California Partners in Flight Riparian Bird Conservation Plan

Yellow-billed Cuckoo (*Coccycus americanus*)

Photo by James Gallagher, Sea and Sage Audubon

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U.S. Bureau of Land Management
Bakersfield Office

RECOMMENDED CITATION

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

SHORTCUTS

references

range map

SUBSPECIES STATUS:

The California Yellow-billed Cuckoo (Grinnell and Miller 1944) (*C. a. occidentalis*): The validity of the subspecies was questioned by Banks (1988). The statistical analysis that he used was found to be faulty, and morphometric measurements that he found non-significant between the two subspecies, actually were significantly different (Laymon pers. obs.). Despite this, Banks (1990) concluded that even though the measurements were significantly different they were not different enough to be regarded as separate subspecies. More recent analysis using multivariate statistics (discriminate function analysis) has shown that 89.6% of eastern and 85.8% of western females can be correctly categorized to subspecies. This is a sufficient morphometric difference for the subspecies to be valid (Franzreb and Laymon 1993).

The California Yellow-billed Cuckoo breeds in scattered locations where suitable habitat is available throughout California, Idaho, Utah, Arizona, New Mexico, extreme western Texas, and possibly Nevada and western Colorado (Gaines and Laymon 1984). In Mexico it breeds south to the Cape region of Baja California, Sinaloa, and Chihuahua (AOU 1957). Historically, it has bred north to southern British Columbia (AOU 1957).

MANAGEMENT STATUS: The Yellow-billed Cuckoo is listed as a California Endangered Species and a U.S. Forest Service Region 5 Sensitive Species. As a result of a petition filed by a coalition of environmental organizations (Manolis et al. 1986), the western subspecies was considered for federal listing as Endangered but was not listed (Federal Register 1988). The decision to not list the cuckoo was justified because of the paper listed above (Banks 1988) which indicated incorrectly that there were no significant differences between the eastern and western subspecies (Federal Register 1988).

DISTRIBUTION

HISTORICAL BREEDING DISTRIBUTION

Historically, the Yellow-billed Cuckoo was a common breeding species in riparian habitat throughout much of lowland California (Grinnell 1915; Grinnell and Miller 1944). Early accounts from the Central Valley list the species as common (Belding 1890). Grinnell and Miller (1944) described the cuckoo's range as the coastal valleys from the Mexican border to Sebastopol, Sonoma County and the Central Valley from Bakersfield and Weldon, Kern County, north to Redding, Shasta County. Small populations were also found in Northern California along the Shasta River, Siskiyou County, and in Surprise Valley, Modoc County. Populations were also found in suitable habitat east of the Sierra Nevada in the Owens Valley and along the Colorado and Mojave rivers. By 1944 cuckoos were no longer present in extensive areas where they were once found "because of removal widely of essential habitat conditions" (Grinnell and Miller 1944).

CURRENT BREEDING DISTRIBUTION

In California, breeding populations of greater than five pairs which persist every year in California are currently limited to the Sacramento River from Red Bluff to Colusa and the South Fork Kern River from Isabella Reservoir to Canebrake Ecological Reserve. Other sites where small populations of cuckoos (<5 pairs) breed or possibly breed (but not necessarily every year) are: The Feather River from Oroville to Verona, Butte, Yuba and Sutter counties; the Prado Flood Control Basin, San Bernardino and Riverside counties; the Amargosa River near Tecopa, Inyo Co.; the Owens Valley near Lone Pine and Big Pine, Inyo Co.; the Santa

Clara River near Santa Clarita, Los Angeles Co.; the Mojave River near Victorville, San Bernardino Co.; and the Colorado River from Needles, San Bernardino Co. to Yuma, Imperial Co. (Laymon and Halterman 1987).

A statewide survey of Yellow-billed Cuckoos in California conducted during 1986 and 1987 found a total of 30-33 pairs and 31 unmated males at nine localities (Laymon and Halterman 1989). The majority of the cuckoos were concentrated along the upper Sacramento River from Red Bluff to Colusa (18 pairs and 19 unmated males) and at the South Fork Kern River (7 pairs and 3 unmated males). The remaining cuckoos were found at scattered locations including: 1 pair and 5 unmated males along the Feather River; 1 to 4 pairs in the Prado Flood Control Basin; 1 unmated male at the Mojave River near Hodge; 1 unmated male in the Owens Valley; 1 pair along the Amargosa River near Tecopa; 1 pair and 1 unmated male along the Colorado River north of Blythe; 1 unmated male along the Colorado River in the Picacho Region; and 1 pair along the Colorado River in the Laguna Dam Region (Laymon and Halterman 1989).

More recent surveys on the Sacramento River from 1987 - 1990 have shown a fluctuating population of 23 - 35 pairs (Halterman 1991). Continuous surveys on the South Fork Kern River from 1985 - 1996 have shown a population that varied from a low of 2 pairs in 1990 to a high of 24 pairs in 1992 (Laymon et al. 1997). These two sites are the only localities in California that sustain breeding populations of Yellow-billed Cuckoos.

ECOLOGY

AVERAGE TERRITORY SIZE

Territory size at the South Fork Kern River ranges from 8 to 40 ha (20 to 100 acres) (Laymon and Halterman 1985). Apparently the territory size can be smaller on the Colorado River because sites as small as 4 ha (10 acres) are occupied by breeding pairs (Laymon and Halterman 1989).

