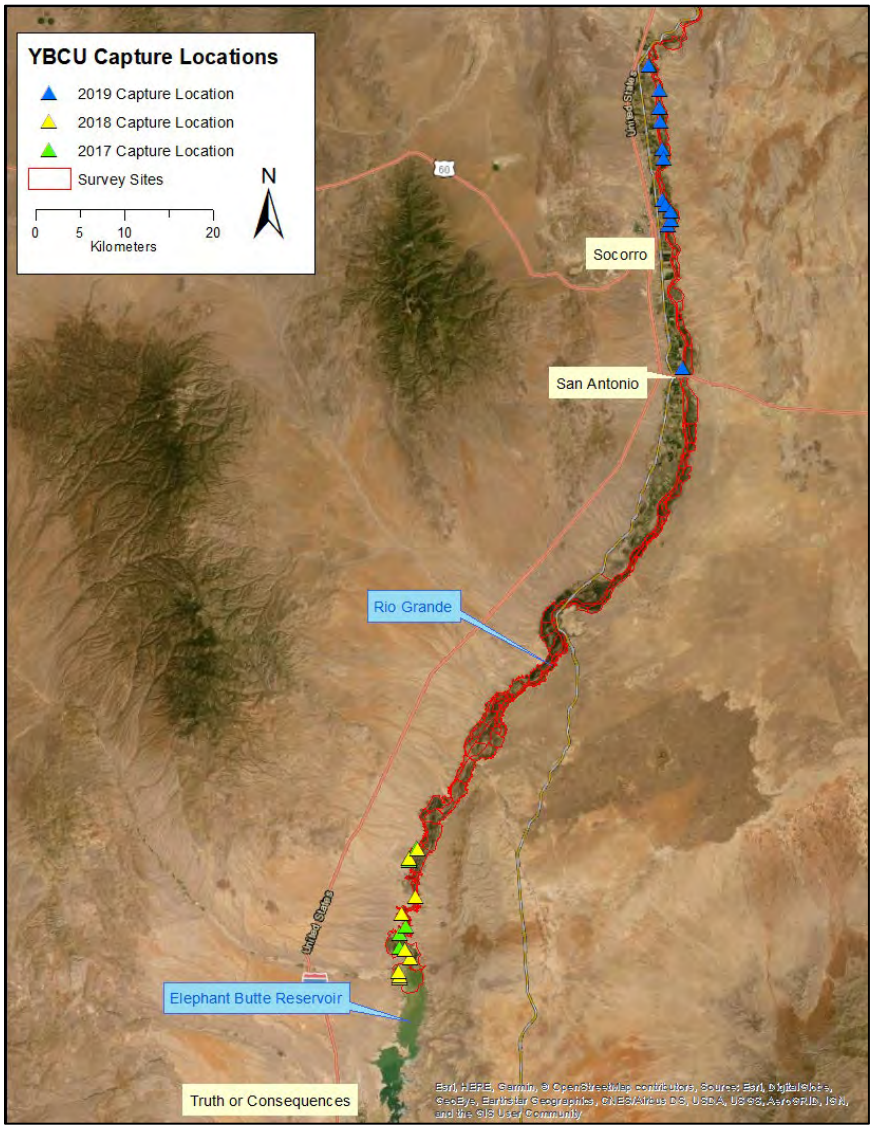

Figure 1. Cuckoo capture locations on the Middle Rio Grande – 2017 to 2019.

Mist netting, Capture, and Instrumentation

Mist nets were set up before dawn, and netting attempts began at first light. Mist nets used were a 60-millimeter mesh, 4-shelf type in 6, 9, or 12-meter (m) lengths, and 2.6 m high. Two nets of the same length were stacked and sewn together to create a taller net (e.g. two 6 m nets were sewn together, one above the other, to form an 8-shelf net that was 6 m long and 5.2 m high). Two 8-shelf nets were run side by side, sharing a center pole, creating two 6 to 12 m lanes that met at the center post. Remotely controlled speakers with recorded cuckoo vocalizations were strategically placed on both sides of the mist net and used to attract cuckoos to the net.

Captured cuckoos were banded with a silver U.S. Fish and Wildlife Service band on the right leg. Bill length, width, and depth, tarsus length, tail length, wing chord, keel fat, and body mass were measured for all captured birds. A blood sample was taken for DNA sexing (Avian Biotech International PermaCode card) using a Sub-Q, 26-gauge needle and a capillary tube. Samples were taken from a sterilized, visible, subcutaneous vessel on the inner thigh.

Cuckoos were instrumented with a 1.8 gram Holohil Systems Ltd. transmitter (BD-2) attached via a piece of canvas glued to the bird's back (Figure 2). A patch of feathers was removed from the back so that the canvas could be attached directly to the skin. Multiple attachment methods were tried during the 2017 pilot study, and attachment to the skin via a canvas base using Gorilla Glue gel (a cyanoacrylate glue) resulted in the longest retention times; tags were shed much more quickly with other methods. Transmitters were tested prior to attachment and were active immediately.

Banding, measurement, blood collection and instrumentation typically required 45 minutes of handling per bird, during which the bird was monitored for signs of stress. Cuckoos were released away from the mist net array to avoid immediate recapture and were observed for stress effects until they flew away.

Figure 2. Radio transmitter attachment technique.

Tracking

Tracking methodologies were based on Sechrist and Ahlers (2003). Transmitters had a range of 0.5 kilometers (km) and a nominal battery life of 14 weeks. Automatic scanning receivers with computer interfaces (ATS model R2100) were coupled with 3-lead antennae to receive signals from instrumented birds. Two technicians conducted searches for instrumented birds from upland areas in proximity to capture locations. Simultaneous location information was collected using hand-held radios to coordinate acquisition and bearing timing. Detected signals were located via compass bearing and UTM coordinates recorded from a Garmin GPS unit at each technician's location. These two bearings and locations were entered into a spreadsheet model on-site to determine whether a successful signal location could be calculated based on a computed intersection of the two bearings.

Biologists attempted to record multiple locations daily for each telemetered bird, and to record locations at different times of day (morning, afternoon, and evening). Pre-dawn stationary locations, as well as concentrations of detections in a small area, were considered indicative of possible nesting and used to guide nest searching efforts.

Nest Monitoring

Systematic nest searches were conducted in areas where radio telemetry detections suggested a concentration of activity. When a nest was located it was observed from afar to determine whether a cuckoo was present, and then its contents were checked with a telescoping mirror or a GoPro attached to a telescoping pole.

Vegetation characteristics around the nest were measured once the nesting attempt was completed. Vegetation species composition and density were measured at the nest and along 50 m transects in the four cardinal directions from the nest.

Data Analysis

Telemetry data was analyzed to provide home range characteristics, daily and seasonal maximum distance traveled, and habitat utilization. Minimum convex polygons, and 50% and 95% Kernel home ranges (KHR) were calculated using ArcMap software. Seasonal maximum distance traveled was calculated as the distance between the two furthest points recorded during the tracking period. Daily maximum distance traveled was calculated as the distance between the two furthest points recorded during a single day. The 50% and 95% KHRs were overlaid with 2016 vegetation classification maps (Siegle et al. 2017) in order to determine the vegetative composition of each cuckoo's habitat. Vegetation within the active floodplain was classified as native, exotic or mixed native and exotic vegetation, and by seral stage. Vegetation outside of the active floodplain was not mapped.

The vegetation composition of each tracked cuckoo's 50% and 95% KHRs is summarized in the tables below. Most home range estimates included areas of non-habitat and open water, and although that area is included in the estimate of home range size it is not listed in the vegetation composition table for each individual. Therefore, vegetation area estimates in the table sum to less than the total area of the home range. Vegetation composition was further broken out to analyze the amount of habitat with a Goodding's willow or cottonwood component, as previous research has found that cuckoos preferentially use Goodding's

willow in particular (Siegle et al. 2017). These presented area estimates overlap with the more general vegetation composition estimates; in other words, area estimates of cottonwood/Goodding's willow provide species-specific detail of the broader categories such as Native Canopy/Mixed Understory. Therefore, the estimates again do not sum to home range size and are not additive in combination with the more general habitat categories. Finally, estimates of the percent of the home range with a native vegetation component, which are included in the text for each tracked individual, include the presence of native species in either the understory or canopy layers.

Although home range size and vegetation composition were calculated for all birds for which movement data was obtained, only those individuals for which at least 30 telemetry locations were obtained over greater than 7 days of tracking were included in summary analyses of the data. Any bird for which those minimums were not met was excluded from summary analyses, as data were considered insufficient to draw strong conclusions. Similar to the tables described above, the summary tables do not include area in the home range classified as non-habitat or open water. Therefore, the percentages presented are the percentage of actual habitat that falls within a given classification (e.g., Native Canopy Dominated), not the percentage of the entire home range that falls within that classification.

RESULTS

Twelve cuckoos (six females and six males) were captured and instrumented during the 2019 breeding season, and at least 30 telemetry locations with > 7 days of tracking were obtained from six of those individuals (Figure 3).

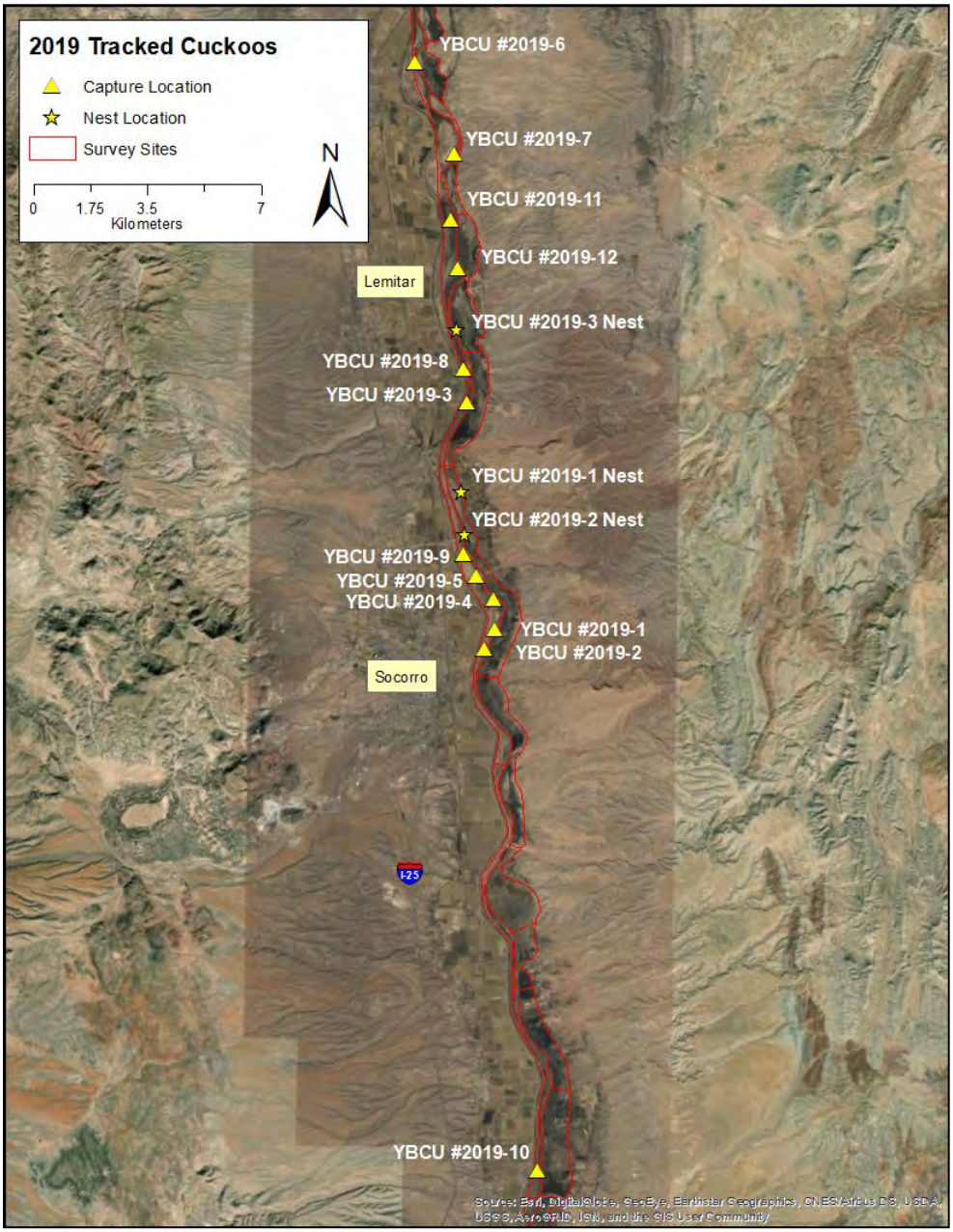

Figure 3. 2019 YBCU capture and nest locations along the Middle Rio Grande.

Yellow-billed Cuckoo #2019-1:

Cuckoo #2019-1 was captured on June 23, 2019 and 118 locations were obtained for the bird over 52 days of tracking (Appendix 1 Table A1, Figure 4). This bird still retained its tag and remained in the study area at the conclusion of the survey season. It was last tracked on August 14.

