Science Support for Recovery of Southwestern Willow Flycatcher (*Empidonax traillii extimus*) on Conserved Lands in San Diego County

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San Diego Association of Governments Environmental Mitigation Program

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Cover: Photograph of Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at the upper San Luis Rey River, San Diego County. Photograph by Scarlett Howell, U.S. Geological Survey, July 2016.

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Conversion Factors

International System of Units to U.S. Customary Units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Mass	
ounce, avoirdupois (oz)	28.35	gram (g)

Datum

Horizontal coordinate information is referenced to the World Geographic System of 1984 (WGS 84).

Abbreviations

HSM	Habitat suitability model
MSP	Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County
SANDAG	San Diego Association of Governments
SDMMP	San Diego Management and Monitoring Program
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VID	Vista Irrigation District

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Executive Summary

This document was developed based on the results of scientific research to support management and recovery of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) and its habitat in San Diego County, California. A migratory species restricted to riparian habitat for breeding, the flycatcher is present in southern California from May to August. The flycatcher has declined over the last several decades primarily in response to habitat loss, and possibly Brown-headed Cowbird (*Molothrus ater*) parasitism. This document compiles and analyzes data collected by USGS scientists on population size, distribution, demography, and breeding habitat condition and uses this information to evaluate potential management options and locations relative to several variables including spatial proximity to currently occupied locations, historical occupation, and potential for restoration that would benefit the flycatcher and expand populations. Location-specific management options and habitat restoration opportunities are ranked based on the contribution of each location to promoting regional flycatcher persistence. The results of these analyses can be used by land and resource managers to develop their habitat management projects and priorities and promote flycatcher recovery.

1 Introduction

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) is one of four subspecies of the Willow Flycatcher in the United States, with a breeding range that includes southern California, Arizona, New Mexico, southern portions of Nevada, Utah, and Colorado, and possibly western Texas (Hubbard, 1987; Unitt, 1987; Browning, 1993). Although other subspecies of Willow Flycatcher migrate through southern California on the way to their breeding grounds further north, only the *extimus* subspecies breeds in San Diego County (Unitt, 1987). Restricted to riparian habitat for breeding, Southwestern Willow Flycatcher (hereafter "flycatcher") populations declined between the1940s and 1970s primarily in response to widespread habitat loss throughout its range and, possibly, brood-parasitism by the Brown-headed Cowbird (*Molothrus ater*; cowbird [Wheelock, 1912; Willett, 1912, 1933; Grinnell and Miller, 1944; Remsen, 1978; Garrett and Dunn, 1981; Unitt, 1984, 1987; Gaines, 1988; Schlorff, 1990; Whitfield and Sogge, 1999]). By 1993, the subspecies was estimated to number approximately 78 territories in California (U.S. Fish and Wildlife Service, 1993) in small, disjunct populations. The flycatcher was listed as endangered by the State of California in 1992 and by the U.S. Fish and Wildlife Service in 1995. Following listing, population estimates for flycatchers in California increased to 256 territories, although the increase was largely attributed to expanded survey effort rather than population growth at known sites (U.S. Fish and Wildlife Service, 2002). Monitoring over the last 20 years has documented a steep decline in flycatcher abundance and distribution at known locations in California (see below).

Two large populations present since the 1980s occur in San Diego County: (1) the upper San Luis Rey River downstream of Lake Henshaw, and (2) the Santa Margarita River at Marine Corps Base Camp Pendleton (MCBCP; Unitt, 1987), along with several small populations that were discovered in the years after listing (Kus and Beck, 1998; Rourke et al., 2004). In recent years, flycatcher numbers at MCBCP have declined precipitously, and several of the small populations that have been regularly surveyed or monitored since their initial discovery have been extirpated (Houston et al., 2024; Howell and Kus, 2025). Surveys of the upper San Luis Rey River population have been irregular since 1999, but declines were observed in recent years (Howell and Kus, 2010; Clark et al., 2014).

The declines observed among known populations of Southwestern Willow Flycatcher in San Diego County indicate that flycatchers could benefit from a regional conservation strategy. Data on the current distribution and demography of the flycatcher within San Diego County, as well as identification of threats and stressors affecting the species, are essential components necessary to develop and implement a comprehensive approach to ensure the persistence of the species in San Diego County.

1.1 Purpose and Study Area

The Southwestern Willow Flycatcher is a covered species under several regional habitat conservation plans, which in San Diego County include the Multiple Species Conservation Program (MSCP) in southwestern San Diego County (City of San Diego, 1998), the Multiple Habitat Conservation Program in coastal north County (MHCP; AMEC et al., 2003), and the proposed North County MSCP plan in northwestern San Diego County (https://engage.sandiegocounty.gov/northcountyplan.html; fig. 1). The MSCP and MHCP were established in the late 1990s and early 2000s, respectively, while the North County MSCP is still in preparation. These plans called for conservation of lands within a preserve system that included lands with important habitat values and sensitive species, and that improved connectivity between core preserve areas (City of San Diego, 1998; AMEC et al., 2003). These plans also included requirements for preserve-level monitoring and management of lands conserved by participating jurisdictions, and recognized the need for coordinated regional monitoring and management across plan boundaries. This regional coordination is facilitated by the San Diego Association of Governments (SANDAG) Environmental Mitigation Program, which funds the San Diego Management and Monitoring Program (SDMMP) to develop and coordinate regional management and monitoring plans. Working collaboratively with state and federal wildlife agencies, tribes, land and resource managers, preserve managers, scientists, non-governmental and non-profit organizations, et al., SDMMP produced a *Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County* (MSP; San Diego Management and Monitoring Program [SDMMP] and The Nature Conservancy [TNC], 2017), which provided a biologically-based foundation to support decision making and funding priorities for managing species and vegetation communities across western San Diego County. The MSP designated the flycatcher as a “Category SL” species – a species whose persistence in the planning area is at high risk of loss without immediate management action above and beyond that of daily maintenance activities such as trash cleanup, ranger patrols to control recreational impacts, and occasional invasive plant management (SDMMP and TNC 2017). Several locations within the MSP Area (MSPA; fig. 1) are currently or were historically occupied by the flycatcher.

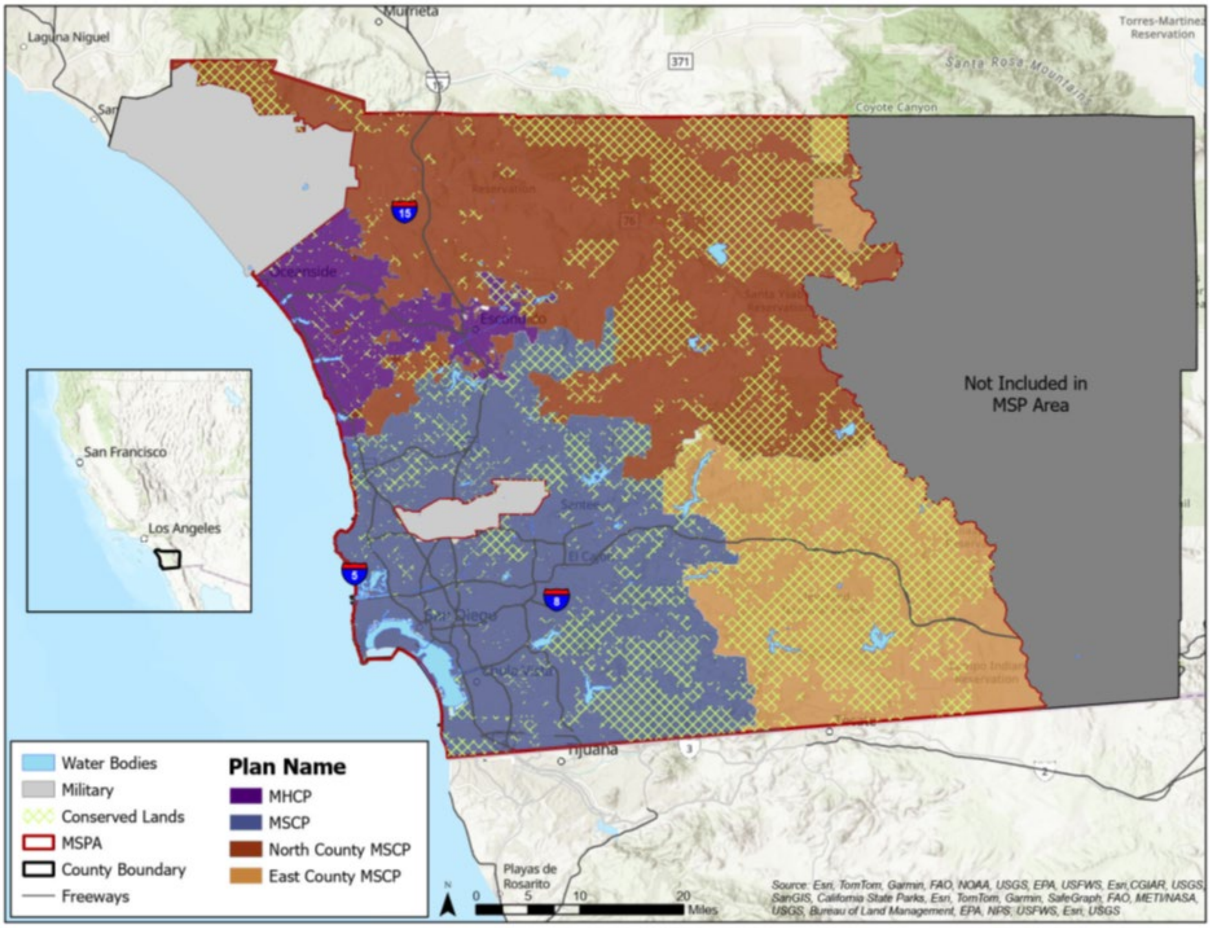


Figure 1. Management strategic plan area and military installations in San Diego County as of 2022. MSP: Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County; MSPA: MSP Area; MHCP: Multiple Habitat Conservation Plan; MSCP: Multiple Species Conservation Program.

To help fulfill the MSP goals and objectives established for the flycatcher, several tasks were initiated by USGS scientists, including surveys and demographic monitoring along the San Luis Rey River and other drainages in San Diego County to determine the current status of the flycatcher within the MSPA (Howell et al., 2022). The information obtained from surveys and monitoring between 2015 and 2023 (Howell and Kus, 2021; 2022; 2023; 2024) were combined with data from other ongoing studies (Houston et al., 2024; Howell and Kus, 2025), as well as all available data on historical occurrences (Unitt, 1987; Kus et al., 2003) to form the basis for the analyses reported here.

Synthesizing recent and historical data and analyses, this document identifies and prioritizes management options and habitat restoration opportunities for flycatcher breeding habitat across the entire MSPA and assesses strategies to encourage flycatchers to recolonize historically occupied areas on conserved lands to further ensure long-term persistence of the flycatcher in the MSPA. The document also incorporates strategies and suggestions from the Southwestern Willow Flycatcher range-wide recovery plan published by the U.S. Fish and Wildlife Service (USFWS) in 2002 (U.S. Fish and Wildlife Service, 2002; hereafter "USFWS recovery plan"). The USFWS recovery plan serves as the primary conservation tool for the flycatcher and includes in-depth, range-wide information on the species, its habitat, and threats, as well as a detailed recovery strategy. The USFWS recovery strategy outlines the following actions for recovering flycatcher populations: (1) increase and improve occupied, suitable, and potential flycatcher breeding habitat; (2) increase metapopulation stability; (3) improve demographic parameters; (4) minimize threats to wintering and migration habitat; (5) survey and monitor; (6) conduct research; (7) provide public education and outreach; (8) assure implementation of laws, policies, and agreements that benefit the flycatcher; and (9) track recovery progress (U.S. Fish and Wildlife Service, 2002). Herein, we focus our analysis on actions on the breeding grounds, including increasing and improving flycatcher breeding habitat, increasing local metapopulation stability, improving demographic parameters, surveying and monitoring, conducting additional research on local populations as necessary, and tracking recovery progress.

This document is structured in two parts. The first part presents background information pertinent to recovery-oriented management of the flycatcher, outlines factors influencing flycatcher population dynamics, and summarizes the current knowledge regarding Southwestern Willow Flycatcher population status, trends, and demography (including productivity, survival, and dispersal) in San Diego County. The second part describes a potential science-based regional conservation approach, details site-specific management options to benefit Southwestern Willow Flycatchers, and ranks sites according to their potential to improve persistence of flycatcher populations. In particular, the second part provides managers with options for developing conservation projects to promote flycatcher recovery.

2 Information Pertinent to Flycatcher Management and Recovery

The information below was adapted from the USFWS recovery plan (U.S. Fish and Wildlife Service, 2002), with additional information obtained from more recent studies, and other relevant literature. Discussed herein are aspects of the flycatcher's life history, habitat requirements, distribution, local population trends, and other demographic factors that are important to flycatcher recovery.

2.1 Life History

The Willow Flycatcher is a small, insectivorous bird, approximately 15 centimeters (cm [5.9 inches]) long and weighing about 12 grams (0.42 ounces). It has a grayish-green back and wings, whitish throat, light grey-olive breast, and pale yellowish belly. The Southwestern *extimus* subspecies is generally paler than other Willow Flycatcher subspecies, has a different song structure, and may differ in morphology and habitat use (Sedgwick, 2020; Mahoney et al., 2020). Flycatchers are aerial foragers that consume a wide variety of prey, including true bugs and leafhoppers (Hemiptera), flies (Diptera), beetles (Coleoptera), dragonflies (Odonata), wasps and bees (Hymenoptera), butterflies, moths, and caterpillars (Lepidoptera: Drost et al., 2003; Durst et al., 2008).

The flycatcher is a Nearctic-Neotropical migrant that spends only 3–4 months on the breeding grounds, with the remaining time spent in migration and on the wintering grounds in Central America and northern South America. Flycatchers begin arriving in southern California in early to mid-May, and usually depart for the wintering grounds in mid-August and early September. Male flycatchers are usually the first to arrive on the breeding grounds, followed by females approximately one week later. First-year flycatchers often arrive after older males and females have already established territories (S. Howell, U.S. Geological Survey, pers. obs.). Males establish territories and sing repeatedly from exposed perches while on the breeding grounds. Male song rate is very high in the early part of the season, and declines as the season progresses and pairing occurs (Sogge et al., 2010).

The territory size of flycatchers is highly variable, and likely depends on population density and habitat quality (U.S. Fish and Wildlife Service, 2002). Most breeding territory sizes are estimated to be approximately 0.2 – 0.5 hectares (ha; (0.5–1.2 acres [ac]), with some territories up to 2.3 ha (5.7 ac; U.S. Fish and Wildlife Service, 2002; Sogge et al., 2010). Flycatcher territories are often clustered together in a small portion of a suitable habitat patch, rather than spread evenly throughout (U.S. Fish and Wildlife Service, 2002). Settlement patterns may be driven by conspecific attraction, or the tendency for individuals of a species to settle near one another, and flycatchers may use the presence of conspecifics as an indication of habitat quality or some other fitness benefit (Danchin et al., 2004). Once a territory has been established, pairing usually occurs within one week.

The mating system of flycatchers is considered to be primarily monogamous, but flycatchers have the capacity for facultative polygyny, whereby one male pairs with more than one female in the same breeding season (Davidson and Allison, 2003; Sedgwick, 2020). Polygyny rates of 5–50 percent have been documented in studies of other flycatcher populations (Whitfield and Enos, 1996, Sferra et al., 1997; Paradzick et al., 2000; McKernan and Braden, 2001; Davidson and Allison, 2003; Sedgwick, 2020). In contrast, polygyny rates (the proportion of paired males that were polygynous) ranging from 0–100 percent annually were documented at MCBCP (Kus et al., 2016). Higher polygyny rates documented at MCBCP coincided with unequal sex ratios, with more females than males present in the population (Kus et al., 2016). Polygynous males most often mated with two females simultaneously or sequentially, but some mated with up to 5 separate females in one breeding season (Kus et al., 2016). First-year females that arrive on the breeding grounds after older females have already begun nesting often establish pair bonds with an already paired male, nesting as close as 20 m from the other paired female (S. Howell, U.S. Geological Survey, pers. obs.). Polygynous males tend to have larger overall territory sizes (U.S. Fish and Wildlife Service, 2002; S. Howell, U.S. Geological Survey, pers. obs.).

Once a pair bond is established, or in some cases without the presence of a male (Howell and Kus, 2025), the female subsequently builds an open-cup nest, which is most often placed in a fork of a willow (*Salix* spp.) or plant with a similar branching structure, usually approximately 1–3 meters ([m]; 3.3–9.8 feet [ft]) above the ground. Nest height can vary considerably, from 0.5 m to 18 m (1.6 ft to 59.1 ft), and may be related to height of nest host or overall canopy height (U.S. Fish and Wildlife Service, 2002). The typical clutch of three to four eggs is laid in May–

June. Females incubate eggs for approximately 12 days until hatching and nestlings fledge 12–15 days after hatching in early July. Renesting regularly occurs after nest failure (U.S. Fish and Wildlife Service, 2002; Howell et al., 2022), and on rare occasions, after a successful first nest (U.S. Fish and Wildlife Service, 2002). Most nests are used only once, although females will often use nest material from a previous nest when constructing a subsequent nest during the same season (McCabe, 1991; U.S. Fish and Wildlife Service, 2002; S. Howell, U.S. Geological Survey, pers. obs.). Although uncommon, the re-use of nests has been documented both between and within breeding seasons (S. Howell, U.S. Geological Survey, pers. obs.). Clutch size decreases with each nest attempt (Holcomb, 1974; McCabe, 1991; Whitfield and Strong, 1995; U.S. Fish and Wildlife Service, 2002).

The primary cause of nest failure in most years is predation. Predators of flycatcher eggs and nestlings include the Common Kingsnake (*Lampropeltis getula*; McKernan and Braden, 2001; Smith et al., 2002), Gopher Snake (*Pituophis catenifer;* Paradzick et al., 2000, McKernan and Braden, 2001), Cooper's Hawk (*Astur cooperii*; Paxton et al., 1997), Red-tailed Hawk (*Buteo jamaicensis*; Whitfield and Lynn, 2001), Great Horned Owl (*Bubo virginianus*; Stoleson and Finch, 1999), Western Screech-owl (*Megascops kennicottiii*; Smith et al., 2002), Yellow-breasted Chat (*Icteria virens*; Paradzick et al., 2000), and Argentine ants (*Linepithema humile*; Famolaro, 1999, S. Howell, U.S. Geological Survey, pers. obs.). Other potential predators include other snakes, corvids, lizards, chipmunks, weasels, racoons, ringtailed cats, wood rats, foxes, and domestic cats (McCabe, 1991, Sogge, 1995, Langridge and Sogge, 1998, Sferra et al., 1997, McCarthey et al., 1998, Paradzick et al., 2000).

In addition to nest predation, cowbird parasitism also contributes to nest failure. The cowbird is a brood parasite that lays its eggs in the nests of other species. The "host" parents then incubate the cowbird eggs and raise the young. Because cowbird eggs require a shorter incubation period than flycatchers and the cowbird nestlings develop more quickly, they often outcompete the hosts' own young for parental care. Parasitized flycatcher nests are rarely successful in fledging flycatcher young, although fledging of host young in parasitized nests does occur (Whitfield and Sogge, 1999; Rothstein et al., 2003).

Annual survival of adult flycatchers ranges from approximately 40–64 percent (Stoleson et al., 2000; McLeod et al., 2007; Paxton et al., 2007), and first-year flycatcher survival is typically approximately half that of adult survival estimates (Stoleson et al., 2000, McLeod et al., 2007; Paxton et al., 2007). However, first-year birds are also more likely to disperse to new sites, which could lower first-year survival estimates (Paxton et al., 2007). Most flycatchers live 1 to 3 years, although some individuals survive up to 11 years (U.S. Fish and Wildlife Service, 2002; Paxton et al., 2007; B. Kus, U.S. Geological Survey, unpub. data).

The majority of adult flycatchers exhibit high site fidelity, usually returning to the same breeding site between years (U.S. Fish and Wildlife Service, 2002; Paxton et al., 2007). However, adult movement between years can occur, and within-drainage movements are more commonly documented than between-drainage movements (Kenwood and Paxton, 2001). Movement is landscape-dependent, and geographical areas where drainages are closer together may experience higher frequencies of movement (Paxton et al., 2007). Distances moved by adults between years range from 2 to 44 kilometers ([km] 1.2 to 27.3 miles [mi]); however, long-distance movements of up to 220 km (136.7 mi) have been observed (McKernan and Braden, 2001; U.S. Fish and Wildlife Service, 2002; Paxton et al., 2007). Adult movement between years has been related to nest success in the prior year, with successful nesters more likely to return to the same breeding location between years (Paxton et al., 2007). First-year flycatchers tend to move longer distances than adults when returning to establish a breeding territory for the first time, and are often the colonizers of newly suitable habitat patches (Paxton et al., 2007). In Arizona, the average natal dispersal distance observed over a 10-year period was 20.5 km (12.7 mi; Paxton et al., 2007). As with movement frequency, dispersal distances are strongly influenced by landscape patterns.