TIME OF OCCURRENCE AND SEASONAL MOVEMENTS

The earliest spring arrival date for California is 23 April; this is the only April record for the state. There are regularly, though not every year, a few arrivals in May, but the majority of breeding pairs arrive in June and some breeders may arrive as late as early July (Gaines and Laymon 1984). Yellow-billed Cuckoos are rarely detected in spring migration in California away from the breeding grounds.

Yellow-billed Cuckoos depart the breeding grounds between late July and mid-September. Yellow-billed Cuckoos are rarely detected in fall migration in California away from the breeding grounds.

MIGRATION STOPOVER CHARACTERISTICS

Nothing is known about migration stopover needs. It is likely that adequate stopover sites are an important factor for the species.

FOOD HABITS

FORAGING STRATEGY

Yellow-billed Cuckoos are primarily foliage gleaners, though at times they sally from a perch and catch flying prey such as dragonflies or butterflies or drop to the ground to catch grasshoppers or tree frogs. Two foraging strategies are employed by the Yellow-billed Cuckoo when they are foliage gleaning. The primarily strategy is to hop slowly from location to location, sitting for several minutes at each location, watching for motion of their primarily green prey on a green leaf background. An alternate strategy, used less much frequently, is to dive into the foliage of a likely looking spot in hopes of dislodging prey (Laymon pers obs.).

While nests are almost always placed in willows, cottonwoods are extremely important for foraging. Two male cuckoos at the South Fork Kern River, equipped with radio transmitters, foraged much more in cottonwoods than would have been predicted by the cottonwood's abundance within the cuckoos home range (Laymon and Halterman 1985). At the South Fork Kern River, cuckoos are found more often at upland sites early in the season in wet years, but not in dry years. It is likely that flooding in wet years reduces the survival of the larvae of the preferred prey (katydids and sphinx moth) which winter underground (Laymon pers. obs.). This forces the cuckoos to forage in upland areas that were not flooded until the prey base in the lower floodplain begins to recover later in the breeding season. The fact that most extant riparian habitat is in the primary floodplain could cause a large reduction in the prey base and be a major cause of the decline of cuckoos in the

West. Restoration efforts should consider planting at least a portion of forests on upper terrace sites that do not regularly flood.

DIET

Yellow-billed Cuckoos feed on larger insects than any other insectivorous birds, with the possible exception of some raptors. A sample of 2420 prey items being fed to young cuckoos were identified at 30 nests at the South Fork Kern River. The provisions that are brought to the young are whole prey items, with the exception of the first few hours after hatching when young are fed regurgitated food (S.A. Laymon pers. obs.; contra Ehrilch et al. 1988). The primary food items were green caterpillars (primarily sphinx moth larvae) at 44.9% of diet (range = 20.0% to 64.5% at different nests), katydids at 21.8% (range = 5.3% to 43.0%), tree frogs at 23.8% (range = 3.7% to 42.7%), and grasshoppers at 8.7% (range = 4.4% to 17.1%). The remaining 1.3% of the diet includes cicadas, dragonflies, butterflies, moths, beetles, and spiders (Laymon et al. 1997). The number of eggs laid was positively correlated to the percent of katydids fed to the young (r^2=0.55, p=0.04) and negatively correlated to the percent of green caterpillars fed to the young (r^2=0.51, p=0.05) and the total number of young fledged per pair was correlated (nearly statistically significant) on the capture time of caterpillars, katydids, and all food types, with shorter capture time correlated to more young fledged (Laymon et al. 1997). The caterpillars and katydids appear to be the preferred food, while the tree frogs and grasshoppers appear to be "fast food" that can be caught quickly to placate the young while the adults then go after the preferred food. Food resources vary greatly from year to year and have a significant impact on reproductive success. (Laymon et al. 1997).

DRINKING

Yellow-billed Cuckoos probably do not need drinking water.

BREEDING HABITAT

On the Sacramento River, from 1987 to 1990, the presence of depositional point bars and low woody vegetation were used as measures of continuing habitat succession. These were both significant variables determining the presence of cuckoos. The presence of point bars (pairs, r^2=0.05, p<0.05; unmated males, r^2=0.07, p<0.05; and all cuckoos r^2=0.07, p<0.005) was a weaker predictor of the presence of cuckoos than the presence of low woody vegetation (pairs, r^2=0.17, p<0.005; unmated males, r^2=0.09, p<0.05; and all cuckoos r^2=0.17, p<0.005) (Halterman 1991). This is an indication of the importance of a meandering riparian system with healthy hydraulics that is constantly eroding and depositing and creating young riparian habitat. This may be important to the cuckoos because these young rapidly growing stands provide preferred nest sites, have high productivity of invertebrate prey, and have lower prevalence of predators when compared to the older forests (Laymon pers. obs.).

SITE FIDELITY

Little is known regarding site fidelity in the Yellow-billed Cuckoo, but because of apparent movements by cuckoos to take advantage of cicada and tent caterpillar outbreaks in eastern United States, conventional wisdom is that the species is at least partially nomadic (Robbins et al. 1983). Almost all of the young cuckoos hatched and banded at the South Fork Kern River that have been resighted there as adults, have been males. Breeding pairs of cuckoos at this site have been found using the same territory for up to three years indicating at least some site fidelity (Laymon unpublished data).

