APPENDIX B. SPECIES HABITAT SUITABILITY ANALYSIS MODELS

and

SOUTHWESETERN WILLOW FLYCATCHER SURVEY RESULTS for 2014

TABLES

1.0 COVERED AVIAN SPECIES HABITAT SUITABILITY MODELS

Existing habitat for avian species in the Plan Area was assessed using species-specific models. Habitat suitability for riparian obligate species was assessed using species-specific models developed by Dr. Steve Laymon for use on City of Los Angeles (City) lands in the Eastern Sierra. Dr. Steve Laymon worked with Ecosystem Sciences (ES) to develop the models, and Los Angeles Department of Water and Power (LADWP) applied the models using ArcGIS and available vegetation mapping data.

Suitable habitat for the Greater Sage-Grouse within the Plan Area was defined based on the Preliminary Priority Habitat (PPH) map supplied by U.S. Geological Services (USGS). The PPH map was developed by the Bi-State Greater Sage-Grouse Technical Advisory Committee to provide a defensible decision support tool for management of sage-grouse populations (Technical Advisory Committee) http://sagebrusheco.nv.gov/uploadedFiles/sagebrusheconvgov/content/Meetings/USGS_GrSG_Habitat_Mapping.pdf.

The PPH mapping, based on 30-m resolution Landsat imagery, was further refined by removing polygons of selected cover types (i.e. developed land, water, reservoir shoreline, Jeffrey pine complex, singleleaf pine complex, canyon complex, abandoned agriculture, greasewood, and eolian land) identified from high-resolution 2009 imagery.

1.1 Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)

1.1.1 Habitat Use Information

The California Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*), the western subspecies of the Yellow-billed Cuckoo, inhabits dense riparian woodlands in western North America from the Rocky Mountains and Rio Grande River west to the Pacific Ocean, and from Northern Mexico to northern California. It builds a loose stick saucer nest in willows and other riparian trees. Yellow-billed Cuckoos are territorial during the breeding season and return to the same nesting territory in subsequent years.

Historic nesting locations in California range from near sea level in southern California to 4,600 feet in the Owens Valley near Big Pine. Breeding sites in the Sacramento Valley range from 49 to 262 feet elevation; sites at the South Fork Kern River range from 2,575 to 2,887 feet.

The California Yellow-billed Cuckoo is an endangered species in California and is a de facto endangered subspecies throughout its range (Gaines and Laymon 1984, Laymon and Halterman 1987a). The species was once common in the western states but has been extirpated from much of its previous range including southern British Columbia, Washington, Oregon, Idaho, Utah, Nevada, and much of northern California (Laymon and Halterman 1987a, Roberson 1980).

A 1977 survey of Yellow-billed Cuckoos found a population of 122 to 163 pairs in California, including 35 to 68 pairs in northern California and 87 to 95 pairs in southern California (Gaines and Laymon 1984). Habitat loss along the Colorado River from 1978 to 1985 prompted a re-survey in 1986 and 1987, which showed significant Yellow-billed Cuckoo population declines throughout California (Laymon and Halterman 1987b). The status of the subspecies in Arizona, New Mexico and Mexico is not known.

Management of riparian habitats to prevent further declines of the subspecies is an important issue in the West. The habitat suitability model presented in this document is designed to help predict both habitat use of a given habitat patch and to guide future riparian habitat restoration efforts.

Food

The California Yellow-billed Cuckoo feeds on a variety of large insects and small vertebrate prey. Cuckoos typically forage at a slow pace, spending much time sitting and scanning for prey. When prey is spotted the birds pounce on it with great speed. In the eastern United States, Yellow-billed Cuckoos feed primarily on tent caterpillars, sometimes eating over 100 caterpillars from one web; cuckoos also move into areas with periodic cicada outbreaks. In the western United States, their primary prey is sphinx moth caterpillars, katydids, grasshoppers, and tree frogs. They forage primarily in the foliage of trees, but also dive out to catch flying insects or hop on the ground to capture tree frogs and grasshoppers. The Yellow-billed Cuckoo employs two foraging strategies when they are foliage gleaning: the primary strategy is to hop slowly from location to location, sitting for several minutes at each location and watching for motion of their prey; another strategy is to dive into the foliage where prey may be present to dislodge the prey from the foliage (Laymon 1998).

A 12-year study, along the South Fork Kern River, identified 2,420 prey items as they were being fed to young cuckoos in 30 nests. The primary food items were green caterpillars (primarily sphinx moth larvae) at 45 percent of total diet (range = 20 to 65 percent), tree frogs at 24 percent (range = 4 to 43 percent), katydids at 22 percent (range = 5 to 43 percent), and grasshoppers at 9 percent (range = 4 to 17 percent). Tree frogs are an important food source needed to successfully fledge young in some years (Laymon and Halterman 1985, Laymon and Halterman 1987b). For certain pairs, tree frogs supply more than 40 percent of the food items. Tree frogs are most abundant in cool, moist habitats with seasonal ponds and a willow canopy (Laymon and Halterman 1985, Laymon pers. observation).

The number of eggs laid was positively correlated with the percent of katydids fed to the young (r2=0.55, p=0.04). The total number of young fledged per pair was negatively correlated (nearly statistically significant) with 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).

Little information is available on the foraging habitat of Yellow-billed Cuckoos in California. Laymon (1980) found on the Sacramento River that even cuckoos nesting in walnut orchards captured 88 percent of their food in riparian habitat. Of 37 observed foraging bouts, 50 percent were in cottonwoods, 16 percent in willows and 30 percent in white alders. During these bouts 26 food items were captured. Only 8 percent were caught in cottonwoods. However, 29 percent of the food brought to the nest (n=260) was a species of sphinx moth larvae found primarily in cottonwoods (Laymon 1980 pers observ., Donald Chandler pers. comm.). These data suggest a poor match between foraging substrate observed and actually used ($X2 = 6.20$, $p = 0.01$).

Observer bias in determining use of foraging substrate by cuckoos was further examined at the Kern River (Laymon and Halterman 1985). Of 62 observed foraging bouts of non-telemetered cuckoos, 87 percent were in willows and 13 percent were in cottonwoods. In contrast, 80 percent of 46 foraging observations on two cuckoos fitted with radio transmitters were in cottonwoods while only 20 percent were in willows. The difference in these distributions was statistically significant ($X2 = 49.35$, $p< .0001$). They concluded that a serious bias existed when foraging observations were made without the assistance of radio telemetry.

At 11 foraging sites determined by radio telemetry, vegetation was measured in 0.1-acre circles centered at those sites. A mean of 1,118 trees/hectare (2.47 acres) and a median of 428 trees/hectare (range = 98 to 4,768 trees/hectare) were measured (Laymon and Halterman 1985). The mean canopy closure was 83 percent and the mean foliage volume was 874 m3/hectare (range = 280 to 1,970 m3/ha). The foliage composition by volume at these sites was 69 percent cottonwood and 31 percent other (primarily willow). The average canopy height was 40 feet and ranged from 20 to 65 feet. The high foliage volume of cottonwoods appeared to be an important characteristic of foraging sites. Researchers on the Colorado River have also found that high levels of foliage volume are important to Yellow-billed Cuckoos (Anderson and Ohmart 1984, Rosenberg 1980).

Water

Little is known regarding the use of water by Yellow-billed Cuckoos. They have been seen drinking water and bathing, but they probably do not need drinking water because their food is primarily soft-bodied insects. At the South Fork Kern River the average distance to water was 1,017 feet ($SD = 1,330$, $n = 95$) and ranged from zero to a high of 4,921 feet (Laymon et al. 1997). Many nests are placed directly over water, but this does not appear to be necessary because many are also a long distance from water. At the Bill Williams River in Arizona, the average distance to water was 135 feet ($SD = 154$, $n = 14$), with a range of zero to 574 feet (Halterman, unpublished data).

Cover

There is no evidence that Yellow-billed Cuckoos have need for any specific habitat values for cover other than the habitat that is needed for reproduction and food.

Reproduction

The Yellow-billed Cuckoo's breeding season varies regionally with the availability of preferred food. In California and Arizona they rarely begin nesting before mid-June, while the eastern subspecies begins nesting in April and May. Courtship involves the male attracting the female with cooing calls and then offering food. Mating occurs when a female accepts the males offering, with the food often exchanged during copulation.

Yellow-billed Cuckoos build loose saucer-shaped stick nests. Both parents build the nest, incubate, and tend the young. Clutch size varies from two to five eggs depending on the available food supply. Typical of all cuckoos that raise their own young, the male incubates and broods all night while the female and male divide incubation and brooding equally during the day. The incubation and nestling period is relatively short with the eggs hatching in 11 to 12 days and fledging in five to seven days. Since incubation begins when the first egg is laid, the young hatch asynchronously, with the oldest young near fledging while the youngest is just hatching.

Asynchronous hatching in cuckoos can lead to brood reduction if food supplies decline during the breeding season. When this occurs, the last egg is no longer incubated after the first young hatches, and the young dies in the egg. In times of food stress, males may remove the youngest chick from the nest while still alive (Laymon, pers. observ.). In one case, a chick that was deposited in another cuckoo's nest was raised successfully by the adoptive parents. When young leave the nest they are approximately half the size of the parents. The parents feed them for three to six weeks until they are entirely independent.

Yellow-billed Cuckoos have been found breeding communally. They also occasionally parasitize other bird's nests when food is abundant. In some cases, these "parasitized" nests have been shown to be communal nests, with adult cuckoos sometimes sharing duties with other species such as American Robin and Mourning Dove (Bent 1964, Nolan and Thompson 1975). Nesting Yellow-billed Cuckoos often have apparently unrelated helper males. These helpers can supply the young with up to 40 percent of their food, allowing the dominant pair to raise a second brood. The helper may have an opportunity to father some young of the second brood and gets to perfect his parenting skills on other cuckoo's young. Yellow-billed Cuckoos, during years of exceptionally high food abundance, have successfully raised three broods in a season and double brood regularly. Yellow-billed Cuckoo males tend the young of the first nest; a second clutch can be initiated as soon as the fledglings leave the first nest.

Shelton (1911) observed two nests near Santa Rosa, California and described the nesting habitat as bottomland "...covered with a thick growth of willow, small ash and scrub oak, while the whole is tangled together with an undergrowth of poison oak, wild blackberry and various creepers, forming ... an impenetrable jungle, hanging far out over the water." The nests were located on a horizontal willow branch and in a clump of poison oak.

Jay (1911) observed 40 nests in coastal Los Angeles County, where there were "...numerous swampy places and river bottoms... surrounded by willow timber." All 40 nests were found in willows. One area that supported several pairs every summer was a 40 acre patch of second growth willow "...not as dense as ... some groves and ... [with] grass... interspersing the willows."

Hanna (1937) examined 24 nests along the Santa Ana River near Riverside. He described the ideal nesting habitat as "damp willow thickets mixed with cottonwood trees and with heavy underbrush of nettles, wild-grape vines and cattails." He rarely found nests more than a few hundred yards from water. Twenty-two of the 24 nests he observed were in willows, one was in an alder, and one was in a cottonwood. Six of the nests were partly supported or concealed by wild grapevines and one was in a mistletoe clump. Most nests were "...well out on a horizontal or leaning limb." The average height of the nests was 13 feet.

Based on the three studies described above and their own personal observations, Grinnell and Miller (1944) described the Yellow-billed Cuckoo's habitat as follows: "Most characteristic, riparian jungles of willows of fairly old growth, often mixed with cottonwoods, and with a tangled 'lower story' of blackberry, nettles, or wild grape. Such conditions are obtained on the broad lower flood-bottoms of our larger streams." This was the first "habitat model" for the species to appear in the literature.

More recent accounts of cuckoo nest sites come from the Sacramento River and the South Fork Kern River. Among eight pairs of cuckoos documented along the Sacramento River near Chico in 1980, five nested in a poorly maintained walnut orchard and three nested along a willow lined slough (Laymon 1980). Four of these nests were located on densely foliaged horizontal branches with a live canopy both above and below the nest. There was no ground cover in the walnut orchard where three nests were found. The walnut trees had been planted 25 to 30 feet apart and the tree canopies had grown together, providing a cool, moist microclimate, especially after irrigation. The walnut trees had been planted at a density of approximately 275 trees/hectare (2.47 acres).

Vegetation surveys were conducted at 95 nests at the South Fork of the Kern River. All of the nests were in willows with the exception of one, which was located in a mistletoe clump in a Fremont cottonwood (*Populus fremontii*). Of the 94 nests in willows, 54 (57.4 percent) were in Goodding's black willow (*Salix gooddingi*) and 40 (42.6 percent) were in red willow (*Salix lavigata*). The average nest tree height was 31 feet (SD=11.5); the shortest nest tree was 8.2 feet while the tallest was 58 feet. The diameter at breast height (DBH) of the average nest tree was 10 inches (SD=7.4) and ranged from 1.2 to 35.4 inches (Laymon et al. 1997).

The average nest height was 15.8 feet (SD=9.8) and ranged from a low of 4.3 feet to a high of 43 feet. Sixty six of the nests (69.5 percent) were placed on horizontal branches, while 13 (13.7 percent) were placed in tree crotches and 16 (16.8 percent) were in vertical forks. Nests were placed closer to the tip of the branches than to the trunk of the tree. On average, nests were placed 4.6 feet (SD=1.9; range 0 to 9.8 feet) from the tip of the branch in a clump of dense foliage and 8.9 feet from the trunk (SD=10.2; range = 0 to 39 feet) (Laymon et al. 1997).

The majority of the nests (72 percent) were placed on the east side of the nest tree. There was a greater proportion of east facing nests than would be expected by chance (X2=9.45, p=0.002). Estimated cover above the nests averaged 93.4 percent (SD= 15.1) and ranged from 0 to 100 percent. Average canopy closure on the nest site vegetation sampling plot averaged 74 percent (SD=15.6) and ranged from 16.5 to 98 percent. At the center of the plot under the nest, the canopy closure averaged 96.8 percent (SD=7.3) and ranged from 63 to 100 percent. At 16.4 feet from the nest, the canopy closure averaged 75 percent (SD=18.1) and ranged from 17.5 to 100 percent; at 33 feet from the nest, the canopy closure averaged 63.8 percent (SD=26.1) and ranged from 0 to 100 percent (Laymon et al. 1997).

1.1.2 Interspersion and Composition

Gaines (1974) concluded that the home range of the Yellow-billed Cuckoo averaged 24.7 acres on the Sacramento River. He also concluded that cuckoos did not occur in areas where there was less than 24.7 acres of habitat, where a strip of habitat was less than 919 feet long or 295 feet wide, and where distance to water was greater than 295 feet.

Laymon (1980) found that the average home range per pair of four pairs along the Sacramento River was 42 acres, of which on average, 25 acres was forested. On the Kern River in 1985, an average home range of 25 acres per pair was found for six pairs, while with the aid of radio telemetry, the average home range of two pairs was 42 acres (Laymon and Halterman 1985). This indicates that home ranges might be underestimated without the use of telemetry. Home ranges were determined without the aid of radio telemetry in 1986 and 1987. In 1986, the home range of eight pairs of cuckoos averaged 72 acres, while in 1987 the home range for all three pairs exceeded 99 acres per pair (Laymon and Halterman 1987b). Telemetry may have shown the actual home ranges to be even larger. Forty acres is likely the minimum home range the species uses on the Kern River. More detailed studies using radio telemetry are needed to ascertain the true home range size.

Patch size is a very important landscape feature for Yellow-billed Cuckoos. In California, away from the Colorado River, cuckoos occupied 10 percent of 21 sites 49 to 99 acres in extent; 59 percent of 17 sites 101 to 198 acres in extent; and 100 percent of seven sites greater than 198 acres in extent. The trend towards increased occupancy with increased patch size is significant ($t = 3.63$, $p < 0.001$) (Laymon et al. 1989).

On the Sacramento River from 1987 to 1990, the extent of habitat in five-mile river stretches was used as a measure of habitat fragmentation. This was the second most important variable in determining the presence of pairs ($r2=0.16$, $p < 0.005$), unmated males ($r2=0.10$, $p < 0.005$), and all cuckoos encountered during this four-year study ($r2=0.17$, $p < 0.005$) (Halterman 1991). 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, $r2=0.05$, $p < 0.05$) was a weaker predictor of cuckoo presence than low woody vegetation (pairs, $r2=0.17$, $p < 0.005$) (Halterman 1991). Halterman (1991) found that a multiple regression model combining patch size, extent of habitat within a five-mile river stretch, presence of point bars, and presence of low woody vegetation explained 46 percent of the variance in location of cuckoo pairs on the Sacramento River. This indicates 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. observ.).

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. observ.). On the

Sacramento River, adjacent habitat varied from dry range land to irrigated farmland and orchards. The distribution of Yellow-billed Cuckoos at 74 sites along the Sacramento River was not correlated with surrounding land use ($r2 = 0.03$, $p = 0.59$) (Halterman 1991).

Micro-climate may play a very important part in habitat selection. It is likely 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).

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 cuckoo's 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. 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.

Areas of habitat of seemingly adequate size might not be used as breeding sites due to their isolation from other habitat patches. Similar areas might be utilized because a surrounding overgrown orchard has effectively increased the size of the habitat patch. Best (1983) found that the presence of fencerow vegetation increased bird species richness in Iowa farmlands. In a study of urban wood-lots Gotfryd and Hansell (1986) found that the quality of habitat in the neighborhood surrounding a wood-lot was the best predictor of breeding-bird density. Although the importance of surrounding land use in breeding-site selection among Yellow-billed Cuckoo is not yet understood, some workers have speculated that a smaller habitat area may be sufficient if surrounded by areas of less suitable habitat such as an orchard (James Snowden, pers. comm., Laymon, pers. observ.). Because the area of a riparian site is important to the cuckoo, the size of adjacent orchards may also impact site selection.

