Yellow-billed Cuckoo Surveys in New Mexico, 2022

Prepared for:
New Mexico Department of Game and Fish
1 Wildlife Way
Santa Fe, NM 87507

Prepared by:
John R. Stanek
Southern Sierra Research Station
P.O. Box 1316
Weldon, CA 93283

Submitted:
June 2023

Contents

List of Tables

List of Figures

Introduction

The western yellow-billed cuckoo (*Coccyzus americanus*) was historically described as common in appropriate habitat (Grinnell and Miller 1944) and could be found west of the Continental Divide from Texas to British Columbia. Following the extensive loss of riparian forest over the last century, the western yellow-billed cuckoo population suffered significant range reductions and extirpations from large areas of its historical range (Gaines and Laymon 1984, Halterman et al. 2001, Hughes 2020). In 2001, the United States Fish and Wildlife Service (USFWS) formally recognized the western yellow-billed cuckoo population as a separate Distinct Population Segment (DPS) and a candidate for protective listing under the Endangered Species Act (Figure 1, USFWS 2001). In 2014, the USFWS officially recognized the western yellow-billed cuckoo DPS as a threatened species under the Endangered Species Act (USFWS 2014), and in 2021 the USFWS finalized the critical habitat designation for the DPS (Figure 1, USFWS 2021).

Eleven of twelve states within the DPS, Arizona (AZ), California (CA), Colorado (CO), Idaho (ID), Nevada (NV), Montana (MT), New Mexico (NM), Oregon (OR), Utah (UT), Washington (WA), Texas (TX), and Wyoming (WY) have recognized the yellow-billed cuckoo (hereafter "cuckoo") as a Species of Greatest Conservation Need (SGCN). State Wildlife Action Plans identify data needs and management actions to advance conservation of this species, but there is a fundamental lack of knowledge on the species' current distribution. Most of the potential habitat within the DPS range has not been systematically surveyed for cuckoos, resulting in a lack of knowledge of the species. This crucial impediment prevents the efficient evaluation of conservation concerns and hinders targeted on-the-ground conservation.

The twelve states within the DPS range, Southern Sierra Research Station, and Klamath Bird Observatory collaborated on the "Western Yellow-billed Cuckoo Range-wide Occupancy Assessment" proposal and received federal funding through the Competitive State Wildlife Grant (C-SWG) program. This project addresses critical data gaps by bringing together all states within the western DPS to implement three linked objectives:

1) develop a western DPS range-wide Species Distribution Model (SDM),
2) implement a western DPS range-wide survey, and
3) investigate use of autonomous recording units (ARUs) as an alternate survey method.

For Objective 1, the Utah Division of Wildlife Resources (UT DWR) identified potential breeding habitat throughout the western DPS range by developing a SDM using extant location data, imagery, and several bio-physical factors; all states contributed data and evaluated records for inclusion in the data set. For Objective 2, partner states implemented the first ever coordinated and standardized range-wide cuckoo survey using the USFWS call-broadcast protocol (Halterman et al. 2016) to identify and estimate cuckoo habitat occupancy both across their range and within each participating state. The 2014 proposed critical habitat for cuckoo was used as a surrogate estimate of modeled riparian habitat to allocate effort by state for the 2022 range-wide survey, with a minimum effort assigned for states without any proposed critical habitat. Results from the Objective 2 surveys conducted in 2022 will be used to inform and refine Objective 1 model improvements. Finally, for Objective 3, California Department of Fish and Wildlife (CDFW) conducted surveys and ARU monitoring at select sample units to

investigate if acoustic recordings provide estimates of detection probability comparable to the call-broadcast protocol.

This report focuses on the planning and implementation of cuckoo surveys conducted in New Mexico by the Southern Sierra Research Station (SSRS) and New Mexico Department of Game and Fish (NMDGF) in 2022 to meet the Objective 2 goals within New Mexico.
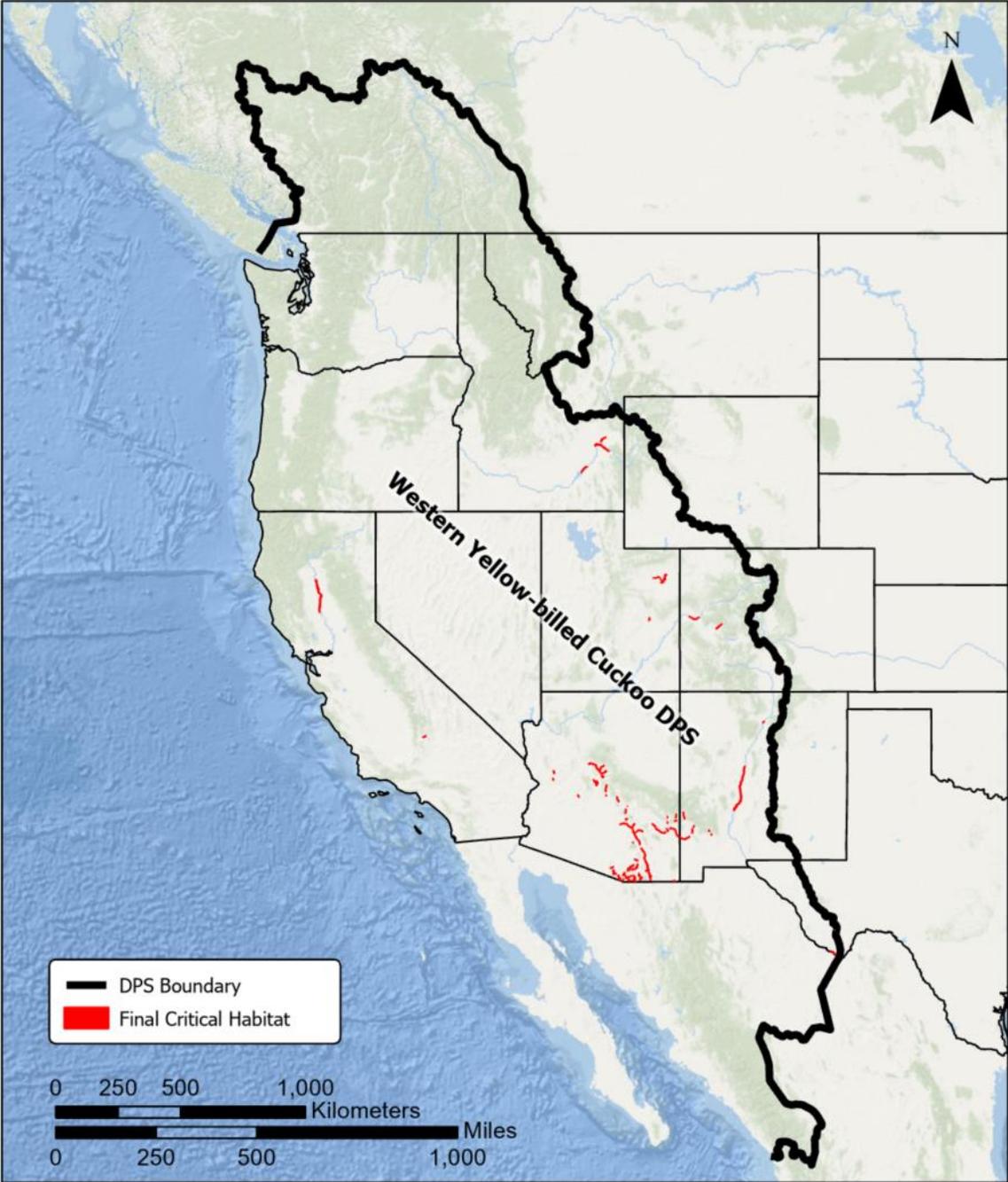

Figure 1. Western Yellow-billed Cuckoo Distinct Population Segment (DPS) boundary and designated critical habitat (USFWS 2021).

Methods

Sample Unit Selection

Under Objective 1, UT DWR developed a preliminary SDM for the western DPS, based on historical cuckoo observation data and covariates. This preliminary SDM, a modelled grid of 1 km^2 cells of potentially suitable cuckoo habitat, was used as the foundation for the Objective 2 sampling frame. The core team of this project, a collaboration of UT DWR staff, AZ Game and Fish Department (AZGFD) statistician and staff, NMDGF staff, CDFW staff, and SSRS staff, finalized the sampling strata, and developed a non-subjective ruleset to guide the sample unit review process to assess sample units for inclusion or rejection for the 2022 range-wide survey effort. Based on estimated strata variances, 25% of the sample units in each state were allocated to modeled SDM sample units, and 75% were allocated to sample units with historical occupancy.

Modeled habitat and historical occupancy sample units were randomly ranked and reviewed by NMDGF and SSRS staff with the goal of identifying a minimum of 39 sample units (also called grid cells, survey sites, sites) to survey, plus additional sample units to be used as backup/replacement sites as needed or as additional sites if surveyor capacity allowed for a greater number of surveys. The core team determined that a minimum of one survey point within potentially suitable habitat must be present within a grid cell in order to retain the sample unit and that 10 survey points per site was the minimum survey effort for efficiency; sample units that did not contain any suitable habitat were removed from the sampling frame to ensure that inferences would not be made in areas lacking cuckoo habitat. During the assessment process, sample units were rejected if any of the following were true: no suitable habitat (zero trees/tall shrubs) within the sample unit; insufficient habitat to survey (fewer than 10 survey points) within and adjacent to the sample unit; inaccessible due to logistical constraints (no access permission or >1 hour of hiking required to access the site); or the area was considered unsafe. Sample units were also rejected if another entity was planning to conduct surveys within the sample unit during the 2022 breeding season. Because other entities surveying for cuckoos would follow the same USFWS survey protocol as the range-wide project, data from these rejected "other entity" sample units will be incorporated into the final SDM (Objective 1) and occupancy model analyses (Objective 2) to be completed by June 2023. The Bureau of Reclamation (Reclamation) provided valuable insights regarding habitat suitability along the Rio Grande; multiple sites were rejected due to lack of habitat because of recent catastrophic bosque fires.

Surveys

Occupancy and cuckoo detection totals calculated from standard cuckoo surveys are the standard metrics used to describe cuckoo survey results (Stanek and Stanek 2012, McNeil et al. 2013, Halterman et al. 2016). However, cuckoo secretive traits, variable responsiveness, and somewhat transitory behavior leads to imperfect detection of the species (McNeil et al. 2013, Johnson and Benson 2022). Locating cuckoos can be difficult, as they are inherently secretive, avoid detection and call infrequently (Hamilton and Hamilton 1965, Halterman et al. 2016). Furthermore, their responsiveness to call-broadcast surveys varies with their breeding stage (McNeil et al. 2013, SSRS unpublished data). In addition to variable detectability, cuckoo behaviors, such as large overlapping home-ranges, polyandry, local movement, and within-

season emigration or immigration, add uncertainty in estimating cuckoo populations. In sum, estimating cuckoo abundance from survey data is difficult, and it is possible to both under count or over count the number of cuckoos present (Halterman et al. 2016). As such, survey results are best suited to estimate cuckoo habitat occupancy rather than cuckoo abundance.

For the range-wide surveys, field staff followed the standard USFWS call-broadcast cuckoo survey methodology (Halterman et al. 2016), with a single modification approved by the USFWS, to conduct three surveys per site instead of four. The standard cuckoo survey protocol calls for four surveys from June 15 to August 15, approximately once every two weeks (Halterman et al. 2016). The decision to conduct only three surveys was derived from the need to maximize the sample size while maintaining a statistically viable sampling effort. For the range-wide project, three surveys were conducted during the first three standard survey periods (Table 1) from June 15 to July 31 and timed to coincide with maximum cuckoo detectability (Halterman et al. 2016). Call-broadcast surveys greatly increase cuckoo response and detection (Halterman et al. 2016). Cuckoos are significantly less responsive to call-broadcast recordings after nestlings fledge, generally in August during the standard fourth survey (McNeil et al. 2013); Dillon et al. (2018) report that conducting a fourth cuckoo survey only marginally increases the 95% positive occupancy identification achieved from three surveys. For the range-wide project, occupancy and territory estimates will be based off the results of three surveys, which will be conservative but comparable to results based off four surveys, especially if fourth survey data are removed from other data sources in comparative analyses.

Table 1. Cuckoo survey dates for the Range-wide survey project, 2022

Survey Number	Survey Dates
1	June 15 – June 30
2	July 1 – July 15
3	July 16 – July 31

Prior to the field season, NMDGF identified potential survey routes using digital aerial imagery and property boundaries, with consideration of logistical access constraints and coverage of suitable habitat within and adjacent to the sample unit; to the degree practicable, all suitable habitat within the selected grid was surveyed before moving into an adjacent sample unit. Field technicians were instructed to conduct protocol call-broadcast surveys at a minimum of 10 survey points, with a goal of up to 25 survey points per survey visit to maximize survey coverage each morning. The amount of visually apparent (as determined pre-survey from aerial imagery) and on the ground habitat (as estimated by field staff during surveys) varied between sample units. Sample units were not visited prior to 2022 field survey implementation. Field staff were allowed to alter planned survey routes if needed based on habitat and environmental conditions encountered on their first visit to the site.

New Mexico Department of Game and Fish personnel were already permitted to survey cuckoos under the Department's Native Endangered and Threatened Species Recovery Permit ESPER0007078. Stanek (TE-017549) and Hathcock (TE082492-0) were also permitted prior to 2023, and other SSRS staff (Stewart, Petersen, Moulton and, Godfrey) received training and

were added to the SSRS list of authorized individuals to conduct cuckoo surveys in NM under TE-017549-7.3. SSRS also obtained the required NMDGF Special Use Permit 3855 to conduct surveys.

Southern Sierra Research Station and NMDGF staff conducted surveys following the recommended cuckoo survey protocol (Halterman et al. 2016). Surveys were conducted along point transects on foot prior to sunrise until 10:30 am. Survey points were spaced 100m apart, unless a cuckoo was detected at the prior point or between points (see below). Upon arriving at a survey point, surveyors listened and watched for cuckoos for one minute. If no cuckoos were detected, surveyors used an mp3 player and handheld speaker (SSRS) or FoxPro Unit (NMDGF) to broadcast a five-second yellow-billed cuckoo contact call at approximately 70 decibels once per minute for five minutes. Each five-second contact call was followed by 55 seconds of active observation and listening. If a cuckoo was detected, call-playbacks were discontinued immediately, and all pertinent data recorded. Following a detection, surveyors progressed along the point transect 300m from the cuckoo's estimated location to conduct the next call-broadcast sequence. Moving 300m from the bird's estimated location is done to avoid/minimize additional disturbance and prevent duplicate detections of the same cuckoo (Halterman et al. 2016).

For each survey point and cuckoo detection, the surveyor recorded pertinent data required by the protocol, including time of detection, response type, observed behavior, vocalizations, presence of other cuckoos, and any observed interactions between cuckoos. Any evidence of breeding was recorded, including carrying food or nesting material, copulation, the presence of a juvenile, or a nest. An individual cuckoo visually observed or heard during a survey was recorded as a survey detection. Based on observer inference, if the same individual cuckoo was detected more than once during a single survey, the initial detection was recorded as a "new" survey detection. Repeat detections of the same individuals were recorded as a "repeat" detection and not used in the final cuckoo survey detection summation. In general, cuckoos located >300m apart during a single survey were counted as separate individuals (Halterman et al. 2016) and therefore separate survey detections. Cuckoos encountered any time other than during a survey were classified as incidental detections. The same data were collected for incidental and survey detections.