Across their range, flycatchers are believed to exist and interact as metapopulations (U.S. Fish and Wildlife Service, 2002). A metapopulation is a group of geographically separate flycatcher breeding populations connected through immigration and emigration (U.S. Fish and Wildlife Service, 2002). Flycatcher populations are most stable where large populations or multiple smaller sites exist within close proximity (U.S. Fish and Wildlife Service, 2002). Within well-connected populations, immigration and emigration can be fairly common; multiple immigration and emigration events occurred between MCBCP and many of the smaller populations along the San Luis Rey River from 2000–18 (B. Kus, U.S. Geological Survey, unpub. data, 2000–14; Howell et al., 2022).

2.2 Habitat Requirements

Flycatchers are riparian obligates and require riparian vegetation for breeding. Flycatcher breeding habitat is characterized by patches of dense vegetation along rivers, streams, and reservoir inflows, interspersed with small openings, open water, or areas of sparse vegetation. Vegetation species composition varies across the flycatcher's range, but most breeding habitats include tree or shrub cover that is at least 3 meters ([m]; 9.8 feet [ft]) tall, with patches of dense vegetation within 3–4 m (9.8–13.1 ft) of the ground. In addition, flycatcher breeding habitat is almost always located near or adjacent to areas of standing water or saturated soil (U.S. Fish and Wildlife Service, 2002; Sogge et al., 2010). Common tree, shrub, and herbaceous species found in flycatcher breeding habitats include willow (*Salix* spp.), cottonwood (*Populus* spp.), boxelder (*Acer negundo*), tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), mulefat (*Baccharis salicifolia*), arrowweed (*Pluchea sericea*), stinging nettle (*Urtica* spp.), blackberry (*Rubus* spp.), poison oak (*Toxicodendron diversilobum*), poison hemlock (*Conium maculatum*), and perennial pepperweed (*Lepidium latifolium*: U.S. Fish and Wildlife Service, 2002; Howell et al., 2022).

Riparian habitat is continually changing, driven by occasional disturbances such as large floods that remove existing habitat, creating a heterogeneous mosaic of different-aged patches of habitat. Given the dynamic nature of riparian habitat, there are several different stages of habitat development that are important to flycatcher recovery (U.S. Fish and Wildlife Service, 2002). Suitable breeding habitat, which has all the components as described above, can be either occupied or unoccupied. Occupied suitable habitat is a riparian area that provides all the characteristics for breeding flycatchers, and is currently occupied by flycatchers. Unoccupied suitable habitat appears to have all the physical, hydrological, and vegetative components necessary for breeding flycatchers, but is not currently supporting breeding flycatcher. Potentially suitable habitat is missing one or more necessary components, which could be restored or enhanced to become suitable habitat in the future, or it may be habitat that is at an earlier successional stage and not yet mature enough for breeding flycatchers. Paxton et al. (2007) studied the timing of patch evolution in Arizona and in their system, newly developed riparian patches were suitable to be occupied by breeding flycatchers approximately 3 years after a scouring event or reservoir drawdown exposed bare soil. Unsuitable habitats are those found outside the floodplain and disconnected from the hydrological requirements necessary to develop into suitable habitat, even with extensive management (U.S. Fish and Wildlife Service, 2002).

As riparian patches develop and mature, flycatcher occupancy changes over time. Young, newly suitable habitat is quickly occupied and for the first few years, the number of territorial flycatchers increases, followed by a stage in which flycatcher numbers are stable but not growing, and finally, the number of flycatchers within an aging patch declines, and the habitat may eventually be abandoned (Theimer et al., 2018). Newly suitable habitat patches are often colonized by dispersing first-year flycatchers, especially if they are within close proximity to existing habitat (Paxton et al., 2007). In Arizona, some habitat patches only had a lifespan in which they were suitable and occupied for 6–10 years (Theimer et al., 2018). This highlights the need to develop and maintain riparian systems in which there is some quantity of all different stages of growth. If habitat is only protected, but never allowed to reset and regenerate, it will eventually mature and reach a point of ecological succession in which it is too mature for flycatchers. In the healthiest riparian systems, there will be younger, more suitable habitat available within close proximity for flycatchers to transition into as the existing habitat ages out (U.S. Fish and Wildlife Service, 2002). Suitable but unoccupied and potentially suitable habitat patches play an important role in flycatcher recovery because they will provide habitat for flycatchers to move into as the population expands, and to provide refugia for flycatchers to move into in the event of a flood or fire that degrades or eliminates currently occupied habitat (U.S. Fish and Wildlife Service, 2002).

2.3 Distribution and Population Trends (pre–2015)

Range-wide, the distribution of flycatchers consists of a few large (> 10 territories) populations, but the majority of populations are small. Arizona, New Mexico, and California account for approximately 90 percent of all flycatcher territories, with the remaining territories occurring in Nevada, Utah, and Colorado (Durst et al., 2008). The largest populations occur in New Mexico along the Gila and Rio Grande Rivers (500+ territories; Durst et al., 2008), and in Arizona along the Gila, Salt, and San Pedro Rivers (400+ territories; Durst et al., 2008).

In California, one of the largest flycatcher populations historically occurred at the Kern River Preserve in Kern County. The Kern population peaked at 38 territories in 1997, but declined steeply until 2014 when the last pair was observed (Whitfield, 2019). Other large populations in California have been documented at the Santa Ynez River in Santa Barbara County, and the Owen’s River in Inyo and Mono Counties. The Santa Ynez population had approximately 27 territories in 2000 (Kus et al., 2003), but surveys done in 2012 documented a decline and reduced distribution (5 territories; Ball et al., 2012). The Owen’s River population had a minimum of 24 territories in 2001 (Kus et al., 2003), and recent surveys estimated the current population at approximately 50–100 territories annually from 2021–23 (Great Basin Bird Observatory, 2023).

The remaining large populations in California occur in San Diego County, including two large historical populations that have been present since the 1980s (Unitt, 1987): (1) the upper San Luis Rey River downstream of Lake Henshaw, and (2) the Santa Margarita River at Marine Corps Base Camp Pendleton. The largest historical population of flycatchers in San Diego County is the upper San Luis Rey River population located in the northeastern portion of San Diego County. This population was first discovered by Unitt (1984, 1987), with 12 territories observed, and up to 48 territories were confirmed in 1999 (Kus et al., 1999; Varanus Biological Services, 2000, 2001). A smaller portion of the historical survey area was surveyed in 2009, and a decline of 30 percent was reported compared to 1999 (within the same survey footprint; Howell and Kus, 2010). The same reduced footprint was surveyed in 2013, and the authors estimated a decline of 17 percent compared to 1999 (Clark et al., 2014) However, because of differences in survey extent and effort between years (the population was intensively monitored in 1999 vs. four surveys in 2009 vs. surveys augmented with nest checks in 2013), population estimates and trends should be interpreted with caution.

The second largest historical population in San Diego County is located in the northern portion of the County, along the Santa Margarita River at Marine Corps Base Camp Pendleton. This population increased from 5 territories in 1981 (Unitt, 1987) to a high of 23 territories in 2004, but declined precipitously beginning in 2007, and was down to 5 territories by 2014 (Howell and Kus, 2025).

In addition to these large populations, several small (<6 territories) populations were located in the years following listing as a federally endangered species. The majority of these smaller populations were documented along the San Luis Rey River, including Pala in 2000 and 2001 (Kus et al., 2003), Couser Canyon from 1998–2002 (B. Kus, U.S. Geological Survey, unpub. data, 1998, 2002; Kus et al., 2003), Bonsall beginning in 2006 (B. Kus, U.S. Geological Survey, unpub. data, 2006-–14), Guajome Lake from 1999–2005 (Kus et al., 2003, B. Kus, unpub. data, 2004, 2005), and Whelan Lake from 2000–07 (Kus et al., 2003; B. Kus, U.S. Geological Survey, unpub. data, 2004–07). In 2011, 1–2 flycatchers suspected to be a pair were reported along Horse Ranch Creek, a tributary of the San Luis Rey River (Natural Resource Consultants, 2011).

Small breeding populations (1–3 territories) have also been historically documented along several other drainages in San Diego County. Breeding flycatchers were documented at San Dieguito River (1997, 1999–2001; Kus and Beck, 1998; Kus et al., 2003), Santa Ysabel Creek (1997; Kus and Beck, 1998), Cedar Creek at William Heise Park (2001; Kus et al., 2003), San Diego River above El Capitan Reservoir (2001; Kus et al., 2003), Sweetwater Reservoir (1997–99; Famolaro, 1999; Kus et al., 2003), and San Felipe Creek (1999–2001; Kus et al., 2003). Breeding flycatchers were also confirmed at several other drainages on MCBCP in the late 1990s and early 2000s: Fallbrook (2000–06), Las Flores (1995–96 and 2003–04), Pilgrim (1995–97), and San Mateo Creeks (2007; Kus, 1996; Griffith Wildlife Biology, 1997, 2000; Howell and Kus, 2025). A flycatcher was seen with nesting material at the south end of Lake Cuyamaca in 1984, but no flycatchers were documented in 1986 (Unitt, 1987).

Territorial flycatchers have been reported at Agua Caliente Creek (Kus et al., 2003), Marcario Canyon near Agua Hedionda Creek (Kus et al., 2003), Pilgrim Creek south of MCBCP (Kus et al., 2003), Mission Valley (2009 and 2010; B. Kus, U.S. Geological Survey, unpub. data, 2009, 2010), and Chocolate Canyon (2010; Merkel & Associates, 2010) along the San Diego River. Lastly, Unitt reported on several locations in the 1970s and 1980s that he suggested may have been intermittently occupied by territorial flycatchers, including the upper Santa Margarita River northeast of Fallbrook, Lower Otay Lake at Jamul Creek, and the Tijuana River Valley, but none were present at these locations in 1986 (Unitt, 1987).

3 Factors Affecting Flycatcher Population Dynamics (Threats and Stressors)

Many of the threats and stressors that historically contributed to reduced population sizes and range contraction are still affecting flycatchers in modern times. Historically, the primary drivers of decline were the destruction and modification of riparian habitat, caused by altered hydrological processes including reduced water flows related to diversion and groundwater pumping, interruptions in hydrological cycles by dams and stream channelization that alter flood and fire regimes, direct removal of riparian vegetation, conversion to agriculture, livestock overgrazing, and establishment of invasive non-native plants (U.S. Fish and Wildlife Service, 2002). Additionally, cowbird parasitism reduced reproductive success at many flycatcher breeding sites and contributed to further declines in the population (U.S. Fish and Wildlife Service, 2002).

3.1 Habitat Loss and Modification

<u>Altered Hydrology</u>

Altered hydrological processes in the form of groundwater pumping, water diversion, channelization, and dams, are suggested as one of the primary mechanisms that contributed to the historical reduction of riparian habitat and subsequent reduction of flycatchers across the historical range (U.S. Fish and Wildlife Service, 2002). Surface diversions and pumping of groundwater can lower the water table and reduce surface flows, interrupting the processes that maintain riparian habitat, and contributing to declines in habitat quality and quantity. Channelization is used primarily for flood control, and impacts include separating a stream or river from its floodplain, reducing the water table in the area outside the channel, and reducing the width of the floodplain (U.S. Fish and Wildlife Service, 2002). Dams have the potential to affect the riparian downstream of a dam by altering the flow of water, which can impact natural processes such as sediment deposition, seed recruitment, and can also allow more debris to accumulate, increasing the risk of fire (U.S. Fish and Wildlife Service, 2002). Upstream of dams, reduced reservoir levels during periods of drought can create new habitat, but also lead to the potential for prolonged inundation of habitat when reservoir levels increase. Riparian habitat and flycatcher populations at reservoir sites tend to be vulnerable, often resulting in unstable flycatcher populations (Hubbard, 1987; U.S. Fish and Wildlife Service, 2002, Paxton et al., 2007).

Urbanization

Urbanization contributes to flycatcher habitat loss and modification. Urbanization causes direct impacts to riparian habitat from flood control measures implemented to control flooding of infrastructure and housing developments adjacent to riparian. Many riparian systems are channelized and contained within levees, and additional flood control practices such as mowing riparian vegetation in the middle of the channel reduces the overall quantity of riparian vegetation. This creates fringe habitat that exists in a narrow string on the edge of the floodplain, and magnifies edge effects, such as increased predation and parasitism. Riparian habitats adjacent to housing developments may have higher instances of predation from cats. Additionally, many riparian systems in San Diego County's urban areas have increased numbers of unhoused persons living in the habitat. Much of the riparian habitat is altered to build sometimes large encampments, and increased quantities of trash and human waste attract large numbers of nest predators such as corvids. Moreover, a large network of trails is created throughout the once contiguous riparian habitat, exacerbating edge effects. There is also an increased incidence of repeated fires in riparian habitat impacted by unhoused communities, further reducing the suitability for flycatchers.

Invasive and non-native plants

There are many different invasive non-native plants in San Diego County, some of which pose a greater threat to flycatchers than others. Giant reed (*Arundo donax*), which spread rapidly along California waterways after introduction in the 1800s for erosion control, can form dense monotypic stands that crowd out native riparian habitat, making the habitat unsuitable for flycatchers (U.S. Fish and Wildlife Service, 2002; Kisner, 2004). Removal has occurred in many San Diego riparian areas, including at MCBCP and portions of the San Luis Rey River, but giant reed is still present along many of the riparian areas in San Diego County. In contrast, there are many other non-native invasive plants found within San Diego County flycatcher habitat that flycatchers will readily nest in, and do not pose the same level of threat as giant reed. Tamarisk was introduced into riparian areas beginning in the 1800s for bank stabilization, and can form dense monotypic stands. Tamarisk has been removed from some riparian areas in San Diego (e.g., MCBCP), but it persists in some locations including small amounts at San Dieguito and Lake Henshaw. In both of these locations, flycatchers have placed nests in tamarisk. Non-native herbaceous species that are well established in San Diego include poison hemlock and perennial pepperweed. Both of these species have also been used as nesting substrate by flycatchers. Poison hemlock was used often by flycatchers on MCBCP, and is thought to be a surrogate for native stinging nettle (*Urtica dioica*). Flycatchers may nest in poison hemlock even when a native species is available, and poison hemlock often grows in mixed stands with native species. However, poison hemlock often appears lush and appealing to flycatchers at the beginning of the nesting season, but as the season progresses and the plant dries out, it wilts and can no longer support the nest, causing failure. Restoration plans that include non-native plant removal can benefit from a thorough assessment to ensure that there is alternative nesting substrate present while the habitat recovers.

Non-native insect pests

In addition to non-native plants, there are several non-native insects that have recently impacted occupied or suitable flycatcher habitat, including goldspotted oak borer (*Agrilus auroguttatus*; hereafter, GSOB) and Kuroshio shot-hole borer (*Euwallacea kuroshio*.; hereafter, SHB). GSOB has had the most detrimental effect on flycatchers in San Diego County because the occupied flycatcher habitat along the upper San Luis Rey River includes a large component of coast live oak (*Quercus agrifolia*), which the flycatchers have used as a preferred nesting substrate (Kus et al., 1999; Varanus Biological Services, 2000; Howell and Kus, 2010; Clark et al., 2014). It is thought that GSOB arrived in California in the last two decades, likely in firewood transported from Arizona or Mexico, where the GSOB is known to occur (Hishinuma et al., 2011). GSOB is unlikely to impact other suitable riparian habitats in San Diego County, since oaks are not typically a component in coastal riparian systems.

The invasive non-native SHB is an introduced pest native to Asia. It was first encountered in urban and agricultural settings in San Diego County in 2012 and first detected in a riparian forest in late summer 2015 at the Tijuana River (Boland, 2016). Pregnant female beetles bore into tree trunks and branches, creating galleries in which they lay their eggs, and cultivate a pathogenic fungus (*Fusarium* spp.) used as a food source by developing larvae. Damage to the tree's vascular system and disruption of water and nutrient flow can kill trees in as little as 6 months after initial infestation. Of the sites where SHB has been documented, the Tijuana River has been most affected, and the once dense willow-dominated woodland that contains suitable habitat for flycatchers experienced median tree mortality of 41 percent and lost approximately 79 percent of the original tree canopy (Boland, 2018). The SHB has the potential to impact other suitable flycatcher locations, and has been detected along the lower and middle San Luis Rey River, the San Diego River, and potentially at San Dieguito River. However, none of the impacts from SHB at these locations have been as severe as those observed at the Tijuana River.

Fire

Historically, fire did not occur frequently in California riparian systems (U.S. Fish and Wildlife Service, 2002). However, the reduction of water by processes discussed above allows for the buildup of fuel in the understory, which increases the risk of fire (U.S. Fish and Wildlife Service, 2002). The increase in non-native vegetation such as giant reed and tamarisk has also contributed to increased fire frequency. Some of the most detrimental impacts occur when fires take place during the breeding season, and flycatchers are forced to disperse to unburned habitat patches potentially incurring increased risk of predation, increased competition for suitable habitat elsewhere, and delayed or foregone breeding opportunities. A fire that occurred on MCBCP in May 2014 occurred just as breeding flycatchers were arriving and beginning to settle on their breeding territories, and ultimately burned two of the three habitat patches that were still actively used by breeding flycatchers (B.Kus, U.S. Geological Survey, unpub. data, 2014). This fire likely contributed to the near extirpation that has occurred at MCBCP. While riparian habitat regenerates quickly, and can recover within three years, there is often a larger component of non-native vegetation than what was present before the fire, further reducing habitat suitability. Additionally, the habitat modifications that occur in the process of fire control, such as fire breaks, can destroy large swaths of unburned habitat.

Livestock Overgrazing

Overgrazing by livestock has been suggested as a major factor in the modification and destruction of riparian habitat elsewhere in the flycatcher's range (Marshall and Stoleson, 2000; U.S. Fish and Wildlife Service, 2002). Changes in land use along the San Luis Rey River, including the removal of grazing from Forest Service lands in the early 1990s was credited with the growth of the flycatcher population on Forest Service lands downstream of Lake Henshaw (U.S. Fish and Wildlife Service, 2002). However, impacts from grazing can be minimized by following best management practices including rotational grazing, and exclusion of cattle from riparian habitat during the late spring and summer when seed recruitment occurs in riparian vegetation. Grazing that occurs during the growing season contributes to even-aged, non-reproducing communities of mature willows, with no understory (Marshall and Stoleson, 2000). The USFWS recovery plan (2002) describes a riparian grazing system that was compatible with the large population of flycatchers on the South Fork of the Kern River in California in the 90's, and more recently, the Owens River population and the San Luis Valley population in Colorado both coexist with sustainable grazing practices (Los Angeles Department of Water and Power, 2005; ERO, 2012).

3.2 Loss of Metapopulation Dynamics

Riparian habitat by nature is a rare and patchy habitat, driven by periodic disturbances such as floods that scour the landscape, destroying existing habitat and creating new habitat patches. Species such as the flycatcher that rely on patchy habitat exist as metapopulations, where regional connectivity to other populations is maintained through dispersal, immigration, and emigration. The ability of a metapopulation to persist may be related to population size, with larger groups likely to be more stable, and better able to withstand events such as flooding, wildfire, or drought (U.S. Fish and Wildlife Service, 2002). Smaller populations are more vulnerable to extirpation. From 1993 to 2001, 94 percent of flycatcher sites that were extirpated range-wide contained five or fewer territories (Sogge et al., 2003).

Proximity to a source population is a key component of colonizing new or recolonizing historically occupied habitat as dispersal events decrease with increased distance to the source population (U.S. Fish and Wildlife Service, 2002; Paxton et al., 2007). Isolated populations, even large ones, are at greater risk of local extirpation resulting from stochastic events such as flooding, wildfire, or disease. Isolation from other source populations was one of the reasons suggested for the decline of the Kern River Valley population (Whitfield, 2019). Smaller populations that are within close proximity to one another, or to a larger population, can contribute to metapopulation stability.