NEST SUBSTRATE

Nests at the South Fork Kern River are placed predominately in willows (99%, n=95). The lone exception was placed in a clump of mistletoe in a cottonwood (Laymon et al. 1997). On the Santa Ana River 22 of 24 nests (92%) were in willows, one was in a cottonwood and one was in an alder (Hanna 1937). On the Sacramento River nests have been found in willows, cottonwoods, box elders, as well as rarely in orchards including prune, English walnut, and almond (Laymon pers. obs., Halterman pers com., Gaines and Laymon 1984). Several nests on the Sacramento River were draped with wild grape (Laymon pers. obs.) and this was also noted on the Santa Ana River (Hanna 1937). At the Bill Williams River, of 14 nests, 11 (78.6%) have been in willows, 1 (7.1%) in a cottonwood, and 2 (14.3%) in tamarisk (Halterman unpublished data).

HEIGHT OF NEST

Nests at the South Fork Kern River average 4.8 m (S.D. = 3.0, n = 95), with a range from 1.3 m to 13.0 m (Laymon et al. 1997). On the Sacramento river, a nest was found as high as 30 m in a cottonwood. On the Santa Ana River, nests ranged from 1.3 m to 10 m in height and the average nest height was 4.3 m (Hanna 1937). At the Bill Williams River the average nest height was 6.0 m (S.D. = 3.4, n = 14), with a range from 1.8 m to 13.0 m. (Halterman unpublished data).

HEIGHT OF NEST PLANT

The average height of nest tree at the South Fork Kern River was 9.4 m (SD = 3.5, n = 95) and ranged from 2.5 m to 17.8 m (Laymon et al. 1997). At the Bill Williams River the average nest tree height was 8.8 m (S.D. = 4.3, n = 14), with a range from 3.5 m to 20.0 m. (Halterman unpublished data).

PLANTS CONCEALING THE NEST

Nest is generally concealed by willow foliage (Laymon et al. 1997; Hanna 1937). Several nests at the South Fork Kern River (3) and Santa Ana River (1) were concealed in mistletoe (Laymon et al. 1997; Hanna 1937). Several nests on the Sacramento River and Santa Ana River were concealed by wild grape (Laymon pers obs.; Hanna 1937). One nest on the Santa Ana River was in a dead willow and was concealed by poison oak vines (Hanna 1937). Rarely nests are sufficiently low and herbaceous growth such as tules, cattails, and golden rod is sufficiently tall that they provide nest concealment (Laymon pers. obs.).

PERCENT NEST COVER

Nest cover at the South Fork Kern River is high, averaging 93.4% (SD = 15.1, n = 95) and ranging from a low of 0.0% to a high of 100% (Laymon et al 1997). At the Bill Williams River the average nest cover was 78.4% (SD = 17.8, n = 14), with a range from 45% to 100% (Halterman unpublished data).

VEGETATION SURROUNDING THE NEST

Measurements from 0.04 ha (0.1 acre) plots.

CANOPY COVER (averaged densiometer readings)

At the South Fork Kern River, the average canopy cover on a $1/10^{th}$ acre plot around the nest is 74.1% (SD = 15.6, n = 85) ranging from a low of 16.5% to 98.0%. Canopy closure declines and standard deviation increases as one moves farther from the nest. At the nest the average canopy closure is 96.8% (SD = 7.3, n = 75), at 5 m from the nest the average canopy closure is 75.1% (SD = 18.1, n = 75), and at 10 m from the nest the average canopy closure is 63.8% (SD = 26.1, n = 75) (Laymon et al 1997). At the Bill Williams River the average canopy cover was 77.1% (S.D. = 12.7, n = 14), with a range from 51% to 92% (Halterman unpublished data). Canopy closure declines and standard deviation increases as one moves farther from the nest. At the nest the average canopy closure is 94.6% (SD = 4.8, n = 14), at 5 m from the nest the average canopy closure is 71.3% (SD = 16.9, n = 14), and at 10 m from the nest the average canopy closure is 68.2% (SD = 18.9, n = 14) (Halterman unpublished data).

AVERAGE TOP CANOPY HEIGHT

At the South Fork Kern River the average canopy height at nest sites was 9.1 m (SD = 2.6, n = 83) and ranged from 4.4 m to 19.5 m (Laymon et al 1997). At the Bill Williams River the average canopy height was 8.2 m (SD = 2.2, n = 14), with a range from 4.3 m to 13.3 m (Halterman unpublished data).

DOMINANT PLANT SPECIES IN CANOPY

At the South Fork Kern River the dominant tree species in the canopy at Yellow-billed Cuckoo nest sites was Gooding's black willow (*Salix gooddingii*) (68%) (Laymon et al 1997).

AVERAGE SHRUB COVER

At the South Fork Kern River the average shrub cover was 3.5% (SD = 8.4, n = 85) with a range from 0% to 50% (Laymon et al 1997). At the Bill Williams River the average shrub cover was 33% (SD = 22.5, n = 14), with a range from 5% to 85% (Halterman unpublished data).

CO-DOMINANT PLANT SPECIES IN CANOPY

At the South Fork Kern River the co-dominant plant species in the canopy were red willow (*Salix laevigata)* (19.1%), and Fremont cottonwood (*Populus fremontii*) (10.3%) (Laymon et al 1997).