During cuckoo surveys, the presence of NM avian SGCN (Appendix 1) were passively monitored and recorded to fill in state distribution and population data gaps. All data were collected using the ESRI Field Maps app on personal android and Apple smartphones. Data were synced as often as possible, usually daily, with the project's ArcGIS Online map hosted by the UT DWR.

Habitat Characteristics

At each site, surveyors visually estimated various habitat metrics to characterize the entirety of the area surveyed (described in Halterman et al. 2016, with additional clarifying instructions in USFWS and BOR 2021). Estimated habitat data included: overall native vs non-native vegetation composition (%), average overstory height for the site, estimated site canopy cover, the five most abundant canopy species and their respective percent cover, the five most abundant understory species and their respective percent cover, and adjacent habitat types (such

as agriculture, residential, pinyon-juniper woodland, mixed conifer forest, etc.). The habitat data were recorded using the ESRI Field Maps app on personal android and Apple smartphones.

Breeding Territories

While surveys are best used to assess cuckoo occupancy, cuckoo territory estimation methods, based on spatial and temporal cuckoo detections, have been developed to help provide a population estimate. The territory estimation method, evolved from a Breeding Bird Atlas breeding pair estimation method (Corman and Wise-Gervais 2005), has been refined over several years (Holmes et al. 2008, McNeil et al. 2013) and incorporated into the survey protocol (Halterman et al. 2016). We calculated possible, probable, and confirmed (Table 2) cuckoo territory estimates using the 2022 survey data.

Table 2. Cuckoo breeding territory estimation method based on cuckoo survey detections (from Halterman et. al 2016).

Breeding Territory Estimate	Definition
Possible Breeding Territory (PO)	Two or more total detections within a 300- to 500-m area during two survey visits and at least 10 days apart.
Probable Breeding Territory (PR)	Three or more total detections within a 300- to 500-m area during at least three survey visits and at least 10 days between each detection. Or PO territory plus a cuckoo observed carrying food (single observation), carrying a stick (single observation), traveling as a pair, or exchanging vocalizations with another cuckoo.
Confirmed Breeding Territory (CO)	Observation of copulation, stick carry to nest, carrying food (multiple observations), distraction display, nest, or fledgling.

Results

Sample Unit Selection

Based on the survey capacity of SSRS and NMDGF staff, 52 sites were selected for surveys, exceeding the planned effort of 39 sites based on range-wide site allocation by state. Following the developed ruleset, a total of 278 sites were evaluated via desktop review; NMDGF and SSRS staff identified and acquired permission to access 65 potential sample units in NM. During the first survey period, 13 sites were rejected and replaced with backup sites due to lack of habitat (n=2) or lack of access due to locked gates, poor road conditions, cliffs, flooding, or closures related to the Black Range Fire (n=11). Final sample units (n=52) were spread across the DPS range in NM, and located on city, state, federal, private, and tribal lands (Figure 2); access permission was acquired, as well as required permits from the State Land Office (SLO), Bandelier National Monument, San Ildefonso Pueblo, Middle Rio Grande Conservancy District (MRGCD), New Mexico Tech, Ladder Ranch, Corrales Bosque Preserve, Rio Rancho Bosque, and Albuquerque Open Space. One of these 52 sites, Site 0161, was surveyed by U.S. Forest Service (USFS) in June, and NMDGF in July. During the sample unit review process, 91 sample units were rejected because other entities planned to conduct cuckoo surveys in these areas in 2022; these rejected sites included: 6 sites for EcoPlateau on The Nature Conservancy
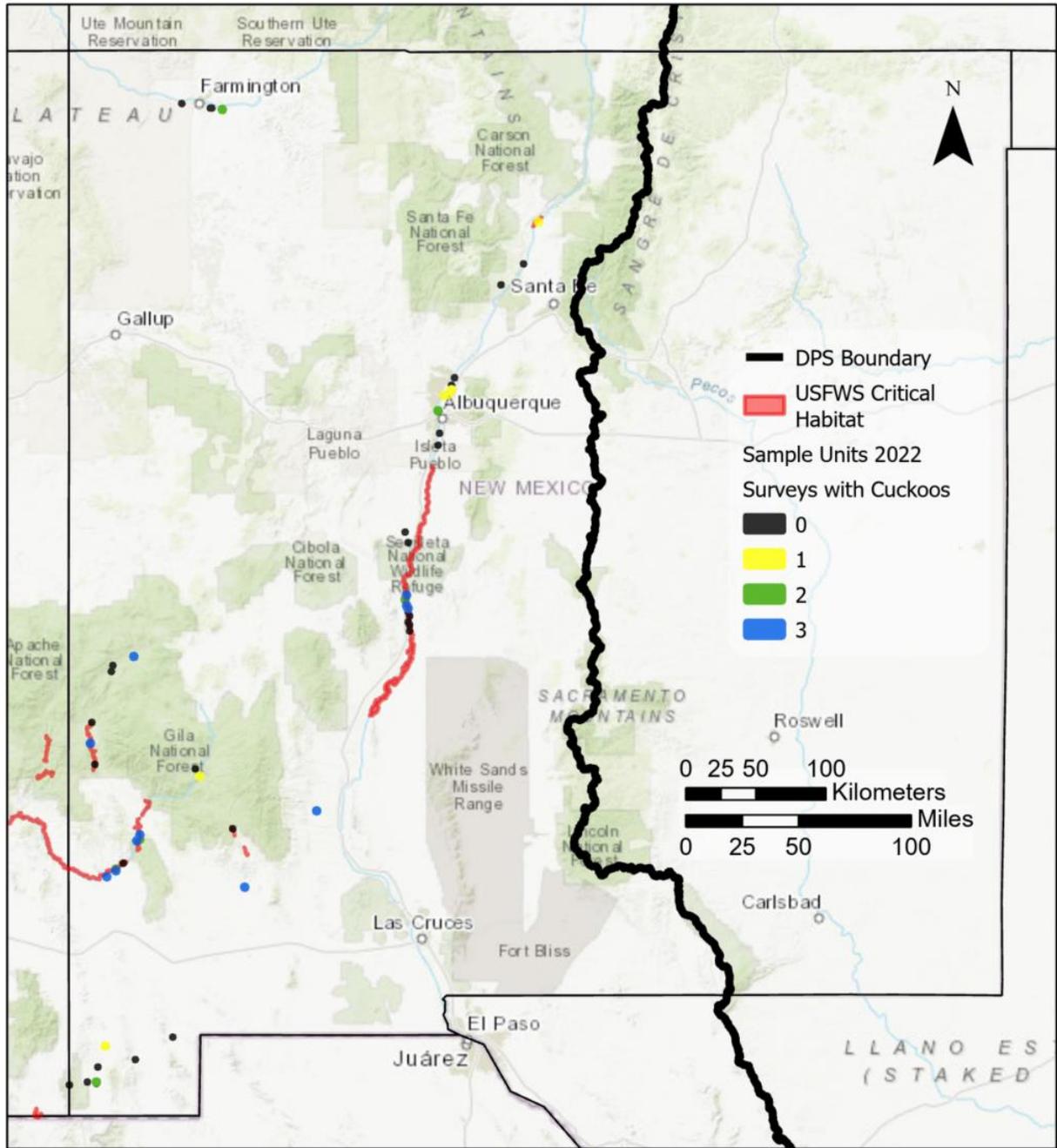
Figure 2. Distribution of 52 Yellow-billed Cuckoo survey sites (sample units) surveyed in New Mexico, 2022.

Nineteen sites were located within designated Yellow-billed Cuckoo Critical Habitat (USFWS 2021). Cuckoos were not detected at 29 sites (black dots). Cuckoos were detected on a single survey at six sites (yellow dots), on two surveys at six sites (green dots), and on all three surveys at eleven sites (blue dots).

(TNC) properties on the Gila River, 5 sites for the USFWS at Bosque del Apache Wildlife Refuge on the Rio Grande, and 80 sample units for Reclamation on the Rio Grande. 2022 data from these 91 rejected sample units, as well as 2022 data from additional surveys completed by

7

Reclamation, Sevilleta National Wildlife Refuge, Los Alamos National Laboratory, Bureau of Land Management (BLM), Ecosphere, Bosque del Apache, EcoPlateau, and TetraTech are not included in this report, but will be incorporated into the second iteration of the Objective 1 SDM (all other entity data) and Objective 2 occupancy estimates (data from the 91 sample units) for the range-wide project.

Due to the high number of sample sites with historic occupancy where other entities planned to survey in 2022, the decision was made to increase the number of modeled sites surveyed by SSRS and NMDGF. Although the original distribution was planned as 75% historic:25% modelled sites, the final site distribution was 63% historic (n=33):37% modelled (n=19).

Surveys

From June 16 to Aug 2, SSRS field staff (6) and NMDGF staff (2) conducted cuckoo surveys at 52 sites, three times each, at a total of 2,955 survey points, yielding 99 total cuckoo survey detections (Table 3, Figures 2-14). Across all 52 sites, the average site point transect was 2.6 kilometers in length (Figures 3-14), encompassing an average of 19 call-broadcast survey points each. Cuckoo detections were highest in the Gila River area (n = 42) and at sites along the middle Rio Grande near Socorro (n = 21). Individual sites with the greatest number of detections were found at the Gila River sites 1005 (n = 13), site 0181 (n = 10), middle Rio Grande Socorro site 1433 (n = 10), and along the Las Animas Creek on the Ladder Ranch at site 0178 (n= 10). Sites included suitable habitat on the Department's Socorro-Escondida (site 0914), Heart-Bar (site 0192), River Ranch (site 1485), and Red Rock (site 0995) Wildlife Management Areas (WMA), and cuckoos were detected on the Socorro-Escondida (site 0914) and River Ranch (site 1485) properties.

Across the 52 surveyed sites, a total of 20 survey routes were either within (n = 19), or partially within (n = 1), the final critical habitat designated by the USFWS (USFWS 2021). Cuckoos (n = 65) were detected on 11 of these 20 survey routes within designated critical habitat; cuckoos (n=34) were detected on 11 of 32 routes outside critical habitat.

Breeding Territories

Following the territory estimation methods outlined in the survey protocol (Table 2), based on survey detections and behavior observations, a total of 29 breeding territories were estimated at the surveyed sites, including 18 Possible, 9 Probable, and 2 confirmed. Possible breeding territories include detections in the same area during 2 survey visits. Probable territories were based on 3 or more total detections in an area over 3 survey visits, and/or two or more detections in an area where vocal exchanges were observed between cuckoos. Confirmed territories were based on an observed copulation and locating a cuckoo fledgling.

Table 3. Cuckoo survey detections and estimated territories in NM, 2022.

River Reach	Site - Ownership[A]	Detections by survey visit				Territories [B]		
		1	2	3	Total	PO	PR	CO
San Juan River	1059 - SLO	0	0	0	0	0	0	0
	1027 - Private	0	0	0	0	0	0	0
	1452 - Private	0	0	0	0	0	0	0
	1004 - BLM	0	1	1	2	1	0	0
	San Juan River total	**0**	**1**	**1**	**2**	**1**	**0**	**0**
Rio Grande (near Espanola)	0916 - State	0	1	0	1	0	0	0
	1023 - San Ildefonso Pueblo	0	0	0	0	0	0	0
	Rio Grande (Esp.) total	**0**	**1**	**0**	**1**	**0**	**0**	**0**
Los Frijoles	0932 - Bandelier National Monument	0	0	0	0	0	0	0
	Los Frijoles total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Rio Grande (near Albuquerque)	0180 - Rio Rancho Bosque	0	0	0	0	0	0	0
	0950 - Corrales Bosque Preserve	0	0	0	0	0	0	0
	1549 - Corrales Bosque Preserve	1	0	0	1	0	0	0
	1446 - Corrales Bosque Preserve	0	1	0	1	0	0	0
	1047 - Corrales Bosque Preserve	0	1	0	1	0	0	0
	1445 - Albuquerque Open Space	1	1	0	2	1	0	0
	1546 - Albuquerque Open Space	0	0	0	0	0	0	0
	0920 - SLO + Albuquerque Open Space	0	0	0	0	0	0	0
	Rio Grande (Abq.) total	**2**	**3**	**0**	**5**	**1**	**0**	**0**
Rio Puerco	1055 - BLM	0	0	0	0	0	0	0
	1536 - BLM	0	0	0	0	0	0	0
	Rio Puerco total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Rio Grande (near Socorro)	1430 - BLM + MRGCD	1	2	2	5	0	1	0
	0986 - MRGCD	0	1	1	2	1	0	0
	0914 - WMA + MRGCD	1	2	1	4	1	1	0
	1433 - NM Tech	3	2	5	10	1	2	0
	0930 - NM Tech + MRCGD	0	0	0	0	0	0	0
	0955 - NM Tech + MRCGD	0	0	0	0	0	0	0
	1428 - MRGCD	0	0	0	0	0	0	0
	0174 - MRGCD	0	0	0	0	0	0	0
	0926 - MRGCD	0	0	0	0	0	0	0
	Rio Grande (Soc.) total	**5**	**7**	**9**	**21**	**3**	**4**	**0**
Las Animas Creek	0178 - Private	1	3	6	10	2	1	0
	Las Animas Creek total	**1**	**3**	**6**	**10**	**2**	**1**	**0**

Table 3. (cont.) Cuckoo survey detections and estimated territories in NM, 2022.

River Reach	Site - Ownership [A]	Detections by survey visit				Territories [B]		
		1	2	3	Total	PO	PR	CO
Tularosa River	1527 - USFS	1	1	1	3	0	1	0
	Tularosa River total	**1**	**1**	**1**	**3**	**0**	**1**	**0**
San Francisco River	1422 - USFS	0	0	0	0	0	0	0
	1421 - USFS	0	0	0	0	0	0	0
	1052 - USFS	0	0	0	0	0	0	0
	0161 - USFS	1	1	1	3	0	1	0
	1405 - USFS	0	0	0	0	0	0	0
	San Francisco total	**1**	**1**	**1**	**3**	**0**	**1**	**0**
Gila River	0192 - WMA + USFS	0	0	0	0	0	0	0
	0997 - USFS	0	0	1	1	0	0	0
	0181 - Private	3	4	3	10	1	1	0
	0165 - USFS	0	1	4	5	1	0	0
	1005 - Private + USFS	2	6	5	13	2	1	1
	0995 - WMA	0	0	0	0	0	0	0
	1389 - Private	0	1	1	2	1	0	0
	1003 - Private	1	3	2	6	2	0	0
	1383 - Private	2	1	2	5	2	0	0
	Gila River total	**8**	**16**	**18**	**42**	**9**	**2**	**1**
Mimbres River	1011 – TNC	0	0	0	0	0	0	0
	1485 - WMA	4	2	1	7	1	0	1
		4	**2**	**1**	**7**	**1**	**0**	**1**
Nachita Valley	1058 - SLO + BLM	0	0	0	0	0	0	0
	Nachita Valley Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gillespie Creek	0194 - SLO	0	0	0	0	0	0	0
	Gillespie Creek Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Animas Creek	0941 - Private	3	0	0	3	0	0	0
	1044 - Private	0	0	0	0	0	0	0
	1370 - Private	1	0	1	2	1	0	0
	0173 - Private	0	0	0	0	0	0	0
	Animas Creek Total	**4**	**0**	**1**	**5**	**1**	**0**	**0**
Whitmire Creek	1028 - Private	0	0	0	0	0	0	0
	Whitmire Creek Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cottonwood Creek	1368 - USFS	0	0	0	0	0	0	0
	Cottonwood Cr. Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All Sites	**Grand Total**	**26**	**35**	**38**	**99**	**18**	**9**	**2**

[A] Ownership abbreviations: BLM – Bureau of Land Management, MRGCD – Middle Rio Grande Conservancy District, NM Tech – New Mexico Tech, SLO – State Land Office, State – New Mexico State Land, TNC – The Nature Conservancy, USFS – United States Forest Service, WMA – Wildlife Management Area.

