U.S. Fish & Wildlife Service

A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo

Yellow-billed Cuckoo

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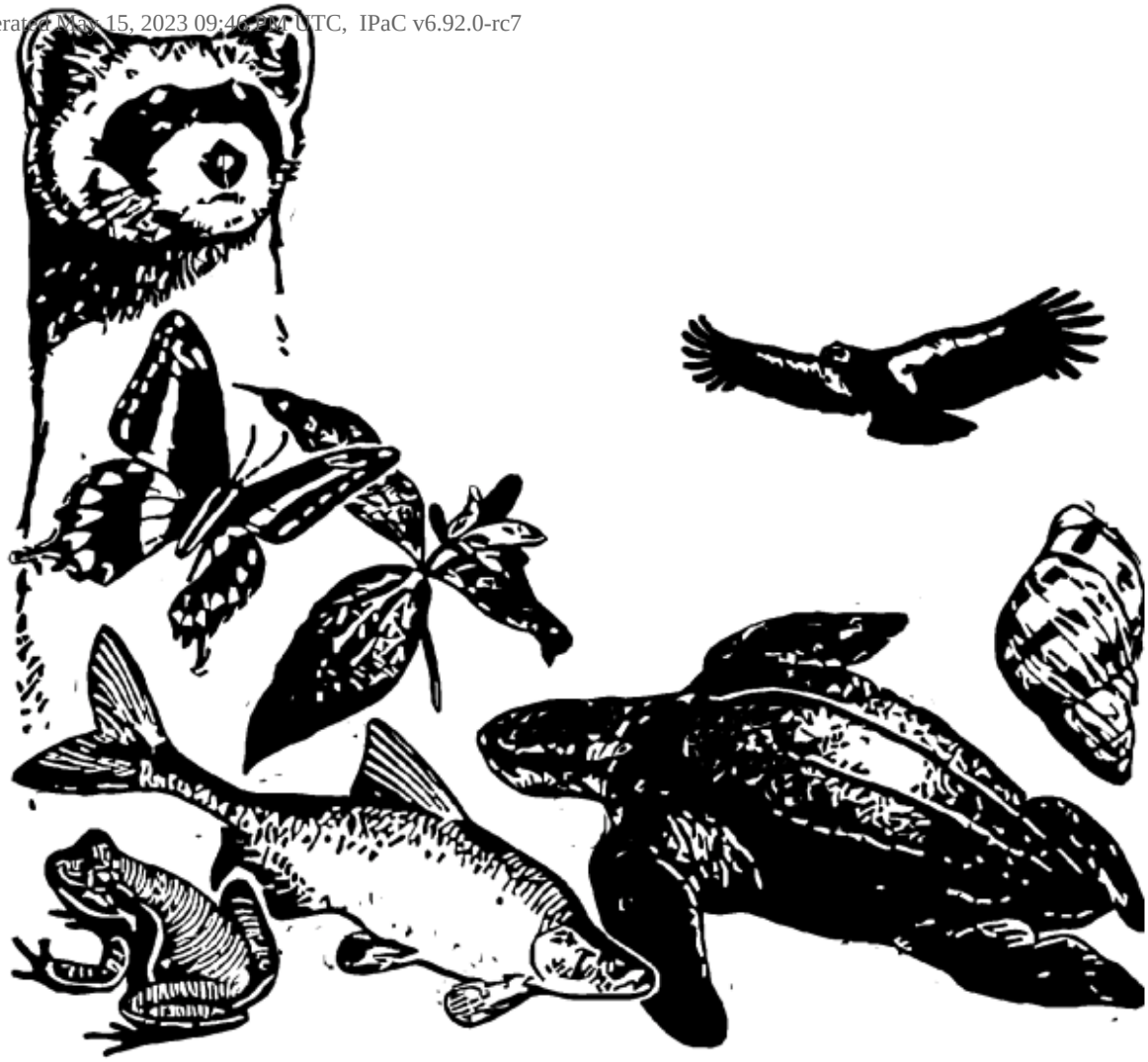

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Cover: Western Yellow-billed Cuckoo. Photograph taken by Murrelet Halterman

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

Purpose

Our intent is to detail the current standard survey protocol and survey data interpretation for the western Distinct Population Segment (DPS) of Yellow-billed Cuckoos (*Coccyzus americanus*). It is intended to determine if a habitat patch contains one or more Yellow-billed Cuckoos, and is not designed to establish the exact distribution and abundance of cuckoos at a site. This protocol is intended to maximize detectability and efficiency; determining precise Yellow-billed Cuckoo numbers, locations, and breeding status requires many more visits and additional observation. This survey protocol also does not address issues and techniques associated with nest monitoring or other cuckoo research activities, but we discuss basic natural history and nest searching information in order to enhance surveyor understanding. This document is not intended to provide comprehensive coverage of that information. For more information on Yellow-billed Cuckoo biology see Hughes (1999), the final listing rule (79 FR 59992) and proposed critical habitat rule (79 FR 48547) for the species, and reports cited in this document.

Background

As early as 1944 the species was noted to be declining in California due to habitat loss and alteration (Grinnell and Miller 1944). The western population of the Yellow-billed Cuckoo was petitioned for listing as a federally endangered species in 1999 (USFWS 2001). In 2002 the western DPS was determined to be warranted but precluded for listing by higher priority species. On October 3, 2013 the proposed rule to list the western DPS of the Yellow-billed Cuckoo as a Threatened species was published in the Federal Register (78 FR 61621) and on October 3, 2014 the final listing rule was published (79 FR 59992) and the listing went into effect November 3, 2014.

At the time of the initial petition in 1999, little was known of the extent of the western population outside of California. Since then there has been additional research on distribution, ecology, and habitat use of the Yellow-billed Cuckoo in the western United States. We now have information on the population distribution in most of the western states, although there are still many areas that have not been thoroughly surveyed.

Breeding populations exist in California in the Sacramento Valley along the Sacramento River and some tributaries (although recent surveys found no evidence of breeding (Dettling and Howell 2011)), the South Fork Kern River, and restoration sites near Blythe on the lower Colorado River (Figure 1; Halterman et al 2001, McNeil et al 2013, Stanek and Stanek 2012). In Arizona, cuckoos are known to breed primarily within the Bill Williams, Big Sandy , Agua Fria,

Verde River, Gila River, Santa Cruz and San Pedro river watersheds, as well as multiple restoration sites along the lower Colorado River (Corman and Magill 2002, Halterman 2009, Johnson et al. 2010, McNeil et al. 2013). In New Mexico they breed on the Gila River and the middle Rio Grande (Stoleson and Finch 1998, Woodward et al. 2002, Ahlers and Moore 2012). In Colorado there are small numbers along the Colorado River and upper Rio Grande (Beason 2010). There are no known breeding populations in Oregon (Marshall et al. 2003). In Idaho there is reported breeding on the Snake River (Cavallaro 2011). In Nevada they may occasionally breed on the Carson, Virgin and Muddy Rivers (Halterman 2001, McKernan and Braden 2002, Tomlinson 2010, McNeil et al. 2013).

Figure 1. Range of the western Distinct Population Segment of the Yellow-billed Cuckoo.

In order to advance our understanding of the distribution of Yellow-billed Cuckoos, we need an effective and standardized survey protocol and uniform reporting of survey results. Cuckoos seldom call on their own and have a relatively low level of responsiveness to playback (Halterman 2009), and thus can be difficult to detect, making it difficult to accurately track populations. This document is intended to provide clear guidelines to agencies, consultants, volunteers, and researchers, to monitor Yellow-billed Cuckoo populations and determine habitat

occupancy. Because of the similarity of habitat use and survey techniques, some information was borrowed with permission from the SWFL protocol (Sogge et al. 2010).

Section 1. Natural History

Breeding Range and Taxonomy

Western Yellow-billed Cuckoos historically bred throughout riparian systems of western North America from southern British Columbia to northwestern Mexico (Hughes 1999). They inhabited the deciduous riparian woodlands once lining most rivers and streams. Since at least the 1850s, Yellow-billed Cuckoo populations have declined dramatically (Roberson 1980, Gaines and Laymon 1984, Laymon and Halterman 1987) and breeding cuckoos have been extirpated over much of the western range, including British Columbia, Oregon, and Washington (Hughes 1999). Although the western Yellow-billed Cuckoo has been described as a subspecies called the California Cuckoo (*Coccyzus americanus occidentalis*) (Ridgeway 1887, AOU 1956), there has been debate about its taxonomic status. There is research that both supports (Franzreb and Laymon 1993, Pruett et al. 2001), and refutes subspecies status (Banks 1988 and 1990, Fleischer 2001). The range of the Distinct Population Segment of the Yellow-billed Cuckoo is essentially the same as the range of the subspecies.

Migration and Winter Range

The Yellow-billed Cuckoo is a Neotropical migrant bird that winters in South America east of the Andes, primarily south of the Amazon Basin in southern Brazil, Paraguay, Uruguay, eastern Bolivia, and northern Argentina (78 FR 61621). The winter range and migration routes of the western Yellow-billed Cuckoo are poorly known. Eastern and western cuckoos may intermingle on the wintering grounds and in migration, or they may have separate wintering grounds and migration routes. Geolocator data is available from one single cuckoo captured during the breeding season on the middle Rio Grande River in New Mexico (Sechrist et al. 2012). This data indicates that the bird spent five months, from late November through April, in eastern Bolivia, southwestern Brazil, Paraguay, and northeastern Argentina. This cuckoo traveled south to southern Sonora, Mexico, in late July, then back to the Rio Grande before migrating southeast through Texas and eastern Mexico in August and September, and Honduras, Panama, and Columbia in October, and the upper Amazon basin in November. In the Spring it followed a different migration route through Brazil, Columbia, Venezuela, the Caribbean, the Yucatan Peninsula in Mexico, to the lower Rio Grande, then to the Conchas River in Chihuahua, Mexico, then back to the Rio Grande near its original capture point in early July (Sechrist et al. 2012, 78 FR 61621). There's little additional information on the western Yellow-billed Cuckoo's migration routes. Research indicates that the San Pedro River, and the lower Colorado River and its tributaries are migratory corridors (Halterman 2009) and a migrating flock was recorded by Miller (1950) in the Cape region of Baja California Sur in late May or early June (78 FR 61621).

Breeding Habitat

Breeding western Yellow-billed Cuckoos are riparian obligates and currently nest almost exclusively in low to moderate elevation riparian woodlands with native broadleaf trees and shrubs that are 20 hectares (ha) (50 acres (ac)) or more in extent within arid to semiarid

landscapes (Hughes 1999, 79 FR 59992). They are most commonly associated with cottonwood–willow–dominated vegetation cover, but the composition of dominant riparian vegetation can vary across its range. In California, habitat often consists of willows (*Salix* spp) mixed with Fremont cottonwoods (*Populus fremontii*) and, in other portions of its range, narrow-leaf cottonwood (*Populus augustifolia*) and mesquite (*Prosopis* spp.) are important habitat components. In Arizona, habitat may also contain box elder (*Acer negundo*), Arizona alder (*Alnus oblongifolia*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), oak (*Quercus* spp.), netleaf hackberry (*Celtis reticulata*), velvet ash (*Fraxinus velutina*), Mexican elderberry (*Sambuccus mexicanus*), tamarisk (*Tamarix* spp.), and *Baccharis* ssp.; (Corman and Magill 2000, Corman 2005, Johnson et al. 2010). Occupancy rates (the percent of patches surveyed with at least one cuckoo detection) in Arizona were highest in cottonwood/willow/ash/ mesquite habitat (70.7% occupancy), cottonwood/willow/ash/mesquite/with less than 75% tamarisk habitat (60.7% occupancy), and mesquite bosque/hackberry habitat (60.0% occupancy). Yellow-billed Cuckoos were much less common in sycamore/cottonwood habitat (46.2% occupancy), sycamore/alder/willow/ash/walnut habitat (33.3% occupancy), and habitat comprised of greater than 75% tamarisk cover (33.3% occupancy; Johnson et al. 2010).