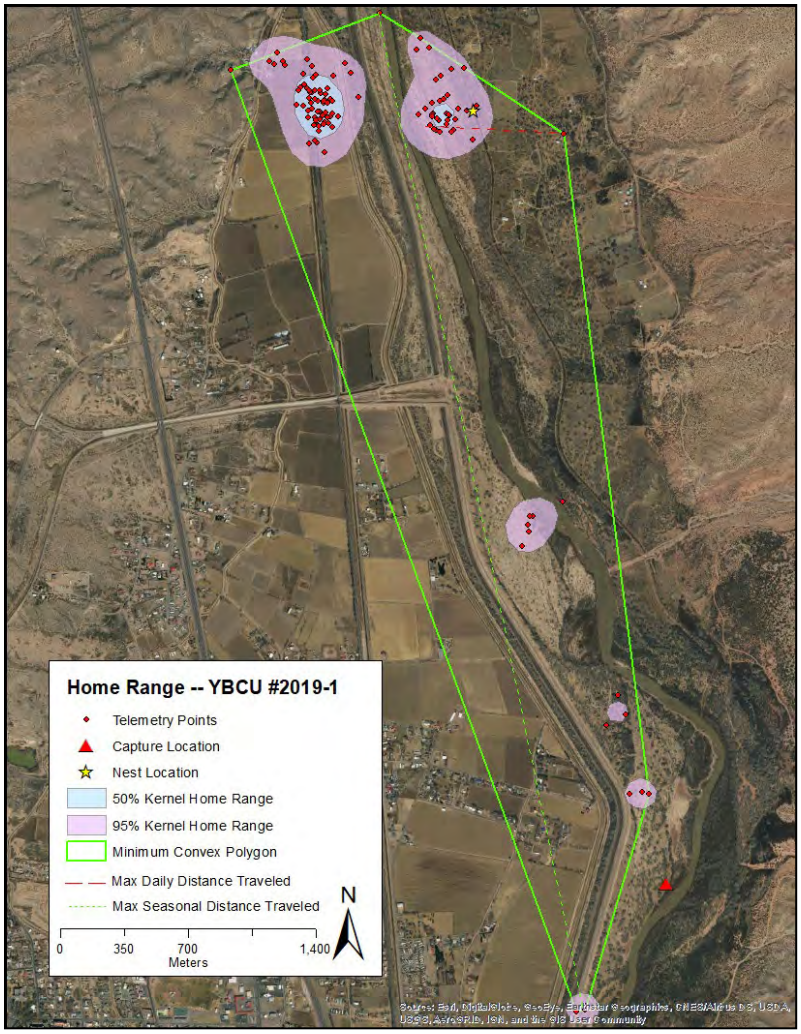

Figure 4. Home range estimates and maximum distance traveled by YBCU #2019-1.

All of the woody vegetation within this individual's 95% kernel home range had a native species component (Table 1, Figure 5). The entirety of the area encompassed by this individual's 50% kernel home range (the bird's core use area) was un-mapped vegetation outside of the study area and open areas considered non-habitat. Two core use areas were identified during analysis, both of which were concentrated along drainage canals bordered with very narrow (<40 m wide) strips of native riparian vegetation.

The eastern drainage canal, along which a nest was confirmed, formed the eastern boundary of the study area and was not included in mapped vegetation. Much of the area identified as

open, non-habitat during 2016 vegetation mapping has since grown into sparse, early stage salt cedar and the abundance of detections in that vegetation may reflect the bird foraging in the area around the nest. The nest was located in coyote willow along the irrigation canal and successfully fledged one of two nestlings. Likewise, the western core use area identified was located along a canal outside of the active floodplain and not included in vegetation mapping efforts. This canal was similarly bordered by narrow strips of riparian vegetation, which were flanked by agricultural fields on both sides. Overall, the 50% KHR (the bird's core use area) encompassed 9 ha, and the 95% KHR encompassed 69 ha.

Table 1. Home range attributes for Cuckoo #2019-1.

Number of Telemetry Points	118
Telemetry Date Range	6/23 – 8/14
Maximum Seasonal Distance Traveled	5574 m
Maximum Daily Distance Traveled	206 m
Minimum Convex Polygon Home Range	580.7 ha
Kernel Home Range - 95% Probability	69.1 ha
Kernel Home Range - 50% Probability	8.7 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Native Understory	0.7 ha
Native Canopy/ Mixed Understory	1.0 ha
Native Canopy/ Exotic Understory	1.8 ha
Native Canopy/ No Understory	1.3 ha
Native Understory	1.0 ha
Goodding's Willow Component	0 ha
Cottonwood Component	5.5 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
100% Non-habitat/ Un-mapped Vegetation	

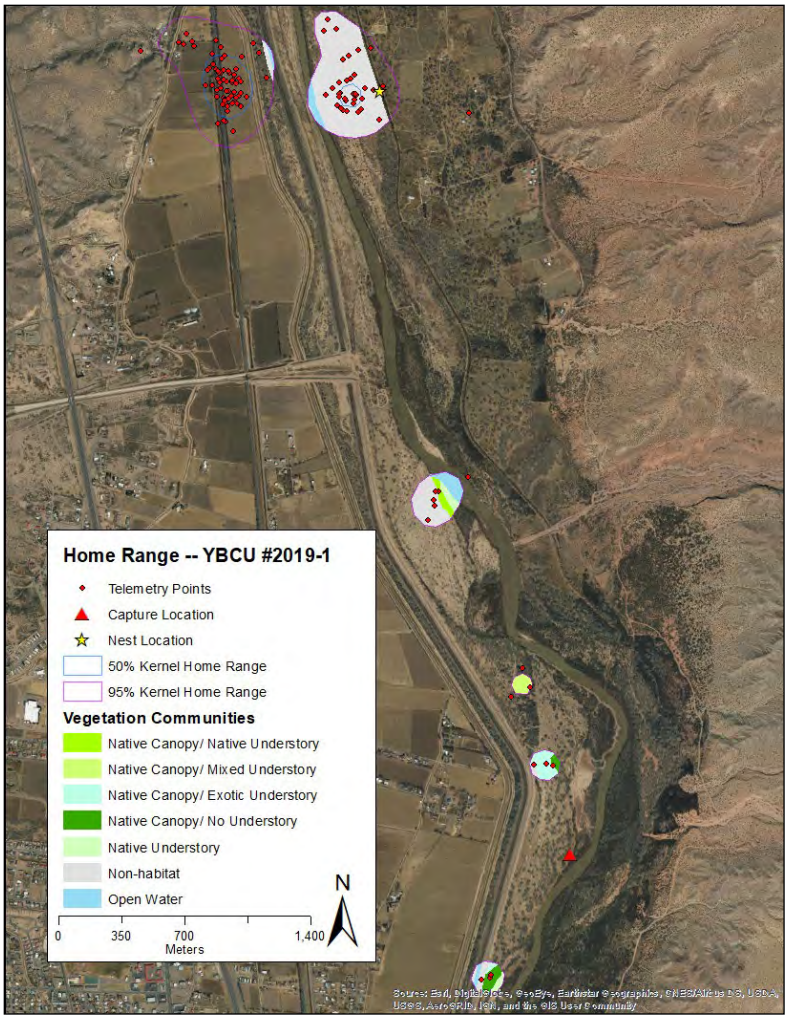

Figure 5. Home range vegetation composition for YBCU #2019-1.

Yellow-billed Cuckoo #2019-2:

Cuckoo #2019-2 was captured on June 25, 2019 and 102 locations were obtained for the bird over 41 days of tracking prior to the radio tag being shed (Table A2, Figure 6). The shed tag was retrieved on August 5.

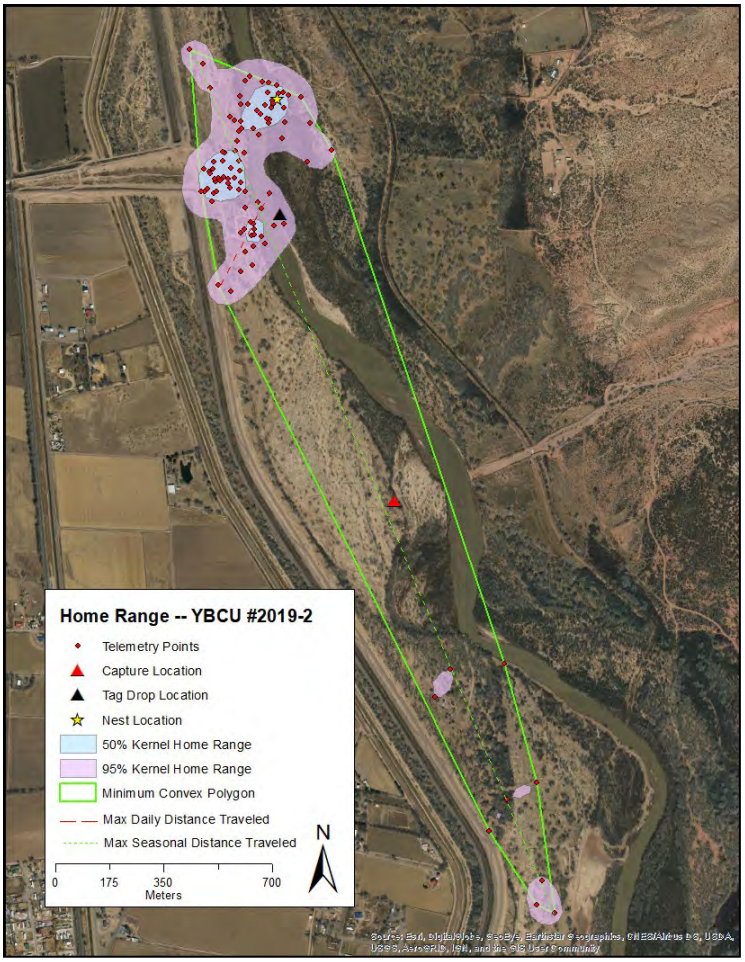

Figure 6. Home range estimates and maximum distance traveled by YBCU #2019-2.

Approximately 86 percent of the habitat in this bird's 95% KHR and 71 percent of habitat in the 50% KHR had a native vegetation component. The estimated home range spanned the Rio Grande, with core use areas on both sides of the river (Table 2, Figure 7). The estimated 95% KHR was 25 ha and the estimated core use area was 4 ha. This cuckoo's 95% KHR closely bordered, and partially overlapped, that of YBCU #2019-9. This bird was tracked to its nest in Russian olive on July 24. The nest was first confirmed with three nestlings but was found empty prior to the feasible fledge date and was considered to likely have failed due to predation.

Table 2. Home range attributes for YBCU #2019-2.

Number of Telemetry Points	102
Telemetry Date Range	6/25 – 8/5
Maximum Seasonal Distance Traveled	3010 m
Maximum Daily Distance Traveled	339 m
Minimum Convex Polygon Home Range	96.9 ha
Kernel Home Range - 95% Probability	24.6 ha
Kernel Home Range - 50% Probability	4.0 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Exotic Understory	2.8 ha
Native Canopy/ Mixed Understory	0.4 ha
Exotic Canopy/ Native Understory	0.9 ha
Mixed Canopy/ Exotic Understory	0.1 ha
Native Canopy/ No Understory	4.7 ha
Exotic Canopy/ No Understory	1.7 ha
Mixed Canopy/ No Understory	0.6 ha
Native Understory	1.1 ha
Exotic Understory	3.1 ha
Mixed Understory	1.2 ha
Goodding's Willow Component	0 ha
Cottonwood Component	9.6 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Exotic Understory	0.01 ha
Native Canopy/ No Understory	2.1 ha
Exotic Canopy/ No Understory	0.4 ha
Mixed Canopy/ No Understory	0.04 ha
Native Understory	0.1 ha
Exotic Understory	0.04 ha
Mixed Understory	0.4 ha
Goodding's Willow Component	0 ha
Cottonwood Component	2.2 ha

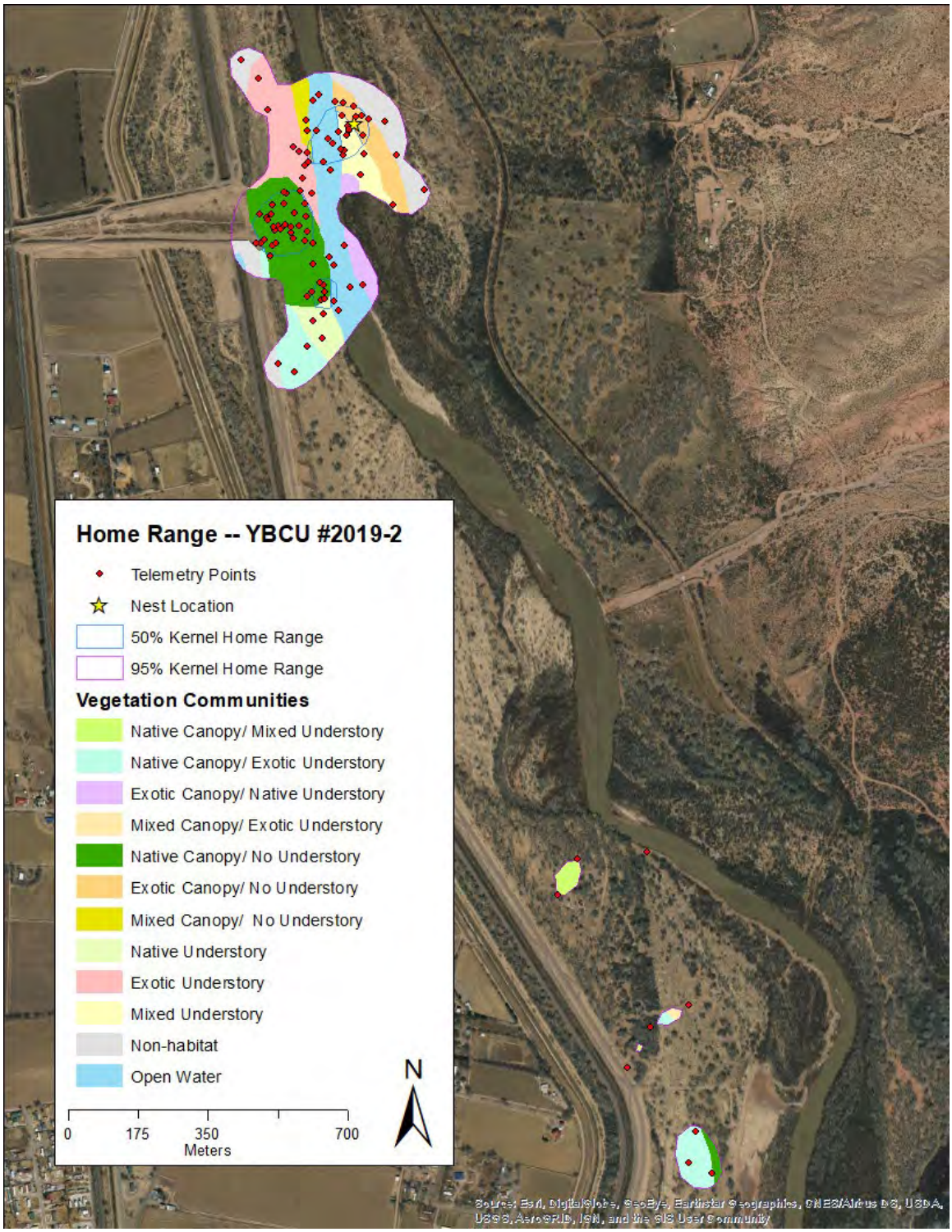

Figure 7. Home range vegetation composition for YBCU #2019-2.