[B] Territory abbreviations: PO – Possible Territory, PR – Probable Territory, CO – Confirmed Territory. See table 2 for definitions.
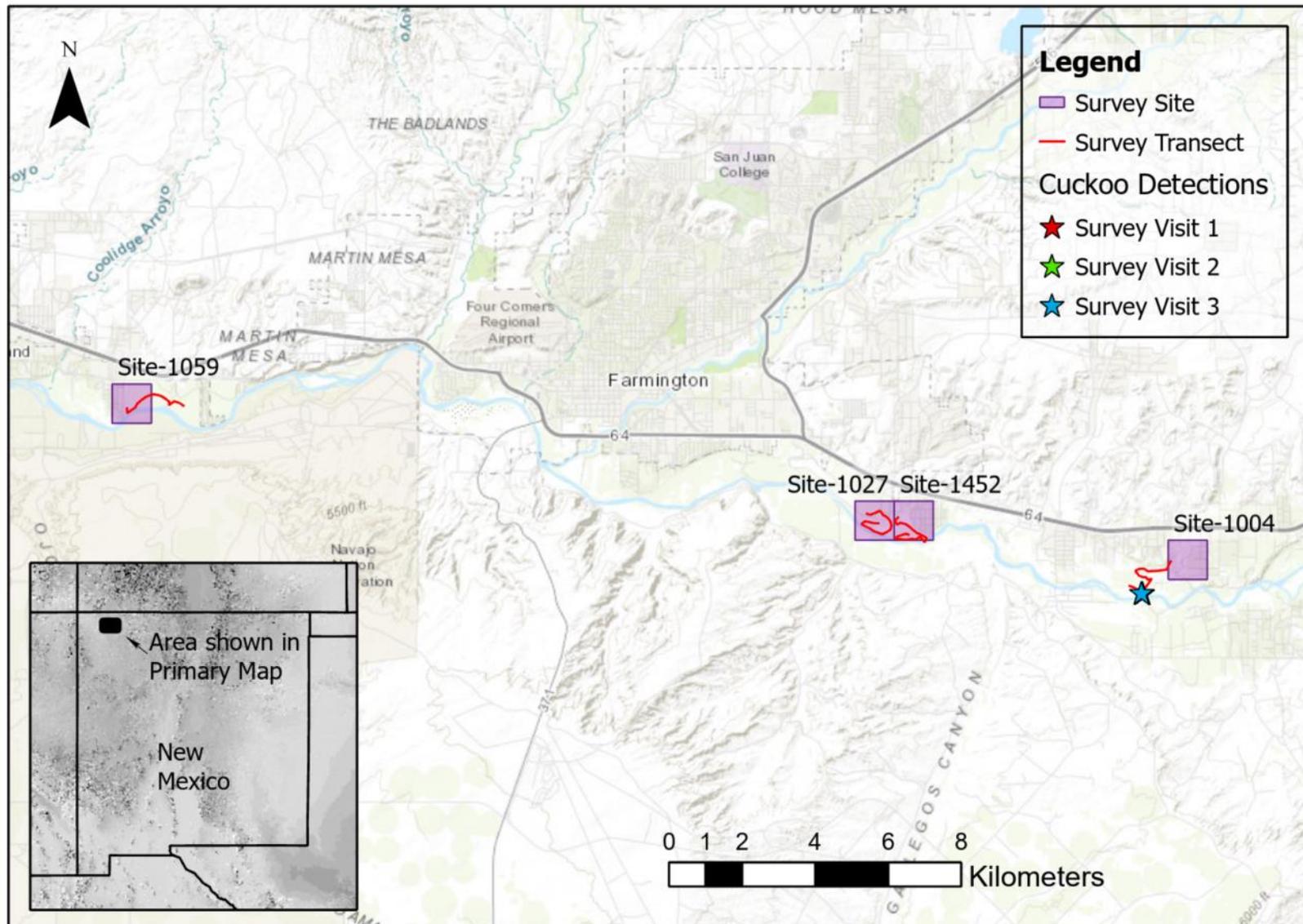
Figure 3. San Juan River sites and transects surveyed in 2022.
Two total cuckoos were detected at site 1004 on survey visits 2 and 3.

