

Ecosystems Mission Area—Species Management Research Program

**Prepared in cooperation with Assistant Chief of Staff, Environmental Security, U.S. Marine Corps
Base Camp Pendleton**

**Distribution, Abundance, Breeding Activities, and
Restoration Efforts for the Southwestern Willow
Flycatcher at Marine Corps Base Camp Pendleton,
California—2025 Annual Report**

Open-File Report 2026–1016

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By Suellen Lynn, Scarlett L. Howell, and Barbara E. Kus

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Contents

Acknowledgments	iii
Executive Summary	1
Introduction.....	1
Conspecific Attraction Study.....	2
Artificial Seep Study.....	2
Study Areas and Methods.....	3
Population Size and Distribution	3
Core Areas	3
Habitat Characteristics	5
Conspecific Playback Surveys	6
Breeding Productivity Methods	6
Nest Site Characteristics	8
Banded Bird Observations, Site Fidelity, and Movement.....	8
Artificial Seep Study.....	8
Vegetation Structure and Plant Composition.....	10
Data Analyses.....	10
Vegetation Structure and Plant Composition.....	10
Results	11
Flycatcher Population Size and Distribution	11
Transients.....	11
Residents.....	11
Conspecific Playback Surveys and Artificial Seep Monitoring	13
Habitat Characteristics	13
Breeding Productivity Results	13
Banded Bird Observations	13
Vegetation at Artificial Seep and Reference Sites.....	14
Discussion.....	19
Conclusions.....	21
References Cited.....	22
Appendix 1. Southwestern Willow Flycatcher (<i>Empidonax traillii extimus</i>) Survey Areas at Marine Corps Base Camp Pendleton, 2025	27
Appendix 2. Vegetation Sampling Locations and Vegetation Sampling Data Sheet, Marine Corps Base Camp Pendleton, 2025.....	33
Appendix 3. Locations of Willow Flycatchers (<i>Empidonax traillii</i>) at Marine Corps Base Camp Pendleton, 2025	36

Figures

1. Map showing Southwestern Willow Flycatcher survey and historic breeding areas at Marine Corps Base Camp Pendleton, 2025	4
2. Map showing Southwestern Willow Flycatcher conspecific playback survey plots, automated playback unit locations, artificial seep locations, and historic breeding territories at Marine Corps Base Camp Pendleton, 2025.....	7
3. Map showing location of Seep and Reference sites at Marine Corps Base Camp Pendleton, 2025.....	9
4. Diagram showing vegetation sampling plot configuration.....	10
5. Graph showing number of resident Southwestern Willow Flycatchers by sex and total number of flycatcher territories at Marine Corps Base Camp Pendleton, 2000–25.....	11
6. Graph showing average percent cover at vegetation sampling locations by height class and plant type at Seep and Reference sites, Santa Margarita River, Marine Corps Base Camp Pendleton, 2025	14
7. Map showing percentage soil saturation at Seep site vegetation sampling plots, Marine Corps Base Camp Pendleton, 2025	16
8. Map showing percentage soil saturation at Reference site vegetation sampling plots, Marine Corps Base Camp Pendleton, 2025	17

Tables

1. Distribution of territorial Southwestern Willow Flycatchers at Marine Corps Base Camp Pendleton, 2000–25	12
2. Habitat characteristics of Willow Flycatcher locations at Marine Corps Base Camp Pendleton, 2025.....	13
3. Spearman’s rank correlations and significance of these correlations between soil saturation and vegetation cover by height category, Marine Corps Base Camp Pendleton, 2025.....	18
4. Average percent cover of plant species identified as important in Southwestern Willow Flycatcher habitat model at Seep and Reference site vegetation sampling plots and results of Mann-Whitney <i>U</i> -tests comparing Seep and Reference sites, Marine Corps Base Camp Pendleton, 2025.....	18
5. Spearman’s rank correlations and significance of these correlations between soil saturation and plant species identified as important in the Southwestern Willow Flycatcher habitat model by height category, Marine Corps Base Camp Pendleton, 2025	18

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
Area		
square meter (m ²)	0.0002471	acre
Flow rate		
liter per minute (L/min)	15.85	gallon per minute (gal/min)

Datums

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

Horizontal coordinate information in mapped figures is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

ρ	Spearman's rank statistic
AC/S	Assistant Chief of Staff
MCBCP	Marine Corps Base Camp Pendleton
min	minute
s	second

Distribution, Abundance, Breeding Activities, and Restoration Efforts for the Southwestern Willow Flycatcher at Marine Corps Base Camp Pendleton, California—2025 Annual Report

By Suellen Lynn, Scarlett L. Howell, and Barbara E. Kus

Executive Summary

The purpose of this report is to provide the Marine Corps with an annual summary of the distribution, abundance, and breeding activity of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*; flycatcher) and to present results of management actions implemented to attract flycatchers and enhance flycatcher habitat at Marine Corps Base Camp Pendleton (MCBCP, or Base). Surveys for the flycatcher were done on Base between May 6 and July 23, 2025. All MCBCP's historically occupied riparian habitat (core survey area) was surveyed for flycatchers in 2025. None of the non-core survey areas were surveyed in 2025.

No resident flycatchers were detected on Base in 2025. The one resident (female) present in 2024 did not return to the territory she occupied in 2024, and she was not detected within the historically occupied habitat surveyed in 2025.

Eight transient Willow Flycatchers of unknown subspecies were observed on two of the five drainages surveyed in 2025: Las Flores Creek and the Santa Margarita River. No Willow Flycatchers were detected at Fallbrook, Pilgrim, or San Mateo Creeks. Transients in 2025 occurred in mixed willow and riparian scrub habitats, dominated by multiple willow species (*Salix* spp.). Exotic vegetation was recorded in most flycatcher locations and was dominant (cover of exotics greater than 50 percent) in more than half of all transient locations. The most common exotic plant in habitat used by flycatchers was poison hemlock (*Conium maculatum*). All six of the flycatchers that were observed closely enough to determine banding status were unbanded.

Two measures were initiated in recent years to attract and retain resident breeding flycatchers on MCBCP: conspecific attraction using flycatcher song broadcasts and installation

of artificial seeps to enhance flycatcher habitat. We surveyed plots with and without speakers that broadcast flycatcher vocalizations throughout the breeding season and detected two transient Willow Flycatchers within 20 meters of one speaker in 2025. We set up permanent vegetation sampling points surrounding artificial seeps and nearby sites without artificial seeps (Reference sites) to determine the effects of surface-water enhancement by seep pumps. Vegetation cover was highest near the ground and decreased with increasing height. Woody vegetation made up most of the cover at all height categories. Soil saturation in 2025 was higher at the sites near seeps than at the Reference sites and was associated with higher native herbaceous cover and lower non-native cover.

Introduction

The purpose of this report is to provide the Marine Corps with an annual summary of the distribution, abundance, and breeding activity of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*; flycatcher) and to present results of management actions implemented to attract flycatchers and enhance flycatcher habitat at Marine Corps Base Camp Pendleton (MCBCP, or Base). The results are intended to provide the Base with biological information to inform appropriate management of the flycatcher and support the dual missions of enacting environmental stewardship and maintaining military readiness in accordance with the Base Integrated Natural Resources Management Plan (Marine Corps Base Camp Pendleton, 2023) and U.S. Fish and Wildlife Service Programmatic Biological Opinion (U.S. Fish and Wildlife Service, 1995).

The Southwestern Willow Flycatcher is one of four subspecies of Willow Flycatcher in the United States, with a breeding range that includes southern California, Arizona, New Mexico, extreme southern parts of Nevada and Utah, southwestern Colorado, and western Texas (Hubbard, 1987; Unitt, 1987; Browning, 1993). Restricted to riparian habitat for breeding, the Southwestern Willow Flycatcher has declined in recent decades primarily in response to widespread habitat loss throughout its range and, possibly, Brown-headed Cowbird (*Molothrus ater*; cowbird) parasitism (Wheelock, 1912; Willett, 1912, 1933; Grinnell and Miller, 1944; Remson, 1978; Garrett and Dunn, 1981; Unitt, 1984, 1987; Gaines, 1988; Schlorff, 1990; Whitfield and Sogge, 1999). By 1993, the species was believed to number approximately 70 pairs in California in small, disjunct populations (U.S. Fish and Wildlife Service, 1993). The Southwestern Willow Flycatcher was listed as endangered by the State of California in 1992 and by the U.S. Fish and Wildlife Service in 1995. After listing, population estimates for flycatchers in California increased to 256 territories, with the increase largely attributed to expanded survey effort rather than population growth at known sites (U.S. Fish and Wildlife Service, 2002). In the 2014 5-year status review, estimates of California flycatcher territories decreased to 172, with declines occurring statewide (Durst and others, 2008; U.S. Fish and Wildlife Service, 2014).

Southwestern Willow Flycatchers in southern California co-occur with the Least Bell's Vireo (*Vireo bellii pusillus*; vireo), another riparian obligate species endangered by habitat loss and cowbird parasitism. However, unlike the vireo, which has increased ten-fold since the mid-1980s in response to management alleviating these threats (U.S. Fish and Wildlife Service, 2006), flycatcher numbers have remained low. As of 2023, most of the Southwestern Willow Flycatchers in California were concentrated at two known sites: (1) the Owens River valley in Inyo County (approximately 57 territories; Great Basin Bird Observatory, 2023), and (2) the upper San Luis Rey River at Lake Henshaw in San Diego County (approximately 47 territories; Howell and Kus, 2025a). Outside of these sites, Southwestern Willow Flycatchers occur as small, isolated populations of one to a half-dozen pairs. Many of these small populations in San Diego County have been occupied intermittently, including Bonsall, Couser Canyon, Guajome Lake, and Whelan Lake on the San Luis Rey River, San Dieguito River, San Diego River, and Sweetwater River (Unitt, 1987; Kus and others, 2003). The three locations closest to MCBCP, Bonsall, Guajome, and Whelan Lake, were last occupied in 2021, 2005, and 2007, respectively (Allen and Kus, 2022; B. Kus, U.S. Geological Survey, unpub. data, 2005; Houston and others, 2024). The population of Southwestern Willow Flycatchers at MCBCP was at one time one of the largest in southern California (Unitt, 1987). Flycatcher numbers peaked in 2004 at 42 individuals, followed by declines that began in 2005.

Male Southwestern Willow Flycatchers typically begin arriving in southern California in early to mid-May, and females arrive approximately 1 week later (Unitt, 1987; Howell and Kus, 2025b). Territorial males sing repeatedly from exposed perches while on the breeding grounds to attract a mate. Once a pair bond is established, or in some cases without the presence of a male, the female builds an open-cup nest that usually is placed in a branch fork of a willow (*Salix* spp.) or plant with a similar branching structure, approximately 1–3 meters (m) above the ground (Howell and Kus, 2025b; Sedgwick, 2020). The typical clutch of three to four eggs is laid in May–June. Females incubate for approximately 12 days, and nestlings fledge within 12–15 days in late June (Sogge and others, 2010). Adults usually depart from their breeding territory from mid-August through early September to their wintering grounds in central Mexico, Central America, and northern South America (Sogge and others, 2010).

Conspecific Attraction Study

In response to declining flycatcher numbers on Base, a conspecific playback study was initiated in 2018 to explore if this method could be used to attract breeding flycatchers to recolonize MCBCP. Conspecific attraction, the tendency for individuals of a species to settle near one another, has been used successfully as a tool for recolonizing restored Sierra Nevada meadows with Willow Flycatchers of the *adastus* and *brewsteri* subspecies (Schofield and others, 2018), but it has not been applied to any populations of the *extimus* subspecies. This report presents the results of Southwestern Willow Flycatcher response to conspecific playback.

Artificial Seep Study

In 2019, MCBCP began installing artificial seeps along the Santa Margarita River as part of a Conjunctive Use Project to enhance Willow Flycatcher habitat. The artificial seep pumps were designed to increase the amount of surface water present to enhance flycatcher breeding habitat. From 2020 through 2024, as a surrogate for absent flycatchers, we monitored Least Bell's Vireo breeding activity associated with changes in vegetation and soil saturation at nest sites surrounding the artificial seeps (Lynn and Kus, 2024; Lynn and others, 2024a, 2024b, 2024c; B. Kus, U.S. Geological Survey, unpub. data, 2024). However, changes in nest sites between years introduced variation in vegetation and soil saturation conditions that could not be attributed directly to the artificial seeps. Therefore, starting in 2025, we established permanent sampling plots to monitor changes in vegetation and soil saturation associated with seep pumps over time. This report presents baseline analyses and results of the response of vegetation to artificial seeps starting in the sixth year of operation.

The primary purpose of this study, which began in 2000, was to document the status of Southwestern Willow Flycatchers at MCBCP in San Diego County, California. Specifically, our goals were to (1) determine the size and composition of the Willow Flycatcher population on Base; (2) document annual survival, fidelity, and movement of resident flycatchers; (3) document nesting activities; and (4) characterize habitat used by flycatchers. The second purpose of this study was to present results of management efforts to attract and retain Southwestern Willow Flycatchers at MCBCP. Specifically, those goals were to (5) evaluate the use of conspecific playback to attract breeding Southwestern Willow Flycatchers to historically occupied habitat to facilitate recolonization; and (6) document the vegetation structure, plant composition, and soil saturation within the areas affected by artificial seeps established to enhance flycatcher habitat compared to similar areas without artificial seeps.

Data collected from this study are critical to inform natural resource managers about the status of this endangered species at MCBCP and guide modification of land use and management practices as appropriate to support the species' survival. This work was funded by and performed in cooperation with the Assistant Chief of Staff (AC/S), Environmental Security, Resources Management Division, Marine Corps Base Camp Pendleton, California. All activities were covered under 10(a)1(A) Recovery Permit #ESPER0004080-0.3 and a protocol approved by the Western Ecological Research Center Institutional Animal Care and Use Committee for compliance with the Animal Welfare Act. This report includes an annual update to surveys that have been performed since 2000 (Kus, 2001; Kus and Ferree, 2003; Kus and Kenwood, 2003, 2005, 2006a, b; Kenwood and Kus, 2007; Rourke and others, 2008; Howell and Kus, 2009a, b, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2024a, b, c, 2025b, c; and Howell and others, 2018, 2020). The study background, objectives, and methods originally were presented in Kus (2001) and are updated in this report.

Study Areas and Methods

Population Size and Distribution

From 2000 to 2018, all MCBCP's major drainages and several minor ones that supported riparian habitat were surveyed annually for flycatchers. In 2019, a reduced monitoring plan was implemented in which annual surveys for flycatchers were done only in core survey areas, where breeding had historically been documented on Base. The remaining unoccupied riparian habitat was divided into five non-core survey groups, with each group to be surveyed on a rotational schedule every 5 years, beginning in 2020. In 2025, all of MCBCP's historically occupied riparian habitat (core survey area; [fig. 1](#)) was surveyed for flycatchers. In 2020 and 2021, non-core survey areas A and C (respectively, [fig. 1](#))

were surveyed for flycatchers; however, because of funding limitations, none of the non-core survey groups were surveyed for flycatchers in 2022, 2023, 2024, or 2025. Protocol surveys were done three times between May 15 and July 31, 2025 ([fig. 1](#); [app. 1](#), [figs. 1.1–1.6](#)). Field work was completed by U.S. Geological Survey personnel: Lisa Allen, Annabelle Bernabe, Alexandra Houston, Scarlett Howell, Suellen Lynn, and Shannon Mendia. The specific areas surveyed were as follows:

Core Areas

1. Santa Margarita River:

- (a) Air Station East, Effluent Seep, Bell North, Bell South: from Basilone Road to a point approximately 8.5 kilometers (km) downstream on the east side of the Santa Margarita River ([app. 1](#), [figs. 1.2–1.3](#)).
- (b) Rifle Range, Pump Road North: from the Rifle Range along Stagecoach Road to a point approximately 2.5 km downstream ([app. 1](#), [fig. 1.2](#)).
- (c) Above Hospital, Below Hospital West: from the confluence with De Luz Creek to Basilone Road ([app. 1](#), [figs. 1.1–1.2](#)).