Yellow-billed Cuckoo #2019-3:

Cuckoo #2019-3 was captured in a patch of native overstory vegetation on July 22, 2019 and 75 locations were obtained for the bird over 23 days of tracking (Table A3, Figure 8). This bird retained its tag and remained in the study area at the conclusion of the study season. It was last tracked on August 14.

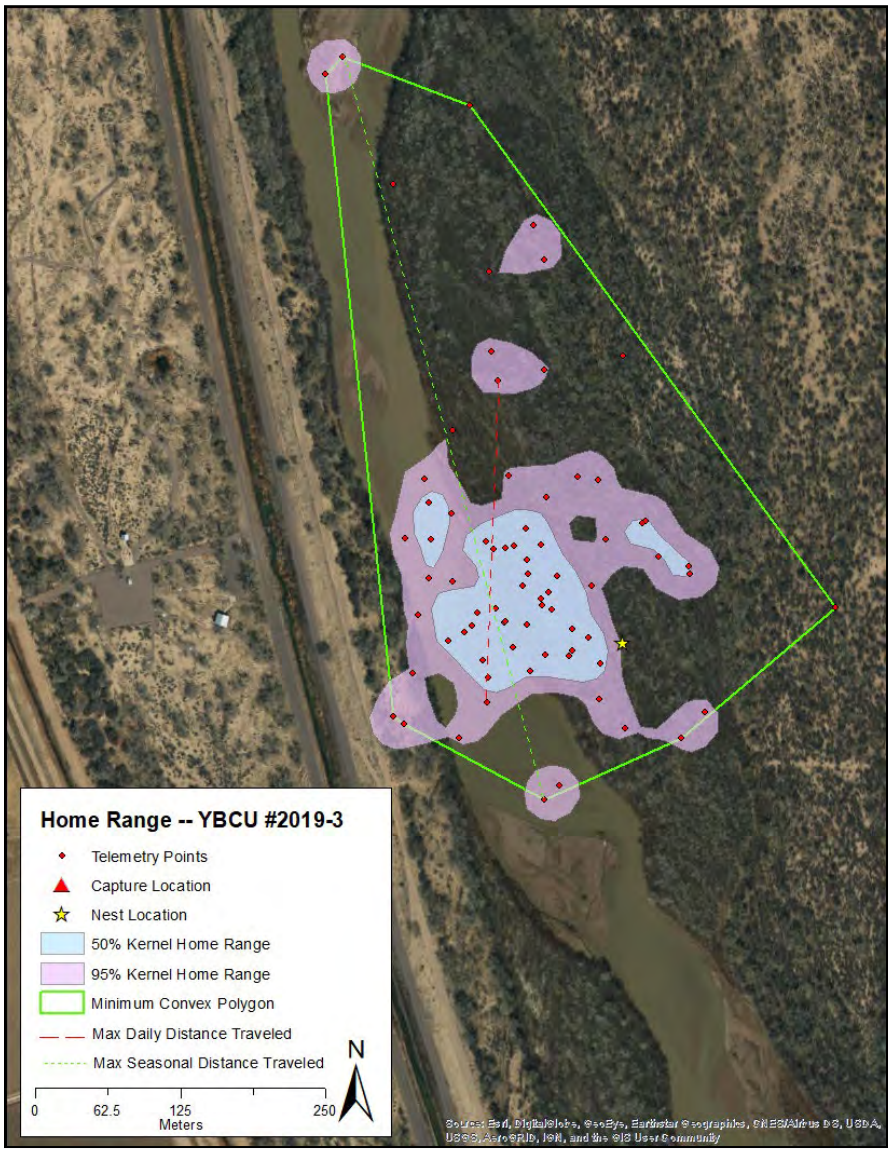

Figure 8. Vegetation composition at the capture location of YBCU #2019-3. Individual captured approximately 2 km south, location not visible on map.

One hundred percent of the woody vegetation within this individual's 95% and 50% KHRs had a native species component (Table 3, Figure 9). The home range spanned the Rio Grande, and the large number of points in the river corridor may be due to the inherent error in precision associated with conducting a radio telemetry study on a highly mobile species. The 50% KHR, the bird's core use area, was approximately 2 ha, and the 95% KHR was 6 ha.

This individual was tracked to its nest, located in Russian olive, on July 31. The nest had two nestlings, approximately three to five days old, at the last nest check but was not monitored to completion due to the culmination of the study season. The nest outcome could not be confirmed.

Table 3. Home range attributes for YBCU #2019-3.

Number of Telemetry Points	75
Telemetry Date Range	7/22 – 8/14
Maximum Seasonal Distance Traveled	662 m
Maximum Daily Distance Traveled	277 m
Minimum Convex Polygon Home Range	15.4 ha
Kernel Home Range - 95% Probability	5.6 ha
Kernel Home Range - 50% Probability	1.8 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Mixed Understory	<0.01 ha
Mixed Canopy/ Exotic Understory	0.2 ha
Mixed Canopy/ Mixed Understory	3.1 ha
Native Canopy/ No Understory	0.3 ha
Goodding's Willow Component	0 ha
Cottonwood Component	3.6 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Mixed Canopy/ Mixed Understory	1.1 ha
Goodding's Willow Component	0 ha
Cottonwood Component	1.1 ha

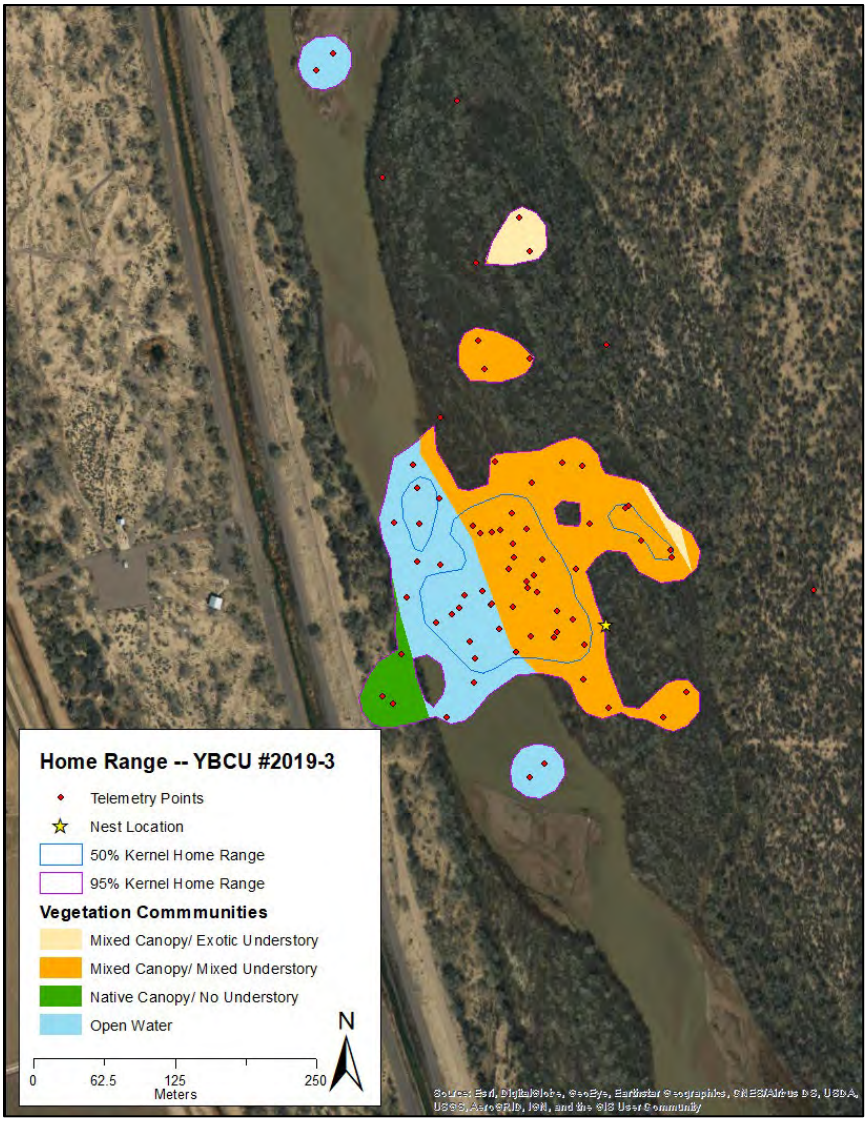

Figure 9. Home range vegetation composition for YBCU #2019-3.

Yellow-billed Cuckoo #2019-4:

Cuckoo #4 was captured on July 17, 2019 and 56 locations were obtained for this bird over 17 days of tracking (Table A4, Figure 10). This bird was suspected to be a juvenile based on its dark lower mandible, and therefore likely a non-breeding bird. It was last detected on August 3, after which time it was assumed to have migrated out of the study area.

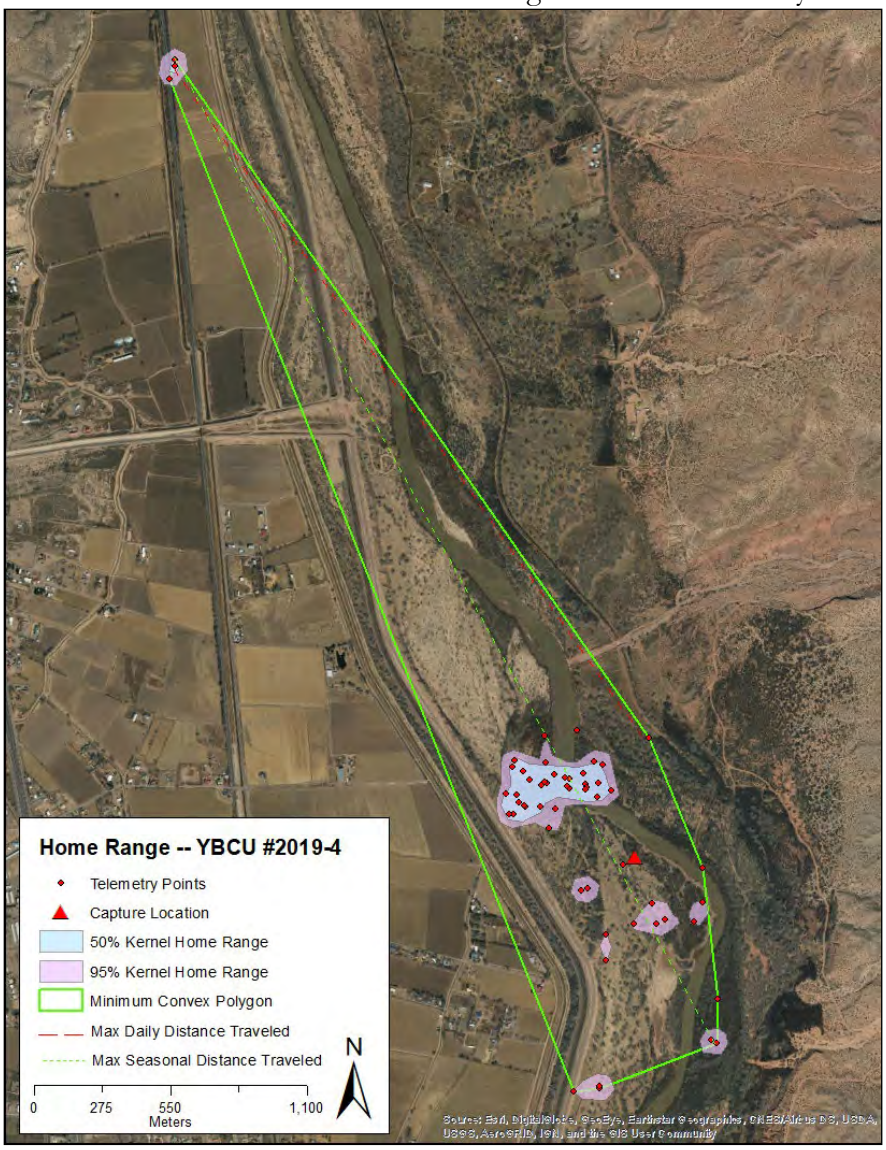

Figure 10. Home range estimates and maximum distance traveled by YBCU #2019-4.

All of the woody vegetation communities within this individual's 50% and 95% KHRs contained a native species component (Table 4, Figure 11). The estimated 95% KHR was 19 ha and the estimated 50% KHR was 7 ha. The bird's home range spanned the Rio Grande, and included some small, isolated patches of habitat. The northernmost patch included in this cuckoo's home range was located outside of the active floodplain and consequently no vegetation composition data was available.

Table 4. Home range attributes for YBCU #2019-4.