DOMINANT SHRUB SPECIES

The only shrub species at the South Fork Kern River is mulefat (*Baccharis salicifolia*) (Laymon pers. obs.).

AVERAGE FORB COVER

At the South Fork Kern River the average forb cover was 51.3% (SD = 33.1, n = 85) and ranged from 0.0% to 100% (Laymon et al 1997). At the Bill Williams River the average forb cover was 6% (SD = 17.5, n = 14), with a range from 0% to 69% (Halterman unpublished data).

DOMINANT FORB SPECIES

Stinging nettle (*Urtica holosericea*), mugwort (*artemisia douglasiana*), and golden rod (*Solidago occidentalis*) are often dominant forbs at cuckoo nest sites at the South Fork Kern River (Laymon pers. obs.).

GROUND COVER

Grass/sedge: At the South Fork Kern River the average grass/sedge cover was 17.3% (SD = 24.8, n = 83) and ranged from a low of 0.0% to a high of 100% (Laymon et al. 1997). At the Bill Williams River the average grass cover was 15% (SD = 22.6 n = 14), with a range from 0% to 86% (Halterman unpublished data).

Bare ground: At the South Fork Kern River the average bare ground cover was 23.6% (SD = 35.6, n = 86) and ranged from a low of 0.0% to a high of 98% (Laymon et al. 1997). At the Bill Williams River the average bare ground cover was 66% (SD = 27.0 n = 14), with a range from 1% to 100% (Halterman unpublished data).

TREE DBH

At the South Fork Kern River the average quadratic DBH was 22.9 cm (SD = 13.5, n = 85) and ranged from a low of 5.8 cm to a high of 85.3 cm (Laymon et al. 1997). At the Bill Williams River the average quadratic DBH was 17.3 cm (SD = 7.6, n = 14), with a range from 6 cm to 40 cm (Halterman unpublished data).

DISTANCE TO WATER

At the South Fork Kern River the average distance to water was 310 m (SD = 405.5, n = 95) and ranged from a low of 0.0 m to a high of 1500 m (Laymon et al. 1997). At the Bill Williams River the average distance to water was 41 m (SD = 46.9, n = 14), with a range from 0 m to 175 m (Halterman unpublished data).

NEST TYPE

Open saucer nest, similar in size and appearance to that of a Mourning Dove but having more structural integrity. From a sample of 95 nests at the South Fork Kern River none have fallen from the tree while in use, a problem frequently found with Mourning Dove nests. Nests tend to be constructed of smaller diameter twigs and the twigs are more expertly woven than Mourning Doves (Laymon pers. obs.).

BREEDING BIOLOGY

TYPICAL BREEDING DENSITIES

Yellow-billed Cuckoos are loosely territorial. They do not defend a territory, but given uniform habitat they are regularly spaced through the landscape. Along the Sacramento River, in an area of extensive foraging habitat (cottonwoods) and extremely restricted nesting habitat (willows and English walnuts), nests were place as close as 60 m apart showing that they are capable of nesting in close proximity to one another (Laymon 1980). Densities at the South Fork Kern River from 1985 to 1996 have averaged 0.85 pairs/40 ha and ranged from a low of 0.15 pairs/40 ha in 1990 to a high of 1.4 pairs/40 ha in 1993 (Laymon unpublished data). Halterman (1991) found that a multiple regression model combining patch size, extent of habitat within an 8

km river stretch, presence of point bars, and presence of low woody vegetation explained 46% of the variance of cuckoo pairs on the Sacramento River.

INITIATION OF NESTING

The peak of the breeding season at the South Fork Kern River is in the first half of July, though nests have been started as early as June and as late as early August (Laymon unpublished data).

DISPLAYS

Courtship displays generally involve the male following the female around carrying a food item. Copulation, which can take several minutes often involves the male feeding the female a food item while the copulation takes place (Laymon pers. obs.). Cuckoos use a distraction display to draw potential predators away from the nest. When a nest is approached, the parent drops off the nest and spreads its rufous wings and tail and gives a vigorous broken winged display low in the tree and shrub foliage (Laymon pers. obs.).

MATING SYSTEM

Most pairs of cuckoos (approximately 70%) are monogamous (Laymon unpublished data). Approximately 30% of the nests have helper males attending the young. These helpers appear to be unrelated younger male cuckoos. Helping appears to be done so the young male can gain practice with the hope of being the dominant male during the second breeding attempt, though in all cases that have been observed the same male is dominant for both the first and second broods. The dominant male and female appear to tolerate the helper because the food supplied to the young by the helper may allow the pair to double brood. Several nests that have been observed have been communal, with two pairs of cuckoos laying eggs and tending young in the same nest. Cuckoo eggs hatch asynchronously, because they begin incubation when the first egg is laid. As a result, there are young of various ages in the nest. Cuckoos practice brood reduction by removing the youngest chick if food resources are scarce. The young is removed by the dominant male while it is still alive. In one case, post-hatching parasitism has been observed when a live chick was dumped into another cuckoo pairs nest and was successfully raised by the adoptive parents (Laymon et al. 1997).