2. Fallbrook Creek, Lake O'Neill: at the inflow to Lake O'Neill, as well as around the lake ([app. 1](#), [fig. 1.1](#)).

3. Las Flores Creek, Upper Las Flores North: between a point 1.6 km downstream from Basilone Road to the Zulu Impact Area boundary approximately 0.8 km upstream from Basilone Road, including the side drainage adjacent to the 43 area ([app. 1](#), [fig. 1.4](#)).

4. San Mateo Creek, Lower San Mateo Bottom: between the Pacific Ocean and a point approximately 3.6 km upstream, including habitat south of the creek and south of the agricultural fields ([app. 1](#), [fig. 1.5](#)).

5. Pilgrim Creek, South of Vandegrift: between the southern Base boundary and Vandegrift Boulevard, including the two side drainages east of Pilgrim Creek ([app. 1](#), [fig. 1.6](#)).

Investigators followed standard survey protocol (Sogge and others, 2010), moving slowly (approximately 2 km per hour) through the riparian habitat while searching and listening for Willow Flycatchers. Observers walked along the edge(s) of the riparian corridor on the upland or river side where habitat was narrow enough to detect a bird on the opposite edge. In wider stands, observers traversed the habitat, choosing routes that permitted detection of all birds throughout its extent. Surveys typically began at sunrise and were completed by early afternoon, avoiding conditions of high winds and extreme heat that can reduce bird activity and detectability.

4 Distribution, Abundance, Breeding Activities, and Restoration Efforts for the SWF, Camp Pendleton, California—2025

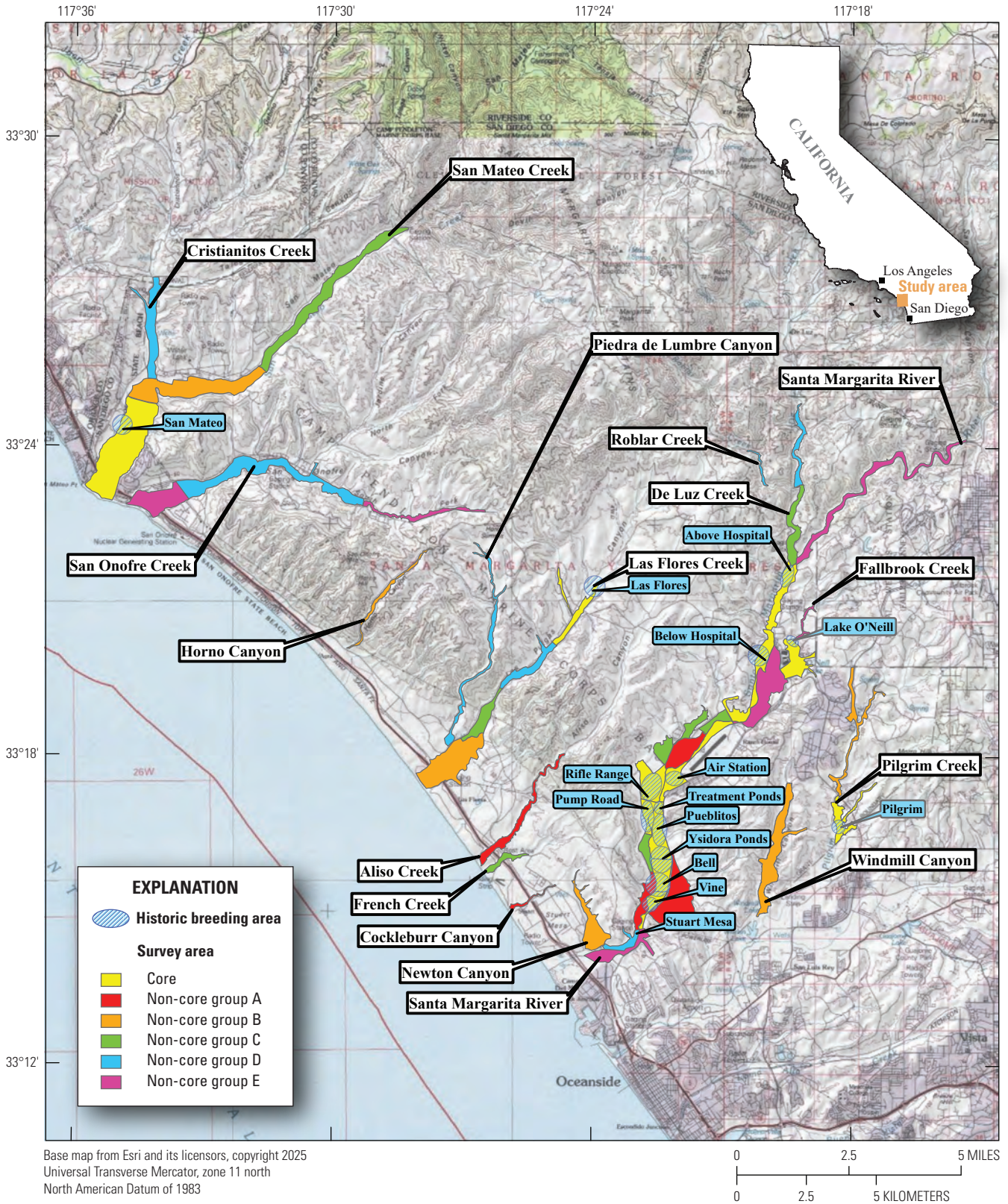


Figure 1. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey and historic breeding areas at Marine Corps Base Camp Pendleton, 2025. Only core areas were surveyed in 2025.

Upon initiation of the survey, investigators stood quietly for 1–2 minutes (min), listening for spontaneously singing Willow Flycatchers and acclimating to surrounding conditions, such as road noise, air traffic, and other bird songs. If flycatchers were not detected during the initial listening period, investigators broadcasted the Willow Flycatcher song (fitz-bew), using an MP3 player or phone and an amplified speaker, at the volume of typical bird songs for approximately 10–15 seconds (s) and then looked and listened for approximately 1 min for a response. Song playback was ceased immediately upon detection of a Willow Flycatcher. Willow Flycatchers typically responded by moving silently toward the song, singing in response to the song or responding with some other call or vocalization. This procedure was repeated (including a 10-s, quiet, pre-broadcast listening period) every 20–30 m throughout the survey site and more often if background noise was loud. If a Willow Flycatcher was detected, the investigator moved approximately 80–100 m beyond the detection before implementing additional playback to avoid double counting birds. Because *Empidonax* flycatchers look very similar and species other than Willow Flycatchers may be present in the habitat, identification of Willow Flycatchers was not made by sight alone; the primary song (fitz-bew) was required for detection purposes (Sogge and others, 2010). If a potential Willow Flycatcher responded silently, approached, or responded with another vocalization (for example, whitts) but did not sing, observers carefully backed away and waited quietly. In most cases, if the bird was a Willow Flycatcher, it sang within a short time (5–10 min). *Empidonax* flycatchers that did not sing by the end of the encounter but were suspected to be breeding Southwestern Willow Flycatcher were re-visited within 3 days (refer to the “Breeding Productivity Methods” section). *Empidonax* flycatchers that did not sing and were not suspected to be breeding individuals were not counted in survey results, unless the individual was detected again in a subsequent survey period (Sogge and others, 2010).

For each bird encountered, investigators recorded age (adult or juvenile), breeding status (paired, unpaired, or transient), and if possible, if the bird was banded. Flycatcher

locations were mapped using Environmental Systems Research Institute Field Maps (Esri, 2025) on mobile phones with built in Global Positioning System to determine geographic coordinates (World Geodetic System 1984).

Habitat Characteristics

Habitat was characterized by visual inspection within 50 m of each flycatcher location. Dominant native and non-native plants were recorded, and percent cover of non-native vegetation was estimated using cover categories of less than 5, 5–50, 51–95, and greater than 95 percent within the area used by each flycatcher detected. The overall habitat type at each location was specified according to the following categories:

Mixed willow riparian: Habitat dominated by one or more willow species, including Goodding’s black willow (*Salix gooddingii*), arroyo willow (*S. lasiolepis*), and red willow (*S. laevigata*), with mule fat (*Baccharis salicifolia*) as a frequent co-dominant.

Willow-cottonwood: Willow riparian habitat in which Fremont cottonwood (*Populus fremontii*) is a co-dominant.

Willow-sycamore: Willow riparian habitat in which Western sycamore (*Platanus racemosa*) is a co-dominant.

Sycamore-oak: Woodlands in which sycamore and coast live oak (*Quercus agrifolia*) occur as co-dominants.

Riparian scrub: Dry or sandy habitat dominated by sandbar willow (*S. exigua*) or mule fat, with few other woody species.

Upland scrub: Non-riparian, often disturbed upland communities adjacent to riparian habitat.

Non-native: Sites vegetated exclusively with non-native species, such as giant reed (*Arundo donax*) and salt cedar (*Tamarix* spp.).

Conspecific Playback Surveys

Historic breeding territories at MCBCP were grouped into 14 plots; 7 of the plots received conspecific vocalization broadcasts designed to attract Southwestern Willow Flycatchers, and the remaining 7 served as a control group, receiving no vocalization broadcasts (fig. 2; Schofield and others, 2018). Of the seven conspecific playback plots, five were on the Santa Margarita River, one was at Lake O’Neill, and one was at Pilgrim Creek. Six of the control plots were on the Santa Margarita River, and the remaining control plot was on Pilgrim Creek. In the conspecific playback plots, an automated unit broadcasted a combination of Willow Flycatcher vocalizations (primary “fitz-bew” song and various calls, interspersed with silence) from 0100 to 0600, 0700 to 0900, and 2000 to 2100 Pacific Standard Time. Vocalizations were broadcast at a volume level mimicking the typical level of spontaneously singing Willow Flycatchers and could be heard by observers at a maximum of 80 m away from the broadcast unit. Automated broadcast units consisted of a FOXPRO NX4 wildlife caller (FOXPRO, Lewiston, Pennsylvania, USA) connected to a Favolcano CN101A digital programmable timer (Favolcano, Fujian, China) and an external power source (12-volt, 9 amp-hours, AH, battery). The automated broadcast units were operated from April 30 to August 1, 2025, spanning the time when northbound flycatchers would be searching for locations to settle and potentially encompassing southbound flycatchers that might settle in future breeding seasons. Control plots not receiving broadcast vocalizations were at least 200 m from the broadcast unit to eliminate influence from the broadcast.

Surveys were done every other week from May to July in the conspecific playback and control plots to determine if any Southwestern Willow Flycatchers had established a territory. Surveys in 2025 began on May 6 and concluded on July 23. Investigators surveyed within 50 m of all historic breeding territories that fell within the playback or control plot, following a slightly modified survey protocol developed to attract Willow Flycatchers of the *adustus* and *brewsteri* subspecies to restored Sierra Nevada meadows (Schofield and others, 2018). Upon initiation of the survey, investigators stood quietly for 3–5 min, listening for spontaneously singing or calling Willow Flycatchers. If flycatchers were not detected during the initial listening period, investigators broadcasted the Willow Flycatcher song for approximately 30 s and then looked and listened for approximately 2 min for a response. If no response was detected, investigators repeated the 30-s broadcast and 2-min listening period. If flycatchers were not detected after the second round of broadcasting/listening, the investigator moved to the next historic location within the survey plot and repeated the sequence with a 1-min, pre-broadcast listening period before beginning the 30-s playback. In plots with automated broadcast units, if the survey was done during the time the broadcast was scheduled, the units were turned off before beginning the survey.

Breeding Productivity Methods

Flycatchers observed during protocol surveys that were suspected to be resident birds (for example, observed in more than one survey period, pair vocalizations heard, evidence of nesting seen) were revisited within 3 days of the detection date. Resident birds were observed for evidence of nesting, and nests were located and monitored following standard protocol (Rourke and others, 1999). Nests were visited as infrequently as possible to minimize disturbance and reduce the chances of leading predators or cowbirds to nest sites. Typically, there were three to four visits per nest, spaced approximately 5–10 days apart, depending on the stage of the nest when initially detected. The first visit was timed to determine the number of eggs laid, the next to confirm hatching and age of young, and the last to band nestlings. After a nest became inactive, six possible nest fates were assigned based on the following parameters:

Successful: Nests that fledged at least one young.

Fledging was confirmed by detection of young outside the nest.

Depredated: This category included (1) nests seen in the process of ant or other predation; (2) nests found with evidence, such as eggshell fragments, feathers, or partially consumed nestlings in or below the nest; (3) nests with eggs or nestlings later found empty and torn from supporting branch, either partially or completely, typically indicative of mammal predation (Peterson and others, 2004); and (4) nests that had eggs or nestlings but were later found intact and empty before the expected fledge date with no evidence of eggs or nestlings on the ground, consistent with snake and bird predation, which typically leave no sign (Peterson and others, 2004).

Parasitized: This category included (1) nests that were abandoned with one or more cowbird eggs in the nest and (2) nests that were tended by the host but contained only cowbird eggs.

Incomplete: Nests that were seen under construction but were never completed.

Other: This category included (1) nests that failed for reasons that were known, such as host plant failure or surrounding vegetation falling and crushing a nest; (2) nests with inviable eggs that did not hatch after more than two weeks; (3) or human disturbance, such as mowing or weed-whacking. This category also included nests that appeared to have failed because of cowbird predation, such as (1) abandoned nests containing punctured eggs in or below the nest; (2) nests where nestlings were killed by a puncture wound to the skull; or (3) nests where nestlings were ejected from the nest and found on the ground.