11

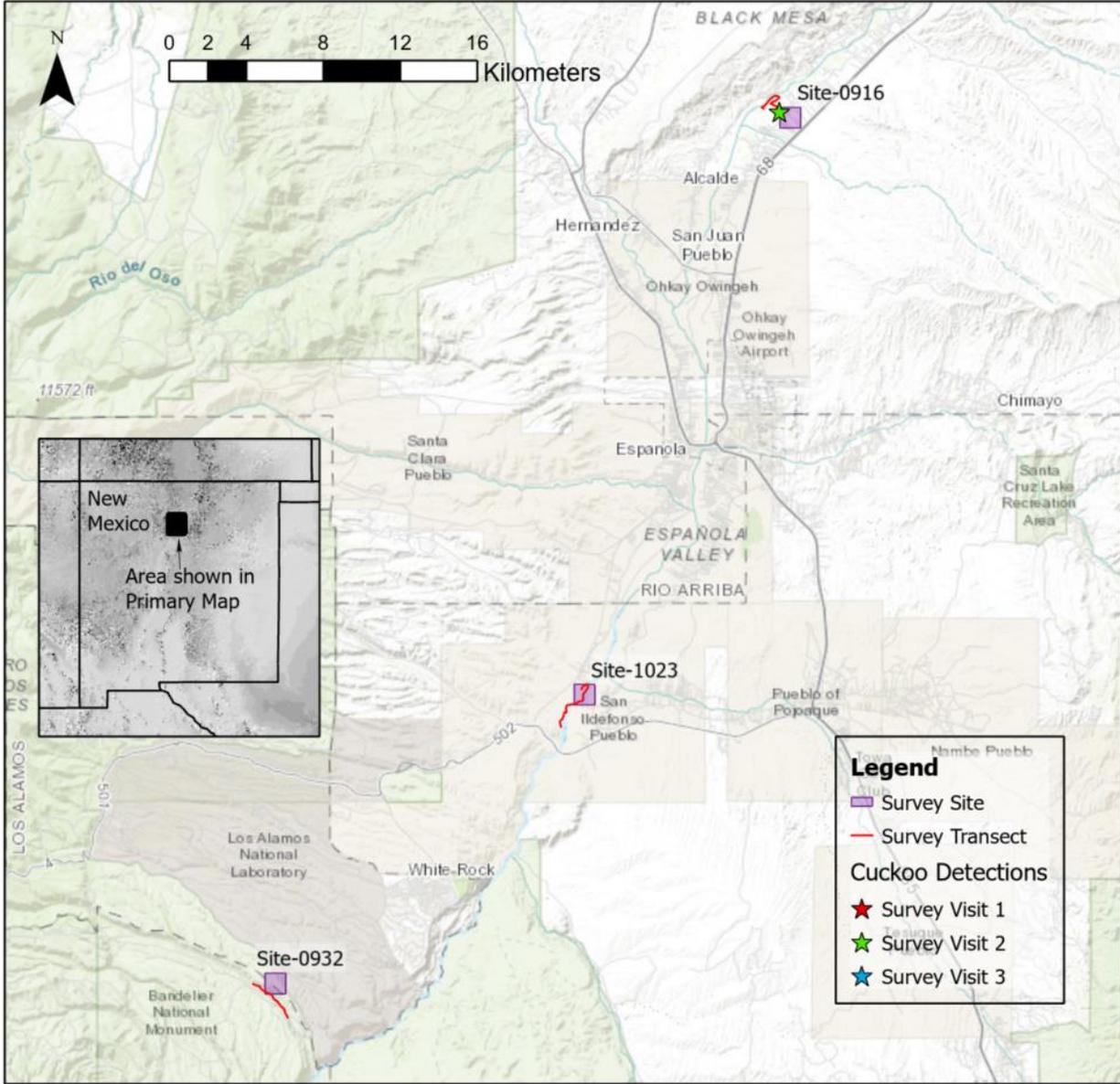**Figure 4**. Rio Grande sites (near Espanola) and transects surveyed in 2022.
A single cuckoo was detected at site 0916.
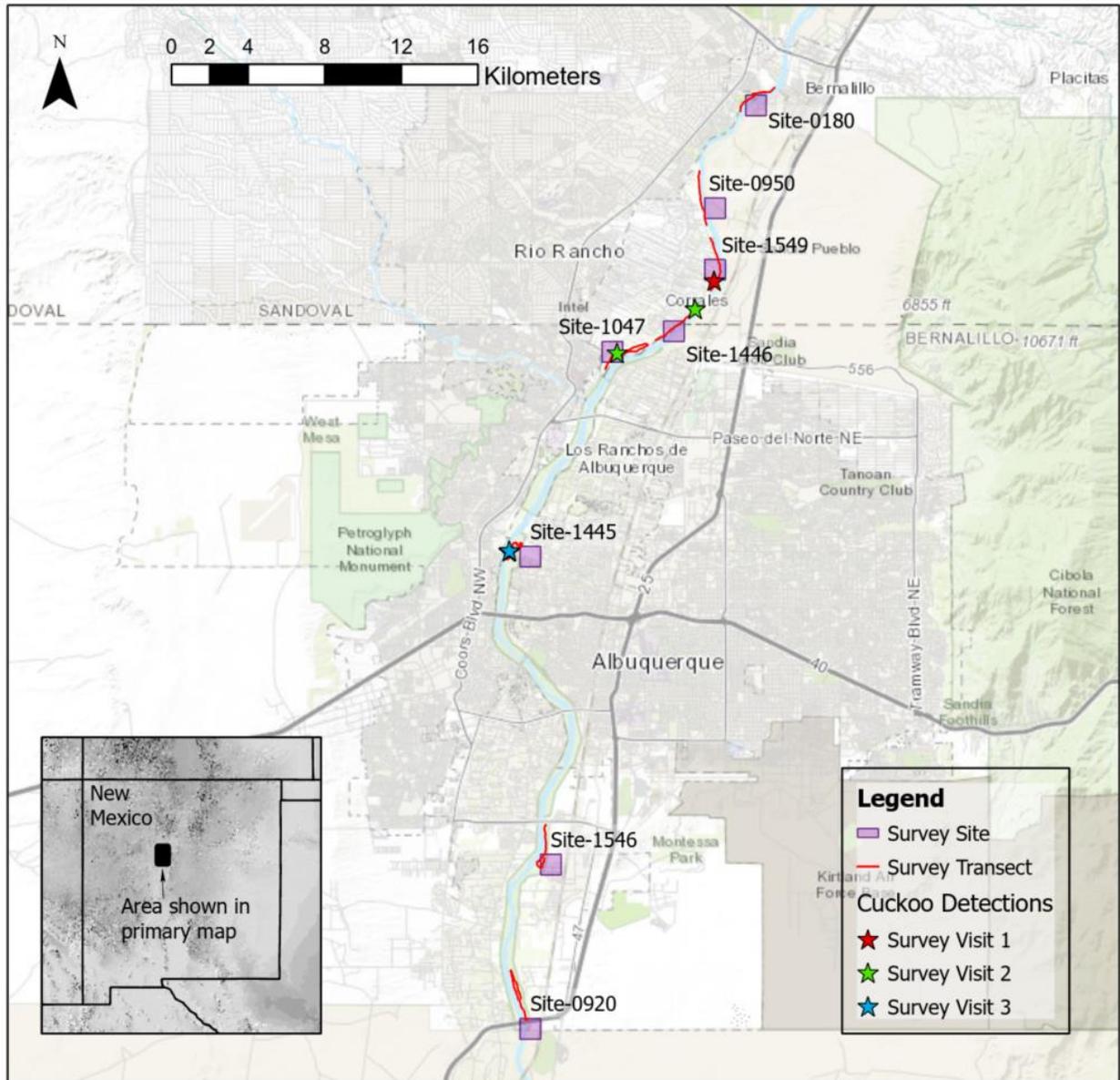
Figure 5. Rio Grande sites (near Albuquerque) and transects surveyed in 2022.
Five cuckoos were detected at these sites, including visit 2 and visit 3 detections at site 1445.
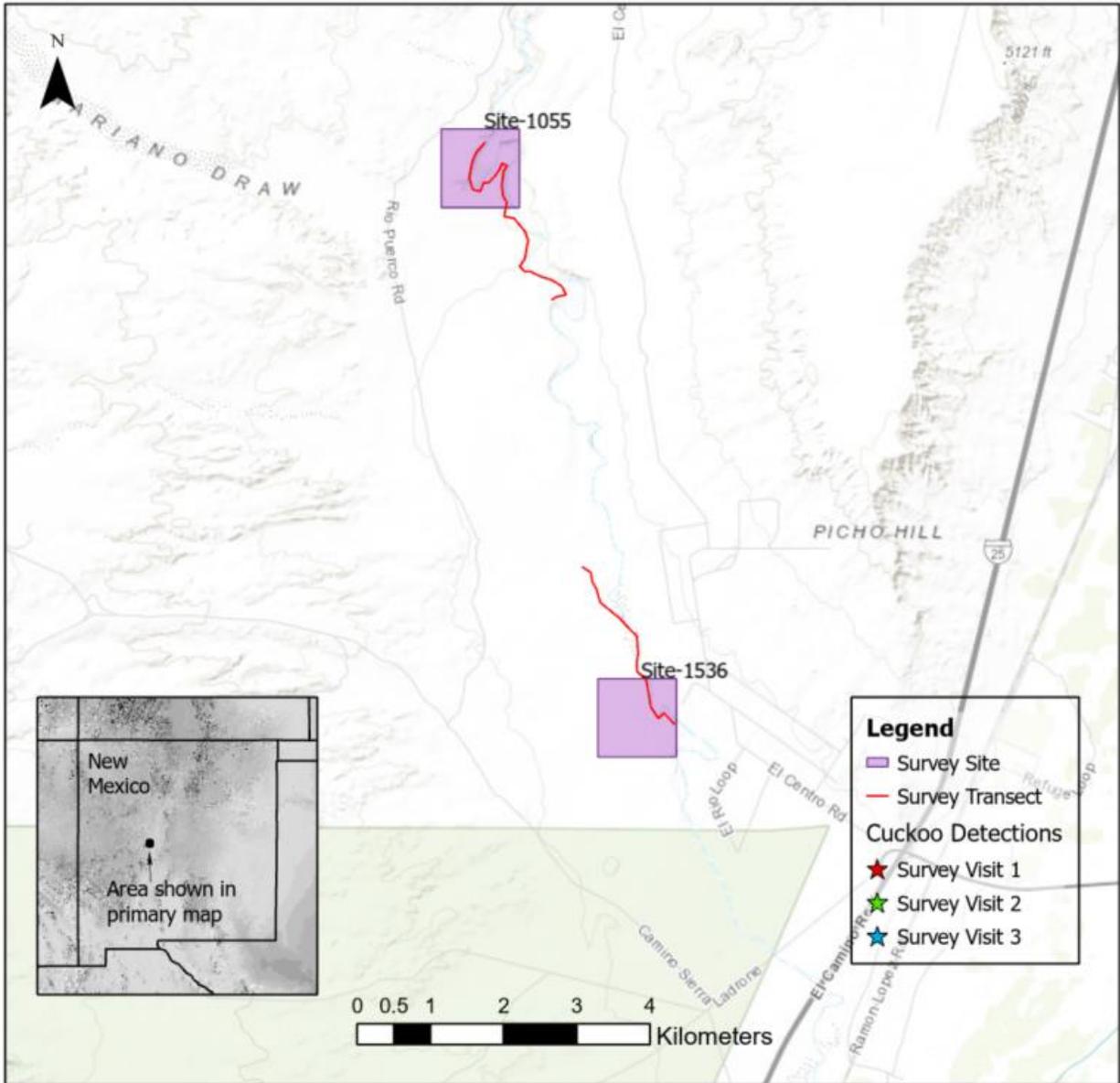
Figure 6. Rio Puerco sites and transects surveyed in 2022.
No cuckoos were detected at these sites.
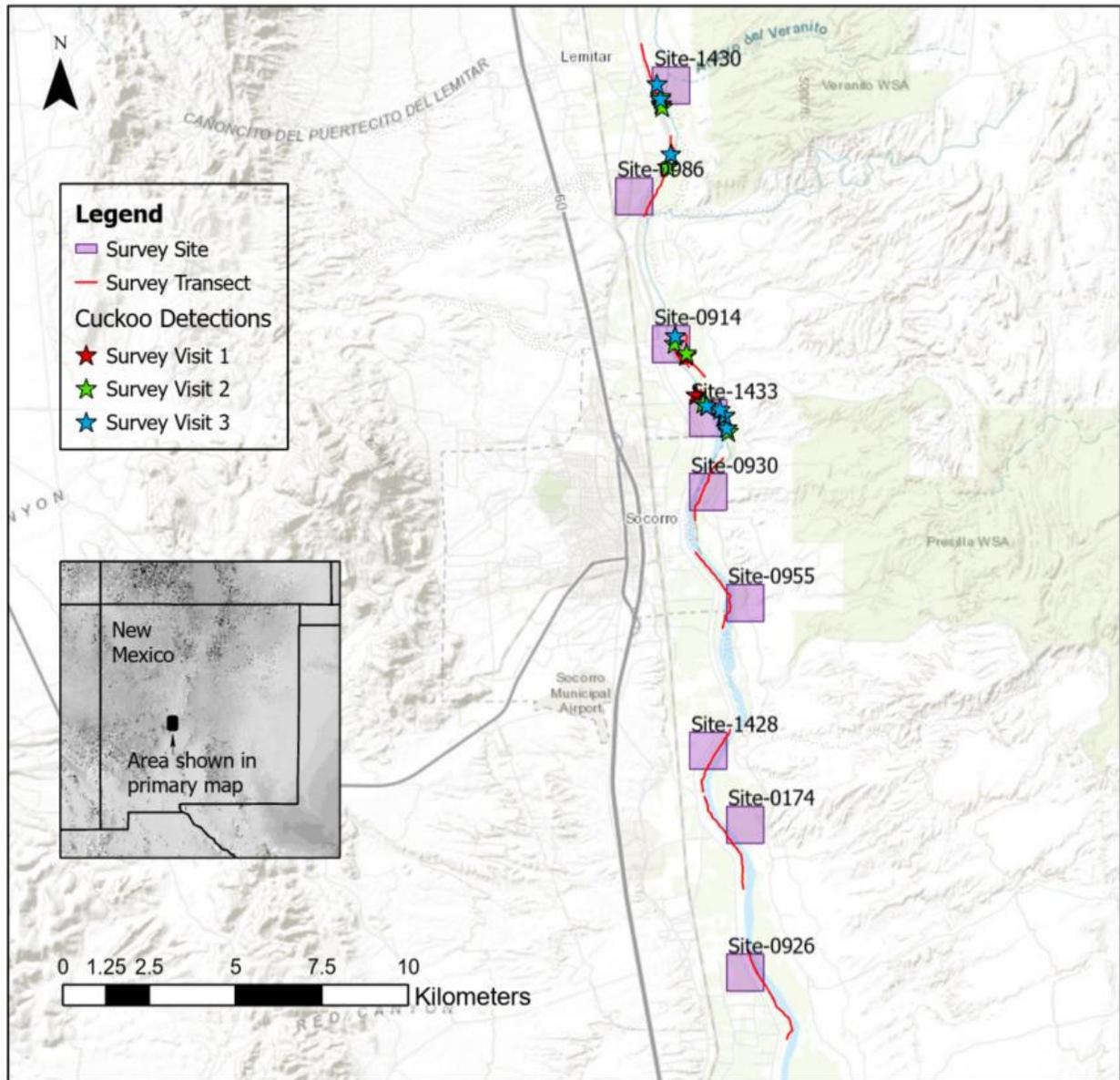
Figure 7. Rio Grande sites (near Socorro) and transects surveyed in 2022.
Field staff detected a total of 21 cuckoos over three survey visits across these nine sites. Site 1433 had a total of 10 cuckoo detections.
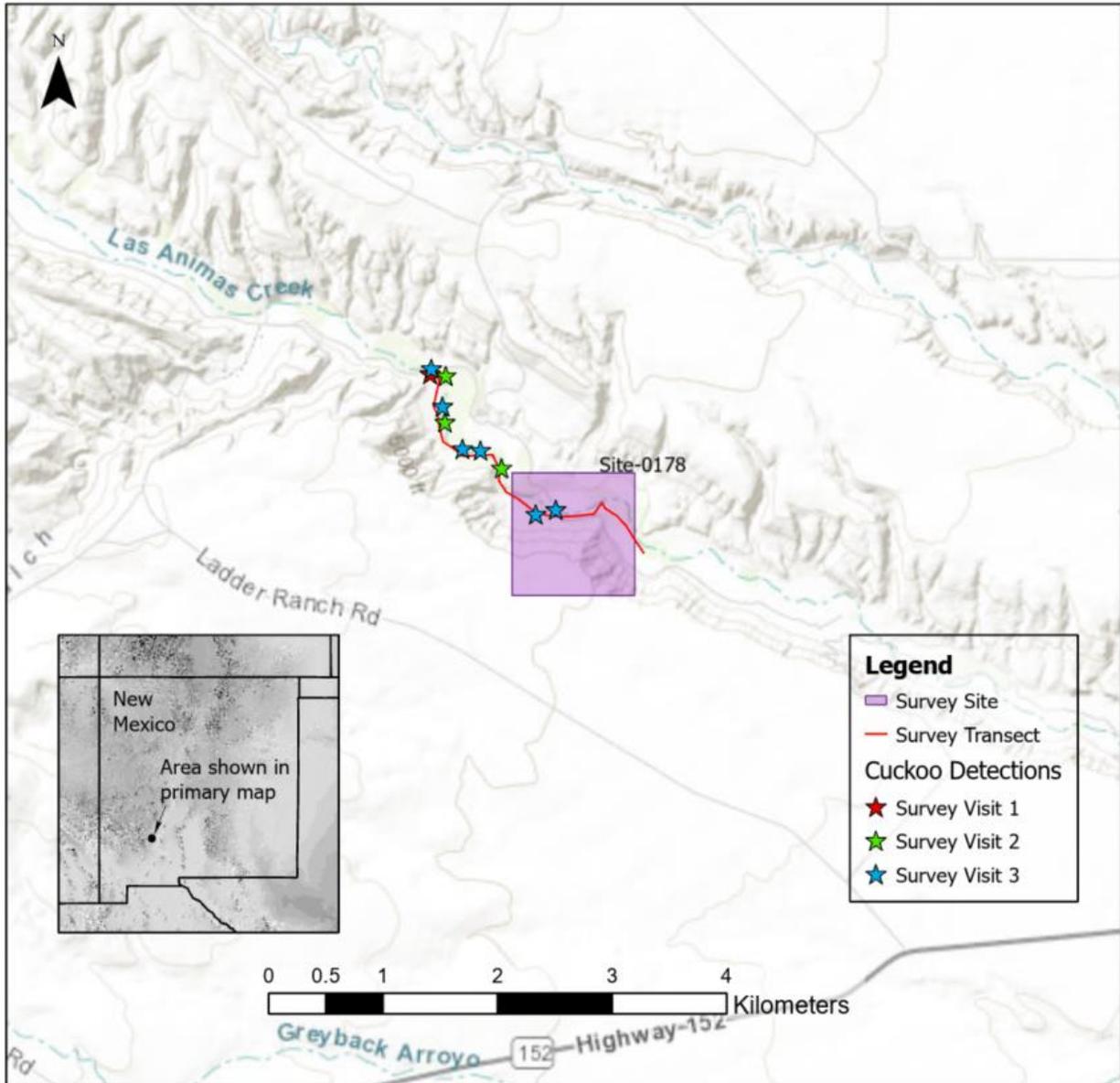
Figure 8. Las Animas Creek site (on the Ladder Ranch) and transect surveyed in 2022. Ten cuckoo detections, across all three survey visits, were made here in 2022.
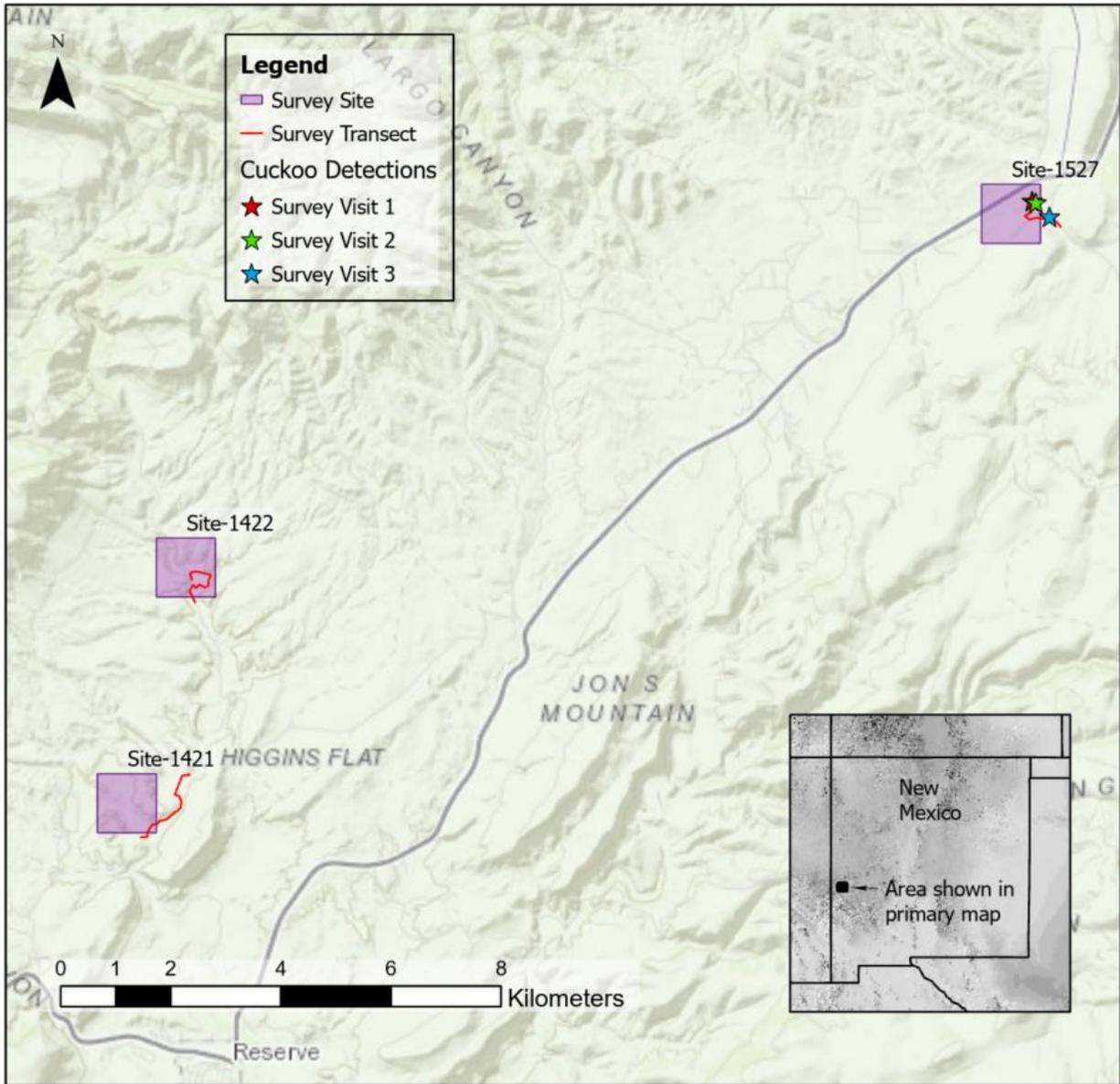
Figure 9. Tularosa and San Francisco River sites and transects surveyed in 2022. Tularosa site 1527 had three total cuckoo detections.