Number of Telemetry Points	56
Telemetry Date Range	7/17 – 8/3
Maximum Seasonal Distance Traveled	4523 m
Maximum Daily Distance Traveled	3357 m
Minimum Convex Polygon Home Range	233.9 ha
Kernel Home Range - 95% Probability	18.9 ha
Kernel Home Range - 50% Probability	7.0 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Exotic Understory	0.9 ha
Native Canopy/ Mixed Understory	4.5 ha
Mixed Canopy/ Native Understory	0.6 ha
Mixed Canopy/ Exotic Understory	3.8 ha
Mixed Canopy/ Mixed Understory	3.5 ha
Native Canopy/ No Understory	0.8 ha
Mixed Canopy/ No Understory	0.4 ha
Goodding's Willow Component	3.0 ha
Cottonwood Component	14.6 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Mixed Understory	2.1 ha
Mixed Canopy/ Exotic Understory	1.3 ha
Mixed Canopy/ Mixed Understory	1.5 ha
Native Canopy/ No Understory	0.3 ha
Goodding's Willow Component	1.5 ha
Cottonwood Component	5.2 ha

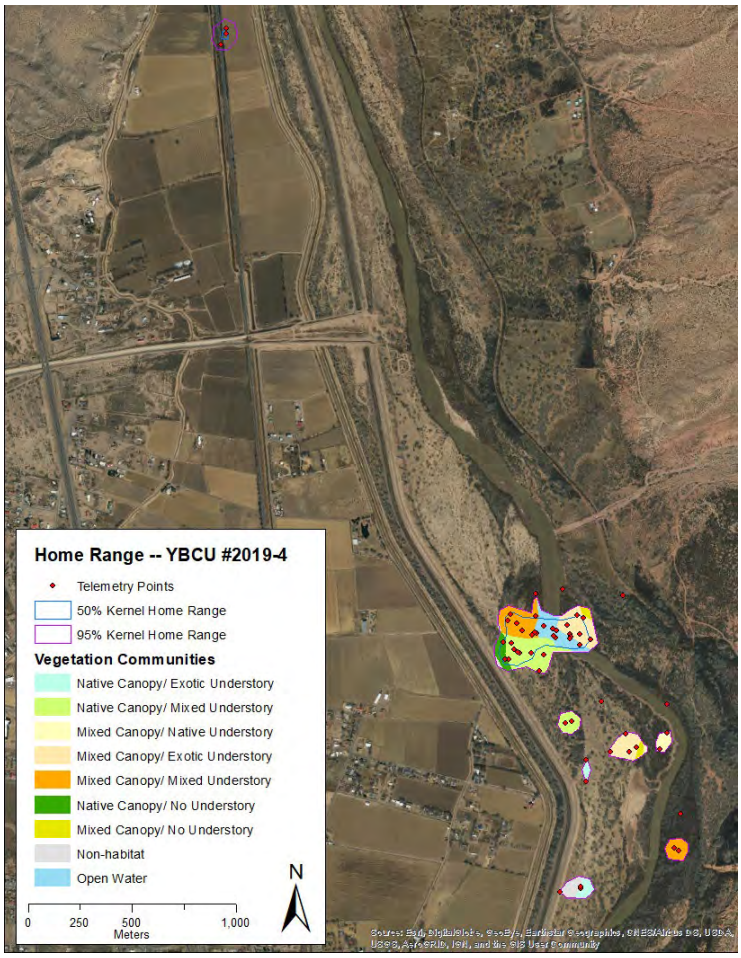

Figure 11. Home range vegetation composition for YBCU #2019-4.

Yellow-billed Cuckoo #2019-5:

Cuckoo #2019-5 was captured on June 26, 2019 and 39 locations were collected on it over 15 days of tracking. This individual moved more than seven kilometers north shortly after its initial capture, where it remained for the rest of the tracking period. The bird's shed tag was retrieved on July 11, but biologists suspect that it was shed many days prior to that day given the concentration of telemetry locations during that time period (Table A5, Figures 12 & 13).

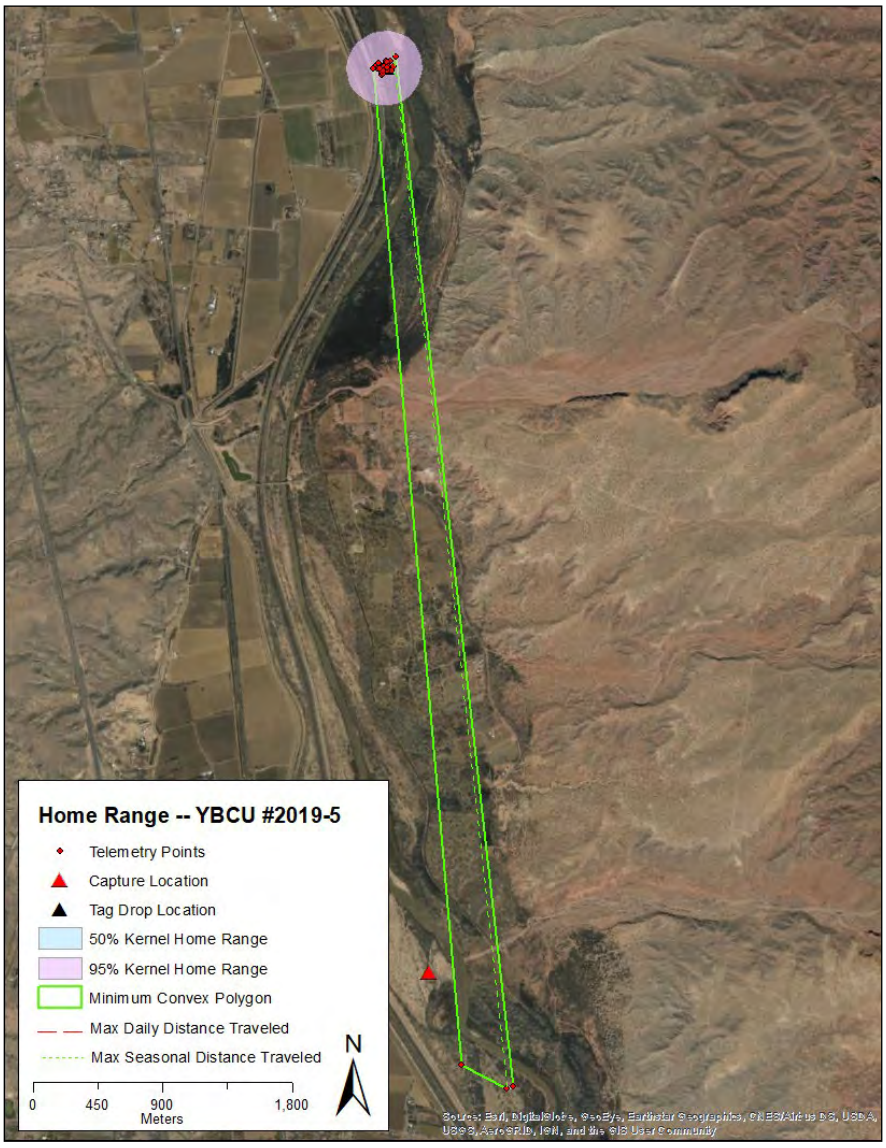

Figure 12. Home range estimates and maximum distance traveled by YBCU #2019-5.

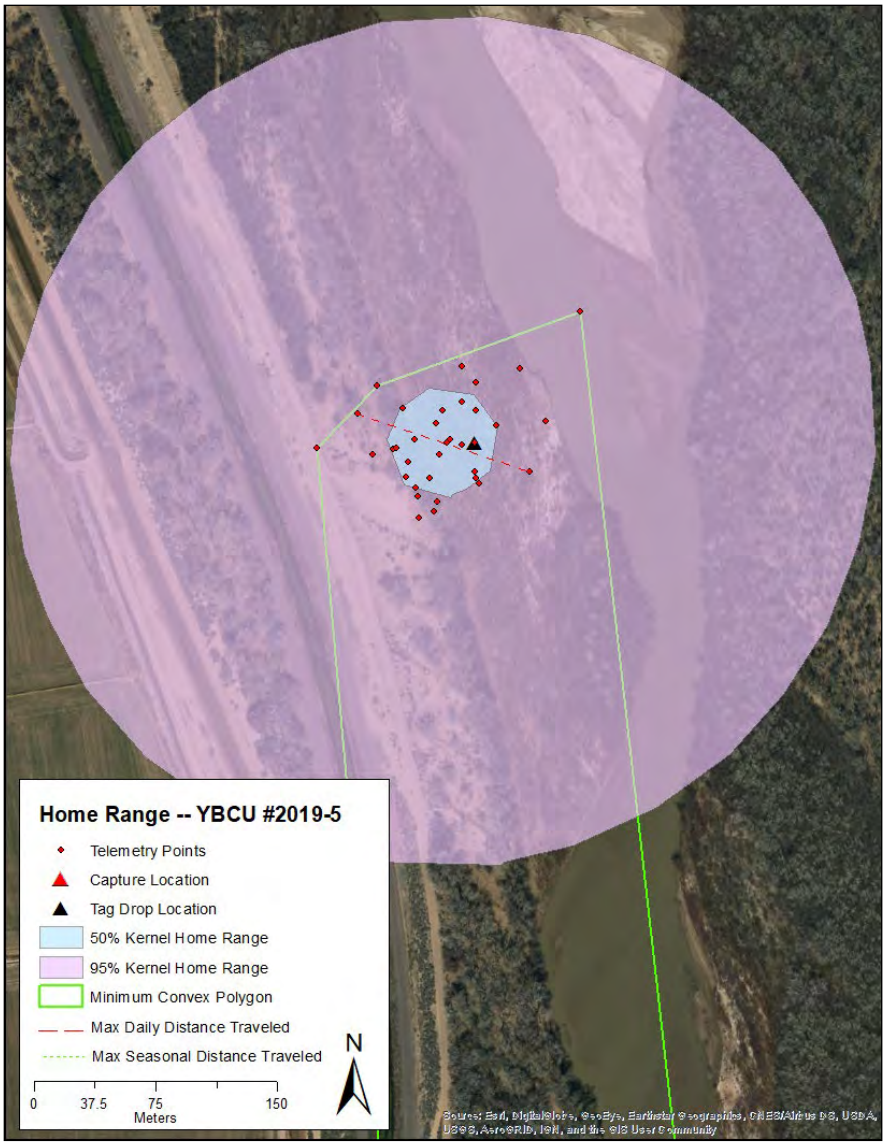

Figure 13. Detailed view of home range estimates for YBCU #2019-5.

All of the woody vegetation communities within this individual's 50% and 95% KHRs contained a native species component (Table 5, Figure 14). The estimated 95% KHR was 22 ha and the estimated 50% KHR was 0.3 ha. However, although the requisite minimum 30 telemetry points were obtained for this bird to be included in summary analyses, the concentration of detections locations leading up to the date the shed tag was located suggests that the tag was actually shed many days prior. It is therefore suspected that the home range estimates for this individual may be considerably smaller than is accurate, and data from this individual were not included in summary analyses.

Table 5. Home range attributes for YBCU #2019-5.

Number of Telemetry Points	39
Telemetry Date Range	6/26 – 7/11
Maximum Seasonal Distance Traveled	7210 m
Maximum Daily Distance Traveled	112 m
Minimum Convex Polygon Home Range	182.9 ha
Kernel Home Range - 95% Probability	21.9 ha
Kernel Home Range - 50% Probability	0.3 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Exotic Understory	2.0 ha
Mixed Canopy/ Exotic Understory	2.5 ha
Mixed Canopy/ Mixed Understory	1.8 ha
Mixed Canopy/ No Understory	0.3 ha
Native Understory	3.2 ha
Exotic Understory	0.5 ha
Goodding's Willow Component	1.1 ha
Cottonwood Component	6.6 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Exotic Understory	0.1 ha
Native Understory	0.2 ha
Goodding's Willow Component	0 ha
Cottonwood Component	0.1 ha

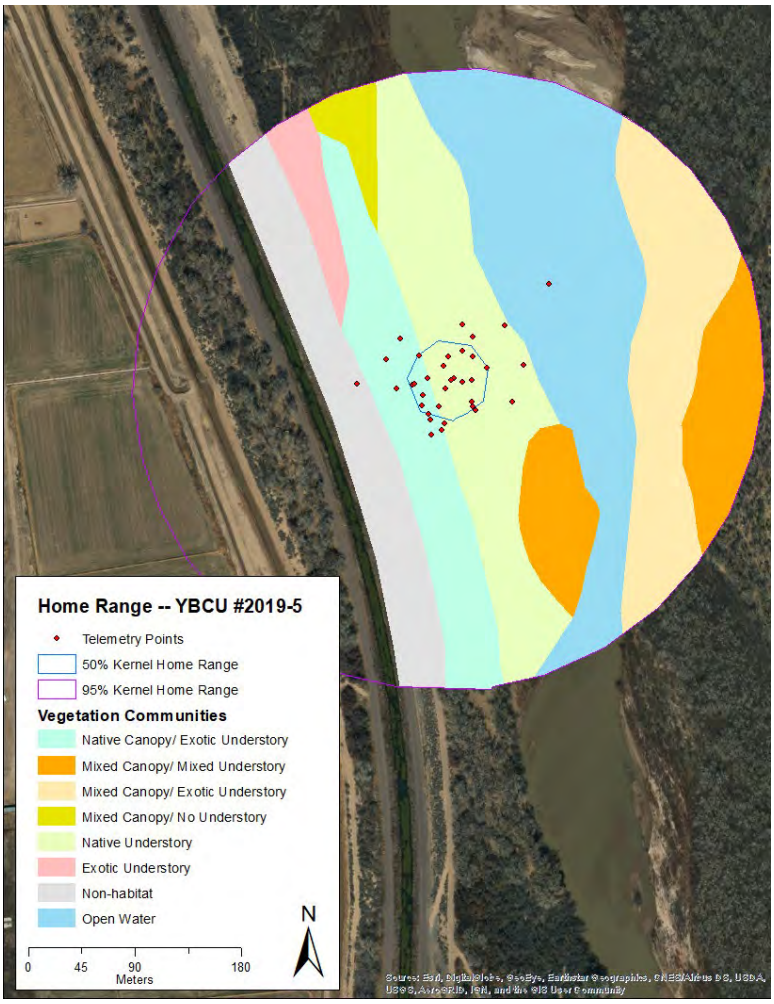

Figure 14. Vegetation composition at home range location of YBCU #2019-5.

Yellow-billed Cuckoo #2019-6:

Cuckoo #2019-6 was captured on June 28, 2019 and 33 locations were obtained for the bird over 11 days of tracking (Table A6, Figure 15). The bird was last detected on July 9 and assumed to have migrated out of the study area.