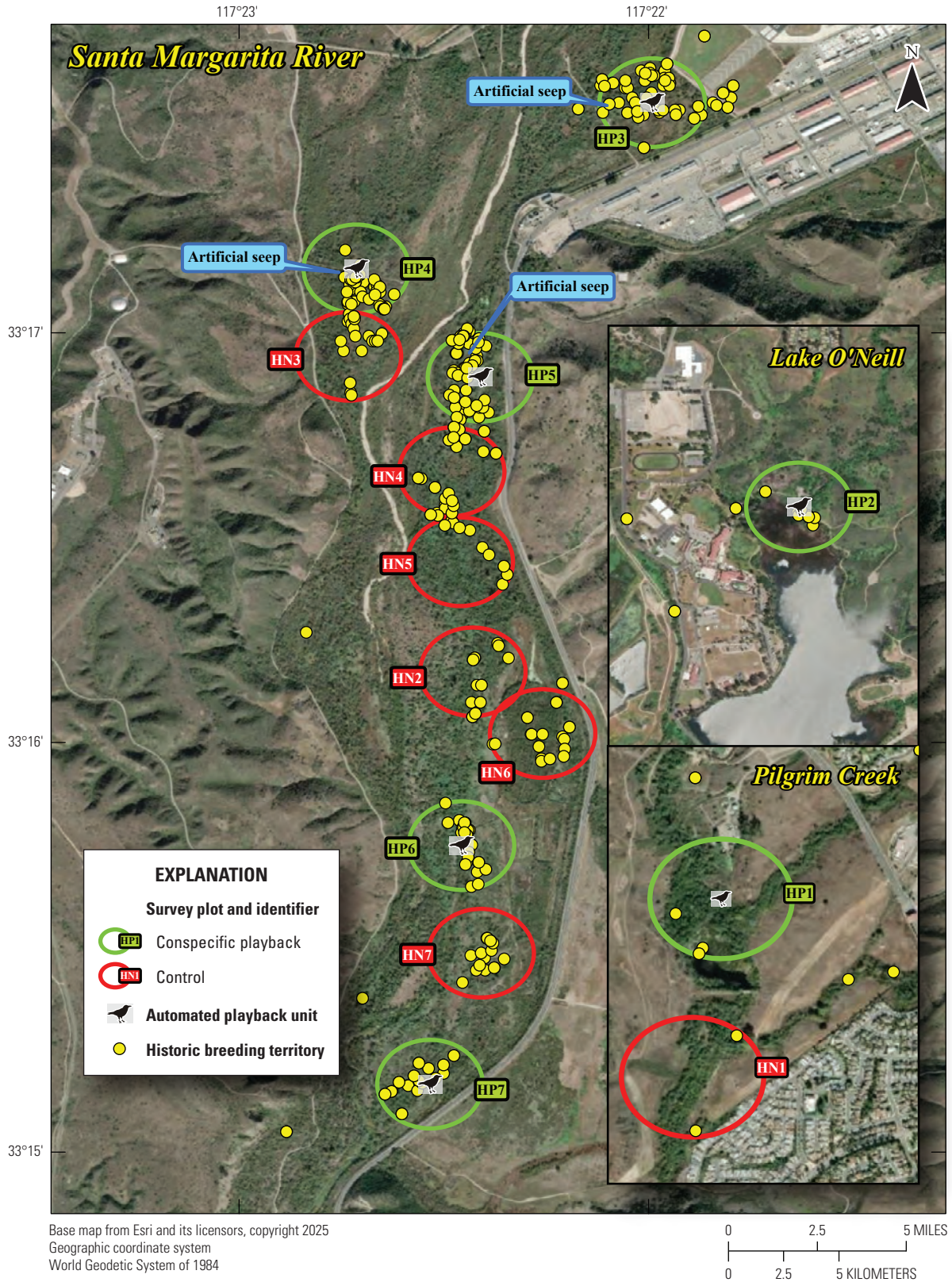


Figure 2. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) conspecific playback survey plots, automated playback unit locations, artificial seep locations, and historic breeding territories at Marine Corps Base Camp Pendleton, 2025.

Unknown: This designation was used when no other reason could be confirmed. In many instances, unknown fate was assigned to nests that were likely depredated but, because we could not confirm egg-laying, did not fit the criteria of Depredated; these failures are explained more fully in the “Results” section.

Nest Site Characteristics

Nest site characteristics were recorded after the abandonment or fledging of nests. Measurements included nest height, host species, host height, distance from the nest to the edge of the host species, and distance from the nest to the edge of the clump of riparian vegetation (Rourke and others, 1999). Distance to edge of the clump was expressed as a negative number if the nest was not in a clump of riparian vegetation. For example, if the nest was in a field of poison hemlock (*Conium maculatum*) without any other riparian vegetation present, the distance to the nearest clump of riparian vegetation was measured and the value expressed as a negative number.

Banded Bird Observations, Site Fidelity, and Movement

We attempted to capture and color band all resident flycatchers detected on MCBCP starting in 2000. Attempts were made each year to capture any unbanded adults within their territories using mist nets and band them with a numbered federal band on one leg and a solid or bi-colored metal band on the other. Any observed nestlings would be banded at 7–10 days of age with a silver, aluminum, federal-numbered band on the left leg. Returning adults previously banded as nestlings (natal) were target netted to determine their identity, and their original band was supplemented with one additional band to generate a unique color combination.

During surveys, we attempted to resight all Willow Flycatchers to determine whether they were banded, and if so, to confirm their identity by reading their unique color band combination or by recapturing birds with single federal bands. We used resighting data to determine the number of banded birds present in one year that returned the following year, and of the birds that returned, to determine site fidelity and movement. If banded flycatchers were identified, site fidelity and between-year and within-year movements were determined by measuring the distance between the center of a flycatcher’s breeding territory in 2024 (or last year detected) and the center of the same flycatcher’s breeding territory in 2025. Territory centers were estimated based on the area used by the flycatchers during surveys and nest monitoring. Adult flycatchers exhibited site fidelity if they returned to within 100 m of their last occupied territory, and natal flycatchers exhibited natal site fidelity if detected anywhere on Base.

Artificial Seep Study

In April 2019, MCBCP completed construction of a weir system designed to divert water from the Santa Margarita River to Lake O’Neill and several recharging ponds for the Conjunctive Use Project (P. McConnell, Vernadero Group, unpub. data, 2018). The purpose of the Conjunctive Use Project is to provide additional water for MCBCP and the Fallbrook Public Utility District (P. McConnell, Vernadero Group, unpub. data, 2018). Upstream groundwater withdrawal could affect flycatcher habitat adversely by reducing surface water, a critical component of flycatcher habitat (Sogge and others, 2010); therefore, the Biological Opinion issued by the U.S. Fish and Wildlife Service (2016) required MCBCP to initiate a habitat enhancement project to offset anticipated impacts to flycatcher habitat. We collaborated with AC/S Environmental Security to design an experiment testing the effectiveness of artificial seeps to enhance flycatcher habitat, and in January 2019, MCBCP began operating an artificial seep along the Santa Margarita River to compensate for groundwater withdrawal upstream. Two more artificial seeps were installed in early 2021 for a total of three artificial seeps. A low-volume (20–40 liters per minute), shallow groundwater irrigation pumping well was installed at each artificial seep location to draw water to the surface during daylight hours from approximately mid-April to the end of August each year, although maintenance issues prevented consistent operation on exact dates every year. The pumps were solar-powered and directed water to two–six outlet pipes at each site. The seeps were within three of the conspecific playback plots (fig. 2) along the Santa Margarita River. During conspecific playback surveys, we observed the habitat immediately surrounding the seeps and recorded if any Willow Flycatchers were using the area.

We focused on two of the three artificial seeps to examine the effect of the seep pumps on flycatcher habitat (fig. 3). Two outlet pipes at the Pump Road site and six outlet pipes at the Old Treatment Ponds site directed water to an area of approximately 1,500 square meters (m²). To adjust for even distribution of surface water at the Old Treatment Ponds site and to compensate for low water pressure, two outlet valves were closed for the full operating season in 2020 and 2024, one outlet valve was closed for the full operating season in 2021 and 2022, and one outlet valve was closed for the last month of the operating season in 2023. Water was pumped to the surface when there was sufficient sunlight for solar panels to generate power beginning in April and ending in August each year. Shallow pools created by the seep pumps were small (8–44 m²) and limited to the immediate vicinity of the outlet pipes. The pump at the Pump Road North Seep site was non-functional for the 2023 field season and the pump at the Old Treatment Ponds North Seep site was non-functional for the 2025 field season.

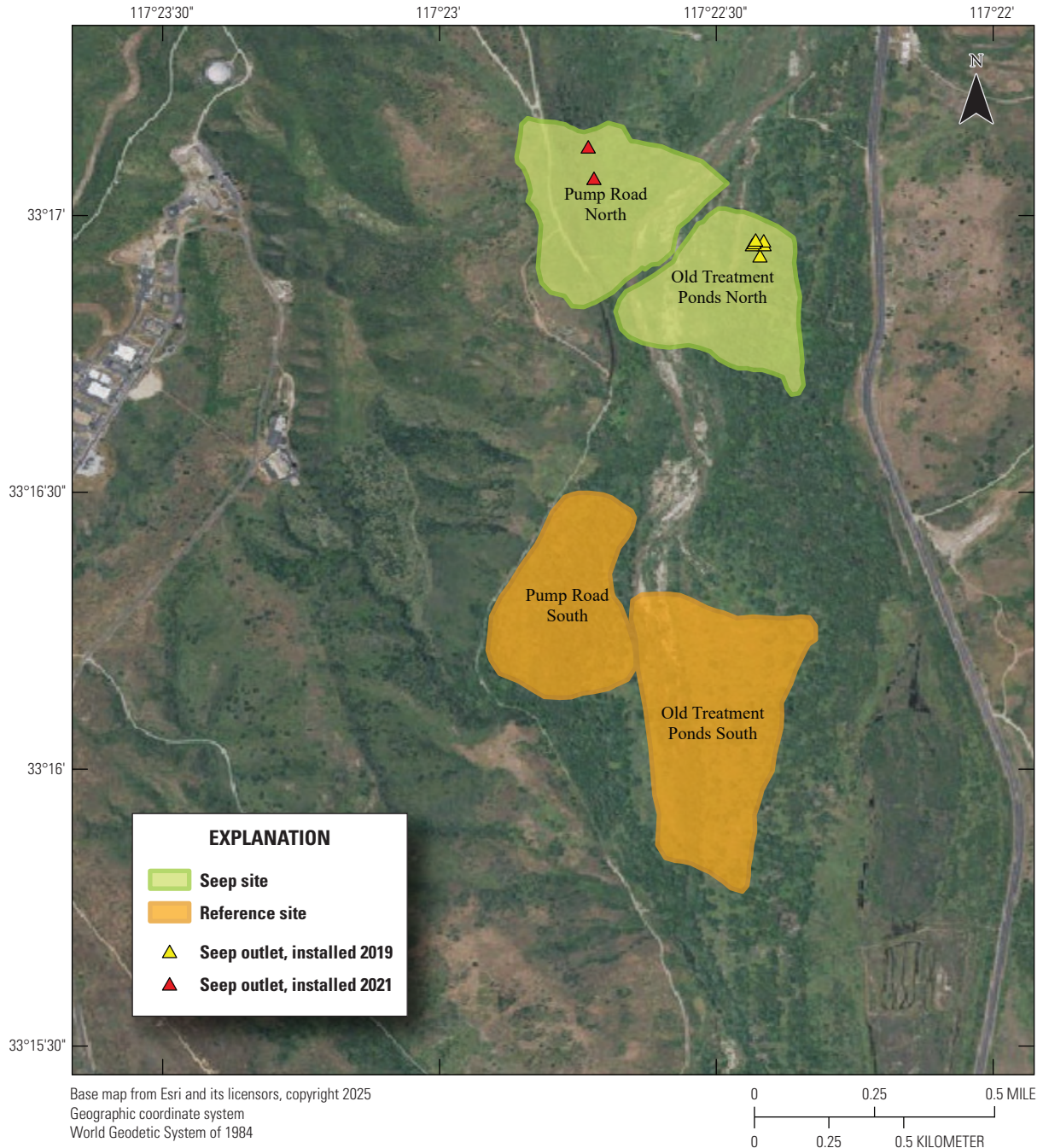


Figure 3. Location of Seep and Reference sites at Marine Corps Base Camp Pendleton, 2025.

We established two types of study plots: Seep and Reference sites. In 2023, we temporarily reclassified one site as Intermediate to incorporate the potential consequences of an unanticipated disruption to the operation of the seep pump (fig. 3); however, we abandoned this designation when the second seep pump failed to operate in 2025, reestablishing parity between the Seep sites. Originally, two Seep sites were selected. The Seep sites surrounded and extended downstream from (1) the seep installed in 2019 northwest of the Old Treatment Ponds area and (2) the seep installed in 2021 in the

Pump Road area. A Reference site was selected 0.5–0.8 km from each Seep site. Reference sites were on the same side of the Santa Margarita River as their corresponding Seep sites and encompassed similar vegetation as the corresponding Seep site. Although seep pumps at both Seep sites experienced unanticipated disruptions causing inconsistency in annual operation, we anticipated that both Seep sites would become wetter relative to the Reference sites as a result of the effects of the upstream water diversion and annual surface water augmentation near the seep pumps.

Vegetation Structure and Plant Composition

From 2020 through 2024, we collected data on vegetation and soil saturation associated with artificial seeps at Least Bell's Vireo nest sites (Lynn and Kus, 2024; Lynn and others, 2024a, 2024b, 2024c; B. Kus, U.S. Geological Survey, unpub. data, 2024). However, changes in nest sites between years introduced variation in vegetation and soil saturation conditions that could not be attributed directly to the artificial seeps. Therefore, in 2025, we established permanent vegetation sampling locations at the two Seep sites and two Reference sites to better associate the cumulative response of riparian habitat to locally augmented surface water. We collected vegetation data at 12 locations at each of the 2 Seep sites and 12 locations at each of the two Reference sites, for a total of 48 vegetation sampling locations (app. 2). Vegetation data were collected using a protocol developed to characterize flycatcher habitat in 2001 and 2002 (Rourke and others, 2004). Each sampling location consisted of a center plot and 3 satellite plots (fig. 4), totaling 192 sampling plots. Satellite plots were 15 m from the center plot at 0, 120, and 240 degrees. We collected global positioning system coordinates at the center of each plot.

Vegetation cover within 5 m of the center of the plot was visually estimated at three height intervals: 0–3, 3–6, and greater than 6 m. A 7.5-m-tall fiberglass telescoping pole (Hastings non-conductive fiberglass telescoping measuring rod, model M-25, Hastings, Michigan), demarcated in 1-m intervals, was used to determine height class and canopy height. Overall (or total) foliage cover was recorded as the percentage of volume (percent cover) occupied by all foliage in the plot in each height interval, combining all species together. Overall non-native foliage cover was measured as the percent cover of all non-native species (herbaceous and woody) within the plot at each height interval. Overall

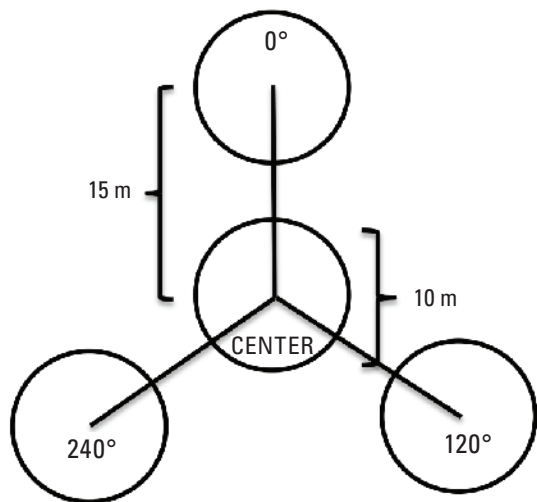


Figure 4. Vegetation sampling plot configuration. Abbreviations: m, meter; °, degrees.

foliage and non-native cover were estimated using a modified Daubenmire (1959) scale with cover classes: less than 1, 1–10, 11–25, 26–50, 51–75, 76–90, and greater than 90 percent. Cover classes were further refined using “+” and “–” to indicate if the estimate was in the upper or lower range of the cover class. We described the composition of vegetation at each height category by recording the percentage of the overall foliage cover made up by each of the three species (species 1, 2 and 3) contributing the most cover, as well as a fourth category called “All Other” species, with the four cover estimates summing to 100 percent. We also measured canopy height (estimated if above 7.5 m) and recorded soil saturation (percentage of relative saturation) at the center of each plot using a Kelway model HB-2 soil pH and moisture meter (Kel Instruments Co., Inc., Teaneck, New Jersey).