At the landscape level, the amount of cottonwood–willow-dominated vegetation cover and the width of riparian habitat influence western Yellow-billed Cuckoo breeding distribution (Gaines and Laymon 1984, Halterman 1991, Holmes et al. 2008, Givertz and Greco 2009, Johnson et al. 2012, 79 FR 59992). Riparian patches used by breeding cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. Yellow-billed Cuckoos mainly nest in patches that are as large as 80 ha (several hundred ac); for example, San Pedro River, Arizona or Elephant Butte Reservoir, New Mexico, but they will nest in areas as small as 20 ha (Beal Lake Conservation Area at Havasu National Wildlife Refuge in Arizona (McNeil et. al. 2013). They have not been found nesting in isolated patches 0.4–0.8 ha (1-2 ac) or narrow, linear riparian habitats that are less than 10-20 meters (m) (33-66 ft) wide, although single birds have been detected in such isolated patches or linear habitats during migration or the early breeding season (mid-late June). In California, Yellow-billed Cuckoos are most likely to be found in patches of willow–cottonwood riparian habitat greater than 80 ha (200 ac) in size. Yellow-billed Cuckoos rarely used smaller patches of habitat (under 20 ha in size), particularly when patches were distant from other patches of riparian habitat (Laymon and Halterman 1989). In Arizona, on the lower Colorado River, Yellow-billed Cuckoos used large patches of habitat (> 20 ha) and areas with dense canopy closure for nesting (McNeil et al. 2013), and habitat modeling identified several important features associated with cuckoo breeding habitat: (1) a 4.5 ha (11.1 ac) core area of dense cottonwood-willow vegetation and (2) a large (72 ha/178 ac) native forest surrounding the core (Johnson et al 2012). The odds of cuckoo occurrence decreased rapidly as the amount of tamarisk cover increased or when cottonwood-willow vegetation was scarce (Johnson et al. 2012). On the Verde River in Arizona, sites occupied by cuckoos were at least 100 m (330 feet) wide; 79% of occupied sites were over 200 m (650 ft) wide, and 92% had at least 5 ha (12 ac) of mesquite in the uplands bordering the riparian patch. On average, occupied sites were larger than unoccupied sites (mean riparian patch width of occupied sites was 253 m (830 ft), and 134 m (440 ft) for unoccupied sites (Holmes et al. 2008).

At large spatial scales, cuckoos have been observed using newly formed sapling stands of riparian vegetation, first documented on the Sacramento River (Halterman 1991). Since then, cuckoos have been recorded using flood irrigated, fast-growing, restoration habitat that was less than a year old for foraging, and less than two years old for nesting (McNeil et al. 2013). Ahlers et al. (2014) found increasing numbers of cuckoos on the middle Rio Grande River in NM, likely in response to an increase of young riparian habitat through natural regeneration. The same was found on the Kern River where the majority of detections and all of the nests were found within the relatively younger habitat (Stanek and Stanek 2012). Johnson et al. (2008) found cuckoos nesting at a newly formed site, with three years old willows, on the Lake Mead/ Colorado River Delta, over 100 km from the nearest known breeding population. Although the mechanisms driving these fluctuations are unknown, it seems likely that availability of suitable breeding habitat and prey abundance are driving factors behind these changes (Greco 2012, Koenig and Leibhold 2005, Barber at al. 2008, Johnson et al. 2008, McNeil et al. 2013).

Yellow-billed Cuckoo habitat can be characterized and quantified in a number of ways, depending on the objectives of the observers. For the purposes of this protocol, we use a relatively simple approach, similar to that used in the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) protocol (Sogge et al. 2010), that can be used to broadly describe and classify survey sites based on woody plant species composition and habitat structure. As described above, these, along with patch size and connectivity, have been documented as important components of cuckoo habitat, but they are likely not the only ones. Measuring other potentially important aspects of cuckoo habitat such as food availability, predators, hydrology, and environmental factors such as temperature and humidity, are beyond the scope of this protocol.

The general categories used to characterize cuckoo habitat in this protocol are based on the composition of the tree/shrub vegetation at the site: native broadleaf (>75% of cover from native trees/shrubs); exotic/introduced (>75% of cover from exotic trees/shrubs); mixed native/exotic-mostly native (51% - 75% cover from native trees/shrubs); and mixed native/exotic-mostly exotic (51% - 75% cover from exotic trees/shrubs). Each site's canopy and understory canopy height, canopy and understory canopy cover, and the cover of particular dominant plant species in the canopy and understory canopy are also recorded.

The native broadleaf tree/shrub category for breeding sites within the Western Yellow-billed Cuckoo range are described above, and often have a distinct overstory of willow, cottonwood, or other broadleaf trees, with recognizable sub-canopy layers and an understory of mixed species trees and shrubs, including tamarisk. Sites are classified as native broadleaf if greater than 75% of the cover is contributed by native broadleaf species. Exotic/introduced are sites where exotic/introduced trees/shrubs contribute 75% or greater of the vegetation cover. These sites are typically dominated by tamarisk or Russian olive (*Elaeagnus angustifolia*). Mixed native/exotic sites ("mixed exotic native-mostly native" and "mixed exotic native-mostly exotic) include mixtures of native broadleaf trees and shrubs mixed with exotic/introduced species such as tamarisk and Russian olive. The exotics are primarily in the understory canopy, but may be a component of the canopy, and the native/exotic components may be dispersed throughout the habitat or concentrated as a distinct patch within a larger matrix of habitat. If a particular site is dominated primarily by natives (i.e. 51% - 75% native) it is classified as mixed exotic native-

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mostly native. If it is dominated primarily by exotics/introduced species (i.e. 51% - 75% exotic) it is classified as mixed exotic native-mostly exotic.

The ultimate measure of habitat suitability is not simply whether or not a site is occupied. Habitat suitability occurs along a gradient from high too poor to unsuitable; the best habitats are those in which cuckoo reproductive success and survivorship result in a stable or growing population. Some occupied habitats may be acting as population sources, while others may be functioning as population sinks (Pulliam 1988). Therefore, it can take extensive research to determine the quality of any given habitat patch. Not all unoccupied habitat is unsuitable; some sites with suitable habitat may be geographically isolated or newly established, such that they are not yet colonized by breeding cuckoos. Small habitat patches may also provide critical stopover sites for refueling and resting during migration. There also may not be enough cuckoos in a given area, particularly at the periphery of its current range, to fill all available habitat.

Breeding Chronology and Biology

Western Yellow-billed Cuckoos are late spring migrants. In Arizona and California, a few individuals occasionally arrive in mid- to late May, but the majority do not arrive until mid-June, with late migrants straggling into early July (Corman 2005; Laymon 1998a). Nesting typically occurs between late June and late July, but may occasionally begin as early as late May, and continue into September. Cuckoos have been observed in California as late as mid-September (M. Halterman, pers. obs., McNeil and Tracy 2013, Parametrix and SSRS 2015) and mid-October in southeastern Arizona (Corman 2005). In southeastern Arizona (and possibly in other parts of the southwest), nesting may regularly continue into September, with some birds occasionally noted feeding older fledglings into early October (Corman and Magill 2000, Halterman 2002).

Nests and Eggs

Both adults build the nest, incubate the eggs, and brood and feed the young. Nest building may take as little as half a day, with additional material added to the nest as incubation proceeds (Halterman 2009). Nests are typically well-concealed in dense vegetation (Halterman 2002; Laymon et al. 1997; McNeil et al 2013). Typical clutch size varies from two to four eggs, but exceptionally one and five egg clutches have been observed. Larger clutches are likely the result of conspecific parasitism (Hughes 1999; Laymon et al 1997; Laymon 1998a; McNeil et al. 2013). Eggs, which are a pale bluish-green, are usually laid every second day, but the interval may be variable (Hughes 1999). Eggs are incubated from 9-11 days (Hughes 1999) and young cuckoos fledge five to eight days after hatching, with six days being typical (Laymon and Halterman 1985, Halterman 2009). Males incubate the eggs at night, and both sexes alternate incubation and nestling care during the day (Halterman 2009, Payne 2005). Males appear to be the primary caregiver of the young post-fledging (Halterman 2009).

Typically Western Yellow-billed Cuckoos have one brood per year (Ehrlich et al 1988). In California at the South Fork Kern River, in years of abundant food resources, two and even three broods have successfully fledged. Double brooding was observed in less than half of the 12 years of study there and triple brooding was observed only once (Laymon 1998a). Double broods have been regularly observed on the upper San Pedro River (Halterman 2009) and on the lower

Colorado and Bill Williams rivers (McNeil et al. 2013). Triple broods have occasionally been observed at these sites.

Fledglings continue to be dependent on the adults for approximately 14-21 days, seeking food from adults by giving short “cuk-cuk-cuk” calls. At approximately 14 days, fledglings give louder calls, but appear to lack the full range of adult vocalizations. The fledglings may continue to be dependent on the adults until they are 28-32 days old (Halterman 2009, McNeil et al. 2013). Young birds can be distinguished for several weeks post-fledging by the paler yellow coloration on the bill, and a shorter tail with slightly paler coloration (dark gray instead of black; Pyle 1997). It is very difficult to see these subtleties in the field, however, and aging fully-grown juveniles can be problematic for all but the most experienced observers (Halterman 2008).

Vocalizations

Cuckoos call infrequently, with an unsolicited vocalization rate of one call/hour (Halterman 2009). Their vocalizations are described by Hughes (1999) and others (Bent 1940, Hamilton and Hamilton 1965, Potter 1980). Common calls include variations of the contact call. This is a series of “kuk” notes with or without “kowlp” notes, given by both sexes (Halterman 2009; Hughes 1999). Also commonly heard is the “coo” call, apparently given primarily by females (Halterman 2009). A very soft “coo” call seems to be given by adults to nestlings. Adults also give an alarm consisting of a low “wooden knocking” call, continued until the threat leaves the area. This call is typically given in the vicinity of a nest or fledgling. Calls are described in detail in the Survey Protocol Section, Yellow-billed Cuckoo Identification, below.

Food and Foraging

Cuckoos eat a wide variety of prey items. These are primarily large arthropods such as cicadas, katydids, grasshoppers, and caterpillars, but may also include small lizards, frogs, spiders, tent caterpillars, and a variety of other insects. There is evidence to suggest that population levels and breeding may be closely tied to abundance of certain food items (Clay 1929, Bent 1940, Preble 1957, Hamilton and Hamilton 1965, Nolan and Thompson 1975, Laymon 1980, Koenig and Liebhold 2005, Halterman 2009, McNeil et al. 2013). Cuckoos typically perch inconspicuously while visually searching nearby vegetation for prey (Hamilton and Hamilton 1965, Stiles and Skutch 1989). This foraging method contributes to the difficulty of detection. They may venture out into surrounding low vegetation (flooded fields, younger habitat, sacaton (*Sporobolus* sp.) grassland) after observing prey items while perched in the riparian (Halterman 2002; McNeil et al. 2013).