CLUTCH SIZE

Clutch size at the South Fork Kern River is two to five eggs. Nests with more than five eggs have been laid by more than one female. The size of the clutch appears to be related to food availability. The number of eggs per nest averaged 2.95 over the 92 nests. The minimum number of eggs for completed nests was two and the maximum, laid by one female, was five. One nest (1.1%) had one egg, 20 nests (20.2%) had two eggs, 57 (60.6%) had three eggs, 11 (11.7%) had four eggs, and 2 (2.1%) had five eggs. The only six egg clutch was laid by two females, four by the dominant female and two by a secondary female that had her first nest destroyed after her first egg was laid (Laymon et al. 1997).At the Bill Williams River in western Arizona, the average clutch size for 14 nests was 2.3 eggs/nest (Halterman unpublished data). No four or five egg clutches have been found at this location.

INCUBATION

The male and female share equally in incubation, with the exception that males do all the nocturnal incubation (Laymon pers. obs.).

INCUBATION PERIOD

Incubation period is 11 to 12 days (Laymon pers. obs.).

NESTLING PERIOD

5 to 8 days. Most young cuckoos leave the nest on day 6. At the time they leave the nest they cannot fly, but can climb through the canopy vegetation (Laymon pers. obs.).

DEVELPOPMENT AT HATCHING

Yellow-billed Cuckoos are altricial and are completely unfeathered and helpless at hatching (Laymon pers. obs.).

PARENTAL CARE

Males and females brood and feed the young in nearly equal proportion, with the exception that the male does all of the nocturnal brooding. In some cases, when a second brood is attempted, the male takes on nearly total care of the young of the first brood and in addition, helps with the care of the young of the second brood after they hatch. In some cases, helper males provide a significant portion of the food (>40%) to the young (Laymon pers. obs.).

POST FLEDGING BIOLOGY OF OFFSPRING

Young cuckoos are tended by their parents for at least two weeks after fledging. A young cuckoo banded at the South Fork Kern River was found dead in Phoenix 45 days after hatching (Laymon unpublished data).

DELAYED BREEDING

In cuckoo populations in California there are usually more males than females. This leads to delayed breeding in many young males (Laymon pers. obs.). Most females appear to breed in their first year and a few year old males at the South Fork Kern River have acquired mates and successfully bred. Many first year males are helpers at other nests.

NUMBER OF BROODS

Typically Yellow-billed Cuckoos have one brood per year (Ehrlich et al. 1988). At the South Fork Kern River, in years of abundant food resources, two and even three broods have been successfully fledged (Laymon et al. 1997). The occurrence of double and triple brooding of Yellow-billed Cuckoos is significant, indicating that the reproductive potential of the species is much greater than was previously believed. Instead of a pair of cuckoos being able to produce three to four young per season, they can actually produce up to ten young per season, if sufficient food resources are available. This is very important in constructing population models for the species. However, at the South Fork Kern River we found that cuckoos double brooded in less than half of the years and we only found evidence of triple brooding in one year of 12 years of study, 1992 (Laymon et al. 1997). At the Bill Williams River study site, no evidence of double brooding has been detected (Halterman pers. com.).

LANDSCAPE FACTORS

ELEVATION

Historic nesting locations in California range from near sea level in southern California to 1400 m in the Owens Valley near Big Pine. Breeding sites in the Sacramento Valley range from 15 m to 80 m and at the South Fork Kern River sites range from 785 m to 880 m.

FRAGMENTATION

On the Sacramento River, from 1987 to 1990, the extent of habitat in 8 km river stretches was used as a measure of habitat fragmentation. This was the second most important variable in determining the presence of pairs (r^2=0.16, $p<0.005$), unmated males (r^2=0.10, $p<0.005$), and all cuckoos encountered during this four-year study (r^2=0.17, $p<0.005$) (Halterman 1991).

PATCH SIZE

Patch size is a very important landscape feature for Yellow-billed Cuckoos. In California, away from the Colorado River, cuckoos occupied 9.5% of 21 sites 20 to 40 ha in extent, 58.8% of 17 sites 41 to 80 ha in extent, and 100% of 7 sites greater than 80 ha in extent. The trend towards increased occupancy with increased patch size is significant ($t = 3.63$, $p<0.001$) (Laymon and Halterman 1989). On the Sacramento River, from 1987 to 1990, the extent of patch size was the most important variable in determining occupancy for pairs (r^2=0.25, $p<0.005$), unmated males (r^2=0.18, $p<0.005$), and all cuckoos encountered (r^2=0.27, $p<0.005$)(Halterman 1991).

DISTURBANCE

Human disturbance is rarely a factor affecting cuckoos in California. People seldom venture into the hot, humid, vegetation-tangled, and insect infested habitats where cuckoos nest and forage. Foraging cuckoos are nearly oblivious to human presence (Laymon pers. obs.). Nesting cuckoos can be disturbed by visits to the nest site and will not return to the nest after they are flushed from the nest, when humans are in a direct line of sight nearer than 50 m. This would only be a problem if people were inadvertently working or picnicking near a nest, which seldom happens. Close up nest checking by researchers during the nest building, laying, and incubation may lead to nest abandonment, though this seldom happens. Cuckoos do not abandon nests once the first young hatches (Laymon pers. obs., M.D. Halterman pers. com.).

ADJACENT LAND USE

The land adjacent to Yellow-billed Cuckoo breeding habitat at the South Fork Kern River is primarily flood irrigated pasture and dry range land (Laymon pers. obs.). On the Sacramento River adjacent habitat varied from dry range land to irrigated farm land and orchards. The distribution of Yellow-billed Cuckoos at 74 sites along the Sacramento River was not correlated with surrounding land use ($r^2 = 0.03$, $p = 0.59$) (Halterman 1991).