The need for larger rather than smaller habitat patches is evident from the increased proportion of occupancy by Yellow-billed Cuckoos as patch size increases, and from literature showing lower nesting success for open cup nesting birds near edges of large habitat fragments and in smaller habitat fragments (Chasko and Gates 1982, Gates and Gysel 1978). Wilcove (1985) shows that increased nest predation reaches up to 1,969 feet into the forest interior. This indicates that reserves smaller than 247 acres are less valuable than larger reserves (Wilcove et al. 1986). The width factor also is derived from the adverse effects of edge. The more circular a preserve is, the less these edge effects will come into play (Diamond 1975 and Temple 1986).

Temple (1986) emphasized the use of a core area (> 328 feet from the edge) instead of total area to determine the usable size of a forest fragment. Therefore, the more circular (and less linear) a patch, the greater the usable space. The distance a cuckoo can forage from the nest is limited by its need to return frequently to the nest. A habitat patch of 99 acres that is 247 feet wide and 1,312 feet long might be unsuitable, while a square or circular patch the same size would be suitable.

1.1.3 Habitat Suitability Index (HSI) Model for Yellow-billed Cuckoo

Model Applicability

Geographic Area - This Habitat Suitability Index (HSI) model was developed from data gathered in the South Fork Kern River Valley. This HSI model applies to the cover types listed below that occur within the breeding range of the Yellow-billed Cuckoo in California. The model may also be applied to cottonwood-willow riparian habitat in Arizona, but should be tested. The model was not developed for the mesquite habitat in the Southwest, and probably is not suitable in those habitats.

Season - This HSI model was developed to evaluate the quality of habitat for Yellow-billed Cuckoos during the breeding season (May – September).

Cover Types - The model was developed for application in deciduous riparian woodlands and forests. It should be equally applicable for both of the primary cover types, which include Valley-Foothill Riparian, and Desert Riparian habitats (Mayer and Laudenslayer 1988). The region covered is the California Dry Steppe Province (262) within the Mediterranean Division (Bailey 1995).

Minimum Habitat Area - The minimum habitat area for this model is 10 hectares (25 acres). During the 1986-87 Yellow-billed Cuckoo surveys in California, no sites smaller than 10 hectares had breeding pairs (Laymon and Halterman 1989). The maximum home range observed for the species is approximately 40 hectares (100 acres) (Laymon, pers. observ.). This is probably the largest area in which a pair of cuckoos can effectively provision their young. Sites with a total amount of riparian habitat less than 10 hectares, within a 40 hectare (100 acre area) should be considered unsuitable.

Model Description

Overview - The Yellow-billed Cuckoo can satisfy all of its breeding season habitat requirements within the Valley-Foothill Riparian and Desert Riparian cover types. In this model it is assumed that requirements for reproduction and feeding are met by the same habitat parameters, even though nesting requirements may be more restrictive.

Reproductive Component - Habitat suitability for reproduction is assumed to be optimum when average canopy closure is > 70 percent, average canopy height is 7 to 10 meters, basal area is 5 to 20 m2/hectare (2.47 acres), and foliage volume is 30,000 to 90,000 m3/hectare. Intermediate habitat suitability occurs when the average canopy closure is between 50 and 70 percent, average canopy height is 5 to 6 meters and > 10 meters, basal area is 25 to 55 m2/hectare, and foliage volume is > 90,000 m3/hectare. Low suitability occurs when the average canopy closure is between 30 and 50 percent, average canopy height is 4 to 5 meters, basal area is 2 to 3 m2/hectare and > 55 m2/hectare, and foliage volume is 10,000 to 20,000 m3/hectare. Stands with an average canopy closure of < 30 percent, average canopy height < 3 meters, average basal area < 1 m2/hectare, and foliage volume < 10,000 m3/hectare, are considered unsuitable.

HSI Determination - It is assumed that the habitat variables are partially compensatory, and that 0.0 values for any variable would result in the stand being unsuitable. The habitat suitability of a stand is estimated by its reproductive suitability index (SIR). Until tests are carried out, the recommended model form is:

$$SIR = (SIV1 \times SIV2 \times SIV3 \times SIV4)^{1/4} \qquad \text{(Equation 1)}$$

Users of the model are encouraged to work with local data to determine the best method for integrating the four habitat variables.

A particular assessment area may be comprised of many stands that differ for one or more of the habitat variables. An HSI for an assessment area can be calculated with Equation 2:

$$HSI = \frac{\sum_{i=1}^{n} (Ai\ SIRi)}{\text{Total Area}} \qquad \text{(Equation 2)}$$

Where
n = the number of distinct stands
Ai = the area of stand type I
SIRi = the reproductive index of stand type I defined by Equation 1

Application of the Model

Summary of Model Variables - The model is designed to accept some variables estimated from aerial photos. Accuracy of the data and the results should increase with ground-truthing. Conversion factors to obtain basal area and foliage volume from measures of tree canopy diameter have not been developed for riparian habitats as they have for coniferous forest types. Data from on-the-ground measurements will be more accurate, but also more time consuming than data obtained from aerial photos.

The relationships between habitat variables, Yellow-billed Cuckoo life requisites, cover types, and overall habitat suitability are shown below:

Habitat variables	Life requisite	Cover Types	
Shrub cover ▷	Reproduction ▷	Riparian ▷	HSI
Average canopy closure ▷		Deciduous ▷	
Habitat Width ▷		Forest ▷	

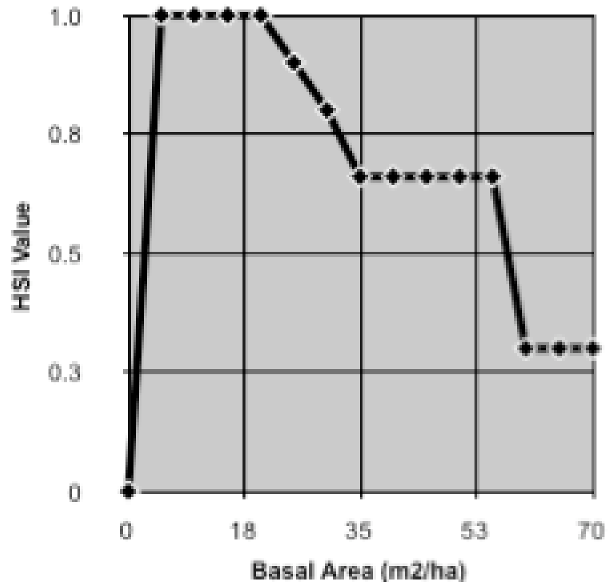
Model Assumptions - One major assumption of the model is that one or more suitable nest trees are found within a projected home range. The nests are placed predominately in willows but in some areas, alder, box elder, wild grape and other trees can be used.

Heavy grazing during the nesting season can adversely impact the species by both damaging the habitat and directly destroying nests. It is assumed that in this model, the potential grazing/browsing impacts will be covered by V1, riparian shrub cover.

Variable Definition

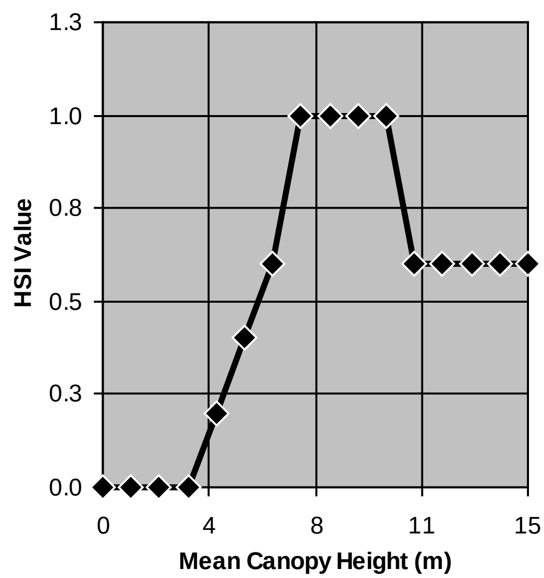
V1 – Percent Canopy Closure (the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation taller than 3.0 meters [10 ft.]).

Suggested Measurement Technique - Canopy closure can be estimated with aerial photographs, or can be measured using a densiometer or other canopy closure measurement device.



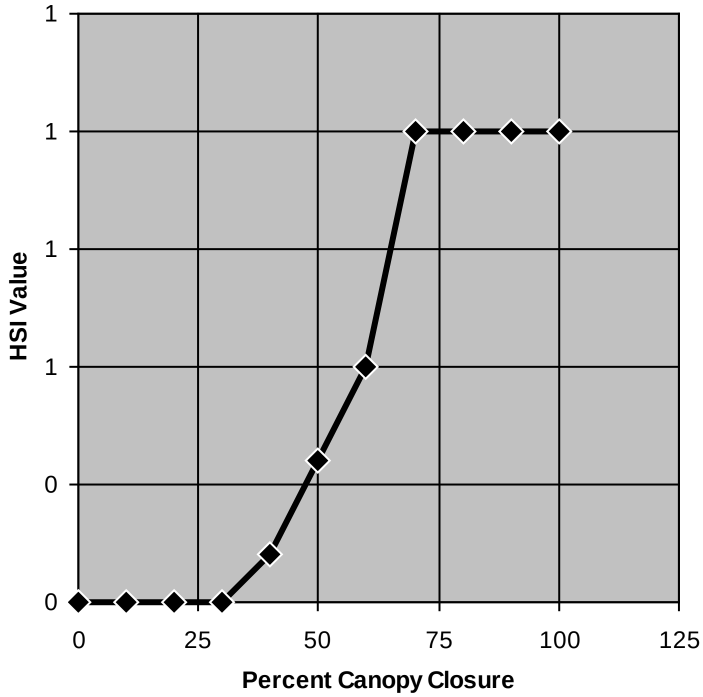
V2 – Average Canopy Height (the average height of all trees [dominant and subdominant] greater than 3.0 meters in height and 10 cm DBH).

Suggested Measurement Technique - Average canopy height can be estimated from aerial photographs, can be measured from the ground using a range finder, or can be estimated from the ground.



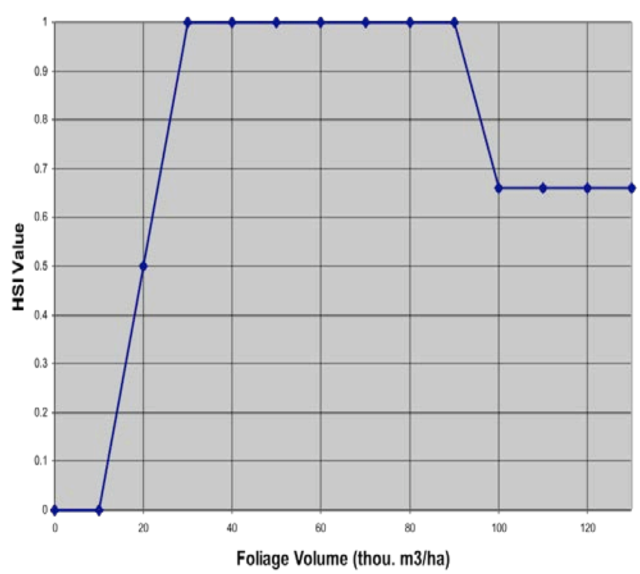
V3 – Basal Area (the average basal area of a stand. This measure includes all dominant, subdominant and understory trees with a diameter greater than 3 cm).

Suggested Measurement Technique - Basal area can be estimated from aerial photographs, or measured on the ground using a DBH tape and measuring all trees in a sample of 1/10th-acre plots.



V4 – Foliage Volume (the average foliage volume of all trees greater than 3 meters in height and 3 cm DBH. This measure includes dominate, subdominant and understory trees).

Suggested Measurement Technique - Foliage volume can be estimated from aerial photographs, or can be measured on the ground using a tape measure and measuring all trees in a sample of 1/10th acre plots.



1.1.4 Other Yellow-billed Cuckoo Habitat Models

Several other habitat models that have been developed for Yellow-billed Cuckoos are described below.

Sacramento River Regression Model (Halterman 1991)

The riparian forests of the Sacramento River once constituted a nearly continuous band of habitat for 650 km from north of Red Bluff to the Sacramento Delta. This band ranged from 1.6 to 16 kilometers in width with an average of 4.8 kilometers, and covered 320,000 hectares along all the river systems of the Sacramento Valley. Agricultural and urban expansion, dam construction and other flood control practices, and bank stabilization projects have reduced this amount by about 98 percent, to 6800 hectares. The once-continuous band of forest has been broken into isolated fragments of varying size. Halterman (1991) characterized the macro-habitat and vegetation at all 73 habitat patches between Red Bluff and Colusa. Variables included area of patch (ha), habitat type, distance to adjacent habitat areas, surrounding vegetation, and the presence of point bars and low woody vegetation.

Surveys revealed a fluctuating Yellow-billed Cuckoo population, from a low of 18 pairs to a high of 35 pairs. Seventy-two percent of the pairs were located in the 35 kilometers between Hamilton City and 8 kilometers south of Ord Bend, while only 33 percent of the available habitat was found in this stretch of the river. Only one pair of cuckoos was found at a site with less than 10 hectares of habitat.

Regression analysis revealed a positive relationship between presence of cuckoo pairs and the following variables: area of patch (r2=0.25), hectares of habitat in each 20 8-kilometer segments (r2=0.16), presence of point bars (r2=0.05), and presence of young woody vegetation (r2=0.17). Forty hectares was the average area of sites with mated cuckoos, while sites without pairs of cuckoos averaged 35 hectares.

The significant variables from the simple regression analysis were used to generate a multiple regression model. Area of site, hectares of habitat in each 8-km segment, and presence of young woody vegetation were the largest contributing factors to the best fitting multiple regression model for mated cuckoos. The sequential R2 value was 0.47 for pairs. These three variables explained 47 percent of the variation in the distribution of pairs of Yellow-billed Cuckoos on the Sacramento River.

General Cuckoo Occurrence Model (Laymon and Halterman 1989)

In California, away from the Colorado River, a relationship exists between size of habitat patch and the proportion of patches that are occupied by either pairs or unmated males. Of the 21 sites 20-40 hectares in extent, only two were occupied (9.5 percent); of the 17 sites 41 80 hectares in extent, 10 were occupied (58.8 percent); and, of the seven sites greater than 80 hectares, all were occupied (100 percent). This trend towards increased occupancy with increased size of habitat patch is significant ($t=3.63$, $p < 0.001$). Along the Colorado River a greater proportion of small sites, 20-40 hectares in extent were occupied. Of the 13 sites 20 - 40 hectares in extent on the Colorado River, six were occupied (46.2 percent), and the only site greater than 80 hectares was occupied. Cuckoos were not using small patches of habitat, particularly when they were isolated.

This led to the development of a model for determining what habitat might be optimal, suitable, marginal, or unsuitable (Table 1). Additional criteria such as canopy closure may be important.

This model emphasizes dominant tree species, total area and area width. Dominant tree species is important since cuckoos only breed in willow-cottonwood and mesquite habitats in California. Willow-cottonwood habitats are greatly preferred, while mesquite habitats may be occupied, but only after the willow-cottonwood habitats are saturated.

Table 1. Habitat Suitability of Yellow-billed Cuckoos in California Based on 1986-87 Surveys

Habitat Suitability	Habitat Type	Area (ha)	Width (m)
Optimum	Willow-Cottonwood	>80	>600
Suitable	Willow-Cottonwood	41-80	>200
Marginal	Willow-Cottonwood	20-40	100-200
Marginal	Mesquite	>20	>200
Unsuitable	Willow-Cottonwood	<15	<100
Unsuitable	Mesquite	<20	--
Unsuitable	Saltcedar	--	--

Using this new definition of Yellow-billed Cuckoo habitat, the previously defined suitable habitat is divided into three categories. At present in California, away from the Colorado River, there are 2,768 hectares of riparian habitat that could be used by cuckoos; of this, 26 percent is marginal, 36 percent is suitable, and 38 percent is optimal. Along the Colorado River, including the Bill Williams River, there is 572 hectares of habitat, of which 51 percent is marginal and 49 percent is optimal.

1.2 Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

1.2.1 Habitat Use Information

General

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) inhabits riparian woodlands in southwestern North America from the Rocky Mountains and Rio Grande River west to the Pacific Ocean and from Northern Mexico north to southern California, Nevada, Utah, and Colorado. It builds a small open-cup nest in willows and other riparian trees, shrubs, and tall understory forbs. Southwestern Willow Flycatchers are territorial during the breeding season and return to the same nesting territory in subsequent years. In fall, they migrate to Central and South America for the winter.

Historic nesting locations in California range from near sea level in southern California to 4,921 feet in the Owens Valley near Bishop (Grinnell and Miller 1944). Breeding sites in the South Fork Kern River range from 2,575 to 2887 feet. The subspecies breeds to 8,530 feet in northern Arizona and southwestern Colorado (Sogge et al. 1997). Recent breeding sites near Mono Lake are above 6,562 feet but the subspecies of these records is uncertain.

There are several subspecies of Willow Flycatcher: two subspecies breed in California and another migrates through the state. The Southwestern Willow Flycatcher is an endangered species throughout its range. The subspecies was once common in the southwestern states but has been greatly reduced in both range and numbers (Unitt 1987). A summary of breeding locations in California from 1993 to 2001 showed a population of 256 territories at 77 locations

(Sogge et al. 2003). The largest populations were found along the San Luis Rey River, San Diego County (61 pairs); the Santa Ana River, San Bernardino and Riverside counties (38 pairs); the Santa Ynez River, Santa Barbara County (33 pairs); the Owens Valley, Inyo County (28 pairs); the South Fork Kern River, Kern County (23 pairs); and the Santa Margarita River, San Diego County (23 pairs). The California population represents approximately 25 percent of the known population of the subspecies (Sogge et al. 2003).