Site Fidelity and Local Population Fluctuations

Little is known about population substructure, dispersal of young and post-breeding adults, juvenile and adult site fidelity, or the factors influencing breeding site detection and selection. Research indicates that the San Pedro River, lower Colorado River and tributaries are migratory corridors, in addition to being breeding areas (Halterman 2009). Cuckoos were captured and equipped with transmitters in suitable nesting habitat on these rivers; and many of these birds left the area before breeding. A small number of birds that left their banding location were detected

in the same season at other riparian sites. These within-season movements varied from 1 km to nearly 500 km (Halterman 2002, McNeil et al. 2013). Additional research is needed at other sites, particularly with more northern populations, to determine if these movements occur range wide.

Between-year fluctuations in estimated populations have been observed at multiple locations throughout the range. From 1997 to 2004, the estimated population on the Bill Williams River fluctuated between 6 and 28 pairs (20 to 78 survey detections/year; Halterman 2008). The estimated population of the South Fork Kern River fluctuated from less than 5 pairs to more than 20 pairs over a 12 year period (Laymon et al. 1997). The population on the San Pedro River fluctuated greatly from 2001 to 2007, with numbers halving from 2003 to 2006, then apparently doubling from 2006 to 2007 (Halterman 2008). Populations on the Sacramento River have shown year-to-year fluctuations (Halterman 1991) and decade-to-decade fluctuations (Laymon and Halterman 1987, Halterman et al. 2001, Dettling and Howell 2011).

The methods used to estimate population size varied between studies, but it is clear that Yellow-billed Cuckoo populations increase or decrease locally well beyond the expected fluctuations of a closed population. These studies indicate a species that is not only capable of, but likely adapted to, locating and utilizing resources that are highly variable in time and space. Multiple years of surveying are therefore required to obtain a reasonable estimation of occupancy, habitat use, and distribution.

Little is known about survivorship of Yellow-billed Cuckoos, though the Institute for Bird Populations reports an estimated annual survival probability of 50% (NBII/MAPS Avian Demographics Query Interface). Limited data from the San Pedro River, Arizona, with color-banded birds, indicates that a small percentage of the population (about 5%) returns to the breeding sites each year (Halterman 2009). On the lower Colorado River, primarily in LCR-MSCP habitat creation sites, about 10% of the banded birds were recaptured in the area one or more years after initial capture (McNeil et al. 2013). Returning birds on the San Pedro were re-sighted approximately 25 m (80 ft) and over 2 km (1.2 miles) from their banding location (Halterman 2009). Returning birds banded as adults on the lower Colorado River were re-sighted between approximately 25 m (80 ft) and 40 km (25 miles) from their banding location (McNeil et al. 2013). Returning birds banded as nestlings/fledglings on the Lower Colorado River were re-sighted between ~30 m (100 ft) to ~80 km (50 miles) from their banding location (McNeil et al. 2013). Breeding pairs of banded cuckoos at this site were found using the same territory for up to three years (Laymon 1998a).

Threats to the Cuckoo and Habitat

The decline of the western Yellow-billed Cuckoo is primarily the result of riparian habitat loss and degradation. Within the three states with the highest historical number of Yellow-billed Cuckoos, past riparian habitat losses are estimated to be about 90 to 95 percent in Arizona, 90 percent in New Mexico, and 90 to 99 percent in California (Ohmart 1994, USDOI 1994, Noss et al. 1995) Many of these habitat losses occurred historically, and although habitat destruction continues, many past impacts have ramifications that are ongoing and affect the size, extent, and quality of riparian vegetation within the range of the western Yellow-billed Cuckoo. Principal causes of riparian habitat destruction, modification, and degradation in the range have occurred

from alteration of hydrology due to dams, water diversions, management of river flow that differs from natural hydrological patterns, channelization, and levees and other forms of bank stabilization that encroach into the floodplain (79 FR 48547). These losses are further exacerbated by conversion of floodplains for agricultural uses, such as crops and livestock grazing. In combination with altered hydrology, these threats promote the conversion of existing primarily native habitats to monotypic stands of non-native vegetation, reducing the suitability of riparian habitats for the cuckoo.

Because of the absence or near absence of nesting by Yellow-billed Cuckoos in monotypic stands of tamarisk and other nonnative vegetation, the available literature suggests that conversion of native or mixed (native and non-native) riparian woodlands to nearly monotypic stands of tamarisk and other non-native vegetation, coupled with the inability of native vegetation to regenerate under altered hydrological conditions, is a significant threat to the western Yellow-billed Cuckoo now and in the future (79 FR 48547). Non-native vegetation occurs across most of the range; its establishment can be caused by altered hydrology or other disturbances, which are widespread throughout the range. Non-native vegetation is expected to increasingly modify and decrease habitat for the western Yellow-billed Cuckoo within a majority of its range in the United States and northern Mexico. Other threats to riparian habitat include long-term drought and climate change.

Section 2. Survey Protocol

This basic protocol has changed little since it was first written in 1998 (Laymon 1998) and expanded in 1999 (Halterman 1999). There have been a number of refinements as research has increased our knowledge of this elusive species. The greatest change is in interpretation of results. Previous versions of this protocol have been used effectively to survey hundreds of sites in the western United States.

Yellow-billed Cuckoos are challenging to survey for a number of reasons. They have a low unsolicited calling rate, averaging about one call/hour making standard point count surveys particularly ineffective (Halterman 2009). They have large home ranges, with average 95% kernel home ranges varying from 19.5 ha (48.2 ac) to 42.3 ha (104.5 ac), depending on location, breeding status, and gender of the individual (Halterman 2009, McNeil et al. 2013, Sechrist et al. 2009). This brevity of peak of activity, along with the potential for double and triple brooding, further complicates complete survey coverage. The peak of cuckoo nesting activity lasts only about one month, with breeding activity of the western DPS of the Yellow-billed Cuckoo peaking in July (Laymon et al. 1997, Halterman 1991, 2009; McNeil et al. 2013), but in some years breeding can start in May and end in September. Detection rates also peak during July and drop off dramatically after mid-August regardless of breeding status (Laymon et al 1997, Halterman 2008, Ahlers 2012, McNeil et al. 2013). Males and females are sexually monomorphic in appearance and in many behaviors (Halterman 2009). Breeding can only be confirmed by finding an active nest, seeing fledglings, distraction or alarm displays, or copulation. These render interpretation of survey results problematic. Given these challenges, no methodology can assure 100% detection rates. This protocol does provide an effective tool for detecting cuckoos when surveys are conducted by trained surveyors.

The secretive and sometimes subtle life history characteristics of this species influence how Yellow-billed Cuckoo surveys should be conducted and form the basis upon which this protocol was developed. This protocol is based on the use of repeated call-playback surveys during pre-determined periods of the breeding season, to confirm presence or to derive a high degree of confidence regarding cuckoo absence at a site. Such species-specific survey techniques are necessary to collect reliable presence/absence information for this and other rare and secretive species (Johnson et al 1981, Sogge et al. 1997, Conway and Simon 2003).

The primary objective of this protocol is to provide a standardized survey technique to detect Yellow-billed Cuckoos, estimate breeding status, and facilitate consistent and standardized data reporting. The survey technique will, at a minimum, help determine presence of the species in the surveyed habitat for that breeding season. Ultimately, the quality of the survey that is conducted will depend on the experience, preparation, training, and in-the-field diligence of the individual surveyor.

This protocol is designed for use by persons who are non-specialists with Yellow-billed Cuckoos or who are not expert birders. However, surveyors must have sufficient knowledge, training, and experience with bird identification and surveys to visually distinguish Yellow-billed Cuckoos from similar species, and be able to distinguish Yellow-billed Cuckoo calls from similar vocalizations of other species. Visual sightings of cuckoos are relatively rare and often fleeting, and surveyors experienced with bird identification and behavioral observations of nesting birds will be best able to understand these brief observations. A surveyor's dedication and attitude, willingness to work early hours in dense, rugged and wet habitats, and ability to remain alert and aware of cues also are important. Surveys conducted improperly or by unqualified, inexperienced, or complacent personnel may lead to inaccurate results and unwarranted conclusions.

Surveys conducted by qualified personnel in a consistent and standardized manner will enable continued monitoring of general population trends at and among sites, and among years. Annual or periodic surveys in cooperation with State and Federal agencies should aid resource managers in gathering basic information on cuckoo status and distribution at various spatial scales. Identifying occupied and unoccupied sites will assist resource managers in assessing potential impacts of proposed projects, avoiding impacts to occupied habitat, identifying suitable habitat characteristics, developing effective restoration management plans, and assessing species recovery.

Like previous versions, this revised protocol is based on call-playback techniques. However, it includes changes in the timing of surveys to increase the probability of detecting cuckoos and to help determine if detected cuckoos are breeders or migrants. A detailed description of surveys and timing is discussed in the section "Timing and Number of Visits." The current survey data sheets are easier to use and submit than previous versions, and allow reporting all site visits within a single year on one form. The new survey forms also are formatted such that they are comparable to the current and widely used Southwestern Willow Flycatcher (SWFL) survey forms.

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This protocol is intended to determine if a habitat patch contains Yellow-billed Cuckoos, and is not designed to establish the location of nests or the exact distribution and abundance of cuckoos at a site. Determining precise cuckoo numbers and locations requires many more visits and additional time observing behavior. This survey protocol also does not address issues and techniques associated with nest monitoring or other cuckoo research activities. Those efforts are beyond the scope needed for most survey purposes, and require advanced levels of experience and skills to gather useful data and avoid potential negative effects to cuckoos. If nest monitoring is a required component of your study, personnel experienced with and permitted for nest searching and monitoring must be included in the project. We provide general information on nest searching so surveyors will recognize the behavior of cuckoos near a nest, and thus avoid unnecessary disturbance around a nest that might cause nest abandonment or predation.

Biologists who are not expert birders or specialists with Yellow-billed Cuckoos can effectively use this protocol. However, please note that prior to conducting any surveys, all surveyors are required to attend or have attended a U.S. Fish and Wildlife Service (USFWS)-approved Yellow-billed Cuckoo survey training workshop, and have knowledge and experience with bird identification, survey techniques, avian breeding behavior, and ecology sufficient to effectively apply this protocol.

Non-Protocol (Exploratory) Surveys

Under special circumstances, it may be permissible to use call-playback in a way that does not follow the protocol. They are intended to assess whether an area merits full protocol surveys, and to increase general distribution knowledge. These exploratory surveys will allow agency personnel (or others working with their approval) to survey 1-3 times at sites that are not scheduled for regular surveys. These exploratory surveys are not intended to be conducted in project areas. These surveys are not intended to estimate the distribution and abundance of cuckoos at the site, and can only be conducted by individuals with all appropriate State and Federal permits and permissions.

Permits

Federal endangered species 10(a) 1(A) recovery permits are required to conduct surveys for Yellow-billed Cuckoos in all USFWS regions where the western Yellow-billed Cuckoo DPS breeds. State permits may also be required, and both federal and state permits may take several months to obtain so please plan ahead. Permits or permission are often required to access potential survey locations. The level of permitting will depend on the applicant's expertise in observing and handling cuckoos and attending a USFWS-approved Yellow-billed Cuckoo survey protocol workshop.

Permits will cover a range of activities, and will depend on the applicants experience level and needs. Permits are required for the following activities: surveys, nest searching and monitoring, banding adults and nestlings, attaching transmitters to cuckoos, radio telemetry, and blood and feather sample collection.

Pre-Survey Preparation

Pre-survey preparation is essential to conducting efficient, quality surveys. It is often overlooked, but can prove to be one of the more important aspects in achieving high-quality survey results. All surveyors are required to attend a USFWS-approved, survey protocol workshop prior to conducting surveys and should carefully study the Yellow-billed Cuckoo Identification section, below. It is especially critical for surveyors to be familiar with Yellow-billed Cuckoo vocalizations before going in the field. Surveyors should study calls, songs, drawings, photographs, and videos (if available) of Yellow-billed Cuckoos. An excellent source of vocalizations is the xeno-canto website (www.xeno-canto.org). This site is a community shared bird-sound database.