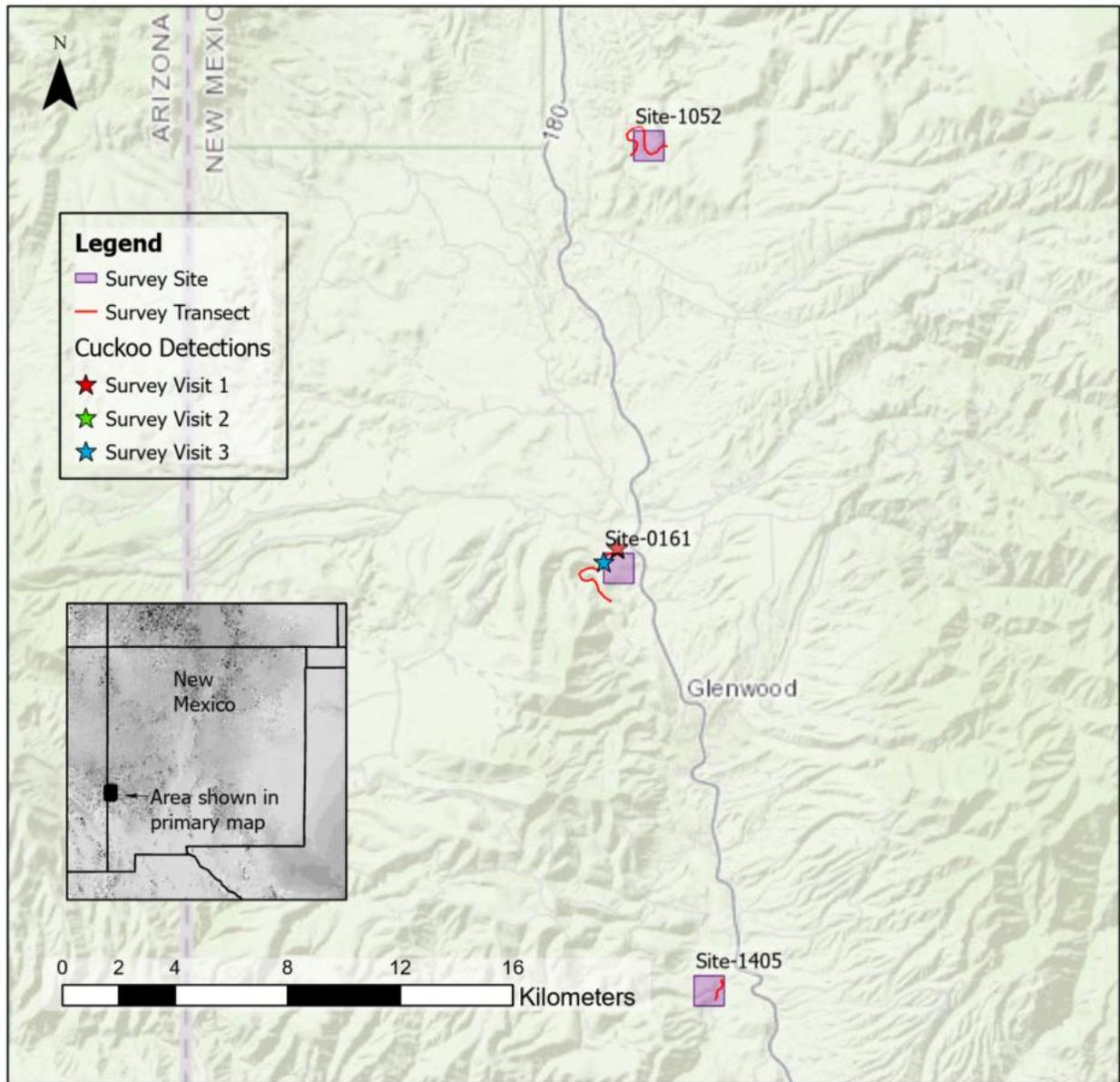
Figure 10. San Francisco River sites and transects surveyed in 2022.
Site 0161 had three total cuckoo detections in 2022.
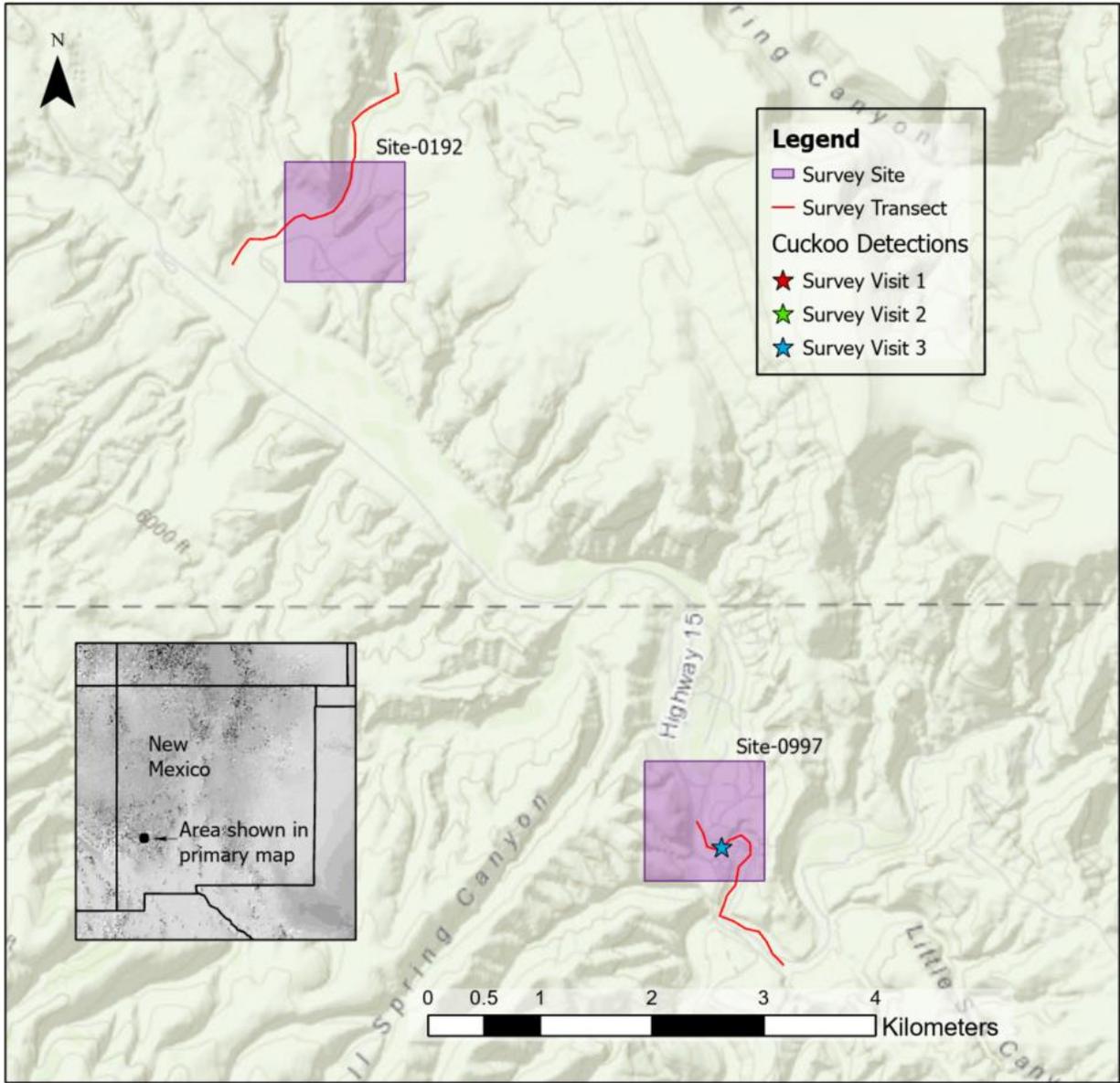
Figure 11. Northern Gila River sites (West and Middle Forks) and transects surveyed in 2022. One cuckoo was detected at site 0997.
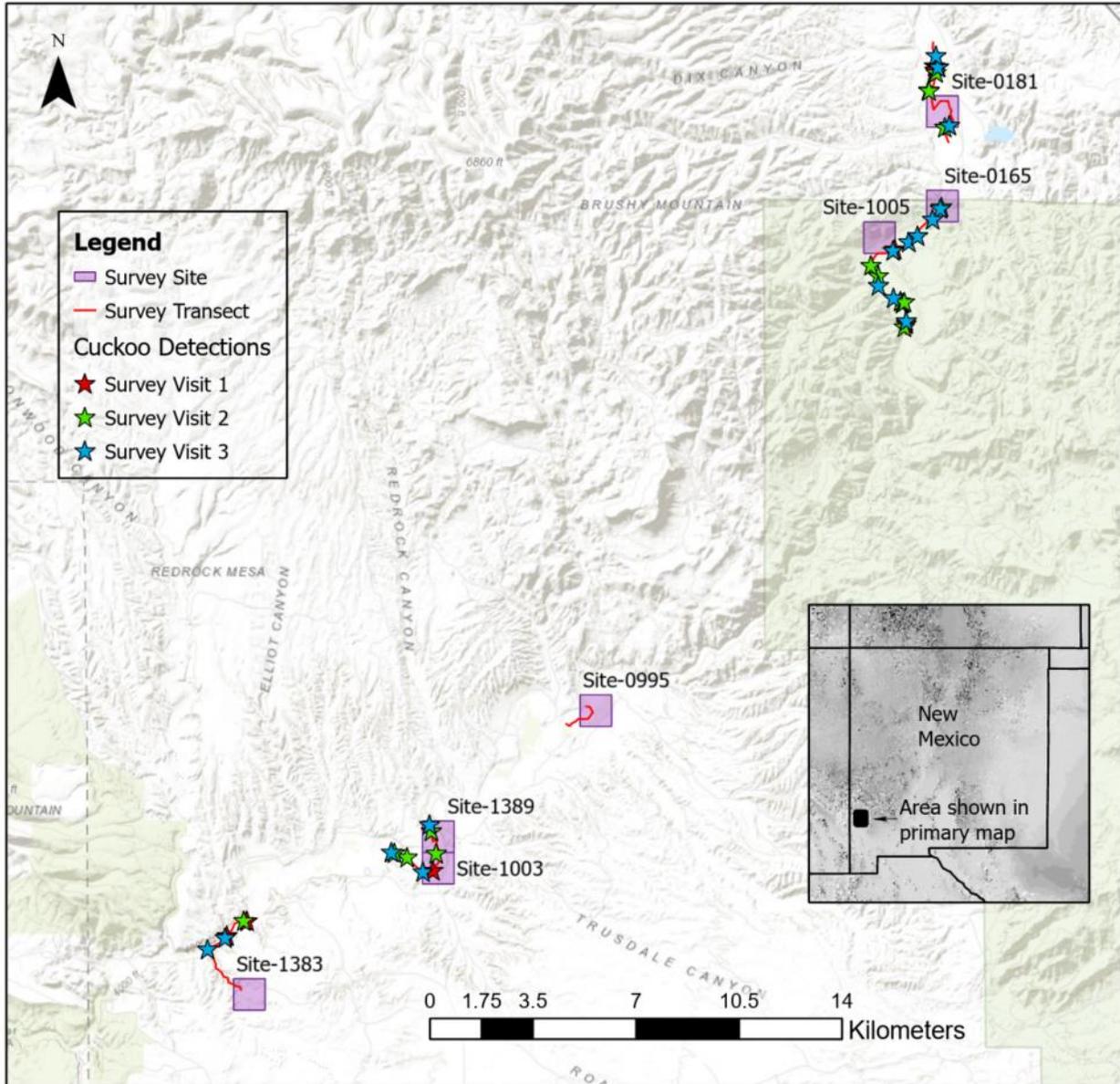
Figure 12. Gila River sites and transects surveyed in 2022.
Surveyors had forty-two total cuckoodetections across nine Gila River sites (including the two sites in Figure 11). The greatest number of cuckoo detections were observed at sites 1005 (13 total detections) and 0181 (10 total detections).
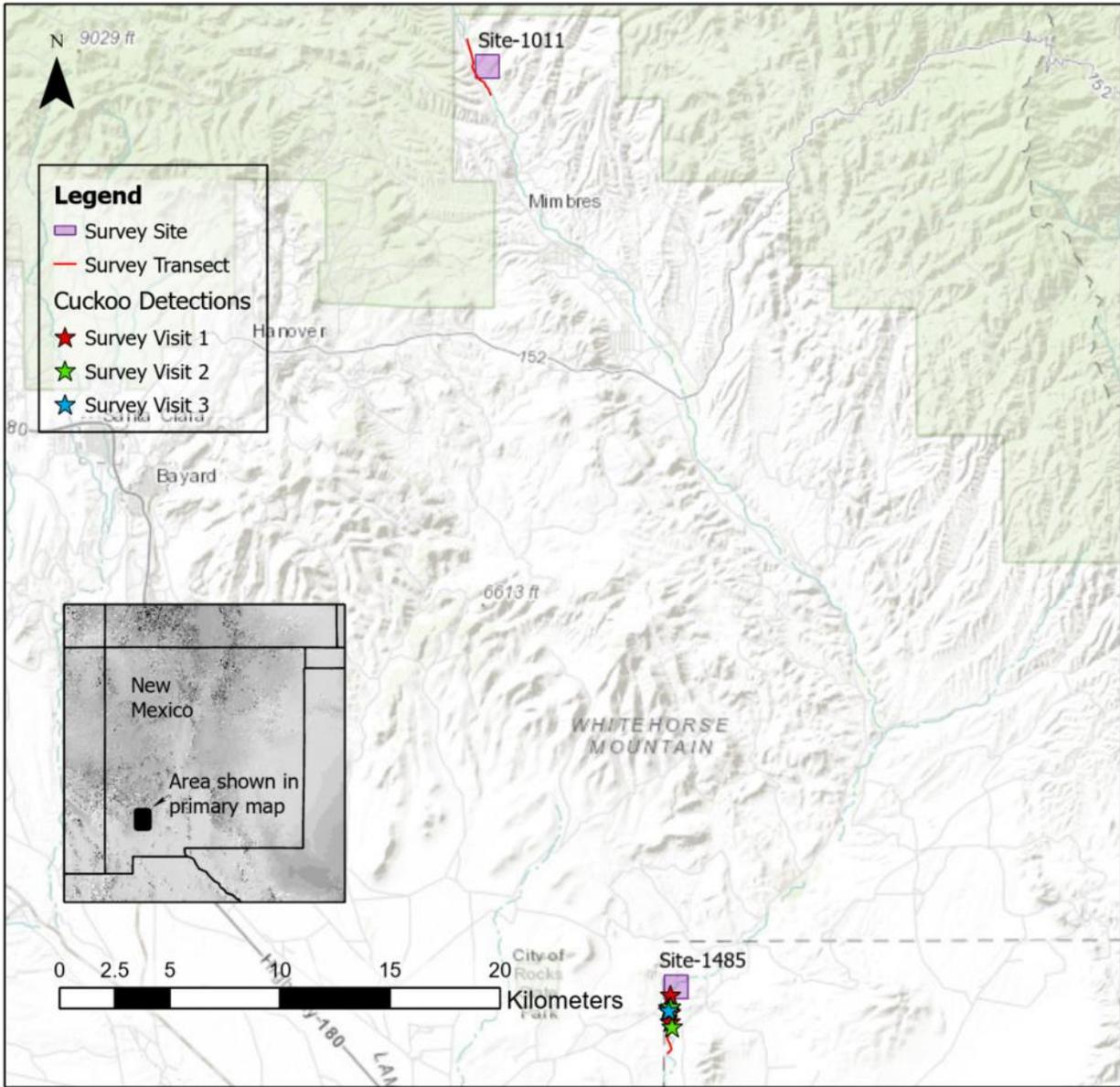
Figure 13. Mimbres River sites and transects surveyed in 2022.
Site 1485 had a total of seven cuckoo detections.
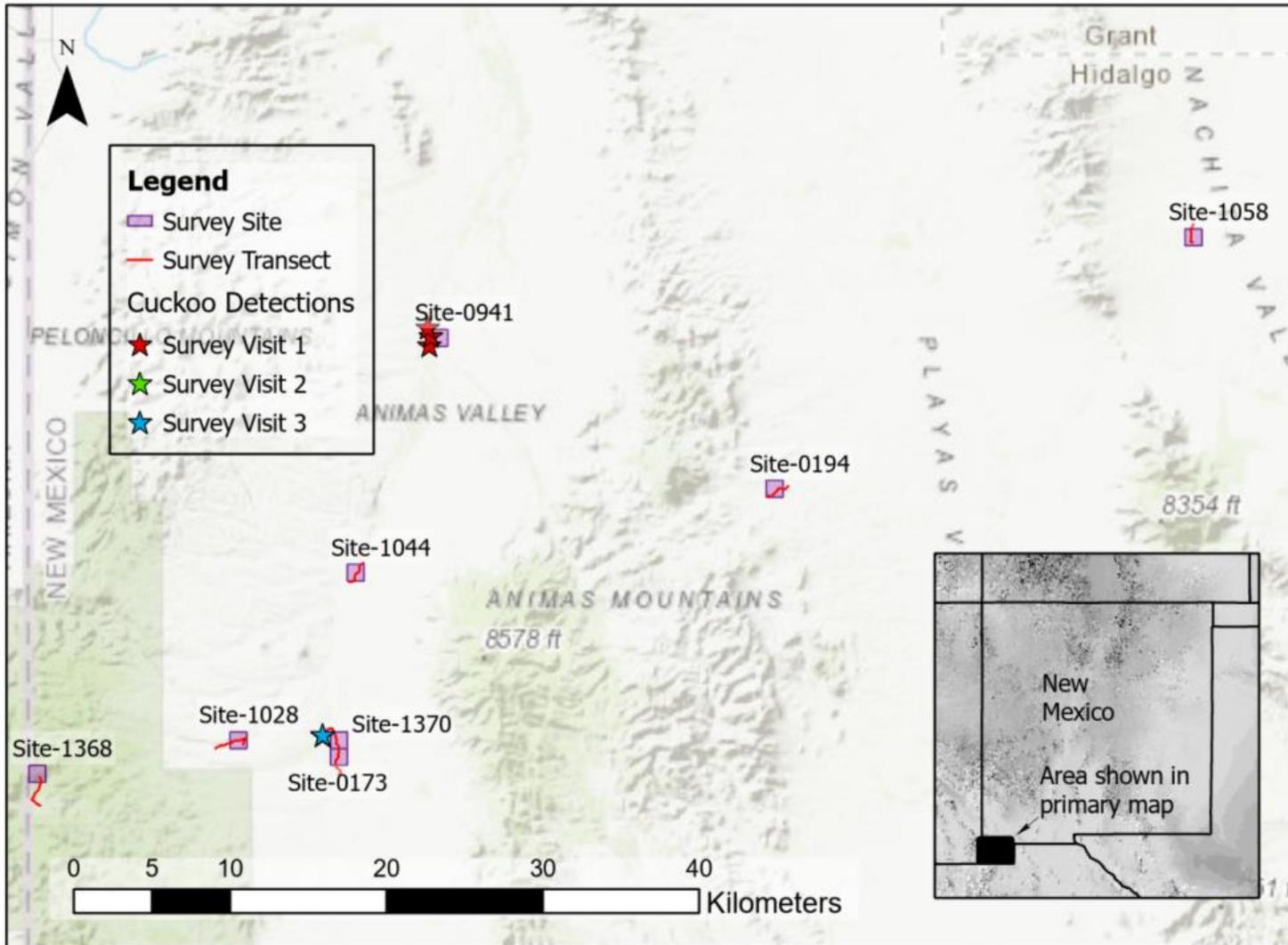
Figure 14. Southern New Mexico sites and transects surveyed in 2022.
Across eight sites in the NM "Bootheel", five total detections were made at two Animas Creek sites, sites 0941 (3 detections), and site 1370 (2 detections).