CLIMATE

Micro-climate may play a very important part in habitat selection. It is possible that Yellow-billed Cuckoos evolved in the humid eastern portion of North America and were only able to colonize the west along the humid river bottoms (Hamilton and Hamilton 1965). A study of temperature and humidity at nest sites, forest edges, and in the open on the Sacramento and Kern rivers showed a decrease in temperature and an increase in humidity closer to the nest (Launer et al. 1990).

PESTICIDE USE

Information on Yellow-billed Cuckoos and effects of pesticides has been little studied and the evidence is conflicting. Several studies in Florida showed that Yellow-billed Cuckoos, based on lipid weight, carried low levels of DDT (0.42 ppm in spring and 1.12 ppm in fall) (Grocki and Johnston 1974; Johnston 1975). Eggs taken from two nests in the Sacramento Valley also contained low pesticide levels (0.08 and 0.11 ppm DDE) (Laymon 1980). Yellow-billed Cuckoo eggshells collected in the South Fork Kern River in 1985 averaged 19% thinner than pre-DDT era eggs, a level of thinning that could cause reproductive failure in some species (Laymon and Halterman 1987). This indicates the possibility that even small pesticide loads in this species can cause significant eggshell thinning. Pesticides, especially larvacides used in mosquito control, could be a major threat when applied on a widespread area (especially aerially). Along the Stanislaus River at Caswell State Park, where cuckoos previously nested, larvacides were regularly applied by air during the spring and summer for many years. This resulted in an avifauna depauperate of insect eating birds such as warblers, vireos, orioles, flycatchers, and cuckoos (Laymon pers. obs.). The direct effect of pesticide poisoning, especially of cuckoos nesting in or near orchards, can be great. The young in a nest in a walnut orchard that was sprayed with Zolone for codling moths and aphids could not maintain their balance on tree branches after fledging and repeatedly fell to the ground. This falling behavior has never been observed at dozens of other unsprayed nests (Laymon 1980; Laymon pers. obs.).

PREDATORS

Red-shouldered Hawks and Northern Harriers have been observed preying on nestlings. Cuckoos drive Western Scrub-Jays and Loggerhead Shrikes away from the nests. On the Sacramento River there appeared to be an inverse relationship between the presence of cuckoos and scrub jays, indicating a possible aversion by the cuckoos to nesting at sites with Western Scrub-Jays (Laymon pers. obs.). Cooper's Hawks are probably the only predator capable of taking adult Yellow-billed Cuckoos.

EXOTIC SPECIES INVASION/ENCROACHMENT

The degradation of cottonwood-willow riparian habitat as a result of the invasion by salt cedar (*tamarisk sp*.) and giant reed (*Arundo donax*) is a major problem over much of the cuckoo's range. Along the Sacramento River, domestic fig and black walnut have also become dominant tree species, while probably offering little to cuckoos for either nesting or foraging. All of these invasive exotics are poor at providing foraging opportunities for cuckoos because the cuckoos preferred prey are not found on these substrates. These exotics also do not offer good nest sites. A possible exception is that cuckoos have nested on two occasions in tamarisk at the Bill Williams River (Halterman pers. com.).

DEMOGRAPHY AND POPULATION TRENDS

POPULATION TREND

There is insufficient data to determine trends of Yellow-billed Cuckoos in California using BBS data. Throughout the United States this cuckoo has shown a 1.6% per year decline from 1966 to 1996 (Sauer et al. 1997). Yellow-billed cuckoos in the western BBS region have showed a decline of 4.7% per year during the same time period, though the number of counts on which cuckoos are found is very low and therefore the results are unreliable (n = 17). Of the 30 states and provinces in which sufficient data exists, only two show increasing trends and neither are significant: Ontario, +3.7%/year, p=0.16, n=26; Pennsylvania, +0.7%/year, p=0.58, n=108. On the other hand, 26 states show a declining trend and 12 are declining significantly: Alabama, p<0.001; Connecticut, p<0.001; Georgia, p<0.001; Illinois, p<0.001; Indiana, p<0.001; Kentucky, p=0.01; Michigan, p<0.001; Missouri, p=0.05; Ohio, p=0.02; Tennessee, p<0.001; Texas, p<0.001; and Wisconsin, p=0.03 (Sauer et al. 1997).

In California, Yellow-billed Cuckoos have shown both historic and recent population declines. Recent declines showed a population of cuckoos in the state of 123 to 163 pairs in 1977 falling to 30 to 33 pairs 10 years later, a 73% to 82% decline (Laymon and Halterman 1989). No statewide surveys have been conducted for the species since 1987.

DEMOGRAPHICS

Many demographic parameters are unknown or poorly known for the Yellow-billed Cuckoo. Reproductive potential is one of the few parameters for which we have good data, but only for two sites. Nest success at the South Fork Kern River from 1985 to 1996 has averaged 87% (n = 94) (Laymon et al. 1997). Nest success at the Bill Williams River has averaged 77% (n=13) (Halterman pers com.).