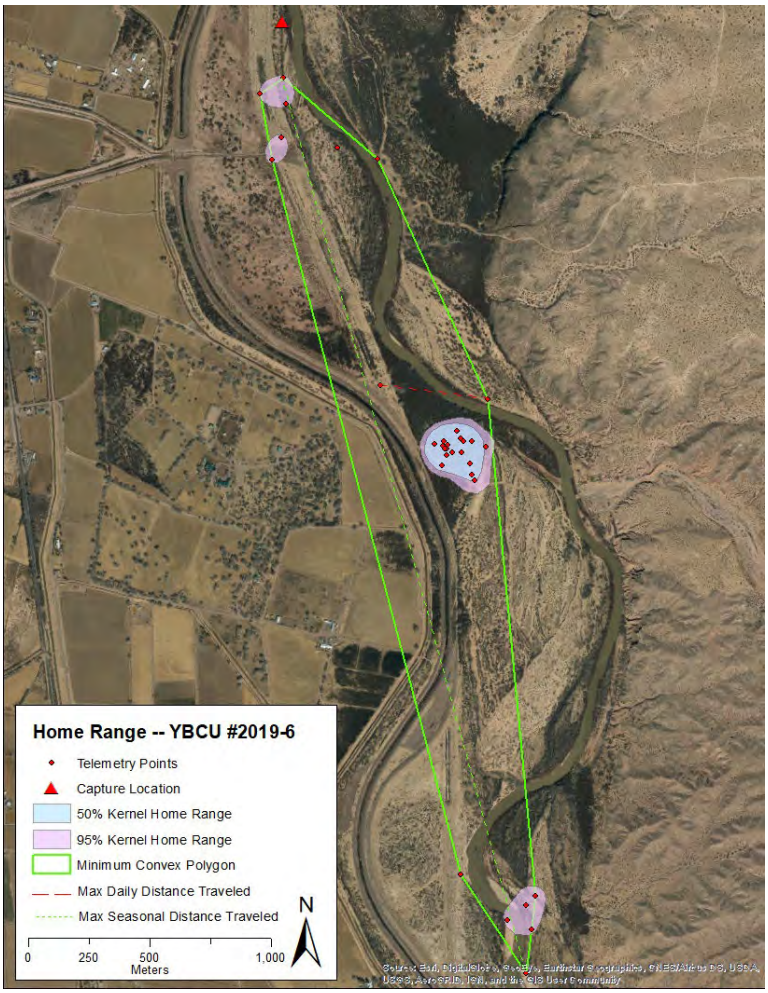

Figure 15. Home range estimates and maximum distance traveled by YBCU #2019-6.

Approximately 96 percent of the woody vegetation within this individual's 95% KHR, and 100 percent of the 50% KHR, had a native species component (Table 6, Figure 16). The core use area was in a patch of mixed native and exotic vegetation approximately 70 m from the Rio Grande. The 50% KHR, the bird's core use area, was 4 ha, and the 95% KHR was 12 ha.

Table 6. Home range attributes for YBCU #2019-6.

Number of Telemetry Points	33
Telemetry Date Range	6/28 – 7/9
Maximum Seasonal Distance Traveled	3831 m
Maximum Daily Distance Traveled	448 m
Minimum Convex Polygon Home Range	159.2 ha
Kernel Home Range - 95% Probability	12.0 ha
Kernel Home Range - 50% Probability	4.4 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy / Mixed Understory	<0.01 ha
Native Canopy / Exotic Understory	0.5 ha
Exotic Canopy/ Native Understory	6.3 ha
Mixed Canopy/ Native Understory	0.02 ha
Mixed Canopy/ Mixed Understory	0.6 ha
Native Understory	1.0 ha
Exotic Understory	0.3 ha
Goodding's Willow Component	0 ha
Cottonwood Component	2.2 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Exotic Canopy/ Native Understory	4.4 ha
Goodding's Willow Component	0 ha
Cottonwood Component	0 ha

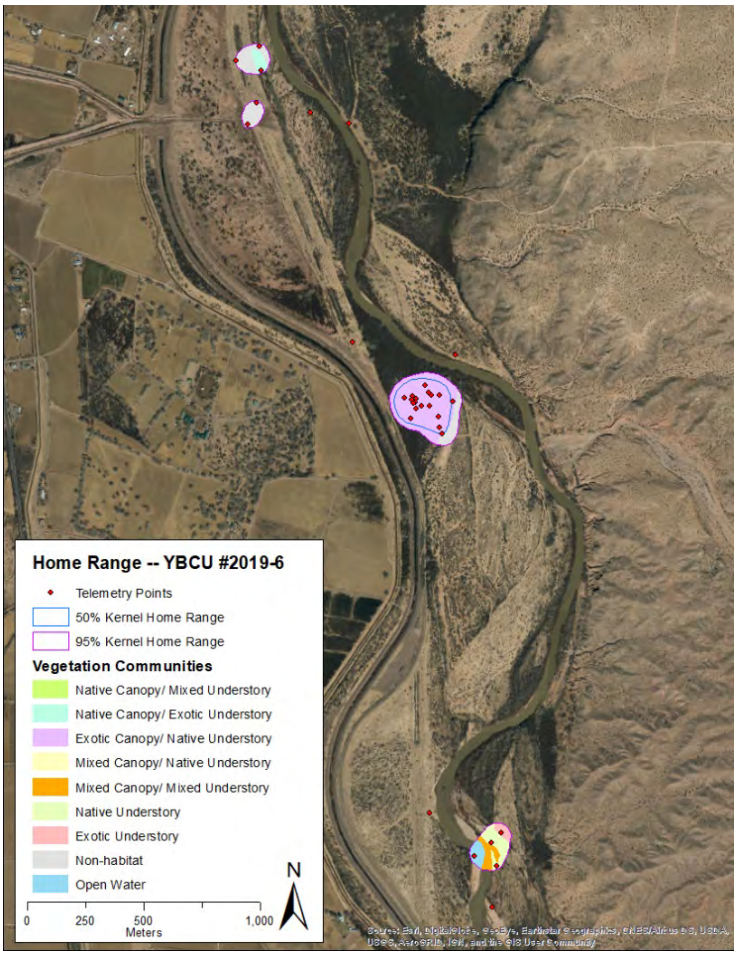

Figure 16. Home range vegetation composition for YBCU #2019-6.

Yellow-billed Cuckoo #2019-7:

Cuckoo #2019-7 was captured on July 9, 2019 and 32 locations were obtained for the bird over 15 days of tracking (Table A7, Figure 17). The shed tag was located and retrieved on July 24.

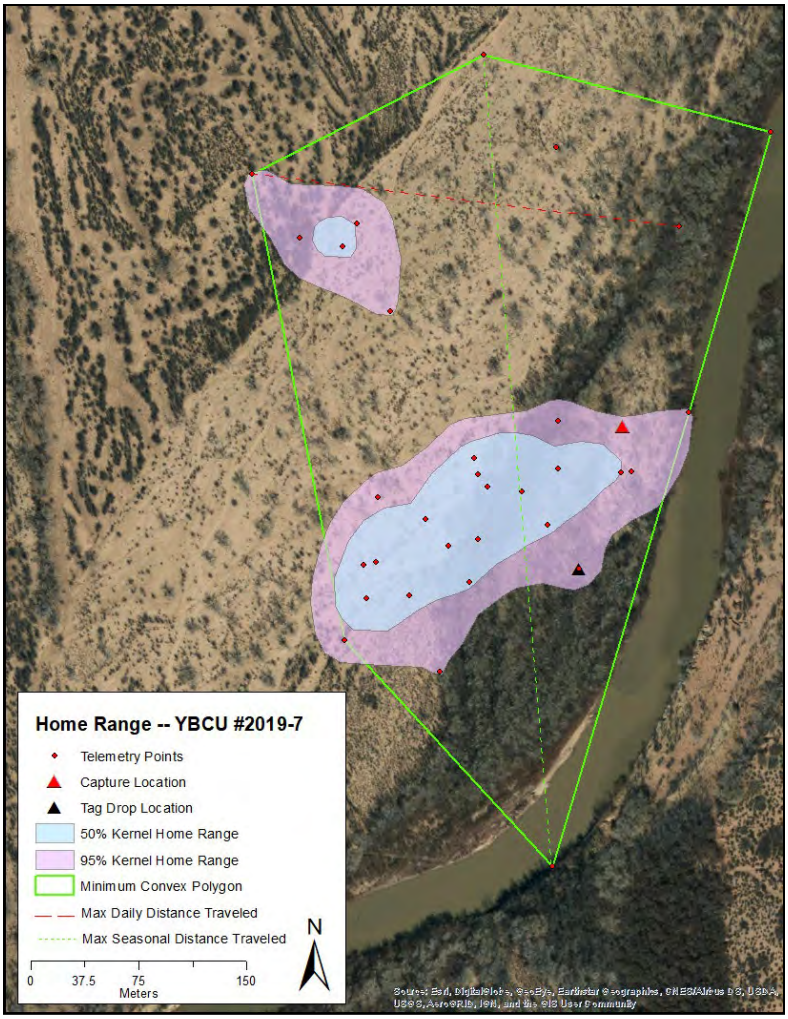

Figure 17. Home range estimates and maximum distance traveled by YBCU #2019-7.

All of the habitat within this cuckoo's 50% and 95% KHRs contained a native vegetation component (Table 7, Figure 18). The core use area was approximately 45 m from the Rio Grande. The 95% KHR was 4 ha and the 50% KHR was 2 ha.

Table 7. Home range attributes for YBCU #2019-7.

Number of Telemetry Points	32
Telemetry Date Range	7/9 – 7/24
Maximum Seasonal Distance Traveled	563 m
Maximum Daily Distance Traveled	299 m
Minimum Convex Polygon Home Range	12.0 ha
Kernel Home Range - 95% Probability	3.7 ha
Kernel Home Range - 50% Probability	1.5 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Mixed Understory	0.9 ha
Cottonwood Component	0.9 ha
Goodding's Willow Component	0 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Mixed Understory	0.5 ha
Cottonwood Component	0.5 ha
Goodding's Willow Component	0 ha

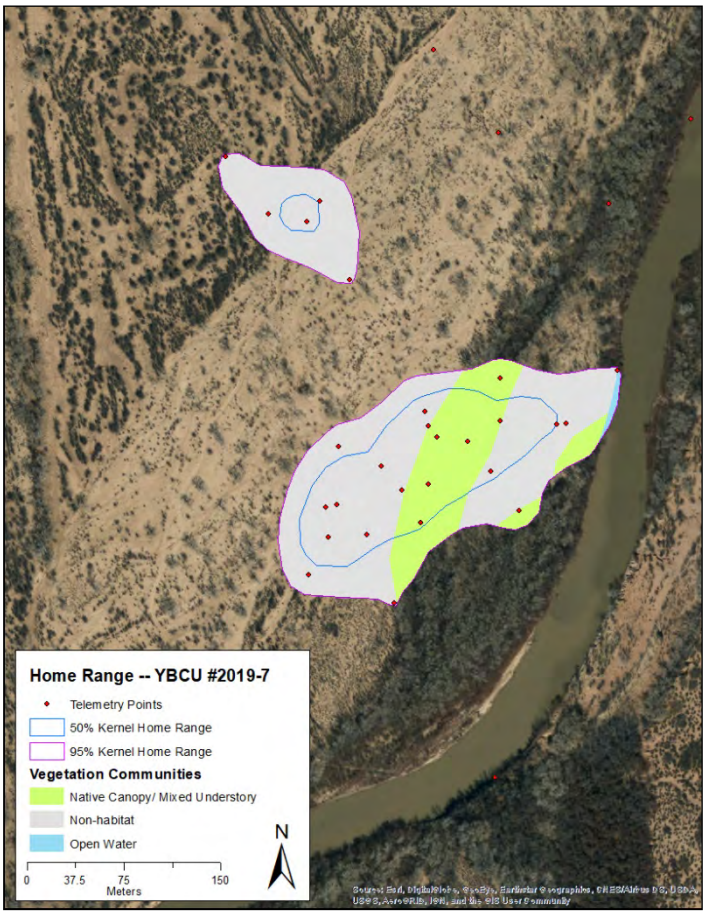

Figure 18. Home range vegetation composition for YBCU #2019-7.

Yellow-billed Cuckoo #2019-8:

Cuckoo #2019-8 was captured on July 8, 2019 and 29 locations were obtained for the bird over 16 days of tracking prior to shedding its tag (Table A8, Figure 19). The shed tag was retrieved on July 24.

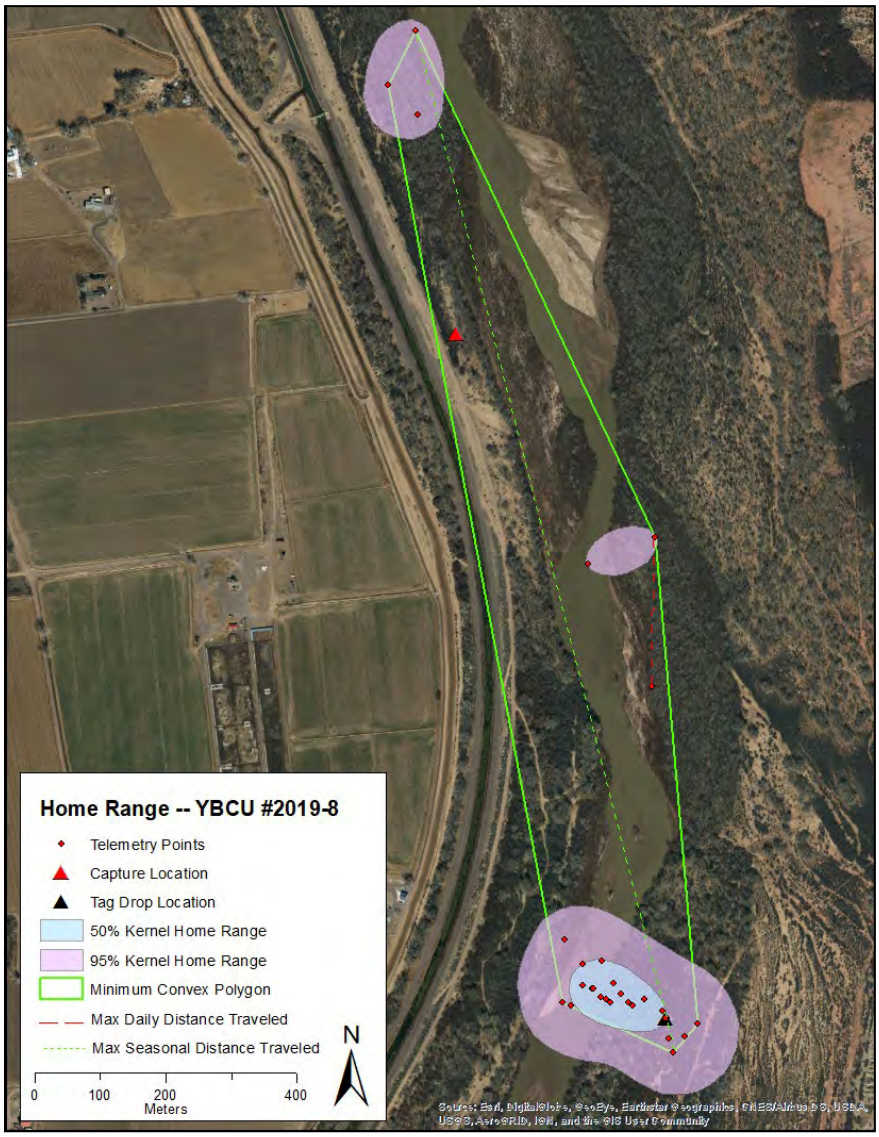

Figure 19. Home range estimates and maximum distance traveled by YBCU #2019-8.