SGCN Species

While conducting cuckoo surveys, surveyors were tasked to passively look and listen for NM avian SGCN. However, cuckoo surveys were prioritized, SSRS field staff were not hired based on their overall avian identification skills, and this list of detected species (Table 4) does not fully represent SGCN presence at survey sites. Observations of federally endangered Southwestern Willow Flycatcher (*Empidonax trallii extimis*) were made by experienced and/or permitted personnel (Table 3); although the full survey protocol (Sogge et al. 2010) was not completed, detections of unsolicited *fitz-bew* vocalizations during the non-migrant period (06/15-07/20) within suitable habitat and the breeding range are indicative of this subspecies.

Table 4. New Mexico avian Species of Greatest Conservation Need (excluding Yellow-billed Cuckoo) observed at study sites while conducting cuckoo surveys, 2022.

| SGCN	Sites[1]
Abert's Towhee	1003/1389[2], 1383
Bell's Vireo	0181, 1003/1389, 1005, 1383
Cassin's Finch	1055
Common Blackhawk	0181, 1003/1389, 1005, 0916, 1023, 1052, 1370, 1383, 1405
Common Nighthawk	0161, 0914, 1052, 1055, 1383
Gila Woodpecker	1003/1389, 1005, 1383
Juniper Titmouse	1023
Lewis's Woodpecker	0916
Lucy's Warbler	0920, 0950, 1047, 1383, 1446
Western Bluebird	0180, 0916, 0920, 0950, 1047, 1549
Gould's Wild Turkey	0173
Southwestern Willow Flycatcher	0920, 1003/1389, 1023, 1383, 1546

[1] See table 3 and figures 3-14 for site locations. [2] The avian species list for Sites 1389 and 1003 is combined; these sites are adjacent and each of the three surveys included full coverage of suitable habitat within both sites.

Habitat Characteristics

At each site, as part of the USFWS survey protocol, surveyors visually estimated broad habitat metrics that characterized the entirety of the surveyed area (Figures 15-19, Tables 5, Tables 7 - 18). This data revealed both similarities and variations in vegetative characteristics between sites. Cottonwood species (*Populus* species) were the most common dominant overstory species recorded per site (n= 41 sites, Figure 15). Hackberry species (*Celtis* species), Velvet Ash (*Fraxinus velutina*), Ponderosa Pine (*Pinus ponderosa*), Mesquite species (*Prosopis* species), Gambel's Oak (*Quercus gambelii*), Goodding's Willow (*Salix gooddingii*), and Tamarisk species (*Tamarix* species, [*chinensis, ramosissima, pentandra*]) were identified as the dominant tree species across eleven other sites (Figure 15).
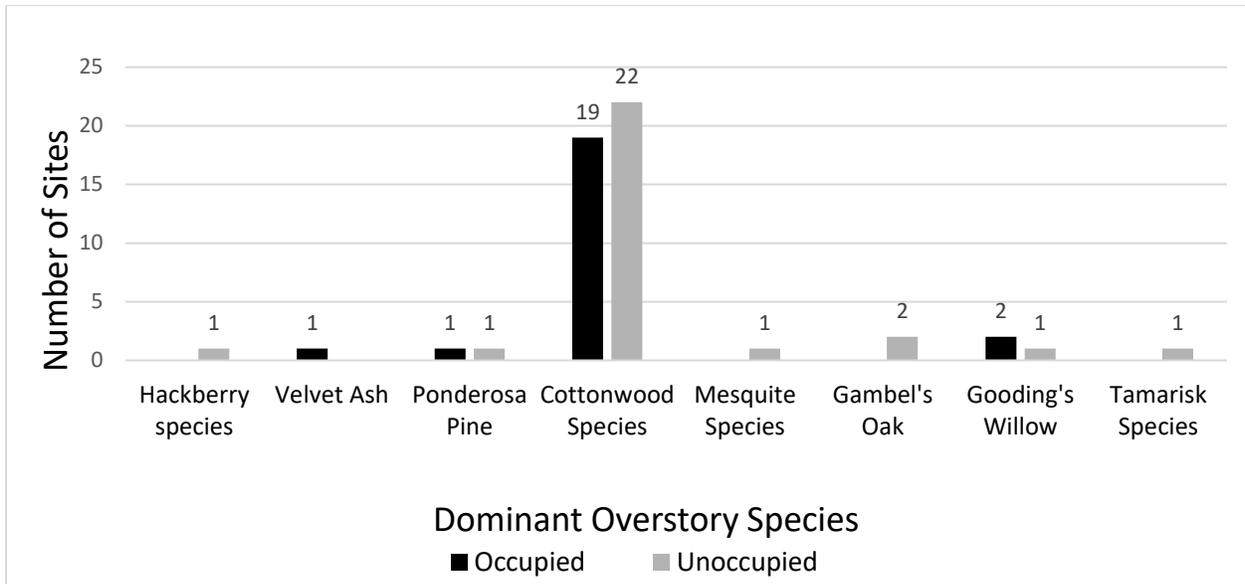
Figure 15. Dominant overstory species recorded at cuckoo-occupied and -unoccupied sites in 2022. At forty-one sites, cottonwood species (*Populus* sp., POSP) were identified as the dominant overstory tree species. Hackberry species (*Celtis* species), Velvet Ash (*Fraxinus velutina*), Ponderosa Pine (*Pinus ponderosa*), Mesquite Species (*Prosopis* species), Gambel's Oak (*Quercus gambelii*), Goodding's Willow (*Salix gooddingii*), and Tamarisk Species (*Tamarix species,* [*chinensis, ramosissima, pentandra*]) were identified as the dominant tree species across other eleven sites.

At cottonwood-dominated sites, percent canopy cover was greater at occupied sites (mean = 71%, median = 80%, n = 19 sites) compared to unoccupied sites (mean = 61%, median = 75%, n = 21 sites). Due to the non-normal distribution of this canopy cover data, we assessed median canopy cover using a non-parametric Man-Whitney U analysis and found no statistically significant difference between occupied and unoccupied sites ($p = 0.216$, Figure 16).
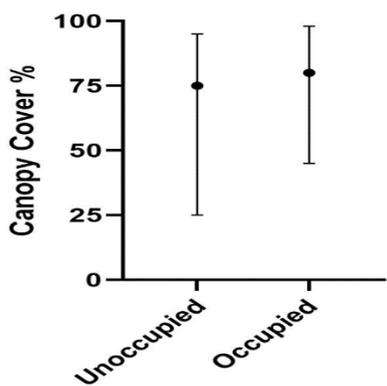
The dominant understory species per site showed greater diversity than the overstory species, with Russian Olive (n = 9 sites, *Elaeagnus angustifolia*), Tamarisk species (n = 10 sites), and Willow species (n = 9 sites, *Salix* species) recorded most often (Figure 17). The average percent cover for these three dominant understory species was similar between occupied and unoccupied sites (Figure 18).

Figure 16. Median canopy cover differences between sites occupied by cuckoos (80%), and unoccupied sites (75%) dominated by cottonwoods were not significantly different. 95% confidence intervals shown.

24
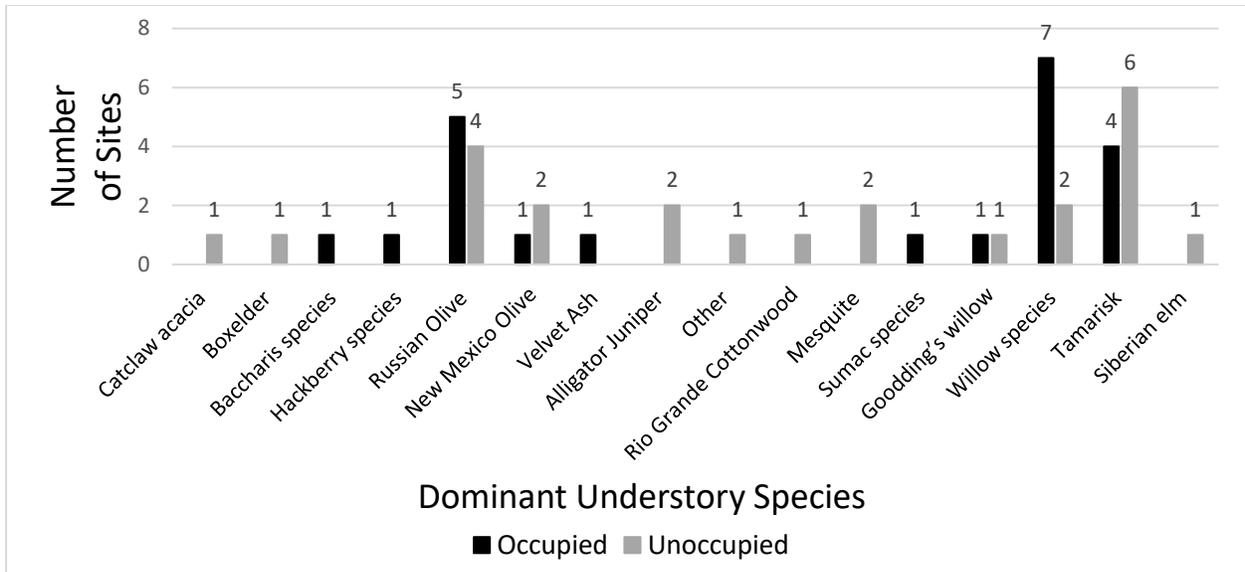
Figure 17. Dominant understory species recorded at cuckoo-occupied and -unoccupied sites in New Mexico, 2022.

The dominant understory species at sites varied, but the most common were Tamarisk (n=10 sites, *Tamarix* species, [*chinensis, ramosissima, pentandra*]), Russian Olive (n = 9 sites, *Elaeagnus angustifolia*), and Willow species (n=9 sites, *Salix* species). Catclaw acacia (*Senegalia greggii*), Boxelder (*Acer negundo*), Baccharis species (*Baccharis* species), Hackberry species (*Celtis* species), New mexico Olive (*Forestiera neomexicana, Forestiera pubescens*), Velvet Ash (*Fraxinus velutina*), Alligator Juniper (*Juniperus pachyphloea*), Rio Grande Cottonwood (*Populus deltoides)*, Mesquite species (*Prosopis* species), Sumac species (*Rhus* species), Goodding's Willow (*Salix* gooddingii), and Siberian Elm (*Ulmus pumila*) were identified as the dominant understory species at 18 sites.

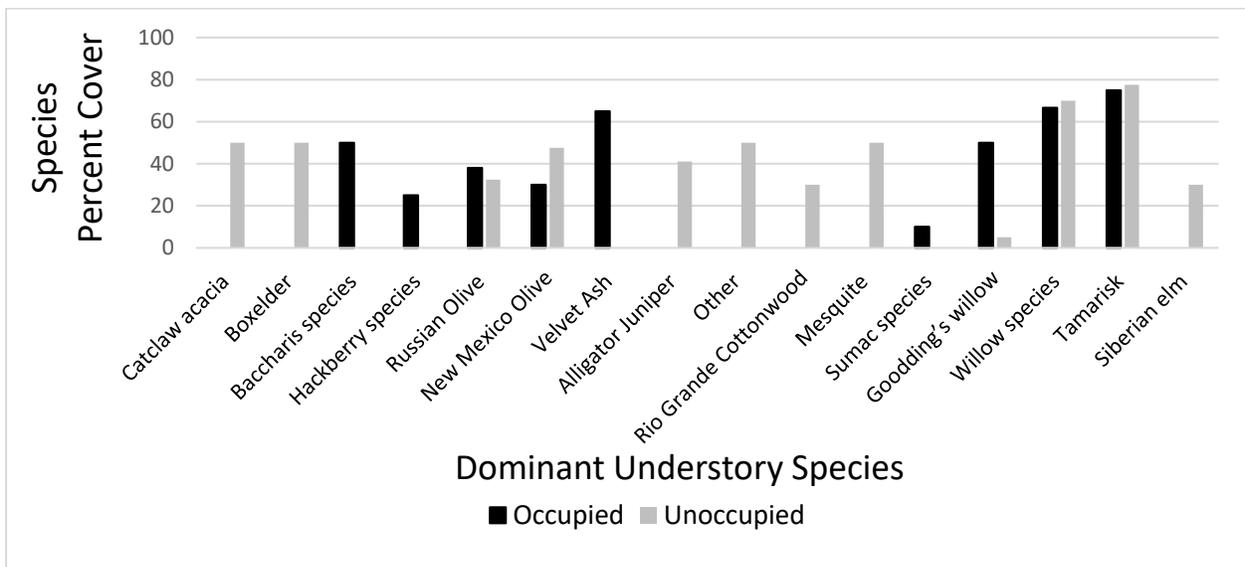**Figure 18.** Percent cover of dominant understory species recorded at cuckoo-occupied and -unoccupied New Mexico sites, 2022.