3.3 Factors Affecting Demographic Parameters

Cowbird parasitism

Cowbird parasitism negatively affects the flycatcher by reducing reproductive performance. Although some parasitized flycatcher nests can fledge flycatcher young (Uyehara et al., 2000), the majority of parasitized flycatcher nests result in failure (Rothstein et al., 2003). Even if management is performed to remove cowbird eggs from parasitized nests, parasitism still diminishes reproductive success (Uyehara et al., 2000). Parasitism typically results in reductions in number of flycatcher young fledged via clutch size reduction. Clutch size reduction occurs when cowbird females remove a host egg and replace it with one of their own (Uyehara et al., 2000; Rothstein et al., 2003). Moreover, parasitism contributes to lower nest success via increased predation rates. Stumpf et al. (2011) found predation rates were higher in parasitized flycatcher nests compared to unparasitized nests. Parasitized nests may be at greater risk from predation because of increased activity at nest sites from adult flycatchers attempting to thwart parasitism attempts and increased noise from cowbird nestlings that may increase auditory cues for predators. Cowbird parasitism may also increase during drought years (Smith and Johnson, 2008; Ellis et al., 2008; Colón et al., 2017).

Predation

In most years, predation is the primary reason for nest failure, as is the case with most nesting songbirds (Ricklefs, 1969; Martin, 1993). The amount of predation risk can be affected by habitat structure, whereby habitat that is fragmented may provide increased opportunities for predators. Whitfield (1990) noted that predation on flycatcher nests increased with decreasing distance to edge.

Drought

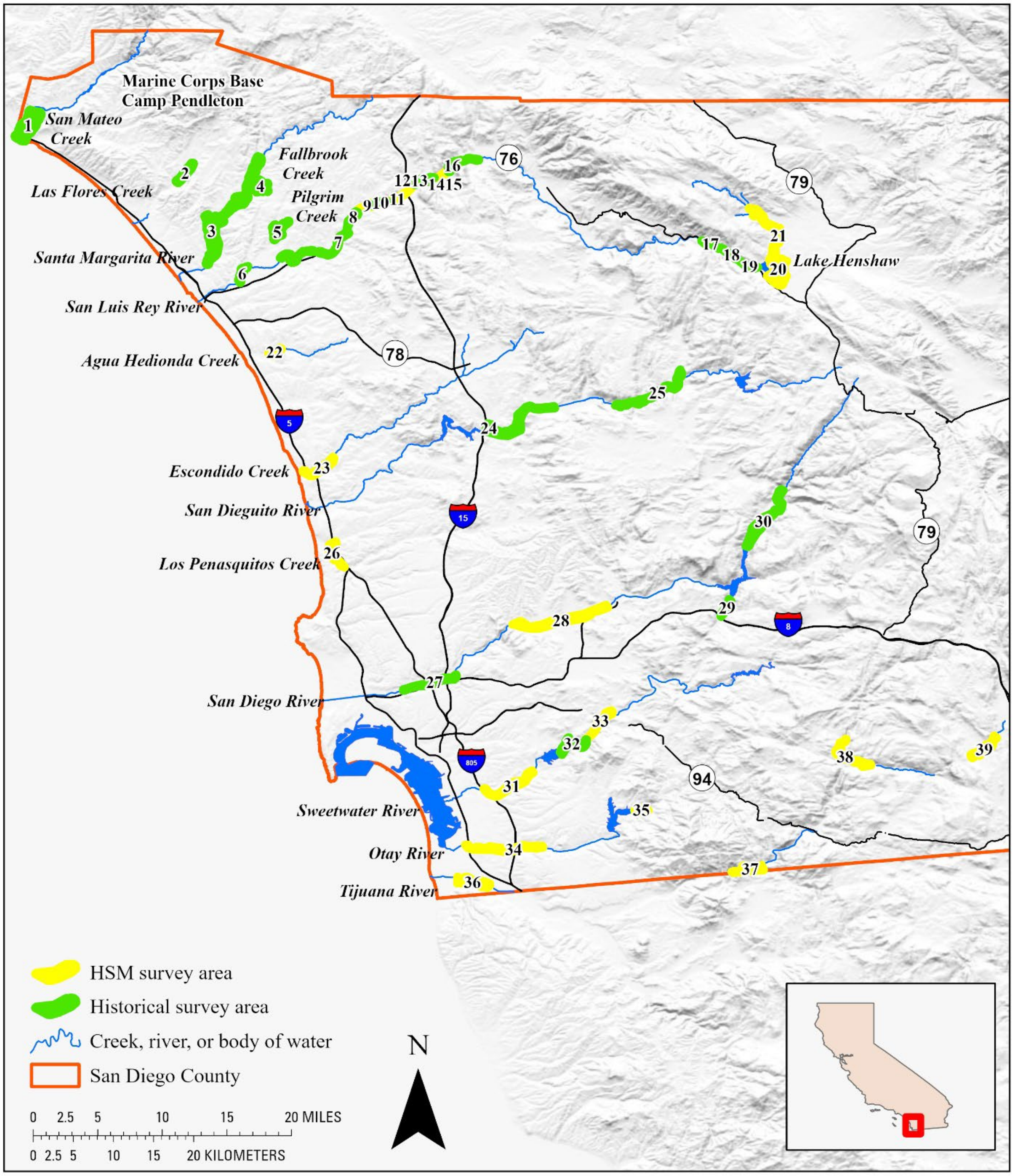
Drought impacts include reduced surface and soil moisture, which creates dry and drought stressed vegetation with reduced biomass, and a reduced prey base. Songbirds respond to reduced food availability by not breeding, delaying nesting, attempting fewer nests, and having smaller clutches (Bolger et al., 2005). A flycatcher diet study in Arizona found a five-fold difference in arthropod biomass collected during a drought year (2002) compared to a year with average precipitation (2004; Durst et al., 2008), and reduced biomass was also reported in 2002 by Bolger et al. (2005). Reduced productivity and fewer nesting attempts were observed among breeding flycatchers at MCBCP in the same drought year (2002), and some adult females did not initiate nesting at all (B.Kus, U.S. Geological Survey, unpub. data, 2002). Drought effects may also compound the impacts of predation (Bolger et al., 2005; Preston and Rotenberry, 2006; Smith and Johnson, 2008; McCreedy and van Riper III, 2015). The climate in California is projected to become warmer and drier with more frequent, intense, and prolonged droughts (Diffenbaugh et al., 2015). A recent genomic study analyzing how all four subspecies of Willow Flycatcher will adapt to changing weather patterns such as a temperature increases and reduced precipitation identified the endangered *extimus* subspecies as the one most vulnerable to change (Ruegg et al., 2018). Some recent climate models also predict that California will suffer from increased instances of extremely wet weather and intense storms which may promote flooding, and introduce a "whiplash" effect of extreme dry years followed directly by extreme wet years (Swain et al., 2018). Changing weather patterns are also likely to exacerbate fire conditions and alter the fire regime such that fires occur more frequently and burn hotter (Steblein et al., 2021).

4 Current Status of Southwestern Willow Flycatcher in San Diego County

4.1 Flycatcher Distribution, Abundance, and Population Trends

USGS conducted surveys from 2015–19 to determine the status and distribution of flycatchers in San Diego County (Howell et al., 2022). Follow-up surveys performed from 2020–23 (Howell and Kus, 2021; 2022; 2023; 2024) were combined with data from other ongoing studies (Houston et al., 2024; Howell and Kus, 2025) to evaluate population trends among flycatcher populations in San Diego County. In total, USGS surveyed 39 locations along 14 drainages (fig. 2; table 1). Locations selected for surveys were those considered to have the greatest potential for supporting breeding Southwestern Willow Flycatchers, based either on historical occupancy or the prediction of suitable habitat using a habitat suitability model (HSM) developed by USGS biogeographer James Hatten (2016; appendix 1). Survey locations included 21 historical locations and 18 additional locations predicted to be suitable (fig. 2). All historically occupied locations were predicted to be suitable by the model.

USGS biologists conducted flycatcher surveys following standard survey techniques for flycatchers (Sogge et al., 2010). Most locations were surveyed during a single year from 2015–19, but surveys were conducted annually from 2015–23 at Whelan Lake, Santa Margarita River (MCBCP), and three locations along the upper San Luis Rey River (Cleveland National Forest, Rey River Ranch, Vista Irrigation District), from 2015–21 at Bonsall, and from 2018–23 at Lake Henshaw.



Base from U.S. Geological Survey and other Federal and State digital data, various scales; Shaded relief from Esri and its licensors, copyright 2025; Geographic coordinate system, World Geodetic System of 1984

Survey areas from Howell et al. (2022), Houston et al. (2024), and Howell and Kus (2025)

Figure 2. Southwestern Willow Flycatcher survey locations in San Diego County. Numbers refer to location names (see table 1). HSM: habitat suitability model (Hatten, 2016).

Table 1. Historical and current status and distribution of Southwestern Willow Flycatchers in San Diego County, California.

[Watersheds/sites indicated by shading. Locations ordered from north to south, and if more than one location within a watershed/site, locations numbered west to east. #Terr, number of territories tallied in survey year, or the first year in a range of years, #Hist Terr, highest number of historical territories prior to 2015; —, no prior survey data. Abbreviations: #, number; Terr, territory; USGS, U.S. Geological Survey.]

Loc #	Location	Survey Year[1]	#Terr	#Hist Terr	Source
		Marine Corps Base Camp Pendleton			
1	San Mateo Creek	2015–23[1]	0	1	Howell and Kus, 2025
2	Las Flores Creek	2015–23[1]	0	3	Howell and Kus, 2025
3	Santa Margarita River	2015–23[1]	4	23	Howell and Kus, 2025
14	Fallbrook Creek	2015–23[1]	0	2	Howell and Kus, 2025
5	Pilgrim Creek	2015–23[1]	0	6	Kus, 1996; Howell and Kus, 2025
		San Luis Rey			
6	Whelan Lake	2015–23[1]	0	4	B. Kus, USGS unpub. data, 2006; Houston et al., 2024
7	Guajome Lake	2015	0	6	B. Kus, USGS unpub. data, 2003; Howell et al., 2022
8	Bonsall	2015–21[1]	2	6	B. Kus, USGS unpub. data, 2014; Howell et al., 2022
9	Rincon	2015	0	0	Howell et al., 2022
10	DOT	2015	0	1	EDAW, 2007; Howell et al., 2022
11	East	2015	0	0	Howell et al., 2022
12	Pala gateway	2015	0	0	Howell et al., 2022
13	Pankey Ranch	2015	0	3	Varanus Biological Services, 2004; Howell et al., 2022
14	Couser Canyon	2015	0	2	Kus et al., 2003; Howell et al., 2022
15	Gregory Canyon	2018	0	–	Howell et al., 2022
16	Pala	2015	0	2	Kus et al., 2003; Howell et al., 2022
17	Rey River Ranch	2015–23[1]	9	19	Kus et al., 1999; Varanus Biological Services, 2000, 2001; Howell and Kus, 2022
18	Cleveland National Forest	2015–23[1]	11	22	Kus et al., 1999; Varanus Biological Services, 2000, 2001; Howell and Kus, 2022
19	Vista Irrigation District	2015–23[1]	7	7	Kus et al., 1999; Varanus Biological Services, 2000, 2001; Howell and Kus, 2022
20	Lake Henshaw	2018–23[1]	16	–	Howell et al., 2022
21	West Fork	2018	0	–	Howell et al., 2022
		Carlsbad			
22	Agua Hedionda Creek	2016	0	–	Howell et al., 2022
23	Escondido Creek	2018	0	–	Howell et al., 2022
		San Dieguito			
24	Santa Ysabel Creek	2016	0	1	Kus and Beck, 1998; Howell et al., 2022
25	San Dieguito River	2016	1	3	Kus et al., 2003; Howell et al., 2022

Loc #	Location	Survey Year[1]	#Terr	#Hist Terr	Source
		Los Peñasquitos			
26	Los Peñasquitos Creek	2018	0	–	Howell et al., 2022
		San Diego			
27	Valley	2016	0	1	B. Kus, USGS unpub. data, 2009–10; Howell et al., 2022
28	Santee	2016	0	0	Howell et al., 2022
29	Chocolate Canyon	2018	0	1	Howell et al., 2022
30	El Capitan	2016	0	2	Kus et al., 2003; Howell et al., 2022
		Sweetwater			
31	Sweetwater 805	2017	0	–	Howell et al., 2022
32	Sweetwater Reservoir	2017	0	2	Kus et al., 2003; Howell et al., 2022
33	San Diego NWR	2017	0	0	Howell et al., 2022
		Otay			
34	Otay I-5 to Heritage	2018	0	0	Howell et al., 2022
35	Jamul Creek	2018	0	0	Howell et al., 2022
		Tijuana			
36	Tijuana River	2017	0	0	Howell et al., 2022
37	Marron Valley	2019	0	–	Howell et al., 2022
38	Cottonwood Barrett	2019	0	–	Howell et al., 2022
39	Cottonwood Moreno	2019	0	0	Howell et al., 2022

[1]Surveyed in multiple years; earliest survey year results reported in table.

Distribution and Abundance

Of the 39 locations surveyed between 2015–23, only 18 percent (7/39) supported breeding flycatchers. The majority of locations with breeding flycatchers occurred along the San Luis Rey River; the Santa Margarita River and the San Dieguito River were the only other drainages with breeding flycatchers (table 1). Based on the initial survey year at each location, we documented 50 flycatcher territories containing a minimum of 84 resident flycatchers from 2015–19 (table 1; Howell et al., 2022; Howell and Kus, 2025). Breeding flycatchers were documented for the first time at Lake Henshaw, the only new location surveyed that supported flycatchers.

Population Trends

Of the 39 locations surveyed, 21 were historically occupied by breeding or territorial flycatchers, and flycatchers continued in 29 percent (6/21) of these locations. Among the historically occupied locations that still contained flycatchers, numbers declined at all of them from previously reported numbers (fig.3). Of the two small populations that were still occupied, the number of territories at Bonsall declined from a high of four (2014; B. Kus, U.S. Geological Survey, unpub. data, 2014) to two (fig.3; table 1), and the number of territories at San Dieguito declined from the previous confirmed high of three (1997; Kus and Beck, 1998) to one (fig. 3; table 1). Follow up surveys and territory visits in subsequent years at Bonsall (2016–21;) and San Dieguito (2017–18) documented extirpation at these two locations (Allen et al., 2017; 2018; Allen and Kus, 2019; 2020; 2021; 2022; B. Kus, U.S. Geological Survey, unpub. data, 2017–18). At the Santa Margarita River, the population declined from a high of 23 territories in 2004 to 4 territories by 2015 (fig. 3), and the population has since been reduced to 1 unpaired female (Howell and Kus, 2025). No territories were documented on any of the other historically occupied drainages at MCBCP (table 1; Howell and Kus, 2025).

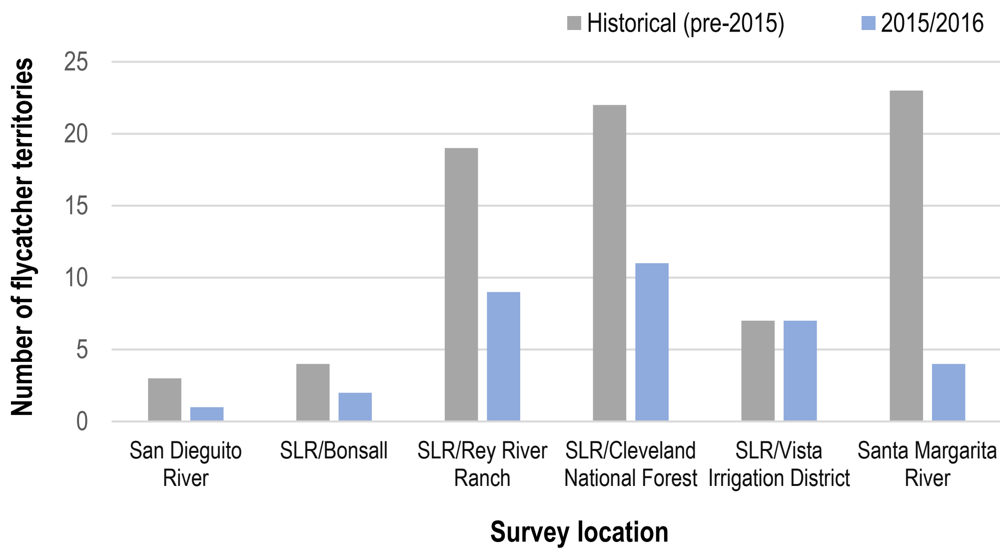


Figure 3. Number of Southwestern Willow Flycatcher territories at historically occupied locations in San Diego County, California. [Historical = highest number of territories pre-2015]

The collective number of territories on the upper San Luis Rey River downstream from Lake Henshaw declined 44 percent between 1999 (48 territories, table 1; Cleveland National Forest, Rey River Ranch, and Vista Irrigation District and 2015 (27 territories), and declines continued in subsequent years. From 2018–23 following the initial discovery of the Lake Henshaw population, a complete shift in distribution was documented, with all flycatchers in the upper San Luis Rey River population moving to Lake Henshaw (fig. 4; Howell et al., 2022; Howell and Kus, 2021, 2022a, 2023). As of 2023, no flycatcher territories were documented downstream from Lake Henshaw. The Lake Henshaw location is the only location with a positive trend from 2018–23; the population steadily increased from 2018–21, had a slight decline in 2022, and increased again in 2023 (fig. 4)

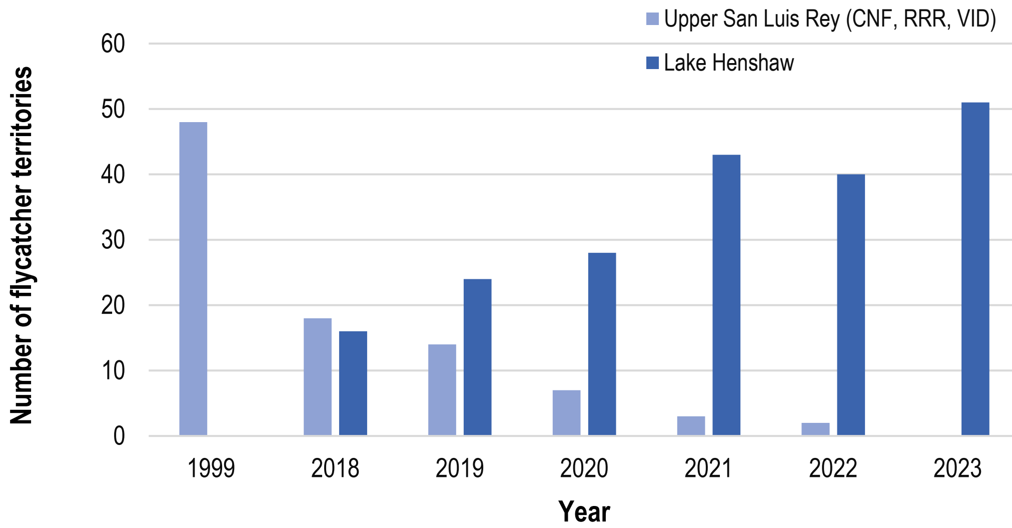


Figure 4. Distribution of Southwestern Willow Flycatcher territories on the upper San Luis Rey River and Lake Henshaw, San Diego County, California, 1999, and 2018–2023. [CNF, Cleveland National Forest; RRR, Rey River Ranch; VID, Vista Irrigation District]

4.2 Flycatcher Productivity, Survival, and Dispersal

Howell et al. (2022) conducted a 4-year demographic study of Southwestern Willow Flycatchers to collect baseline data on flycatcher productivity, survival, and dispersal in the upper San Luis Rey River population downstream from Lake Henshaw from 2016–19. Investigators monitored the nesting activities of flycatchers each year between May and August. The study focused on two primary determinants of population size: productivity and survival. Flycatcher nests were located and monitored weekly to collect data on clutch size, nest parasitism, nest success, and annual productivity of breeding pairs. Adults and nestlings were individually banded to generate data on annual survival and dispersal. The effects of precipitation on annual survival were assessed by comparing these parameters across years varying in annual rainfall (Howell et al., 2022). Annual precipitation was calculated for the "bio-year", which started on October 1 of the calendar year before breeding and ending on March 31 of the breeding season year. Bio-year precipitation was further subdivided into two periods (fig. 5): October to December (early winter), and January to March (late winter), to examine whether timing of rainfall, in addition to amount of rainfall, influenced survival.