Management of riparian habitats to prevent further declines of the subspecies is an important issue in the West. The Willow Flycatcher habitat suitability model described below is designed to help predict habitat use of a given habitat patch by developing a numerical habitat relationship model.

Food

The Southwestern Willow Flycatcher feeds on a variety of small flying insect prey. Willow Flycatchers typically fly-catch by sitting on a perch and flying out after a passing insect, or hover glean by hovering near foliage and picking the insects off the vegetation.

Little research has been done on the food habits of this species. Beal (1912 in Bent 1942) examined the stomach contents of 135 specimens of another subspecies in eastern North America and found 96 percent of the diet was animal food and the remainder was vegetable matter (elderberries and blackberries). *Hymenoptera* (mostly wasps and bees) made up 41 percent of the diet; *Coleoptera*, 18 percent; Diptera (such as crane, robber, house, and dung flies), 14 percent; *Hemiptera* (true bugs), 8 percent; *Lepidoptera* (moths and caterpillars), 8 percent; *Orthoptera* (mostly small grasshoppers), 4 percent; and the remainder included a variety of small insects.

One recent study has examined the food habits the Southwestern Willow Flycatcher (Drost et al. 2003). Prey remains in 59 fecal samples from flycatchers at the Kern River Preserve in southern California were examined. A total of 379 prey individuals were identified in the samples. Dominant prey, both in total numbers and in percent occurrence, were true bugs (*Hemiptera*), flies (*Diptera*), and beetles (*Coleoptera*). Leafhoppers (*Homoptera: Cicadellidae*), spiders (*Araneae*), bees and wasps (*Hymenoptera*), and dragonflies and damselflies (*Odonata*) were also common items. There was a significant difference between the diet of nestlings and adults, with the young birds being fed more odonates and beetles (Drost et al. 2003).

Water

There is no information in the literature on use of water for drinking by this species. Nearly all nesting territories have open water or super-saturated soil at the nest site.

Cover

There is no evidence that Southwestern Willow Flycatchers have need for any specific habitat values for cover other than the habitat that is needed for reproduction and food.

Reproduction

The Southwestern Willow Flycatcher's breeding season varies regionally. At the South Fork Kern River from 1992 to 1997, the average first spring arrival date was April 27, with the earliest date of April 16, 1992, and the latest date of May 10, 1997, (S. Laymon, pers. observ.). In California they begin nesting in mid-May, with the first eggs laid in late May. The last eggs are laid in late July (Sedgwick 2000). Courtship involves the male attracting the female with advertising calls and chasing behavior.

Nest construction usually begins within a week of pair formation. Willow Flycatchers build a small compact open-cup nest of weed stems, plant fibers (especially of nettles), and dried grass. The nest is built entirely by the female (Sedgwick 2000). The females generally do all the incubation, but both parents tend the young.

Southwestern Willow Flycatcher clutch size varies from two to five eggs, with three or four eggs being the norm. The incubation and nestling period is relatively short with the eggs hatching in 12 to 15 days and the young fledging in 12 to 13 days. The young hatch over one to three days, indicating that incubation begins prior to laying the last egg. Young reach adult weight when about eight days of age. The young associate with the parents on the territory and are fed by them for about two weeks after fledging, and then disperse (Sedgewick 2000).

Willow Flycatchers are generally monogamous, but polygyny can occur in some populations (Craig and Williams 1998). Generally only one brood is raised per year, unless the first brood fails. In a small percentage of the nests at the South Fork Kern River (5 to 10 percent) pairs have successfully raised two broods (Craig and Williams 1998).

In some populations, nest parasitism by Brown-headed Cowbirds (*Molothrus ater*) is very high. At the South Fork Kern River, an average of 64 percent of the nests were parasitized over a four year period from 1989 to 1992 (Whitfield et al. 1997), severely impacting the reproductive success and causing a dramatic population decline.

Willow Flycatcher breeding habitat in California is typically moist mountain meadows with perennial streams; lowland riparian woodlands dominated by tree form willows (*Salix* spp.) and cottonwoods (*Populus* spp.); or smaller spring-fed or boggy areas with willow or alders (*Alnus* spp.) (Serena 1982, Harris et al. 1988, and Whitfield et al. 1997). Riparian deciduous shrubs or trees such as willow or alder are essential elements of Willow Flycatcher territories (Sanders and Flett 1989, Harris et al. 1988). Unlike the habitat in mountain meadows, flycatchers in lowland riverine habitats use contiguous willow thickets, possibly because the linear nature of these areas provide sufficient edge and the tree-like willows typically found in these areas provide sufficient openings within the willow canopy (Harris 1991, Craig and Williams 1998).

The Southwestern Willow Flycatcher is a riparian obligate species restricted to dense stream-side vegetation. Four general habitat types are used by the Southwestern Willow Flycatcher throughout its range: monotypic high-elevation willow shrub; monotypic dense stands of introduced shrubs such as saltcedar (T*amarix*) or Russian olive (*Elaeagnus*); native broadleaf tree-dominated habitats; and mixed native/exotic habitats (Sogge et al. 1997). Of these, native broadleaf-dominated and mixed native/exotic are mainly used in California. The native broadleaf-dominated habitat is composed of a single species or a mixture of broadleaf trees and shrubs (cottonwood, willow, box elder [*Acer negundo*], ash [*Fraxinus*], alder, and buttonbush [*Cephalanthus*]), from 10 to 49 feet tall, and characterized by trees of different size classes with multiple layers of canopy (Sogge et al. 1997). The mixed native/exotic habitat is composed of dense mixtures of native broadleaf trees and shrubs and introduced species such as saltcedar or Russian olive. The vegetation of occupied flycatcher sites includes dense patches usually interspersed with small openings, open water, or shorter vegetation, creating a mosaic that is not uniformly dense (Sogge et al. 1997, Craig and Williams 1998).

Nests are typically placed in the fork of a branch with small (0.4 to 0.8 inches) vertical stems supporting the nest (Sogge et al. 1997). Nests have been found in willows, box elder, saltcedar, live oak (*Quercus agrifolia*), buttonbush, black twinberry (*Lonicera involucrata*), Fremont cottonwood, alder, blackberry (*Rubus ursinus*), mulefat (*Baccharis* spp.), and stinging nettle (*Urtica* spp.) (Sogge et al. 1997, Sferra et al. 1997).

On the South Fork Kern River, Willow Flycatchers nest in areas that have more trees greater than 16 feet tall, a larger amount of tree canopy cover from 22 to 100 percent (averaging 74.4 percent), and a larger amount of foliage volume from zero to 13 feet than random areas (Whitfield 1990). These nests typically occur in areas with multi-layered vegetation and fairly high (60 to 65 percent) tree canopy cover (Whitfield and Enos 1996). In a study of 344 nests found during nine years on the South Fork Kern River, 244 (73 percent) of nests were supported by willows; 46 (14 percent) were supported by a combination of willow and nettle; 30 (9 percent) were supported entirely by nettle; seven (2 percent) were supported by mulefat; and the remaining nests were supported by cottonwood (*Populus fremontii*), white alder (*Alnus rhombifolia*), and ash trees (*Fraxinus* sp.) (Whitfield et al. 1997, Craig and Williams 1998).

Along the San Luis Rey River in San Diego County in 1994, Willow Flycatchers nested in coast live oaks (n = 7), blackberry hedges (n = 5), and flowering ash (*Fraxinus dipetala*; n = 1) (Griffith Wildlife Biology 1995). Along the lower Colorado River in Arizona, seven nests were found in Goodding's black willow (*Salix gooddingii*) (at Lake Mead Delta) and one in salt cedar (*Tamarix* sp.) at Topock Marsh (McKernan 1997, Craig and Williams 1998).

Typical nest placement is such that the nests may be susceptible to damage from wind, cattle, and predators (KRCD 1988 and Valentine et al. 1988), although this susceptibility may be more significant in the Sierra Nevada than in lowland riparian habitats (Harris 1991). Nest height varies considerably, ranging from 2 to 59 feet above the ground (Sogge et al. 1997). In an analysis based on 187 egg sets in museum collections, nest height ranged from two to 17.9 feet, with an average of 7.5 feet (Unitt 1987). At the South Fork Kern River, the average nest height of 186 nests was 7.2 feet (Whitfield et al. 1997). Most nests (108 of 134) were between 2 to 10 feet high, with the highest nest at 33 feet (Whitfield et al. 1997). Nests were placed significantly higher and farther into willow clumps at the Kern River Preserve than those reported at higher altitude study sites for the *E. t. Brewsterii* subspecies (KRCD 1988 and Valentine et al. 1988). This may reflect differences in habitat structure between the short, shrubby willows of montane meadows and the larger willows characteristic of the lowland mature riparian forest, or a difference between subspecies habitat preferences.

On the South Fork Kern River, nest tree canopy height averages 17.2 feet (n=151) (Whitfield and Enos 1996). On the lower Colorado River, nest tree canopy height averaged 20.8 feet (n=7) (McKernan 1997). The highest nest tree heights were found on the upper San Luis Rey River, where they averaged 23.7 feet, ranging from 6.5 to 65 feet (Griffith Wildlife Biology 1995).

The southwestern subspecies is an exception to the finding that Willow Flycatchers do not occur in areas of dense tree cover (Harris 1991). On the South Fork Kern River, mean canopy cover on plots around the nests was 74.4 percent, with a range of 22 to 100 percent (Whitfield and Enos 1996). Although canopy cover can be dense, the flycatcher nests are often in large openings under the willow canopy (Harris 1991). Tree canopy cover immediately above the nests averaged 93.4 percent (n = 150; range = 20 to 100 percent) (Whitfield and Enos 1996). Nests were typically located in areas with multiple layers of vegetation and fairly high tree canopy cover (Whitfield and Enos 1996).

On the South Fork Kern River, the average ground cover is 33.5 percent (n = 153), with a range of 0 to 99 percent (Whitfield and Enos 1996). Ground cover at this site is often sparse in Willow Flycatcher territories because of the density of the canopy, as well as the presence of surface water (Whitfield and Enos 1996).

Southwestern Willow Flycatchers only establish nests near surface water or saturated soil (Sogge et al. 1997, Whitfield et al. 1997). Water may dry up and is not necessarily present at the later stages of the breeding cycle. At the South Fork Kern River, distance from nest to nearest water averaged 70 feet (SD = 14.4, range = 0 to 820 feet, n = 140 nests) (Whitfield et al. 1997). Almost half of the nests (46 percent) were above water at the time they were built or shortly before they were built (Whitfield et al. 1997).

Interspersion and Composition

At the Kern River Preserve, from 1994 to 1997, using all riparian habitat in the study area, average breeding densities were three pairs per 100 acres. When using only the areas of habitat patches where nests were clustered, the average breeding density was 15 pairs per 100 acres (Whitfield and Placer 1994, Whitfield and Strong 1995, Whitfield and Enos 1996, Whitfield et al. 1997). However, the location of breeding clusters shifts between years and not all sites are used each year (M. Whitfield, pers. comm.).

Willow patch dynamics in regard to Willow Flycatcher habitat suitability is still unknown. Various authors describe openings as an important component of Willow Flycatcher nesting habitat (Grinnell and Storer 1924, Meanley 1952, King 1955, Walkinshaw 1966). In Sierra Nevadan montane meadows, willow thickets interspersed with open spaces are typically used for nesting, while large, contiguous willow thickets are avoided (Harris et al. 1988). Twenty-five nests in the Tahoe, Toiyabe, and Plumas National Forests were an average of 4.27 feet (SD = 1.64 feet) from the closest shrub canopy opening (Craig and Williams 1998). Sanders and Flett (1989) felt that openings within willow patches appear to increase habitat suitability. However, in a survey of 125 sites in the Sierra Nevada/Cascade mountain ranges, it was not possible to predict presence or absence of Willow Flycatchers by willow clump sizes (Harris et al. 1988). Nonetheless, some openness in the shrub stratum seems important.

Southwestern Willow Flycatchers have nested in patches of riparian habitat as small as 1.5 acres in the Grand Canyon (Sogge et al. 1995) to larger than 500 acres (e.g. Roosevelt Lake and Lake Mead, Arizona) (Sogge et al. 1997). There are no records from narrow, linear riparian habitats less than 33 feet wide (Sogge et al. 1997). At the South Fork Kern River, the total riparian forest is about 2,800 acres, but the four major breeding sites range from 18 to 60 acres in extent (S. Laymon, pers. observation).

Willow Flycatchers in the Sierra Nevada have been observed nesting near trails created or maintained by livestock. This placement near the edges of willow clumps makes the nests susceptible to being knocked over by cattle (Stafford and Valentine 1985, Flett and Sanders 1987, Valentine 1987, Valentine et al. 1988, Sanders and Flett 1989).

Livestock grazing can also indirectly affect Willow Flycatcher habitat by altering the vegetation and hydrology. Livestock can eat the lower branches of riparian deciduous shrubs and consume or trample young riparian plants (Taylor 1986). A decrease in foliar density within the lower 5 feet of riparian deciduous vegetation, where most Willow Flycatcher build their nests is of particular concern (Fowler et al. 1991). In Utah, Duff (1979) found that livestock exclusion resulted in an increase in the portion of willow plants used by Willow Flycatchers for nesting. In

Oregon, Taylor and Littlefield (1986) found that the increase in a Willow Flycatcher population coincided with a dramatic decrease in the number of cattle using the area and the elimination of willow cutting and spraying. In another area, these authors found a negative statistical correlation between frequency of cattle grazing on an annual basis and the numbers of Willow Flycatchers (Taylor and Littlefield 1986). Most of their studied areas had undergone prolonged (up to 50 years), intensive annual grazing by livestock, as well as cutting and spraying of willows.

Heavy recreational use of Willow Flycatcher habitat, such as off-road vehicles (that can compact soils), can negatively affect the quality of Willow Flycatcher habitat and potentially cause direct disturbance to nesting birds.

1.2.2 Habitat Suitability Index (HSI) Model for Southwestern Willow Flycatcher

Model Applicability

Geographic Area - This Habitat Suitability Index (HSI) model was developed from data gathered in the South Fork Kern River Valley and in coastal southern California. The model applies to the cover types listed below within the breeding range of the Southwestern Willow Flycatcher in California. The model was not developed for mountain meadows in the Sierra Nevada, and may not be suitable in those habitats.

Season - The model was developed to evaluate quality of habitat for Southwestern Willow Flycatcher during the breeding season (May – August).

Cover Types - This model was developed for application in deciduous riparian woodland and forest. It should be equally applicable for the primary cover types, which are Valley-Foothill Riparian and Desert Riparian habitats (Mayer and Laudenslayer 1988). The region covered is the California Dry Steppe Province (262) within the Mediterranean Division (Bailey 1995).

Minimum Habitat Area - The minimum habitat area for this model is 1 acre. There is only one record of a Willow Flycatcher's territory in a habitat area smaller than 1 acre. The home range size of the Southwestern Willow Flycatcher varies from 0.6 to 1.1 acres (Craig and Williams 1998). Sites with less than 0.6 acres of willow habitat within 1 acre should be considered unsuitable.

Verification Level - Dr. Steve Laymon, the author of this model, has a total of 23 years of field experience with the Southwestern Willow Flycatcher. The model has not been tested.

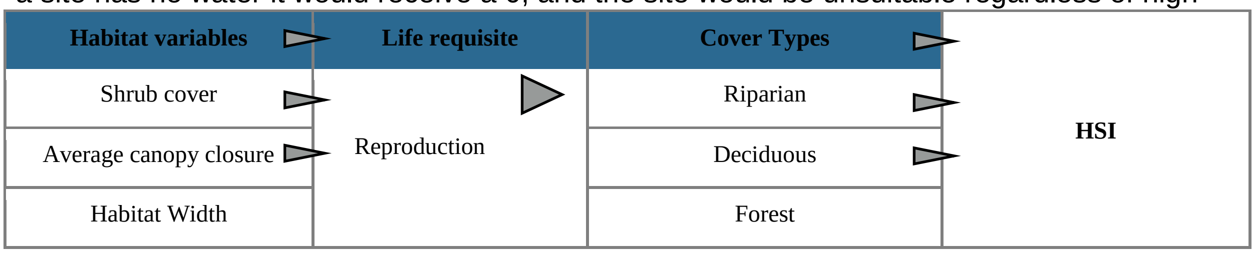
Model Description

Overview - The Southwestern Willow Flycatcher can satisfy all of its breeding season habitat requirements within the Valley-Foothill Riparian and Desert Riparian cover types. This model assumes that requirements for reproduction and feeding are met by the same habitat parameters, even though nesting requirements may be more restrictive.

Reproductive Component - Habitat suitability for reproduction is assumed to be optimum when there is standing or running water or super-saturated soil at the beginning of the breeding season; greater than 70 percent canopy closure; more than 75 percent willow foliage in the 3.3 to 10 feet level; and greater than 330 feet habitat width. Intermediate habitat suitability occurs when there is standing or running water at the beginning of the breeding season; 50 to 69 percent canopy closure; 50 to 74 percent willow foliage in the 3.3 to 10 feet level; and 165 to

327 feet in width. Low habitat suitability occurs when there is standing or running water at the beginning of the breeding season; 20 to 49 percent canopy closure; 20 to 49 percent willow foliage in the 3.3 to 10 feet level; and 33 to 162 feet in width. Riparian areas with no standing or running water, less than 20 percent canopy closure, less than 20 percent willow cover, and less than 33 feet in width are considered unsuitable.