All of the habitat within this cuckoo's 50% KHR and 98 percent of habitat in the 95% KHR contained a native vegetation component (Table 8, Figure 20). The bird's home range spanned the Rio Grande, with detections on both sides of the river. The 95% KHR was 9 ha and the 50% KHR was 1 ha.

Table 8. Home range attributes for YBCU #2019-8.

Number of Telemetry Points	29
Telemetry Date Range	7/8 – 7/24
Maximum Seasonal Distance Traveled	1601 m
Maximum Daily Distance Traveled	225 m
Minimum Convex Polygon Home Range	30.4 ha
Kernel Home Range - 95% Probability	9.0 ha
Kernel Home Range - 50% Probability	1.2 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy / Exotic Understory	0.7 ha
Native Canopy / Mixed Understory	0.9 ha
Mixed Canopy/ Exotic Understory	0.4 ha
Native Canopy/ No Understory	<0.01 ha
Mixed Canopy/ No Understory	1.3 ha
Mixed Understory	2.9 ha
Goodding's Willow Component	1.3 ha
Cottonwood Component	3.4 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Mixed Understory	0.3 ha
Mixed Understory	0.4 ha
Goodding's Willow Component	0 ha
Cottonwood Component	0.3 ha

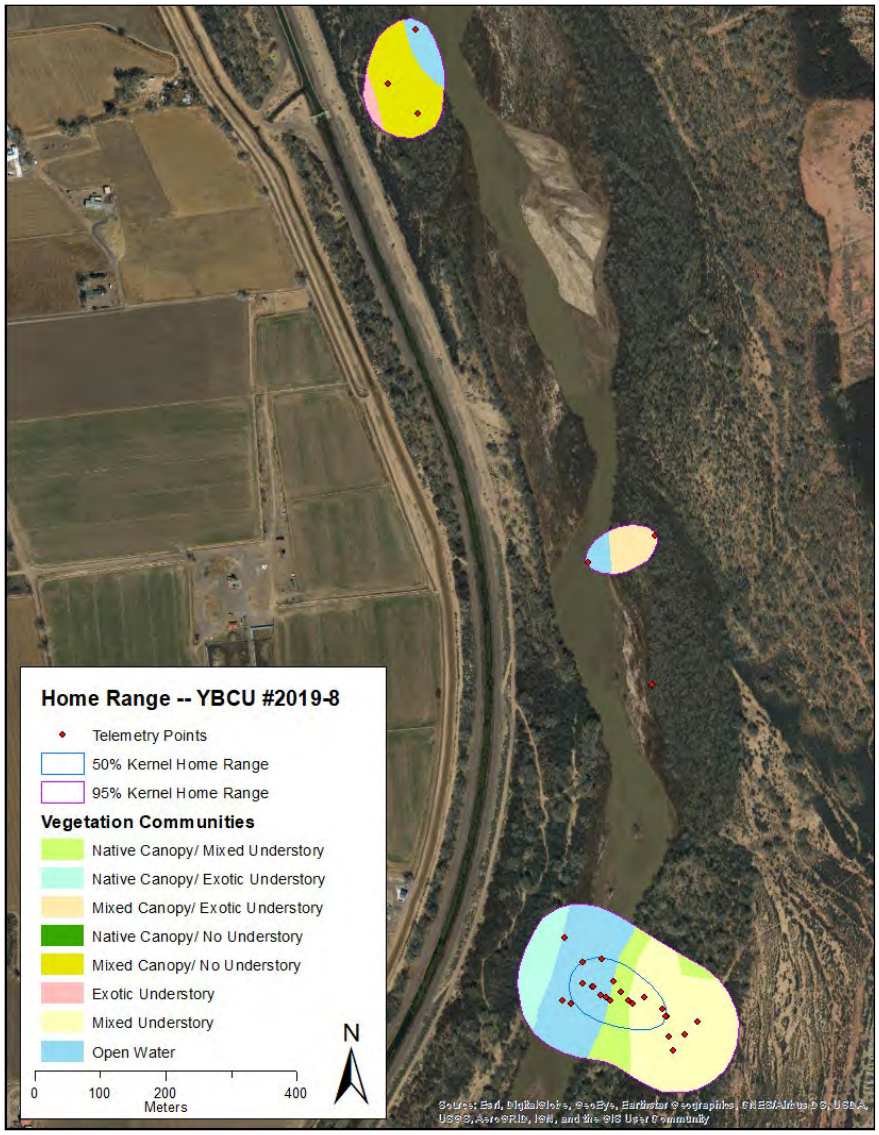

Figure 20. Home range vegetation composition for YBCU #2019-8.

Yellow-billed Cuckoo #2019-9:

Cuckoo #2019-9 was captured on July 13, 2019 and 21 locations were obtained for the bird over 9 days of tracking prior to the bird shedding its tag (Table A9, Figure 21). The shed tag was retrieved on July 22.

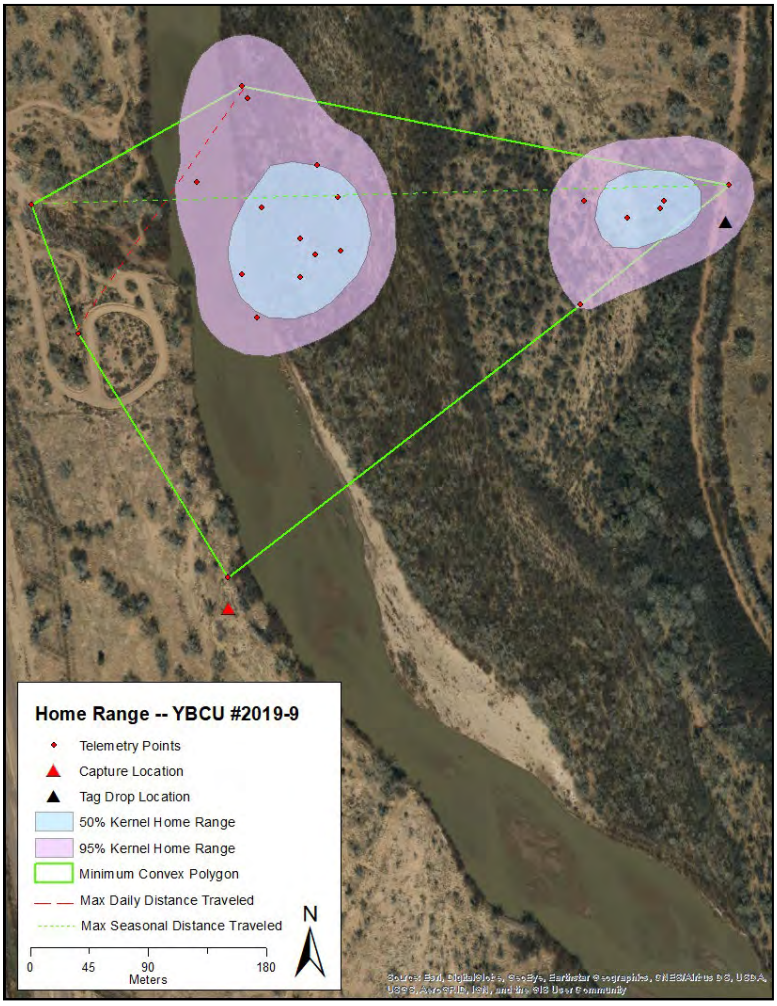

Figure 21. Home range estimates and maximum distance traveled by YBCU #2019-9.

All of the habitat in this cuckoo's 50% KHR, and 93 percent of habitat in its 95% KHR, contained a native vegetation component (Table 9, Figure 22). Although only a small number of locations were obtained for this individual prior to its tag being shed, the available data suggest that it had a 95% KHR of 5 ha and a 50% KHR of 1 ha. However, these may be underestimates due to the overall paucity of data. The bird's home range bordered the Rio Grande, with detections on both sides of the river. This cuckoo's 95% KHR closely bordered, and partially overlapped, that of YBCU #2019-2.

Table 9. Home range attributes for YBCU #2019-9.

Number of Telemetry Points	21
Telemetry Date Range	7/13 – 7/22
Maximum Seasonal Distance Traveled	531 m
Maximum Daily Distance Traveled	226 m
Minimum Convex Polygon Home Range	10.2 ha
Kernel Home Range - 95% Probability	4.5 ha
Kernel Home Range - 50% Probability	1.4 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Exotic Understory	0.8 ha
Exotic Canopy/ Native Understory	1.3 ha
Exotic Understory	0.2 ha
Mixed Understory	0.7 ha
Goodding's Willow Component	0 ha
Cottonwood Component	0.8 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Native Canopy/ Exotic Understory	0.3 ha
Exotic Canopy/ Native Understory	0.7 ha
Mixed Understory	0.2 ha
Goodding's Willow Component	0 ha
Cottonwood Component	0.3 ha

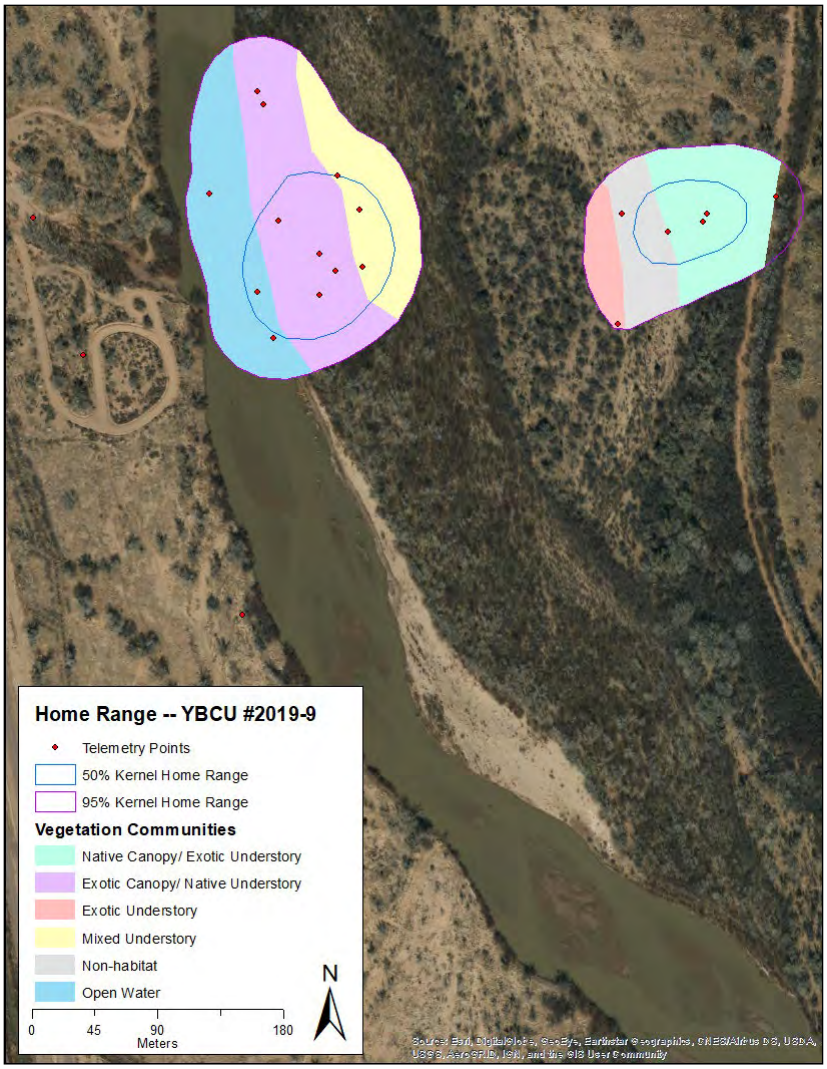

Figure 22. Home range vegetation composition for YBCU #2019-9.

Yellow-billed Cuckoo #2019-10:

Cuckoo #2019-10 was captured on July 10, 2019 and 20 locations were obtained for the bird over 10 days of tracking (Table A10, Figure 23). This individual was last detected on July 20 and was assumed to have subsequently migrated out of the study area.

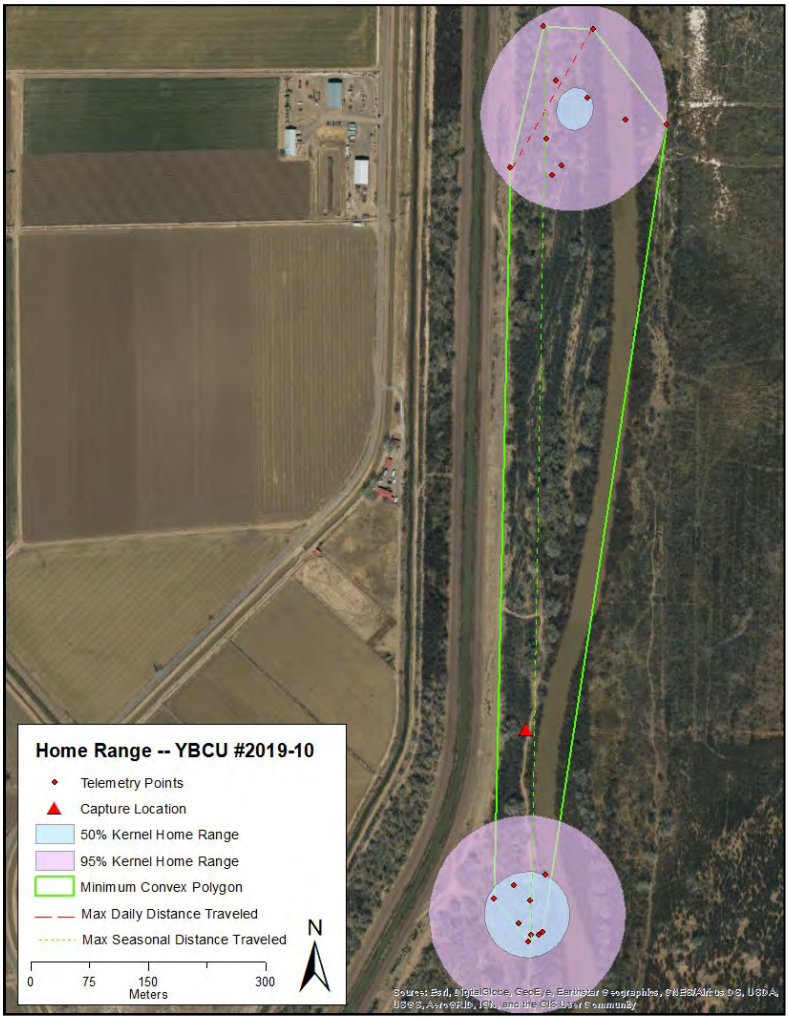

Figure 23. Home range estimates and maximum distance traveled by YBCU #2019-10.