Data Analyses

Vegetation Structure and Plant Composition

At each height category, the estimates of the top three species contributing the most cover and the fourth category representing “All Other” were converted to percent cover values of the sampling plot area ($n=192$) by multiplying the estimate by the overall foliage cover at that height. For example, if the overall foliage cover was 75 percent and species 1 made up 50 percent of the overall cover, the actual cover of species 1 was 50 percent of 75 percent, or 37.5 percent (0.50 multiplied by $0.75=0.375$). We then calculated the average percent cover of each plant species, total cover, cover of non-native plant species, canopy height, and soil saturation across the center and three satellite plots at each sampling location to obtain means for each location ($n=48$). For the three top species, we further classified plant species into native herbaceous vegetation, woody vegetation (including both native and non-native species), and all herbaceous vegetation to calculate average percent cover of each of these three groups at each height category and sampling location. We also identified the maximum canopy height among the center and three satellite plots at each sampling location. We used Student's *t*-test when data were normally distributed and Mann-Whitney *U*-tests when data were not normally distributed to determine if there were differences between Seep and Reference sites in (1) average canopy height; (2) maximum canopy height; (3) average soil saturation, and, at each height category, (4) average vegetation volume (percent cover) of all plant species (total cover); (5) average vegetation volume of woody species; (6) average vegetation volume of all herbaceous species; (7) average vegetation volume of native herbaceous species; and (8) average vegetation volume of non-native species (including herbaceous and woody species). No analyses were made across height categories or among vegetation type categories, so no adjustments were made for multiple comparisons.

For soil saturation analyses, we excluded missing data at five plots (two at the Seep sites and three at the Reference sites) and also soil saturation measurements at two locations (eight plots) at Pump Road North after recognizing that the soil moisture reader may have been malfunctioning. We used Pearson's correlation to examine the relationship between soil saturation and the distance of each plot from the nearest seep outlet at the two Seep sites at the sampling plot scale ($n=86$). We used Spearman's rank correlation to examine the relationship between the average soil saturation at each location (average of four plots per location) and (1) canopy height, and, at each height category, (2) percentage of total foliage cover; (3) percentage of woody cover; (4) percentage of herbaceous cover; (5) percentage of native herbaceous cover; and (6) percentage of non-native cover.

In 2018, vegetation data collected at flycatcher territories and nearby unused areas in 2001 and 2002 were compiled into a statistical model to predict flycatcher occupancy on MCBCP (Howell and others, 2018). The habitat model predicted that flycatchers would occupy areas with high total vegetation cover between 3 and 6 m and high poison hemlock and Goodding's black willow cover below 3 m. Stinging nettle (*Urtica dioica*) cover below 3 m and Goodding's black willow cover above 6 m were considered noteworthy, although not as straight-forward, components of the habitat model. Although poison hemlock is a non-native herbaceous annual plant in this ecosystem, and hence not ideal for flycatcher habitat in a historic sense, it likely serves as a replacement for native herbaceous annual plants that are no longer predominant on Base. We used Mann-Whitney U -tests to determine if there were differences between Seep and Reference sites in poison hemlock cover (below 3 m), stinging nettle cover (below 3 m), and Goodding's black willow cover (below 3 m and above 6 m). We used Spearman's rank correlation to examine the

relationship between soil saturation and the same three plant species. Data were analyzed using Program R (R Core Team, 2025). Two-tailed tests were considered significant if $P \leq 0.10$. Means are presented with standard deviations.

All data from previous years at MCBCP used in comparisons with current data can be found in the following documents: Kus, 2001; Kus and Ferree, 2003; Kus and Kenwood, 2003, 2005, 2006a, b; Kenwood and Kus, 2007; Rourke and others, 2008; Howell and Kus, 2009a, b, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2024a, b, c, 2025b, c; and Howell and others, 2018, 2020.

Results

Flycatcher Population Size and Distribution

Transients

Eight transient Willow Flycatchers of unknown subspecies were observed during protocol and conspecific playback surveys (app. 3, figs. 3.1–3.2). All transients were detected between May 19 and June 16. Transients were detected on the Santa Margarita River (seven) and Las Flores Creek (one) but were not detected on Fallbrook, Pilgrim, or San Mateo Creeks.

Residents

No resident Southwestern Willow Flycatchers were detected during the 2025 breeding season (table 1). Overall, the resident flycatcher population on Base decreased by one from 2024 to 2025 (fig. 5; table 1).

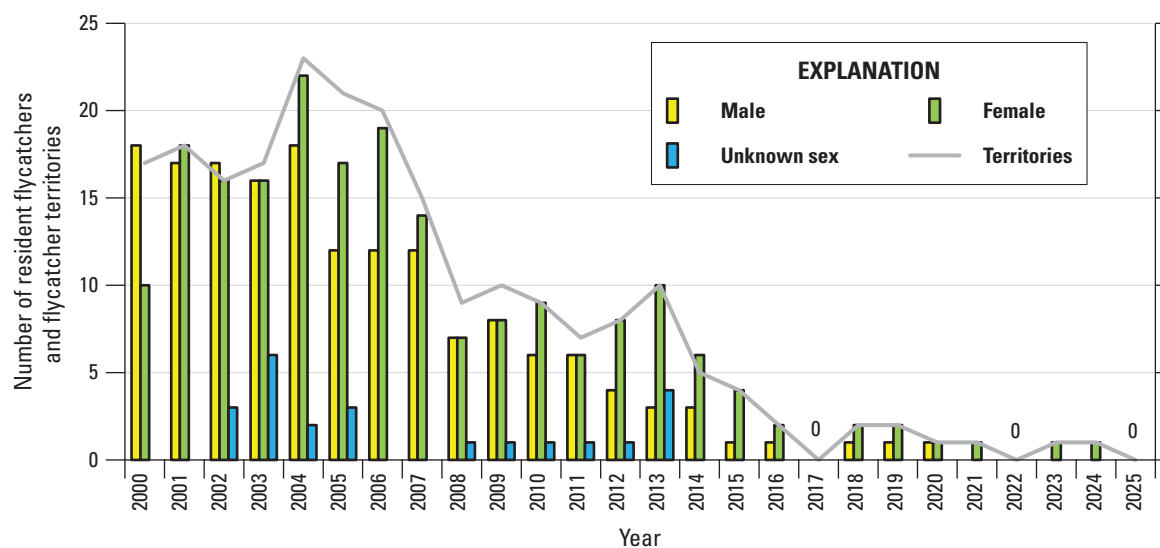


Figure 5. Number of resident Southwestern Willow Flycatchers (*Empidonax traillii extimus*) by sex and total number of flycatcher territories at Marine Corps Base Camp Pendleton, 2000–25.

Table 1. Distribution of territorial Southwestern Willow Flycatchers (*Empidonax traillii extimus*) at Marine Corps Base Camp Pendleton, 2000–25.

[Refer to [figure 1](#) for drainage/breeding areas]

Drainage/ breeding area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Fallbrook Creek																											
Lake O'Neill	2	2	2	3	2	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Las Flores Creek																											
Las Flores	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilgrim Creek																											
Pilgrim	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
San Mateo Creek																											
San Mateo	0	0	0	0	0	0	0	2	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Santa Margarita River																											
Above Hospital	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Below Hospital	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Station	6	5	2	0	2	0	0	4	4	5	6	5	6	5	3	0	1	0	²⁰	1	0	0	0	1	1	0	
Rifle Range	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pump Road	2	6	6	5	11	9	6	8	3	3	3	2	¹	2	0	0	0	0	0	0	0	0	0	0	0	0	
Treatment Ponds	1	1	0	0	0	1	5	4	2	4	4	3	3	4	3	4	2	0	²⁰	0	0	0	0	0	0	0	
Pueblitos	4	7	6	9	8	4	9	2	5	3	¹	1	0	¹	2	¹	0	0	3	2	2	1	0	0	0	0	
Ysidora Ponds	5	8	4	4	6	9	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bell	4	4	6	3	10	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Vine	4	2	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stuart Mesa	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	28	35	33	32	40	29	31	26	14	16	15	12	12	13	9	5	3	0	3	3	2	1	0	1	1	0	

¹One male's territory overlapped two breeding areas, included in Treatment Ponds total.

²Two different females used additional breeding areas (Air Station and Treatment Ponds) before settling in Pueblitos, included in Pueblitos total.

Conspecific Playback Surveys and Artificial Seep Monitoring

Transient flycatchers were detected in 14 percent (1/7) of the conspecific playback plots and 14 percent (1/7) of control plots with no playback (app. 3, fig. 3.1). Two transient flycatchers were detected within 20 m of a conspecific broadcast unit. Transient flycatchers were not observed near any operational artificial seep outputs.

Habitat Characteristics

Transient flycatcher detections occurred in habitat classified as riparian scrub and mixed willow riparian (table 2). Most flycatcher locations were dominated by one of three willow species: arroyo willow, red willow, or sandbar willow. Exotic vegetation was present in most flycatcher locations in 2025. Twenty-five percent (2/8) of flycatcher locations had habitat composed of 5–50 percent exotic vegetation, and 63 percent of locations (5/8) were dominated by exotic vegetation (percent cover of exotics greater than 50 percent). The most common exotic plant in the habitat used by flycatchers was poison hemlock, which was present in 75 percent of locations (6/8; table 2).

During surveys, observers incidentally observed large stands of dead and dying trees within many of the historic flycatcher breeding areas because of ongoing invasive shothole borer (*Euwallacea* spp.) infestation (Nobua-Behrmann and others, 2023). The tops of many willow trees were snapped off, which reduced overall canopy height and density. In addition to trees that were already dead, others showed evidence of active infestation (for example, frass and wet staining at entrance holes; Nobua-Behrmann and others, 2023).

Breeding Productivity Results

No Southwestern Willow Flycatcher nesting was observed in 2025.

Banded Bird Observations

Most transient flycatchers were observed closely enough to confidently determine if they were banded (6/8). None of the closely observed flycatchers were banded.

Table 2. Habitat characteristics of Willow Flycatcher (*Empidonax traillii*) locations at Marine Corps Base Camp Pendleton, 2025.

[ID, identification; <, less than; —, no data]

Bird ID	Drainage	Breeding status	Habitat type	Dominant plant species	Non-native plant cover (percent)	Dominant non-native species
UL01F	Las Flores Creek	Transient	Riparian scrub	Coyote brush (<i>Baccharis pilularis</i>)	5–50	Black mustard (<i>Brassica nigra</i>)
HP501F	Santa Margarita River	Transient	Mixed willow	Arroyo (<i>Salix lasiolepis</i>) or red willow (<i>Salix laevigata</i>)	51–95	Poison hemlock (<i>Conium maculatum</i>)
HP502F	Santa Margarita River	Transient	Mixed willow	Arroyo or red willow	51–95	Poison hemlock
PRN01F	Santa Margarita River	Transient	Mixed willow	Arroyo or red willow	5–50	Poison hemlock
RR01F	Santa Margarita River	Transient	Riparian scrub	Sandbar willow (<i>Salix exigua</i>)	51–95	Poison hemlock
RR02F	Santa Margarita River	Transient	Mixed willow	Arroyo or red willow	51–95	Poison hemlock
RR03F	Santa Margarita River	Transient	Riparian scrub	Sandbar willow	<5	—
RR04F	Santa Margarita River	Transient	Riparian scrub	Sandbar willow	51–95	Poison hemlock

Vegetation at Artificial Seep and Reference Sites

In 2025, we identified 43 common plants at vegetation plots throughout all sites. The most common plant species was the woody red or arroyo willow, which was one of the top 3 species at 37 of the 48 sampling locations (77 percent). Other common woody plant species were Goodding’s black willow (26 locations; 54 percent), poison oak (*Toxicodendron diversilobum*) (24 locations; 50 percent), mule fat (23 locations; 48 percent), and blue elderberry (*Sambucus nigra*; 20 locations; 42 percent). The second most common plant species and the most common herbaceous species was stinging nettle (32 locations; 67 percent), followed

by poison hemlock (29 locations; 60 percent). We determined that 13 plant species were common at 20 percent of locations or more. Of these 13 plant species, 3 were non-native: poison hemlock, black mustard (*Brassica nigra*), and perennial pepperweed (*Lepidium latifolium*).

Overall vegetation cover in 2025 was highest near the ground and decreased with increasing height (fig. 6). Woody vegetation made up most of the cover at all height categories, with cover ranging from 35 percent below 3 m to 8 percent above 6 m. Herbaceous cover (total and native) was concentrated near the ground with very little (less than 2 percent cover) above 3 m. Non-native vegetation was present at all height categories, tapering from 19 percent below 3 m to 1 percent or less above 6 m.

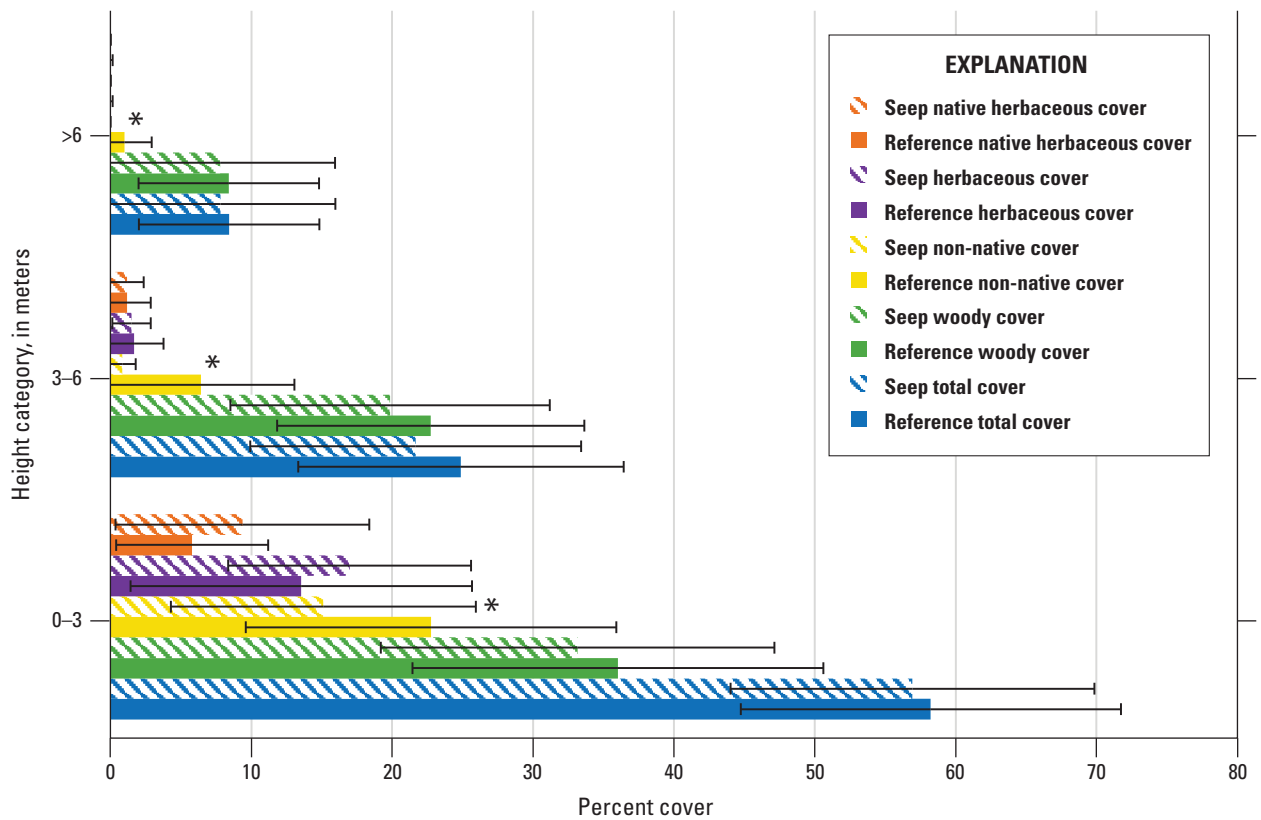


Figure 6. Average percent cover at vegetation sampling locations by height class and plant type at Seep and Reference sites, Santa Margarita River, Marine Corps Base Camp Pendleton, 2025. Error bars represent 1 standard deviation. Asterisk (*) indicates a significant difference among sites (Mann-Whitney *U*-test, $P \leq 0.10$). No analyses were made across height categories or among vegetation type categories; therefore, no adjustments were made for multiple comparisons. Abbreviations: >, greater than; \leq less than or equal to.