HSI Determination - It is assumed that standing or running water (or super-saturated soils) at the beginning of the nesting season is necessary for occupancy of a habitat patch. Therefore, if a site has no water it would receive a 0, and the site would be unsuitable regardless of high values for the other variables. The remaining variables to some degree compensate for each other and are therefore averaged in the model. The habitat suitability of a stand is estimated by its reproductive suitability index (SIR). Until tests are carried out the recommended model form is:



$$SIR = SIV1 * (SIV2 + SIV3 + SIV4)/3 \qquad \text{(Equation 1)}$$

Users of the model are encouraged to work with local data to determine the best method for integrating the four habitat variables (presence of water, average canopy closure, willow foliage 1 to 3 meters [3.3 to 10 feet], and habitat width).

A particular assessment area may be comprised of many stands that differ for one or more of the habitat variables. An HSI for an assessment area can be calculated with Equation 2.

$$HSI = \text{sum of } (SIR1*A1)/\text{Total Area} \qquad \text{(Equation 2)}$$

Where Ai = the area of stand type I
SIRi = the reproductive index of stand type I defined by Equation 1

Application of the Model

Summary of Model Variables - The model is designed to accept some variables estimated from aerial photos. Accuracy of the data and therefore the results should increase with ground-truthing. Data from on-the-ground measurements will be more accurate, but also more time consuming to collect than data from aerial photos.

The relationships between habitat variables, Southwestern Willow Flycatcher life requisites, cover types, and overall habitat suitability are shown in the next figure.

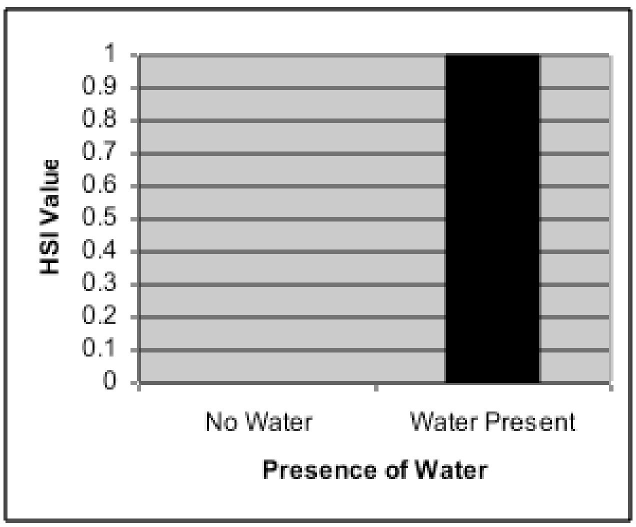
Model Assumptions - It is assumed that this model will be applied in areas where Southwestern Willow Flycatchers occur. Because the species has a very low population level it may not occur in all areas where the habitat is suitable.

Heavy grazing during the nesting season can adversely impact the species by both damaging the habitat and directly destroying nests. It is assumed that in this model the potential grazing/browsing impacts will be covered by V3, willow foliage in the 1 - 3 meter (3.3 to 10 feet) range.

Another assumption is that areas without water at the beginning of the nesting season are unsuitable. This can become problematic because of the extreme variation in rainfall from year to year. If mapping and ground truthing are done in an extremely dry year, it is possible that suitable habitat could be missed (e.g. riparian habitat that would rate as unsuitable in dry years could rate high in wet years). The implementation of the model should be done by projecting the habitat condition for wet years.

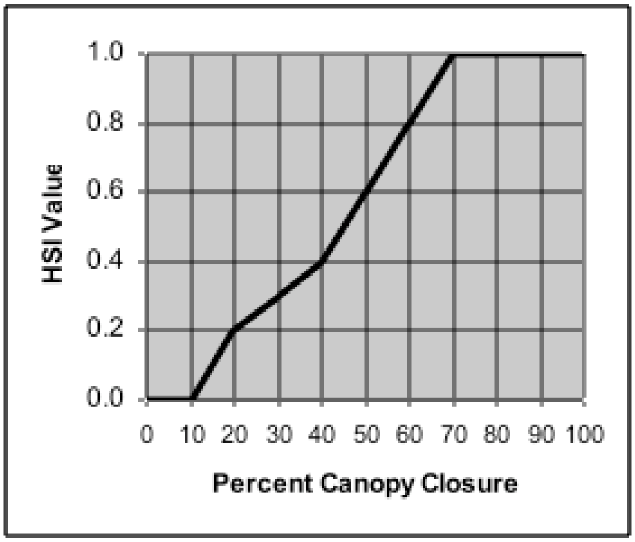
Variable Definition

V1 – Presence of running or standing water or super-saturated soil at the beginning of the breeding season.
Suggested Measurement Technique - This data can be obtained from aerial photos, maps or other sources. If this data is not available, on-the-ground inspection is necessary.



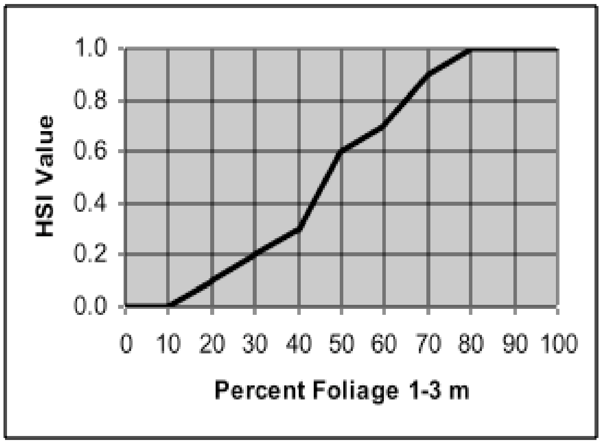
V2 – Percent Canopy Closure (the percent of the ground surface that is shaded by a vertical projection of the canopies of all live woody vegetation taller than 2 meters [6.6 feet]).

Suggested Measurement Technique - Canopy closure can be estimated from aerial photographs or can be measured using a densitometer or other canopy closure measurement device.



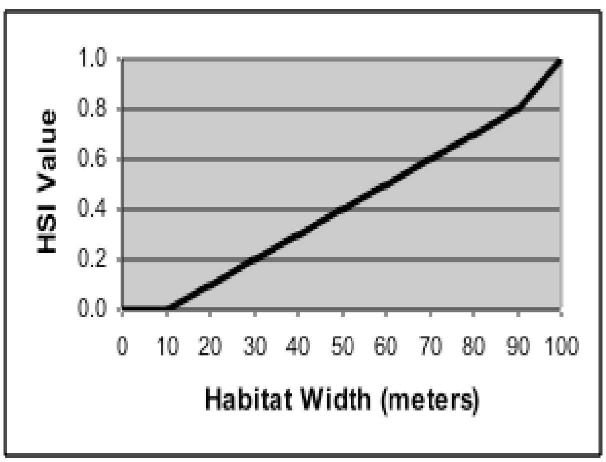
V3 – Percent Willow Foliage Cover in the 1-3 meter Level (percent of the ground surface that is shaded by a three dimensional projection of the foliage of all live woody vegetation within 1-3 meters [3.3 to 10 feet] of the ground).

Suggested Measurement Technique - In some cases, when the willow trees and shrubs are short, this cover can be measured from aerial photos. Otherwise, on-the-ground estimates will be needed to determine if the vegetation is willow and how much occurs at the 1-3 meter [3.3 to 20 feet] level.



V4 – Habitat Width of Riparian Habitat.

Suggested Measurement Technique - Width of habitat can be measured using aerial photographs.



1.2.3 Other Southwestern Flycatcher Habitat Models

There is one other habitat model that has been developed for Willow Flycatchers (Fowler et al. 1991). It was developed for the Brewster's Willow Flycatchers in mountain meadows in the Sierra Nevada using data from the Sierra and Plumas National Forests. It is applicable only to mountain meadows. The variables used in the model are presence of water, meadow size, riparian deciduous shrub cover, and foliar cover density.

1.3 Least Bell's Vireo (*Vireo bellii pusillus*)

1.3.1 Habitat Use Information

General

The Bell's Vireo (*Vireo bellii*) breeds in the central and southwestern United States and northern Mexico, and winters in Mexico and Baja California. The Least Bell's Vireo (*Vireo bellii pusillus*), the westernmost of the four subspecies, breeds in riparian woodlands from central California south to northern Baja California, and winters in southern Baja California. It builds a small open-cup nest in willows and other riparian trees, shrubs, and tall understory forbs. Least Bell's Vireos are territorial during the breeding season and return to the same nesting territory in subsequent years.

Historic nesting locations in California range from below sea level in Death Valley to 4,100 feet in the Owens Valley near Bishop. Most of the historic breeding range is below 1,000 feet. The Central Valley, north to northern Tehama County, was likely the core of the subspecies' breeding range and they were abundant there, often being the most common species. They were also found in coastal valleys north to Santa Clara County and at scattered locations in the desert west of the Colorado River (Grinnell and Miller 1944).

The Least Bell's Vireo is an endangered species throughout its range. The species has been greatly reduced in both range and numbers (Kus 2002). By 1986, the population was composed of an estimated 300 pairs and the range had been reduced to less than 25 percent of its original size. Many believed that the species was nearing extinction. Brown-headed Cowbird control in southern California has allowed vireo populations to increase during the past 15 years. In 1998, the population size had increased to 2,000 pairs (L. Hays, pers. comm.). It is likely that the species is secure as long as habitat quality does not decline and control of cowbirds continues.

In the Owens Valley in Inyo County the Least Bell's Vireo was historically fairly common. A.K. Fisher's Death Valley expedition (1893) found the species at Olancha, Lone Pine, and near Bishop along Bishop Creek. They considered the species to be a "tolerably common summer resident" in the valley. In recent years there have been three records for the Least Bell's Vireo in the Owens Valley: one at Big Pine in May 1976, one in Bishop in early December 2002, and another in Bishop in September 2005 (Tom and Jo Heindel, pers. comm.)

Management of riparian habitats to prevent further declines of the subspecies is an important issue in the West. The habitat suitability model described below is designed to help predict use of a given habitat patch. In this document, we present data on habitat use for the Least Bell's Vireo and develop a numerical habitat relationship model (HSI model).

Food

The Least Bell's Vireo feeds on a variety of small insect prey. They typically foliage glean (pick the prey off the vegetation while perched) or hover glean (hovering near foliage and picking the insects off the vegetation) and rarely fly catch (Miner 1989, Salata 1983).

Least Bell's Vireos forage at all levels, but prefer the lower to mid-strata (Grinnell and Miller 1944, Goldwasser 1981, Gray and Greaves 1984). Salata (1983) found that 69 percent of 131 foraging observations were within 12 feet of the ground. Miner (1989) found a preference for foraging activity in vegetation between 9 and 18 feet in height.

Little research has been conducted on the food habits of the Bell's Vireo and none has been done on the Least Bell's Vireo. Chapin (1925 in Bent 1950) examined stomach contents of 52 specimens in the eastern United States and found 99 percent of the diet was animal food; the remainder was vegetable matter. In Chapin's study, Hemiptera (true bugs) made up 34 percent of the diet: Orthoptera (small grasshoppers) made up 19 percent; Lepidoptera (moths and caterpillars) was 21 percent; Coleoptera (beetles) made up 15 percent; and Hymenoptera (mostly wasps and bees) made up six percent of the diet.

Water

There is no information in the literature on use of water for drinking by this species. They probably satisfy their water needs from their insect prey. Nesting territories are often near water, but the presence of water is not essential for nesting.

Cover

There is no evidence that Least Bell's Vireos have need for any specific habitat values for cover other than the habitat that is needed for reproduction and food.

Reproduction

The Least Bell's Vireo's breeding season varies regionally. In southern California, the vireos arrive on their breeding territories in mid-March (Kus 2002), but northern populations historically arrived about a month later (Belding 1890, Grinnell et al. 1930).

They begin nesting in late March, with the first eggs laid then. The latest that eggs are laid is in early July (Kus 2002). The vireo can raise up to four broods per year, but normally will only raise one. Courtship involves the male actively chasing the female around the territory and includes colliding behavior, with the male running into the female (Barlow 1962 and Brown 1993). Bell's Vireos are monogamous, but mate switching occurs between broods within a year and very few pairs are together for more than one year (Greaves 1987).

Nest construction usually begins within a few days of pair formation. Bell's Vireos build a small open-cup nest of grass, weed stems, plant fibers, and dried leaves (Brown 1993). The nest is built by both members of the pair (Barlow 1962). The females generally do all the nocturnal incubation, but males and females share incubation duties during the day time (Brown 1993). Both male and female tend the young (Barlow 1962).

Least Bell's Vireo clutch sizes vary from three to five eggs, with four eggs being the norm (Bent 1950). The incubation and nestling period is 14 to 15 days (Brown 1993), and fledging occurs in 10 to 12 days (Kus 2002). The young hatch over one to three days, depending on when incubation was initiated (Barlow 1962). The young associate with the parents on the territory and are fed by them for about three to four weeks after fledging and before dispersing (Barlow 1962).

Nest parasitism of Least Bell's Vireos by Brown-headed Cowbirds (*Molothrus ater*) is generally extremely high, except in areas where cowbirds are being trapped. A demographic analysis has shown that with an average parasitism rate of 48 percent (the average for eight studies of the species), a Bell's Vireo population will be extirpated in 18 years (Laymon 1987). Cowbirds, which first arrived in California from the Southwest, are clearly the primary cause for the decline of this vireo in California.

Least Bell's Vireo breeding habitat is typically low elevation riparian woodlands dominated by tree-form willows (*Salix* spp.) and cottonwoods (*Populus* spp.). Brown (1993) described the species habitat as "Dense, low, shrubby vegetation, generally early successional stages in riparian areas, …scrub oak, and mesquite brushlands, often near water in arid regions." Most nest sites have an overstory of willows or cottonwoods, but the most critical habitat component is a dense shrub layer from two feet to 10 feet (Goldwasser 1981, Franzreb 1989).

Nesting Bell's Vireos generally use early successional riparian habitat, which provides the dense cover necessary for nests and a structurally diverse canopy for foraging (Kus 2002). This type of vegetation is generally found between five and 10 years after regeneration (Goldwasser 1981). In San Diego County in California, Kus (1998) found that the species colonized restored riparian sites within three to five years after planting.

Nests are typically suspended from small branching forks (both vertical and horizontal) in small trees, shrubs, or herbaceous vegetation (Barlow 1962). Nests are generally placed between 1.5 and 4.5 feet off the ground; nests higher than six feet are exceptional (Brown 1993, Kus 2002). Nests are placed in a wide variety of plants including willow (*Salix*, many spp.), mesquite (*Prosopis* spp.), rose (*Rosa* spp.), oak (*Quercus* spp.), mulefat (*Baccharis* spp.), and cottonwood (*Populus* spp.) (Brown 1993). Nests have also been built in poison oak (*Toxicodentron diversilobum*), mugwort (*Artemisia douglasiana*), and at least 20 other species of vines, herbs, shrubs and trees. Willows and rose are the most frequently used substrate; in a sample of 126 nests, 56 percent were located in willows and 11 percent were in rose bushes (Franzreb 1989). Typical nest placement is such that the nests may be susceptible to damage from wind, cattle, and predators.

Despite the large number of Least Bell's Vireo nests that have been found and monitored, surprisingly little has been done to characterize the nest site using standard vegetation survey parameters. Additionally, there have been no studies that examine the use of nest sites versus habitat availability. As a result, quantitative characterization of the habitat is difficult.

Nest plants (tree, shrub, or forb) in five studies cited by Kus (2002) averaged 11.1 feet in height. On the Santa Ynez River, the nest plants averaged 9.1 feet in height and ranged from 2.6 to 39.7 feet (Olson and Gray 1989).

Tree canopy closure at nest sites was reported on only two studies. At Camp Pendelton in San Diego County, canopy closure averaged 25 percent (Salata 1983). In a study of 102 nests on the San Luis Rey River, tree canopy closure was higher and averaged 55.2 percent in a 0.04 hectare (0.09 acres) plot centered on the nest, while canopy cover within 16.4 feet of the nest averaged 66.7 percent (Sharp and Kus 2006).

Density of trees greater than three inches in diameter was measured during two studies. On the Santa Ynez River, in a 0.4 hectare (.98 acres) plot surrounding the nest, there was an average of 309 trees/hectare (2.47 acres) (Olson and Gray 1989); on the San Luis Rey River, there were an average of 175 trees/hectare (2.47 acres) in this size range (Sharp and Kus 2006). Goldwasser (1981) found averages of 91, 154, and 65 trees/hectare (2.47 acres) greater than three inches at nest sites in San Diego County.

On the Santa Ynez River, the average height of canopy trees was 27 feet with a range of 5.9 to 59.5 feet (Olson and Gray 1989). At the Santa Margarita River on Camp Pendleton, San Diego County, the average was 22.8 feet with a range of 9.8 to 48.8 feet (Salata 1983).

Although many authors list shrub cover as the most important component of vireo habitat, no study estimated percent shrub cover. One study determined that shrub stem density was higher at vireo nest sites (5,550 stems/hectare) than at random sites (3,673, 1,693, and 2,740 stems/hectare) in three occupied study areas (Goldwasser 1981). This higher stem density undoubtedly yields higher shrub density than the average found in riparian areas in general.