The number of young hatched at the South Fork Kern River has averaged 2.53 young/nest indicating a 87% egg to chick ratio (269 eggs:233 young hatched). The number of young fledged at the South Fork Kern River has averaged 2.14 young/nest indicating a 74% egg to fledgling ratio (269 eggs:199 young fledged) (Laymon et al. 1997). At the Bill Williams River 27 eggs from 12 nests have produced 18 young for a 67% egg to fledgling ratio. These 12 nests produced 1.5 young/nest (Halterman unpublished data).

Because Yellow-billed Cuckoos are capable of double and even triple brooding under good condition, the average number of young produced can be higher than 2.14 young/female/year. At the South Fork Kern River, triple brooding is very rare and has only been observed in 1 of 13 years and then for only 2 of 23 pairs. Double brooding has occurred in about 5 of the 13 years (including the year of triple brooding), but even in those years approximately 50% of the pairs do not double brood. Given these parameters, the average number of young produced at the South Fork Kern River is approximately 2.57 young/female/year (Laymon unpublished data).

The mortality rates for young and adults are unknown. Life expectancy is unknown. Age at first breeding is one year for females and one to two years for males (Laymon pers. obs.).

MANAGEMENT ISSUES AND OPTIONS

In California, away from the Colorado River, there is currently 2768 ha of Yellow-billed Cuckoo habitat (38% optimal, 36% suitable, and 26% marginal). On the Colorado River, there is 572 ha of habitat (including the Arizona side of the river) of which 49% is optimal and 51% is marginal. In 1986-1987 a total of 30 to 33 breeding pairs of cuckoos were found in California (Laymon and Halterman 1989). This is a very small number and the species is obviously critically endangered in the state.

Management of Yellow-billed Cuckoos in California requires more than habitat preservation. All existing habitat should be preserved regardless of present habitat quality and low quality habitat needs to be upgraded to suitable or optimal. This will, however, probably not insure the survival of the species in the state. In addition to preservation, much habitat restoration is needed before recovery of the cuckoo is possible.

On the South Fork Kern River an experimental study using riparian restoration showed that the number of pairs of cuckoos is closely related to the amount of available habitat. This site had a restoration program which began in 1996 and has established 125 ha (310 acres) of willow-cottonwood habitat on the Kern River Preserve, all of which was being used by cuckoos by the summer of 1996. An additional 510 ha (1275 acres)

of habitat was established by natural regeneration during the drought in the South Fork Wildlife Area and the Isabella Reservoir Draw-Down Zone between 1987 and 1992. Using regression analysis, more than half of the variation in cuckoo numbers (51.3%) was explained by the amount of available habitat (r^2=0.51, p=0.009). This pattern held for the Kern River Preserve (r^2=0.44, p=0.02), the South Fork Wildlife Area (r^2=0.59, p=0.003), and the Isabella Reservoir Draw-Down Zone (r^2=0.97, p<0.00001) (Laymon et al 1997). This finding gives us great hope that we can make a positive effect on the recovery of the cuckoo using restoration. This leads to the question of what type of habitat to create.

Two habitat models for Yellow-billed Cuckoos have been developed. Gaines and Laymon (1984) concluded that willow-cottonwood habitat of any age with high humidity and a habitat breadth of 325 feet (100 m) was necessary for suitable Yellow-billed Cuckoo habitat. Additional research based on occupancy rates allowed for refinement of these requirements. Laymon and Halterman (1989) concluded that sites > 80 ha (200 acres) in extent and wider than 600 m (1950 feet) were optimal, sites 41-80 ha (101-200 acres) in extent and wider than 200 m (650 feet) were suitable, sites 20-40 ha (50-100 acres) in extent and 100-200 m (325-650 feet) in width were marginal, and sites <15 ha (38 acres) in extent and < 100 m (325 feet) in width were unsuitable.

Micro-habitat requirements are also important. Nesting groves at the South Fork Kern River are characterized by higher canopy closure, higher foliage volume, intermediate basal area, and intermediate tree height when compared to random sites (Laymon et al. 1997). Sites with less than 40% canopy closure are unsuitable, those with 40%-65% are marginal to suitable, and those with greater than 65% are optimal.

Cuckoos seldom use sites that have a foliage volume of less than 20,000 m^3/ha (64,354 yds^3/acre) and these sites are considered unsuitable. Most nest sites have a foliage volume from 30,000m^3/ha (96,530 yds^3/acre) to 90,000m^3/ha (289,591 yds^3/acre) and these sites are considered optimal. Sites with 20,000m^3/ha (64,354 yds^3/acre) to 30,000m^3/ha (96,530 yds^3/acre) and over 90,000m^3/ha (289,591 yds^3/acre) appear to be suitable (Laymon et al. 1997).

Cuckoos tend to choose nest sites with a mean canopy height of 7 - 10 m (23 feet - 33 feet). This tree height may be optimal for the species. Sites with a mean canopy height from 4 m to 7 m (13 feet - 23 feet) are chosen less frequently but appear to be suitable, as are sites with a mean canopy height of 10 m to 15 m (33 feet - 49 feet). Sites with a mean canopy height of less than 4 m (13 feet) are unsuitable (Laymon et al. 1997) .

Cuckoos tend to choose nest sites that have a basal area (as defined as the summation of the cross-sectional area of a trees trunk at breast height for a given land area) of between 5m^2/ha (21.9 ft^2/acre) and 20m^2/ha (87.5 ft^2/acre) and these sites appear to be optimal. Sites with basal area 20m^2/ha (87.5 ft^2/acre) to 55m^2/ha (240.7 ft^2/acre) are not used as frequently but are suitable. Sites with basal area less than 5m^2/ha (21.9 ft^2/acre) and over 55m^2/ha (240.7 ft^2/acre) are seldom used by cuckoos and can be considered marginal (Laymon et al. 1997).