Soil saturation varied among sites, with highly saturated plots more common at the Seep sites than at the Reference sites in 2025 (figs. 7, 8). Most of the plots at the Old Treatment Ponds Seep site (85 percent) and Pump Road Seep site (100 percent) had greater than 50-percent soil saturation (fig. 7), whereas only 20 percent of plots at the Old Treatment Ponds Reference site and 36 percent of plots at the Pump Road Reference site had greater than 50-percent soil saturation (fig. 8). Soil was 100-percent saturated at more than 60 percent of plots at the Seep sites and less than 20 percent of plots at the Reference sites (figs. 7, 8). Plots were wet throughout the Pump Road Seep site. At the Old Treatment Ponds Seep site, wet plots were prevalent in the center of the site, with drier plots at the extreme northern end and an area southeast of the seep outlets. The plots in the Pump Road Reference site were mostly dry, with a few wet areas at the north end and at the southwest end of the site where water collects on a dirt road in wet years. Similarly, the Old Treatment Ponds Reference site was mostly dry, with a few wet plots at the eastern edge near a seasonal pond. Soil saturation was significantly higher at the Seep sites (90 ± 15 percent) than at Reference sites (30 ± 32 percent; $t=8.29$, $P < 0.001$). We did not find a linear association between soil saturation and distance from the nearest seep outlet at the Seep sites ($\rho=0.20$, $P=0.38$).

In 2025, we determined that the relationships of total cover and woody cover with soil saturation were not statistically significant; however, non-native vegetation above 3 m decreased with increasing soil saturation, and native herbaceous cover above 3 m, albeit low, increased with increasing soil saturation (table 3). Statistically, total

herbaceous cover above 6 m also increased significantly with increasing soil saturation ($\rho=0.27$, $P=0.07$), although the amount of herbaceous vegetation at this height was small, and the relationship was not biologically significant. We did not find a significant correlation between soil saturation and average canopy height ($\rho=-0.09$, $P=0.53$).

In 2025, we did not find significant differences between Seep and Reference sites in total, woody, total herbaceous, or native herbaceous cover (fig. 6). However, non-native cover was higher at the Reference sites than at the Seep sites at all height categories, confirming the negative relationship described above between soil saturation and non-native vegetation. The average canopy height did not differ significantly between Seep and Reference sites (7.4 ± 2.9 m, 8.1 ± 2.9 m, respectively; $t=0.86$, degrees of freedom [df]=45.98, $P=0.19$). We also did not find a significant difference in maximum canopy height between Seep and Reference sites (9.5 ± 3.7 m, 11.0 ± 3.9 m, respectively; $t=1.35$, df=45.85, $P=0.18$).

In 2025, the average percent cover was low for all plant species that were considered important or noteworthy in the Southwestern Willow Flycatcher habitat model (Howell and others, 2018) and we did not find significant differences between Seep and Reference sites for any species at any height category (table 4). However, poison hemlock cover below 3 m significantly decreased with increasing soil saturation (table 5). We did not find significant correlations between stinging nettle cover and soil saturation or cover of Goodding's black willow and soil saturation.

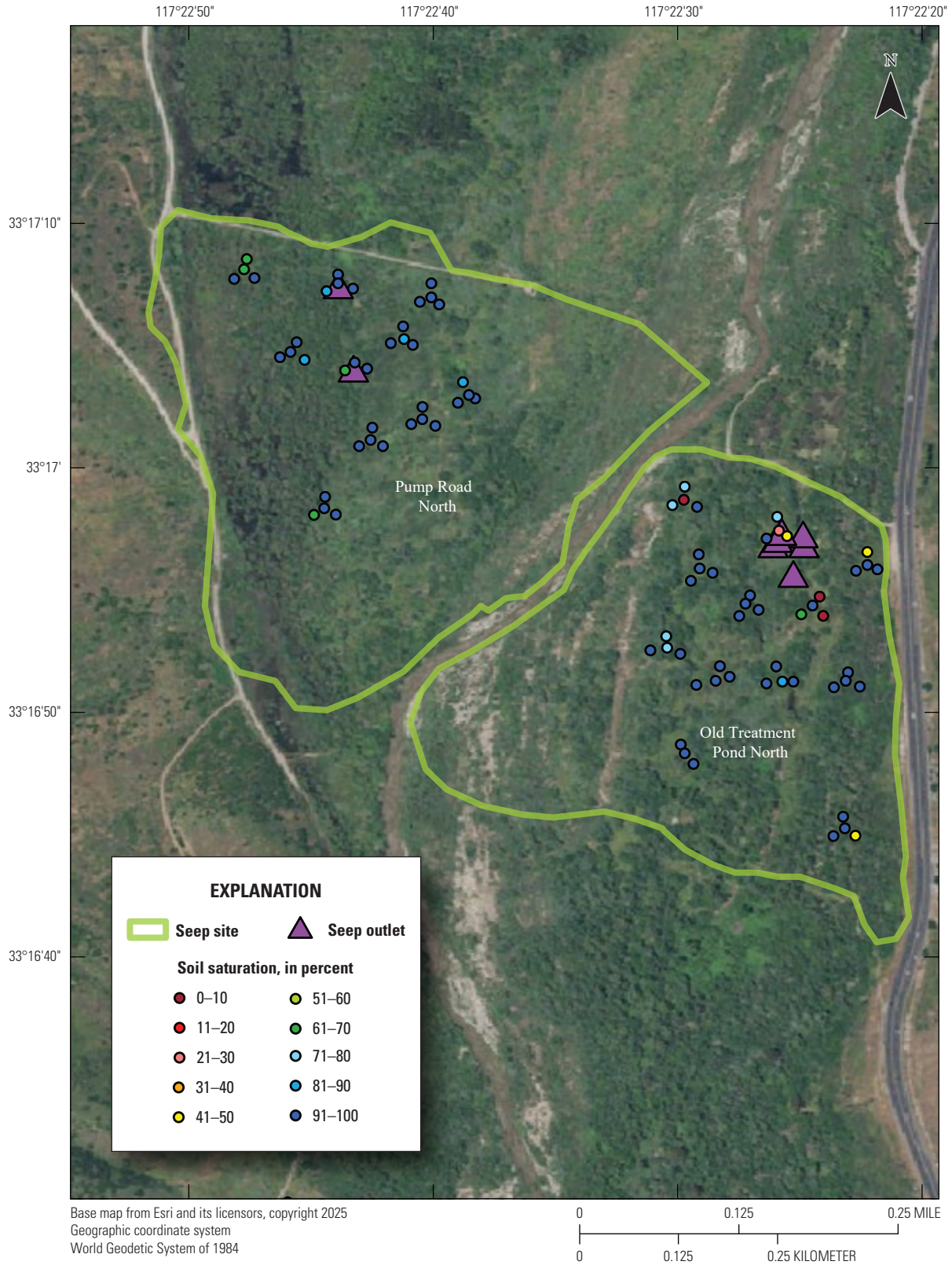


Figure 7. Percentage soil saturation at Seep site vegetation sampling plots, Marine Corps Base Camp Pendleton, 2025. Soil saturation was not collected at some plots. We excluded two locations (eight plots) at Pump Road North because of equipment malfunction. Refer to [figure 3](#) for overview map.

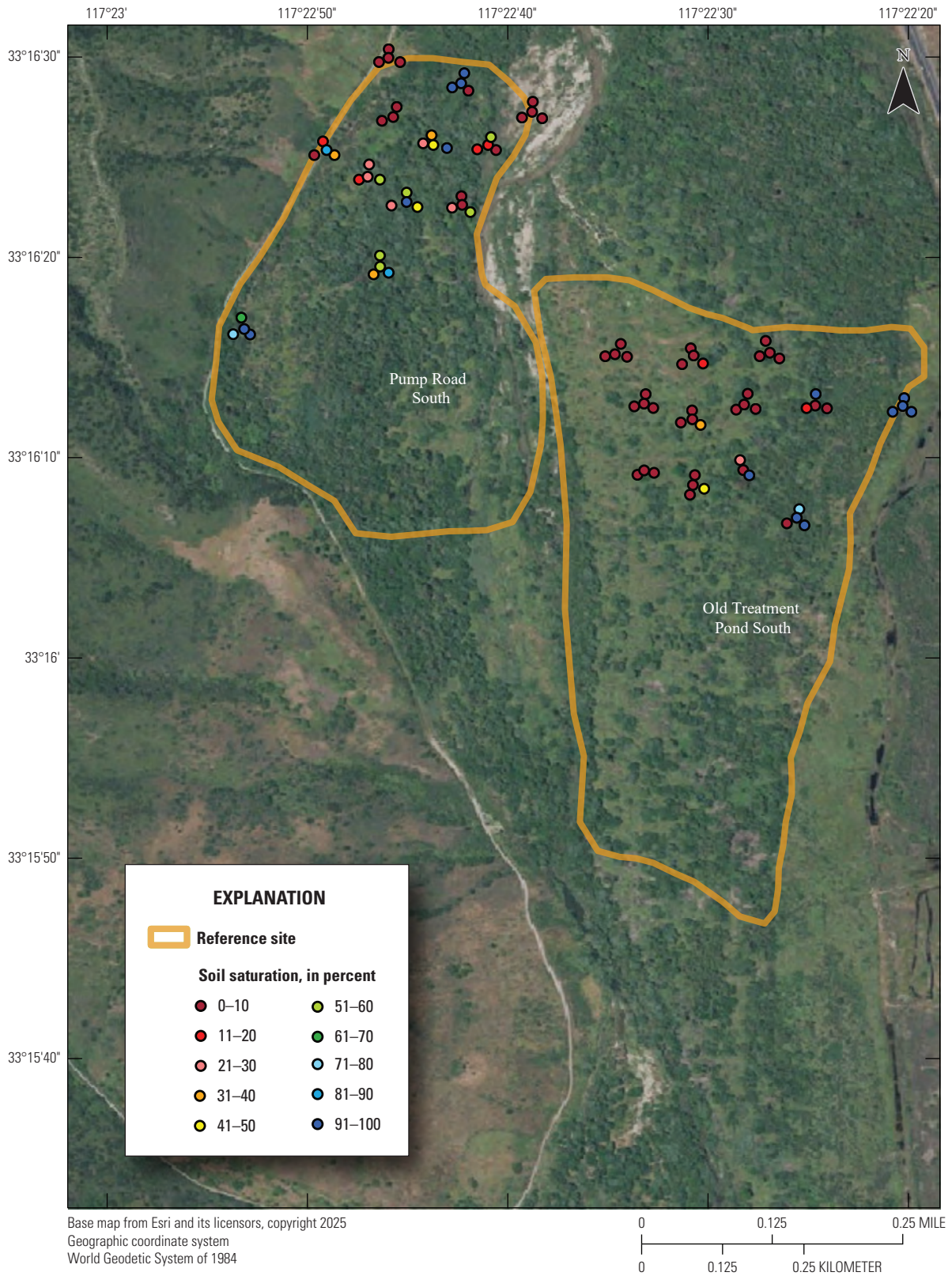


Figure 8. Percentage soil saturation at Reference site vegetation sampling plots, Marine Corps Base Camp Pendleton, 2025. Soil saturation was not collected at some plots. Refer to [figure 3](#) for overview map.

Table 3. Spearman’s rank correlations (ρ) and significance of these correlations (P) between soil saturation and vegetation cover by height category, Marine Corps Base Camp Pendleton, 2025.

[No analyses were made across height categories or among vegetation type categories; therefore, no adjustments were made for multiple comparisons. **Abbreviations:** m, meter; ρ , Spearman’s rank correlation statistic; P , significance; >, greater than]

Height category	Total cover		Woody cover		Total herbaceous cover		Native herbaceous cover		Non-native cover	
	ρ	P	ρ	P	ρ	P	ρ	P	ρ	P
0–3 m	0.08	0.61	0.07	0.63	0.14	0.36	0.12	0.41	-0.13	0.39
3–6 m	-0.14	0.37	-0.15	0.31	0.17	0.25	¹ 0.27	¹ 0.07	¹ -0.37	¹ 0.01
>6 m	-0.04	0.80	-0.04	0.79	¹ 0.27	¹ 0.07	¹ 0.27	¹ 0.07	¹ -0.44	¹ 0.002

¹Significant result.

Table 4. Average percent cover of plant species identified as important in Southwestern Willow Flycatcher (*Empidonax traillii extimus*) habitat model (Howell and others, 2018) at Seep and Reference site vegetation sampling plots and results of Mann-Whitney U -tests (P) comparing Seep and Reference sites, Marine Corps Base Camp Pendleton, 2025.

[No analyses were made across height categories or among vegetation categories; therefore, no adjustments were made for multiple comparisons. **Abbreviations:** m, meters; P , significance; >, greater than; \pm , plus or minus]

Plant species and height category	Average percent cover		P
	Seep sites	Reference sites	
Poison hemlock 0–3 m	2.3 \pm 4.3	2.0 \pm 2.4	0.71
Stinging nettle 0–3 m	3.8 \pm 5.8	3.2 \pm 4.3	0.93
Goodding's black willow 0–3 m	5.2 \pm 7.4	3.2 \pm 4.7	0.39
Goodding's black willow >6 m	4.0 \pm 6.0	2.8 \pm 4.1	0.49

Table 5. Spearman’s rank correlations (ρ) and significance of these correlations (P) between soil saturation and plant species identified as important in the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) habitat model (Howell and others, 2018) by height category, Marine Corps Base Camp Pendleton, 2025.

[No analyses were made across height categories or among vegetation type categories; therefore, no adjustments were made for multiple comparisons. **Abbreviations:** m, meter; ρ , Spearman’s rank correlation statistic; P , significance; >, greater than; —, no data]

Height category	Poison hemlock		Stinging nettle		Goodding's black willow	
	ρ	P	ρ	P	ρ	P
0–3 m	¹ -0.27	¹ 0.07	0.18	0.23	0.15	0.32
>6 m	—	—	—	—	0.13	0.38

¹Significant result.

Discussion

In 2025, no resident Southwestern Willow Flycatchers were detected on MCBCP, a decrease from the one unpaired female that was present in 2024. This marks the third time since annual monitoring began in 2000 that no resident flycatchers were detected; before 2025, no residents were detected in 2017 or 2022. From 2000 to 2004, the resident population of Southwestern Willow Flycatchers on Base increased annually, peaking at 42 individuals in 2004. An overall downward trend began in 2005 characterized by several stepwise population declines, where the resident population dropped by more than 24 percent from one year to the next (2004–05: 24 percent; 2007–08: 42 percent; 2013–14: 47 percent; 2014–15: 44 percent; and 2015–16: 40 percent). Resident flycatchers were not detected on Base in 2017, but in 2018, three flycatchers that previously had been detected on Base returned and bred. The resident population remained at three individuals from 2018 to 2019 before resuming the downward trend, with a 33-percent decline from 2019 to 2020, followed by a 50-percent decline from 2020 to 2021 when no breeding male flycatchers were detected on Base, leaving a single, resident female that was not detected in 2022. After no resident flycatchers were observed in 2022, a natal female established a territory in 2023 and returned in 2024 but remained unpaired throughout both breeding seasons.

The number of transient Willow Flycatchers detected annually in the core survey area has varied greatly, despite consistent survey scope and effort, from a low of 2 in 2000 to a high of 42 in 2016. Although factors influencing the migratory route and variable timing of transient Willow Flycatchers are unclear, it remains clear that MCBCP can provide important stop-over habitat for migrating Willow Flycatchers. Transient flycatchers typically have been found in willow and riparian scrub habitat, frequently with substantial exotic vegetation.