Ground cover was mentioned in several vireo studies. The percent ground cover at nest sites at several study areas in San Diego County was 62 percent at Sweetwater River (no. of nest sites (n)=29), 65 percent at San Luis Rey River (n=23), and 29 percent at San Diego River (n=21) (RECON 1989). Goldwasser (1981), however, concluded that ground cover has no apparent effect on the habitat value for Bell's Vireos.

There is no data on the distance of nests from water, however, nests are found within active floodplains and are often within about 984 feet of surface water (Kus 2002). In a recent study of 102 nests, Sharp and Kus (2006) found that Least Bell's Vireos nests were placed an average distance of 218 feet from the river channel and 364 feet from the riparian forest edge.

With the exception of the center of the Least Bell's Vireo's current range in coastal southern California, most suitable habitat in the species' former range is currently not occupied.

Interspersion and Composition

Least Bell's Vireos are territorial, defending their nest site and foraging area from other pairs. Territories range from as small as 0.5 acres to as large as 3.3 acres (Brown 1993). In other studies their average territory size has ranged from 1.8 (Collins et al 1989) to 2.8 acres (Kus 2002). One study explored the relationship between territory size and reproductive success, but no significant relationships were found (Newman 1992). In all cases, the sizes of the territories were based on observations of territorial birds, sometimes with the aid of color banding. The actual home ranges are likely to be larger.

Breeding density of the Least Bell's Vireo is difficult to determine because pairs are often clumped, and intervening seemingly suitable habitat is often not occupied. At two study sites in San Diego County, density of nesting pairs was calculated at 16.4 pairs/40 hectares (99 acres) (San Diego River) and 8.8 pairs/40 hectares (99 acres) (San Luis Rey River) (Kus 2002). However, in some portions of the San Luis Rey River study area the density was as high as 112 pairs/40 hectares (99 acres) (Kus 2002).

Minimum habitat patch size has not been determined for the species, but in one study, nesting vireos were found to occur at higher frequencies in the portions of the riparian zone that were greater than 625 feet in width (RECON 1989).

The riparian system is adapted to periodic flooding, thus allowing vegetation to quickly recover from disturbance as long as the natural water flow and sedimentation regimes are intact. This natural flooding is currently restricted because of upstream dams in almost all river systems used by the Least Bell's Vireo. Least Bell's Vireos often nest near habitat edges, openings, and trails. Nest failure can be caused by human disturbance such as trampling of nests or nest sites, or clearing of vegetation (Franzreb 1989). Brood parasitism and habitat fragmentation are the primary factors causing the species decline and are both results of human-induced disturbance.

Potential adverse impacts on riparian habitat and nesting Least Bell's Vireo are associated with urbanization and agriculture. These adverse impacts include runoff from agricultural fields and roadways, traffic noise, feral pets, recreational use of habitat, and increased foraging habitat for Brown-headed Cowbirds (Kus 2002). Much of the riparian habitat in southern California is now surrounded by farming, cattle grazing, and horse ranching, all of which are excellent cowbird foraging habitat. Riparian habitat was removed to make way for these other uses, both fragmenting and narrowing the remaining riparian zone. Other nesting areas are adjacent to urban development including roads, golf courses, residential areas, and commercial development. Vireo territories (n=35) bordering on agricultural and urban areas were significantly less successful in producing young than territories bordering on coastal sage scrub, grassland, and chaparral (RECON 1989). All of these activities have rendered the remaining habitat less suitable.

1.3.2 Habitat Suitability Index (HSI) Model the Least Bell's Vireo

Model Applicability

Geographic Area - This Habitat Suitability Index (HSI) model was developed from data primarily gathered in coastal southern California. The model applies to the cover types listed below within the breeding range of the Least Bell's Vireo in California. This model should not be used above an elevation of 4,225 feet because the species has not been recorded as a breeder above that elevation.

Season - The model was developed to evaluate quality of habitat for Least Bell's Vireo during the breeding season (March – August).

Cover Types - This model was developed for application in deciduous riparian woodlands and forests. It should be equally applicable in the primary cover types, which include Valley-Foothill Riparian and Desert Riparian habitats (Mayer and Laudenslayer 1988). The region covered is the California Dry Steppe Province (262) within the Mediterranean Division (Bailey 1995).

Minimum Habitat Area - The minimum habitat area for this model is 0.2 hectares (0.5 acres). There are no published records of a Least Bell's Vireo territory in a habitat area smaller than 0.2 hectares (0.5 acres). The home range size of the Least Bell's Vireo varies from 0.2 to 1.3 hectares (0.5 to 3.3 acres). Sites with less than 0.2 hectares (0.5 acres) of willow and shrub habitat within 0.4 hectares (.98 acres) should be considered unsuitable.

Verification Level - Dr. Steve Laymon, the author of this model, has a total of 23 years of field experience with the Least Bell's Vireo. The model has not been tested.

Model Description

Overview - The Least Bell's Vireo can satisfy all of its breeding season habitat requirements within the Valley-Foothill Riparian and Desert Riparian cover types. In this model it is assumed that requirements for reproduction and feeding are met by the same habitat parameters, even though nesting requirements may be more restrictive.

Reproductive Component - Habitat suitability for reproduction is assumed to be high when there is a riparian shrub cover greater than 60 percent, a 20 to 50 percent riparian tree canopy closure, and a habitat width greater than 200 meters (660 feet). Intermediate habitat suitability includes a 40 to 60 percent shrub cover, a 10 to 20 percent or 50 to 80 percent canopy closure, and 100 to 200 meters (328 to 656 feet) habitat width. Low habitat suitability occurs when shrub cover is 10 to 39 percent, canopy closure is less than 10 percent or greater than 80 percent, and habitat width is 50 to 100 meters (164 to 328 feet). Riparian areas with less than 10 percent shrub cover and less than 50 meters (164 feet) in width are considered unsuitable.

HSI Determination - It is assumed that while the variables have some compensatory traits, that if there is either too little shrub cover or the habitat is too narrow, the habitat is not suitable. The habitat suitability of a stand is estimated by its reproductive suitability index (SIR). Until tests are conducted, the recommended model form is:

SIR = (SIV1 x SIV2 x SIV3) 1/3 (Equation 1)

Users of the model are encouraged to work with local data to determine the best method for integrating the habitat variables (shrub cover, canopy closure, and habitat width).

A particular assessment area may be comprised of many stands that differ for one or more of the habitat variables. An HSI for an assessment area can be calculated with Equation 2.

HSI = sum of (SIR1*A1)/Total Area (Equation 2)

Where Ai = the area of stand type I
SIRi = the reproductive index of stand type I defined by Equation 1

Application of the Model

Summary of Model Variables - The model is designed to accept some variables estimated from aerial photos. Accuracy of the data and therefore the results should increase with ground-truthing. Data from on-the-ground measurements will be more accurate, but also more time consuming than data from aerial photos.

The relationships between habitat variables, Least Bell's Vireo life requisites, cover types, and overall habitat suitability are shown below:

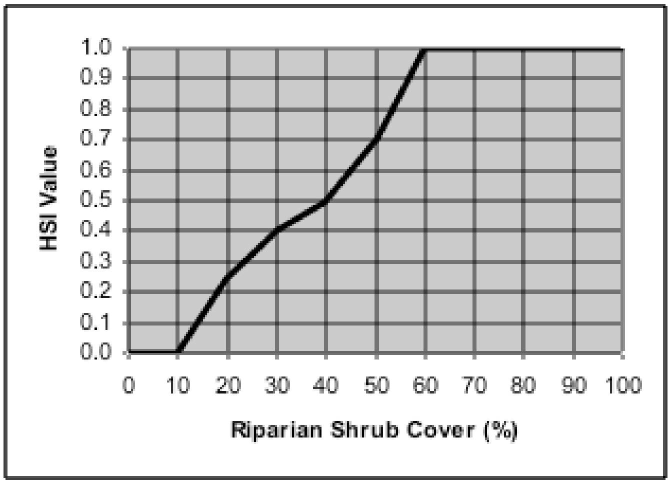
Habitat variables	Life requisite	Cover Types	
Riparian Shrub cover	Reproduction	Riparian Deciduous Forest and Shrub	**HSI**
Average canopy closure			
Habitat Width			

Model Assumptions - It is assumed that the model will be applied in areas where Least Bell's Vireos occur. Because the species has a very low population level in much of its former range, including the Owens Valley, it may not occur in many areas where the habitat is suitable.

Heavy grazing during the nesting season can adversely impact the species by both damaging the habitat and directly destroying nests. It is assumed that in this model, the potential grazing/browsing impacts will be covered by V1, riparian shrub cover.

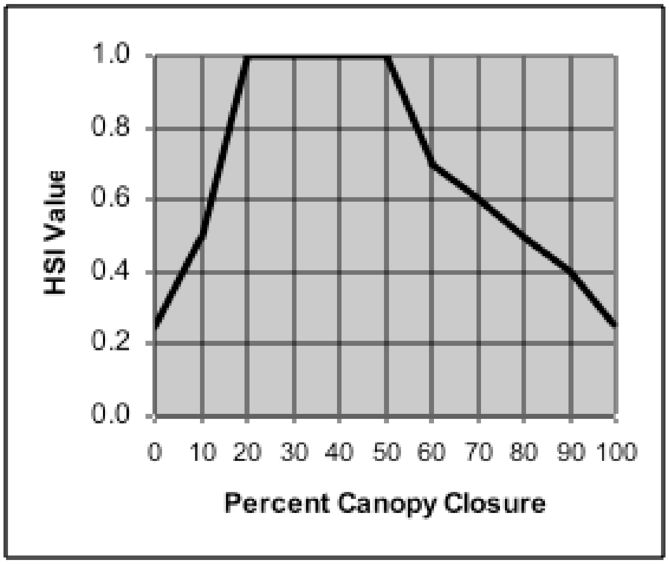
Variable Definition

V1 – Percent Riparian Shrub Cover (the percent of the ground surface that is shaded by a vertical projection of riparian shrubs, in the 0 to 3 meter [0 to .98 feet] range).
Suggested Measurement Technique - This data can be obtained from aerial photos or from on-the-ground estimation.



V2 – Percent Canopy Closure (the percent of the ground surface that is shaded by a vertical projection of the canopies of all live woody vegetation taller than 2 meters [6.6 feet]).

Suggested Measurement Technique - Canopy closure can be estimated from aerial photographs or can be measured using a densitometer or other canopy closure measurement device.



V3 – Habitat Width of Riparian Habitat.

Suggested Measurement Technique - Width of habitat can be measured from aerial photographs.

1.3.3 Other Least Bell's Vireo Habitat Models

There are no other existing habitat suitability models for the Least Bell's Vireo.

Habitat Suitability Analysis – Riparian Obligate Bird Species

The Los Angeles Department of Water and Power's (LADWP) Habitat Conservation Plan (HCP) covers three riparian obligate avian species; Yellow-billed Cuckoo, Southwestern Willow Flycatcher and Least Bell's Vireo, and one non riparian-obligate species: Greater Sage-Grouse. Habitat Suitability models were developed by Dr. Steve Laymon for the three riparian obligate species specifically for use on City lands in Inyo and Mono Counties. The following section documents the process and results of applying these habitat suitability models to areas supporting riparian vegetation using Geographic Information System (GIS), ground-truthing, and local knowledge of vegetation conditions. Suitability analysis was performed in a GIS (ArcGIS 9.0 and ArcGIS 10.0).

1.3.4 Methods

The following methodology (visually displayed in Figure 2) describes the process by which GIS data was used to apply the Habitat Suitability Models. to evaluate the reproductive suitability of riparian habitats on City land in Inyo and Mono counties, California for the three riparian obligate avian species; Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*; hereafter YBCU), Southwestern Willow Flycatcher (*Empidonax traillii extimus*; hereafter SWFL), and Least Bell's Vireo (*Vireo bellii pusillus* hereafter LBVI).

LADWP has made significant investments in documenting and monitoring vegetation resources on its lands in Inyo and Mono Counties. As a result, vegetation mapping has been conducted on virtually all parcels. This information is available in the form of ArcView shapefiles wherein polygons delineate the boundaries of distinct vegetation communities. These shapefiles were created either by LADWP, White Horse Associates or Ecosystem Sciences. The mapping products differ from one another in terms of the specific information they contained, and in the nomenclature used when defining vegetation communities, but in all, communities comprised of woody riparian vegetation are clearly defined.

LADWP has also invested in the collection of aerial and satellite imagery, with imagery of some areas available dating back to 1929. The most recent aerial imagery capture was in 2009. The 2009 imagery is high resolution color imagery with a spatial resolution of 0.3 meters.

The vegetation shapefiles, the 2009 high resolution aerial imagery, and the models developed by Dr. Steve Laymon were used to evaluate habitat conditions for the HCP-covered species.

1.3.5 Base Layer of Potential Riparian Habitats

A total of 11 GIS mapping products (shapefiles) were used to create a single shapefile representing all areas supporting riparian communities that will be evaluated for their potential suitability for the three riparian obligate species. In locations where vegetation mapping polygons overlapped in coverage, the most current mapping information was used. The 11 mapping products are listed below and described in Appendix A (Mapping Products Inyo and Mono Counties, California) of the Habitat Conservation Plan:

Mono County Riparian Mapping (Ecosystem Sciences 2011)

Owens Gorge (LADWP 2010 – based on 2009 high resolution aerial photographs)

Middle Owens River Project (MORP) riparian area (WHA 2004d)

Lower Owens River Project (LORP) (LADWP 2010 – based on 2009 high resolution aerial photographs)

Delta Habitat Area (LADWP 2010 – based on 2009 high resolution aerial photographs)

Blackrock area (LADWP 2010 – based on 2009 high resolution aerial photographs)

Baker Creek area (WHA 2004e)

Hogback Creek area (WHA 2004f)

Inventory of springs and seeps (Ecosystems Sciences 1999)

Owens River Tributary Inventory 2005 Conditions (WHA 2006b)

Vegetation Parcels (LADWP/Inyo County 1984-1987 – used only in areas not covered by more recent mapping efforts

All three HCP riparian obligate species are reliant on Desert Riparian Habitats which are described by Mayer and Laudenslayer (1988). Desert Riparian habitats are characterized by dense groves of low, shrub like trees or tall shrubs (Küchler 1977) to woodlands of small to medium-sized trees (Cheatham and Haller 1975). These habitats are found adjacent to permanent surface water (e.g., streams, springs) or in naturally sub-irrigated areas (Parker and Matyas 1981). Usually an abrupt transition occurs between riparian and adjacent shorter and more open desert habitats. Riparian vegetation height depends on constituent plant species, willow thickets range from 1 to 3 m (3 to 10 ft) in height (Cheatham and Haller 1975) whereas Fremont cottonwoods may exceed 24 m (80 ft). In Inyo and Mono Counties, riparian habitats are dominated by willow species. In the Owens Valley, the tree willow species present are Goodding's willow and red willow. Other riparian trees are Fremont cottonwood, black cottonwood, and aspen. Black locust and oak (Quercus spp.) occur in some areas as a component of the riparian community and were considered in evaluating canopy structure and height. Fremont cottonwood is found throughout the valley, while black cottonwood and aspen occur at higher elevation sites and at some locations on alluvial fans. Shrub willow species include primarily coyote willow with lesser amounts of arroyo willow. Other riparian shrub species include Wood's rose and desert olive. Each corresponding vegetation type from the 11 mapping products that matched Mayer and Laudenslayer's (1988) description of Desert Riparian Habitat were extracted from their original file and merged into one file that served as the potential habitat for the three riparian obligate avian species covered in the HCP. Table # shows the vegetation community types extracted from each shapefile used. All mapping product GIS shapefiles were projected to match the 2009 high resolution imagery projection (UTM NAD83 Zone 11), which served as the base layer for all analyses. WHA 2006b legend consists of vegetative series and associations. Series are vegetation types that exhibit the same dominant species and generally adhere to the series descriptions found in Sawyer and Keeler-Wolf's (1995) *A Manual of California Vegetation*. WHA's vegetation associations are subsets of a vegetative series in which associations are differentiated by the prominence of sub-dominant species. WHA's vegetative series offers the broadest and most inclusive legend component and thus was used to select the vegetation types that correspond to Mayer and Laudenslayer's (1988) Desert Riparian Habitat. Table 1 presents the classification used in each shapefile, and vegetation communities extracted from each mapping product. Aspen, Locust, and Oak, and were included as they may provide some habitat for the HCP avian species.

Table 2. Classification Used and Vegetation Communities Selected from Each Shapefile

Vegetation Shapefile	Classification	Vegetation Communities Selected
Mono County Riparian Mapping	SN (Series Name)	Aspen Black Cottonwood Coyote willow Mixed Willow Red willow
Owens Gorge	Class_Name	Aspen Cottonwood Riparian Shrub Riparian Shrub/marsh Wilow tree
Middle Owens River	Series_Nam	Coyote willow Fremont cottonwood Goodding-red willow Locust Rose
Lower Owens River	Veg_Name	Riparian Forest (cottonwood) Riparian Forest (tree willow) Riparian Shrub
Delta Habitat Area	Class_Name	Riparian Forest (tree willow)
Blackrock	Series_Nam	Riparian Forest (cottonwood) Riparian Forest (tree willow) Riparian Shrub
Baker Creek	Series_Nam	Arroyo willow Coyote willow Locust Oak Red willow
Hogback Creek	Series_Nam	Coyote willow Fremont cottonwood Red willow
Seeps and Springs	Name	Riparian Shrub Riparian Shrub (individual) Riparian Shrub/Wet Meadow Trees Trees (individual) Trees/Wet meadow Woodland
Tributary Inventory	SN (Series Name)	Arroyo willow Black Cottonwood Coyote willow Fremont cottonwood Goodding-red willow Locust Red willow Rose Silver Buffaloberry
Vegetation Parcels	Comm_Name	Aspen Rip Forest Modoc-G.B. Cottw/Willow Riparian F Modoc-Great Basin Riparian Scrub Mojave Riparian Forest

WHA's vegetative associations were retained for each mapping product as they provide a more detailed description of the structure and habitat attributes of each series. Association definitions were used to provide habitat attribute data to the potential habitat shapefile. More information on each association can be found in Appendix A of the HCP (Mapping Products Inyo and Mono Counties, California).