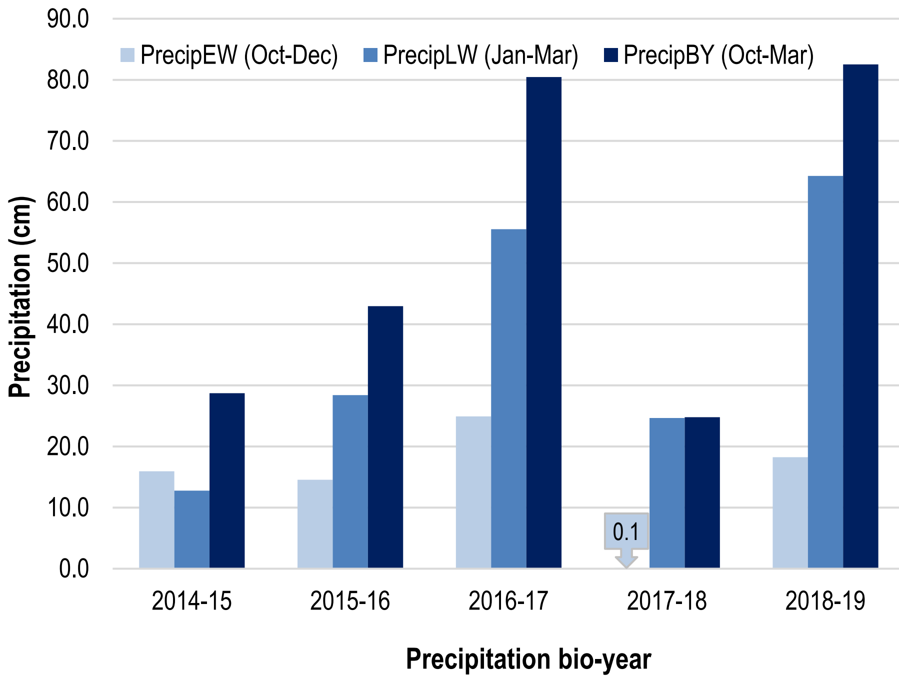


Figure 5. Pre-breeding season precipitation totals from the Vista Irrigation District Lake Henshaw Dam weather station, San Diego County, California, 2015–19. [PrecipBY, pre-breeding season precipitation from October 1 of the calendar year before the breeding season and ending on March 31 of the breeding season year; PrecipEW, early winter precipitation from October to December of the calendar year before the breeding season; PrecipLW, late winter precipitation from January to March of the breeding season year]

Productivity

Between 18 and 41 nests were monitored annually within 11–21 territories (Howell et al., 2022). The measures of breeding productivity documented at the upper San Luis Rey River monitoring area were highly variable, and within the timeframe of the study, showed somewhat biennial rather than annual variation. Flycatchers experienced greater success in the first two years of the study, with apparent nest success and seasonal productivity significantly higher in 2016 and 2017 than in 2018 and 2019. Apparent nest success was highly variable, ranging from a high of 37 percent in 2016 and 2017 to a low of 11 percent in 2019 (fig. 6). Clutch size was lower in the final year of the study (2019), compared to the first three years (fig. 7). The highest productivity documented was 1.6 young per pair in 2016, and by the end of the study, productivity had dropped to 0.5 young per pair (fig. 8). The decline in breeding productivity in the latter 2 years of the study coincided with increased cowbird parasitism; from 4 to 27 percent of flycatcher nests each year were parasitized with the highest parasitism occurring in 2018 (23 percent) and 2019 (27 percent; fig. 9). Higher rates of predation also occurred in 2018 and 2019, compared to the low of 49 percent in 2016 (Howell et al., 2022).

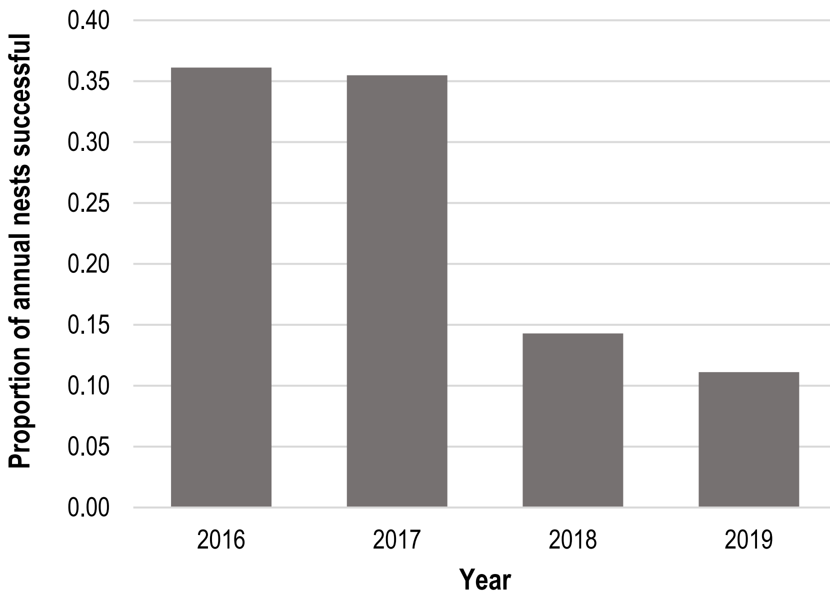


Figure 6. Southwestern Willow Flycatcher nest success by year at the upper San Luis Rey River monitoring area, San Diego County, California, 2016-2019.

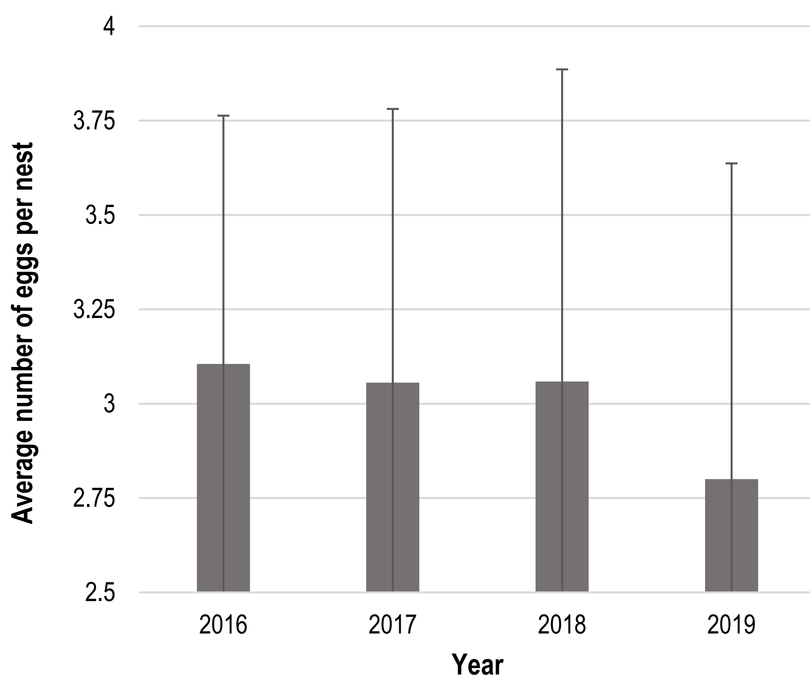


Figure 7. Southwestern Willow Flycatcher clutch size by year at the upper San Luis Rey River monitoring area, San Diego County, California, 2016–19. Error bars represent standard deviations.

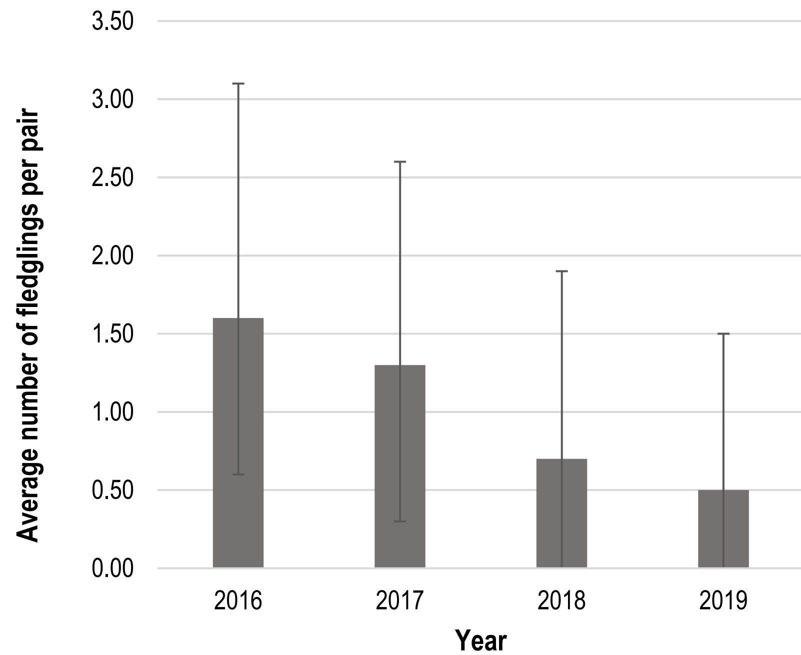


Figure 8. Southwestern Willow Flycatcher fledglings per pair by year at the upper San Luis Rey River monitoring area, San Diego County, California, 2016–19. Error bars represent standard deviations.

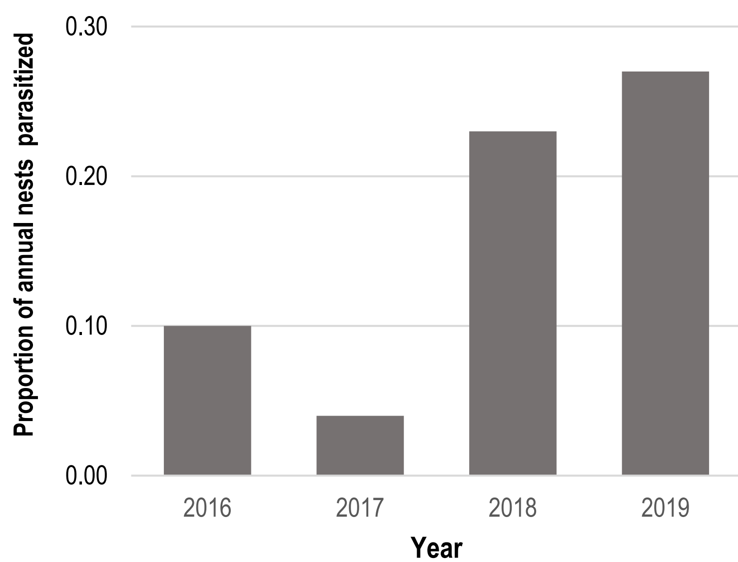


Figure 9. Proportion of Southwestern Willow Flycatcher nests parasitized by Brown-headed Cowbirds by year at the upper San Luis Rey River monitoring area, San Diego County, California, 2016–19.

Survival

A total of 83 nestling flycatchers (57 of which survived to fledge) and 36 adults were color banded in the upper San Luis Rey monitoring area between 2015 and 2018 (Howell et al., 2022). Of these, 50 individuals (31 males and 19 females), plus one male originally banded in the study area in 2010, and one female immigrant from MCBCP, were resighted during surveys and monitoring. Annual survival was calculated for an "Adults only" group (n=52), which included 38 flycatchers banded as adults and 14 first-year flycatchers that returned to breed in study area. Adult annual survival estimates were significantly higher for male flycatchers compared to female flycatchers (69 ±7 percent vs. 45 ±10 percent, respectively). Annual survival was also calculated for an "Adults and first-year birds" group (n=95; 38 adults and 57 nestlings), and included age, year, and previous year precipitation covariates. Survival of adult flycatchers was significantly higher than that of first-year flycatchers; annual survival ranged from 52 to 75 percent for adults, and from 24 to 41 percent for first-year birds. There was no evidence that previous year precipitation influenced annual survival of either age class.

Dispersal

Adult flycatchers in the monitored population exhibited high territory fidelity, with 69 ±13 percent returning to the same breeding territory from year to year (table 2; Howell et al., 2022). Adult flycatchers successful in fledging young in the prior year were more likely to return to the same breeding territory than unsuccessful birds (Howell et al., 2022). The average distance moved between years by adult flycatchers was 0.5 ± 0.8 km (0.3 ± 0.5 mi; Howell et al., 2022). In contrast, first-year flycatchers in the monitored population dispersed, on average, 3.1 ± 2.6 km (1.9 ± 1.6 mi; Howell et al., 2022). While most dispersals by first-year flycatchers were short, two longer distance dispersals were documented during countywide surveys from 2015–19 (Howell et al., 2022). Two females originally banded as nestlings at MCBCP were observed for the first time as breeding adults; one female was last seen in 2013 and dispersed a distance of 55 km (34.2 mi) to the upper San Luis Rey River monitoring area in 2015), while the second was last seen in 2010 and dispersed 41 km (25.5 mi) to breed at the San Dieguito River in 2017 (Howell et al., 2022).

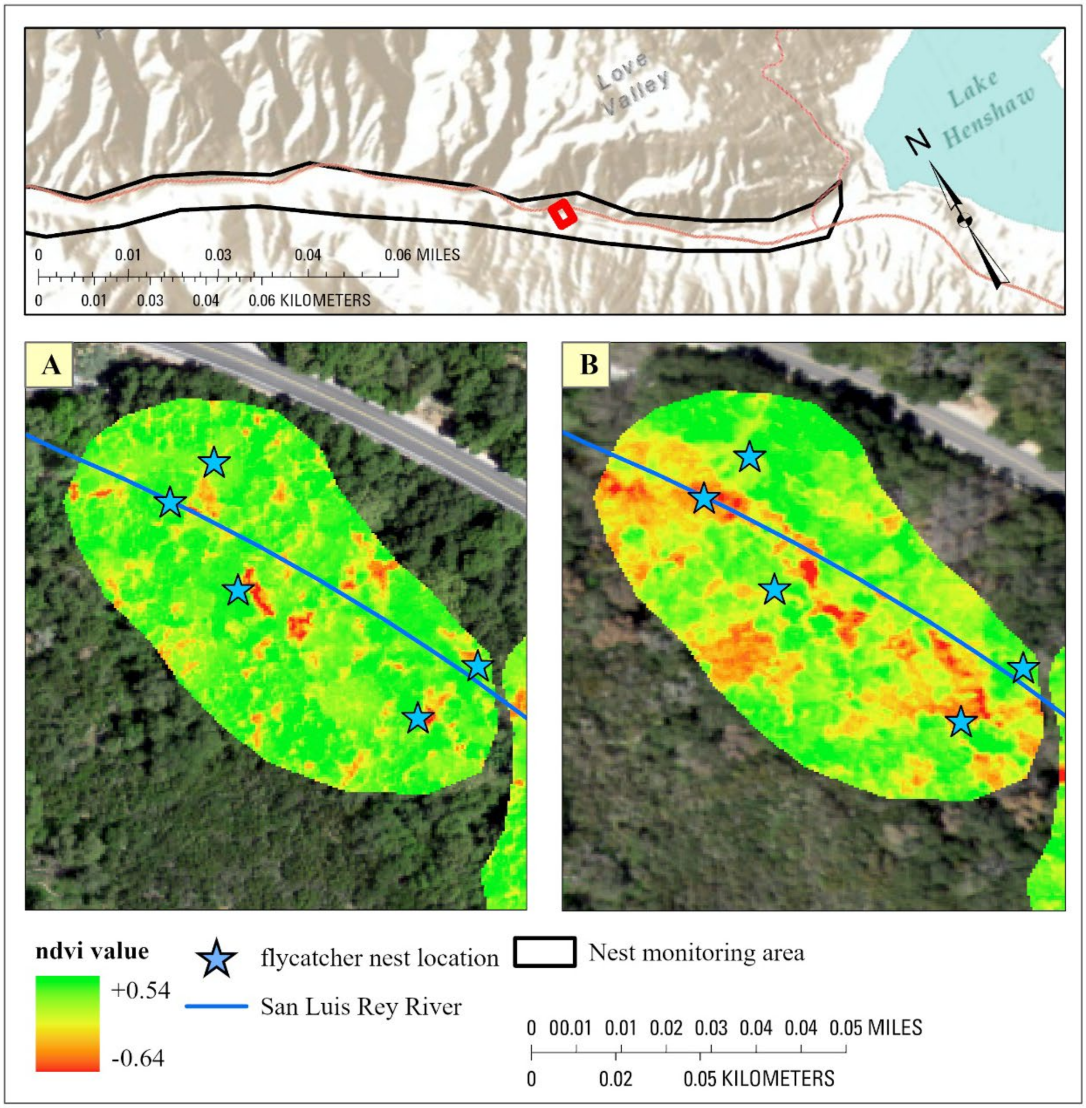
Table 2. Territory fidelity of adult banded Southwestern Willow Flycatchers at the upper San Luis Rey River monitoring area, San Diego County, California, 2015–19. [±, plus or minus; SD, standard deviation]

	Number of adults returning to territory from previous year			Number of territorial adults from previous year			Proportion of adults exhibiting territory fidelity		
Years	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
2015–16	2	1	3	3	1	4	0.67	1.00	0.75
2016–17	5	6	11	7	7	14	0.71	0.86	0.79
2017–18	6	2	8	8	3	11	0.75	0.67	0.73
2018–19	4	0	4	7	1	8	0.57	0.00	0.50
Average±SD							0.68±0.08	0.63±0.44	0.69±0.13

4.3 Flycatcher Breeding Habitat and Nest Site Characteristics

Howell et al. (2022) collected vegetation data in flycatcher territories at the upper San Luis Rey River population downstream from Lake Henshaw from 2016–19. Investigators recorded the dominant plant species in each monitored flycatcher territory and host plant species at flycatcher nest locations. In 2018, investigators began noticing dead and dying oaks in the monitoring area. To aid in evaluating habitat changes in flycatcher territories related to dead and dying oaks, normalized difference vegetation indices (NDVI) were computed and compared between 2016 and 2020 in all territories occupied by resident flycatchers between 2016 and 2019.

As previous studies have shown, coast live oak is one of the primary components of the habitat at the upper San Luis Rey River monitoring area (Kus et al., 1999; Howell and Kus, 2010). The high proportion of oak in the upper San Luis Rey River monitoring area is unusual in that most of the occupied flycatcher habitats are primarily dominated by more typical riparian vegetation such as willow, cottonwood, and alder. From 2016–19, coast live oak was a co-dominant species in 63 percent of flycatcher territories. Coast live oak was also the most commonly used nest host, with 70 percent of nests placed in this species. Howell et al. (2022) found that NDVI values decreased in 49 percent of flycatcher territories. The change is visually apparent with the spectrum of NDVI values overlaid on aerial imagery in one example territory (fig. 10) that showed a decline in overall NDVI values: live vegetation appears green on the image, and dead vegetation appears red (the San Luis Rey River also appears as “dead” vegetation within the image). This particular territory was occupied for 3 years of the study (2016–18) but was vacant in 2019. The oak death was likely the result of goldspotted oak borer infestation. In the areas with dead oaks, the canopy appeared to be more open and there were more gaps in the habitat; this may have created additional opportunities for predation and parasitism. Howell et al. (2022) found no differences between years in nest placement and no indication that flycatchers adjusted their nest placement to avoid oak trees. Coast live oak remained the most commonly used nest host even in later years after dead and dying oaks were observed.



Base from U.S. Geological Survey and other Federal and State digital data, various scales; World terrain from Esri and its licensors, copyright 2025;
Geographic coordinate system, World Geodetic System of 1984

Adapted from Howell et al. (2022)

Figure 10. Comparison of NDVI values from A, 2016 to B, 2020 at a Southwestern Willow Flycatcher territory (in red box, upper panel) at the upper San Luis Rey River monitoring area, San Diego County, California.

5 Management Strategy to Promote Recovery

The long-term regional management goal for Southwestern Willow Flycatchers on conserved lands in San Diego County (SDMMP and TNC, 2017) is to:

"Protect, enhance, and restore Southwestern Willow Flycatcher occupied and historically occupied habitat to create resilient, self-sustaining populations that provide for persistence over the long-term (>100 years)."

Research studies and monitoring conducted from 2015–23 revealed that the flycatcher population on conserved lands in San Diego County is extremely limited. The management considerations outlined here follow the general management strategy of bolstering populations on conserved lands and identifies location-specific considerations, threat analyses, and management options for reducing threats and improving habitat quality that can guide flycatcher recovery. These regional strategies and options are a resource land managers can use when designing habitat management projects to benefit flycatchers. Some of the key factors considered in Southwestern Willow Flycatcher management strategy include:

- Flycatcher populations have a history of decline rangewide due to habitat loss and fragmentation, and possibly Brown-headed Cowbird nest parasitism. Losses that occurred prior to the 1970s were first highlighted by Unitt (1987). The species was listed as state endangered in 1992 and federally endangered in 1995.
- Rangewide, flycatcher populations consist of many small populations (<5 territories) and a small number of large populations (>10 territories). Small flycatcher populations are vulnerable to local extinction. From 1993-2001, 61 of the 65 flycatcher sites that were extirpated contained fewer than five territories (Sogge et al., 2003).
- Only two small populations (<5 territories) were located during surveys in San Diego County from 2015–19 (Bonsall and San Dieguito), and follow-up surveys from 2020–23 documented extirpation in both populations.
- Only one large population (>10 territories) was documented in San Diego County during surveys from 2015 to 2023 (upper San Luis Rey River).
- Between 2018 and 2023, the large population along the upper San Luis Rey River that had been present since the 1980s shifted from downstream of Lake Henshaw to the habitat surrounding Lake Henshaw. The shift was likely prompted by habitat decline downstream in combination with large expanses of new riparian growth at Lake Henshaw following reservoir drawdown during a long-term drought from 2012–16.
- At Marine Corps Base Camp Pendleton, the once stable population along the Santa Margarita River that peaked in 2004 with 23 territories was reduced to a single territory by 2023 (Howell and Kus, 2025).
- The demography study conducted at the upper San Luis Rey River population revealed that the monitored population suffered from low reproductive parameters in some years, including nest success (ranging from 11-37% annually) and seasonal productivity (0.5 ± 1.0 to 1.6 ± 1.5 fledglings per pair annually; Howell et al., 2022).
- Annual Brown-headed Cowbird parasitism of flycatcher nests at the upper San Luis Rey River ranged from 4–10 percent in 2016 and 2017, and 23–27 percent in 2018 and 2019 (Howell et al., 2022). No cowbird trapping occurred from 2016–19, but the site was previously trapped from 1992–99 (Wells, 1999). At Marine Corps Base Camp Pendleton,

a trapping program in place since 1983 has been effective in reducing parasitism to zero (Kus and Whitfield, 2005).