Over the past two decades, many factors have been suggested as potential reasons for the flycatcher population decline at MCBCP, including habitat senescence, overgrowth of exotic vegetation, habitat changes related to drought and changes in surface water, habitat loss from fire, and the detrimental effect of invasive insects on flycatcher habitat. Habitat degradation resulting from invasive shothole borer, which was first noted in 2019 (S. Mendia, U.S. Geological Survey written commun., 2025), continued in 2025. Large stands of trees, including willow and sycamore along the Santa Margarita River, appeared to be infested and were declining or dead. The canopy was less dense in many historically occupied breeding areas, and there were many dead trees with the tops snapped off. Although some willow trees that appeared to have been affected by shothole borer in past years were crown sprouting and may eventually recover, the overall vegetation structure of the area has changed, which may reduce suitability for breeding flycatchers in the short term.

The seep habitat enhancement project initiated by AC/S Environmental Security to augment surface water in historically occupied habitat is an important step in attempting to mitigate declines in the flycatcher population that could be related to changes in surface water on Base. Surface water or saturated soil has been identified as the most universal component of flycatcher habitat (Sogge and others, 2010). The addition of surface water also is intended to enhance other desirable habitat conditions for breeding flycatchers, such as a dense understory from 0 to 3 m, which was reported to be an important variable in previous nest vegetation studies (Rourke and others, 2004). Although all study sites experienced the same level of precipitation each year, the Seep sites, which have received varying amounts of supplemental surface water since 2019, had higher soil saturation than the Reference sites. Cumulative supplementation of surface water at the Seep sites after dry and wet winters likely helped to maintain moist conditions at these sites that were not maintained at the Reference sites. Soil saturation at both Seep sites likely is enhanced by naturally occurring surface water that persists in ponded areas within the sites during wet years.

The Willow Flycatcher habitat model developed on MCBCP from vegetation data collected in 2001 and 2002 predicted that flycatcher occupancy would be higher in areas with high total vegetation cover between 3 and 6 m and high poison hemlock and Goodding's black willow cover below 3 m (Howell and others, 2018). Stinging nettle below 3 m and Goodding's black willow above 6 m were considered noteworthy, although less straight-forward, components of the habitat models (Howell and others, 2018). Even though seep pumps were operating for at least 4 of the last 6 years at Seep sites, in 2025, we did not find a difference in total vegetation cover between Seep and Reference sites at any height category, nor was total vegetation cover associated with higher soil saturation. We also did not find that soil saturation had a positive effect on poison hemlock, Goodding's black willow, or stinging nettle, nor did the cover of any of these three species differ between Seep and Reference sites. However, average cover of each of these plant species was low (5 percent or less) at all sites at the height categories that were identified as important. Although soil saturation has been maintained at elevated levels at the Seep sites, it appears that this wetness did not translate directly to improved habitat conditions favored by flycatchers in 2025. Nevertheless, the range-wide Southwestern Willow Flycatcher habitat model (Hatten, 2016), updated in 2023 (J. Hatten, U.S. Geological Survey, unpub. data, 2023), classified the study sites as medium- to high-quality flycatcher habitat. We did not document flycatchers breeding in any of our artificial seep study sites in 2025, although transient flycatchers were detected at the Old Treatment Pond Seep site during one conspecific playback survey.

The intent of the surface water augmentation study was to determine if increased surface water improved habitat conditions for flycatchers by comparing sites with and without surface-water augmentation over time. Many confounding factors have arisen that have introduced complexity, hampering our ability to identify strong patterns associated with Seep pumps. Seep pump operation was not consistent at both sites where seep pumps were installed. Seep pumps were installed in different years (2019 versus 2021) and failed to operate in 2023 at the Pump Road North Seep site and in 2025 at the Old Treatment Ponds North Seep site. Site selection likely also confounded discrimination between sites with and without augmented surface water. Naturally-occurring surface water in areas near seep pumps likely made artificial surface water augmentation superfluous in wet years and may have obscured the effect of the seep pumps even in dry years. Fine-scale soil differences and micro-topography also may have affected soil saturation. Available soil type and topographic data were coarse and could not identify fine-scale features, such as small swales and depressions that collected organic debris or barren sandy berms sculpted by annual water flow that were observed by surveyors. Selecting permanent sampling plots starting in 2025 will be helpful in minimizing some of the confounding factors because it will allow tracking of soil saturation and vegetation changes under the same micro-geographic conditions over time. Future steps that would help reveal more nuanced relationships associated with surface-water augmentation include identification of soil types and topographic relief at a finer scale, regular maintenance of the seep pumps to ensure their consistent operation, and considering selection of a new, drier seep pump location as an alternative to the naturally wet Pump Road Seep site.

Although habitat enhancement is an important aspect in flycatcher recovery, the primary obstacle that must be overcome for the MCBCP flycatcher population to rebound is the lack of a close source population for recolonization. Because there has been no productivity from breeding flycatchers on MCBCP since 2020, no additional recruitment is expected in the coming years. For the population to recover, immigration will have to occur. In past years, our banding studies have allowed us to document both immigration into and emigration out of the MCBCP population, providing

clear evidence that MCBCP played a role in the regional metapopulation. Immigration from nearby populations on the San Luis Rey River occurred multiple times in the early years of the study (2002, 2004, 2006–08), with adult and first-year flycatchers moving onto Base. However, populations along the San Luis Rey River that once augmented the MCBCP population, including Guajome Lake, Whelan Lake, and Bonsall, were extirpated in 2006, 2008, and 2021, respectively, and there is no longer a close source of potential immigrants (Allen and Kus, 2022; Houston and others, 2024). The nearest known population of Southwestern Willow Flycatchers in San Diego County is at Lake Henshaw on the upper San Luis Rey River, approximately 60 km from MCBCP. The upper San Luis Rey River population has been monitored annually since 2015, and during that time, only one MCBCP natal has been detected (Howell and Kus, 2022; Howell and others, 2022). Although long distance dispersal can occur, most of the movements documented on MCBCP and other locations in San Diego County have been shorter dispersals (Howell and others, 2022).

The drivers of the decline of resident flycatchers on MCBCP are varied and unclear. Nonetheless, several measures have been initiated in recent years in an attempt to reverse the declines, including the use of conspecific attraction to facilitate recolonization of historically occupied breeding areas. An experimental study using conspecific playback was initiated on Base in 2018 and has continued annually through 2025 (Howell and others, 2018, 2020; Howell and Kus 2024a, b, c, 2025b, c). In 2018, when the study on Base was first initiated, a previously unknown male settled adjacent to the playback unit, allowing breeding activities to resume after no breeding flycatchers were detected on Base in 2017. This male returned for two additional breeding seasons (2019, 2020) but was not present in 2021 or 2022. In 2023, a natal female settled within 110 m of the conspecific attraction playback in the Air Station breeding area but remained unpaired. This female returned to the same area in 2024, and once again, remained unpaired. It is possible that conspecific attraction will be effective in attracting breeding flycatchers in future years. The continuation of conspecific attraction playback may play an important role in restoring the population of resident flycatchers on Base.

Conclusions

The Southwestern Willow Flycatcher population in California seems to be experiencing a statewide decline that is not isolated to Marine Corps Base Camp Pendleton (MCBCP or “Base”). Populations on the Kern River (Mary Whitfield, Southern Sierra Research Station, written commun., 2023), Bonsall on the San Luis Rey River (Allen and Kus, 2022), and the lower San Luis Rey River (Houston and others, 2024) have experienced steep declines or have been extirpated in recent years. The one exception within the San Diego region appears to be the upper San Luis Rey River population at Lake Henshaw, which was estimated to include a minimum of 47 individuals in 2024 (Howell and Kus, 2025a). After a high of 42 flycatchers in 2004, the population at MCBCP has been on a downward trajectory from 2005 to the present (2025), with temporary extirpations occurring in 2017 and 2022. Although one resident Willow Flycatcher returned to the Base in 2023, and was present again in 2024, no resident flycatchers were detected in 2025, and the resident population appears to have succumbed to extirpation again. Habitat loss from fire, potential changes in habitat composition, prolonged drought, and invasive species likely have been detrimental to the long-term persistence of this endangered species on Base. Southwestern Willow Flycatchers also may be facing pressures on their wintering grounds and migratory stopover sites, including, but not limited to, habitat degradation and conversion to agriculture (M. Whitfield, Southern Sierra Research Station, written commun., 2020).

Our long-term research supports the environmental stewardship program at MCBCP to protect endangered species and promote their recovery. Based on our observations of Southwestern Willow Flycatchers breeding under a variety of environmental conditions, the following actions have high potential for enhancing habitat suitability and availability on Base, thereby contributing to flycatcher recovery:

1. Evaluating potential changes in vegetation structure related to invasive shothole borer that may have reduced the suitability of historically occupied areas on Base and developing restoration scenarios if warranted.
2. Continuing to operate artificial seeps consistently to create desirable habitat conditions for breeding flycatchers and evaluating vegetation response to artificial seeps.
3. Continuing to operate conspecific broadcasts to facilitate recolonization of historically occupied breeding areas.

Until the Southwestern Willow Flycatcher population on Base rebounds, any projects that alter the habitat in historically occupied areas warrant careful consideration. In addition, communication between the AC/S Environmental Security and other military departments will likely become increasingly important. Our findings and experience indicate that effects to flycatcher habitat can be minimized when maintenance activities, such as clearing vegetation, are coordinated among personnel. This coordination and cooperation among various departments could help maintain a balance among the sometimes competing land uses on Base, including military activities, recreation, habitat protection, and endangered species management.

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Appendix 1. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Areas at Marine Corps Base Camp Pendleton, 2025

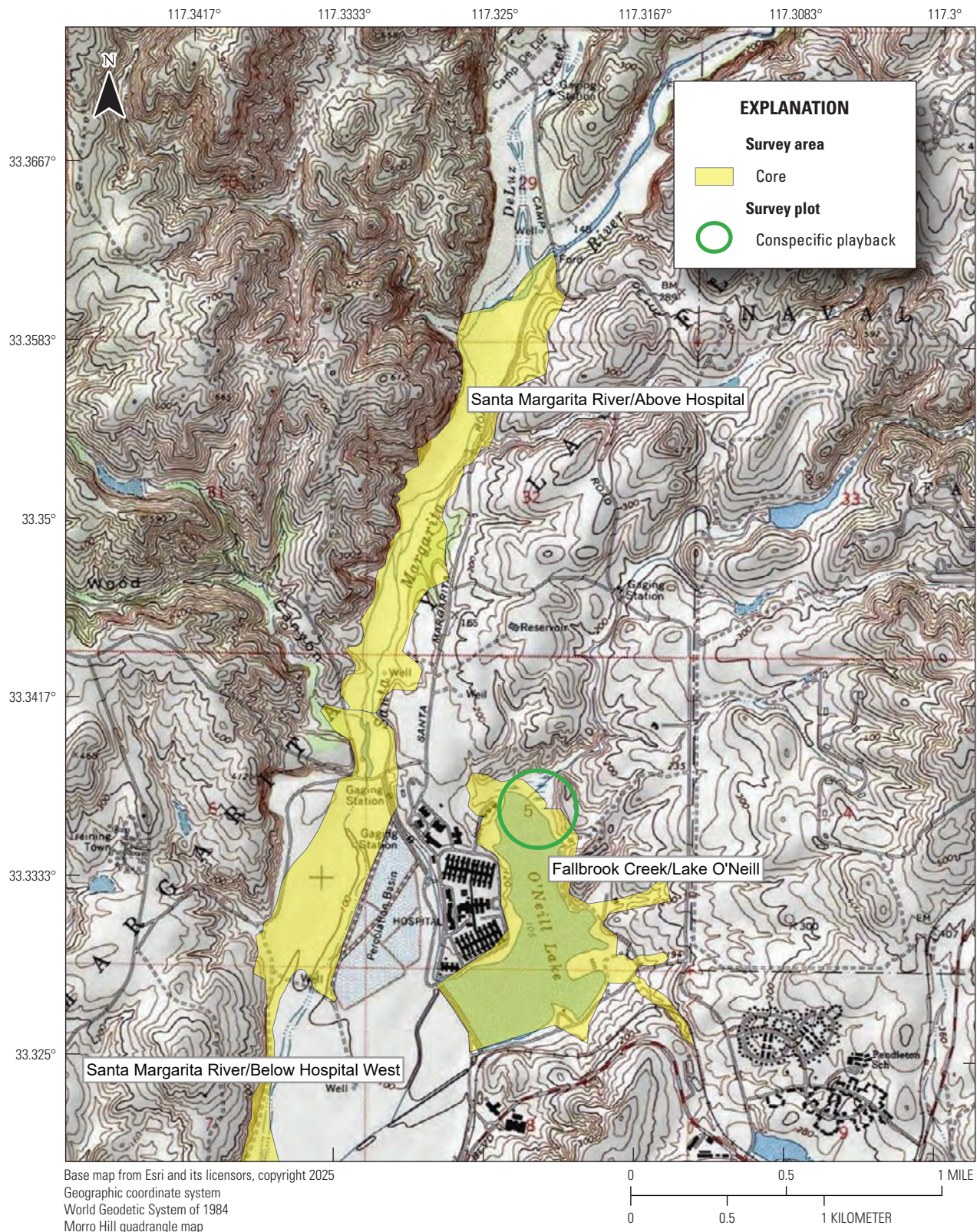


Figure 1.1. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey areas at Marine Corps Base Camp Pendleton, 2025: Santa Margarita River (upstream) and Fallbrook Creek.

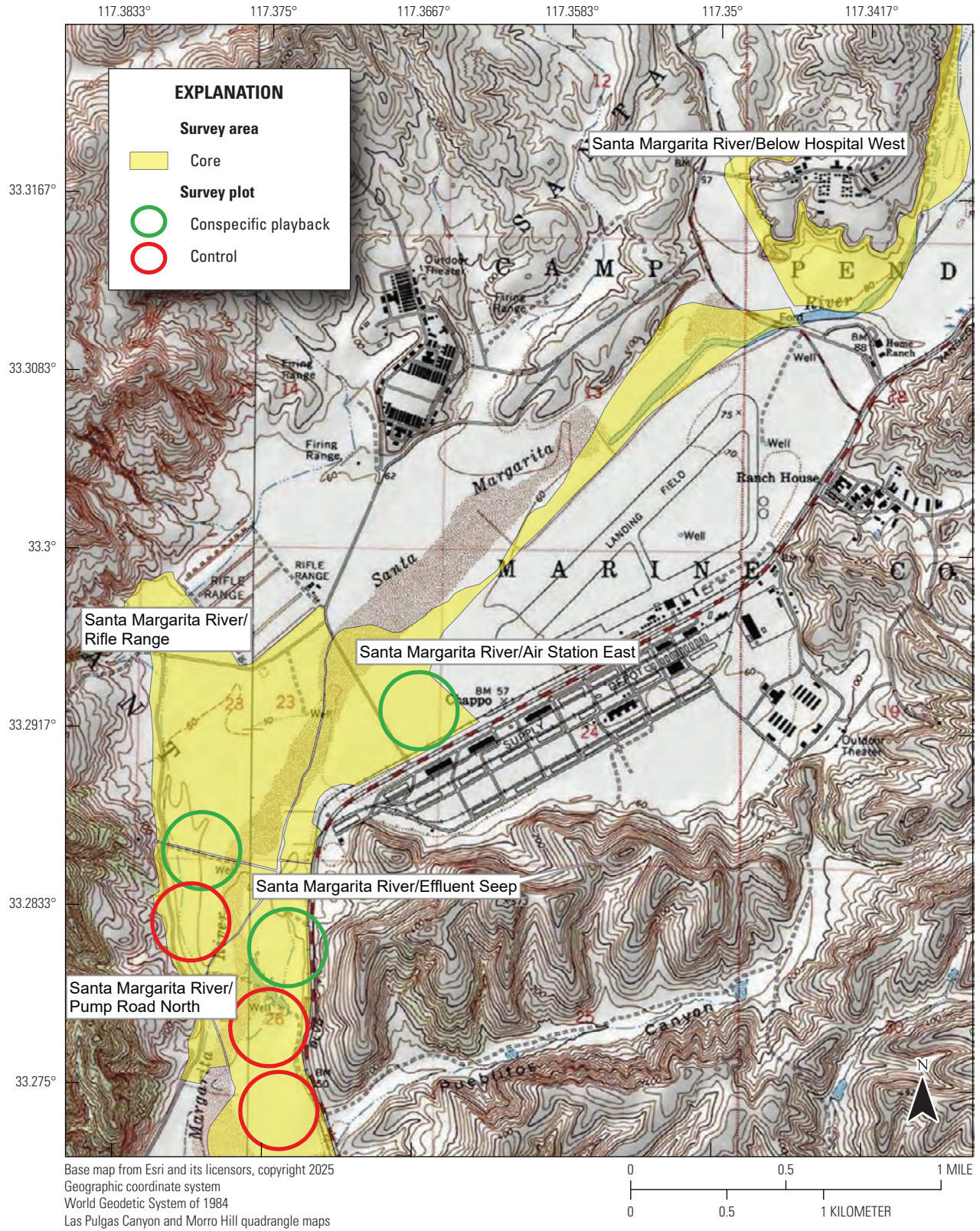


Figure 1.2. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey areas at Marine Corps Base Camp Pendleton, 2025: Santa Margarita River (midstream).