The best habitats for nesting are therefore at large sites with high canopy cover and foliage volume, and moderately large and tall trees. Sites capable of producing this type of habitat should receive the highest priority when restoration plans are developed.

Launer et al. (1990) recommended that "Given the limited extent of existing habitat, efforts should be made to restore or create suitable habitat. As discussed in relation to the protection of existing habitat, these restoration efforts should be concentrated in areas adjacent to existing habitat patches, or in areas of sufficient extent to create comparatively large tracts of habitat (a minimum of 100 ha, although smaller patches could be acceptable under certain circumstances). Again, geographic considerations appear to be very important, and restoration efforts in the southern portion of the nesting range should probably have first priority."

HABITAT AND POPULATION OBJECTIVES

The amount of habitat that is needed for a self-sustaining population is a result of a trade off between number of patches, patch size, and patch isolation as pointed out by Shaffer (1985). Using simulation modeling, it has been demonstrated that populations of <10 pairs are very unstable and always become extinct in a short period of time (Richter-Dyn and Goel 1972; Roth 1974). In addition, Shaffer (1981) theorized that with more

realistic models this minimum number would increase. A minimum of 25 pairs in a subpopulation with interchange to other subpopulations should be reasonably safe from extinction by stochastic events. This should be a minimum goal for any major subpopulation. This goal was adopted by The Nature Conservancy and The National Audubon Society for the habitat management plan for Yellow-billed Cuckoos at the Kern River Preserve. At present, no subpopulations >25 pairs exist in California. The Bill Williams River in western Arizona population meets this criteria (Laymon and Halterman 1989).

Table 1. Minimum management goals for subpopulations, pairs, and reforestation of suitable habitat, based on 100 acres per pair, for Yellow-billed Cuckoos in California and western Arizona.

Locality	Subpopulation	Pairs	Current Suitable (acre)	Reforestation Suitable (acre)
Northern California				
Sacramento R.	6	150	5850	9150
Feather R.	1	25	600	1900
Stanislaus R.	1	25	600	1900
Cosumnes R.	1	25	0	2500
Merced R.	1	25	0	2500
Kings R.	1	25	0	2500
Mendota	1	25	0	2500
Sub Total	12	300	7,050	22,950
Southern California				
Kern R.	1	25	1000	1500
Prado Dam	1	25	600	1900
Mojave R.	1	25	200	2300
Owens R.	1	25	0	2500
Sub Total	4	100	1,800	8,200
Colorado River				
Needles-Parker	4	100	1650	8350
Parker-Blythe	2	50	0	5000
Blythe-Yuma	3	75	0	7500
Sub Total	9	225	1,650	20,850

Total	**25**	**625**	**10,500**	**52,000**

The number of subpopulations needed is an important issue. Using simulation models, Roth (1974), shows that the variance of mean subpopulation size decreases as the number of subpopulations increases. The Sacramento River subpopulation is close to 25 pairs if it is assumed that the entire river is considered one subpopulation. A subpopulation should be defined as the cuckoos breeding in a discrete area with relatively contiguous habitat. A 3 km break between the habitat patches might be sufficient to delineate a subpopulation and an 8 km break would certainly be sufficient. Using an 8 km break, the Sacramento River from Red Bluff to Colusa now encompasses six subpopulations. The minimum population goal for the Sacramento River would be 150 pairs of cuckoos (25 pairs x 6 subpopulations = 150 pairs). Using the figure of 100 acres per pair, this would require a total of 15,000 acres of suitable or optimal habitat and would require restoration of 9150 acres (Laymon and Halterman 1989).

Because the Sacramento Valley population is isolated, additional subpopulations will be needed to connect this population to the ones to the south and east. This plan recommends the establishment of one subpopulation on the Feather River, five in the San Joaquin Valley, and three in southern California. The establishment of seven subpopulations on the lower Colorado River is also needed. A minimum of 25 subpopulations of at least 25 pairs each would provide habitat for a minimum of 625 pairs (Table 1). This number, while only a fraction (i.e. <5%) of the original population of cuckoos in California, should: (1) provide protection from extinction by stochastic events, (2) provide sufficient genetic diversity (Soule and Simberloff 1986), (3) cover much of the cuckooÕs original range and habitats in California, and (4) provide sufficient colonists to occupy small, outlying sites. To accomplish this goal, a total of 52,000 ha of suitable or optimal habitat must be restored (Table 1; Laymon and Halterman 1989).

MONITORING METHODS AND RESEARCH NEEDS

Yellow-billed Cuckoos are at such low densities in California that monitoring them with traditional methods such as point counts or spot mapping is not possible. Surveys using playback of the contact call are the only acceptable way to monitor the species. Several sites in California (Kern River, Sacramento River and Colorado River) should be monitored on a yearly basis and a statewide survey every ten years is needed to monitor trends for this species.

Research on the movement patterns between subpopulations is needed to determine the potential for genetic interchange. Research on the effects of pesticide residues, especially on migration cuckoos is needed. More research on the effects of riparian habitat restoration is needed to determine the optimum mix of willows and cottonwoods to plant on these sites.

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