- Nests in 2017 experienced lower predation and parasitism which translated into earlier fledge dates (Howell et al., 2022), which has been related to higher first-year survival (Whitfield and Strong, 1995; Paxton et al., 2007).

- In 2018, USGS biologists observed dead and dying oaks along the San Luis Rey River downstream of Lake Henshaw, which was later attributed to GSOB infestation. In the areas with dead oaks, the canopy appeared to be more open and there were more gaps in the habitat, which may have created additional opportunities for predation and cowbird parasitism.

- Adult flycatchers exhibit high site fidelity and the majority return to the previous year's territory each year.
- Adult flycatchers may move short distances to occupy a new habitat patch between years, especially if nest success was reduced in the previous year (Paxton et al., 2007; Howell et al., 2022), but they would be more likely to move somewhere close to their previous location (Paxton et al., 2007; Theimer et al., 2018).
- While most movements by adult flycatchers are short, Howell et al. (2022) also documented an adult male that moved 31 km within the same breeding season (Allen et al., 2018).
- Natal/first-year flycatcher dispersal documented in the monitored upper San Luis Rey population averaged 3.1 ± 2.6 km (Howell et al., 2022).

- Flycatchers are more likely to colonize habitat in close proximity to existing habitat, and first-year flycatchers are the most likely candidates to colonize new habitat.

- Flycatchers are sometimes described as having semi-colonial nesting behavior and often cluster into a small portion of a larger habitat patch (U.S. Fish and Wildlife Service, 2002).

- Several of the important components of stable metapopulations have been disrupted in San Diego County; only a small number of occupied sites remain, and those remaining are isolated. In the 1990s and 2000s, multiple small populations existed in San Diego County, most within close proximity to the large population at MCBCP. These small populations contributed to metapopulation stability through immigration and emigration, which was documented multiple times (Howell and Kus, 2025). There are no longer any small populations in San Diego County.

- Aside from the habitat directly downstream, the Lake Henshaw population is approximately 30 km distant from the next closest suitable habitat. The USFWS recovery plan suggests that locations within 15 km of a source population are the most likely to be colonized (U.S. Fish and Wildlife Service, 2002).

- The USFWS recovery plan suggests that locations larger than 25 ha (61.8 ac) are more stable within the metapopulation framework, and would have ample habitat for population expansion (U.S. Fish and Wildlife Service, 2002).

- Conspecific attraction, the tendency for individuals of a species to settle near one another, has been successfully used as a tool for recolonizing restored Sierra Nevada meadows by willow flycatchers (Schofield et al., 2018). Conspecific playback has also been used locally at MCBCP since 2018 with some success (Howell and Kus, 2025).

- Many riparian habitats in San Diego County are impacted by urbanization, including the lower and middle San Luis Rey River, San Diego River, Sweetwater River, Otay River, and Tijuana River. Several locations that contain suitable or potentially suitable flycatcher habitat are subject to current or future planned water management activities that could alter hydrology and impact habitat suitability. Plans to manage cross-border sewage flows in the Tijuana River Valley include diverting treated water away from the river, which will likely impact the amount of suitable riparian (PG Environmental, 2021). At MCBCP, water drawdowns and diversions are occurring, which will likely place additional stress on the riparian habitat that has already lost many of the natural processes, such as large floods, that played a role in creating suitable habitat for the flycatcher population. The current population at Lake Henshaw could be subject to reductions in habitat availability as water levels in the reservoir fluctuate.

- Fire has occurred in many of the occupied riparian habitats in San Diego County, including Bonsall along the middle San Luis Rey River, which was occupied in 2015. Bonsall was affected by the Lilac fire in 2017, which burned the majority of the habitat where breeding birds had occurred since 2006. Fires have also occurred in other occupied or suitable breeding locations, including the San Diego River above El Capitan Dam (2003 Cedar Fire), San Dieguito River/Santa Ysabel Creek (2007 Witch Fire), Sweetwater Reservoir (2007 Harris Fire), and according to fire maps, the habitat downstream from Lake Henshaw (1974 River Fire).

Based on these findings, it is important to develop management strategies to ensure the persistence of the Southwestern Willow Flycatcher in San Diego County. Existing populations are vulnerable to further decline in size, especially when subjected to habitat degradation and cowbird parasitism. The upper San Luis Rey/Lake Henshaw population is essential to the persistence of flycatchers within the MSPA, as it is the only remaining population in San Diego County with breeding flycatchers, and therefore will be the only source for recolonization. Reestablishing populations on conserved lands in close proximity to Lake Henshaw will be critical because the flycatchers need additional suitable habitat to move into if something happens to the existing habitat at Lake Henshaw, and in order to expand populations in San Diego County. Based on the analysis of data presented in the first part of this document, a regional strategy is described in the next section, followed by site-specific management options and priorities.

5.1 Bolster existing populations by increasing productivity and first-year survival

A demographic analysis included in the USFWS recovery plan concluded that management designed to increase the number of fledglings per female would have the greatest impact on population growth, followed closely by increasing first-year survival (U.S. Fish and Wildlife Service, 2002). The first priority is increasing productivity and first-year survival at the only remaining flycatcher source population, Lake Henshaw (fig. 11). Increasing productivity and fostering conditions that promote high first-year survival offers the best potential for recolonizing historically occupied flycatcher habitat on conserved lands, such as at Cleveland National Forest, San Dieguito River, El Capitan, and Bonsall–I15. Higher productivity in 2017 observed during demographic monitoring from 2016–19 likely contributed to the population expansion and shift to Lake Henshaw, as most of the first-year flycatchers encountered in later years originated in 2017 (Howell et al., 2022).

Efforts to mitigate low productivity by initiating cowbird control, especially during drought years when flycatchers may experience increased parasitism and predation, could create conditions that expand populations. The USFWS recovery plan suggests that cowbird control be explored when parasitism rates exceed 20–30 percent for two or more years, and also suggests that a lower threshold of 10 percent may be justified if a local population or metapopulation is at increased risk for extirpation (U.S. Fish and Wildlife Service, 2002). Removal of cowbird eggs from accessible parasitized nests during baseline studies is a way to lessen the impacts of parasitism (U.S. Fish and Wildlife Service, 2002). Cowbird control activities (trapping, shooting) and flycatcher nest monitoring with cowbird egg removal could increase productivity, and in turn, increase first-year survival. The effectiveness of cowbird control varies when it comes to augmenting populations because it does not always translate into population expansion (Kus and Whitfield, 2005). However, cowbird control at MCBCP was credited as one of the reasons for population growth in the 1980s (Unitt, 1987) and for increased nest success on the Kern River (Whitfield et al., 1999).

Management options:

5.1.1 Monitoring study at Lake Henshaw to assess parasitism rate (1–2yr baseline with cowbird egg removal when feasible)

5.1.2 After baseline monitoring, if parasitism rate exceeds 10 percent, initiate cowbird management activities

5.2 Expand occurrences via habitat restoration

The second priority is ensuring there are suitable habitats near the source population (Lake Henshaw) to allow for population expansion and to increase metapopulation stability. The USFWS recovery plan recommends increasing the extent, quality, and distribution of riparian habitat close to existing populations to increase the stability of metapopulations (U.S. Fish and Wildlife Service, 2002). Habitat in close proximity to existing populations provides replacement habitat in the event that current habitat is destroyed, and provides new habitat for future population expansion (U.S. Fish and Wildlife Service, 2002). Flycatchers will occupy smaller patches (<10 ha; Sogge et al., 2003), providing an opportunity to restore habitat patches near occupied habitat without requiring more expensive habitat restoration projects.

The extent of currently occupied habitat at Lake Henshaw has likely only developed in recent years, following drought from 2012–16 (Howell et al., 2022). Given the nature and purpose of reservoirs and water storage facilities such as Lake Henshaw, there is a high likelihood that the currently occupied habitat will experience prolonged inundation at some point in the future. Determining if there is any potential habitat that can be restored above the average high-water line at Lake Henshaw could allow the population to persist at this location. This additional habitat could also allow the population to expand.

An equally important location to restore is the conserved land downstream of Lake Henshaw at Cleveland National Forest and possibly Vista Irrigation District lands, where the upper San Luis Rey River population resided before moving to Lake Henshaw. This area downstream from the currently occupied location has been altered by GSOB infestation, which caused a large number of oaks to die, creating gaps in the canopy, and changing the overall character of the habitat. Efforts to return this area to a more willow-dominated riparian by planting more willows could increase cover and fill in canopy gaps, which in turn may increase nest success by reducing predation and parasitism risk. This area is the most likely area for flycatchers to move into if the habitat at Lake Henshaw is compromised by prolonged inundation, or when the population at Lake Henshaw increases and population expansion occurs.

Lastly, assessments to evaluate the habitat suitability at other potential flycatcher occupancy locations, and development of restoration plans that ensure locations have vegetation characteristics within the range of those found at occupied sites would support flycatcher recovery.

<u>Management options</u>:

5.2.1 Explore high water refugia options above the high-water line at Lake Henshaw and support land managers in developing a restoration plan to ensure flycatchers have alternative habitat to occupy when prolonged inundation occurs. Such a plan could include strategies for active restoration (for example, planting shrubs and trees) and passive restoration (for example, through grazing management)

5.2.2 Evaluate restoration options on conserved lands downstream of Lake Henshaw to mitigate GSOB effects

5.2.3 Develop habitat assessment protocol for use in determining if habitat is suitable for breeding flycatchers

5.2.4 Conduct habitat assessment at high priority (see below in section 6.2 for discussion of prioritization criteria) locations and identify restoration options for improving habitat as warranted

5.3 Explore options for restoring riparian habitat via increased water flow and mimicking natural hydrology in managed systems

In many cases, restoring the hydrological conditions that create suitable riparian conditions will be necessary for the success of habitat restoration plans. However, with the majority of water sources managed in some way, determining ways to mimic natural hydrology could play a role in successful habitat restoration. In some occupied flycatcher habitats, water has been pumped across the landscape to simulate a flooded system and encourage habitat for flycatchers, and agricultural return flows have been used to increase survival of riparian vegetation following restoration projects (Briggs and Cornelius, 1998; U.S. Fish and Wildlife Service, 2002; Smith and Johnson, 2008). Additionally, MCBCP has created a series of artificial seeps to hydrate areas that flycatchers previously occupied, but flycatchers have since abandoned (Howell and Kus, 2025).

Determining if locations have the proper hydrological conditions to support suitable breeding habitat will aid in flycatcher recovery. Developing a simplified way for non-hydrologists to assess and evaluate hydrological conditions could aid in flycatcher recovery, to ensure that restoration efforts are not wasted on areas that no longer have the hydrology to support suitable riparian habitat. The following options could be explored to restore hydrological conditions that encourage habitat growth and enhance habitat suitability for flycatchers: (1) explore ways to return water flows in managed systems; (2) identify potential changes in water release timing that might benefit flycatcher habitat in managed water regimes; (3) identify areas where water surpluses/flood flows can be used to mimic the natural flood cycle in managed systems; (4) explore ways to use urban waste water for habitat restoration to expand habitat; and (5) explore ways to reactivate flood plains by pumping water across areas to aid in willow seed recruitment to expand native riparian forests.

Management options:

- 5.3.1 Develop hydrology assessment for evaluating hydrological conditions that support suitable habitat
- 5.3.2 Conduct hydrological assessment at locations supporting riparian habitat
- 5.3.3 Work collaboratively with state/county watershed regulators and water management agencies to maintain or improve hydrological conditions that support flycatcher habitat, if warranted

5.4 Expand knowledge of existing populations and potential expansion sites

Continued surveillance of the remaining population is needed to identify and mitigate any newly emerging threats. Given that the Lake Henshaw population is the last remaining population of breeding flycatchers, continued surveillance to evaluate potential management activities is warranted. Regular and ongoing monitoring enables action against new threats to be implemented quickly, reducing negative effects on existing populations.

Regular surveillance including standardized surveys at high and medium priority (see below in section 6.2 for discussion of prioritization criteria) locations on a rotational schedule would facilitate detection of any new colonization that occurs. Standardized and systematic surveys conducted every 2–3 years at high priority locations would encompass the average lifespan of a flycatcher, and ensure that new colonization is not overlooked. Surveys of medium priority locations every 5 years would allow detection of any changes in habitat suitability or other factors that might change that location's ranking and associated survey frequency.

Lastly, annual updates and evaluation of the HSM (Hatten, 2016) allow for identification of any newly predicted suitable habitat. Newly suitable locations could then be included in the following year's survey rotation.

Management options:

5.4.1 Continue to survey source populations and recently occupied locations (less than 5 years) annually
5.4.2 Conduct demographic monitoring at Lake Henshaw to identify unique threats
5.4.3 Survey high priority locations every 2–3 years
5.4.4 Survey medium priority locations every 5 years
5.4.5 Survey any "newly suitable" locations identified by HSM in the following years survey rotation

5.5 Encourage establishment of additional populations on conserved lands

The long-term persistence of the flycatcher population within the MSPA is likely dependent upon establishing or reestablishing additional populations within close proximity to the existing source population at Lake Henshaw. However, there are several high priority locations on conserved lands that may be farther away from the source population, and beyond the expected dispersal distances of flycatchers. Conspecific attraction, the tendency for individuals of a species to settle near one another, has been successfully used as a tool for recolonizing restored Sierra Nevada meadows by Willow Flycatchers (Schofield et al., 2018). Conspecific playback has been used locally at MCBCP since 2018 with some success. Setting up automated playback units that broadcast flycatcher vocalizations during the migratory period when first-year flycatchers are looking for locations to settle, especially following years with high productivity, could encourage colonization of high priority locations located farther than 15 km (9.3 mi) from the source population.

Management options:

5.5.1 Conspecific playback at high priority locations greater than 15 km (9.3 mi) from source populations following high productivity years to encourage settlement

5.6 Create best management practices and early detection system for SHB in occupied habitat

The invasion of SHB at the Tijuana River devastated the habitat, damaging mature willow trees within months of the SHB's arrival (Boland, 2016). An invasion of SHB at Lake Henshaw could result in population declines. Developing best management practices that include an early warning system to identify infestations in habitat within SHB dispersal distance of Lake Henshaw would provide some insurance against SHB habitat destruction at Lake Henshaw. Best management practices could also include a plan to increase surveillance if local entities that previously conducted trapping along riparian corridors in San Diego County discontinue their surveillance program.

Management options:

5.6.1 Develop and implement an early warning system to detect SHB in nearby habitat, before it reaches occupied habitat

5.7 Create best management practices for fire management in occupied habitat

A fire management plan that works in coordination with local firefighters and land managers to ensure that if a fire breaks out in occupied or potential expansion locations, the fire is suppressed in a way that minimizes the impact on flycatchers. Plans could include steps for preventing wildfires, and steps to evaluate if restoration including non-native habitat removal is warranted post-fire.

Management options:

5.7.1 Develop a fire management plan for occupied and potential flycatcher habitats

6 Evaluation of Potential Locations for Management Actions

Riparian habitat within San Diego County was evaluated based on several criteria to determine which locations offer the best potential for expanding flycatcher populations within the MSPA. Factors such as habitat suitability, current occupation, historical occupation, habitat extent, and proximity to existing populations were used in the evaluation.

6.1 Flycatcher Suitability Model

A flycatcher habitat suitability model (HSM) was used to identify and prioritize locations predicted to have suitable flycatcher habitat for management within the MSPA (Appendix 1, fig. 1.1; Hatten and Paradzick, 2003; Hatten, 2016, 2022). The 2022 HSM output, which used Landsat satellite images obtained in 2022, was used in the evaluation of potentially suitable habitat (Hatten, 2022). Proposed locations selected using the HSM had greater than 40-percent probability of suitable habitat, and locations that included predictions in the two highest suitability categories (greater than 60 percent and greater than 80 percent; Hatten, 2016) were prioritized. A “HSM score” was calculated by dividing the sum of the number of hectares with 60 percent suitability and 80 percent suitability by the total number of hectares (ha) within the habitat patch [(60% ha+80% ha)/Patch ha]. Predicted habitat patches with a higher proportion of suitable habitat in the two highest suitability categories were prioritized because this indicates a higher likelihood there is suitable flycatcher habitat present.

6.2 Prioritization Factors

Thirty-nine locations were evaluated and ranked in terms of their potential to support breeding flycatchers. The following factors were deemed important based on flycatcher biology, conserved lands status, etc. (table 3).

- Locations with current occurrences
- Locations on conserved lands within the MSPA
- Proximity to source population
- Locations with historical occurrences
- Locations with a higher HSM score
- Larger locations (Patch size in ha)

These criteria were used to evaluate and determine the closest potential locations for population expansion and establishment of additional populations (figs. 11–15; table 3). The scores from individual criteria were accumulated and locations were assigned high, medium, or low priorities. All prioritizations are based on the most current information and may change under future conditions.

High:

1. Current population, or
2. Locations within 15 km (9.3 mi) of source population on conserved lands, regardless of HSM score
3. Locations within 40 km (24.9 mi), plus historical occurrence, conserved lands, patch size >25 ha (61.8 ac), and HSM score greater than 0.50 (El Capitan, San Dieguito)
4. Locations within 60 km (37.3 mi), plus historical occurrence, conserved lands, patch size >25 ha (61.8 ac), and HSM score greater than 0.75 (Bonsall–I15)

Medium:

1. Locations within 15km (9.3 mi) of source population, plus historical occurrences, but not on conserved lands (Rey River Ranch), regardless of HSM score
2. Locations within 40km (24.9 mi), plus historical occurrences, conserved lands, patch size >25 ha (61.8 ac), and HSM score less than 0.50 (Santa Ysabel)
3. Locations within 40km (24.9 mi), plus historical occurrences, not on conserved lands, and HSM score greater than 0.50 (Pala)

4. Locations greater than 40km (24.9 mi), plus historical occurrence, conserved lands, patch size >25 ha (61.8 ac), and HSM score greater than 0.50 (Guajome Lake)
5. Locations greater than 40km (24.9 mi), no historical occurrence, conserved lands, patch size >25 ha (61.8 ac), and HSM score greater than 0.75 (Santee)

Low:

1. Locations that do not meet the criteria for high or medium priority

Locations on conserved lands within 15 km (9.3 mi) of the source population at Lake Henshaw were given the highest priority, as these are the locations most likely to be colonized by dispersing flycatchers in the future (table 3). The closest locations to the existing source population are those downstream, where the upper San Luis Rey population resided before the shift to Lake Henshaw (fig. 11). With the exception of Rey River Ranch, which is on private land, all locations downstream and the San Luis Rey River West Fork were assigned high priority (table 3). Several additional locations that have the best potential for expanding occurrences, and are on conserved lands were identified: the San Luis Rey/Bonsall–I15 (fig. 12; approximately 46 km [28.6 mi] from Lake Henshaw), San Dieguito River (fig. 13; approximately 35 km [21.7 mi] from Lake Henshaw), and El Capitan (fig. 14; approximately 31 km [19.3 mi] from Lake Henshaw). While these locations are not close, they are within the "long-distance dispersal" distances observed by USGS (Howell et al., 2022). High priority was also assigned to MCBCP's Santa Margarita River, despite this historical location's distance from Lake Henshaw (58 km [36 mi]; table 3), and not being within the MSPA. The Santa Margarita River was one of two large populations historically present in San Diego County, it contains the largest contiguous block of riparian habitat, and it will be crucial to restoring regional metapopulation stability.