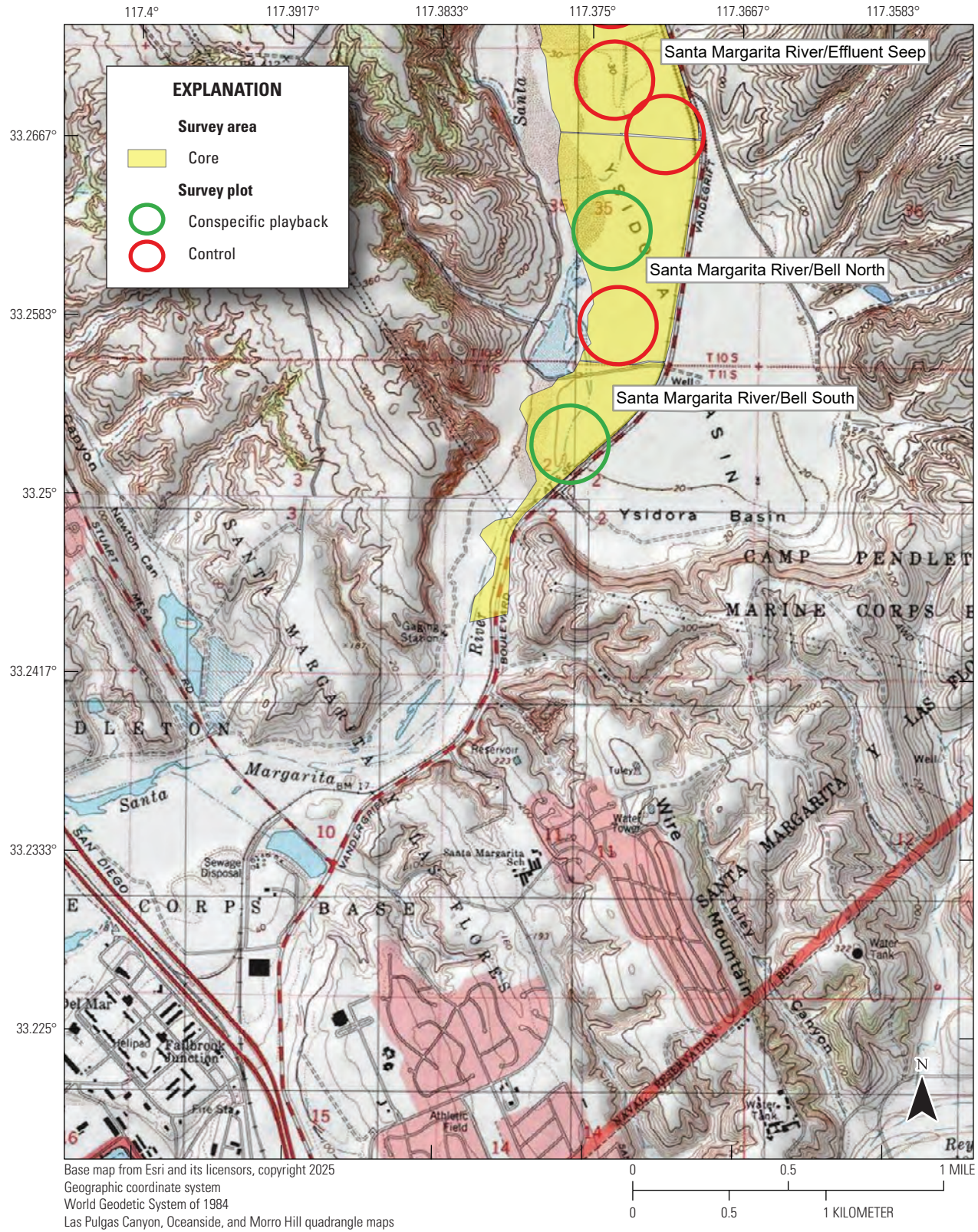


Figure 1.3. Southwestern Willow Flycatcher (*Empidonax traillii eximus*) survey areas at Marine Corps Base Camp Pendleton, 2025: Santa Margarita River (downstream).

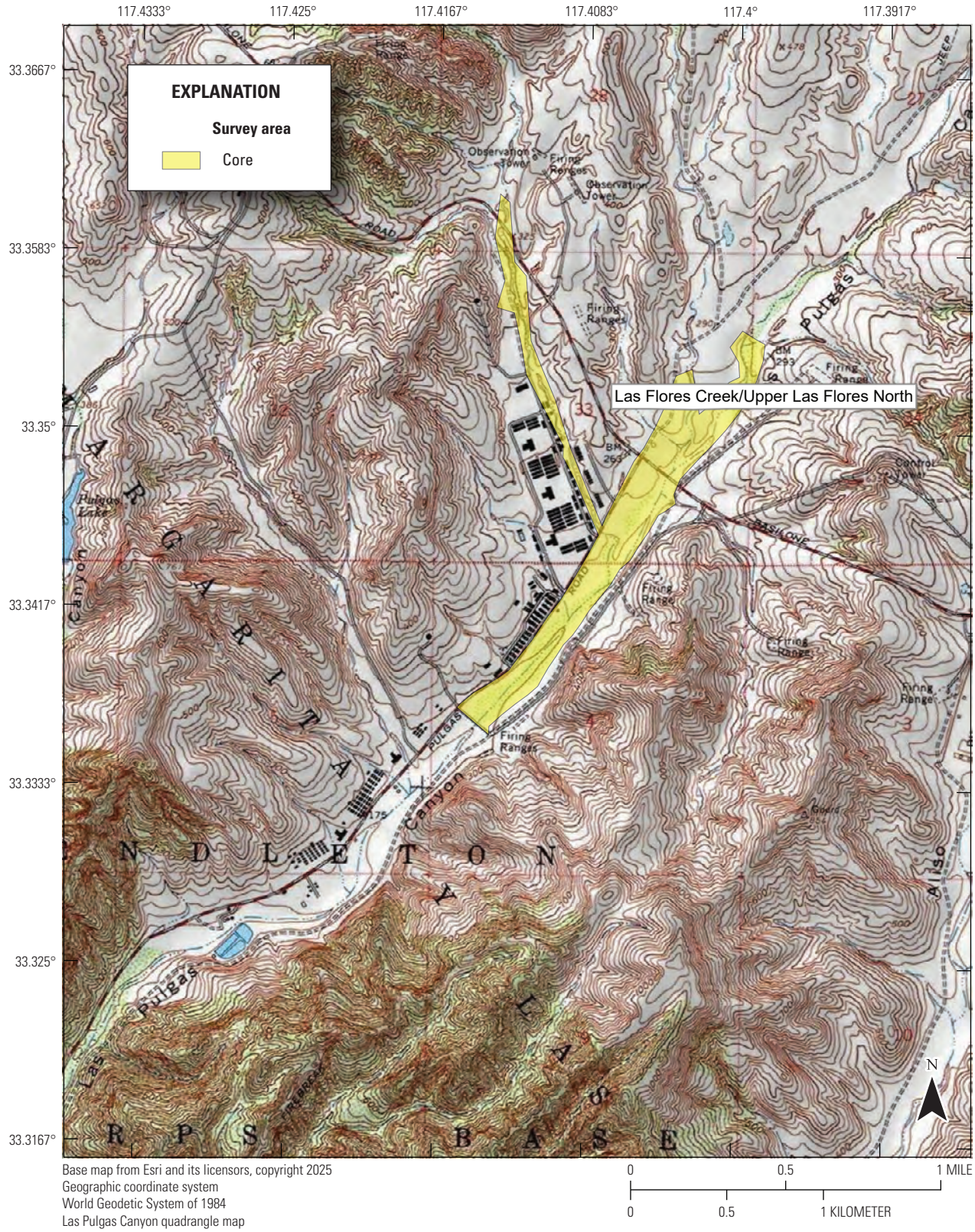


Figure 1.4. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey areas at Marine Corps Base Camp Pendleton, 2025: Las Flores Creek.

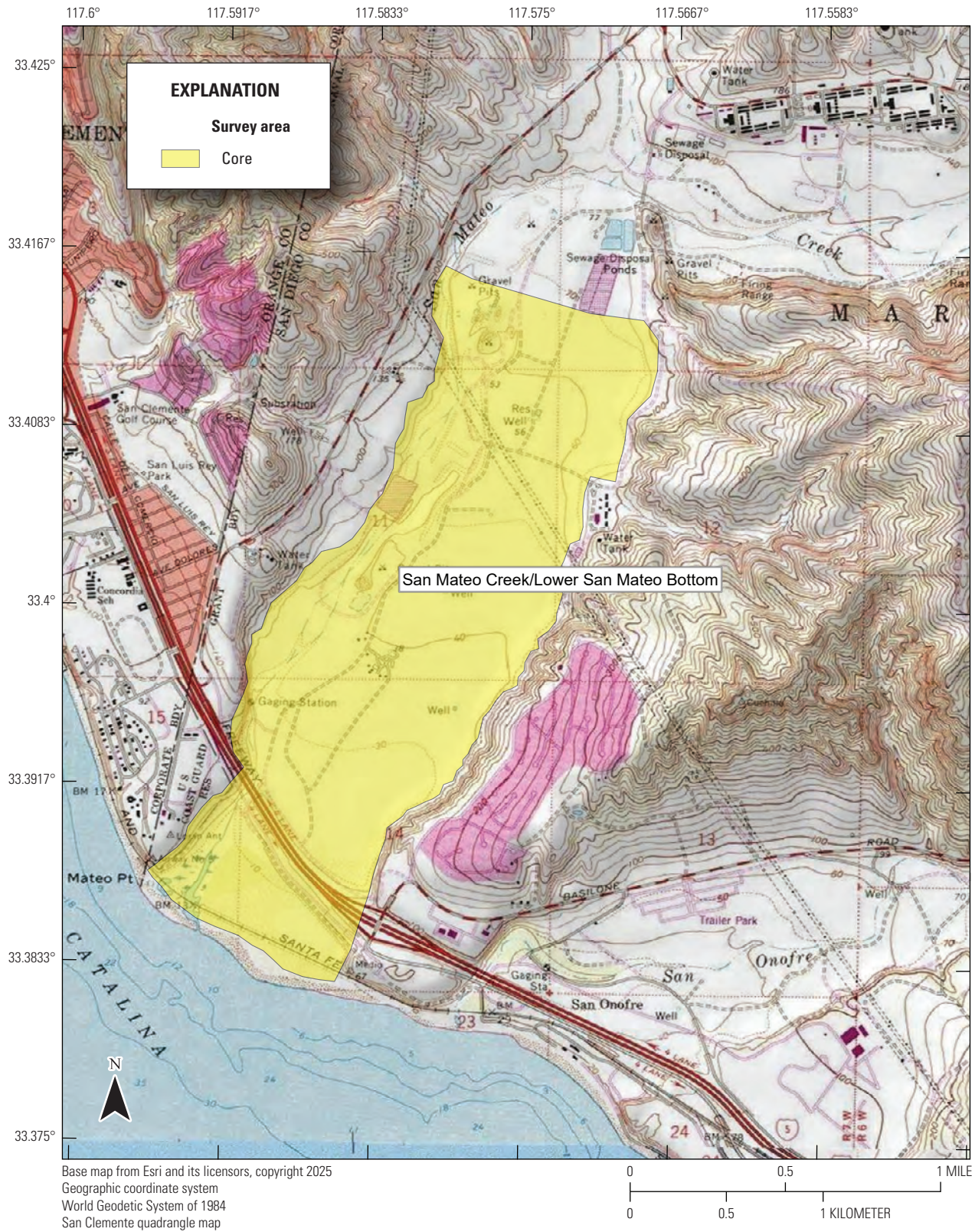


Figure 1.5. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey areas at Marine Corps Base Camp Pendleton, 2025: San Mateo Creek.

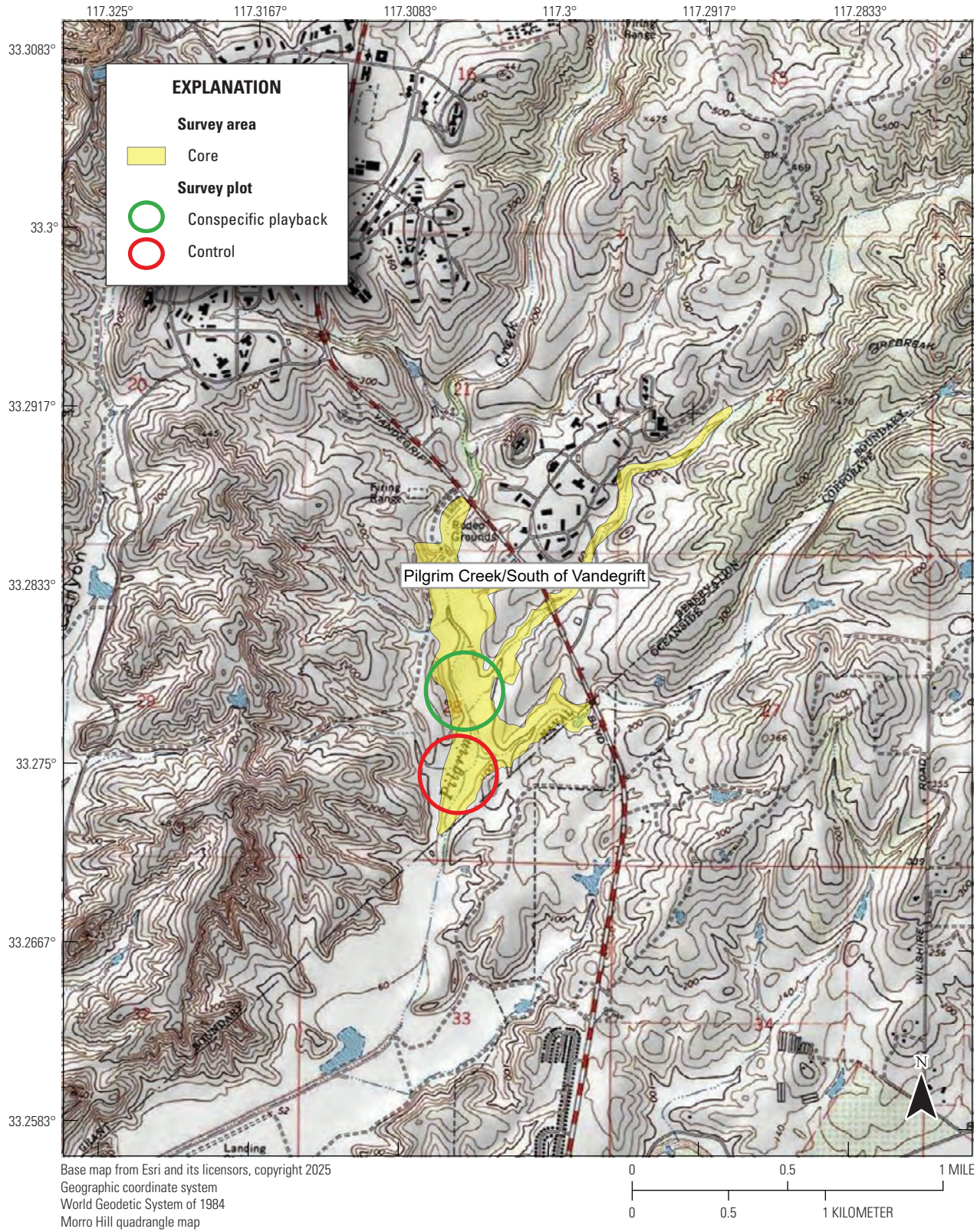


Figure 1.6. Southwestern Willow Flycatcher (*Empidonax traillii eximus*) survey areas at Marine Corps Base Camp Pendleton, 2025: Pilgrim Creek.