In examining cuckoo occupancy by native vs. non-native vegetation categorization, occupancy was similar at mixed native and exotic vegetation sites, and at sites dominated by native plants (Table 5). Cuckoos were not detected at sites dominated (>75%) by non-native, exotic vegetation (Table 5, n = 4 sites). At three of these four sites, cottonwood species were the dominant overstory species recorded with a sparse overstory canopy cover of (1%, 1%, and 15%), and at the remaining site, tamarisk was recorded as the dominant overstory tree with a relatively low overstory canopy cover of 20%. All four of these sites identified tamarisk as the dominant understory species with a high percent cover between 80-95%. These four sites (0174, 1055, 1428, 1536) were located on the Rio Grande (Socorro area, n = 2), and Rio Puerco (n = 2).

Table 5. Site native vs. exotic vegetation categorization for cuckoo-occupied and -unoccupied sites in New Mexico, 2022.

Native/Exotic Category	Description	Occupied Sites	Unoccupied Sites
Exotic/introduced plants	>75 % of the tree/shrub layer of the site is composed of exotic/introduced plants.	0	4
Mixed native and exotic plants (mostly exotic)	51% -75% of the tree/shrub layer of the site is composed of exotic/introduced plants.	7	6
Mixed native and exotic plants (mostly native)	51% -75% of the tree/shrub layer of the site is composed of native broadleaf plants.	4	3
Native broadleaf plants	>75 % of the tree/shrub layer of the site is composed of native broadleaf plants.	11	13

Discussion

Cuckoo surveys were conducted at 52 randomly selected sites across NM, and included sites found on the largest rivers in the state, the Rio Grande and San Juan, to small creeks such as Los Frijoles Creek in Bandelier National Monument and ephemeral riparian drainages within the bootheel of southern NM. On average, site surveys consisted of 19 survey points, surveyed three times each, along 2.6 km of habitat. Cuckoos were detected in 10 of 16 areas surveyed (Table 3). Cuckoos were not detected along Los Frijoles Creek, the Rio Puerco (north of La Joya Wildlife Management Area), and in four drainages in the "bootheel" of southern NM (Nachita Valley, Gillespie Creek, Whitmire Creek, and Cottonwood Creek). Cuckoos were detected (at least one observation) at 44% of sites surveyed (23 of 52 sites).

In comparison to other cuckoo monitoring studies that used the USFWS survey protocol (Halterman et al. 2016), occupancy and territory estimates derived from this study are conservative, as they are based on three cuckoo surveys per site, instead of the standard four surveys. In southern NM, we detected few cuckoos across the seven "bootheel" sites. One possible territory was estimated at a private ranch near Animas Creek. Three detections made during the first round of surveys in the Animas Valley suggest that this area was used as migratory stop-over habitat.

26

Of the sites surveyed in this study, the greatest concentration of cuckoos was found in the river areas around the Gila Mountains, including the Gila River, San Francisco River, Tularosa River, Mimbres River, and Las Animas Creek. Cuckoos were detected in all of these river systems, but the majority were found along the Gila River, where we observed 42% (42 out of 99) of the study's cuckoo detections, and 41% (12 out of 29) of estimated territories across just nine sites.

Forty-four percent of the Socorro area Rio Grande sites (4 out of 9 sites) had cuckoo detections, with 21 total detections and 7 estimated territories. The Socorro area site 1433 had the greatest number of detections in the area (10 detections) and estimated territories (n=3).

Further north along the Rio Grande, in the greater Albuquerque area, we had five total detections, and a possible territory located on Albuquerque Open Space property. Three total detections were made at three different Corrales area sites during the first two survey visits, suggesting that this area offers important stopover habitat for cuckoos travelling north.

We had only three cuckoo detections in northern NM (north of Albuquerque). On the Los Luceros Historic Site (0916) along the Rio Grande north of Espanola, we had a single cuckoo detection in mid-July. With only three visits to the site, it is difficult to determine if this was a cuckoo detected in migration, or a resident bird with a complete or partial territory at the Los Luceros site. At one of the four San Juan River sites, site 1004, we had single cuckoo detections on the two July surveys, resulting in a possible estimated territory.

In coordination with Reclamation, this project did not conduct cuckoo surveys along most of the Rio Grande south of Belen, with exception of a river stretch near Socorro. Reclamation has conducted cuckoo surveys along the majority of the Middle and Lower Rio Grande in NM annually since 2008 (White et al. 2020), and their annual cuckoo detection totals (2008-2019, 266-428 total detections) far exceed those observed in this study, with most detections occurring near the Elephant Butte Reservoir inlet. However, differences in sampling effort confound comparisons between Reclamation's results and those from this study. Inclusion of detection results from 85 Rio Grande sites rejected by this project due to 2022 surveys conducted by other entities (USFWS at Bosque del Apache Wildlife Refuge and Reclamation Rio Grande sites) will allow for an equitable comparison between the results observed in this study and the high-density results regularly observed on the Middle Rio Grande.

Cuckoo habitat use observed in this study aligned with that previously documented for the species. The majority of our sites had a cottonwood-dominant overstory, with an understory most often dominated by native (willow species) and non-native (Russian olive, tamarisk) vegetation, which is consistent with the typical habitat associated with western cuckoos (Gaines 1974, Sechrist et al. 2013, Halterman et al. 2016). Our observed site occupancy followed documented trends, showing a preference for sites with <75% exotic overstory (Halterman et al. 2016), avoidance of tamarisk-dominated sites (Johnson et al. 2017), and selection for sites with a lower canopy height (Wohner et al. 2020, Stanek et al. 2021). We surveyed few Goodding's Willow-dominated riparian habitat sites, but this habitat is prevalent and important on the Rio Grande in NM (Siegle et al. 2022), where the state's largest cuckoo population is estimated to reside (Dillon et al. 2018). The utility of the collected habitat data could be improved over the current

method of recording a single habitat estimate to represent an entire site using visual estimation, which can be widely variable and inaccurate (Korhonen et al., 2006). Rapid estimation assessments recorded at survey points may be more informative (such as McLaren et al. 2019) and we recommend that the Yellow-billed Cuckoo Working Group work with the USFWS, states, and regional avian organizations to discuss alternate methods to improve the habitat data collection.

Lastly, in southern AZ cuckoos have recently been documented breeding in xeroriaprian habitat in ephemeral and intermittent drainages (USFWS 2021). In these areas, summer monsoonal rains drive productivity to promote rapid summer vegetation growth and "green-up" (USFWS 2021), and presumably an increased abundance of cuckoo prey species. These Sonoran Desert, mid-elevation sky island areas appear to hold a large cuckoo breeding population, and are typified by Madrean evergreen woodlands, desert and semi-desert scrub, and semi-desert grasslands (USFWS 2021). In 2022, we conducted surveys at 8 sites scattered across the southern NM "bootheel" region near the AZ border (Figure 14) resulting in few cuckoo detections and only one possible territory. While assessing the sampling frame sample units, most potential sample units in the bootheel were rejected due to lack of suitable habitat based on aerial imagery and site visits; the majority of these locations were along arroyos lacking an overstory component with semi-desert scrub (acacia, mesquite, creosote) and semi-desert grassland communities. Based on these rejected sites, and given the sparse cuckoo results from our 2022 surveys in this southern NM region, we recognize that the southern NM Chihuahuan Desert areas may not provide the conditions needed to support cuckoos. We recommend a closer examination of the habitats found in southern NM, including the Peloncillo and Animas Mountains where Madrean communities and larger trees occur, where habitat may be comparable to areas used by cuckoos in southern AZ.

Literature Cited

Corman, T.E. and Wise-Gervais, C. eds., 2005. *The Arizona breeding bird atlas*. UNM Press.

Dillon, K.G., D. Ahlers, and D. Moore. 2018. Yellow-billed cuckoo Study Results – 2017. Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico. Bureau of Reclamation Technical Service Center, Denver, Colorado.

Gaines, D. 1974. Review of the status of the yellow-billed cuckoo in California: Sacramento Valley populations. The Condor 76(2): 204-209.

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

Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27:1-608.

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

Halterman, M.D., D.S. Gilmer, S.A. Laymon, and G.A. Falxa. 2001. Status of the yellow-billed cuckoo in California: 1999-2000. Report to the USGS-BRD Dixon Field Station, 6924 Tremont Rd, Dixon, CA 95620.

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

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

Hughes, J.M. 2020. Yellow-billed Cuckoo (*Coccyzus americanus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.yebcuc.01

Johnson, C.A. and T.J. Benson. 2022. Dynamic occupancy models reveal Black-billed and Yellow-billed Cuckoos have high rates of turnover during the breeding season. Ornithological Applications 124:1-13. https://doi.org/10.1093/ornithapp/duac021

Johnson, M.J., J.R. Hatten, J.A. Holmes and P.B. Shafroth. 2017. Identifying western yellow-billed cuckoo breeding habitat with a dual modelling approach. Ecological Modelling 347: 50-62.

Korhonen, L., K.T. Korhonen, M. Rautiainen, and P. Stenber., 2006. Estimation of forest canopy cover: a comparison of field measurement techniques. Silva Fennica 40(4): 577–588.

M. F. McLaren, C.M. White, N.J. Van Lanen, J.J. Birek, J.M. Berven, and D. Hanni. J. 2019. Integrated Monitoring in Bird Conservation Regions (IMBCR): Field protocol for spatially-balanced sampling of land bird populations. Unpublished report. Bird Conservancy of the Rockies, Brighton, Colorado, USA.

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

New Mexico Department of Game and Fish. 2019. State Wildlife Action Plan for New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

Sogge, M.K., D. Ahlers, and S.J. Sferra. 2010. A natural history summary and survey protocol for the southwestern willow flycatcher: U.S. Geological Survey Techniques and Methods 2A-10, 38 p.

Sechrist, J., D.D. Ahlers, K.P. Zehfuss, R.H. Doster, E.H. Paxton, and V.M. Ryan. 2013. Home Range and Use of Habitat of Western Yellow-Billed Cuckoos On the Middle Rio Grande, New Mexico. The Southwestern Naturalist 58(4): 411-419.

Siegle, R., D. Moore, and T. Barron. 2022. Western Yellow-billed Cuckoo Breeding Habitat Suitability Middle Rio Grande, New Mexico Upper Colorado Basin. Bureau of Reclamation, Technical Services Center, Denver, CO.

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

Stanek, J.E., Mcneil, S.E., Tracy, D., Stanek, J.R., Manning, J.A. and M.D. Halterman, 2021. Western Yellow-Billed Cuckoo Nest-Site Selection and Success in Restored and Natural Riparian Forests. The Journal of Wildlife Management, 85(4), pp.782-793.

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

U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo. Final Rule. Federal Register 86:20798-21005.

United States Fish and Wildlife Service. 2014. Determination of threatened status of the western distinct population segment of the Yellow-billed Cuckoo (*Coccyzus americanus*). Federal Register 79:5991-60038.

U. S. Fish and Wildlife Service and U.S. Bureau of Reclamation. 2021. Draft Addendum to Appendices 1 to 3 in Halterman, M.D., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2016. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: Draft. U.S. Fish and Wildlife Techniques and Methods. Prepared by Susan Sferra, Vicky Ryan, and Meghan White for USFWS, Arizona, New Mexico, and Texas, Albuquerque, New Mexico and U.S. Bureau of Reclamation, Denver Technical Center, Denver, Colorado.
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiP1uy1 76n9AhXvJDQIHVbTD18QFnoECBUQAQ&url=https%3A%2F%2Fwww.fws.gov%2Fsites%2 Fdefault%2Ffiles%2Fdocuments%2F2021%2520Instructions%2520for%2520completing%2520 YBCU%2520Survey%2520Summary%2520Forms%252006.04.21.pdf&usg=AOvVaw1XyJM6l _YDFy1MbCy3SULO

White, M., Moore, D., and R. Siegle. 2020. Yellow-billed Cuckoo Study Results – 2019 Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico. U. S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Wohner, P.J., Laymon, S.A., Stanek, J.E., King, S.L. and R.J. Cooper. 2020. Challenging our understanding of western Yellow-billed Cuckoo habitat needs and accepted management practices. *Restoration Ecology*, *29* (3), p.e13331.

Acknowledgments

Appendix 1 NM Species of Greatest Conservation Need

Table 6. New Mexico avian Species of Greatest Conservation Need (SGCN) (NMDGF 2019).