Medium priority locations will have a key role to play in flycatcher recovery in San Diego. Many of these are large habitat patches with the potential to support large populations of flycatchers in the future. In many cases, these locations have historical occurrences, but may need some management such as restoration to provide suitable habitat for flycatchers in the future. Management actions at locations along the San Luis Rey River near MCBCP that are within the MSPA, such as Guajome Lake, and Whelan Lake, and which historically provided sources of immigrant flycatchers to MCBCP, could serve to bolster populations at MCBCP. The Sweetwater River area includes two locations, one at Sweetwater Reservoir and one at the San Diego National Wildlife Refuge, and while they are very far from the source population, together they provide a large block of high quality riparian habitat that could be occupied in the future if populations at Lake Henshaw expand.

Some of the locations that are low priority at the present time could be elevated in priority in future years if conditions change. For example, Agua Hedionda is currently low priority, but if the nearby population at MCBCP improves, then this location would be in closer proximity to a source population, and would be elevated to medium priority. Two locations that were not previously surveyed, Horse Ranch Creek and Lake Cuyamaca, may benefit from future evaluation. A territorial flycatcher was reported at Horse Ranch Creek in 2011, but the location was not on conserved lands and was not included in surveys completed by Howell et al. (2022); the ownership has now changed and a portion of the land is conserved. At Lake Cuyamaca, Unitt (1987) reported at least one breeding flycatcher at that location in 1984, but none when he followed up in 1986, and no habitat was observed during a brief evaluation in 2019 (S. Howell, U.S. Geological Survey, pers. obs., 2019). Lake Cuyamaca habitat may develop at some point in the future, or be a candidate for restoration activities.

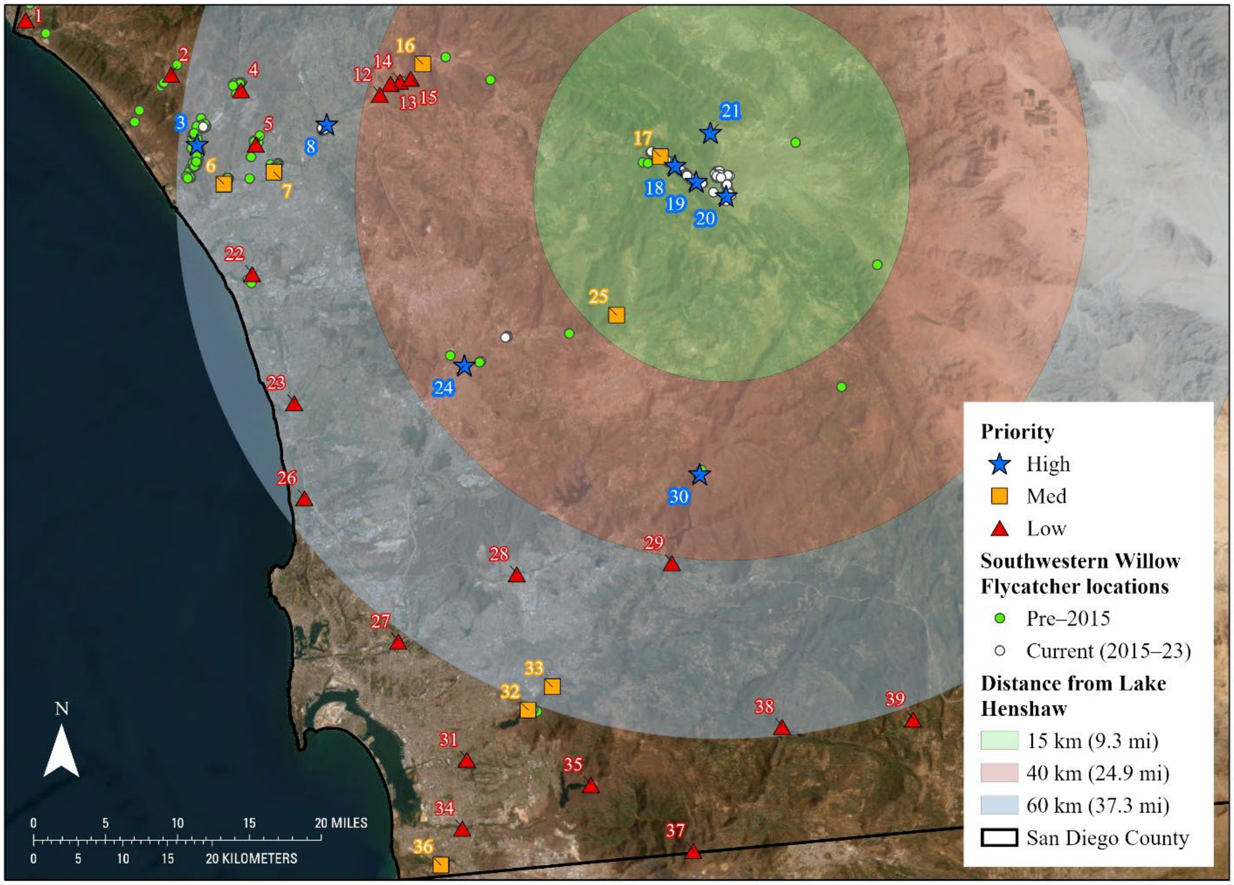
Table 3. Evaluation of flycatcher locations in San Diego County for prioritization.

[Loc #, corresponds to location number on figure 2 and table 1; NS, not surveyed 2015–23. Location: sorted by proximity to source population at Lake Henshaw. Shading on table corresponds to shading in figure 11. Green, within 15 km (9.3 mi), Pink = within 40 km (24.9 mi), Blue = within 60 km (37.3 mi); Hist Occ, Historical occupancy; N, no; P, pre-1987 (Unitt, 1987); U, unknown; Y, yes; HSM score, (HSM60%+HSM80%/Patch size (ha); Ha, hectares; %, percent; Abbreviations: #, number; Consv., conserved; HSM, habitat suitability model; Loc, location; MCBCP, Marine Corps Base Camp Pendleton; Mgmt, Management; SDNWR, San Diego National Wildlife Refuge]

Loc #	Location	Proximity (closest)	Hist Occ	Consv. Land	Patch size (Ha)	HSM 40%	HSM 60%	HSM 80%	HSM score	Priority
20	Lake Henshaw	0.0	U	Special District	153.8	32.1	54.1	67.6	0.79	High
21	West Fork	1.8	U	Special District	8.2	5.7	2.5	0.0	0.30	High
19	Vista Irrigation District	1.9	Y	Special District	15.0	7.7	4.9	0.0	0.33	High
18	Cleveland National Forest	3.4	Y	Yes	18.0	9.2	3.8	0.0	0.21	High
17	Rey River Ranch	6.4	Y	No	21.0	10.2	5.2	0.0	0.25	Med
25	Santa Ysabel Creek	17.5	Y	Yes	28.1	23.4	4.5	0.2	0.16	Med
30	El Capitan	30.5	Y	Yes	72.9	28.6	27.9	16.4	0.61	High
24	San Dieguito River	35.3	Y	Yes	98.7	39.9	40.9	18.0	0.60	High
NS	Lake Cuyamaca	36.2	P	Mixed	0.3	0.2	0.1	0.0	0.33	Low
16	Pala Indian Reservation	39.2	Y	Tribal	15.2	5.4	4.4	5.4	0.64	Med
15	MSLR/Gregory Canyon	42.0	U	No	12.7	4.0	6.0	2.7	0.69	Low
14	MSLR /Couser Canyon	43.4	Y	No	11.6	4.6	3.9	2.8	0.57	Low
13	MSLR /Pankey Ranch	44.1	Y	No	10.4	6.5	3.8	0.2	0.38	Low
NS	Horse Ranch Creek	45.3	Y	Mixed	0.0	0.0	0.0	0.0	0.00	Low
12	Pala Gateway	45.6	U	Tribal	11.0	1.4	3.3	6.3	0.88	Low
8–11	Bonsall–I15[1]	46.2	Y	Mixed	136.5	22.3	30.9	83.2	0.84	High

Loc #	Location	Proximity (closest)	Hist Occ	Consv. Land	Patch size (Ha)	HSM 40%	HSM 60%	HSM 80%	HSM score	Priority
29	Chocolate Canyon	47.4	Y	Mixed	1.1	1.1	0.0	0.0	0.00	Low
7	Guajome Lake	49.7	Y	Yes	83.9	34.4	33.7	15.8	0.59	Med
5	MCBCP/Pilgrim Creek	52.0	Y	Military	15.7	7.3	8.4	0.0	0.53	Low
28	Santee	52.4	N	Mixed	60.8	18.7	18.6	23.5	0.69	Low
4	MCBCP/Fallbrook Creek	55.0	Y	Military	3.3	1.2	0.2	2.0	0.65	Low
6	Whelan Lake	55.0	Y	Yes	87.1	17.3	24.1	45.7	0.80	Med
3	MCBCP/Santa Margarita River	58.0	Y	Military	467.7	119.4	174.8	173.5	0.74	High
23	Escondido Creek	60.6	U	Yes	31.9	17.9	10.1	3.9	0.44	Low
22	Agua Hedionda Creek	61.5	U	Yes	24.1	6.9	10.0	7.2	0.71	Low
2	MCBCP/Las Flores Creek	64.1	Y	Military	54.6	33.4	19.9	1.4	0.39	Low
33	SDNWR	66.6	N	Yes	58.8	3.8	22.0	33.0	0.94	Med
26	Los Peñasquitos Creek	68.1	U	Yes	52.9	14.6	21.0	17.4	0.72	Low
27	Valley	70.6	Y	Mixed	21.3	4.2	3.3	13.8	0.80	Low
32	Sweetwater Reservoir	71.8	Y	Yes	77.8	23.0	23.8	31.0	0.70	Med
39	Cottonwood Moreno	72.0	N	Yes	13.8	8.2	5.3	0.3	0.41	Low
38	Cottonwood Barrett	72.2	U	Yes	0.0	0.0	0.0	0.0	0.00	Low
31	Sweetwater 805	78.6	U	Yes	43.7	18.3	15.0	10.4	0.58	Low
35	Jamul Creek	79.4	P	Yes	18.3	3.2	6.0	9.0	0.82	Low
1	MCBCP/San Mateo Creek	79.6	Y	Military	1.2	0.5	0.6	0.0	0.54	Low
37	Marron Valley	86.2	U	Yes	12.8	5.9	6.4	0.5	0.54	Low
34	Otay I5-Heritage	88.4	N	Mixed	22.3	11.7	9.0	1.5	0.47	Low
36	Tijuana River	95.8	P	Yes	141.1	14.1	33.6	93.4	0.90	Med

[1]Bonsall, DOT, Rincon, and East combined for evaluation and prioritization purposes



Base map from Esri and its licensors, copyright 2025

Pre–2015 locations from Kus and Beck (1998), Kus et al. (1999, 2003), Varanus Biological Services (1999, 2000), and Howell and Kus (2025); current locations from Howell et al. (2022), Howell and Kus (2021, 2022, 2023, 2024)

Figure 11. Southwestern Willow Flycatcher location priorities in relation to source population at Lake Henshaw, San Diego County, California. Ring buffer on figure represents distance to Lake Henshaw and corresponds to shading in table 3. Green buffer, within 15 km (9.3 mi), Pink = within 40 km (24.9 mi), Blue = within 60 km (37.3 mi). High priority (blue star) and medium priority (orange square) locations are named on map, low priority (red triangle) locations unnamed. Abbreviations: SDNWR, San Diego National Wildlife Refuge.

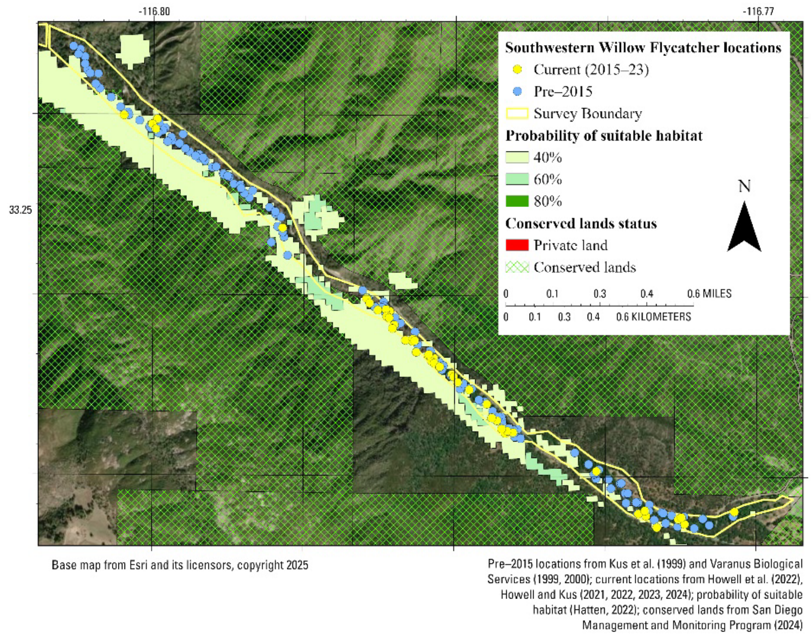


Figure 12. Southwestern Willow Flycatcher High priority management locations with current (2015–23) and historical (pre–2015) occupancy, habitat suitability model (HSM), and conserved lands status: Upper San Luis Rey River; Cleveland National Forest and Vista Irrigation District.

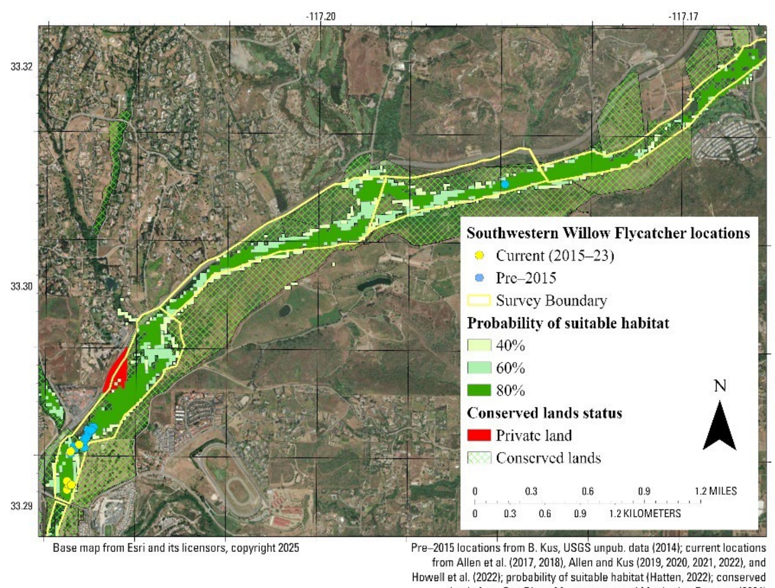


Figure 13. Southwestern Willow Flycatcher High priority locations with current (2015–23) and historical (pre–2015) occupancy, habitat suitability model (HSM), and conserved lands status: San Luis Rey; Bonsall-I15.

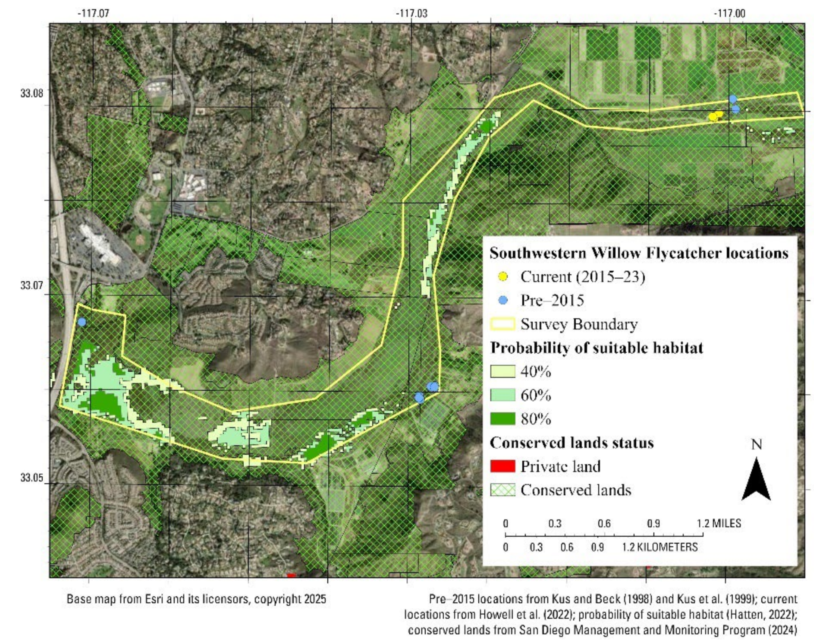


Figure 14. Southwestern Willow Flycatcher High priority locations with current (2015–23) and historical (pre–2015) occupancy, habitat suitability model (HSM), and conserved lands status: San Dieguito River.

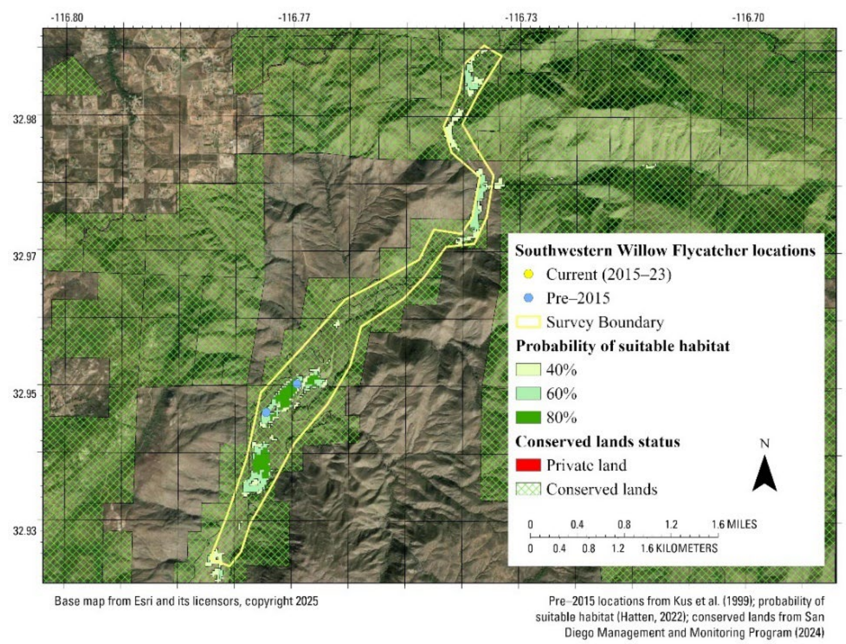


Figure 15. Southwestern Willow Flycatcher High priority locations with current (2015–23) and historical (pre–2015) occupancy, habitat suitability model (HSM), and conserved lands status: San Diego River, El Capitan.

7 Implementation Plan

Based on the management strategies identified in section 5, and the locations prioritized in section 6, the following management options summarize an implementation plan for locations within the MSPA (table 4). Implementation plans for locations not on conserved lands are not addressed in this table.

Table 4. Implementation plan for management options proposed for Southwestern Willow Flycatcher recovery within the MSPA in San Diego County.

[Management option numbers correspond to options in section 5. Abbreviations: DFW, Department of Fish and Wildlife; DPR, Department of Parks and Recreation; MCBCP, Marine Corps Base Camp Pendleton; PUD, Public Utilities Department; SDGE, San Diego Gas and Electric; SDNWR, San Diego National Wildlife Refuge; USFWS, U.S. Fish and Wildlife Service]

Location	Management priority	Management options	Landowner/Manager
Lake Henshaw	High	5.1.1, 5.1.2; 5.2.1; 5.4.1, 5.4.2	Vista Irrigation District
West Fork	High	5.2.1; 5.3.2	Vista Irrigation District
Vista Irrigation District	High	5.2.2; 5.4.1	Vista Irrigation District
Cleveland National Forest	High	5.2.2; 5.4.1	U. S. Forest Service
El Capitan	High	5.2.4; 5.3.2; 5.5.1	City of San Diego PUD; U.S. Forest Service
San Dieguito River	High	5.2.4; 5.3.2; 5.5.1	City of San Diego PUD
Bonsall–I15	High	5.2.4; 5.3.2; 5.5.1	County of San Diego DPR; Caltrans; City of Oceanside
Santa Ysabel Creek	Med	5.4.4	City of San Diego PUD; U.S. Forest Service; California DFW
Guajome Lake	Med	5.4.4	County of San Diego DPR; Caltrans; City of Oceanside; Private
Whelan Lake	Med	5.4.4	City of Oceanside
SDNWR	Med	5.4.4	USFWS
Sweetwater Reservoir	Med	5.4.4	Sweetwater Authority
Tijuana River	Med	5.4.4	County of San Diego DPR; City of San Diego; USFWS
Lake Cuyamaca	Low	5.4.5	California DPR; Helix Water District; Private
Horse Ranch Creek	Low	5.4.5	Fallbrook Land Conservancy; Private
Chocolate Canyon	Low	5.4.5	City of San Diego PUD; SDGE
Valley	Low	5.4.5	California DFW; City of San Diego

Location	Management priority	Management options	Landowner/Manager
Santee	Low	5.4.5	City of San Diego; City of Santee; San Diego River Park Conservancy
Agua Hedionda Creek	Low	5.4.5	California DFW
Escondido Creek	Low	5.4.5	California DFW
Los Peñasquitos Creek	Low	5.4.5	California DPR
Otay I5-Heritage	Low	5.4.5	City of Chula Vista; City of San Diego; County of San Diego, DPR
Jamul Creek	Low	5.4.5	City of San Diego PUD
Sweetwater 805	Low	5.4.5	County of San Diego , DPR
Cottonwood Moreno	Low	5.4.5	City of San Diego; County of San Diego, DPR
Cottonwood Barrett	Low	5.4.5	City of San Diego PUD
Marron Valley	Low	5.4.5	City of San Diego PUD

8 Riparian Restoration Plan

Several high priority flycatcher locations may benefit from habitat restoration to increase or create habitat for breeding flycatchers. Specific management options as discussed above include developing habitat adjacent to the currently occupied habitat at Lake Henshaw to provide habitat above the high-water line and mitigating the impacts of GSOB oak die-off downstream of Lake Henshaw. Options for restoration to increase habitat suitability at San Diego River/El Capitan, San Dieguito River, and the Middle San Luis Rey River/Bonsall–I15 will be addressed following the development and implementation of future habitat assessments.