Surveyors should also become familiar with cuckoo habitat. If possible, visit as many known Yellow-billed Cuckoo breeding sites as possible and study photos of cuckoo habitat. Such visits are usually part of the Yellow-billed Cuckoo survey protocol workshops. All visits should be coordinated with USFWS, State wildlife agencies, and the property manager/owner, and must avoid disturbance to cuckoos. While visiting these sites, carefully observe the habitat characteristics to develop a mental image of the key features of suitable habitat.

Prior to conducting any presence/absence surveys in your respective State or USFWS Region, contact the respective cuckoo coordinators to discuss the proposed survey sites and determine if the sites have been surveyed in prior years. If possible, obtain copies of previous survey forms and maintain consistency with naming conventions and site boundaries. Study the forms to determine if cuckoos have been previously detected at the site, record locations of any previous detections, and read the comments provided by prior surveyors. While surveying, be sure to pay special attention to any patches where cuckoos have previously been detected. However, please realize if it has been several years since a location has been surveyed, some habitat sections may have changed, for better or worse. As an example, newer riparian sections may have developed in size and density to become appropriate nesting/foraging areas.

Familiarity with the survey site prior to the first surveys is the best way to be prepared for the conditions you will experience. It is the individual surveyor's responsibility to survey all suitable habitat within the respective site. It's best to layout and walk transects in advance of the surveys. Determine the best access routes to your sites and always have a back-up plan available in the event of unforeseen conditions (for example, locked gates, weather, etc.). Know the local property boundaries and transect start and stop points (if previously surveyed), where the potential hazards may be, including deep water, barbed wire fencing, and difficult terrain. Be prepared to work hard and remain focused and diligent in a wide range of physically demanding conditions. At many sites, these include heat, cold, wading through flowing or stagnant water, muddy or swampy conditions, and quicksand, crawling through dense thickets, and exposure to rattlesnakes, skunks, and biting insects.

The day before conducting the survey, set a time for departure to the site. Surveying generally occurs in the early morning, beginning just before sunrise and continuing, depending on environmental factors (including noise levels), until 1100 or until temperatures reach 40C/104F whichever comes first. Know the directions to the survey site and estimate the time it will take to

get to the first point by driving and walking, possibly in the dark. If possible, preload you're GPS (or other navigation device) with survey transects and survey points. Your departure time for the following morning should ensure arrival at the starting point approximately one hour before sunrise. If the survey takes more than two hours, make an effort to start at the opposite end of the transect for each survey round, so that all points are surveyed in the earlier hours. This may not always be logistically possible.

It is imperative that all surveyors exercise safety first. Be aware of hazards and how to avoid them, and do not allow the need to conduct surveys to supersede common sense and safety. Inform your coworkers where you will be surveying and when you anticipate returning. Always take plenty of water and know how to effectively use your equipment, especially compass, Global Positioning System (GPS), and maps.

Equipment

Table 1. List of items for conducting Yellow-billed Cuckoo surveys.

Required Items	Details
USGS Map and/or aerial photo (orthorectified; color photocopies) of survey area	A marked copy is required to be attached to survey datasheets submitted at the end of the season. The survey site needs to be delineated and detections clearly marked. If the survey area differed between visits, individual surveys should be delineated.
Broadcast equipment (e.g., Audio device, and speakers) and batteries	Must be capable of broadcasting recorded calls 100 m without distortion (recommended speaker volume of 70 db). Having a fully charged device and extra batteries as well as back-up/extra broadcast equipment is highly recommended to avoid abandoning a survey due to equipment failure. Use only the provided contact call for broadcast.
Standardized survey form	Multiple copies for each survey.
Recorded contact/kowlp calls	Acquired by attending Yellow-billed Cuckoo protocol workshop.
Binoculars	A pair with 7-10 power that can provide crisp images in poor lighting conditions.
GPS device with extra batteries	With start and stop UTMs for previously surveyed areas. All surveyor locations at time of detection should be recorded as waypoints. The compass direction and distance to individual detections are recorded from the waypoint.
Compass	The compass bearing is taken, and distance to the detected cuckoo(s) is estimated, from the surveyor's waypoint. The compass feature on the GPS unit is often much more difficult to use in the field than a compass. A compass may also help surveyors navigate through the patch more easily than using the GPS.
Clipboard or electronic device	Survey results and observations should be recorded directly onto the survey data form to ensure that all required data is collected and recorded.
Pens, Pencils, and Sharpies	Take multiples of each.
Device to record time	Use the GPS unit, watch, or phone
Optional Items	**Details**
Cell phone/portable radio	For communication between surveyors and for safety.

Camera	Helpful for habitat photos of survey sites, especially where cuckoos are found.
Laser Rangefinder	For measuring distance to detections (if possible) and height of trees.
Hard copy of start/stop UTMs	Use as a back-up for the GPS unit.

Yellow-billed Cuckoo Identification

Yellow-billed Cuckoos are a slender, medium-sized bird, about 30 cm in length, and weighing about 60 grams. The upperparts are grey-brown, the underside is clean white, and the tail is long with white spots at the end of the central rectrices. A flash of bright rufous in the wings is usually visible in flight, and occasionally while perched. The legs are blue-gray, but are seldom visible since cuckoos typically perch so that the legs are hidden under the belly. The bill is long and slightly down-curved, with a mostly black upper mandible and lower mandible ranging from yellow to orange with a black tip. Flight is generally direct and agile. Sexes are similar, and although females average larger than males, this difference is seldom visible in the field (Pyle 1997, Halterman 2009). In general, look for a slender bird with a bright white chest, long tail, and grey-brown head contrasting with a white throat.

When seen clearly, this species is unmistakable. Often you will only have a fleeting glimpse of a bird, so you need to quickly assess what you've seen. Be sure to study all available photos and video of cuckoos. Familiarization with images of both cuckoos and similar species will aid in rapid and correct identification in the field. There are a number of species that can be mistaken for cuckoos when seen briefly. These include:

1. Ash-throated Flycatchers (*Myiarchus cinerascens*) are the most similar to cuckoos, with a slender build, rufous in the wings, a relatively long tail, and agile flight pattern. They often fly closer during cuckoo call playback. The breast typically appears gray, the head is "puffy", and there is no strong contrast between brown upperparts and white underparts. Look for the shorter bill and tail when this species is perched.
2. Mourning Doves (*Zenaida macroura*) are heavier, the breast appears tan/gray, the tail is pointed, and the flight is relatively heavy and direct.
3. White-winged Doves (*Zenaida asiatica*) are much larger, with tan/gray breast, and show a bold flash of white in the wings in flight.
4. Northern Mockingbirds (*Mimus polyglottos*) are slender with a relatively long tail tipped with white. Look for the large white wing patches and lack of strong contrast between the chest and back.
5. The rusty flash of a Northern Flicker's (*Colaptes auratus*) wings are reminiscent of the rufous flash in a cuckoo's wings, but either calls or subsequent views will aid in correct identification.
6. Brown-crested Flycatchers (*Myiarchus tyrannulus*) are also similar, but the bright yellow belly and the larger head facilitate correct identification.
7. Loggerhead Shrikes (*Lanius ludovicianus*) and both California (*Toxostoma redivivum*) and Crissal thrashers (*Toxostoma crissale*) may also look like cuckoos when seen fleetingly.

The majority of Yellow-billed Cuckoo detections are from birds that are heard but never seen (Halterman et al 2001; Halterman 2009, McNeil et al. 2013), so it is critically important to know

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the calls of this species as well as similar species. There are two commonly heard calls, which can be given by males or females. Each call can be confused with calls of a number of other birds, especially when heard at a distance. We will discuss each in detail:

1. Contact call - also referred to as the "kowlp" call. This is a series of a variable number of "kuk" notes followed by a variable number of "kowlp" notes. This can be given at any time during the breeding season. Individuals may give calls with variable combinations of kuks and kowlps, and may omit one or the other of the notes altogether. Although distinctive when heard clearly, there are several species with similar calls, particularly when heard from a distance. The most similar species is the Yellow-breasted Chat (*Icteria virens*), which sometimes appears to give calls mimicking the cadence of cuckoo calls following playback. Chats also typically give a single diagnostic sharp "chuck". Familiarization with the calls of this species is critical to correct identification where the two co-occur. Pied-billed Grebe (*Podilymbus podiceps*) calls can also sound very similar to cuckoo calls; the fact that the call emanates from a wetland will usually help distinguish this species, though this call is loud, carries well, and the presence of a wetland may not be known. Less similar, but still worth learning, are most woodpecker and accipiter calls.

2. Coo call. This is given with greatest frequency in the early and middle part of the breeding season. It typically consists of a 5-8 evenly-pitched and evenly-spaced "coo" notes, ending with 1-3 notes on a lower pitch. The number of coo notes may vary from one or two notes to several minutes of continuous calling. Although diagnostic when heard clearly, there are a number of species with similar calls. The most similar is Greater Roadrunner (*Geococcyx californianus*); its call is a series of "coos" which drop in pitch with each note. Distant notes of both Mourning and White-winged dove calls can sound almost identical to cuckoo coos, but the pattern is very different, with only 1-3 coo notes heard. Both dove species typically repeat their calls, so the initially questionable coo can usually be identified with careful attention. Other sounds which, when heard from a distance and at the edge of hearing, could be (and have been) confused with the cuckoo coo call include noisy cows, barking dogs, and machinery.

Less commonly heard, but important to know, is the cuckoo alarm call, sometimes called the knocker call. This is a short series of soft wooden "kuk-kuk-kuk-kuk" notes. This is typically given near a nest or fledglings, but can be heard anytime a cuckoo is disturbed. The call typically is given multiple times, and at relatively close range. It is best to assume that the alarmed bird is near a nest or young, particularly in July and August, and leave the area to avoid further disturbance.

An excellent source of vocalizations of all these species is the xeno-canto website (www.xeno-canto.org). This site is a community shared bird-sound database.

Timing and Number of Visits

The timing of this protocol is intended to assess Yellow-billed Cuckoo presence, and potentially estimate abundance and distribution. Accurate population determination is beyond the scope of

this protocol, but conducting surveys during the peak of breeding activity will increase the probability of detecting any cuckoos that are present. This call-playback technique detects cuckoos that may otherwise be overlooked. Multiple surveys at each site are important, and with appropriate effort, avian biologists without extensive experience with cuckoos can find and verify Yellow-billed Cuckoo presence.

There are three survey periods. Surveys are conducted for the sole purpose of assessing whether Yellow-billed Cuckoos are present at a site. A minimum of four survey visits are required (Figure 2). Four surveys conducted during the three survey periods listed in Figure 2 will have an 80% probability of detecting an individual cuckoo (Carstensen et al. 2015, Halterman 2009) and a 95% probability of detecting cuckoos, when they are present at a site during the breeding season (McNeil et al. 2013, Carstensen et al. 2015).

Prior to the field season, we suggest developing a sampling schedule, based on the survey periods (Figure 2) and the number and extent of sites to be surveyed. Yellow-billed Cuckoo surveys should be scheduled to begin after a thorough training session (including attending a survey protocol workshop). Initiation of sampling is tailored to the phenology of the Yellow-billed Cuckoo in the study region, and is generally timed to begin after resident individuals have arrived, presumably to breed, within the region. Due to differences in breeding seasons across the western US, a survey window of ± 3 days is acceptable for the start and end of each survey period. Each survey site is visited a minimum of four times within the breeding season, with a minimum of 12 days and a maximum of 15 days between surveys at a particular site.