Approximately 93 percent of habitat in the 50% KHR, and 83 percent of habitat in the 95% KHR, contained a native vegetation component (Table 10, Figure 24). The bird's home range spanned the Rio Grande with detections on both sides of the river. The estimated 95% KHR was 10 ha and the estimated 50% KHR was 1 ha. However, only a small number of locations were obtained for this individual before it migrated out of the study area, resulting in a scarcity of data with which to accurately estimate home range size and habitat use.

Table 10. Home range attributes for YBCU #2019-10.

Number of Telemetry Points	20
Telemetry Date Range	7/10 – 7/20
Maximum Seasonal Distance Traveled	1165 m
Maximum Daily Distance Traveled	206 m
Minimum Convex Polygon Home Range	14.9 ha
Kernel Home Range - 95% Probability	9.9 ha
Kernel Home Range - 50% Probability	1.1 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Native Canopy/ Mixed Understory	0.2 ha
Exotic Canopy/ Exotic Understory	1.2 ha
Mixed Canopy/ Native Understory	0.5 ha
Native Canopy/ No Understory	3.4 ha
Mixed Canopy/ No Understory	1.0 ha
Mixed Understory	0.7 ha
Goodding's Willow Component	0.1 ha
Cottonwood Component	5.0 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Exotic Canopy/ Exotic Understory	0.1 ha
Native Canopy/ No Understory	0.7 ha
Mixed Canopy/ No Understory	<0.01 ha
Mixed Understory	0.2 ha
Goodding's Willow Component	<0.01 ha
Cottonwood Component	0.7 ha

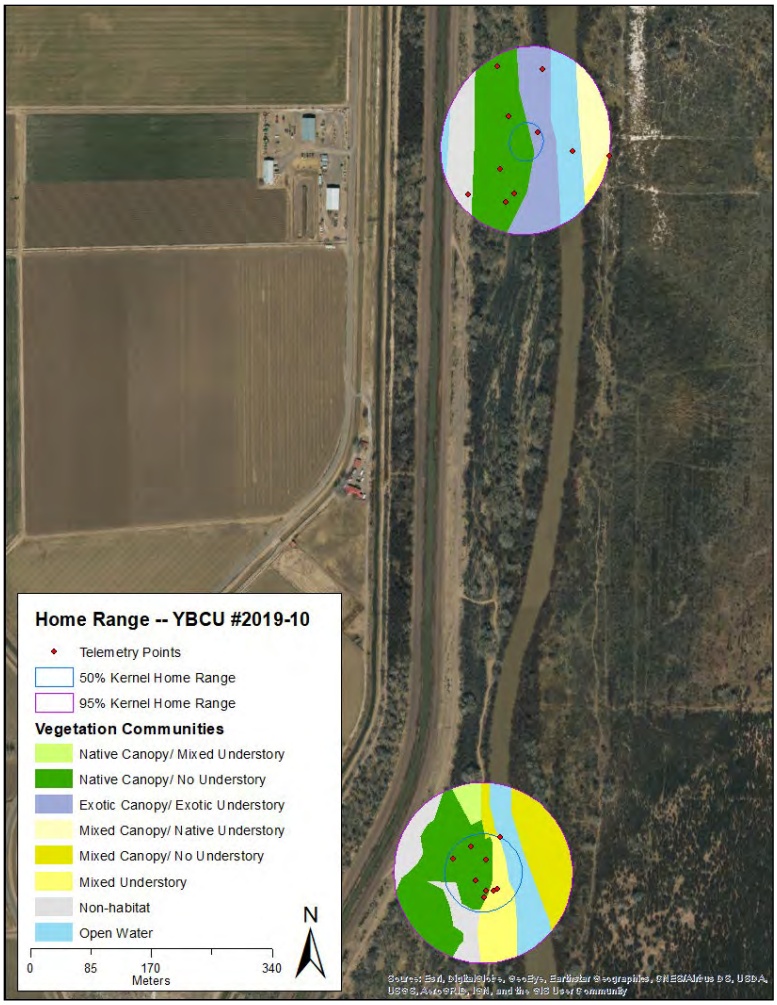

Figure 24. Home range vegetation composition for YBCU #2019-10.

Yellow-billed Cuckoo #2019-11:

Cuckoo #2019-11 was captured on July 1, 2019 and 17 locations were obtained for the bird over 8 days of tracking (Table A11, Figure 25). The bird was assumed to have migrated out of the study area after it was last detected on July 9.

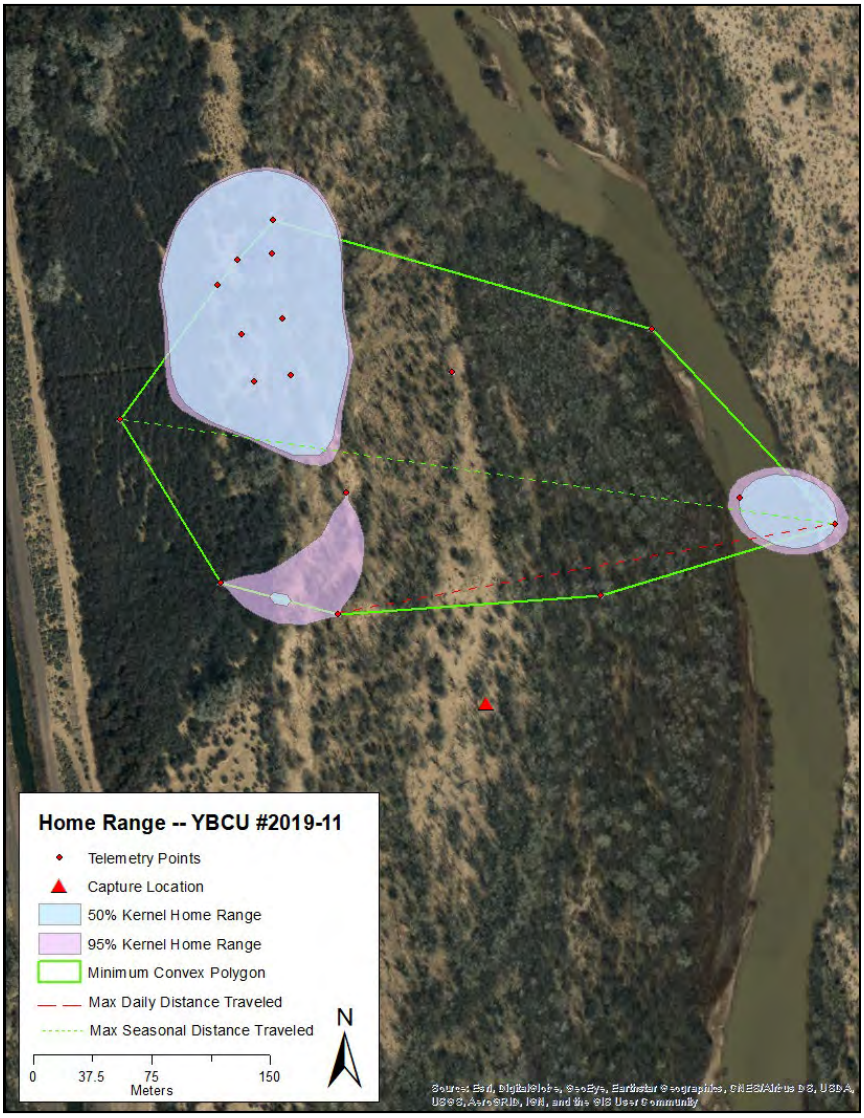

Figure 25. Home range estimates and maximum distance traveled by YBCU #2019-11.

Approximately 70 percent of habitat in the 50% and 95% KHRs contained a native vegetation component; the remaining habitat was dominated by exotic overstory vegetation (Table 11, Figure 26). Only 17 locations were collected for this individual before it migrated out of the study area, and territory size and habitat use is therefore likely underestimated.

Table 11. Home range attributes for YBCU #2019-11.

Number of Telemetry Points	17
Telemetry Date Range	7/1 – 7/9
Maximum Seasonal Distance Traveled	456 m
Maximum Daily Distance Traveled	318 m
Minimum Convex Polygon Home Range	7.2 ha
Kernel Home Range - 95% Probability	1.9 ha
Kernel Home Range - 50% Probability	2.5 ha
Vegetation Composition - Kernel Home Range - 95% Probability	
Mixed Canopy/ Native Understory	1.1 ha
Exotic Canopy/ No Understory	0.7 ha
Mixed Understory	0.4 ha
Goodding's Willow Component	0 ha
Cottonwood Component	1.1 ha
Vegetation Composition - Kernel Home Range - 50% Probability	
Mixed Canopy/ Native Understory	1.1 ha
Exotic Canopy/ No Understory	0.5 ha
Mixed Understory	0.1 ha
Goodding's Willow Component	0 ha
Cottonwood Component	1.1 ha

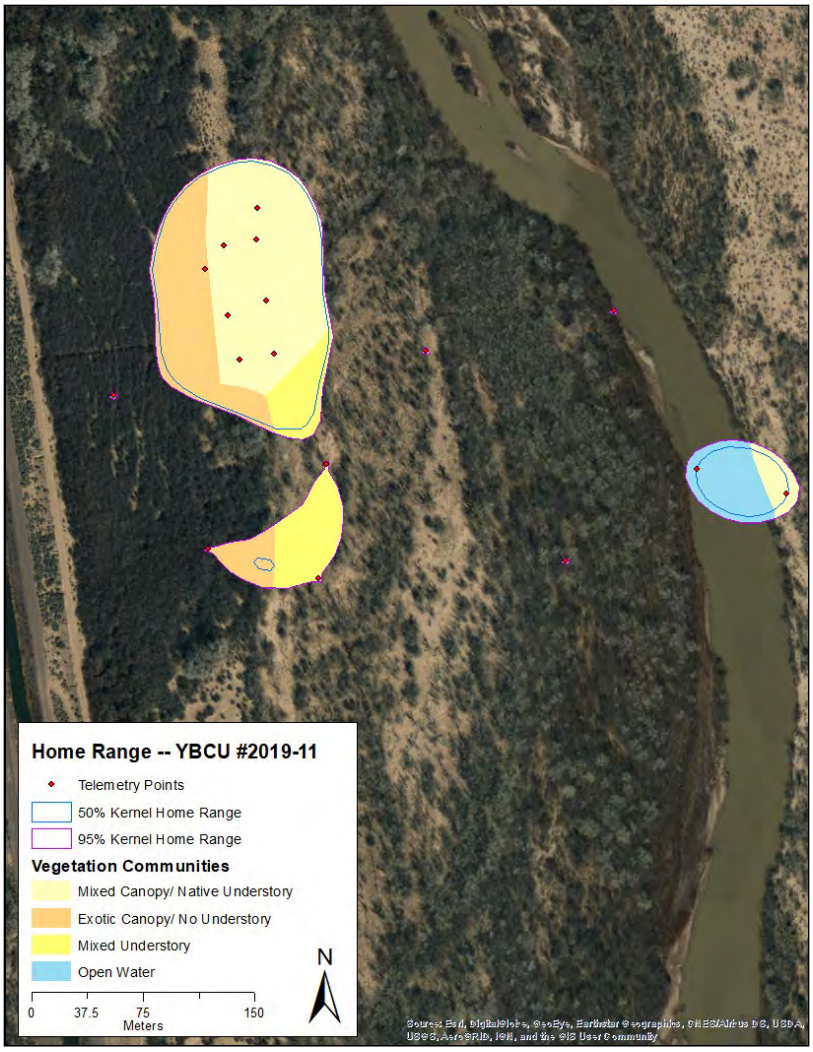

Figure 26. Home range vegetation composition for YBCU #2019-11.

Yellow-billed Cuckoo #2019-12:

Cuckoo #2019-12 was captured on June 24, 2019 but only 6 locations were obtained over 2 days of tracking before the bird migrated out of the study area (Table A12, Figure 27). The bird immediately moved nearly 17 km north after it was initially captured, and then could not be relocated. Home range and habitat composition could not be calculated for this individual due to the lack of data.