Common Name	Scientific Name
White-tailed Ptarmigan	*Lagopus leucura*
Flammulated Owl	*Psiloscops flammeolus*
Mexican Whip-poor-will	*Antrostomus arizonae*
Lewis's Woodpecker	*Melanerpes lewis*
Gray Vireo	*Vireo vicinior*
Pinyon Jay	*Gymnorhinus cyanocephalus*
Juniper Titmouse	*Baeolophus ridgwayi*
Bendire's Thrasher	*Toxostoma bendirei*
Sprague's Pipit	*Anthus spragueii*
Painted Redstart	*Myioborus pictus*
Grace's Warbler	*Setophaga graciae*
Black-throated Gray Warbler	*Setophaga nigrescens*
Red-faced Warbler	*Cardellina rubrifrons*
Virginia's Warbler	*Oreothlypis virginiae*
Black-chinned Sparrow	*Spizella atrogularis*
Arizona Grasshopper Sparrow	*Ammodramus savannarum ammolegus*
Chestnut-collared Longspur	*Calcarius ornatus*
McCown's Longspur	*Rhynchophanes mccownii*
Gould's Wild Turkey	*Meleagris gallopavo mexicana*
Eared Grebe	*Podiceps nigricollis*
American Bittern	*Botaurus lentiginosus*
Bald Eagle	*Haliaeetus leucocephalus*
Peregrine Falcon	*Falco peregrinus*
Boreal Owl	*Aegolius funereus*
Burrowing Owl	*Athene cunicularia*
Black Swift	*Cypseloides niger*
Bell's Vireo	*Vireo bellii*
Bank Swallow	*Riparia riparia*
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*
Mountain Plover	*Charadrius montanus*
Snowy Plover	*Charadrius nivosus*
Long-billed Curlew	*Numenius americanus*
Neotropic Cormorant	*Phalacrocorax brasilianus*
Common Ground-dove	*Columbina passerina*
Whiskered Screech-Owl	*Megascops trichopsis*
Common Nighthawk	*Chordeiles minor*
Costa's Hummingbird	*Calypte costae*
Violet-crowned Hummingbird	*Amazilia violiceps*

Williamson's Sapsucker	*Sphyrapicus thyroideus*
Gila Woodpecker	*Melanerpes uropygialis*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Northern Beardless Tyrannulet	*Camptostoma imberbe*
Olive-sided Flycatcher	*Contopus cooperi*
Thick-billed Kingbird	*Tyrannus crassirostris*
Loggerhead Shrike	*Lanius ludovicianus*
Clark's Nutcracker	*Nucifraga columbiana*
Pygmy Nuthatch	*Sitta pygmaea*
Mountain Bluebird	*Sialia currucoides*
Western Bluebird	*Sialia mexicana*
Lucy's Warbler	*Oreothlypis luciae*
Yellow-eyed Junco	*Junco phaeonotus*
Baird's Sparrow	*Ammodramus bairdii*
Cassin's Sparrow	*Peucaea cassinii*
Sagebrush Sparrow	*Artemisiospiza nevadensis*
Vesper Sparrow	*Pooecetes gramineus*
Varied Bunting	*Passerina versicolor*
Cassin's Finch	*Haemorhous cassinii*
Evening Grosbeak	*Coccothraustes vespertinus*
Clark's Grebe	*Aechmophorus clarkii*
Common Black Hawk	*Buteogallus anthracinus*
Elf Owl	*Micrathene whitneyi*
Broad-billed Hummingbird	*Cynanthus latirostris*
Lucifer Hummingbird	*Calothorax lucifer*
Elegant Trogon	*Trogon elegans*
Botteri's Sparrow	*Peucaea botterii*
Abert's Towhee	*Melozone aberti*
Brown-capped Rosy-Finch	*Leucosticte australis*
Aplomado Falcon	*Falco femoralis*
Least Tern	*Sternula antillarum*
Yellow-billed Cuckoo	*Coccyzus americanus*
Mexican Spotted Owl	*Strix occidentalis lucida*
Southwestern Willow Flycatcher	*Empidonax traillii extimus*

Appendix 2   Habitat Data Summaries

Table 7. Woody plant species list for Arizona, New Mexico, and Texas (USFWS and BOR 2021) used for cuckoo survey plant identification in NM cuckoo surveys, 2022.

Common Name	Genus	Species
White fir	*Abies*	*concolor*
Fir species	*Abies*	species
Acacia species	*Acacia/Senegalia*	species
Catclaw acacia	*Senegalia* (old genus is *Acacia*)	*greggii*
Acacia Species	*Acacia*	species
Rocky Mountain Maple	*Acer*	*glabrum*
Boxelder	*Acer*	*negundo*
Maple species	*Acer*	species
Thinleaf Alder	*Alnus*	*incana ssp. tenuifolia*
Arizona alder	*Alnus*	*oblongifolia*
White alder	*Alnus*	*rhombifolia*
Alder species	*Alnus*	species
Indigobush	*Amorpha*	*fructicosa*
Dogbane	*Apocynum*	*cannabinum*
Texas madrone	*Arbutus*	*xalapensis*
Manzanita	Arctostaphylos	species
Baccharis species	Baccharis	species
Bamboo	Bamboo	species
Burned		
Cactus species	Cactus	species
Pecan	*Carya*	*illinoinensis*
Desert hackberry	*Celtis*	*ehrenbergiana*
Sugar hackberry	*Celtis*	*laevigata*
Western hackberry, Net-leafed hackberry Canyon hackberry	*Celtis*	*reticulata*
Hackberry species	*Celtis*	species
Palo verde (2 species) Foothills Palo Verde (Cercidium microphyllum) or Blue Palo Verde (Cercidium floridum)	*Cercidium*	species
Desert willow	*Chilopsis*	*linearis*
Conifer species	Conifer	species
Dogwood species	*Cornus*	species
Arizona cypress	*Cupressus*	*arizonica*
Russian Olive	*Elaeagnus*	*angustifolia*

New Mexico Olive, Privet, New Mexican Forestiera	*Forestiera*	*neomexicana*
New Mexico Olive, Stretchberry	*Forestiera*	*pubescens*
New Mexico Olive species	*Forestiera*	species
European ash	*Fraxinus*	*excelsior*
Arizona Ash, Velvet Ash	*Fraxinus*	*velutina*
Ash species	*Fraxinus*	species
Walnut species	*Juglans*	species
Arizona walnut	*Juglans*	*major*
Black walnut	*Juglans*	*nigra*
English walnut	*Juglans*	*regia*
One-seed juniper	*Juniperus*	*monosperma*
Alligator Juniper	*Juniperus*	*pachyphloea*
Rocky Mountain Juniper	*Juniperus*	*scopulorum*
Juniper species	*Juniperus*	species
Wolfberry species	*Lycium*	species
Apple tree species	*Malus*	species
Mimosa	*Mimosa*	species
White mulberry	*Morus*	*alba*
Texas mulberry	*Morus*	*microphylla*
Mulberry	*Morus*	species
None	*None*	none
Other	*Other*	Other
Ironwood	*Olneya*	tesota
Palo Verde	*Parkinsonia*	species
Engelmann's spruce	*Picea*	engelmannii
Blue spruce	*Picea*	pungens
Spruce Species	*Picea*	species
Pinyon pine	*Pinus*	edulis
Ponderosa pine	*Pinus*	ponderosa
Mexican Pinyon Pine	*Pinus*	cembroides
Pine species	*Pinus*	species
Arizona Sycamore	*Plantanus*	*wrightii*
Narrowleaf Cottonwood	*Populus*	*angustifolia*
Rio Grande Cottonwood, includes subspecies *wislizenii*	*Populus*	*deltoides*
Fremont Cottonwood	*Populus*	*fremontii*
Populus species	*Populus*	species
Honey mesquite	*Prosopis*	*glandulosa*
Screwbean mesquite	*Prosopis*	*pubescens*
Mesquite	*Prosopis*	*species*
Velvet Mesquite	*Prosopis*	*velutina*

Fruit trees- domestic (almond, prune, etc.	*Prunus*	species
Chokecherry	*Prunus*	*virginiana*
Douglas-fir	*Pseudotsuga*	*menziesii*
Hoptree	*Ptelea*	*trifoliata*
Gambel's oak	*Quercus*	*gambelii*
Grey oak	*Quercus*	*grisea*
Valley oak	*Quercus*	*lobata*
Chinaquapin oak	*Quercus*	*muehlenbergii*
Oak species	*Quercus*	species
Gray littleleaf sumac	*Rhus*	*microphylla*
Sumac species	*Rhus*	species
Three-leaf sumac	*Rhus*	*trilobata*
New Mexico locust	*Robinia*	*neomexicana*
Wild rose	*Rosa*	*woodsii*
Rose species	*Rosa*	species
Arizona Rose	*Rosa*	*arizonica*
Blackberry	*Rubus*	species
Peachleaf willow	*Salix*	*amygdaloides*
Bebb willow	*Salix*	*bebbiana*
Red Willow (Bonpland)	*Salix*	*bonplandiana*
Coyote willow/ Sandbar Willow	*Salix*	*exigua*
Geyer Willow	*Salix*	*geyeriana*
Tree willow, Goodding's willow, Black willow	*Salix*	*gooddingii*
Bluestem willow, Sandbar willow	*Salix*	*irrorata*
Arroyo willow	*Salix*	*lasiolepis*
red willow	*Salix*	*laevigata*
Yellow willow	*Salix*	*lutea*
Park willow	*Salix*	*monticola*
Black willow	*Salix*	*nigra*
Yewleaf willow	*Salix*	*taxifolia*
Willow species	*Salix*	*species*
Mexican elderberry	*Sambucus*	*mexicana*
Soapberry	*Sapindus*	*saponaria*
Snag (any species)	*SNAG*	*SNAG*
Athel tamarisk	*Tamarix*	*aphylla*
Five-stamen saltcedar	*Tamarix*	*chinensis*
Saltcedar	*Tamarix*	*pentandra*
Saltcedar	*Tamarix*	*ramosissiama*

Salt Cedar / Tamarisk. Does not include athel tamarisk.	*Tamarix*	*species (chinensis / ramosissima/pentandra)*
Chinese Elm	*Ulmus*	*parvifolia*
Siberian elm	*Ulmus*	*pumila*
Elm species	*Ulmus*	*species*
Unknown	*Unknown*	*Unknown*
Grey Thorn Old name is Condalia lycioides	*Ziziphus*	*obtusifolia*

Table 8. Estimated site overstory, understory, and presence of surface water or wet soil characteristics.

Estimated Habitat Characteristic	Occupied	Unoccupied
Number of Sites with surface water or wet soil within 300m	23	29
Site average overstory height (m)	16.7 (n=23)	17.2 (n=27)
Site average overstory cover percent	35.5 (n=23)	31.6 (n=25)
Site average understory height (m)	3.8 (n=23)	4.3 (n=26)
Site average understory cover percent	50.0 (n=23)	60.4 (n=25)

Table 9. Dominant overstory species #1 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Hackberry species	0	1		15
Velvet Ash	1	0	40	
Ponderosa Pine	1	1	55	25
Narrowleaf Cottonwood	2	5	43	50
Rio Grande Cottonwood	9	7	90	96
Fremont Cottonwood	6	3	65	39
Cottonwood species	2	6	30	41
Mesquite species	0	1		98
Grey Oak	0	2		50
Goodding's Willow	2	1	55	50
Tamarisk	0	1		90

Table 10. Dominant overstory species #2 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	1	5	35
Russian Olive	4	3	13	5
Walnut species	0	2		2
Juniper species	0	1		80
Mexican Pinyon Pine	0	1		25
Arizona Sycamore	1	2	30	5
Narrowleaf Cottonwood	1	0	45	
Rio Grande Cottonwood	0	1		10
Fremont Cottonwood	5	2	33	18
Cottonwood species	0	1		15
Mesquite species	1	2	80	44
Goodding's Willow	4	1	15	1
Soapberry	0	1		1
Willow species	1	1	10	5
Dead tree snag	0	1		1
Tamarisk	0	1		1
Siberian Elm	2	4	2	4

Table 11. Dominant overstory species #3 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	1	25	10
Hackberry species	1	0	5	
Desert Willow	1	0	1	
Russian Olive	2	2	1	1
Walnut species	1	0	10	
Alligator Juniper	0	2		18
Pine species	0	1		3
Arizona Sycamore	4	1	7	10
Fremont Cottonwood	0	2		10
Goodding's Willow	3	5	11	1
Willow species	0	1		2
Tamarisk	0	1		5
Elm species	1	0	5	

Table 12. Dominant overstory species #4 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	0	1	
Alder species	2	1	8	1
Hackberry species	1	0	4	
Ash species	0	1		1
Velvet Ash	2	1	11	10
Walnut species	1	1	1	1
Arizona Walnut	1	0	1	
Juniper species	0	1		10
Ponderosa Pine	0	1		8
Oak species	0	1		10
New Mexico locust	1	0	5	
Goodding's Willow	0	1		10
Tamarisk	1	1	2	1
Siberian Elm	0	1		5

Table 13. Dominant overstory species #5 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Alder species	1	1	5	5
Hackberry species	1	0	1	
Russian Olive	0	1		1
Velvet Ash	1	0	1	
Walnut species	1	1	1	1
Arizona Walnut	1	1	5	5
One-seed juniper	0	1		10
Alligator Juniper	1	0	5	
Ponderosa Pine	1	0	5	
Arizona Sycamore	1	0	5	
Mesquite species	0	1		10
Gambel's Oak	0	1		10

Table 14. Dominant understory species #1 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Catclaw Acacia	0	1		50
Boxelder	0	1		50
Baccharis species	1	0	50	
Hackberry species	1	0	25	
Russian Olive	5	4	38	33
New Mexico Olive	1	1	30	55
New Mexico Olive, Stretchberry	0	1		40
Velvet Ash	1	0	65	
Alligator Juniper	0	2		41
Other	0	1		50
Rio Grande Cottonwood	0	1		30
Mesquite species	0	2		50
Sumac species	1	0	10	
Coyote Willow, Sandbar Willow	1	0	40	
Goodding's Willow	1	1	50	5
Willow species	6	2	71	70
Tamarisk	3	6	75	78
Siberian Elm	0	1		30

Table 15. Dominant understory species #2 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	0	10	
Manzanita	0	1		75
Baccharis species	2	2	15	15
Hackberry species	2	0	5	
Russian Olive	1	4	25	28
New Mexico Olive	1	1	20	30
New Mexico Olive, Stretchberry	2	1	13	25
New Mexico Olive species	1	0	25	
Arizona Walnut	0	1		25
Juniper species	1	1	75	75
Other	0	1		50
Arizona Sycamore	0	1		20
Narrowleaf Cottonwood	0	1		20
Cottonwood species	1	0	15	
Honey Mesquite	1	0	5	
Mesquite species	1	0	20	
Sumac species	0	1		10
Coyote Willow, Sandbar Willow	0	2		6
Goodding's Willow	3	0	23	
Willow species	1	2	25	18
Tamarisk	2	3	20	35
Siberian Elm	1	0	20	

Table 16. Dominant understory species #3 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	0	10	
Baccharis species	3	2	25	6
Desert hackberry	0	1		50
Russian Olive	1	1	35	10
New Mexico Olive	1	2	10	23
Velvet Ash	1	1	10	10
Other	2	1	23	20
Arizona Sycamore	1	0	10	
Narrowleaf Cottonwood	0	1		25
Rio Grande Cottonwood	1	0	15	
Cottonwood species	0	1		25
Mesquite species	1	0	5	
Coyote Willow, Sandbar Willow	0	2		25
Goodding's Willow	1	0	1	
Willow species	2	4	8	13
Tamarisk	4	1	10	10
Siberian Elm	1	1	20	10

Table 17. Dominant understory species #4 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	0	5	
Baccharis species	2	2	10	15
Hackberry species	1	1	8	5
Russian Olive	0	1		5
New Mexico Olive, Stretchberry	0	3		8
Walnut species	2	0	10	
Arizona Walnut	0	1		10
Juniper species	1	0	5	
Rio Grande Cottonwood	0	3		5
Mesquite species	2	1	13	25
New Mexico locust	1	0	5	
Willow species	1	1	1	10
Tamarisk	2	2	10	17
Siberian Elm	1	0	10	

Table 18. Dominant understory species #5 recorded during cuckoo surveys in NM, 2022.

Species	Number of Sites		Average Percent Cover	
	Occupied	Unoccupied	Occupied	Unoccupied
Boxelder	1	0	5	
Baccharis species	3	3	17	5
Burned	0	1		1
Hackberry species	3	0	10	
Russian Olive	0	1		1
New Mexico Olive species	0	1		15
Velvet Ash	1	0	5	
Juniper species	2	0	1	
Rio Grande Cottonwood	1	0	10	
Coyote Willow, Sandbar Willow	2	0	13	
Willow species	0	2		10
Tamarisk	0	2		8
Siberian Elm	0	1		10