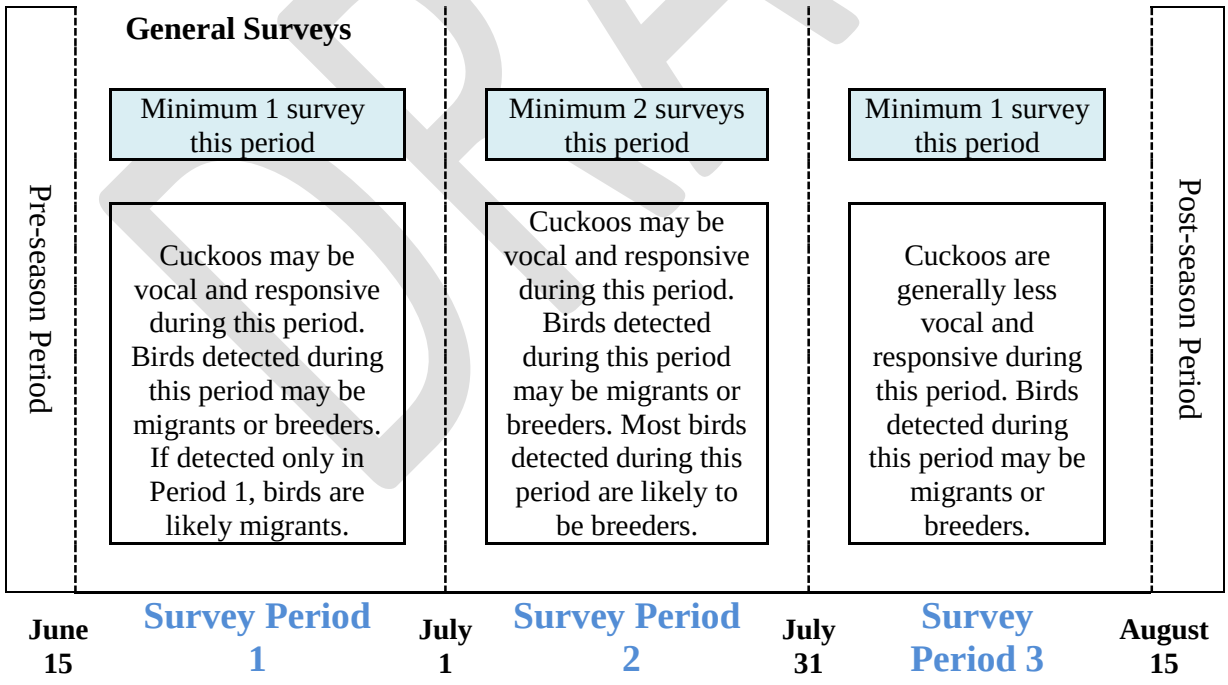

Figure 2. Recommended number and timing of visits during each survey period for Yellow-billed Cuckoo surveys.

If breeding confirmation is required, more visits will be needed and they must be conducted by surveyors permitted to search for nests. Even with additional effort, it may not be possible to verify breeding activity during a season. When developing a survey schedule for multiple surveyors, care should be given to scheduling so that multiple surveyors do not overlap areas, and the risk of a surveyor mistaking a broadcast call for a cuckoo is reduced. Additionally, if surveyors are working on adjacent plots, they should communicate both during and after surveys to avoid double counting.

Pre-season Survey Period: late May to June 14. No surveys required. This spans the earliest time that cuckoos may arrive on breeding grounds, but most cuckoos present during this period are likely migrants. However, cuckoos will occasionally begin breeding during this time.

Survey Period 1: June 15 to June 30. One survey is required. This survey occurs as migrating birds are passing through, and breeding birds arrive. Although many birds detected during this time may be migrants, surveys during this time will help with seasonal survey detection interpretation, and will also allow surveyors to familiarize themselves with all survey areas.

Survey Period 2: July 1 (+ or – 3 days) to July 31 (+ or – 3 days). Two surveys are required during this period. Cuckoos encountered during this time are mostly breeders, though migrants, wandering individuals, and young of the year may be encountered. This is the period when breeding activity is most likely to be observed (e.g. copulation, food carries, alarm calls). Extra time should be taken to cautiously observe all cuckoos encountered during this time, while avoiding disrupting potentially breeding birds.

Survey Period 3: August 1 to August 15. One survey is required, and most breeding birds are finishing breeding activities and departing. Cuckoos are typically much less vocal and responsive during this time than during Survey Period 2.

Post-breeding Period: August 16 through September. Cuckoos in the southwest may initiate nesting, build second or third nests, or provide care for fledglings in this period (Halterman 2009; McNeil et al. 2013). This is particularly true in southeastern Arizona where local conditions often allow for a lengthier breeding season. Surveys during this time will help clarify cuckoo use of the site, and length of time on the site. Birds encountered during this period may also be migrants. Cuckoos are less vocal during this time than during Survey Period 2.

The best way to confirm breeding status of cuckoos detected at a site is to do follow-up visits and observe cuckoo behavior at a distance. Careful notes should be taken during these visits. Playback calls should not be used during follow up visits, and great care must be taken in order to avoid disturbing nesting birds.

Reporting Requirements and Datasheets

Reporting requirements may vary by region and entity (Federal, State, and Private, for example). Check your permits and other information from permitting agencies for reporting requirements. Although these requirements vary, there is information that is required by any permitting agency, such as the location of the area surveyed and the location and number of cuckoo detections. For

your convenience we have provided three sample datasheets. These can be obtained from any of the following websites:

https://www.fws.gov/southwest/es/Documents/R2ES/YBCU_SurveyProtocol_FINAL_DRAFT_22Apr2015.pdf

https://www.fws.gov/southwest/es/arizona/Yellow.htm

https://www.facebook.com/groups/746657762142636/

1. Yellow-billed Cuckoo Survey Seasonal Summary Form. This form is meant to be completed at the end of the survey season, to summarize data collected across the survey periods. One form can be used for each site surveyed. If required, it can be filled out and submitted at the end of the season. There are three associated documents:
    a. PDF for printing.
    b. Excel file for data entry and electronic submission. This includes a formula to convert distance and direction from the observer to correct the estimated location (UTM) of a cuckoo detection.
    c. Yellow-billed Cuckoo Survey Summary Form Instructions (Appendix 1, this document).
2. Optional Yellow-billed Cuckoo Daily Datasheet. This form can be printed and used for each day's survey, and has room for notes and additional observations. It is not currently required in any Regions, and is provided as a convenience to surveyors.
    a. PDF for printing and field use.
    b. Optional Yellow-billed Daily Datasheet Instructions (Appendix 2, this document).
3. Site Description Form. This form can be used to describe the general characteristics of the site being surveyed. The intent is for one form to be filled out for each site surveyed. This form is included in the 2015 version of the Seasonal Summary Form, so you not need to complete this form separately if you are using the older form.
    a. PDF for printing and use in the field.
    b. Excel file for data entry and electronic submission.
    c. Site Description Form Instructions (Appendix 3, this document).

Survey Methods

The survey methods described below fulfill the primary objective of assessing the presence of Yellow-billed Cuckoos within a survey area during that breeding season. This protocol is primarily a call-back technique, a proven method for eliciting response from nearby Yellow-billed Cuckoos, when conducted as described below. This technique has also been used extensively to survey for Willow Flycatchers (Sogge et al. 2010) and increases the detectability of species that occur in low densities or in dense vegetation (Johnson et al. 1981, Sogge et al. 1997). The call-back technique simulates the presence of a cuckoo in the area, which may elicit a

response from a cuckoo (if there is one in the area), increasing its detectability. At each site, surveyors should broadcast a series of recorded Yellow-billed Cuckoo contact/“kowlp” calls, and look and listen for responses. In addition to maximizing the likelihood of detecting nearby cuckoos, this method also allows for positive identification by comparing the responding bird’s vocalizations to the known Yellow-billed Cuckoo recording.

It is recommended that cuckoo surveys not be conducted at the same time as other state or federal permitted bird surveys. For example, it is preferable that a surveyor not conduct a cuckoo survey at the same time that they are conducting a Southwestern Willow Flycatcher survey or Least Bell’s Vireo (*Vireo bellii pusillus*) survey. Doing so could negatively impact the detection of one or more species being surveyed and impair the ability to compare survey results to surveys where only one species was actively surveyed.

Begin surveys as soon as there is enough light to safely walk (just before sunrise) and continue, depending on the temperature, wind, rain, background noise, and other environmental factors, until 1100. Surveys should not be conducted after temperatures reach 40 degrees C (104 F). If the detectability of cuckoos is being reduced by environmental factors (e.g. excessive heat, cold, wind, or noise), surveys planned for that day should be postponed until conditions improve. Within a study area all potentially suitable habitat patches should be surveyed. A patch is defined as an area of riparian habitat 5 ha or greater in extent that is separated by at least 300 m from an adjacent patch of apparently suitable cuckoo habitat. The 5 ha is considered a typical minimum size for cuckoo occupancy, as no cuckoos have been detected attempting to nest in patches this size or smaller in Arizona or California (Halterman et al. 2001, Johnson et al. 2010). Suitable habitat falls into two types: 1. multi-layered riparian vegetation, with riparian canopy trees (at least a few within the patch) and at least one layer of understory vegetation; 2. mesquite and/or hackberry bosque, primarily in southeastern Arizona or when adjacent to habitat 1 above. Suitable breeding habitat often includes dense young riparian cottonwood/willow vegetation (Halterman 1991, Greco et al. 2002, McNeil et al. 2013).

Surveys can be conducted from the edge (within 10 m) when a patch is less than 200 m in width, provided the entire perimeter is surveyed. It is critical to survey all suitable habitat within an area. Small, linear patches may be thoroughly covered by a single transect along the perimeter. For larger sites, when suitable habitat exceeds 200 m in width, use a systematic survey path that assures complete patch coverage throughout the length and width of the site. Area with multiple, adjacent transects should be surveyed concurrently and in coordination (via text message or radio contact). This will help minimize duplicate detection of the same cuckoo, potentially on different transects/sites, and enable a more accurate territory estimation. The surveyor can skip over areas of unsuitable habitat (e.g. an extensive cobble bar) between patches, if the unsuitable habitat is at least 300 m in extent. Areas with small, narrow stringers of habitat, steep banks, and backwater sloughs can be surveyed by playback from a boat. It is the surveyor’s responsibility to ensure all suitable habitat within the site is thoroughly surveyed.

The broadcast consists of five contact/kowlp calls, each spaced one minute apart. For consistency and comparability of the data, use only the call provided during the protocol training workshop (or from the authors). The recording should be played at approximately 70db. The standard survey forms can be obtained from http://www.fws.gov/southwest/es/. Negative data is

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important, so complete the datasheet for all surveys conducted, regardless of detections. There are other forms which may be better suited to specific research needs. For those forms, it is best to contact specific researchers directly.

Arrive at the broadcast-point and wait at least one minute to listen for unsolicited cuckoo calls (i.e. cuckoos that may be calling before broadcast of the calls). Listen carefully for cuckoos, recognize and shift your attention from other bird species songs and calls, and focus on listening for cuckoos. The majority of responses occur after the first or second broadcast call, so surveyors need to be alert and prepared before beginning playback (McNeil et al. 2013, Carstensen et al. 2015).
If you do not hear any cuckoos during the initial listening period, begin the first broadcast. Listen and watch intently for responding cuckoos during and after each of the five broadcast calls. This includes watching for movement as silent birds may move closer to investigate. If no cuckoo is detected at the broadcast-point after five broadcast calls, continue 100 m along the transect and start a new broadcast as described above. Use additional datasheets for additional broadcast-points within the transect. Use the back of each datasheet to record observations and comments, linking the data by recording the “note #” in the right column of the survey data table on the front of the datasheet, and on the back of the datasheet along with the corresponding observations and comments.