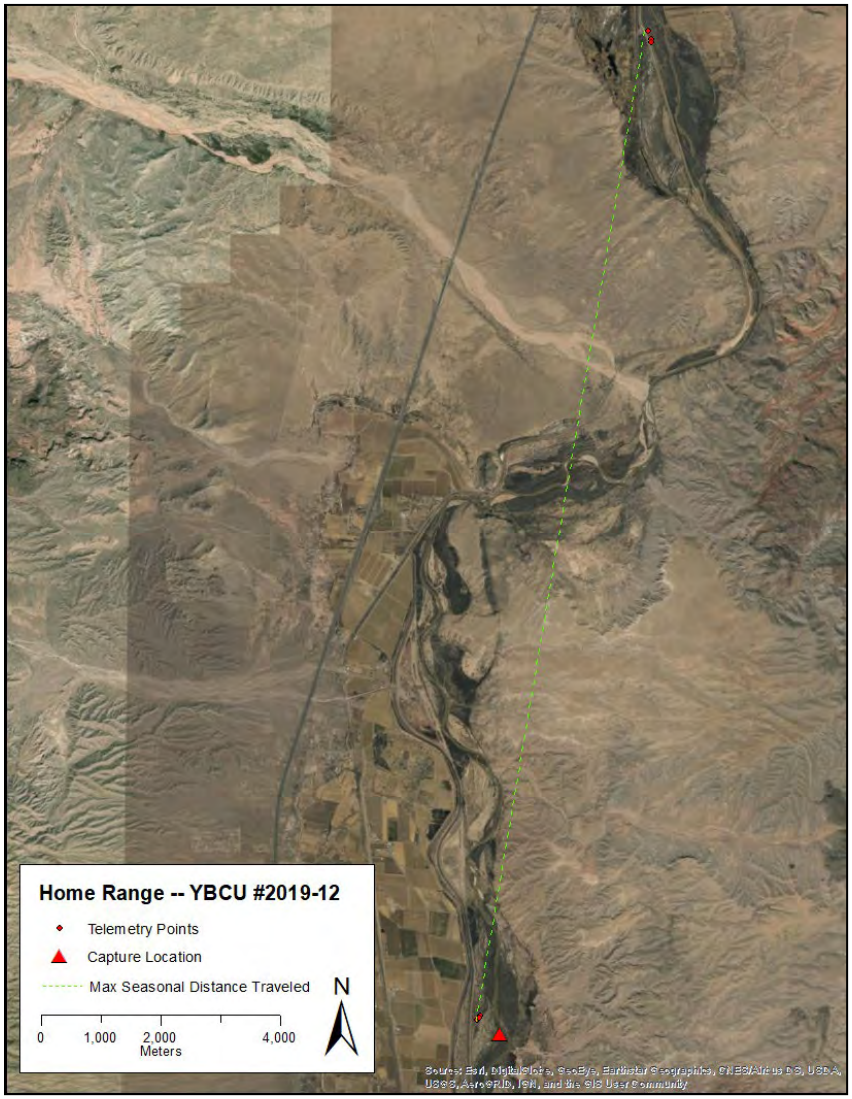

Figure 27. Maximum distance traveled by YBCU #2019-12.

SUMMARY OF 2019 MOVEMENT AND HABITAT COMPOSITION DATA

Home range and habitat composition data were summarized for all cuckoos captured in 2019 for which at least 30 telemetry locations were obtained over greater than 7 days of tracking. Any bird for which those minimums were not met, or where early tag shedding affected the data (e.g., #2019-5), was excluded from summary analyses as data were considered insufficient to draw strong conclusions. Sufficient data were obtained for 6 individuals in 2019 with an average of 69 telemetry locations obtained per individual.

The 6 radio tagged birds for which usable data was obtained traveled an average maximum distance of over 3 km (3027 m) during the tracking period and an average maximum daily distance of nearly 1 km (908 m). The average core use area (50% KHR) was 5 ha and the average breeding and foraging habitat size (95% KHR) was 22 ha (Table 12, Figure 28).

Table 12. Summary of 2019 cuckoo movement and habitat composition data (n = 6). Range presented in parentheses.

Average Number of Telemetry Points	69 (32-118)
Average Maximum Seasonal Distance Traveled	3027 m (563-5574)
Average Maximum Daily Distance Traveled	908 m (277-3357)
Average Minimum Convex Polygon Home Range	183 ha (12-581)
95% Kernel Home Range	
Average Area	22 ha (4-69)
Percent of Habitat w/ Native Vegetation Component	90%
Percent of Habitat w/ Native-dominated Canopy	41%
Percent of Habitat w/ Goodding's Willow Component	6%
Percent of Habitat w/ Cottonwood Component	72%
Percent of Habitat w/ Overstory Structure	84%
Percent of Habitat without Overstory Structure	16%
50% Kernel Home Range	
Average area	5 ha (2-9)
Percent of Habitat w/ Native Vegetation Component	97%
Percent of Habitat w/ Native-dominated Canopy	35%
Percent of Habitat w/ Goodding's Willow Component	10%
Percent of Habitat w/ Cottonwood Component	63%
Percent of Habitat w/ Overstory Structure	96%
Percent of Habitat without Overstory Structure	4%

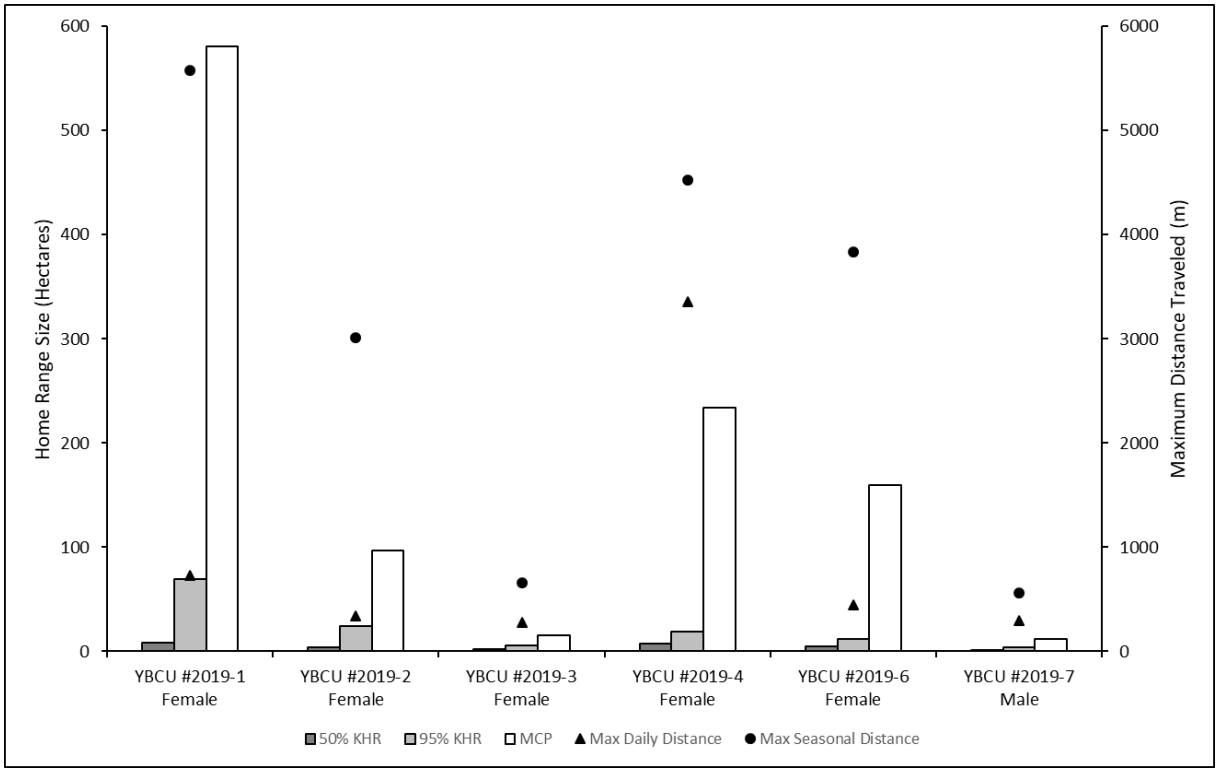

Figure 28. 2019 YBCU home range estimates and maximum distance traveled along the Middle Rio Grande, NM.
(MCP = overall territory size)

NEST MONITORING

Three nests belonging to radio tagged cuckoos were located in 2019. One nest fledged one of two nestlings successfully, one was suspected to have failed during the nestling stage likely due to predation, and the third was last observed with nestlings but not monitored to completion due to the study season ending. Clutch sizes ranged from two to three eggs. Nests were constructed between approximately 4 and 9 m above the ground in coyote willow (n=1) or Russian olive (n=2). Canopy cover at the 3 nests ranged from approximately 90 to 98 percent.

DISCUSSION

Western Yellow-billed Cuckoos are thought to be highly mobile with large home ranges, and this was supported by the data obtained in the first three years of this study. The smallest core use area (50% KHR) recorded in 2019 was 2 ha, and the largest was 9 ha. The core use area is considered to be where bird activity is concentrated and where, if breeding, a YBCU pair would build a nest. Likewise, the use area thought to include both nesting and foraging habitat (95% KHR) averaged 22 ha in 2019, with the smallest observed being 4 ha and the largest observed 69 ha.

There were notable differences in home range sizes when 2019 data was compared to data from the previous two years. Capture efforts in 2017 and 2018 were focused on The Narrows of Elephant Butte Reservoir between river mile 48 and 37. In 2019, capture efforts were in the San Acacia and Escondida reaches, between river mile 116 and 87. Habitat in these upper reaches is generally constrained to smaller and more isolated patches, compared to the contiguous stretches of suitable habitat found in The Narrows. Although the overall territory size (MCP) and distance traveled were slightly larger in the northern habitat, kernel home ranges were three times as large in The Narrows as in the northern part of the study area (Table 13).

Table 13. Comparison of 2017-2018 and 2019 cuckoo movement and habitat composition data. Range presented in parentheses.

	2017/2018 *(n=8)*	**2019** *(n=6)*
Average Number of Telemetry Points	64	69
Average Maximum Seasonal Distance Traveled	2161 m	3027 m
Average Maximum Daily Distance Traveled	878 m	908 m
Average Minimum Convex Polygon Home Range	162 ha	183 ha
95% Kernel Home Range		
Average Area	60 ha (7-216)	22 ha (4-69)
Percent of Habitat w/ Native Vegetation Component	68%	90%
Percent of Habitat w/ Native-dominated Canopy	41%	41%
Percent of Habitat w/ Goodding's Willow Component	37%	6%
Percent of Habitat w/ Cottonwood Component	26%	72%
Percent of Habitat w/ Overstory Structure	48%	84%
Percent of Habitat without Overstory Structure	52%	16%
50% Kernel Home Range		
Average area	11 ha (2-36)	5 ha (2-9)
Percent of Habitat w/ Native Vegetation Component	72%	97%
Percent of Habitat w/ Native-dominated Canopy	55%	35%
Percent of Habitat w/ Goodding's Willow Component	48%	10%
Percent of Habitat w/ Cottonwood Component	31%	63%
Percent of Habitat w/ Overstory Structure	59%	96%
Percent of Habitat without Overstory Structure	41%	4%

This interannual variation likely reflects the differences in habitat patch size, continuity, and overall availability in the different parts of their breeding range along the Rio Grande. Highly suitable habitat patches in The Narrows are often surrounded by lower stature habitat of more moderate suitability containing vegetation with the composition and structure sufficient for cuckoo use. However, in the northern reaches in which cuckoos were tracked in 2019, suitable habitat patches are often surrounded by open areas and non-habitat. Combined, these results suggest that cuckoos will certainly use larger expanses of habitat when it is available but can breed in smaller patches if that is all that is present. A larger sample size of nests is needed to determine whether there are patch size-dependent differences in nest success.

In all years of the study, the majority of vegetation in cuckoos' home ranges had a native vegetation component, and approximately one quarter of the home range was characterized by native-dominated vegetation communities. Indeed, 97 percent of core use areas had a native vegetation component in the northern reaches in which cuckoos were monitored in 2019. Mature native overstory vegetation is known to be an important aspect of suitable cuckoo breeding habitat, and previous research has found a preference for Goodding's willow habitat such that cuckoos use habitat with a Goodding's willow component disproportionately to its availability on the landscape (Siegle et al. 2017). In The Narrows, Goodding's willow comprised a component of 37 percent of the vegetation communities in 95% KHRs and was a component of nearly half of all vegetation communities in core use areas. However, only 10 percent of core use areas in the northern reaches had a Goodding's willow component. Instead cottonwood was the dominant native overstory vegetation species, observed to be a component of 63 percent of core use areas and nearly three quarters of 95% KHRs (Table 13). Again, this reflects the fact that cottonwood is much more abundant on the landscape than Goodding's willow in these northern reaches, and cuckoos exhibit some flexibility to use the habitat type that is available. Nevertheless, it is important to note that although the data suggest that cuckoos can use the smaller, more isolated, and less vegetation species-diverse habitat patches observed in the northern part of the study area, cuckoo abundance and breeding density is markedly lower in these areas than in locations such as The Narrows which contains much larger and contiguous expanses of suitable habitat (Dillon et al. 2019).

Approximately 60 percent of core use areas in The Narrows were comprised of vegetation communities with overstory structure, and 40 percent were comprised of understory vegetation without an overstory component. Understory-only vegetation communities can provide foraging habitat for cuckoos, but they do not provide suitable nesting habitat. Indeed, in the much patchier and overall more limited habitat in which cuckoos were tracked in 2019 only 4 percent of core use areas and 16 percent of 95% KHRs contained understory vegetation without an overstory component (Table 13).

Nevertheless, the habitat use results are clearly indicative of the importance of mature overstory vegetation structure to breeding cuckoos, particularly vegetation communities with a native species component. Particularly in the patchy, habitat-limited northern reaches of the Rio Grande, nearly 100 percent of home ranges had a native vegetation

component and overstory vegetation structure, indicating that this habitat type is a requirement for cuckoo breeding habitat. It is likely that the abundance of this habitat type in The Narrows of Elephant Butte Reservoir is a key factor in the observed growth of the YBCU population in this area over the last several years.

RECOMMENDATIONS

1. Continued radio tracking of cuckoos throughout the Middle Rio Grande to gather information on patch size and vegetation composition requirements of cuckoo breeding habitat.
2. Locate and monitor nests in order to gain knowledge of reproductive success and nesting cycles.
3. Measure vegetation characteristics at confirmed nest sites to define nest site requirements.

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PEER REVIEW DOCUMENTATION

PROJECT AND DOCUMENT INFORMATION

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Document Date December 2019

Team Leader Dave Moore, 86-68290, Wildlife Biologist

Document Author(s)/Preparer(s) K. Dillon and D. Moore

Peer Reviewer Tori Barron, 86-68290, Biologist

Peer Reviewer _____

REVIEW REQUIREMENT

Part A: Document Does Not Require Peer Review

Explain _____

Part B: Document Requires Peer Review: SCOPE OF PEER REVIEW

Peer Review restricted to the following Items/Section(s):	Reviewer:
Complete Document Subject to Review	Tori Barron

REVIEW CERTIFICATION

Peer Reviewer - I have reviewed the assigned Items/Section(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer: Tori Barron Review Date: December 23, 2019 Signature: Tori Barron

Reviewer: _____ Review Date: _____ Signature: _____

I have discussed the above document and review requirements with the Peer Reviewer and believe that this review is completed, and that the document will meet the requirements of the project.

Team Leader: Dave Moore Date: December 23, 2019 Signature: Dave Moore