8.1 Lake Henshaw

Existing Habitat Conditions

The majority of the currently occupied habitat at Lake Henshaw is below the high-water line. There is a risk that the currently occupied habitat will experience prolonged inundation resulting in habitat mortality at some point in the future. Figure 16 shows the impact to current territory locations under a) a high water scenario, and a b) low-average water scenario.

Opportunities for Enhancement and Restoration

Evaluate the extent of habitat above the high-water line and explore opportunities for restoring habitat to support flycatchers. Develop a habitat restoration plan to augment existing available habitat and provide high water refugia. If hydrological conditions are not conducive to seed establishment at time of restoration, explore the feasibility of pumping water from the lake into target restoration area, and then outflow back to the lake to mimic conditions that would be conducive to seed deposition. See fig. 16c for a visual of potential habitat development area outlined in green.

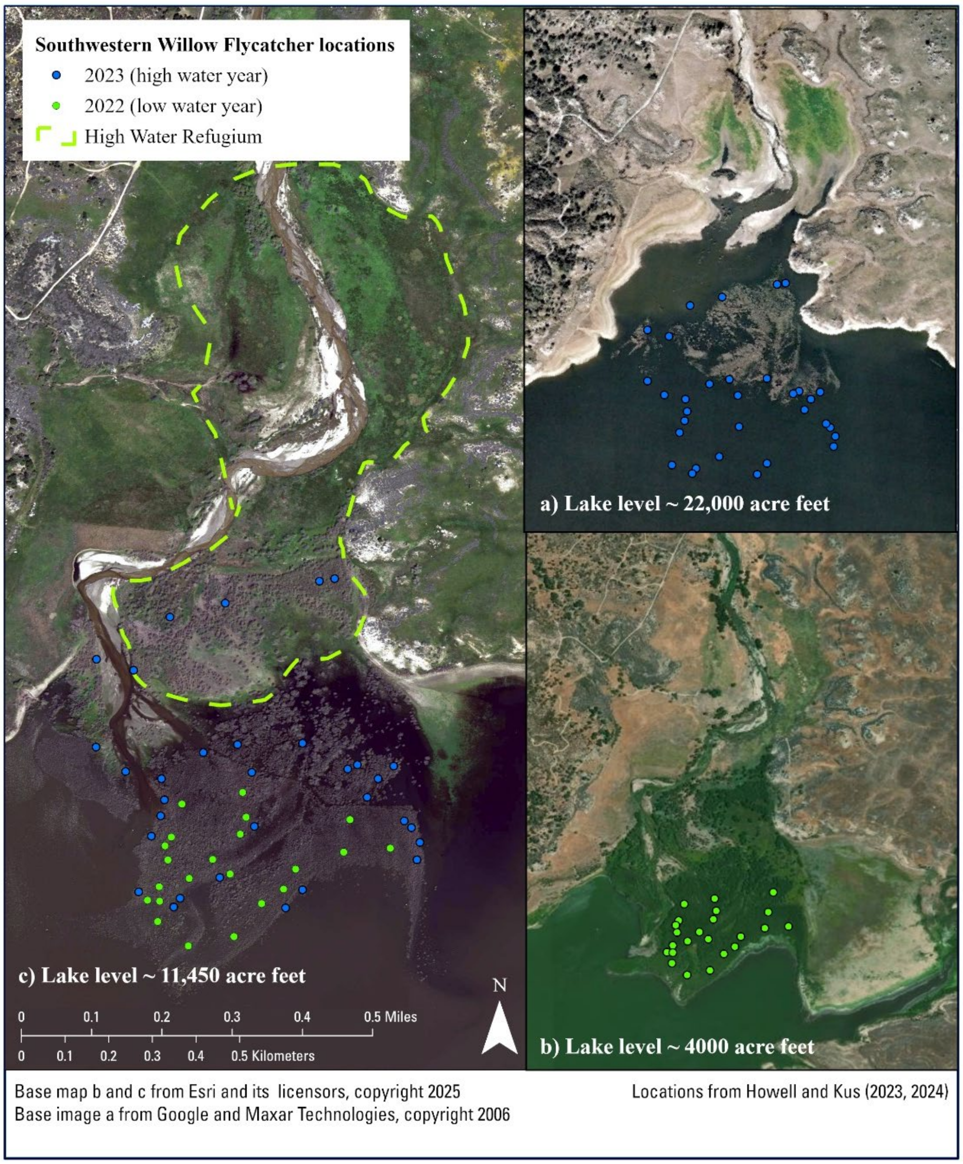


Figure 16. Example of Southwestern Willow Flycatcher territories in currently occupied footprint at Lake Henshaw at a) inundation level (approximately 22,000 acre-feet), b) low level (approximately 4,000 acre-feet), and c) potential footprint of high water refugium, San Diego County, California.

8.2 Upper San Luis Rey Downstream of Lake Henshaw

Existing Habitat Conditions

Oak mortality caused by GSOB. Increased canopy openings caused by dead oaks, likely increased openings for cowbirds and other predators.

Opportunities for Restoration

Evaluate how best to restore riparian habitat downstream from Lake Henshaw, where coast live oak dominates the habitat. Although the habitat component that is impacted by GSOB is coast live oak, it is likely impractical to replant oak, since oak would take a long time to mature. Moreover, the use of oak by nesting flycatchers is atypical and likely related to the site's history. The riparian forest along the upper San Luis Rey River was cleared in the 1950s (Unitt, 1984), and the remnant flycatcher population likely began using oak as an alternative nest substrate. In other occupied riparian habitats, flycatchers primarily nest in more typical riparian vegetation such as willow, ash, alder, etc. The habitat already contains a large component of mid- and overstory riparian vegetation, so replacing openings created by dead oak with faster growing riparian species such as willow and ash could create a suitable habitat for nearby populations at Lake Henshaw to recolonize as the population expands, or during times of prolonged inundation.

8.3 San Dieguito River

Existing Habitat Conditions

Specific habitat conditions unknown. Conduct habitat assessment to evaluate restoration opportunities and potential to improve habitat for flycatchers.

Opportunities for Restoration

Subject to outcome of habitat assessment.

8.4 San Diego River/El Capitan

Existing Habitat Conditions

Specific habitat conditions unknown. Conduct habitat assessment to evaluate restoration opportunities and potential to improve habitat for flycatchers.

Opportunities for Enhancement and Restoration

Subject to outcome of habitat assessment.

8.5 San Luis Rey River/Bonsall–I15

Existing Habitat Conditions

Specific habitat conditions unknown. Conduct habitat assessment to evaluate restoration opportunities and potential to improve habitat for flycatchers.

Opportunities for Enhancement and Restoration

Subject to outcome of habitat assessment.

References Cited

Allen, L.D., Howell, S.L., and Kus, B.E., 2017, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Middle San Luis Rey River, San Diego, southern California – 2016 data summary: U.S. Geological Survey Data Series 1065, 11 p. [Available at https://doi.org/10.3133/ds1065.]

Allen, L.D., Howell, S.L., and Kus, B.E., 2018, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Middle San Luis Rey River, San Diego County, southern California – 2017 data summary: U.S. Geological Survey Data Series 1082, 12 p. [Available at https://doi.org/10.3133/ds1082.]

Allen, L.D., and Kus, B.E., 2019, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the middle San Luis Rey River, San Diego County, southern California – 2018 data summary: U.S. Geological Survey Data Series 1109, 12 p. [Available at https://doi.org/10.3133/ds1109.]

Allen, L.D., and Kus, B.E., 2020, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Middle San Luis Rey River, San Diego County, southern California – 2019 data summary: U.S. Geological Survey Data Series 1122, 11 p. [Available at https://doi.org/10.3133/ds1122.]

Allen, L.D., and Kus, B.E., 2021, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the middle San Luis Rey River, San Diego County, southern California – 2020 data summary: U.S. Geological Survey Data Series 1134, 11 p. [Available at https://doi.org/10.3133/ds1134.]

Allen, L.D., and Kus, B.E., 2022, Distribution and abundance of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Middle San Luis Rey River, San Diego County, southern California – 2021 Data summary: U.S. Geological Survey Data Report 1147, 12 p. [Available at https://doi.org/10.3133/dr1147.]

AMEC Earth and Environmental (AMEC), Conservation Biology Institute (CBI), Onaka Planning and Economics, and the Rick Alexander Company, 2003, Final MHCP Plan, V. 1: Prepared for the Multiple Habitat Conservation Program.

Ball, M.L., McCreedy, C, Geupel, G.R., and Robinette, D, 2012, Protocol-level Southwestern Willow Flycatcher Surveys of the Santa Ynez River and San Antonio Creek, 2012 Breeding Season, Petaluma, Calif., PRBO Conservation Science.

Boland, J.M., 2016, The impact of an invasive ambrosia beetle on the riparian habitats of the Tijuana River Valley, California: PeerJ 4:e2141. [Available at https://peerj.com/articles/2141/.]

Boland, J.M., 2018, The Kuroshio Shot Hole Borer in the Tijuana River Valley in 2017-18 (Year Three) – Infestation rates, forest recovery, and a new model: Final Report for U.S. Navy, U.S. Fish and Wildlife Service and Southwest Wetlands Interpretive Association. 74 pages.

Bolger, D.T., Patten, M.A., and Bostock, D.C., 2005, Avian reproductive failure in response to an extreme climatic event: Oecologia, v. 142, p. 398–406. [Available at https://doi.org/10.1007/s00442-004-1734-9.]

Briggs, M.K. and Cornelius, S, 1998, Opportunities for ecological improvement along the lower Colorado River and delta: Wetlands, v. 18, p. 513-529.

Browning, M.R., 1993, Comments on the taxonomy of Empidonax traillii (Willow Flycatcher): Western Birds, v. 24, p. 241–257. [Available at https://sora.unm.edu/sites/default/files/journals/wb/v24n04/p0241-p0257.pdf.]

City of San Diego, 1998, Final Multiple Species Conservation Program: MSCP Plan, San Diego, California. [Available from: FinalMSCPProgramPlan.pdf (sandiegocounty.gov).]

Clark, K., Hargrove, L., and Unitt, P., 2014, Southwestern Willow Flycatcher (*Empidonax traillii extimus*) surveys and nest monitoring at the upper San Luis Rey River, San Diego County: Prepared for Cleveland National Forest, San Diego, California.

Colón, M.R., Long, A.M, and Morrison, M.L., 2017, Responses of an endangered songbird to an extreme drought event: Southeastern Naturalist, v. 16, p.195-214. [Available at https://doi.org/10.1656/058.016.0207.]

Danchin, E., Giraldeau, L., Valone, T.J., and Wagner, R.H., 2004, Public information: From nosy neighbors to cultural evolution: Science, v. 305, p. 487–491. [Available at https://www.science.org/doi/full/10.1126/science.1098254.]

Davidson, R.F., and Allison, L.J., 2003, Effects of monogamy and polygyny on reproductive success in Southwestern Willow Flycatchers (*Empidonax traillii extimus*) in Arizona: Studies in Avian Biology, v. 26, p. 118–124.

Diffenbaugh, N.S., Swain, D.L., and Touma, D., 2015, Anthropogenic warming has increased drought risk in California: Proceedings of the National Academy of Sciences, v. 112, p. 3931- 3936.

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

Durst, S.L., Theimer, T.C., Paxton, E.H., and Sogge, M.K., 2008, Age, habitat, and yearly variation in the diet of a generalist insectivore, the Southwestern Willow Flycatcher: Condor, v. 110, p. 514–525.

EDAW, 2007, 45-day summary report of focused surveys for the Southwestern Willow Flycatcher for the State Route 76 East expansion project, County of San Diego, California: Report to Carlsbad Fish and Wildlife Office, Carlsbad, California.

Ellis, L.A., Weddle, D.M., Stump, S.D., English, H.C., and Graber, A.E., 2008, Southwestern Willow Flycatcher final survey and monitoring report: Arizona Game and Fish Department, Research Technical Guidance Bulletin #10, Phoenix, Arizona, USA.

ERO Resources Corporation, 2012, San Luis Valley Regional Habitat Conservation Plan: Submitted pursuant to Section 10(A)(1)(B) of the Endangered Species Act to the U.S. Fish and Wildlife Service, Prepared for Rio Grande Water Conservation District, Alamosa, CO. ERO Resources Corporation, Denver, CO.

Famolaro, P. 1999, 1998 Endangered/threatened species monitoring report: Sweetwater Authority Water Quality Department, Spring Valley, California.

Gaines, D., 1988, Birds of Yosemite and the east slope: Lee Vining, Calif., Artemesia Press, 123 p.

Garrett, K., and Dunn, J., 1981, Birds of southern California – Status and distribution: Los Angeles, Calif., Los Angeles Audubon Society, 408 p.

Great Basin Bird Observatory, 2023, Population assessment and monitoring of Southwestern Willow Flycatcher, Western Yellow-billed Cuckoo, and Least Bell’s Vireo on the Owens River watershed: Reno, Nevada, Great Basin Bird Observatory.

Griffith Wildlife Biology, 1995, The status of the Southwestern Willow Flycatcher at the upper San Luis Rey River, San Diego County, California, in 1994: Final report prepared for USDA Forest Service, Palomar Ranger District by Jane C. Griffith and John T. Griffith, Griffith Wildlife Biology, Calumet, Michigan.

Griffith Wildlife Biology, 1997, The status of the Least Bell’s Vireo and Southwestern Willow Flycatcher at Marine Corps Base Camp Pendleton, in 1996: Final report prepared for Assistant Chief of Staff, Environmental Security, Camp Pendleton, Griffith Wildlife Biology, Calumet, Michigan.

Griffith Wildlife Biology, 2000, The Status of the Southwestern Willow Flycatcher at Marine Corps Base Camp Pendleton, in 1999: Final report prepared for Assistant Chief of Staff, Environmental Security, Camp Pendleton, Griffith Wildlife Biology, Calumet, Michigan.

Grinnell, J., and Miller, A.H., 1944, The distribution of the birds of California: Berkeley, Calif., Pacific Coast Avifauna, v. 27, 608 p.

Hatten, J.R., 2016, A satellite model of Southwestern Willow Flycatcher (*Empidonax traillii extimus*) breeding habitat and a simulation of potential effects of tamarisk leaf beetles

(*Diorhabda* spp.), southwestern United States: U.S. Geological Survey Open-File Report 2016–1120, 88 p. [Available at https://doi.org/10.3133/ofr20161120.]

Hatten, J.R., 2022, Southwestern Willow Flycatcher habitat viewer: U.S. Geological Survey, [Available at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=0fea104260ef465fbd53b69b25a2a5f9.]

Hatten, J.R., and Paradzick, C.E., 2003, a multi-scaled model of Southwestern Willow Flycatcher breeding habitat: Journal of Wildlife Management, v. 67, p.774-788.

Hishinuma, S., Coleman, T.W., Flint, M.L., and Seybold, S.J., 2011, Goldspotted oak borer – Field identification guide: University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, Oakland, California, 6 pp. [Available at https://ipm.ucanr.edu/legacy_assets/PDF/MISC/GSOB_field-identification-guide.pdf.]

Holcomb, L.C., 1974, The influence of nest building and egg laying behavior on clutch size in renests of the willow flycatcher: Bird Banding, v. 45, p. 320-325.

Houston, A., Allen, L.D., Mendia, S.M., and Kus, B.E., 2024, Least Bell's Vireos and Southwestern Willow Flycatchers – Breeding activities and habitat use – 2023 annual report: U.S. Geological Survey Open-File Report 2024–1040, 77 p. [Available at https://doi.org/10.3133/ofr20241040.]

Howell, S.L., and B.E. Kus. 2010, Status of the Southwestern Willow Flycatcher on the Upper San Luis Rey River, San Diego County, California, in 2009: Prepared for U.S. Forest Service, Cleveland National Forest.

Howell, S.L., and Kus, B.E., 2021, Distribution and abundance of Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the upper San Luis Rey River, San Diego County, California – 2020 data summary: U.S. Geological Survey Data Series 1140, 11 p., [Available at https://doi.org/10.3133/ds1140.]

Howell, S.L., and Kus, B.E., 2022, Distribution and abundance of Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Upper San Luis Rey River, San Diego County, California – 2021 data summary: Data Report 1158, 11 p. [Available at https://doi.org/ 10.3133/ dr1158.]

Howell, S.L., and Kus, B.E., 2023, Distribution and abundance of Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the upper San Luis Rey River, San Diego County, California – 2022 data summary: U.S. Geological Survey Data Report 1173, 11 p. [Available at https://doi.org/10.3133/dr1173/.]

Howell, S.L., and Kus, B.E., 2024, Distribution and abundance of Southwestern Willow Flycatchers (*Empidonax traillii extimus*) on the Upper San Luis Rey River, San Diego

County, California – 2023 data summary: U.S. Geological Survey Data Report 1194, 13 p. [Available at https://doi.org/10.3133/dr1194.]

Howell, S.L., and Kus, B.E., 2025, Distribution, abundance, and breeding activities of the Southwestern Willow Flycatcher at Marine Corps Base Camp Pendleton, California – 2023 Annual report: U.S. Geological Survey Open-File Report 2025–1001, 33 p. [Available at https://doi.org/10.3133/ofr20251001.]

Howell, S.L., Kus, B.E., and Mendia, S.M., 2022, Distribution and demography of Southwestern Willow Flycatchers in San Diego County, 2015–19: U.S. Geological Survey Open-File Report 2022–1082, 43 p. [Available at https://doi.org/10.3133/ofr20221082.]

Hubbard, J.P., 1987, The status of the Willow Flycatcher in New Mexico: Santa Fe, N. Mex., New Mexico Department of Game and Fish, Endangered Species Program, 29 p.

Kenwood, K.E., and Paxton, E.H., 2001, Survivorship and movements of Southwestern Willow Flycatchers in Arizona – 2001: U.S. Geological Survey report to the Bureau of Reclamation, Phoenix, Arizona.

Kisner, D. A, 2004, The effect of giant reed (*Arundo donax*) on the southern California riparian bird community. Master's thesis, San Diego State University, San Diego, CA.

Kus, B.E., 1996, Status of the Least Bell's Vireo and Southwestern Willow Flycatcher at Marine Corps Base Camp Pendleton, California in 1995: Final Report: Camp Pendleton, Calif., Prepared for the U.S. Marine Corps, Environmental and Natural Resources Office.

Kus, B.E., and Beck, P.P., 1998, Distribution and abundance of the Least Bell's Vireo (*Vireo bellii pusillus*) and the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at selected southern California sites in 1997: Sacramento, Calif., Prepared for the California Department of Fish and Game, Wildlife Management Division.

Kus, B.E., Beck, P.P., and Wells, J.M., 1999, Status and breeding activities of the Southwestern Willow Flycatcher at the Cleveland National Forest in 1999: Prepared for the U.S. Forest Service, Cleveland National Forest.

Kus, B.E., Beck, P.P., and Wells, J.M., 2003, Southwestern Willow Flycatcher populations in California – Distribution, abundance, and potential for conservation: Studies in Avian Biology, v. 26, p. 12–21.

Kus, B.E., and Rourke, J.W., 2005, Breeding activities of the Southwestern Willow Flycatcher in the San Luis Rey Flood Risk Management Project Area, San Diego County, California, in 2005: San Diego, Calif., Prepared for RECON Environmental, Inc.