All extracted Desert Riparian Habitats from the mapping products were merged into one shapefile using the Merge tool found in ArcToolbox's general folder. The resulting shapefile contained all potential habitats for the HCP riparian obligate avian species in Mono and Inyo counties on City land. The merge function created a single shapefile that had errors due to the overlap of data from several of the mapping products. This is a common occurrence when several shapefiles are merged as the possibility exists that some polygons will overlap. WHA's springs and seeps (Ecosystem Sciences 1999) map product overlapped several other mapping products. Coverage of this merged shapefile was evaluated in order to determine if polygons existed for all potential habitat. Areas not covered by any of the existing shapefile include parcels north of Mono Lake, Ainslee Meadow in southern Mono County, Slide Canyon in southern Inyo County, and Haiwee Reservoir. Areas not covered by any previous mapping effort were digitized and added to the base layer.

Overlapping features cause errors in acreage and width measurements, resulting in the overestimation, or incorrect mapping, of suitable habitat for the three HCP riparian obligate species. Employing the *Find Polygon Overlap Tool*, overlapping polygons in the habitat shapefile were identified. Overlapping polygons were hand edited or deleted to create a clean potential habitat shapefile which was used to evaluate the suitability of riparian habitats in Mono and Inyo counties for the three riparian obligate avian species.

Elevation Masking

Applying the suitability models to the potential habitat GIS data created in the previous section occurred in ArcGIS 10. The following sections describe the methods used to create a single shapefile for each avian species that documents the reproductive suitability of project area riparian habitats.

Table 3. Elevation Mask Per HCP Riparian Obligate Species

HCP Riparian Obligate Species	Known Elevation Range	Modeled Elevation Mask
Yellow-billed Cuckoo	Sea level to 4,500 ft	6000 ft
Southwestern Willow Flycatcher	<100 ft to 8,000 ft	8,000 ft
Bell's Vireo	Sea level to 4,100 ft	4,100 ft

Species-specific elevation masks were created in ArcGIS 10 to determine what portion of the potential habitat in Inyo and Mono counties on City land was available to the species. The elevation masks were used to clip the potential habitat shapefile created during the previous steps. The elevation masks were derived from a 30m DEM of Inyo and Mono counties. Each elevation mask was created in the ESRI ArcGIS extension Spatial Analyst. Clipping the potential habitat GIS shapefile to with the elevation mask created a species specific GIS layer (shapefile) for each species were used as the base layer for the reproductive suitability modeling.

1.4 Yellow-billed Cuckoo Habitat Mapping

Table 4 shows the four model variables for Yellow-billed Cuckoo, plus other factors that were taken into consideration during the mapping process. Before assigning values for each model variable, the base layer was further processed, applying the appropriate elevation mask for Yellow-billed Cuckoo, and defining potential habitat patches that met the minimum acreage required by this species. The Yellow-billed Cuckoo has a documented range in California from sea-level to greater than 4,500 ft. (Laymon 1988). After consultation with Steve Laymon, the suitability model author, a 6,000 ft. elevation limit for the YBCU was employed for the model. Some of the known YBCU habitat in the Owens Valley is very near the 4,500 ft. limit (Baker Creek), thus it was decided to use a 6000 ft. limit for the model to ensure all potential habitat was evaluated.

Table 4. Four Model Variables for the Yellow-billed Cuckoo

Yellow-billed Cuckoo		
V1	Percent Canopy Closure of vegetation taller than 3 meters	<30% unsuitable
V2	Average Canopy Height of trees >3 meters tall and > 10 cm DBH	Average height < 3 m
V3	Basal area of a stand; trees with diameter > 3 cm	< 1 m2/2.47 acres (or < 1 m2/hectare)
V4	Foliage Volume of trees > 3 meters tall and > 3 cm DBH	<10,000 m3/2.47 acres (1 hectare) unsuitable
Other Considerations		
Elevation	<6000 feet	
Minimum acreage	25 acre	
Minimum acreage w/in larger area	25 acres within 100 acres	Patches <25 acre and more than 200 meters from next patch are unsuitable

Following creation of a base layer shapefile for YBCU with the appropriate elevation mask applied, potential nesting patches that met the minimum patch size of 12.36 acres were identified. The “Dissolve” tool was applied to the YBCU base layer shapefile, with the option “create singlepart” checked. Dissolve removes boundaries between adjacent polygons, creating larger potential habitat patches. All patches that met the minimum nest patch size of 12.36 acres were selected and exported. Yellow-billed Cuckoos may use habitat patches smaller than 12.36 acres, as long as they are within 200 meters of the larger patch. Polygons from the YBCU base layer that were within 200 meters of potential nest patches were selected and joined to the shapefile containing potential nest patches. This shapefile was renamed “YBCU_Potential_Habitat.”

Table 5. Values for Model Variables

	Percent Canopy Closure of vegetation taller than 3 meters	
	Category	**SIV1**
V1	< 30%	0.0
	30-50%	0.2
	50-70%	0.7
	>70%	1.0

	Average Canopy Height of trees >3 meters tall and > 10 cm DBH	
	Category	**SIV2**
V2	<3 meters	0.0
	4-5 meters	0.3
	5-6 meters	0.5
	7-10 meters	1.0
	>10 meters	0.8

	Basal area of a stand; trees with diameter > 3 cm		
	Category	**Rank**	**SIV3**
V3	< 1 m^2/2.47 acres	1	0.0
	2-3 m^2/2.47 acres	2	0.5
	5-20 m^2/2.47 acres	3	1.0
	25-55 m^2/2.47 acres	4	0.8
	>55 m^2/2.47 acres	5	0.3

	Foliage Volume of trees > 3 meters tall and > 3 cm DBH		
	Category	**Rank**	**SIV4**
V4	<10,000 m^3/2.47 acres	1	0.0
	10,000-20,000 m^3/2.47 acres	2	0.3
	30,000-90,000 m^3/2.47 acres	3	1.0
	>90,000 m^3/2.47 acres	4	0.7

Values for each of the four model variables were assigned to each polygon of this shapefile. Each polygon was viewed with the 2009 imagery displayed as the background. Categories were developed for each variable based on the descriptions in the model regarding break points for unsuitable, marginal, moderate and high suitability habitats. The SIV or suitability value for each category was determined following a review of the accompanying graphs.

For V1, the category of cover assigned to a polygon was determined by evaluating the cover of all woody riparian trees and shrubs that were over 3 meters tall. Whether or not the woody riparian vegetation met the minimum height of 3 meters was based on expert knowledge of the area, a consideration of the species present, an evaluation of shadows visible on the aerial photographs, and a comparison of the difference in the apparent height of the vegetation in question to adjacent upland vegetation. V2 was determined by evaluating the average canopy height of riparian trees (*S. gooddingi, S. laevigata, P. fremontii, R. pseudoacacia*, and *Quercus* spp.). A rank number was applied to both V3 and V4, taking into consideration the basal area and foliage volume of the riparian tree species listed above. After assigning categories or ranks for each variable and to each polygon, the appropriate SIV values for each variable were added to the data tables. The HSI value was calculated in Microsoft Excel for each polygon using the following equation:

$$SIR = (SIV1 \times SIV2 \times SIV3 \times SIV4)^{1/4}.$$

Because this equation is a geometric average, a value of 0 for any one of the four variables will result in a SIR of 0, and the polygon will be rated as “unsuitable”. The resulting SIR values were joined to the ArcGIS data table. Unsuitable polygons were selected and deleted. The remaining polygons that were suitable were dissolved once again, polygons that met the minimum nest patch size of 12.26 acres were selected, and smaller polygons within 200 meters of potential nest patches were retained. Polygons that were less than 12.26 acres in size, and more than 200 meters from a polygon of this size were deleted. After calculating the HSI values for each polygon at a site the suitability values were converted to one of three suitability classes: Marginal (HSI = 0.1-0.33), Moderate (HSI = 0.34-0.66) and High (HSI = 0.67-1.0).

A total of 310.5 acres were determined to be suitable for Yellow-billed Cuckoo on City land in Inyo County. Table 6 shows the amount of acreage in each suitability class. Figures 1-8 show the location of areas mapped as suitable for Yellow-billed Cuckoo. The maps are arranged from north to south and only areas supporting habitat are depicted.

Table 6. Acreage in Each Suitability Class

	Acreage of Suitable Habitat			
Riparian Obligate Species	Low	Moderate	High	Total
Yellow-billed Cuckoo	157.4	102.4	50.7	310.5

1.5 Southwestern Willow Flycatcher Habitat Mapping

Table 7 shows the four model variables for Southwestern Willow Flycatcher, plus other factors that were taken into consideration during the mapping process. Before assigning values for each model variable, the base layer was further processed, applying the appropriate elevation mask for Southwestern Willow Flycatcher, and defining potential habitat patches that met the minimum acreage required by this species. The Southwestern Willow Flycatcher has the greatest elevation range of the three riparian obligate species, with nesting occurring from near sea level to over 8,500 feet in some parts of their range, although most often found in lower elevation sites (U.S. Fish and Wildlife Service 2002). The SWFL occurs only rarely over 6,000 ft. (Bent 1942, Craig and Williams 1998). Grinnell and Miller (year) report that Willow Flycatchers (subspecies uncertain) have been found up to almost 8,000 feet in the vicinity of Mammoth Lake, Mono County. Areas up to 8,000 feet were evaluated for Southwestern Willow Flycatcher, although some uncertainty exists regarding the maximum elevation at which extimus might occur in Inyo and Mono counties. Following creation of a base layer shapefile for SWFL with the appropriate elevation mask applied, potential nesting patches that met the minimum patch size of 1.98 acres were identified. The “Dissolve” tool was applied to the SWFL base layer shapefile, with the option “create singlepart” checked. Dissolve removes boundaries between adjacent polygons, creating larger potential habitat patches. All patches that met the minimum nest patch size of 1.98 acres were selected and exported. Southwestern Willow Flycatcher may use habitat patches smaller than 1.98 acres, as long as they are within 100 meters of the larger patch. Polygons from the SWFL base layer that were within 100 meters of potential nest patches were selected and joined to the shapefile containing potential nest patches. This shapefile was renamed “SWFL _Potential_Habitat”.

Table 7. Four Model Variables for the Southwestern Willow Flycatcher

Willow Flycatcher

Variables	**Description**	**Minimum values**
V1	Standing or running water or super-saturated soil at beginning of breeding season	No water is unsuitable
V2	Percent Canopy Closure of vegetation taller than 2 meters	<20% unsuitable
V3	Percent Willow Cover 1-3 meter range	<20% unsuitable
V4	Riparian Habitat Width	<10 meter unsuitable
Other Considerations		
Elevation	<8000 feet	
Minimum acreage		1.98 acres (0.8 ha)
Minimum acreage within larger area		Patches <1 acre and more than 100 meters from next patch are unsuitable
Cover	Nest typically in areas of multiple vegetation layers and fairly high tree canopy cover	

Values for each of the four model variables were assigned to each polygon of this shapefile. Each polygon was viewed with the 2009 imagery displayed as the background. Categories were developed for each variable based on the descriptions in the model regarding break points for unsuitable, low, moderate and optimum suitability habitats. The SIV or suitability value for each category was determined following a review of the accompanying graphs.

Water availability (V1) is assessed as presence or absence during the breeding season. Water availability (V1) was determined in part, by using the “Water regimen” data available for all Owens Valley shapefiles. Water regimen categories selected were: high water table, intermittently flooded, permanently flooded, saturated, infrequently flooded, and seasonally flooded. All polygons with these water regimen categories were assigned V1 = presence. Polygons in Seeps and Springs, Mono County Riparian Mapping and Owens Gorge shapefiles file did not have the water regimen attribute, so polygons in these files were evaluated individually for the presence of water. All Seeps and Springs, Gorge, and most Mono County Riparian Mapping polygons were assigned V1 = presence. All other polygons were assigned V1= absence. In addition, all polygons within 18.29 meters (20 yards) of a polygon with V1 were selected and also assigned a value of 1 for V1. This is based on the WIFL recovery plan stating that nest patches are within 20 meters of water (saturated soil, infrequently flooded etc).

For V2, the category of cover assigned to a polygon was determined by evaluating the cover of all woody riparian trees and shrubs that were over 2 meters tall. Assessment of 2 meter minimum height of woody riparian vegetation was based on expert knowledge of the area, a consideration of the species present, an evaluation of shadows visible on the aerial photographs, and a comparison of the difference in the apparent height of the vegetation in question to adjacent upland vegetation. Ground truthing was conducted in conjunction with ground truthing for V3.

Percent willow coverage (V3) was determined by evaluating the percent cover of willow species only in the 1-3 meter range. Areas throughout Owens Valley and Mono County were ground truthed to determine whether V3 categories were assigned appropriately.

The ArcView Script “PolygonWidth” was used to determine polygon width (V4). This script worked in ArcView 9, but not in ArcView 10. This script determines the width of a polygon at the centroid. Using the graphs found in the Model, for V4 (Habitat Width) a best fit curve, using a quadratic equation. In Excel, functions were used to solve the equation for y (V4), with x = polygon width. When polygon widths were less than10 meter, y = 0. The determination of polygon width was based on the combined (=dissolved) width of all suitable polygons, and not of individual polygons. After assigning categories or ranks for each variable and to each polygon, the appropriate SIR values for each variable were added to the data tables.

Table 8. Reproductive Suitability Index (SIR) for Southwestern Willow Flycatcher

Southwestern Willow Flycatcher

V1	Standing or running water or super-saturated soil at beginning of breeding season	
	Category	**SIV1**
	No water	0.0
	Water present	1.0

V2	Percent Canopy Closure of vegetation taller than 2 meters	
	Category	**SIV2**
	< 20%	0.0
	20-49%	0.4
	50-69%	0.8
	>70%	1.0

Southwestern Willow Flycatcher

V3	Percent Willow Cover 1-3 meter range	
	Category	**SIV3**
	< 20%	0.0
	20-49%	0.4
	50-74%	0.8
	>75%	1.0

V4	Riparian Habitat Width	
	ArcView script used to determine width-SIV4 calculated with regression equation	

The HSI value was calculated in Microsoft Excel for each polygon using the following equation:

SIR = SIV1 * (SIV2 + SIV3 + SIV4)/3

Because the presence of water at the beginning of the nesting season is necessary for occupancy, this equation is only partially compensatory. The absence of water will result in a site being rated as unsuitable, regardless of the score for the remaining variable. The remaining variables are compensatory, and therefore averaged in the equation. The resulting SIR values were joined to the ArcGIS data table. Unsuitable polygons were selected and deleted. The remaining polygons that were suitable were dissolved once again, polygons that met the minimum nest patch size of 1.98 acres were selected, and smaller polygons within 100 meters of potential nest patches were retained. Polygons that were less than 1.98 acres in size, and more than 100 meters from a polygon of this size were deleted. After calculating the HSI values for each polygon at a site the suitability values were converted to one of three suitability classes:

Marginal (HSI = 0.1-0.33), Moderate (HSI = 0.34-0.66) and High (HSI = 0.67-1.0).

A total of 2082.9 acres were determined to be suitable for Southwestern Willow Flycatcher on City land in Inyo and Mono Counties. Table 9 shows the amount of acreage in each suitability class. Figures 9-64 show the location of areas mapped as suitable for Southwestern Willow Flycatcher. The maps are grouped by geographic area, and then arranged north to south, and only areas supporting habitat are depicted. Figures 9-17 show suitable habitat in the Mono Basin. Figures 18-21 show suitable habitat in the Owens Gorge. Figures 22-40 show suitable habitat along the Owens River in Owens Valley. Figures 41-65 show suitable habitat in off-rivers areas in southern Mono County and in Inyo County.

Table 9. Acreage in Each Suitability Class

	Acreage of Suitable Habitat			
Riparian Obligate Species	Low	Moderate	High	Total
Southwestern Willow Flycatcher	1259.9	601.9	221.1	2082.9

1.6 Least Bell's Vireo Habitat Mapping

Table 10 shows the three model variables for Least Bell's Vireo, plus other factors that were taken into consideration during the mapping process. Before assigning values for each model variable, the base layer was further processed, applying the appropriate elevation mask for Least Bell's Vireo, and defining potential habitat patches that met the minimum acreage required by this species. The maximum documented elevation occurrence of the Least Bell's Vireo is 4,100 ft. near Bishop, California (Grinnell and Miller 1944). Almost all of the Owens River in Owens Valley is below 4,100 feet. Elevation exceeds 4,100 feet upstream of the diversion to Bishop Creek in Pleasant Valley. Areas of the Owens River upstream of this point to Pleasant Valley Reservoir, and the riparian vegetation along tributaries to the Owens River in this area was also included. Thus areas exceeded the 4,100 feet elevation mask when contiguous with other potential habitat.

Least Bell's Vireos are associated with active floodplains and are often nest within 300 meters of surface water. To further refine potential habitat for this species, only polygons occurring in floodplain were evaluated. Landform information is available for all shapefiles covering the Owens River and its tributaries in the Owens Valley. The landform selected was "floodplain", and a separate shapefile containing all polygons with this classification was created. The working LBVI shapefile was clipped with the floodplain file, resulting in a shapefile only containing polygons on a floodplain landform.