Response to the broadcast call could take several forms. One or more Yellow-billed Cuckoos may move quietly (without calling) toward the surveyor, so it is critical to watch carefully for responding birds from any direction, including behind you. Cuckoos that fly silently toward the survey are difficult to detect and necessitate the full attention of the surveyor. In between broadcast calls, surveyors should be listening for cuckoos, and not be filling out the datasheet. Cuckoos may respond by calling from a distance, so listen for these responses. Cuckoos typically respond with the contact/kowlp call, but may also respond with a coo call or, rarely, an alarm call. When a cuckoo is detected, terminate the broadcast, as it may divert the bird from normal breeding activity or attract the attention of predators. Concentrate on observing the bird rather than immediately recording data. Several hundred cuckoos have been banded in the western United States over the last decade; carefully check cuckoos for leg bands, and carefully record the band color, combination and order.

After a cuckoo has been detected and appropriate data collected, move 300 m further along the transect before resuming the survey. This will minimize the likelihood of detecting the same cuckoo (Halterman 2009, McNeil et al 2013). While it is unusual for cuckoos to move 300 m after being detected by a surveyor, the surveyor should be aware of the possibility, attempt to track an individual’s movements, and use their judgment to estimate if subsequent detections are separate individuals or the same individual. Please make note of all observations about individual movements and the reasoning used in determining number of individuals on the back of the data sheet.

When a cuckoo is encountered between broadcast points (i.e. an unsolicited detection is made while traveling to, from, or between broadcast points), stop and record all information in the same manner as if the detection was made during a broadcast. Do not broadcast calls. After making observations and recording information regarding the detection(s), move 300 m from the

point where the detection was made, along the transect. Continue with the procedures for conducting a survey broadcast.

Interpreting and Reporting Survey Results

This protocol is intended to be used to assess if a habitat patch contains a Yellow-billed Cuckoo. Therefore, the best way to interpret survey detections is a simple detection/non-detection determination. Determination of numbers and breeding status of cuckoos is more complex, and caution should be used when interpreting survey detection data. Because of the cuckoo's elusive and mobile nature, it is easy to both over- and under-estimate cuckoo populations. Over-estimation may occur when highly mobile individuals are detected on subsequent surveys hundreds of meters from their original detection and counted as "new" individuals (Halterman 2009, McNeil et al. 2013). Underestimation may occur because cuckoos vocalize infrequently, and respond and are detected less than half the time they are present during call playback (Halterman 2009).

The following information is one method of interpreting detection data, and should be used with caution. After the survey is completed, locations of cuckoos should be plotted as UTM coordinates on either USGS quad maps or in a GIS (geographic information system). Detection locations can be compared to estimate the total number of cuckoos detected at a site during a survey season. Separation of adjacent detections is based primarily on the distance between detections. If cuckoos are located greater than 300 m apart on the same survey, they are considered separate detections (Holmes et al. 2008, Halterman 2009, Henneman 2009). McNeil et al. (2013) and Ahlers et al. (2012) have developed similar methods for determining the number of Yellow-billed Cuckoo territories, and this should be consulted for a detailed interpretation of survey results.

Although it is difficult to accurately determine number of territories and breeding status, Holmes et al. (2008), and, later, the Southern Sierra Research Station developed a method of interpreting detections to estimate possible, probable, and confirmed breeding territories (Table 2). This determination is often only possible when follow-up visits are made to areas where cuckoos were detected during surveys. These visits may be part of nest searching or mist netting efforts. The following is from Holmes et al. (2008) and McNeil et al. (2013), and should be used, in addition to total detections, when reporting breeding status.

Table 2. Interpretation of results to estimate breeding status (from Holmes et al. 2008 and McNeil et al. 2013)

Estimation Type	Term	Definition
Breeding Territory Estimation	Possible breeding territory (PO)	Two or more total detections in an area during two survey periods and at least 10 days apart. For example, within a certain area, one detection made during Survey Period 2 coupled with another cuckoo detection made 10 days later, also during Survey Period 2, warrants a PO territory designation.
	Probable breeding territory (PR)	Three or more total detections in an area during at least three survey periods and at least 10 days between each detection. PO territory plus YBCUs observed carrying food (single observation), carrying a stick (single observation), traveling as a pair, or exchanging vocalizations.
	Confirmed breeding territory (CO)	Observation of copulation, stick carry to nest, carrying food (multiple observations), distraction display, nest, or fledgling.
Population estimation	Minimum breeding territory	The observed number of confirmed breeding territories (CO).
Occupancy estimation	Site occupancy	Occupancy is based on two or more total survey detections during two or more survey periods and at least 10 days apart. Multiple detections in an area over an extended period of time suggest that the area may have been used for breeding.

Section 3. Nest Searching

Nest searching

CAUTION: Because of the possibility of observer-induced nest abandonment, nest searching and monitoring should only be conducted when part of focused research activities. Special Federal and State permitting are required to conduct nest searching and monitoring. We provide general information on nesting activity and nest searching here so surveyors are familiar with the behaviors, and can avoid inadvertent use of these techniques.

Yellow-billed Cuckoos will nest in a wide variety of substrates, with placement height ranging from 1 m (3 ft) to 20 m (65 ft) (Hughes 1999). Nests are usually placed on either a fairly thin branch (horizontal or vertical) in larger trees or shrubs, or next to the trunk of a smaller diameter

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at breast height (DBH) tree (Halterman 2002, 2008). Nests have been observed in a number of plant species including willow, cottonwood, alder, ash, mesquite, hackberry, seep willow (*Baccharis salicolifolia*) sycamore (*Plantanus* spp.), and tamarisk. There is usually a fairly high percentage of vegetation cover directly above the nest, and several meters around the nest (Laymon et al. 1997, Halterman 2005, McNeil et al. 2013).

Nesting cuckoos can be very sensitive to disturbance, especially during the pair formation and nest building stage. Nests located prior to the first egg are particularly susceptible to abandonment. At least five nests were abandoned during seven years of study on the Bill Williams River National Wildlife Refuge, possibly due, at least in part, to human disturbance (Halterman 2001, Halterman et al. 2009). Surveyors must be alert to cuckoos' behavioral signs of disturbance near a nest, which include alarm calls given repeatedly while watching the intruder, broken wing displays, or flying in with prey, then eating it instead of going to the nest. If these occur, the observer has been detected, the cuckoo is distressed, and the observer should move back. Recorded calls should not be used to elicit a response during nest searching and monitoring activities, as cuckoos have been observed leaving the nest in response to a recorded call.

Nest searching is done using two methods. Please use this information to avoid unintentionally searching for nests. When cuckoos make a nest exchange, typically one bird will call 10m or more from the nest, and the mate on the nest will answer (M. Halterman, unpublished data). The first method uses the observation of these behaviors. Two to three people will work together, triangulating on the vocalizations. The second method involves carefully searching all vegetation in the area where a cuckoo has vocalized several times, and a nest is suspected. Following the flight direction of cuckoos carrying food can also be used to locate nests.

If a nest is found, observers should leave the area after marking the general nest location with a GPS and making brief notes of the general description of the nest site (e.g., plant species used for nest substrate, approximate height of nest, and placement within the tree/shrub canopy). GPS readings should be taken no closer than 10 m from the nest, to avoid disturbance. A general description of the nest site should be completed soon after leaving the area. This information may be used for follow-up monitoring by an appropriately permitted individual.

Nest monitoring

If authorized to do so, surveyors can monitor active nests to determine nest fate. Nesting activity can be monitored and recorded by an observer sitting quietly 30-40 m from the nest for several hours. A blind or dense cover should be utilized for all nest monitoring and feeding observations. Signs of disturbance include an adult cuckoo giving a soft repetitive knocking call around the observer, and adults flying in with food, but not going to the nest. If these behaviors are observed for more than 20 minutes, the observer should leave the area. Also, because cuckoos are sensitive to disturbance at the nest, nest checks should only be conducted every 3-4 days (Halterman 2000). Both sexes incubate the eggs and care for the young (Nolan and Thompson 1975, Potter 1980, Payne 2005). Nest exchanges occur, on average, every two hours during incubation

(Halterman 2009). Nest exchanges increase when cuckoos are feeding nestlings, with up to 22 exchanges per day observed on the San Pedro River NCA (Halterman 2009).

Special Considerations

To avoid adverse impacts to Yellow-billed Cuckoos, follow these guidelines when performing all surveys:

1. Obtain all necessary Federal, State, and agency permits and permissions prior to conducting any surveys. Failure to do so leaves you liable for violation of the Endangered Species Act, various State laws, and prosecution for trespass.

2. Do not play the recording more than necessary or needlessly elicit vocal responses once Yellow-billed Cuckoos have been located. This may distract breeding birds from caring for eggs or young. If cuckoos are vocalizing upon arrival at the site, and your objective is to determine their presence or absence at a particular site—there is no need to play the recording. Excessive playing of the recording also may attract the attention of predators. Stop playing the survey recording as soon as you have confirmed the presence of a Yellow-billed Cuckoo, and do not play the recording again until you have moved 300 m from the estimated or known location of the previously detected cuckoo.

3. Proceed cautiously while moving through Yellow-billed Cuckoo habitat. Continuously check the area around you to avoid disturbance to nests of Yellow-billed Cuckoos and other species. Do not break understory vegetation, even dead branches, to create a path through the surveyed habitat.

4. Do not approach known or suspected nests. Nest searching and monitoring require specific State and Federal permits, have their own specialized methodologies (e.g. Martin and Geupel 1993), and are not intended to be a part of this survey protocol.

5. If you find yourself close to a known or suspected nest, move away slowly to avoid startling the birds or force-fledging the young. Avoid physical contact with the nest or nest tree, to prevent physical disturbance and leaving a scent. Do not leave the nest area by the same route that you approached. This leaves a “dead end” trail that could guide a potential predator to the nest/nest tree. If nest monitoring is a component of the study, but you are not specifically permitted to monitor the nest, store a waypoint with your GPS, affix a small flag at least 10 m away and hidden from view of the nest. Record the compass bearing to the nest on the flagging. Report your findings to an agency cuckoo coordinator or a biologist who is permitted to monitor nests.

6. If you use flagging to mark an area where cuckoos are found, use it conservatively and make certain the flagging is not near an active nest. Check with the property owner or land-management agency before flagging to be sure that similar flagging is not being used for other purposes in the area. Unless conducting specific and authorized/permitted nest monitoring,

flagging should be placed no closer than 10 m to any nest. Keep flagging inconspicuous from general public view to avoid attracting people or animals to an occupied site, and remove it at the end of the breeding season.

7. Watch for and note the presence of potential nest predators, particularly birds, such as Common Ravens (*Corvus corax*), American Crows (*Corvus brachyrhynchos*), jays, magpies, and accipiters. If such predators are in the immediate vicinity, wait for them to leave before playing the recording, or move on to the next broadcast-point.