Appendix 2. Vegetation Sampling Locations and Vegetation Sampling Data Sheet, Marine Corps Base Camp Pendleton, 2025

Table 2.1. Vegetation sampling center plot locations, Marine Corps Base Camp Pendleton, 2025.

[ID, identification; WGS 84, World Geodetic System of 1984]

Plot ID	Longitude	Latitude	Datum
Old Treatment Ponds Seep site			
OTPN02	-117.37493	33.28297	WGS 84
OTPN03	-117.37385	33.28262	WGS 84
OTPN04	-117.37284	33.28223	WGS 84
OTPN08	-117.37475	33.28219	WGS 84
OTPN09	-117.37347	33.28177	WGS 84
OTPN10	-117.37309	33.28091	WGS 84
OTPN13	-117.37512	33.28129	WGS 84
OTPN14	-117.37423	33.28179	WGS 84
OTPN15	-117.37381	33.28091	WGS 84
OTPN17	-117.37310	33.27924	WGS 84
OTPN19	-117.37457	33.28091	WGS 84
OTPN23	-117.37492	33.28009	WGS 84
Pump Road Seep site			
PRN02	-117.37993	33.28559	WGS 84
PRN03	-117.37886	33.28543	WGS 84
PRN04	-117.37780	33.28527	WGS 84
PRN07	-117.37992	33.28387	WGS 84
PRN08	-117.37940	33.28465	WGS 84
PRN09	-117.37811	33.28480	WGS 84
PRN10	-117.37737	33.28416	WGS 84
PRN13	-117.37917	33.28374	WGS 84
PRN14	-117.37867	33.28453	WGS 84
PRN15	-117.37790	33.28389	WGS 84
PRN18	-117.37902	33.28287	WGS 84
PRN19	-117.37849	33.28365	WGS 84

Table 2.1. Vegetation sampling center plot locations, Marine Corps Base Camp Pendleton, 2025.—Continued

[ID, identification; WGS 84, World Geodetic System of 1984]

Plot ID	Longitude	Latitude	Datum
Old Treatment Ponds Reference site			
OTPS02	-117.37629	33.27088	WGS 84
OTPS03	-117.37520	33.27086	WGS 84
OTPS04	-117.37414	33.27090	WGS 84
OTPS07	-117.37351	33.27017	WGS 84
OTPS09	-117.37230	33.27016	WGS 84
OTPS11	-117.37589	33.27019	WGS 84
OTPS12	-117.37450	33.27018	WGS 84
OTPS16	-117.37589	33.26927	WGS 84
OTPS17	-117.37522	33.26998	WGS 84
OTPS18	-117.37451	33.26927	WGS 84
OTPS19	-117.37377	33.26861	WGS 84
OTPS21	-117.37521	33.26907	WGS 84
Pump Road Reference site			
PRS01	-117.37943	33.27499	WGS 84
PRS02	-117.37842	33.27464	WGS 84
PRS03	-117.37744	33.27424	WGS 84
PRS04	-117.38029	33.27371	WGS 84
PRS05	-117.37937	33.27417	WGS 84
PRS06	-117.37805	33.27378	WGS 84
PRS08	-117.37972	33.27334	WGS 84
PRS09	-117.37881	33.27378	WGS 84
PRS10	-117.37841	33.27295	WGS 84
PRS13	-117.37918	33.27299	WGS 84
PRS17	-117.38143	33.27123	WGS 84
PRS19	-117.37955	33.27209	WGS 84

Pendleton CUP Seep Vegetation Data Form – 2025

Observer(s): _____ Date: 2025 Site: PRN PRS OTPN OTPS Plot ID: _____

% Cover		1-10%	11-25%	26-50%	51-75%	76-90%	>90%
CODE		1	2	3	4	5	6

Center Plot										
Height	Overall Foliage Cover	Non-native Cover		Species 1	Sp. 1 % Cover	Species 2	Sp. 2 % Cover	Species 3	Sp. 3 % Cover	All Other
0-3 m										
3-6 m										
>6 m										
GPS Coordinates		N:			W:			Canopy Height:		
Soil Saturation:								Canopy Species:		
Comments:										

Satellite Plots (15m from Center Plot)

0 Degrees Plot										
Height	Overall Foliage Cover	Non-native Cover		Species 1	Sp. 1 % Cover	Species 2	Sp. 2 % Cover	Species 3	Sp. 3 % Cover	All Other
0-3 m										
3-6 m										
>6 m										
GPS Coordinates		N:			W:			Canopy Height:		
Soil Saturation:								Canopy Species:		
Comments:										

Figure 2.1. Marine Corps Base Camp Pendleton Seep Vegetation Data Form, 2025.

Pendleton CUP Seep Vegetation Data Form – 2025

Observer(s): _____ Date: _____ 2025 Site: PRN PRS OTPN OTPS Plot ID: _____

% Cover CODE	1-10% 1	11-25% 2	26-50% 3	51-75% 4	76-90% 5	>90% 6
------------------------	-------------------	--------------------	--------------------	--------------------	--------------------	------------------

120 Degrees Plot										
Height	Overall Foliage Cover	Non-native Cover		Species 1	Sp. 1 % Cover	Species 2	Sp. 2 % Cover	Species 3	Sp. 3 % Cover	All Other
0-3 m										
3-6 m										
>6 m										
GPS Coordinates		N:			W:			Canopy Height:		
Soil Saturation:								Canopy Species:		
Comments:										

240 Degrees Plot										
Height	Overall Foliage Cover	Non-native Cover		Species 1	Sp. 1 % Cover	Species 2	Sp. 2 % Cover	Species 3	Sp. 3 % Cover	All Other
0-3 m										
3-6 m										
>6 m										
GPS Coordinates		N:			W:			Canopy Height:		
Soil Saturation:								Canopy Species:		
Comments:										

Figure 2.1.—Continued

Appendix 3. Locations of Willow Flycatchers (*Empidonax traillii*) at Marine Corps Base Camp Pendleton, 2025

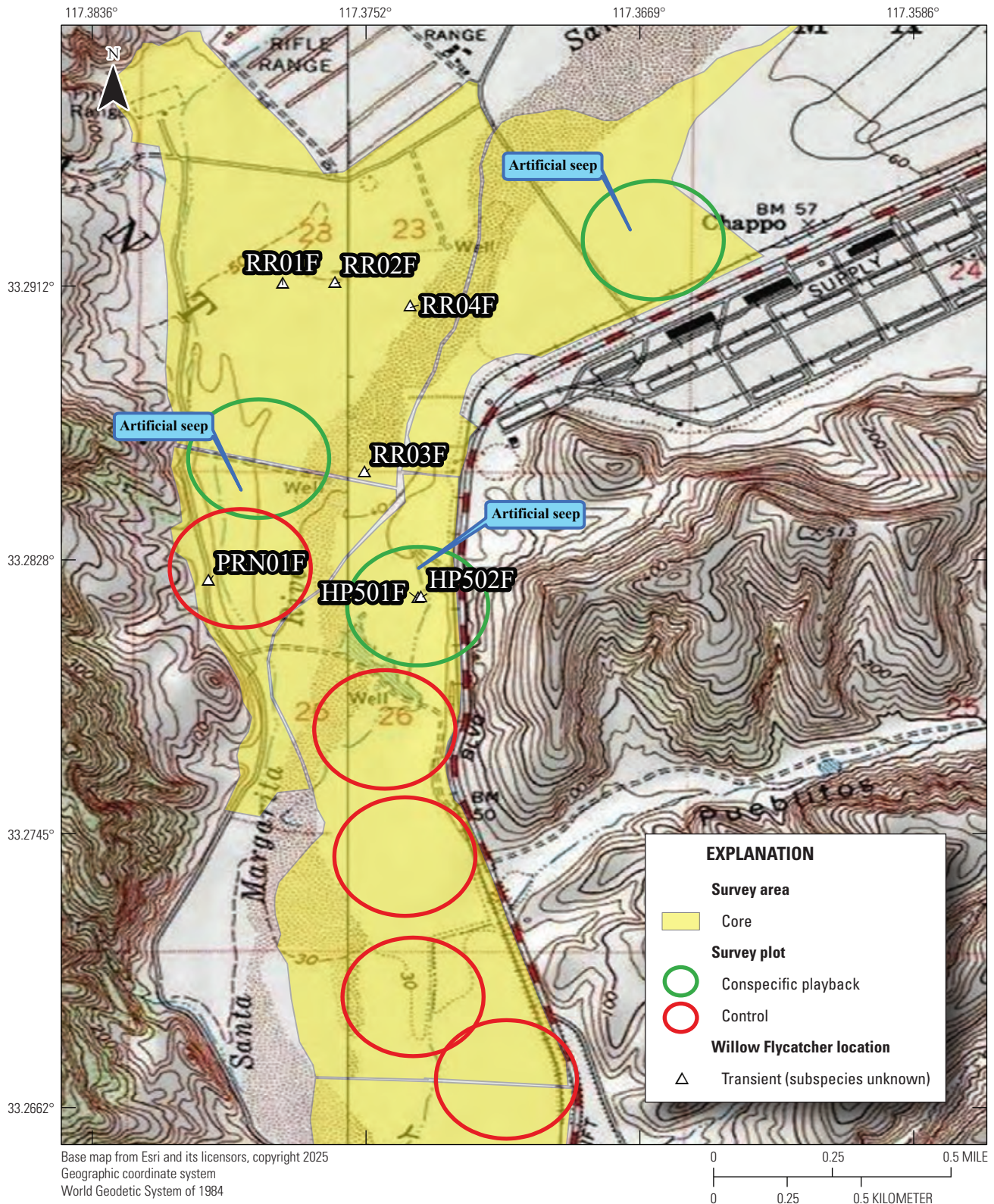


Figure 3.1. Locations of transient Willow Flycatchers (*Empidonax traillii*) at Marine Corps Base Camp Pendleton, 2025: Santa Margarita River.

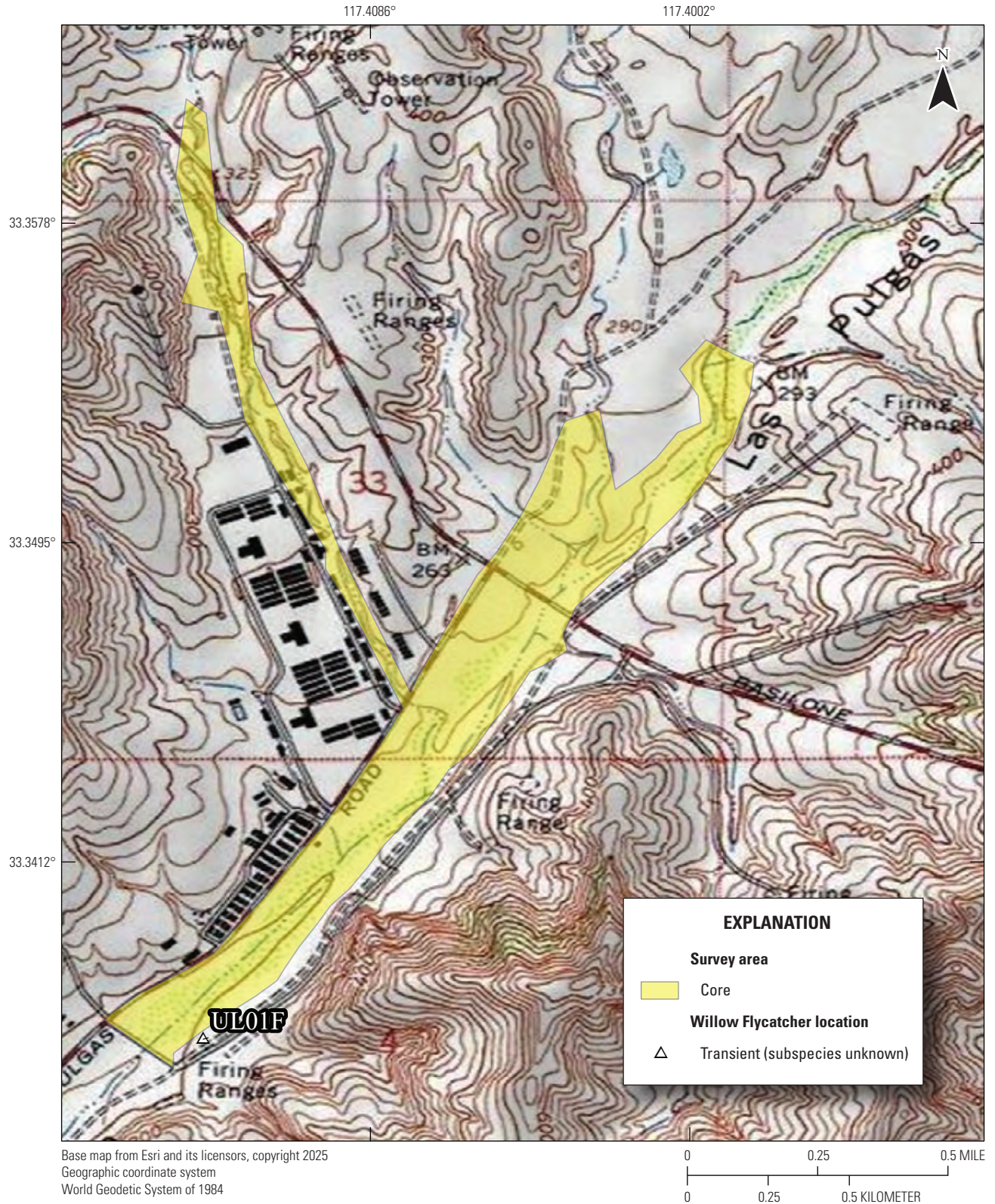


Figure 3.2. Locations of transient Willow Flycatchers (*Empidonax traillii*) at Marine Corps Base Camp Pendleton, 2025: Las Flores Creek.

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