Kus, B.E., and Whitfield, M.J., 2005, Parasitism, productivity, and population growth – Response of Least Bell's Vireos (*Vireo bellii pusillus*) and Southwestern Willow Flycatchers (*Empidonax traillii extimus*) to cowbird (*Molothrus* spp.) control, *in* Ortega, C.P., Chace, J.F., and Peer, B.D., eds., Management of cowbirds and their hosts – Balancing science, ethics, and mandates: Ornithological Monographs, no. 57, p. 16–27. [Available at om057.pdf]

Kus, B.E., Howell, S.L., and Wood, D.A., 2016, Female-biased sex ratio, polygyny, and persistence in the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*): Condor, v. 119, p. 17–25. [Available at https://doi.org/10.1650/CONDOR-16-119.1]

Langridge, S.M. and Sogge, M.K., 1998, Banding and genetic sampling of willow flycatchers in Utah: 1997 and 1998: U.S. Geological Survey Colorado Plateau Field Station/Northern Arizona University report, 60 p.

Los Angeles Department of Water and Power, 2005, Conservation Strategy for the Southwestern Willow Flycatcher on City of Los Angeles Department of Water and Power Lands in the Owens Management Unit. [Available at LADWP-willow-flycatcher-conservation-strategy.pdf]

Mahoney, S.M., Reudink, M.W., Pasch, B. and Theimer, T.C., 2020, Song but not plumage varies geographically among willow flycatcher *Empidonax traillii* subspecies: Journal of Avian Biology, 2020 e02621. [Available at https://doi.org/10.1111/jav.02621.

Marshall, R.M, and Stoleson, S.H., 2000, Threats, *in* Finch, D.M., Stoleson, S.H., eds., Status, ecology, and conservation of the Southwestern Willow Flycatcher: Gen. Tech. Rep. RMRS-GTR-60. Ogden, UT, p. 13–24.

Martin, T.E., 1993, Nest predation and nest sites: New perspectives on old patterns: BioScience, v. 43, p. 523–532. [Available at https://doi.org/10.2307/1311947]

McCabe, R.A, 1991, The little green bird – ecology of the willow flycatcher: Palmer publications, Inc., Amherst, Wisconsin, 171 p.

McCarthey, T.D., Paradzick, C.E., Rourke, J.W., Sumner, M.W., and Davidson, R.F., 1998, Arizona Partners in Flight Southwestern Willow Flycatcher 1997 survey and nest monitoring report: Nongame and Endangered Wildlife Program Technical Report 130, Arizona Game and Fish Department, Phoenix, Arizona, 81 p.

McCreedy, C., and van Riper, C. III., 2015, Drought-caused delay in nesting of Sonoran desert birds and its facilitation of parasite-and predator-mediated variation in reproductive success: Auk, v. 132, p. 235–247. [Available at https://doi.org/10.1642/AUK-13-253.1]

McKernan, R.L. and Braden, R.L., 2001, Status, distribution, and habitat affinities of Southwestern Willow Flycatchers along the lower Colorado River Year-5, 2000: San Bernardino County Museum, Redlands, California.

McLeod, M.A., Koronkiewicz, T.J., Brown, B.T., and Carothers, S.W., 2007, Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2006: Annual report submitted to Bureau of Reclamation, Boulder City, Nevada by SWCA Environmental Consultants, Flagstaff, Arizona, 194 p.

Merkel & Associates, Inc., 2010, 45-day letter report of Southwestern Willow Flycatcher focused surveys at Chocolate Canyon (Alpine, San Diego County) for SDG&E Sunrise Powerlink Mitigation Lands, San Diego County, California: Report to Carlsbad Fish and Wildlife Office, Carlsbad, California.

Natural Resource Consultants, 2011, 2011 results of presence/absence surveys for the Least Bell's Vireo (*Vireo bellii pusillus*) and Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at Meadowood off-site improvement locations, in the vicinity of the Community of Fallbrook, San Diego County, California: Report to Carlsbad Fish and Wildlife Office, Carlsbad, California.

Paradzick, C.E., Davidson, R.F., Rourke, J.W., Sumner, M.W., Wartell, A.M., and McCarthey, T.D, 2000, Southwestern Willow Flycatcher 1999 survey and nest monitoring report. Technical Report 151: Arizona Game and Fish Department, Phoenix, Arizona, 93 p.

Paxton, E.H., Sogge, M.K., Durst, S.L., Theimer, T.C., and Hatten, J.R., 2007, The ecology of the Southwestern Willow Flycatcher in central Arizona – A 10-year synthesis report: U.S. Geological Survey Open-File Report 2007–1381, 143 p. [Available at https://doi.org/10.3133/ofr20071381.]

Preston, K. L., and Rotenberry, J. T., 2006, The role of food, nest predation, and climate in timing of Wrentit reproductive activities: Condor, v. 108, p. 832–841.

PG Environmental, 2021, Water infrastructure alternatives analysis: Final Report, USMCA Mitigation of Contaminated Transboundary Flows Project, Prepared for the United States Environmental Protection Agency, Washington, DC.

Remsen, J.V., Jr., 1978, Bird species of special concern in California: California Department of Fish and Game, Wildlife Management Division, Administrative Report 78–1, 67 p.

Ricklefs, R.E., 1969, An analysis of nesting mortality in birds: Smithsonian Contributions to Zoology no. 8. [Available at https://repository.si.edu/bitstream/handle/10088/5389/SCtZ-0009-Lo_res.pdf.]

Rothstein, S.I., Kus, B.E., Whitfield, M.J., and Sferra, S.J., 2003, Recommendations for cowbird management in recovery efforts for the Southwestern Willow Flycatcher: Studies in Avian Biology, v. 26, p. 157–167.

Rourke, J. W., Kus, B. E., and Whitfield, M.J., 2004, Distribution and abundance of the Southwestern Willow Flycatcher at selected southern California sites in 2001: Prepared for the California Department of Fish and Game, Species Conservation and Recovery Program Report 2004-05, Sacramento, California.

Ruegg, K., Bay, R. A., Anderson, E. C., Saracco, J. F., Harrigan, R. J., Whitfield, M., Paxton, E. H., and Smith, T. B., 2018, Ecological genomics predicts climate vulnerability in an endangered southwestern songbird: Ecology Letters, v. 21, p.1085–1096.

San Diego Management and Monitoring Program and The Nature Conservancy, 2017, Management and monitoring strategic plan for Conserved Lands in Western San Diego County – A strategic habitat conservation roadmap: Prepared for San Diego Association of Governments, San Diego, CA. [Available at https://sdmmp.com/msp_doc.php.]

San Diego Management and Monitoring Program, 2024, Conserved lands San Diego 2024: San Diego Management and Monitoring Program, San Diego, CA. [Available at https://sdmmp.com/view_article.php?cid=SDMMP_CID_71_6603419c92f44.]

Schlorff, R.W., 1990, Report to the Fish and Game Commission – Status review of the Willow Flycatcher (*Empidonax traillii*) in California: State of California, Resources Agency, Department of Fish and Game, Wildlife Management Division, Department Candidate Species Status Report 90–04, 23 p. [Available at https://nrm.d fg.ca.gov/ FileHandler.ashx? DocumentID= 22572.]

Schofield, L.N., Loffland, H.L., Siegel, R.B., Stermer, C.J., and Mathewson, H.A., 2018, Using conspecific broadcast for Willow Flycatcher restoration: Avian Conservation and Ecology, v. 13, 10 p. [Available at https://doi.org/10.5751/ACE-01216-130123.]

Sedgwick, J. A., 2020, Willow Flycatcher (*Empidonax traillii*): version 1.0 *in* Poole, A.F. and Gill, F.B., eds., Birds of the World, Cornell Lab of Ornithology, Ithaca, NY, USA. [Available at https://doi.org/10.2173/bow.wilfly.01]

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

Smith, J., and Johnson, K., 2008, Water requirements for Southwestern Willow Flycatcher habitat at the Pueblo of Isleta: Natural Heritage Publication No. 07- GTR-329, Natural Heritage New Mexico, Museum of Southwestern Biology, Albuquerque, NM. [Available at https://webapps.usgs.gov/mrgescp/documents/Smith%20and%20Johnson_2008_Water%20Requirements%20for%20SWFL%20Habitat%20and%20Nesting%20at%20the%20Pueblo%20of%20Isleta.pdf]

Smith, A.B., Paradzick, C.E., Woodward, A.A., Dockens, P.E.T., and McCarthey T.D., 2002, Southwestern Willow Flycatcher 2001 survey and nest monitoring report: Nongame and Endangered Wildlife Program Technical Report 191, Arizona Game and Fish Department, Phoenix, Arizona.

Sogge, M.K., 1995, Southwestern Willow Flycatcher (*Empidonax traillii extimus*) monitoring at Tuzigoot National Monument: 1995 progress report to the National Park Service, National Biological Service Colorado Plateau Research Station/Northern Arizona University report, 20 p.

Sogge, M.K., Ahlers, D., and Sferra, S.J., 2010, A natural history summary and survey protocol for the Southwestern Willow Flycatcher: U.S. Geological Survey Techniques and Methods, 2A-10, 38 p. [Available at https://pubs.usgs.gov/tm/tm2a10/.]

Sogge, M.K., Sferra, S.J., McCarthey, T.D., Williams, S.O., and Kus, B.E., 2003, Distribution and characteristics of Southwestern Willow Flycatcher breeding sites and territories, 1993-2001: Studies in Avian Biology, v. 26, p. 5–11.

Steblein, P.F., Loehman, R.A., Miller, M.P., Holomuzki, J.R., Soileau, S.C., Brooks, M.L., Drane-Maury, M., Hamilton, H.M., Kean, J.W., Keeley, J.E., Mason, R.R., Jr., McKerrow, A., Meldrum, J.R., Molder, E.B., Murphy, S.F., Peterson, B., Plumlee, G.S., Shinneman, D.J., van Mantgem, P.J., and York, A., 2021, U.S. Geological Survey wildland fire science strategic plan, 2021–26: U.S. Geological Survey Circular 1471, 30 p. [Available at https://doi.org/10.3133/cir1471.]

Stoleson, S.H., and Finch, D.M., 1999, Reproductive success of Southwestern Willow Flycatchers in the Cliff-Gila Valley, New Mexico: Report to Phelps-Dodge Corporation, USDA Forest Service, Rocky Mountain Research Station, Albuquerque, New Mexico, 25 p.

Stoleson, S.H., Whitfield, M.J., and Sogge, M.K., 2000, Demographic characteristics and population modeling: *in* Finch, D.M., Stoleson, S.H., eds., Status, ecology, and conservation of the Southwestern Willow Flycatcher. Gen. Tech. Rep. RMRS-GTR-60, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 83-94.

Stumpf, K.J., Theimer, T.C., McLeod, M.A., and Koronkiewicz, T.J., 2011, Distance from riparian edge reduces brood parasitism of Southwestern Willow Flycatchers, whereas parasitism increases nest predation risk: The Journal of Wildlife Management, v. 76, p. 269–277. [Available at https://wildlife.onlinelibrary.wiley.com/doi/10.1002/jwmg.246.

Swain, D.L., Langenbrunner, B., and Neelin, J.D., 2018, Increasing precipitation volatility in twenty-first-century California: Nature Climate Change, v. 8, p. 427–433. [Available at https://doi.org/10.1038/s41558-018-0140-y.]

Theimer, T. C., Sogge, M. K., and Paxton, E. H, 2018, Patch age since disturbance drives patch dynamics for flycatchers breeding in both reservoir and riverine habitat: Ecosphere, v. 9:e02425. [Available at Patch age since disturbance drives patch dynamics for flycatchers breeding in both reservoir and riverine habitat - Theimer - 2018 - Ecosphere - Wiley Online Library]

Uyehara, J. C., Whitfield, M.J., Goldwasser, L., 2000, The ecology of Brown-headed Cowbirds and their effects on Southwestern Willow Flycatchers: *in* Finch, D.M., Stoleson, S.H., eds., Status, ecology, and conservation of the Southwestern Willow Flycatcher. Gen. Tech. Rep. RMRS-GTR-60. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 95-106.

Unitt, P., 1984, The birds of San Diego County: San Diego Society of Natural History, Memoir 13, 276 p.

Unitt, P., 1987, *Empidonax traillii extimus* – An endangered subspecies: Western Birds, v. 18, p. 137–162.

U.S. Fish and Wildlife Service, 1993, Proposal to list the Southwestern Willow Flycatcher as an endangered species and to designate critical habitat: Federal Register, v. 58, p. 39495–39522.

U.S. Fish and Wildlife Service, 2002, Southwestern Willow Flycatcher recovery plan: Albuquerque, N. Mex., i-ix + 210 p., appendices A-O. [Available at https://www.fs.usda.gov/rm/pubs_other/rmrs_2002_finch_d001.pdf.]

Varanus Biological Services, 2000, Southwestern Willow Flycatcher data summary 1995–1999: Prepared for the U.S. Bureau of Reclamation, Phoenix area office, Phoenix, Ariz.

Varanus Biological Services, 2001, Southwestern Willow Flycatcher field season 2000 data summary: Prepared for the U.S. Bureau of Reclamation, Phoenix area office, Phoenix, Ariz.

Varanus Biological Services, 2004, 45-Day Report 2004 Protocol Surveys for Southwestern Willow Flycatcher along State Route 76 near Rosemary's Mountain, San Diego, California: Report to Carlsbad Fish and Wildlife Office, Carlsbad, California.

Wells, J., 1999, 1999 USFS Upper San Luis Rey River Brown-headed Cowbird trapping program: Prepared for USDA Forest Service, Cleveland National Forest.

Wheelock, I.G., 1912, Birds of California – An introduction to more than three hundred common birds of the state and adjacent islands: A.C. McClurg and Company, Chicago, Ill.

Whitfield, M.J., 1990, Willow flycatcher reproductive response to Brown-headed Cowbird parasitism: Master's Thesis, California State University, Chico.

Whitfield, M.J., 2019, Southwestern Willow Flycatcher monitoring and removal of Brown-headed Cowbirds for the South Fork Kern River Valley in 2018: Draft Final report, Prepared for the State of California Department of Fish and Wildlife, Sacramento, Calif.

Whitfield, M.J., and Enos, K.M., 1996, A Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatcher, South Fork Kern River, California – 1996: California Department of Fish and Game Report, Sacramento, California, 14 p.

Whitfield, M.J., and Lynn, J.C., 2001, Southwestern Willow Flycatcher *(Empidonax traillii extimus*) surveys, nest monitoring and removal of Brown-headed Cowbirds on the South Fork Kern River, CA in 2000: Final report prepared for the U.S. Army Corps of Engineers, Sacramento District, Purchase order DACW05-00-220, Sacramento, CA, and California Dept. of Fish and Game, Bird and Management Conservation Program (contract #P9985311).

Whitfield, M.J., and Sogge, M.K., 1999, Range-wide impact of Brown-headed Cowbird parasitism on the Southwestern Willow Flycatcher (*Empidonax traillii extimus*): Studies in Avian Biology, v. 18, p. 182–190.

Whitfield, M.J., and Strong, C.M., 1995, A Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatcher, South Fork Kern River, California: California Department of Fish and Game, Bird and Mammal Conservation Program Report 95-4, Sacramento, California, 17 p.

Whitfield, M.J., Enos, K.M, and Rowe, S.P., 1999, Is Brown-headed Cowbird trapping effective for managing populations of the endangered Southwestern Willow Flycatcher?: Studies in Avian Biology, v. 18, p. 260-266.

Willett, G., 1912, Birds of the Pacific slope of southern California: Pacific Coast Avifauna, v. 7, 122 p.

Willett, G., 1933, A revised list of the birds of southwestern California: Pacific Coast Avifauna, v. 21, 204 p.

Appendix 1. Southwestern Willow Flycatcher Habitat Suitability Model

USGS biogeographer James Hatten developed a Southwestern Willow Flycatcher habitat suitability model to make predictions on where currently suitable habitat may be located across the range of the flycatcher (Hatten, 2016). The model was originally developed in 2003 (Hatten and Paradzick, 2003), and incorporated Landsat satellite imagery and a digital elevation model to evaluate variables such as floodplain size, vegetation density, and variation in vegetation density to predict potentially suitable flycatcher habitat. The model scored riparian habitat into five probability classes, with the top three classes (greater than 40 percent, 60 percent, and 80 percent) predicting suitable habitat (Hatten and Paradzick, 2003; Hatten, 2016).

The habitat suitability model was used to select 21 survey locations based on the 2013 model output, which used Landsat satellite images obtained in 2013 to identify habitat predicted to be suitable for breeding flycatchers (Hatten, 2016). Survey locations selected using the habitat model had greater than 40-percent probability of suitable habitat, and survey locations that included predictions in the two highest suitability categories were prioritized (greater than 60 percent and greater than 80 percent; Hatten, 2016).

The model output was updated annually from 2013–22 and was available as an online GIS viewer (fig 1.1; Hatten, 2022). The 2022 model output predicted that there is approximately 2640 ha of suitable habitat in San Diego County.

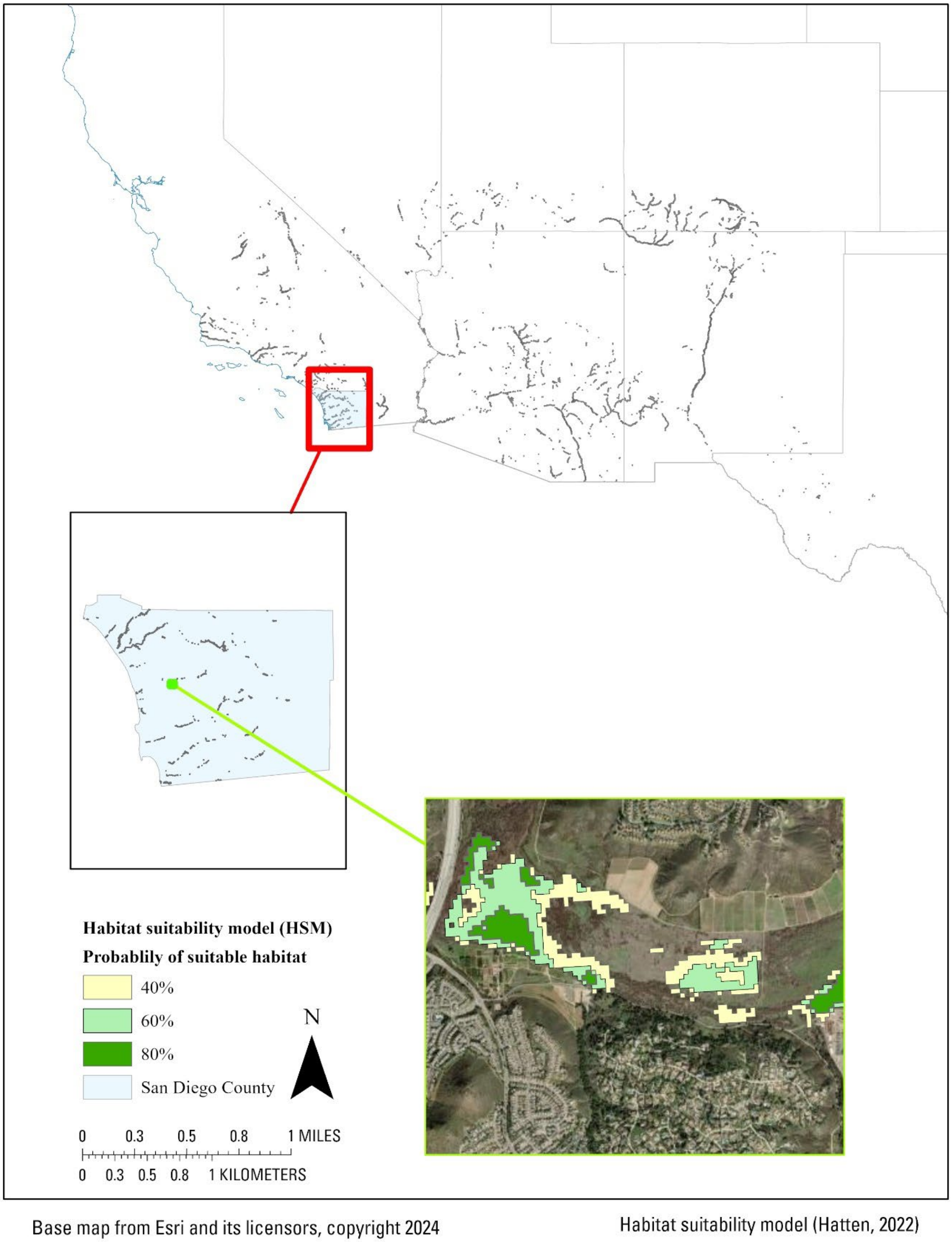


Figure 1.1. Example of Southwestern Willow Flycatcher habitat suitability model rangewide and in San Diego County.