Next, potential nesting patches that met the minimum patch size of 0.5 acres were identified. The "Dissolve" tool was applied to the LBVI base layer shapefile, with the option "create singlepart" checked. Dissolve removes boundaries between adjacent polygons, creating larger potential habitat patches. All patches that met the minimum nest patch size of 0.5 acres were selected and exported. Least Bell's Vireo may use habitat patches smaller than 0.5acres, as long as they are within 50 meters of the larger patch. Polygons from the LBVI base layer that were within 50 meters of potential nest patches were selected and joined to the shapefile containing potential nest patches. This shapefile was renamed "LBVI _Potential_Habitat".

Table 10. Model Variables for Least Bell's Vireo

Least Bell's Vireo

Variables	**Description**	**Minimum values**
V1	Percent Riparian shrub cover in 0 to 3 meter range	<10% unsuitable
V2	Percent Canopy Closure of vegetation taller than 2 meters	No minimum
V3	Riparian Habitat Width	< 50 m wide unsuitable
Other Considerations		
Elevation	<4225 feet	
Minimum acreage	0.5 acres	
Minimum acreage w/in larger area	0.5 acres within 0.98 acres	
Distance to water	No data, but nests are found within active floodplains and often within 300 meters of surface water	Patches <.5 acre and more than 50 meters from next patch are unsuitable

Values for each of the four model variables were assigned to each polygon of this shapefile. Each polygon was viewed with the 2009 imagery displayed as the background. Categories were developed for each variable based on the descriptions in the model regarding break points for unsuitable, low, moderate and optimum suitability habitats. The SIV or suitability value for each category was determined following a review of the accompanying graphs.

For V1, the percent cover of composed of riparian shrub species only was evaluated using 2009 aerial images, expert knowledge of the area, an evaluation of shadows visible on the aerial photographs, and a comparison of the difference in the apparent height of the vegetation in question to adjacent upland vegetation. For V2, the category of cover assigned to a polygon was determined by evaluating the cover of all woody riparian trees and shrubs that were over 2 meters tall. Whether or not the woody riparian vegetation met the minimum height of 2 meters was based on expert knowledge of the area, a consideration of the species present, an evaluation of shadows visible on the aerial photographs, and a comparison of the difference in the apparent height of the vegetation in question to adjacent upland vegetation. V3 was determined by evaluating the percent cover of willow species only in the 1-3 meter range. The ArcView Script "PolygonWidth" was used to determine polygon width. This script worked in ArcView 9, but not in ArcView 10. This script determines the width of a polygon at the centroid. Using the graphs found in the Model, for V4 (Habitat Width) a best fit curve, using a quadratic equation. In Excel, functions were used to solve the equation for y (V4), with x = polygon width. The determination of polygon width was based on the combined (=dissolved) width of all suitable polygons, and not of individual polygons.

Least Bell's Vireo

	Percent Riparian shrub cover in 0 to 3 meter range	
	Category	**SIV1**
V1	< 10%	0.0
	10-39%	0.3
	40-60%	0.7
	>60%	1.0

	Percent Canopy Closure of vegetation taller than 2 meters	
	Category	**SIV2**
	< 10%	0.25
V2	10-20%	0.75
	20-50%	1.00
	50-80%	0.75
	>80%	0.40

	Riparian Habitat Width	
V3	**ArcView script used to determine width-SIV3 calculated with regression equation**	

After assigning categories or ranks for each variable and to each polygon, the appropriate SIR values for each variable were added to the data tables. Areas throughout Owens Valley were ground-truthed, with particular attention paid to values assigned to V1, which is the most difficult variable to assess using aerial images.

The HSI value was calculated in Microsoft Excel for each polygon using the following equation: SIR = (SIV1 x SIV2 x SIV3)1/3. Because this equation is geometric, a value of 0 for any one of the four variables will result in a SIR of 0, and the polygon will be rated as “unsuitable”. The resulting SIR values were joined to the ArcGIS data table. Unsuitable polygons were selected and deleted. The remaining polygons that were suitable were dissolved once again, polygons that met the minimum nest patch size of 0.5 acres were selected, and smaller polygons within 50 meters of potential nest patches were retained. Polygons that were less than 0.5 acres in size, and more than 50 meters from a polygon of this size were deleted.

A total of 1266.9 acres were determined to be suitable for Least Bell’s Vireo on City land in Inyo County. Table 11 shows the amount of acreage in each suitability class. Figures 66-83 show the location of areas mapped as suitable for Least Bell’s Vireo. The maps are arranged from north to south and only areas supporting habitat are depicted.

Table 11. Acreage in Each Suitability Class

	Acreage of Suitable Habitat			
Riparian Obligate Species	Low	Moderate	High	Total
Least Bell's Vireo	321.4	921.9	23.5	1266.9

1.7 Discussion

City land holdings in Mono and Inyo counties contain suitable habitat for each of the avian species covered in the HCP. Table 5 shows the acreage of habitat by suitability class, for each riparian obligate species. The YBCU has the least available habitat on City land in Inyo County. This is primarily due to its requirement of a minimum nest patch of 12.36 acres (5 ha). Secondarily, the YBCU model indicates that high cover sites with medium to large trees are needed for this species. There are few riparian areas in Inyo County are both large enough in size, and composed of primarily riparian trees to meet the needs for YBCU. The SWFL has the most suitable habitat within Inyo and Mono counties on City land. The SWFL is also the only one of the three species whose range includes Mono County. Elevations in most areas of Mono County are above that considered potential for YBCU and LBVI. The elevation range for LBVI restricts potential habitat for this species valley floor in Owens Valley, including the Owens River and its tributaries. Suitable habitat for this species is restricted primarily due to the minimum habitat width requirement of 50 meters. Many patches meeting the 0.5 acre minimum patch size requirement, that were otherwise suitable based on appropriate vegetation cover and vertical structure aspects, were determined to be unsuitable because they did not meet the minimum width requirement.

The suitability models represent the habitat available to the three HCP riparian obligate avian species on City land in Mono and Inyo counties. The results of this study allow LADWP to determine appropriate strategies, locations, and timing for their operations that do not negatively affect the habitat available to the Yellow billed Cuckoo, Southwestern Willow Flycatcher and Least Bell's Vireo.

1.8 Habitat Suitability Analysis - Greater Sage-Grouse

1.8.1 Introduction

The Greater Sage-Grouse, (*Centrocercus urophasianus*) (herein referred to as the GRSG) is included as one of the avian species for the Habitat Conservation Plan. Mono County represents the southwestern extreme of the GRSG range. GRSG in this region, including adjacent counties of Nevada, have been found to be genetically distinct as compared to GRSG across the rest of their range (Oyler-McCance et al. 2005). The GRSG is found in Mono County on City land with concentrations of the species in Long Valley and the Mono Basin (Figure 5). The USFWS believes that listing the "Bi-state" population of the GRSG as threatened or endangered is warranted but precluded by higher priority listing actions (USFWS 2010).

Purpose

The purpose of this study is to identify suitable habitat for the GRSG on City land in Mono County, California. The main objective of the study is demarcating suitable habitat for the species, so that the LADWP can develop management actions that allows them to continue operations and maintenance of their water delivery and power generation systems without hindering the GRSG.

1.8.2 Greater Sage-Grouse Habitat

The GRSG prefers sagebrush habitat for nesting and rearing its young. The following description of GRSG nesting and habitat preferences is taken from the California Partners in Flight Sagebrush Bird Conservation Plan (CPIF 2005). GRSG males form leks (strutting grounds) opportunistically at sites within or adjacent to potential nesting habitat. Leks, or breeding display sites, typically occur in open areas surrounded by sagebrush where visibility among males is unobstructed by vegetation or topography (Connelly et al 2000).

Mean height of sagebrush usually preferred by nesting GRSG ranges from 29 to 80 cm and nests tend to be under the tallest sagebrush within a stand (Keister and Willis 1986, Wakkinen 1990). In general, GRSG nests are placed under shrubs having greater canopy, ground and lateral cover than at random sites (Wakkinen 1990, Fischer 1994, Heath et al. 1997, Sveum et al. 1998a, Holloran 1999). Sagebrush cover near nest sites was greater around successful nests than unsuccessful nests in Montana (Wallestad and Pyrah 1974) and Oregon (Gregg 1991). Wallestad and Pyrah (1974) also indicated that successful nests were in sagebrush stands with greater average canopy coverage (27%) than those of unsuccessful nests (20%). The greatest nest success found by Gregg in Oregon occurred in mountain big sagebrush (*A. tridentata vaseyana*) where shrubs 40-80 cm in height had greater canopy cover at the site of successful nests than at unsuccessful nests (Gregg 1991).

In short, the overall habitat requirement of the GRSG is sagebrush cover of varying heights and densities. Several parcels of City land in Mono County meet these requirements.

1.8.3 Methods

Suitable habitat for the Greater Sage-Grouse within the Plan Area was defined based on the Preliminary Priority Habitat (PPH) map supplied by U.S. Geological Services (USGS). The PPH map was developed by the Bi-State Greater Sage-Grouse Technical Advisory Committee to provide a defensible decision support tool for management of sage-grouse populations Technical Advisory Committee
http://sagebrusheco.nv.gov/uploadedFiles/sagebrusheconvgov/content/Meetings/USGS_GrSG_Habitat_Mapping.pdf.

The PPH mapping, based on 30-m resolution Landsat imagery, was further refined by removing polygons of selected cover types (i.e. developed land, water, reservoir shoreline, Jeffrey pine complex, singleleaf pine complex, canyon complex, abandoned agriculture, greasewood, and eolian land) identified from high-resolution 2009 imagery.

1.8.4 Results

Potential Greater Sage-Grouse habitat was identified on City land throughout Long Valley and in the Mono Basin. At total of 31,511 acres is considered potential habitat. Figure 84 shows the areas classified as potential habitat on City lands in the Mono Basin, and Figure 85 shows potential habitat in Long Valley. The acreage of suitable habitat for the GRSG on City land in Mono County is overestimated and should only be used for management decisions and HCP implementation consideration.

1.8.5 Literature Cited

Anderson, B.W. and R.D. Ohmart. 1984. A vegetation management study for the enhancement of wildlife. Boulder City, Nevada: U.S. Bureau of Reclamation.

Bailey, R.G. 1995. Description of the Ecoregions of the United States. Washington D.C.: USDA Forest Service, miscellaneous publication 1391.

Barlow, J. C. 1962. Natural history of the Bell vireo, Vireo bellii. Audubon. University of Kansas Publication. *Museum of Natural History* 12:241-296.

Belding, L. 1890. Land Birds of the Pacific District. *California Academy of Sciences Occasional Papers* 2.

Bent, A.C. 1942. Life Histories of North American flycatchers, larks, swallows and their allies. Smithsonian Institution. *U.S. National Museum Bulletin* 179:1-155.

Bent, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. *U. S. Natural Museum Bulletin* 197.

Bent, A.C. 1970. *Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies*. New York: Dover Publications, Inc.

Best, L. 1983. Bird use of fencerows: Implications of contemporary fencerow management practices. *Wildlife Society Bulletin* 11:343-347.

Brown, B.T. 1993. Bell's Vireo. In *The Birds of North America*, number 35. Philadelphia: The Academy of Natural Sciences.

CalPIF (California Partners in Flight). 2005. Version 1.0. The sagebrush bird conservation plan: a strategy for protecting and managing sagebrush habitats and associated birds in California. PRBO Conservation Science, Stinson Beach, CA. http://www.prbo.org/calpif/plans/.

Chapin, E. A. 1925. Food habits of the vireos. U. S. Department of Agriculture Bulletin 1355.

Chasko, G.G. and J.E. Gates. 1982. Avian habitat suitability along a transmissionline corridor in an oakhickory forest region. *Wildlife Monograph* 82.

Collins, C.T., L.R. Hays, M. Wheller, and D. Willick. 1989. The status and management of the Least Bell's Vireo within the Prado Basin, California during 1989. Fountain Valley, CA: Orange County Water District.

Connelly ,J. W., K. P. Reese, R. A. Fischer, and W. L. Wakkinen. 2000b. Response of sage-grouse breeding population to fire in southeastern Idaho. Wildlife Society Bulletin 28:90–96.

Craig, D. and P. L. Williams. 1998. Willow Flycatcher (*Empidonax traillii*). 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.

Diamond, J.M. 1974. The island dilemma: lessons of modern biogeography studies for the design of natural reserves. *Biological Conservation* 7:129146.

Drost, C.A., E.H. Paxton, M.K. Sogge, and M.J. Whitfield. 2003. Food habits of the Southwestern Willow Flycatcher during the nesting season. Studies in Avian Biology: 26:96–103.

Duff, D.A. 1979. Riparian habitat recovery on Big Creek, Rich County, Utah, pp. 91-92. *In* O.B. Cope, ed.

Proceeding of a forum on grazing and riparian/stream ecosystems. Denver, CO: Trout Unlimited.

Fisher, A.K. 1893. Report on the ornithology of the Death Valley Expedition of 1891. *North American Fauna* 7:7-158.

Flett, M. A. and S. D. Sanders. 1987. Ecology of a Sierra Nevada population of Willow Flycatchers. *Western Birds* 18:37-42.

Fowler, C., B. Valentine, S. Sanders, and M. Stafford. 1991. Suitability Index Model: Willow Flycatcher (*Empidonax traillii*). Tahoe National Forest, USDA Forest Service.

Franzreb, K.E. 1989. *Ecology and conservation of the endangered Least Bell's Vireo*, biological report 89. Washington, D.C.: U.S. Fish & Wildlife Service.

Gaines, D. 1974. Review of the status of the Yellowbilled Cuckoo in California: Sacramento Valley populations. *Condor* 76:204209.

Gaines, D. and S.A. Laymon. 1984. Decline, status, and preservation of the Yellow-billed Cuckoo in California. *Western Birds* 15:4980.

Gates, J. E. and L.W. Gysel. 1978. Avian nest dispersion and fledging success in fieldforest ecotones. *Ecology* 59:871883.

Goldwasser, S. 1981. Habitat requirements of the Least Bell's Vireo. California Department of Fish and Game Final Report, Job IV-38.1.

Gotfryd, A. and R.I.C. Hansel. 1986. Prediction of Bird-community Metrics in Urban Woodlots. In (eds. J. Verner, M.L. Morrison, and C.J. Ralph) *Wildlife 2000: Modeling habitat relationships of Terrestrial Vertebrates*. Madison, Wisconsin: University of Wisconsin Press.

Gray, M. V., and J. Greaves. 1984. Riparian forest as habitat for the Least Bell's Vireo. In (eds. R. Warner and K. Hendrix) *California riparian systems: ecology, conservation and productive management*. Davis, CA: University of California Press.

Greaves, J.M. 1987. Nest-site tenacity of the Least Bell's Vireo. *Western Birds* 18:50-54.

Gregg, M.A. 1991. Use and selection of nesting habitat by sage grouse in Oregon. Thesis, Oregon State University, Corvallis, USA.

Griffith Wildlife Biology. 1995. *The status of the Southwestern Willow Flycatcher at the Upper San Luis Rey River, San Diego County, California, in 1994*. Ramona, CA: Palomar Ranger District, USDA Forest Service.

Grinnell, J., J. Dixon, and J. M. Lindsdale. 1930. Vertebrate natural history of a section of northern California through Lassen Peak. University of California Publication. *Zoology* 35:1-584.

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

Grinnell, J. and T.I. Storer. 1924. *Animal life in the Yosemite*. Berkeley, CA: University of California Press.

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

Halterman, M.D. 1991. Distribution and habitat use of the Yellow-billed Cuckoo on the Sacramento River, California, 1987-90. Master's Thesis, California State University, Chico.

Hamilton III, W.J., and M.E. Hamilton. 1965. Breeding characteristics of Yellow-billed Cuckoos in Arizona. *Proc. California Academy of Sciences, Fourth Series* 32:405-432.

Hanna, W.C. 1937. California Cuckoo in the San Bernardino Valley, California. *Condor* 39:5759.

Harris, J.H. 1991. Effects of brood parasitism by Brown-headed Cowbirds on Willow Flycatcher nesting success along the Kern River, California. *Western Birds* 22:13-26.

Harris, J.H., S.D. Sanders, and M.A. Flett. 1988. *The status and distribution of the Willow Flycatcher in the Sierra Nevada: results of the survey*, administrative report 88-1. Wildlife Management Division, California Department of Fish and Game.

Hilliard, D.P. 2008. Modeling and Mapping Reptile Distributions on the Idaho National Laboratory. Masters Thesis.

Holloran, M.J. 1999. Sage grouse (*Centrocercus urophasianus*) seasonal habitat use near Casper, Wyoming. Thesis, University of Wyoming, Laramie, USA.

Jay, A. 1911. Nesting of the California Cuckoo in Los Angeles County, California. *Condor* 13:6973.

Keister, G.P., and M.J. Willis. 1986. Habitat selection and success of sage grouse hens while nesting and brooding. Oregon Department of Fish and Wildlife, Progress Report W- 87-R-2, Subproject 285, Portland, Oregon, USA.

Kolada, E.J., J.S. Sedinger, and M.L. Casazza. 2008a. Nest site selection by Greater Sage-Grouse in Mono County, California. The Journal of Wildlife Management 73(8).

Kolada, E.J., M.L. Casazza, and J.S. Sedinger. 2008b. Ecological Factors Influencing Nest Survival of Greater Sage-Grouse in Mono County, California. The Journal of Wildlife Management 73(8).