8. Non-indigenous plants and animals can pose a significant threat to cuckoo habitat and may be unintentionally spread by field personnel, including those conducting cuckoo surveys. Simple avoidance and sanitation measures can help prevent the spread of these organisms to other environments. To avoid being a carrier of non-indigenous plants or animals from one field site to another, visually inspect and clean your clothing, gear, and vehicles before moving to a different field site. A detailed description on how to prevent and control the spread of these species is available by visiting the Hazard Analysis and Critical Control Point Planning for Natural Resource Management web site (http://www.haccp-nrm.org). Several non-native species of concern in survey locations are the tamarisk leaf beetle (*Diorhabda* spp.), quagga mussel (*Dreissena rostriformis bugensis*), cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), giant salvinia (*Salvinia molesta*), water milfoil (*Myriophyllum spicatum*), parrot's feather (*M. aquaticum*), and amphibian chytrid fungus (*Batrachochytrium dendrobatidis*).

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Appendix 1. Instructions for completing the Yellow-billed Cuckoo Survey Seasonal Summary Form.

NOTE- CHECK YOUR PERMIT – REPORTING REQUIREMENTS VARY BETWEEN REGIONS

These instructions are provided as guidance for completing the Survey Summary Form. It is important to complete all fields of the datasheet using a standardized format as described. Write clearly so that others can easily read the data. In addition to documenting sites with cuckoos, it is important to know areas where cuckoos were not detected; datasheets for these areas would have all information on the datasheet completed.

Attach the following: (1) copy of USGS quad/topographical map or similar (REQUIRED) of survey area, outlining survey site and location of cuckoo detections; (2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected cuckoos or their nests; (3) photos (if taken) of the interior of the patch, exterior of the patch, and overall site. Submit completed forms to both the appropriate state Yellow-billed Cuckoo coordinator and the US Fish and Wildlife Service (USFWS). Forms can also be completed digitally and submitted via email with attached or embedded topographic maps and photographs.

We recommend scanning or otherwise imaging data sheets immediately after the day's survey is completed. In the event of loss or damage to the data sheet, the information can be salvaged.

Page 1 of Survey Form

Site Name. Standardized site names are provided by the cuckoo survey coordinators for each state and should be consistent with the naming of other sites that might be in the area. If the site is new, work with your state or USFWS cuckoo coordinator to determine suitable site names before the beginning of the survey season. If the site was previously surveyed, use the site name from previous years (which can be obtained from the state or USFWS cuckoo coordinator). If you are uncertain if the site was previously surveyed, contact your state or USFWS cuckoo coordinator.

County. Record the county where the site is located.

State. Record the state where the site is located.

USGS Quad Name. Provide the full quad name, as shown on the appropriate standard 7.5-minute topographic maps.

Elevation. This can be obtained from a handheld GPS unit, USGS quad map, or a GIS elevation layer. Please use the most accurate information available. Please record data in meters.

Creek, River, Wetland, or Lake Name. Give the name of the riparian feature, such as the lake or watercourse, where the survey is being conducted.

Site Coordinates. Provide the start and end points of the survey, which will indicate the linear, straight-line extent of survey area, based on Universal Transverse Mercator coordinates (UTMs). If the start and end points of the survey changed significantly among visits, enter separate coordinates for each survey in the comments section on the back of the survey sheet. Note that we do not need the coordinates for the detailed path taken by the surveyor(s).

Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

Datum. For uniformity of data, please use NAD83.

Ownership. Circle the appropriate owner for the site (BLM, Reclamation, NPS, USFWS, USFS, Tribal, State, Private, or other (Municipal/County)).

Was site surveyed in previous year? Circle yes or no.

If yes, what site name was used? If the site was surveyed in the previous year, record the site name used in the previous year.

Survey Visit #. Survey 1 – 5. See the protocol for an explanation of the number of required visits for each survey period. Note: A survey is defined as a complete protocol-based survey that occurs over no more than 1 day. If a site is so large as to require more than a single day to survey, consider splitting the site into multiple sub-sites and use separate survey forms for each. Casual, pre-season, supplemental, or follow-up visits to check on the status of a territory should not be listed in this column, but should be documented in the comments section on page 2 or in the survey continuation sheet.

Observer(s). Record your first initial(s) and last name(s).

Date: Indicate the date that the survey was conducted using the format mm/dd/yyyy.

Start and Stop. Record the start and stop time of the survey, given in 24-hour format (e.g., 1600 hours rather than 4:00 p.m.).

Total hrs. Calculate the total hours, rounded to the nearest tenth (0.1) hour, based on time spent surveying the site and the number of surveyors. For single-observer surveys, or when multiple observers stay together throughout the survey, total the number of hours from survey start to end. If two or more observers surveyed different sections of one site concurrently and independently, sum the number of hours each observer spent surveying the site.

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Total Number of YBCUs detected. Record the total number of unique individual adult/fledgling Yellow-billed Cuckoos detected during this particular survey. Do not count nestlings. (But do record whether nestlings or fledglings were found in the comments section.)

Detection Type. Record how the cuckoo was detected using two codes. First, record whether the detection was "Incidental" (with a code of "I") if the cuckoo not was detected during the 6 minutes of each call playback survey point. If the cuckoo was detected during a Call playback survey, record it as a "P". Second, record whether the detection was A = aural (you only heard a cuckoo), V = Visual (you only saw it), or B = both (you heard and saw it).

Vocalization Type. If the detection was aural, record the type of vocalization heard as "CON" = Contact/kowlp, "COO" = coo, "ALA" = alarm (soft knocker call) ,"OV" = other (and describe the "other" vocalization under notes section.

Playback Number (#). Record the number of times the 'kowlp' call was played before the cuckoo responded.

Behavior Code. Record the appropriate breeding behavior code(s), for the behavior observed using the following codes (listed on the datasheet).

Surveyor Detection Coordinates. Enter the UTM Easting (E) and Northing (N) for the location of the surveyor when the cuckoo was detected. The direction (compass bearing) and distance to the detected cuckoo are estimated from this point.

Distance. Estimate as accurately as possible, the distance in meters to the detected cuckoo.

Bearing. Estimate, as accurately as possible, the compass bearing in degrees to the detected cuckoo from the surveyor location. The compass declination should be set to the magnetic declination of the survey area. Magnetic declination values can be located on USGS 7.5 minute quad maps or can be found using an internet search for "your state" + magnetic declination.

Cuckoo Number (#). Record a sequential number, starting with the number 1 for the first observation of the survey, in the row pertaining to the broadcast - point in which the observation was made. Use this reference number for other note-worthy information in the note section on the datasheet - record the cuckoo number and detailed notes regarding your observations including breeding behavior.

Corrected Coordinates. The Yellow-billed Cuckoo location is calculated based on the surveyor's location, distance, and bearing. Use the provided "Yellow-Billed Cuckoo Survey Summary Form for electronic submission" datasheet, which will calculate these coordinates.

Survey Summary. At the end of the survey season, complete the survey summary on the front page of the datasheet, near the bottom. Record the total number of detections made (across all surveys at the site); the number of possible breeding territories (see interpreting and reporting survey results in the protocol); and the total number of survey hours (the sum of all hours spent surveying the site).

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

Page 2: Yellow-billed Cuckoo Survey Seasonal Summary Form, continued

Yellow-billed Cuckoo survey and detection form, continued: Please use this form for additional detections, follow-up visits, and any other circumstance when more detail is needed. Please use the detailed instructions above for filling out the form.

Page 2 of Survey Form

Name of Reporting Individual. Indicate the full first and last name of the reporting individual.

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

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

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

E-mail. Provide the reporting individual's E-mail.

U.S. Fish and Wildlife Service (USFWS) Permit #. List the full number of the required federal permit under which the survey was completed.

State Permit #. If a State permit is required by the State in which the survey was completed, provide the full number of the State wildlife agency permit.

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

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

Did you survey the same general area during each visit to this site this year? Yes/No. Circle Yes or No; if No, summarize in the comments below.

If site was surveyed last year, did you survey the same general area this year? Yes/No. Circle Yes or No; if No, record the reason and how the survey varied in the comments below.

Overall Vegetation Characteristics: This describes the overall vegetation characteristic for the site, namely which species predominantly comprise the tree/shrub layer. Check one of the following categories:

Native broadleaf plants - >75 % of the tree/shrub layer of the site is composed of native broadleaf plants.

Exotic/introduced plants - >75 % of the tree/shrub layer of the site is composed of exotic/introduced plants.

Mixed native and exotic plants (mostly native) – 51% -75% of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly exotic) – 51% -75% of the tree/shrub layer of the site is composed of exotic/introduced plants.

Average height of canopy. Provide the best estimate of the average height of the top of the canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate. Specify units used.

Estimated Canopy Cover. Estimate the percent canopy cover for the site.

Overstory Vegetation. Estimate the percent cover provided by the dominant overstory plant species at the site: cottonwood, tamarisk, Goodding's willow, Russian olive, coyote willow, and 'other". If other than the species listed, specify the species.

Average height of understory canopy. The understory canopy comprises a distinct layer (that does not have to be present throughout the site) below the overstory canopy. Provide the best estimate of the average height of the top of the understory canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate. Specify units used.

Estimated Understory Canopy Cover. Estimate the percent understory canopy cover for the site.

Understory Vegetation. Estimate the percent cover provided by the dominant understory plant species at the site: cottonwood, tamarisk, Baccharis, Goodding's willow, Russian olive, New Mexico olive, coyote willow, and 'other". If other than the species listed, specify the species.

Was surface water or saturated soil present at or within 300 meters of the site? Circle yes or no.

Was this true of all patches surveyed? Circle yes or no.
Comments. Provide comments regarding differences between survey patches within the site. For example, if the average canopy for the site is 30% cover, but within one patch it is 60%, describe this. Also note any significant differences between dominant overstory and understory vegetation among patches within the site. Document these differences with photographs whenever possible and reference comments to photos number whenever available. Note potential threats (e.g., livestock, ORV, hunting, etc.) to the site. If *Diorhabda* beetles are observed, contact your

USFWS and state cuckoo coordinator immediately. Attach additional pages or use the continuation sheet if needed.

Page 2 of Survey Summary Form

Yellow-billed Cuckoo survey and detection form, continued: Please use this form for additional detections, follow-up visits, and any other circumstance when more detail is needed. Please use the detailed instructions above for filling out the form.

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Appendix 2. Instructions for Completing the OPTIONAL Yellow-billed Cuckoo Daily Datasheet

Total YBCU detections: at the end of the survey, record the total number of cuckoos detected during the survey. This is the actual number of detections. Interpretation of survey results (i.e. detections vs. number of cuckoos actually present) can be discussed in your report, but not here.

Page __ of __ : It is important to track number of pages, especially when datasheets are scanned.

Surveyor name: Record the first and last name of the primary surveyor.

Surveyor email: Record the best email address for the primary surveyor.

Surveyor phone number: Record the best phone number for the primary surveyor.

Site Code: Letter or alphanumeric code that denotes a particular site, intended to track sites throughout the season and across years. When applicable, you may use the same code identification as for Southwestern Willow Flycatcher sites.

Site Name: Write the full, unique name of the site to be surveyed. When applicable, you may use the same site name identification as for Southwestern Willow Flycatcher sites (Obtain these from your USFWS office).

Survey Period: The survey period in which the survey is being conducted (1-4), as defined in the protocol. Period 1 (one survey required): June 15-June 30. Period 2 (two surveys required): July 1 –July 31. Period 3 (one survey required): August 1-August 15.

Visit #: In many cases, this will be the same as the survey period, as most sites will be surveyed only once during a survey period. If more than one visit is conducted within one or more survey periods, number the visits sequentially, from the start of the survey season to the end. Such visits are typically for follow-up to determine breeding status.

Date: The month (mm) / day (dd) / year (yyyy) the survey is conducted.

Drainage: The name of the river, stream, or drainage where the site is located.

State, County: State two letter code (i.e. AZ); County full name (i.e. Coconino)

Additional Observers: First and last name of all additional surveyors.