King, J.R. 1955. Notes on the life history of Traill's Flycatcher (*Empidonax traillii*) in southeastern Washington. *Auk* 72:148-173.

KRCD. 1988. Willow Flycatcher Annual Report - 1987. *Kings River Conservation District Res. Report* 88-01.

Kus, B. 2002. Least Bell's Vireo (Vireo bellii pusillus). 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 [Accessed 24 May 2010].

Kus, B.E. 1998. Use of restored riparian habitat by the endangered Least Bell's Vireo. *Restoration Ecology* 6:75-82.

Kus, B. 2002. Least Bell's Vireo (*Vireo bellii pusillus*). 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 .

Laymon, S.A. 1980. *Feeding and nesting behavior of the Yellowbilled Cuckoo in the Sacramento Valley*, administrative report 802. Sacramento, CA: California Department of Fish and Game.

Laymon, S.A. 1987. Brown-headed Cowbirds in California: Historical Perspectives and Management Opportunities in Riparian Habitats. *Western Birds* 18:63-70.

Laymon, S.A. 1998. Bird conservation plan, species: Yellow-billed Cuckoo (Coccyzus americanus). California Partners in Flight. http://www.prbo.org/CPIF/Riparian/Ybcu.html [Accessed 24 May 2010].

Laymon, S.A. and M.D. Halterman. 1985. Yellow-billed Cuckoos in the Kern River Valley: 1985 population, habitat use, and management recommendations, unpublished. Weldon, CA: The Nature Conservancy.

Laymon, S.A. and M.D. Halterman. 1987a. Can the western subspecies of the Yellowbilled Cuckoo be saved from extinction? *Western Birds* 18:1925.

Laymon, S.A. and M.D. Halterman. 1987b. *The status of Yellow-billed Cuckoos in California: 1986 1987*, draft administrative report. Sacramento, California: California Department of Fish and Game.

Laymon, S.A. and M.D. Halterman. 1989. A proposed habitat management plan for Yellow-billed Cuckoos in California. In (ed. D. Able) *California Riparian Systems: protection, management and restoration for the 1990's*. Berkeley, CA: USDA Forest Service.

Launer, A.E., D. Murphy, S.A. Laymon, and M.D. Halterman. 1990. *1990 Distribution and Habitat Requirements of the Yellow-billed Cuckoo in California*, unpublished draft administrative report. Stanford, CA: Center for Conservation Biology, Department of Biological Sciences, Stanford University.

Laymon, S.A., P.L. Williams, and M.D. Halterman. 1997. Breeding status of the Yellow-billed Cuckoo in the South Fork Kern River Valley, Kern County, California: Summary Report 1985-1996. Prepared for the U.S.D.A. Forest Service, Sequoia National Forest, Cannell Meadow Ranger District, Kernville, CA.

Laymon, S.A. and P.L. Williams. 1998. Breeding status of the Yellow-billed Cuckoo in the South Fork Kern River Valley, Kern County, California: Summer 1997. Prepared for the U.S.D.A. Forest Service, Sequoia National Forest, Cannell Meadow Ranger District, Kernville, CA.

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.

Mayer, K.E and W.F. Laudenslayer. 1988. *A Guide to Wildlife Habitats of California*. Sacramento, CA: California Department of Forestry and Fire Protection.

McKernan, R.L. 1997. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River: Year 1 - 1996. Boulder City, Nevada: U.S. Bureau of Reclamation Lower Colorado River Region.

Meanley, B. 1952. Notes on nesting of Traill's Flycatcher (*Empidonax traillii*) in southeastern Arkansas. *Wilson Bulletin* 64:111-112.

Miner, K. L. 1989. Foraging ecology of the Least Bell' Vireo, (Vireo bellii pusillus). Unpublished Master's thesis, San Diego State University..

Newman, J. 1992. Relationships between territory size, habitat structure and reproductive success in the least Bell's vireo, (Vireo bellii pusillus). Unpublished Master's thesis, San Diego State University..

Nolan Jr., V. and C.F. Thompson. 1975. The occurrence and significance of anomalous reproductive activities in two North American parasitic cuckoos Coccyzus spp. *Ibis* 117:496-503.

Olson, T. E. and M. V. Gray. 1989. Characteristics of least Bell's vireo nest sites along the Santa Ynez River. In *Proceedings of the California Riparian Systems Conference: protection, management, and restoration for the 1990's*; September 22-24; Davis, CA. Dana L. Abell (ed.), General Technical Report, PSW-110, Berkeley, CA.

RECON. 1989. Comprehensive species management plan for the Least Bell's Vireo (Vireo bellii pusillus). , San Diego, CA: San Diego Association of Governments.

Roberson, D. 1980. Rare birds of the west coast. Pacific Grove, CA: Woodcock Publications.

Rosenberg, K.V. 1980. Breeding bird community organization in a desert riparian forest. MS Thesis, Department of Zoology, Arizona State University, Tempe, Arizona.

Salata, L. 1983. Status of the least Bell's vireo on Camp Pendleton, California: report on research done in 1983, unpublished report. Laguna Niguel, CA: U.S. Fish and Wildlife Service.

Sanders, S. D., and M. A. Flett. 1989. *Ecology of a Sierra Nevada population of Willow Flycatchers (Empidonax traillii), 1986-1987*. State of California, the Resources Agency, Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section.

Sedgwick, J.A. 2000. Willow Flycatcher (*Empidonax traillii*). In (eds. A. Poole and F. Gill) *The Birds of North America*, number 533. Philadelphia, PA: The Birds of North America, Inc.

Serena, M. 1982. The status and distribution of the Willow Flycatcher (*Empidonax traillii*) in selected portions of the Sierra Nevada, 1982. California Department of Fish and Game. *Wildlife Management Branch Administrative Report* 82-5.

Sferra, S.J., T.E. Corman, C.E. Paradzick, J.W. Rourke, J.A. Spencer, and M.W. Sumner. 1997. Arizona Partners in Flight Southwestern Willow Flycatcher Survey: 1993-1996 Summary Report. Phoenix, AZ: Arizona Fish and Game Department. *Nongame and Endangered Wildlife Program Technical Report* 113.

Sharp, B.L. and B.E. Kus. 2006. Factors influencing the incidence of Cowbird parasitism of Least Bell's Vireo. *Journal of Wildlife Management* 70:682-690.

Shelton, A.C. 1911. Nesting of the California Cuckoo. *Condor* 13:1922.

Sogge, M.K, S.J. Sferra, T.D. McCarthey, S.O. Williams, and B.E. Kus. 1993. Distribution and Characteristics of Southwestern Willow Flycatcher Breeding Sites and Territories: 1993-2001. *Studies in Avian Biology* 26:5-11.

Sogge, M.K., T.J. Tibbitts, C. van Ripper III, and T. May. 1995. *Status of the Southwestern Willow Flycatcher along the Colorado River in Grand Canyon National Park—1995*, summary report. National Biological Service Colorado Plateau Research Station/Northern Arizona University.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbitts. 1997. *A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol*, technical report NPS/NAUCPRS/NRTR-97/12. USDI National Park Service, Colorado Plateau Research Station at Northern Arizona University.

Sogge, M.K., S.J. Sferra, T.D. McCarthey, S.O. Williams, and B.E. Kus. 2003. Distribution and characteristics of Southwestern Willow Flycatcher breeding sites and territories: 1993-2001. *Studies in Avian Biology* 26.

Stafford, M. D. and B. E. Valentine. 1985. A preliminary report on the biology of the Willow Flycatcher in the central Sierra Nevada. *CAL-NEVA Wildlife Transactions* 1985:66-77.

Sveum, C. M., W. D. Edge, and J. A. Crawford. 1998a. Nesting habitat selection by sage-grouse in south-central Washington. Journal of Range Management 51:265–269.

Taylor, D.M. 1986. Effects of cattle grazing on passerine birds nesting in riparian habitat. *Journal of Range Management* 39:254-258.

Taylor, D.M., and C.D. Littlefield. 1986. Willow Flycatcher and Yellow Warbler response to cattle grazing. *American Birds* 40:1169-1173.

Temple, S.A. 1986. Predicting impacts of habitat fragmentation on forest birds: a comparison of two methods. In (eds. J. Verner, M.L. Morrison, and C.J. Ralph) *Wildlife 2000*. Madison, WS: University of Wisconsin Press.

Unitt, P. 1987. *Empidonax traillii extimus*: An endangered subspecies. *Western Birds* 18(3):137-162.

USFWS. 2010. 12-Month Findings for Petitions to List the Greater Sage- Grouse (*Centrocercus urophasianus*) as Threatened or Endangered. March 5, 2010. Federal Register 50 CFR Part 17. http://www.fws.gov/mountain-prairie/species/birds/sagegrouse/FR03052010.pdf (accessed March 10, 2010).

U.S. Fish and Wildlife Service. 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque. New Mexico. i – ix plus 210 pp. Appendices A-O.

USGS. 2002. Born of Fire – Restoring Sagebrush Steppe (Factsheet). U.S. Geological Survey. Covallis, Or. Accessed 4/26/2011 from http://fresc.usgs.gov/products/fs/fs-126-02.pdf.

Valentine, B.E. 1987. *Implications of recent research on the Willow Flycatcher to forest management*, research report 87-01. USDA, USFS, Pacific Southwest Region, Annual Workshop. Fresno, CA: King's River Conservation District.

Valentine, B. E., T. A. Roberts, S. D. Boland, and A. P. Woodman. 1988. Livestock management and productivity of Willow Flycatchers in the central Sierra Nevada. *Transactions of the Western Section of the Wildlife Society* 24:105-114.

Wakkinen, W. L. 1990. Nest site characteristics and spring–summer movements of migratory sage- grouse in southeastern Idaho. Thesis, University of Idaho, Moscow, USA.

Walkinshaw, L. 1966. Summer biology of Traill's Flycatcher. *Wilson Bulletin* 78:31-46.

Wallestad, R.O., and D.B. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38:630–633.

Wiechman, L., and K.P. Reese. 2008. Movement Patterns and Population Dynamics of Greater Sage-Grouse in Mono County, California. Moscow ID: Department of Fish and Wildlife Resources, College of Natural Resources, University of Idaho.

Whitfield, M.J. 1990. Willow Flycatcher reproductive response to Brown-headed Cowbird parasitism. M.S. Thesis, California State University, Chico.

Whitfield, M.J. and J.J. Placer. 1994. Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatchers, South Fork Kern River, California. Report prepared for California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section.

Whitfield, M.J., and C.M. Strong. 1995. A Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatcher, South Fork Kern River, California, 1995. Report prepared for California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section.

Whitfield, M.J., and K. Enos. 1996. A Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatcher, South Fork Kern River, California, 1996. Report prepared for: U.S. Army Corps of Engineers, Sacramento District and the California Department of Fish and Game.

Whitfield, M.J., K. Enos, and S. Rowe. 1997. Reproductive response of the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) to the removal of Brown-headed Cowbirds. Draft Report prepared for U.S. Army Corps of Engineers, Sacramento District, and California Department of Fish and Game, Wildlife Management Division of Bird and Mammal Conservation Program.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migrating songbirds. *Ecology* 66(4):1211-1214.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. In (ed. M.E. Soule) *Conservation biology: the science of scarcity and diversity*. Sunderland, MA: Sinauer Associates Inc.

2014 Owens Basin Southwestern Willow Flycatcher Survey Results

Lacey Greene, California Department of Fish and Wildlife

During the spring and summer of 2014, the California Department of Fish and Wildlife (CDFW), Point Blue Conservation Sciences (PBCS), US Fish and Wildlife Service (USFWS), and the Los Angeles Department of Water and Power (LADWP) collaborated to survey 36 sites using the USGS protocol (Sogge et al. 2010) for southwestern willow flycatchers (WIFL's). This survey was supported by a USFWS Section 6 Grant F13AP00745 and represents the most extensive survey effort in this management unit. We implemented a "General Survey" which included a minimum of three sites visits between May 15th and July 17th and often follow-up visits at sites with WIFL observations. The intent of this survey protocol is to determine the presence or absence of WIFL in the surveyed habitat for the breeding season; this protocol does not target migratory birds. In total, we counted 82 residential southwestern willow flycatchers (WIFL) consisting of 47 territories including 33 confirmed pairs and 1 polygynous group (2 females, 1 male).

Table 1: CDFW Owens Basin Southwestern Willow Flycatcher Survey Results by Site and Survey Period

	Site	Period 1: May 15 - June 4	Period 2: June 4 - June 26	Period 3: June 26 - July 17
	Surveyed Sites	**Fitzbew (WIFL)**	**Fitzbew (WIFL)**	**Total (Territories, Pairs, Polygyny)**
1	Baker N of Sugarloaf Rd	-	-	-
2	Baker S of Sugarloaf Rd	-	-	-
3	Birchim Canyon	-	-	-
4	Big Pine Creek at Glacier Lodge Rd	-	-	-
5	Calvert Slough	-	-	-
6	China Slough E	-	-	-
7	China Slough W	-	-	-
8	Diaz Lake N	-	-	-
9	Fuller Creek at McMurry Meadows	-	-	-
10	Fuller Creek at Tinemaha Creek	-	-	-
11	Hogback Creek *	-	1 (2)	-
12	Hogback Creek W at base of mnts	-	2 (2)	-
13	Hogback spring N	-	-	-
14	Horton Creek	5 (6)	8 (10)	11 (7 territories, 4 pairs)
15	Independence Creek	0 (2)	1 (1)	-
16	Little Blackrock Springs	-	-	-
17	Lone Pine Creek E of Lone Pine	-	-	-
18	Lone Pine Creek N Fork	-	-	-
19	Lone Pine Creek along whitney portal road*	-	0 (1)	
20	Lone Pine Creek W at base of mnts	-	-	-
21	Lower Rock Creek	-	-	-
22	Lubkin Creek E	-	-	-
23	Lubkin Creek W upper section	-	-	-
24	Oak Creek	0 (3)	-	-
25	Old Orchard	-	-	-
26	Owens River: PVR to 5 bridges*	37 (42)	35 (47)	49 (27 territories, 20 pairs, 1 polygynous group)
27	Owens River: 5 bridges to Hwy 6*	0 (1)	-	-
28	Owens River: Hwy 6 to Line*	5 (6)	6 (8)	14 (9 territories, 4 pairs)
29	Owens River: Line to Warm Springs*	3 (3)	2 (3)	4 (2 territories, 2 pairs)
30	Owens River: Hwy 168 to Tinnemaha	18 (24)	4 (6)	4 (2 territories, 2 pairs)
31	Reinhackle	-	-	-
32	Shepherd Creek	1 (3)	-	-
33	South Fork Waste	-	-	-
34	Thibaut Spring	2 (2)	2 (2)	-
35	Tinemaha Creek at Campground	-	-	-
36	Tuttle Creek	-	-	-
	Opportunistic Observations	0 (1)	1 (1)	-
	Totals	73 (93)	62 (83)	82 (47 territories, 33 pairs, 1 polygynous group)

* means the site has been surveyed before. Still waiting on the exact location of the Big Pine Creek Survey

During survey periods 1 and 2, all official WIFL's were all confirmed with a "Fitzbew" based on the protocol. The total WIFL count including silent and 'whitting' birds is indicated in parentheses after the official count. Territories were determined based on observations in the third survey period where considerably more time was spent observing birds within the occupied habitat. Because of the additional time spent confirming pairs, the data from the third survey period is considered the final count and a minimum estimate of residential willow flycatchers in the Owens Basin. There is a low likelihood of double counting birds because all of the data comes from a 22 day period and all territories were confirmed with multiple observations. Territorial behavior had already been confirmed at two sites in the second survey period (Owens River PVR to 5 Bridges and Horton Creek) so during the third survey period, time at these sites was spent determining territory locations, confirming pair status and looking for nests. At all other sites the standard survey protocol was followed in period 3, but additional time was spent identifying territories, confirming pairs, and locating nests as needed.

In 2006 there were 190 known southwestern willow flycatcher territories in California and 1262 known territories total[1]. From the Owens River Drainage this included 5 sites and 28 territories based mostly on surveys from 2001[2]. It is not possible to know whether our count (5 sites, 47 territories) represents an increase in WIFL within the Owens River Basin or just more extensive survey efforts. However, our results suggest that the WIFL population in the Owens River Basin is not declining, and is close to the Recovery Plan goal of 50 territories in the Owens River Basin [3]. There are two stretches of the Owens River that we were not able to include in this year's survey efforts so it is very possible there are 50+ WIFL territories in the Owens River Basin.

Of particular note is the Chalk Bluff Site (Owens River from Pleasant Valley Reservoir to 5 Bridges Road) in which we confirmed 27 territories. Durst et al.[1] found that only 3% of all WIFL breeding sites have more than 21 territories. The Chalk Bluff site contained more than half of the total count of birds and territories in the Owens River Basin. Based on our updated count the Owens River Basin and assuming the 2006 territory estimate for the rest of California is still accurate[1] contains 22% of known WIFL territories in California and the Chalk Bluff site alone contains 13% of California's WIFL territories.

Another noteworthy site is Horton Creek in which we documented 11 residential WIFL including 7 territories and 4 confirmed pairs. To our knowledge, WIFL had not been previously documented in a formal survey at this site, although LADWP staff where aware of their presence.

1. Durst, S. L. *et al. Southwestern Willow Flycatcher Breeding Site and Territory Summary – 2006*. (2007).

2. Rourke, J., Kus, B. & Whitfield, M. Distribution and abundance of the southwestern willow flycatcher at selected southern California sites in 2001. (2004).

3. USFWS. *SWWF Final Recovery Plan Southwestern Willow Flycatcher (Empidonax traillii extimus)*. (2002).