Survey Start/End Time (hhmm): Write in the time of the start and end of the initial broadcast-point count (at the transect starting point) using the hour and minute format in military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Wind (0-5): Record wind measured with an anemometer. Alternatively, record the Beaufort wind code (0 through 5; Page 2 of form) as it applies to the strength of the wind during the survey. Record the average wind condition, not the maximum condition (e.g., periods of gusty winds). Do not survey if wind is greater than code 4.

Cloud Cover: Record cloud cover as: clear (C: <25%), partly overcast (PO: 25%-49%), mostly overcast (MO: 50-74%), or overcast (O: 75%+) If there are patches of clouds in different areas of the sky, try to visualize gathering all of them together into one part of the sky and recording what percent of cloud cover that would represent.

Precip (0-5): Record the appropriate code (0 through 5). Surveyors should not be surveying if rain is more than an intermittent drizzle. See chart on datasheet, Pg. 2.

Noise (0-3): Record the noise code (0-3) that applies to background noise conditions during the transect, as it relates to your ability to hear cuckoos. Record the average noise conditions, not the maximum condition. 0 = Quiet - no noise that interferes with bird detection. 1 = Faint Noise - slight noise that has only a minimal effect of bird detection. 2 = Moderate Noise - probably can't hear some birds beyond 100m. 3 = Loud Noise - Only the closest birds are detected. See chart on datasheet, Pg. 2.

Temperature: Record the ambient temperature; specify if collected in Fahrenheit or Celsius.

NAD: Surveyors should be using NAD 83.

UTM Start/Stop: Enter the UTM Easting (E) and Northing (N) for the transect starting point, and again for the end of the transect.

Start and Stop GPS Accuracy: The accuracy of the GPS reading for the UTMs, recorded in meters.

Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

General survey data.

Call Point Start Time (hhmm): Write in the time of the start of the individual broadcast-point count (when the surveyor first arrives at the point) using the hour and minute format using military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Survey Call Point UTM Coordinates: Enter the UTM Northing (N) and Easting (E) for the individual survey point.

Waypoint Number: Record this if you are saving them on your GPS unit.

Yellow-billed Cuckoo detections:

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(Reminder: When a cuckoo is detected at a point, terminate the broadcast. **Do not continue to play the recording once a cuckoo is detected.)**

Detection #: When a cuckoo is detected, record a unique number for the detection. If it is the first detection of the survey visit, the detection number is "1". If more than one cuckoo is detected at the point, record the second detection in the next row on the data sheet, and record the detection number as "2". In the columns to the left (Point Start Time, UTM coordinates) record "" to denote that these values are the same as those in the row directly above. Also, if more than one cuckoo is detected at a point, be sure to thoroughly describe your observations under "Notes". If you think the same cuckoo is detected later at a different point during the survey or incidentally before or after the survey, give that bird a new detection number, but make a note of this. .

Time of Detection: Record the time that the cuckoo was detected, using the hour and minute format using military time. Fill in all four digits. Examples are 0630 (6:30 am), 1300 (1:00 pm).

Record how the cuckoo was detected. **I = Incidental** (between call broadcast points) or **P = Playback** (following broadcast calls).

Detection type: **A = Aural**, **V = Visual**, or **B = Both**. If the cuckoo was detected both by sight and sound (i.e., "B"), write in parenthesis the order in which the type of detections occurred. For example, "B (A/V), and describe the detection(s) under "Note #" as detailed below.

Compass Bearing (^{o}): Record the estimated compass bearing, in degrees, to the detected cuckoo. The compass declination should be set to zero.

Estimated Distance (m): Record the horizontal distance in meters between the broadcast point (where you are standing), and the location or presumed location of the cuckoo where you first detect it.

Accuracy of Estimate (Est. Accuracy): Indicate relative accuracy of your estimate using the codes shown in Table 1. Determine your pace by counting your steps per measured distance. Recalibrate your pace prior to and throughout the field season to ensure accuracy. Code reminders are on Pg. 2 of the datasheet.

Table 1. Codes for quantifying the degree of accuracy in estimating the distance to a detected cuckoo.

Accuracy Code	Explanation
1	Measured distance, using laser rangefinder or pacing, to a known location.
2	Measured distance, using laser rangefinder or pacing, to an estimated location.
3	Estimated location of detection and distance, feel confident it was within **25 m** of true location.
4	Estimated location of detection and distance, feel confident it was within **50 m** of true location.

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5	Estimated location of detection and distance, feel confident it was within **100 m** of true location.
6	Little confidence in your estimate, a complete "guesstimate".

Vocal codes (Vocalization codes): Record the appropriate code (see Pg. 2, data sheet), or series of codes for any calls heard when you made the detection. Use more than one code, when appropriate.

Behavior/Breeding: Record the appropriate breeding behavior code(s), for the behavior observed using the codes on Pg. 2 data sheet. You may enter more than one code in this box. Note that if you use Vocal Exchange (VEX) you will enter data in 2 rows, one for each bird. Use more than one code, when appropriate.

Note #: To record observations of cuckoo detections, or other note-worthy information, first record a sequential number, starting with the number 1 for the first observation of the survey, in the row pertaining to the broadcast - point in which the observation was made. Use the space on the bottom of the data sheet to record detailed notes regarding your observations. Use the back of the data sheet if more space is needed.

***:** Two blank columns are provided so surveyors can record additional information that may be of interest, such as cicada presence, presence of other avian species of interest, etc.

Data Entry, Data Proof, Data Scan: These are provided for QA/QC of your data.

Review your federal and state permit requirements. Be sure to submit appropriate forms and reports on time to USFWS and other agencies. Retain a copy for your records.

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Appendix 3. Instructions for Completing the Yellow-billed Cuckoo Survey Site Description Form

These instructions are provided as guidance for completing the Yellow-billed Cuckoo Survey Site Description Form. It is important to complete all fields of the datasheet using a standardized format as described. Type or write clearly so that others can easily read the data. Describe any unique habitat features in Comments.

We recommend scanning or otherwise imaging data sheets immediately after the day's survey is completed. In the event of loss or damage to the data sheet, the information can be salvaged.

Date report completed: Indicate the date that the survey was conducted using the format mm/dd/yyyy.

Site Name: Write the full, unique name of the site to be surveyed. When applicable, you may use the same site name identification as for Southwestern Willow Flycatcher sites (Obtain these from your USFWS office).

State. Record the state where the site is located.

County. Record the county where the site is located.

Name of Reporting individual: Record the first and last name of the primary surveyor.

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

Phone #: Record the best phone number for the primary surveyor.

Email: Record the best email address for the primary surveyor.

U.S. Fish and Wildlife Service (USFWS) Permit #. List the full number of the required federal permit under which the survey was completed.

State Permit #. If a State permit is required by the State in which the survey was completed, provide the full number of the State wildlife agency permit.

Site Coordinates. Provide the start and end points of the survey, which will indicate the linear, straight-line extent of survey area, based on Universal Transverse Mercator coordinates (UTMs). If the start and end points of the survey changed significantly among visits, enter separate coordinates for each survey in the comments section on the back of the survey sheet.

UTM Zone. Provide the appropriate UTM zone for the site, which is displayed along with the coordinates by most GPS units.

NAD: Surveyors should be using NAD 83.

USGS Quad Name(s). Provide the full quad name, as shown on the appropriate standard 7.5-minute topographic maps. Please list the names of all Quads covered by the survey site.
Length of area surveyed. Estimate the linear straight-line distance of the length of the area surveyed, in kilometers. This is not an estimate of the total distance walked throughout the survey site. Do not provide a range of distances.

Elevation. This can be obtained from a handheld GPS unit, USGS Quad map, or a GIS elevation layer. Please use the most accurate information available. Please record data in meters.

Name of nearest Creek, River, Wetland, or Lake. Give the name of the riparian feature, such as the lake or watercourse, where the survey is being conducted.

Ownership. Circle the appropriate owner for the site (BLM, Reclamation, NPS, USFWS, USFS, Tribal, State, Private, or Other (Municipal/County)).

Was site surveyed in previous year? Circle yes or no.

If yes, what site name was used? If the site was surveyed in the previous year, record the site name used in the previous year.

Did you survey the same general area during each visit to this site this year? Yes/No. Circle Yes or No; if No, summarize in the comments below.

If site was surveyed last year, did you survey the same general area this year? Yes/No. Circle Yes or No; if No, record the reason and how the survey varied in the comments below.

Native/Exotic:

Native broadleaf plants - >75 % of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly native) – 51% -75% of the tree/shrub layer of the site is composed of native broadleaf plants.

Mixed native and exotic plants (mostly exotic) – 51% -75% of the tree/shrub layer of the site is composed of exotic/introduced plants.

Exotic/introduced plants - >75 % of the tree/shrub layer of the site is composed of exotic/introduced plants.

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Overstory Vegetation. Provide the scientific names of the five most common species in the overstory, and the estimated percent cover provided each species. It is possible for there to be an overstory present with no understory. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Average height of canopy. Provide the best estimate of the average height, in meters, of the top of the canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate.

Estimated Overall Canopy Cover. Estimate the overall percent canopy cover for the site.

Understory Vegetation. The understory canopy comprises a distinct woody layer (that does not have to be present throughout the site) below the overstory canopy. For example, a cottonwood overstory might have a willow understory. It's also possible that there may only be an overstory, with no understory. Willow or mesquite, for example, may have no understory. Provide the scientific names of the five most common species in the understory, and the estimated percent cover provided each species. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Average height of understory canopy. Provide the best estimate of the average height, in meters, of the top of the understory canopy throughout the patch. Although canopy height can vary, give only a single (not a range) overall height estimate.

Estimated Overall Understory Cover. Estimate the percent understory cover for the site.

Describe adjacent habitat: Describe the types of habitat adjacent to the survey area. Include upland vegetation type, such as agricultural or residential areas, roads, and any other relevant information.

Adjacent Habitat. Provide the names of the five most common types of adjacent habitat, and the estimated percent cover provided each type. Alternatively, you can list up to five types of surrounding land use. For example: Fallow Ag field, 50%; suburb, 25%, Walnut orchard, 25%. Use the following cover categories: <1%; 10%, 25%, 50%, 75%, 90%, 100%.

Was surface water or saturated soil present at or within 300 meters of the site? Circle yes or no.

Was this true of all patches surveyed? Circle yes or no.

Comments. Provide comments regarding differences between survey patches within the site. For example, if the average canopy for the site is 30% cover, but within one patch it is 60%, describe this. Also note any significant differences between dominant overstory and understory vegetation among patches within the site. Document these differences with photographs whenever possible and reference comments to photos number whenever available. Note potential threats (e.g.,

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livestock, ORV, hunting, etc.) to the site. If *Diorhabda* beetles are observed, contact your USFWS and State cuckoo coordinator immediately. Attach additional pages or use the continuation sheet if needed.

PAGE 2. The first four sections are required in case pages become separated.

Site Name.

Name of Reporting Individual.

Phone Number.

E-mail.

Map: Attach the following: (1) copy of USGS quad/topographical map or similar (REQUIRED) of survey area, outlining survey site and location of cuckoo detections; (2) sketch or aerial photo showing site location, patch shape, openings, survey route, location of any detected cuckoos or their nests; (3) photos (if taken) of the interior of the patch, exterior of the patch, and overall site. Submit completed forms to both the appropriate State Yellow-billed Cuckoo coordinator and the US Fish and Wildlife Service (USFWS) as required by your permits. When required or recommended, forms should be completed digitally (Microsoft Word or Excel) and submitted via email with attached or embedded topographic maps and photographs.

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